MARY RIVER PROJECT

MMER
ENVIRONMENTAL EFFECTS MONITORING
STUDY DESIGN FRAMEWORK

Volume 10
Appendix 10D-14

Prepared For:
Baffinland Iron Mines Corporation

Prepared By:
Sikumiut Environmental Management Ltd.
And
Knight Piesold Consultants

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1.0 Introduction

This document describes a study design framework for an Aquatic Effects Monitoring Plan (AEMP) for the Mary River Project. The study design will address Environment Canada requirements under the Metal Mining Effluent Regulations (MMER). This document has been jointly prepared by Knight Piesold Consulting and Sikumiut Environmental Management Ltd. and is provided for information and inclusion in the Mary River Project Environmental Impact Statement.

2.0 Metal mining Effluent Regulations Requirements

The Metal Mining Effluent Regulations (MMER), promulgated in 2002 under the *Fisheries Act*, require metal mines to undertake environmental effects monitoring (EEM) to ensure the adequate protection of all receiving aquatic environments. The MMER apply to all "mines", "mines under development", or "recognized closed mines" that:

- Discharge an effluent containing deleterious substances with a flow rate that exceeds 50 m^3 / day, based on effluent deposited from the final discharge points (including seeps) of the mine; and
- Deposit a deleterious substance in such a way that it enters or can enter any water that is frequented by fish.

The MMER stipulates a number of conditions under which a mine may release effluent into the environment. The conditions include the requirement for:

- Effluent Monitoring Studies to monitor effluent for pH deleterious substances and acute lethality (Sections 12 to 18); and
- Environmental Effects Monitoring (EEM) studies.

The EEM studies are specified in Schedule 5 of the Regulations and are designed to monitor the potential effects of effluent on the receiving environment, i.e., on fish populations, on fish tissue and on the benthic invertebrates community.

Table 1 presents an overview of the MMER monitoring requirements. The regulations are prescriptive regarding the Effluent Monitoring Studies and stipulate specific analytical tests, parameters and frequency of sampling of the effluent. In addition to periodic sampling of the effluent at the final discharge points for pH and the deleterious substances listed in Schedule 4 of the regulations, bioassay tests are also required. These include acute lethality testing (as specified in Reference Method EPS1/RM/13) and Daphnia magna monitoring (see Reference Method EPS 1/RM/14).

The EEM, on the other hand, is focused on the receiving environment and the determination of whether there are any detrimental effects on water quality, fish populations, fish tissue, or the benthic invertebrate community. These biological environmental effects monitoring studies are project specific, and as such the study designs are approved by Environment Canada.

Table 1 MMER Environmental Monitoring Requirements

Monitoring Type	Sampling Medium	Test/ Study	Frequency
Effluent Monitoring	Final Discharge Points	Deleterious Substances	Weekly
		pH	Weekly
		Acute Lethality Testing	Monthly
		Daphnia magna Testing	Monthly
EEM	Receiving Waterbody	Effluent characterization	4 times a year
		Water quality	4 times a year
		Sub-lethal toxicity testing	2 times a year
	Final Discharge Point and Reference Sites	Biological Studies	As per Study Design
		Site Characterization	
		Study Design	
		Fish Population studies*	
		Fish Tissue (metals)**	
		Benthic Invertebrates	

* Required If the concentration of effluent is > 1 %, 250 m from the final discharge point

** Required if the concentration of total mercury in effluent is less than 0.10 µg/L in 12 consecutive samples

The EEM consist of effluent, water quality, and biological monitoring. Effluent is monitored for chemistry, discharge rate and sub-lethal toxicity. Water quality monitoring of the receiving environment includes chemistry and flow rate, and is intended to provide supporting information for the biological monitoring program. Biological monitoring is conducted to identify any effects on biota while the mine is discharging.

Prior to initiation of the EEM and within 12 months of the mine beginning operation, a Study Design report, which includes a descriptive site characterization and study plan, is required to be submitted to Environment Canada for review and approval. The first biological monitoring will commence not sooner than 6 months following submission of the Study Design.

