Baffinland

AQUATIC EFFECTS MONITORING PROGRAM FRAMEWORK

February 2013

Aquatic Effects Monitoring Framework

1.0 Introduction

The Aquatic Effects Management Program (AEMP) aims to address issues identified during the environmental assessment (EIS) process that could potentially impact the aquatic receiving environments surrounding the project development. Building from earlier baseline monitoring (FEIS 2012), the AEMP described the general monitoring strategy designed to detect effects to the freshwater aquatic environment.

The AEMP is designed to take an integrated, ecosystem-based approach that links mitigation and monitoring of physical/chemical effects to key ecological receptors in the receiving environment.

The AEMP addresses key issues identified in the FEIS that have the potential to affect the Freshwater environment valued ecosystems components (VECs). The freshwater VECs are:

- Water quantity;
- Water and sediment quality, and,
- Freshwater biota and fish habitat.

Baffinland has implemented mitigation measures in the Project to minimize adverse effects. Several management and monitoring plans are intended to inform the "adaptive management" process, which relies on the early identification of potential problems and the development of additional mitigation options to address them.

The AEMP is designed to detect project-related impacts at temporal and spatial scales that are ecologically relevant (i.e., on a basin spatial scale). The program targets flows, general water and sediment quality, primary productivity (phytoplankton) and benthic community structure of the streams/lake impacted by project activities.

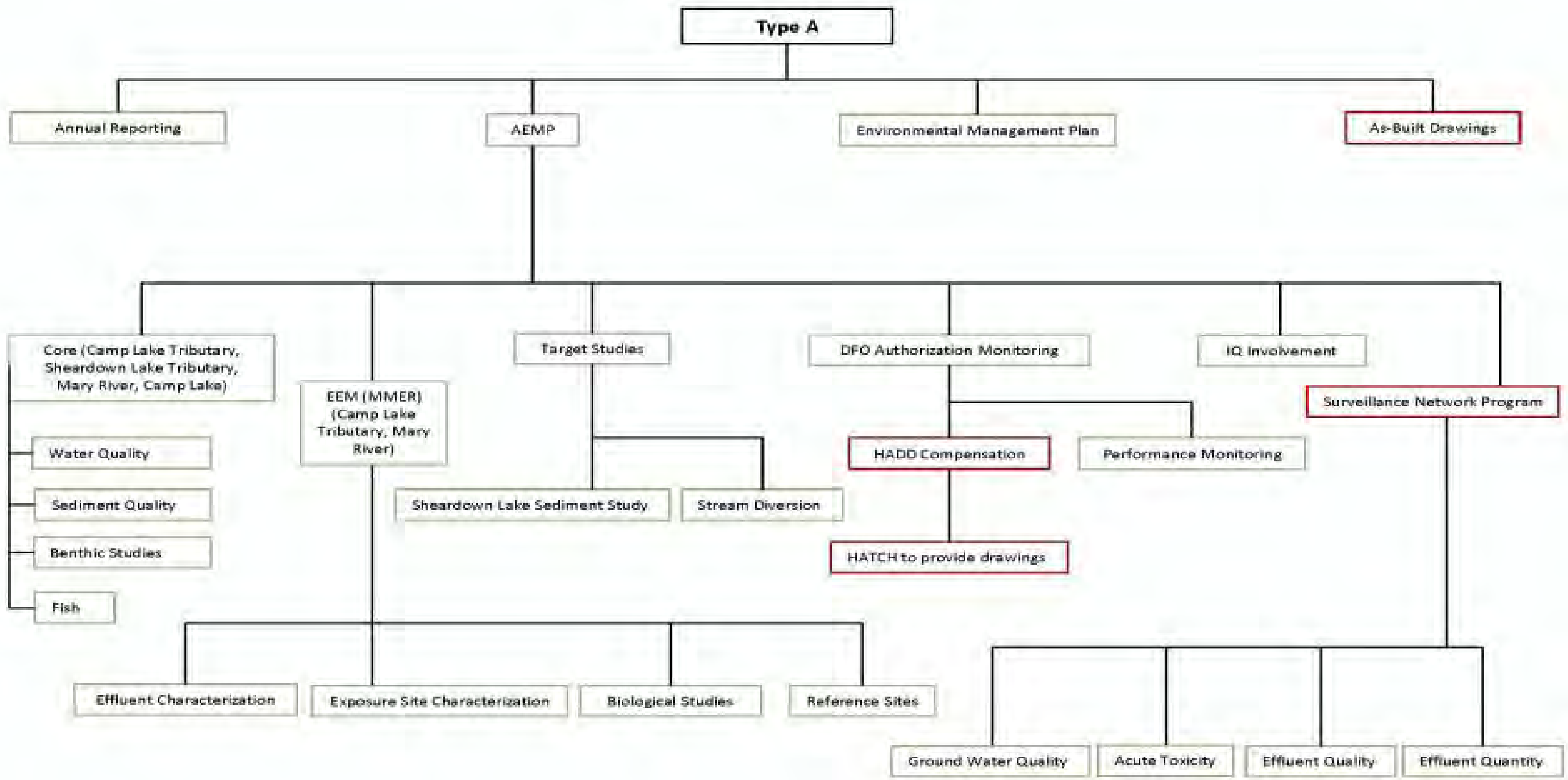
The proposed approach is to structure the Aquatic Effects Monitoring Program to serve as an overarching 'umbrella' into which the results of all related monitoring programs for the Type A Water Licence are captured.

Based on the definition of water management areas established by the Nunavut Water Regulations, the Mary River Project spans two water management areas:

- Water Management # 48 basically encompasses Baffinland's land lease on Inuit Owned Land. It encompasses all facilities at Milne Inlet, the Tote Road, the Mine Site and the northern portion of the Railway;
- Water Management Area # 21 encompasses the southern portion of the Railway and the Steensby Port facilities.

The AEMP will be implemented in two phases. Phase I will be implemented upon issuance of the Water Licence and deals with construction phase of the project and non-mining related activities. Phase II will be implemented with the start of the mining operation. This document describes the conceptual AEMP framework presented in Figure 1.

Figure 1: AEMP Framework



2.0 Identification of Issues and Concerns Associated with the Project

The concerns associated with the Project relative to potential effects on the aquatic ecosystems are presented for each of the Project's geographical areas. These concerns are listed for the construction and operation phase of the Project. Since abandonment and reclamation activities are similar in nature to the construction activities, the concerns identified for the construction period are also relevant for the closure phase. Where specific concerns arise due to the nature of the activity at a specific site, these concerns are identified under the closure/post closure discussion (i.e. Mine pit water quality).

2.1 Milne Port (Nunavut Water Management Area 48)

Milne Port will be developed at the onset of the construction period and will serve as the main staging areas for material and equipment required for the construction activities at the Mine Site and the northern section of the railway. The site will include the air strip, fuel depots, camp and waste water treatment plant, laydown areas, maintenance facilities, and, temporary waste transit areas. Three sites have been identified for the fresh water supply for this facility (refer to Schedule 2). A layout of the Milne Port site is presented in Schedule 1, drawing H337697-4610-07-042-0001. Two quarries will be developed to provide aggregate for the site development.

At Milne Port, all site drainage is channel to a central ditch that discharges into Milne Inlet. Treated sewage effluent as well as treated oily water effluent also discharge to this ditch at a distance of approximately 200 m from the Milne Inlet shore line. As a result, site drainage and effluent discharge have no effects on the freshwater receiving environment.

The concerns for potential freshwater aquatic effects during the construction, operation and closure of the Milne site are related to:

Water Quantity

- Withdrawal of water from Philips Creek and 33 km Lake;
- Construction of Water Intakes – TSS/turbidity, avoidance of spawning areas

Water and Sediment Quality

- Quarry management (runoff quality, ARD potential, residual ammonia from blasting activities), and,
- Spills caused by accidents and malfunctions.

Freshwater Biota and Fish Habitat

- No concerns as there are no project works impacting on fish habitat.

The discharge criteria for the effluent and runoff water quality are presented in Schedule 3. The precise coordinates for the location of all controlled discharges from the Milne Site are presented in Schedule 4.

2.2 Tote Road (Nunavut Water Management Area 48)

The Tote Road links Milne Port to the Mine Site. All material received at Milne will be transported by truck on this road link. Realignment and regarding of sections of this road will be required. Some water crossing may be rebuilt as part of the on-going maintenance of the road. Several borrow pits have been identified along the Tote road that will provide the necessary aggregate and material for ongoing road maintenance and road improvement.

The concerns for potential aquatic effects during construction, operation and closure of the Tote road are related to:

Water and sediment quality

- Dust fall from road traffic and related effects on water quality;
- Drainage management from borrow pits.

Freshwater Biota and Fish Habitat

- Construction and ongoing maintenance of stream crossing;
- Bank erosion, stability, blockage, integrity of the water crossings, fish passage.

2.3 Mine Site (Nunavut Water Management Area 48)

The development and exploitation of the mine is the purpose of the Project. 18 MTPA of iron ore will be mined, sized, stockpiled and loaded onto rail cars for transport to the Steensby Port. The Mine Site includes the large infrastructure required to support mining activities (camp, maintenance shops, fuel depots, laydown areas, waste handling and storage facilities, landfill site and landfarm, explosives storage, manufacture and use). A layout of the Mine Site is presented in Schedule 1, drawing H337697-4610-07-042-0002. The freshwater supply for the Mine Site will be drawn from Camp Lake (refer to Schedule 2). Two quarries will be developed to provide aggregate material for the site development.

There are concerns for potential aquatic effects from the onset of construction to post closure of the mine site. These concerns are as follows:

Table 2.1: Potential Aquatic Effects at the Mine Site

VEC	Concern	Pathway	Indicator
Water Quantity	Withdrawal of water from Camp Lake		volume withdrawn
	Flow diversion from Sheardown Lake		visual – water level
Water and Sediment Quality	Earthworks	Surface runoff discharging to Camp Lake, Sheardown Lake, lake tributaries and Mary River	TSS, dust, spills
	Construction activities		TSS, dust, spills
	Site drainage		TSS, dust, spills
	Quarry site drainage		TSS, dust, spills, residual ammonia
	Fuel tank farms	Discharges from secondary containment areas to receiving environment – surface drainage	hydrocarbons
	Waste storage area		metals
	Bermed storage area		metals, hydrocarbon
	Landfarm		metals, hydrocabon
	Landfill		metals, hydrocabon
	Treated Sewage Effluent (exploration camp)	Outfall to Sheardown Lake	BOD, TSS, nutrient
	Treated Sewage Effluent (main camp)	Outfall to Mary River	BOD, TSS, nutrient

	Treated Effluent from Oily Water Treatment Plant	Outfall to Mary River	TSS, hydrocarbon
	Waste rock stockpile drainage	discharge to Camp Lake tributary	TSS, metals, nutrients
	Waste rock stockpile drainage	discharge to Mary River	TSS, metals, nutrients
	ROM stockpile drainage	discharge to Mary River	TSS, metals, nutrients
	Ore stockpile drainage	discharge to Mary River	TSS, metals, nutrients
	Mine pit dewatering	discharge to Camp Lake tributary	TSS, metals, nutrients/blasting residues
	Mine pit water post closure	end of life mine life pit water quality	metals
	Dust	TSS in runoff	increase TSS
Freshwater Biota and Fish Habitat	footprint of facilities in water bodies – water crossings	loss of habitat – crossing of Mary River , Camp Lake tributaries	habitat compensation
	Integrity of water crossing	alteration of habitat	erosion, blockage
	Fish passage	alteration of habitat	blockage, barrier
	Diversion of water from Sheardown Lake	alteration or loss of habitat	low flow and barrier to fish passage
	Dust	alteration of habitat	increase in sediment layer in stream bottoms and lakes
Groundwater quality	Landfill	seepage in groundwater	metals

The discharge criteria for the effluent and runoff water quality are presented in Schedule 3. The precise coordinates for the location of all controlled discharges from the Mine Site are presented in Schedule 4.

2.4 Railway (Nunavut Water Management Area 48 and 21)

The iron ore will be transported from the mine site to the Steensby Port by railway. The concerns for potential aquatic effects occur mainly during the construction period of the railway embankment. Four construction camps (with sewage treatment plant and waste incinerators) will be established at the onset of the construction period. Sewage effluent from these camps will be transported by truck to either the Mine Site or the Steensby Port sewage treatment facilities for treatment. There will be no local discharges of treated effluent (trucked to Steensby or Mine site sewage treatment plant). Domestic water supply and water required for construction activities will be drawn from a number of local lakes (refer to Schedule 2). Several quarries will be developed along the railway alignment in order to provide the necessary rock and aggregate required for the rail embankment, stream crossing and bridge construction.

The concerns for potential aquatic effects during construction, operation and closure of the railway are related to the loss or alteration of fish habitat:

Water quantity (potable water and construction activities)

- Construction of Water Intakes – TSS/turbidity, avoidance of spawning areas

Water and sediment quality

- Surface runoff water quality (TSS, spills, dust from traffic);
- Quarry management (runoff water quality, TSS, ARD, blasting & ammonia);

- Freshwater Biota and Fish Habitat;
- Stream/river crossings ;
- Flow velocity, TSS, erosion, fish stranding, fish passage and integrity of the water crossing;
- Lake and river encroachment – loss of habitat;
- Blasting near water (blasting overpressure) along Cockburn Lake.

2.5 Steensby Port (Nunavut Water Management Area 21)

The iron ore will be sized and stockpiled at Steensby Port prior to being loaded into the ore carriers for shipment. Steensby Port will contain large infrastructure required for on-going support of the Port, the railway operation as well as the mine. The infrastructure at Steensby will include an airstrip, maintenance facilities (vehicles and railway), fuel depots, camps, warehouses, laydown areas, waste handling and storage facilities, landfill site, landfarm, explosives storage facilities, a freight dock, an ore stockpile and the ore loading dock. A layout of the Mine Site is presented in Schedule 1, drawing H337697-4610-07-042-0003. The freshwater supply for the Steensby Port will be drawn from a local lake (refer to Schedule 2). Two quarries will be developed to provide aggregate for the development of the site.

At the Steensby site, surface drainage will be directed toward Steensby Inlet. Treated sewage effluent and oily water treatment effluent will discharge to Steensby Inlet via an outfall at a 35 m depth. As a result, site drainage and effluent discharge have no effects on the freshwater receiving environment.

The concerns for potential freshwater aquatic effects during the construction, operation and closure of the Steensby port are related to:

Water Quantity

- Withdrawal of water from 3 km Lake and ST 347 Lake;
- Construction of Water Intakes – TSS/turbidity, avoidance of spawning areas

Water and Sediment Quality

- Quarry management (runoff quality, ARD potential, residual ammonia from blasting activities), and,
- Spills caused by accidents and malfunctions.

Freshwater Biota and Fish Habitat

- No concerns as there are no project works impacting on fish habitat.

The discharge criteria for the effluent and runoff water quality are presented in Schedule 3. The precise coordinates for the location of all controlled discharges from the Steensby Site are presented in Schedule 4.

3.0 Problem Formulation for Aquatic Effects Monitoring

In order to identify potential effects, linkage between key issues and pathways must be understood. Key indicators and thresholds enable early detection of potential effects.

3.1 Water Quantity

Article 20 Inuit Water Rights of the Nunavut Land Claims Agreement (NLCA) formally recognizes the importance of water quantity and flow to the Inuit. Under the NLCA, Inuit require compensation if a project or activity will substantially affect the quantity of water flowing through Inuit-Owned Lands. Therefore, water quantity has been identified as a VEC with respect to hydrology. The water quantity VEC can be defined as the spatial and temporal variability of the volume of water within the RSA that may be subject to alteration by Project activities.

Key Issues and Pathways for Water Quantities

Key issues identified for freshwater quantity are:

- Water Withdrawal;
- Water Diversion (stream diversion or changes to flow patterns in a specific watershed);
- Drainage flows (runoff) or Effluent Discharge.

Key Indicators and Benchmarks

The key indicators for water quantity are:

- Water withdrawn for consumption – quantities as per Schedule 2

The benchmarks are the water quantities authorized under the Type A Water Licence. These benchmarks are presented in Schedule 2.

Diversions, Drainage Flows (Runoff) and Effluent Discharges

Diversions, drainage flows and effluent discharges are mainly impacted at the Mine Site and have potential effects on fish habitat due to reduction or increase in flows that result from the site development. This will be discussed under paragraph 3.3.1.

3.2 Water and Sediment Quality VEC

Key Issues and Pathways

Key issues considered for the surface water and sediment quality VEC are summarized in the table below:

Table 3.1 : Key Issues for Water and Sediment Quality at the Mine Site			
Pathway	Key issues	Location	Project Phases
Surface runoff	Uncontrolled runoff at construction site Erosion and sediment entrainment Site drainage control Spills and contamination Drainage from quarry sites	All	Construction Operation Closure
Discharges from secondary containment	Fuel depots/storage – contact water may be contaminated with hydrocarbon/petroleum products	Milne Port Mine Site Railway construction Steensby Port Quarry sites	Construction Operation Closure
Discharge of brine used for drilling in permafrost	salinity of the discharge	Railway tunnels	Construction
Pooling water in landfarm	Pooling water maybe contaminated with hydrocarbon/petroleum product and may required treatment prior to discharge	Milne Port Mine Site Steensby Port	Construction Operation Closure
Pooling water in landfill	Pooling water maybe contaminated with metals, hydrocarbon/petroleum product and may required treatment prior to discharge	Mine Site Steensby Port	Construction Operation Closure
Treated sewage effluent discharges	effectiveness of treatment – pH, flows, Biological oxygen demand (BOD), Faecal Coliform (FC), TSS, nutrient, metals, oil and grease	Sheardown Lake Mary River outfall	Construction Operation Closure
Treated oily water treatment plant discharge	effectiveness of treatment – pH, flows, TSS, metals, oil and grease	Mary River outfall	Construction Operation Closure
Dust fall	TSS in runoff, sediment deposition on stream and lake bottoms	Mine Site	Construction Operation Closure
Run of Mine Ore stockpile contact water	metals, TSS	Mary River	Operation
Ore stockpile contact water	metals, TSS	Mary River	Operation
Mine pit dewatering	metals, TSS, blasting residue (ammonia)	Camp Lake Tributary	Operation
Waste rock stockpile drainage – west side	ARD, metals, TSS, blasting residue (ammonia)	Camp Lake Tributary	Operation Closure Post closure
Waste rock stockpile drainage – east side	ARD, metals, TSS, blasting residue (ammonia)	Mary River	Operation Closure Post closure
Mine pit water	ARD, metals	Mine pit	Post closure

Key Indicators and Benchmarks

For the detection of potential effect on water and sediment quality VEC the list of key indicators that are considered to be the most relevant and important elements of the VEC fall into four categories:

- General Parameters;
- Metals;
- Nutrients; and,
- Petroleum Hydrocarbons.

The benchmarks identified represent a level of change where adverse effects may be expected to occur. In the case of water and sediment quality, it is important to note that the benchmarks do not relate to water or sediment quality in itself, but rather to known effects on aquatic receptors that rely on water and sediment to exist.

The benchmarks used for the identification of potential aquatic effects on the water and sediment quality VECs are presented in Schedule 5 – Key Indicators and Benchmarkss for Receiving Water and Sediment Quality VECs.

3.3 Freshwater Aquatic Biota and Habitat

Key Issues and Pathways

The primary question concerning potential effect of the Project is: “What effect would the Project have on Arctic Char populations, movements, and health/condition?” Potential linkages between the Project components/activities and Arctic Char are presented graphically in Figure 7-4.9 (extracted from FEIS, Volume 7, page 202). These linkage pathways fall into three key issues:

- Key Issue #1: Potential effects on the health and condition of Arctic Char;
- Key Issue #2: Potential effects on their habitat; and,
- Key Issue #3: Potential effects on their direct mortality.

Key Indicators and Benchmarks

3.3.1 Potential effects on the health and condition of Arctic Char

Project-related changes in water and/or sediment quality have the potential to affect the health and condition of Arctic Char. The major pathways of effects are based on the residual effects identified in the water and sediment quality assessment. Linkages considered for potential effects include three general categories:

- Point source discharges (treated sewage effluent, Waste Rock Stockpile runoff, ore stockpile runoff, mine pit water and Run of Mine stockpile runoff, and exploration drilling runoff);
- Aqueous non-point sources (NPS; including effects related to sediment and erosion, release of blasting residues, general site runoff, development of quarries and borrow pits); and
- Dust emissions and introduction to surface waters.

Effects considered under this Key Issue relate to sub-lethal effects of Project-related changes in water and/or sediment quality on fish health and condition.

The key indicator is thus chronic toxicity. The benchmark for this indicator is presented in Schedule 5.

3.3.2 Potential effects on fish habitat

Project activities with the potential to affect Arctic Char habitat were considered, including:

- Placement of Project infrastructure in water bodies (e.g., water intakes, sewage outfalls, stream crossings, lake encroachments, laydown areas);
- Various Project-related effects pathways that may alter other aquatic biota that are food sources for char or form a component of the food web and thus may affect the productive capacity of their habitat (i.e., lower trophic level biota);
- Project-related effects on sedimentation rates that may result in alteration of habitat quality (e.g., due to dust deposition);
- Project-related changes to hydrology and subsequent effects on aquatic habitat (e.g., water withdrawal, stream diversion); and
- Project-related effects on fish passage, with subsequent effects on the availability of habitat, including:
    - Stream crossing construction and operation; and,
    - Changes in hydrology that may alter hydraulic conditions necessary for fish passage (e.g., stream velocities, water depth).

Most of these key issues relate to construction activities in or near water bodies.

With the development of the Mine site, the following changes will occur:

- Water withdrawn from Camp Lake for domestic and industrial consumption will discharged (after treatment) to the Mary River.
- Drainage patterns where the Mine site infrastructures/facilities are located will be altered. Most site runoff will be redirected to Mary River. As a result, less runoff will discharge to Sheardown Lake and Camp Lake. Tributaries of Sheardown Lake will be impacted. Lower flows may create barriers to fish passage.
- Mine pit dewatering will be directed to the waste rock sedimentation pond which discharges into a Camp Lake tributary, thus diverting flows from the Mary River.

The Key Indicators for potential effects on fish habitat are:

- Benthos – biodiversity indices;
- Chlorophyll a – productivity;
- Fish – length/weight, age, CPUE.

The benchmarks for these indicators are presented in Schedule 5.

3.3.3 Potential effects on direct fish mortality

Project-related activities with the potential to cause direct mortality of Arctic Char considered include:

- Effects of sedimentation on mortality of eggs;
- Potential egg stranding related to winter drawdown at water source lakes; and
- Potential fish stranding related to water diversions and/or alterations in discharge or water levels.

The Key Indicator for potential effects on direct fish mortality is a fish kill event.

The benchmark is presented in Schedule 5.

3.3.4 Potential Effects of Blasting on Fish

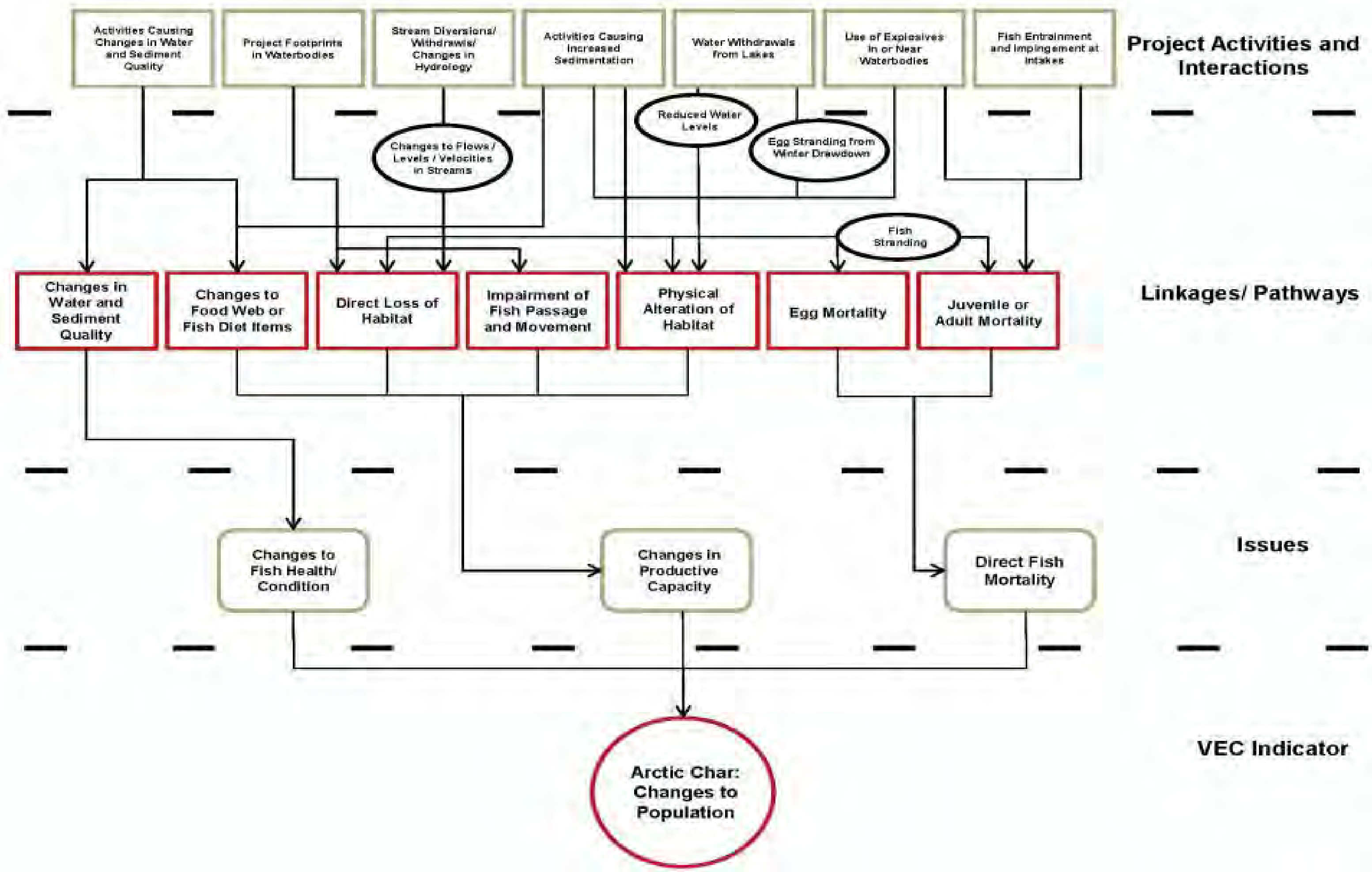
Blasting will be conducted to support Construction and Operation phases of the Project. DFO "Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters" (Wright and Hopky 1998) are intended "to provide information to proponents on the conservation and protection of fish, marine mammals, and their habitat from impacts arising from the use of confined or unconfined explosives in or near Canadian fisheries waters." As indicated by Wright and Hopky (1998), "the detonation of explosives in or adjacent to fish habitat has been demonstrated to cause disturbance, injury and/or death to fish and marine mammals, and/or the harmful alteration, disruption or destruction of their habitats, sometimes at a considerable distance from the point of detonation."

The concern for potential effect due to blasting overpressure mainly arises for the railway construction along Cockburn Lake where significant blasting is required for:

- The railway embankment on the east flank of Cockburn Lake, and,
- The tunnel construction.

The Key Indicators for potential effects on direct fish mortality due to blasting overpressure are fish kill events. The benchmarks are presented in Schedule 5.

Figure 7-4.9: Linkage between Project Effects and Arctic Char (FEIS Volume 7)



3.3.5 Stream and River Crossing Construction

Construction of stream crossings and river crossings for the Railway and railway access road and the Tote Road has the potential to cause:

- Stranding of Arctic Char due to the need for isolation of the watercourses. These effects will be mitigated through the use of appropriate timing windows for construction when possible and through fish salvage operations when required.
- Potential for direct mortality of Arctic Char eggs due to placement of Project water crossing in stream/river beds. This encroachments in streams/rivers is mitigated through avoidance (where possible) of infrastructure placement on spawning habitat and adherence to appropriate timing windows. Mitigation measures for all construction activities in fish-bearing waters are described in Section 4 of this report.

The Key Indicators for potential effects on direct fish mortality or fish passage are:

- Visual barriers to fish movement in stream bed

4.0 AEMP Related Management Plans and Monitoring Programs

This section presents an overview of the Management Plans and associated Monitoring Programs that are related to the AEMP.

4.1 Meteorological Stations

Three meteorological stations have been established, at the mine site, Steensby Port, and Milne Prot locations. The stations record air temperature, relative humidity, precipitation, wind direction, and wind speed. Data collected from the meteorological stations are establishing a climatic record in key project areas. Details of the auto-stations are presented in Annex 1 of this Management Plan.

During 2009, each station was retrofitted with new research technology being tested to determine its ability to transfer data remotely in real time. Tide gauges will also be installed after project approval at Steensby Port Site to monitor relative sea level and storm.

4.2 Site Hydrology

Stream flow has been monitored at the Mary River Project since 2006, with up to 16 seasonal stream gauges operated at various times on smaller river/creek systems, and 4 year-round hydrometric stations operated by the Water Survey of Canada since that time. Table 4.1 summarizes the stream flow record.

A long-term hydrological record does not exist for the North Baffin Region. A total of 6 years of stream flow data has been collected at the Project site, including the specific receiving waters of mine effluent (H05 – Camp Lake Tributary L1, and H06 – Mary River). The location of the H1 to H10 stream gauges in the vicinity of the Mine Site are shown on Figure 7-1.3.

The data quality to date has been good though the record is relatively short. Baffinland has committed to maintaining a hydrometric network as the project moves forward. Fortunately, the watercourses that will receive mine effluents and that will be affected by diversions and other effects are among those that are gauged.

Table 4.1: Project Stream Gauging Record

Stations	Station Type	Period of Record	Drainage Area (km^2)	Coordinates (UTM)		
				Zone	Easting	Northing
H01	Stream flow	2006-2008, 2011, 2012	250	17W	532831	7946247
H02	Stream flow	2006-2008, 2010, 2012	210	17W	555712	7915514
H03	Stream flow	2006-2008, 2010	30.5	17W	557485	7919401
H04	Stream flow	2006-2008, 2010, 2012	8.3	17W	557639	7915579
H05 (Camp Lake Tributary L1)	Stream flow	2006-2008, 2010-2012	5.3	17W	558906	7915079
H06 (Mary River)	Stream flow	2006-2008, 2010-2012	240	17W	563922	7912984
H07	Stream flow	2006-2008, 2011	14.7	17W	564451	7913194
H08	Stream flow	2006-2008	208	17W	568732	7912881
H09	Stream flow	2006-2008	158	17W	576011	7847687
H10	Water Level	2008	8.2	17W	560905	7911838
H11 (Sheardown Lake Tributary)	Stream flow	2011, 2012	3.6	17W	560503	7913545

H12	Water Level	2011, 2012	-	17W	597867	7800065
BR11	Stream flow	2008, 2012	53	17W	573122	7904914
BR25	Stream flow	2008, 2012	113	17W	585420	7900082
BR96-2	Stream flow	2008, 2012	31	17W	609300	7839474
BR137	Stream flow	2008,2010-2012	314	17W	598663	7807981
Isortoq River	Stream flow	2006-2012	7170	18W	432810	7780920
Mary River	Stream flow	2006-2012	690	17W	556360	7903750
Ravn River	Stream flow	2006-2012	8220	17W	558020	7894160
Rowley River	Stream flow	2006-2012	3500	18W	411230	7818830

4.3 Environmental Monitoring Plan

The Environmental Protection Plan (EPP) regroups detailed operation procedures for routine Project operations that ensure protection of the receiving environment. The EPP is updated as required throughout the life of the Project. Some procedures include monitoring and reporting requirements.

4.4 Surface Runoff – Surface Water and Aquatic Ecosystems Management Plan

Suspended sediment or contaminated runoff is a major pathway for potential effects on the water and sediment quality VEC. Elevated suspended solids (TSS) in runoff or contamination of runoff can occur due to:

- Earthworks and construction activities at the Mine Site, Milne Inlet Tote Road, the railway, Steensby Port;
- Uncontrolled runoff discharging to the freshwater environment (from Tote road, Mine site, quarry sites, railway construction sites). Note that the surface runoff from the Milne Port site and the Steensby Port site is directed to the marine waters;
- Surface runoff contaminated by hydrocarbon spills as a result of accidents and malfunctions.

Recognizing the potential for aquatic effect, Baffinland has implemented its Surface Water and Aquatic Ecosystem Management Plan. The "Surface Water and Aquatic Ecosystem Management Plan" (SWAEMP) outlines the processes and procedures to document the quality and quantity of water that will interact with Project components over the life of the Project. It includes management practices to limit the potential for adverse impacts to receiving waters, aquatic ecosystems, fish and fish habitat. The SWAEMP outlines the use of "best management practices" for the management of runoff collection systems at Project facilities and addresses point and non-point discharges to surface waters from Project components and discharge quality and quantity relative to the receiving water system.

Monitoring Requirements

The SWAEMP also outlines specific routine inspection requirements for sedimentation ponds as well as various works throughout the Project site. The plan also outlines mitigation measures required for stream/river crossings works as well as for general operation and construction activities in proximity of water courses. The SWAEMP identifies the roles and responsibilities, specific requirements, and mitigation and management actions for erosion and sedimentation controls for the Project. The SWAEMP includes methods for controlling erosion for both temporary and long-term stabilization efforts. Table 10.1 of the SWAEMP (reproduced below) outlines the routine inspection and monitoring requirements.

Table 4.2: Routine Inspection and Monitoring for SWAEMP

Site	Routine Inspection		
Milne Port Mine Site Steensby Port facilities Rail camp locations Milne Inlet Tote Road and Refuge stations	- Water management systems - Sediment and erosion control structures - Evidence of hydrocarbon staining or leaks from containment devices - Full-time supervision of fuel transfer operations - Water intakes - Flow meter readings - Rutting by vehicles		
Milne Inlet Tote Road Railway Construction Road Railway	- Sediment and erosion control structures - Fuel leaks - Drip Pans and Equipment condition - Any rutting by vehicles		
Spoil Deposit locations Tunnelling locations	- Sediment and erosion control structures - Evidence of hydrocarbon staining or leaks from containment devices - Fuel leaks - Drip Pans and Equipment condition - Rutting by vehicles		
Borrow sites and rock quarries	- Evidence of hydrocarbon staining or leaks from containment devices - Full-time supervision of fuel transfer operations - Sediment and erosion control structures - Drip Pans and Equipment condition		
Drill sites	Pre-drilling	Drilling period	Post drilling
	- Drillhole coordinates - Water source coordinates - Site photo - Water source photo - Distance to nearest water source - Archaeological approval - Completed wildlife survey	- Fuel leaks - Sediment and erosion control structures - Drip Pans - Equipment condition - Any rutting by vehicles - Water intake - Water management - Flow meter reading	- All materials and debris removed from site - Quantity of equipment, rods or casing left in the hole - Site photo - Water source photo - Water use assessment - Environmental concerns - Wildlife concerns
Waste Rock Stockpile	- Sediment and erosion control structures - Evidence of hydrocarbon staining or leaks from containment devices - Evidence of ARD and ML - Drip Pans - Equipment condition		
Bulk Fuel Storage Facilities Milne Port Mary River Steensby Port	- Primary containment structure - Evidence of hydrocarbon staining or leaks from containment devices - Equipment condition - Spill kit		
Explosives Storage Mary River	- Primary containment structure - Access and security		

Steensby Port	- Equipment condition - Rutting by vehicles
Laydown and storage areas	- Sediment and erosion control structures - Evidence of hydrocarbon staining or leaks from containment devices - Fuel leaks - Drip Pans - Equipment condition - Rutting by vehicles
Routine inspection and site monitoring will be undertaken by the Environmental Superintendent or designate	

Performance Indicators

The SWAEMP establishes the following discharge criteria for runoff water quality:

Parameter	Maximum Average Concentration (mg/L)	Concentration of any grab sample (mg/L)
Total Suspended Solid	50	100
Hydrocarbon	no visible sheen	

Update of the SWAEMP

The SWAEMP is updated as required. The current version of the SWAEMP was prepared in support of the licensing process. The SWAEMP will be updated sixty (60) prior to commencement of construction activities and will be submitted to the Nunavut Water Board.

