Baffinland Iron Mines Corporation

Fresh Water Supply, Sewage, and Wastewater Management Plan

BAF-PH1-830-P16-0010

Rev 5

Prepared By: Connor Devereaux
Department: Environment
Title: Environmental Superintendent
Date: March 29, 2018
Signature:

Approved By: Gerald Rogers
Department: Operations
Title : General Manager
Date: March 29, 2018
Signature:

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Index of Major Changes/Modifications in Revision 5

Item No.	Description of Change	Relevant Section
1	Dust suppressant low flow year restrictions	4.2
2	Water management ponds	7.4
2	Updated Roles and Responsibilities tables (Table 12-1 & 12-2) to reflect current operations and organizational structure.	12.1
4	Updated Sewage Treatment Process	5.4

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1 INTRODUCTION

This document describes the plan to manage the fresh water supply and wastewater for the various camp sites to be developed for the Mary River Project during the Project's construction and operation phases. Specifically, this document focuses on freshwater supply and wastewater treatment and disposal at Milne Port, the Mine Site, Steensby Port, and various rail camps.

In accordance with annual reporting requirements, this plan has been updated to take into account commitments made with respect to submissions received during the preliminary and technical review of various regulatory application documents as well as final submissions and issues raised during Public Hearing Processes. This plan has also been updated to support the current Work Plan presented in Appendix B.

The Fresh Water Supply, Sewage, and Wastewater Management Plan (the Plan) is an update to the existing plan and supersedes the BAF-PH1-830-P16-0010, Revision 4, dated March 2016, plan. This Plan will continue to support the Membrane Biological Reactor (MBR) sewage treatment plants (STPs) installed in 2014 which service the Mine Site Complex (MSC) and Port Site Complex (PSC) camps, and continue to support the potable water supply and oily water treatment activities under the Type 'A' Water Licence. This Plan will also support future upgrades and additions to the MBR STPs necessary to service future MSC and PSC camp expansions at Mine Site and Milne Port, respectively.

This Plan should be used in conjunction with the Aquatic Effects Monitoring Plan (AEMP)[1] (BAF-PH1-830-P16-0039) and the Surface Water Sampling Program – Quality Assurance and Quality Control (QA/QC) Plan[2] (BAF-PH1-830-P16-0001).

[1] Baffinland Iron Mines Corporation. Mary River Project – Aquatic Effects Monitoring Plan, Rev. 2. March 2016.

[2] Baffinland Iron Mines Corporation, Mary River Project - Sampling Program – Quality Assurance and Quality Control (QA/QC) Rev. 2, March 2017.

2 REGULATIONS, STANDARDS, AND CODES

As a minimum standard of acceptability, all actions undertaken will be compliant with appropriate sections of both Federal and Territorial legislation as indicated in the table below:

TABLE 2-1: APPLICABLE REGULATIONS, STANDARDS, AND CODES

TITLE	NUMBER/ACRONYM
American Water Works Association	AWWA
International Building Codes	IBC
National Sanitation Foundation	NSF
Health Canada Guidelines for Canadian Drinking Water Quality	GCDWQ
Northwest Territories Water Supply System Regulations	NWT Regulation 108-2009
Safe Drinking Water Act, 2002	Ontario Regulation 170/03
Nunavut Waters and Nunavut Surface Rights Tribunal Act, SC2 002, c. 10	--
Northwest Territories Water Act	NWTWA
Northwest Territories Water Regulations (SOR/93-303)	--
Ontario Drinking Water Quality Standards	--
Federal *Fisheries Act*	--
Canadian Environmental Protection Act (1999)	CEPA
CCME Water Quality Guidelines for the Protection of Aquatic Life	--
Ontario Guidelines for Sewage Works, 2008	--
CCME Guidelines for Compost Quality	--
Drinking Water System Components	NSF/ANSI Standard 61
Filtering Material	AWWA Standard B100
Granular Activated Carbon	AWWA Standard B604
Canada Occupational Health and Safety Regulations	OSH
Metal Mining Effluent Regulations	MMER

3 SUSTAINABLE DEVELOPMENT POLICY

At Baffinland Iron Mines Corporation (Baffinland), we are committed to conducting all aspects of our business in accordance with the principles of sustainable development & corporate responsibility and always with the needs of future generations in mind. Baffinland conducts its business in accordance with the Universal Declaration of Human Rights and ArcelorMittal's Human Rights Policy which applies to all employees and affiliates globally.

Everything we do is underpinned by our responsibility to protect the environment, to operate safely and fiscally responsibly and with utmost respect for the cultural values and legal rights of Inuit. We expect each and every employee, contractor, and visitor to demonstrate courageous leadership in personally committing to this policy through their actions. The Sustainable Development and Human Rights Policy is communicated to the public, all employees and contractors and it will be reviewed and revised as necessary on a regular basis. The following four pillars form the foundation of our corporate responsibility strategy:

1. Health and Safety
2. Environment
3. Upholding Human Rights of Stakeholders
4. Transparent Governance

1.0 HEALTH AND SAFETY

- We strive to achieve the safest workplace for our employees and contractors; free from occupational injury and illness, where everyone goes home safe everyday of their working life. Why? Because our people are our greatest asset. Nothing is as important as their health and safety. Our motto is "Safety First, Always".
- We report, manage and learn from injuries, illnesses and high potential incidents to foster a workplace culture focused on safety and the prevention of incidents.
- We foster and maintain a positive culture of shared responsibility based on participation, behaviour, awareness and promoting active courageous leadership. We allow our employees and contractors the right to stop any work if and when they see something that is not safe.

2.0 ENVIRONMENT

- Baffinland employs a balance of the best scientific and traditional Inuit knowledge to safeguard the environment.
- Baffinland applies the principles of pollution prevention, waste reduction and continuous improvement to minimize ecosystem impacts, and facilitate biodiversity conservation.
- We continuously seek to use energy, raw materials and natural resources more efficiently and effectively. We strive to develop more sustainable practices.
- Baffinland ensures that an effective closure strategy is in place at all stages of project development to ensure reclamation objectives are met.

3.0 UPHOLDING HUMAN RIGHTS OF STAKEHOLDERS

- We respect human rights, the dignity of others and the diversity in our workforce. Baffinland honours and respects the unique cultural values and traditions of Inuit.
- Baffinland does not tolerate discrimination against individuals on the basis of race, colour, gender, religion, political opinion, nationality or social origin, or harassment of individuals freely employed.
- Baffinland contributes to the social, cultural and economic development of sustainable communities in the North Baffin Region.
- We honour our commitments by being sensitive to local needs and priorities through engagement with local communities, governments, employees and the public. We work in active partnership to create a shared understanding of relevant social, economic and environmental issues, and take their views into consideration when making decisions.
- We expect our employees and contractors, as well as community members, to bring human rights concerns to our attention through our external grievance mechanism and internal human resources channels. Baffinland is committed to engaging with our communities of interest on our human rights impacts and to reporting on our performance.

4.0 TRANSPARENT GOVERNANCE

- Baffinland will take steps to understand, evaluate and manage risks on a continuing basis, including those that may impact the environment, employees, contractors, local communities, customers and shareholders.
- Baffinland endeavours to ensure that adequate resources are available and that systems are in place to implement risk-based management systems, including defined standards and objectives for continuous improvement.
- We measure and review performance with respect to our safety, health, environmental, socio-economic commitments and set annual targets and objectives.
- Baffinland conducts all activities in compliance with the highest applicable legal & regulatory requirements and internal standards.

We strive to employ our shareholder's capital effectively and efficiently and demonstrate honesty and integrity by applying the highest standards of ethical conduct.

5.0 FURTHER INFORMATION

Please refer to the following policies and documents for more information on Baffinland's commitment to operating in an environmentally and socially responsible manner:

Health, Safety and Environment Policy
Workplace Conduct Policy
Inuktitut in the Workplace Policy
Site Access Policy
Hunting and Fishing (Harvesting) Policy
Annual Report to Nunavut Impact Review Board
ArcelorMittal Canada Sustainability and Corporate Responsibility Report

If you have questions about Baffinland's commitment to upholding human rights, please direct them to contact@baffinland.com.

Brian Penney

Chief Executive Officer
March 2016

Health, Safety and Environment Policy

This Baffinland Iron Mines Corporation Policy on Health, Safety and Environment is a statement of our commitment to achieving a safe, healthy and environmentally responsible workplace. We will not compromise this policy for the achievement of any other organizational goals.

We implement this Policy through the following commitments:

- Continual improvement of safety, occupational health and environmental performance
- Meeting or exceeding the requirements of regulations and company policies
- Integrating sustainable development principles into our decision-making processes
- Maintaining an effective Health, Safety and Environmental Management System
- Sharing and adopting improved technologies and best practices to prevent injuries, occupational illnesses and environmental impacts
- Engaging stakeholders through open and transparent communication.
- Efficiently using resources, and practicing responsible minimization, reuse, recycling and disposal of waste.
- Reclamation of lands to a condition acceptable to stakeholders.

Our commitment to provide the leadership and action necessary to accomplish this policy is exemplified by the following principles:

- As evidenced by our motto “Safety First, Always” and our actions Health and safety of personnel and protection of the environment are values not priorities.
- All injuries, occupational illnesses and environmental impacts can be prevented.
- Employee involvement and active contribution through courageous leadership is essential for preventing injuries, occupational illnesses and environmental impacts.
- Working in a manner that is healthy, safe and environmentally sound is a condition of employment.
- All operating exposures can be safeguarded.
- Training employees to work in a manner that is healthy, safe and environmentally sound is essential.
- Prevention of personal injuries, occupational illnesses and environmental impacts is good business.
- Respect for the communities in which we operate is the basis for productive relationships.

We have a responsibility to provide a safe workplace and utilize systems of work to meet this goal. All employees must be clear in understanding the personal responsibilities and accountabilities in relation to the tasks we undertake.

The health and safety of all people working at our operation and responsible management of the environment are core values to Baffinland. In ensuring our overall profitability and business success every Baffinland and business partner employee working at our work sites is required to adhere to this Policy.

Brian Penney
Chief Executive Officer
March 2016

4 FRESH WATER

4.1 GENERAL MITIGATION MEASURES FOR WATER USE

4.1.1 WATER INTAKES

4.1.1.1 ENGINEERING INTAKE STRUCTURES

Engineered intake structures are designed to minimize erosion, avoid sediment issues, and provide protection from ice and peak water flows. Care is taken to ensure that disturbance to aquatic environments is minimized during installation and maintenance of infrastructure. Riprap used in construction is clean, free of fine sediment, non-acid leaching, and non-metal generating.

4.1.1.2 SCREENS ON INTAKE PIPES

Intakes are screened in accordance with the Fisheries and Oceans Canada (DFO) Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO Guideline, 1995) to ensure no entrainment or impingement of fish. It also requires a water withdrawal rate such that fish do not become impinged on the screen.

4.1.1.3 SELECTION OF SHORT-TERM WATER TAKE LOCATIONS

Short-term water intake will be required at many locations for a variety of needs including concrete manufacture, drilling, and dust suppression, etc. A screening process will be used to confirm whether water sources are considered adequate as water take locations. Source selection begins by looking for the largest possible water body that is feasible for use. Lakes are considered first, followed by ponds and then large rivers. Streams and creeks will not be used for short-term water withdrawal without prior approval of the Water Licence Inspector. The DFO guideline used for water taken from water bodies is to restrict removal of water to a maximum of 5% of the total volume. During winter under ice conditions, water must be drawn from below two metres (2 m) of non-frozen water (as the top two metres (2 m) of water provides higher oxygenation for resident fish). During the open-water season, the water taking guideline states that no significant drawdown shall be caused. There must be no impact to fish or fish habitat.

4.1.1.4 WATER METERING AND WATER CONSERVATION MEASURES

Water meters are installed at strategic locations to monitor water consumption and enable the development of management strategies to reduce water usage/consumption. These strategies include the installation of low flow water taps, water use for drilling operation, etc.

4.2 FRESH WATER SOURCES

All fresh water for domestic camp use and industrial purposes, during Construction and Operations[1] Phases of the Project shall be obtained in amount and from sources listed in the Table below:

TABLE 4-1: WATER USE FOR DOMESTIC AND INDUSTRIAL PURPOSES DURING THE CONSTRUCTION AND OPERATION PHASES 1 *

Site	Source	Construction Phase	Operations Phase
		Volume (m^3/day)[2]	Volume (m^3/day)[2]
Milne Port (Milne Inlet)	Phillips Creek (summer)	367.5	367.5
	Km 32 Lake (Winter)		
Mine Site (Mary River)	Camp Lake	657.5	355.4
Steensby Port (Steensby Inlet)	ST 347 Km Lake	435.8	243.6
	3 Km Lake		
Raven River	Camp Lake	145.2	N/A
Mid-Rail	Nivek Lake (Summer)	79.5	N/A
	Ravn Camp Lake (Winter)		
Cockburn North (Tunnels Camp)	Cockburn Lake	101.4	N/A
Cockburn South Camp	Cockburn Lake	111.1	N/A
TOTAL		**1,898**	**966.5**

*Source: Type 'A' Water Licence (2AM-MRY1325 – Amendment No. 1).

[1]Baffinland began Early Revenue Phase operations in September 2014.

[2]Volumes by source are combined volumes for domestic and industrial purposes.

TABLE 4-2: WATER USE LOCATIONS AUTHORIZED FOR DUST SUPPRESSION*

Site	Source	Proposed Maximum Volume (m3/day)	Restriction
Tote Road	Phillip's Creek	212	None
	Km 32 Lake	364	
	CV128	579.5	
	CV099	110	June – July only during low flow (less than mean flow) years
	CV087	90	
	CV078	75	
	Katiktok Lake	318	None
	BG50	150	
	BG32	120	June – July only during low flow (less than mean flow) years
	CV217	130	None
	Muriel Lake	212	
	David Lake	132	June – July only during low flow (less than mean flow) years
	BG17	75	
	CV233 (Tom River)	135	None
	Camp Lake	86	

*Source: Type 'A' Water Licence (2AM-MRY1325 – Amendment No. 1)

The above water sources have been approved by the Water Board as freshwater sources for dust suppression. Authorization by the Water Board in writing must be obtained prior to withdrawing water at these sources listed above for any purpose other than dust suppression. Streams will not be used as a water source unless authorized and approved by the Board in writing. Additionally, no material shall be removed from below the ordinary High Water Mark (HWM) of any water body unless authorized. For remote fresh water requirements such as dust suppression, tunnelling, and geotechnical and exploration drilling, some water may be drawn by truck from nearby lakes and ponds and used directly for these purposes.

Sources that are restricted by low flow years will have a visual inspection completed by environmental personnel to determine if restrictions need to be put in place on a regular basis. Environment personnel will then perform instantaneous flow measurement by staff gauge monitoring if deemed necessary. The instantaneous flow estimate will be done by measuring the height of water on a staff gauge and applying it to the rating curves of the representative streams around the Project. This data will be compared to low flow indices from current monitoring locations for a representative stream to determine if it is a low flow year in consultation with a hydrologist. The Environment department will inform operators of any restrictions.

Water used for the purposes of exploration drilling and domestic camp use at supporting satellite exploration camps will be withdrawn under the authorization of Baffinland's Exploration Type B Water Licence (2BE-MRY1421). Water withdrawn for domestic camp use at satellite exploration camps will be

withdrawn from sources proximal to each camp. Total water use for all satellite exploration camps will not exceed 49 m^3 per day. Likewise, drill water will be withdrawn from water source(s) proximal to drilling targets and shall not exceed 250 m^3 per day. Therefore, the volume of water withdrawn for all purposes under this licence will not exceed 299 m^3 per day.

4.3 FRESH WATER SYSTEM PROCESS DESCRIPTION

The following sections describe the fresh water systems at the various Project sites.

Each site also includes a potable water treatment system which produces drinking water for the personnel at the site during construction and operation phases. These systems treat water to meet the Guidelines for Canadian Drinking Water Quality as well as the Ontario Drinking Water Quality Standards.

Minimum process equipment requirements are based upon the Northwest Territories Water Supply System Regulations, NWT Regulation 108-2009, Ontario Design Guidelines for Drinking Water Systems 2008, Ontario Regulation 170/03 – Drinking Water Systems, the Procedure for Disinfection of Drinking Water in Ontario, as well as best management practices.

4.3.1 MILNE PORT

Currently onsite at Milne Port there are two existing camps that support operations and construction activities. These camps include the Port Weatherhaven (PWH) Camp and the Port Site Complex (PSC) Camp. Each camp contains a Potable Water Treatment Plant (PWTP) within or near the camp as well as freshwater tanks to store raw water being delivered. The freshwater demand for construction and operation are shown on drawing Milne Inlet – Water Supply Balance Block Flow Diagram in Appendix C of this plan.

A raw water truck draws water from either KM 32 lake (in winter/summer) or Phillips Creek (in summer) and delivers the water to a water storage tank near the camp. Water from this tank will be used to provide fire water as well as meet the fresh water requirements of the site. A stand pipe within the tank ensures that fire water is always available in the tank. The Milne Port camp layout including the locations of potable water related infrastructure is presented in Appendix B.

The potable water treatment scheme consists of coagulation followed by media filtration and disinfection by ultraviolet radiation. The water then undergoes a secondary disinfection by sodium hypochlorite injection to ensure residual chlorine content at the point of use.

4.3.2 MARY RIVER SITE

Currently onsite at the Mine Site there are two camps that support construction, operations and site wide exploration activities. These camps include the Mine Site Weatherhaven (MWH) Camp and the Mine Site Complex (MSC) Camp. Each camp contains a Potable Water Treatment Plant (PWTP) within or near the camp as well as freshwater tanks to store raw water being delivered. The freshwater demand for

construction and operation are shown on drawing Mine Site – Water Supply Balance Block Flow Diagram in Appendix C of this plan.

Fresh water supply for the Mary River Mine Site is obtained using an electric pump positioned inside a heated and insulated pumphouse on a raw water jetty on Camp Lake. Water is pumped directly from the lake source to water storage tanks located at both camps. Water from these tanks will be used to provide fire water as well as meet the fresh water requirements of the site. A stand pipe within each tank ensures that fire water is always available in the tank. The Mine Site camp layout including locations of potable water related infrastructure is presented in Appendix B of this Plan.

Some fresh water requirements such as road dust suppression, exploration drilling, quarry dust suppression, and concrete and explosives manufacturing will be provided directly from Camp Lake and other nearby lakes using water trucks. Exploration drilling will continue throughout the construction and operation phases of the Project.

The potable water treatment scheme consists of coagulation followed by media filtration and disinfection by ultraviolet radiation. The water will then undergo a secondary disinfection by sodium hypochlorite injection to ensure residual chlorine content at the point of use.

5 SEWAGE TREATMENT

5.1 SEWAGE GENERATION RATE

The estimated generation of sewage is based upon a per capita generation as shown below:

TABLE 5-1: STP AVERAGE SEWAGE FLOW DESIGN BASIS

Parameter	Design Value	Source
Sewage Generation per Capita	300 L/person/day	Design Basis – Sewage Treatment Plant, Doc. No. H337697-4000-10-109-0002 (FEIS, Appendix 3B).

During 2016, actual sewage generated per person ranged from approximately 150 to 250 litres per day.

5.2 SEWAGE DISCHARGE CRITERIA

All sewage generated from relevant Project sites is directed to the Sewage Treatment Facilities or as otherwise approved by the Nunavut Water Board. As per the Type A Water Licence (2AM-MRY1325 – Amendment No. 1) Baffinland is constructing and operating infrastructure and facilities designed to contain, withhold, divert, or retain Water and/or Waste in accordance with applicable legislation and industry standards. Effluent will be discharged such that surface erosion is minimized and no additional impacts are created. The quality of the sewage treatment plant effluent discharging to freshwater or directly into the ocean shall be in accordance with the applicable site discharge limits and the approved Type A Water Licence (2AM- MRY1325 - Amendment No. 1) as listed in the following table:

TABLE 5-2: EFFLUENT DISCHARGE QUALITY LIMITS FOR SEWAGE TREATMENT FACILITIES TO FRESHWATER AND TO THE OCEAN*

Parameter	Unit	Maximum Concentration of Any Grab Sample discharging into Freshwater (mg/L)	Maximum Concentration of any Grab Sample discharging into Ocean (mg/L)
		Monitoring Locations: MS-01, MS-01a, MS-MRY-04, MS-MRY-04A	Monitoring Locations: MP-01, MP-01A SP-01, SP-01A,
BOD_5	mg/L	30	100
TSS	mg/L	35	120
Faecal Coliform	cfu/100 mL	1000 CFU /100 ml	10,000 CFU /100 ml

Parameter	Unit	Maximum Concentration of Any Grab Sample discharging into Freshwater (mg/L)	Maximum Concentration of any Grab Sample discharging into Ocean (mg/L)
		Monitoring Locations: MS-01, MS-01a, MS-MRY-04, MS-MRY-04A	Monitoring Locations: MP-01, MP-01A SP-01, SP-01A,
Oil and Grease*	mg/L	No visible sheen	No visible sheen
pH	---	Between 6.0 and 9.5	Between 6.0 and 9.5
Ammonia (NH3-N)	mg/L	4.0	-
Total Phosphorus (MS-01)	mg/L	4.0	-
Total Phosphorus (MS-01a)	mg/L	1.0	-
Toxicity	---	Final effluent not acutely toxic	Final effluent not acutely toxic

*Source: Type A Water Licence (2AM-MRY1325 - Amendment No. 1) Table 4 and 5.

