BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT
H337697

Design Basis - Sewage Treatment Plant

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1. General

1.1 Introduction

Baffinland Iron Mines Corporation is developing an Iron Ore Mine Site on Baffin Island named the Mary River Project. This design basis will be for several new sewage treatment plants (STPs) that will support the mine. It is anticipated that there will be a four (4) year construction phase followed by approximately twenty (20) years of operation of the mine. These new systems will therefore be designed to accommodate the expected flows of sewage from the various mine camps for both the construction and operation phases.

During the development of the project there will be eight (8) separate sites each housing a varying number of people. Two (2) sites will have construction sewage treatment plants as well as permanent sewage treatment plants. These are:

- Mine Site
- Steensby Port.

Four (4) sites may have temporary camps which will be demobilized after construction. The temporary camps are:

- Ravn River Camp
- Mid-Rail Camp
- South Cockburn Camp
- Milne Port.

The sewage water will be collected and treated at a sewage treatment facility located at each site. The treated effluent shall be discharged. Due to restricted Total Phosphorus discharge limits for Mary River, an opportunity exists to reclaim and reuse the treated effluent for toilets and urinals. This will offset the potable water demand at Mary River, and reduce the volume discharged.

The wastewater discharge criteria will be based on the Nunavut Water Board licence requirements for discharge. These licence requirements are for the existing sewage treatment plants. These guidelines are summarized in the document “Wastewater Management Plan”, Table 3-2 Water License Discharge Requirements. In addition, the wastewater discharge criteria will meet the Health Canada guidelines for the Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing (January 2010, Cat:H128-1/10-602E). Where applicable, the more stringent requirements of the two guidelines shall be implemented.

1.2 Description

This design criteria provides the basis for the engineering design of the sewage treatment plants (STPs), as part of the sewage water treatment requirements for the Mary River Baffinland Iron Ore mine.

Information relating to sewage production, plant personnel and sewage composition has been summarized in the subsequent sections.

Separate STP units are to be provided to meet the construction needs and the operation needs of the mine. The new STPs are to be designed to function without using any of the existing equipment or infrastructure.

The STPs will be required to treat sewage from lavatories, showers, laundry wastewater and sinks from the plant areas.

Storm water will not be collected in the STPs. Other treatment systems exist for the storm water.

2. References

2.1 Codes and Standards

Unless specifically stated otherwise, the design of the sewage equipment will be in accordance with the latest revision of the following codes, standards and regulations. In addition, the design will comply with any laws or regulations of local authorities and Certificate of Approval.

Table 2-1: Applicable Regulations, Standards and Codes

Number / Acronym	Title
AWWA	American Water Works Association
IBC	International Building Codes
Nunavut Waters and Nunavut Surface Rights Tribunal Act, SC 2002, c 10	
Northwest Territories Water Act	
Northwest Territories Water Regulations (SOR/93-303)	
Canadian Fisheries Act	
Canadian Environmental Protection Act (1999)	
CCME Water Quality Guidelines for the Protection of Aquatic Life	
Ontario Guidelines for Sewage Works 2008	
CCME Guidelines for Compost Quality	
Health Canada, Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing (January 2010, Cat:H128-1/10-602E)	
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration

2.2 Proposed Equipment

The following sections provide details relating to the proposed future sewage treatment systems.

2.2.1 Source of Sewage:

Sewage flow will be collected from all lavatories, showers and sinks from the personnel area facilities, cafeterias, washing stations, and laundry facilities.

3. Existing Equipment Description

As the project is already in the preliminary stages of development there is some existing sewage treatment equipment at two of the sites. Descriptions of the existing systems follow:

3.1 Existing Sewage Treatment Systems

Mary River Camp: The wastewater treatment facility, consists of a Rotating Biological Contactor (RBC) and ultra-violet light (UV) disinfection.

Milne Inlet Camp: The wastewater treatment facilities at Milne consist of a RBC (complete with UV disinfection).