4.5 Quarry and Borrow Pit Operation – Quarry and Borrow Pit Management Plan

Construction of the project infrastructure will require the development of numerous quarries. The concerns associated with operation of quarries and borrow pits are:

- Residual ammonia / nutrient input resulting from blasting activities at the various quarry sites during the construction period.
- Suspended sediment entrained by drainage at the quarry and borrow pits sites.

Recognizing the potential for aquatic effect, Baffinland has implemented its Quarry and Borrow Pit Management Plan. The purpose of this management plan is to provide strict guidelines for the selection and development of quarry and borrow pit sites. The guidelines include:

- A screening protocol for acceptable quarry sites on the basis of the ARD generation potential of the quarry material;
- Minimum set backs from water courses/bodies;
- The use of best management practices for blasting in order to minimize losses of explosives;
- The requirements for the quarry specific development plan to include:
    - A quarry development plan;
    - A site specific drainage plan;
    - An abandonment and closure plan.

Conceptual Approach to Screening for Potential Metal Leaching / Acid Rock Drainage (ML/ARD)

Potential quarry sites have already been identified along the corridor in excess of what is expected to be required to allow flexibility and choice as both geomaterial and geochemical characterization of quarry sites proceeds in advance of construction. Screening level ML/ARD assessment has identified that in general rock materials along the corridor have a low potential for ML/ARD. Further assessment will be done on a site specific basis to ensure that materials for railway construction aggregate meet acceptable physical and geochemical requirements. In particular, the work will use industry standard methods and guidance provided in MEND 2009 (MEND 2009, Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials, Natural Resources Canada) to confirm that aggregate materials used will have a low potential for ML/ARD.

The following summarizes the project approach for ML/ARD assessment at proposed quarry sites. Initial assessment of potential quarry sites will consist of the following steps:

- Review existing geological information and data (surface geological maps, borehole logs and any available test results) applicable to the site.
- Conduct site reconnaissance including further geological inspection and sampling of surface materials if appropriate.
- Develop priority list of potential quarry sites for further assessment, based on the geochemical, geomaterial and geotechnical assessments.

After completion of the above initial assessment, decisions will be made regarding the development of quarry sites. Quarry sites that exhibit evidence of ML/ARD potential will either not be developed, or will be further investigated using additional ML/ARD characterization techniques (MEND 2009). These additional studies will provide further geochemical characterization data that will allow for a risk based and acceptable approach to be used for the final decision making process.

Performance Indicators and Thresholds for Quarry Sites

The performance indicators for the pit/quarry are visual and depend on regular inspection and maintenance of the pit/quarry site. These indicators are:

- Site safety and security;
- General site condition and "housekeeping";
- Positive drainage and absence of water pooling/ponding on the pit/quarry site; and
- Ground/slope stability.

Monitoring and Reporting Requirements for Quarry Sites

Operation of the borrow pits and quarries must be monitored to ensure they are proceeding according to the Borrow Pit and Quarry Management Plan and remain in compliance with regulations and land-use permits. Monitoring focuses on:

- Regular inspection of site-preparation measures;
- Site safety and security; and,
- Site maintenance and general housekeeping conditions.

- Regular inspection of drainage and water management structures and assessment of their effectiveness;
- Determining if the granular resource material is still suitable for end-use;
- Establishing how much ground-ice is present in the material and behaviour and volume loss of the material as thawing occurs;
- Inspecting records of wildlife interactions and sightings; and,
- Reporting quantities of material extracted.

Site monitoring is required for several years after closure to assess whether reclamation objectives have been met. Post-closure monitoring requirements will be specified in the land-use permits.

4.6 Effluent from Waste Water Treatment Facilities and secondary Containment Facilities – Waste Water Management Plan

The Project operates several sewage treatment facilities as well as three oily water treatment facilities. At Milne Port, the treated sewage effluents and the oily water treatment effluent both discharge to an open ditch which flow directly to Milne Inlet. At Steensby Port, the treated sewage effluent and oily water treatment plant effluent discharge to the marine environment at a 35 m depth via a marine outfall. Hence these facilities have no potential effects on the freshwater aquatic ecosystems.

For the railway construction camps, the treated effluent is trucked to either the Mine Site sewage treatment plant or the Steensby Port sewage treatment plant.

Discharge water quality criteria (key performance indicators) for all waste water treatment facilities are presented in Schedule 4.

Landfarms and non hazardous waste landfills are also in use at the Mine Site and Steensby Port. Runoff water collected within these sites is contained, analysed and treated if required prior to discharge to the receiving environment. The discharge water quality criteria for the surface runoff pooling at the landfarm and landfill are presented in Schedule 4.

Fuel tank farms are all erected within an impermeable secondary containment structure. Runoff water pooling within these secondary containment is analysed and treated if required prior to discharge to the receiving environment. Discharge water quality criteria for water collected in these secondary containment areas is presented in Schedule 4.

The requirements for the management of all waste water generated at the Project sites are described in the Waste Water Management Plan (WWMP). This management provides the design basis for the waste water treatment facilities, the operational manual, and the performance criteria for these facilities.

4.7 Waste Management Plan

The aim of the Waste Management Plan is to implement a sound waste minimization program that will focus upon the principles of Reduction / Recovery / Reuse / Recycling. The residual waste generated by

the Project activities will then be disposed of in a landfill/landfarm, incinerated or shipped off-site to southern Canada for final disposal, treatment, or recycling.

This Waste Management Plan deals with wastes generated by the Mary River Project including, among others, inert and hazardous solid wastes, i.e., solids, semi-solid and sludge, used oils, contaminated fuel, and antifreeze, used chemical products, biomedical waste and spills clean-up materials. The management of sewage effluent and sludge from the sewage treatment plants is the subject of the Waste Water Management Plan.

The Waste Management Plan presents the various disposal methods, the types and expected quantities of waste produced and the ultimate disposal of the waste stream. The Plan also defines the roles and responsibilities, specific requirements, and monitoring controls for managing solid and hazardous wastes generated by the Project. It also presents the strategy for adaptive management and continuous improvement.

In order to handle, storage, transport and treat / dispose the wastes generated during the construction operation and closure phase of the Project, several treatment or disposal facilities must be built on-site to ensure that the waste management is being conducted in a safe, efficient and environmental-compliant manner. The infrastructure deemed necessary to manage the wastes appropriately are:

- Two long term waste management facilities at the Mine Site and Steensby Port;
- Two long term landfills and landfarm's at the Mine Site and Steensby Port;
- Temporary landfarm, incinerator, hazardous / medical waste storage facility and waste oil treatment/recovery facility at Milne Port;
- Temporary incinerator and waste storage areas at Mine Site, Steensby Port and Rail Camps for use only during construction.

The Waste Management Plan (WMP) presented in this document establishes a management strategy for all the wastes generated during the construction, operation, closure and reclamation of the Project.

<u>Waste Management Monitoring</u>

Waste monitoring includes the visual inspection of three main components of the waste management system (described below) and the measurement and recording of all wastes taken off site a) The quantities hazardous waste transported off-site for disposal. The following information will be reported on an annual basis as currently is the practice:

- The quantities hazardous waste transported off-site for disposal;
- The location and name of the disposal facility for each waste type;
- The date that each was hauled off-site for disposal, for each occasion that these are removed from the site;
- Quantities of non-hazardous inert solid wastes disposed in the landfill.
- Quantities of hydrocarbon contaminated soils and water processed in treatment facilities.

Inert solid wastes will be stored and disposed in a manner that minimizes the opportunity for wind-blown debris and animal attraction. Any wastes that are shipped off site will be recorded using an Off-Site Waste Disposal Log or equivalent developed from the EPP.

Regular visual inspection of waste management facilities will be conducted by the HSE Manager to ensure proper operation and adequate environmental/health and safety controls are in place. Waste audits will be undertaken periodically generation points to ensure waste streams are properly segregated.

Incinerator Monitoring

Monitoring of the incinerator operation involves ensuring proper operation and that appropriate wastes are incinerated.

Records are kept by incinerator operators of what waste is burned, when and how much. Other record keeping requirements include:

- Operating data including readings from the process and emissions monitoring instruments;
- Weather conditions (i.e. air temperature and wind speed) at the time the incinerator is being operated;
- Repairs and maintenance performed on the incinerator and monitoring instruments;
- Major changes in operation;
- Quantity, condition and disposal location of the collected bottom ash;
- Operator training.

Records will be maintained onsite throughout the operational life of the facility and be made available to Inspectors and other regulatory officials upon request.

Landfill Monitoring

Monitoring of the inert landfill, involves visual inspections to ensure that only inert wastes are deposited in the landfill, and that adequate cover is provided so that wastes are contained and are not being dispersed by the wind. The Waste Disposal Facility (Landfill) Inspection Form is included in the EPP and landfill operating procedures. Wastes is managed and monitored for compatibility with landfill disposal prior to disposal in the landfill. Also Waste audits will be undertaken periodically at generation points to ensure waste streams are properly segregated and that potential wildlife attractants are diverted from landfill.

A written operations manual has been developed and submitted to the Water Board as part of the landfill design and commissioning process. The operations manual provides the following information:

- description of the facility and the design;
- the maintenance schedule, frequency of inspection of dams, dykes and drainage works;
- the operation schedule;
- identify the personnel responsible for completion of operations;
- the runoff and drainage control within and around the facility and restoration of erosion;
- treatment option for contaminated drainage;
- the control of effluent discharge and effluent quality;
- prevention measures for windblown debris;
- management procedures for sorting of waste, along with management of hazardous waste and recyclable materials.

Waste Management Operations Monitoring

In addition to specific monitoring and reporting requirements under the regulatory approvals such as the water license, QIA land lease, land use permits, and fisheries authorization as well as monitoring of project effects, routine inspections of various aspects of the waste management operations are conducted. These routine inspections are conducted to confirm overall conformance with the requirements of the Waste Management Plan, companion EPP, and operating procedures / work instructions, and will include inspections of site-based waste management activities.

Compliance Monitoring Forms are used to document the findings and required actions. These reports are generated as an internal operational management tool to promote continuous improvement in environmental performance and stewardship. Checklists are used as internal operational monitoring and compliance tools. These checklists are integrated into the EPP and other operating procedures / work instructions.

Annual Reporting

An annual report will be completed for the overall project and will include the following information on the landfill:

- Total volume of waste deposited in the landfill site during the previous year;
- Progression of the landfill site development, indicating the landfill site location currently in use and areas that have been closed;
- Monitoring results;
- Remaining life expectancy of the landfill site;
- Details of operational problems encountered during the year and the measures taken to resolve the operational problems;
- Photographs.

4.8 Hazardous Material and Hazardous Waste Management

The purpose of this plan is to provide a consolidated source of information on the safe and environmentally sound transportation, storage, and handling of the major hazardous products to be used at the Mary River Project. A hazardous material is one that, as a result of its physical, chemical, or other properties, poses a hazard to human health or the environment when it is improperly handled, used, stored, disposed of, or otherwise managed. In combination with Baffinland Iron Mines (BIM) “Emergency Response Plan” and “Spill Contingency Plan,” this Hazardous Materials and Hazardous Waste Management Plan (HMMP) provide instruction on the prevention, detection, containment, response, and mitigation of accidents that could result from handling hazardous materials.

The plan is based on the following principles for best practice management of hazardous materials:

- Identify and prepare materials and waste inventories;
- Characterize potential environmental hazards posed by those materials;
- Allocate clear responsibility for managing hazardous materials;
- Describe methods for transport, storage, handling, and use;
- Identify means of long-term storage and disposal;
- Prepare contingency and emergency response plans;
- Ensure training for management, workers, and contractors whose responsibilities include handling hazardous materials; and
- Maintain and review records of hazardous material consumption and incidents in order to anticipate and avoid impacts on personal health and the environment.

BIM recognizes that incorporating proper hazardous material management into other environmental management plans and systems leads to risk reduction, improved process control, and cost savings.

All hazardous materials to be used at the Mary River Project will be manufactured, delivered, stored, and handled in compliance with all applicable federal and territorial regulation. BIM is strongly committed to preventing, to the greatest extent possible, both inadvertent release of these substances to the environment and accidents resulting from mishandling or mishap. BIM will institute programs for employee training, facility inspection, periodic drills to test systems, and procedural review to address deficiencies, accountability, and continuous improvement objectives.

BIM will actively work towards minimizing the generation of hazardous wastes by investigating alternatives to the use of hazardous materials, by recycling products and containers wherever feasible, and by treating wastes using state-of-the-art technologies before any release to the environment.

Performance Indicators, Thresholds, and Incident Response

Periodic inspections of hazardous materials management facilities will ensure compliance with this Hazardous Materials Management Plan. The EPP and associated operations procedures/work instructions outline detailed procedures for handling and storage of fuel, lubricants and other hazardous materials. These procedures are in place and training will be provided to all employees and contractors on hazardous materials handling. Accidental spills are the most likely type of environmental incident to occur while conducting the above mentioned activities.

Response procedures, documented in the EPP and the Emergency and Spill Response Plan, are in place to deal with these occurrences.

The ultimate performance indicator for hazardous materials management is the number of incidents of non compliance reported on a daily or monthly basis. Incidents of non-compliance are classified by type and each type entails remedial actions as outlined in Baffinland EH&S Management Framework (Hazard Identification and Risk Assessment Standard).

Where an investigation triggers a review and update of established EPP procedures, these reviews and update will be carried out in accordance the procedures established by Baffinland`s EHS Framework.

Hazardous Materials Monitoring

Hazardous materials monitoring includes the visual inspection of three main components of the hazardous materials management system (described below) and the measurement and recording of all hazardous materials taken off site. The following information will be reported on an annual basis as currently is the practice:

- The quantities hazardous materials transported off-site for disposal;
- The location and name of the disposal facility for each hazardous materials type;
- The date that each was hauled off-site for disposal, for each occasion that these are removed from the site;
- Quantities of non-hazardous inert solid hazardous materials disposed in the landfill; and
- Quantities of hydrocarbon contaminated soils and water processed in treatment facilities.

Regular visual inspection of hazardous materials management facilities will be conducted by the HSE Manager to ensure proper operation and adequate environmental/health and safety controls are in place.

Hazardous materials audits will be undertaken periodically generation points to ensure hazardous materials streams are properly segregated.

Operations Monitoring

In addition to specific monitoring and reporting requirements under the regulatory approvals such as the water license, QIA land lease, land use permits, and fisheries authorization as well as monitoring of Project effects, the Environmental Lead will coordinate routine inspections of various aspects of the operations. Routine inspections are conducted to confirm overall conformance with the requirements of the Hazardous Materials Management Plan, companion EPP, and operating procedures/work instructions, and will include inspections of site-based hazardous materials management activities.

Compliance Monitoring Forms are used to document the findings and required actions. These reports are generated as an internal operational management tool to promote continuous improvement in environmental performance and stewardship. Checklists are used as internal operational monitoring and compliance tools. These checklists are integrated into the EPP and other operating procedures/work instructions.

4.9 Air Quality Management Plan

The Air and Noise Abatement Management Plan provides guidance on management of air emissions and noise from construction and operation activities. The plan includes action to control airborne particulates and noise hazards. It also defines action to mitigate, prevent, or avoid to the extent practical noise nuisance to site personnel and nearby populations. The plan addresses greenhouse gas emissions and includes an assessment of emissions from the complete lifecycle of the product, aimed at improving management of energy and greenhouse gas emissions, building emissions abatement and energy saving considerations into the business decision-making processes.

Potential sources of project-related effects on air quality include exhaust emissions from vehicles, mining activities, aircraft, generators and other equipment, emissions from camp incinerators, and fugitive dust emissions from road traffic during snow-free periods.

Daily inspection of facilities will ensure strict compliance with this Air Quality and Noise Abatement Management Plan. The EPP outlines detailed procedures for dust-suppression techniques.

Training/instruction will be provided to all employees and contractors as required on the use of dust suppressant. Scheduled maintenance on mobile equipment and stationary equipment will ensure that emissions are in line with vendors` specifications and emission criteria.

Air Quality Monitoring

Passive and active air quality monitoring will be conducted. Active monitoring will involve measuring TSP in areas of activity at the mine site and Steensby Port. Passive sampling will include collecting SO2, NO2, O3, and dust fall samples simultaneously. Note that activities at Milne Port are limited to receiving material and equipment by sealifts. Receipt of material and equipment by sealifts will be take place during the construction phase, and infrequently thereafter for the routine replacement of equipment.

During both construction and operation, the monitoring program will focus on TSP and dust deposition. Air quality data will be collected via active (TSP) and passive sampling methods (SO2, NO2, O3, and dust fall, including metal deposition). Snow-core sampling will be used to determine dust fall at specified locations. The sampling locations and frequency will be established before the onset of construction and will be revised / updated before start of operation. For an overview of the indicators and corrective action to be taken should thresholds be exceeded, see Table below;

Air Quality Performance Indicators

Location	Frequency	Indicator	Corrective Action
Mine Site	Number of sampling locations and frequency to be established	SO_2 NO_2 $PM_{2.5}$ TSP	Review mitigation measures in place Review equipment specification and performance Review maintenance schedule for combustion equipment
Steensby Port	Number of sampling locations and frequency to be established	SO_2 NO_2 $PM_{2.5}$ TSP	Review mitigation measures in place Review equipment specification and performance Review maintenance schedule for combustion equipment

Dust Fall Performance Indicators and Thresholds

Location	Indicator	Threshold	Corrective Action
Mine Site	Dust Fall	4.6 $g/m^2/yr$	Use dust suppressant Review mitigation measures in place Review equipment specification and performance Review maintenance schedule for combustion equipment
Steensby Port	Dust Fall	4.6 $g/m^2/yr$	Use dust suppressant Review mitigation measures in place Review equipment specification and performance Review maintenance schedule for combustion equipment

Incinerator Emission Testing

Non-hazardous combustible camp waste is disposed of in camp incinerators. Incinerated waste is generally generated from the kitchen and personnel accommodations. Camp incinerators are installed at each of the camps associated with the mine site, Milne Port (only during construction), and Steensby Port, and each rail camp. Each of these incinerators uses dual chamber, variable-airflow design technology and is specifically designed for remote camp operations.

These incinerators are capable of meeting the Canadian Council of Ministers of the Environment (CCME), CWS for mercury emissions, and the CCME-CWS for dioxins and furans. The waste incinerators are operated as required. Standard operating procedures have been developed in accordance with manufacturers' recommendations and operators receive training by experienced supervisory personnel. Incinerator ash generated is stored onsite in 200-L drums for future disposal in the onsite landfill.

4.10 Explosives Management Plan

This plan outline the actions that will be taken to address any environmental spill issue at the point of origin related to the explosives manufacturing process which will in turn assist in the reduction of potential contaminant release into the environment.

The control and use of explosives within Canada and the Territorial area are covered by existing federal and territorial regulations. Operational policies and procedures which meet or exceed the required regulations will be implemented.

The main applicable regulations in the case of the Mary River project include (but are not limited to):

- The Canada Explosives Act;
- Transportation of Dangerous Goods Act;
- Occupational Health & Safety, Nunavut – Explosives Use Act Northwest Territories / Nunavut Mine Health and Safety Act and Regulations
- Extensive documentation, monitoring and reporting is required under these regulations.

The Explosives Management Plan is prepared by Baffinland's explosive contractor and maintains detailed "Basis of Safety" documentation for the safe handling, use and manufacturing of explosives. In addition to those "Basis of Safety" documents, there will be overlapping reference to other critical model procedures, training requirements and integration with mine site activities.

As a precondition of receipt of federal licensing for the storage, use, transportation and manufacture of explosives there is the requirement to have in place a detailed site specific Emergency Response Plan (ERP). A detailed ERP, prepared in accordance with the guidance provided in the CAN/CSA Z731-03 Standard for "Emergency Preparedness and Response" will be prepared during development of the project. It will be integrated with the mine site ERP to maximize resource utilization, training and planning efforts. As indicated above this document must be prepared in advance of receipt of any federal explosives license.

The licensed Explosives Contractor will include a detailed operations manual for the conduct of operations on the Mary River and Steensby Port sites for the purposes of transportation, storage, handling and manufacture of explosives. The recommended explosives products are currently listed as approved products federally. They are industry proven for use in northern climates and are accepted globally.

All proposed infrastructure and manufacturing processes will be licensed and approved by Natural Resources Canada – Explosives Regulatory Division. In addition to the raw materials required for explosives manufacture, the Explosives Contractor will be providing pre-packaged commercial products to support the operations at the Mary River and Steensby Port sites. This will include detonators, boosters, pre-packaged commercial explosives for specialty operations and detonating cord. All of these materials will be transported and stored in accordance with the regulations identified above. Magazine storage sites will be included in the overall federally issued explosives license.

The Explosives Management Plan outlines the detailed procedures for safe handling, transportation, storage and manufacture of explosive, as well as, procedures for waste management and spill management.

The explosives manufacturing plant is design to have zero discharge of liquid effluent. An evaporator is utilized within the plant to treat liquid waste resulting from explosive trucks wash down and general plant wash water. The residues from this evaporator may be reused in the manufacture of explosives or disposed of as a hazardous waste.

4.11 Blasting Management Plan

Potential Impacts

As described in Volume 3 (Sections 2.0 and 3.0), blasting will be conducted across the Project Areas to support construction and operation phases of the Project.

Blasting can be harmful to fish and fish eggs through creation of shock waves that result in a rapid increase followed by a rapid decrease in peak pressure (or overpressure). These physical effects may in turn cause sublethal or lethal effects to fish, including but not limited to rupture of the swimbladder, damage to internal organs, and rupturing of blood vessels. Blasting may also directly affect fish eggs through creation of vibrations (i.e., peak particle velocity).

Blasting may also affect water quality, which may in turn affect fish. Specifically the use of ammonium nitrate fuel oils (ANFOs) may introduce ammonia, nitrate, and nitrite to surface waters. TSS may also be increased due to introduction of particulate materials to surface waters.

Mitigation

A Blasting Management Plan (BMP) will be developed and will provide a description of mitigation activities and physical monitoring that will be conducted (i.e., monitoring of overpressure and peak particle velocity). The BMP will incorporate "Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters" (Wright and Hopky 1998) which intended "to provide information to proponents on the conservation and protection of fish, marine mammals, and their habitat from impacts arising from the use of confined or unconfined explosives in or near Canadian fisheries waters." Where it is not possible to meet the guidelines, potential mitigation may include the following: use of timing windows; sub-division of larger charges into a series of smaller discrete detonations; deployment of bubble/air curtains; and removal or exclusion of fish from the work area prior to the blast (Wright and Hopky 1998).

Baffinland committed to implementing best management practices in its use of explosives and to provide a Blasting Ammonium Nitrate Management Framework. The Plan will incorporate key points as presented in the framework below.

Ammonium Nitrate Blasting Management Plan Framework

Soluble inorganic nitrogen compounds such as ammonium nitrate (AN) are commonly used in explosives to support mining operations throughout the world. Large quantities of AN will be shipped and stored at the Mary River site and used in the manufacture and use of explosives used in blasting operations. The framework plan focuses on the control and mitigation of key potential risks arising from the management and use of AN explosives associated with quarrying and mining operations during the construction and operations phase of the Project. The potential risks arise from the aqueous dissolution of soluble nitrogen compounds and the potential pathways/impacts to surface water bodies which may support aquatic life. The framework plan has been developed based on a review of similar plans implemented at other Northern mines such as the Diavik and Ekati diamond mines. Due to potential environmental concerns related to the introduction of nitrogen compounds, Baffinland in concert with its EPCM contractor will introduce site specific operating procedures to limit, control and mitigate the release of undetonated explosives from blasting operations.

The specific objectives for the framework Plan are as follows:

- To identify and implement ammonia management options to achieve the lowest practical ammonia concentrations in the treated mine water discharge to the receiving environment, and, To ensure that explosives are used and water is managed in such a way that ammonia losses do not result in a change in the trophic status of receiving water bodies.

Ammonium Nitrate Explosives - Potential Risks

The primary ecological concerns with ammonia are acute end-of-pipe toxicity and chronic toxicity in downstream lakes. Secondary issues relate to ammonia as a nutrient and the fact that ammonia nitrifies to nitrate in the environment. Some forms of nitrogen such as anionic ammonia or free ammonia and nitrite can be detrimental to fish at elevated concentrations. Nitrate, in the presence of phosphorus, can contribute to the process of freshwater eutrophication. The natural concentration of phosphorus in lakes in North Baffin region is low and measures will be implemented to limit phosphorous loading to both the aquatic receiving environment. This involves control of sediment loading to surface waters during construction and the minimization of phosphate in effluent discharge.

The primary source of inorganic nitrogen typically found at mine sites is undetonated ammonium nitrate (AN)-based explosives.

Potential Pathways

Ammonium nitrate is highly soluble and can readily leach into surface water by one or more of the following pathways:

- Spillage, which is the most common source of ammonium nitrate loss and the easiest to control;
- Improper selection of explosives medium, leading to losses of explosives through incomplete detonation; and
- Site peculiarities such as geology and groundwater affecting the migration of explosives into permeable fractures or fault systems and causing incomplete detonation.

Due to potential environmental concerns related to the introduction of nitrogen compounds at the Mary River Project, operating procedures will implemented to limit, control and mitigate the release of undetonated explosives originating from blasting operations.

Source Controls

Proactively controlling the source of AN explosives has a positive net environmental effect versus managing ammonia after dissolution in water which is much more difficult. The AN-based explosives handling procedures require that personnel who handle explosives take the necessary precautions to prevent spillage during blasting operations. When AN-based explosives come in contact with water, some dissolution of ammonium nitrate occurs. To limit explosives-water contact, areas that are subject to shallow groundwater flows are identified, and dewatered prior to blasting. Proper selection of explosives can prevent dissolution and release to the receiving environment. For example, emulsion based ammonium nitrate-fuel oil (ANFO) mixture contains emulsifiers can minimize AN dissolution in water and improve blast performance. The types of procedures to be developed and actions to be taken will include the following:

- Loading explosives in wet blast holes and limiting stand time for explosives in wet holes.
- Rigorous employee orientation & training procedures for managing, transporting and loading explosives into blast holes.
- Selecting, adopting, and manufacturing the optimum explosive mix types and loading procedures for site specific applications.
- Quarry and pit plans will incorporate a site specific drainage control plan.

Performance Monitoring

A performance monitoring program will be implemented to ensure that AN release to receiving waters from AN explosives is minimized and remain non- acutely toxic to aquatic organisms. Site specific performance targets will be developed and finalized in concert with the EPCM and blasting contractors. The performance monitoring targets may include the following key elements:

- Ammonia and nitrate monitoring of surface water flows to aquatic or marine receiving environment.
- Blast performance monitoring to optimize blasting efficiency.
- Monitoring and auditing of field operations related to explosive selection, manufacturing, handling, blasting, and pit/quarry development to ensure acceptable field implementation of procedures and delivery of associated training.

In the event that performance monitoring indicates that targets are not being met, corrective actions will be taken to improve performance and contingency measures will be taken to prevent the discharge of acutely toxic ammonia discharges to the aquatic receiving environment.

4.12 Waste Rock Management Plan

A waste rock disposal area designed for permanent storage of waste rock will be located north of the open pit. Based on the current mine plan, an estimated 640 Mt of waste rock will be generated from the mining of Deposit No. 1.

Open-pit mining will generate large quantities of waste rock that will be stored at dedicated locations and quantities of ore that will be stored temporarily in ore stockpiles while being crushed and transported to Milne and Steensby Ports. Waste rock and ore will require environmentally acceptable management and storage locations and practices. These materials have been characterized and grouped on the basis of geochemical static and kinetic test work. Environmental management plans are developed for each material group based on projected chemical reactivity and physical properties to ensure long-term environmentally acceptable storage.

The Waste Rock Management Plan (WRMP) addresses the issues of deposition of the waste rock, inspection, potential release of contaminants to the receiving environment, geotechnical stability, as well as closure considerations. As additional geochemical, geotechnical, and geological data are collected, and detailed engineering is completed, the management plan will be further optimized using an approach that protects the environment while operating in a cost-effective manner.

Monitoring and Reporting Requirements

The Waste Rock Management Plan is an integral part of the Type A Water Licence. Annual reporting requirements will include information on:

- Quantity of waste rock deposited;
- Update on geotechnical stability;
- Update on geochemical investigations and kinetic test work; and,
- Water quality of surface runoff from waste rock stockpile.

The runoff from the waste rock stockpile is classified as an effluent discharge under the Metal Mining Effluent Regulation (MMER). Schedule 5 of the MMER required the establishment of an Environmental Effect Monitoring Plan (EEM). This EEM will be addressed under the AEMP discussion (section 5.3).

4.13 Emergency Response and Spill Contingency plan

Baffinland has a comprehensive Emergency Response and Spill Contingency Plan (ERP) for the Mary River Project. The ERP is reviewed and updated annually on the basis of:

- Hazard and operability reviews for existing activities/operations;
- Installation of new facilities;
- Training and field exercise to respond to simulated incident and accidents on site.

The ERP is supported by the following management plans:

- Oil Pollution Emergency Plan (OPEP) – Milne Inlet Fuel Storage Facility
- Oil Pollution Emergency Plan (OPEP) – Steensby Port Fuel Storage Facility
- The Explosives Management Plan.

The ERP and OPEPs are submitted to Transport Canada and the GN Department of Environment for review on an annual basis.

Baffinland has the obligation under its various land leases, Project Certificate, Water Licences and other permits to report spill to the Government of Nunavut Spill Report Line, to QIA, and to the water license inspector within 24 hours of the event, and submit a written spill report using the appropriate form (refer to ERP for report and documentation requirement).

An incident or accident report will be prepared following every reportable spill. Depending on the severity of the accident, some environmental monitoring follow up may be required. Such on-going “post-accident” monitoring would be the subject of “Target study”.

4.14 Abandonment and Reclamation Plan

A Preliminary Abandonment and Reclamation Plan (A&R Plan) was submitted with the Type A Water Licence application. This A&R Plan outlines the approach and principles that Baffinland will adopt for progressive site closure, closure objectives and post closure monitoring requirements. The A&R Plan also provides an estimate of site closure cost.

The A&R Plan will be updated on a regular basis. Baffinland expects to submit the next revision of the A&R Plan (interim A&R Plan) prior to commencement of the mine pre-stripping activities.

4.15 Habitat Compensation

Baffinland must obtain appropriate authorizations or letters of advice from the Department of Fisherieis and Oceans (DFO) for construction activities at water crossings. Section 35 of the Fisheries Act prohibits the harmful alteration, disruption or destruction (HADD) of fish habitat and provides the Minister with the power to authorize terms and conditions which would allow projects to proceed in compliance with the Act. The DFO (1998) defines HADD as, "any meaningful change in one or more habitat components that can reasonably be expected to cause a real reduction in the capacity of the habitat to support the life requisites of fish." A HADD occurs when the physical, chemical, or biological features of a water body are sufficiently altered, such that habitat becomes less suitable for one or more life history processes of fish. Habitat compensation is an option for achieving no net loss when residual impacts of projects on habitat productive capacity are deemed harmful after other less invasive options have been implemented. Habitat compensation involves replacing the loss of fish habitat with newly created habitat or improving the productive capacity of some other natural habitat. Depending on the nature and scope of the compensatory works, habitat compensation may require, multiple seasons of post-construction monitoring. A No Net Loss Habitat Compensation and Monitoring Plan is a requirement of an HADD authorization.

Mitigation measures are likely to be implemented during the project's planning, design, construction and/or operation phases in order to protect fish and fish habitat. The mitigation plans are prepared and implemented by the Company with advice typically provided by DFO staff.

Commonly used mitigation measures can include:

- Working within fisheries timing windows to minimize interference with fish migration and spawning;
- Selecting the least harmful equipment/ materials/ construction methods;
- Ensuring fish passage around obstructions during and after construction;
- Implementing measures to control siltation at construction sites.

Upgrades to some of the existing Tote Road crossings will be required to support the construction phase of the project and the installation of new crossings will be required as part of the railway construction and operation.

Permanent or temporary water crossings are authorized under the Type A Water License provided the Department of Fisheries and Oceans has granted authorizations for undertaking the proposed work.

4.15.1 Tote Road Upgrade (Water Management Area 48)

The Bulk Sampling Program was completed in 2007-2008 and confirmed the quality and marketability of the Mary River iron ore. As part of the Bulk Sampling Program initiative, upgrades to the original Milne Inlet Tote Road (Tote Road) were necessary to facilitate the transport of the iron ore to the coast at Milne Inlet, where the iron ore was transported via sealift to Europe for testing. Currently the road is used as a means of transport of personnel, equipment, and supplies, between the Mary River and Milne Inlet Camps. The Tote Road, which was first established in the 1960's, runs approximately 105 km from the Mary River exploration camp to Milne Inlet. It was designated as a public use road during the Nunavut Land Claims Agreement and is defined as such in the North Baffin Land Use Plan.

The upgrades completed in 2009, included adjustments to the road alignment to facilitate haul road travel, road bed improvements, road widening and installation of drainage crossings along the route. The Tote Road upgrades were designed to enhance the flow conditions of the waterways, reduce potential erosion-related effects, and improve the opportunity for fish to access upstream habitat.

To summarize for conceptual design purposes, crossings were grouped into five main categories based on catchment area, geometry and estimated peak flows. The main groupings are as follows:

- Extra-Small crossings with upstream watershed areas of less than 0.5 km2
- Small crossings with upstream watershed areas between 0.5 km2 and 2.5 km2
- Medium crossings with upstream watershed areas between 2.5 km2 and 7.5 km2
- Large crossings with upstream watershed areas between 7.5 km2 and 30 km2
- Extra-Large crossings with upstream watershed areas greater than 30 km2

Corrugated steel culvert pipes (CSP) were used for most crossings. Modified sea containers were used for the four Extra-Large crossings (three of the Extra-Large crossings use a combination of corrugated steel culvert pipes and sea containers).