Note, that locations MP-01 and MP-01a discharge directly into the ocean, therefore ocean discharge criteria would apply. In addition, facilities associated with monitoring stations MRY-MP-04 and MRY-MP-04a were decommissioned in 2013 and therefore the stations have been discontinued.

Recycled water and use of reclaimed water from the various Treatment Facilities (MBRs, OWSs, etc.), surface water management ponds, and embankment dams and approved discharge locations may be used if waters meet appropriate discharge criteria for those facilities. Sludge generated from Sewage Treatment Facilities or any other facilities shall be incinerated using the Milne Port and Mine Site onsite incinerators, or in the landfill with the appropriate approvals from authorities.

5.3 TREATED WASTEWATER GENERATION AND DISCHARGE/OUTFALL LOCATIONS

Treated sewage and wastewater for the Project are discharged to the following locations:

TABLE 5-3: APPROXIMATE TREATED EFFLUENT GENERATION AND DISCHARGE/OUTFALL LOCATIONS*

Camp/Site	Discharge/Outfall Location		Coordinates
	Summer	Winter	
Milne Port	Ocean at Milne Inlet		N: 7976338

Camp/Site	Discharge/Outfall Location		Coordinates
	Summer	Winter	
			E: 503636
Mine Site	Sheardown Lake for Exploration Camp	Storage Pond	N: 7913630 E: 559733
	Discharge 1 to Mary River		N: 7911946 E: 562321
	Discharge 2 to Mary river		N: 7911938 E: 562342
	Discharge 3 to Mary River		N: 7912010 E: 562249
Tote Road Work Sites	Conveyed to Mine Site or Milne Port Sewage Treatment		N/A
Steensby (Port)**	Ocean at Steensby Port		N: 7801412 E: 593378
Ravn River Area**	Conveyed to Mine Site Sewage Treatment		N/A
Mid-Rail Area**	Conveyed to Mine Site Sewage Treatment		N/A
Cockburn Tunnels Area**	Conveyed to Steensby Sewage Treatment		N/A
Cockburn South Camp**	Conveyed to Steensby Sewage Treatment		N/A

*Refer to Site Block Flow Diagrams in Appendix C for Milne Port and Mine Site anticipated annual effluent discharge.
** These sites are not expected to be active in the foreseeable future.

Treated wastewater effluent will be discharged at a distance of least thirty-one metres (31 m) above the Ordinary High Water Mark of any water body or watercourse, or where direct flow into the adjacent water body or watercourse is possible, so that surface erosion is minimized and additional impacts are avoided.

5.4 SEWAGE TREATMENT PROCESS DESCRIPTION

The process description for the sewage treatment systems at each site are described in the sections that follow. Note that for design purposes originally a per capita sewage generation rate of 344 L/person/day had been considered, which is higher than the per capita potable water consumption rate of 300 L/person/day. This was to ensure that the sewage treatment systems would have a higher design allowance. For consistency 300 L/person/day will now be used for both potable water consumption and sewage generation. On average sewage generated per person ranges from approximately 100 to 300 litres

per day. In addition, actual camp occupancy can be optimized based on potable water conservation measures that can be implemented to reduce per capita water consumption and reduce overall sewage generation from current rates.

5.4.1 MILNE PORT

The onsite STP for Milne Port is a Membrane Biological Reactor (MBR) facility that was installed in 2014. Raw sewage generated at the PSC camp is pumped directly via lift stations and sewage lines to the MBR facility at Milne Port. Raw sewage generated at the PWH camp is stored in a raw sewage bladder until it is transported using a vacuum truck to the Milne Port MBR for treatment.

Treated effluent from the MBR sewage treatment plant is stored in a series of treated effluent tanks which collectively have a hydraulic retention time of eight hours (at minimum) based upon nominal flows. It is designed such that the effluent tank will be at a low level during operation. This design allows for delay of discharge should sampling indicate that the effluent quality does not meet the applicable criteria. Such delay allows the effluent to be mixed, re-treated, and re-tested before discharge. Once sampling indicates that effluent is meeting discharge criteria the treated effluent stream is directed to discharge via truck or pipeline to the overland outfall discharge location (See Table 5-3 for coordinates). The discharge location at Milne Inlet is shown on the Milne Port Site Layout (refer to Appendix B).

Should discharge be necessary from the treated effluent tanks due to volume, the off-spec effluent will be stored in the Milne Port polishing waste stabilization pond (PWSP). The off-spec effluent will be removed by vacuum truck and fed into the new sewage plant feed tank for re-processing or treated by means of a pond treatment system (i.e. DAF system). Should there be high volumes of off-spec effluent greater than the capacity of the existing PWSP, the Type A (2AM-MRY1325 – Amendment 1) allows for the construction of a second PWSP to be built at Milne Port. This second PWSP (No. 2) would work in parallel with the existing PWSP and be treated in the same manner.

In the event that there is an electrical power outage that causes the sewage treatment plant to be completely inoperable, raw sewage will be diverted temporarily, trucked to the PWSP, until the sewage plant is operational. At that time, partially or untreated sewage from the PWSP(s) will be trucked back to the treatment plant for treatment or treated using an in situ pond treatment system and discharged to the ocean outfall (Refer to Appendix F - PWSP Effluent Discharge Plan). The PWSP Effluent Discharge Plan is used as a reference guideline by the onsite environmental team. Water quality parameters will be monitored in the spring and a discharge plan will be developed based on the determined water quality conditions. Discharges from Project PWSPs will be monitored and treated as outlined in the PWSP Effluent Discharge Plan to ensure effluent discharged meets the applicable water quality criteria outlined in the Type A Water Licence. In the event that water treatment methods differ significantly from the PWSP Effluent Discharge Plan, Baffinland will seek third party consultation to determine the appropriate water treatment methods.

The sludge generated by the MBR is de-watered using a mechanical de-watering device, a filter press, and then incinerated. Sludge is stored in an animal proof secure area. Odour generation is limited as a result of the sludge being aerobically digested, de-watered, and incinerated regularly such that the sewage cake is not stored for significant periods. Odour control carbon vents are installed where deemed necessary. The incinerator design considered the solids content of the sludge from the dewatering device. Note that there is a potential option to dispose of de-watered sludge in the Mine Site landfill with the appropriate approvals from authorities. Sewage sludge also accumulates in the bottom of the lift stations that service the accommodations camps at Project sites. Regular maintenance of the lift stations includes the periodic removal of the accumulated sewage sludge.

The sewage treatment system basis as described above will be applicable for current and future construction and operations requirements. The site layout showing the location of camp, sewage treatment and ancillary facilities is presented in Appendix B.

5.4.2 MARY RIVER MINE SITE

The onsite STP for the Mine Site is a Membrane Biological Reactor (MBR) facility that was installed in 2014. The Rotating Biological Contactor (RBC) type STP (Seprotech manufactured), previously used to treat sewage from the Mine Site Weatherhaven camp, will eventually be decommissioned however in the interim it is being used as a temporary holding facility/surge tank for the Mine Site Weatherhaven camp. Raw sewage is transported from the RBC by vacuum truck to the MBR for treatment. In the meantime, the option to re-commission this plant remains, should the need arise, as the required approvals for this facility are still in place.

Treated effluent from the new MBR sewage treatment plant is stored in a series of treated effluent tanks which collectively have a hydraulic retention time of 8 hours (at minimum) based upon nominal flows. It is designed such that the effluent tanks will be at a low level during operation. This design allows for delay of discharge should sampling indicate that the effluent quality does not meet the applicable criteria. Such delay allows the effluent to be mixed, retreated, and retested before discharge. Once sampling indicates that effluent is meeting discharge criteria the treated effluent stream is directed to discharge via pipeline to the Mary River discharge locations (See Table 5-3 for winter and summer discharge co-ordinates). The discharge locations at the Mine Site is shown on the Mine Site Layout presented in Appendix B.

Riprap has been used at the discharge locations to reduce sedimentation and erosion at the discharge location and along the drainages upstream of Mary River. Specific discharge locations into Mary River can be seen on the Mine Site Layout found in Appendix B. The discharge strategy will be reviewed annually and optimized as necessary.

In the event that there is an electrical power outage that causes the sewage treatment plant to become inoperable, raw sewage will be temporarily trucked to local existing polishing waste stabilization ponds until the sewage plant comes on line again. Partially or untreated sewage from the PWSPs from this event will either be trucked back to the treatment plant for treatment/reprocessing or treated in situ at the

pond location (Refer to Appendix F - PWSP Effluent Discharge Plan). The PWSP Effluent Discharge Plan is used as a reference guideline by the onsite environmental team. Water quality parameters will be monitored in the spring and a discharge plan will be developed based on the determined water quality conditions. Discharges from Project PWSPs will be monitored and treated as outlined in the PWSP Effluent Discharge Plan to ensure effluent discharged meets the applicable water quality criteria outlined in the Type A Water Licence. In the event that water treatment methods differ significantly from the PWSP Effluent Discharge Plan, Baffinland will seek third party consultation to determine the appropriate water treatment methods.

The sludge generated at the new MBR is dewatered using a mechanical dewatering device, a filter press, and then incinerated. Sludge cake is stored in an animal proof secure area. Odour generation will be limited because the sludge will be aerobically digested, dewatered and incinerated regularly such that the sewage cake is not stored for significant periods. Odour control carbon vents are installed where deemed necessary. The incinerator design considered the solids content of the sludge from the dewatering device. Sewage sludge also accumulates in the bottom of the lift stations that service the accommodations camps at Project sites. Regular maintenance of the lift stations includes the periodic removal of the accumulated sewage sludge.

The MBR sewage treatment plant is designed to also process raw or partially treated sewage from Ravn and Mid-Rail camps in the event these facilities have been constructed. The sewage could be transported to the Mary River permanent sewage treatment facility via vacuum truck.

The sewage treatment system basis as described above is adequate for current construction and operations requirements. The modular nature of the plants makes it very simple to add containerized plants for increased sewage treatment capacity. The site layout showing the location of camp, sewage treatment and ancillary facilities is presented in Appendix B.

6 OILY WATER/WASTEWATER TREATMENT

There are two sources of potentially oily water that have been identified at Milne Port and the Mine Site. There is the wash-water generated at the vehicle maintenance facilities, waste management building, emergency response garage, and truck wash, as well as the surface water that collects within the bulk fuel storage berms, hazardous waste storage berms, and Landfarm facilities at Project sites. Based on the different nature of these two wastewater sources, distinct discharge criteria (and treatment plans) have been developed for each.

6.1 OILY WATER TREATMENT DISCHARGE CRITERIA

All discharge from the Oily Water/Wastewater Treatment Facilities for monitoring stations MP-02, MS-02, and SP-02 will not exceed the following Effluent quality limits provided in Table 6-1 below.

TABLE 6-1: EFFLUENT DISCHARGE QUALITY LIMITS FOR OILY WATER TREATMENT FACILITIES*

Parameter	Maximum Concentration of Any Grab Sample (mg/L)
pH	6 – 9.5
TSS	35
Ammonia	4
Phosphorous	4
Benzene	0.370
Ethylbenzene	0.090
Toluene	0.002
Oil and Grease	15 and no visible sheen
Arsenic	0.50
Copper	0.30
Lead	0.20
Nickel	0.50
Zinc	0.50

*Source: Type A Water Licence (2AM-MRY1325 – Amendment No. 1) Table 6.

All discharge from Bulk Fuel Storage Facilities will not exceed the following effluent quality limits outlined in Table 6-2. Applicable Monitoring Stations include MP-03, MP-MRY-7, MS-03, MS-04, MS-MRY-6, SP-04 and SP-05.

TABLE 6-2: EFFLUENT DISCHARGE QUALITY LIMITS FOR THE BULK FUEL STORAGE FACILITIES*

Parameter	Maximum Concentration of any Grab Sample (mg/L)
Benzene	0.370
Toluene	0.002
Ethylbenzene	0.090
Lead	0.001
Oil and Grease	15 and no visible sheen

*Source: Type A Water Licence (2AM-MRY1325 Amendment No. 1) Table 8

All discharge from Landfarm Facilities, including the Contaminated Snow Containment Berms, will not exceed the following effluent quality limits outlined in Table 6-3. Applicable Monitoring Stations include MP-04, MS-05 and SP-06.

TABLE 6-3: EFFLUENT DISCHARGE QUALITY LIMITS FOR THE LANDFARM FACILITIES*

Parameter	Maximum Concentration of any Grab Sample (mg/L)
pH range	Between 6.0 and 9.0
Total Suspended Solids	15
Oil and Grease	15 and no sheen
Total Lead	0.001
Benzene	0.370
Toluene	0.002
Ethylbenzene	0.090

*Source: Type A Water Licence (2AM-MRY1325 - Amendment No. 1) Table 9

6.2 OILY WATER/WASTEWATER TREATMENT PROCESS DESCRIPTION

Oily water and wastewater generated by the Project shall be treated at the Oily Water/Wastewater Treatment Facilities allowed under the scope of the Licence. The process description for both oily water/wastewater treatment systems at each site are described in the sections that follow.

6.2.1 MILNE PORT

Oily water may be generated at the Milne Port from the following sources (this neglects minor oily water generated from accidental spills which will be handled by the Spill Contingency Plan):

- Vehicle maintenance and wash facilities (i.e. truck wash, snow/ice melt, equipment and floor wash down water).

- Bulk fuel storage facility (tank farm).
- Concrete sumps in buildings such as Maintenance Shops, Waste Management Building, Emergency Response Building, etc.
- Lined containment facilities/berms (i.e. hazardous waste, product storage).

All possible sources listed above are shown in the Milne Port layout presented in Appendix B.

Any oily water generated from the Milne Port Bulk Fuel Storage Facility or other lined containment facilities is collected in sump(s) within each facility. The water is then treated directly by the prefabricated mobile oily water separator (OWS) contained within a 40' seacan or an on-site constructed oily water separator. The prefabricated mobile OWS uses a series of skimmers, filters, clay, and activated carbon to capture and remove hydrocarbons from oily water.

Wash and melt water generated at the vehicle maintenance facilities, waste management building, and emergency response garage collects in each building's designated sump(s) by gravity flow. Suspended material in the wastewater settles out in the sump. All sump water collected in these buildings is collected and stored at engineered lined containment facilities until the water can be treated during the open water season using the mobile OWS system. Following treatment by the OWS, the treated effluent will be pH adjusted, if required, and resampled to ensure effluent water quality meets the applicable discharge criteria before the effluent is finally discharged to the receiving environment.

All effluent discharges of treated oily water/wastewater to the receiving environment will be discharged under intentions to meet effluent discharge criteria outlined in Section 6.1. Depending on the situation, treated oily water effluent may be blended with treated sewage and discharged, or discharged directly based on sampling.

6.2.2 MARY RIVER SITE

Oily water may be generated at the Mine Site from the following sources (this neglects minor oily water generated from accidental spills which will be handled by the Spill Contingency Plan):

- Vehicle maintenance and wash facilities (i.e. truck wash, snow/ice melt, equipment and floor wash down water).
- Bulk fuel storage facility (tank farm).
- Emulsion plant wash water
- Concrete sumps in buildings such as Maintenance Shops, Waste Management Building, Emergency Response Building, etc.
- Lined containment facilities/berms (i.e. hazardous waste, product storage).

All possible sources listed above are shown in the Mine Site layout presented in Appendix B.

Wash and melt water generated at the vehicle maintenance facilities, truck wash, waste management building, and emergency response garage collects in each buildings designated sump(s) by gravity flow. Suspended material in the wastewater settles out in the sump. All sump water collected in these buildings will be transferred to the Truck Wash Facility for treatment using the facility's oily water treatment plant, once it is fully commissioned. Prior to commissioning the Truck Wash Facility or in the event of a breakdown of that facility process, sump water will be transferred to Totes that will be stored in hazardous containment lined facilities. The water in these Totes will discharged and treated in lined berms utilizing the mobile OWS system or shipped off site for disposal at an accredited treatment facility.

The Truck Wash Facility is equipped with an oily water treatment plant as well as trays and a sump to capture all wash water generated at the facility, allowing it to recycle up to 90% of the water used. Wash water produced in the truck wash facility (truck washing, equipment and floor wash down) will flow by gravity and be collected in the trays and a local sump. Suspended material in the wastewater is removed using a series of sumps, settling tanks (de-muck tank) and filters. Free and emulsified oil in the wastewater is removed by the facility's oily water treatment plant which utilizes a series of skimmers, activated carbon and filters in order to substantially reduce oil levels in the recycled wastewater. The water is then reused by the facility to wash down equipment and vehicles. Should there need to be a discharge from the facility to the receiving environment, the wastewater is further treated with the facility's reverse osmosis unit and pH controller to ensure the final effluent meets all discharge criteria outlined in the Type A Water Licence.

Treated effluent from the truck wash's oily water treatment plant will be pumped to the discharge outfall at the Mary River or other on land location as agreed to by the Water Licence Inspector. Most water is recycled and reused within the facility. The separated waste oil will be stored in a local tank. Periodically, the oil from the tank will be drained and shipped off site or incinerated. Accumulated suspended solids will be periodically removed by bucket loader vehicle and sent to the Landfarm Facility for treatment if contaminated with hydrocarbons or the landfill if demonstrated to be non-hazardous.

Collected stormwater run-off from the Mine Site Bulk Fuel Storage Facility and/or other lined containment facilities (i.e. hazardous waste berms, etc.) will be treated using the mobile OWS system and discharged directly to the adjacent land surface. As mentioned prior, the mobile OWS system is a prefabricated mobile oily water separator contained within a 40' seacan. The mobile OWS system uses a series of skimmers, filters, clay and activated carbon to capture and remove oils and hydrocarbons from wastewater. Effluent from the mobile OWS will be sampled regularly to ensure effluent quality meets the applicable discharge criteria outlined in the Type A Water Licence.

Depending on the situation, effluent from either the mobile OWS system or the Truck Wash Facility may be blended with treated sewage and discharged, or discharged directly based on sampling.

The emulsion plant is equipped with its own wastewater treatment plant which utilizes an evaporation system to evaporate the water leaving solid residue and oil. This residue will be tested for toxicity and if necessary will be taken off-site for disposal at a licensed facility, otherwise the waste will be landfilled.

7 WATER MANAGEMENT PONDS

The water management ponds described in the sections below were constructed in 2015 to retain runoff water from the Milne Port ore stockpile pad and the Mine Site crushing pad and waste rock stockpile. The following improvements were completed in 2017:

- Complete contouring and ditching and expansion of stockpile and crushing pads at Project sites to effectively direct runoff from stockpile and crushing areas to their respective sedimentation ponds;
- Construction maintenance of the waste rock stockpile pond at the Mine Site; and
- Construction maintenance of diversion and collection ditches for the waste rock pile to direct surface water run off to the waste rock stockpile pond

7.1 DISCHARGE CRITERIA

All discharge from the water management ponds (MS-06, MS-07, MS-08, MS-09, and SP-07) associated with the Project's mining operations (crushing, ore, and waste rock stockpiles) will not exceed the following effluent quality limits provided in Table 7-1.

In addition, effluent discharged from water management ponds at the Mine Site (MS-06, MS-07, MS-08, MS-09) will not exceed the effluent quality limits within the Metal Mining Effluent Regulations (MMER) provided in Table 7-2. When the maximum limit for a parameter differs between the MMER and Water Licence discharge criteria, the more conservative (lower) limit for the parameter will be adopted.

7.1.1 TYPE A WATER LICENCE – NUNAVUT WATER BOARD

TABLE 7-1: EFFLUENT DISCHARGE QUALITY LIMITS FOR OPEN PIT, STOCKPILES, AND SEDIMENTATION PONDS (NWB)*

Parameter	Maximum Concentration of Any Grab Sample (mg/L)
Total Arsenic	0.50
Total Copper	0.30
Total Lead	0.20
Total Nickel	0.50
Total Zinc	0.50
Total Suspended Solids	15
Oil and Grease	No visible sheen
Toxicity	Not acutely toxic
pH	6.0 – 9.5

*Source: Type A Water Licence (2AM-MRY1325 – Amendment No. 1) Table 10.

7.1.2 METAL MINING EFFLUENT REGULATIONS – ENVIRONMENT CANADA*

TABLE 7-2: EFFLUENT DISCHARGE QUALITY LIMITS FOR OPEN PIT, STOCKPILES, AND SEDIMENTATION PONDS (EC)*

Parameter	Mean Monthly Limit (mg/L)[1]	Maximum Concentration of Any Grab Sample (mg/L)
Total Arsenic	0.50	1.00
Total Copper	0.30	0.60
Total Lead	0.20	0.40
Total Nickel	0.50	1.00
Total Zinc	0.50	1.00
Total Suspended Solids	15	30
Radium-226	0.37 Bq/L	1.11
pH	6 – 9.5	6 – 9.5
Toxicity	Not acutely toxic	Not acutely toxic

*Source: Metal Mining Effluent Regulations, Schedule 4

[1] Parameters listed above are sampled weekly during discharge.

Additional parameters including sub-lethal toxicity, aluminum, cadmium, iron, mercury, molybdenum, ammonia, nitrate, hardness, alkalinity and specific conductance are also required under MMER, however these parameters do not have a maximum water quality discharge limit but instead are used to provide additional information to assist in interpreting toxicity results and identifying potential effects on the receiving environment. For additional information on the MMER requirements pertaining to the Project refer to Appendix H.

