Sabina
GOLD & SILVER CORP.

BACK RIVER PROJECT
Aquatic Effects Management Plan

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BACK RIVER PROJECT
AQUATIC EFFECTS MANAGEMENT PLAN

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Acronyms

AEMP	Aquatic Effects Management Plan
DFO	Fisheries and Oceans Canada
EEM	Environmental Effects Monitoring
FEIS	Final Environmental Impact Statement
KIA	Kitikmeot Inuit Association
MAD	Main Application Document
MLA	Marine Laydown Area
MMER	Metal Mining Effluent Regulations
NWB	Nunavut Water Board
the Project	Back River Project
Sabina	Sabina Gold & Silver Corp.
TK	Traditional Knowledge

1. Introduction

1.1 BACKGROUND

The Back River Project (the Project) is a proposed gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of southwestern Nunavut. It is situated approximately 400 kilometres (km) southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 520 km northeast of Yellowknife, Northwest Territories. The Project is located predominantly within the Queen Maud Gulf Watershed (Nunavut Water Regulations, Schedule 4).

The Project is comprised of two main areas with interconnecting winter ice roads (WIR) (Main Application Document [MAD] Appendix A, base Figure 2): Goose Property (MAD Appendix A, base Figure 3) and the Marine Laydown Area (MLA) (MAD Appendix A, base Figure 4) situated along the western shore of southern Bathurst Inlet. The majority of annual resupply will be completed using the MLA, and an approximately 160 km long WIR will connect the MLA to the Goose Property. Refer to the MAD Appendix A, base Figures 1 to 5 for general site layout and locations. A detailed project description is provided in the MAD.

The life of the Project, from mobilization to post closure, is 27 years: 4 years of Mobilization and Construction Phase (Year -4 to Year -1), 10 years of Operations (Year 1 to Year 10), 8 years of Closure (Year 10 to Year 18), and 5 years of Post-Closure monitoring (Year 18 to Year 23). The proposed AEMP applies to the Construction Phase and will be updated as necessary to accommodate future phases. In the event that the Project goes into Temporary Closure and/or care and maintenance, the AEMP will be updated to reflect required monitoring.

The overall purpose of the AEMP is to monitor the aquatic environment for Mine-related effects, to assess and update predictions, and to provide the basis for informed management decisions by the Project to minimize, mitigate, and/or manage potential adverse effects on the environment.

The AEMP is a comprehensive program that considers Project related effects on the aquatic environment and is harmonized to meet Metal Mining Effluent Regulations (MMER) and Environmental Effects Monitoring (EEM) requirements. It is expected that the Back River site will be subject to the MMER when lakes are dewatered in the Construction Phase

Earlier versions of the AEMP included a marine sampling component. The marine component has been removed from this version of the AEMP document as the AEMP is intended to focus on the Project area under the jurisdiction of the Nunavut Water Board (NWB). Marine related water monitoring can be found in the Marine Monitoring Plan (Supporting Document [SD]-23).

In addition, Sabina has committed to working with the Kitikmeot Inuit Association (KIA) prior to the first technical meeting of the NWB water licensing process to update this AEMP and to develop adaptive management thresholds (Commitment FA-KIA-C-1).

1.2 SCOPE AND OBJECTIVES

The AEMP has been designed to comply with existing regulations and follows those guidelines provided by the federal government and the government of Nunavut, including the *Fisheries Act* (Government of Canada 1985), the *Metal Mining Effluent Regulations* (Government of Canada 2002), the Nunavut *Environmental Protection Act* (Government of Northwest Territories 1988), and the *Nunavut Land Claim Agreement Act* (Government of Canada 1993). The overall objective of the AEMP is to monitor for potential mine-related effects on the aquatic environment as per regulatory requirements.

The core components of the AEMP include monitoring of water quality, sediment quality, benthic invertebrate community, and fish (health and tissue chemistry). The AEMP will operate through the life of the mine; however, this iteration of the design is focussed on the construction phase. This version of the AEMP was developed in consideration of commitments made during the regulatory review process (refer to Appendix B-1 of the MAD).

The AEMP is a living document and it will be updated, as necessary, based on regulatory changes, Project-related changes, incident investigations, the need for changes to existing mitigation measures, and input from regulators and the KIA. The AEMP includes a response framework, which is central to the effective implementation of the AEMP, as it serves to identify changes through early warning indicators and trigger additional investigation, monitoring, or the implementation of additional mitigation measures.

Environmental monitoring outside of the AEMP can be found in the Marine Monitoring Plan (SD-23), Environmental Management and Protection Plan (SD-20), and the Water Management Plan (SD-05).

1.3 APPLICABLE STANDARDS, GUIDELINES, AND REGULATIONS

This AEMP has been designed to comply with existing regulations and follow the available guidelines provided by the federal government and the Government of Nunavut. Applicable regulations include:

- *Arctic Waters Pollution Prevention Act* (1985a);
- *Canada Shipping Act* (2001);
- *Fisheries Act* (1985b), including the Metal Mining Effluent Regulations (SOR/2002-222);
- *Nunavut Environmental Protection Act* (1988);
- *Nunavut Land Claim Agreement Act* (1993); and
- *Oceans Act* (1996).

Mitigation and management measures have been drawn from knowledge and experience contained in guidelines and research documents. Project infrastructure and activities will follow the relevant guidelines, and the adaptive management strategy includes seeking new knowledge and strategies to minimize Project effects on the aquatic environment. Relevant guidelines for the monitoring, mitigation, and management plans presented in this AEMP include:

- A Guide to Canada’s Ballast Water Control and Management Regulations (Transport Canada 2007).
- Acid Mine Drainage in Permafrost Regions: Issues, Control Strategies and Research Requirements (MEND 1996).
- Canadian Council of Ministers of the Environment Sediment Quality Guidelines for the Protection of Aquatic Life (CCME 2013a).
- Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Aquatic Life (CCME 2013b).
- Fisheries and Oceans Canada (DFO) Nunavut Operational Statement: Culvert Maintenance (DFO 2009).
- DFO Nunavut Operational Statement: Timing Windows (DFO 2009).
- DFO Nunavut Operational Statement: Clear Span Bridges (DFO 2009).
- DFO Nunavut Operational Statement: Temporary Stream Crossing (DFO 2009).

- o DFO Nunavut Operational Statement: Ice Bridges and Snow Fills (DFO 2009).
- o DFO Nunavut Operational Statement: Mineral Exploration Activities (DFO 2009).
- o DFO Protocol for Winter Water Withdrawal from Ice-Covered Waterbodies in the Northwest Territories and Nunavut (DFO 2010).
- o Environmental Code of Practice for Metal Mines (Environment Canada 2012a).
- o Environmental Guideline for Dust Suppression (Environmental Protection Service 2002).
- o Environmental Guideline for the Burning and Incineration of Solid Waste (Government of Nunavut 2012).
- o Good Environmental Practices for Northern Mining and Necessary Infrastructure Task 2 Report (Nunavut Regional Adaptation Collaborative 2012).
- o Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions (Transportation Association of Canada 2010).
- o Guidelines for the Operation of Tankers and Barges in Canadian Arctic Waters (Transport Canada 1997).
- o Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998).
- o Metal Mining Effluent Regulations (SOR/2002-222).
- o Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories (AANDC 2009).
- o Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring (Environment Canada 2012)

1.4 DOCUMENT STRUCTURE

This document outlines Sabina's proposed AEMP for the Project during Construction. Specifically, this document is divided into the following sections:

- o Mine and water management plan overview (Section 2);
- o Conceptual site model of interactions (Section 3);
- o Overview of the AEMP (Section 4);
- o Design details of the AEMP for water quality, sediment quality, benthic invertebrate community, and fish (Section 5);
- o Outline of the Response Framework (Section 6); and
- o Outline of expected Annual Reporting requirements (Section 7).

2. Mine Overview

The Project involves the Construction, Operations, and Closure of open pit and underground mines at the Goose Property. A MLA will be established at Bathurst Inlet to deliver supplies, via a 160 km winter ice road connecting the MLA to the Goose Property.

The Project life is described in Phases as follows:

- Phase 1 – Mobilization and Construction (4 years; Years -4 to -1);
- Phase 2 – Operations (10 years; Years 1 to 10);
- Phase 3 – Closure (8 years; Years 10 to 18); and
- Phase 4 – Post-Closure (5 years; Years 18 to 23).

The mine plan consists of open pit mining plus underground mining at four deposits, supporting a 6,000 tonnes per day milling operation over an estimated 10 year mine life. The four deposits are as follows:

- Umwelt (Umwelt open pit mine and Umwelt underground mine);
- Llama (Llama open pit mine and Llama underground mine);
- Goose Main (Goose Main open pit mine and Goose Main underground mine); and
- Echo (Echo open pit mine and Echo underground mine).

2.1 PROJECT PHASES

The AEMP has been designed to consider all phases of mine development, with emphasis placed on the early phases of development in the current version. Updates are anticipated to the AEMP design plan as the mine progresses through the four phases of development: Mobilization and Construction, Operations, Closure, and with additional monitoring and mitigation continuing into Post-Closure. Mobilization and Construction activities may be preceded by development works.

