Baffinland

UPDATED AQUATIC EFFECTS MONITORING PROGRAM FRAMEWORK

NOVEMBER 2013

1 INTRODUCTION 5

2 ISSUES AND CONCERNS ASSOCIATED WITH THE PROJECT 8
2.1 INTRODUCTION 8
2.2 MINE SITE (WATER MANAGEMENT AREA 48) 8
2.3 MILNE PORT (WATER MANAGEMENT AREA 48) 8
2.4 TOTE ROAD (WATER MANAGEMENT AREA 48) 9
2.5 RAILWAY (WATER MANAGEMENT AREAS 48 AND 21) 9
2.6 STEENSBY PORT (MANAGEMENT AREA 21) 11

3 PROBLEM FORMULATION FOR AQUATIC EFFECTS MONITORING 12
3.1 WATER QUANTITY 12
3.2 WATER AND SEDIMENT QUALITY VEC 12
3.3 FRESHWATER AQUATIC BIOTA AND HABITAT 14
3.3.1 Potential effects on the Health and Condition of Arctic Char 14
3.3.2 Potential Effects on Fish Habitat 16
3.3.3 Potential Effects on Direct Fish Mortality 17
3.3.4 Potential Effects of Blasting on Fish 17
3.3.5 Stream and River Crossing Construction and Lake Encroachments 18

4 AEMP RELATED MONITORING PROGRAMS 19
4.1 METEOROLOGICAL STATIONS 19
4.2 SITE HYDROLOGY 19
4.3 AIR QUALITY MONITORING 19
4.4 HABITAT COMPENSATION 22
4.4.1 Tote Road Upgrade (Water Management Area 48) 22
4.4.2 Railway Construction (Water Management Area 21) 24
4.4.3 Construction of Water Crossings and Lake Encroachment 25
4.4.4 Construction Monitoring 25
4.4.5 Post Construction Monitoring - Performance Monitoring 26
4.4.6 Habitat Compensation Works - Performance Monitoring 27
4.5 OTHER ENVIRONMENTAL MANAGEMENT AND MONITORING PLANS 27
4.6 INUIT QAUJIMAJATUQANGIT 28

5 SURVEILLANCE NETWORK PROGRAM 30
5.1 SURVEILLANCE NETWORK PROGRAM OVERVIEW 30
5.2 EFFLUENT QUANTITY 30
5.3 EFFLUENT QUALITY 30
5.4 ACUTE TOXICITY 30

6 ENVIRONMENTAL EFFECTS MONITORING STUDY DESIGN SUMMARY 34
6.1 OVERVIEW 34
6.2 SITE CHARACTERIZATION 34
6.2.1 Camp Lake Tributary Exposure Areas 38
6.2.2 Camp Lake Tributary Near Field Exposure Area 38
6.2.3 Camp Lake Tributary Far Field Exposure Area 38
6.2.4 Camp Lake Tributary Reference Areas 39

6.2.5 Camp Lake Tributary Reference Area 2 ... 39
6.2.6 Camp Lake Tributary Reference Area 3 ... 41
6.2.7 Camp Lake Tributary Reference Area 4 ... 41
6.3 MARY RIVER EXPOSURE AREAS ... 42
6.3.1 Mary River Near Field Exposure Area ... 42
6.3.2 Mary River Far Field Exposure Area ... 43
6.3.3 Mary River Alternate Far Field Exposure Area ... 46
6.4 MARY RIVER REFERENCE AREAS ... 46
6.4.1 Mary River Reference Area 1 ... 46
6.4.2 Mary River Reference Area 2 ... 46
6.4.3 Mary River Reference Area 3 ... 47
6.4.4 Mary River Reference Area 4 ... 47
6.5 STUDY DESIGN METHODOLOGY ... 48
6.5.1 Effluent Plume Delineation Study ... 48
6.5.2 Water Quality Monitoring ... 49
6.5.3 Sediment Quality Monitoring ... 49
6.5.4 Benthic Invertebrate Survey ... 50
6.5.5 Fish Community, Population and Usability Survey ... 52
6.6 SUMMARY AND NEXT STEPS ... 54

7 CORE RECEIVING ENVIRONMENT MONITORING PROGRAM ... 55
7.1 CREMP OVERVIEW ... 55
7.1.1 Review of Baseline Data for Water Quality ... 55
7.1.2 Review of Baseline Data for Sediment Quality ... 56
7.1.3 Review of Baseline Data for Freshwater Biota ... 56
7.1.4 Phytoplankton ... 59
7.1.5 Benthic Invertebrates ... 59
7.1.6 Arctic Char ... 59
7.2 REFERENCE SITES ... 61
7.2.1 Desktop Screening Exercise Overview ... 64
7.2.2 Candidate Reference Lake Reconnaissance Survey Overview ... 64

8 TARGET STUDIES/SPECIFIC EFFECTS STUDIES AND FOLLOW-UP ... 68
8.1 INTRODUCTION ... 68
8.2 DUST DEPOSITION: SEDIMENTATION IN SURFACE WATERS ... 68
8.2.1 Potential Impacts ... 68
8.2.2 Mitigation ... 68
8.2.3 Monitoring ... 68
8.2.4 Baseline Sedimentation Study ... 69
8.3 STREAM DIVERSIONS: EFFECTS ON ARCTIC CHAR MOVEMENTS ... 71
8.3.1 Potential Impacts ... 71
8.3.2 Mitigation ... 71
8.3.3 Monitoring ... 71

9 PROPOSED APPROACH FOR ASSESSMENT OF AQUATIC EFFECTS ... 72
9.1 WATER AND SEDIMENT QUALITY OVERVIEW ... 72
9.2 PROPOSED APPROACH FOR AEMP SEDIMENT DATA ASSESSMENT ... 72

9.2.1 Perspective on CCME Sediment Quality Guidelines 72
9.2.2 Proposed AEMP Sediment Quality Benchmarks 73
9.2.3 Proposed Assessment Approach: AEMP Sediment Data 73
9.3 PROPOSED APPROACH FOR AEMP SURFACE QUALITY ASSESSMENT 75
9.3.1 Proposed AEMP Surface Water Quality Benchmarks 75
9.3.2 Proposed Assessment Approach: AEMP Water Quality Data 75
9.4 CONCEPTUAL APPROACH FOR IDENTIFICATION OF KEY METRICS AND CRITICAL EFFECTS SIZES FOR CREMP BIOTA DATA 75
9.4.1 Biological Critical Effects Sizes 76
9.4.2 Arctic Char 77
9.4.3 Benthic Invertebrates 78
9.4.4 Phytoplankton 79

10 QUALITY CONTROL AND QUALITY ASSURANCE (QA/QC) 83
10.1 WATER QUALITY 83
10.2 SEDIMENT QUALITY 83
10.3 BENTHIC INVERTEBRATE SURVEY 83
10.4 FISH 84
10.5 DATA EVALUATION 84

11 ANNUAL REPORTING 85

12 REFERENCES 86

TABLES

Table 2.1 Potential Residual Effects to the Mine Site Aquatic Environment 10
Table 3.1 Key Issues for Water and Sediment Quality at the Mine Site 13
Table 4.1 Project Stream Gauging Record 20
Table 4.2 Summary of Water Crossing Decision Table 24
Table 6.1 Freshwater EEM Study Design Exposure and Candidate Reference Areas 35
Table 6.2 Estimated Mine Effluent and Baseline Receiving Water Flows 48
Table 6.3 Benthic Invertebrate Community Survey Effect Indicators and Endpoints 52
Table 6.4 Fish Survey Measurements, Expected Precision and Summary Statistics 53
Table 6.5 Fish Population Effect Indicators and Endpoints 53
Table 7.1 Potential Candidate Reference Lakes Surveyed in 2013 for the CREMP 66
Table 9.1 MMER EEM Critical Effects Sizes (CES) for Fish Populations 78
Table 9.2 Summary of Selected Trophic Status Classification Schemes for Lakes 82

FIGURES

Figure 1.1 AEMP Framework 6
Figure 3.1 Linkage Diagram Illustrating Project Activities/Pathways of Potential Effects - Arctic Char 15
Figure 4.1 Mine Site Hydrology Monitoring Station Locations 21
Figure 5.1 Mine Site Surveillance Network Program (SNP) 31
Figure 5.2 Milne Port Surveillance Network Program (SNP) 32
Figure 5.3 Steensby Port Surveillance Network Program (SNP) 33
Figure 6.1 Proposed Exposure Areas for the Environmental Effects Monitoring (EEM) Program 36
Figure 6.2 Candidate Reference Areas for EEM Program 37
Figure 6.3 Camp Lake Tributary EEM Exposure Areas 40
Figure 6.4 Mary River Near Field EEM Exposure Area 44
Figure 6.5 Mary River Far Field EEM Exposure Area 45
Figure 7.1 CREMP Water and Sediment Monitoring Locations 58
Figure 7.2 CREMP Benthic Invertebrate Community Sample Locations 60
Figure 7.3 2013 Camp Lake Fish Sampling Locations 62
Figure 7.4 2013 Sheardown Lake Fish Sampling Locations 63
Figure 7.5 Candidate Reference Lakes Surveyed in 2013 67
Figure 8.1 2013 Baseline Sediment Trap Locations 70
Figure 9.1 Proposed Water/Sediment Assessment Approach and Response Framework 74

SCHEDULES

Schedule 1 Freshwater Intakes and Volumes
Schedule 2 Discharge Limits for Wastewater
Schedule 3 Compliance Monitoring Schedule for Effluent Discharges
Schedule 4 SNP Monitoring Parameters
Schedule 5 EEM and CREMP Monitoring Parameters
Schedule 6 Site Specific Monitoring Framework
Schedule 7 Water Crossing Performance Monitoring Framework
Schedule 8 EEM Photo Gallery

1 INTRODUCTION

The Aquatic Effects Monitoring Program (AEMP) will aim to address issues identified during the environmental assessment (EA) process that could potentially affect the aquatic receiving environments surrounding the project development. Building from earlier baseline monitoring, the AEMP describes the general monitoring strategy designed to detect effects to the freshwater aquatic environment.

The AEMP is a monitoring program designed to:

- Detect short-term and long-term effects of the Project's activities on the aquatic environment resulting from the Project
- Evaluate the accuracy of impact predictions
- Assess the effectiveness of planned mitigation measures
- Identify additional mitigation measures to avert or reduce environmental effects

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

- Water quantity
- Water and sediment quality
- Freshwater biota and fish habitat

Baffinland has implemented mitigation measures 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 these potential problems.

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, water and sediment quality, primary productivity (phytoplankton), benthic community structure and fish (specifically Arctic Char) within the streams and lakes potentially affected by project activities.

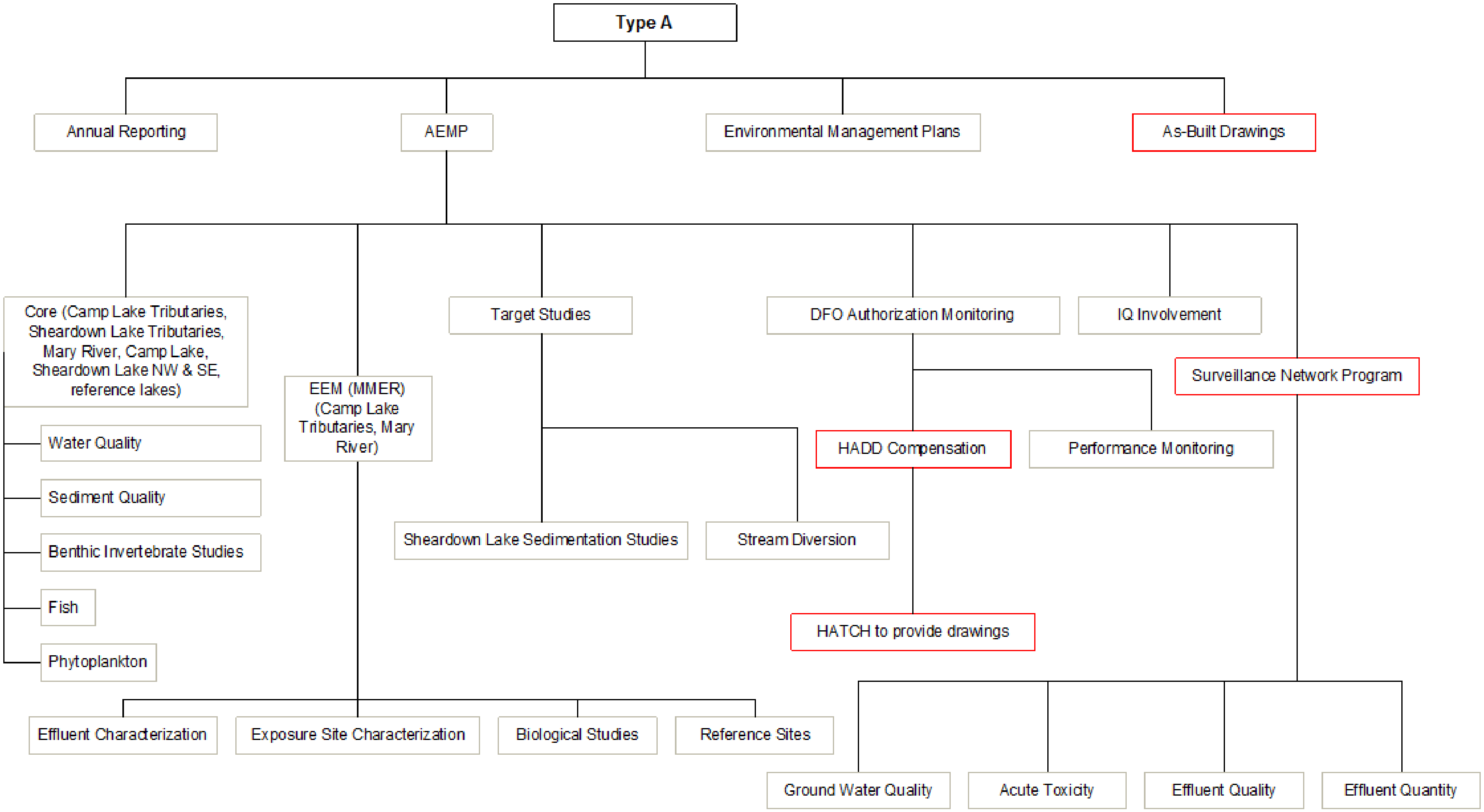
The proposed approach is to structure the AEMP to serve as an overarching 'umbrella' into which the results of all related monitoring programs for the approved Type A Water Licence are captured (NWB, 2013).

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

- Eclipse Sound Water Management Area # 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.
- Gifford 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 has been initiated under this AEMP Framework with the issuance of the Water Licence (NWB, 2013) and deals with construction phase of the project and non-mining related activities. This document describes the conceptual AEMP framework presented on Figure 1.1.

Figure 1.1 AEMP Framework



Phase II will be implemented with the start of the mining operation as described in the future AEMP Plan.

This AEMP Framework is an update of an earlier AEMP Framework prepared in February 2013. This update includes the following additional information:

- Updates to the text and schedules to reflect the contents of the Type A Water Licence issued to Baffinland
- Summaries of the outcome of the baseline integrity reviews completed on the various aquatic components of the AEMP
- Information on reference stream and lake work completed in 2013
- An updated EEM study design summary based on exposure site and reference site characterization work completed in 2013
- Details of a lake sedimentation monitoring study completed in 2013

Baffinland notes that an addendum to its FEIS (the FEIS Addendum; Baffinland, 2013) is currently under review that if approved will permit the company to transport 3.5 Mt/a of iron ore out of Milne Port during the open water season. Baffinland intends to capture this potential project change in the future AEMP Plan prior to mine operation.

2 ISSUES AND CONCERNS ASSOCIATED WITH THE PROJECT

2.1 INTRODUCTION

Potential effects on aquatic ecosystems are presented below for each of the Project components within the two geographical areas for the construction and operation phases of the Project. Since abandonment and reclamation activities are similar in nature to construction activities, the concerns identified for the construction phase are also relevant for the closure phase.

2.2 MINE SITE (WATER MANAGEMENT AREA 48)

The Mine Site includes the infrastructure required to support mining activities (camp, maintenance shops, fuel depots, wastewater treatment facility (WWTF), laydown areas, waste handling and storage facilities, landfill site and landfarm, explosives storage, manufacture and use). The freshwater supply for the Mine Site will be drawn from Camp Lake (Schedule 1). Two quarries will be developed within the Mine Site area to provide aggregate material for the site development.

Potential aquatic effects at the Mine Site are listed in Table 2.1.

2.3 MILNE PORT (WATER MANAGEMENT AREA 48)

The construction period at Milne Port began in the summer of 2013 following issuance of the Type A Water Licence (NWB, 2013). Milne Port 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 includes the airstrip, fuel depots, camp and WWTF, laydown areas, maintenance facilities, and, temporary waste transit areas. Two sites have been identified for the fresh water supply for this facility (Schedule 1). Two quarries will be developed to provide aggregate for the site development.

At Milne Port, all site drainage is channeled 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 shoreline. As a result, site drainage and effluent discharge have no effects on the freshwater receiving environment. The original location of this ditch will be relocated to the east as a result of the final development plan for Milne Port.

The concerns for potential freshwater aquatic effects during the construction, operation and closure of the Milne Port site are listed below:

<u>Water Quantity</u>

- Withdrawal of water from Philips Creek (summer) and KM 32 Lake (winter)

<u>Water and Sediment Quality</u>

- Quarry management (runoff quality, ARD potential, residual ammonia from blasting activities)
- Construction of water intakes - TSS/turbidity
- Spills caused by accidents and malfunctions

Freshwater Biota and Fish Habitat

- Low magnitude effects to fish and fish habitat related to water quality changes

The discharge criteria for the effluent and runoff water quality are presented in Schedule 2. The precise coordinates for the location of all controlled discharges from the Milne Port site are presented in Schedule 3.

2.4 TOTE ROAD (WATER MANAGEMENT AREA 48)

The Milne Inlet Tote Road connects Milne Port to the Mine Site. All material received at Milne Port will be transported by truck on the Tote Road. Realignment and re-grading of some road sections will be required. Select water crossings may be rebuilt as part of the ongoing maintenance of the road. A number of 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

- Dustfall 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
- Changes in water quality that may affect biota
- Bank erosion, stability, blockage, integrity of the water crossings, fish passage

2.5 RAILWAY (WATER MANAGEMENT AREAS 48 AND 21)

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 (Schedule 1). A number of 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)

- Water withdrawals affecting downstream flows

Water and Sediment Quality

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

Table 2.1 Potential Residual Effects to the Mine Site Aquatic Environment

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, hydrocarbon
	Landfill		Metals, hydrocarbon
	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	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
	Water diversions – changes in streams	Alteration or loss of habitat	Low flow and barrier to fish passage
	Changes in water and sediment quality (point and non-point sources)	Effects on Arctic Char health and condition; effects on lower trophic level biota (Arctic Char habitat)	Arctic char health and condition; population metrics; benthic invertebrate community metrics
	Dust Deposition	Alteration of habitat	Increased sediment deposition in streams and lakes Benthic invertebrate community metrics
		Deposition on Arctic Char eggs – reduced egg survival	Sedimentation rates in Arctic Char spawning habitat
Groundwater quality	Landfill	seepage in groundwater	Metals

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, TSS (construction)
- Changes in water quality (e.g., dust, sewage effluent) - effects on Arctic Char health and condition/habitat
- Blasting near water (blasting overpressure) along Cockburn Lake.

2.6 STEENSBY PORT (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 ongoing 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, a WWTF, 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. The freshwater supply for the Steensby Port will be drawn from two local lakes (Schedule 1). 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 treated oily water will discharge to Steensby Inlet via an outfall at a 35 m depth. As a result, site drainage and effluent discharge have minimal 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 (dust suppression and other minor uses) and ST347 Lake (permanent camp)

Water and Sediment Quality

- Quarry management (runoff quality, ARD potential, residual ammonia from blasting activities)
- Construction of water intakes - TSS/turbidity
- Spills caused by accidents and malfunctions

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, TSS (construction)
- Construction of water intakes - avoidance of spawning areas

The discharge criteria for the effluent and runoff water quality are presented in Schedule 2. The precise coordinates for the location of all controlled discharges from the Steensby Site are presented in Schedule 3.

3 PROBLEM FORMULATION FOR AQUATIC EFFECTS MONITORING

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. 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.

Conditions applying to water use and management have been outlined in Part E of the issued water licence (NWB, 2013). These conditions will be adhered to throughout the life of the Project and applicable timeframe of this licence. Baffinland will not exceed 1,589 m^3/day and 580,000 m^3/year total water use from all sources during the construction phase of the Project. During the operation phase of the Project Baffinland will not exceed 630 m^3/day or 230,000 m^3/year for total domestic camp and industrial water use from all sources. All water sources for the Project are summarized in Schedule 1 with their associated co-ordinates (in degrees, minutes and seconds of latitude and longitude) as required by Part I (7) of the water licence (NWB, 2013).

Key Issues and Pathways for Water Quantities

Key issues identified for freshwater quantity are listed below:

- 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 listed below:

- Water withdrawn for consumption

The benchmarks are the water quantities authorized under the Type A Water Licence, which are presented in Schedule 1.