7.2 MILNE PORT STOCKPILE SEDIMENTATION PONDS

The two (2) Milne Port stockpile sedimentation ponds (east and west) were constructed to temporarily retain the runoff water from the Milne Port ore stockpile and crushing/screening area and to contain the sediment load. During normal operation, runoff from the stockpile area drains to the stockpile sedimentation ponds. The ponds were designed with sufficient retention time to ensure the sediment would gravity-settle to the bottom of the pond and allow the runoff to be tested before the water reaches the overflow weirs. The ponds are equipped with overflow weirs designed to allow the unloaded surface water to drain through a controlled discharge to Milne Inlet. Alternatively, the pond can be pumped out using a portable pump arrangement.

In the case that the sedimentation pond effluent quality does not meet the discharge criteria outlined in the Type A Water Licence by means of sediment gravity settling alone, additional treatment methods (i.e. flocculants, GAC, clay, filters, etc.) will be employed to ensure effluent compliance.

The ponds were designed to fit within the foreshore areas north of the stockpile area and therefore do not encroach near the shoreline.

7.3 MINE SITE ORE CRUSHER PAD SEDIMENTATION POND

The Mine Site ore crusher pad sedimentation pond was completed in 2015. This pond is designed to temporarily retain the runoff water from the Mine Site crusher pad area and contain the sediment load, particularly during seasonal freshet activities. During normal operation, runoff from the crusher area drains to the sedimentation pond (west of the crusher pad). The pond is equipped with an overflow weir designed to allow, for extreme weather periods (e.g. greater than a 1 in 10 year, 24 hour design storm), the unloaded surface water to drain through a controlled discharge to Sheardown Lake however this is not the normal operating water shed. The ponds were designed with sufficient retention time to ensure the sediment would gravity-settle to the bottom of the pond before the water reaches the overflow weir.

The pond is also equipped with a pump pad on the northwest side. The normal operation of the pond will be to test the water quality for MMER and applicable Water Licence requirements and when on spec, control discharge using a portable pump arrangement. The pump arrangement connects into the treated effluent discharge pipeline for discharge to Mary River.

In the case that the sedimentation pond effluent quality does not meet the applicable discharge criteria by means of sediment gravity settling alone, additional treatment methods (i.e. flocculants, GAC, clay, filters, etc.) will be employed to ensure effluent compliance.

7.4 MINE SITE WASTE ROCK STOCKPILE POND

The Waste Rock Facility Surface Water Management Pond (WRF pond) was constructed to support Deposit No. 1 mining operations and is located northeast of the Deposit No. 1 open pit. Seepage and storm water runoff originating from the Waste Rock Stockpile is intercepted by the Facility's perimeter collection ditches and directed to the WRF pond. The WRF pond for the Mine Site was constructed in 2016 and is designed to temporarily retain surface water runoff. The pond is equipped with a pump pad on the north side. The pond is tested to ensure the effluent meets MMER and applicable Water licence Criteria and then controlled discharged seasonally using a portable pump arrangement. The pump arrangement discharges to a discharge diversion channel accessed by the overflow weir or directly to the Mary River Water Shed. The diversion channel drains into a small natural drainage which then in turn discharges to Mary River at a location designated in the Environmental Effects Monitoring Study Design. If required effluent will be transported via layflat hose to the Mary River watershed.

In high rainfall periods (e.g. greater than a 1 in 10 year, 24 hour design storm), the pond is also equipped with an overflow weir on the north side designed to allow the unloaded surface water to drain through a controlled discharge diversion channel, also to Mary River. The pond was designed with sufficient retention time to ensure the sediment would gravity-settle to the bottom of the pond before the water reaches the overflow weir. However Baffinland endeavors to control discharge water from the pond to meet MMER monitoring requirements using pumping systems.

In the case that the WRF pond effluent quality does not meet the applicable discharge criteria by means of sediment gravity settling alone, additional treatment methods or systems will be employed to ensure effluent compliance.

8 LANDFILL

8.1 DISCHARGE CRITERIA

All runoff and seepage from the Landfill Facilities at Monitoring Stations MS-MRY-13A, MS-MRY-13B and SP-08 will not exceed the following Effluent quality limits presented in the table below:

TABLE 8-1: EFFLUENT DISCHARGE QUALITY LIMITS FOR THE LANDFILL FACILITIES*

Parameter	Maximum Concentration of Any Grab Sample (mg/L)
pH range	Between 6.0 and 9.5
Total As	0.5
Total Cu	0.3
Total Pb	0.2
Total Ni	0.5
Total Zn	0.5
TSS	15
Oil and Grease	No visible sheen

*Source: Type A Water Licence (2AM-MRY1325 - Amendment No. 1) Table 7

8.2 MINE SITE LANDFILL

The Mine Site Landfill Facility is located just south of the NE Basin of Sheardown Lake. Both facility's monitoring stations, MS-MRY-13A and MS-MRY-13B, are sampled monthly during the open water season and are situated on a small stream down gradient of the Landfill Facility. The small stream drains into the NE Basin of Sheardown Lake on its southern shoreline. Refer to the Mine Site Layout presented in Appendix B for the exact location of the monitoring stations and Landfill Facility.

9 OPERATIONS AND MAINTENANCE (O & M)

The project specific O & M Manual for Sewage Treatment Systems is provided by Newterra Ltd in Appendix D. Sample plans for operation and maintenance of the potable water and oily water systems are given below. These plans were provided by the vendors of potable and oily water treatment systems.

9.1 POTABLE WATER TREATMENT SYSTEM O & M PLAN

9.1.1 REGULAR MAINTENANCE SCHEDULE

The potable water system is fully automatic, and only requires limited supervision and regular maintenance.

The following maintenance schedule is subject to regulations from local government, and instructions from original equipment manufacturers.

The following maintenance schedule is common for all potable treatment plants.

TABLE 9-1: RECOMMENDED MAINTENANCE SCHEDULE- POTABLE TREATMENT PLANTS

Items	Description
Daily	• Alarm check. • Chemical storage level check. • Controller time check. • Pressure gauge check. • Total and free chlorine testing. • Turbidity check.
Monthly	• Turbidity analyzer check/calibration. • Residual chlorine/pH analyzer check/calibration.
Annual	• Filter media level check, and refill if required. • UV lamp replacement.

9.1.2 MONITORING PLAN

The monitoring plan is subject to local regulations of drinking water and other related codes. The following instruments will be provided to monitor the operation and performance of system.

- Inlet flow meter: to monitor feed flow, backwash flow, rinse flow and filtered flow.
- Effluent turbidity analyzer: to monitor turbidity in produced water.

- Effluent pH/residual chlorine analyzer: to monitor pH and residual chlorine of produced water.

The PLC system in control panel will totalize raw water, produced water, backwash water, chemical injection, pump running time etc.

Periodically sampling and lab test for raw water and treated water will be applied to ensure the treated water meeting drinking water standards. The frequency of the sampling and testing will be determined by the ministry and outlined in the certificate of approval.

9.2 MOBILE OILY WATER SEPARATOR (OWS) SYSTEM

9.2.1 SYSTEM OVERVIEW

The mobile OWS is a prefabricated system (Newterra Ltd.) housed in a 40' seacan and is designed to remove oil, grease and BTE compounds from hydrocarbon contaminated water. The unit includes an API type separator to remove free product, a bag filter for solids removal and three adsorption units (one clay, two granular activated carbon) for oil/grease and BTE removal. In the event that the contaminated water has lead concentrations that exceed the discharge limits outlined in Baffinland's Type 'A' Water Licence, additional treatment barrels containing lead removal media are added to the end of the mobile OWS unit. Figure 9-1 shows the Process Flow Diagram for the OWS. The OWS (Newterra Ltd. model OWS-24) is sized for a water temperature of 7°C, specific gravity of 0.88 (diesel/furnace oil), TOG concentration of 50mg/L and flow rate of 50 gpm.

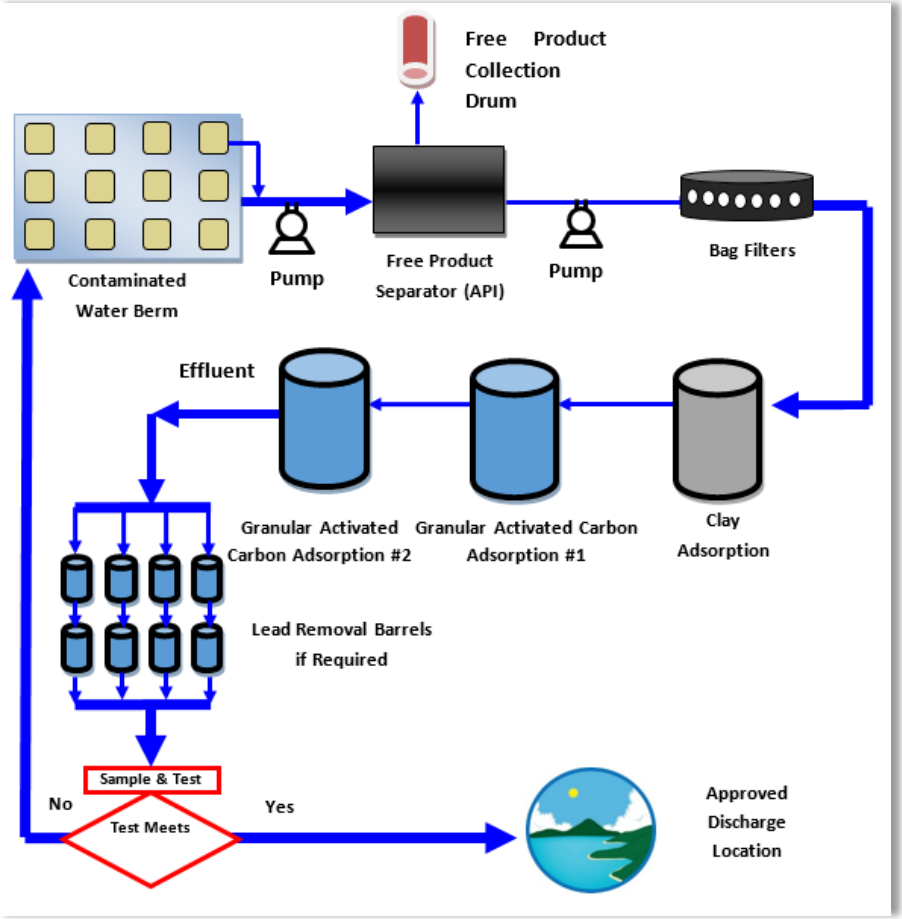


FIGURE 9-1 – MOBILE OWS FLOW PROCESS DIAGRAM

9.2.2 OPERATION AND MAINTENANCE PLAN

For the O&M procedures and schedule relating to the mobile OWS unit, refer to the Baffinland Mobile Oily Water Separator (OWS) Manual provided in Appendix G.

9.3 OILY WATER TREATMENT PLANT (FOR VEHICLE WASH WATER) O & M PLAN

9.3.1 REGULAR MAINTENANCE AND MONITORING SCHEDULE

Regular system maintenance entails routine inspection of mechanical and electrical components. It is recommended that the system be inspected weekly to ensure that components are in good working order. Spare parts lists will be included with the Operations and Maintenance Manuals, with critical spare parts and system expendables highlighted. Recommended stock quantities will also be given.

Operational maintenance is mainly comprised of waste removal and expendable replacement in addition to some preventative maintenance on mechanical components. Maintenance activities, locations and their recommended frequencies are given below.

TABLE 9-2: MAINTENANCE ACTIVITIES, LOCATIONS AND THEIR RECOMMENDED FREQUENCIES

Maintenance Task	Location	Frequency
Sludge/sediment removal	De-muck tank	Twice/week
Oil Removal	Waste oil storage	Weekly
Media change out	CMAFU-2	TBD
Media change out	DPL30	TBD
Filter change out	Reverse Osmosis Unit	TBD
Membrane cleaning	Reverse Osmosis Unit	TBD
Media change out (plates)	Oil Coalescing System	TBD
Pump seals	Various	Annually

Additional, non-routine maintenance will be required throughout the life of the equipment. The recommended spare parts list and appropriate site stock levels are designed to keep the system running continuously with only scheduled downtime.

In addition to maintenance, monitoring the system performance and effluent quality are also necessary. A flow totalizer will be used at the effluent discharge to accurately summate the volume of treated water being released. This in conjunction with the quality data from the various system flows will allow forecasting for media and consumable change-out as well as waste oil and sludge/sediment generation. Residual contaminants below the regulatory limits can also be used in conjunction with treated volumes to determine area loadings over certain periods of time.

Monitoring tasks, locations and frequencies are listed in the table below. The prefix, GI, in the task column denotes “General Inspection”. The Truck Wash Facility layout and component O & M manuals are presented in Appendix I.

TABLE 9-3: MONITORING TASKS, LOCATIONS AND FREQUENCIES

Monitoring Task	Location	Frequency
GI – solids/liquid separators (levels, appearance, pump operation)	De-muck system, CMAFU-2	Daily
Sample – solids/liquid separator effluent	CMAFU-2 effluent	TBD
GI – OWS (levels, appearance, dosing pump)	OWS room	Daily
Sample – OWS Inlet	CMAFU-2 effluent	TBD
GI – Chemical Treatment (tanks, totes, levels, appearance, mixers, dosing pumps, effluent pump, pressures)	Chemical room	Daily
GI – Filtration (units, pressures)	Reverse Osmosis Unit	Daily
GI – Media Vessels (units, pressures, backwash pump, treated water storage)	OCS Tank, DPL30	Daily
Sample – OWS outlet	DPL30 effluent	Quarterly/Monthly
Sample – Reverse osmosis effluent	Reverse Osmosis Unit effluent	Quarterly/Monthly
GI – Miscellaneous (vertical heaters, air compressors, air dryers, controls)	Various	Daily

A joint maintenance/monitoring log should be kept to ensure that operational data and changes/responses are properly documented.

The monitoring guidelines are recommended as a minimum to ensure proper operation, health, safety and protection of the surrounding environment. If corporate or regional policies in effect or enacted require more stringent monitoring, the scope and schedule should be adjusted to meet these requirements.

10 CONTINGENCY MEASURES

Design criteria for the potable, sewage and oily water treatment systems have been reviewed and revised to provide additional safety factor.

The sewage treatment systems are set back sufficiently from surface water bodies and are fully enclosed units. In the event of a spill of untreated or partially treated sewage from these facilities, Baffinland will follow the procedures in its Spill Contingency Plan. Sewage spills are treated the same as more immediately hazardous hydrocarbon based spills.

11 SAMPLING, MONITORING, AND REPORTING

Generally, sampling and monitoring of the potable and wastewater treatment systems will include the following:

- Regular sampling of sewage and wastewater discharge in accordance with water licence requirements.
- More frequent internal process sampling and monitoring to identify potential upset conditions early that could lead to non-compliance.
- Record of volumes of sewage and wastewater effluent discharged and sludge generated in accordance with water licence requirements.
- Completion of daily checklists related to the O & M requirements for the facilities and the reporting of any upset conditions that require action.
- Aquatic effects monitoring program to confirm/validate environmental predictions.

The monitoring program will identify upset conditions related to the sewage treatment plants which will be immediately reported to the COO and Environmental and Surface Works Superintendent for corrective action.

11.1 POTABLE WATER SYSTEM MONITORING

Untreated freshwater will be sampled at active take locations and/or from the raw water tank at the potable treatment plants. Treated potable water will be sampled from the potable treatment plant effluent as well as several locations throughout the distribution system.

Samples shall be collected at active water take location for select analyses at frequencies specified in applicable regulations/guidelines. A typical list of parameters which may be tested includes the following:

Calcium, Magnesium, Sodium, Potassium, Aluminum, Arsenic, Boron, Barium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Selenium, Silver, Strontium, Thallium, Vanadium, Zinc, Tin, pH, Conductivity, Alkalinity as CaCO3, TDS (COND-CALC), TSS (total suspended solids), Turbidity, Phenols, N-NH3, SO4, Cl, Br,N-NO2, N-NO3, NO2 + NO3 as N, Mercury, Hardness as CaCO3, COD (chemical oxygen demand), Oil and Grease.

A comparison of the sampling results to the Guidelines for Canadian Drinking Water Quality (GCDWQ) will be completed.

11.2 SEWAGE TREATMENT SYSTEM MONITORING

Treated sewage effluent will be monitored and sampled at proposed locations specified in the Type 'A' Water Licence (2AM-MRY1325 – Amendment No. 1). The effluent discharge criteria was summarized in Table 5-3.

11.3 OILY WATER TREATMENT SYSTEM MONITORING

Treated oily water effluent will be monitored and sampled at proposed locations specified in the Aquatic Effects Monitoring Program, BAF-PH1-830-P16-0039, (June 2014), and Type A Water Licence (2AM-MRY1325 – Amendment No. 1). The applicable effluent discharge criteria for oily water was summarized in Section 6.1 of this plan.

12 ENVIRONMENTAL RESPONSIBILITIES

12.1 ROLES AND RESPONSIBILITIES

The Baffinland Environmental Team is organised into two parts, on site as well as off site. The organisational structure for the Mary River Project in relation to the environment discipline is shown in Table 12-1 and 12-2 below.

TABLE 12-1: Baffinland Senior Management

Baffinland Senior Management	
Position	**Responsibilities and Accountabilities**
Chief of Operations	- Reports to Baffinland's CEO - Overall accountability for the operation of the Project - Allocation of resources (human and financial) for the implementation of Baffinland's commitments and objectives related to health, safety and environment during operation - Accountable for on-site environmental, health and safety performance during operation
VP Sustainable Development	- Reports to Baffinland's CEO - Establish corporate environmental policies and objectives - Monitors and reports on Baffinland's performance related to environmental policies and objectives - Liaise with regulatory authorities - Obtains necessary permits and authorizations - Monitors compliance with terms and conditions of permits and licences
Chief Procurement Officer	- Reports to Baffinland's CEO - Accountable for procurement and purchasing - Ensure that environmental commitments, policies and objectives are included in all contract documents

Baffinland Senior Management	
Position	**Responsibilities and Accountabilities**
Director Inuit, Government and Stakeholder Relations	- Reports to VP Sustainable Development - Accountable for external communication (Governments, media, NGO, others) related to Baffinland's press release and overall communication of site incidents/events - Community liaisons report to position
Director of Sustainable Development	- Reports directly to VP Sustainable Development and indirect reporting and coordination with Chief of Operations - Liaises with the senior management, regulators and stakeholders - Ensures effective monitoring and auditing of environmental performance of departments and contractors on site and identifies opportunities for improvement - Monitors compliance with permits, licenses and authorizations - Ensures all regulatory environmental monitoring and reporting requirements (monthly, annual) are met - Leads and coordinates site permitting requirements. - Initiates and oversees environmental studies

Baffinland's Project Environmental Department provides direction and oversight for environmental activities on-site. Project departmental accountabilities and responsibilities are identified in Table 12-2.

TABLE 12-2: Baffinland Project Environmental Department (Onsite)

Baffinland Project Environmental Department (Onsite)	
Position	**Responsibilities and Accountabilities**
Environmental Superintendent	- Reports to Director of Sustainable Development and indirect reporting and coordination with Chief of Operations - Overall accountability for environmental staff and performance at site - Coordinates implementation and monitors the performance of the Environmental Management System at site - Serves as the liaison for regulators during onsite inspections and visits - Provides ongoing environmental education and environmental awareness training to all employees and contract workers - Oversees investigations and reporting of environmental incidents to regulatory bodies, stakeholders and senior management - Reviews updates for management plans
Environmental Coordinator	- Reports to the Environmental Superintendent - Specific accountabilities for environmental monitoring and reporting - Provides day to day direction to Environmental staff onsite - Serves as a liaison for regulators during onsite inspections and visits. - Provides ongoing environmental education and environmental awareness training to all employees and contract workers

Baffinland Project Environmental Department (Onsite)	
Position	**Responsibilities and Accountabilities**
	- Assists with environmental database management - Prepare updates for management plans - Assist with monitoring and sampling activities as per the project's management plans
Environmental Monitor and Technician	- Reports to the Environmental Superintendent or designate - Assists with environmental database management - Assists with monitoring and sampling activities as per the Project's management plans
QIA Monitor	- Works alongside the Baffinland Environment Department to ensure the proper implementation of all environmental management and monitoring plans - Acts as the QIA liaison for onsite environmental matters
Environmental Support Groups (Consultants, etc.)	- Assists with sampling, monitoring and reporting activities as required by permits, licenses and environmental management plans - Provides technical expertise to various environmental studies

12.2 TRAINING AND AWARENESS

Staff and sub-contractors working on site will receive environmental training as part of the Site Orientation, to achieve a basic understanding of their obligations regarding environmental compliance with regulatory requirements, commitments and best practices.

Operations superintendents and contractor supervisors will be provided with this Management Plan, and will receive additional orientation with respect to the requirements outlined in this Plan. In addition, supervising level staff and sub-contractors will be provided with the Operational Standards (found in the Environmental Protection Plan) as a written guidance for their work.

Targeted environmental awareness training will be provided to both individuals and groups of workers assuming a specific authority or responsibility for environmental management or those undertaking an activity with an elevated high risk of environmental impact. These will be delivered in the form of toolbox/tailgate meetings or other means as appropriate.

The content of the environmental component of the site induction will include at a minimum:

a. Location of environmental sensitivities.
b. Location of additional information on environmental matters.
c. Due diligence responsibilities.
d. Responsibilities related to waste management, minimizing noise as necessary, road traffic rules, etc.
e. Principles and necessary steps to avoid encounters with bears or other wildlife and what to do if one such encounter occurs.