The DFO issued a HADD authorization for approximately 8,500 m^2 of fish habitat that was to be disturbed for the Tote Road upgrade project. Based on subsequent monitoring, this estimate was revised to 7,850 m^2 of disturbance with habitat compensation measures to be implemented that would restore and enhance approximately 15,000 m^2 of habitat. The original Fisheries Act Authorization and Fish Habitat No Net Loss and Monitoring Plan (the Plan) to support the construction of 25 crossings identified as HADD (and 14 crossings identified as Habitat Compensation) were issued and approved in 2007. The HADD crossings were primarily classified within the Extra-Large, Large, Medium, and Small categories. The Plan outlined the measures necessary to mitigate and compensate, to the greatest possible extent practicable, the impacts to fish habitat at the Tote Road watercourse crossings. The plan also described a monitoring plan to be implemented during and after construction. This plan has been implemented during the period of construction (2007-2009) and post construction from 2009 to the present. Annual reports for the above have already been submitted to DFO for the years 2007 to 2011.

A large number of crossings mainly within the Small and Extra-Small categories were determined to be of low quality habitat and Letters of Advice were issued by the DFO to facilitate and construct these crossing upgrades along the road.

It is anticipated that future upgrades for crossings required for the Tote Road in the coming years, once the Project has been approved and Type A Water Licence issued, can be accommodated by means of either:

- Amendments to the existing FA and addendums to the currently approved No Net Loss Plans for HADD, or,
- Letters of Advice issued by DFO, for crossings that are of low value fish habitat.

Watercourses initially identified as HADD (n = 25) and compensation (n = 14) sites (Knight Piesold 2007a) were each assessed for the quality of available fish habitat at least once between 2006 and 2009 (Baffin land 2009). Sites identified as not fish-bearing waters were typically visited only once while others were assessed on multiple occasions to monitor for potential changes. In 2010, any fish-bearing sites that showed some change in the quality and/or accessibility of fish habitat since they were initially assessed were revisited for detailed habitat surveys. Of these sites, seven required some level of additional monitoring in 2011. Two HADD (BG-01 and CV-225) and two LOA (BG-27, CV-112) crossings where fish access improvement structures were constructed in 2010 (Baffinland 2010) required fish passage surveys in July 2011, to assess long term success of the structures. Two other HADD crossings (CV-129 and CV-114) were identified, during 2010 surveys, as being at least partial barriers to fish movements. Construction of fish access improvement structures and initial monitoring surveys at these two sites were completed in 2011. At HADD crossing CV-078, a potential for stranding of fish in isolated plunge pools downstream of overflow culverts was identified during the 2010 survey. This site was assessed in more detail in 2011 and necessary compensation will be completed by spring 2012.

To determine fish use of available habitat and fish passage success at these sites, 50 m reaches upstream and downstream of each crossing were sampled with a backpack electrofisher (Smith Root model LR-24). Electrofisher settings and duration were recorded for each reach fished. All captured fish were identified to species, measured for fork length (mm), and returned to the area from which they were sampled. Size range, mean length, and catch-per-unit-effort (CPUE - measured as the number of fish captured per minute of electrofishing) were calculated and tabulated by watercourse and reach.

4.15.2 Railway Construction (Water Management Area 21)

The Water License application included eight (8) design descriptions for crossings at locations AR-BR-37-1, AR-CV-144-1, BR-37-1, CV-17-1, CV-51-2; CV-52-2, CV-76-3, and CV-8-2.

Pursuant to the No Net Loss provisions of the Fisheries Act, Baffinland is negotiating an overall "Fish Habitat Compensation Agreement" with the DFO for fish habitat alteration, disturbance and destruction (HADD) as it relates to the Project as a whole. HADD compensation specific to the water crossings is an integral part of this Compensation Agreement.

As background information for the Fish Habitat Compensation Agreement, a "fish habitat rating" was assigned for each water crossing along the railway corridor on the basis of stream characterization undertaken during the environmental baseline studies (refer to the FEIS, Water Crossing Decision Table, presented in Volume 3, Appendix 3B, Attachment 7).

Fish Habitat Rating	Table 2-16 Bridges Crossings	Table 2-17 Culvert Crossings	Table 2-18 Temporary Access Road	Total Number of Crossings (Temporary + Permanent)
Important	16	28	29	73
Marginal	3	18	28	49
None or "0"	11	162	158	331
Total Crossings	30	208	215	

These baseline field studies completed recently by Baffinland indicate a poor rating for "fish habitat" for at least 173 of the proposed permanent crossings and 158 of the temporary access crossings. Although all crossings will require a DFO authorization under the Fisheries Act, the concern for HADD focuses mainly on the crossing rated as "important" (63) and to a lesser extent, crossings rated as "marginal" (49) for fish habitat. Construction of some of the crossings classified as Marginal and all crossings classified as "None" may be facilitated by means of Letters of Advice issued by the DFO. Mitigation and monitoring measures to be implemented during construction activities for crossings along the Rail Alignment and post-construction monitoring will be largely developed and implemented based on Tote Road upgrade experience and lessons learned from 2007 to the present.

4.15.3 Construction of Water Crossings and Lake Encroachment

Potential Impacts

Construction of stream crossings and lake encroachments could increase TSS and in turn potentially affect aquatic biota, including Arctic Char. Construction activities that entail isolation of construction works (e.g., cofferdams/diversions) may also strand fish. Construction of lake encroachments could potentially affect Arctic Char eggs if construction activities occurred during the spawning and egg incubation period in Arctic Char spawning habitat.

Mitigation

In general, mitigation for the potential impacts to Arctic Char may include, but are not necessarily limited to:

- Construction of stream crossings will be conducted when practicable during the ice-cover season. This will mitigate potential effects on fish which are absent from streams in winter.
- Potential for direct mortality of Arctic char eggs due to placement of Project encroachments in water bodies will be mitigated through avoidance of infrastructure placement on Arctic char spawning habitat.
- Timing windows will be adhered to the extent practicable to minimize and avoid effects on fish.
- A salvage fishery will be completed where required during stream crossing construction (i.e., behind work areas that are isolated such as cofferdams). Fish would be collected and live-released.

As is the case for all crossings with fish habitat, fish passage will be accommodated in the crossing design. With culverts properly sized to maintain or enhance fish passage capabilities, the potential for negative effects is negligible with the appropriate mitigation measures put in place. The release of sediment associated with the construction works during the flowing water season will be minimized by using standard accepted practices including limiting the time spent in-stream to the maximum extent possible, and the application of sediment and erosion control measures. The longer term potential effect of the crossing on channel morphology and erosion will be minimized by incorporating bank protection measures, as necessary and overflow swales to pass high flood flows.

4.15.4 Construction Monitoring

Drawings for construction will be developed and approved by DFO in accordance with the Fisheries Authorization (FA) prior to commencing construction activities. Construction monitoring will ensure that measures and works specified in the fisheries authorization will be implemented and functioning as intended.

Environmental monitoring to be adopted will be based on the methodologies applied during the 2007-2008 Tote Road upgrades and subsequent post-construction monitoring. Final details of monitoring methodologies and monitoring forms to be used will be provided in the Fish Habitat and No Net Loss Monitoring Plan to be submitted for approval to DFO prior to the commencement of crossing construction activities. Examples of pre-construction, construction, post construction, and turbidity monitoring forms that detail the type of information to be collected are presented in Schedule 8.

During in-water construction of fish habitat crossings (designated as HADD and others) as well as corresponding compensation sites, a designated environmental inspector will be on site to ensure implementation of the designs as intended. During periods of flow, the construction of HADD authorized crossings will be monitored for turbidity downstream of the crossings where possible. Crossings will be visually inspected immediately after road construction to confirm that the installations are functioning as intended and that fish access has been maintained or enhanced. Positive and/or negative effects will be documented.

Turbidity has been shown to affect fish habitat. Suspended solids in turbid water can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. Settled particles can smother eggs of fish and aquatic insects.

During road construction, on-site visual monitoring of turbidity will be conducted, and will be used to ensure that various mitigation measures are implemented, including:

- Minimizing timing of in-water work
- Limiting fording to one-time, where possible
- Implementing and maintaining effective sediment and erosion control measures
- Delaying work if it is visibly apparent that char are migrating through the particular Crossing

To document site conditions during and after construction and decommissioning, turbidity will be monitored in watercourses with fish habitat both upstream and downstream of construction activities where possible.

Turbidity will be measured during construction, as well as approximately 2 weeks after construction activity is completed at each monitored watercourse crossing. In comparing background data with post-construction data, factors affecting turbidity, such as weather conditions and stream flow, will be considered. Turbidity measured post construction will be compared with upstream turbidity measured during construction.

4.15.5 Post Construction Monitoring - Performance Monitoring

The general approach to post construction performance monitoring is presented below.

Potential Impacts

Stream crossings may impede upstream or downstream fish passage, which in turn may result in loss of available habitat (i.e., inability to access habitat upstream of a culvert) and/or fish stranding (i.e., inability to move downstream into lakes for overwintering). Stream crossings may also cause increases in turbidity and TSS in watercourses due to erosion of the crossing structure and/or shoreline or the re-suspension of sediments.

Mitigation

The primary mitigation for these potential effects is mitigation by design. That is, stream crossings have been designed to facilitate fish passage and to minimize or prevent effects of turbidity/TSS through implementation of appropriate sediment and erosion control measures. Issues regarding the performance of stream crossings identified during follow-up monitoring may be managed through implementation of corrective measures.

Monitoring

Monitoring of stream crossings located in Arctic Char habitat will be conducted similar to monitoring along the Tote Road as part of the Fish Habitat No Net Loss and Monitoring Plan submitted to and approved by the DFO for that project component and summarized in annual reports.

In general, stream crossings located in Arctic Char habitat will be inspected visually during the initial years of operation, during low and high flow conditions (where feasible), to assess the integrity of the structures and connectivity between downstream and upstream habitats. The composition and quality of the habitat at each crossing will also be assessed and compared with pre-construction data to monitor for significant changes that may affect Arctic Char use. Such changes can occur as a result of erosional processes associated with the crossings that may result in accumulation of finer substrates than are naturally present. The frequency of inspections may be reduced based on the outcome of initial monitoring. For example, a majority of the crossings along the Tote Road showed no change in habitat composition or fish accessibility during the first few years of monitoring (2008-2010) and the frequency of inspections for these crossings has since been reduced with the concurrence of the DFO. In addition, a subset of stream crossings located in Arctic Char habitat will be visually assessed for the presence of Arctic Char and fish passage. Stream velocities will be measured, the presence of Arctic Char upstream and downstream of the culverts and connectivity will be visually assessed. If required (i.e., visual inspection is inconclusive), electrofishing may be conducted to confirm passage of Arctic Char. Corrective measures will be implemented should issues be identified through the monitoring program.

4.15.6 Habitat Compensation Works – Performance Monitoring

A Fish Habitat No Net Loss Compensation and Monitoring Plan will be developed to compensate for the HADD originating from the Project. The compensation works will be monitored to ensure they are functioning as intended and to allow for modifications to improve performance if required.

5.0 AEMP Framework Components

5.1 Core Monitoring Program Overview

A core receiving water program will be established to monitor effects of the Project on the downstream aquatic environment. The Core program expands the geographic extent of environmental effects monitoring (EEM) being carried out under the Metal Mining Effluent Regulations (MMER).

The core receiving water program will focus on follow-up monitoring to validate predictions to aquatic Valued Ecosystem Components (VECs) and Key Indicators, as follows:

- Water quantity
- Water and sediment quality
- Freshwater biota (indicators benthic invertebrates, phytoplankton and key indicator Arctic Char)

Based on the conclusions in the FEIS, water quality effects will be primarily confined to the mine site, and particularly Camp Lake and tributaries, Sheardown Lake and tributaries, and Mary River. Mary Lake is the ultimate receiving water for these drainage areas, but is sufficient size that detectable effects are not predicted (monitoring will confirm this).

5.2 Review of Baseline Integrity beyond the MMER Exposure Areas

The MMER Study Plan, developed as a separate document, identifies the exposure areas in the freshwater environment that will receive mine effluent discharges. This section reviews the availability of baseline data for the aquatic environment downstream of the MMER exposure areas and areas that may be affected by other pathways (e.g., dust deposition), namely:

- Camp Lake – to which the Camp Lake tributaries L1 and L0 will discharge
- Sheardown Lake – which will experience changes in water quality due to airborne dust dispersion and runoff, sewage effluent discharges from the exploration camp during construction, and potential changes in productivity to the main tributary of Sheardown Lake
- Camp and Sheardown Lake tributaries – which will be affected by dust deposition and water diversions;
- Mary River – downstream of the MMER exposure area near the railway crossing
- Mary Lake – to which both the Mary River and Camp Lake eventually reports

5.2.1 Qualitative Review of Baseline Data for Water Quantity

Refer to discussion in section 4.2.

5.2.2 Qualitative Review of Baseline Data for Water Quality

Baseline water quality information has been collected across the Mine Site area since 2005. Stream and lake sampling locations are shown on Figures 5.1, 5.3, 5.5 and 5.7 (attached in Schedule 1). In 2012, water quality sampling was carried out on a subset of these sampling locations (not shown).

The sampling locations provide excellent coverage of the mine site area watersheds, and standard sampling methodologies were consistently applied by the same field staff over nearly the entire sampling record.

Analytical results prior to mid-2007 utilized higher method detection limits for certain parameters which had few detects over the entire sampling period (2 to 4% of the results were measured above method detection limits). During water quality modelling for the FEIS, it was necessary to discard the higher MDL results on the basis that the non-detect results artificially skewed calculations of mean and 90th percentile concentrations.

Even undertaking these measures in the water quality modelling, the analytical MDLs applied for water quality baseline sampling for mercury and selenium were near the selected receiving environment water quality guidelines (CCME Criteria for the Protection of Freshwater Aquatic Life – CCME-PAL), and consequently water quality modelling suggested that mercury and selenium could be contaminants of concern. Lower MDL sampling for these two parameters was undertaken in 2012 to resolve the MDL issue.

Tables 5.1 and 5.2 present the methods, sites and years sampled for water and sediment quality, invertebrates and fish sampling within the Mary River and Camp Lake and tributaries, and Mary Lake, respectively.

Table 5.1 : Existing information collected from sites in the Mary River and Camp Lake Tributary 1 from 2005-2012 in the vicinity of proposed EEM sampling locations

Mary River			
Parameter	**Gear & Methods**	**Site**	**Years Sampled**
Water Quality	Surface water sample - in situ and laboratory analyses (routine parameters and metals)	C0-10	2005-07, 2009-10, 2012
		D0-01	2005-08, 2011
		E0-01	2006-08
		E0-03	2005-07, 2009-12
		E0-04	2011
		E0-10	2006-07, 2009, 2011-12
		E0-12	2011
		E0-21	2011-12
		E0-204	2011-12
		E2-01	2005-08, 2012
		E2-03	2005
		E3-01	2005-07, 2009-12
		E3-02	2011
		E3-03	2005, 2011
		E4-01	2005-07, 2009-12
		F0-01	2005-07, 2011-12
		G0-01	2005-07, 2011-12
Sediment Quality	Surface sediment sample - in situ and laboratory analyses (routine parameters and metals)	C0-10	2006-07, 2012
		D0-01	2005, 2011
		E0-01	2007
		E0-03	2005, 2011
		E0-04	2011
		E0-10	Planned
		E0-12	2011
		E0-20	2011
		E0-21	2011
		E2-01	2005, 2012

		E3-01	2011-12
		E3-02	2011
		E3-03	2011
		E4-01	2011-12
		F0-01	Planned
		G0-01	Planned
Benthic Invertebrates	Surber 250 um mesh - 1 replicate	D0-01	2005
		E0-01a	2005
		E0-01a	2005
	Surber 500 um mesh - 3 replicates separated by ~ 3 wetted stream widths	C0-10	2006-07
		E0-01	2007
Fish	Backpack electrofisher - 50 m reaches, 3 passes	C0-10	2006-07
		E0-01	2006 & 2008
		E0-01a	2006 & 2008
Camp Lake Tributary 1			
Water Quality	Surface water sample - in situ and laboratory analyses (routine parameters and metals)	FS-01	2005
		L0-01	2005-07, 2012
		L1-08	2005, 2008, 2011-12
		L1-09	2011-12
		L1-024	2005, 2012
Sediment Quality	Surface sediment sample - in situ and laboratory analyses (routine parameters and metals)	FS-01	2005
		CLT-1 DS	2007
		CLT-1 US	2007
		L0-01	2012
		L1-02	2012
		L1-08	2011-12
		L1-09	2011-12
Benthic Invertebrates	Surber 250 um mesh - 1 replicate	FS-01	2005
	Surber 500 um mesh - 3 replicates separated by ~ 3 wetted stream widths	CLT-1 DS	2007
		CLT-1 US	2007
Fish	Backpack electrofisher - 50 m reaches, 3 passes	CLT-1 Reach 1	2007-2010; multiple times annually
		CLT-1 Reach 2	2007
		CLT-1 Reach 3	2007

Table 5.2:
Existing information collected from sites in Mary and Camp lakes from 2005-2012 to support EEM sampling

Mary Lake			
Water Quality	Surface and bottom water samples - in situ and laboratory analyses (routine parameters and metals)	A0-10	2008
		BL0-01	2006-08
		BL0-03	2007-08
		BL0-04	2007-08
		BL0-05	2006-08, 2011-12
		BL0-05-B4	2011-12
		BL0-06	2007-08

Sediment Quality	Surface sediment sample - in situ and laboratory analyses (routine parameters and metals)	BL0-01	2006-07
		BL0-03	2007
		BL0-04	2007
		BL0-05	2006-07, 2012
		BL0-06	2007
Benthic Invertebrates	Ponar grab - 3 replicates per site	BL0-01	2006-07
		BL0-03	2007
		BL0-04	2007
		BL0-05	2006-07
		BL0-06	2007
Fish - nearshore	Backpack electrofisher - 50-100 m reaches	MLN-02	2008
		MLN-04	2008
		MLS-01	2006, 2008
		MLS-05	2008
		MLS-06	2008
		MLS-07	2008
		MLS-08	2008
		MLS-09	2008
		MLS-10	2008
Fish - adult	Standard index gillnetting - measurements include metals analyses for a subsample of captured fish	Many sites	2006-2008
Camp Lake			
Water Quality	Surface and bottom water samples - in situ and laboratory analyses (routine parameters and metals)	JL0-01	2006-08, 2011-12
		JL0-02	2007-08, 2011-12
		JL0-09	2007-08, 2012
Sediment Quality	Surface sediment sample - in situ and laboratory analyses (routine parameters and metals)	JL0-01	2007, 2012
		JL0-02	2007, 2012
		JL0-07	2007
		JL0-09	2007, 2012
		JL0-10	2007
Benthic Invertebrates	Ponar grab - 3 replicates per site	JL0-01	2007
		JL0-02	2007
		JL0-07	2007
		JL0-09	2007
		JL0-10	2007
Fish - nearshore	Backpack electrofisher - 50-100 m reaches	CL-01	2007
Fish - adult	Standard index gillnetting - measurements include metals analyses for a subsample of captured fish	Many sites	2006-2008

5.2.3 Qualitative Review of Baseline Data for Sediment Quality

Baseline sediment quality data has been collected across the Mine Site area since 2005. Sediment sampling locations at the Mine Site are shown on Figure 5.1, 5.3, 5.5 and 5.6. Good coverage of the mine site area has been made over sampling period, as summarized in Tables 5.1 and 5.2. However, Environment Canada requested during the NIRB review that Baffinland undertake thin sediment sampling in lakes; this has been completed for 2012 only.

Therefore, there is one year of pre-development lake sediment quality baseline using the thin sample protocol, though stream sampling of sediment quality has been carried out using consistent protocols for several years.

5.2.4 Qualitative Review of Baseline Data for Freshwater Biota

The following provides an overview of existing baseline data collected on benthic invertebrates and fish for potential receiving environments in the Mary River Mine Area.

Approach / Background for Review

A workshop held on October 29-30, 2012 on aquatic effects monitoring identified several streams and lakes within the Mine Area that are either known to or anticipated to require biological monitoring during construction and/or operation. Specifically, two streams – Camp Lake Tributary 1 and the Mary River - will be the primary receiving environments of mine-related effluents and will be subject to Environmental Effects Monitoring (EEM) under the Metal Mining Effluent Regulations (MMER).

In addition, several other streams, as well as Camp Lake Tributary 1 and the Mary River, may be affected by other pathways of effect, including but not necessarily limited to sewage effluent discharge, dust deposition, changes in flows, and/or non-point sources. Camp, Sheardown, and Mary lakes, which receive drainage from these tributaries / streams may also be affected by these pathways. Therefore, the following review provides a summary of existing baseline data collected in these Mine Area streams and lakes to facilitate a preliminary qualitative review of the adequacy of the baseline data set for post-Project monitoring.

The review examined the following:

- Locations of sampling sites in relation to predicted Project effects;
- Sampling methods; and
- Quantity of information.

5.2.4.1 Benthic Invertebrates

Benthic invertebrate sampling was initiated in 2005 in the Mine Area, and initially included sampling of streams only. The program was expanded in 2006 to include lakes and additional stream sampling sites. The following provides an overview of the methods recommended in the EEM guidance document and comparison of baseline data to these methodologies to identify appropriateness of existing data for post-Project monitoring.

Sampling Areas

Locations of baseline benthic invertebrate sampling are illustrated in Figure 5.2, 5.4, 5.6 and 5.8 (attached in Schedule 1). Baseline studies have included sampling in all of the waterbodies identified above.

Sample Size

Environment Canada (2012) recommends benthic invertebrate sampling should include at a minimum, 5 replicate stations, each consisting of a minimum of 3 sub-samples, for both the exposure and reference areas. Replicate stations should be located within the dominant habitat class to reduce variability (where possible). Actual number of samples may vary on a site-specific basis and existing data should be analysed to identify adequate sample size.

Baseline sampling has included between 3 and 7 replicate stations within streams and lakes in the Mine Area, depending on the year and area sampled; the exception was in 2005 when only 1 replicate station was sampled (Tables 5.1 and 5.2). In general, five sub-samples were collected for each replicate station (the exception was for Mary Lake in 2007 where only one sub-sample was collected for logistical reasons).

Sampling Equipment and Mesh Size

Environment Canada (2012) recommends the use of quantitative sampling equipment and specifically, grab samplers such as a Ponar or Ekman dredge for depositional habitats and stream-net samplers for erosional habitats in freshwater systems.

All baseline data collected in lakes used either an Ekman or a Ponar dredge and all stream/river sampling used a Surber sampling device (Tables 5.1 and 5.2). Methodologies are thus consistent with the guidance document.

Environment Canada (2012) recommends the use of a 500 µm mesh size for the freshwater environment and that samples should be preserved in 10% buffered formalin.

All sampling for the Mine Area lakes and streams, with the exception of samples collected in 2005 when a mesh size of 250 µm was used, used a 500 µm mesh size and 10% buffered formalin.

Timing of Sampling

Timing of sampling should be concentrated within a single sampling season and should consider timing of previous sampling and the most ecologically relevant season. Timing should also occur during effluent discharge but after the receiving environment has been exposed to the effluent for sufficient period during which effects would reasonably be expected to occur (i.e., generally within 3-6 months).

Benthic invertebrate sampling has been conducted in the Mary River Mine Area in summer/fall, with the most recent data collected in late August-September time period. This is an ecologically relevant time for sampling and would be most appropriate considering the effluent discharge regime (i.e., discharge during the open-water season only) and hydrology (i.e., streams/rivers freeze solid).

Taxonomic Identifications

Environment Canada (2012) recommends taxonomic identification to the family level for first and subsequent monitoring of freshwater systems but that finer taxonomic resolution may be required to detect more subtle effects.

All benthic invertebrate sorting and taxonomic identifications were conducted by the same laboratory (Zaranko Environmental Assessment Services [ZEAS] Inc., Nobleton, ON), using the same laboratory methods among study years. Macroinvertebrates were identified to the lowest practical level using the most recent publications. Most taxa were identified to the level of Genus or Species, with the exception of flatworms, mites, and harpacticoid crustaceans, which were identified to Order.

5.2.4.2 Fish Populations / Communities

Sampling of the fish community was initiated in 2005 in the Mine Area; Year 1 of the baseline studies was primarily a reconnaissance exercise aimed at identifying fish species present in the area and general distribution. Subsequent studies examined:

- Fish distribution across the Mine Area streams and identification of fish barriers;
- Fish movements (Arctic Char) between water bodies;
- Fish population characteristics and condition (catch-per-unit-effort, age structure, length/size at age, sex and sexual maturity, condition factors, deformities, erosion, lesions, and tumours, and internal and external parasites);
- Seasonal movement of Arctic Char from lakes into and out of streams/rivers;
- Anadromy;
- Seasonal use of various habitat types by different life history stages;
- Metals in liver and muscle; and
- Spawning areas/timing.

The Mine Area streams and lakes support only two fish species: land-locked Arctic Char (Salvelinus alpinus); and, Ninespine Stickleback (Pungitius pungitius). Of these, abundance of Ninespine Stickleback is relatively limited and highly localized while Arctic Char are overwhelmingly the most abundant fish species in the area. As Mine Area rivers and streams freeze solid during winter, overwintering habitat is provided exclusively by lakes.

Environment Canada (2012) recommends monitoring of sexually mature individuals of a minimum of two fish species for EEM programs and use of invasive sampling (i.e., lethal) if acceptable. Alternative study designs include non-lethal sampling methods for fish populations/communities, as well as studies of juvenile fish if appropriate and/or required.

The following provides an overview of the methods recommended in the EEM guidance document and comparison of baseline data to these methodologies to identify appropriateness of existing data for post-Project monitoring.

Given that there are only two fish species present in the area, fish monitoring in the Mine Area would be limited to successful capture of sufficient numbers of both of these fish species in the exposure areas. In most lakes and streams in the exposure area, Arctic Char are sufficiently abundant that successful capture of enough fish for monitoring purposes is possible. In contrast, Ninespine Stickleback are absent or uncommon in a number of water bodies, including the two primary receiving environments (Camp Lake Tributary 1 and the Mary River). Similar results have been observed in most water bodies surveyed for all components of the Mary River Project. It is unlikely, even with extensive effort, that sufficient numbers of Ninespine Stickleback could be captured for monitoring purposes from either the receiving environments or from prospective reference areas. It is therefore proposed that only a single species, Arctic Char, be used for the EEM program.

The exposure areas downstream of Mine effluent discharges (i.e., the Mary River and Camp Lake Tributary 1) support primarily juvenile Arctic Char and few sexually mature individuals. The mean length of Arctic Char captured in exposure area streams is typically in the 100-110 mm range (Table 7). In lakes, the mean size is 300-400 mm. Analysis of sexual maturity in Arctic Char captured from study area lakes indicates that both sexes generally reach maturity at lengths greater than 250 mm. Although sufficient numbers of mature individuals could be sampled from exposure area lakes, it would not be possible to collect enough from the primary receiving environments. It is therefore proposed to apply the Environment Canada (2012) methods for monitoring immature fish in these areas. Monitoring conducted in Mine Area lakes would include sampling of sexually mature and immature individuals of the populations.

It is proposed to apply non-lethal sampling methods as there is concern that lethal sampling may exert substantive impacts on the fish populations, particularly in a smaller stream such as Camp Lake Tributary 1.

<u>Sampling Areas and Timing of Sampling</u>

Environment Canada (2012) recommends the exposure area should be selected to ensure that the fish collected have been exposed to the effluent. Timing of sampling should consider the time of year, hydrology/habitat variability, stage of reproductive development, and effluent discharge regime. Fish biology will also affect timing of sampling (e.g., seasonal use of exposure areas). Reference and exposure areas should be sampled as close in time as feasible.

Locations of baseline fish sampling are illustrated in Figures 5.2, 5.4, 5.6 and 5.8. Baseline sampling of Camp, Sheardown and Mary Lakes with standard index gill nets typically occurred during summer (late July/early August) with some fall sampling to identify spawning locations. Sampling in exposure area streams was conducted during spring, summer and fall to document seasonal use of stream habitat by both species of fish.

<u>Sample Size</u>

For non-lethal sampling, Environment Canada (2012) recommends sampling of a minimum of 100 fish older than young of the year (YOY) for each study site but also recommends retaining and measuring all YOY collected during the sampling for older fish. Where possible, fish older than YOY should represent the whole range of fish sizes and be representative of the population (mature and immature).

The numbers and size range of fish captured in the primary receiving environments during baseline studies (Tables 6 and 7), suggest that capturing a minimum of 100 fish older than YOY over a broad size range is feasible in both areas. Minimum requirements should also be achievable in exposure area lakes.

<u>Metrics</u>

Non-lethal sampling should include length (±1 mm), weight (± 0.01 g), assessment of external condition (i.e., DELTs), external sex determination (if possible), and age (where possible). Baseline studies included measurement of all of these metrics.

<u>Sampling Equipment</u>

Environment Canada (2012) indicates the same gear type should be used for sampling reference and exposure areas and ideally only one gear type is used for the fish study. In streams and nearshore areas of lakes, backpack electrofishing has been the primary method of sampling and will be used for sampling these areas during the EEM program. Standard index gillnetting has been used for baseline lake surveys and will continue to be used during the EEM program.

Baseline studies have included sampling in all of the waterbodies identified above. The robustness of the existing baseline data will be assessed through conduct of a power analysis prior to finalization of the AEMP to determine appropriate sample sizes and thresholds.

5.2.4.3 Phytoplankton

Phytoplankton was measured during the baseline studies conducted in the Mine Area to provide a measure of primary productivity. The most intensive studies were conducted in Mine Area lakes, but limited information has also been collected from a number of streams. The following provides an overview of the baseline phytoplankton data.

Locations of baseline phytoplankton sampling sites are illustrated in Figure 5.5.

Streams

Phytoplankton was sampled in the Mary and Tom rivers and tributaries to Sheardown Lake during the baseline studies. Measurements included chlorophyll a, as a general indicator of biomass. Sampling for analysis of chlorophyll a was conducted three times in the open-water seasons of 2007 and 2008 (spring, summer, and fall) in conjunction with the water quality sampling program, though not all sites were sampled during each period. There are no baseline data for Camp Lake tributary streams.

Lakes

Phytoplankton was sampled in Camp, Sheardown Lake NW, Sheardown Lake SE, and Mary Lake at 3-5 sites during the baseline studies. Measurements included chlorophyll a, as a general indicator of biomass, and phytoplankton taxonomy and biomass. Sampling for analysis of chlorophyll a and taxonomic composition was conducted twice in the open-water seasons of 2007 and 2008 in conjunction with the water quality sampling program. Chlorophyll a was also measured at a subset of lake sites in the ice-cover seasons of 2007 and 2008.

Chlorophyll a was measured approximately 1 m below the water surface and 1 m above the sediments in lakes, consistent with the water quality sampling methods. Sampling for analysis of taxonomic composition were collected from across the euphotic zone using a depth integrating sampler.

Sampling in streams consisted of near surface grab samples, consistent with the methodology applied for water quality sampling.

5.3 Core Receiving Environment Monitoring (CREM) Sampling Locations

The proposed sampling locations for the CREMP are shown on Figure 5.9.

5.4 Reference Sites

5.4.1 Study Area

The objective is to identify suitable reference lakes for Sheardown Lake NW and Camp Lake, located within reasonably close proximity to the lakes. , The screening study area will initially consider lakes within a 60 km radius of Sheardown Lake NW and Camp Lake. This area may be reduced pending results of the initial screening.

5.4.2 Screening Criteria

Lakes within the 60 km radius from Sheardown Lake NW and Camp Lake will be evaluated against the criteria provided in Table 5.3. The screening will be done sequentially beginning with the criteria with the highest priority (i.e., lake surface area). Phase 1 screening is based solely on lake surface area. Phase 2 screening will be based on lake shape, location in the drainage basin, geology and potentially, elevation (if required). Phase 3 screening would consider lake surface area: drainage basin area ratios, existing or potential development, and potentially slope (if required).

Table 5.3: Screening Criteria

Screening Phase	Criteria
1	Size (area)
2	Lake Shape
2	Location in Drainage Basin
2	Elevation
2	Geology
3	Drainage Basin:Lake Area
3	Average drainage basin slope
3	Existing or Potential Development1
4	Shoreline Development Ratio
4	Proximity and Practicality
4	Availability of Existing Data and Traditional Knowledge

The next phase of desktop screening will involve further screening of sites based on comparable geology to that of the mine site area lakes. A short-list of candidate reference lakes will be identified for investigation during the summer of 2013

5.4.3 Integrity of Baseline Data

Components that will be reviewed include water quality, sediment quality, benthic invertebrates, and fish. The main tasks are:

- Inventory Data
- Review and summarize sampling and analysis methods
- Identify key questions and metrics
- Review existing baseline data for these sampling sites/areas
- Identify data gaps
- Advise on Study Design.

The data review willwill address adequacy of data for both the Metal Mining Effluent Regulations (MMER) Environmental Effects Monitoring (EEM) and the Core Receiving Environment Monitoring Program (CREMP) components of the overall aquatic effects monitoring program for the Mine site.

<u>Inventory Data</u>

A preliminary inventory of baseline data has been completed. This information will be compiled and summarized in the review document, focusing upon areas and water bodies that have been identified for inclusion in the EEM program and/or CREMP. Emphasis on this exercise to date has focused upon EEM exposure areas, rather than examination of the larger area that is proposed to be included in CREMP. Additionally, existing data for the Mary River, upstream of EEM discharge points will be inventoried to determine if this area may serve as a suitable upstream reference area for at least a subset of environmental components.

Review of Methods

This step will include reviewing and summarizing sampling and analysis methods, and identifying issues that will affect use of the data for post-Project monitoring. As noted above, this exercise is partially complete.

Identify Key Questions and Metrics for CREMP

Key questions will be developed (or confirmed) for CREMP to guide the review of baseline data adequacy and, ultimately, design of the monitoring program. The adequacy of baseline data to address these key questions will be addressed in the subsequent task, described below.

Key metrics, indicators, or contaminants of potential concern will be identified (or confirmed) to guide the subsequent detailed review of baseline data. These questions and metrics will be developed through discussions with Baffinland and, it is suggested, will focus upon key effects identified in the FEIS, as well as metrics identified in the MMER EEM Guidance Document.