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 is discussed in Section 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 Table 3.1.

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 require 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 require 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
Dustfall	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 runoff – west pond	ARD, metals, TSS, blasting residue (ammonia)	Camp Lake Tributary	Operation Closure Post-closure
Waste rock stockpile runoff – east pond	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 effects on the water and sediment quality VECs, the list of key indicators that are considered to be the most relevant and important elements of the VECs are separated into four categories as follows:

- General Parameters
- Metals
- Nutrients
- 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 will be developed as described in Section 9.

3.3 FRESHWATER AQUATIC BIOTA AND HABITAT

Key Issues and Pathways

Arctic Char (*Salvelinus alpinus*) are the primary freshwater biota of interest regarding potential effects of the Project on the aquatic environment. Potential linkages between the Project components/activities and Arctic Char are presented on Figure 3.1. These linkage pathways can be categorised into three key issues as follows:

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

Key Indicators and Benchmarks

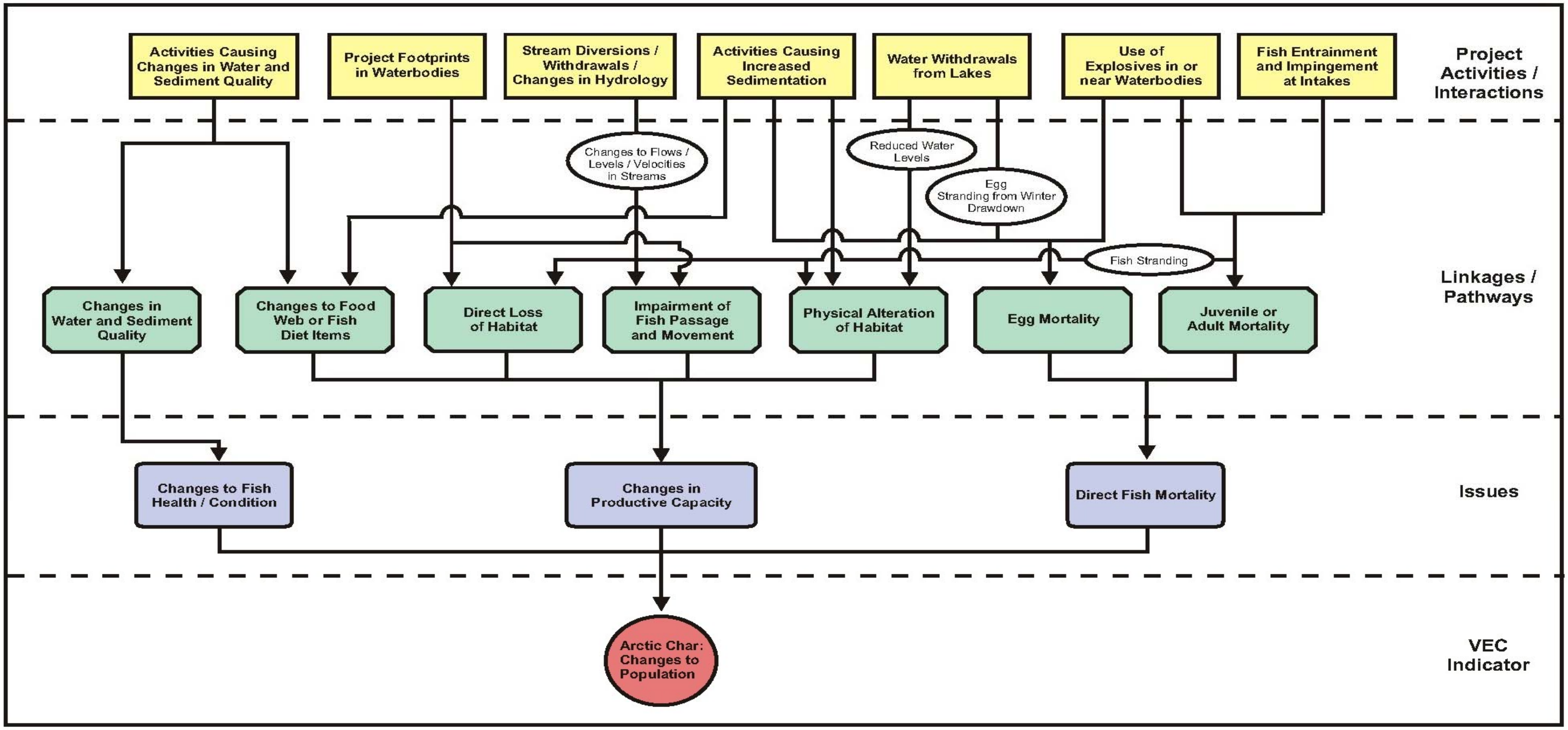
3.3.1 Potential effects on the Health and Condition of Arctic Char

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, 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)
- 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 indicators are Arctic Char length/weight, age, condition and CPUE. A discussion regarding potential benchmarks for this indicator is presented in Section 9.4.



BAFFINLAND IRON MINES CORPORATION		
MARY RIVER PROJECT		
LINKAGE DIAGRAM ILLUSTRATING PROJECT ACTIVITIES/PATHWAYS OF POTENTIAL EFFECTS - ARCTIC CHAR		
NORTH/SOUTH CONSULTANTS INC.	P/A NO. NB102-181/33	REF. NO. NB13-00586
	FIGURE 3.1	REV 0

3.3.2 Potential Effects on Fish Habitat

Project activities with the potential to affect Arctic Char habitat include the following:

- 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 Arctic 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)
- Project-related effects on fish passage, with subsequent effects on the availability of habitat, including:
  - Stream crossing construction and operation
  - 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.

The following changes are associated with mine site development:

- Water withdrawn from Camp Lake for domestic and industrial consumption will be discharged (after treatment) to the Mary River
- Water withdrawal from Camp Lake will affect lake water levels and outflow discharge
- 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 Arctic Char habitat are as follows:

- Benthic invertebrate community – metrics may include densities and indices such as Chironomidae proportion, Shannon`s Equitability, Simpson`s Diversity index, and total taxa richness
- Primary productivity - Chlorophyll *a*
- Arctic Char - length/weight, age, condition, CPUE

A discussion regarding potential benchmarks for this indicator is presented in Section 9.4.

3.3.3 Potential Effects on Direct Fish Mortality

Project-related activities with the potential to cause direct mortality of Arctic char that are considered include the following:

- Effects of sedimentation on mortality of eggs
- Potential egg stranding related to winter drawdown at water source lakes
- Blasting in or near Arctic Char habitat
- Placement of Project infrastructure in Arctic Char habitat (i.e., potential spawning areas)
- Potential for entrainment and/or impingement of Arctic Char eggs and juveniles at water intakes
- Potential fish stranding related to water diversions and/or alterations in discharge or water levels

Potential effects of sedimentation on survival (hatching success) of Arctic Char eggs will be addressed through monitoring sediment deposition rates in Sheardown Lake as a target study (see Section 8). Potential for winter drawdown to cause egg stranding will be addressed through monitoring of water levels as the primary indicator, supported by information on Arctic char population monitoring (e.g., year class strengths, recruitment). Potential effects of blasting in or near Arctic Char habitat is addressed through the blasting management and monitoring program (see Section 4.11). The potential for placement of Project infrastructure to cause direct mortality of Arctic Char (i.e., placement of infrastructure on fish eggs) is addressed through mitigation and management, specifically through avoidance of potential spawning areas and/or by adherence to timing windows to avoid the egg incubation period. Potential for entrainment and impingement of fish at water intakes will be mitigated through adherence to Department of Fisheries and Oceans (DFO) Freshwater intake end-of-pipe fish screen guideline (DFO, 1995). The last potential pathway of effect will be addressed through a follow-up target study to confirm fish passage at Mine area streams affected by water diversions (see Section 8.1.2).

Key indicators for potential effects on direct fish mortality may include sedimentation monitoring, water level monitoring, monitoring during blasting and follow up monitoring at the mine site tributaries.

3.3.4 Potential Effects of Blasting on Fish

Blasting will be conducted to support the 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 effects due to blasting overpressure mainly arises for the railway construction along Cockburn Lake where significant blasting is required for the following project components:

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

The key indicator for potential effects will be determined according to the DFO decision regarding the application for authorization under the *Fisheries Act*.

3.3.5 Stream and River Crossing Construction and Lake Encroachments

Construction of watercourse crossings along the railway, railway access road, and Milne Inlet Tote Road have the potential to cause the following effects:

- Stranding of Arctic Char due to the need for isolation of the watercourses. This effect will be mitigated through the use of appropriate timing windows for construction when possible and through fish salvage operations when required.
- Potential impediments to fish passage at stream crossings due to changes in water levels, flows and/or velocities. This potential pathway of effect would be addressed through follow-up monitoring at selected stream crossings (i.e., a subset) to evaluate fish passage. This monitoring is described in detail in Section 4.15.5.

4 AEMP RELATED MONITORING PROGRAMS

This section presents an overview of environmental monitoring that relates to and supports the AEMP.

4.1 METEOROLOGICAL STATIONS

Three meteorological stations have been established, one each at the mine site, Steensby Port, and Milne Port 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.

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. Stream flow data has been collected at the Project site since 2006. Baffinland continues to operate seven seasonal stream gauges, six of which are located in the vicinity of the mine site (Figure 4.1) and include the following stream gauges relevant to the AEMP:

- Camp Lake Tributary 1 – which will receive mine effluent from the west pond (Station H05)
- Mary River – which will receive mine effluent from the east pond, ROM pond and ore stockpiles along with treated sewage effluent from the camp (Station H06)
- Sheardown Lake Tributary 1 – which will experience decreased flows due to diversions associated with the west pond (Station H11)

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.

4.3 AIR QUALITY MONITORING

The Air and Noise Abatement Management Plan provides guidance on management of air emissions and noise from construction and operation activities. The plan also describes the air quality monitoring that will be carried out for the Project.

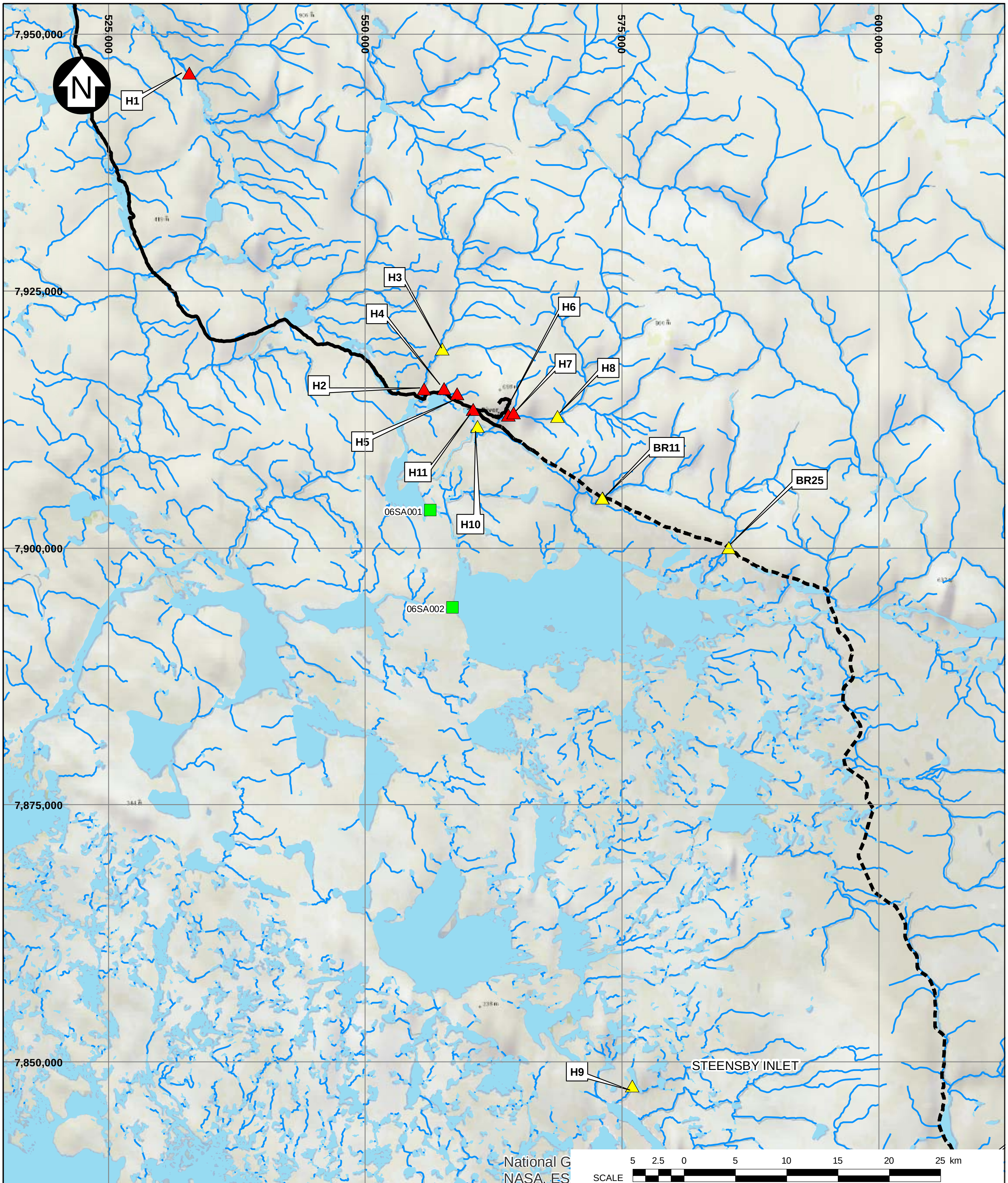
Passive and active air quality monitoring will be conducted at Milne Port, the Mine Site and Steensby Port. Active monitoring will involve measuring total suspended particulate (TSP) in areas of activity at the mine site and Steensby Port. Passive sampling will include collecting sulphur dioxide (SO_2), nitrogen dioxides (NO_2), ozone (O_3), and dustfall samples simultaneously.

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 (SO_2, NO_2, O_3, and dustfall, including metal deposition). Snow-core sampling will be used to determine dust fall at specified locations. Dustfall monitoring is being conducted at transects along the Milne Inlet Tote Road. Emission testing is being conducted on Project incinerators. The approach, indicators, thresholds and proposed response actions are described in the Air and Noise Abatement Management Plan.

Table 4.1 Project Stream Gauging Record

STATION ID	STATION TYPE	PERIOD OF RECORD	DRAINAGE AREA (km^2)	COORDINATES (UTM)		
				Zone	Easting	Northing
H01	Stream flow	2006-2008, 2011-2013	250	17W	532831	7946247
H02	Stream flow	2006-2008, 2010, 2012, 2013	210	17W	555712	7915514
H03	Stream flow	2006-2008, 2010	30.5	17W	557485	7919401
H04	Stream flow	2006-2008, 2010, 2012, 2013	8.3	17W	557639	7915579
H05 (Camp Lake Tributary L1)	Stream flow	2006-2008, 2010-2013	5.3	17W	558906	7915079
H06 (Mary River)	Stream flow	2006-2008, 2010-2013	240	17W	563922	7912984
H07	Stream flow	2006-2008, 2011, 2013	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	2011-2013	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

Air quality monitoring program is a supporting monitoring program to the AEMP as dustfall monitoring may be able inform the findings of effects to the aquatic environment, as well as measure changes in dustfall due to changes in the Project or in the application of mitigation measures.



LEGEND:

- ACTIVE STREAM FLOW GAUGING STATION
- INACTIVE STREAM FLOW GAUGING STATION
- WATER SURVEY OF CANADA HYDROMETRIC STATION (2006-2012)
- MILNE INLET TOTE ROAD
- PROPOSED RAIL ALIGNMENT
- RIVER/STREAM/DRAINAGE
- WATER

NOTES:

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2004). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS SHOWN IN UTM NAD83 ZONE 17 AND IS IN METRES.
3. PROPOSED RAIL ALIGNMENT PROVIDED BY CANARAIL CONSULTANTS INC. IN OCTOBER 2010.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	15NOV'13	ISSUED WITH TRANSMITTAL	DKK	AS	RAC	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

MINE SITE HYDROLOGY MONITORING STATION LOCATIONS

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE 4.1 REV 0

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4.4 HABITAT COMPENSATION

Baffinland must obtain appropriate authorizations or letters of advice from the DFO for construction activities at water crossings. Section 35 of the *Fisheries Act* prohibits the harmful alteration, disruption or destruction 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.

4.4.1 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 km^2
- Small crossings with upstream watershed areas between 0.5 km2 and 2.5 km^2
- Medium crossings with upstream watershed areas between 2.5 km2 and 7.5 km^2
- Large crossings with upstream watershed areas between 7.5 km2 and 30 km^2
- Extra-Large crossings with upstream watershed areas greater than 30 km^2

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 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 can be accommodated by means of either:

- Amendments to the existing FA and addendums to the currently approved No Net Loss Plans for HADD
- 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 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 (North/South Consultants Inc., 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 CPUE (measured as the number of fish captured per minute of electrofishing) were calculated and tabulated by watercourse and reach.

4.4.2 Railway Construction (Water Management Area 21)

The Water License application included eight (8) design descriptions for crossings at the following locations:

- AR-BR-37-1
- AR-CV-144-1
- BR-37-1
- CV-17-1
- CV-51-2
- CV-52-2
- CV-76-3
- 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 a 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 water crossings along the railway corridor on the basis of stream characterization undertaken during the environmental baseline studies. Details of these assessments are provided in the FEIS, presented in Volume 3, Appendix 3B, Attachment 7 (Baffinland, 2012). A summary of these assessments is provided in Table 4.2.

Table 4.2 Summary of Water Crossing Decision Table

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.

4.4.3 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 of 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 effects 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.

4.4.4 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.

4.4.5 Post Construction Monitoring - Performance Monitoring

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

<u>Potential Impacts</u>

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.

<u>Mitigation</u>

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.

4.4.6 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.

4.5 OTHER ENVIRONMENTAL MANAGEMENT AND MONITORING PLANS

A number of management and monitoring plans (EMMPs) were developed as part of the FEIS and/or the Type A Water Licence. These plans include:

- Environmental Protection Plan
- Surface Water and Aquatic Ecosystems Management Plan
- Quarry and Borrow Pit Management Plan
- Waste Water Management Plan
- Waste Management Plan
- Hazardous Materials and Hazardous Waste Management Plan
- Explosives Management Plan
- Blasting Management Plan
- Waste Rock Management Plan
- Emergency Response and Spill Contingency Plan
- Abandonment and Reclamation Plan

The above management plans all have linkages to water, and the issues and concerns identified in Section 2 involve mitigation measures identified in the above plans. Like the AEMP, these plans are living documents which will be updated periodically throughout the Project life to account for changes in the Project, the success of mitigation measures and the results of monitoring.

4.6 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 Guidelines (2009), 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.

5 SURVEILLANCE NETWORK PROGRAM

5.1 SURVEILLANCE NETWORK PROGRAM OVERVIEW

The Surveillance Network Program (SNP) is a compliance-based monitoring program defined in the Type A Water Licence.

A number of effluent and waste discharges are regulated by the water licence, including:

- Mine effluent (pit water and runoff from ore and waste rock stockpiles)
- Treated sewage effluent
- Oily water
- Sewage sludge
- Solid waste landfilled on-site
- Hazardous and non-hazardous wastes taken off-site for disposal
- Landfill seepage/effluent
- Water from bulk fuel storage facility containment
- Hydrocarbon impacted soil treated in landfarms
- Waste rock

The coordinates for each discharge location are listed in Schedule 4 and are shown on the following figures:

- Mine Site Surveillance Network Program (Figure 5.1)
- Milne Port Surveillance Network Program (Figure 5.2)
- Steensby Port Surveillance Network Program (Figure 5.3)

The discharge location, monitoring parameters and frequency details of each station are summarized in Schedule 4. Some SNP stations will be utilized for monitoring of contact mine water under the MMERs (Section 6). The SNP results are integrated into interpretation and recommendations of the annual AEMP program.