3.0 Existing Knowledge

Between 2005 and 2010, extensive aquatic baseline studies have been conducted as part of the environmental assessment of the Project. The majority of the aquatic studies have been undertaken in the Mine Local Study Area and have included collection of information on:

- Water quality and quantity;
- Aquatic habitat (streams and lakes);
- Primary producers (phytoplankton, periphyton, and aquatic plants);
- Secondary producers (zooplankton, invertebrate drift and benthic invertebrates);
- Fish communities and populations; and
- Metals in fish tissue.

This body of knowledge will be useful as baseline data for the MMER related monitoring studies as well as for the selection of reference sites.

3.1 Water Quality Sampling

Water samples were collected from streams and lakes within the Mine Site local study area in 2005, 2006, 2007 and 2008. Streams sampled for water quality within the Project area typically had naturally elevated concentrations or values for dissolved oxygen, turbidity, aluminum and iron. Some average values for pH exceeded the CCME guidelines as did average values for cadmium and mercury at most sites. Selenium routinely was reported at the CCME guideline level. When all areas for stream sampling were compared, based on Water Quality Index values, the sampling locations within the area between Camp Lake and Milne Port indicated "excellent" water quality. Average values for pH exceeded the CCME range of 6.5 to 8.5 for lakes within the Mine Site area (Mary Lake, Camp Lake and Sheardown Lake). Cadmium and mercury were at or above CCME guideline levels in Mary Lake. Parameters that were at or above the CCME guideline levels in Camp Lake and the northwest and southeast basins of Sheardown Lake included cadmium, mercury and selenium.

The water quality of Steensby Inlet was sampled in 2007 and 2008 and was circumneutral, hard, and clear with moderate amounts of nutrients. Nutrient concentrations tended to be higher in deep waters than they were near the surface, and a distinct upper layer of water was observed. Nutrients are generally higher during the ice cover season than during the open-water season. Overall, nutrient concentrations are generally within the range of those found in nearby arctic waters. The major elements in water samples collected from Steensby Inlet reflect those typical of marine waters (e.g., chloride, sodium, sulphate and magnesium). Several metals (including cadmium and iron) are present in such low concentrations that they are generally below the analytical level of detection.

3.2 Freshwater and Marine Aquatic Sampling

Site specific data were collected for freshwater aquatic habitat (streams and lakes), primary producers (e.g., phytoplankton and aquatic plants), secondary producers (e.g., zooplankton and invertebrates), fish populations and movements and baseline metals in Arctic char (*Salvelinus alpinus*). Only two fish species were present in the freshwater study areas - Arctic char and ninespine stickleback (*Pungitius pungitius*). Both species were generally abundant and widespread in distribution. All streams with the possible exception of large rivers freeze solid in winter, therefore, lakes provide the only overwintering habitat for both species. Lakes also provide spawning habitat for Arctic char across the study areas. Many streams provide rearing and foraging habitat and potential protection from predators for juvenile Arctic char. Most of the drainage basins that support Arctic char either contain barriers preventing anadromous migrations and/or are distant from the coast and most populations in the study areas are land-locked. Mercury concentrations in Arctic char muscle exceeded guidelines for human consumption in some fish captured, although concentrations were similar to those reported for other land-locked Arctic char populations. In general, the lower trophic level communities were found to be similar to other areas of the Canadian Arctic. As is typical of Arctic ecosystems, the freshwater environment is relatively nutrient-poor and primary productivity is relatively low. In general, Arctic freshwater ecosystems are characterized by relatively low diversity of zooplankton communities due to low temperatures and nutrients. Results of the baseline studies for Mine Area lakes are consistent with this generalization. The benthic invertebrate communities in the Mine Area are generally moderately diverse, although higher diversity is found in some small tributaries, and are dominated by chironomids.