Review Baseline Data

Sampling areas have been proposed for the EEM program and water bodies have been identified for CREMP. Baseline data for these areas will be compiled and representative data will be analysed for key metrics to determine the robustness of the existing data as a tool for monitoring post-Project effects (i.e., before-after comparisons). The precise approach may vary according to the environmental component and sampling area and may include:

- Water quality data:
    - Analysis of seasonality of water quality data in order to determine the design of the monitoring program (specifically how data should be pooled and analysed);
    - Should the seasonal analysis indicate baseline data collected in the open-water season (and/or ice-cover season) may be pooled (i.e., no seasonal differences), the pooled data set will be subject to a power analysis to determine the number of samples that will be required to detect a predefined level of change;
    - Spatial differences in existing water quality data could also be examined statistically to determine if existing sampling sites may be pooled for future analyses (e.g., multiple sites within a lake).
- Sediment quality data:
    - Review variability of sediment quality data (this comparison could include comparison between sites, replicates, and/or sampling years);
    - Conduct of a power analysis to assist with identification of the number of samples that will be required to detect a predefined level of change (the level of change will be identified for this analysis through discussions with Baffinland);
    - Comparison of sediment quality data collected from the upper 5 cm of sediment to results obtained from the upper 2 cm of sediment.
- Benthic Invertebrates:

  - Review existing sampling sites in relation to predominant habitat types in the water bodies that will be sampled under EEM and CREMP;
  - Review spatial and inter-annual differences for a subset of data;
  - Conduct a power analysis on a subset of the baseline data to determine the level of change that may be detectable through a before and after comparison (key metrics);
  - Identify appropriate sampling areas/sites based on key exposure areas for CREMP, in consideration of habitat types and existing information.
- Fish (Arctic Char):
  - Conduct a power analysis for key metrics in selected water bodies/areas to determine the level of change that may be detected using a before and after comparison. Metrics will be based on those identified for non-lethal sampling described in the EEM Guidance document.

Identify Data Gaps

Data gaps will be identified based on the tasks identified above, and will include consideration of:

- Need for establishment of additional or different sampling sites; and
- Additional baseline data collection to strengthen the robustness of the existing data.

Study Design for CREMP

Based on the review of baseline data in relation to key questions, recommendations regarding a detailed monitoring program design for CREMP will be proposed. This may include identification of sampling areas/sites, the number of samples (i.e., sample sizes), modifications to sampling methodology, and/or identification of the most sensitive metrics for detecting environmental change (in relation to potential Project effects).

Identification of thresholds for the monitoring program, which is understood will be undertaken through a separate exercise, could also be considered within this review process. Specifically, power analyses could be conducted to determine the sampling size/effort that will be required to detect the predefined level of change (i.e., exceedance of thresholds).

5.4.4 Data Analyses

Data analyses for the core receiving environment monitoring program will be consistent with the MMER and 2012 Guidance Documents.

5.5 Surveillance Network Program (SNP)

SNP Stations are located primarily at end-of-pipe (EOP) locations throughout operation (see Figure 5.18 attached in Schedule 1 and coordinates for end of pipe discharges in Schedule 4). There is an overlap between some SNP and MMER locations (stations associated with contact mine water). The SNP results are integrated into interpretation and recommendations of annual AEMP program.

5.5.1 Effluent Quantity

Daily monitoring of effluent volumes discharged to receiving environment. The coordinates for each discharge location are presented in Schedule 4.

5.5.2 Effluent Quality

Periodic sampling provides data on effluent quality that are compared to Water Licence Criteria. Refer to Schedule 3 of end of pipe water quality criteria.

Effluent quantity and quality together provide concentration and loadings data for downstream receiving environments.

5.5.3 Acute Toxicity

Periodic acute toxicity testing for end of pipe sewage effluent discharge locations provides data on possible acute impacts to effluent exposure areas.

5.5.4 Groundwater Quality

Inputs to receiving environment via shallow groundwater are measured and can be integrated into overall interpretation of AEMP results (minor non-point sources).

5.6 Environmental Effects Monitoring (MMER requirements)

There are two exposure areas in the freshwater environment at the mine site, as indicated above. The protocols for the MMER are established in the 2012 guidance document, but there are some conditions at the two exposure areas that make standard sampling at the exposure areas difficult.

- Camp Lake Tributary L0
- Mary River (3 discharges)

Sampling and data analysis protocols are prescribed by the MMER. The characterization of exposure areas was initiated in 2012. Some discretion is required in the selection of exposure areas for monitoring.

Figure 6.1 (Schedule 1) shows the mine effluent discharges and exposure areas for the Mine Site.

The Camp Lake tributary area is where the west stormwater pond draining the west side of the waste rock pile will discharge to. Near field and far field exposure areas have been identified for monitoring.

There are also three mine effluent discharges to the Mary River:

- The East Pond collecting stormwater from the east side of the waste rock pile;
- The run-of-mine (ROM) stockpile; and,
- The main ore stockpile at the rail load-out area.

The Mary River above the third discharge is very high energy with steep side walls, making safe access a challenge. Additionally, the bouldery, high energy section of river is not suitable for sampling sediment or benthic invertebrates.

The EEM study design is discussed in section 6.0. The EEM study will be triggered once the flow of MMER effluent exceeds 50 m3/day.

5.7 Target Studies / Specific Studies and Follow-up

Specific effects monitoring (or targeted monitoring – whatever terminology is preferred) is defined as monitoring conducted to address a specific question or potential impact and/or studies that are relatively confined in terms of spatial and/or temporal scope. Targeted environmental studies relate to specific environmental concerns that require further investigation. Two examples of potential targeted studies are presented below.

5.7.1 Dust Deposition: Sedimentation in Surface Waters

In addition to the Core Monitoring Program that will be conducted in the Mine Area, specific effects monitoring will be conducted to monitor effects related to the introduction of dust, and other sources of suspended solids, in surface waters and subsequent deposition on aquatic habitat.

Potential Impacts

Dust will be directly deposited on watercourses during the open-water season and will be indirectly introduced from runoff within the watersheds; introduction will likely be greatest during the snowmelt/freshet period. Potential effects of dust on aquatic ecosystems includes effects on water quality (i.e., TSS, metals, nutrients, water clarity) when suspended in the water column and effects once deposited on the lake bottom or streambed. Sedimentation of dust in lakes and streams may affect aquatic biota through changes in sediment quality (e., metals, nutrients, particle size, organic matter), through changes in habitat quality (i.e., changes in substrate composition), direct effects on benthos (i.e., smothering), and direct effects on fish eggs (i.e., smothering of eggs).

Mitigation

Mitigation is described in the Air Quality Management Plan and the Surface Water and Aquatic Ecosystems Management Plan.

Monitoring

Potential effects of dust deposition on water and sediment quality are described within the Core Monitoring Program. Monitoring of dust deposition rates within the watersheds is described within the Air Quality Management Plan.

Effects of dust deposition on sedimentation rates in Mine Area lakes will also be monitored through deployment of sediment traps in Sheardown Lake. Sheardown Lake will receive direct deposition of dust as well as introduction of dust from the drainage basin.

Traps would be located at suspected Arctic Char spawning site(s) to assess potential effects of sedimentation on Arctic Char eggs, and potentially in other habitat types to assess effects to benthos. Additionally, sediment traps would be deployed in reference lakes for comparison. Traps would be deployed year-round. Traps would be emptied prior to the spawning period in suspected spawning areas, redeployed at these sites, and again retrieved and emptied following egg hatching to facilitate determination of rates of sedimentation for the egg incubation period.

The proposed threshold for assessing potential effects on Arctic Char eggs is a sedimentation rate of 1 mm over the egg incubation period.

Monitoring for effects of sedimentation in Mine Area waterbodies would also include visual assessments of dust deposition in conjunction with Core Monitoring, including sediment quality monitoring (i.e., assuming dust will be readily distinguishable from existing deposited sediments). Sediment cores will be examined for evidence of dust accumulation near the surface of the sediments through visual examination and thickness of the dust deposition layer will be measured if feasible.

5.7.2 Stream Diversions: Effects on Arctic Char Movements

In addition to the Core Monitoring Program that will be conducted in the Mine Area, specific effects monitoring will be conducted to monitor effects related to Mine Area stream diversions on Arctic Char movements.

Potential Impacts

Stream diversions in the Mine Area have the potential to affect the ability of Arctic Char to access small tributaries in the spring, which are used primarily by juvenile Arctic Char, as well as the ability of Arctic Char to move out of these streams into lakes for overwintering in the fall. Effects on Arctic Char therefore potentially include loss of use of stream habitat if fish passage is impeded in spring and/or mortalities in the event fish became stranded in the streams in fall.

Five tributary streams will be affected by diversions in the Mine Area. These streams are relatively shallow and stranding is presumed to occur occasionally in the current environment. However, there is potential for increased stranding during Project operation, closure, and post-closure.

Mitigation

Mitigation would be implemented in the event that monitoring indicated unacceptable effects on Arctic Char and may include:

- Monitoring and salvage fishery(ies) as required;
- If required, channel improvement(s) could be considered; and,
- Exclusion of Arctic Char from streams.

Monitoring

The five affected streams will be monitored in spring and fall during the initial years of operation, targeting low and high flows where possible. Results of this initial monitoring will be reviewed to determine whether either mitigation is required and/or if on-going monitoring would be required.

In spring, all five streams will be visually assessed to monitor for potential barriers and obstructions to upstream fish passage. Baseline studies have been conducted to identify areas of the streams with the greatest potential to create fish barriers and these areas will be targeted during the monitoring program. Mitigation (e.g., channel improvements) may be considered if, based on the results of the initial years of monitoring, upstream movements of Arctic Char appear to have been affected by stream diversions.

To monitor for potential fish stranding in fall, the streams will be visually assessed for fish barriers and presence/stranding of Arctic Char. If stranding is identified, a salvage fishery will be conducted and Arctic Char will be transported and released to the downstream lake(s). Additional mitigation (e.g., channel improvements) may be considered if, based on the results of the initial years of monitoring, downstream movements of Arctic Char appear to have been affected by stream diversions.

5.8 Inuit Qaujimajatuqangit

The INAC (2009) AEMP Guidelines[1] reportedly provide a basis for incorporating traditional knowledge (in the case of Nunavut this is termed IQ or Inuit Qaujimajatuqangit) into AEMP programs in an efficient and effective manner. The guidelines recognize a need for a flexible process for developing and implementing AEMPs that provide opportunities for input by interested parties including local communities and organizations. This is to ensure that Inuit interests and needs are understood and respected, especially in regard to potential effects of land or water use in potentially affected watersheds. The INAC (2009) AEMP Guidelines present three key sources of IQ that contribute to an understanding of the environment.

1. Shared information within the community, and an oral history spanning multiple generations including specific observations, patterns of biophysical, social, and cultural phenomena, inferences relative to cause and effect, and predictions of the impacts of human activities. This information is obtained by means of direct observation and experience of the Inuit peoples.
2. Essential information on the use and management of the environment which can enhance understanding of cultural practices and social activities, land use patterns, archeological sites, harvesting practices, and harvesting levels, both now and in the past.
3. Information on the values that people place on the environment.

During the initial development of this AEMP Framework document, the Qikiqtani Inuit Association (QIA) was invited to attend and participate in stakeholder meetings so that IQ could be incorporated into AEMP development and the implementation process. During these meetings, several of the participants had extensive experience with past projects where attempts were made to incorporate IQ and western science based programs as part of the AEMP. These participants openly shared their experiences with meeting attendees especially in regard to the difficulties involved in successfully incorporating IQ into AEMPs which by their very nature are highly scientific and statistical. However, success was made, and based on suggestions and discussions between Baffinland and QIA, and the application of the INAC (2009) Guidelines, the following initiatives are proposed for consideration.

- During future meetings, Baffinland and Inuit representatives familiar with the Project area could discuss the status of current IQ in relation to:
    - Baseline conditions within the study area and IQ knowledge in regards to the structure and function of the aquatic ecosystem in the Project Study Area (PSA).
    - Historic perspective and understanding of variability associated with the aquatic ecosystems.
    - Traditional direct and indirect resource uses by Inuit of the aquatic ecosystem within the PSA and validation of the potential effects of the Project on traditional activities as identified in the FEIS.
- As has been the practice over the last two years, Baffinland will continue to recruit and train local skilled Inuit environmental technologists to assist with future AEMP field sampling and monitoring programs. In this way, Baffinland Project staff can continue to mentor local Inuit in regards to the scientific and technical aspects of the AEMP and the Inuit can share their practical, historical, and traditional knowledge with Baffinland personnel.

[1] Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories: Overview Report, Indian and Northern Affairs Canada (INAC) Yellowknife, Northwest Territories, June 2009 Version

- Documentation of the above initiatives so that an IQ database as related to the AEMP can be developed, shared with others, and included in annual reports.

Periodic AEMP workshops will be held and QIA/community members who have expertise in the IQ aspects of aquatic ecosystems can participate and contribute to future program development and changes.

6.0 EEM Study Design

6.1 Purpose

The study design describes in detail how the first cycle EEM monitoring study will be undertaken. It outlines the proposed activities involved in the investigation of water quality, sediment quality, and freshwater biota community at a number of pre-determined sampling areas in the Camp Lake Tributary and Mary River which are the freshwater receiving water bodies for treated effluent being discharged from the Project. Figure 6.1 presents the locations of all near field and far field exposure areas on the Camp Lake Tributary and Mary River. Table 6.1 provides the coordinates of all exposure and proposed reference areas for the study design. The baseline environmental data collected to date at the exposure and reference areas by North/South Consultants Inc. (NSC) and Knight Piésold Limited (KPL) on behalf of Baffinland are also discussed in this study design.

Table 6.1: Freshwater EEM Study Design Exposure and Reference Area Coordinates		
Study Area ID	**Latitude (deg. min. sec.)**	**Longitude (deg. min. sec.)**
Camp Lake Tributary Near Field Exposure Area	71° 19’ 48.89” N	79° 21’ 44.43” W
Camp Lake Tributary Far Field Exposure Area	71° 19’ 46.21” N	79° 22’ 43.90” W
Camp Lake Tributary Reference Area 1 (Tote Road)	71° 38’ 22.72” N	80° 22’ 42.26” W
Camp Lake Tributary Reference Area 2 (Tote Road)	71° 31’ 51.36” N	80° 15’ 56.58” W
Camp Lake Tributary Reference Area 3 (Rail Alignment)	71° 16’ 32.28” N	79° 07’ 46.62” W
Camp Lake Tributary Reference Area 4 (Rail Alignment)	71° 15’ 48.80” N	79° 05’ 17.20” W
Mary River Near Field Exposure Area (SW & Fish at outfall)	71° 18' 10.05" N	79° 14' 59.29" W
Mary River Near Field Exposure Area (SED & Benthos)	71° 17’ 58.93” N	79° 15’ 17.20” W
Mary River Far Field Exposure Area	71° 17’ 05.35” N	79° 20’ 32.11” W
Mary River Alternate Far Field Exposure Area	71° 15’ 32.44” N	79° 24’ 02.56” W
Mary River Reference Area 1	71° 11’ 44.22” N	79° 58’ 11.65” W
Mary River Reference Area 2	71° 14’ 15.37” N	79° 01’ 53.99” W
Mary River Reference Area 3	71° 11’ 17.53” N	78° 37’ 34.97” W
Mary River Reference Area 4	71° 20' 18.00” N	78° 59' 46.76” W
NOTE: Exposure area coordinates represent the upstream extend of each study area, whereas the reference area coordinates represent the general area of investigation to confirm reference area suitability.		

6.2 Site Characterization and Baseline Data

6.2.1 Camp Lake Tributary Exposure and Reference Areas

The Camp Lake Tributary (CLT) located north of the existing exploration camp contains a near field exposure area and a far field exposure area. These exposure areas are located respectively upstream and downstream of the existing Tote Road. Four reference areas generally outside of the range of anticipated mining influences have been selected with similar aquatic habitat to the CLT exposure areas. Criteria evaluated during the reference site selection process included available data describing substrate type, stream flow/discharge, depth and presence of fish as well as connectivity/access to over-wintering fish habitat.

6.2.2 Camp Lake Tributary Near Field Exposure Area

The Camp Lake Tributary Near Field (CLT-NF) exposure area is positioned downstream of a fish barrier (waterfall) as illustrated in Figure 6.2. The area is characterized by moderate relief with steep vertical banks maintaining a seasonal wetted width of approximately 5.5m. Riparian vegetation includes grasses, mosses, and wildflowers. The stream has abundant undercut banks (80%) and boulders (5%) that provide in-stream cover. Baseline data has been collected in the CLT-NF exposure area by KPL and NSC. KPL has utilized sample station L1-09 in the CLF-NF exposure area during the baseline surface water quality monitoring program. NSC identified this area as Camp Lake Tributary #1 spanning from the waterfall downstream to Camp Lake. Photographs of the CLT-NF exposure area presented in Schedule 9, refer to Photo No.1 to 4.

Various baseline data collection programs have been initiated to date. Ongoing baseline surface water quality monitoring has taken place in this area since 2011. Surficial sediment quality monitoring was conducted at three locations within the exposure area in 2007, 2011 and 2012. An aquatic habitat assessment of the exposure area including benthic invertebrate and fish community surveys was conducted in 2007. Backpack electrofishing has taken place multiple times annually from 2007-2010.

6.2.3 Camp Lake Tributary Far Field Exposure Area

The Camp Lake Tributary Far Field (CLT-FF) exposure area is located downstream of the Tote Road stream crossing as illustrated in Figure 6.2. The CLT-FF exposure area begins downstream of this floodplain where the channelized stream forms a defined watercourse reporting downstream to Camp Lake. The area is characterized by moderate relief with steep vertical banks that maintain a seasonal wetted width of approximately 5.5 m. Riparian vegetation includes grasses, mosses, and wildflowers. A plunge pool and broad floodplain is located immediately downstream of the culverts. Photographs of the CLT-FF exposure area are presented in Schedule 9, refer to photo No.5 to 8.

The CLT-FF exposure area has had various baseline data collection programs conducted in the past. Ongoing surface water quality monitoring has been conducted at this location in 2005-2007, 2011 and 2012. Surficial sediment quality monitoring was conducted at three locations within the exposure area in 2007, 2011 and 2012. An aquatic habitat assessment of the exposure area including benthic invertebrate and fish community surveys was conducted in 2007. Backpack electrofishing has taken place multiple times annually from 2007-2010.

6.2.4 Camp Lake Tributary Reference Area

There are four candidate reference areas anticipated to have similar aquatic habitat as the CLT-NF and CLT-FF exposure areas. These include two areas along the Tote Road between the Mary River Exploration Camp and Milne Inlet as well as two locations proximate to the rail alignment north of Angajurjualuk Lake. Figure 6.3 (Schedule 1) presents the location of the candidate reference areas for this study including the Camp Lake Tributary reference areas.

- Camp Lake Tributary Reference Area 1

The Camp Lake Tributary Reference Area 1 (CLT-REF01) stream is located at kilometre 99 of the Tote Road between Katiktok Lake and KM 32 Lake as illustrated on Figure 6.3. This area has similar relief to the CLT exposure areas. CLT-REF1 stream has been identified as CV-099 during baseline aquatic habitat assessments and is also known as sample location N1-050 for the ongoing baseline surface water quality monitoring program. Sediment quality monitoring has not been conducted to date in this area. During the baseline aquatic habitat assessment fish community surveys were conducted in 2008 and 2009. Arctic char were collected at this station; however Ninespine stickleback were not detected. Photo No. 9 to 12 in Schedule 9 illustrate in situ conditions at station CV-099.

- Camp Lake Tributary Reference Area 2

The Camp Lake Tributary Reference Area 2 (CLT-REF02) stream is located at kilometre 78 of the Tote Road and reports to Katiktok Lake. This stream is a first order tributary to Phillips Creek western tributary that joins Phillips Creek before crossing under the Tote Road. The CLT-REF02 stream has been identified as culvert crossing CV-078 for baseline aquatic habitat assessments and is also known as sample location N1-060 for the ongoing baseline surface water quality monitoring program. Surface water quality has been monitored at the Tote Road crossing location in 2005, 2006, 2011 and 2012. Sediment quality monitoring has not been conducted in this area. Fish community surveys were conducted in 2009 and 2010. Arctic char were collected at this station but Ninespine stickleback were not detected. Photo No. 13 to 16 in Schedule 9 illustrate the in situ conditions at station N1-060.

- Camp Lake Tributary Reference Area 3

The Camp Lake Tributary Reference Area 3 (CLT-REF03) stream is located along the proposed rail alignment flowing in a south-west direction, reporting to an unnamed lake. It is located within the outer perimeter of the predicted dust plume, however it will still be evaluated as a suitable reference area. The CLT-REF03 stream has been identified as station CV-004-1 for baseline aquatic habitat assessments and is also known as sample location E2-08 for ongoing baseline surface water quality and sediment quality monitoring programs. Surface water quality at this location has been monitored in 2005 and 2012. Sediment quality monitoring was conducted in 2012 at in this area. Aquatic habitat assessments including benthic invertebrate and fish community surveys were completed in 2008. Photo No. 17 to 20 in Schedule 9 illustrate the in situ conditions at station E2-08 and CV-004-1.

- Camp Lake Tributary Reference Area 4

The Camp Lake Tributary Reference Area 4 (CLT-REF04) stream is located along the proposed rail alignment flowing in a westerly direction, reporting to an unnamed lake. CLT-REF04 stream has been identified as station CV-006-1 during baseline aquatic habitat assessments. Surface water quality at this location was monitored in 2008 during fish community sampling surveys. Sediment quality monitoring has not been conducted to date at this location. Photo No. 21 to 24 in Schedule 9 illustrate the in situ conditions at station CV-006-01.

6.2.5 Mary River exposure and Reference Areas

Mary River (MR) is located south east of Deposit 1 and the proposed mine site. The exposure area of the river will receive three discrete MMER effluent inputs listed in descending order, upstream to downstream:

- East waste rock pond discharge,
- Run of mine (ROM) pond discharge and
- Ore stockpile runoff located at the same discharge point as the treated sewage effluent discharge proximate to the proposed rail alignment crossing.

The MR aquatic habitat between these effluent discharge points is a high energy environment dominated by a boulder substrate and steep banks. Baseline surface water quality monitoring has been collected from the bank at various locations throughout the MR exposure area. Benthic invertebrate and sediment samples have not been successfully collected in this section due to the in situ conditions and safety concerns involved with these activities. Fish community surveys have been restricted to shoreline habitat sampling due to high stream velocity restricting mid-stream access.

Three reference areas geographically outside of the range of anticipated mining influences have been selected with similar aquatic habitat to the MR exposure areas. Criteria evaluated during the reference site selection process included available data describing substrate type, stream flow/discharge, depth and presence of fish as well as connectivity/access to over-wintering fish habitat.

6.2.6 Mary River Near Field Exposure Area

The Mary River flows in a southwest direction reporting to Mary Lake approximately 12.8km downstream. This area has bank full heights of approximately two metres with an additional area of floodplain that is temporarily submerged during spring freshet. Following the high energy river sections proximate to the MMER discharge locations the Mary River Near Field (MRY-NF) exposure area stream spreads across a broad floodplain in many braided channels. These braided channels become one defined watercourse approximately 1350m upstream of the Sheardown Lake (SDL) outlet channel confluence.

This study proposes to sample surface water quality and conduct the fish population survey beginning at the ore stockpile discharge as illustrated on Figure 6.4 due to the turbulent river conditions in the upstream MRY-NF reaches. The fish population survey will be extended into the downstream sections of the river as deemed by catch per unit effort (CPUE). Sediment quality and benthic invertebrate sampling is proposed to occur between the SDL confluence and upstream braided sections of the MR where baseline data has been successfully collected.

Surface water quality near the ore stockpile runoff discharge location has been monitored at sample location E0-21 in 2011 and 2012. Station E0-20 is located on the MR where the braided channels merge together to form a defined river channel that has also been sampled in 2011 and 2012.Sediment quality monitoring was conducted in 2011 at station E0-20 and E0-21. Station E0-01 is located immediately upstream of the SDL confluence channel where sediment quality monitoring was completed in 2007.Benthic invertebrate sampling utilizing a surber sampler was completed at station E0-20 in 2007 with fish community surveys completed in 2006 and 2008 in this area. Photo No. 25 to 32 in Schedule 9 illustrate the in situ conditions at stations E0-20 and E0-21.

6.2.7 Mary River Far Field Exposure Area

The Mary River Far Field (MRY-FF) exposure area upstream extent is located approximately 2300m downstream of the SDL confluence as illustrated on Figure 6.5. The river follows a meandering path with wetted widths of approximately 40-50m. Some reaches have shallow cobble shoals with deeper pools and runs.

Baseline surface water quality monitoring at station C0-05 was conducted in 2007, 2008 and 2011. Sediment quality sampling at station C0-05 was conducted in 2007 and 2011. A fish community survey has not been conducted at this location on the river however the barrier-free conditions between MRY-FF and MRY-NF allow fish migration through both exposure areas. A fish community/population survey is not proposed for the MRY-FF exposure area. Photo No. 33 to 36 in Schedule 9 illustrate the in situ conditions at station C0-05.6.2.8Mary River Alternative Far Field Exposure Area

The Mary River Alternate Far Field (MRY-AFF) Exposure Area has been included in this study design in order to provide an option for a far field exposure area should the originally proposed MRY-FF area be deemed unsuitable. The MRY-AFF is located approximately 3km upstream of Mary Lake with a similar aquatic environment as MRY-FF. Station C0-01 is located at the downstream extend of the MRY-AFF exposure area and has been utilized for baseline environmental monitoring.

Ongoing baseline surface water quality monitoring at station C0-01 has been conducted in 2005, 2006, 2007 and 2012. Sediment quality sampling at station C0-01 was conducted in 2005, 2007 and 2012. A fish community survey has not been conducted at this location on the river however the barrier-free conditions of MRY-AFF, MRY-FF and MRY-NF allow fish migration through both exposure areas. A fish community/population survey is not proposed for the MRY-AFF exposure area.

6.2.8 Mary River Reference Areas

Four reference areas have been selected with similar aquatic habitat to the MR exposure areas. These streams are 11 to 27km away from the MRY-NF exposure area in separate drainage basins. One area is located north of Inuktorfik Lake while the remaining two locations are proximate to the rail alignment north of Angajurjualuk Lake.

- Mary River Reference Area 1

Mary River Reference Area 1 (MRY-REF01) flows in a southwest direction, this unnamed stream reports to Inuktorfik Lake east of the Ravn River (see Figure 6.3). This area has low relief with a predominant meandering pattern and a similar aquatic habitat as the MRY-NF exposure area. Aerial surveillance of this stream indicated that the substrate, width and general gradient also appeared to be similar to the MRY-NF exposure area. Arial surveillance of this area took place in 2012 with a detailed field data collection program planned for 2013 to confirm this area's suitable as a reference area. Photo No. 37 and 38 in Schedule 9 illustrate the in situ conditions in this area.

- Mary River Reference Area 2

The Mary River Reference Area 2 (MRY-REF02) is located along the proposed rail alignment. This stream flows in a southern direction reporting to north shore of Angajurjualuk Lake. This area is marginally within the predicted dust plume of the mine as illustrated on Figure 6.3. Some baseline data collection programs have been conducted in this area that included station S2-010 and BR-011-1. Baseline surface water quality monitoring at station S2-010 was conducted in 2006 and 2011. Sediment quality sampling has not been conducted at this location to date. An aquatic habitat assessment at station BR-011-1 located upstream of station S2-010 was completed in 2008. Photo No. 39 and 40 in Schedule 9 illustrate the in situ conditions at station BR-011-1.

- Mary River Reference Area 3

Mary River Reference Area 3 (MRY-REF03) is also located along the proposed rail alignment. This stream flows in a south west direction reporting to Angajurjualuk Lake near the outlet of the Ravn River. This area is outside of the predicted dust plum, approximately 27km south east of the exposure areas. Baseline data collection programs have been conducted in this area that included station S2-020 and BR-025-1. Surface water quality monitoring at station S2-020 was conducted in 2006 and 2011. Sediment quality sampling has not been conducted at this location to date. An aquatic habitat assessment was conducted at station BR-025-1 that is located upstream of station S2-020. A fish community survey was also completed at BR-025-1 in 2008. Photo No. 41 and 42 in Schedule 9 illustrate the in situ conditions at station BR-025-1.

- Mary River Reference Area 4

Mary River Reference Area 4 (MRY-REF04) is located upstream of the MR waterfall outside of the estimated dust plume. This area is being considered as per Environment Canada suggestion that this area may serve as a water quality, sediment quality and benthic invertebrate assessment area. It is acknowledged that the MR waterfall poses an impassable barrier to fish and no fish species have been detected in this area during baseline aquatic assessment campaigns. Surface water quality monitoring at station G0-09 was conducted in 2006, 2007 and 2012. Sediment quality monitoring at station G0-09 was conducted in 2006, 2007, 2009, 2010 and 2012. Similarly, baseline benthic invertebrate and fish community surveys have also taken place at G0-09. Photo No. 43 and 44 in Schedule 9 illustrate the in situ conditions at station G0-09.

6.3 Study Design Methodology

6.3.1 Effluent Plume Delineation Study

Site characterization will include an effluent plume delineation study meant to confirm the estimated effluent concentration and the manner in which mine effluent will mix with the receiving environment. The effluent plume delineation study will follow guidance provided in the *Revised Technical Guidance on How to Conduct Effluent Plume Delineation Studies* document available from Environment Canada (2003) as well as information provided in the Metal Mining Technical Guidance for Environmental Effects Monitoring (MMTG) document.

Effluent discharge has been estimated for the MMER final discharge points. The 10-year low flow conditions of the receivers were generated during baseline studies using hydrology data from Project stations (Table 6.2).

The Mary River will have three final discharge points with a total estimated effluent discharge of 3,340,780 m^3/yr. The estimated 10-year low flow conditions of Mary River at the furthest downstream discharge point (E0-21) are 56,792,925 m^3/yr. The effluent concentration is estimated to be 6%, with little dilution between E0-21 and the outlet to Mary Lake.

Camp Lake Tributary will receive effluent from the west pond (MS-08). Effluent concentrations have been estimated at station L1-09, which is located upstream of the L1 and L0 stream confluence (Table 6.2). The estimated 10-year low flow conditions of Camp Lake Tributary, at station L0-01, which is upstream of the outlet to Camp Lake, is 410,110 m^3/yr. The estimated effluent concentration in Camp Lake Tributary, before reporting to Camp Lake is 46%.

Based on these calculations, effluent concentrations in the Mary River and Camp Lake Tributary are estimated to be greater than 1% within 250 m of the final discharge points.

Table 6.2: Estimated Mine Effluent and Baseline Receiving Water Flows

Effluent Source	Receiving Water	Station ID	Baseline Receiver Discharge at Stn (m^3/yr)	Estimated Effluent Discharge (m^3/yr)
East Pond (MS-09)	Mary River	E0-10	53,166,261	3,133,194
ROM Pond (MS-07)	Mary River	E0-12	N/A	97,573
Ore Stockpile Runoff (MS-06)	Mary River	E0-21	56,792,925	109,951
		TOTAL	**56,792,925**	**3,340,718**
West Pond (MS-08)	Camp Lake Tributary (upstream of L0)	L1-09	332,139	354,060
West Pond (MS-08)	Camp Lake Tributary (upstream of Camp Lk.)	L0-01	410,110	354,060
		TOTAL	**410,110**	**354,060**

NOTE: Discharge data provided in the Final Environmental Impact Assessment, Revised April 2012

6.3.2 Water Quality Monitoring

Sampling and analysis of water quality will be undertaken as part of the first cycle EEM study to compare the current water quality of the reference locations to that of the exposure locations. Water quality samples will be taken concurrently with sediment and benthic sampling unless otherwise noted. Samples will be obtained by sub-surface grabs at least 15 cm below the surface (for total water depths of less than 2.0 m) directly into pre-labelled laboratory sample containers. For stations deeper than 2.0 m, a Kemmerer bottle will be used to obtain composite samples from the subsurface and near bottom layers. Sampling will proceed from the least "impacted" areas (reference areas) to the most "impacted" station. Field staff will wear laboratory gloves at all times during sampling.

All samples will be preserved according to protocol and stored at 4°C in a chilled cooler until delivered for laboratory analysis. Sample identification, date, time and other pertinent project information will be recorded in a field logbook, on the sample container and on the Chain of Custody (COC) forms.

All water samples will be submitted to the selected analytical laboratory for the following analyses as prescribed by the MMER and the MMTG document: total metals (Ag, Al, As, Ba, B, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Ni, Na, Pb, Sb, Se, Si, Ti, Te, U, V, Zn, Ra 226), cyanide, hardness, dissolved anions (chloride, fluoride, sulphate, nitrite, nitrate), total suspended solids, alkalinity, ammonia, total phosphorus, total organic carbon and pH.

Detection limits for the above parameters will be at or below the site specific receiving water quality criteria based on the CCME guidelines for the protection of freshwater aquatic life. Field measurements of standard water quality parameters; pH, conductivity, dissolved oxygen (DO), turbidity, temperature and stream discharge will also be recorded at each study area using portable instruments, calibrated daily with standards of known value.

For QA/QC purposes a laboratory prepared trip blank will accompany all water samples during sampling and transport. Field blanks for 10% of the samples will also be performed. In addition, three discrete water quality samples will be collected at each study area as recommended in the MMTG document. Laboratory blanks, duplicates, spikes and reference standards will be employed according to standard operating procedures. COC forms will accompany all samples for identification, tracking and transporting purposes. The level of QA/QC employed will provide confidence in the data collected.

6.3.3 Sediment Quality Monitoring

Sampling and analysis of sediment quality will be carried out as part of the first cycle EEM program to compare the current sediment quality of the reference locations to that of the exposure locations. Surficial sediment samples (top 2 cm) will be collected from all sampling areas, concurrently with water quality and benthic sampling, using a core-type sampler. Samples will be obtained for chemical, particle size and total organic carbon (TOC) analyses. One discrete sediment sample will be obtained for each replicate benthic sample transect (ie. five samples from each exposure and reference area) when possible.

Where coarse substrate such as sand, gravel or cobble exists, samples will be obtained for particle size analysis as related to the benthic invertebrate sample stations. As described in Section 2, baseline data indicates little depositional areas in the high energy exposure environments. All samples will be placed in clean, pre-labelled glass jars as per the analytical laboratory requirements. All samples will be kept chilled at 4°C until samples are delivered for laboratory analysis.

All sediment samples submitted to the laboratory will be analyzed for the following chemical parameters; metals (Ag, Al, As, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Ni, Pb, Sb, Se, Ti, Te, U, V, Zn) P, B, S, Si and pH. Particle size distribution and TOC analyses will also be performed on each sample.

For QA/QC purposes, one field duplicate sample will be collected for every ten sediment samples, and will be analyzed separately. COC forms will accompany all samples for identification, tracking and transporting purposes. The level of QA/QC employed will provide confidence in the data collected.

6.3.4 Benthic Invertebrate Survey

A benthic invertebrate community survey will be conducted as part of the first cycle EEM study as required by the MMER. The results of this survey will compare the current benthic invertebrate communities between the exposure and reference areas. It is proposed that the benthic invertebrate survey take place in the late summer or early fall (late July to late August), as previous studies have indicated that this is an appropriate season to ensure the collection of the widest diversity of invertebrates. The collection of benthic invertebrates will take place at the selected sampling areas.

For the benthic survey, the values of α and β will both be set at 0.1. This will result in a power of 0.9. To achieve this, the sample size will be set at five. Five replicate stations will be located within each of the exposure and reference sampling areas. Each replicate station will be approximately six times the bank-full width apart.