5.2 EFFLUENT QUANTITY

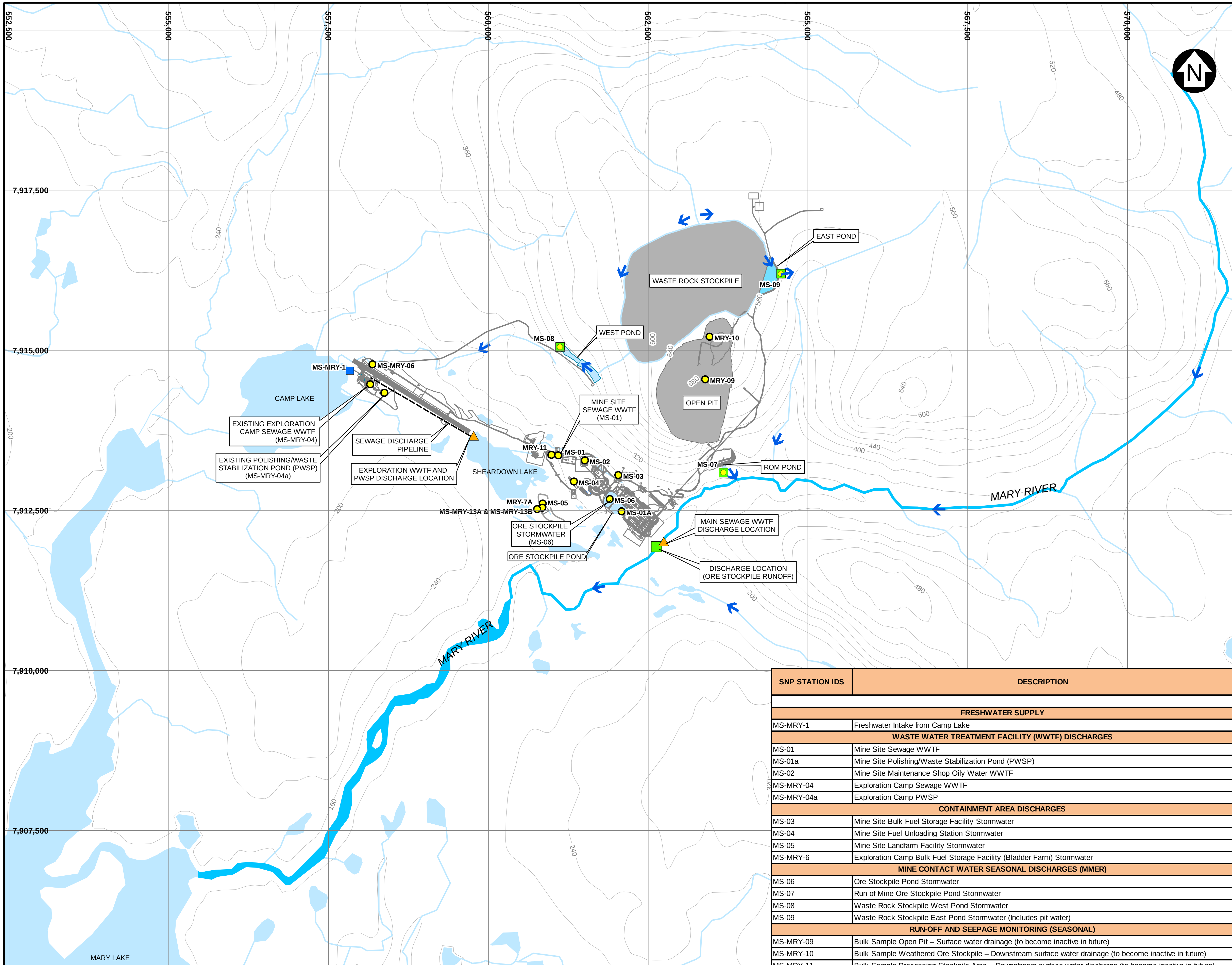
The Type A Water Licence requires the reporting of monthly and annual volumes of effluents and wastes discharged by the Project, listed in Section 5.1.

5.3 EFFLUENT QUALITY

Schedule 3 presents the discharge quality criteria specified in the Type A Water Licence. Effluent quantity and quality together provide concentration and loadings data for downstream receiving environments.

5.4 ACUTE TOXICITY

Periodic acute toxicity testing for end of pipe sewage effluent discharge locations provides data on possible acute impacts to effluent exposure areas. Testing of treated sewage effluent is required by the licence to confirm that the effluent is not acutely toxic.



LEGEND:

- PROPOSED SURVEILLANCE NETWORK PROGRAM (SNP) STATION
- MINE EFFLUENT DISCHARGE LOCATION
- TREATED SEWAGE DISCHARGE LOCATION
- FRESHWATER INTAKE LOCATION
- EXISTING TOTE ROAD
- PROPOSED RAILWAY ALIGNMENT
- PROPOSED CONSTRUCTION ACCESS ROAD
- PROPOSED SITE INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- WATER

SURVEILLANCE NETWORK PROGRAM (SNP):

- FIRST LEVEL OF MONITORING FOCUSES ON DISCHARGE QUALITY.
- THERE IS OFTEN AN OVERLAP WITH SNP STATIONS AND EEM STATIONS REQUIRED UNDER THE METAL MINING EFFLUENT REGULATION (MMER).

SNP STATION IDS	DESCRIPTION
	FRESHWATER SUPPLY
MS-MRY-1	Freshwater Intake from Camp Lake
	WASTE WATER TREATMENT FACILITY (WWTF) DISCHARGES
MS-01	Mine Site Sewage WWTF
MS-01a	Mine Site Polishing/Waste Stabilization Pond (PWSP)
MS-02	Mine Site Maintenance Shop Oily Water WWTF
MS-MRY-04	Exploration Camp Sewage WWTF
MS-MRY-04a	Exploration Camp PWSP
	CONTAINMENT AREA DISCHARGES
MS-03	Mine Site Bulk Fuel Storage Facility Stormwater
MS-04	Mine Site Fuel Unloading Station Stormwater
MS-05	Mine Site Landfarm Facility Stormwater
MS-MRY-6	Exploration Camp Bulk Fuel Storage Facility (Bladder Farm) Stormwater
	MINE CONTACT WATER SEASONAL DISCHARGES (MMER)
MS-06	Ore Stockpile Pond Stormwater
MS-07	Run of Mine Ore Stockpile Pond Stormwater
MS-08	Waste Rock Stockpile West Pond Stormwater
MS-09	Waste Rock Stockpile East Pond Stormwater (Includes pit water)
	RUN-OFF AND SEEPAGE MONITORING (SEASONAL)
MS-MRY-09	Bulk Sample Open Pit – Surface water drainage (to become inactive in future)
MS-MRY-10	Bulk Sample Weathered Ore Stockpile – Downstream surface water drainage (to become inactive in future)
MS-MRY-11	Bulk Sample Processing Stockpile Area – Downstream surface water discharge (to become inactive in future)
MS-MRY-13a & -13b	Non-Hazardous Waste Landfill – Downstream surface water drainage

NOTES:

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2004). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS UTM NAD83 ZONE17.
3. CONTOUR ARE IN METRES. CONTOUR INTERVAL VARIES.
4. LAKE SAMPLE LOCATIONS VARY SLIGHTLY DURING WINTER MONTHS DUE TO ICE CONDITIONS.

SCALE 500 250 0 500 1,000 1,500 2,000 2,500 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

MINE SITE SURVEILLANCE NETWORK PROGRAM (SNP)

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE 5.1 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	15NOV'13	ISSUED WITH TRANSMITTAL	DKK	AS	RAC	RAC

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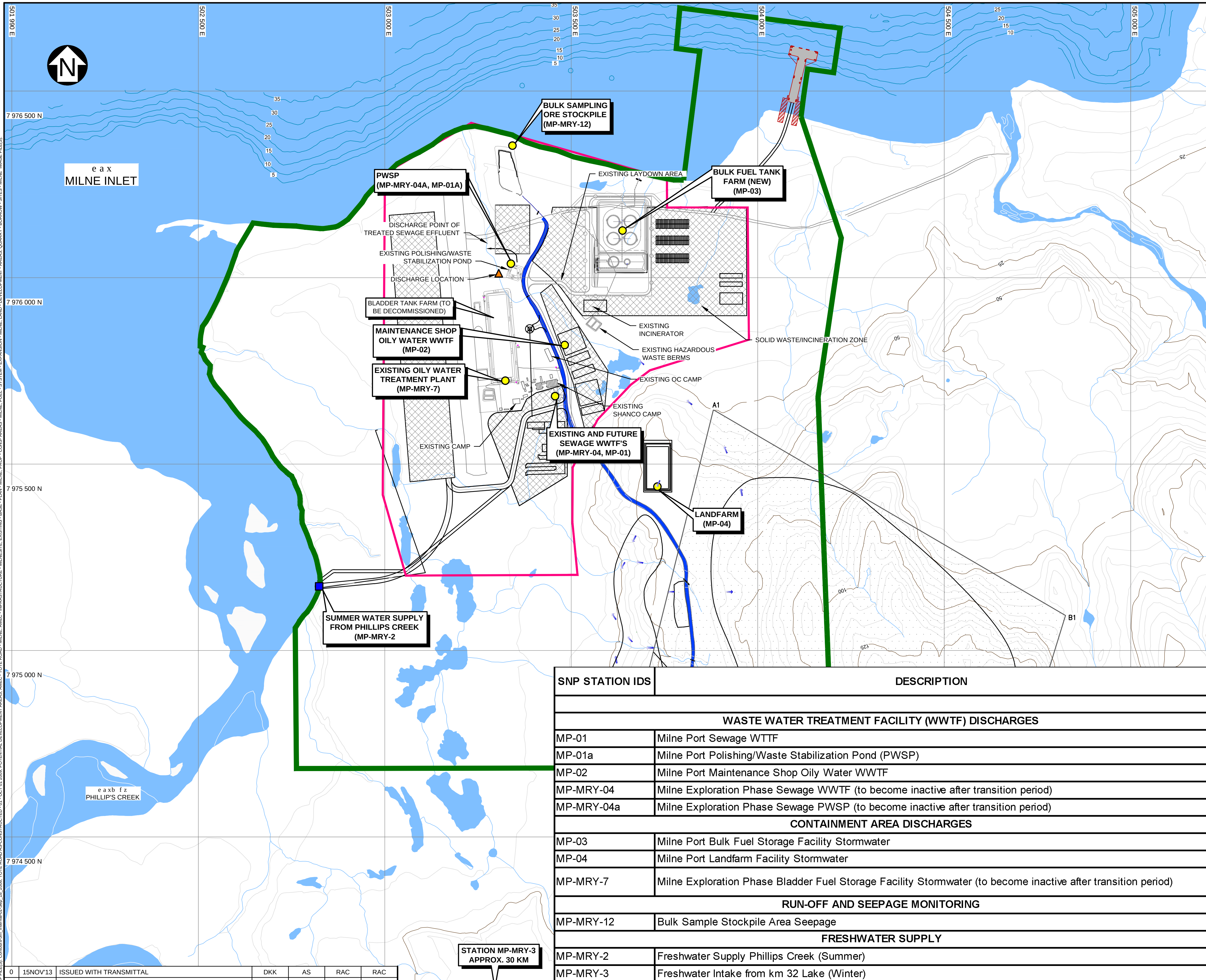

LEGEND:

- WATER
- LAYDOWN AREA
- RIVER/STREAM/DRAINAGE
- MILNE INLET TOTE ROAD
- POTENTIAL DEVELOPMENT AREA
- FLOW DIRECTION
- MONITORING LOCATION
- FRESHWATER INTAKE LOCATION
- DISCHARGE LOCATION

NOTES:

1. TOPOGRAPHY PROVIDED BY EAGLE MAPPING (2005).
2. COORDINATE GRID IS SHOWN IN UTM (NAD83) ZONE 17 AND IS IN METRES.
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 5 METRES.
4. SITE INFRASTRUCTURE PROVIDED BY SIKUMIUT (NOVEMBER, 2012).
5. CONTOURED BATHYMETRY PROVIDED BY ENTERPRISES NORMAND JUNEAU INC., DATED SEPTEMBER 9, 2010 (CONTOUR INTERVAL 1m).

SCALE A 100 50 0 100 200 300 400 500 m

SNP STATION IDS	DESCRIPTION
WASTE WATER TREATMENT FACILITY (WWTF) DISCHARGES	
MP-01	Milne Port Sewage WTTF
MP-01a	Milne Port Polishing/Waste Stabilization Pond (PWSP)
MP-02	Milne Port Maintenance Shop Oily Water WWTF
MP-MRY-04	Milne Exploration Phase Sewage WWTF (to become inactive after transition period)
MP-MRY-04a	Milne Exploration Phase Sewage PWSP (to become inactive after transition period)
CONTAINMENT AREA DISCHARGES	
MP-03	Milne Port Bulk Fuel Storage Facility Stormwater
MP-04	Milne Port Landfarm Facility Stormwater
MP-MRY-7	Milne Exploration Phase Bladder Fuel Storage Facility Stormwater (to become inactive after transition period)
RUN-OFF AND SEEPAGE MONITORING	
MP-MRY-12	Bulk Sample Stockpile Area Seepage
FRESHWATER SUPPLY	
MP-MRY-2	Freshwater Supply Phillips Creek (Summer)
MP-MRY-3	Freshwater Intake from km 32 Lake (Winter)

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	15NOV'13	ISSUED WITH TRANSMITTAL	DKK	AS	RAC	RAC

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

MILNE PORT SURVEILLANCE NETWORK PROGRAM (SNP)

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE	REV
5.2	0

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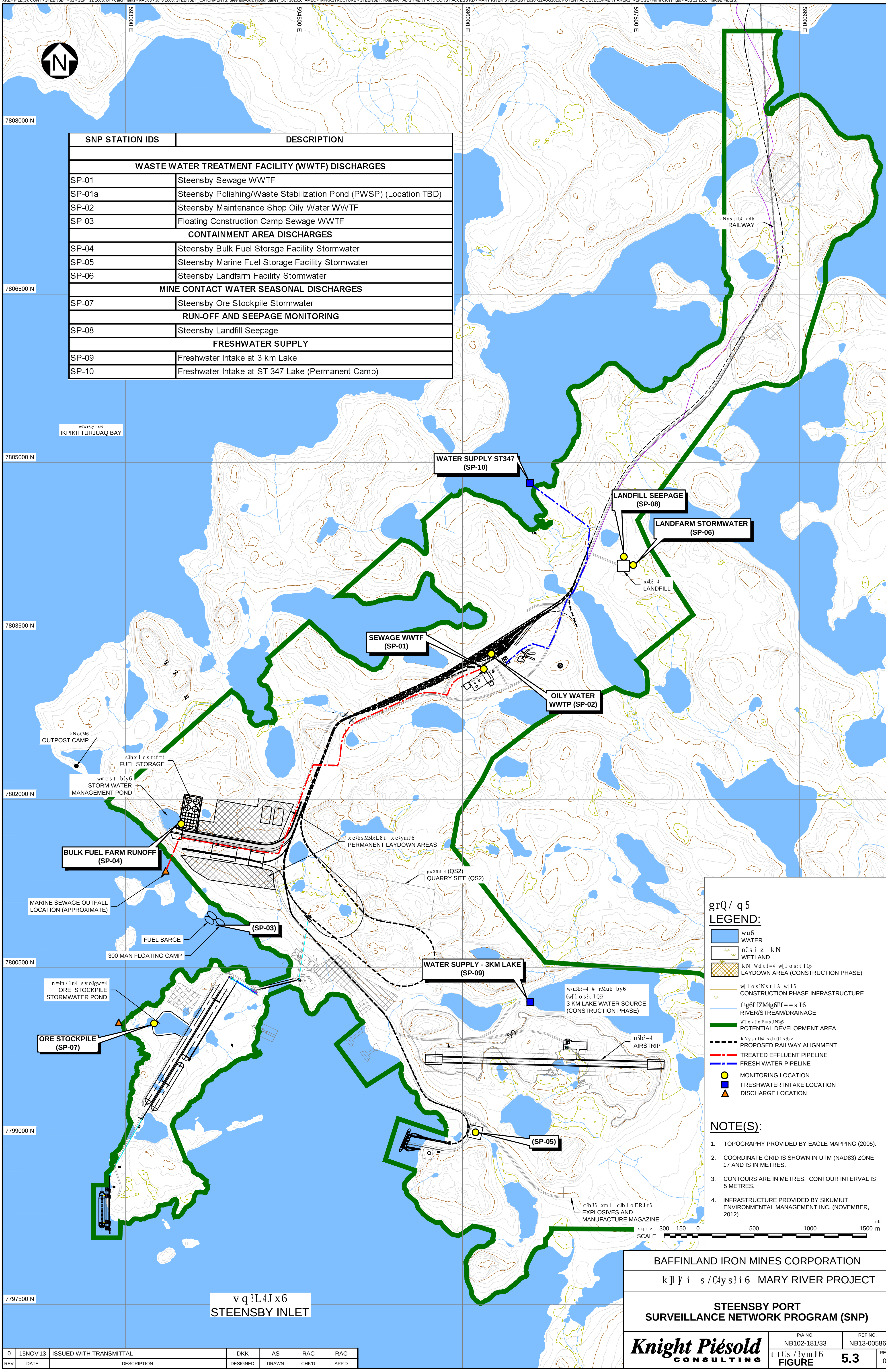
XREF FILE(S): CONT - STEENSBY - 01 - SEPT 22 2008; 04 - Catchments - NAD83 - Jul 8 2008; STEENSBY_CATCHMENTS; SteensbyQuarryBoundaries_OCT182010; AMEC - INFRASTRUCTURE - STEENSBY; RAILWAY ALIGNMENT AND CONST ACCESS RD - MARY RIVER STEENSBY 2010 -12AUG2010; POTENTIAL DEVELOPMENT AREAS; REFUGE (Farm Crossings) - Aug 12 2010 IMAGE FILE(S):



SNP STATION IDS	DESCRIPTION
WASTE WATER TREATMENT FACILITY (WWTF) DISCHARGES	
SP-01	Steensby Sewage WWTF
SP-01a	Steensby Polishing/Waste Stabilization Pond (PWSP) (Location TBD)
SP-02	Steensby Maintenance Shop Oily Water WWTF
SP-03	Floating Construction Camp Sewage WWTF
CONTAINMENT AREA DISCHARGES	
SP-04	Steensby Bulk Fuel Storage Facility Stormwater
SP-05	Steensby Marine Fuel Storage Facility Stormwater
SP-06	Steensby Landfarm Facility Stormwater
MINE CONTACT WATER SEASONAL DISCHARGES	
SP-07	Steensby Ore Stockpile Stormwater
RUN-OFF AND SEEPAGE MONITORING	
SP-08	Steensby Landfill Seepage
FRESHWATER SUPPLY	
SP-09	Freshwater Intake at 3 km Lake
SP-10	Freshwater Intake at ST 347 Lake (Permanent Camp)

NOTE(S):

1. TOPOGRAPHY PROVIDED BY EAGLE MAPPING (2005).
2. COORDINATE GRID IS SHOWN IN UTM (NAD83) ZONE 17 AND IS IN METRES.
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 5 METRES.
4. INFRASTRUCTURE PROVIDED BY SIKUMIUT ENVIRONMENTAL MANAGEMENT INC. (NOVEMBER, 2012).

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

STEENSBY PORT SURVEILLANCE NETWORK PROGRAM (SNP)

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE 5.3 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	15NOV'13	ISSUED WITH TRANSMITTAL	DKK	AS	RAC	RAC

6 ENVIRONMENTAL EFFECTS MONITORING STUDY DESIGN SUMMARY

6.1 OVERVIEW

The Metal Mining Effluent Regulations (MMER) regulate the discharge of mine effluents from metal mines in Canada. These regulations, administered under the federal *Fisheries Act* (1985), apply to mining and milling operations that discharge effluent(s) at a rate greater than 50 m^3/day and therefore will apply to the Mary River Project once effluent flow reaches this threshold.

The MMER outline requirements for routine effluent monitoring, acute lethality testing, and Environmental Effects Monitoring (EEM). The objective of EEM is to determine whether mining activity is causing an effect on fish, benthic invertebrate communities and/or the use of fisheries resources (based on mercury accumulation in fish tissues).

A draft EEM study design has been prepared in accordance with the MMER as prescribed by the EEM technical guidance document (EC, 2012). The study design describes in detail how the Cycle 1 EEM monitoring study will be undertaken. It outlines the proposed activities involved in the investigation of water quality, sediment quality, and freshwater biota community to meet the objectives of the EEM program in accordance with the MMER. In accordance with the technical guidance document (EC, 2012), this study will take into account all relevant site characterization information, previous biological monitoring data, and comments and/or recommendations stemming from previous efforts in the area.

The study will be reviewed and approved by the Environment Canada Technical Advisory Panel (TAP) prior to initiation of the Cycle 1 EEM study. The following is a summary of the draft EEM study design.

6.2 SITE CHARACTERIZATION

The Mary River and Camp Lake Tributary 1 are the two receiving watercourses identified for the Project (Figure 6.1).

The Mary River will receive mine effluent from three final discharge points as follows:

- East Pond discharge collecting stormwater from the east side of the waste rock pile
- Run-of-mine (ROM) stockpile discharge
- The main ore stockpile at the rail load-out area

Camp Lake Tributary 1 will be the final discharge point for the West Pond, which will collect stormwater from the west side of the waste rock pile.

In preparation for these regulatory obligations, Baffinland characterized the two exposure areas (Mary River and Camp Lake Tributary 1) as well as candidate reference areas in 2013.

Candidate reference areas, representing the in situ physical and biological conditions of the exposure areas, were identified through a series of desktop screenings and ground truthing activities in 2012 and 2013. At least three candidate reference areas for each receiving watercourse have been characterized to evaluate their suitability for comparison to the respective exposure areas.

The coordinates of all exposure and candidate reference areas for the study design are provided in Table 6.1. The locations of all proposed exposure areas on the Camp Lake Tributary and Mary River are shown on Figure 6.1. The candidate reference areas for the study are shown on Figure 6.2. The baseline environmental data collected to date at the exposure and reference areas by North/South

Consultants Inc. (NSC) and Knight Piésold Ltd. (KP) on behalf of Baffinland are also discussed in this study design.