In general, the marine fish community near the Steensby Port is characterized by low species diversity and abundance. Arctic char, fourhorn sculpin, (*Myoxocephalus quadricornis*), shorthorn sculpin (*M.*

scorpius), and Atlantic spiny lumpsucker (*Eumicrotremus spinosus*) were captured during experimental gillnetting programs. Arctic cod (*Boreogadus saida*) and larval sculpin (most likely ribbed sculpin, *Triglops pingeli*) are also present as indicated by Arctic char stomach contents. Arctic char were the most common species observed, comprising 90.6 % of the total catch between 2007 and 2010. The average concentration of mercury within muscle tissue samples collected from the Arctic char catch was within the Health Canada commercial export limit of 0.5 ug/g. Benthic infauna sampling in Steensby Inlet indicated that Polychaetes, followed by Malacostraca or Ostracoda, were the most abundant taxa of the 202 benthic infauna species identified. Benthic invertebrate community composition and densities changed with depth with the highest densities between 10 m and 45 m and the lowest occurred at 3 m.

3.3 Water Quality Modeling

Water quality modeling carried out as part of the geochemistry program for the Project predicted that the runoff from the ore stockpiles will be high in suspended solids, about neutral to mildly acidic (pH 5.5. to 6) with low dissolved metal concentrations below limits established under the MMER. It was noted that treatment may be required to reduce suspended solids below the MMER average criteria of 15 mg/L, and to potentially adjust pH to above 6. It is anticipated that with the implementation of treatment options the effluent at each of the final discharge points will be within MMER guideline levels.

4.0 Final Discharge Points

There are a total of four identified final discharge points associated with the operation of the Mary River Project (Table 2). Three will be located at the mine site and one at Steensby Port The three discharge points at the mine site will include two at the waste rock storage area and the other downstream of the ore stockpile. The single discharge point at Steensby Port will be at the outflow of the ore stockpile storm water pond which will flow into the marine environment.

Table 2 Identified Final Discharge Points and Receiving Water Bodies

Project Area	Discharge Source	Receiving Watercourse	Fish Bearing Status
Regulated Discharges (MMER)			
Mine Site	Mine Contact Water – West waste rock stockpile runoff from Surface Water Management (SWM) pond	Camp Lake and CL-Trib1	Yes
Mine Site	Mine Contact Water – East waste rock stockpile runoff from SWM pond	Mary River	Yes
Mine Site	Mine Contact Water - Ore stockpile runoff	Mary River	Yes
Steensby Port	Mine Contact Water - Ore stockpile runoff	Steensby Inlet	Yes

5.0 Effluent Monitoring Study

The Effluent Monitoring Study will be initiated upon project start-up, and will involve the periodic sampling of the effluent at the identified final discharge points (Table 2).

The MMER requirements for an Effluent Monitoring Study include grab samples of the effluent at each final discharge point:

a. Analysis for pH and the deleterious substances as listed in Schedule 4 of the regulations to be conducted weekly;

b. Acute lethality testing in accordance with procedures specified in Reference Method EPS1/RM/13 to be conducted monthly; and

c. Daphnia magna monitoring in accordance with procedures specified in Reference Method EPS 1/RM/14 to be conducted monthly.

6.0 Environmental Effects Monitoring

As previously noted, Schedule 5 of the MMER provides detailed requirements for the conduct of water monitoring and biological studies to monitor potential effects of effluent on fish populations, fish tissue and on the benthic invertebrate community in the area of the final discharge points. Prior to the conduct of the biological monitoring studies the MMER requires that a study design be developed and submitted to Environment Canada for approval. The study design should provide a site characterization of potential sampling sites, specific information on how the respective studies will be conducted and how the studies will provide the information necessary to determine whether the effluent has had an effect on the respective sampling targets.

6.1 Study Site Selection

Sampling will be conducted at the four exposure sites at the Mine Site and Steensby Port, as well as at a freshwater and a marine reference site. Sampling will be conducted for fish populations, fish tissue and benthic invertebrates at each reference and exposure site.

6.1.1 Exposure Sites

Three of the four exposure sites will be located at the mine site and one at Steensby Port. The three discharge points at the mine site will include two at the waste rock storage area and the other downstream of the ore stockpile. The single discharge point at Steensby Port will be at the outflow of the ore stockpile storm water pond which will flow into the marine environment.

Based on the information provided in Table 1, the following exposure zones are recommended to be included in the study area.

Exposure Zone 1 – Camp Lake and tributary CLT-1 from the discharge of mine contact water from the west waste rock stormwater pond, as well as reduced flows. Tributary CLT-2 will experience reduced flows only.