The spatial extent of each sampling area will be approximately 30 times the bank-full width, or of ample distance to accommodate the required number of replicate samples. Three replicate field sub-samples will be collected at each of the five replicate stations (transects). The replicate field sub-samples will be collected and preserved as discrete samples and analyzed separately. These field sub-samples will be placed randomly within the replicate station so that all members of the benthic community within the area have an equal chance of being collected. Replicates are needed to ensure that a larger surface area at each station is collected, resulting in a larger proportion of the benthic community represented in the results.

Benthic samples will be collected from similar habitats at each of the monitoring areas. At all replicate stations and sampling areas the substrate type, stream width/depth, flow dynamics and vegetation will be evaluated prior to sample collection. The benthic samples will be collected using a Surber sampler at all the stations. The same collection gear will be used at all stations. All samples will be sieved in the field using a 500 micron sieve (tray or bucket).

The surficial area sampled will be recorded for each sample collected. Each replicate will be collected, stored separately and preserved with 10% buffered formalin solution. The habitat at each station will be described in detail while in the field, and the field collection record will be completed for each station. COC forms will accompany all samples for identification, tracking and transporting purposes.

Sample Processing

Benthic samples will be analyzed by an experienced taxonomist. All samples will be sorted with the use of a stereomicroscope (10X). A second independent taxonomist will verify the original analyses.

Samples will be washed through a 500 micron sieve and sorted entirely, except in the following instances: those samples with large amounts of organic matter (i.e., detritus, filamentous algae) and samples with high densities of major taxa. In these cases, samples will be first washed through a large mesh size sieve (3.36 mm), to remove all coarse detritus, leaves, and rocks. Large organisms such as leeches, crayfish, fourth instar dragonflies, stoneflies, and mayflies retained in the sieve will be removed from the associated debris. The remaining sample fraction will be sub-sampled quantitatively, if necessary. For QA/QC evaluation, the sorted sediments and debris will be re-preserved and retained for up to six months following submission of the second cycle interpretive report. For those samples that were sub-sampled, sorted and unsorted fractions will be re-preserved separately. Sorted organisms will be re-preserved.

Taxonomy

All invertebrates will be identified to the lowest practical level, usually family level. Additional identification of leeches, oligochaetes, stoneflies, mayflies (*Baetis, Stenomena* and *Hexagenia*), dragonflies, amphipods (*Gammarus*), adult beetles and bugs may be identified to species.

Chironimids and oligochaetes will be mounted on glass slides in a clearing media prior to identification. In samples with large numbers of oligochaetes and chironomids, a random sample of no less than 20% of the selected individuals from each group will be removed from the sample for identification, up to a maximum of 100 individuals.

Following identification and enumeration, a detailed list of individuals collected will be submitted for each replicate field sub-sample. The list will be in a standard spreadsheet format.

Data Evaluation

All data will be entered into an electronic database with controlled access. Screening studies will be employed to check for transcription errors or suspicious data points. An individual not responsible for entering the data will confirm that the data entered represents the original. Missing data will be distinguished from absence of particular taxa by using non-zero value codes, with definitions built into each file.

The variation among stations within the study area, among samples within the stations (field sub-samples) and analytical variation (among laboratory replicates) will be calculated as estimates of the components of variation in the data set and compared to the expected values.

The benthic community will be investigated to determine if mine discharge is having an effect on the receiving system, as defined by Environment Canada (2002). An effect will be deemed to have occurred in the benthic community when a significant statistical difference between the exposure and reference areas is found for one or more of the key descriptors. The critical effect size of +/- 2 standard deviations will be used for determining an effect as per the MMTG document.

Using all of the following community indices (Table 6.3), within an Analysis of Variance (ANOVA) model for control/impact designs, the benthic community at each exposure area will be compared to the reference areas to determine effect and provide supporting data:

Table 6.3: Benthic Invertebrate Community Survey Effect Indicators and Endpoints	
Effect Indicator	**Effect Endpoints**
Total benthic invertebrate density (TID)	Number of animals per unit area
Evenness index	Simpson's evenness
Taxa (family) richness	Number of taxa
Similarity index	Bray-Curtis index
NOTE: Modified from MMTG guidance document Table 1-2	

QA/QC

Triplicate field sub-samples from each replicate station will be collected for benthic invertebrate analyses, to compensate for the spatial variability encountered with these organisms. Appropriate QA/QC measures related to processing and identification, as outlined in the MMTG document will be followed. These measures will incorporate the proper steps related to re-sorting, sub-sampling and maintenance of a voucher collection, as needed. The voucher collection will be taxonomically analysed by a second qualified invertebrate taxonomist.

6.3.5 Fish Community, Population and Usability Survey

Fish Community

Sufficient historic data have been collected to properly characterize the freshwater fish community in the study areas. Only two fish species are present in the exposure areas; Arctic char and Ninespine stickleback. A fish population survey will be conducted as discussed below; any new fish species collected during this study will be documented in the final interpretive report.

Fish Population

A fish population survey of the exposure and reference areas will be conducted as required under the MMER. This is required as the effluent concentration is estimated to be above 1% at a distance of 250 metres from the final discharge points. This study will attempt to collect sufficient numbers of the two sentinel species Arctic char and Ninespine stickleback to conduct statistical analyses at the appropriate power. All reasonable efforts will be made to collect sufficient numbers of fish; however, historic collection data indicates anticipated challenges for collection of sufficient numbers of Ninespine stickleback. EC officials will be notified of insufficient collection numbers and an agreed upon course of action will be followed to complete the study.

Non-destructive capture methods will be employed as the primary methods for all fish population sampling. Non-destructive techniques will include electrofishing, trap-netting and minnow trapping, with electrofishing utilized as the primary means of conducting the survey. As noted in the site characterizations, the study areas provide habitat for immature fish with limited available habitat. A non-lethal survey will pose less of an impact on the fish population than a lethal survey.

Sections of aquatic habitat within the vicinity of each sample area will be fished. The operator of the electrofishing unit will start at a downstream location (relative to the area) and fish in an upstream direction towards any natural barriers (e.g., riffle, waterfall or natural dam). In this manner, all fish resident in the section of stream being sampled can be captured for analysis. A summary table of the specific sampling dates, collection method, fish species and corresponding numbers collected as well as a calculated catch per unit effort (CPUE) will be included in the final interpretive report.

The fish community survey will follow the non-lethal fish sampling requirements as outlined in the MMTG guidance document. Attempts will be made to capture at least 100 individuals older than young of the year (+YOY) for each of the two sentinel species. This will allow sufficient numbers for the application of robust parametric tests during analysis. Any YOY individuals collected will be measured and the proportion of fish that are YOY will be estimated from the first 100 fish collected.

All fish captured will be released alive except for a sub-sample to be retained for aging purposes.
Tables 6.4 and 6.5 outline the fish survey measurements and effect indicators proposed for this study:

Table 6.4: Fish Survey Measurements, Expected Precision and Summary Statistics

Measurement Requirement	Expected Precision	Reporting of Summary Statistics
Length (fork and total)	+/- 1mm	Mean, median, SD, standard error, minimum and maximum values for sampling areas
Total body weight (fresh)	+/- 1.0%	Mean, median, SD, standard error, minimum and maximum values for sampling areas
Age	+/- 1year	Mean, median, SD, standard error, minimum and maximum values for sampling areas
Abnormalities	N/A	Presence of any lesions, tumours, parasites, or other abnormalities.
Sex	N/A	N/A
NOTE: Modified from MMTG guidance document Table 3-1		

Table 6.5: Fish Population Effect Indicators and Endpoints

Effect Indicator	Non-lethal Effect and Supporting Endpoints
Survival	Length-frequency distribution Age-frequency distribution (if possible)

Growth	Length of YOY (age 0) at end of growth period Weight of YOY (age 0) at end of growth period Size of YOY+ (age 1+) Size at age (if possible)
Reproduction	Relative abundance of YOY (% composition of YOY) YOY survival
Condition	Body weight at length
NOTE: Modified from MMTG guidance document Table 3-3	

Aging using scales will be undertaken. The preservation of additional aging structures (otoliths) will be attempted. Aging structures will be removed from a minimum of 10% of the test populations sampled. These specimens will also be sexed to determine the male/female ratio of the test population.

Data will be tested for normality and homogeneity of variance prior to specific hypothesis testing. Transformations of the original data will be performed to normalize or homogenize the variances, where needed. An ANOVA model will be used to test for population differences related to the areas sampled (Reference versus Exposure), for length, weight, and condition factor provided the populations are normally distributed, of equal variance and independent of one another. An ANCOVA model will test for interactions for size-at-age and condition factor (length versus weight by area). These analyses will be robust enough to provide the required information to compare fish populations among areas during this study.

Fish Usability

Effluent quality has been estimated using humidity cell testing results of the ore, local precipitation volumes as well as contact time that precipitation will have with the ore and waste rock stockpiles. The effluent quality is not expected to possess mercury concentrations ≥0.01 µg/L, therefore a fish usability study is not proposed in this study design. Should effluent characterization results report concentrations of mercury ≥0.01 µg/L, a fish usability study will be undertaken as required by the MMER.

6.4 Closure

Additional baseline data will be collected during the 2013 sampling period to bolster the baseline data set and confirm in situ conditions at the proposed study areas. All components of this study will satisfy the strict requirements for EEM studies, as prescribed under the MMER and other related guidance documents.

6.5 References

Baffinland Iron Mines Corporation Mary River Project Freshwater Aquatic Environment Baseline Draft Report: Fish and Fish Habitat. March 2008.

Baffinland Iron Mines Corporation Mary River Project Freshwater Aquatic Biota and Habitat Baseline Synthesis Report 2005-2010. November 2010. North/South Consultants Inc.

Environment Canada, 2003. Revised technical guidance on how to conduct effluent plume delineation studies. National EEM Office, National Water Research Institute and Environment Canada. March 2003.

Environment Canada. 2012. Metal Mining Technical Guidance for Environmental Effects Monitoring. The National Environmental Effects Monitoring Office.Minister of Justice. 2012. Consolidation Metal Mining Effluent Regulations. SOR/2002-222. Current to September 12, 2012.

7.0 Quality Control and Quality Assurance (QA/QC)

7.1 Water Quality

For QA/QC purposes a laboratory prepared triple blank will accompany all water samples during sampling and transport. Field blanks for 10% of the samples will also be performed. In addition, three discrete water quality samples will be collected at each study area as recommended in the Metal Mining Technical Guidance (MMT)G document. Laboratory blanks, duplicates, spikes and reference standards will be employed according to standard operating procedures. The Chain of Custody (COC) forms will accompany all samples for identification, tracking and transporting purposes.

7.2 Sediment Quality

For QA/QC purposes, one field duplicate sample will be collected for every ten sediment samples, and will be analyzed separately. COC forms will accompany all samples for identification, tracking and transporting purposes.

7.3 Benthic Invertebrate Survey

Triplicate field sub-samples from each replicate station will be collected for benthic invertebrate analyses, to compensate for the spatial variability encountered with these organisms. Appropriate QA/QC measures related to processing and identification, as outlined in the MMTG document will be followed (see blue text below taken from the draft study design for additional detail). These measures will incorporate the proper steps related to re-sorting, sub-sampling and maintenance of a voucher collection, as needed. The voucher collection will be taxonomically analysed by a second qualified invertebrate taxonomist.

7.4 Fish

QA/QC technical procedures will be utilized for all field sampling, laboratory analysis, data entry and data analysis to produce technically sound and scientifically defensible results. As part of routine QA/QC for field operations, equipment will be regularly inspected, maintained and replaced if necessary. Detailed field notes will be recorded with a daily end of day check to verify completeness and accuracy of the recorded data. Ten percent of all age data will undergo a second assessment. If ages deviate more than one year from the original assessment, all ages will be reassessed. All data entered electronically will undergo a 100% transcription QA/QC by a second person to identify any transcription errors and/or invalid data.

7.5 Sample Processing

Benthic samples will be analyzed by an experienced taxonomist. All samples will be sorted with the use of a stereomicroscope (10X). A second independent taxonomist will verify the original analyses.

Samples will be washed through a 500 micron sieve and sorted entirely, except in the following instances: those samples with large amounts of organic matter (i.e., detritus, filamentous algae) and samples with high densities of major taxa. In these cases, samples will be first washed through a large mesh size sieve (3.36 mm), to remove all coarse detritus, leaves, and rocks. Large organisms such as leeches, crayfish, late instar dragonflies, stoneflies, and mayflies retained in the sieve will be removed from the associated debris. The remaining sample fraction will be sub-sampled quantitatively, if necessary. For QA/QC evaluation, the sorted sediments and debris will be re-preserved and retained for up to six months following submission of the first cycle interpretive report. For those samples that were sub-sampled, sorted and unsorted fractions will be re-preserved separately. Sorted organisms will be re-preserved.

7.6 Taxonomy

All invertebrates will be identified to the lowest practical level, usually family level. Chironimids and oligochaetes will be mounted on glass slides in a clearing media prior to identification. In samples with large numbers of oligochaetes and chironomids, a random sample of no less than 20% of the selected individuals from each group will be removed from the sample for identification, up to a maximum of 100 individuals.

Following identification and enumeration, a detailed list of individuals collected will be submitted for each replicate station. The list will be in a standard spreadsheet format.

7.7 Data Evaluation

All data will be entered into an electronic database with controlled access. Screening studies will be employed to check for transcription errors or suspicious data points. An individual not responsible for entering the data will confirm that the data entered represents the original. Missing data will be distinguished from absence of particular taxa by using non-zero value codes, with definitions built into each file.

The variation among stations within the study area, among samples within the stations (field sub-samples) and analytical variation (among laboratory replicates) will be calculated as estimates of the components of variation in the data set and compared to the expected values.

The benthic community will be investigated to determine if mine discharge is having an effect on the receiving system, as defined by Environment Canada (2012). An effect will be deemed to have occurred in the benthic community when a significant statistical difference between the exposure and reference areas is found for one or more of the key descriptors. The critical effect size of +/- 2 standard deviations will be used for determining an effect as per the MMTG document.

8.0 Annual Reporting

Annual reporting for the AEMP will be based on the on the Nunavut Watershed Management Areas no 48 and no. 21.

Water Management Area no. 48 will provide the results of the monitoring for:

- Milne Port;
- The Tote Road;
- The Mine Site, and,
- The northern section of the railway.

Water Management Area no 21 will provide results of the monitoring for:

- The southern section of the railway, and,
- Steensby Port.

Schedule 1 - Site Layout, Figures and Maps

Site Layouts

Figures for Section 5.1 – Core Receiving Environment Monitoring Program

Figure for Section 6.0

Figure 2.1 – Milne Inlet Proposed Surveillance Network Program

Figure 2.2 – Overall Mine Site AEMP

Figure 2.3 – Steensby Port Proposed Surveillance Network Program

Figure 5.1: Water and sediment quality sampling sites in Camp Lake Tributary 1, 2005-2012

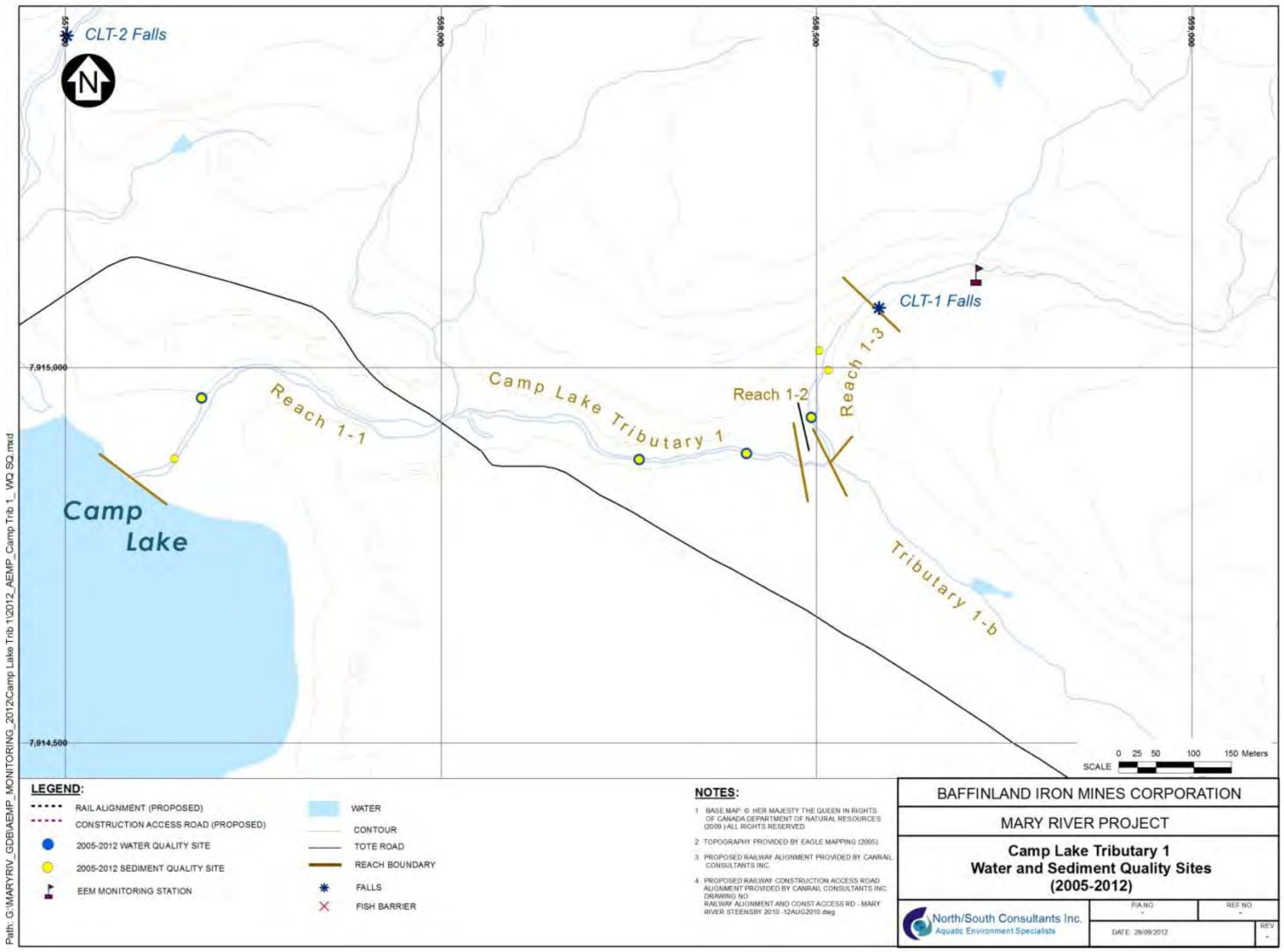


Figure 5.2: Benthic invertebrate and fish sampling sites in Camp Lake Tributary 1, 2005-2012

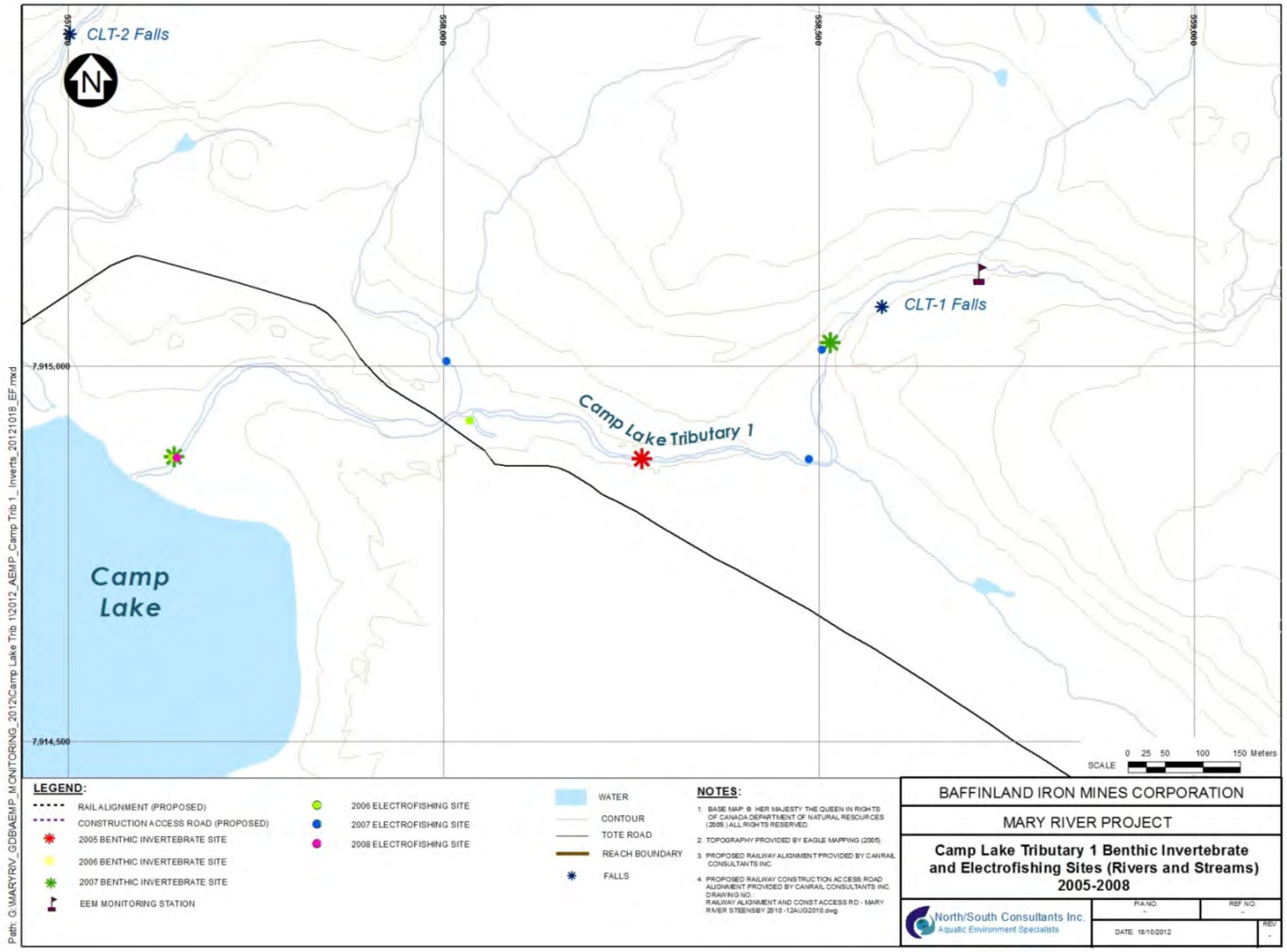


Figure 5.3: Water and sediment quality sampling sites in the reaches of the Mary River between Sheardown Lake and the falls, 2005-2012

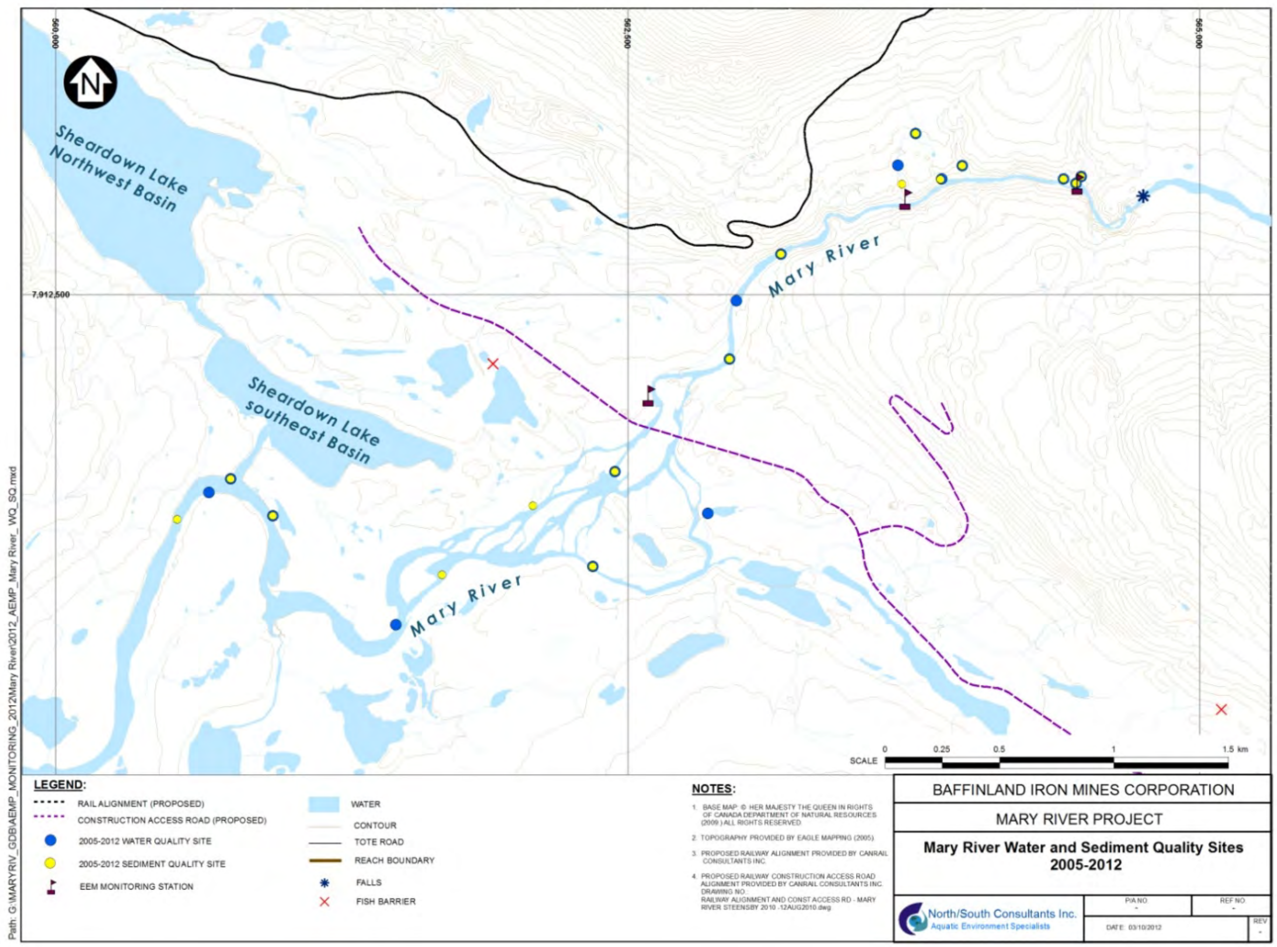


Figure 5.4: Benthic invertebrate and fish sampling sites in the reaches of the Mary River between Sheardown Lake and the falls, 2005-2012

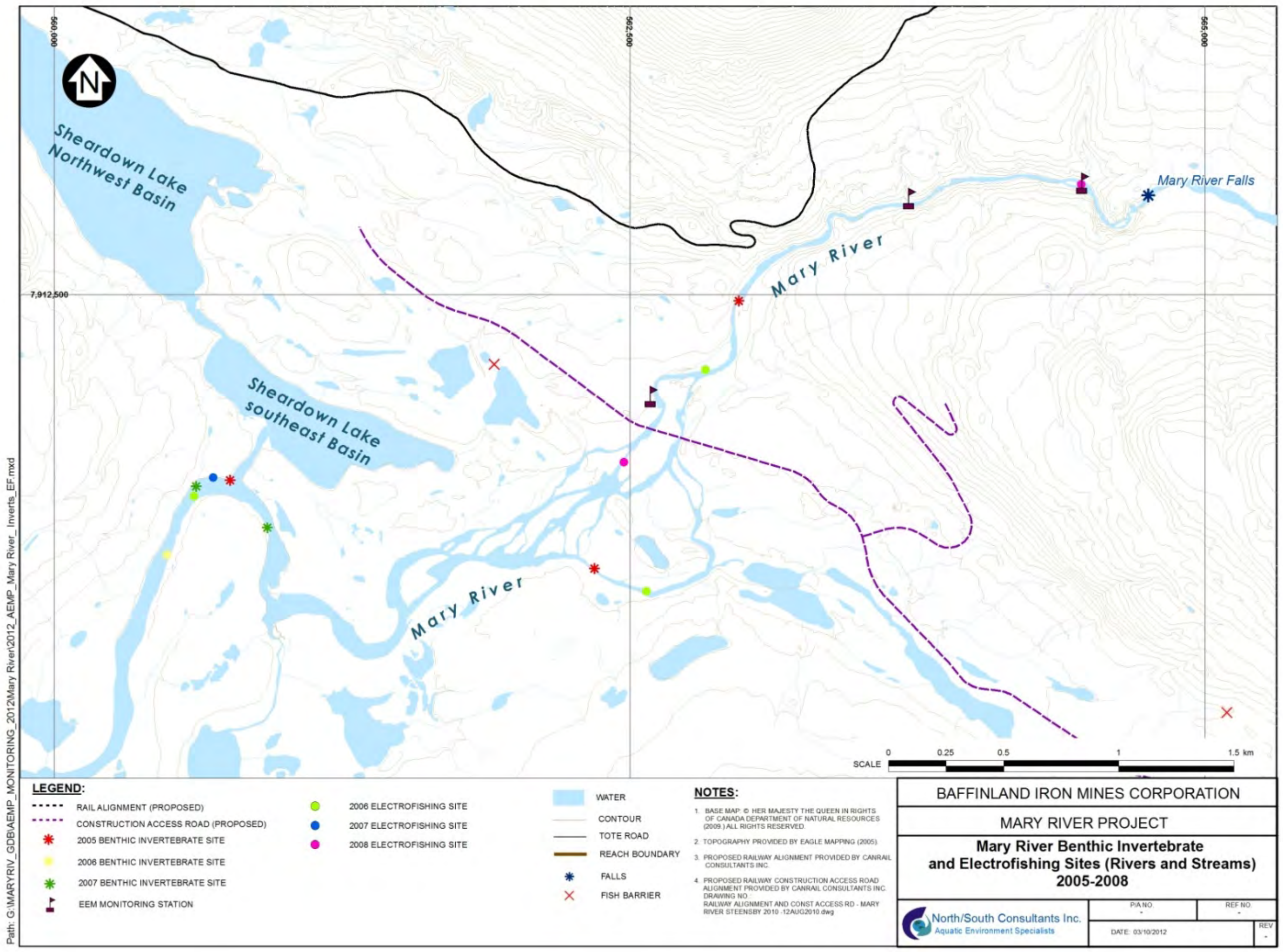


Figure 5.5: Water quality sampling locations in the Mine Area where phytoplankton and/or chlorophyll a samples were collected: 2007-2008

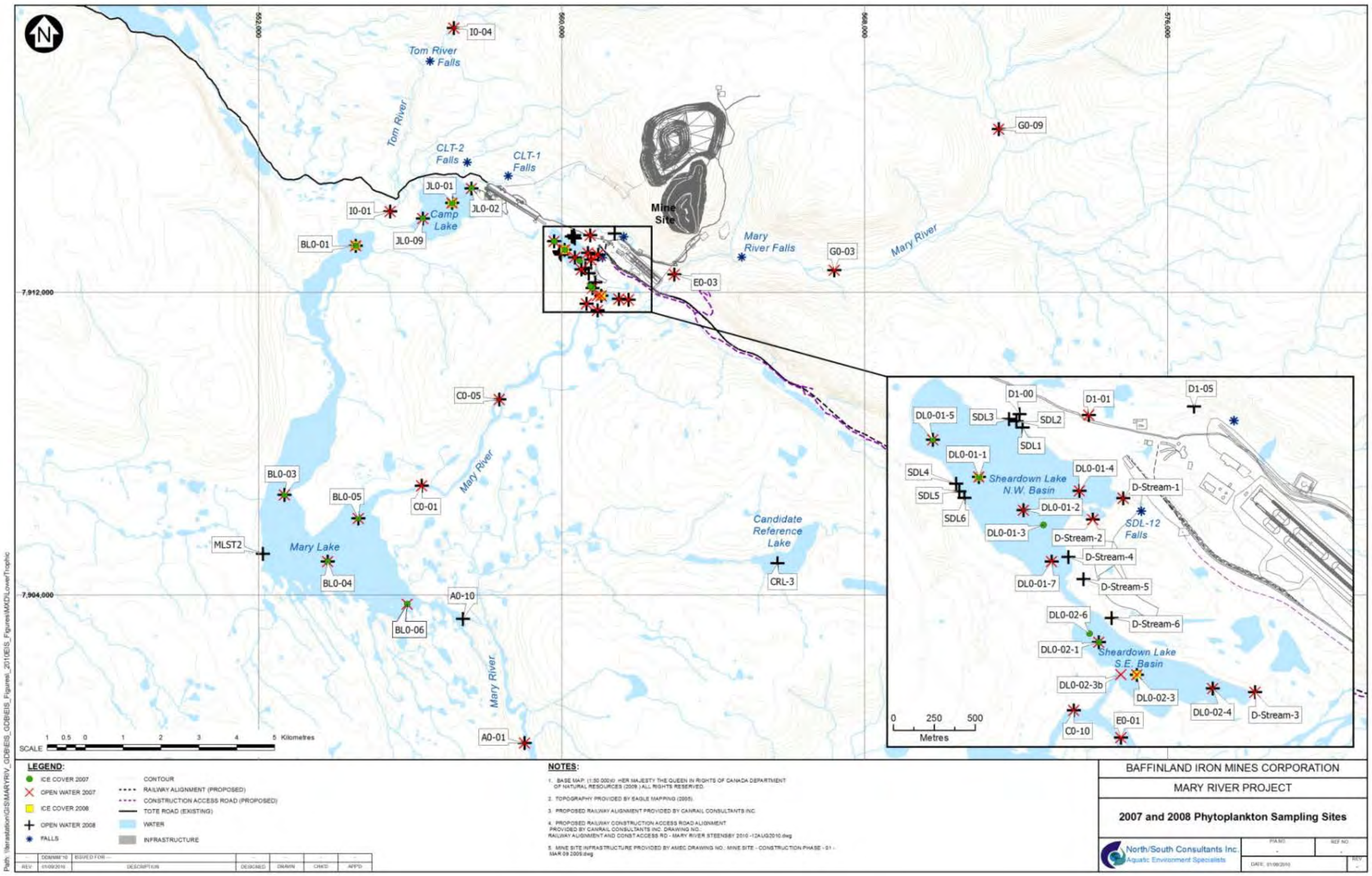


Figure 5.6: Benthic invertebrate and nearshore fish sampling sites in Camp Lake, 2005-2012