Table 6.1 Freshwater EEM Study Design Exposure and Candidate Reference Areas

STUDY AREA ID	LATITUDE (DEG. MIN. SEC.)	LONGITUDE (DEG. MIN. SEC.)
Camp Lake Tributary Near Field Exposure Area	71° 19’ 46” N	79° 21’ 46” W
Camp Lake Tributary Far Field Exposure Area	71° 19’ 46” N	79° 22’ 46” W
Camp Lake Tributary Reference Area 2	71° 31’ 51” N	80° 15’ 42” W
Camp Lake Tributary Reference Area 3	71° 15’ 56” N	79° 06’ 27” W
Camp Lake Tributary Reference Area 4	71° 15’ 28” N	79° 04’ 23” W
Mary River Near Field Exposure Area (Surface water & Fish at outfall)	71 17' 50" N	79° 15' 57" W
Mary River Near Field Exposure Area (Sediment & Benthos)	71° 17’ 42” N	79° 16’ 47” W
Mary River Far Field Exposure Area	71° 16’ 42” N	79° 22’ 11” W
Mary River Alternate Far Field Exposure Area	71° 15’ 32” N	79° 24’ 03” W
Mary River Reference Area 1	71° 12’ 47” N	79° 56’ 17” W
Mary River Reference Area 2	71° 13’ 21” N	79° 02’ 46” W
Mary River Reference Area 3	71° 10’ 26” N	78° 39’ 31” W
Mary River Reference Area 4	71° 20' 43” N	79° 00' 04” W

NOTES:

1. AREA COORDINATES REPRESENT THE UPSTREAM EXTEND OF EACH STUDY AREA.

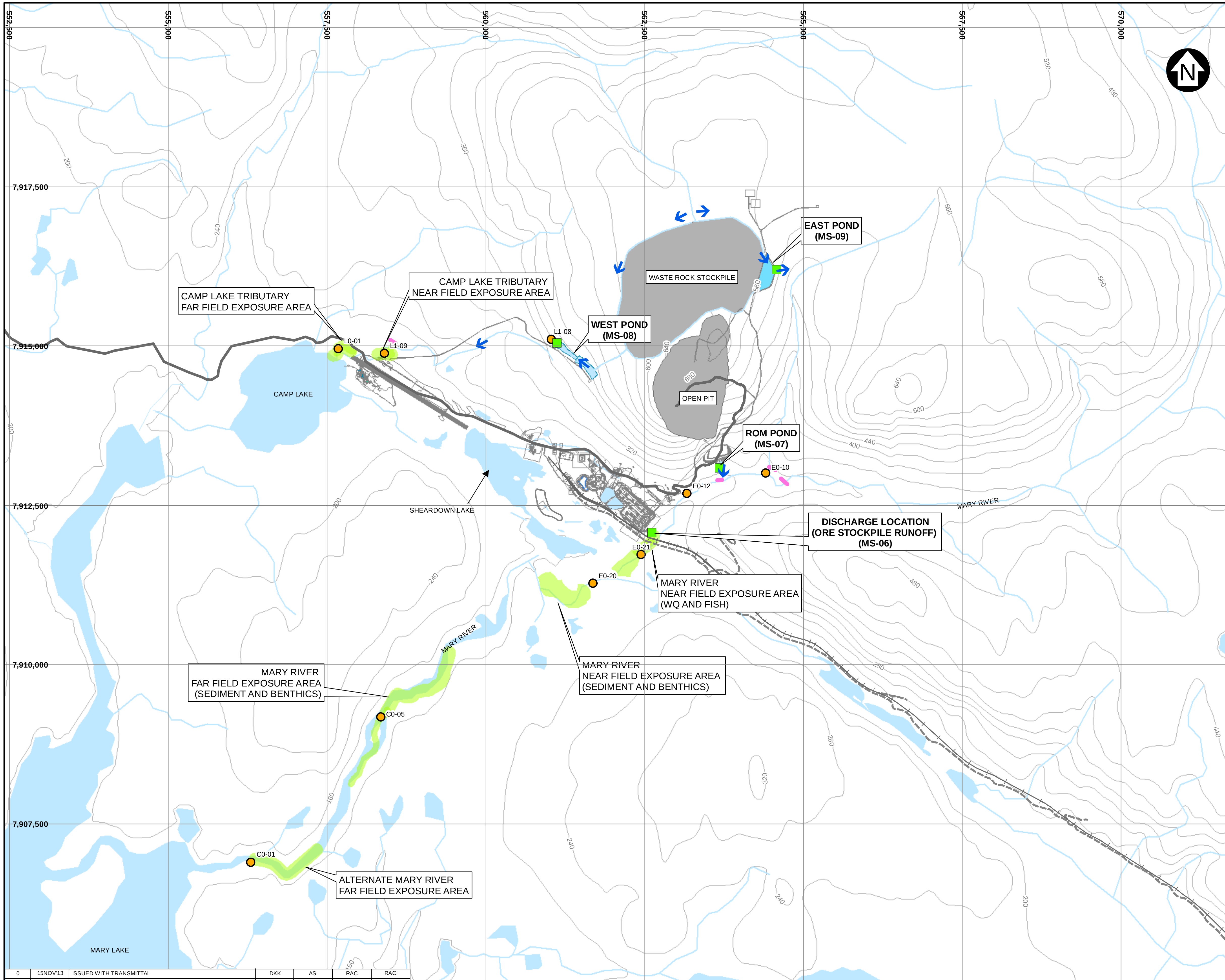
The site characterization program involved:

- Identifying the in-situ habitat conditions
- Water quality sampling
- Sediment quality sampling
- Benthic invertebrate sampling
- Fish community and population sampling

The exposure area habitat information was used to determine suitable candidate reference study areas and the position of reference replicate transects.

All areas were sampled for water quality, utilizing existing monitoring stations where available. The list of parameters is provided in Group 3 of Schedule 5.

Sediment samples were collected for particle size distribution analysis and total organic carbon (TOC) content at each of the five replicate transects in each area, in support of the benthic invertebrate community composition sampling program. The replicate transects were located in wadeable erosional habitat, therefore depositional organic sediment was not available for sampling or metals analysis.



LEGEND:

- MINE EFFLUENT DISCHARGE LOCATION
- ENVIRONMENTAL EFFECTS MONITORING STATION (EEM) (WATER, SEDIMENT, BENTHICS AND FISH)
- EEM STUDY DESIGN EXPOSURE AREA
- FISH BARRIER
- EXISTING TOTE ROAD
- PROPOSED RAILWAY ALIGNMENT
- PROPOSED CONSTRUCTION ACCESS ROAD
- PROPOSED SITE INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- WATER

ENVIRONMENTAL EFFECTS MONITORING PROGRAM (EEM):

- SECOND LEVEL MONITORING FOCUSES ON THE MINE EFFLUENT AND THE RECEIVING AQUATIC ENVIRONMENT AT AND IMMEDIATELY DOWNSTREAM OF DISCHARGE.
- REQUIRED BY LAW - METAL MINING EFFLUENT REGULATIONS (MMER).
- MONITORS MINE EFFLUENT DISCHARGES FROM PIT, ORE STOCKPILES AND WASTE ROCK STOCKPILES (SHOWN AS GREEN SQUARE ICONS).
- INCLUDES SITE CHARACTERIZATION OF "EXPOSURE AREAS" IMMEDIATELY DOWNSTREAM (NEAR FIELD) AND FURTHER DOWNSTREAM OF DISCHARGES (LIGHT GREEN HIGHLIGHTING).
- INCLUDES MONITORING OF EFFLUENT, INCLUDING WATER QUALITY AND AQUATIC TOXICITY TESTING.
- ALSO INCLUDES MONITORING OF WATER AND SEDIMENT QUALITY, BENTHIC INVERTEBRATES AND FISH POPULATIONS.
- RESULTS COMPARED TO MONITORING OF "REFERENCE SITES" FOUND AWAY FROM THE DISTURBANCE OF THE MINE.
- THERE IS ONE MINE EFFLUENT DISCHARGE TO A TRIBUTARY OF CAMP LAKE (FROM MS-09, THE WEST WASTE ROCK STORMWATER POND).
- THERE ARE THREE MINE EFFLUENT DISCHARGES TO THE MARY RIVER: THE EAST WASTE ROCK POND (MS-10), THE RUN OF MINE ORE STOCKPILE POND (MS-08), AND THE MAIN ORE STOCKPILE POND (MS-07).

NOTES:

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2004). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS UTM NAD83 ZONE17.
3. CONTOUR ARE IN METRES. CONTOUR INTERVAL VARIES.
4. LAKE SAMPLE LOCATIONS VARY SLIGHTLY DURING WINTER MONTHS DUE TO ICE CONDITIONS.

SCALE 500 250 0 500 1,000 1,500 2,000 2,500 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

PROPOSED EXPOSURE AREAS FOR THE ENVIRONMENTAL EFFECTS MONITORING (EEM) PROGRAM

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE 6.1 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	15NOV'13	ISSUED WITH TRANSMITTAL	DKK	AS	RAC	RAC

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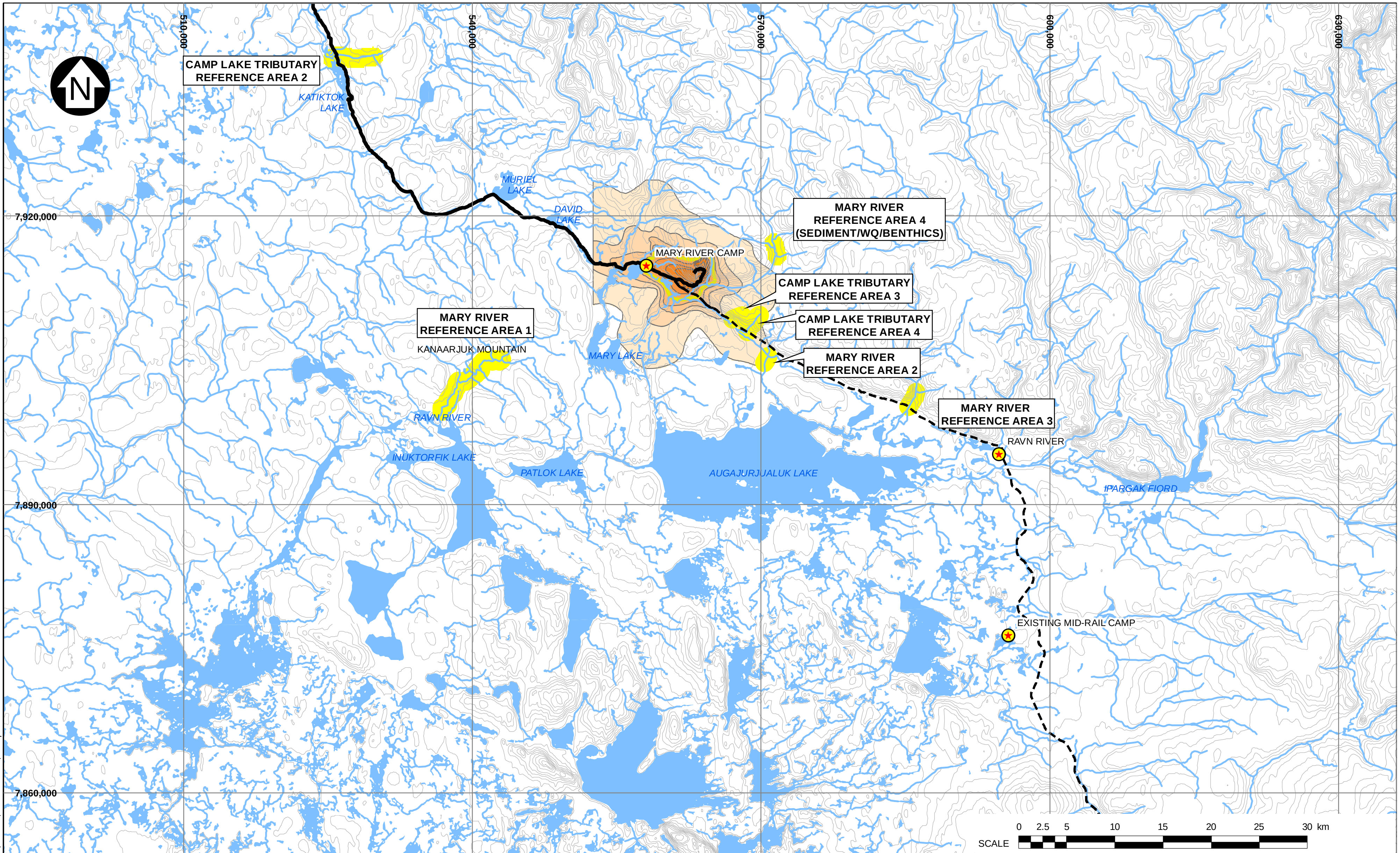

LEGEND:

- EXISTING TOTE ROAD
- PROPOSED RAILWAY ALIGNMENT
- PROPOSED CONSTRUCTION ACCESS ROAD
- PROPOSED SITE INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- PHOTO/VIDEO RECORD (2012-2013)
- WATER

Annual TSP Dep. ($g/m^2/yr$)

- 2 - 7.5
- 7.5 - 15
- 15 - 30
- 30 - 55
- 55 - 120
- 120 - 240
- 240 - 480
- > 480

NOTES:

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA DEPARTMENT OF NATURAL RESOURCES (2009). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 17N.
3. CONTOUR INTERVAL IS 20 METRES.
4. TOTAL SUSPENDED PARTICULATE CONTOURS PROVIDED BY RWDI AIR INC. (2011). PRESENTED IN THE FINAL ENVIRONMENT IMPACT ASSESSMENT.

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CANDIDATE REFERENCE AREAS FOR EEM PROGRAM

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE 6.2 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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The benthic macroinvertebrate community was sampled using a Hess sampler as recommended by the technical guidance document (EC, 2012). Three grab samples were collected at each replicate transect and retained in separate containers for discrete analysis. Taxonomic identification results were not available at the time of this report's publication. These results will elucidate the community assemblages in the exposure areas and support rationale for the selection of suitable reference areas.

Fish community and population sampling was conducted utilizing a Smith-Root backpack electrofishing unit. The collection of 100 juvenile Arctic char older than young-of-year (YOY) was attempted at all study areas. Subsamples of the captured fish were retained for age verification to characterize the sampled community. The age verification results were not yet available. Historic fish collection data show fork lengths can be used to estimate age differences between YOY and older than YOY individuals. This has been used to estimate the capture results and will be confirmed using the laboratory verifications for the final study design.

6.2.1 Camp Lake Tributary Exposure 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. The exposure areas are located respectively upstream and downstream of the existing Tote Road.

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 on Figure 6.3. Photos 1 to 4 in Schedule 8 present conditions at the CLT-NF exposure area. The land immediately adjacent to the stream is relatively flat. The stream has steep vertical banks. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 4.7 m to 6.5 m. Riparian vegetation includes grasses, mosses, and wildflowers. The stream has abundant undercut banks and boulders that provide in-stream cover. The dominant substrate is gravel followed by coarse sand as defined by the particle size fractions of the Wentworth classification (1922).

Backpack electrofishing captured 120 Arctic char with a high CPUE of 8.6 individuals caught per minute of electrofishing effort. This CPUE is in line with previous electrofishing activities in the stream. The fork lengths measured from the first 100 individuals indicate all fish were older than YOY. Ninespine stickleback were not captured from this area in 2013.

Baseline data has been collected in the CLT-NF exposure area at a number of stations. Station L1-09 has been utilized in the ongoing baseline monitoring program to establish a record of surface water quality and sediment quality.

Baseline data collection programs in the CLT-NF area have been initiated prior to the 2013 site characterization program. 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, 2012 and 2013. Historic aquatic habitat assessments in this area characterizing the benthic invertebrate and fish communities were conducted in 2007. Backpack electrofishing has taken place multiple times annually between 2007 and 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 6.3. The CLT-FF exposure area begins downstream of a braided section where the channelized stream forms a defined watercourse reporting to Camp Lake. The land immediately adjacent to the stream is relatively flat. The stream has steep vertical banks. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 3.4 m to 6.0 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by coarse sand (Wentworth, 1922).

Electrofishing was not conducted in this area since the MMERs only require collection of fish data in the near field exposure areas and the references areas.

Baseline data has been collected in the CLT-FF exposure area at station L0-01, which has been utilized in the ongoing baseline monitoring program to establish a record of surface water quality and sediment quality.

Photos 5 to 8 in Schedule 8 present conditions at the CLT-FF exposure area.

Baseline data collection programs have been conducted in the CLT-FF exposure area prior to the 2013 characterization program. Ongoing surface water quality monitoring has been conducted at this location in 2005-2007, 2011, 2012 and 2013. 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 between 2007 and 2010.

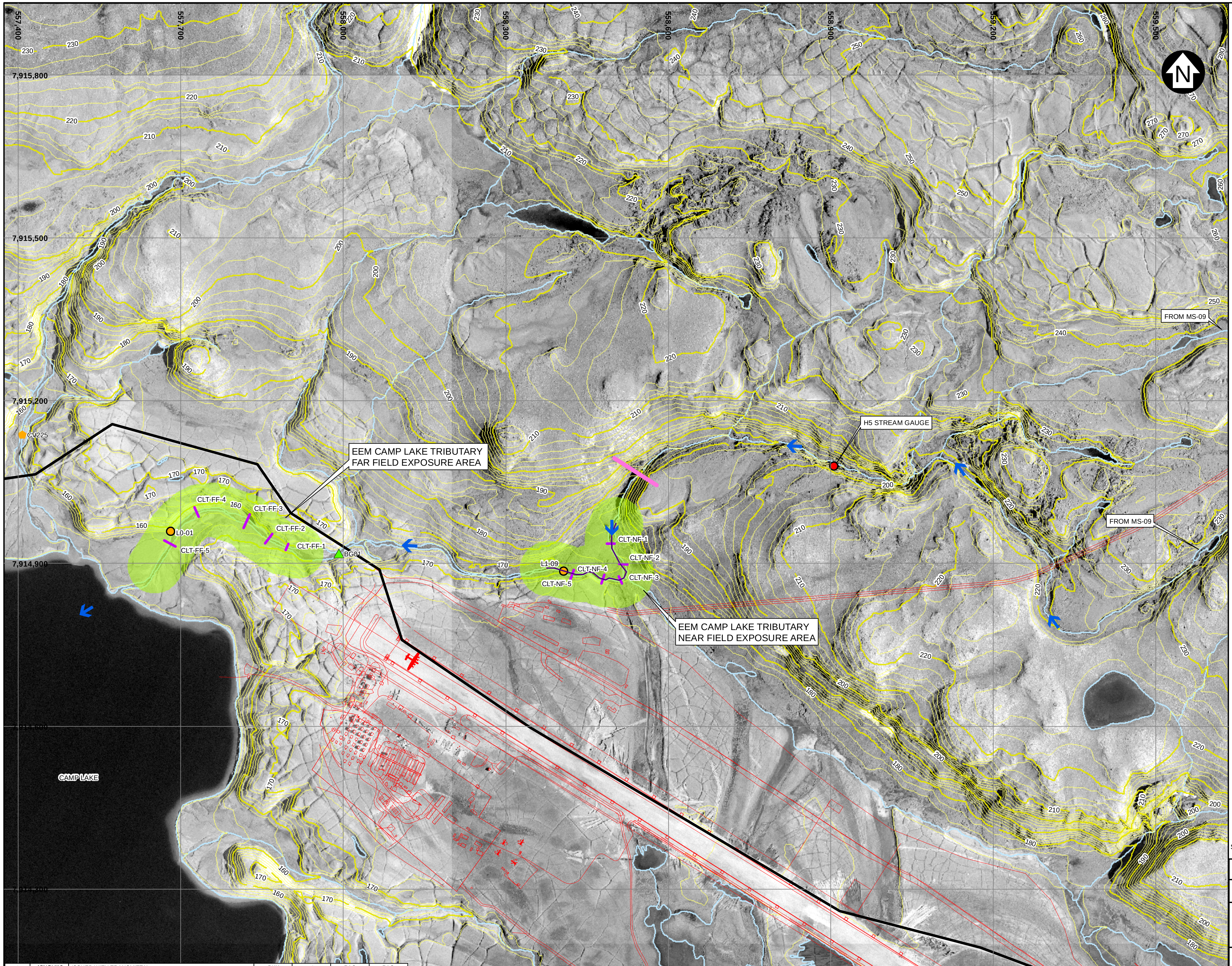
6.2.4 Camp Lake Tributary Reference Areas

There are three candidate reference areas anticipated to have similar aquatic habitat as the CLT-NF and CLT-FF exposure areas. These include one area along the Tote Road between the Mary River Exploration Camp and Milne Inlet as well as two locations near the rail alignment, north of Angajurjualuk Lake. Three candidate reference areas generally outside of the anticipated range of mining influences have been selected for comparison to the CLT exposure areas. Figure 6.3 presents the location of the candidate reference areas for this study. A fourth candidate (CLT-REF1) was found not to be a suitable candidate.

6.2.5 Camp Lake Tributary Reference Area 2

The Camp Lake Tributary Reference Area 2 (CLT-REF2) 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-REF2 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.

The land immediately adjacent to the stream is relatively flat near the road and becomes steeper upstream. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 10.8 m to 22.6 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by silt (Wentworth, 1922).