Development works is defined as any construction activities as defined in Section 1.5 but specific to activities allowed under the provision of the Nunavut Agreement Article 13, Section 13.5.5 or the NWNSRTA. This phase will commence after receipt of the NIRB Final Hearing Report on the FEIS or earlier (if possible), the (new or amended) Type B Water Licence from the NWB, and the land use permits from the Kitikmeot Inuit Association (KIA) and INAC where needed

Construction is defined as any activities undertaken for the purposes of establishing or constructing components, infrastructure, and facilities required for development of a mine. Full mine site construction will commence following receipt of a Type A Water Licence from the NWB and Land Use Permit from the KIA. Construction is proposed to take approximately four years.

Operations is defined as the period that the Process Plant is operating and producing a commodity (i.e., gold). The mine is expected to operate for 10 years. During the mine start-up, this will include a 12-month commissioning period planned for Q4 of Y-1 to Q4 of Y1. Operations at the Project (Years 1 to 10) focus on the economic recovery of gold and delivery to market. Other activities during Operations will include ongoing exploration supported by the Project Infrastructure and ongoing progressive reclamation. Operations, Phase 2, is divided into three Stages as determined by the active tailings management facility and will occur from Year 1 to Year 10.

- Phase 2, Stage 1 – Tailings Storage Facility – For the first two years of Operations (Years 1 and 2), a purpose-built TSF will be utilized;
- Phase 2, Stage 2 – Umwelt TF – From Years 2 to 6, the mined-out Umwelt Pit will be used for the tailings deposition; and
- Phase 2, Stage 3 – Goose Main TF – From Year 6 onward, tailings will be disposed of in the mined-out Goose Main open pit mine (Goose Main Pit).

Closure (Abandonment, Reclamation, and Closure) **and Post-Closure** is defined as an Operator ceasing operations at a facility without the intent of resuming mining activities. The expectation will be that the site will be reclaimed and post-closure monitoring will continue until it can be demonstrated that the mine site is both chemically and physically stable. Closure is expected to take 8 years and Sabina proposes at this time 5 years Post-Closure monitoring. Closure consist of two stages:

- Phase 3, Stage 1 (Active Closure) - Approximately two years to complete and entails the bulk of the physical closure activities.
- Phase 3, Stage 2 (Passive Closure) - Approximately six years of water treatment followed by final decommissioning of the remaining elements of the Property.

A minimum of five years of Post-Closure monitoring will follow the above phases of mine closure during which confirmation monitoring will occur. The expectation will be that the site will be reclaimed and Post-Closure monitoring will continue until it can be demonstrated that the mine site is both chemically and physically stable.

2.2 WATER MANAGEMENT PLAN

All water on the Project is categorized into three types: contact water (includes site contact water and mine contact water), non-contact water (i.e., runoff from undisturbed areas), and intercepted groundwater (which is saline). Only non-contact water will be diverted off-site without treatment.

Each type of water will be managed separately throughout each Project phase.

Detailed descriptions of Project water management can be found in the MAD (Section 5.3.4) and the Water Management Plan (SD-05).

Direct discharge of water to the receiving environment will occur during the Construction Phase (i.e., through dewatering of Llama and Umwelt lakes) and Post-Closure (i.e., through reconnection of the pit lakes with Goose Lake). Contact water (including effluent) will be stored on-site in the tailings storage facility or the Saline Water Pond during Operations and Closure.

3. Conceptual Site Model

3.1 INTRODUCTION

The conceptual site model for the Back River AEMP considers linkages between the stressors identified in the Final Environmental Impact Statement (FEIS), changes to water and sediment quality from those stressors, the response by the receptors from changes in water and sediment quality, and changes in aquatic ecosystem function related to changes in aquatic interactions.

3.2 STRESSORS OF CONCERN AND TRANSPORT PATHWAYS

As part of the FEIS, the residual effects (i.e. effects which remain following application of the management and mitigation measures outlined in the FEIS) of project activities on valued ecosystem components were determined. Residual effects of the Project were identified for water (FEIS Volume 6, Chapter 4, Section 4.5.4) and sediment quality (FEIS Volume 6, Chapter 5, Section 5.5.4). There were no residual effects identified for fish (FEIS Volume 6, Chapter 6, Section 6.5.5). A summary of the Project activities and water quality interaction pathways with the potential for residual effects are summarized in Table 3.2-1. The same interactions and residual effects were identified for sediment quality.

Table 3.2-1. Matrix of Project Activities, Interaction Pathways, and Residual Effects to Water Quality and Sediment Quality

Project Activity	Interaction Pathway and Project Phase															
	Runoff				Water Withdrawal				Discharge				Aerial Deposition			
	Construction	Operations	Closure	Post-closure	Construction	Operations	Closure	Post-closure	Construction	Operations	Closure	Post-closure	Construction	Operations	Closure	Post-closure
Construction and Decommissioning	yes	-	-	yes	-	-	-	-	yes				-	-	-	-
Winter Ice Roads	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Site Contact Water	yes	yes	yes	yes	-	-	-	-	-	-	-	-	-	-	-	-
Mine Contact Water	yes	-	-	yes	-	-	-	-	yes				-	-	-	-
Water Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quarries and Borrow Pits	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Explosives	yes	yes	yes	yes	-	-	-	-	-	-	-	-	yes	yes	-	-
Fuels, Oils, and PAH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Treated Sewage Discharge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dust Deposition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Yes = project activities with potential residual effects; - = no residual effects; PAH = polycyclic aromatic hydrocarbon.

Four Project components or activities with potential for residual effects were identified:

- Construction and Decommissioning Activities - Project activities that include the clearing of overburden, dewatering, earthworks, and construction activities for pads and infrastructure.
- Site Contact Water - the runoff from Project infrastructure including pad areas, laydown areas, roads, and airstrips.
- Mine Contact Water - water that contacts mine surfaces and operations, including runoff from waste rock storage areas and ore storage areas, water management structures (e.g., Saline Water Pond), drilling water from exploration, and open pit and underground water.
- Explosives - Project activities related to the transport, manufacture, storage, and use of explosives.

Three pathways with linkages between the Project and surface water were defined:

- Runoff discharge (all four Project phases) – the transport of material or compounds from the terrestrial environment into the freshwater environment by precipitation or snowmelt.
- Direct discharge (Construction) - the direct input of Project water into freshwater waterbodies.
- Aerial deposition (Construction and Operations) - the direct input of material and chemical compounds from the air into the freshwater environment.

As a result of the above noted Project linkages with surface water, predictions were made regarding residual effects of the Project to water quality. These predications indicated that the effect would be:

- Negative, with low to moderate magnitude;
- Short to medium term in duration;
- Sporadic and local in extent; and
- Reversible.

The overall significance of these residual effects was rated as not significant (FEIS Volume 6, Chapter 4, Section 4.10).

3.3 EXPOSURE MEDIA AND ECOLOGICAL RECEPTORS

The aquatic monitoring components of the AEMP include exposure media (i.e., water quality, sediment quality, and fish tissue [when considering the consumption of fish]) and ecological receptors (i.e., benthic invertebrate community, and fish). Biological responses of the ecological receptors to changes in water and sediment quality are considered through the AEMP. For example, changes in water quality or sediment quality may influence the benthic invertebrate community, which in turn may influence small fish and young fish upon which larger fish feed. The inclusion of exposure media and ecological receptors in the AEMP design plan enables effective monitoring of the aquatic environment for changes as a result of Project activities.

Data will be collected through the AEMP to quantify, describe and monitor for changes in assessment and measurement endpoints (Table 3.3-1). Assessment endpoints, as identified in the FEIS, reflect the overarching valued ecosystem components (i.e., freshwater quality, sediment quality, and habitat, aquatic ecology, and aquatic biota supporting commercial, recreation, and aboriginal fisheries) in the study area. Measurement endpoints are the quantifiable and measurable metrics included in the AEMP, such as concentrations of metals or nutrients in water, or the density of benthic invertebrate species (Table 3.3-1).

Table 3.3-1. Measurement and Assessment Endpoints

Aquatic Monitoring Component	Measurement Endpoint	Supporting Evidence	Assessment Endpoint
Water Quality	Concentrations of metals and nutrients in effluent discharge and surface water	Concentrations of toxicity-modifying parameters (e.g., pH, hardness) Sediment chemistry Concentrations of other parameters (e.g., chlorophyll *a*)	Suitability of water to support an aquatic ecosystem Suitability of water as a drinking source for people and wildlife Suitability of water for traditional and downstream uses
	Chronic toxicity response of an algal and invertebrate species in effluent discharge	Water chemistry Sediment chemistry	
Sediment Quality	Concentrations of nutrients and metals in surficial sediments	Water chemistry Sediment particle size and total organic carbon	
Benthic Invertebrate Community	Total invertebrate density and densities of dominant invertebrate groups	Water chemistry Sediment chemistry Physical habitat characteristics	Maintenance of a functional benthic invertebrate community
	Taxonomic richness		
	Benthic community composition		
	Benthic community similarity between exposure and reference areas		
Fish Health	Reproduction (energy use)	Site characterization Water chemistry Sediment chemistry Benthic invertebrate community Target species abundance (catch per unit effort) Fish tissue chemistry	Maintenance of fish health
	Condition (energy storage)		
	Survival (age)		
Fish Tissue	Fish tissue chemistry (small bodied fish, all metals; large bodied fish, mercury only)	Water chemistry Sediment chemistry	Maintenance of fish tissue metal concentrations that do not pose a risk to wildlife or human health

3.4 IMPACT HYPOTHESES

The pathways and stressors of the conceptual site model were identified and developed with consideration of the residual effects identified in the FEIS (Table 3.2-1), and the measurement and assessment endpoints (Table 3.3-1). From the FEIS, the main stressors and pathways of concern are summarized as follows:

- Construction
  - discharge from lake dewatering;
  - runoff from Project infrastructure (e.g., pad areas, laydown areas, roads, airstrip); and
  - aerial deposition from blasting and use of explosives.
- Operations
  - runoff from Project infrastructure (e.g., waste rock storage pad areas, laydown areas, roads, tailings storage facility, airstrip); and
  - aerial deposition from blasting and use of explosives.
- Closure
  - runoff from Project infrastructure (e.g., waste rock storage pad areas, laydown areas, roads, airstrip); and
  - aerial deposition from blasting and use of explosives.
- Post-Closure
  - runoff from Project infrastructure (e.g., waste rock storage pad areas, laydown areas, roads, airstrip); and
  - release of pit water to downstream environments.