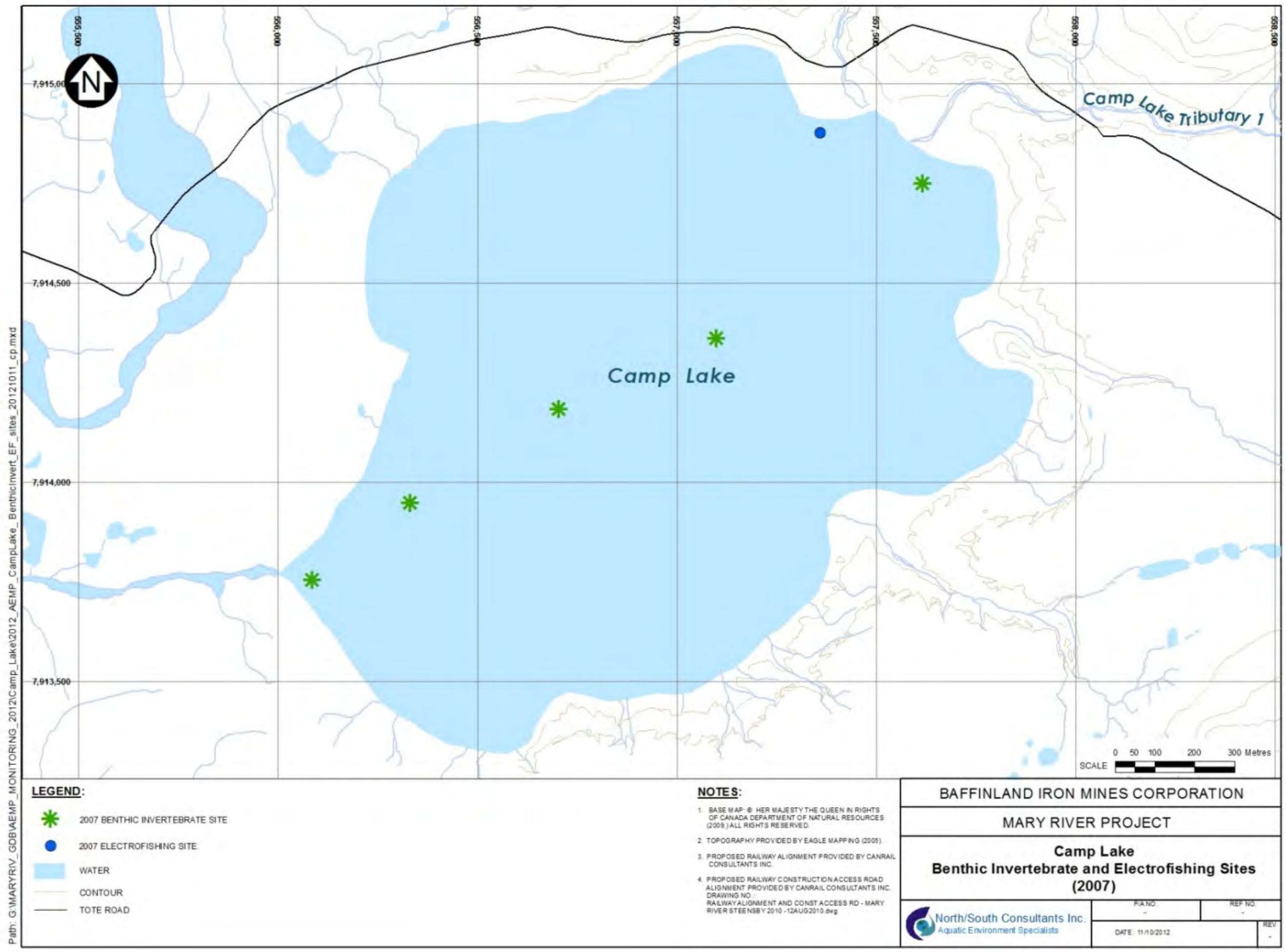


Figure 5.7: Water and sediment quality sampling sites in Mary Lake, 2005-2012

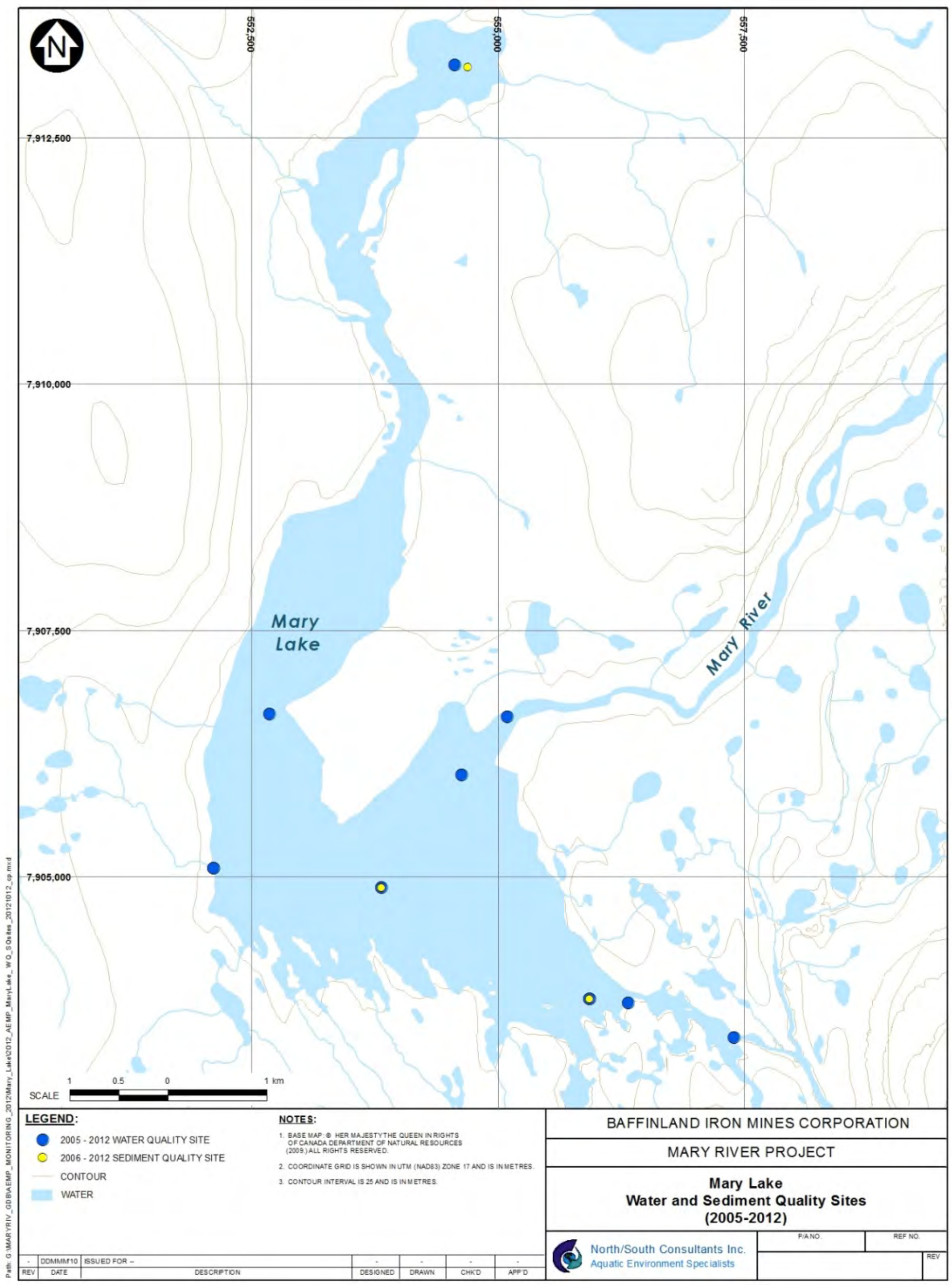


Figure 5.8: Benthic invertebrate and nearshore fish sampling sites in Mary Lake, 2005-2012

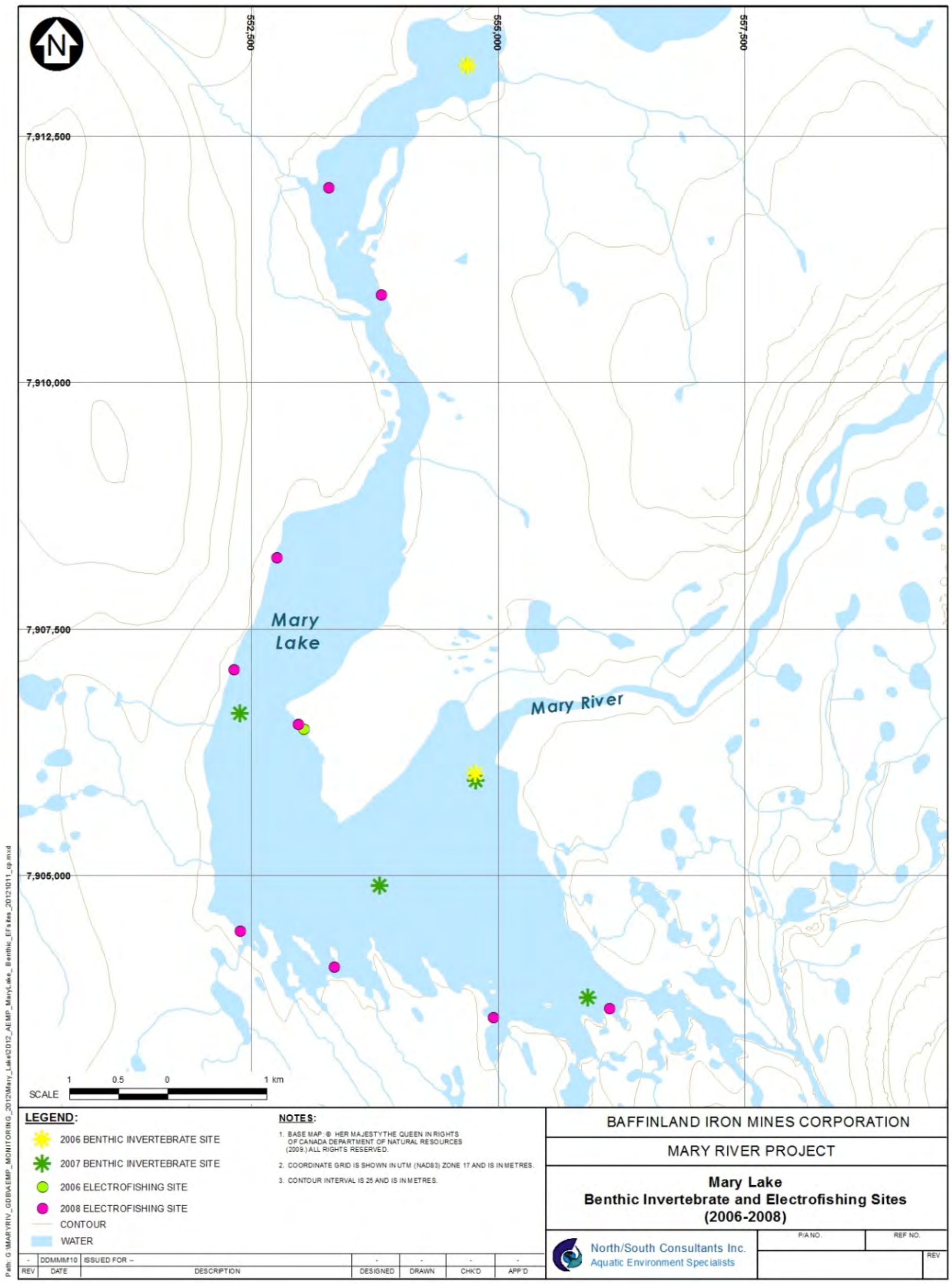


Figure 5.9 – Proposed Sampling Locations for the Core Receiving Environment Monitoring (CREM)

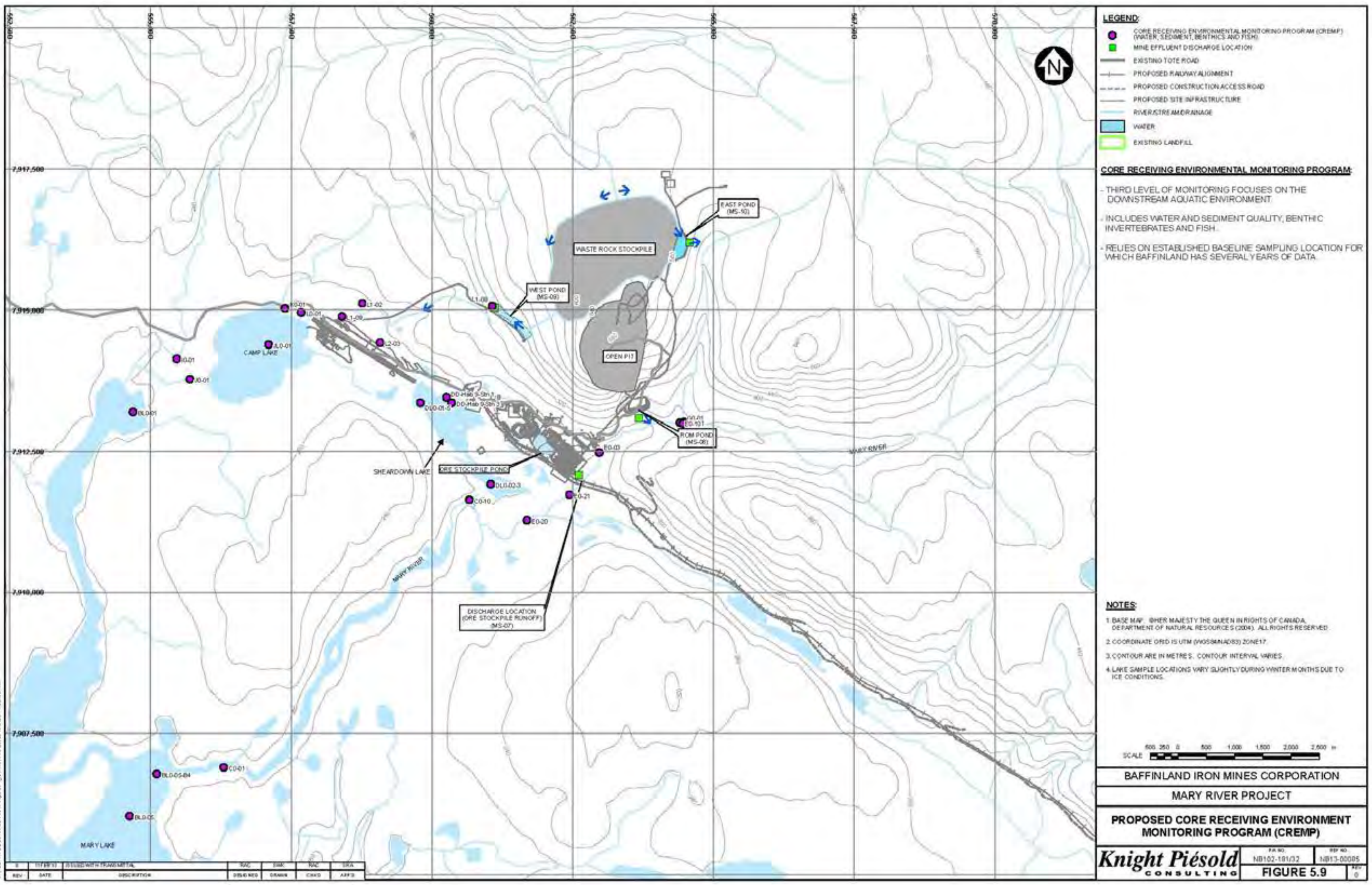


Figure 5.10: Map of potential Camp Lake Tributary 1 reference streams in the mine area

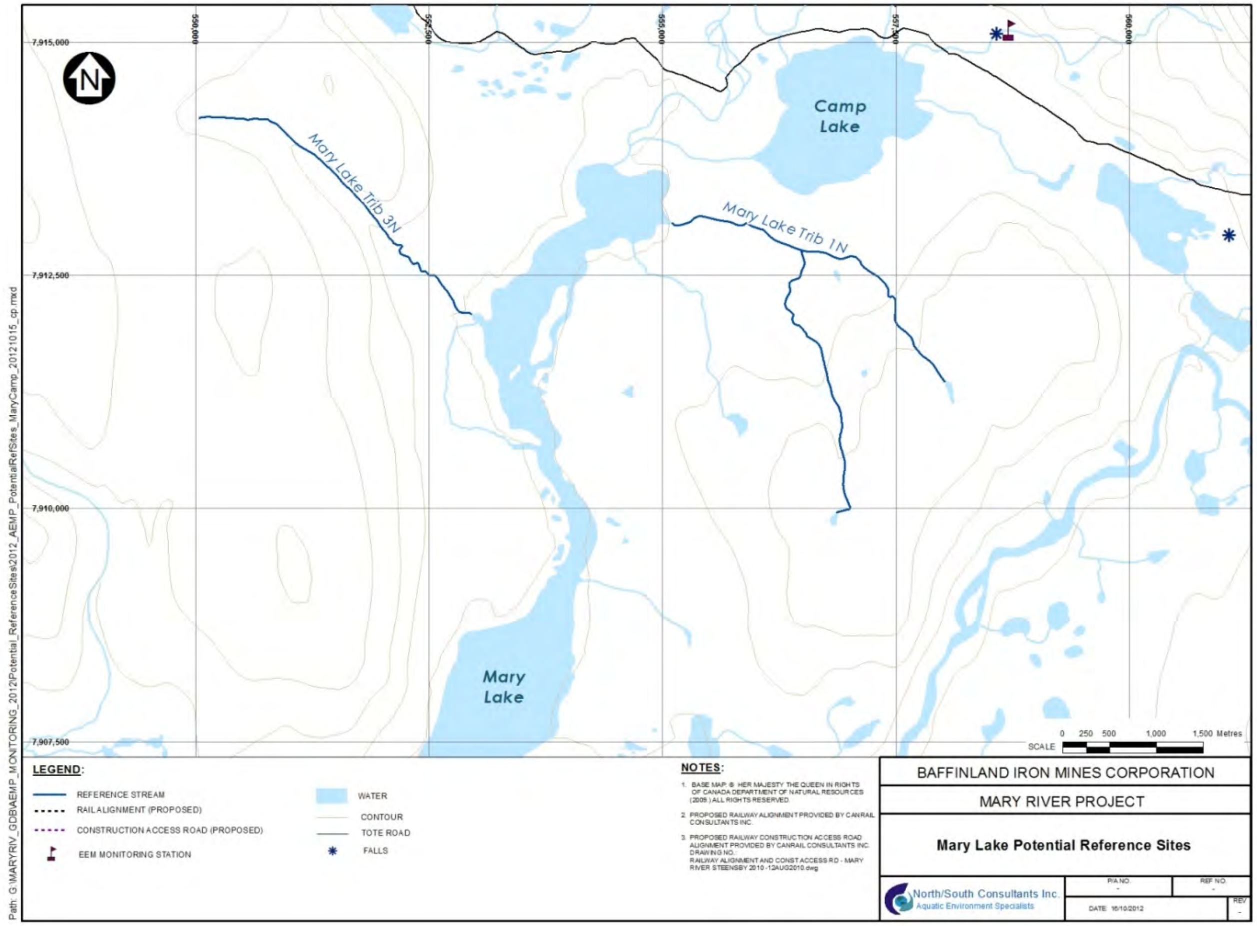


Figure 5.11: Map of potential Camp Lake Tributary 1 and Mary River reference streams along the Tote Road

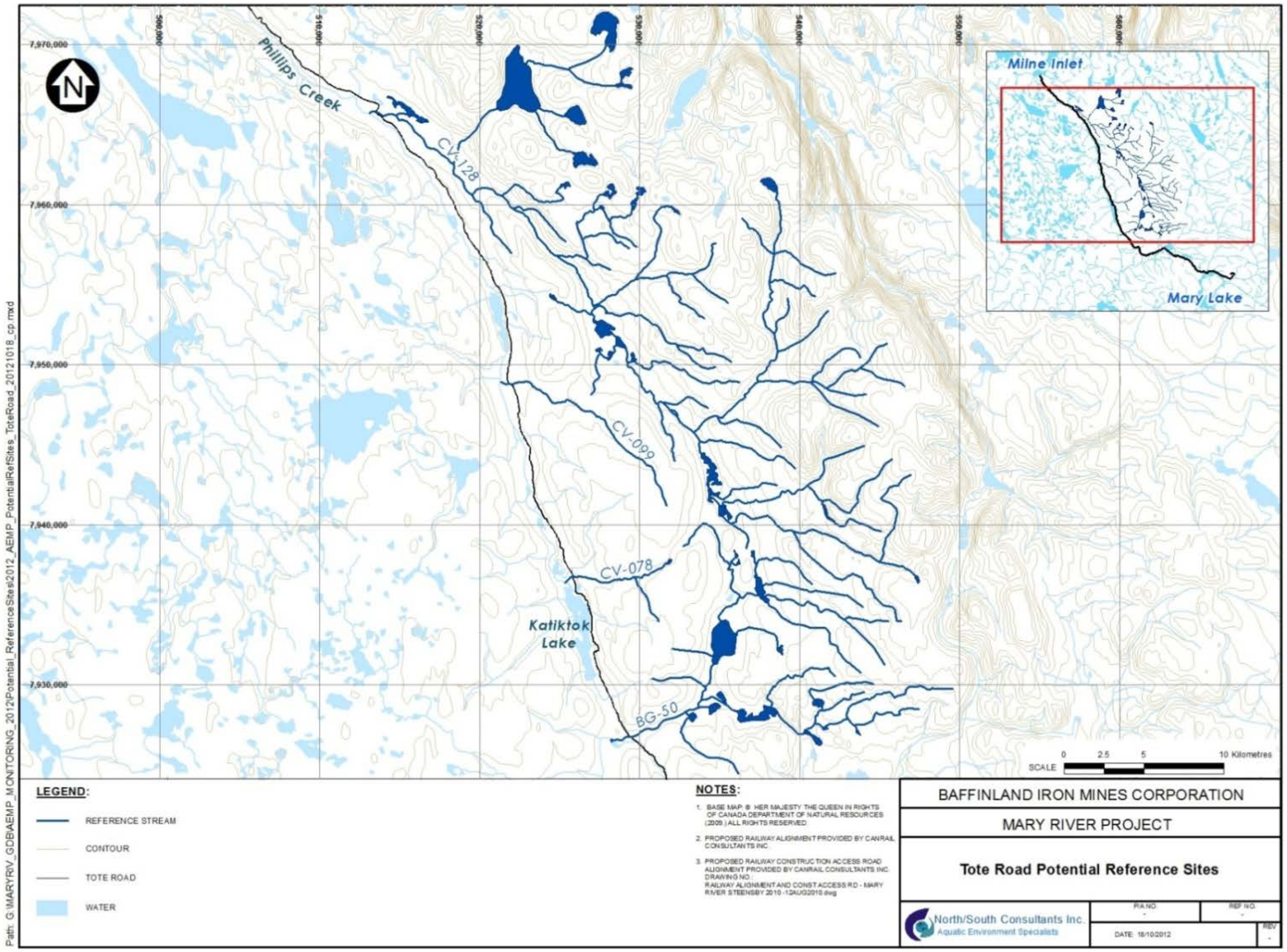


Figure 5.12: Map of potential Camp Lake Tributary 1 reference streams in the Steensby Inlet area

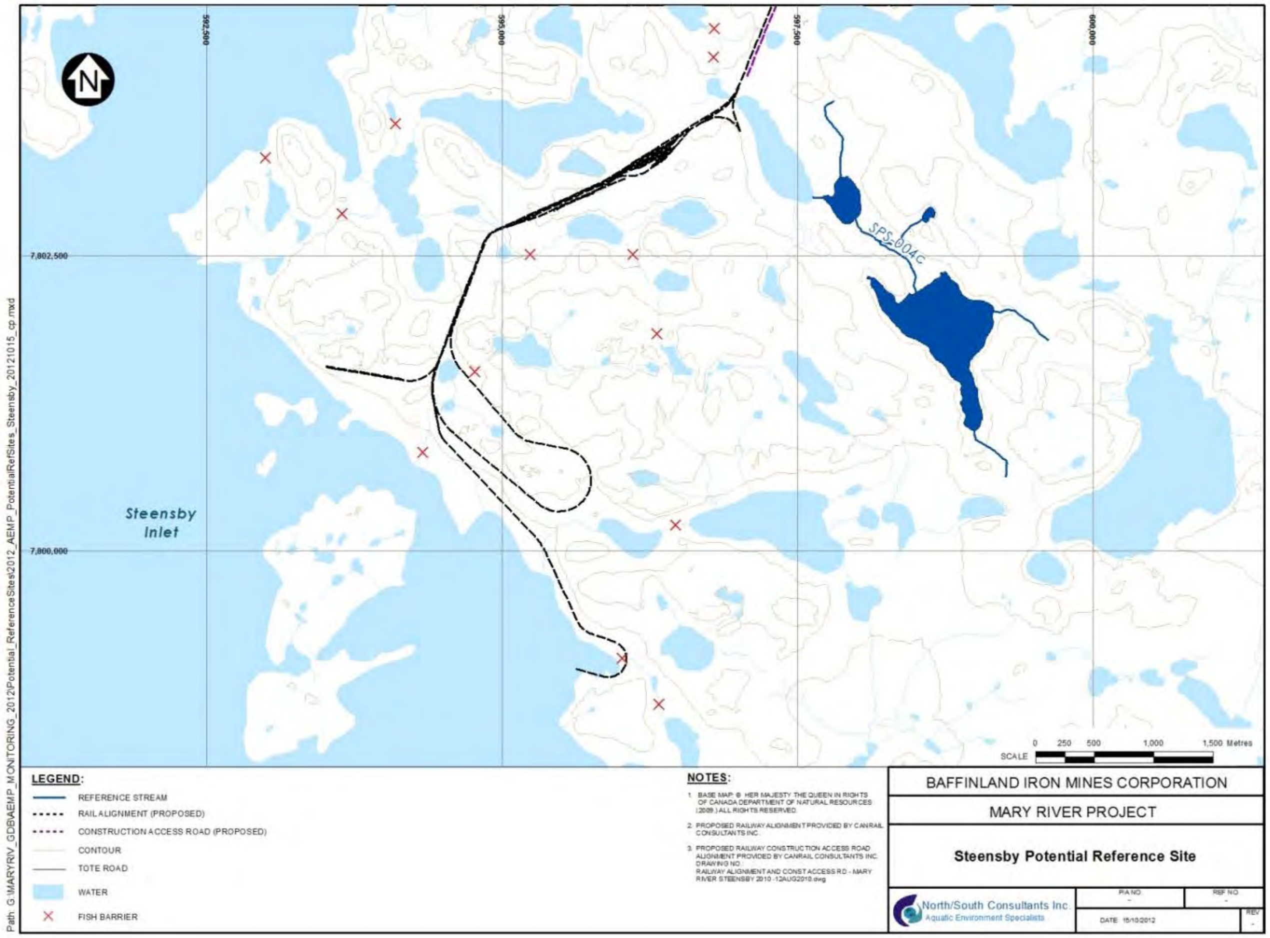


Figure 5.13: Map of potential Camp Lake Tributary 1 and Mary River reference streams along the rail route

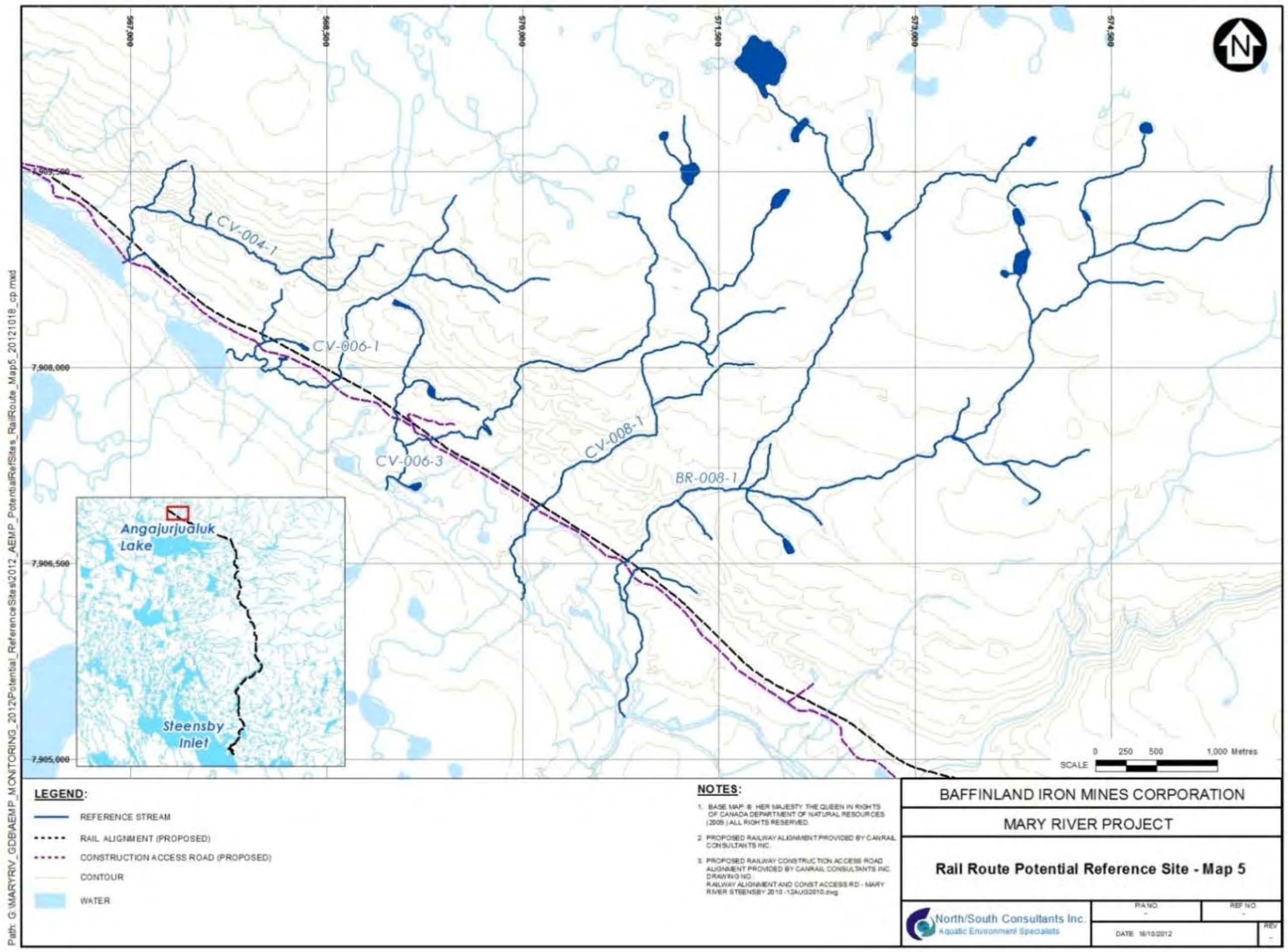


Figure 5.14: Map of potential Camp Lake Tributary 1 and Mary River reference streams along the rail route

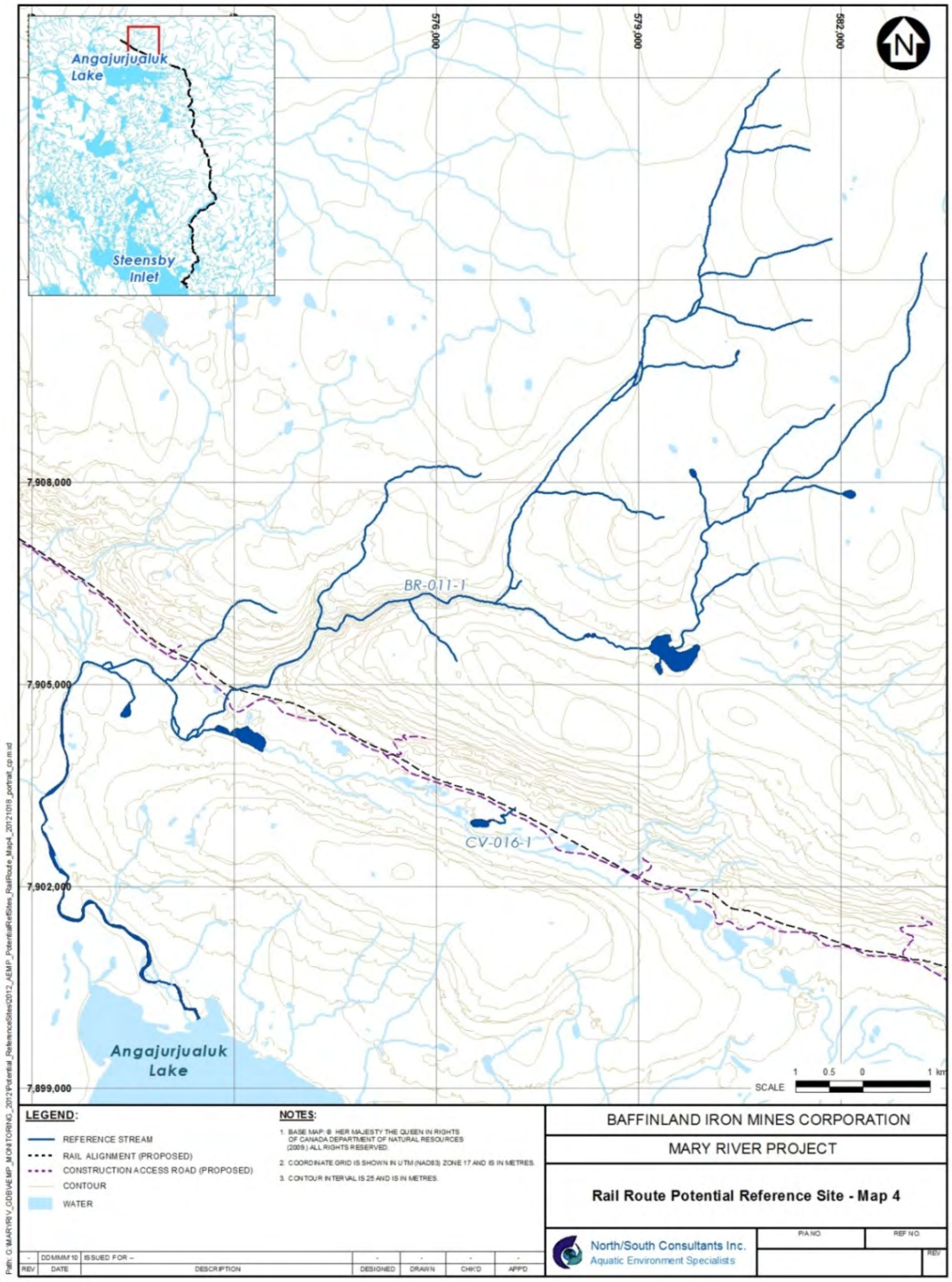


Figure 5.15: Map of potential Camp Lake Tributary 1 and Mary River reference streams along the rail route