LEGEND:

- ACTIVE WATER QUALITY SAMPLE LOCATION
- ACTIVE STREAM GAUGE LOCATION
- CULVERT CROSSING
- DIRECTION OF WATER FLOW
- MAJOR CONTOUR
- EXISTING TOTE ROAD
- PROPOSED SITE INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- EEM REPLICATE TRANSECTS
- FISH BARRIER
- EEM STUDY DESIGN EXPOSURE AREA

NOTES:

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2009). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS UTM NAD83 ZONE 17.
3. CONTOUR ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. ORTHO PHOTOS PROVIDED BY EAGLE MAPPING (2006).

SCALE 75 37.5 0 75 150 225 300 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CAMP LAKE TRIBUTARY EEM EXPOSURE AREAS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	15NOV'13	ISSUED WITH TRANSMITTAL	DKK	AS	RAC	RAC

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE 6.3 REV 0

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Backpack electrofishing captured 30 Arctic char with a low CPUE of 1.2 individuals caught per minute of electrofishing effort. This CPUE indicates this area may not be suitable for an EEM fish population study. The fork lengths measured from these individuals indicate all but one fish were older than YOY. There was no Ninespine stickleback captured from this area in 2013.

Photos 9 to 12 in Schedule 8 show the CLT-REF2 candidate reference area.

Surface water quality has been monitored at the tote road crossing location in 2005, 2006, 2011 and 2012. Sediment quality monitoring was not historically 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.

6.2.6 Camp Lake Tributary Reference Area 3

The Camp Lake Tributary Reference Area 3 (CLT-REF3) stream is located along the rail alignment flowing in a south-west direction, reporting to an unnamed lake. While located within the outer perimeter of the predicted dust plume, it was evaluated as a suitable reference area. The CLT-REF3 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.

The land immediately adjacent to the stream is relatively flat on the left bank and has a steep upland slope on the right bank near the three downstream replicate transects. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 3.3 m to 5.7 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by coarse sand (Wentworth, 1922). The substrate of CLT-REF3 was most similar to the substrate found at the near field and far field study areas.

Backpack electrofishing captured 116 Arctic char with a high CPUE of 9.1 individuals caught per minute of electrofishing effort. This CPUE is similar to the results from the near field exposure area. The fork lengths measured from the first 100 individuals indicate 84 fish were older than YOY. There was no Ninespine stickleback captured from this area in 2013.

Photos 13 to 16 in Schedule 8 show the CLT-REF3 candidate reference area.

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 conducted in 2008.

6.2.7 Camp Lake Tributary Reference Area 4

The Camp Lake Tributary Reference Area 4 (CLT-REF4) stream is located along the proposed rail alignment flowing in a westerly direction, reporting to an unnamed lake. This candidate reference stream and connected lake network is within the same drainage system as the Mary River candidate reference area MRY-REF2. The CLT-REF4 stream has been identified as station CV-006-1 during baseline aquatic habitat assessments.

The land immediately adjacent to the stream is relatively flat with dense riparian vegetation downstream of the replicate transects. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 2.0 m to 3.6 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by coarse sand (Wentworth, 1922). The substrate of CLT-REF4 has nearly one third percent more gravel in its distribution classification than CLT-NF.

Backpack electrofishing captured 116 Arctic char with a moderate CPUE of 5.3 individuals caught per minute of electrofishing effort. This CPUE is comparable to the results from the near field exposure area. The fork lengths measured from the first 100 individuals indicate all fish were older than YOY. There was one Ninespine stickleback captured from this area in 2013.

Photos 17 to 20 in Schedule 8 show the CLT-REF2 candidate reference area.

Surface water quality at this location was monitored in 2008 during fish community sampling surveys. Sediment quality monitoring was not historically conducted at this location.

6.3 MARY RIVER EXPOSURE AREAS

Mary River is located southeast of the mine site. The exposure area of the river will receive three discrete MMER final discharge point effluent inputs listed in descending order, upstream to downstream as follows:

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

The Mary River aquatic habitat between these effluent discharge points is a high energy environment dominated by a boulder substrate and steep sloping banks. Baseline surface water quality monitoring has been collected from the bank at various locations throughout the Mary River 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.

Four reference areas geographically outside of the range of anticipated mining influences have been selected with similar aquatic habitat to the Mary River exposure areas. One of these areas (MRY-REF4) was included following a recommendation by EC to locate one study area on the Mary River. The only available areas outside of the predicted dust plume are located upstream of the Mary River fish barrier (waterfall). MRY-REF4 is a candidate reference area for the benthic invertebrate community EEM component since it has been proven that the Mary River is fishless upstream of the waterfall (North/South Consultants Inc., 2008). The lack of Arctic Char at this location may affect the benthic community assemblages which will be evaluated once the benthic invertebrate taxonomy data has been analysed in the first quarter of 2014.

6.3.1 Mary River Near Field Exposure Area

The Mary River flows in a southwest direction reporting to Mary Lake approximately 12.8 km downstream. The turbulent, high energy sections of the Mary River near the MMER final discharge points have bankfull heights of approximately two metres with an area of adjacent flat land that shows evidence of temporary submersion and scouring during spring freshet flows. The ongoing baseline water quality monitoring program utilizes several sample station in this area, some of which will be used for the EEM program.

During study design development, the challenges of standard biological sampling in the immediate vicinity of the final discharge points were discussed with EC staff. Following an EC staff site visit, it was agreed that the benthic invertebrate and sediment sampling EEM component would take place in wadeable habitat downstream of the dangerous, high velocity conditions. It was also decided that water sampling will remain near the discharge locations as per historic monitoring and the fish sampling EEM component will take place upstream of the benthic study area, as close to the final discharge point as safely possible.

The Mary River Near Field (MRY-NF) exposure area has two stream sections. The benthic and sediment stream section begins downstream of a broad, flat area of many braided channels. These braided channels become one defined watercourse approximately 1,350 m upstream of the Sheardown Lake (SDL) outlet channel confluence. During the 2013 site characterization program five replicate transects were established upstream of this confluence as illustrated on Figure 6.4.

The surface water quality and fish sample area is located downstream of the ore stockpile discharge, extending across the braided section of the river where historic baseline fisheries data has successfully been collected (Figure 6.4).

The land immediately adjacent to the river is relatively flat on the west side, with steep banks on the east. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 30 m to 46 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by coarse sand (Wentworth, 1922).

Backpack electrofishing captured 108 Arctic char with a low CPUE of 1.6 individuals caught per minute of electrofishing effort. The fork lengths measured from the first 100 individuals indicate all fish were older than YOY. There was no Ninespine stickleback captured from this area in 2013.

Photos 21 to 24 in Schedule 8 show the MRY-NF exposure area.

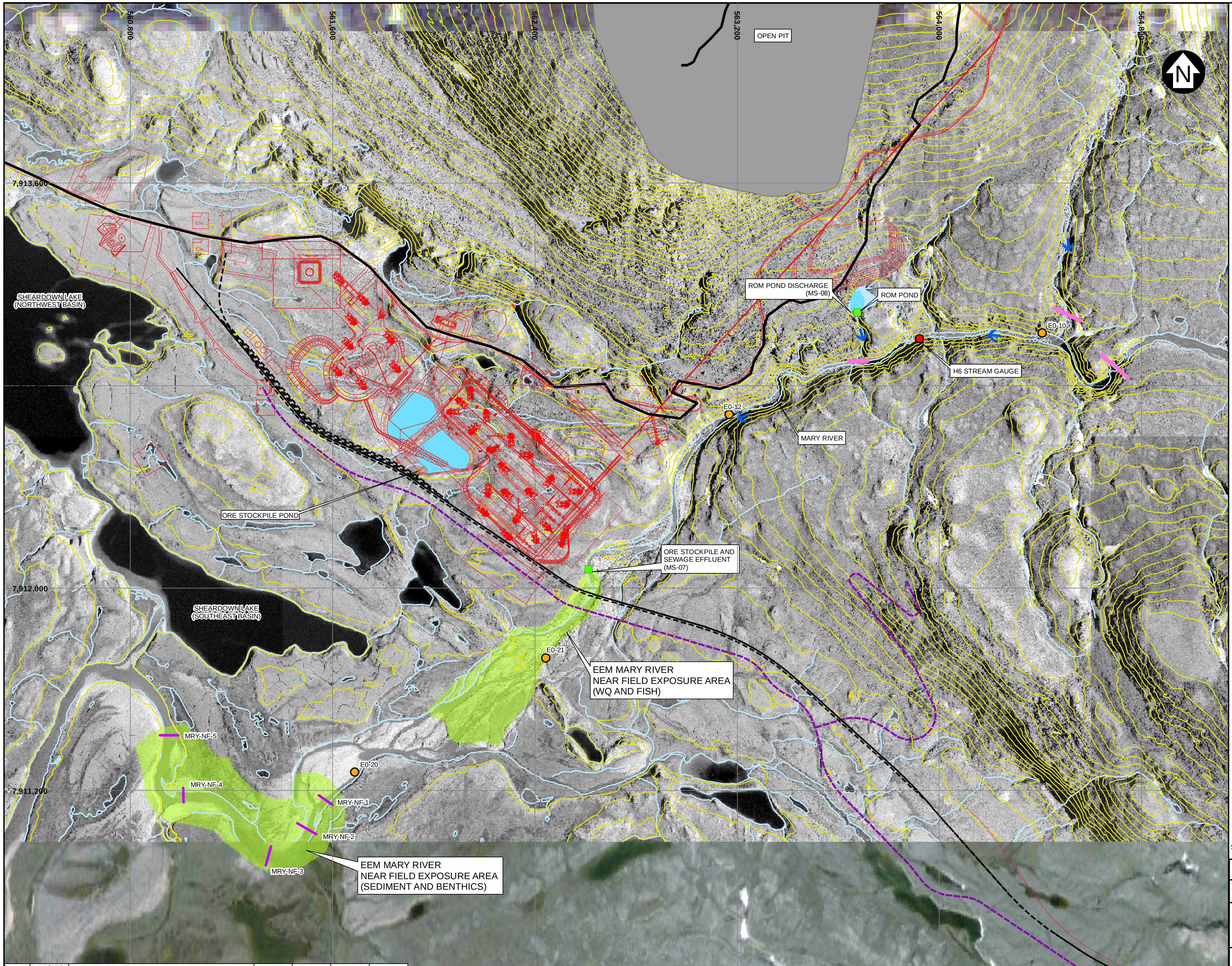
The sample locations currently used for the surface water quality monitoring program are shown on Figure 6.4. Surface water quality near the ore stockpile runoff discharge location has been monitored at sample location E0-21 since 2011. Station E0-20 is located on the Mary River where the braided channels merge together to form a defined river channel that has also been sampled since 2011. 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.

6.3.2 Mary River Far Field Exposure Area

The upstream extent of the Mary River Far Field (MRY-FF) exposure area is located approximately 3,900 m downstream of the SDL confluence as shown on Figure 6.5. The land immediately adjacent to the river has gentle slopes (< 30°). Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 37 m to 98 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by coarse sand (Wentworth, 1922). Electrofishing was not conducted in this area since the MMERs only require collection of fish data in the near field exposure areas and the references areas.

Photos 25 to 28 in Schedule 8 show the MRY-FF exposure area.

Active and historic baseline biological monitoring stations are located within this study area as shown on Figure 6.5. 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 permits fish migration through these exposure areas.



LEGEND:

- ACTIVE WATER QUALITY SAMPLE LOCATION
- ACTIVE STREAM GAUGE LOCATION
- FINAL DISCHARGE POINT
- DIRECTION OF WATER FLOW
- CONTOUR
- EXISTING TOTE ROAD
- PROPOSED RAILWAY ALIGNMENT
- PROPOSED CONSTRUCTION ACCESS ROAD
- PROPOSED SITE INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- EEM REPLICATE TRANSECT
- FISH BARRIER
- WATER
- HIGHLIGHTED WATER FEATURE
- EEM STUDY DESIGN EXPOSURE AREA

NOTES:

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2009). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS UTM NAD83 ZONE 17.
3. CONTOUR ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. ORTHO PHOTOS PROVIDED BY EAGLE MAPPING (2006).

SCALE 200 100 0 200 400 600 800 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

MARY RIVER NEAR FIELD EEM EXPOSURE AREA

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE 6.4 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	14NOV'13	ISSUED WITH TRANSMITTAL	DKK	AS	RAC	RAC

SAVED: I:\1102\00181\33\A\GIS\Figs\B30_r0.mxd; Nov 15, 2013 1:21 PM; asimpson

LEGEND:

- HISTORIC WATER QUALITY SAMPLE LOCATION
- ACTIVE WATER QUALITY SAMPLE LOCATION
- DIRECTION OF WATER FLOW
- MAJOR CONTOUR
- MINOR CONTOUR
- EXISTING TOTE ROAD
- PROPOSED RAILWAY ALIGNMENT
- PROPOSED CONSTRUCTION ACCESS ROAD
- PROPOSED SITE INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- EEM REPLICATE TRANSECT
- WATER
- EEM STUDY DESIGN EXPOSURE AREA

NOTES:

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2009). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS UTM NAD83 ZONE 17.
3. CONTOUR ARE IN METRES. CONTOUR INTERVAL IS 2 m.
4. ORTHO PHOTOS PROVIDED BY EAGLE MAPPING (2006).
5. GOOGLE IMAGERY OBTAINED NOVEMBER 6 2012.

SCALE 200 100 0 200 400 600 800 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

MARY RIVER FAR FIELD EEM EXPOSURE AREA

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE 6.5 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	15NOV'13	ISSUED WITH TRANSMITTAL	DKK	AS	RAC	RAC

SAVED: I:\1\02\00181\33\A\GIS\Figs\B31_r0.mxd; Nov 15, 2013 1:25 PM; asimpson

6.3.3 Mary River Alternate 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. Station C0-01 is located at the downstream extend of the MRY-AFF exposure area and has been utilized for baseline environmental monitoring. This study area was not visited during the 2013 site characterization program and will only be considered following receipt and analysis of all characterization data.

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. Electrofishing will not be conducted in this area since the MMERs only require collection of fish data in the near field exposure areas and the references areas.

6.4 MARY RIVER REFERENCE AREAS

Four candidate reference areas were visited during the 2013 site characterization program. These streams are between 11 km and 27 km away from the MRY-NF exposure area. Three of these candidate areas are in separate drainage basins from MRY-NF. These areas include drainage basins located north of Inuktorfik Lake and two areas near the rail alignment north of Angajurjualuk Lake. The fourth candidate reference area is located on the Mary River, upstream of the Mary River waterfall.

6.4.1 Mary River Reference Area 1

Mary River Reference Area 1 (MRY-REF1) flows in a southwest direction, this unnamed stream reports to Inuktorfik Lake east of the Ravn River as shown on Figure 6.2. The land immediately adjacent to the stream is relatively flat. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 30 m to 44 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by coarse sand (Wentworth, 1922). The substrate of MRY-REF1 has nearly equal ratios of these particle sizes, unlike the higher percentage of gravel at the exposure areas.

Backpack electrofishing captured 26 Arctic char with a low CPUE of 1.2 individuals caught per minute of electrofishing effort. This CPUE indicates this area may not be suitable for an EEM fish population study. The fork lengths measured from these individuals indicate all fish were older than YOY. There was 26 Ninespine stickleback captured from this area in 2013.

Photos 29 to 32 in Schedule 8 show the MRY-REF1 candidate reference area.

6.4.2 Mary River Reference Area 2

The Mary River Reference Area 2 (MRY-REF2) 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 6.2.

The land immediately adjacent to the stream is relatively flat. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 30 m to 44 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by coarse sand (Wentworth, 1922). The substrate of MRY-REF1 has nearly equal ratios of these particle sizes, unlike the higher percentage of gravel at the exposure areas.

Backpack electrofishing captured 22 Arctic char with a very low CPUE of 0.7 individuals caught per minute of electrofishing effort. The fish sampling activities at this area were only conducted in the downstream reaches and were ended prematurely due to weather conditions. Additional fishing effort may yield higher CPUE in the upstream reaches of this study area. The fork lengths measured from these individuals indicate all fish were older than YOY. There was no Ninespine stickleback captured from this area in 2013.

Photos 33 to 26 in Schedule 8 show the MRY-REF2 candidate reference area.

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 historically been conducted at this location. An aquatic habitat assessment at station BR-011-1 located upstream of station S2-010 was completed in 2008.

6.4.3 Mary River Reference Area 3

Mary River Reference Area 3 (MRY-REF3) 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 27 km south east of the exposure areas.

The land immediately adjacent to the stream is relatively flat. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 26 m to 46 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by coarse sand (Wentworth, 1922). The substrate of MRY-REF3 was most similar to the substrate found at the near field study area.

Backpack electrofishing captured 114 Arctic char with a moderate CPUE of 2.0 individuals caught per minute of electrofishing effort. This CPUE is higher than the CPUE results from the near field exposure area. The fork lengths measured from the first 100 individuals indicate 93 fish were older than YOY. There was no Ninespine stickleback captured from this area in 2013.

Photos 37 to 40 in Schedule 8 show the MRY-REF3 candidate reference area.

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 historically been conducted at this location. 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.

6.4.4 Mary River Reference Area 4

Mary River Reference Area 4 (MRY-REF04) is located upstream of the MR waterfall outside of the predicted dust plume. The land immediately adjacent to the stream has a gentle slope similar to the MRY-FF exposure area. Site characterization in 2013 measured the wetted width at five replicate transects that ranged from 22 m to 30 m. Riparian vegetation includes grasses, mosses, and wildflowers. The dominant substrate is gravel followed by coarse sand (Wentworth, 1922). The substrate of MRY-REF4 was most similar to the substrate found at the far field study area. Since MRY-REF4 is located upstream of the Mary River waterfall, no fishing effort was made.

Photos 41 to 44 in Schedule 8 show the MRY-REF3 candidate reference area.

Baseline data collection programs have been conducted in this area that included surface water quality monitoring at station G0-09 conducted in 2006, 2007, 2012 and 2013. 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.

6.5 STUDY DESIGN METHODOLOGY

6.5.1 Effluent Plume Delineation Study

Site characterization will include an effluent plume delineation study 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 technical guidance document for EEM (EC, 2012).

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 three final discharge points to the Mary River will have a total estimated effluent discharge of 3,340,600 m^3/yr. The estimated 10-year low flow conditions of Mary River at the furthest downstream discharge point (E0-21) are 56,793,000 m^3/yr. The effluent concentration is estimated to be 6%, with little dilution between E0-21 and the outlet to Mary Lake.

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	53,166,000	3,133,000
ROM Pond (MS-07)	Mary River	E0-12	N/A	97,600
Ore Stockpile Runoff (MS-06)	Mary River	E0-21	56,793,000	110,000
		TOTAL	**56,793,000**	**3,340,600**
West Pond (MS-08)	Camp Lake Tributary (upstream of L0)	L1-09	332,100	354,100[1]
West Pond (MS-08)	Camp Lake Tributary (upstream of Camp Lake)	L0-01	410,100	354,100[1]
		TOTAL	**410,100**	**354,100**

NOTES:

1. DISCHARGE DATA PROVIDED IN THE FINAL ENVIRONMENTAL IMPACT ASSESSMENT (BAFFINLAND, 2012).

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.

6.5.2 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. Sampling will proceed from the least “impacted” areas (reference areas) to the most “impacted” station. Field staff will wear nitrile 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 technical guidance 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), CN-, hardness, dissolved anions (Cl-, F-, SO2-4, NO2-, NO3-), total suspended solids, alkalinity, NH3, total P, 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), 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 technical guidance document (EC, 2012). 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.

6.5.3 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 (i.e. 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. The existing baseline data indicates few depositional areas are present 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.

6.5.4 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 bankfull 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 Hess 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 a 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 EEM technical guidance document (EC, 2012).

Using the standard community indices within an Analysis of Variance (ANOVA) model for control/impact designs, the benthic community at the exposure areas will be compared to their representative reference area(s) 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

NOTES:

1. MODIFIED FROM METAL MINING TECHNICAL GUIDANCE DOCUMENT TABLE 3-1 (EC, 2012).

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 EEM technical guidance document will be followed (EC, 2012). 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 invertebrate taxonomist.

6.5.5 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. 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 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 technical guidance document (EC, 2012). Attempts will be made to capture at least 100 individuals older than young of the year (+YOY) for each of the two sentinel species. 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. Table 6.4 and Table 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

NOTES:
1. MODIFIED FROM THE TECHNICAL GUIDANCE DOCUMENT TABLE 3-1 (EC, 2012).

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

NOTES:
1. MODIFIED FROM THE TECHNICAL GUIDANCE DOCUMENT TABLE 3-3 (EC, 2012).

Aging using fin rays 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 and from all incidental mortalities. The ratio of male/female specimens retained for age verification will be attempted.

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 contain 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.

6.6 SUMMARY AND NEXT STEPS

The 2013 field work confirmed in-situ conditions at the exposure areas and candidate reference areas. This information coupled with the currently outstanding data (e.g., benthic taxonomic identification and fish ageing data) will provide rationale for the selection of suitable reference areas. This section of the AEMP framework document will be updated in the next iteration, following review and analysis of the outstanding data. The anticipated EEM timeline that includes milestones associated with the MMER requirements is subject to change based on regulatory approvals and the start of mining.