Two impact hypotheses have been proposed to examine the pathway of effects, as follows:

- Toxicological Impairment Hypothesis - toxicity to aquatic organisms due to release of substances of toxicological concern; and
- Nutrient Enrichment Hypothesis – increased productivity from the release of nitrogen.

Data collected and analyzed through the AEMP will be used to assess these hypotheses.

4. Aquatic Effects Management Plan Overview

4.1 OUTLINE

The AEMP is designed to monitor for effects on the aquatic receiving environment and fulfill monitoring requirements of the MMER EEM program. The MMER EEM requirements are triggered when:

- cumulative daily effluent discharge rates exceed 50 cubic metres per day (m^3/d); and/or
- deleterious substances are discharged into any waterbody as per subsection 36(3) of the *Fisheries Act* (Government of Canada 1985).

Results of the AEMP will be evaluated annually and will be considered relative to the two impact hypotheses (Section 3.4; toxicological impairment and nutrient enrichment), key objectives (Section 4.2), and the adaptive management Response Framework (Section 6). Additional on-site water quality monitoring will occur (e.g., streams monitored as part of the Water Management Plan [SD-05]), which will not be considered directly within the AEMP. However, these additional monitoring programs will be aligned, where possible, with the AEMP monitoring, and results from the other monitoring programs may be used to aid in interpretation of the AEMP data.

4.2 KEY OBJECTIVES AND QUESTIONS

The impact hypotheses for the Project focus on toxicological impairment and nutrient enrichment. The hypotheses will be addressed through five objectives of the AEMP:

1. determine the short and long-term effects of the Project on the aquatic environment;
2. evaluate the accuracy of the Project effect predictions;
3. assess the effectiveness of proposed mitigation and management measures;
4. identify additional mitigation measures to avert or reduce environmental effects due to Project activities; and
5. comply with MMER requirements.

These objectives will be addressed within the AEMP by considering the following key questions (as appropriate):

- How do the data compare to benchmarks (e.g., water quality guidelines, water licence limits, AEMP benchmarks)?
- Are there changes in measurement endpoints in the exposure area relative to baseline conditions, and are the changes due to mining activities?
- Are trends in the exposure area data consistent with trends in the reference area?

4.3 STUDY DESIGN OVERVIEW

The core of the AEMP was designed to be consistent with the regulatory requirements of the MMER as specified in the EEM guidance (Environment Canada 2012) with respect to effluent characterization and water quality monitoring (i.e., annual program), and biological monitoring (i.e., surveys every three years for benthic invertebrates and fish). Additional monitoring is included where necessary to meet the needs of the Type A Water Licence and FEIS commitments (i.e., additional water quality and biological sampling).

Effluent characterization and water quality monitoring as proposed (Section 5) will meet the requirements of the MMER and the Type A Water Licence, but will also support the interpretation of biological data for the EEM study. Effluent characterization involves collection of effluent samples at the last point of control before discharge; these effluent samples are analyzed for concentrations of deleterious substances, other parameters, and tested for acute and chronic toxicity. Effluent results will be incorporated in the annual AEMP report to support interpretation of water, sediment, and biological data.

4.3.1 Sampling Areas

AEMP samples will be collected from exposure and reference areas with coordinated collection of water, sediments, and benthic invertebrates at key stations. Water quality monitoring involves collection of samples from exposure and reference areas which are analyzed for the same suite of parameters as in the effluent samples. Sediment and benthic samples are collected from the same exposure and reference areas as water quality samples. Fish will be collected from the exposure and reference areas from habitat appropriate to the sentinel species.

The exposure and reference areas are defined as follows:

- Reference Area
  - The reference area includes a waterbody with physical and chemical features similar to the exposure area. The waterbody has been identified as Reference B Lake (Table 4.3-1; Figure 4.3-1) and is considered a suitable reference area to support the statistical design of the AEMP.
    - Reference B Lake is approximately 15 km southeast of the Goose Property Area and is topographically and bathymetrically similar to Goose Lake and Propeller Lake.
    - Additional information on the suitability of Reference B Lake as a reference area was provided in response to information request 38 from the Kitikmeot Inuit Association during the FEIS stage.
  - For purposes of MMER, a reference area (for water and biological sampling) is a waterbody that is similar to the exposure area (Government of Canada 2002), and is a waterbody that can easily be sampled on a regular schedule. This also meets the needs of the AEMP and the Water Licence.
- Exposure Area
  - The exposure area includes those waterbodies downstream and adjacent to the Project infrastructure, including Goose Lake and Propeller Lake, and areas downstream of the discharge point (Table 4.3-1; Figure 4.3-1).

    - Goose Lake, adjacent to most of the Project infrastructure, is the closest receiving environment.
    - Propeller Lake is downstream of Goose Lake and is considered a far-field exposure area.

- For purposes of MMER, the exposure area (for water and biological sampling) is the area surrounding the point of entry of effluent from the final discharge point (Government of Canada 2002).
    - During the Construction Phase, Llama and Umwelt lakes will be dewatered with discharge directed to Goose Lake (upstream of "Goose Neck").
    - During the Operations and Closure phases, all site contact water will be stored on-site in the pits and ponds.
    - During the Post-Closure Phase (and after reclamation and filling of the pits), the pits will overflow, and there will be runoff from the reclaimed facilities (e.g., stockpiles) to the downstream receiving environment.
    - As stated previously, this version of the AEMP (and thus alignment with MMER) is focussed on the construction phase with dewatering discharge into Goose Lake.

A summary of sampling areas and locations are provided in Table 4.3-1.

Table 4.3-1. Overview of the Waterbodies and Sampling Areas Included in the Aquatic Effects Management Plan

Sampling Area	Waterbody	Waterbody Area	Sampling Location ID	Purpose	Description
Reference Area	Reference Lake	Lake	BRP-38	Comparison to the Exposure Area	Reference Lake B located approximately 15 km to the southeast of the Goose Property
		Outlet	BRP-39		
Exposure Area	Goose Lake	West Bay; Near-field Area	BRP-31	Potential exposure lake due to proximity to Project infrastructure and activities, including: water withdrawals, downstream of Llama/Umwelt area (waste rock storage areas, open pits, saline pond storage), downstream of Echo Pit and activities, downstream of Gander Pond area (airstrip, infrastructure), downstream of Tailings Storage Facility, Goose Main Pit, and overflow from Goose Main Pit in Post-Closure.	Large lake adjacent to Project activities; potential source of potable water. Receiving environment for Project runoff from WRSAs, saline pond, closed pits, and tailings facility
		Centre Basin; Mid-field Area A	BRP-32		
		Southeast Basin; Mid-field Area B	BRP-33		
		Outlet	BRP-34[1]		
	Propeller Lake	South Basin; Far-field Area A	BRP-35	Potential exposure lake due to location downstream of all Goose Property Area activities.	Large lake downstream of Goose Lake and catchments with the majority of Project activities.
		North Basin; Far-field Area B	BRP-36		
		Outlet	BRP-37[1]		

1) These locations are similar to the locations modelled in the Water Quality Model and can be used as compliance points.