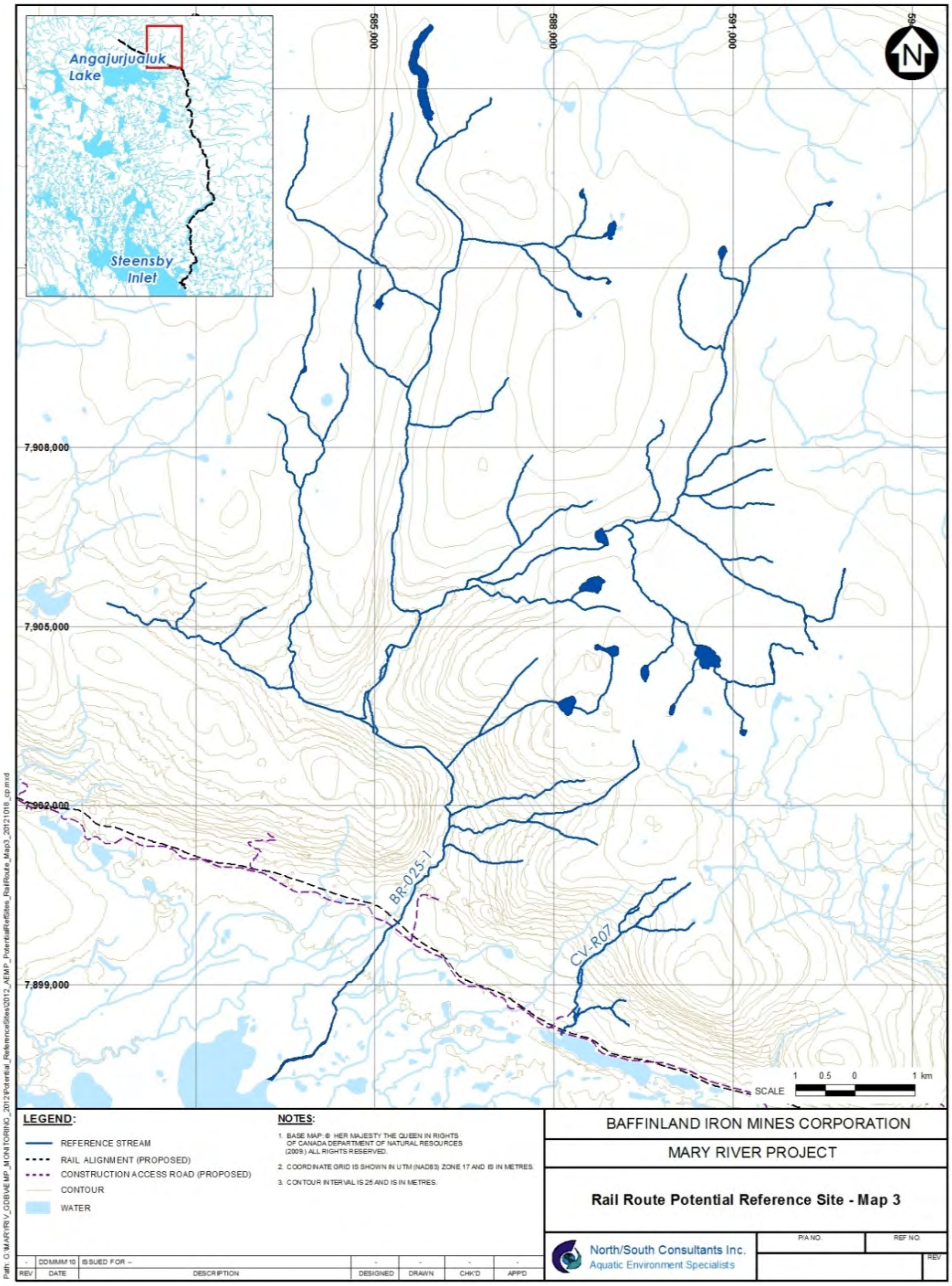


Figure 5.16: Map of potential Camp Lake Tributary 1 and Mary River reference streams along the rail route

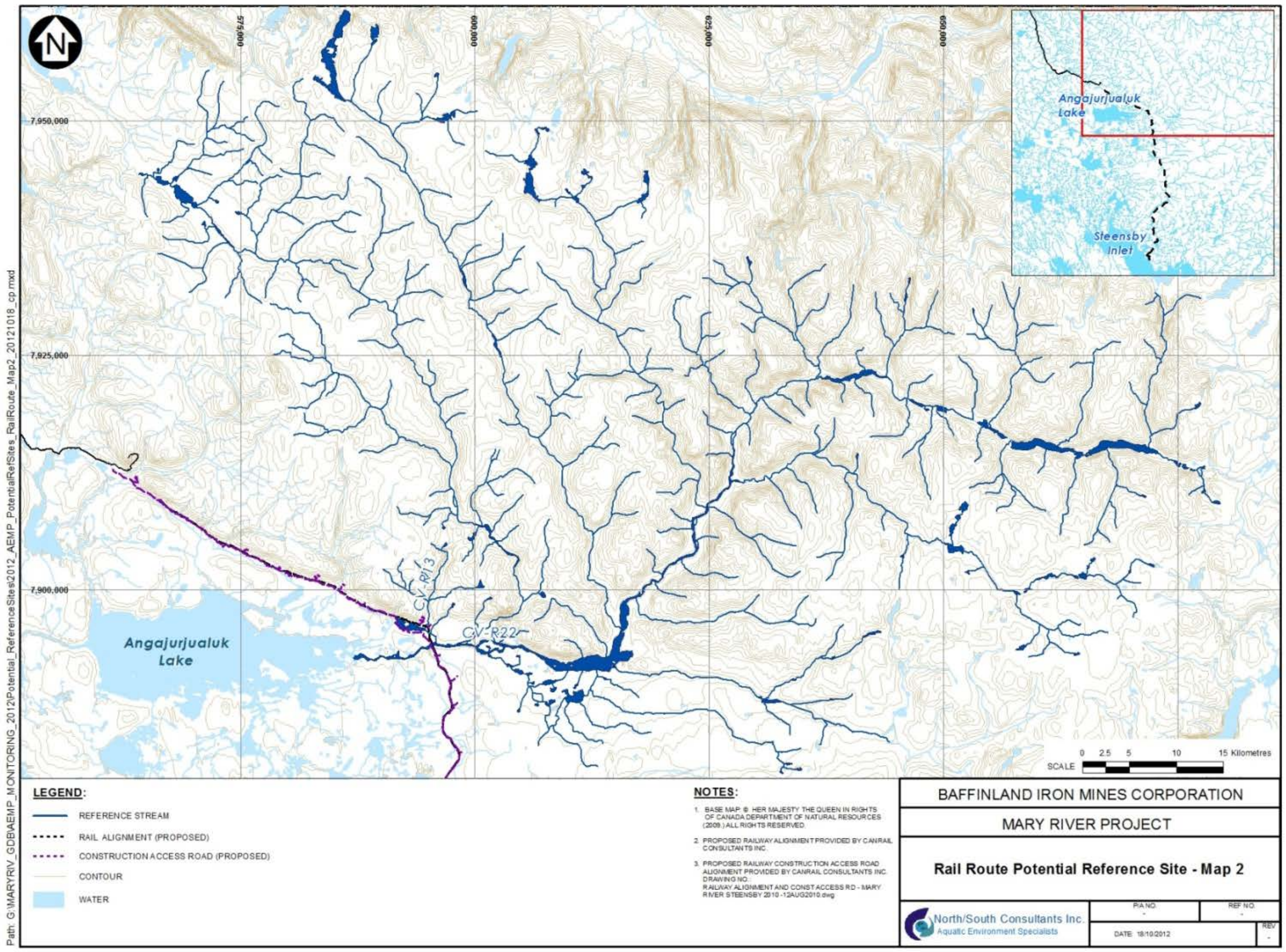


Figure 5.17: Map of potential Camp Lake Tributary 1 and Mary River reference streams along the rail route

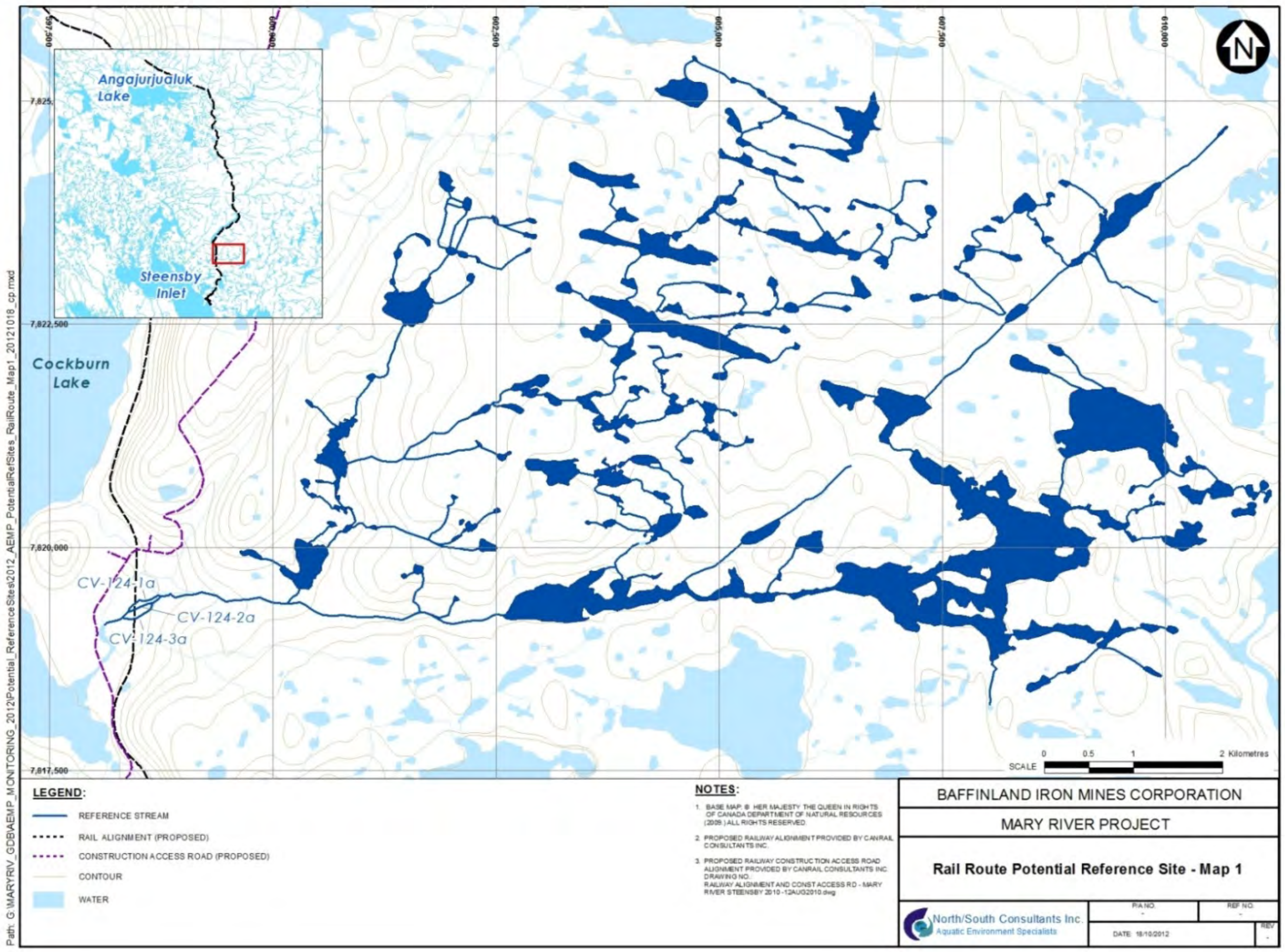


Figure 5.18: Proposed Mine SNP

Figure 6.1 - Proposed Mine EEM

Figure 6.2 - Camp Lake Tributary EEM Exposure Areas

Figure 6.3 - Candidate EEM Reference Areas

Figure 6.4 - Mary River Near Field EEM Exposure Area

Figure 6.5 - Mary River Far Field EEM Exposure Area

Schedule 2 - Freshwater Intake and Water Quantities

Camp / Site	SNP Monitoring ID	Intake	Coordinates	Permit Limit (m^3/yr)	Threshold (m^3/d)
Milne Port	MP-MRY-2	Phillips Creek (summer)	N: 7964579 E: 521714	25,000	≤ Permit Limit, minimize water source drawdown
	MP-MRY-3	Km 32 Lake (winter)	N: 7951862 E: 514503		
Mine Site	MS-MRY-1	Camp Lake	N:7914695 E: 557818	240,000	≤ Permit Limit, minimize water source drawdown
Steensby (Port)	SP-08	ST 347 Lake (permanent camp)	N:7804826 E: 596600	155,000	≤ Permit Limit, minimize water source drawdown
	SP-09	3 Km lake (dust suppression & other minor uses)	N:7800206 E: 596698		
Ravn River Area	TBD	Ravn Camp Lake	N: 7895658 E: 594510	53,000	≤ Permit Limit, minimize water source drawdown
Mid-Rail Area	TBD	Nivek Lake (summer) Ravn Camp Lake (winter)	N: 7876430 E: 595602	29,000	≤ Permit Limit, minimize water source drawdown
Cockburn Lake Tunnels Camp	TBD	Cockburn Lake	N: 7833929 E: 603882	37,000	≤ Permit Limit, minimize water source drawdown
Cockburn South Camp	TBD	Cockburn Lake	N: 7820563 E: 597661	41,000	≤ Permit Limit, minimize water source drawdown

Schedule 3 - Compliance Monitoring - Waste Water Quality Discharge Criteria

Table 1: Treated Sewage Effluent Discharge Quality Standards

Table 1a: Treated Sewage Effluent Discharge to Freshwater (Mine Site Sewage Treatment Plants)	
Parameter	Maximum Average Concentration
BOD5	30 mg/L
Total Suspended Solids	35 mg/L
Fecal Coliform	1000 CFU/100 mL
Ammonia	average: 4 mg/L ; maximum grab concentration: 8 mg/L
Phosphorus	average: 4 mg/L ; maximum grab concentration: 8 mg/L
Oil and Grease	No visible sheen
pH	between 6.0 – 9.5

Note: For the discharge to Sheardown Lake, the Phosphorus discharge criteria shall be 1 mg/L average concentration and 2 mg/L maximum grab concentration.

Table 1b: Treated Sewage Effluent Discharge to Marine Waters	
Parameter	Maximum Average Concentration
BOD5	100 mg/L
Total Suspended Solids	120 mg/L
Fecal Coliform	10,000 CFU/100 mL
Oil and Grease	No visible sheen
pH	Between 7.0 to 9.5

Table 2: Oily Water Treatment Plant Effluent Quality Standards

Parameter	Discharge Limit(mg/L)
pH	6 – 9.5
TSS	35
Ammonia	4 mg/L average concentration; 8 mg/L max. grab concentration
Phosphorous	4 mg/L average concentration; 8 mg/L max. grab concentration
Benzene	0.370
Ethylbenzene	0.090
Toluene	0.002
Oil and Grease	15 and no visible sheen
Arsenic	0.5
Copper	0.30
Lead	0.20
Nickel	0.50
Zinc	0.50

Table 3: Containment Areas - Bulk Fuel Storage Facility Stormwater

Parameter	Maximum Average Concentration (µg/L)
Benzene	*370*
Toluene	*2*
Ethyl benzene	*90*
Lead	*1*
Oil and Grease	15,000 and no visible sheen

Table 4: Landfarm Facility Stormwater

Parameter	Maximum Average Concentration (ug/L)
pH	6.0-9.0
Total Suspended Solids	15,000
Oil and Grease	15 and no sheen
Total Lead	1
Benzene	370
Toluene	2
Ethylebenzene	90

Table 5: Non-Hazardous Waste Landfill Runoff / Seepage

Parameters	Maximum Average Concentration (mg/L)
pH	6.0-9.5
Total As	0.5
Total Cu	0.3
Total Pb	0.2
Total Ni	0.5
Total Zn	0.5
Total Suspended Solids	15
Oil and Grease	No visible sheen

Table 6: Waste Rock and Ore Stockpiles Runoff Water Quality Criteria

Deleterious Substance	**Maximum Authorized Monthly Mean Concentration (mg/L)**	**Maximum Authorized Concentration in Composite Sample (Mg/L)**	**Maximum Authorized Concentration in Grab Sample (mg/L)**
pH			6.0 < pH < 9.0
Ammonia			Non-acutely toxic
Nitrate			Non-acutely toxic
Deleterious Substances - mg/L (MMER Schedule 4)			
Arsenic	0.50	0.75	1.00
Copper	0.30	0.45	0.60
Lead	0.20	0.30	0.40
Nickel	0.50	0.75	1.00
Zinc	0.50	0.75	1.00
TSS	15.00	22.50	30.00
Acute toxicity			
Fish species			MMER Schedule 5

Schedule 4 - Compliance Monitoring for Effluent and Runoff Discharges from Project Sites

Table 1: Milne Port – Compliance Monitoring for Effluent and Runoff Discharges

Proposed SNP & Other Station IDs	WASTE WATER TREATMENT FACILITY (WWTF) DISCHARGES	Discharge Coordinates	Compliance Criteria (Refer to Schedule 3)	Monitoring Parameters (Refer to Schedule 6a)	Monitoring Frequency	Receiving Environment
MP-01	Milne Port Sewage WTTF	N: 7975764 E: 503462	Table 1	Groups 1, 2, 3	Monthly (year round).	In ditch downstream of the PWSP which drains to Milne Inlet
MP-01a	Milne Port Polishing/Waste Stabilization Pond (PWSP)	N: 7976118 E: 503344	Table 1	Groups 1, 2, 3	Monthly (summer)	
MP-02	Milne Port Maintenance Shop Oily Water WWTF	N: 7955545 E: 503350	Table 2	Groups 1, 4	Monthly or as required.	
MP-MRY-04	Milne Exploration Phase Sewage WWTF (to become inactive after transition period)	N: 7975764 E: 503462	Table 1	Groups 1, 2, 3	Monthly (year round). Daily flow.	
MP-MRY-04a	Milne Exploration Phase Sewage PWSP (to become inactive after transition period)	N: 7976118 E: 503344	Table 1	Groups 1,2,3	Monthly (summer) Daily flow	
	CONTAINMENT AREA DISCHARGES					
MP-03	Milne Port Bulk Fuel Storage Facility Stormwater	N: 7976209 E: 503641	Table 3	Groups 1, 5	Monthly (summer)	
MP-04	Milne Port Landfarm Facility Stormwater	N: 7975528 E: 503740	Table 4	Groups 1, 5 plus TSS	Monthly (summer)	To adjacent land surface
MP-MRY-7	Milne Exploration Phase Bladder Fuel Storage Facility Stormwater (to become inactive after transition period)	N: 7976097 E: 503309	Table 3	Groups 1, 5	Monthly (summer)	In ditch downstream of the PWSP which drains to Milne Inlet
	RUN-OFF AND SEEPAGE MONITORING					
MP-MRY-12	Bulk Sample Stockpile Area Seepage	N: 7976452 E: 503356	Table 5	Group 6	Monthly (summer)	N/A

Table 2: Mine Site – Compliance Monitoring for Effluent or Runoff Discharges						
Proposed SNP & Other Station IDs	**WASTE WATER TREATMENT FACILITY (WWTF) DISCHARGES**	**Discharge Coordinates**	**Compliance Criteria (Refer to Schedule 3)**	**Monitoring Parameters (Refer to Schedule 6a)**	**Monitoring Frequency**	**Receiving Environment**
MS-01	Mine Site Sewage WWTF	N: 7912429 E: 562962	Table 1	Groups 1, 2, 3	Monthly. (year round)	Outfall to Mary River
MS-01a	Mine Site Polishing/Waste Stabilization Pond (PWSP)	TBD	Table 1	Groups 1, 2, 3	Monthly (summer)	Sheardown Lake
MS-02	Mine Site Maintenance Shop Oily Water WWTF	N: 7913224 E: 561618	Table 2	Groups 1, 4	Monthly or as required	Outfall to Mary River
MS-MRY-04	Exploration Camp Sewage WWTF		Table 1	Groups 1, 2, 3	Monthly. (year round).	Outfall to Mary River
MS-MRY-04a	Exploration Camp PWSP		Table 1	Groups 1, 2, 3	Monthly (summer)	Mary River
	CONTAINMENT AREA DISCHARGES					
MS-03	Mine Site Bulk Fuel Storage Facility Stormwater	N: 7913050 E: 562031	Table 3	Groups 1, 5	Monthly (summer)	Adjacent land surface.
MS-04	Mine Site Fuel Unloading Station Stormwater	N: 7912973 E: 561360	Table 3	Groups 1, 5	Monthly (summer)	Adjacent land surface.
MS-05	Mine Site Landfarm Facility Stormwater	TBD	Table 4	Groups 1, 5, plus TSS	Monthly (summer)	Adjacent land surface.
MS-MRY-6	Exploration Camp Bulk Fuel Storage Facility (Bladder Farm) Stormwater	N: 7912603 E: 560852	Table 3	Groups 1, 5	Monthly (summer)	Adjacent land surface.

	MINE CONTACT WATER SEASONAL DISCHARGES (MMER)					
MS-06+	Ore Stockpile Pond Stormwater	N: 7912444 E: 562063	Table 6	Groups 1, 6	Monthly (Summer)	Mary River
MS-07	Run of Mine Ore Stockpile Pond Stormwater	N: 7913507 E: 564159	Table 6	Groups 1, 6	Monthly (summer)	Mary River
MS-08	Waste Rock Stockpile West pond	N: 7916449 E: 564405	Table 6	Groups 1, 6	Monthly (summer).	Camp Lake Tributary
MS-09	Waste Rock Stockpile East pond (include mine pit water)	N: 7915050 E: 561129	Table 6	Groups 1, 6	Monthly (summer)	Mary River
	RUN-OFF AND SEEPAGE MONITORING (SEASONAL)					
MS-MRY-09	Bulk Sample Open Pit – Surface water drainage (to become inactive in future)		Table 5	Groups 1, 3, 7	Monthly (summer)	N/A
MS-MRY-10	Bulk Sample Weathered Ore Stockpile – Downstream surface water drainage (to become inactive in future)		Table 5	Groups 1, 3, 7	Monthly (summer)	N/A
MS-MRY-11	Bulk Sample Processing Stockpile Area – Downstream surface water discharge (to become inactive in future)		Table 5	Groups 1, 3, 7	Monthly (summer)	N/A
MS-MRY-13a & MS-MRY-13b	Non-Hazardous Waste Landfill – Downstream surface water drainage		Table 5	Groups 1, 3, 7	Monthly (summer)	N/A

Table 3: Steensby Port – Compliance Monitoring for Effluent or Runoff Discharges						
Proposed SNP & Other Station IDs	**WASTE WATER TREATMENT FACILITY (WWTF) DISCHARGES**	**Discharge Coordinates**	**Compliance Criteria (Refer to Schedule 3)**	**Monitoring Parameters (Refer to Schedule 6a)**	**Monitoring Frequency**	**Receiving Environment**
SP-01	Steensby Sewage WWTF	N: 7803154 E: 596181	Table 1	Groups 1, 2, 3	Monthly (year round)	Steensby Inlet via ocean outfall
SP-01a	Steensby Polishing/Waste Stabilization Pond (PWSP)	TBD	Table 1	Groups 1, 2, 3	Monthly (summer)	Steensby Inlet via ocean outfall
SP-02	Steensby Maintenance Shop Oily Water WWTF	N: 7803293 E: 590283	Table 2	Groups 1, 4	Monthly or as required	Steensby Inlet via ocean outfall
SP-03	Floating Construction Camp Sewage WWTF	N: 7801713 E: 593376	Table 1	Groups 1, 2, 3	Monthly	Steensby Inlet (35 m depth)
	CONTAINMENT AREA DISCHARGES					
SP-04	Steensby Bulk Fuel Storage Facility Stormwater	N: 7801713 E: 593376	Table 3	Groups 1, 5	As required (monthly)	Adjacent Land Surface
SP-05	Steensby Marine Fuel Storage Facility Stormwater	N: 7801713 E: 593376	Table 3	Groups 1, 5	As required (monthly)	Adjacent land surface.
SP-06	Steensby Landfarm Facility Stormwater	N: 7804080 E: 597531	Table 4	Groups 1, 5 (plus TSS)	As required (monthly)	Adjacent land surface.
	MINE CONTACT WATER SEASONAL DISCHARGES					
SP-07	Steensby Ore Stockpile Stormwater	N: 7799991 E: 593237	Schedule 3 Table 5	Groups 1, 3, 7	When Flow (MMER)	Steensby Inlet
	RUN-OFF AND SEEPAGE MONITORING					
SP-08	Steensby Landfill Seepage	N: E:	Schedule 3 Table 2	Group 6	As required (monthly)	N/A

Note: Non-SNP stations highlighted in blue shading – discharge is directly to ocean. SNP stations are those which may discharge to adjacent land surface or to storm water management ponds.

Schedule 5 - Proposed Approach for Assessment of Aquatic Effects Monitoring Program for Sediment, Surface Water Data and Biota

1.0 Introduction

As outlined in the Aquatic Effects Monitoring Program (AEMP) Framework, surface water and sediment data will be collected in a number of receiving environment areas associated with the Mary River Project throughout the life of mine, as well as reference areas. The assessment of these data must follow a standardized approach agreed upon by both the regulators, stakeholders and mine operators. This section outlines a proposed approach for sediment and surface water data assessment, including the selection of appropriate benchmarks. The proposed approach ensures a conservative (i.e., protective) evaluation which is in keeping with widely accepted guidance and practices used to evaluate environmental data across Canada (e.g., CCME).

For sediment and water quality VEC, the list of key indicators that are considered to be most relevant fall into four categories:

- General Parameters (water quality)
- Metals (water and sediment quality)
- Nutrients (water quality)
- Petroleum hydrocarbons (water and sediment quality)

The proposed approach for assessment of sediment data is presented in Section 2.0, with surface water assessment approach being presented in Section 3.0.

2.0 Proposed Approach for AEMP Sediment Data Assessment

2.1 Perspective on CCME Sediment Quality Guidelines

The Canadian Council for Ministers of the Environment (CCME) have developed a series of sediment quality guidelines for the protection of aquatic life which are typically used across Canada as assessment benchmarks for monitoring data. These guidelines were developed using a standardized protocol (CCME, 1995) involving the extensive review of field-based (co-located) sediment chemistry and toxicity data. Where data are available, the protocol uses both the National Status and Trends Program approach (NSTP), as well as a spiked sediment toxicity test approach (SSTT), to derive sediment quality guidelines. In the NSTP approach, information relating to sediment concentrations and effects is compiled from numerous geographic locations throughout North America, for many different species and biological end points. Much of the information compiled is field-collected data that considers complex mixtures of chemicals (and thus their interactive effects), various sediment types (*i.e.*, with different particle sizes and concentrations of substances), and varying conditions of bioavailability. These data are entered into a Biological Effects Database for Sediments, or BEDS. Sediment quality guidelines are then statistically derived from the BEDS (CCME, 2002).

Typically, two sediment quality guidelines calculated from this database, as follows:

1) A Threshold Effects Level (TEL), a concentration below which adverse effects are expected to occur rarely.

2) A Probable Effects Level (PEL), a concentration above which adverse effects are expected to occur frequently.

The lower of these values (TEL) can be independently evaluated using the SSTT approach. Data using the SSTT approach are not available for many of the chemicals considered by CCME. Where this is the case, the term Interim Sediment Quality Guideline (ISQG) is used, rather than TEL for the lower of the two guidelines (CCME, 2002).

Both the ISQG and the PEL guidelines are commonly used to assess sediment quality across Canada. These are generic values intended to be conservative, and the CCME recognizes that they do not consider site specific modifying factors that can influence bioavailability of chemicals in sediments, which can alter toxicity. In addition, benthic organisms have the ability to acclimate and adapt to metals in sediments, especially in areas of natural enrichment, which is also not considered in the development of the generic guidelines. In general, CCME (2002) recommends that assessment of potential for adverse effects in biota related to sediment contamination involve the use of not only sediment quality guidelines, but also other assessment tools, such as data on natural background concentrations of substances of interest, biological assessments (such as benthic community analyses), and/or other toxicity data (such as site-specific testing), as needed.

2.2 Proposed AEMP Sediment Benchmarks

The proposed approach for selecting AEMP sediment benchmarks will include the following:

- Select CCME sediment quality guidelines, where available. The ISQG will be used as the initial point of comparison, where one exists. The PEL will be used to provide added perspective related to risk potential, if sediment metals levels are found to exceed the ISQG;
- Where CCME guidelines are not available, a surrogate guideline from another jurisdiction will be selected (e.g., provincial sediment quality guidelines; US EPA, etc).
- In addition, baseline data will be assessed, and a statistical metric of baseline levels (e.g., 95th percentile of baseline data, to be determined) for any naturally occurring substances (metals/metalloids) will be calculated;
- The higher of the CCME/surrogate guideline or natural baseline will be selected as the AEMP benchmark.

2.3 Proposed Assessment Approach: AEMP Sediment Data

The proposed approach for assessing sediment data is outlined in Figure 1, and includes the following steps:

- Comparison of sediment parameters to the AEMP Benchmarks
- If concentrations are less than the AEMP Benchmarks, adverse effects are not expected to occur in aquatic fauna, and risks are considered negligible.
- If concentrations are greater than the AEMP benchmark, there is a potential for toxicity that requires further investigation.

3.0 Proposed Approach for AEMP Surface Water Assessment

The typical starting point for assessment of surface water data collected in any aquatic effects monitoring program are the Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life (WQGL - PAL) values, established by the Canadian Council of Ministers of the Environment (CCME, various years, with updates up to 2012). These guidelines reflect the most current scientific data at the time they were developed, and are intended to provide protection to all forms of aquatic life and aquatic life cycles, including the most sensitive life stages, at all locations across Canada (CCME, 2007). Since they are generic and do not account for site-specific factors that can alter toxicity, these national guidelines can be modified using widely accepted procedures, to derive site-adapted or site-specific guidelines or objectives for a given project or location (CCME, 2003).

The proposed framework for development of site specific water quality guidelines for the Mary River project is presented in Annex 1.

3.1 Proposed AEMP Surface Water Quality Benchmarks

The proposed approach for selecting AEMP surface water benchmarks will include the following:

- Select CCME WQGIs (PAL – freshwater), where available or a SSWQO, if already derived;
- Where CCME guidelines are not available, or are not considered relevant, a surrogate guideline from another jurisdiction will be selected (e.g., provincial water quality guideline; US EPA; relevant guideline from another operator, etc).
- In addition, baseline data will be assessed, and a statistical metric of baseline levels (e.g., 95^{th} percentile of baseline data, to be determined) for any naturally occurring substances (metals/metalloids) will be calculated;
- The higher of the CCME/surrogate guideline or natural baseline will be selected as the AEMP benchmark.

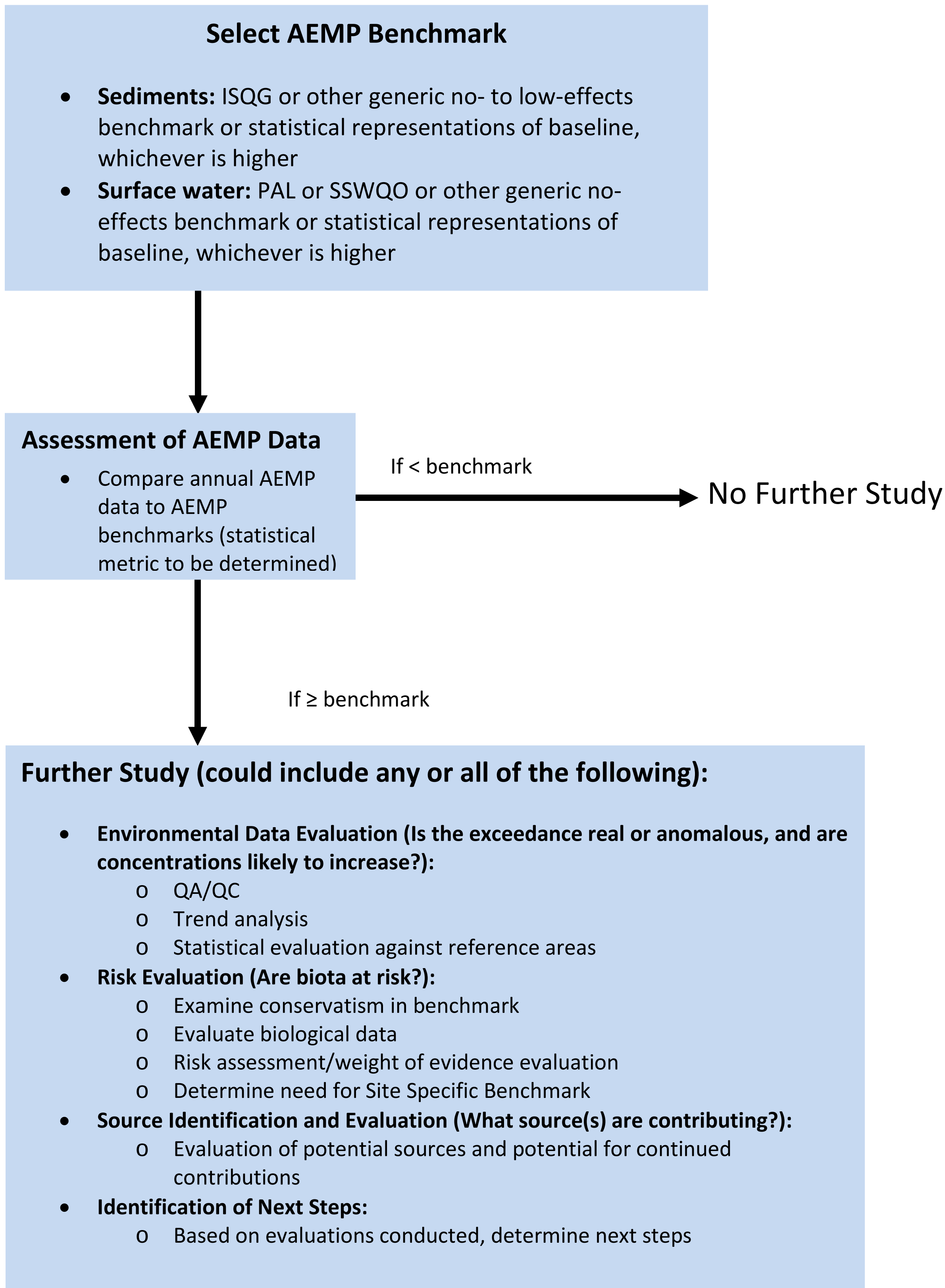
3.2 Proposed Assessment Approach: AEMP Water Quality Data

As outlined in Figure 1(which follows), the proposed approach for assessment of AEMP surface water data will be:

- Comparison of water quality parameters to the recommended AEMP Benchmark (CCME generic WQGL – PAL, a water quality guideline from another jurisdiction, or a SSWQO)
- If concentrations are less than the recommended values, adverse effects are not expected to occur in aquatic fauna, and risks are considered negligible.
- If concentrations are greater than the recommended value, there is a potential for toxicity that requires further investigation. If a SSWQO has not yet been derived, further investigation may include development of a SSWQO.

The assessment of surface water and sediment data over the life of the project will be on-going, and the recommended AEMP benchmarks throughout this process may change, as more data become available. For example, a SSWQO established early on in the life of the mine may require updating in 10 years, based on new published literature which has become available, or site specific toxicity tests conducted to further understand ETMF or resident species toxicity. The iterative, cyclical nature of data assessment under an AEMP is well established (MacDonald et al, 2009).