12.3 COMMUNICATION

The types of communications for which members of the team will participate include the following:

a. Formal written correspondence and meetings with stakeholders.
b. Site visits by community representatives.
c. Design, construction and planning meetings.
d. Field inspections and monitoring reports disseminated by the Environmental Superintendent.
e. Electronic communications.
f. Tailgate/toolbox meetings.
g. Formal written correspondence and meetings with government regulatory bodies.
h. Formal environmental awareness training.

Communications will be appropriately recorded and filed for future reference. Where appropriate, the copies of communications will be forwarded to Senior Management and the Environmental Superintendent.

12.4 EXTERNAL COMMUNICATIONS

Effective forms of communication include the proactive notification to external stakeholders of Project activity. Project activity updates will be provided to the communities of North Baffin through various means including regular meetings, public notices and radio announcements as appropriate. Baffinland will maintain Community Liaison Offices to assist in this regard.

12.5 CONSTRUCTION

During the construction phase of the Project, the Baffinland Head of Health Safety and Environment will be responsible for implementing this Plan. This Management Plan will be updated to take into account the numerous construction sites, and types of construction equipment utilized.

12.6 OPERATION AND CLOSURE

For the operations and closure phases, Baffinland will revise its organizational structure to reflect the realities of the operation. The Head of Health Safety and Environment will be responsible for subsequent updates and implementation of the Plan.

12.7 MARY RIVER PROJECT ORGANIZATIONAL CHARTS

For further information regarding the Mary River Projects organizational structure in relation to the environment discipline, please refer to the Organization Chart (Table 12.1, 12.2).

Appendix A -
Table of Concordance with Type A Water Licence (2AM-MRY1325 - Amendment No. 1) Terms and Conditions

Table A-1 shows the Part, number and Condition of the Type A Water Licence (2AM-MRY1325 - Amendment No 1 and the location where the condition is located within the Freshwater Supply, Sewage and Wastewater Management Plan.

TABLE A-1: CONCORDANCE TABLE - TYPE A WATER LICENCE 2AM-MRY1325 AMENDMENT NO 1

Part	Number	Condition	Section/Commitment
B	11	The Licensee shall post signs in the appropriate areas to inform the public of the location of infrastructure and/or facilities designed to contain, withhold, divert or retain Water and/or Waste. All signs must be in English, Inuktitut, and French.	Signage, written in English, Inuktitut, and French, will be posted inform the public of the location of infrastructure and/or facilities designed to contain, withhold, divert or retain Water and/or Waste.
D	2	The Licensee shall submit to the Board for review and acceptance, at least sixty (60) days prior to construction or in a timeframe otherwise approved by the Board in writing, final design and for-construction drawings, stamped and signed by a Professional Engineer, for all infrastructure and/or facilities designed to contain, withhold, divert or retain Water and/or Waste, as authorized under the Licence.	60 days prior to construction. If more immediate timeline required, Baffinland will issue letter to NWB with early drawings.

Part	Number	Condition	Section/Commitment
	17	The Licensee shall submit a Construction Summary Report to the Board, within ninety (90) days following the completion of any structure designed to contain, withhold, divert or retain Waters or Wastes, as authorized by the Board. The construction summary report shall be prepared by an Engineer(s) in accordance with Schedule D, Item 1.	90 days following the completion of any structure designed to contain, withhold, divert or retain Waters or Wastes, as authorized by the Board.
D	23	The Licensee shall construct and operate all infrastructure and Facilities authorized by the Board that are designed to contain, withhold, divert or retain Water and/or Waste, in accordance with all applicable legislation and industry standards.	Demonstrated and outlined by this plan.
E	3	The Licensee shall obtain all fresh Water for domestic camp use and industrial purposes, during the Construction Phase of the Project, in amounts and from the sources described in Table 2, or from sources otherwise approved by the Board in writing. In addition to the source-specific limits prescribed in Table 2, the Licensee is authorized to use up to one thousand eight hundred and eighty-eight (1,888) cubic metres of Water per day, to a maximum of six hundred and eighty-nine thousand (689,000) cubic metres of Water annually, during the Construction Phase of the Project. **Table 2: Water Use Authorized for Domestic and Industrial Purposes during Project Construction Phase** **Site** / **Source** / **Volume (m^3/day)** / **Combined Volume (m^3/year)** Milne Port (Milne Inlet) / Phillips Creek (summer) / Km 32 Lake (winter) / 367.5 / ~ 134,000 Mine Site (Mary River) / Camp Lake / 657.5 / 240,000 SteensbyPort (Steensby Inlet) / ST 347 Km Lake / 3 km Lake / 435.8 / 155,400 Ravn River / Camp Lake / 145.2 / Mid-Rail / Nivek Lake (summer) / Ravn Camp Lake (winter) / 79.5 / Cockburn North (Tunnels Camp) / Cockburn Lake / 101.4 / Cockburn South Camp / Cockburn Lake / 111.1 / **Annual Total** / **~ 689,000 m^3/Annually**	Table 4-1
E	5	The Licensee may recycle water and use reclaimed water from the various Treatment Facilities, surface water management ponds and embankment dams and approved discharge locations under the licence if such waters meet appropriate discharge criteria for those facilities.	5.2

Part	Number	Condition	Section/Commitment
E	6	The Licensee shall equip all Water intake hoses with screens of an appropriate mesh size, consistent with the requirements of Fisheries and Ocean Canada's (DFO) Freshwater Intake End-of-Pipe Fish Screen Guidelines (1995), to prevent the entrainment of fish are and shall withdraw Water at a rate such that fish do not become impinged on the screen.	4.1.1.2
E	8	Streams cannot be used as a water source unless authorized and approved by the Board in writing.	4.2
E	9	The Licensee shall notify the Inspector and the Board at least ten (10) days in advance of using Water from any sources not identified in the Application or requiring approval as per Part E, Item 8.	10 days in advance of using Water from any sources not identified in the Application or requiring approval.
E	10	The Licensee shall update or revise annually following the commencement of the Operations Phase and/or the Early Revenue Phase, the Project Blockflow Diagram Water Supply Balance information for the various Project sites, provided with the Application and submit for review of the Board. The submission shall be included with the Annual Report under Part B, Item 4.	The Plan is updated to include the planned construction numbers as well as the current Work Plan. Updates will be provided as required to include the Operations Phase.
E	11	The Licensee shall carry out weekly inspections of all structures designed to contain, withhold, divert or retain Waters or Wastes during periods of flow and maintain records of the inspections and findings, for review upon the request by the Board or an Inspector.	8
E	12	The Licensee shall not remove any material from below the ordinary High Water Mark of any water body unless authorized.	4.2
E	25	The Licensee is authorized to withdraw up to 1,500 m3 / day to a maximum of 547,500 m3 annually of Water specifically for use in dust suppression or control along the Tote Road during the Early Revenue Phase (ERP) of the Project. Water for dust suppression or control shall be obtained from the sources in accordance with thresholds established in Table 2-3.	Table 4-2

<table>
<tr><th>Part</th><th>Number</th><th>Condition</th><th>Section/Commitment</th></tr>
<tr><td></td><td></td><td>
Table 2-3: Water use Authorized for Dust Suppression
<table>
<tr><th>Site</th><th>Source</th><th>Prosed Maximum Volume (m^3/day)</th><th>Restriction</th></tr>
<tr><td rowspan="13">Tote Road</td><td>Phillip's Creek</td><td>212</td><td rowspan="3">None</td></tr>
<tr><td>Km 32 Lake</td><td>364</td></tr>
<tr><td>CV128</td><td>579.5</td></tr>
<tr><td>CV099</td><td>110</td><td rowspan="3">June –July only during low flow(less than mean flow) years</td></tr>
<tr><td>CV087</td><td>90</td></tr>
<tr><td>CV078</td><td>75</td></tr>
<tr><td>Katiktok Lake</td><td>318</td><td rowspan="2">None</td></tr>
<tr><td>BG50</td><td>150</td></tr>
<tr><td>BG32</td><td>120</td><td>June –July only during low flow(less than mean flow) years</td></tr>
<tr><td>CV217</td><td>130</td><td rowspan="2">None</td></tr>
<tr><td>Muriel Lake</td><td>212</td></tr>
<tr><td>David Lake</td><td>132</td><td>June –July only during low</td></tr>
<tr><td>BG17</td><td>75</td><td>flow(less than mean flow) years</td></tr>
<tr><td>CV233 (Tom River)</td><td>135</td><td rowspan="2">None</td></tr>
<tr><td>Camp Lake</td><td>86</td></tr>
</table>
</td><td></td></tr>
<tr><td>E</td><td>26</td><td>The Licensee shall obtain authorization from the Board in writing prior to using Water authorized under Part E, Item 25, for purposes other than that authorized in Part E, Item 25.</td><td>4.2</td></tr>
<tr><td>F</td><td>9</td><td>The Licensee shall treat oily water and wastewater generated by the Project at the Oily Water/Wastewater Treatment Facilities authorized under the scope of the Licence.</td><td>6.3</td></tr>
<tr><td>F</td><td>11</td><td>The Licensee shall provide at least ten (10) days' notice to the Inspector prior to planned Discharges from any Waste Management Facility, Oily Water/Wastewater Treatment Facilities, Sewage Treatment Facilities, and any other relevant facilities associated with the Project. The notice shall include the estimated volume proposed for Discharge and the location and description of the receiving environment.</td><td>10 days prior to the commencement of any treated effluent discharge.</td></tr>
<tr><td>F</td><td>12</td><td>The Licensee shall, unless otherwise approved by the Board in writing, discharge effluent at a distance of least thirty-one (31) metres above the Ordinary High Water Mark of any Water body, where direct flow into the Water body is not possible, such that surface erosion is minimized and no additional impacts are created.</td><td>Section 5.3</td></tr>
<tr><td>F</td><td>14</td><td>The Licensee shall direct all Sewage generated from the relevant Project sites to the Sewage Treatment Facilities or as otherwise approved by the Board in writing.</td><td>5.2</td></tr>
</table>

Part	Number	Condition	Section/Commitment
F	15	The Licensee shall treat all Sewage waste generated at the Ravn River and Mid-Rail camps and Sewage generated at the Cockburn North and Cockburn South camps at either the Mine Site Sewage Treatment Facility or the Steensby Port Sewage Treatment Facility, unless otherwise approved by the Board in writing.	Appendix E

<table>
<tr><th>Part</th><th>Number</th><th>Condition</th><th>Section/Commitment</th></tr>
<tr><td>F</td><td>16</td><td>The Licensee shall provide to the Board for review, at least sixty (60) days prior to installation, detailed specifications and operational requirements for the Sewage storage tanks proposed for the Railway camps.</td><td>60 days prior to installation</td></tr>
<tr><td>F</td><td>17</td><td>All discharge from the Sewage Treatment Facilities including the Polishing Waste Stabilization Ponds directly into fresh Water bodies at Monitoring Stations MP-01, MP-01a, MP-MRY-04, MP-MRY-04a, MS-01, MS-01a, MS-MRY-04, MS-MRY-04a, and/or from monitoring stations as otherwise approved by the Board in writing, must not exceed the following Effluent quality limits:
Table 4: Effluent Quality Discharge Limits for Sewage Treatment Facilities to Freshwater Receiving Environment
<table><tr><th>Parameter</th><th>Maximum Concentration of Any Grab Sample (mg/L)</th></tr><tr><td>BOD_5</td><td>30</td></tr><tr><td>Total Suspended Solids</td><td>35</td></tr><tr><td>Faecal Coliform</td><td>1000 CFU/100 mL</td></tr><tr><td>Oil and Grease</td><td>No visible sheen</td></tr><tr><td>pH</td><td>Between 6.0 and 9.5</td></tr><tr><td>Ammonia (NH3-N)</td><td>4.0</td></tr><tr><td>Total Phosphorous (MS-01)</td><td>4.0</td></tr><tr><td>Total Phosphorous (MS-01a)</td><td>1.0</td></tr><tr><td>Toxicity</td><td>Not acutely toxic</td></tr></table>(Note that treated effluent discharge from MP-01 and MP-01a is directed to the ocean, therefore ocean discharge criteria (F18) would therefore apply)</td><td>Table 5-2</td></tr>
<tr><td>F</td><td>18</td><td>All discharge from the Sewage Treatment Facilities including the Polishing Waste Stabilization Ponds at Monitoring Stations SP-01, SP-01a, and/or from monitoring stations as otherwise approved by the Board in writing, directly into the ocean or to ditches flowing into the ocean shall not exceed the following Effluent quality limits:
Table 5: Effluent Quality Discharge Limits for Sewage Treatment Facilities to the Ocean
<table><tr><th>Parameter</th><th>Maximum Concentration of Any Grab Sample (mg/L)</th></tr><tr><td>BOD_5</td><td>100</td></tr><tr><td>Total Suspended Solids</td><td>120</td></tr><tr><td>Faecal Coliform</td><td>10,000 CFU/100 mL</td></tr><tr><td>Oil and Grease</td><td>No visible sheen</td></tr><tr><td>pH</td><td>Between 6.0 and 9.5</td></tr><tr><td>Toxicity</td><td>Not acutely toxic</td></tr></table>(Note that treated effluent discharge from MP-01 and MP-01a is directed to the ocean, therefore the above ocean discharge criteria are applied for these locations)</td><td>Table 5-2</td></tr>
<tr><td>F</td><td>19</td><td>Sludge generated from the Sewage Treatment Facilities or any other facilities shall be confirmed to be non-hazardous</td><td>5.2</td></tr>
</table>

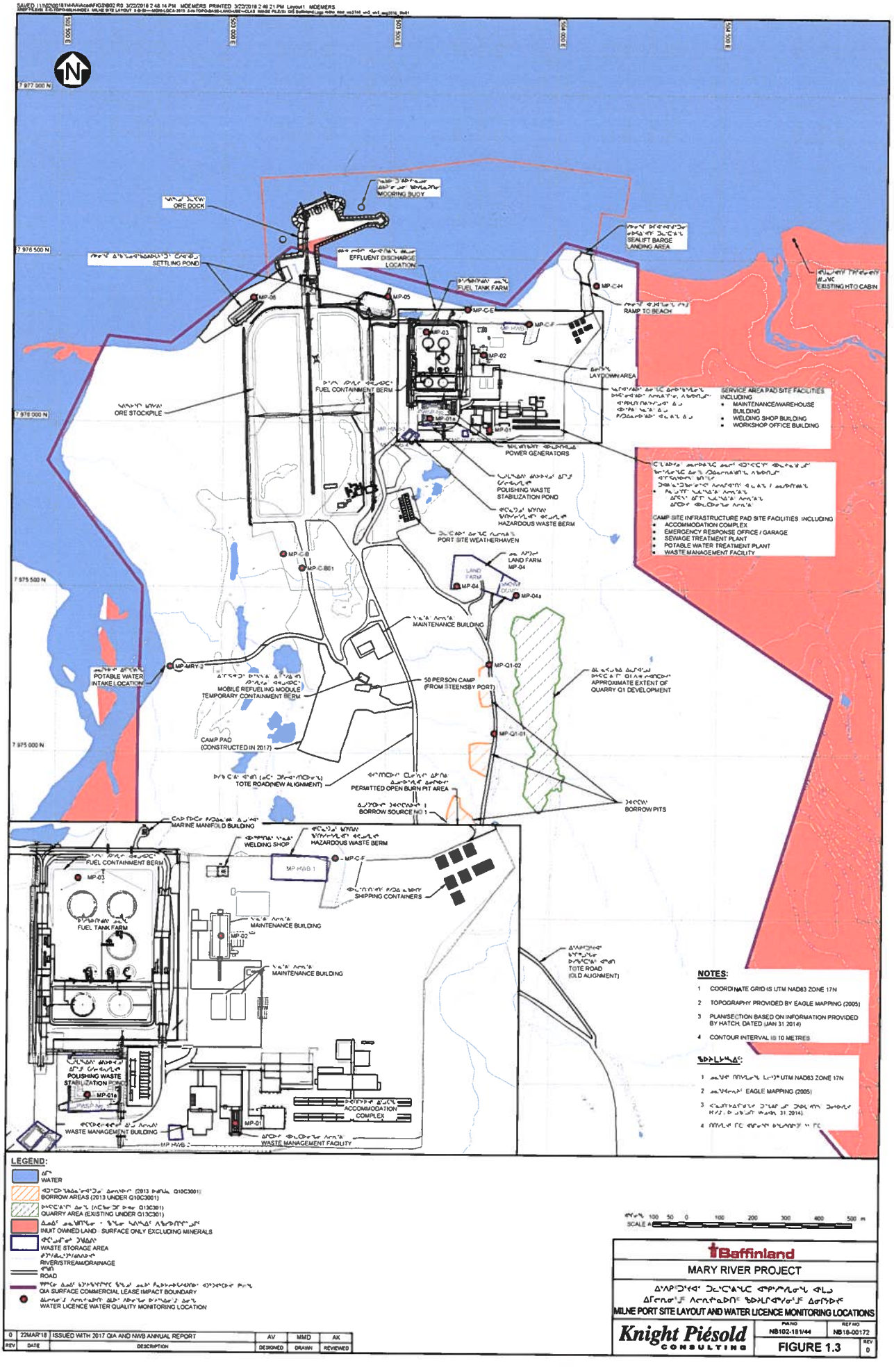
<table>
<tr><th>Part</th><th>Number</th><th>Condition</th><th>Section/Commitment</th></tr>
<tr><td></td><td></td><td>and the results provided to the Board for review prior to disposal at any Landfill Facility or as otherwise approved by the Board in writing.</td><td></td></tr>
<tr><td>F</td><td>20</td><td>All discharge from the Oily Water/Wastewater Treatment Facilities at Monitoring Stations MP-02, MS-02, SP-02 must not exceed the following Effluent quality limits:
Table 6: Effluent Quality Discharge Limits for Oily Water Treatment Facilities
<table>
<tr><th>Parameter</th><th>Maximum Concentration of Any Grab Sample (mg/L)</th></tr>
<tr><td>pH</td><td>Between 6.0 and 9.5</td></tr>
<tr><td>TSS</td><td>35</td></tr>
<tr><td>Ammonia</td><td>4.0</td></tr>
<tr><td>Phosphorous</td><td>4.0</td></tr>
<tr><td>Benzene</td><td>0.370</td></tr>
<tr><td>Ethylbenzene</td><td>0.090</td></tr>
<tr><td>Toluene</td><td>0.002</td></tr>
<tr><td>Oil and Grease</td><td>15 and no visible sheen</td></tr>
<tr><td>Arsenic</td><td>0.50</td></tr>
<tr><td>Copper</td><td>0.30</td></tr>
<tr><td>Lead</td><td>0.20</td></tr>
<tr><td>Nickel</td><td>0.50</td></tr>
<tr><td>Zinc</td><td>0.50</td></tr>
</table></td><td>Table 6-1</td></tr>
<tr><td>F</td><td>21</td><td>All discharge from the Landfill Facilities at Monitoring Stations MS-MRY-13a, MS-MRY-13b and SP-08 must not exceed the following Effluent quality limits:
Table 7: Effluent Quality Discharge Limits for the Landfill Facilities
<table>
<tr><th>Parameter</th><th>Maximum Concentration of Any Grab Sample (mg/L)</th></tr>
<tr><td>pH</td><td>Between 6.0 and 9.5</td></tr>
<tr><td>Total As</td><td>0.5</td></tr>
<tr><td>Total Cu</td><td>0.3</td></tr>
<tr><td>Total Pb</td><td>0.2</td></tr>
<tr><td>Total Ni</td><td>0.5</td></tr>
<tr><td>Total Zn</td><td>0.5</td></tr>
<tr><td>Total Suspended Solids</td><td>15</td></tr>
<tr><td>Oil and Grease</td><td>No visible sheen</td></tr>
</table></td><td>Table 5-4</td></tr>
<tr><td>F</td><td>22</td><td>All discharge from the Bulk Fuel Storage Facilities at Monitoring Stations MP-03, MP-MRY-7, MS-03, MS-04, MS-MRY-6, SP-04 and SP-05 must not exceed the following Effluent quality limits:
Table 8: Effluent Quality Discharge Limits for the Bulk Fuel Storage Facilities
<table>
<tr><th>Parameter</th><th>Maximum Concentration of Any Grab Sample (ug/L)</th></tr>
<tr><td>Benzene</td><td>370</td></tr>
<tr><td>Toluene</td><td>2</td></tr>
<tr><td>Ethylbenzene</td><td>90</td></tr>
<tr><td>Lead</td><td>1</td></tr>
<tr><td>Oil and Grease</td><td>15,000 and no visible sheen</td></tr>
</table></td><td>Table 5-5</td></tr>
</table>

<table>
<tr><th>Part</th><th>Number</th><th>Condition</th><th>Section/Commitment</th></tr>
<tr><td>F</td><td>23</td><td>All discharge from the Landfarm Facilities at Monitoring Stations MP-04, MS-05 and SP-06 must not exceed the following Effluent quality limits:

Table 9: Effluent Quality Discharge Limits for the Landfarm Facilities
<table><tr><th>Parameters</th><th>Maximum Concentration of Any Grab Sample (mg/L)</th></tr><tr><td>pH</td><td>Between 6.0 and 9.0</td></tr><tr><td>Total Suspended Solids</td><td>15</td></tr><tr><td>Oil and Grease</td><td>15 and no sheen</td></tr><tr><td>Total Lead</td><td>0.001</td></tr><tr><td>Benzene</td><td>0.370</td></tr><tr><td>Toluene</td><td>0.002</td></tr><tr><td>Ethylebenzene</td><td>0.090</td></tr></table></td><td>Table 5-6</td></tr>
<tr><td>F</td><td>24</td><td>All Discharge from the Bulk Sample Open Pit, Bulk Sample Weathered Ore Stockpile, Bulk Sample Processing Stockpile Area and Bulk Sample Stockpile Area Seepage and runoff from the at Milne Inlet at Monitoring Stations MS-MRY-09, MS-MRY-10, MS-MRY-11, MP-MRY-12 and/or monitoring stations as otherwise approved by the Board shall not exceed the following Effluent quality limits:

Table 10: Effluent Quality Discharge Limits for Open Pit, Stockpiles, and Sedimentation Ponds
<table><tr><th>Parameter</th><th>Maximum Concentration of Any Grab Sample (mg/L)</th></tr><tr><td>Total Arsenic</td><td>0.50</td></tr><tr><td>Total Copper</td><td>0.30</td></tr><tr><td>Total Lead</td><td>0.20</td></tr><tr><td>Total Nickel</td><td>0.50</td></tr><tr><td>Total Zinc</td><td>0.50</td></tr><tr><td>Total Suspended Solids</td><td>15.0</td></tr><tr><td>Oil and Grease</td><td>No visible sheen</td></tr><tr><td>Toxicity</td><td>Not acutely toxic</td></tr><tr><td colspan="2">The waste discharge shall have a pH of between 6.0 and 9.5</td></tr></table></td><td>Table 5-7</td></tr>
<tr><td>F</td><td>26</td><td>All discharge from the Ponds associated with the Run of Mine Ore Stockpile, Ore Stockpile, West and East Sediment Ponds at Monitoring stations MS-06+, MS-07, MS-08 MS-09 and SP-07 shall not exceed the Effluent quality limits of Part F, Item 25</td><td>5.3 and Table 5-7</td></tr>
</table>

Appendix B -
Site Layout (Mine Site and Port Site)



NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 17N
2. TOPOGRAPHY PROVIDED BY EAGLE MAPPING (2005)
3. PLAN/SECTION BASED ON INFORMATION PROVIDED BY HATCH, DATED (JAN 31, 2014)
4. CONTOUR INTERVAL IS 10 METRES

LEGEND:

- WATER
- BORROW AREAS (2013 UNDER Q10C3001)
- QUARRY AREA (EXISTING UNDER Q13C301)
- INUIT OWNED LAND - SURFACE ONLY EXCLUDING MINERALS
- WASTE STORAGE AREA
- RIVER/STREAM/DRAINAGE
- ROAD
- QIA SURFACE COMMERCIAL LEASE IMPACT BOUNDARY
- WATER LICENCE WATER QUALITY MONITORING LOCATION

SCALE A: 100 50 0 100 200 300 400 500 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	22MAR'18	ISSUED WITH 2017 QIA AND NWB ANNUAL REPORT	AV	MMD	AK

Baffinland

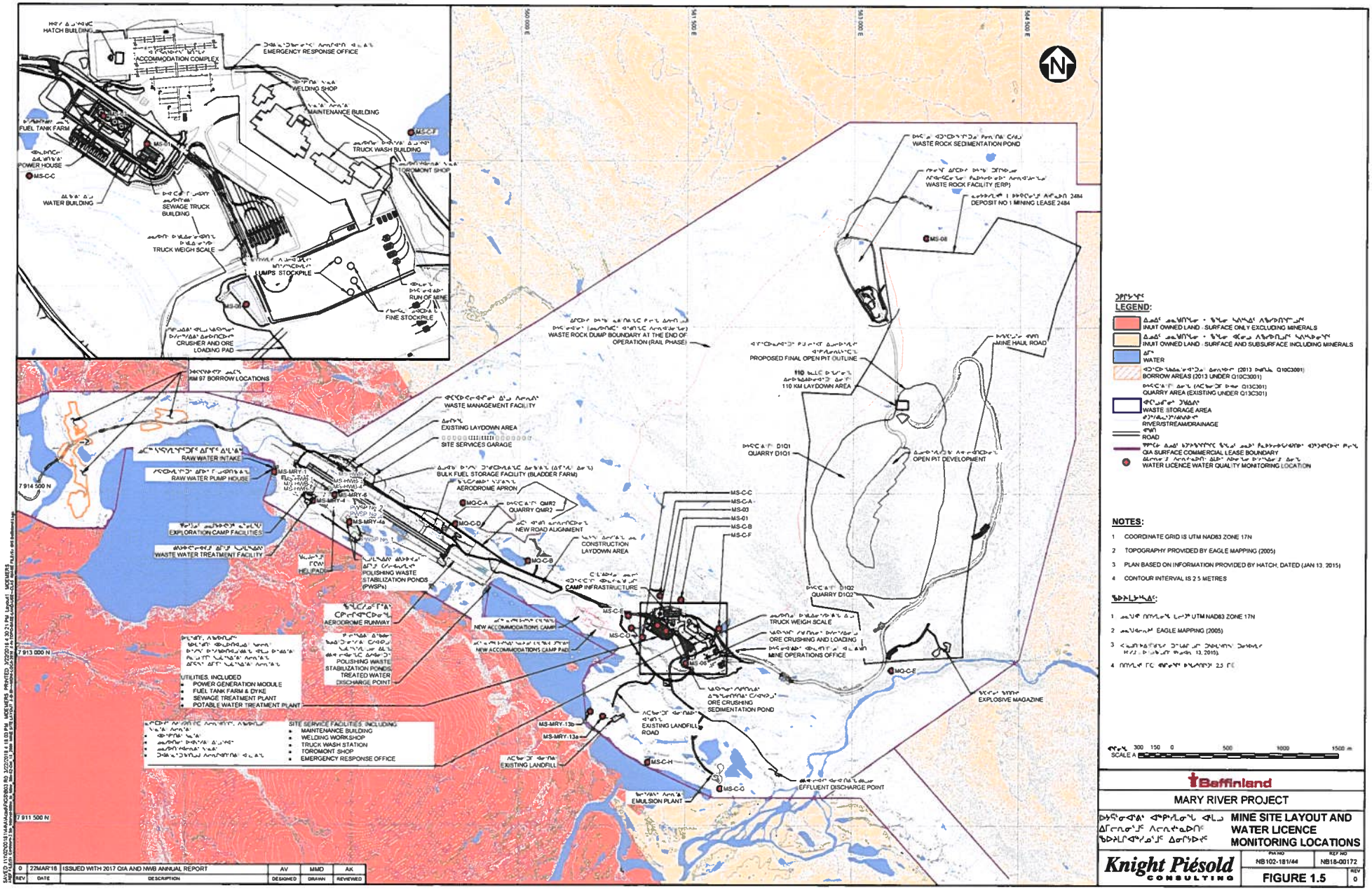
MARY RIVER PROJECT

MILNE PORT SITE LAYOUT AND WATER LICENCE MONITORING LOCATIONS

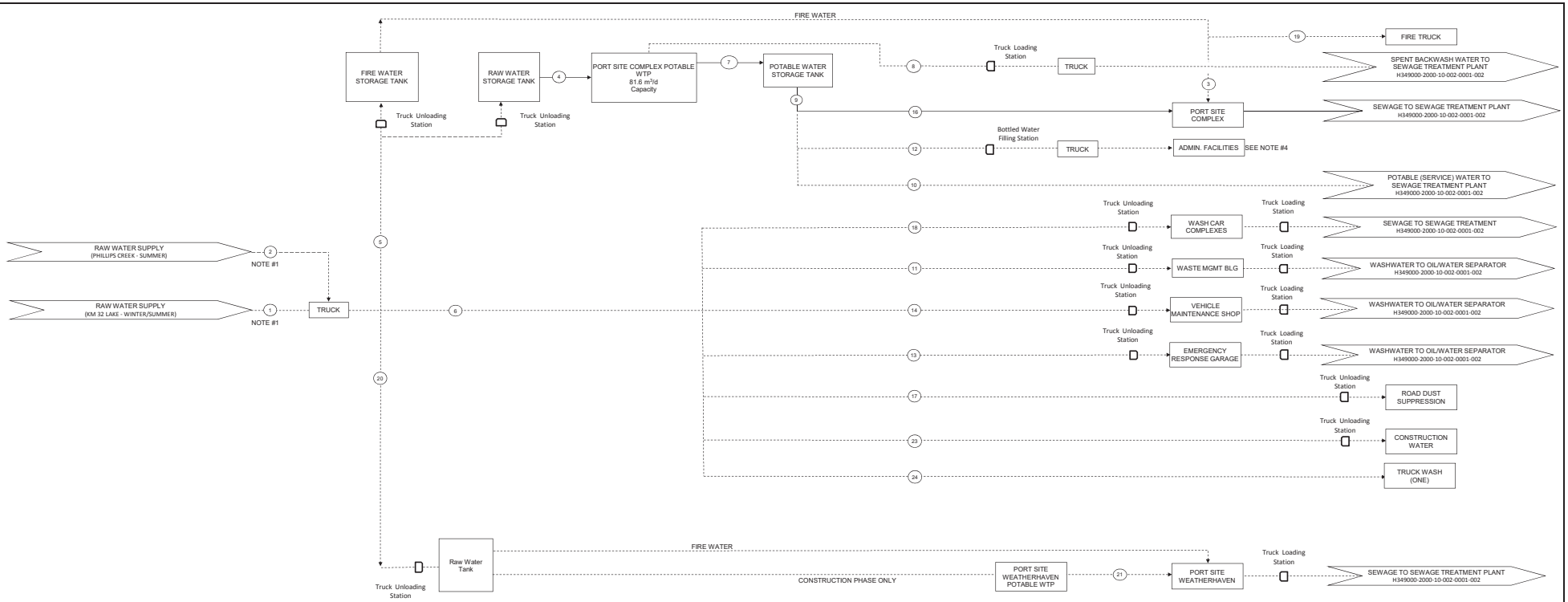
Knight Piésold CONSULTING

PIN NO NB102-181/44 | REF NO NB18-00172

FIGURE 1.3 | REV 0


HATCH BUILDING
ACCOMMODATION COMPLEX
EMERGENCY RESPONSE OFFICE
WELDING SHOP
MAINTENANCE BUILDING
FUEL TANK FARM
TRUCK WASH BUILDING
TOROMONT SHOP
POWER HOUSE
WATER BUILDING
SEWAGE TRUCK BUILDING
TRUCK WEIGH SCALE
LUMPS STOCKPILE
RUN OF MINE
FINE STOCKPILE
CRUSHER AND ORE LOADING PAD
WASTE ROCK DUMP BOUNDARY AT THE END OF OPERATION (RAIL PHASE)
WASTE ROCK SEDIMENTATION POND
WASTE ROCK FACILITY (ERF)
DEPOSIT NO 1 MINING LEASE 2484
PROPOSED FINAL OPEN PIT OUTLINE
110 KM LAYDOWN AREA
MINE HAUL ROAD
QUARRY D1Q1
OPEN PIT DEVELOPMENT
QUARRY D1Q2
TRUCK WEIGH SCALE
ORE CRUSHING AND LOADING
MINE OPERATIONS OFFICE
ORE CRUSHING SEDIMENTATION POND
EXPLOSIVE MAGAZINE
EXISTING LANDFILL ROAD
EXISTING LANDFILL
EMULSION PLANT
EFFLUENT DISCHARGE POINT
KM 97 BORROW LOCATIONS
WASTE MANAGEMENT FACILITY
EXISTING LAYDOWN AREA
SITE SERVICES GARAGE
RAW WATER INTAKE
RAW WATER PUMP HOUSE
BULK FUEL STORAGE FACILITY (BLADDER FARM)
AERODROME APRON
QUARRY QMR2
NEW ROAD ALIGNMENT
CONSTRUCTION LAYDOWN AREA
EXPLORATION CAMP FACILITIES
WASTE WATER TREATMENT FACILITY
POLISHING WASTE STABILIZATION PONDS (PWSPs)
CAMP INFRASTRUCTURE
AERODROME RUNWAY
NEW ACCOMMODATIONS CAMP
NEW ACCOMMODATIONS CAMP PAD
POLISHING WASTE STABILIZATION PONDS TREATED WATER DISCHARGE POINT
UTILITIES, INCLUDED
POWER GENERATION MODULE
FUEL TANK FARM & DYKE
SEWAGE TREATMENT PLANT
POTABLE WATER TREATMENT PLANT
SITE SERVICE FACILITIES, INCLUDING
MAINTENANCE BUILDING
WELDING WORKSHOP
TRUCK WASH STATION
TOROMONT SHOP
EMERGENCY RESPONSE OFFICE
MS-MRY-1
MS-MRY-2
MS-MRY-3
MS-MRY-4
MS-MRY-5
MS-MRY-6
MS-MRY-4a
MS-MRY-13b
MS-MRY-13a
MS-C-A
MS-C-B
MS-C-C
MS-C-D
MS-C-E
MS-C-F
MS-C-G
MS-C-H
MS-01
MS-03
MS-05
MS-08
MQ-C-A
MQ-C-B
MQ-C-D
MQ-C-E
7 914 500 N
7 913 000 N
7 911 500 N
560 000 E
561 500 E
563 000 E
564 500 E
LEGEND:
INUIT OWNED LAND - SURFACE ONLY EXCLUDING MINERALS
INUIT OWNED LAND - SURFACE AND SUBSURFACE INCLUDING MINERALS
WATER
BORROW AREAS (2013 UNDER Q10C3001)
QUARRY AREA (EXISTING UNDER Q13C301)
WASTE STORAGE AREA
RIVER/STREAM/DRAINAGE
ROAD
QIA SURFACE COMMERCIAL LEASE BOUNDARY
WATER LICENCE WATER QUALITY MONITORING LOCATION
NOTES:
1 COORDINATE GRID IS UTM NAD83 ZONE 17N
2 TOPOGRAPHY PROVIDED BY EAGLE MAPPING (2005)
3 PLAN BASED ON INFORMATION PROVIDED BY HATCH, DATED (JAN 13, 2015)
4 CONTOUR INTERVAL IS 2.5 METRES
SCALE A 300 150 0 500 1000 1500 m
0 22MAR18 ISSUED WITH 2017 QIA AND NWB ANNUAL REPORT AV MMD AK
REV DATE DESCRIPTION DESIGNED DRAWN REVIEWED
Baffinland
MARY RIVER PROJECT
MINE SITE LAYOUT AND WATER LICENCE MONITORING LOCATIONS
Knight Piésold CONSULTING
PWA NO NB102-181/44
REF NO NB18-00172
FIGURE 1.5
REV 0

Appendix C -
Block Flow Diagrams – Milne Port and Mine Site



	NOTE #1	NOTE #1										
Stream No.	1	2	3	4	5	6	7	8	9	10	11	12
Stream Description	WINTER RAW WATER SUPPLY	SUMMER RAW WATER SUPPLY	FIREWATER	RAW WATER FEED TO PORT SITE COMPLEX CAMP POTABLE WTP	RAW WATER FEED TO PORT SITE COMPLEX CAMP	RAW WATER FEED TO VARIOUS LOCATIONS (NON-CAMP)	POTABLE WATER FROM PORT SITE COMPLEX CAMP POTABLE WTP	POTABLE WTP SPENT BACKWASH WATER	POTABLE WATER DISTRIBUTION	POTABLE (SERVICE) WATER TO STP	RAW WATER (WASHWATER) TO WASTE MGMT BLG	POTABLE (BOTTLED) WATER TO ADMIN. BUILDING
Construction Phase - Design (m^3/h)	15.31	15.31	300	3.40	346.26	143.49	3.40	0.00013	13.50	1.000	1.000	0.200
Construction Phase - Nominal (m^3/h)	5.26	5.26	-	2.52	2.52	1.34	2.52	0.00013	2.52	0.060	0.043	0.008
Operation Phase - Design (m3/h)	15.31	15.31	300	3.40	346.26	142.57	3.40	0.00013	13.50	1.000	1.000	0.200
Operation Phase - Nominal (m3/h)	3.61	3.61	-	2.53	2.53	1.08	2.53	0.00013	2.53	0.060	0.043	0.008
Stream No.	13	14	15	16	17	18	19	20	21	22	23	24
Stream Description	RAW WATER (WASHWATER) TO EMERG. RESPONSE SHOP	RAW WATER (WASHWATER) TO VEHICLE MAINT. SHOP	NOT USED	POTABLE WATER TO PORT SITE COMPLEX CAMP	RAW WATER TO DUST SUPPRESSION	RAW WATER TO TEMP. WASH CAR COMPLEXES	FIRETRUCK	RAW WATER FEED TO CONSTRUCTION CAMPS	POTABLE WATER TO WEATHERHAVEN CAMP	POTABLE WATER TO SHENCO CAMP	CONSTRUCTION WATER	TRUCK WASH (ONE)
Construction Phase - Design (m^3/h)	1.000	42.86	0.000	12.30	42.86	42.9	42.86	0.00	7.01	0.00	0.92	12.00
Construction Phase - Nominal (m^3/h)	0.043	0.25	0.000	2.46	0.21	0.04	0.00	0.00	1.40	0.00	0.01	0.75
Operation Phase - Design (m3/h)	1.000	42.86	0.000	12.30	42.86	42.9	42.86	0.00	0.00	0.00	0.00	12.00
Operation Phase - Nominal (m3/h)	0.043	0.00	0.000	2.46	0.21	0.0	0.00	0.00	0.00	0.00	0.00	0.75

NOTE(S):

1.0 Raw water supply flow rate from Philips Creek (Summer) & KM 32 Lake (Winter/Summer) are equal to or less than Type A Water Licence 2AM-MRY1325 Amend. No. 1 flow rate limit of 367.5 m^3/day (134,137.5 m^3/year).

2.0 Construction phase potable water supply flow rate is 92.7 m^3/day total.

3.0 Operational phase potable water supply flow rate is 59.0 m^3/d total.

4.0 Sewage generated by the Admin. Facilities reports to the Wash Car Complexes, which provide washroom facilities for these users.

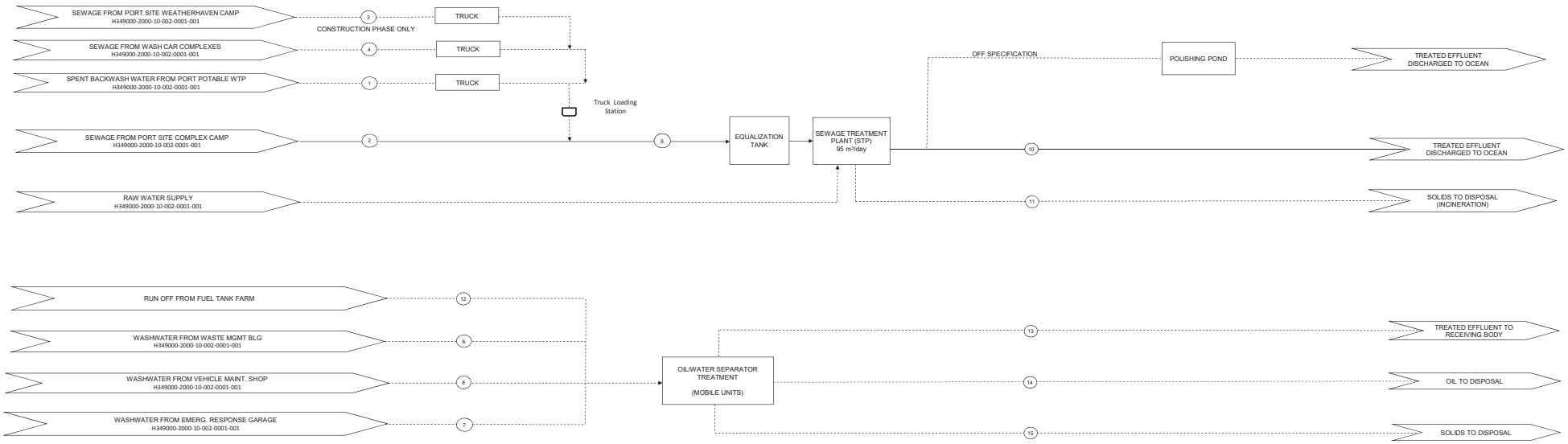
LEGEND:

CONTINUOUS FLOW ———

INTERMITTENT FLOW - - - - - - -

Baffinland

EDITED BY:	ANDREW VERMEER	MARY RIVER PROJECT
DATE:	17-MAR-2016	
CHECKED BY:	ALLAN KNIGHT	MILNE INLET PORT SITE WATER SUPPLY BALANCE BLOCK FLOW DIAGRAM 2016 Work Plan (cont'd from DWG# H349000-2000-10-002-0001)
DATE:	17-MAR-2016	
PROJ. MGR		SCALE NTS OR AS NOTED
DATE:		DWG NO. H349001-2000-10-002-0001-001
		REV B



Stream No.	1	2	3	4	5	6	7	8	9	10	11	12
Stream Description	SPENT BACKWASH WATER FROM PORT SITE COMPLEX POTABLE WTP	SEWAGE FROM PORT SITE COMPLEX CAMP	SEWAGE FROM WEATHERHAVEN (MATRIX) CAMP	SEWAGE FROM WASH CAR COMPLEXES	SEWAGE FROM SHENCO CAMP	WASHWATER FROM WASTE MGMT BLG	WASHWATER FROM EMER. RESPONSE GARAGE	WASHWATER FROM VEHICLE MAINT. SHOP	SEWAGE FEED TO EQ TANK/STP	SEWAGE TREATMENT PLANT EFFLUENT	SEWAGE TREATMENT PLANT SOLIDS TO DISPOSAL	RUN OFF WATER FROM TANK FARM
Construction Phase - Design (m^3/h)	0.00013	12.30	7.01	42.9	0.00	1.00	1.00	42.86	19.31	3.83	0.030	202.0
Construction Phase - Nominal (m^3/h)	0.00013	2.46	1.40	0.04	0.00	0.04	0.04	0.25	3.86	3.83	0.030	0.93
Operation Phase - Design (m^3/h)	0.00013	12.30	0.00	42.9	0.00	1.00	1.00	42.86	12.30	3.83	0.019	202.0
Operation Phase - Nominal (m^3/h)	0.00013	2.46	0.00	0.04	0.00	0.04	0.04	0.00	2.46	2.44	0.019	0.93
Stream No.	13	14	15	16	17	18	19	20	21	22	23	24
Stream Description	COMBINED OIL/WATER SEPARATOR EFFLUENT	COMBINED OIL/WATER SEPARATOR OIL	COMBINED OIL/WATER SEPARATOR SOLIDS	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED
Construction Phase - Design (m^3/h)	1.04	0.002	0.221									
Construction Phase - Nominal (m^3/h)	1.04	0.002	0.221									
Operation Phase - Design (m3/h)	1.04	0.002	0.221									
Operation Phase - Nominal (m3/h)	0.84	0.002	0.178									

NOTE(S): See drawing # H349000-2000-10-002-0001-001 for notes.