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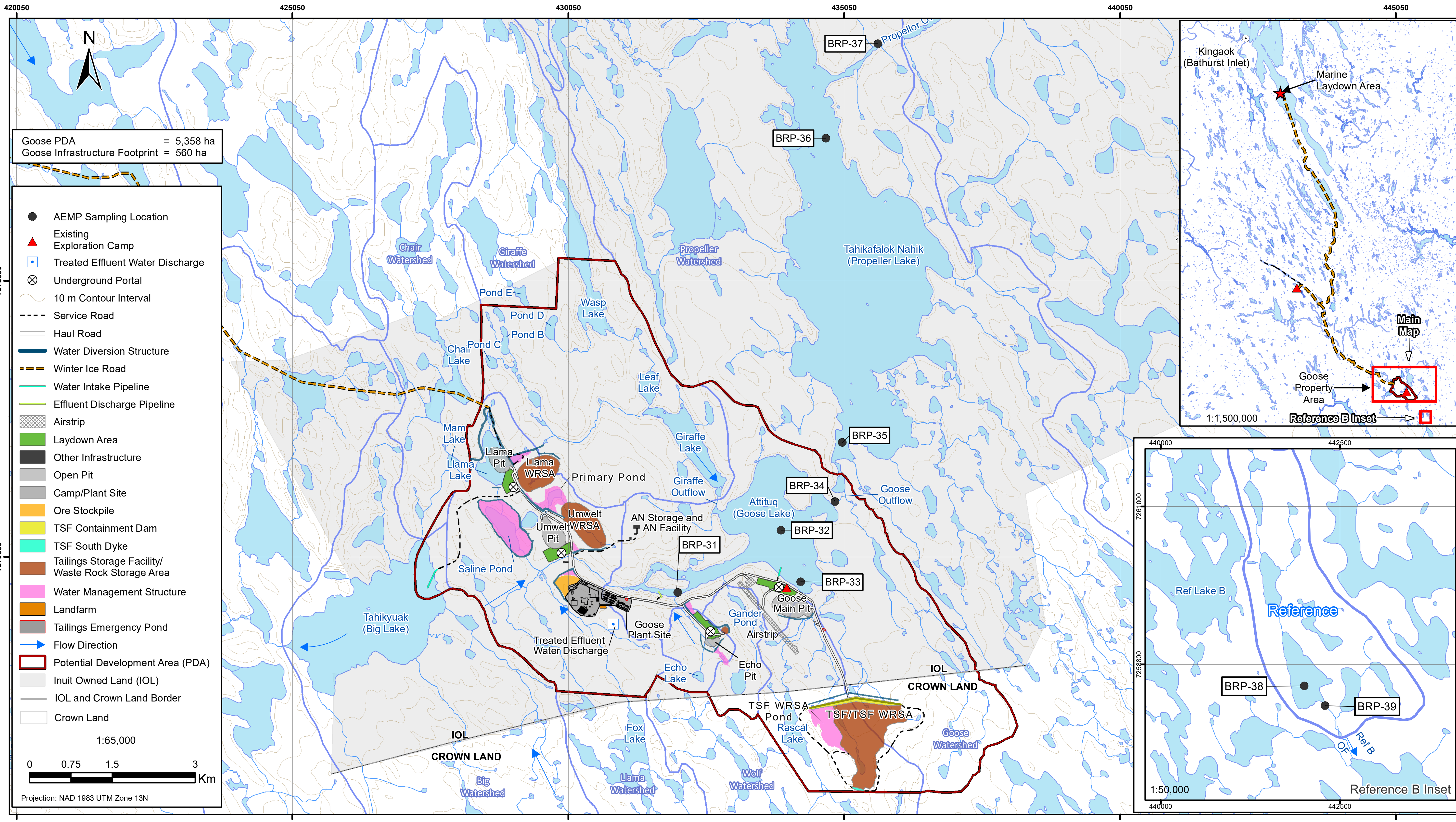

Figure 4.3-1

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Proposed AEMP Sampling Locations
Goose Property Area, Back River Project

4.3.2 Sampling Structure

From each of the lake sampling areas, five stations with similar features of water depth and substrate type will be sampled for water quality, sediment quality, and the benthic invertebrate community; from the lake outlet sampling areas, one station will be sampled for water quality (Table 4.3-2). Five stations per sampling area is consistent with Metal Mining Technical Guidance for EEM (Environment Canada 2012). The five stations (exact coordinates to be determined) will be located within a small area and separated by at least 20 m (Environment Canada 2012) such that the data will be representative of variability within one area.

At the lake stations, one to two water quality samples are proposed to be collected (Table 4.3-2); the number of samples at each lake station will depend upon the total water depth and the presence of stratification. If the depth of water is more than 4 m, and the water is stratified, discrete and independent top and bottom samples will be collected at each station (i.e., n=2 at each station). If the depth of water is less than 4 m, one sample from the middle of the water column will be collected at each station (i.e., n=1 at each station).

Fish will be monitored in the three lakes (i.e., Goose, Propeller, and Reference B), in habitat appropriate to the sentinel species (Slimy Sculpin [*Cottus cognatus*] and Lake Trout [*Salvelinus namaycush*]). Collection locations for all fish catches will be recorded to document fish metal collection by lake, location, and species. Slimy Sculpin will be collected from four areas: the near-field exposure area (Goose Lake), two far-field exposure areas (both in Propeller Lake), and a reference area (Reference Lake B). Lake Trout will be collected from three areas: the near-field exposure area (Goose Lake), one far-field exposure area (Propeller Lake), and a reference area (Reference Lake B).

4.3.3 Sampling Frequency

The current proposed program includes under-ice and open-water sampling for water quality (Table 4.3-3). As based on the Water Management Plan (SD-05) for the Project, the water quality monitoring schedule could be reduced in the near-field and reference areas to just open-water only during periods of time where there is no direct discharge to surface water (i.e., Operations to Closure phases). Sampling for the other components would only occur during open-water conditions.

The current proposed program frequency during the Construction Phase of development is every year for water quality, and every three years for sediment quality, benthic invertebrates, and fish (Table 4.3-4). The timing for collection of sediment quality, benthic invertebrates, and fish will be aligned with when MMER is triggered for this site and when the first EEM biological study is required. Since there will be no discharge during Operations (about 10 years) and Closure (about 8 years), the program frequency should be reconsidered for these future phases.

Overall, the proposed study design is intended to facilitate the characterization of spatial and temporal variation, as part of an AEMP designed to fulfil both EEM/MMER (as required) and AEMP requirements.

Table 4.3-2. Overview of the Aquatic Effects Management Plan Sampling Design by Component, Stations, and Samples per Station

Waterbody	Sampling Area	Sampling Location ID	Number of Stations[1]	Number of Samples per Station or Area per Sampling Event						
				Water Quality		Sediment Quality	Benthic Invertebrate Community	Fish Health		Fish Tissue
				Full Chemistry	Chlorophyll *a*			Slimy Sculpin (Lethal Survey)	Lake Trout (Non-lethal Survey)	
Reference lake	Lake	BRP-38	5[2]	1 to 2[3]	3	1	1	60 per area	100 per area	8 male and 8 female per species per area
	Outlet	BRP-39	1	3	-	-	-	-	-	-
Goose Lake	West Bay; Near-field Area	BRP-31	5[2]	1 to 2[3]	3	1	1	60 per area	100 per area	8 male and 8 female per species per area
	Centre Basin; Mid-field Area A	BRP-32	5[2]	1 to 2[3]	3	1	1	-	-	-
	Southeast Basin; Mid-field Area B	BRP-33	5[2]	1 to 2[3]	3	1	1	-	-	-
	Outlet	BRP-34	1	3	-	-	-	-	-	-
Propeller Lake	South Basin; Far-field Area A	BRP-35	5[2]	1 to 2[3]	3	1	1	60 per area	100 per area	8 male and 8 female per species per area
	North Basin; Far-field Area B	BRP-36	5[2]	1 to 2[3]	3	-	-	60 per area[4]	-	8 male and 8 female per species per area
	Outlet	BRP-37	1	3	-	-	-	-	-	-

Note: - area not sampled for monitoring component.
1) Number of stations applies to water quality, sediment quality, and benthic invertebrate community sampling only; fish will be sampled in the areas but from habitat appropriate to the sentinel species.
2) Environment Canada (2012)
3) If the depth of water is more than 4 m, and the water is stratified, discrete water samples will be collected from each of the top and bottom of the water column (n=2 samples/station). If the depth of water is less than 4 m, one sample from the middle of the water column will be collected (n=1 sample/station).
4) Added in response to Kitikmeot Inuit Association request for an additional Slimy Sculpin Sampling Area.

Table 4.3-3. Overview of the Aquatic Effects Management Plan Sampling Design by Component and Season

Waterbody	Sampling Area	Sampling Location ID	Sampling Season							
			Water Quality[2]		Sediment Quality	Benthic Invertebrate Community	Fish Health		Fish Tissue
			Full Chemistry	Chlorophyll a			Slimy Sculpin (Lethal Survey)	Lake Trout (Non-lethal Survey)	
Reference lake	Lake	BRP-38	Four times per year[1]	April, August	August	August	August	July	July, August
	Outlet	BRP-39	June, August	-	-	-	-	-	-
Goose Lake	West Bay; Near-field Area	BRP-31	Four times per year[1]	April, August	August	August	August	-	August
	Centre Basin; Mid-field Area A	BRP-32	April, August	April, August	August	August	-	July	July
	Southeast Basin; Mid-field Area B	BRP-33	April, August	April, August	August	August	-	-	-
	Outlet	BRP-34	June, August	-	-	-	-	-	-
Propeller Lake	South Basin; Far-field Area A	BRP-35	April, August	April, August	August	August	August	July	July, August
	North Basin; Far-field Area B	BRP-36	April, August	April, August	-	-	August	-	August
	Outlet	BRP-37	June, August	-	-	-	-	-	-

Note: - area not sampled for monitoring component.
1) The defined MMER reference and exposure stations to be sampled four times per year and not less than one month apart; therefore, these stations (or others to be determined) will be sampled more frequently than the other stations.
2) April sampling may be omitted during phases of the Project when there is no under-ice discharge or discharge during the previous open-water season.