Exposure Zone 2 – The Mary River ranging from the headwaters (upstream of mine activities) to the inlet to Mary Lake from the discharge of mine contact water from the east waste rock stormwater pond, open pit and ROM stormwater pond,

Exposure Zone 3 – The outflow of the Ore Stockpile storm water pond which will discharge into Mary River near the proposed railway bridge location.

Exposure Zone 4 – Steensby Inlet resulting from the discharge of mine contact water from the ore stockpile stormwater pond.

6.1.2 Reference Sites

For many EEM study designs, a comparison is required with respect to a control or reference value. Such a value can be available through data collection from an area unaffected by the Project, but similar to the sampling area in all other respects. The challenge is to select a location which is close enough to

the sampling area to be similar in terms of biophysical features, but which is not likely to be exposed to discharges, effluents or other interactions with the Project. As well, the selected site should be relatively pristine. Sampling at reference sites will include: water quality, sub-lethal toxicity testing, fish population studies, fish tissue collection and benthic invertebrate studies.

To maximize the temporal component of the background data, where possible, reference sites will be selected from sites previously sampled as part of the environmental assessment baseline studies. Four candidate freshwater sampling sites have already been allocated a Site ID during the environmental assessment baseline sampling which are included below. Marine water quality sampling was also carried out in Steensby Inlet as part of the environmental assessment baseline sampling. A previously sampled site will be selected as a reference site which is outside the potential zone of influence of the final discharge point.

Baseline sampling of the candidate reference sites as well as at the proposed final discharge points will be conducted to characterize pre-project conditions at all sampling locations.

The candidate reference sites include:

- Mary River, approximately 5 km upstream of the ore stockpile discharge point (Site ID G0-03);
- Upstream of East SWM pond in Camp Lake Tributary, (Site ID L1-06);
- Upstream of the West SWM pond in an unnamed tributary to Mary River ("F"), (Site ID F0-05); and
- Steensby Port marine sites.

The freshwater and marine reference sites will be selected from these candidate sites based on pre-determined selection criteria and the results of the site characterization outlined in the following section. Given that the three mine exposure sites discharge into tributaries, the freshwater reference site will be located on a comparable tributary system.

For the freshwater reference sites the following criteria apply:

- Comparability to exposure site in regards to:
    - drainage basin size;
    - habitat features;
    - stream order;
    - depth and width;
    - water velocity;
    - riparian vegetation;
    - geology;
    - water quality;
    - fish community structure; and
    - benthic invertebrate density and diversity.
- Previous sampling history;
- Outside of zone of influence (aquatic and airborne) of the mine and associated infrastructure and activities; and
- Accessibility.

The criteria for the Steensby Port marine reference site will include:

- Previous sampling history; and
- Comparable to the exposure site with regard to:
  - Geography
  - Bathymetry
  - Tides and currents
  - Fetch and exposure
  - Fish community
  - Benthic invertebrate community
  - Marine flora
  - Water quality
  - Proximity to Steensby Port
  - Accessibility
  - Outside of the zone of influence (aquatic and airborne) of Steensby Port and associated infrastructure and activities.

The precise number and location of reference sampling sites will be determined by the final study design.

6.1.3 Site Characterization

Site characterization information is used to identify suitable sampling areas that have similar habitats in the exposure and reference areas, and to obtain information on other discharges and confounding factors that may affect the interpretation of data obtained from those areas. Plume delineation will be completed for each exposure zone to better define sampling areas at each site. Table 3 summarizes site characterization information that will be included in the study design. This information will be collected at the exposure sites as well as the candidate reference sites and will be used in the selection of final freshwater and marine reference sites.