February 2014	Benthic invertebrate taxonomic analysis completed for 2013 study
April-May 2014	Mining begins with pre-stripping
June 2014	Mine is subject to MMERs once effluent discharge rate reaches 50 m^3/day
August 2014	Submission of Identifying Information & Final Discharge Points (within 60 days after date mine is subject to MMERs)
June-August 2014	Summer field work if required (i.e., further characterization of study areas)
September 2014	Submit Cycle One Study Design (12 months from initial date when Mine was subject to MMERs)
August-Sept 2015	First Cycle Biological Monitoring Study (conducted no sooner than 6 months after Cycle One SD submission date)
December 2016	Submit First Cycle Interpretive Report (within 30 months from initial date when Mine was subject to MMERs)
TBD	Subsequent Study Design submitted 6 months prior to subsequent Biological Monitoring Study
December 2019	Subsequent Interpretive Report submitted 36 months following the date on which the previous interpretive report was to be submitted

7 CORE RECEIVING ENVIRONMENT MONITORING PROGRAM

7.1 CREMP OVERVIEW

The Core Receiving Environment Monitoring Program (CREMP) is being established to monitor effects of the Project on the downstream aquatic environment. The CREMP focuses 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 (benthic invertebrates indicators, phytoplankton and Arctic Char)

The EEM study design (Section 6) identifies the exposure areas in the freshwater environment that will receive mine effluent discharges. The CREMP encompasses a larger geographic extent than the EEM program and is intended to monitor potential effects to the aquatic environment via other pathways such as dust deposition or changes in water flow due to diversions.

Based on the conclusions in the FEIS, mine site aquatic effects will be primarily confined to the Mary River, Camp Lake, Sheardown Lake and their associated tributaries. Mary Lake is the ultimate receiving water for these drainage areas, but is of sufficient size that detectable effects are not predicted. The CREMP includes monitoring in Mary Lake to confirm this prediction.

The CREMP is intended to monitor effects as follows:

- Camp and Sheardown Lake tributaries - will be affected by dust deposition and water diversions; Camp Lake Tributary 1 will receive waste rock stockpile runoff from the West Pond
- Sheardown Lake - will experience changes in water quality due to airborne dust dispersion and runoff, sewage effluent discharges from the exploration camp during construction, changes in hydrology, and potential changes in productivity to tributaries of Sheardown Lake
- Camp Lake – will receive runoff from tributaries affected by dust deposition and mine effluent (west pond), will be affected by water diversions and withdrawals, as well as changes in water quality due to airborne dust dispersion
- Mary River – will be subject to airborne dust dispersion and will receive three streams of mine effluent as well as treated sewage effluent
- Mary Lake – is the ultimate receiving waters of Camp Lake, Sheardown Lake and the Mary River

Ongoing monitoring of water quantity (hydrology) is discussed in Section 4.2. A description of the baseline integrity review underway for water quality, sediment quality and freshwater biota is provided below.

7.1.1 Review of Baseline Data for Water Quality

Baseline water quality information has been collected across the Mine Site area since 2005. 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. The baseline data collected from 2005 to 2013 is summarized in a baseline integrity review report (*in-progress*).

The water quality baseline review has included the following steps:

- Identification of the parameters of concern – the FEIS identified the following metals as parameters of potential concern: arsenic, cadmium, chromium, copper and iron
- Identification of trends in the baseline dataset – qualitative identification of locations within the study area that contain naturally elevated concentrations of metals
- A review of method detection limits – higher method detection limits (MDLs) in the historic dataset relative to current water quality objectives (WQOs) presents problems for statistical analysis. A process has been undertaken to remove high MDL results for select parameters from the database, or replace high MDL non-detect results with the lowest MDL values for metals for which a small proportion of the overall database contained detectable concentrations of the metal.
- Aggregation of sample locations – the water quality results for adjacent monitoring stations were reviewed to identify the potential to aggregate the data to increase the statistical power of the dataset
- Review of seasonality of sampling – the baseline dataset has consisted of spring (late June), summer (mid-July) and fall (late August to early September) sampling events
- Statistical analysis – to determine the number of samples required to detect a statistically significant change

The work is nearing completion. Additionally, in 2013, seasonal (spring, summer, fall) water quality sampling was undertaken at the CREMP monitoring locations identified in Figure 7.1.

7.1.2 Review of Baseline Data for Sediment Quality

A review of sediment quality data is underway concurrent with the water quality baseline review described above. Preliminary findings indicate that chromium and copper regularly exceed the CCME Interim Sediment Quality Guideline (ISQG) and iron and nickel regularly exceed the Ontario Lower Effect Level (LEL) guideline, and manganese regularly exceed the Ontario Probable Effect Level (PEL) guideline.

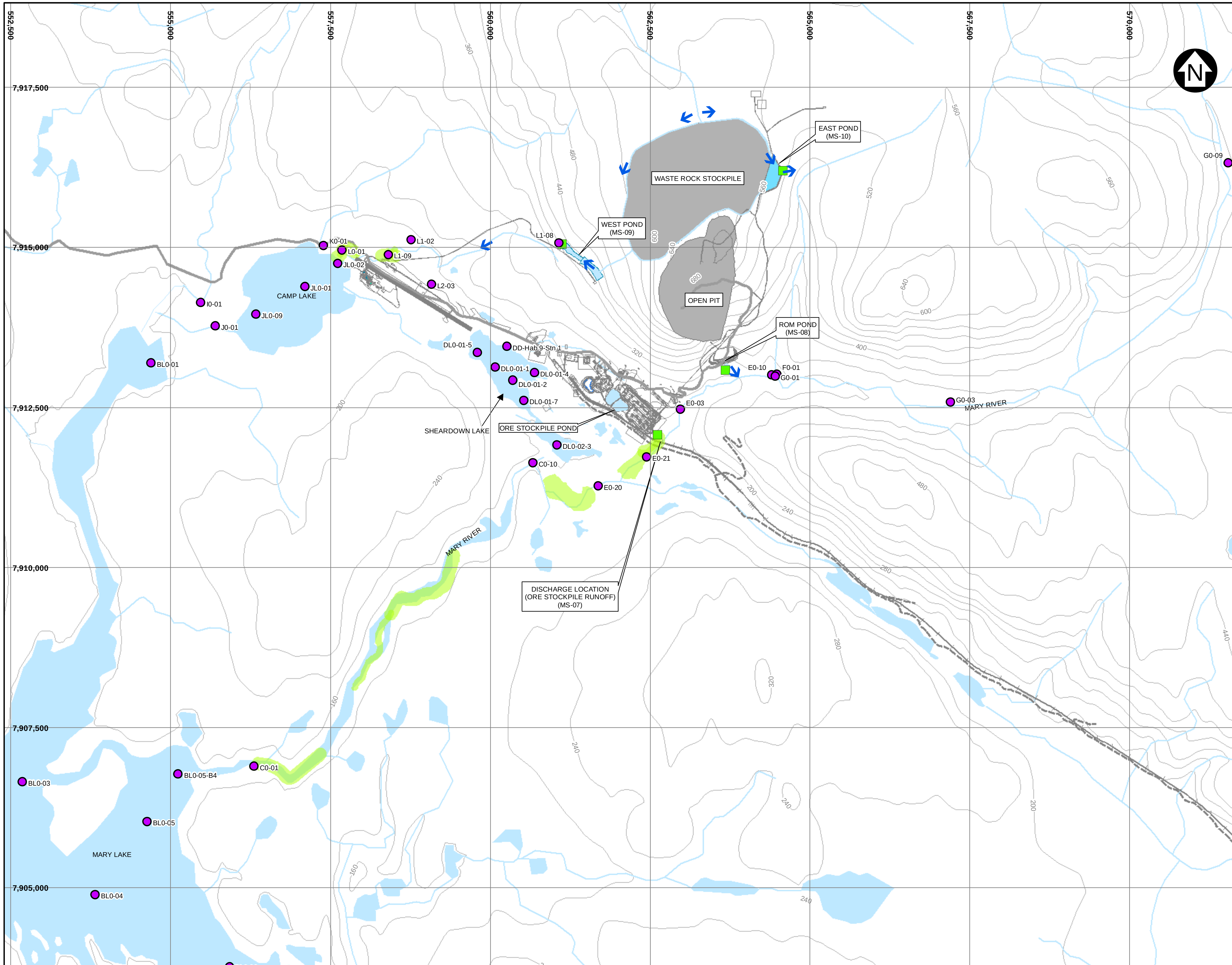
During the FEIS review, Environment Canada requested that Baffinland undertake thin sediment sampling in mine area lakes. This has been completed across the site in 2012 and 2013, and data analysis is underway.

7.1.3 Review of Baseline Data for Freshwater Biota

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 EEM under the MMER (Section 6).

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.

A review of baseline data for phytoplankton, benthic invertebrates, and Arctic Char was completed in 2013 (NSC, 2013a). The review informed the design and conduct of additional baseline studies subsequently conducted in 2013. An overview of the freshwater biota and habitat field studies completed in the open-water season of 2013 is provided below.



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LEGEND:

- CORE RECEIVING ENVIRONMENTAL MONITORING PROGRAM (CREMP) (WATER, SEDIMENT, BENTHICS AND FISH)
- MINE EFFLUENT DISCHARGE LOCATION
- EXISTING TOTE ROAD
- PROPOSED RAILWAY ALIGNMENT
- PROPOSED CONSTRUCTION ACCESS ROAD
- PROPOSED SITE INFRASTRUCTURE
- RIVER/STREAM/DRAINAGE
- WATER

CORE RECEIVING ENVIRONMENTAL MONITORING PROGRAM:

- THIRD LEVEL OF MONITORING FOCUSES ON THE DOWNSTREAM AQUATIC ENVIRONMENT.
- INCLUDES WATER AND SEDIMENT QUALITY, BENTHIC INVERTEBRATES AND FISH.
- RELIES ON ESTABLISHED BASELINE SAMPLING LOCATION FOR WHICH BAFFINLAND HAS SEVERAL YEARS OF DATA.

NOTES:

1. BASE MAP: © HER MAJESTY THE QUEEN IN RIGHTS OF CANADA, DEPARTMENT OF NATURAL RESOURCES (2004). ALL RIGHTS RESERVED.
2. COORDINATE GRID IS UTM NAD83 ZONE17.
3. CONTOUR ARE IN METRES. CONTOUR INTERVAL VARIES.
4. LAKE SAMPLE LOCATIONS VARY SLIGHTLY DURING WINTER MONTHS DUE TO ICE CONDITIONS.

SCALE 500 250 0 500 1,000 1,500 2,000 2,500 m

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

CREMP WATER AND SEDIMENT MONITORING LOCATIONS

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB102-181/33	NB13-00586

FIGURE 7.1 REV 0

7.1.4 Phytoplankton

Samples for analysis of chlorophyll *a* were collected from Camp, Sheardown Lake NW and SE, and Mary Lake and at selected stream sites in association with the water quality sampling program conducted in 2013 to augment and update the baseline database for this component. Sampling was conducted two times in the open-water season at lake sites though not all sites were sampled during both sampling periods. Sampling in streams occurred between one and three times in the open-water season.

7.1.5 Benthic Invertebrates

Sampling of benthic invertebrate communities completed in the Mine Area water bodies through 2011 has been summarized in the baseline integrity review report (NSC, 2013a). Additional sampling was completed in fall 2013 to augment and update the baseline database and focused upon sampling in key (i.e., predominant) habitat types in Camp and Sheardown lakes (Figure 7.2). Five replicate stations were sampled in each of the targeted habitat types. Five sub-samples were collected at each replicate station and preserved separately to facilitate examination of variability between sub-samples (i.e., variability within a replicate station). Due to inclement weather, sampling was not conducted in Mary Lake in 2013. A total of 11 replicate stations (five in each of two habitats, one in the third targeted habitat type) were sampled in Camp Lake, and a total of 10 (five in each of two targeted habitat types) were sampled in each of Sheardown Lake NW and Sheardown Lake SE.

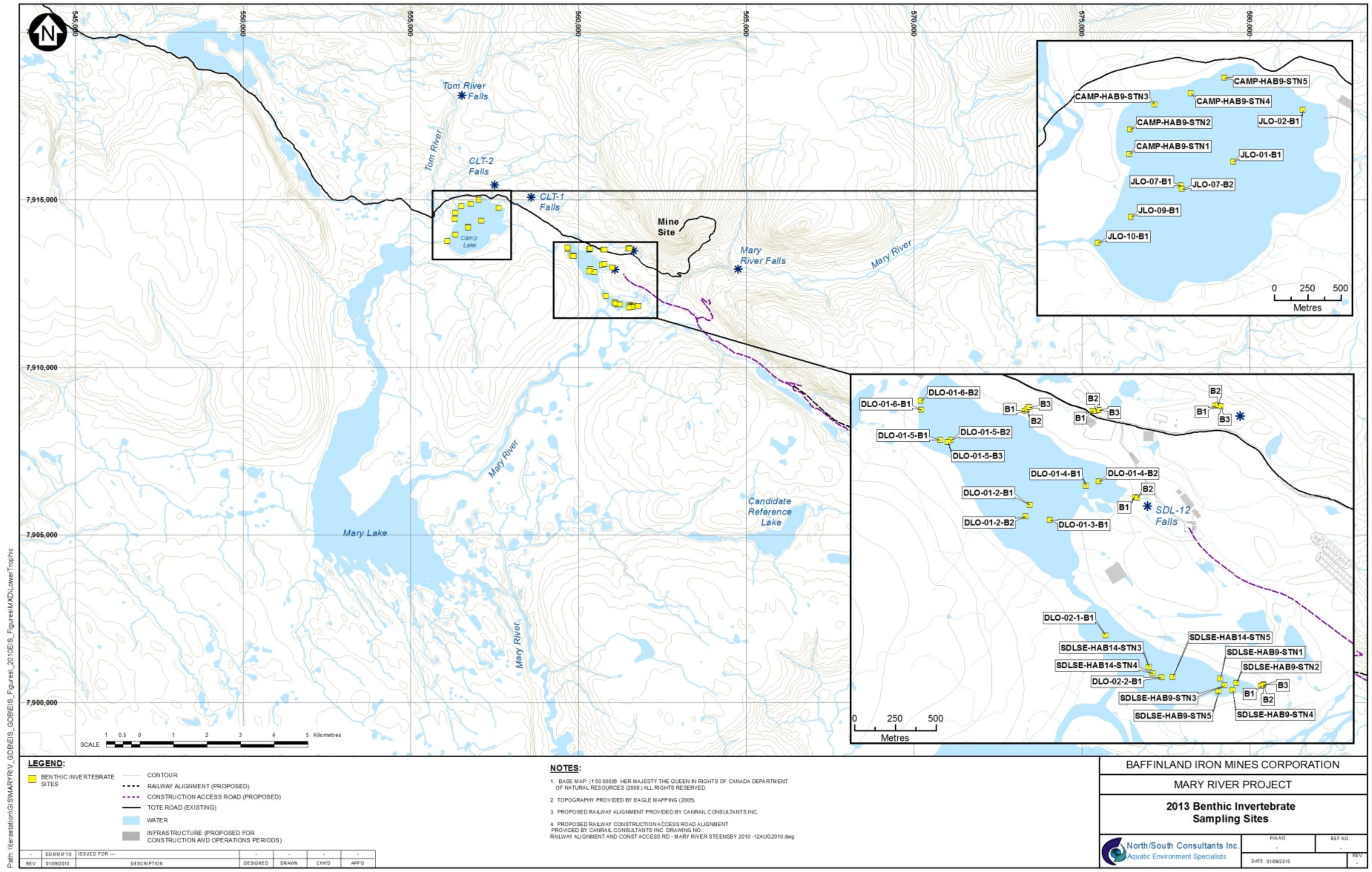
7.1.6 Arctic Char

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
- 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 and spawning habitat are provided exclusively by lakes.

Figure 7.2 CREMP Benthic Invertebrate Community Sample Locations



A review of baseline data on Arctic Char populations in Mine Area lakes collected through 2012 has been summarized in a baseline integrity review report (NSC, 2013a). This review informed the design of subsequent baseline studies conducted in the open-water season of 2013, which are summarized below.

The Arctic Char sampling program conducted in Mine Area lakes in 2013 was designed to be non-lethal and was based upon Environment Canada's EEM survey design (EC 2012). As such, the lake-based sampling program was focused upon obtaining measures of metrics for Age 1+ fish using standardized sampling methods (i.e., standard gang index gillnetting). The program was habitat-based, with sampling effort weighted in accordance with the proportions of major habitat types in each of the lakes. Major habitat types were defined in terms of water depth and substrate as follows:

- Deep (> 12 m)/hard
- Deep/soft
- Shallow (2-12 m)/hard
- Shallow/soft

Sites were randomly selected within these habitats in each lake. Catch rates were lower than anticipated based on gillnetting surveys conducted from 2006-2008 and sampling was enhanced by addition of random sites most likely to optimize catches (e.g., probable spawning areas). Gear included standard gang index gill nets, supplemented with smaller mesh nets (i.e., Swedish nets) and nearshore backpack electrofishing to obtain the required minimum target sample size (100 fish) and range of fish ages/sizes.

Twenty-four standard index and eleven small mesh gillnet gangs were set in Camp Lake from 27-29 August, 2013 (Figure 7.3). Twelve standard index and 6 small mesh gillnet gangs were set in Sheardown NW Lake on 30 August, 2013 (Figure 7.4). A total of 26 Arctic Char were captured in Camp Lake and 28 were captured Sheardown Lake NW with gill nets.

To supplement the small gillnetting catches, backpack electrofishing was conducted at one site in Camp Lake and two sites in Sheardown Lake NW. Fifty-seven juvenile Arctic Char were captured in Camp Lake and 183 Arctic Char and one Ninespine Stickleback were captured in Sheardown Lake NW during electrofishing surveys.

7.2 REFERENCE SITES

Desktop and field studies have been conducted to identify suitable reference lakes for Sheardown Lake NW and Camp Lake, located within reasonably close proximity to the lakes. Desktop screening studies were conducted in 2012-2013, building upon an initial screening exercise conducted in 2008, to identify a list of candidate reference lakes to be subject to reconnaissance surveys in the open-water season of 2013 (NSC, 2013b). Several iterations of this screening exercise were completed to capture a sufficient number of candidates for consideration. A brief overview of the screening process and the 2013 reconnaissance surveys completed is provided below.