Table 4.3-4. Aquatic Effects Management Plan Monitoring Program Frequency

Waterbody	Sampling Area	Sampling Location ID	Monitoring Component and Program Frequency[1]						
			Water Quality		Sediment Quality	Benthic Invertebrate Community	Fish Health		Fish Tissue (Slimy Sculpin and Lake Trout)
			Full Chemistry	Chlorophyll *a*			Slimy Sculpin (Lethal Survey)	Lake Trout (Non-lethal Survey)	
Reference lake	Lake	BRP-38	Annual	Annual	Every three years	Every three years	Every three years	Every three years	Every three years
	Outlet	BRP-39	Annual	-	-	-	-	-	-
Goose Lake	West Bay; Near-field Area	BRP-31	Annual	Annual	Every three years	Every three years	Every three years	Every three years	Every three years
	Centre Basin; Mid-field Area A	BRP-32	Annual	Annual	Every three years	Every three years	-	-	-
	Southeast Basin; Mid-field Area B	BRP-33	Annual	Annual	Every three years	Every three years	-	-	-
	Outlet	BRP-34	Annual	-	-	-	-	-	-
Propeller Lake	South Basin; Far-field Area A	BRP-35	Annual	Annual	Every three years	Every three years	Every three years	Every three years	Every three years
	North Basin; Far-field Area B	BRP-36	Annual	Annual	-	-	Every three years	-	Every three years
	Outlet	BRP-37	Annual	-	-	-	-	-	-

Note: - area not sampled for monitoring component.
1) Program frequency and sampling areas may be re-adjusted after the Construction Phase (i.e., during the phases where there is no discharge to Goose Lake).

4.4 INCORPORATION OF TRADITIONAL KNOWLEDGE/INUIT QAUJIMAJATUQANGIT

Traditional Knowledge (TK) can be defined as a "cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission" (NIRB 2007). Traditional Knowledge studies provide a valuable way of documenting spatial and temporal patterns of hunting, harvesting, fishing, habitation and travel in a given area. They can also provide detailed information on local ecological processes, socio-cultural patterns and institutions, spirituality, ethical, and other matters.

Sabina recognizes the inherent value of TK and the importance local communities place on its use in the environmental assessment of proposed developments. As such, Sabina has made significant efforts to engage local communities through incorporation of their TK into Project planning and design. Volume 3 of the FEIS describes Sabina's approach to TK and the methods used to collect and interpret it. Specific details as to how TK has been incorporated into these activities are summarized in Volume 3, Section 3.1, Table 3.1-1 "Uses of Traditional Knowledge in Sabina's Final Environmental Impact Statement for the Back River Project" of the FEIS, and are described in further detail in relevant volumes of the FEIS.

Sabina has utilized six primary sources of TK:

- a Naonaiyaotit Traditional Knowledge Project database report for the Project;
- theme-based TK workshops;
- a report on existing and publicly available Northwest Territories TK;
- the results of public consultation and engagement activities;
- a TK study on the Bernard Harbour Arctic Char fishery; and
- other sources.

Likewise, Inuit Qaujimajatuqangit values have helped guide Sabina's decision making for the Project and have been incorporated into the design of the Company's overall Project management approach. Sabina partnered with the KIA on two key elements of its TK work – preparation of the Naonaiyaotit Traditional Knowledge Project database report and execution of the theme-based TK workshops. The basis of this partnership was a TK Agreement signed between Sabina and the KIA in May 2012. Signing of this agreement provided Sabina with access to TK held by the KIA in the Naonaiyaotit Traditional Knowledge Project database. The agreement also outlines the terms and conditions pertaining to Sabina's use of the TK. Sabina and the KIA additionally cooperated in the collection and reporting of new (or otherwise unrecorded) TK in the Project area.

Traditional Knowledge and Inuit Qaujimajatuqangit collected through the FEIS process was considered in the development of the AEMP. For example, Lake Trout was identified as a preferred species (FEIS Volume 3, Section 3.1, Table 3.1-1) and this species has been carried forward as one of the sentinel species for use in the AEMP. Linkages between water quality and wildlife and fish are recognized by the Inuit, and thus monitoring for water quality, and detecting of changes to water quality, is a key component to the AEMP; water quality monitoring is considered an early warning to potential changes or effects to biological and human receptors. During future program revision and interpretation of results, TK and Inuit Qaujimajatuqangit will continue to be considered and integrated as appropriate.

5. AEMP Study Design Details

5.1 WATER QUALITY

5.1.1 Objectives

The water quality program for the Construction Phase was designed to meet the anticipated Type A Water Licence requirements, and the MMER effluent characterization and water quality monitoring requirements with objectives as follows:

- Evaluate the accuracy of the FEIS predictions and measure the effects of Project activities on water quality;
- Characterize and interpret water quality for the purpose of meeting Part 1, Section 7 of the MMER requirements (Government of Canada 2002);
- Characterize effluent quantity and quality to meet Part 1, Section 4 of the MMER requirements (Government of Canada 2002);
- Assess the efficacy of mitigation and management;
- Identify additional mitigation measures; and
- Provide input into the adaptive management process.

5.1.2 Study Design and Schedule

Effluent characterization samples will be collected from the discharge location at the last point of control. During the Construction Phase, there will be one discharge point to upstream of “Goose Neck” (Figure 4.3-1); discharge will be from the dewatering of Llama and Umwelt lakes. Future discharge locations (if any) will also be sampled in a similar manner. Samples will be collected weekly to multiple times per year as per the MMER schedule (i.e., weekly for deleterious samples, four times per year for detailed characterization, once per month for acute toxicity testing, and two times per year for sublethal toxicity testing). Toxicity Testing will be conducted using the methodologies detailed in the EEM Guidance document.

Water quality samples from the MMER exposure area and reference area stations will be collected four times per year, and not less than one month apart (Tables 4.3-2 to 4.3-4). Water quality samples from the remaining lake stations will be collected twice annually, once during ice-covered conditions (late April, when under-ice water quality may be most strongly affected by seasonal changes), and once during open-water conditions (August). The annual and seasonal sampling schedule may be reduced during other Project phases when there are no discharges to surface water.

Stream water quality samples will be collected twice per year between June and September, depending on the duration of ice-free conditions. The first annual samples will be collected one to two weeks after freshet, which often occurs in mid to late-June, with subsequent samples collected in August.

The study design for water quality sampling in the lakes considers the requirements of MMER while aligning with other components, when possible. The sampling effort (lakes and outlets) takes into account commitments made by Sabina, and is consistent with other monitoring programs in Nunavut and the Northwest Territories, and is reflective of discharge schedule for the Project, and sampling effort to provide appropriate statistical power.

5.1.3 Field Methods

Field measurements will be recorded when samples are collected. To support the effluent characterization samples, in situ measurements of specific conductivity, pH, and temperature will be recorded. At the lake stations, field profiles (measured every 1 m) of specific conductivity, pH, temperature, and dissolved oxygen will be recorded, along with measurements of total water depth, sample collection depth, ice thickness (in winter), and Secchi depth (in open-water). At the stream stations, measurements of specific conductivity, pH, temperature, and dissolved oxygen will be recorded, along with total water depth and sample collection depth. A multi-meter (e.g., YSI 6-Series Multimeter) will be used to record measurements of specific conductivity, pH, temperature, and dissolved oxygen.

In the lakes, water quality samples will be collected from specific sampling stations (coordinates still to be confirmed) from specific depths in the water column. If the water is stratified at a given station, separate and discrete samples will be collected from the top (i.e., 1 m below the surface) and the bottom (i.e., 1 m above the sediments). If the water is not stratified, a single sample will be collected from the middle of the water column. In the lake outlets (i.e., streams), water samples will be collected from within or as close as possible to the centre of the flow channel. Lake samples will be collected with a Kemmerer (or similar), while stream samples will be collected as surface grabs (with or without a sampling pole).

Samples will be collected in bottles provided by an accredited analytical laboratory. The suite of parameters to be analyzed in the samples (final effluent and receiving environment) is listed in Table 5.1-1. Water quality samples will be analyzed by an accredited laboratory at detection limits less than aquatic life and drinking water quality guidelines. The specific limits will be provided once the analytical laboratory has been selected.

Table 5.1-1. Water Quality Parameters

Group	Effluent Characterization	Receiving Environment
Field	Field pH, specific conductivity, and temperature	Field pH, specific conductivity, dissolved oxygen, and temperature, Secchi depth (open-water), total depth, ice thickness (winter)
Conventional Parameters	turbidity, conductivity, hardness, total alkalinity, total dissolved solids, total suspended solids	turbidity, conductivity, hardness, total alkalinity, total dissolved solids, total suspended solids
Major Ions	chloride, calcium, potassium, magnesium, sodium, sulphate, total alkalinity	chloride, calcium, potassium, magnesium, sodium, sulphate, total alkalinity
Cyanide	total cyanide, free cyanide, and weak acid dissociable cyanide	total cyanide, free cyanide, and weak acid dissociable cyanide
Nutrients	ammonia-nitrogen, total Kjeldahl nitrogen, nitrate-nitrogen, nitrite-nitrogen, total phosphorus, total dissolved phosphorus, dissolved organic carbon	ammonia-nitrogen, total Kjeldahl nitrogen, nitrate-nitrogen, nitrite-nitrogen, ortho-phosphate, total dissolved phosphorus, total phosphorus, dissolved organic carbon, and reactive silica.
Biological	-	chlorophyll *a*
Total and dissolved metals[1]	aluminum, antimony, arsenic, barium, beryllium, boron cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc.	aluminum, antimony, arsenic, barium, beryllium, boron cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc.
Other	Radium-226, acute toxicity, sub-lethal toxicity	Radium-226

1) The term metals as used includes non-metals (i.e., selenium) and metalloids (i.e., arsenic).

5.1.4 Data Analysis and Interpretation

Effluent Characterization

Samples collected for effluent characterization will be analyzed to determine annual trends in concentrations and loads, and to compare against the MMER limits for deleterious substances. Results of the acute and sublethal toxicity tests will be evaluated for toxicity response and growth and development effects.

