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Baffinland
Iron Mines Corporation

Design Criteria

Baffin Iron Mine Corporation: Mary River Project
H337697

Milne Port Drainage System and Stormwater Management Ponds

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1. General

1.1 Introduction

The Mary River Project is a proposed iron ore mine and associated facilities located in north Baffin Island, in the Qikiqtani Region of Nunavut. The Project involves the construction, operation, closure, and reclamation of an 18 million tonne-per-annum open pit mine that will operate for 21 years. The high-grade iron ore to be mined is suitable for international shipment after only crushing and screening with no chemical processing facilities. A railway system will transport an additional 18 Mt/a of ore from the mine area to an all-season deep-water port and ship loading facility at Steensby Port where to ore will be loaded into ore carriers for overseas shipment through Foxe Basin.

This document establishes the criteria for the design of Milne Port stormwater management facilities and drainage infrastructure for the Mary River Project located in Baffin Island, Nunavut Canada.

1.2 Scope of Work and Objective

This document outlines the criteria and drainage standards for the Mary River Project Milne Port to be adopted for:

- Drainage ditches for collection and handling of runoff from the operating areas and ore stockpiles area;
- Stormwater management and sedimentation control storages; and
- Stormwater diversion channels (i.e. intercepting "clean" water);

The objective of this design criteria is to provide:

- A safe and efficient stormwater drainage scheme that will minimize disruptions to the mine and operations (including construction) during wet weather periods, while minimizing the potential for negative impacts to the environment in the event of an uncontrolled release of stormwater runoff; and
- Intercept and divert clean stormwater from undisturbed areas.

1.3 References

1.3.1 Codes, Regulation and Standards

Unless specifically noted otherwise, the design of all stormwater management works will be based on applicable parts of the latest revision of current codes, specifications, standards, and regulations. In addition to these, the design will comply with any laws or regulations of local authorities. These codes, standards and documents are declared to be a part of this specification, the same as if fully set forth herein. In the event of conflicting requirements, the most stringent will apply.

- "CDA Dam Safety Guidelines", Canadian Dam Association, 2007;

- "Guidance for assessing the design, size and operation of sedimentation ponds used in Mining", British Columbia Ministry Environment, Lands and of Parks (Draft); and
- 'Environmental, Health and Safety Guidelines for Mining', International Finance Corporation (IFC), December 10, 2007.

ACI	American Concrete Institute, Applicable Standards for the Design of and Construction of Concrete Structures
ASCE 37	American Society of Civil Engineers, Manual of Engineering Practice No. 37, Design and Construction of Sanitary and Storm Sewers
ASTM	American Society for Testing and Materials, applicable standards for the various construction materials specified in this criteria
PPAH 1998	"Pollution Prevention and Abatement Handbook" - World Bank
CMME SOR/2002-222	Canadian Metal Mining Effluent Regulations

1.3.2 Other Project Design Criteria

This design basis should be read in conjunction with the following additional project design criteria (to be added).

1.3.3 Other Documents

Reference will be made to the following documents:

- "Mary River Project Environmental Impact Statement", Baffinland Iron Mines Corporation, 2011.

1.3.4 Units

The International System (SI) will be used for all design calculations, dimensions and material sizes.

2. Milne Port Stormwater Management System

2.1 Surface Drainage

The general criteria for the stormwater management system is described below. Where applicable the criteria described corresponds to that described in the Civil Design Criteria.

- All interior site grading and roads will be designed to provide continuous overland flow without erosion to a drainage ditch system; and
- Provision must be made to ensure that there is a safe flow path for events up to the (one)1 in (ten)10-year event, such that the runoff will not flood key mining areas, cause significant erosion, pick up excessive contaminants or cause other significant problems.

2.2 External Surface Drainage

Additional criteria for drainage of the external area are as follows:

- Run-off from undisturbed areas surrounding the site should be collected in clean-water perimeter ditches and diverted around and/or through the site perimeter;
- To the extent possible, these perimeter ditches will be designed to discharge at locations that best retain the characteristics of the existing natural drainage patterns; and
- Clean water diversion ditches shall be designed to convey the 100-year flood event.

2.3 Runoff and Sediment Load Estimations

The storm water management model (SWMM) is to be used in the estimation of the stormwater runoff volume, peak flow, the flood hydrograph for the designing of SWM ponds.