Figure 7.3 2013 Camp Lake Fish Sampling Locations

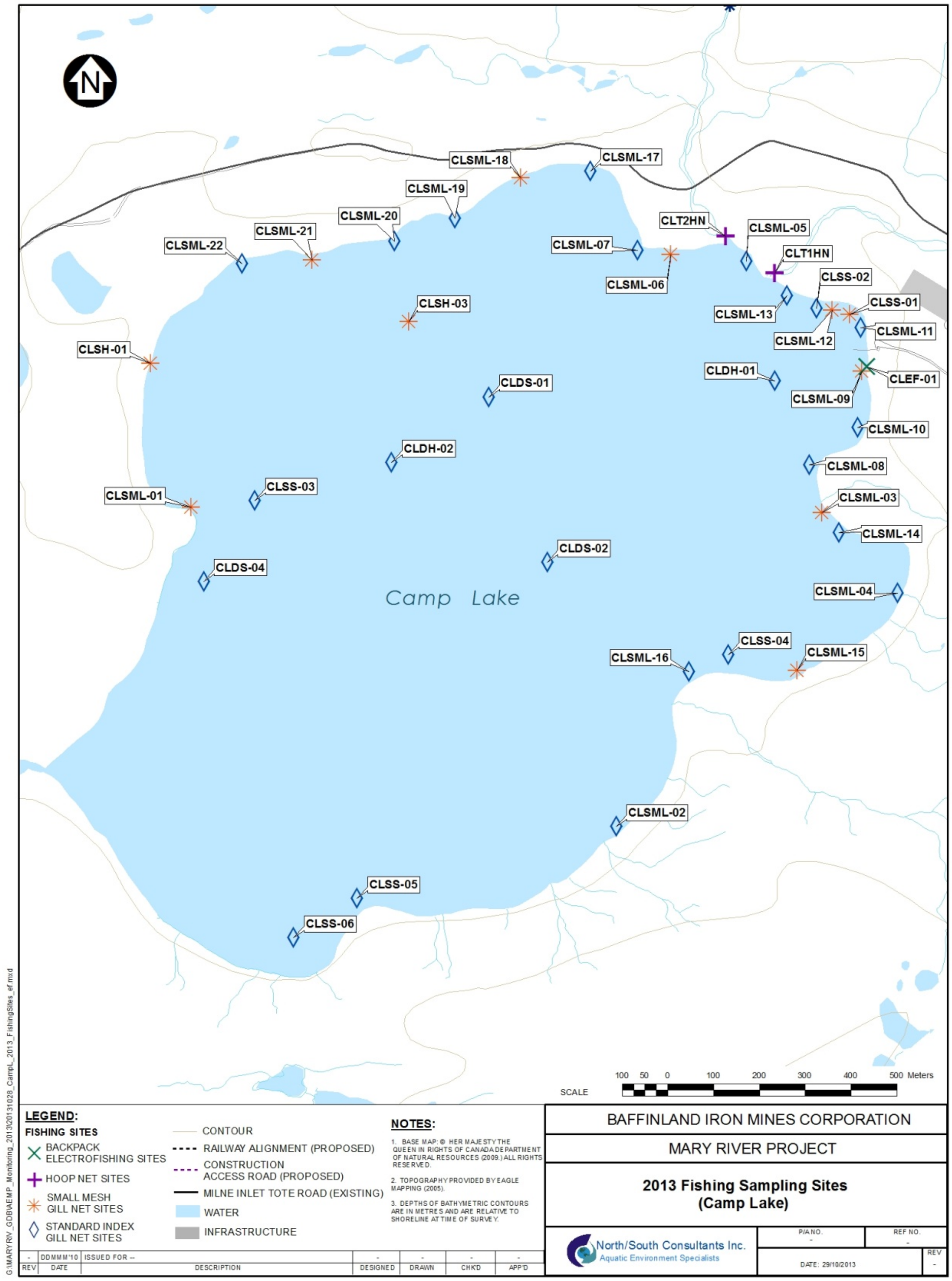
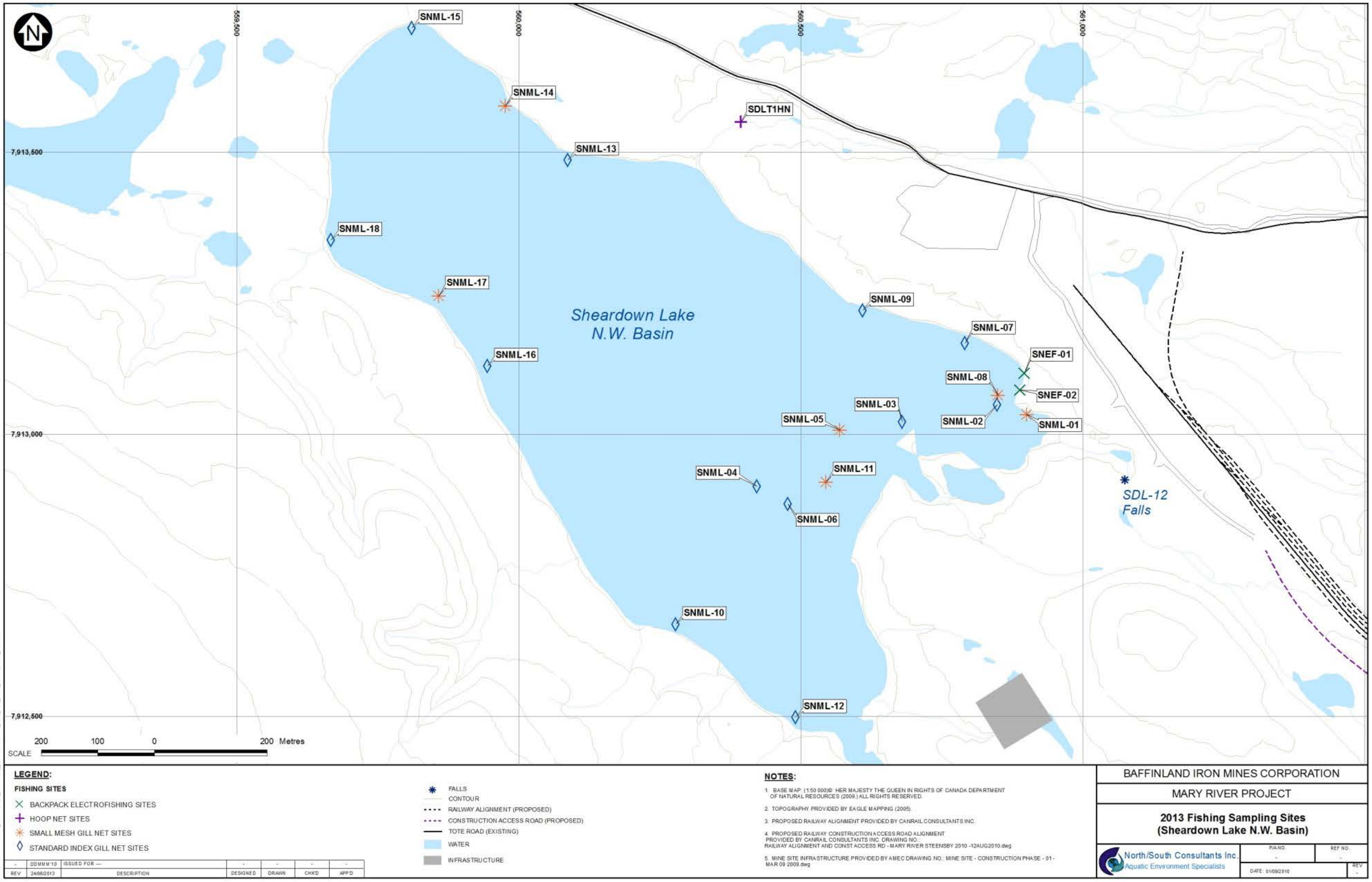


Figure 7.4 2013 Sheardown Lake Fish Sampling Locations



7.2.1 Desktop Screening Exercise Overview

Lakes within an 80 km radius from Sheardown Lake NW and Camp Lake were evaluated against the following criteria:

- Geology
- Lake surface area
- Lake shape
- Location in drainage basin
- Proximity and practicality
- Elevation
- Drainage basin slope
- Drainage basin: lake area ratio
- Average drainage basin slope
- Existing or potential development

As noted above, several iterations of the screening exercise were completed to generate a sufficient number of candidate lakes. The geological criterion was the most restrictive and screening iterations with and without geology as a criterion were completed. Through these screening exercises, twelve lakes were identified as potential candidates for reconnaissance surveys in 2013.

7.2.2 Candidate Reference Lake Reconnaissance Survey Overview

The objective of the reconnaissance surveys was to identify several lakes that could be investigated in detail for consideration as reference lakes in the CREMP. Table 7.1 provides a summary of reconnaissance survey information for all lakes surveyed during the 2013 reconnaissance surveys.

Two surveys of candidate reference lakes were completed in the open-water season of 2013. The first survey was completed in early August shortly following ice-off at the Mine Site, and involved a combination of aerial surveys followed by ground site visits. All twelve of the lakes identified through the desktop screening exercise were initially surveyed by air to identify basic suitability characteristics such as general depth, shoreline substrate and connectivity to other water bodies. Lakes that were identified as unsuitable during the aerial survey were eliminated as potential references. Depth was the primary limiting factor during aerial surveys. Five lakes were eliminated as suitable candidates due to limited depth (estimated as < 3 m); an additional three lakes were eliminated due to the ongoing presence of ice.

Of the remaining four candidate lakes (CR-P3-11, CR-P3-12, CR-P3-09, and CL-P2-13) three were subject to detailed ground surveys; two of the four lakes (CR-P3-11 and CR-P3-12) were immediately adjacent to one another and only one of these (CR-P3-11) was surveyed in detail. Surveys included collection of information on shoreline characteristics (qualitative observations), aquatic habitat (bathymetric and substrate information), fish presence/absence (specifically identification of land-locked resident Arctic Char), and water quality (*in situ* and laboratory measurements) in these three lakes (Figure 7.5) to assist with determining their similarity to Mine Area lakes. Following completion of these surveys, one of the three lakes (CR-P3-09) was subsequently dropped from further consideration due to the suspected presence of a population of dwarf Arctic Char (NSC, 2013b). The remaining two lakes (CR-P3-11 and CR-P3-13) were retained as possible suitable candidates for further consideration. These two lakes were revisited in late August for a second round of water quality sampling and for collection of benthic invertebrate samples.

To provide potential additional options for reference lakes, a second aerial survey was conducted in late August in areas identified as providing potentially suitable lakes for consideration. Eleven alternate lakes to the south of the mine site (ALT-1 to ALT-11) were surveyed aerially for general depth, shoreline substrate and connectivity to other water bodies to expand the list of potential suitable candidates (Figure 7.5). Several lakes appeared potentially suitable as references, but four (ALT-6, ALT-7, ALT-9, and ALT-10) have a combination of abundant, ideal nearshore habitat (cobble), sufficient depths (estimated to be > 10 m), and sufficient size when compared with Camp and/or Sheardown NW lakes.

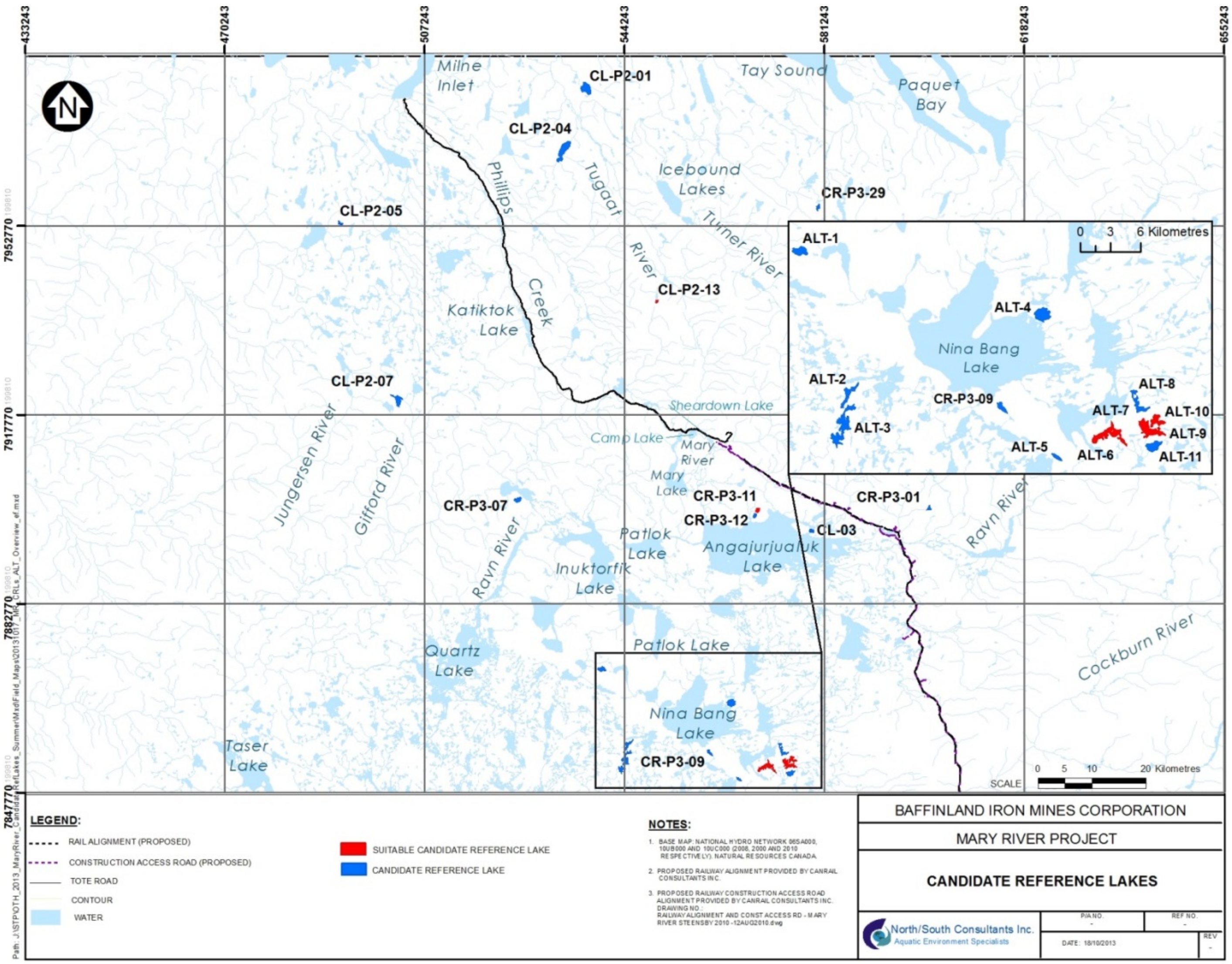
Table 7.1 Potential Candidate Reference Lakes Surveyed in 2013 for the CREMP

LAKE	DATE	SURVEY TYPE	POTENTIAL REFERENCE LAKE STATUS	COMMENTS
CR-P3-07	03-Aug-13	Ground	Not Suitable	Too shallow for overwintering or large adult fish use
CL-P2-05	03-Aug-13	Aerial	Not Suitable	Too shallow for overwintering or large adult fish use
CL-P2-01	03-Aug-13	Aerial	Potentially Suitable	Lake was still ~80% covered in ice and could not be surveyed in detail
CR-P3-29	03-Aug-13	Aerial	Potentially Suitable	Lake was still ~90% covered in ice and could not be surveyed in detail
CL-P2-04	03-Aug-13	Aerial	Potentially Suitable	Lake was still ~80% covered in ice and could not be surveyed in detail
CL-P2-13	07-Aug-13	Ground	Potentially Suitable	Lake is small, but substrate is ideal and there are large, resident Arctic Char
CL-P2-07	03-Aug-13	Aerial	Not Suitable	80-90% of the lake is < 3.0 m deep
CR-P3-09	05-Aug-13	Ground	Not Suitable if resident char are stunted	May need more studies to confirm lack of large fish, but seems unlikely as a reference
CR-P3-01	03-Aug-13	Aerial	Not Suitable	50% of the lake is < 3.0 m deep and lake is isolated from other waterbodies
CL-03	03-Aug-13	Aerial	Not Suitable	Too shallow for overwintering or large adult fish use
CR-P3-11	06-Aug-13	Ground	Potentially Suitable	Substrate not ideal, but resident fish population present
CR-P3-12	03-Aug-13	Aerial	Potentially Suitable	Very similar to CR-P3-11, so only one of the two was surveyed in detail
ALT-01	31-Aug-13	Aerial	Potentially Suitable	Does not have ideal nearshore habitat (larger cobble), but may qualify for more detailed survey
ALT-02	31-Aug-13	Aerial	Potentially Suitable	Nearshore habitat more suitable than ALT-1
ALT-03	31-Aug-13	Aerial	Not Likely Suitable	Substrate decent, but depths a little shallow
ALT-04	31-Aug-13	Aerial	Not Suitable	Essentially a bay in Nina Bang Lake
ALT-05	31-Aug-13	Aerial	Potentially Suitable	Excellent nearshore habitat and depths, but lake is a little small
ALT-06	31-Aug-13	Aerial	Potentially Suitable	Excellent nearshore habitat and depths and lake is larger than other reference sites
ALT-07	31-Aug-13	Aerial	Potentially Suitable	Connected to ALT-06, but even better suited as reference
ALT-08	31-Aug-13	Aerial	Potentially Suitable	Low shoreline slope and lower quality habitat means this is likely less suitable than others in the area
ALT-09	31-Aug-13	Aerial	Potentially Suitable	Among the best nearshore habitat and depth of any ALT lakes
ALT-10	31-Aug-13	Aerial	Potentially Suitable	Shallow connection to ALT-09 with similar habitat
ALT-11	31-Aug-13	Aerial	Potentially Suitable	Good size and depth, but nearshore habitat not as ideal as ALT-06 or ALT-09/10)

NOTES:

1. LAKES HIGHLIGHTED IN BLUE HAVE BEEN IDENTIFIED AS THE BEST POSSIBLE REFERENCE CANDIDATES.

Figure 7.5 Candidate Reference Lakes Surveyed in 2013



8 TARGET STUDIES/SPECIFIC EFFECTS STUDIES AND FOLLOW-UP

8.1 INTRODUCTION

Specific effects monitoring (or targeted monitoring) 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 or follow-up but are not anticipated to be components of the core monitoring program. Two targeted studies are described below.

8.2 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 in aquatic habitat.

8.2.1 Potential Impacts

Dust will be directly deposited on watercourses during the open-water season and on snow and ice during the winter. Dust 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).

8.2.2 Mitigation

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

8.2.3 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 NW. Sheardown Lake NW 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 sites to assess potential effects of sedimentation on Arctic Char eggs, and potentially in other habitat types to assess effects to benthos. 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 benchmark for assessing potential effects on Arctic Char eggs is the benchmark sedimentation rate of 1 mm over the egg incubation period applied in the FEIS.

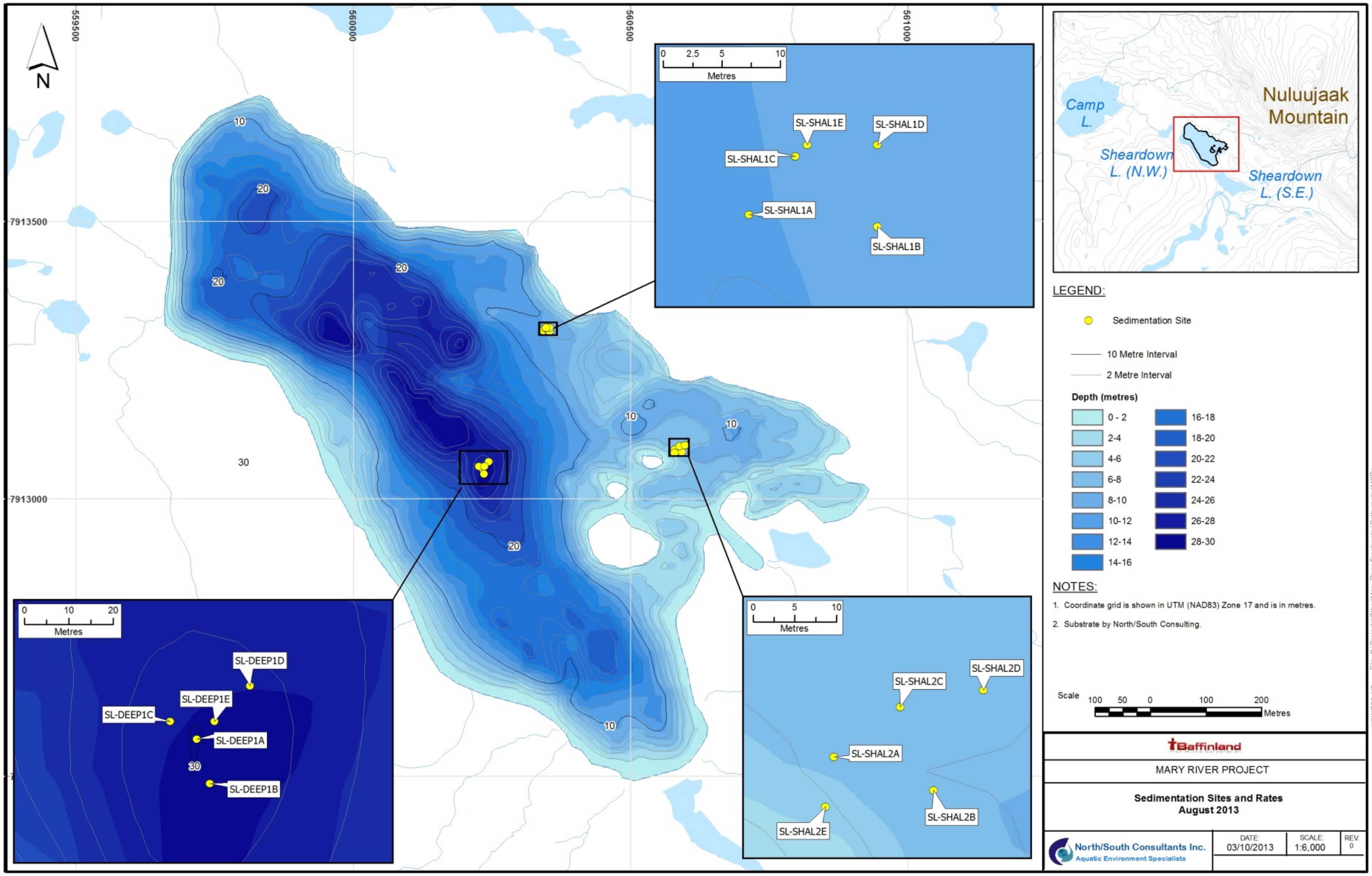
Monitoring for effects of sedimentation in Mine Area water bodies would also include visual assessments of dust deposition in conjunction with Core Monitoring, including sediment quality monitoring (i.e., assuming dust will be readily distinguishable from existing deposited sediments). Sediment cores 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.

8.2.4 Baseline Sedimentation Study

A reconnaissance field sampling program measuring sedimentation in Sheardown Lake NW was undertaken in the open-water season of 2013 to generate baseline information for post-Project comparison. Sediment traps were deployed at three sites in the lake as depicted in Figure 8.1 on August 2, 2013. Five replicates were deployed at each site to ensure adequate sediment was obtained for laboratory analysis and to provide sufficient information to evaluate variability at each site. The sites were selected to generate measurements of sedimentation rates at a deep site, where sedimentation is typically greatest, and at two shallower locations – one of which was located in potential Arctic Char spawning habitat, to generate baseline information on the critical habitat of concern with respect to this effects pathway.

Traps were retrieved near the end of the open-water season (September 6, 2013), emptied, and redeployed. Contents of the traps were submitted to an accredited analytical laboratory (ALS Laboratories, Winnipeg, MB) and analysed for total dry weight. Due to minimal sediment sample size, additional analyses could not be conducted. Traps will be retrieved in 2014 after ice-off to provide measurements of sedimentation rates associated with the spawning and egg incubation periods.

Figure 8.1 2013 Baseline Sediment Trap Locations



8.3 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.

8.3.1 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.