Lakes and Streams

Samples collected from the lakes and streams will be compared to aquatic life guidelines (CCME 1999), drinking water quality guidelines (Health Canada 2014), and the site-specific water quality objective for arsenic (Golder 2016; MAD Appendix E-1), and analyzed for spatial and temporal trends to determine 1) if parameters are increasing over time, 2) if parameters are increasing above guidelines, and 3) if there are differences between the exposure and reference areas. Where guidelines are not available, data will be compared to baseline data and reference area data. If necessary, site-specific guidelines will be developed.

Results will be analyzed and compared to benchmarks (e.g., guidelines, 75th percentile of a guideline, 90th percentile of baseline statistic) developed for the Project (to be developed).

Descriptive summary statistics will be reported for all collected water quality parameters. Quantitative (i.e., statistical) and qualitative (i.e., visual) methods will be used to evaluate potential differences in water quality between reference and exposure areas. All statistical assumptions will be considered and met before accepting the results of statistical inference.

5.1.5 Quality Assurance and Quality Control

Samples will be collected following standard sampling protocol (e.g., see the Quality Assurance and Quality Control Plan; SD-24) by qualified personnel using suitable sampling equipment. Samples for laboratory analysis will be filtered and preserved (as required), and stored in a cool environment before shipping to the laboratory. Quality control samples (i.e., duplicates and blanks) will comprise 10% of all samples collected.

5.2 SEDIMENT QUALITY

5.2.1 Objectives

The sediment quality program for the Construction Phase was designed to meet the Type A Water Licence requirements and the EEM sediment quality monitoring requirements. The sediment quality program objectives are the same as those defined for water quality, with the following modification:

- Collect sediment quality as supporting data for the benthic invertebrate and water quality components for the purpose of meeting Schedule 5, Part 2, Section 11 of the MMER requirements (Government of Canada 2002); and
- Evaluate the accuracy of the FEIS predictions and measure the effects of Project activities on sediment quality.

5.2.2 Study Design and Schedule

The study design for monitoring sediment quality considers the requirements of MMER/EEM, while aligning with the sampling of other components, when possible. Sediment quality samples will be collected in conjunction with the benthic invertebrate surveys to measure Project effects on freshwater sediments, and by extension on the benthic invertebrate community and fish habitat. Sediment quality samples will measure the total organic carbon concentration and particle size distribution at each site, to provide contextual information for the benthic invertebrate community analysis as per the EEM guidance documents, as well as sediment metal concentrations. The sampling effort is consistent with other comparable monitoring programs in Nunavut and the Northwest Territories, and discharge for the Project, with sampling effort sufficient to provide appropriate statistical power for monitoring mine-related effects.

5.2.3 Field Methods

Sampling will be conducted along with the benthic invertebrate program and in coordination, when possible, with the water quality program. Surficial sediment grabs will be collected with an Ekman sampler. The upper two to five centimetres of the centre portion of the grab, will be targeted. At each station, up to three grabs will be collected and the material combined to form a composite sample.

Samples will be collected in containers provided by an accredited analytical laboratory. The suite of parameters to be analyzed in the samples is listed in Table 5.2-1. Sediment quality samples will be analyzed by an accredited laboratory at detection limits less than aquatic life guidelines. The specific limits will be provided once the analytical laboratory has been selected.

Supporting environmental information of field profiles (pH, temperature, dissolved oxygen, conductivity), total water depth, and sediment characteristics will also be collected.

Table 5.2-1. Sediment Quality Parameters

Group	Parameters
Particle Size and Carbon Content	gravel, sand, silt, clay
Nutrients	total organic carbon
Metals[1]	aluminum, antimony, arsenic, beryllium, boron cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc

1) The term metals as used includes metalloids (i.e., arsenic).

5.2.4 Data Analysis and Interpretation

Sediment results will be compared to aquatic life guidelines and analyzed for spatial and temporal trends to determine if parameters are increasing over time, if parameters are increasing above guidelines, and if there are differences between the exposure and reference areas.

Descriptive summary statistics will be reported for all collected sediment quality parameters. Quantitative (i.e., statistical) and qualitative (i.e., visual) methods will be used to evaluate potential differences in sediment quality between reference and exposure areas. All statistical assumptions will be considered and met before accepting the results of statistical inference. Where guidelines are not available, data will be compared to baseline data and reference area data; if necessary, site-specific guidelines will be developed.

5.2.5 Quality Assurance and Quality Control

Samples will be collected following standard sampling protocol (e.g., see the Quality Assurance and Quality Control Plan; SD-24) by qualified personnel using suitable sampling equipment. Samples for laboratory analysis will be stored in a cool environment before shipping to the laboratory. Quality control samples (i.e., duplicates) will be collected at a quantity of 10% of all samples collected.

5.3 BENTHIC INVERTEBRATE COMMUNITY

5.3.1 Objectives

The benthic invertebrate community program for the Construction Phase was designed to meet the Type A Water Licence requirements and the EEM requirements. The benthic invertebrate community program objectives are the same as those defined for water and sediment quality, with the following modification:

- Meet the requirements of Schedule 5, Part 2, Section 9 of the MMER requirements (Government of Canada 2002); and
- Evaluate the accuracy of the FEIS predictions and measure the effects of Project activities on benthic invertebrate communities.

5.3.2 Study Design and Schedule

Benthic invertebrate samples will be collected in conjunction with the sediment quality surveys to measure Project effects on the freshwater the benthic invertebrate community and fish habitat.

Sediment quality samples will measure the total organic carbon concentration and particle size distribution at each site, to provide contextual information for the benthic invertebrate community analysis as per the EEM guidance documents, as well as sediment total metal concentrations.

The study design for monitoring benthic invertebrates considers the requirements of MMER/EEM, while aligning with other components sampling schedule, when possible. The sampling effort for the proposed benthic invertebrate community study design is consistent with other comparable monitoring programs in Nunavut and the Northwest Territories, and discharge for the Project, with sampling effort sufficient to provide appropriate statistical power for monitoring mine-related effects.

Benthic invertebrate samples will be collected within a standard depth range and comparable substrate type at the sampling stations by qualified personnel. For a given year, five replicate stations will be sampled within each of the six sampling areas (total of 30 stations), with one composite sample taken at each station.

5.3.3 Field Methods

Benthic invertebrate samples will be collected within a standard depth range and comparable substrate type at all sampling stations. A standard Ekman grab will be used to collect grab samples from a boat anchored at each sampling station. Each replicate will be a composite sample collected from three grab samples. The composited samples will be sieved through a 500 μm mesh screen, and material retained in the mesh will be placed into a single pre-labelled container, thus creating a single composite sample for each station. Samples will be preserved in 10% neutral buffered formalin.

Sediment samples for chemistry (e.g., metals, nutrients, and carbon content) and particle size distribution will be collected as described in Section 5.2 at the same time, along with supporting environmental information of field profiles (pH, temperature, dissolved oxygen, conductivity), total water depth, sediment characteristics, and benthic sample-related information.

Benthic invertebrate samples will be shipped to a qualified taxonomist for processing, enumeration, and identification to the lowest taxonomic level, typically genus, using recognized taxonomic keys. The samples will be processed according to the standard methods in the Metal Mining Technical Guidance document (Environment Canada 2012), and a reference collection will be produced.

5.3.4 Data Analysis and Interpretation

From the taxonomic analysis of the benthic invertebrate community, the following benthic invertebrate effect endpoints will be calculated and used to evaluate whether changes in the benthic invertebrate community have occurred:

- Total organism density (as organisms per m^2);
- Taxonomic richness as total richness;
- Simpson's diversity and evenness indices;
- Relative invertebrate abundance by major taxonomic group as a percentage of total abundance;
- Densities of dominant taxa: defined as those taxa accounting for more than 5% of the total invertebrates across all stations; and
- Bray-Curtis Index.

Benthic invertebrate endpoints (bullet points above) will be evaluated using statistical (quantitative) and visual (qualitative) methods to evaluate potential differences in benthic community structure between areas. Appropriate statistical analyses will be conducted to evaluate potential differences between the near-field, mid-field, far-field, and reference areas.

If a significant difference between reference and exposure areas is identified then it will be evaluated to determine whether the observed change in the benthic community is within FEIS predictions. The findings of the benthic invertebrate data analysis will be further interpreted in light of results of other monitoring components, such as changes in water and sediment quality.

5.3.5 Quality Assurance and Quality Control

Samples will be collected following standard sampling protocol by qualified personnel using appropriate sampling equipment. Samples will be analyzed by qualified taxonomists using techniques consistent with the Metal Mining Technical Guidance for EEM (Environment Canada 2012) to assess sample sorting efficiency and assessment subsampling procedures should subsampling be required. Ten percent of the samples will be re-sorted. Benthic invertebrate samples will be stored for six years following analysis and a reference collection will be compiled. Data quality will be verified by screening for potential data entry errors.

5.4 FISH

5.4.1 Objectives

The fish program for the Construction Phase includes a fish health program on two target species (Slimy Sculpin and Lake Trout) and a fish tissue chemistry program on one target species (Slimy Sculpin). The programs were designed to meet the EEM requirements (Government of Canada 2002), and the Type A Water Licence requirements, with specific objectives related to fish as follows:

- o Meet the requirements of Schedule 5, Part 2, Section 9 of the MMER regarding a study respecting fish population and fish tissue (Government of Canada 2002), specifically:
  - Conduct the fish tissue study if the trigger is met;
  - Determine whether the Project has an effect on the growth, reproduction, survival or condition of fish; and
  - Determine whether the Project has an effect on metal concentrations in fish tissue.
- o Evaluate the accuracy of the FEIS predictions and measure the effects of Project activities on fish.