2.3.1 Flow Estimation

Flow estimation will be based on the following equations developed by Knight Piésold Consulting:

- $Q_2 = 1.1\ A^{0.79}$;
- $Q_5 = 1.7\ A^{0.77}$;
- $Q_{10} = 2.0\ A^{0.76}$;
- $Q_{25} = 2.6\ A^{0.75}$; and
- $Q_{100} = 3.5\ A^{0.73}$.
- Where Q = peak flow instantaneous flow in m^3/s
- A = drainage area in km^2 ($0.5\ km^2 \leq A \leq 1000\ km^2$)

2.3.2 Stormwater and Sediment Ponds

Stormwater and sediment ponds are modelled by the SWMM model's storage/treatment module. The storage module requires the following parameters:

- Storage-stage information: will be determined using the pond configuration;
- Outlet stage-discharge relationship: determined based on the outlet configuration; and
- The maximum monthly mean outflow sediment concentration must be < 15 mg/L at the final discharge point of the model. If the sediment will not settle by gravity to meet the 15 mg/L requirement, flocculation technology may be needed.

2.4 Ditches

- Drainage ditches will be designed to convey the stormwater runoff peak flow from the 10-year return period storm event to a stormwater and sedimentation basin;
- Open ditches conveying stormwater runoff from 'clean' areas that will not convey any potentially contaminated surface water may be riprap lined for erosion protection passing high gradient areas;
- Design of the drainage ditches will be based on the criteria below in Table 2-1;

- Trapezoidal ditches shall be used where practical;
- Where velocities exceed 1.5 m/s, ditch liners shall be considered; and
- If the ditch is in rock, no liner is required.

2.4.1 Culverts

Ditch culverts for all interior/access roadways and vehicle access points will be designed to convey the runoff peak flow from the 10-year return period storm, such that the inlet headwater level does exceed the crown of the culvert. Their analysis and design will consider design flow, culvert size and material, entrance structure layout, outlet structure layout and erosion protection.

Culvert design will also be subjected to the criteria stated in Table 2-1.

Table 2-1: Drainage Ditch and Culvert Design Criteria

Minimum ditch slope through mine areas (%)		0.3
Maximum ditch Slope (%)	Unlined ditch	2.0
	Riprap lined ditch	4.0 -10
Maximum velocity in ditch (m/s)	Grass-lined ditch	1.5
	Gravel-lined ditch	4.0
Minimum ditch slope (%)		0.3
Minimum ditch depth (mm)		600
Minimum width of ditch bottom (m)		1.0
Ditch side slopes	Rock	1:1
	Soil	2:1 (H:V)
Minimum culvert size (mm)		**600**

3. Erosion Control

Rip rap or concrete will be used at erosion susceptible locations of the storm drainage system including ditch sections subject to high-velocities (1.5 m/s to 4.0 m/s), ditch outlets, storm sewer outfalls and culverts.

Energy dissipaters will be used where the flow velocities would otherwise exceed the acceptable maximum (see Table 2-1).

4. Stormwater and Sedimentation Control

4.1 Sedimentation Ponds

Sedimentation ponds are located directly adjacent waste stockpile areas. The general design criteria for sedimentation ponds are as follows:

- Principal and emergency spillways of the primary sedimentation ponds will be designed based on their respective Incremental Consequence Category (ICC) ratings. The design flood can range from the 100-year return period to the probable maximum flood (PMF) for low to high IHP ratings respectively. ICC ratings will be determined using the CDA 2007 Guidelines; and
- Pond emergency spillways of the stormwater management ponds will be designed to pass the inflow from the inflow design flood corresponding to the ICC classification without any detrimental damage to the spillway or embankment slopes.

4.1.1 Pond Sizing

The pond will be sized to have a storage volume equal to the (one) 1 in (two) 2 year freshet runoff volume.

4.1.2 Pond Design

Ponds will be sized to suit the actual topography of the area. A topographical map will be used to locate a suitable place and to determine the actual area available.

4.1.3 Spillway Design

The spillway will be sized based on the dam ICC classification and the corresponding inflow design flood required by the CDA 2007 Dam Safety Guidelines (CDA, 2007).

4.1.4 Dam classification

The dam will be classified according to the Canadian Dam Association dam safety Guidelines based on the potential incremental consequence category (ICC). Loss of Life (LOL), social, economical and environmental damages resulted from a dam failure event will be evaluated. The dam category will be assigned based on the results of the evaluations.

4.1.5 IDF determination

Once the dam's ICC classification is determined, the inflow design flood (IDF) will be determined based on the CDA Dam Safety guidelines. Each class of ICC rate has different IDF requirement (Table 4-1).

Table 4-1: Inflow Design Flood (IDF) and Consequence Classes (CDA, 2007)

Consequence Class	Inflow Design Flood
Low	1/100 year
Significant	Between 1/100 and 1/1000 year (note 1)
High	1/3 between 1/1000 year and PMF (Note 2)
Very High	2/3 between 1/1000 year and PMF (Note 2)
Extreme	PMF

Note 1: Selected on basis of incremental flood analysis, exposure and consequence of failure.
Note 2: Extrapolation of flood statistics beyond 1/1000 year flood (10-3 AEP) is generally discouraged. The PMF has no associated AEP. The flood defined as "1/3 between 1/1000 year and PMF" or "2/3 between 1/1000 year and PMF" has no defined AEP.