LEGEND:

CONTINUOUS FLOW

INTERMITTENT FLOW

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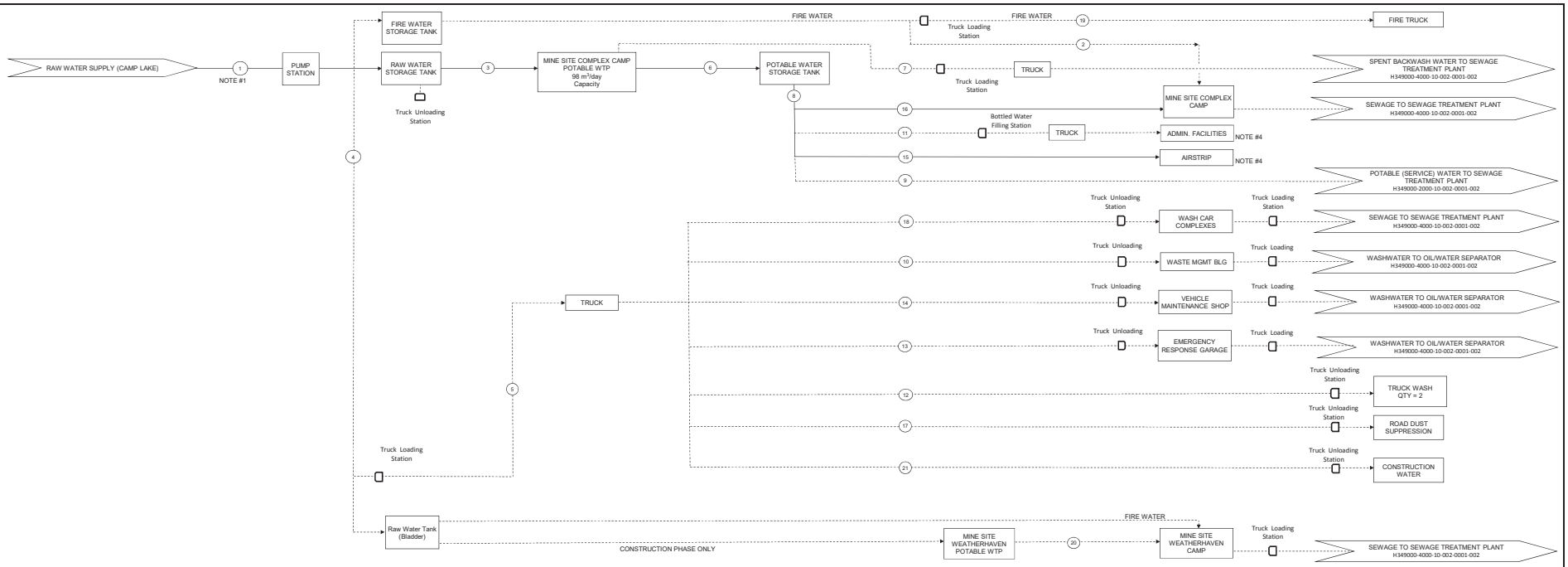
DATE:	17-MAR-2016
CHECKED BY:	ALLAN KNIGHT
DATE:	17-MAR-2016
PROJ. MGR	
DATE:	

MILNE INLET PORT SITE
WASTEWATER BALANCE
BLOCK FLOW DIAGRAM
2016 Work Plan
(cont'd from DWG# H349000-2000-10-002-0001)

SCALE NTS
DR AS NOTED

DWG NO. H349001-2000-10-002-0001-002

REV B



NOTE #1

Stream No.	1	2	3	4	5	6	7	8	9	10	11	12
Stream Description	RAW WATER SUPPLY (CAMP LAKE)	FIRE WATER	RAW WATER FEED TO MINE SITE (HORIZON) POTABLE WTP	RAW WATER TO WEATHERHAVEN CAMP	TRUCKED RAW WATER	POTABLE WATER FROM MINE SITE (HORIZON) CAMP POTABLE WTP	POTABLE WTP SPENT BACKWASH WATER	POTABLE WATER DISTIBUTION	POTABLE (SERVICE) WATER TO STP	RAW WATER (WASHWATER) TO WASTE MGMT BLG	POTABLE (BOTTLED) WATER TO ADMIN. BUILDING	RAW WATER TO TRUCK WASH (QTY=2)
Construction Phase - Design (m^3/h)	27.40	300	4.08	42.86	42.86	4.08	0.00020	21.07	1.000	1.000	0.008	12.000
Construction Phase - Nominal (m^3/h)	7.18	-	3.98	3.20	2.10	3.98	0.00020	3.98	0.060	0.043	0.008	1.500
Operation Phase - Design (m3/h)	27.40	300	4.08	42.86	42.86	4.08	0.00020	21.07	1.000	1.000	0.008	12.000
Operation Phase - Nominal (m3/h)	5.81	-	3.98	1.83	1.83	3.98	0.00020	3.98	0.060	0.043	0.008	1.500
Stream No.	13	14	15	16	17	18	19	20	21	22	23	24
Stream Description	RAW WATER (WASHWATER) TO EMERG. RESPONSE SHOP	RAW WATER (WASHWATER) WATER TO VEHICLE MAINT. SHOP	POTABLE WATER TO AIRSTRIP	POTABLE WATER TO MINE SITE COMPLEX CAMP	RAW WATER FOR DUST SUPPRESSION	RAW WATER TO TEMP. WASH CAR COMPLEXES	FIRE TRUCK	POTABLE WATER TO WEATHERHAVEN CAMP	CONSTRUCTION WATER	NOT USED	NOT USED	NOT USED
Construction Phase - Design (m^3/h)	1.000	42.86	0.480	19.58	42.86	42.9	42.86	5.50	0.92			
Construction Phase - Nominal (m^3/h)	0.043	0.25	0.013	3.92	0.21	0.04	0.04	1.10	0.03			
Operation Phase - Design (m3/h)	1.000	42.86	0.480	19.58	42.86	42.9	42.86	0.00	0.00			
Operation Phase - Nominal (m3/h)	0.043	0.00	0.013	3.92	0.21	0.0	0.00	0.00	0.00			

NOTE(S):

1.0 Raw water supply flow rate from Camp Lake are equal to or less than Type A Water Licence 2AM-MRY1325 Amend. No. 1 flow rate limit of 657.5 m3/day (240,000 m3/year) total.
2.0 Construction phase potable water supply flow rate is 120.4 m^3/day total.
3.0 Operational phase potable water supply flow rate is 94.0 m^3/day total.
4.0 Sewage generated by the Admin Facilities and the Airstrip reports to the Wash Car Complexes, which provide washroom facilities for these users.

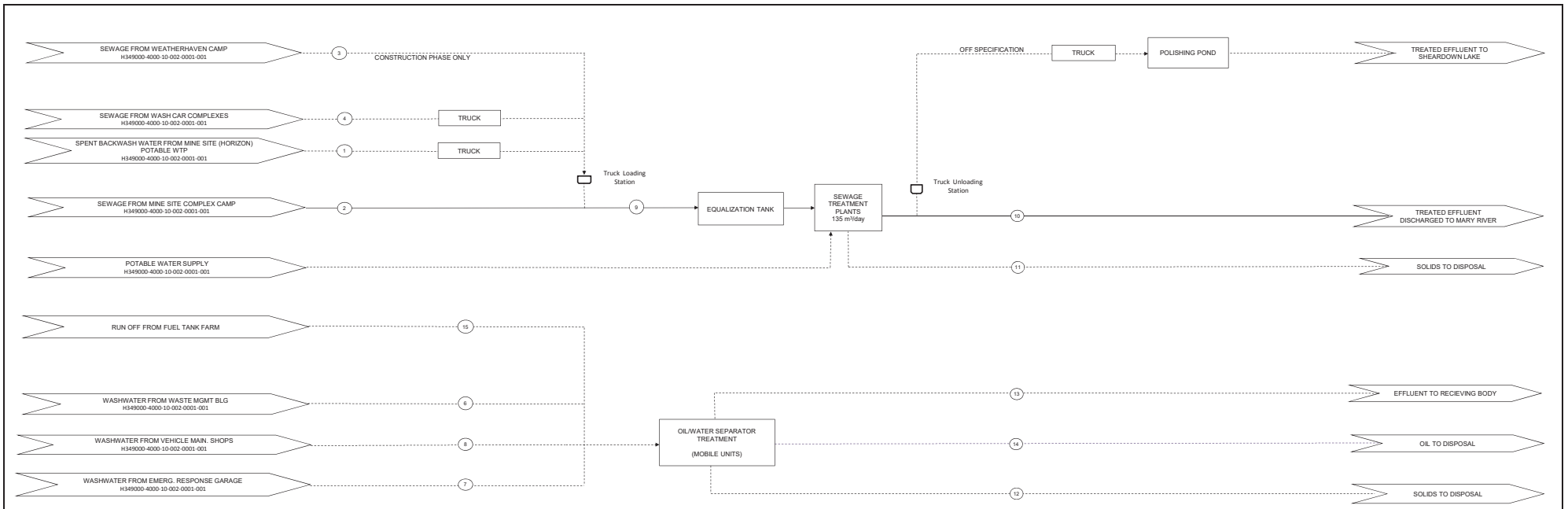
LEGEND:

CONTINUOUS FLOW _____

INTERMITTENT FLOW ----------

Baffinland

EDITED BY:	ANDREW VERMEER	MARY RIVER PROJECT
DATE:	17-MAR-2016	
CHECKED BY:	ALLAN KNIGHT	MINE SITE WATER SUPPLY BALANCE BLOCK FLOW DIAGRAM 2016 Work Plan (cont'd from DWG# H349000-4000-10-002-0001)
DATE:	17-MAR-2016	
PROJ. MGR		SCALE NTS (OR AS NOTED)
DATE:		DWG NO. H349001-4000-10-002-0001-001
		REV B



Stream No.	1	2	3	4	5	6	7	8	9	10	11	12
Stream Description	SPENT BACKWASH WATER FROM MINE SITE POTABLE WTP	SEWAGE FROM MINE SITE (HORIZON) CAMP	SEWAGE FROM WEATHERHAVEN CAMP	SEWAGE FROM WASH CAR COMPLEXES	NOT USED	WASHWATER FROM WASTE MGMT BLG	WASHWATER FROM EMER. RESPONSE GARAGE	WASHWATER FROM VEHICLE MAINT. SHOP	SEWAGE FEED TO EQ TANK/STP	SEWAGE TREATMENT EFFLUENT	SEWAGE TREATMENT PLANT SOLIDS TO DISPOSAL	COMBINED OIL/WATER SEPARATOR SOLIDS
Construction Phase - Design (m^3/h)	0.00020	19.6	5.50	42.9	0.00	1.00	1.00	42.86	25.08	4.98	0.04	0.12
Construction Phase - Nominal (m^3/h)	0.00020	3.92	1.10	0.04	0.00	0.04	0.04	0.25	5.02	4.98	0.04	0.12
Operation Phase - Design (m^3/h)	0.00020	19.6	5.50	42.9	0.00	1.00	1.00	42.86	25.08	4.98	0.03	0.12
Operation Phase - Nominal (m^3/h)	0.00020	3.92	0.00	0.04	0.00	0.04	0.04	0.00	3.92	3.88	0.03	0.02
Stream No.	13	14	15	16	17	18	19	20	21	22	23	24
Stream Description	COMBINED OIL/WATER SEPARATOR EFFLUENT	COMBINED OIL/WATER SEPARATOR OIL	RUN OFF WATER FROM TANK FARM	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED
Construction Phase - Design (m^3/h)	0.27	0.001	9.21									
Construction Phase - Nominal (m^3/h)	0.27	0.001	0.05									
Operation Phase - Design (m3/h)	0.27	0.000	9.21									
Operation Phase - Nominal (m3/h)	0.12	0.000	0.05									

NOTE(S): See drawing # H349000-4000-10-002-0001-001 for notes.

LEGEND:

CONTINUOUS FLOW ———

INTERMITTENT FLOW - - - - -

Baffinland

EDITED BY:	ANDREW VERMEER
DATE:	17-MAR-2016
CHECKED BY:	ALLAN KNIGHT
DATE:	17-MAR-2016
PROJ. MGR	
DATE:	

MARY RIVER PROJECT

MINE SITE
WASTEWATER BALANCE
BLOCK FLOW DIAGRAM
2016 Work Plan
(cont'd from DWG# H349000-4000-10-002-0001)

SCALE NTS OR AS NOTED

DWG NO. H349001-4000-10-002-0001-002

REV B

Appendix - D
Sewage Treatment Plant O & M Manual

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HATCH VENDOR DATA REVIEW

Doc Number	E349000-PM009-00-118-0001	Sub	01
Date Received			

Review Grade	Next Submittal Status
☐ C1 – Proceed to next submission & status	☐ Internal Review ☐ Certified Final ☐ Final ☐ As-Built
☐ C2 – Proceed with exceptions as noted to next submission & status	Next Submittal Date:
☐ C3 – Do not proceed, revise as noted & resubmit	
No further submission required - Complete ☐	
☐ C4 – No further submission required - Cancelled ☐	
No further submission required - Superseded ☐	

Package Coordinator: Name, signature and Date:

REVIEWED ONLY FOR GENERAL CONFORMITY WITH THE SPECIFICATIONS. ACCEPTANCE BY THE ENGINEER DOES NOT WARRANT OR REPRESENT THAT THE INFORMATION CONTAINED ON THIS DRAWING/DOCUMENT IS EITHER ACCURATE OR COMPLETE. THE SOLE RESPONSIBILTY FOR CORRECT DESIGN, DETAILS & DIMENSIONS SHALL REMAIN WITH THE PARTY SUBMITTING THE DRAWING/DOCUMENT.

E349000-PM-009-00-118-0001

Sewage Treatment Plant

Operations & Maintenance Manual

newterra ltd.
1325 California Avenue, Brockville, ON K6V 5Y6
200 555 11th Ave SW, Calgary, AB, T2R 1P6
(800) 420-4056 / www.newterra.com

newterra MicroClear™ Membrane Bioreactor (MBR) Wastewater Treatment Plant

OPERATION AND MAINTENANCE MANUAL

System:	**Milne Port & Mine Site Wastewater Treatment Plants**
Location:	**Baffin Island, Nunavut**
Client:	**Baffinland Iron Mines Corporation (via Hatch)**
Project:	**300106**
Rev.:	**0**
Date:	**June, 2013**

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200 555 11th Ave SW, Calgary, AB, T2R 1P6
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MANUAL OVERVEW

Section	Section Title	Section Description
1	**Introduction**	Introduction to **newterra** MBR WWTP O&M Manual
2	**Safety**	General personal and environmental safety information for operators serving newterra MBR WWTP.
3	**Wastewater Treatment Plant Design Basis**	**newterra** MBR WWTP Specification, Influent / Effluent Characteristics, and Prohibited Items.
4	**Plant Installation, Inspection, and Testing**	Overview of general procedures and actions followed during the plant installation, inspection and initial testing.
5	**Process Control Narrative**	Description of wastewater treatment process and equipment functionality. Control narrative & Control system touchscreen operation.
6	**System Start-Up, Operating Guidelines and Monitoring**	Overview of the plant start-up procedure & operational conditions; monitoring and testing requirements.
7	**System Maintenance**	Schedule for Routine Operation and Maintenance Checkups; membrane cleaning.
8	**Membrane Filtration Unit Shut Down**	Overview of the procedure followed during membrane filtration unit temporary and permanent shut downs; winterization procedure.
9	**Service & Support**	Information regarding the support services offered by **newterra** ltd. including start-up and emergency services; training sessions during plant commissioning.
10	**Warranty and Performance Guarantee**	General warranty statements and conditions for the membrane warranty.

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1325 California Avenue, Brockville, ON K6V 5Y6
200 555 11th Ave SW, Calgary, AB, T2R 1P6
(800) 420-4056 / www.newterra.com

APPPENDICES:

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200 555 11th Ave SW, Calgary, AB, T2R 1P6
(800) 420-4056 / www.newterra.com

1.0 INTRODUCTION

The purpose of this manual is to provide necessary information for the Installation, Operation and Maintenance of the Waste Water Treatment Plant equipment.

ATTENTION	**The newterra MicroClear™ MBR wastewater treatment plant (WWTP) functions optimally if the operating procedures described in this manual are followed. If you have any questions after reading through this manual, please contact newterra ltd.**

- This O&M Manual must be kept on-site and available to employees at all time.
- It is IMPERATIVE that employees read the manual BEFORE working in the plant.
- Employees' must read ***Section 2*** – Health and Safety.
- Technical Support Department contacts are provided in ***Section 9***.

CAUTION: ***Once wetted, the membrane should remain wet, and not be allowed to dry out, to prevent irreversible damage to the membrane.***

WARNING: ***Failure to comply with the instructions provided in this manual can cause equipment & property damage or severe personal injury, and will render the warranty null and void.***

2.0 SAFETY

2.1 Introduction

This section provides general personal and environmental safety information for newterra MBR WWTP operators.

Always refer to local codes and regulations.

Specific equipment and parts safety information can be found in Appendix E. Material Safety Data Sheets (MSDSs) include detailed information regarding health & safety of chemicals used in wastewater treatment process and are presented in Appendix F.

Information and guidelines outlined in this manual **must** be followed at all times prior to system installation and during operation and maintenance.

ESSENTIAL FOR SAFE OPERATION:

1. Installation and operation of the newterra MBR WWTP **must** only be carried out by **trained and qualified** personnel.
2. All necessary **safety precautions must** be carefully exercised, including but not limited to proper use of personal protective equipment considering given working environment and conditions.
3. All **electrical installations and troubleshooting must** only be carried out by licensed electricians.
4. All **plumbing work must** only be carried out by licensed plumbers or qualified personnel.
5. Please keep in mind that trees and shrubs taller than two meters located in close proximity to the plant buildings may become a safety concern at the time of installation or service.

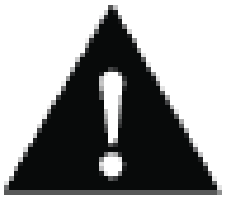
DEFINITION OF SAFETY AND WARNING SIGNS USED IN THE MANUAL

ATTENTION SYMBOL

Special attention is required to ensure compliance with instructions concerning correct operating sequences to prevent damage to the plant or its function.

GENERAL WARNING SIGN

This symbol accompanies all important instructions or warnings associated with risks of injury as well as possible equipment damage.



WARNING

CRITICAL WARNING SIGN

Warns against an unsafe situation or practice associated with severe injury as well as major equipment damage.

2.1 Personal Protective Equipment (PPE)

Personal protective equipment refers to protective clothing, helmets, goggles, or other garments used to prevent injury.

The following list includes the minimum scope of PPE that should be available to newterra MBR WWTP operators:

Eye and Face Protection:

Protective glasses, goggles and face shields prevent wastewater and chemical splashes, tiny dust particles and vapors from getting in eyes and face.

Foot Protection:

Each operator should wear safety boots with steel toe and shank inserts at all times in wastewater plant operating area to protect feet from falling /rolling objects, wastewater and chemicals splashes, and electrical hazards.

Hand Protection:

Wear protective gloves at all times working in wastewater plant operating area; chemical-resistant gloves must be worn when handling chemicals

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Clothing

Wear protective clothing to minimize risk of biohazards. Chemical splash apron must be worn when operator handles chemicals.

2.2 Bacterial Safety

The wastewater contains a mixture of viable bacteria and other biological organisms. A wastewater treatment plant poses a number of bacterial hazards and consequently potential health risk. Immunization protects operator against infection. The use of proper hygiene measures, protective equipment, good housekeeping and common sense prevent contact with pathogens.

These measures prevent infection!

Ensure that hands are washed with an antibacterial soap and warm water and dried by disposable towels on a regular basis, especially prior eating!

Do not expose cuts or open sores to wastewater!

Use personal protective equipment (PPE) at all times in wastewater treatment facility!

Any concern about possible infection should be brought to the attention of medical physician immediately!