Table 3 Site Characterization Information Requirements for the Mary River Project EEM

Information Type	Information to be Reported
General characteristics	• bedrock and surficial geology • topography • soil and vegetation • site accessibility • climatology
Hydrology	• watershed(s) description • water flow (rivers) or dispersion (lakes, estuaries, marine) characteristics • general description of how effluent(s) mix(es) with receiving water • bathymetry mapping (including slope in marine environments) • gradient (rivers) • tides (marine) - mean monthly tide height data • stratification patterns (thermal and chemical) • natural barriers to fish movement • effluent plume delineation

Table 3 Site Characterization Information Requirements for the Mary River Project EEM (Cont'd)

Information Type	Information to be Reported
Anthropogenic influences	• docks, wharves, boat launches, and public recreational zones • bridges, crossings and fordings • water intakes, effluent discharges, storm water discharges, sewer overflows • waste disposal sites • contaminant source inventory, including point- and nonpoint sources • dams, culverts, waterfalls and other barriers to fish movement • surrounding land use • location of aquaculture facilities
Aquatic resource characteristics	• location of exposure and reference areas used in historical studies • fish and shellfish species present (resident and migratory) • relative abundance of fish and shellfish species • use of the exposure and reference areas by fish and shellfish (spawning grounds, nursery areas, etc.) • rare, threatened or endangered fish species (if present) • non-commercial fisheries (recreational and subsistence) • commercial fisheries • zones of macrophyte growth • ecologically relevant benthic invertebrate habitat(s) and their relative proportions, including: • delineation of depositional and erosional zones • substrate classification
Environmental protection systems and practices	• water management • effluent treatment • residence time • waste rock (including use of waste rock for mine back fill and building material)

6.1.4 Habitat Mapping and Classification

A primary component of the site characterization is habitat classification. This information will be compiled for each of the exposure and reference sites. As per Chapter 2 of the Technical Guidance Documentation (2002 / 2011), habitat classification will follow the Classification system developed by the U.S. Fish and Wildlife Service, *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardine et al 1979; Busch and Sly 1992). Both freshwater and marine habitat classification was conducted as part of the baseline data collection associated with the environmental assessment of the Project and will be consolidated and utilized where appropriate for this component.

Information to be used in the habitat classification of each reference or exposure site will include the following:

(a) Rivers:

i. Elevation gradient
ii. Location of dams, falls and other barriers to migration
iii. Mean annual discharge and ranges

iv. General substrate characteristics

(b) Open Coastline:

i. Depth contours
ii. Nearshore substrate characteristics
iii. Shoreline configuration and the locations of inflowing rivers and other discharges and activities
iv. Tide cycles

6.1.5 Plume Delineation

Plume delineation will be conducted for each final discharge location based on guidance provided in the Revised Technical Guidance on How to Conduct Effluent Plume Delineation Studies, (Environment Canada, 2003). The goals will be to estimate where mixing begins and is complete, effluent dilution ratio at set locations downstream from the discharge, and how these factors vary with tides and seasons.

6.2 EEM Field Sampling

Following site characterization, the field programs for water quality, including sub-lethal toxicity testing, and the biological monitoring studies will be designed and conducted to collect information on:

1. Toxicity and quality of effluent;
2. Fish populations;
3. Fish tissue (metals); and
4. Benthic invertebrates.

6.2.1 Water Quality and Toxicity Monitoring

6.2.1.1 Water Quality Monitoring

The MMER requires that water quality monitoring be conducted by:

(a) collecting samples of water from:

i. the exposure area surrounding the point of entry of effluent into water from each final discharge point and from the related reference areas; and

ii. the sampling areas that are selected for the fish population and fish tissue studies and the sampling areas of the benthic invertebrate community studies.

(*b*) recording the temperature of the water and the dissolved oxygen concentration in the water in the exposure and reference areas where the samples are collected;

(*c*) recording the hardness and alkalinity of the sample and the concentrations, in total values, of the following:

- aluminum;
- cadmium;
- iron;
- mercury;
- molybdenum;
- ammonia; and
- nitrate.

i. in the case of effluent that is deposited into fresh water (Mine Site), recording the pH, hardness and alkalinity of the water samples; and

ii. in the case of effluent that is deposited into marine waters (Steensby Port), recording the salinity of the water samples.

(*d*) recording the concentration of the deleterious substances set out in column 1 of Schedule 4 of the MMER with the exception of cyanide because it is not used as a process reagent; and

(*e*) implementing quality assurance and quality control measures that will ensure the accuracy of water quality monitoring data.

6.2.1.2 Sub-lethal Toxicity

As per the requirements specified in the MMER, sub-lethal toxicity testing will be conducted at the Mine site on a fish species, an invertebrate species, a plant species and an algal species; and at Steensby Port - a fish species, an invertebrate species and an algal species.