8.3.2 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
- Exclusion of Arctic Char from streams

8.3.3 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 mitigation is required and/or if ongoing 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.

9 PROPOSED APPROACH FOR ASSESSMENT OF AQUATIC EFFECTS

9.1 WATER AND SEDIMENT QUALITY OVERVIEW

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, as well as reference areas throughout the life of mine. 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 the 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 9.2, with surface water assessment approach being presented in Section 9.3.

9.2 PROPOSED APPROACH FOR AEMP SEDIMENT DATA ASSESSMENT

9.2.1 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.

9.2.2 Proposed AEMP Sediment Quality 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.

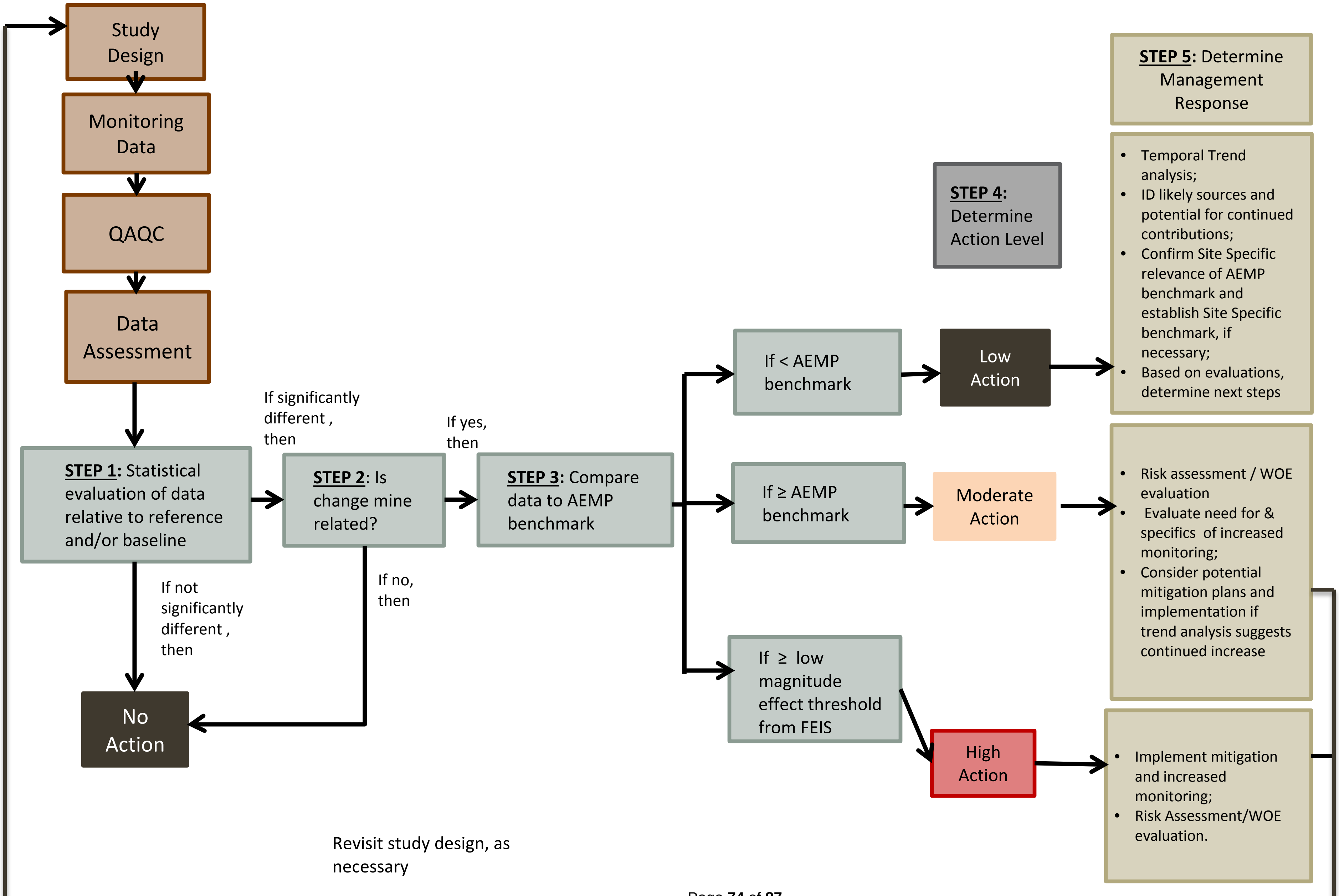
9.2.3 Proposed Assessment Approach: AEMP Sediment Data

The proposed approach for assessing sediment data is outlined in Figure 9.1. A 5-step process has been identified which includes the following steps:

- Statistical evaluation of data relative to reference and/or baseline
- Determining if the statistical change is mine-related
- Comparing monitoring data to the AEMP benchmark
- Determining the action level based on the monitoring result relative to the AEMP benchmark
- Implementing one of three courses of action (low, moderate, high)

If the first step does not detect a statistically significant change, then no action is required. If it is determined the effect is likely mine-related, one of three levels of response (low, moderate or high action) will be implemented ranging from increased monitoring and attention (i.e., trend analyses) to the implementation of further mitigation and/or risk assessment.

Figure 9.1 Proposed Water/Sediment Assessment Approach and Response Framework



9.3 PROPOSED APPROACH FOR AEMP SURFACE QUALITY 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).

9.3.1 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., 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

9.3.2 Proposed Assessment Approach: AEMP Water Quality Data

The same assessment approach used for sediment quality will be applied to water quality (Figure 9.1).

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 becomes 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).

9.4 CONCEPTUAL APPROACH FOR IDENTIFICATION OF KEY METRICS AND CRITICAL EFFECTS SIZES FOR CREMP BIOTA DATA

An initial review of existing freshwater baseline data were completed in 2013 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
- Identification of additional baseline sampling to be conducted in 2013

While not a formal objective of this review, this undertaking also assisted 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 was to advise on the need to collect additional baseline data to augment the robustness of the dataset for monitoring purposes, this analysis was viewed as a preliminary exercise in the development of potential suitable biological benchmarks or "critical effects sizes (CESs)" for the AEMP. Additional baseline data acquired 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.

9.4.1 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
- Follow-up 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)
- 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 final 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 included consideration of published CESs for application under CREMP and it is anticipated that further refinement and development of biological CESs would occur upon reanalysis of the datasets to incorporate data collected in 2013. 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 were 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.

9.4.2 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/water bodies that may be affected by pathways other than MMER effluent discharges (e.g., Sheardown Lake). A preliminary review of existing baseline data for Arctic Char was completed in 2013 to help direct future sampling design and collection of additional baseline data, should monitoring be proposed under CREMP. This exercise included 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 identified the statistical power of the existing data and indicated that the recommended sample size of 100 fish would be adequate to detect CESs of the magnitude indicated in the EEM guidance document (EC, 2012).

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 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 9.1). 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 9.1 MMER EEM Critical Effects Sizes (CES) for Fish Populations

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%

NOTES:

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.
2. CES ARE EXPRESSED AS A PERCENTAGE OF THE REFERENCE MEANS.

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.

9.4.3 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 was completed in 2013 and included an evaluation of these data for the Mine Area. The review assisted with a preliminary assessment of the inherent natural variability in community and richness metrics, which in turn informed the fall 2013 baseline sampling program. This review and the additional baseline data collected in 2013 will ultimately support the development of appropriate CESs for CREMP, if benthic invertebrates are monitored under this program.

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.

The initial review of the benthic invertebrate community data identified the statistical power of the existing data and indicated that the power of the existing data set in Sheardown Lake NW to be able to detect a post-Project change in the mean of ±50% is high for the majority of metrics investigated, with the exception of total macroinvertebrate density. More sensitive metrics to change were identified and these include Chironomidae proportion, Shannon's Equitability, Simpson's Diversity Index, and total taxa richness. Depending on the CES(s) and benthic macroinvertebrate metrics chosen as part of the CREMP, five replicate stations per aquatic habitat type may be adequate; an increase to seven would improve the ability of a few, more sensitive metrics to detect changes in the mean of ±25% and ±20% post-Project.

An assessment of the variability of sub-samples at a replicate station has not been conducted to date, as grabs were composited at each replicate station in previous years prior to identification and enumeration of macroinvertebrates. For 2013, five sub-samples were collected at each replicate station and kept separate to allow further assessment of the number of field sub-samples required to adequately characterize within station variability.

9.4.4 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 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.

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. Examples of 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)
- 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 would 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.

The initial review of existing baseline data (through 2012) was completed in 2013 and indicated relatively low power associated with the two most common metrics employed in phytoplankton monitoring programs (i.e., chlorophyll *a* and total biomass). Low power associated with the baseline chlorophyll *a* data are likely due to the relatively low concentrations that occur in the Study Area lakes and a relatively high frequency of values below analytical detection limits. Phytoplankton biomass is commonly associated with relatively low power due to typically high natural variability. Derived metrics (i.e., diversity, evenness, and richness metrics) were associated with lower variability and greater power. As previously described, additional sampling was conducted in the Mine Area water bodies in the open-water season of 2013 to augment the baseline database. Data will be re-evaluated with the additional information to refine CESs and final design of the CREMP.

Table 9.2 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)

10 QUALITY CONTROL AND QUALITY ASSURANCE (QA/QC)

10.1 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 technical guidance document (EC, 2012). Laboratory blanks, duplicates, spikes and reference standards will be employed according to standard operating procedures. Laboratory Chain of Custody (COC) forms will accompany all samples for identification, tracking and transporting purposes.

10.2 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.

10.3 BENTHIC INVERTEBRATE SURVEY

Field sub-samples would be collected from each benthic invertebrate monitoring replicate station, to compensate for the spatial variability encountered with these organisms. There were five sub-samples collected at each replicate station during the fall 2013 lake benthic invertebrate field program to facilitate examination of variability between sub-samples. This analysis will inform details of the design in future monitoring programs (i.e., number of sub-samples required, pooling of sub-samples prior to analysis). Appropriate QA/QC measures related to processing and identification, as outlined in the EEM technical guidance document will be followed and are described below (EC, 2012). 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.

Benthic samples will be analyzed by a taxonomist. All samples will be sorted with the use of a stereomicroscope (10X). 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 the EEM program. For those samples that were sub-sampled, sorted and unsorted fractions will be re-preserved separately. Sorted organisms will be re-preserved.

All invertebrates will be identified to the lowest practical level, usually genus or species level. Chironomids 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.

10.4 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. All data collection, entry, analysis and QA/QC will be conducted by a trained fish biologist.

The fish ages will be determination by experienced technicians and a minimum of 10% of fish ageing structures that are processed will be independently and blindly aged by a second technician. As a non-lethal survey is proposed, the preferred ageing structure for Arctic Char and that which was collected from mortalities during the baseline studies for ageing purposes (otoliths) will only be collected from incidental mortalities during the monitoring programs. The CREMP and the EEM program are anticipated to employ a non-lethal design and therefore will require use of other ageing structures (i.e., scales or pectoral fin rays) for fish that are live released. Anticipating that scales are the least preferred ageing structure for this species due to their small size, it is assumed that pectoral fin rays will be the primary ageing structure collected during the monitoring program. As part of the QA/QC program, it is recommended to collect both otoliths and pectoral fin rays from incidental mortalities and potentially from a length-stratified sub-sample during the conduct of future studies for the purpose of cross-verification of these two ageing structures. Pectoral fin rays and otoliths were collected from 16 Arctic Char in 2013 to facilitate this comparison.

All data entered electronically will undergo a 100% transcription QA/QC by a second person to identify any transcription errors and/or invalid data.

10.5 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, where applicable.

11 ANNUAL REPORTING

Annual reporting for the AEMP will be completed as specified in the Type A Water Licence, based on the on the Nunavut Watershed Management Areas as follows:

Eclipse Sound Water Management Area No. 48 will provide the results of the monitoring for:

- Milne Port
- The Tote Road
- The Mine Site
- The northern section of the railway

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

- The southern section of the railway
- Steensby Port

Monitoring and reporting will not be carried out for a water management area if there are no activities carried out within that water management area.

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SCHEDULES

SCHEDULE 1 - FRESHWATER INTAKE AND VOLUMES

<table>
<tr><th rowspan="2">CAMP / SITE</th><th rowspan="2">SNP MONITORING ID</th><th rowspan="2">INTAKE</th><th rowspan="2">COORDINATES LAT/LONG</th><th colspan="2">CONSTRUCTION PHASE</th><th colspan="3">OPERATION PHASE</th></tr>
<tr><th>Volume (m^3/day)</th><th>Combined Volume (m^3/yr)</th><th>Domestic Volume (m^3/day)</th><th>Industrial Volume (m^3/day)</th><th>Combined Volume (m^3/yr)</th></tr>
<tr><td rowspan="2">Milne Port</td><td>MP-MRY-2</td><td>Phillips Creek (summer)</td><td>71.780658
-80.377746</td><td rowspan="2">68.5</td><td rowspan="2">25,000</td><td rowspan="2">14.8</td><td rowspan="2">16.2</td><td rowspan="2">31</td></tr>
<tr><td>MP-MRY-3</td><td>Km 32 Lake (winter)</td><td>71.667202
-80.586877</td></tr>
<tr><td>Mine Site</td><td>MS-MRY-1</td><td>Camp Lake</td><td>71.327479
-79.381779</td><td>657.5</td><td>240,000</td><td>203.8</td><td>151.6</td><td>355.4</td></tr>
<tr><td rowspan="2">Steensby (Port)</td><td>SP-08</td><td>ST 347 Lake
(permanent camp)</td><td>70.330959
-78.427808</td><td rowspan="2">435.8</td><td rowspan="2">155,000</td><td rowspan="2">101</td><td rowspan="2">142.6</td><td rowspan="2">243.6</td></tr>
<tr><td>SP-09</td><td>3 Km Lake
(dust suppression & other minor uses)</td><td>70.289537
-78.430393</td></tr>
<tr><td>Ravn River Area</td><td>TBD</td><td>Ravn Camp Lake</td><td>71.145367
-78.379005</td><td>145.2</td><td>53,000</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Mid-Rail Area</td><td>TBD</td><td>Nivek Lake (summer)
Ravn Camp Lake (winter)</td><td>70.972722
-78.371882</td><td>79.5</td><td>29,000</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Cockburn Lake Tunnels Camp</td><td>TBD</td><td>Cockburn Lake</td><td>70.588740
-78.198503</td><td>101.4</td><td>37,000</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Cockburn South Camp</td><td>TBD</td><td>Cockburn Lake</td><td>70.471518
-78.381563</td><td>111.1</td><td>41,000</td><td>-</td><td>-</td><td>-</td></tr>
</table>

SCHEDULE 2 – DISCHARGE LIMITS FOR WASTEWATER
(from Type A Water Licence)

Table 1a: Treated Sewage Effluent Discharge Quality Standards 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

SCHEDULE 2 – DISCHARGE LIMITS FOR WASTEWATER (from Type A Water Licence)

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 (µg/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

Parameter	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

SCHEDULE 2 – DISCHARGE LIMITS FOR WASTEWATER
(from Type A Water Licence)

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 3 - COMPLIANCE MONITORING SCHEDULE FOR EFFLUENT DISCHARGES

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

Proposed SNP & Other Station IDs	WASTE WATER TREATMENT FACILITY (WWTF) DISCHARGES	Discharge Coordinates (m)	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

SCHEDULE 3 - COMPLIANCE MONITORING SCHEDULE FOR EFFLUENT DISCHARGES

Table 2: Mine Site – Compliance Monitoring for Effluent or Runoff Discharges

Proposed SNP & Other Station IDs	WASTE WATER TREATMENT FACILITY (WWTF) DISCHARGES	Discharge Coordinates (m)	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.

SCHEDULE 3 - COMPLIANCE MONITORING SCHEDULE FOR EFFLUENT DISCHARGES

Table 2: Mine Site – Compliance Monitoring for Effluent or Runoff Discharges						
MS-05	Mine Site Landfarm Facility Stormwater	TBD	Table 4	Groups 1, 5, plus TSS	Monthly (summer)	Adjacent land surface.
	CONTAINMENT AREA DISCHARGES					
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

SCHEDULE 3 - COMPLIANCE MONITORING SCHEDULE FOR EFFLUENT DISCHARGES

Table 3: Steensby Port – Compliance Monitoring for Effluent or Runoff Discharges

Proposed SNP & Other Station IDs	WASTE WATER TREATMENT FACILITY (WWTF) DISCHARGES	Discharge Coordinates (m)	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 4 – SNP 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 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 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 5 – EEM AND CREMP MONITORING PARAMETERS

GROUP	USE	PARAMETER
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 5 – EEM AND CREMP MONITORING PARAMETERS

GROUP	USE	PARAMETER
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*).

SCHEDULE 5 – EEM AND CREMP MONITORING PARAMETERS

GROUP	USE	PARAMETER
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)
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**

SCHEDULE 5 – EEM AND CREMP MONITORING PARAMETERS

GROUP	USE	PARAMETER
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 6 - SITE SPECIFIC MONITORING FRAMEWORK

Table 6a - 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 6b - 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:

Baffinland

SCHEDULE 6 - SITE SPECIFIC MONITORING FRAMEWORK

Table 6b (cont'd) - 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 6 - SITE SPECIFIC MONITORING FRAMEWORK

Table 6b (cont'd) - 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 6 - SITE SPECIFIC MONITORING FRAMEWORK

Table 6c - 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 6 - SITE SPECIFIC MONITORING FRAMEWORK

Table 6d - 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 7 – 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? (i.e. is the crossing moving upstream or downstream of its original location? How far? Which direction?)

SITE SKETCH, NOTES, REMARKS: (i.e. high water mark, high turbidity, natural bank erosion, water colour, [illegible] 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: 0.8 for rough, loose rocks or coarse gravel; 0.9 for smooth mud, sand, or hard pan rock

PHOTOS: (upstream, crossing, downstream)

NOTES:

[illegible] - Fish Habitat Compensation\Appendix F\[App F1 - Turbidity Monitoring Data Form.xls]Data Sheet

SCHEDULE 7 – WATER CROSSING PERFORMANCE MONITORING FORMS

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

I:\102-00181-10\Assignment\Report\Report 4, Rev. 0 - Fish Habitat Compensation\Appendix F\App F2 -Watercourse Crossing Monitoring Data Form.xls]Data Sheet

PHOTO 1 – CLT-NF-1 facing upstream towards waterfall barrier.

PHOTO 2 – CLT-NF-3 facing downstream.

PHOTO 3 – CLT-NF-4 and CLT-NF-5 facing upstream.

PHOTO 4 – CLT-NF aerial view including fish barrier upstream.

PHOTO 5 – CLT-FF-1 facing upstream to Tote Road culverts.

PHOTO 6 – CLT-FF-1 facing downstream.

PHOTO 7 – CLT-FF-4 facing downstream.

PHOTO 8 – CLT-FF-5 facing downstream towards Camp Lake.

PHOTO 9 – CLT-REF2-1 facing downstream.

PHOTO 10 – CLT-REF2-1 facing upstream.

PHOTO 11 – CLT-REF2-3 facing downstream.

PHOTO 12 – CLT-REF2-5 facing downstream towards Tote Road.

PHOTO 13 – CLT-REF3-1 facing downstream.

PHOTO 14 – CLT-REF3-2 facing downstream.

PHOTO 15 – CLT-REF3-4 facing downstream.

PHOTO 16 – CLT-REF3 aerial view of study area.

PHOTO 17 – CLT-REF4-1 facing upstream.

PHOTO 18 – CLT-REF4-3 facing downstream.

PHOTO 19 – CLT-REF4-5 facing upstream.

PHOTO 20 – CLT-REF4 aerial view of study area.

PHOTO 21 – MRY-NF-1 facing upstream, Deposit No.1 on horizon.

PHOTO 22 – MRY-NF-4 facing upstream.

PHOTO 23 – MRY-NF sediment characterization and BIC study area.

PHOTO 24 – MRY-NF fish community and water quality study area.


PHOTO 25 – MRY-FF-2 facing upstream.


PHOTO 26 – MRY-FF-4 facing upstream.


PHOTO 27 – MRY-FF-5 facing upstream from right bank.


PHOTO 28 – MRY-FF aerial view of study area facing upstream.

PHOTO 29 – MRY-REF1-1 facing upstream.

PHOTO 30 – MRY-REF1-3 facing downstream.

PHOTO 31 – MRY-REF1-5 facing upstream.

PHOTO 32 – MRY-REF1 aerial view facing upstream.


PHOTO 33 – MRY-REF2-1 facing downstream.


PHOTO 34 – MRY-REF2-2 facing upstream.


PHOTO 35 – MRY-REF2-5 facing downstream.


PHOTO 36 – MRY-REF2-1 to REF2-4 aerial view of study area.

PHOTO 37 – MRY-REF3-1 facing downstream.

PHOTO 38 – MRY-REF3-2 facing upstream.

PHOTO 39 – MRY-REF3-5 facing downstream.

PHOTO 40 – MRY-REF3 aerial view of study area facing upstream.

PHOTO 41 – MRY-REF4-1 facing upstream.

PHOTO 42 – MRY-REF4-2 facing left bank.

PHOTO 43 – MRY-REF4-3 facing downstream.

PHOTO 44 – MRY-REF4-5 facing downstream.