2.3 Chemical Safety

The following chemicals are used in operation of newterra MBR WWTP:

- **Sodium hydroxide (NaOH)** is used for pH adjustment, in case there is a deficiency in alkalinity in influent sewage and pH drops. It is very corrosive and hazardous in case of skin/ eye contact, and ingestion.
- **Sodium hypochlorite (NaOCl)** and **Citric Acid ($C_6H_8O_7$)** are used for cleaning the membranes.
  - √ **Sodium hypochlorite (NaOCl)** is a common disinfectant, which can be an irritant or corrosive, depending on its concentration. It cannot be mixed with organics, ammonia compounds or acids. ***Contact with acids produces highly toxic chlorine gas***. ***It has to be mixed only with pure water.***
  - √ **Citric Acid ($C_6H_8O_7$)** is hazardous in case of skin contact (irritant, sensitizer), or ingestion, eye contact (irritant) and inhalation (lung irritant).

When handling chemicals, it is important to wear proper personal protective equipment such as chemical goggles with combination full face shield, protective clothing with chemical splash apron and chemical-resistant rubber gloves.

The detailed information regarding health & safety of chemicals used in wastewater treatment process can be found in MSDSs presented in Appendix F of the O&M Manual Material.

2.4 Locking out Equipment

Lockout procedures must be followed prior to performing mechanical or electrical maintenance to ensure that equipment has been de-energized.

- All relevant local guidelines and procedures must be applied

2.5 Entering Confined Spaces

Confined space is defined as an area which is enclosed with limited access. The confined space:

- is large enough and so configured that an employee's body can enter and perform assigned work;
- has limited or restricted means for entry or exit; and
- is not designed for continuous employee occupancy;
- the accumulation of hazardous or toxic gases, vapor, dust, fumes, or the creation of an oxygen-deficient atmosphere may occur in confined space.

Follow local laws and regulations with respect to entering a confined space.

2.6 Vision Hazard

An Ultraviolet light (UV) unit is used in the wastewater treatment plant for final disinfection of treated effluent. Do not look directly at the blue UV lamps. Immediate or prolonged exposure to UV light can result in painful eye injury and skin burn.

2.7 Responsibility for Safety

Management:

Management is responsible for providing a safe working environment. This is accomplished partly by:

- Ensuring that all facilities and equipment are built and maintained in accordance with the appropriate safety standards
- Providing adequate funds for equipment and plant maintenance
- Establishing, promoting, and enforcing a ***safety policy***
- Establishing a safety training program
- Supplying easy accessible eyewash and first-aid stations and proper personal protective equipment (PPE) for personnel servicing wastewater treatment facility.

Worker:

- To develop a positive and professional attitude towards safety.
- To avoid mistakes caused by indifference to safety, poor work habits, lack of attentiveness, rushing the job, failure to observe established safety procedures and poor physical condition.

***Remember the "ABC" of accident prevention*:**

ALWAYS BE CAREFUL!!!

In addition to ***"being careful"*,** it is the responsibility of all workers to:

- Work in accordance with established safety procedures
- Follow the established safety rules
- Wear appropriate personal protective equipment (PPE)
- Report all accidents, no matter how minor
- Report potential safety hazards
- Participate in safety programs

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Plant Safety – Simple Rules to Follow

Common sense plays a very important part in the safe operation of any type of plant!

- Wear the appropriate personal protective equipment at all times.
- Keep walkways clear of snow and ice, and loose objects such as pails, shovels, tools, etc.
- Clean up spills of oil, grease, chemicals, or other substances immediately.
- Keep all tools and similar equipment clean, in good condition, and properly stored when not in use.
- Replace all manhole covers, access trap doors, etc. as soon as possible. Erect a safety barrier if it is necessary to leave the opening uncovered.
- Use the proper tools when removing or replacing a manhole cover.
- Wear a safety belt whenever there is the possibility of falling even a short distance, or when working over water.
- Lock out and tag electrical equipment before working on it or the associated equipment.
- Ensure that moving machinery is properly guarded. Wear ear protection in noisy environments.
- Ensure that fire-fighting equipment is in good working condition.

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Hazard Warning Signs/Symbols

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3.0 WASTEWATER TREATMENT PLANT DESIGN BASIS

The **newterra** MBR Wastewater Treatment Plants (WWTPs) are designed for treatment of domestic wastewater from 200-m Mine Site camp with an average design flow of 72 m^3/d and 175-m Milne Port camp with an average design flow of 63 m^3/d. The wastewater treatment plants have been designed to meet the required effluent quality.

newterra MicroClear™ MBR Process Specification

Parameters	Unit	Value	
		Mine Site WWTP	Milne Port WWTP
Design Hydraulic Load			
Average Daily Flow (ADF)	m^3/d	72	63
Selected Design Flow (Q_h)	m^3/h	3	2.63
Organic Load			
COD Load	[kgCOD/d]	76.32	66.78
BOD Load	[kgBOD/d]	38.16	33.39
TKN Load	[kgTKN/d]	5.4	4.73
TAN Load	[kgTAN/d]	3.24	2.84
TP Load	[kgTP/d]	0.86	0.76
TSS Load	[kgTSS/d]	41	35.9
Process Tanks			
One (1) Equalization Tank			
Effective volume	m^3	43.5	43.5
Hydraulic Retention Time (HRT_{EQ})	h	14.5	16.5
One (1) Aeration Tank			
Effective volume	m^3	48	48
$HRT_{AEROBIC}$	h	16	18.3
Two (2) Membrane Tanks			
Total Effective Volume	m^3	5.0	5.0
$HRT_{MEMBRANE}$	h	1.7	1.9

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Parameters	Unit	Value	
		Mine Site WWTP	Milne Port WWTP
MBR System (including aeration tank and membrane tanks)			
Overall Effective Volume	m^3	53	
Overall HRT	h	17.7	20.2
Overall SRT	d	15	16
Internal recirculation rate: Membrane tanks →Aeration tank		4 – 5x influent flow	
Average Design Flux	LMH	18	
Sludge wasting rate (at 1%, 10 g/L)	m^3/d	3.8	2.93
Minimum / maximum design operating temperature	°C	10 / 35	

MicroClear™ MB3-1 membrane module		
MCXL cassettes in each MB3-1 module	nr	15
Individual MB3-1 module filtration area	m^2	105
MB3-1 modules in each membrane tank	nr	1
Total Membrane Filtration Area in two (2) membrane tanks	m^2	210
MB3-1 Module Dimensions (L x W x H)	m	1.30 x 0.70 x 1.85
Housing materials	-	Stainless steel 1.4571 (316 Ti)

Sludge Treatment System	**Unit**	**Value**
One (1) Mixing Tank		
Effective Volume	m^3 (gal)	0.9 (240)
One (1) 6 ft^3 (expandable to 10 ft^3) 630 mm filter press		
Feed from aeration tank		
Sludge volume	m^3	2.93
Sludge concentration	%	1
Dewatered sludge dryness	%	25
Filter press daily run time		
Cycles	c/day	4
Cycle duration	h	4
Overall daily run time	h	16
Construction materials	-	Heavy duty steel skeleton, panted with two part epoxy
Polymer consumption (40 mg/L addition ratio of polymer at 0.25%)	L/d	150

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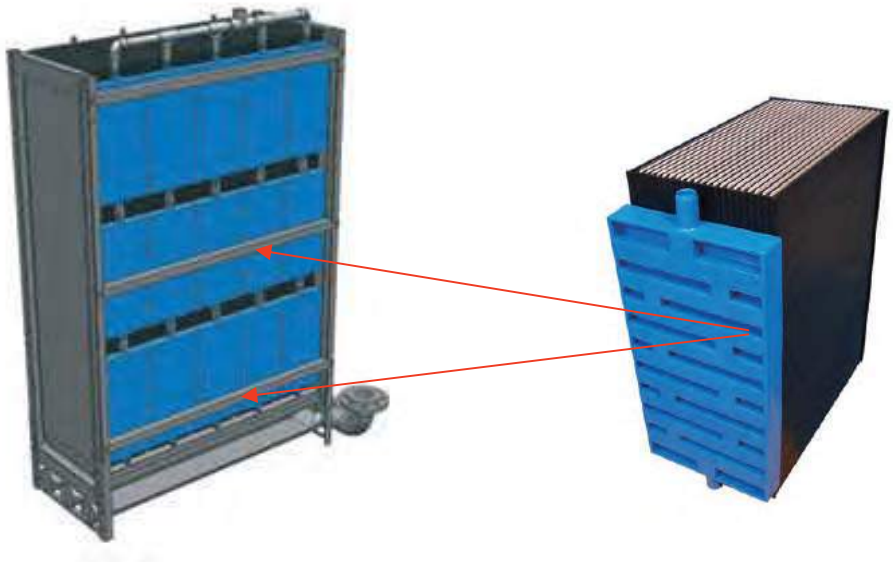

MicroClear™ MB3-1 membrane module

MicroClear™ MCXL membrane cassette

Influent Wastewater/Treated Effluent Characteristics:

Parameters	Unit	Influent Quality	Effluent Quality	
			Mine Site WWTP	Milne Port WWTP
pH	s.u.	6.0 – 9.0	6.0 – 9.5	6.0 – 9.5
Turbidity	NTU		<5	< 5
Fat, Oil, Grease (FOG)	mg/L	< 30	No visible seen	No visible seen
Chemical Oxygen Demand (COD)	mg/L	1060	-	-
Biological Oxygen Demand (BOD_5)	mg/L	530	< 10	< 20
Total Suspended Solids (TSS)	mg/L	570	< 10	< 20
Total Kjeldahl Nitrogen (TKN)	mg/L	75		-
Ammonia Nitrogen (NH_3-N)	mg/L	45	< 2	< 2
Total Phosphorus (TP)	mg/L	12	< 0.1	-
E-Coli / Fecal Coliform	CFU/100 mL		< 200*	< 200*
Alkalinity (assumed)	mg/L as $CaCO_3$	10 – 14	-	-

******After UV disinfection*

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Prohibited Items

The raw wastewater should not contain any of the following substances:

- Hydrocarbons – lubricants, gasoline, diesel, etc.;
- Paints, solvents, silica, silicones and polymers;
- Antibacterial solutions, and products with quaternary ammonia;
- Large quantities of chemicals such as water softener, disinfectants, strong acids & alkalis, pesticides or photographic chemicals;
- Silicone based defoamers;
- Non-biodegradable solid waste (plastic, rubber products, disposable diapers, etc.);
- High amount of metals, such as iron, magnesium, calcium, barium and strontium.

TOXIC MATERIALS SHOULD NOT BE THROWN INTO THE DRAIN!

The raw wastewater should also comply with the following compatibility chart. The lipophilic substances concentration must be lower than **50 mg/L.**

MicroClear™ Membrane Compatibility Chart

Group	Substances	SP-Type Membrane
Chlorinated solvents	Methylene Chloride, Chloroform, Carbon Tetrachloride, Chlorobezene, Trichloroethane (<1%)	--
Esters	Ethyl Acetate, Butyl Acetate, Butyl Acrylate (<1%)	--
Ethers	Ethyl Ether, Polyethylene Oxide (<1%)	--
H_2O_2	<2000 ppm	++
Inorganic acids	HF, HCl, H_2SO_4	pH 0 - 14
Ketones	Acetone, Methyl Ethyl Ketone	--
NaOCl	100,000 ppmxh	++

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Organic acids	Sulfamic Acid, Formic Acid, Oleic Acid, Sulfonic Acid, Acetic Acid, Acrylic Acid, Latic Acid	pH 0 - 14
Phenols		--
Silicones		--
Alcohols	Ethanol, Butanol, Isopropranol (<50%)	+
Aldehydes	Formaldehyde (<1%)	++
Alkali		pH 0 - 14
	Dimethyl Formamide, Dimethyl, Acetamid Dioxane, N-Methyl, Pyrrolidone, Tetramethyl Acetamide	--
Aprotic Solvents	Benzene, Toluene, Xylene, Anthracene, Naphatalene, Gasoline	--
Aromatic hydrocarbon	Methoxyethanol, Ethoxyethanol, Buthoxyethanol	?

(++ = Very good, + = good, - = fair, -- = not recommended)

Removal of Oily Materials

The wastewater must pass through a grease trap (or similar facility for grease/fat removal), if there is kitchen usage onsite. The large amount of oil and fat can harm treatment facility (e.g., clogging pumps and piping and cause foaming in the aeration tank). To avoid premature membrane fouling, maximum FOG concentrations should not exceed 30 mg/L.

Fats, oils and grease (FOG) must be removed prior to MBR. Removing of FOG significantly reduces membrane fouling, foaming potential and increases aeration efficiency.

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4.0 PLANT INSTALLATION, INSPECTION, AND TESTING

The **newterra** MicroClear™ MBR WWTP is a packaged plant which comes complete with containerized inlet screen, equalization tank, post EQ screen, aeration tank, membrane tanks, UV disinfection systems and a sludge dewatering unit. The plant is housed inside multiple 40-ft modified high-cube shipping containers - completely pre-assembled, pre-piped, pre-wired and pre-tested, ready for a quick site installation and start-up. The standard containerized design also allows for modular expandability, portability and quick deployment, particularly beneficial features for work camp applications.

4.1 Site Conditions Requirements

- Installation site for the **newterra** MicroClear™ MBR WWTP should be close to the sewer drain and have a sufficient power source (refer to Electrical Drawings in **Appendix A** of this manual).

- Location must permit easy access for equipment capable of transporting, offloading, and handling of the designed loads.

- There should be adequate space around the containers for safe operation and maintenance.

- The firm base (foundation) must be built to support the full operating weight of the plant to prevent buildings from shifting and pipe/electrical conduit connection failure – pilings or rig mats are recommended (based on site conditions).

The firm base for the container must be level and must be capable of supporting the operating weight.

WARNING: ***Always check with the local utility companies for the location of water lines, electrical and telephone cables, or any additional hazards below grade, prior to excavation. Failure to do so could result in severe bodily injury or death.***

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4.2 Inspection upon Delivery

The **newterra** MicroClear™ MBR WWTP is carefully manufactured, checked, and tested at the manufacturing plant. All equipment is pre-wired, pre-piped, mounted inside the enclosure and factory tested. Upon receiving the system, please perform the following:

- Place the containers onto the prepared firm base to avoid sagging, equipment vibration, and shifting. When lifting the container, ensure that lifting equipment is clear of overhead obstructions such as power lines, trees or rooftops. Be careful during this procedure!
- Be careful when offloading the containers to prevent damage to the internal pipe work.
- Check the containers for any signs of shipping damages.
- Inspect the containers to ensure that no components or parts are missing (refer to the **Packing Slip** presented in **Appendix B** of this manual). Also, inspect for visual damage of the tanks, pumps, blowers, piping, and control panel.
- If the containers, equipment inside and any parts shipped loose are free of damage, proceed with the installation.

For any damages or loss of equipment, **please notify newterra ltd. at (800) 420-4056 immediately.**

4.3 Plant Initial Set up

WARNING: ***The installer must ensure that the installation site is safe from hazards. These could include excavations left open overnight, debris left lying around, and tanks & equipment not properly blocked. Provisions must be made to eliminate the potential hazards by roping off and proper shoring around the excavations, cleaning up at the end of each workday, and proper storage of equipment. Failure to do so could result in severe injury or death.***

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Enclosures Specifications

WWTP Enclosures	newterra MicroClear™ MBR WWTP consists of six (6) cMET certified, built to NEC standard enclosures
Enclosure #1 (SCREEN BLD-7903)	Room #1 - Class 1 Div 2, contains Screen Modules with Screw Screen Compactors (SCR-201/SCR-401), Screen Discharge Tanks (TNK-202/TNK-401), and pumps
	Room #2 - General Purpose (GP), contains Control Panel
Enclosure #2 (EQUALIZATION BLD-7901)	General Purpose (GP), contains Equalization Tank (TNK-301)
Enclosure #3 (AERATION BLD-7902)	General Purpose (GP), contains Aeration Tank (TNK-501)
Enclosure #4 (MBR FILTRATION BLD-7900)	General Purpose (GP), contains Membrane Tanks (TNK-601/TNK-602), scouring blowers, pumps, permeate withdrawal systems, UV system, and chemical units
Enclosure #5 (EFFLUENT BLD-7905)	General Purpose (GP), contains Effluent Tanks (TNK-811/TNK-812/TNK-813/TNK-814), pumps, and chemical units
Enclosure #6 (SLUDGE BLD-7904)	Room #1 - Class 1 Div 2, contains sludge dewatering module including Filter Press (FP=901), mixing tank (TNK-901), air , and pumps
	Room #2 - General Purpose (GP), contains pumps and blowers for aeration tank, and office space
Estimated Dry shipping weight for each enclosure	SCREEN BLD-7903 – 20 000 lb (9072 kg) EQUALIZATION BLD-7901 – 26 000 lb (11 793 kg) AERATION BLD-7902 – 28 000 lb (12 700 kg) MBR FILTRATION BLD-7900 - 23 000 lb (10 432 kg) EFFLUENT BLD-7905 - 15 000 lb (6804 kg) SLUDGE BLD-7904 – 20 000 lb (9072 kg)
Enclosures Dimensions	All enclosures are 40-ft high-cube modified shipping containers: 12.2 m L x 2.44 m W x 2.89 m H (40' L x 8' W x 9'6" H)
Influent supplied head	3.0 m (10')
Treated effluent discharged head pressure	1.5 m (5')
Inlet pipes	3" steel FNPT for wastewater from lift station; 3" steel with female camlock from sewage truck
Discharge pipe	2" steel pipe with 2" flange

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Verify site power per system design criteria.

System Electrical Specifications:

System Power	600-V, 3-Phase, 3-Wire, 60 Hz
Main Disconnect	200 A
Panel Approval and Classification	cMET, Classified
System Approval and Classification	cMET, Classified GP & C1 Div 2
Telemetry Setup	-

Please refer to the as-built electrical drawings in Appendix A of this manual.

ATTENTION	Only trained and certified electricians should make the electrical connections.

Installation Instructions:

1. Remove hatch covers from the interconnecting ports.
2. Place containers tight against each other with the interconnecting ports lining up.
3. Connect electrical power to the **Main Switch Panel** located inside the enclosure **(BLD-CONTROL)** 3 phase, 380 V from available source ensuring correct phase rotation.
4. Ensure that proper electrical grounding and lightning protection is available.
5. Switch **Main Switch Panel's isolator** to the **ON** position.
6. Check all internal lighting, heating, and ventilation for correct operation.
7. Install packed external lighting into brackets above the doorway (double man doors), route the cables to the inside of the container through the ports provided and plug into sockets provided (check for correct operation).

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8. Ensure that a potable water supply is available (used for hydraulic testing during start-up, membrane cleaning, washing hands and for performing onsite testing).

9. **Ensure availability of an emergency eyewash station and personal protection equipment onsite**.

10. Verify membrane modules are secured within the membrane tanks – i.e. verify wheel chocks (if applicable) are in the correct location and that there is no lateral movement (less than an inch) of the membrane modules on the wheel tracks in the tanks.

4.4 Plant Initial Testing

The **newterra** MBR WWTP (except the membrane modules) undergoes electrical and leakage tests in our manufacturing facility prior to shipment; however, fittings could shift during shipment, so it is our standard practice to perform plant initial testing including **dry and hydraulic tests.**

4.4.1 Dry Test

The following tasks have to be performed **before potable water** is introduced into the system:

- Ensure that all tanks are clean and free of any dirt or debris (this is to prevent obstruction or damage to the piping, pumps, and membranes).
- Ensure that all connections have been provided and joints have been tightened.
- Check the placement of the air diffusers in the equalization tank **(TNK-301)** and aeration tank **(TNK-501)** if incorrectly positioned, proper adjustment has to be performed.
- Ensure that a functional check of the electrical and control system has been performed (please refer to the **newterra Pre-commissioning Test Checklist** presented in **Appendix C**).

4.4.2 Hydraulic Test

The hydraulic test is performed using potable water to:

- Check for and fix any leakage;
- Check the setting of level switches/transmitters;
- Check the hydraulic flow through the plant;

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- Check if all the ancillary equipment and controls of the plant function as per design;
- Recalibrate instruments (if applicable);
- Perform clean water test on membranes.

Caution: Once wetted, the membrane should remain wet, and not be allowed to dry out to prevent irreversible damage to the membrane.

Performing the Hydraulic Test

- Fill the system [equalization tank (TNK-301) and aeration tank (TNK-501)] with potable water, run the pumps and check for any signs of leakage.
- Perform electrical and instrumentation (E&I) functional checks and adjustment of level switches.
- Turn on the air blowers B-301/B-302/B-303/B-304/B-305/B-306 for the equalization tank (TNK-301) and blowers B-501/B-502 for the aeration tank (TNK-501), and check for:
    - Buoyancy of air diffusers and if this occurs, empty the tank and fix;
    - Air leakages: if this occurs, tighten up the fittings;
    - Manually check water temperature and DO (dissolved oxygen): with a hand-held DO meter and adjust air flow to keep it up to 0.5 – 1 mg/L for equalization tank (TNK-301) and 2- 3 mg/L for aeration tank (TNK-501); check the DO readings on the touch screen.
    - DO Control System: check automatic ON/OFF of aeration tank air blowers at low and high settings of DO without the return of aerated water from the membrane tanks to aeration tank, and record blower ON/OFF duration.

Membrane Tanks (TNK-601/TKN-602):

- Enable membrane operation.
- Start the pumps (P-501/P-502) for aeration tank and fill the membrane tank (TNK-601) with potable water.
- Start the air blowers (B-601/B-602/B-603/B-604/B-605) for membrane tank (TNK-601) and blowers (B-606/B-607/B-608/B-609/B-610)for membrane tank (TNK-602) and check for an even distribution of air across the membrane filter area and air bubble uniformity above the membrane modules/cassettes.