The sub-lethal toxicity tests will be conducted on the aliquots of water samples collected from the identified final discharge point that has potentially the most adverse environmental impact on the environment.

The sub-lethal toxicity tests conducted at the Mine Site discharge point will be conducted using the following test methodologies, as applicable to each species:

(a) in the case of a fish species:

i. *Biological Test Method: Test of Larval Growth and Survival Using Fathead Minnows* (Report EPS 1RM/22), February 1992, published by the Department of the Environment; or

ii. *Biological Test Method: Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout)* (Reference Method EPS 1/RM/28), July 1998, published by the Department of the Environment.

(b) in the case of an invertebrate species, *Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia* (Report EPS 1/RM/21), February 1992, published by the Department of the Environment;

(c) in the case of a plant species, *Biological Test Method: Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte, Lemna minor* (Reference Method EPS 1/RM/37), March 1999, published by the Department of the Environment; and

(d) in the case of an algal species:

i. *Biological Test Method: Growth Inhibition Test Using Freshwater Alga Selenastrum capricornutum* (Report EPS 1/RM/25), November 1992, published by the Department of the Environment;

ii. *Détermination de l'inhibition de la croissance chez l'algue Selenastrum capricornutum* (Reference Method MA 500-S.cap.2.0), September 1997, published by the Centre d'expertise en analyse environnementale du Québec.

The sub-lethal toxicity tests to be conducted in the marine environment at Steensby Inlet will use the following test methodologies:

(a) Biological Test Method: Fertilization Assay Using Echinoids (Sea Urchins and Sand Dollars) (Report EPS 1/RM/27), December 1992, published by the Department of the Environment;

(b) Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms (Third Edition) (Reference Method EPA/821/R-02/014), October 2002, published by the U.S. Environmental Protection Agency; and

(c) Short-term Methods for Estimating the Chronic Toxicity of Effluent and Receiving Waters to West Coast Marine and Estuarine Organisms (First Edition) (Reference Method EPA/600/R-95-136), August 1995, published by the U.S. Environmental Protection Agency.

6.2.2 Biological Sampling

The biological sampling program will collect data on fish populations, fish tissue and benthic invertebrates at a reference and at the final discharge point with potentially the most adverse environmental impact.

6.2.2.1 Fish Population and Fish Tissue Studies

MMER stipulates that a fish monitoring program is required if the concentration of the effluent is greater than 1 % at a distance of 250 m from a final discharge point. The objective of such a study would be to provide the information necessary to determine if the effluent has an effect on the resident fish populations or on fish tissue.

The sampling program design for environmental effects monitoring in freshwater fish is a simple Before After Control Impact (BACI) design. This design incorporates a reference area away from any Project influence and one exposed area within the Project zone of influence. In this manner, changes attributable to natural variation can be differentiated from changes occurring within the Project.

The endpoint to be assessed in the fish community component is population density (standing stock) expressed as number of individuals and biomass (weight) per unit area. The only two fish species present in the freshwater study area are Arctic charr (landlocked) and ninespine stickleback). For sampling riverine habitat, a station of adequate dimensions is required. The baseline sampling criteria will apply, i.e., stations will be between one and three units in size (1 unit = 100 m^2).

Fish are collected from the exposure and reference areas, and metrics are statistically compared between the two areas to identify effects. These metrics include:

- Catch per Unit Effort;
- Density;
- Length;
- Weight;
- Gonad size;
- Liver size;
- Fecundity; and
- Egg size.

Analysis of metal residues (i.e., mercury) in fish tissues is only required under EEM if the concentration of total mercury in the effluent is equal to or greater than 0.10 µg/L. If required, samples will be obtained coincidentally during the fish population sampling. A sample size of 30 specimens will be collected for each species at each sampling site. An equal number of samples from each length class will be obtained where possible.

The study design for the proposed fish population and fish tissue studies will include a description of and the scientific rationale for:

(a) The fish species selected, taking into account the abundance of the species that would be most exposed to effluent;
(b) The sampling areas selected;
(c) The sample size selected; and
(d) The field and laboratory methodologies selected.