Figure 1: Proposed AEMP Benchmark and Assessment Approach



4.0 Conceptual Approach for Identification of Key Metrics and Critical Effects Sizes for CREMP: Aquatic Biota

As noted in Section 5.4.3, a review of existing freshwater baseline data is currently underway to assist with:

- Identification of key metrics/indicators for monitoring;
- Identification of the robustness of the existing data set for post-Project monitoring;
- Identification of issues or potential modifications to sampling methods or designs (e.g., sampling locations);
- Identification of data gaps; and
- Identification of additional baseline sampling to be considered for 2013.

While not a formal objective of this review, this undertaking will also assist with providing a preliminary measure of the ability of existing data set to be used for monitoring purposes and ultimately the level of change that could be detected by the monitoring program (i.e., the power associated with the existing data to measure change, or to serve as the "before" data set for comparison to "after" in a before/after monitoring program sampling design). As one of the main objectives of this review is to advise on the need to collect additional baseline data to augment the robustness of the dataset for monitoring purposes, this analysis is viewed as a preliminary exercise in the development of potential suitable biological benchmarks or "critical effects sizes (CESs)" for the AEMP. Acquisition of additional baseline data in 2013, as well as ongoing dialogue with regulatory agencies and refinement of Project description details (e.g., geotechnical studies), will be considered in the development of the final biological CESs that would be applied in the AEMP. Specifically, additional baseline data will further refine estimates of natural variability in biological metrics which will in turn assist with identification of appropriate CESs and sensitive indicators of change for CREMP.

4.1 Biological Critical Effects Sizes

Unlike water and sediment quality for which there are readily accepted quantitative benchmarks for monitoring (e.g., CCME water and sediment quality guidelines), there are no analogous benchmarks for biological variables. Instead, benchmarks for biological monitoring typically apply CESs, which refer to a specified degree of change or difference for a biological metric in time or space (e.g., comparisons to reference areas). The level of "acceptable change" in a biological community or population must consider site-specific factors and ultimately the level of risk that is deemed acceptable for a given biological attribute. The development of biological CESs involves some degree of best professional judgment and the interpretation of any observed exceedances in identified CESs during a monitoring program should consider the weight-of-evidence (or "multiple lines of evidence"; INAC 2009). Weight-of-evidence assessment provides a systematic and transparent method for integrating the complexity of data generated in environmental assessment and monitoring programs. An exceedance of a biological CES would typically indicate a cause for investigation for the observed change, as statistically significant changes may occur within biological communities due to natural events. Further, it is important to consider results of monitoring activities for a variety of components (e.g., eutrophication indicators, benthic invertebrates) collectively with environmental variables known to affect biological communities (e.g., water quality), including those that may not be affected by the Project (e.g., climate). CESs for biological components are viewed here as monitoring benchmarks that would be used as a mechanism for an action or response within the overall monitoring framework. The actions/responses may include:

- Further analysis of the monitoring data, including consideration of multiple-lines-of-evidence, to assist with interpretation;

- Investigation of potential cause(s) of the observed change;
- Followup monitoring to confirm initial results and/or to assist with interpretation of the results;
- Trend analyses or additional statistical analyses (e.g., multivariate statistics);
- Targeted study (e.g., toxicity testing); and/or,
- Mitigative measures.

Ultimately, the selection of an appropriate biological indicator and an associated CES should consider the limitations of a monitoring program to detect change (e.g., the natural variability of the biological component in question), the level of acceptable risk/uncertainty, species- or community-specific considerations (e.g., resiliency), the sensitivity of the indicator species or metric, ecological relevance of the metric or endpoint, and site-specific considerations (e.g., logistics, safety, and practical limitations on sampling effort).

Although there are no established benchmarks for biological variables (e.g., abundance) that can be readily adopted or considered for monitoring effects on freshwater biota, CESs for selected biological metrics are prescribed in the MMER EEM Guidance Document (EC 2012) and have been proposed in other recent monitoring programs, such as the Meadowbank Gold Mine CREMP (e.g., Azimuth 2012) and the Diavik Diamond Mine (Golder Associates 2011). Other sources of information that would be considered in the development of biological CESs for the Mary River Project CREMP include INAC (2009), Munkittrick et al. (2009), CCME (1999; updated to 2013), Wek'èezhìi Land and Water Board (2010), and Science Advisory Board for Contaminated Sites in BC (2008).

The review and ongoing development of the AEMP will consider the CESs identified in these initiatives, but will also consider site-specific information and input received from regulatory agencies. As noted above, the initial review of baseline data will include consideration of published CESs for application under CREMP and it is anticipated that further refinement and development of biological CESs would occur following the 2013 field season. Biological CESs may be defined in terms of degree of change from a suitable reference area value or from baseline conditions (i.e., before-after comparisons), or a combination of both (before-after-control-impact). As reference lakes are currently being identified, baseline data collected at the Mine Area lakes will be evaluated for variability and power to assist with development of biological CESs.

A discussion pertaining to the development of CESs for the three biological components that may be monitored under CREMP (Arctic Char, benthic invertebrates, and phytoplankton) is provided below.

4.2 Arctic Char

The CREMP may include monitoring of Arctic Char beyond that conducted as a component of the MMER EEM program to provide monitoring information for areas/waterbodies that may be affected by pathways other than MMER effluent discharges (e.g., Sheardown Lake). A review of existing baseline data for Arctic Char is currently being undertaken to help direct future sampling design and collection of additional baseline data, should monitoring be proposed under CREMP. This exercise will include a preliminary review of existing data for selected metrics to be used as a basis for detecting change in potential future monitoring programs. This initial review will identify the statistical power of the existing data and thus will provide a preliminary assessment of potential CESs that may be detectable with a reasonable effort in future monitoring programs. In addition, this review will assist with the identification of key metrics or indicators of Arctic Char populations that may be used for the CREMP, if Arctic Char are monitored under CREMP.

Should monitoring of Arctic Char in Mine Area lakes be adopted under CREMP, it is anticipated that monitoring would include collection of metrics at the individual and population level, such as condition factors and length-frequency-distributions, and that these metrics would serve as the key measurement endpoints for statistical evaluation and thus for which quantitative CESs may be developed. Population level endpoints, such as catch-per-unit effort (CPUE), if monitored, would provide additional information to assist with overall interpretation of potential effects on Arctic Char, as informed by individual level metrics as well as supporting information such as changes in habitat and water quality (i.e., weight-of-evidence).

Specific monitoring endpoints and potential CESs will consider the guidance provided by EC for MMER EEM programs (EC 2012), as well as other sources of information as noted above, for the study design that is finalized. The MMER identifies CESs for a fish population as a percentage of change from the "reference mean". The "standard" fish population surveys are based on evaluating fish health on two adult fish species and include indicators of fish growth, reproduction and condition (Table 1). The actual indicators measured depend upon the study design, which is in turn defined on a site-specific basis (e.g., lethal versus non-lethal sampling). As noted by INAC (2009), "these effect sizes do not reflect the method recommended by Environment Canada (2004); namely effect sizes that correspond with unacceptable ecological changes." INAC (2009) also notes that Environment Canada (2008) identified these CES "in the absence of clear scientific understanding of the long-term implications of these effects". However, as further noted by INAC (2009) these CESs "may serve as a starting point for discussions on acceptable effect sizes that occur during AEMP development" and will be considered during development of CESs for the Mary River CREMP.

Table 1 MMER EEM Critical effects sizes (CES) for fish populations based on lethal and non-lethal sampling (EC 2012). CES are expressed as a percentage of the reference means.[1]

Effect Indicators	Fish Effect Endpoint		CES
	Lethal Adult Survey	Non-Lethal Survey	
Growth	Weight-at-age	Length and weight of YOY (age 0) at end of growth period	± 25%
Reproduction	Relative fish gonad size	Relative abundance of YOY (% composition of YOY)	± 25%
Condition	Relative liver size	-	± 25%
	Condition Factor	Condition Factor	± 10%
Survival	Age	Length-frequency-distribution	± 25%

[1]CES will be used as guidance in the development of CREMP CESs. Actual CESs developed for the Mary River CREMP will consider variability in baseline data and site-specific factors.

The conclusion that an "actual effect" has occurred is based on results of two consecutive surveys. This guidance should be considered in the development of actions/responses within the CREMP framework.

4.3 Benthic Invertebrates

CREMP may include monitoring of benthic invertebrate community composition and richness metrics at selected sampling locations to support the assessment of potential effects on fish habitat beyond that conducted as a component of the MMER EEM program. Benthic invertebrate community descriptors (i.e., metrics) included in statistical analyses as effect endpoints may include total invertebrate density, taxa (i.e., family) richness, evenness index, and similarity index (Environment Canada 2012). Other metrics may be included as supporting metrics (i.e., not statistically analyzed to determine effects), such as diversity index, taxa (i.e., family) density, taxa (i.e., family) proportion, and taxa (i.e., family) presence/absence. Like Arctic Char, the initial review of the existing benthic invertebrate baseline data is underway and will include an evaluation of these data for the Mine Area. The review will assist with defining the inherent natural variability in community and richness metrics, which will in turn inform the 2013 baseline sampling program and support the development of appropriate CESs for CREMP, if benthic invertebrates are monitored under CREMP.
The MMER identifies CESs for a benthic invertebrate metric (density, Simpson's evenness, taxa richness, Bray-Curtis index) as multiples of within-reference-area standard deviations (i.e., ±2 standard deviations [SDs]). As for Arctic Char, confirmed effects are based on the results of two consecutive surveys. Again, this guidance should be considered in the development of actions/responses within the CREMP framework.

CESs for the benthic invertebrate community monitoring may consider a spatial aspect as well. For example, CESs may be identified (e.g., 50% change or difference in a benthic invertebrate community metric) in reference to a predefined spatial extent (e.g. the entire area of a small lake, or part of a large lake).

Azimuth (2012) recommended the application of a 20% effect size as a monitoring "trigger" and a 50% effect size as a monitoring "threshold" for benthic invertebrate community metrics (i.e., total abundance and richness), where effect size refers to a change or difference relative to before-after-control-impact (BACI). They further note that the terms "threshold" and "trigger" are intended to be applied less strictly for biological variables, relative to chemical variables such as water or sediment quality, due to the inherent natural variability in biological parameters and the need to consider the cause of any observed statistical "changes" in the biological communities. The rationale provided for the identification of the 20% and 50% criteria is "to maintain a transparent (fixed) effect size that is more likely to be ecologically relevant." Where natural variability is high, use of two standard deviations for benthic invertebrate metrics could potentially mean that large and ecologically-relevant effects could occur to some endpoints without being higher than the CES. On the other hand, the limitation of using percentage change to define the CES for a metric when variability is high is reduced statistical power to detect change. Integral to this discussion is the importance of considering the variability in existing data in identifying appropriate CESs.

4.4 Phytoplankton

There is a potential for nutrient enrichment in the Mine Area, notably due to discharge of treated sewage effluent in Sheardown Lake. The CREMP will include periodic monitoring of nutrients in surface waters to provide means for assessing the primary cause of potential eutrophication. However, the CREMP may also include monitoring of eutrophication response variables such as phytoplankton and dissolved oxygen. The latter is considered and described within the CREMP water quality program while monitoring of phytoplankton may be incorporated as a component of the CREMP biological monitoring.

The CREMP may include monitoring of phytoplankton community composition and biomass as well as chlorophyll *a* at selected sampling locations. As previously noted the initial review of the existing baseline data is currently underway and will include an evaluation of the phytoplankton data set for the Mine Area, with an emphasis on Sheardown Lake. The review will assist with defining the natural variability in phytoplankton metrics, which will in turn inform the 2013 baseline field sampling program and ultimately assist with development of appropriate CESs for the CREMP, should this component be incorporated in CREMP.

While there are no established benchmarks for phytoplankton metrics for application in monitoring programs, there is an extensive literature base regarding the issue of eutrophication of freshwater ecosystems as well as numerous trophic categorization schemes for lakes and several for freshwater streams. Several trophic categorization schemes for lakes are provided in Table 2.

Like benthic invertebrate community metrics, Azimuth (2012) recommended the application of a 20% effect size as a monitoring "trigger" and a 50% effect size as a monitoring "threshold" for phytoplankton community metrics (i.e., total biomass and number of species), where effect size refers to a change or difference relative to before-after-control-impact (BACI). They further note that the terms "threshold" and "trigger" are intended to be applied less strictly for biological variables, relative to chemical variables such as water or sediment quality, due to the inherent high natural variability in biological parameters and the need to consider the cause of any observed statistical "changes" in the biological communities. The rationale provided for the identification of the 20% and 50% criteria is "to maintain a transparent (fixed) effect size that is more likely to be ecologically relevant." Inherent to this discussion, is the importance of considering the variability in existing data in identifying appropriate CESs.

Development of CESs for phytoplankton that are adequately sensitive and ecologically appropriate for Sheardown Lake may consider:

- Natural variability in existing phytoplankton community metrics;
- Limitations associated with the data set - specifically issues associated with chlorophyll *a* concentrations being below the analytical detection limits;
- Relationships between nutrients (notably phosphorus) and phytoplankton metrics for Mine Area lakes;
- Lake trophic categorization schemes;
- Information on nutrient-phytoplankton relationships for other comparable northern lakes;
- Guidance and frameworks for the development of nutrient criteria (e.g., USEPA 2000); and
- Literature in which effects CESs for phytoplankton have been identified or adopted.

Additionally, like benthic invertebrates, CESs for phytoplankton may be developed within a spatial context. Specifically, they may consider the spatial extent of effects within or among waterbodies, as it is recognized the spatial extent of effects may occur over a small area (e.g., immediately adjacent to an effluent outfall). This approach has been proposed for the Diavik Diamond Mine for monitoring of potential eutrophication of Lac de Gras (Golder Associates 2011).

It is emphasized that the primary indicator for monitoring for eutrophication in the freshwater environment will be measurements of the nutrients (nitrogen and phosphorus) themselves. Phytoplankton monitoring, if included, would be intended to provide direct measurement of eutrophication response indicators (i.e., primary productivity), as it is the response variables that are of primary concern. Including a response indicator in the monitoring program may be beneficial as the relationships between nutrients and primary productivity may be difficult to predict with existing information, the relationship may be non-linear, and because phytoplankton may be affected by other factors (USEPA 2000), including water clarity which may also be affected by the Project. Development of CESs for phytoplankton, if phytoplankton are incorporated in CREMP, would be consider benchmarks developed for nutrients to ensure the monitoring program is appropriate and complementary. Similarly, if phytoplankton were incorporated in CREMP, the results of the phytoplankton monitoring program would not be considered in isolation, but rather would collectively consider nutrient concentrations, water clarity, and other factors that may affect phytoplankton communities in the interpretation of results.

Table 2 **Summary of selected trophic status classification schemes for lakes**

Variable	Lake Trophic Status							Reference
	Ultra-oligotrophic	Oligotrophic	Oligo-mesotrophic	Mesotrophic	Meso-eutrophic	Eutrophic	Hypereutrophic	
Total Phosphorus (µg/L)	-	< 10	-	10-35		35-100	> 100	OECD (1982)
	<4	4-10	-	10-20	20-35	35-100	> 100	CCME (1999; updated to 2012)
	-	< 5	-	10-30	-	-	> 100	Chambers et al. (2001)
	< 5	-	5-10	-	10-30	30-100	> 100	Wetzel (1983)
	-	< 10	-	10-30	-	-	> 100	Nürnberg (1996)
Chlorophyll *a* (µg/L)	-	<2.5		2.5-8		8-25	> 25	OECD (1982)
	0.01-0.5	0.3-3	-	2-15	-	10-500	-	Wetzel (1983)
	-	< 3.5	-	3.5-9	-	9.1-25	> 25	Nürnberg (1996)
Secchi Disk Depth (m)	-	> 6	-	3-6	-	<1.5	-	OECD (1982)
	-	> 4	-	2-4	-	1-2.1	< 1	Nürnberg (1996)
TN (µg/L)	-	< 350	-	350-650	-	651-1,200	> 1,200	Nürnberg (1996)
	< 1-250	-	250-600	-	500-1,100	-	500-> 15,000	Wetzel (1983)

4.5 References

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Schedule 6 – Program Monitoring Parameters

Schedule 6a - Surveillance Network Program Monitoring Parameters

Group	Parameters
Group 1 – Water Volume	Daily water withdrawal in cubic metres from authorized sources. Daily water discharge from WWTFs, Containment areas,
Group 2 – Treated Sewage WWTF and PWSP Parameters	Biological oxygen demand (BOD_5), pH, total suspended solids, faecal coliforms, oil and grease, ammonia-nitrogen, nitrate-nitrogen, total kjeldahl nitrogen, total phosphorus, total dissolved solids.
Group 3 - Acute Toxicity.	a. Acute lethality to Rainbow Trout, Oncorhynchus mykiss (as perEnvironment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13); and b. Acute lethality to Daphnia magna (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14).
Group 4 – Oily Water WWTF Parameters	pH, Total suspended solids, ammonia, benzene, ethylbenzene, oil and grease, total phosphorus, toluene. **Total metals:** Arsenic, copper, lead, nickel, zinc.
Group 5 – Containment Area Discharge Parameters	Benzene, toluene, ethyl benzene, oil and grease, total petroleum hydrocarbons, lead.
Group 6 – Runoff and Seepage Monitoring Parameters	pH, alkalinity, total suspended solids, total dissolved solids, phenols, total organic carbon, dissolved organic carbon, oil and grease, total petroleum hydrocarbons. **Total metals:** Aluminum, antimony, arsenic, barium, bromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, strontium, thallium, titanium, uranium, vanadium, zinc.
Group 7 - Mine Contact Parameters	pH, total suspended solids, total dissolved solids, alkalinity, hardness, turbidity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate nitrogen, dissolved organic carbon, total organic carbon, total phosphorus, sulphate, fluoride, chloride. **Total and dissolved metals**: Aluminum, arsenic, cadmium, calcium, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, sodium, thallium, uranium, zinc, **Field parameters:** pH, temperature, turbidity, specific conductance.

Schedule 6b – Monitoring Parameters: EEM and CREMP

Group	Use	Parameters
Group 2 – Acute Toxicity	EEM and CREMP	Acute Toxicity Testing on sewage effluent and all MMER discharges a. Acute lethality to Rainbow Trout, *Oncorhynchus mykiss* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13); and b. Acute lethality to *Daphnia magna* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14).
Group 3 – Water quality	EEM and CREMP	**MMER Required (Schedule 4 and Schedule 5 - Section 7):** (Total and dissolved for metals) Aluminum, Cadmium, Iron, Mercury, Molybdenum, Selenium, Ammonia, Nitrate, Temperature, Dissolved oxygen, pH, Hardness, Alkalinity, Conductivity, Total Suspended Solids (TSS), Arsenic, Copper, Cyanide (Exempt), Lead, Nickel, Selenium, Zinc, and Radium 226. **Recommended EEM Variables**: Dissolved Organic Carbon (DOC), Total Organic Carbon (TOC), Total phosphorus, Uranium, Thallium, Manganese, Major cations (calcium, magnesium, potassium, sodium), Fluoride, Chloride, Sulphate,, Water depth, Secchi disk depth, and discharge (streams) **Not Required under MMER but Recommended Supporting Variables:** Total Dissolved Solids (TDS),Oil & Grease, Phenols, Turbidity, Total Kjeldahl nitrogen (TKN), Nitrite, True Colour, and In situ depth profiles for turbidity, DO, pH, temperature, and conductivity (at all receiving environment sites where depth sufficient)
Group 4 – MMER effluent	EEM	**MMER Schedule 4 – Water Quality Monitoring:** Arsenic, Copper, Lead, Nickel, Zinc, TSS, Radium-226, pH, and Discharge rate ***(For use in the marine environment – Steensby Port)***

Schedule 6b – Monitoring Parameters: EEM and CREMP

Group	Use	Parameters
Group 5 – MMER effluent	EEM	**MMER Schedule 5 – Effluent Characterization:** (in addition to Group 4 – all measured as total forms) Aluminum, Cadmium, Iron, Mercury, Molybenum, Ammonia, Nitrate, Hardness, Alkalinity, Selenium, Electrical conductivity, and Temperature **Additional Recommended Variables** Fluoride, Manganese, Uranium, Total phosphorus, Calcium, Chloride, Magnesium, Potassium, Sodium, Sulphate, Thallium, Dissolved organic carbon, TOC **Sublethal Toxicity Testing**: - fish species (either Test of Larval Growth and Survival Using Fathead Minnows or Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout); - invertebrate species (Test of Reproduction and Survival Using the Cladoceran *Ceriodaphnia dubia*); - plant species (Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte, *Lemna minor*); and - algal species (Growth Inhibition Using Freshwater Alga *Selenastrum capricornutum*).
Group 5 - Sediment	EEM and CREMP	**MMER Schedule 5 – Part 2 Biological Studies:** **Sediment quality monitoring:** Total metals (including mercury), TOC, Nutrients (total phosphorus, TKN, and nitrate/nitrite) and particle size distribution
Group 8 - Benthos	EEM and CREMP	**MMER Schedule 5 – Part 2 Biological Studies:** **Benthic Invertebrate Endpoints:** - benthic invertebrate density, taxa richness, similarity index, and evenness index (minimum indices) - supporting variables: total organic carbon and particle size analysis (where sediments present)

Schedule 6b – Monitoring Parameters: EEM and CREMP

Group	Use	Parameters
Group 9	EEM and CREMP	**Fish Population and Health –** **Non-lethal sampling of Arctic Char Populations:** - Fork length; - Wet weight; - External condition (parasites and deformities, erosion, lesions, and tumours) - age - CPUE **NOTE: EEM sampling to consist of juvenile and YOY Arctic Char**
Group 10	CREMP	**Hydrology:** - Stream discharge - Lake water level
Group 11	CREMP	**Primary Production:** - Phytoplankton chlorophyll a/pheophytin a - Dissolved oxygen and temperature profiles - Secchi disk depth

Schedule 7 - Site Specific Monitoring Framework

Table 1: Milne Port Monitoring						
Water Body	**Location Details**	**Station ID**	**Purpose/Monitoring Requirements**	**Monitoring Parameters**	**Monitoring Frequency**	**Sampling Coordinates**
Milne Inlet	30 m from ditch discharge into Milne Inlet	TBD	Exposure area monitoring	Schedule 6 – Group 6 Schedule 6 – Group 7 Schedule 6 – Group 8	One under ice (April – water quality). August (all parameters)	N: TBD E:
	East side of Milne (30m from shore)	TBD	Reference site monitoring	Schedule 6 – Group 6 Schedule 6 – Group 7 Schedule 6 – Group 8	One under ice (April – water quality). August (all parameters)	N: TBD E:

Note: Marine monitoring parameters are not covered by the AEMP – Groups 6, 7 and 8

Table 2a: Mine Site Monitoring Areas						
Water Body	**Location Details**	**Station ID**	**Purpose/Monitoring Requirements**	**Monitoring Parameters**	**Monitoring Frequency**	**Station Coordinates**
Camp Lake Tributary	Discharge from Waste Rock Stockpile west sedimentation pond	L1-08	Monitoring of west sedimentation pond discharge water quality (end of pipe)	Schedule 6b – Group 5	Summer. Monthly and Prior to discharge	N:7915068 E:561076
		L1-09 L0-01	Monitoring of water quality in tributary (MMER NF and FF)	Schedule 6b – Group 3 Schedule 6b – Group 5 Schedule 6b – Group 9	CREMP/MMER will determine parameters and frequency	N: 7916449 E: 558407 N: 7914959 E: 557681
Camp Lake	Camp Lake at inflow of tributary from waste rock water	JL0-01	Water and sediment quality monitoring	Schedule 6b – Group 3 Schedule 6b – Group 5	April and August	N: 7914369 E: 557108
		J0-01	Water and sediment quality monitoring at outflow of Camp Lake	Schedule 6b – Group 3 Schedule 6b – Group 5	Late June and August	N: 7913773 E: 555701
		TBD	Contingency Fish Sampling (if effect on water quality)	Schedule 6b – Group 9	If effects warrant	N: TBD E:

Schedule 7 - Site Specific Monitoring Framework

Table 2a: Mine Site Monitoring Areas

Water Body	Location Details	Station ID	Purpose/Monitoring Requirements	Monitoring Parameters	Monitoring Frequency	Station Coordinates
Tributary to Camp Lake	Passing and Stranding of Fish	TBD	Visual Inspection	TBD	August	TBD
Mary River	Discharge from Waste Rock Stockpile east sedimentation pond (post year 12)	E0-10	Monitoring of east sedimentation pond water quality in Mary River	Schedule 6b – Group 3	Monthly during summer months	N: 7913004 E: 564405
	Discharge from ROM stockpile	G0-10	Monitoring of sedimentation pond water quality in receiving environment	Schedule 6b – Group 3	Monthly during summer months	N: TBD E: (*BIM STN.*)
	Discharge from Ore Stockpile sedimentation pond	E0-21	Monitoring of sedimentation pond water quality in receiving environment (MRY-NF)	Schedule 6b – Group 3	Monthly during summer months (EEM as req'd)	N: 7911724 E: 562444
	Treated effluent outfall from site WWTP	E0-21	Effluents monitored for quality in receiving environment	Schedule 6b – Group 1	Monthly during summer months	N: 7911724 E: 562444
	Immediately downstream of last discharge	E0-20	Monitoring of Mary River water quality after all discharges (MRY-NF)	Schedule 6b – Group 3 Schedule 6b – Group 5 Schedule 6b – Group 9	Monthly during summer months (EEM as req'd)	N: 7911055 E: 561487
	Inflow into Mary Lake	C0-05	Aquatic Effects Monitoring (MRY-FF)	Schedule 6b – Group 3 Schedule 6b – Group 5 Schedule 6b – Group 9	Monthly during summer months (EEM as req'd)	N: 7909170 E: 558352

Schedule 7 - Site Specific Monitoring Framework

Table 2a: Mine Site Monitoring Areas						
Water Body	**Location Details**	**Station ID**	**Purpose/Monitoring Requirements**	**Monitoring Parameters**	**Monitoring Frequency**	**Station Coordinates**
Mary Lake	Inflow of Mary River	BL0-05	Water quality monitoring	Schedule 6b – Group 3 Schedule 6b – Group 5	Monthly during summer months	N: 7906031 E: 554632
		BL0-05-B4	Water quality monitoring	Schedule 6b – Group 3 Schedule 6b – Group 5	Monthly during summer months	N: 7906774 E: 555115
Sheardown Lake	Dust	DD-HAB 9-STN1	Water and sediment quality	Schedule 6b – Group 3 Schedule 6b – Group 5	August	N: 7913455 E: 560259
	Treated Sewage Effluent	DL0-01-5	Water and sediment quality	Schedule 6b – Group 3 Schedule 6b – Group 5	August	N: 7913356 E: 559798
	Outfall of Sheardown Lake	DL0-02-3	Water and sediment quality	Schedule 6b – Group 3 Schedule 6b – Group 5	August	N: 7911915 E: 561046
Sheardown Lake Tributary	Monitor fish passage and stranding	TBD	Visual Inspection	TBD	August	N: TBD E:

Schedule 7 - Site Specific Monitoring Framework

Table 2b: Steensby Port Monitoring Areas					
Station ID	**Location Description**	**Monitoring Coordinates**	**Purpose/Monitoring Requirements**	**Monitoring Parameters**	**Monitoring Frequency**
Steensby Inlet (site 1)	Proximity of ocean outfall	N: TBD E:	Water quality	Schedule 6 – Group 6	April (water quality), August (water quality, sediment and benthos)
			Sediment quality	Schedule 6 – Group 7	
			Benthic	Schedule 6 – Group 8	
Steensby Inlet (site 2)	Proximity of Ore stockpile runoff discharge	N: TBD E:	Water Quality	Schedule 6 – Group 6	annually (summer)
			Sediment quality	Schedule 6 – Group 7	
			Environmental Effects monitoring (MMER)	Schedule 6 – Group 4	
Steensby Inlet (site 3)	Proximity to the Ore Dock	N: TBD E:	Water quality	Schedule 6 – Group 6	annually (summer)
			Sediment quality	Schedule 6 – Group 7	
			Biological studies (sediment, benthos, zooplankton, phytoplankton)	Schedule 6 – Group 8	
Steensby Inlet (site 4)	Proximity to the Freight Dock	N: TBD E:	Water quality	Schedule 6 – Group 6	annually (summer)
			Sediment quality	Schedule 6 – Group 7	
			Biological studies (sediment and benthos)	Schedule 6 – Group 8	
Steensby Inlet (site 5)	Reference Site 1	N: TBD E:	Water quality	Schedule 6 – Group 6	annually (summer)
			Sediment quality	Schedule 6 – Group 7	
			Biological studies **(**sediment and benthos)	Schedule 6 – Group 8	
Steensby Inlet (site 6)	Reference Site 2 (up the coast)	N: TBD E:	Water quality	Schedule 6 – Group 6	annually (summer)
			Sediment quality	Schedule 6 – Group 7	
			Biological studies **(**sediment and benthos)	Schedule 6 – Group 8	
Steensby Inlet (site 7)	Reference Site 3 (down from port)	N: TBD E:	Water quality	Schedule 6 – Group 6	annually (summer)
			Sediment quality	Schedule 6 – Group 7	
			Biological studies (sediment and benthos)	Schedule 6 – Group 8	

Note: Marine monitoring parameters are not covered by the AEMP – Groups 6, 7 and 8

Schedule 7 - Site Specific Monitoring Framework

Table 2c: Reference Monitoring Areas				
Receiving Water Body	**Reference Station ID/Water Body**	**Monitoring Parameters**	**Monitoring Frequency**	**Sampling Coordinate**
Camp Lake Tributary	CLT-REF01 (CV-099, Tote Road)	Schedule 6b – Group 3 Schedule 6b – Group 5	annually	N: 7948851 E: 521853
	CLT-REF02 (CV-078, Tote Road), tributary to Phillips Ck	Schedule 6b – Group 3 Schedule 6b – Group 5	annually	N: 7936771 E: 525943
	CLT-REF03 (CV-004, Rail Alignment)	Schedule 6b – Group 3 Schedule 6b – Group 5	annually	N: 7908363 E: 531184
	CLT-REF04 (CV-006-01, Rail Alignment)	Schedule 6b – Group 3 Schedule 6b – Group 5	annually	N: 7907038 E: 532691
Camp Lake & Sheardown Lake	TBD	Schedule 6b – Group 3	annually	N: TBD E:
	TBD	Schedule 6b – Group 3	annually	N: TBD E:
	TBD	Schedule 6b – Group 3	annually	N: TBD E:
Mary River	MRY-REF01 (Area 2)	Schedule 6b – Group 3 Schedule 6b – Group 5	annually	N: 7899214 E: 501083
	MRY-REF02 (BR-011-1, S2-010)	Schedule 6b – Group 3 Schedule 6b – Group 5	annually	N: 7904175 E: 534761
	MRY-REF03 (BR-025-1)	Schedule 6b – Group 3 Schedule 6b – Group 5	annually	N: 7898429 E: 513446
	MRY-REF04 (G0-09)	Schedule 6b – Group 3 Schedule 6b – Group 5	annually	N: 7916317 E: 571546
Mary Lake	TBD	Schedule 6b – Group 3	annually	N: TBD E:
	TBD	Schedule 6b – Group 3	annually	N: TBD E:
	TBD	Schedule 6b – Group 3	annually	N: TBD E:

Schedule 8 – Water Crossing Performance Monitoring Forms

MARY RIVER PROJECT - TOTE ROAD UPGRADE
TURBIDITY MONITORING DATA FORM

CROSSING ID:

Field Crew: | **Date:** | **Time:**

LOCATION **Datum:** | **Zone:**

Easting (m): | **Northing (m):** | **Elevation (from mapping):** | **Other notes:**

CURRENT WEATHER: **Wind:** **Air Temp:** **Precipitation:** **Cloud Cover (%):**

Recent Weather Events:

CONSTRUCTION **Construction Phase (circle one):** Pre-Construction During Construction Post-Construction

Type of Activity: **Equipment in Use:**

Date Construction Began:

Is the crossing location changing? (ie. is the crossing moving upstream or downstream of its original location? How far? Which direction?)

SITE SKETCH, NOTES, REMARKS: (ie. high water table, high turbidity, natural bank erosion, water colour changes observed in stream, algae in water, etc.)

Is there anything unique about this crossing compared to other watercourses? (ie. steep banks, clay in water, etc.)

Substrate Particles % Areal Coverage (est.)
- **% sand/silt/clay (<2mm)**
- **% gravel (2 - 64 mm)**
- **% cobble (64 - 256 mm)**
- **% boulder (> 256 mm)**
- **% bedrock**

Riparian Vegetation and Shading (describe):

***IN SITU* TURBIDITY READINGS** (complete at least one measurement upstream and downstream of crossing)

Meter Make and Model:

Location	Distance from crossing (m)	Turbidity (NTU)	Time	Location	Distance from crossing (m)	Turbidity (NTU)	Time
Upstream				Upstream			
Crossing				Crossing			
Dwnstrm				Dwnstrm			

FLOW ESTIMATES Location :

High Water Width (m): | **Distance between points (m):**

Wetted Channel Width: | **Time (min):** /

Approx. Average Depth: | **Surface velocity estimate:**

Average Velocity (0.8 [1] x Surface Velocity) (V) =

Note (1) - depends on substrate composition: 0.6 for rough, loose rocks or coarse gravel / 0.9 for smooth mud, sand, or hard pan rock

PHOTOS: (upstream, crossing, downstream)

NOTES:

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MARY RIVER PROJECT - TOTE ROAD UPGRADE
WATERCOURSE CROSSING MONITORING DATA FORM

CROSSING ID:			
Construction Duration:	Start:		Finish:
	Environmental Inspector:	Start (Date and Time):	Finish (Date and Time):
Env. Inspector on-site during in-water work:			
LOCATION	Datum:	Zone:	
Easting (m):	Northing (m):	Elevation (from mapping):	Other notes:

FISH ASSESSMENT PRIOR TO CONSTRUCTION	Date of Inspection:		
Fish Present? Y / N	If Yes, distance from crossing:		US / DS
Spawning Arctic Char present at crossing? Y / N	(If yes, contact biologist)		
Spawning site present 20 m upstream or downstream of crossing? Y / N			

CHANNEL CHARACTERISTICS	Date Measured:											
		Pre-Construction					Post Construction					
Location	Distance	Width (m)		Water Depth (m)			Width (m)		Water Depth (m)			
		Wetted	High W	Max	Avg.		Wetted	High W	Max	Avg.		
Crossing												
Upstream												
Dwnstrm												

SEDIMENT AND EROSION CONTROL MEASURES	
Measure installed:	Date installed:
	Dated removed:
	Turbidity monitored Y / N
Measures taken to stabilise disturbed areas:	

CROSSING INSTALLATION DETAILS			
1.2 m	culverts	lengths of culvert	Notes:
1.0 m	culverts	lengths of culvert	
0.5 m	culverts	lengths of culvert	

PHOTOS *View across crossing, view from upstream, view from downstream and any other to illustrate conditions.*

	Photo #	Date	Direction	Vantage point		Photo #	Date	Direction	Vantage point
Before					After				
across					across				
from US					from US				
from DS					from DS				
During					Sed Con				
across					across				
from US					from US				
from DS					from DS				

NOTES

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Schedule 9 – Photos