The reported capacities of these existing systems are:

Table 3-1: Capacities of Existing Systems

Facility Type	Water/Sewage Quantity (Lpcd)	BOD_5/TSS (Avg. - mg/L)	No. of Persons (Capita)	Total Daily Flow (L/d)	Total Flow 400 days (m^3)
Design Criteria for Mary River Camp	225	460/490	150	33,750	13,500
Design Criteria for Milne Inlet Camp	225	460/490	60	13,500	5,400

3.2 Condition of Existing Sewage Treatment Systems

- Milne Port: Operating
- Mine Site: Operating

4. Design Parameters

Temporary construction sewage water treatment systems will be added onto the existing systems (modular) to expand the treatment requirements during the construction phase. Permanent operations sewage water treatment systems will also be provided to meet the operations phase demands. The temporary plants will be demobilized after the construction phase. During the operations phase, the temporary STP components may be considered as a supply of spare parts or for additional redundancy purposes.

4.1 Raw Sewage Characteristics

The quality of the raw sewage to be used for the design of the STPs was established in previous project work by other consultant groups. This work and the resulting predicted sewage characteristics are found in the document: Mary River Project Environmental Impact Statement Volume 10 Environmental Management Appendix 10d-3 Wastewater Management Plan SD-EMMP-003, Table 3-1 Design Sewage Flows and Strengths, pg. 8 of 29.

The main water quality parameters of the all raw water sources (after equalization) are as follows:

Table 4-1: Raw Sewage Quality

Design	Units	Value
$cBOD_5$	mg/L	350 – 550
TSS	mg/L	400 – 600
NH3-N*	mg/L	55 – 75
TP	mg/L	7 – 13

Notes:

1. The raw sewage quality source is the document: Mary River Project Environmental Impact Statement Volume 10 Environmental Management Appendix 10d-3 Wastewater Management Plan SD-EMMP-003, Table 3-1 Design Sewage Flows and Strengths, pg. 8 of 29. A range has been specified.
2. It was assumed that 100% of the influent TKN hydrolyses to form NH_3-N.

4.2 Sewage Generation Rates

The flow requirements of the sewage water treatment plants will be based upon the worker populations for the different camps and a per capita generation rate as described in the following sections.

4.2.1 Population

An estimate of worker populations for the different STP facilities is shown in the table below:

Table 4-2: Worker Populations

Camp / Site	Worker Population	
	Operation	Construction
Milne Inlet (Port)	40	160
Mary River (Mine Site)	500	500
Steensby (Port)	300	300
Ravn River Area	---	200
Mid-Rail Area	---	200
Cockburn South Camp	---	500

4.3 Average Flow

Average sewage generation has been calculated based on the number of workers at the site and a per capita sludge generation rate.

Table 4-3: STP Average Sewage Flow Design Basis

Parameter	Design Value	Source
Sewage Generation per Capita	344 L / person / day	Design Basis for sewage treatment system for Mary River, Milne Inlet and Tote road (issued for feasibility study) – Nov. 29, 2010 prepared by AMEC. Doc. No. 165926-6780-131-TDR-0001

4.4 Peak Flow

The peak sewage water requirements have been estimated using a typical peaking factor. This peaking factor estimates the peak hourly flowrate above the average demand. This factor is an estimate that is based upon the total number of people that are served by the sewage treatment system.

Table 4-4: STP Peak Sewage Flow Design Basis[1]

Equivalent Population	Night Minimum Hour Factor	Maximum Day Factor	Peak Hour Factor	Design Peak Hour Factor[2,3]
30	0.1	9.5	14.3	16.4
150	0.1	4.9	7.4	8.5
300	0.2	3.6	5.4	6.2
450	0.3	3	4.5	5.2
500	0.4	2.9	4.3	4.9
1000	0.4	2.75	4.13	4.7

Notes:

1. The source for the peak sewage flow rates design basis is the Ontario Design Guidelines for Drinking Water Systems, 2008.
2. A 15% design allowance was added to the Peak Hour Factor.
3. The design peak hour factor will be used in sizing the equalization tank, upstream of the sewage treatment plant.
4. The sewage treatment plant will be designed to handle the average flowrate.