The data collected as part of the environmental assessment baseline studies will be reviewed and used in the development of these studies.

6.2.2.2 Benthic Invertebrate Study

The benthic invertebrate monitoring study is designed to identify changes at that trophic level by comparing density, taxa richness, Simpson's Diversity Index, and Bray-Curtis Index between control and exposure areas. The EEM guidance document (EC, 2011) describes several study design options including: control/impact; gradient; and the reference condition approach. The number of samples required to adequately assess an effect are determined through statistical power analysis on existing data. It is also specified that benthic invertebrate samples must be collected in the most ecologically relevant area considering habitat types with the highest benthic invertebrate diversity and dominant habitat in the exposure area as well as the season when benthic invertebrate diversity is highest and exposure to effluent is highest.

The information respecting the benthic invertebrate community studies will include a description of and the scientific rationale for

- The sample areas selected, taking into account the benthic invertebrate diversity and the area most exposed to effluent;
- The sample size selected ;
- The sample season selected; and
- The field and laboratory methodologies selected.

The data collected as part of the environmental assessment baseline studies will be reviewed and used to develop the study design for the benthic invertebrate study.

7.0 Sampling frequency

As previously noted, the MMER requires that regular monitoring be conducted at each of the final discharge points, the receiving environment and at unaffected reference sites. The MMER requires Effluent Monitoring at each final discharge point of deleterious substances (Column 1 of Schedule 4) and pH, to be conducted not less than once per week and at least 24 hours apart during operation. However, section 13 (1) allows the owner to reduce the frequency of testing for a deleterious substance to not less than once in each calendar quarter if that substance's monthly mean concentration is less than 10 % of

the value set out in column 2 of Schedule 4 for the 12 months preceding the most recent test. Acute lethality and Daphnia magna testing is required to be conducted once a month, however, the frequency of the former may also be reduced if the effluent is determined not to be acutely lethal over a period of 12 consecutive months (MMER 16. (1)).

In regards to the EEM program, the effluent and water quality monitoring studies are required to be conducted four times per calendar year and not less than one month apart. The sub-lethal toxicity testing is to be conducted twice a year for the first three years of operation and then once a year thereafter. The biological components of the EEM will be conducted as per the specific study designs as approved by Environment Canada.

8.0 Quality Assurance and Quality Control

BIM will incorporate a system to allow for internal and external review and audit of the AEMP and its findings. The Quality Assurance / Quality Control (QA/QC) program will be designed to ensure that all field sampling and laboratory analyses yield scientifically defensible results. The QA component of the program will consist of standard operating procedures (SOPs) to aid in sample collection, sample handling, data management and data interpretation. SOPs will be established for sampling methods and procedures, sample handling, labelling, equipment, preserving, record keeping, and shipping as well as analytical methods and procedures, equipment, test system implementation, and record keeping. The QC component of the program will include techniques used to measure and assess data quality and the remedial actions to be taken when data quality objectives (DQOs) are not realized.

9.0 EEM Study Design Table of Contents

In summary, the EEM Study Design will include the following:

- A summary of previous biological monitoring and effluent and water quality sampling;
- Information related to site characterization, including plume delineation studies (if available); reference site selection;
- The objectives of the field monitoring program, including overall approach and rationale for biological monitoring;
- Statistical design criteria, hypotheses, statistical methods and data needs;
- A description of how the biological monitoring studies are to be conducted to determine if there are effects, taking confounding influences into consideration;
- Field sampling plans, including what will be measured, where and when it will be measured, location of exposure and reference sites, and rationale for selection of final discharge points; and
- QA/QC measures that will be taken to ensure validity of data; and schedules for field monitoring and submission of the interpretative report.

The information described above should be incorporated into the study design using the following recommended table of contents:

1. Introduction
2. Site Characterization
   - 2.1. Site Characterization
   - 2.2. Plume Modelling / Delineation

2.3. Calculation of Constituents in the Effluents
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4.3. Sampling Methods and Field Program
4.4. Data Analysis and Interpretation
4.5. Quality Assurance and Quality Control
4.6. Report Preparation

5. Program Schedule

10.0 References

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