5.4.2 Study Design and Schedule

Biological sampling to assess fish health and fish tissue will employ a lethal and a non-lethal fish health survey at the exposure (i.e., Goose Lake and two areas in Propeller Lake) and reference (i.e., Reference B Lake) lakes. The fish health survey will focus on two fish species, as per EEM guidance (Environment Canada 2012). The lethal survey will target Slimy Sculpin, and the non-lethal survey will target Lake Trout.

Slimy Sculpin are small-bodied, relatively short-lived fish that occupy small home-ranges and, therefore, reflect local conditions. The lethal fish health survey will target 20 mature male, 20 mature female, and 20 juvenile Slimy Sculpin from each site, as per EEM guidance (Environment Canada 2012). A total of four areas among the three study lakes will be sampled, including one area in Goose Lake, two areas in Propeller Lake, and one area in Reference B Lake (Table 4.3-4). Whole-body Slimy Sculpin samples will be submitted for fish tissue chemistry analyses; a total of eight adult male and eight adult female samples will be submitted. The fish health and fish tissue chemistry survey will target Slimy Sculpin in the fall (i.e., August), as they begin to develop their gonads for spawning the following spring.

Lake Trout are susceptible to long-term population level effects from lethal sampling, therefore a non-lethal sampling program is proposed. A minimum target sample size of 100 Lake Trout (juvenile and adult) is proposed for each site, in line with EEM guidance (Environment Canada 2012). Non-lethal fish tissue chemistry plug samples will be collected from a subsample (eight adult males and eight adult females) of the fish for fish tissue chemistry analyses for mercury only. The non-lethal fish health survey will target Lake Trout in the spring (i.e., July), as they are most active in the spring and target sample sizes can be best achieved at this time.

The sampling effort for the proposed fish health and fish tissue study design is consistent with other comparable monitoring programs in Nunavut and the Northwest Territories, and discharge for the Project, with sampling effort sufficient to provide appropriate statistical power (e.g., 80%) for monitoring mine-related effects.

5.4.3 Field Methods

Fish collections will be completed using angling, gillnets, beach seines, and backpack electrofishing as fishing methods. Sampling locations will be determined by the presence of appropriate habitat. As much as is reasonably possible, the same amount of effort will be expended using each fishing method within each lake to minimize any possible sampling bias among lakes.

Whole-body Slimy Sculpin and non-lethal tissue plug Lake Trout samples will be submitted for tissue chemistry analysis. If individual Slimy Sculpin fish do not meet minimum sample size requirements for routine tissue chemistry analysis (i.e., 5 grams [g] wet weight [ww]), then samples will be submitted for low-volume microanalysis (i.e., minimum sample volume 0.5 g ww). If Slimy Sculpin samples do not meet either the routine or microanalysis volume requirements, then fish will be combined with others of similar size and same sex (i.e., male only and female only) to create composite samples which meet minimum sample volume requirements. Non-lethal sampling using tissue plugs (Baker et al. 2004) will be employed for Lake Trout.

Fish tissue chemistry samples will be submitted to an appropriate laboratory for analyses of mercury, metals, and major ions listed in Table 5.4-1.

Table 5.4-1. Fish Tissue Parameters

Group	Parameters
Physical parameter	% Moisture
Major Ions and Nutrients	calcium, magnesium, phosphorus, potassium, sodium
Metals[1]	aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, cesium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, rubidium, selenium, silver, strontium, tellurium, thallium, tin, titanium, uranium, vanadium, zinc, and zirconium

1) The term metals as used includes metalloids (i.e., arsenic).

Slimy Sculpin aging structures (i.e., otoliths) and gonads will be submitted for aging and histology analysis, for determination of age and confirmation of sex and reproductive status. Non-lethal Lake Trout aging structures (i.e., pelvic fin rays and scales) will also be submitted for age determination.

5.4.4 Data Analysis and Interpretation

The measurement endpoints of survival, growth, reproduction, and condition will be assessed by collecting fish health data from Slimy Sculpin at the exposure and reference areas every three years, and comparing biological variables (e.g., age, size, organ weights) among sites and over time to monitor for changes in fish health during the life of the Project. Lethal sampling of Slimy Sculpin for the fish health program will include measurement and assessment of the biological variables and effects endpoints listed in Table 5.4-2, and the non-lethal sampling of Lake Trout will include a subset of the variables and effects endpoints.

For fish tissue, an effect on fish usability is defined as total mercury concentrations that exceed 0.5 mg/kg ww as measured in an exposure area, and that are statistically different and greater than mercury concentrations measured from a reference area (Government of Canada 2002). Effects endpoints will be considered statistically different between reference and exposure sites at $\alpha = 0.1$, and target sample sizes of eight fish per group are expected to achieve sufficient power (i.e., >0.8). Sample sizes and achieved power will be re-assessed as part of the regular reporting requirements.

Descriptive summary statistics will be reported for all effect endpoints and tissue chemistry parameters. Fish data will be divided by sex, state of maturity (i.e., male and female fish will be analyzed separately, and immature fish will not be included), and presence or absence of parasites. This is necessary due to different energetic requirements associated with reproduction, which result in differences in growth patterns and subsequent differences in growth rate, body weight, gonad size, and liver size (Environment Canada 2012). Parasitism will also be considered due to the influence some parasites, especially tapeworms, can have on nutrient uptake and energy availability for reproduction and growth.

Table 5.4-2. Fish Biological Variables and Effects Endpoints

Biological Variables	Effects Endpoints	Lake Trout	Slimy Sculpin
Age	Age	X	X
Size (length and weight)	Condition (body weight against length)	X	X
Size at age	body weight against age	X	X
Liver weight	Relative liver size	-	X
	liver weight against body weight		
Gonad weight	Relative gonad size	-	X
	gonad weight against body weight		
Fecundity (egg number and weight)	Relative fecundity	-	X
	(# of eggs/female against body weight)		
	Relative egg size (mean egg weight against body weight [or age])	-	X
Stomach fullness	Food availability	-	X
DELT (deformities, eroded fins, lesions, and tumours)	-	X	X

Note: - = not applicable; x = data will be collected

Once data are sub-divided based on sex and state-of-maturity and, if applicable, parasitism status, but prior to further statistical analyses, data will be tested for normality and homogeneity of variances and screened for potential outliers. All data will be $\log_{10}$ transformed prior to screening the data for outliers and completing the statistical analyses. This will be done because the majority of biological data do not satisfy the statistical requirements of normality and homogeneity of variance unless log transformed. The transformed data will be screened for potential outliers by visual examination of box and whisker plots and linear regression plots. Studentized residuals (SR) from the linear regression analyses will be used as an additional screening tool. Observations that are more than three standard deviations (i.e., $SR>|3|$) from the mean will be checked and validity confirmed; data points will only be removed if warranted. Any outliers that will be removed will be identified, the reasons for removal (e.g., transcription error, analytical error) will be described, and the screening will be re-run (i.e., box plots, linear regression).

An analysis of variance will be used to test for statistical differences between the exposure and reference sites for fish age and size (i.e., length and weight), and tissue chemistry concentrations. The remaining effects endpoints, except diet and DELT, will be analyzed for statistical differences and interactions between the exposure and reference sites using Analysis of Covariance (ANCOVA). Fish tissue chemistry mercury concentrations will also be analyzed by ANCOVA. Potential differences in DELT characteristics between exposure and reference sites will be compared using the Chi Square (X^2) test.

5.4.5 Quality Assurance and Quality Control

Samples will be collected following standard sampling procedures by qualified personnel using suitable sampling equipment. Data quality will be screened for entry errors and will be checked for outliers using boxplots and regression plots. Data entry errors will be corrected, while outliers may be removed to avoid strong leverage. If there is no clear explanation for an outlier, analysis will be conducted in the presence and in the absence of the outlier(s) to determine the magnitude of influence it has on the conclusions, as per EEM guidance (Environment Canada 2012).

Fish samples (e.g., fish tissue chemistry) will be analyzed by an accredited laboratory with trained staff. Analyses will be conducted by recognized protocols and methods with properly calibrated and maintained instrumentation.

5.4.6 Fish and Fish Habitat Protection from Blasting

All Project activities requiring the use of explosives in or near water bodies will adhere to the *Guidelines for Use of Explosives In or Near Canadian Fisheries Waters*, as directed by DFO (Wright and Hopky 1998). The blasting management plan will be discussed with DFO prior to any blasting activities, and subject to adaptive management.

6. Response Framework and Corrective Action

6.1 INTRODUCTION

A Response Framework within an AEMP links the interpretation of monitoring results to management actions, with the intent of meeting the FEIS assessment predictions and maintaining the assessment endpoints (e.g., suitability of water to support an aquatic ecosystem, Table 3.3-1). The Response Framework follows a systematic approach of evaluation and interpretation of results, and implementation of follow-up action (e.g., confirmation of results, further study) or mitigation at pre-defined levels of change (i.e., Action Levels) to reduce or reverse unacceptable or unexpected effects and prevent a significant adverse effect.

This Response Framework was developed with guidance from the Draft Guidelines for Adaptive Management – a Response Framework for Aquatic Effects Monitoring (WLWB 2010).