4.5 Sewage Treatment

Sewage will be generated at several facilities and be pumped to the equalization tank. Sewage from remote locations may be collected locally in holding tanks, then, trucked to the main STP equalization tank for treatment.

The new STP will consist of the following:

- Equalization tank for influent sewage flow normalization and homogenization of sewage characteristics. This tank will come complete with a single piped connection for all piped sewage. This sewage will come from both the accommodation facility as well as other nearby facilities such as the administration building. The equalization tank will also have a suitable connection to receive sewage by vacuum truck.
- Treatment to remove total suspended solids (TSS), reduce biochemical oxygen demand (BOD_5) and stabilize biosolids.
- Disinfection of treated water prior to discharge.
- Treated effluent tank and discharge pumps

Sewage treatment plant (STP) effluent will be discharged by pump to an outfall at the site. In the case of re-use for toilet flushing a separate dedicated set of pumps will be provided to draw effluent for re-use. The STP will be designed to treat peak daily sewage production while operating 24 hours / day and 365 days/year.

The sludge may either be disposed of by incineration or local land fill. In the case of land-fill disposal the sludge from the STP will undergo sufficient stabilization to meet pathogen reduction and vector attraction reduction requirements. As such an optional sludge stabilization step is to be proposed by the contractor.

4.6 Discharge / Outfall Locations

For this phase of the project the proposed treated effluent discharge locations are given in Table 4-5. If the proposed discharge locations change, this report shall be revised / updated.

Table 4-5: Treated Effluent Discharge / Outfall Locations

Camp / Site	Discharge/Outfall Location[1]	
	Summer	Winter
Milne Inlet (Port)	Ocean at Milne Inlet	
Mary River (Mine Site)	Sheardown Lake[2,3]	
Steensby (Port)	Ocean at Steensby Port	
Ravn River Area[4]	Overland discharge, TBD	
Mid-Rail Area[4]	Overland discharge, TBD	
Cockburn South Camp [4]	Cockburn Lake	

Notes:

1. In previous project consultant studies, the discharge / outfall locations have been presented for Milne, Mary River, and Steensby Sites. This information was provided in the document "Mary River Project EIS – Volume 3 Project Description, by BIM", or "Mary River Project EIS – Volume 8 Marine Environment by BIM". In addition the discharge locations for the rail camp sites was presented in the document "Technical Decision Memo, TDM-159952-8000-131-001, by AMEC".

2. In the previous consultant studies, some consideration was made for alternative discharge locations into Mary River or Mary River Lake. However, for the current phase of the project, the STP will be designed to discharge the treated effluent to Sheardown Lake, which has the lowest discharge limits, particularly for Total Phosphorus.

3. The Nunavut Water Board discharge criteria are based upon the characteristics of the water body where the sewage is proposed to be discharged as well as the expected flows of waste. The phosphate limit for instance was developed after a study of the overall phosphorus loadings to Sheardown Lake (the discharge point for the mine site) and modeling results. "Total phosphorus (TP) is also an important nutrient parameter that can trigger eutrophication of arctic lakes. The Canadian Council of Ministers of the Environment (CCME) has thresholds for increases in TP and water quality modelling will consider these thresholds." Excerpt from Summary of Effluent, Waste and Emission Guidelines prepared by Knight Piesold (doc. Number – NB08-00767).

4. Insufficient information is available from the previous reports and studies regarding the allowable discharge limits for the temporary rail camp sites. For the current project, the temporary rail camps shall be designed to meet the strict discharge limits derived in the EIS for Sheardown Lake (at Mary River site). When updated information is available, this design basis will be revised.