6.2 APPROACH

Action Levels (i.e., Low, Moderate, and High) will be used within the Response Framework to determine if follow-up action is required to manage and reverse any detected changes in the aquatic environment. If a Low Action Level has been reached for one or more AEMP component measurement endpoints, for one or both of the impact hypotheses, a management response action will be initiated. Specific terms used in the Response Framework include: Benchmarks, Action Levels, and Significance Threshold, and are defined as follows:

- Benchmark
  - For purposes of the AEMP, a benchmark is a generic term used to refer to a set of numerical standards that are appropriate for the Project and are used for screening of monitoring results. Benchmarks may be derived from generic aquatic life guidelines, generic drinking water guidelines, site-specific water quality guidelines, or baseline concentrations. Benchmarks are set at a level to be protective of aquatic life or drinking water quality.
- Action Levels
  - Action Levels (Low, Moderate, and High) are pre-defined levels of environmental change, often but not exclusively linked to benchmarks, results of statistical tests, or a combination of the two. Exceedance of an Action Level may trigger follow-up management actions or responses. Low Action Levels are still to be developed, and will be set for each monitoring component for each of the two hypotheses. The Low Action Levels will be set through evaluation and consideration of baseline data and regulatory guidelines, and anticipated Project influence. Setting of the Low Action Levels can have large management and operational implications, thus setting of the Low Action Levels, if they are to be based on statistics of baseline data or regulatory guidelines, requires appropriate and detailed evaluation following collection of sufficient data to quantify natural variability in the system. As per the WLWB (2010) guidance document, Low Action Levels will be set initially, followed by setting of Moderate and High Action Levels should a Low Action response be triggered.

- o Significance Threshold
  - – The Significance Threshold is a level of change that would result in a significant adverse effects to assessment endpoints (e.g., water quality has changed such that a healthy aquatic ecosystem cannot be supported). This is considered an unacceptable level of change. The Significance Thresholds focus on the key values of the environment that are to be protected.

If a change in the monitoring data is detected that exceeds a Low Action Level, the type of action taken will depend upon the type of effect observed. Examples of actions are provided in Table 6.2-1.

Table 6.2-1. Examples of Action Levels and Responses

Action Level	Example of Action Level to Support the Impact Hypotheses	Example of Action Level Response
Low	difference between reference and exposure areas, and/or from baseline conditions, but below an applicable benchmark[a] increasing trend toward conditions outside of baseline or normal range, or toward a benchmark	Confirm AEMP best practices were used
		Confirm that the Low Action Level trigger was appropriate
		Compare to FEIS predictions
		Investigate further to identify contributing factors from the Mine
		Examine ecological relevance
		Identify potential mitigation options
		Increase monitoring (frequency or locations)
		Set Moderate and High Action Levels
Moderate	significant difference between reference and exposure areas, and/or from baseline conditions, and benchmark exceeded consistently increasing trend approaching benchmark exceedance	Confirm AEMP best practices were used
		Confirm that the Moderate Action Level trigger was appropriate
		Compare to FEIS predictions
		Investigate further to identify contributing factors from the Mine
		Examine ecological relevance and implications (e.g., conduct a risk assessment)
		Implement mitigation and examine effectiveness of mitigation
		Increase monitoring (frequency or locations)
High	benchmarks consistently exceeded, and/or effect is above predictions but below the Significance Threshold[b]	Confirm AEMP best practices were used
		Confirm that the High Action Level trigger was appropriate
		Compare to FEIS predictions
		Identify and implement improved mitigation to reverse trend
		Remediate

(a) A benchmark is a standard (e.g., guideline, site-specific water quality objective) used in the screening of results; benchmarks are specific to a Project.
(b) A significance threshold is considered a level of unacceptable change and is linked to the assessment endpoints (Table 3.3-1).

6.3 ACTION LEVELS AND SIGNIFICANCE THRESHOLDS

The mine has the potential to result in toxicological impairment (hypothesis 1) and nutrient enrichment (hypothesis 2). Action Levels will be developed for all monitoring components for both hypotheses. Action levels will not be developed for end of pipe effluent data. Rather the end of pipe results will be compared to the MMER and water licence limits, and results of the acute and chronic toxicity tests will be used to evaluate potential constituents of concern for analysis of the receiving environment data. Low Action Levels are the first to be developed, but only after sufficient review of the existing data such that appropriate quantitative metrics are identified. For example, if a waterbody has naturally elevated concentrations of a metal above the generic water quality guidelines, it would be inappropriate to set the action level for that parameter equal to the generic guideline (or other to be determined ecologically relevant benchmark). Further work will be completed to identify appropriate guidelines or benchmarks, but it is anticipated the Response Framework for the Action Levels will be similar to those in Table 6.3-1. Where guidelines are not available, data will be compared to baseline data and reference area data; if necessary, site-specific guidelines will be developed. The definition of Normal Range will be provided for each measurement endpoint, and is generally considered to be the range of natural variability observed in a measurement endpoint, and may include a temporal and spatial component.

Table 6.3-1. Proposed Action Levels for Toxicological Impairment and Nutrient Enrichment Hypotheses

Action Level	Water Quality		Benthic Community	Fish Health	
	Aquatic Life	Human Consumption[(a)]		Aquatic Life	Human Consumption[(a)]
Low	Concentration in exposure area greater than normal range[(b)], supported by temporal trend AND Concentration exceeds a defined percentage of AEMP benchmark[(c)] AND Deviation of trends in concentrations compared to reference areas	Drinking water parameters in exposure area above a defined percentage of a drinking water quality benchmark[(c)]	Decline in exposure area below the normal range in total density, richness, or densities of dominant taxa AND Deviation of trends in total density, richness, or densities of dominant taxa compared to reference areas	Statistically significant difference in fish health endpoints[(d)] or fish tissue chemistry that are beyond the normal range AND Change is in direction and of magnitude that is indicative of an impairment to fish health	Metals in edible fish tissue above normal range
Moderate	TBD[(e)]	TBD[(e)]	TBD[(e)]	TBD[(e)]	TBD[(e)]
High	TBD[(e)]	TBD[(e)]	TBD[(e)]	TBD[(e)]	TBD[(e)]

(a) Applies to the toxicological impairment hypothesis but not the nutrient enrichment hypothesis
(b) Normal range is to be developed for key variables assessed by each monitoring component
(c) Benchmark and percentage of benchmark used in the AEMP to be developed
(d) Key fish health endpoints are condition, relative gonad size, and relative liver size
(e) TBD – to be determined if a Low Action Level is reached.

6.4 PLAN EFFECTIVENESS

The Plan is intended to verify that the Project monitoring is conducted as proposed, mitigation and management measures are effective at mitigating adverse effects on the freshwater receiving environment, and relevant laws and regulations are met. As part of environmental reporting, Sabina will distribute copies of the annual AEMP report to stakeholders to report on mitigation, management and monitoring activities. Sabina may also conduct annual (or as necessary) evaluations of the efficacy of mitigation and management activities and of monitoring activities using relevant methods, such as power analyses or time series analyses. Should new, more sensitive, monitoring methods be introduced, or existing methods be found to lack statistical power or a robust design, updated methods will be proposed. This plan will be updated as required.

7. Environmental Reporting

7.1 ANNUAL AEMP REPORT

An AEMP report on the status of the aquatic environment and detailing any observed trends will be prepared. Reporting of environmental monitoring will include documentation of data collection methodology and data management. The reporting process is an important component of adaptive management, and will serve to track developments in mitigation measures to minimize Project effects on the aquatic environment.

Reporting of all environmental monitoring data will be conducted in accordance with Regulatory requirements and will include annual reports. The annual AEMP report will include the following:

- A summary of Project activities during the monitoring interval;
- A summary of the QA/QC monitoring data obtained during the most recent reporting period;
- Description of the methods used for sample and data collection;
- Detailed evaluation of effects on the designated monitored parameters;
- Results from the evaluation of effects, in text and figures;
- Conclusions from the evaluation of effects; and
- Recommendations (e.g., additional sampling or analysis, adaptive management).

Standardized formats will be used for the annual reports.

7.2 REPORTS UNDER MMER

The AEMP will conform to the reporting requirements of MMER in addition to the annual AEMP report. As a condition of MMER, an initial study design will be submitted to an authorization officer with 12 months of the trigger and six months before biological monitoring is initiated (Schedule 5, s. 14(a) and 15; Government of Canada 2002). This report will contain:

- Site characterization;
- A detailed description of the study to collect data on fish health, fish tissue chemistry, benthic invertebrate community, and supporting environmental data;
- The sampling schedule; and
- A description of the quality assurance and quality control measures for the EEM program.

The first interpretative report will be submitted within 30 months after the mine becomes subject to MMER. The first Cycle 1 interpretative report would follow the Study Design Report, and would occur during any phase where discharge occurs. The interpretative report will contain:

- Documentation and description of sampling areas;
- Schedule of sample collection;
- Sample design, including sample sizes;
- Results of data assessment with appropriate statistical analyses and all supporting raw data;

- Identification of any biological effects;
- Comparison of any effects with results from sublethal toxicity testing (from effluent characterization);
- Conclusions of biological monitoring and water quality studies, taking into account any other potential factors not related to the effluent (anthropogenic or natural), and a description of quality assurance and control measures that were implemented;
- Description of how future study design for monitoring will be affected by the results; and
- Date when the next biological EEM cycle will commence.

8. References

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