4.6.1 Storage or Polishing Pond Considerations

Previous studies had recommended the use of Polishing Waste Stabilization Ponds (ie. Mary River Project Appendix 10d-3 Wastewater Management Plan SD-EMMP-003, March 31, 2010). The existing infrastructure at the Mary River (mine site) includes these ponds in part to allow for secondary treatment of the STP effluent which was not meeting the phosphorus discharge limit. However, based upon practical experience at the site with the STP it was projected that secondary polishing would not be required in the future.

Baffinland has incorporated the temporary storage ponds to be used during periods of start-up, shut-down or during periods of system upset. At this time, the stabilization ponds will not be required as part of the proposed STP design, for the following reasons:

- The proposed new STPs shall be designed to meet the discharge criteria , and discharge year-round to their respective discharge points. Therefore, the ponds are not required
- The proposed new STPs will be modular with extra design capacity such that shut-downs and start-ups can be staggered to avoid performance losses in system capacity
- The STP trains are better able to handle upsets by using the available spare capacity to operate the equipment at more conservative flow rates
- Construction costs for a pond suited to the future flowrates would be exorbitant due to the size as well as the requirements for lining and heating.

4.7 Treated Sewage Effluent Quality

The quality of the sewage treatment plant effluent shall be in accordance with the applicable site discharge limits as listed in the following table. Treated sewage discharge limits have not been provided for the temporary rail camps. This is because no work has been undertaken to evaluate the impact of discharge from these sites into the receiving water bodies. In some cases the precise outfall location is not yet decided. The phosphorus limit will be the most challenging parameter in the design of the STP. As such, the Mary River site discharge criteria will be used for the temporary rail camps. The low discharge limit for phosphorus will allow some flexibility in regard to selecting receiving bodies for the temporary rail camps. Once outfall locations have been proposed, modeling of the concentrations of contaminants will need to be undertaken in order for the Nunavut Water Board to establish appropriate discharge criteria.

Table 4-6: Treated Sewage Discharge Limits

Parameter	Unit	NWB Licence Req.		Water Reclaim / Reuse Req.	Design - Mary River / Construction Camps	Design - Milne Inlet / Steensby Port
		Mary River / Temporary Rail Camps	Milne Inlet / Steensby Port			
BOD_5	mg/L	10	20	10 – 20	<10	<20
TSS	mg/L	10	20	10 – 20	<10	<20
Faecal Coliform	cfu / 100 mL	< 200 counts per 100 ml	< 200 counts per 100 ml	N/A	< 200 counts per 100 ml	< 200 counts per 100 ml
Oil and Grease*	mg/L	No visible sheen	No visible sheen	N/A	No visible sheen	No visible sheen
pH	---	Between 6.0 and 9.5	Between 6.0 and 9.5	N/A	Between 6.0 and 9.5	Between 6.0 and 9.5
Toxicity	---	Final effluent not acutely toxic	Final effluent not acutely toxic	N/A	Final effluent not acutely toxic	Final effluent not acutely toxic
Ammonia	mg/L NH3-N	2	2	N/A	<2	<2
Total Phosphorus	mg/L	< 0.1	N/A	N/A	< 0.1	N/A
Turbidity	NTU	N/A	N/A	2 – 5	< 5	< 5
Escherichia Coli	cfu / 100 mL	N/A	N/A	ND – 200	< 200 counts per 100 ml	< 200 counts per 100 ml
Thermo - tolerant Coliforms	cfu / 100 mL	N/A	N/A	ND – 200	< 200 counts per 100 ml	< 200 counts per 100 ml

Notes:

1. NWB refers to the Nunavut Water Board who prepared the water licence requirements based upon Nunavut water quality guidelines. These limits are summarized in the document "Wastewater Management Plan", Table 3-2 Water License Discharge Requirements and the Original Design Basis.
2. The phosphorus limit was determined by a study of the receiving environment (Sheardown lake) as documented in the Knight Piesold, Memorandum – Progress Report, Water Supply and Sewage Disposal During the Construction Phase, December 17, 2008
3. There will be oil and grease traps provided by others for kitchen waste.
4. The water reclaim and reuse criteria is taken from the Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing (January 2010)
5. N / A – No criteria provided.