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- Check hydraulic flow pattern through the membranes and between membrane modules/ cassettes and tank wall.
- Make a clean copy of the **Clean Water Testing Sheet** presented in **Appendix K** of this O&M Manual.
- Start the permeate (vacuum) pumps P-701/P-702
- Record all checked parameters in the **Clean Water Testing Sheet:**
    - Record the vacuum (TMP) on gauges PI-701/PI-702 [for clean water could be 0.05 to 0.07 bar (20" to 29" WC)].
    - Record ambient temperature, and water temperature and DO with a hand-held DO meter.
    - Gradually increase the permeate flow while recording the vacuum (TMP) on the gauges up to the anticipated peak wastewater flow.
- Forward a complete **Clean Water Testing Sheet** to **newterra** for analysis.

5.0 OPERATION of newterra MicroClear™ MBR

Membrane Bioreactor (MBR) treatment technology is an effective combination of an activated sludge biological treatment process with MicroClear™ MBR membrane filtration technology. The MBR operates at MLSS (mixed liquor suspended solids) concentrations between 8,000 to 12,000 mg/L.

This section provides a brief description of the treatment process and how it is controlled. Most of the equipment in the **newterra** WWTP can be operated in either manual or automatic mode. The system is designed to always run in auto mode. The manual option is provided mainly for maintenance purposes. Equipment and instrumentation identification numbers are referenced from the **Process & Instrumentation Diagram** and **System Layout** presented in **Appendix A** of this O&M Manual.

Automatic Operation

The PLC-based control system is the default operation mode for the **newterra** MicroClear™ MBR. The system operates as a programmable computer that:

- Receives analog and digital input signals from the switches and transmitters being controlled;
- Processes this information using the structure and rules entered into the program;
- Generates outputs that control the equipment - turn equipment **OFF** or **ON**.

Under normal operation, all switches are set in the **AUTO** position on the **HMI**.

All alarms are visually indicated on a beacon stack on the roof of the exterior of the container:

- Green – System OK
- Green Flashing – System Auto Restart
- Red Solid – Warning Alarm
- Red Flashing – Critical Alarm
- No Light – Loss of Power

The MBR will always remain in auto run mode, unless the kill switch is pressed or power is down. The MBR will automatically restart after power failure given that the system was running when the power failed.

All high high level alarms (identified as LSHH on P&ID) indicate a critical situation for imminent tank overflow and could result in pump(s) shutting off to avoid overflow situations and requires immediate operator attention.

Manual Operation

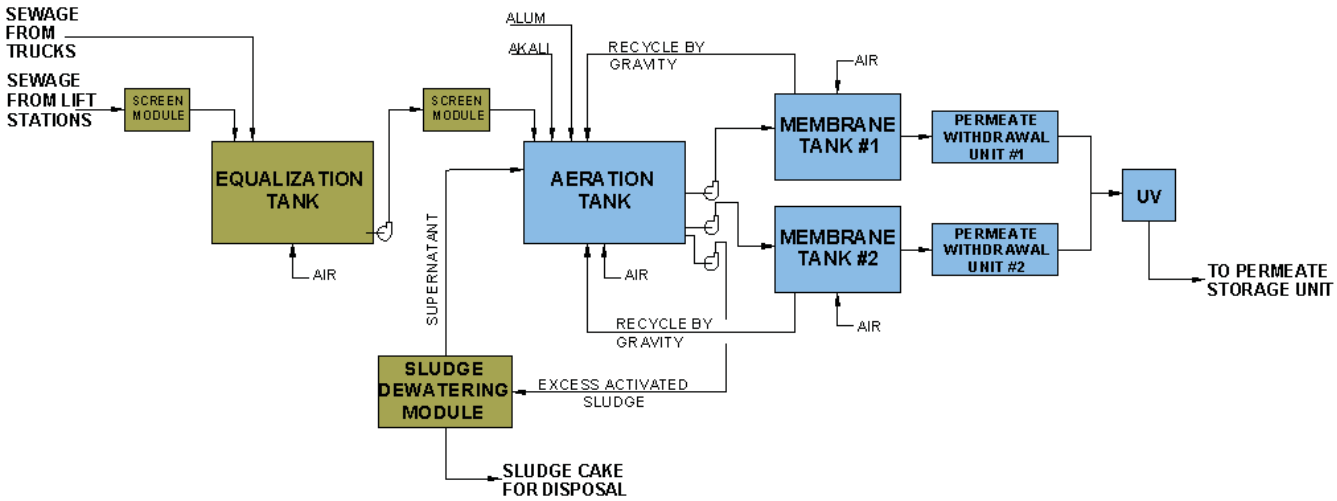
The manual mode of operation is provided for maintenance purposes and for emergency operation of the plant in the unlikely event of a failure of the automatic control system (default operation mode). Operators **must be present when equipment is operated in the manual mode.**

A HAND-OFF-AUTO (H-O-A) switch is provided on the touch screen of the control panel. The HAND position on the switch allows the equipment to be operated in the manual mode.

For safety reasons, a motor in the HAND position will only run for two minutes before it will be automatically stopped.

5.1 Wastewater Treatment Process Description / Control Narrative

The **newterra** MBR WWTP comprises screen modules, equalization tank, aeration tank, membrane filtration module, UV system, permeate storage tank, and sludge dewatering module.



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5.1.1 Buildings/ Utilities

The newterra MBR WWTP is housed inside six (6) enclosures (buildings):

- Screen building (BLD-7903) with two (2) rooms: Room #1 (Electrical Classification – Class 1, Div 2 area), and Room #2 (GP area)
- Equalization tank building (BLD-7901)
- Aeration building (BLD-7902), GP area
- Membrane Filtration building (BLD-7900), GP area
- Effluent building (BLD-7905), GP area
- Sludge building (BLD-7904) with two (2) rooms: Room #1 (Electrical Classification – Class 1 Div 2 area), and Office Room #2 (GP area)

The main control panel is located in the Screen building (BLD-7903), Room #2 (GP area)

5.1.1.1 Wastewater Treatment Plant Power Supply

Please refer to the as-built Electrical Block Diagram presented in Appendix A of this manual.

A power monitor has been installed in the main power distribution panel to ensure proper power and phase rotation is delivered to the system. The main power distribution panel is located in the Screen BLD-7903, Room #2 (GP area).

E-STOP

There are several emergency stop buttons wired to a common system kill circuit (KILL-7901) in the plant:

- Kill Switch Emergency Stop **MCP-01** (ESD-8201) located in the control room of the BLD-7903, Room #2, (GP area)
- Emergency Stop **MCP-02** (ESD-8202) located in BLD-7900
- Emergency Stop **MCP-03** (ESD-8203) located in BLD-7905
- Emergency Stop **MCP-04** (ESD-8204) located in BLD-7904, Room #2 (GP area)
- Emergency Stop Screen (ESD-7931) located in BLD 7903, Room #1 1 (Class 1 Div 2 area)
- Emergency Stop Membrane Filtration (ESD-7911) located in BLD-7900

The following emergency stop switches are used for local shut off:

- Emergency Stop Effluent (ESD-7905) located in BLD-7905
- Emergency Stop Sludge (ESD-7941) located in BLD-7904

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5.1.1.2 SCREEN BLD-7903

Ventilation

Two (2) exhaust blowers (B-7931 & B-7932) provide constant ventilation for the Screen Modules and Building BLD-7903 Room #1 (Electrical Classification – Class 1 Div 2 area). The air from the blowers is passed through a heat recovery system prior to discharging outside. The blowers run at all times at a rate of ~12 air changes per hour to ensure the requirements of the electrically classified location are met.

Alarms

If the blowers' motors stop running an alarm signal will be sent to the PLC from current switches (YI-7931/ YI-7932).

A single exhaust fan (F-7911) is locate in the Room #2 (GP) of the BLD-7903 where the main control panel is located. The purpose of the fan is to prevent the building temperature from climbing higher than desired room set point temperature. The desired room temperature must be set by the operator with the building high temperature switch TSH-7911. If this switch is tripped the exhaust fan will run until the temperature drops below the set point.

Note: The fan (F-7911) is to be used primarily during the summer months - freezing cold air in to the building can lead to condensation/potential freezing risks for critical pieces of equipment.

Hydrogen Sulphide Detection

A Hydrogen Sulphide (H_2S) Detector (AIT-7931) is installed in the screen building (BLD-7903) Room #1 (Electrical Classification – Class 1 Div 2 area). This sensor allows continuous monitoring for H_2S gas. In the event the H_2S alarm level set point is exceeded an alarm will be triggered and indicated on the HMI, an internal and external audible buzzer will sound, the alarm beacon light will illuminate. The water treatment process will continue to run.

Temperature control

For building (BLD-7903), temperature is controlled manually at the local thermostats of the heaters: H-7931/H-7932 for the Room #1 (Electrical Classification - Class 1 Div 2) and H-7933 for the Room #2 (GP area). They are not linked to the PLC.

The operator is required to set the desired building temperature set point in ^{o}F at the temperature switches (TSL-7931 and TSL-7932) located in the general purpose room of this building. If the building temperature falls below the temperature switch setting the electric heaters (H-7931/H-7932) will turn on. H-7933 is locally controlled only.

CAUTION: The temperature switch units are in ^{o}F.

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Alarms

If the temperature of the room #1 and room #2 in the BLD-7903 drops below the low low temperature set point, the alarm switches (TSLL-7931 & TSLL-7932) will trip and after 300 sec a low temperature alarm will register on the HMI and the red beacon light will illuminate. This may indicate that heaters (H-7931/H-7932) are faulty.

5.1.1.3 EQUALIZATION TANK BLD-7901

Ventilation

The Equalization Tank (TNK-301) is equipped with a ventilation exhaust blower (B-307) located in classified area of BLD-7903. The blower runs at all times providing constant ventilation of the equalization tank. The blower vents air at a rate of 12 air changes per hour and exhausts to the exterior of the building.

If the blower's motor stops running an alarm signal will be sent to the PLC from current indicator switch (YI-307).

5.1.1.4 AERATION TANK BLD-7902

Ventilation

The aeration tank head space is vented by a blower (B-503) to the aeration foam tank (see details in subsection 5.2.3).

5.1.1.5 MEMBRANE FILTRATION BLD-7900

Hydrogen Sulphide Detection

A Hydrogen Sulphide (H_2S) Detector (AIT-7911) is installed below the control panel in the permeate extraction system room of building 7900. This sensor allows continuous monitoring for H_2S gas. In the event the H_2S alarm level set point is exceeded an alarm will be triggered and indicated on the HMI, an internal and external audible buzzer will sound, the alarm beacon light will illuminate. The water treatment process will continue to run.

Temperature control

For building (BLD-7900), temperature is controlled manually at the local thermostats for the wall mounted heaters: H-7911/H-7912. They are not linked to the PLC.

The operator is required to set the desired building temperature set point in ^{o}F at the temperature switch (TSL-7912). If the building temperature falls below the temperature switch setting the wall mounted electric heaters (H-7911/H-7912) will turn on.

CAUTION: The temperature switch units are in ^{o}F.

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Alarms

If the temperature in the BLD-7900 drops below the low low temperature set point, the alarm switch (TSLL-7901/TSLL-7905) will trip and after 60 sec the room's temperature alarm will register on the HMI and the red beacon light will illuminate. This may indicate that heaters (H-7911/H-7912) are faulty.

5.1.1.6 EFFLUENT STORAGE BLD-7905

Temperature control

For BLD-7905, temperature is controlled manually at the local thermostat for the wall mounted heaters (H-7951/H-7952). They are not linked to the PLC.

The operator is required to set the desired building temperature set point in ^{o}F at the temperature switch (TSL-7952). If the building temperature falls below the temperature switch setting the wall mounted electric heaters (H-7951/H-7952) will turn on.

CAUTION: The temperature switch units are in ^{o}F.

Alarms

If the temperature in the BLD-7905 drops below the low low temperature set point, the alarm switch (TSLL-7951) will trip and after 60 sec a building temperature alarm will register on the HMI and the red beacon light will illuminate. This may indicate that heaters (H-7951/H-7952) are faulty.

5.1.1.6 SLUDGE BLD-7904

Ventilation

Building (BLD-7904), Room #1, Class 1 Div 2 is equipped with an exhaust blower (B-7941). The blower runs at all times providing constant ventilation of the room. The blower vents air at a rate of 12 air changes per hour. The air from the blower (B-7941) is passed through a heat recovery system prior to discharging outside the BLD-7904.

If the blower's motor stops running an alarm signal will be sent to the PLC from current (YI-7941).

Temperature control

For BLD-7904, temperature is controlled manually at the local thermostats for the wall mounted heaters: H-7941/H-7942 for the Room #1, Class 1 Div 2 and H-7943 for the Room #2 General Purpose. They are not linked to the PLC. There are temperature switches in the BLD-7904: TSL-7941/TSL-7942 for the Room #1 (Class 1 Div 2).

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Alarm

Alarm switch (TSLL-7941) is activated when the temperature falls below set point. This may indicate that heaters (H-7941/H-7942) are faulty.

Compressed air

Air compressor (C-901) supplies air to operate the filter press (FP-901). The air compressor has level switches:

- an oil level switch alarm (LSLL-901) is activated when the oil level is low
- if pressure switch (PSL-901) is activated an alarm will register on the HMI indicating the air compressor has malfunctioned.

5.1.1.7 FIRE AND EXPLOSION PROTECTION

There are some areas in the plant defined as Class 1 Div 2 according to the National Electrical Code Classification (NFPA 70). These areas are:

- Screen building (BLD-7903), Room #1
- Equalization tank zone, (BLD-7901)
- Sludge building (BLD-7904), Room #1

This classification refers to the areas with potential hazards as flammable gas which is not present under normal conditions.

Fire alarm system is implemented across the plant. The fire protection measures include fire alarm system (FAS), fire detection system (FDS), and portable fire extinguishers. Please refer to the Fire Alarm Layout Drawing presented in Appendix A of this manual.

5.1.2 Process Description

5.1.2.1 Screen Modules Building (SCREEN BLD-7903)

Function: a screening process is provided to remove hair, and fibrous materials from wastewater supplied from the lift stations and delivered by sewage trucks.

There are two (2) screen systems in the plant:

- screen module (SCR-201) for screening incoming raw sewage pumped from lift stations
- screen module (SCR-401) for screening effluent from equalization tank (TNK-301) taking into account addition of raw sewage delivered by sewage trucks and added into the equalization tank (TNK-301)

Both screen modules are located in the building (BLD-7903), Room #1 (Class 1 Div 2 area).

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Screw Screen Compactor (SCR-201)/Screen Tank

The screw screen compactor module consists of:

- screw screen compactor with 2-mm opening, equipped with solids bagging
- discharge tank (TNK-202) for collection of the screened wastewater
- external discharge pumps (P-201/P-202) to transfer screened wastewater to the equalization tank (TNK-301)
- self cleaning spray nozzles set on a timer through the HMI

Screw Screen Basin Level Control

The screw screen (SCR-201) will run when the permissive signal (YC-101) to receive from the lift station is ON, and the high level in the screen tank has been reached. If the high level in the screw screen basin has been reached this indicates the screen is clogged. The screw will continue to turn for 2 minutes after the high level condition has cleared.

Screened wastewater flows by gravity from screw screen basin to the screen discharge tank (TNK-202) through 6" discharge pipe.

Alarms

If the clogged screen cannot be cleared and the high high level in the screw screen basin is reached the LSHH-201 will trip. If the LSHH-201 level switch is tripped, an alarm will be generated and will remain visible on the HMI until the alarm condition has cleared. The permissive to receive wastewater from the lift station will be lost. **Operator intervention is required in the event of this alarm!**

In the event the SCR-201 motor trips off on overload an alarm will register on the HMI and the red beacon light will flash.

Screen Tank Level Control:

The screen discharge tank (TNK-202) is equipped with:

- (2) external discharge pumps (P-201 Duty and P-202 Standby)
- discharge pressure indicator (PI-201/ PI-202) to measure the discharge pressure
- motor current switch (YA-201 /YA-202)
- variable frequency drive (VFD-201/VFD-202)
- discharge tank (TNK-202) is equipped with level transmitter (LT-202) and high high level switch (LSHH-202)

After completion of 4 cycles the standby pump will run for 1 cycle. Each time a pump starts the cycle count goes up. As long as the wastewater level in TNK-202 is between the high and low set point, the PLC will allow the operation of the pumps (P-201/P-202) to transfer wastewater to the equalization tank (TNK-301).The VFD's regulate the flow of the pumps to keep the discharge flow rate at the desired set point flow.

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If current switches (YA-201/YA-202) are ON and level transmitter (LT-202) indicates the high set point, then the pumps turn on until the level transmitter (LT-202) gets to its low set point.

If the high level set point is on for more than 5 seconds, pumps (P-201/P-202) will increase speed to clear the high level condition.

Alarms

In the event the screen tank discharge pumps motor current switches (YA-201/YA-202) trip, an alarm will register on the HMI and the red beacon light will flash.

Screen Cleaning:

A potable water connection to the screw screen compactor unit (SCR-201) is used to clean the screw screen. A solenoid valve (SV-201) is controlled on a timer to open the solenoid valve for 2 seconds every 60 minutes, with the goal of removing solid build up on the screw screen. Frequency of cycle can be changed through the HMI.

5.1.2.2 Equalization Tank (TNK-301)

***Function*:** Buffers influent variable flow to prevent concentration fluctuations in (i.e. BOD, TSS etc.) through the MBR treatment system.

The equalization tank (TNK-301) receives screened wastewater from the screen tank (TNK-202). The equalization tank (TNK-301) can also receive raw wastewater from the sewage trucks. There are two truck hook-ups from the screen building (BLD-7903) side equipped with 3" female camlocks, valves and 3" PVC pipes.

WARNING: NO CONTROLS ARE IN PLACE TO SHUT OFF TRUCK INFLUENT TO THE EQUALIZATION TANK IN THE EVENT OF A HIGH OR HIGH HIGH LEVEL CONDITION IN THE EQUALIZATION TANK. THE LEVEL OF THE EQ TANK MUST BE MANUALLY MONITORED AT ALL TIMES DURING THE OFFLOADING OF TRUCKS.

The effective volume of the EQ tank is 43.5 m^3, providing a hydraulic retention time of 14.5 hours. The equalization tank is equipped with:

- level monitoring/control equipment
- 2 electric immersion heaters with local temperature control
- blowers (B-301to B-306) supply air to the air diffusers
- 10 EDI fine-bubble air diffusers for mixing and assisting the elimination of potential odour
- 12 magnesium anodes which act as the tank ground and will be sacrificially eroded as a means of prolonging the tank life
- discharge pumps (P-301/ P-302) for transferring wastewater to the SCR-401

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Air Diffusers Control

Blowers (B-301- B-306) supply air to the air diffusers installed in the bottom of the equalization tank. A pressure indicator (PI-301) and switch (PLS-301) is installed on the discharge side of the blowers.

Alarms

If the blower air pressure drops below set point, the low pressure switch (PLS-301) will trip and a low pressure alarm will be activated through the PLC. The flashing red beacon light will illuminate.

Temperature Control

The equalization tank (TNK-301) is heated via 2 electric immersion heaters (H-301/H-302).Temperature in the tank is controlled via a local thermostat. Recommended temperature setting for TSL-301/TSL-302 is 10°C to 15°C.

Alarms

If the Temperature Switch Low Low (TSLL-301) is tripped an alarm signal will register on the HMI and the flashing red beacon light will illuminate.

Note: As a low water level in the tank can cause damage to the heaters, the Level Switch Low Low (LSLL-301) is installed in the equalization tank to protect the immersion heaters and if tripped will shut the tank heaters off and initiate an alarm signal from the PLC.

Transfer Pumps/Level Control

The equalization tank (TNK-301) has two (2) external pumps (P-301, P-302) with one of the pumps acting as a standby. Pump (P-301) operates for 4 cycles, pump (P-302) for 1. This pump transfers the wastewater from the equalization tank (TNK-301) to SCR-401 screw screen basin tank.

The equalization tank discharge pumps (P-301/P-302) have local pressure indicators (PI-302/PI-303) to measure discharge pressure and motor current switches (YI-301/YI-302). The discharge pressure can be used to determine an estimation of the flow rate based on the pump curve.

A level transmitter (LT-301) is used to indicate the liquor level in the equalization tank (TNK-301). As long as the level in the tank is above set point, the PLC will allow the operation of either EQ tank discharge pump (P-301 or P-302). If the high level in the EQ tank is met the screen tank supply pumps will be turned off.

Alarms

In the event the equalization tank discharge pumps motor current switches (YI-401/YI-402) trip, an alarm will register on the HMI and the red beacon light will flash.

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The Level Switch High High (LSHH-301) if tripped will send a signal to the PLC to warn of imminent overflow in the equalization tank (TNK-301).

Post EQ Screw Screen Compactor (SCR-401)

The screw screen compactor module consists of:

- screw screen compactor with 2-mm opening, equipped with solids bagging
- discharge tank (TNK-401) for collection of the screened wastewater
- external discharge pumps (P-401/P-402) to transfer screened wastewater to the aeration tank (TNK-501)
- self cleaning spray nozzles set on a timer through the HMI

Screw Screen Basin Level Control

The screw screen (SCR-401) will run when the high level in the screen tank has been reached. If the high level in the screw screen basin has been reached this indicates the screen is clogged. The screw will continue to turn for 2 minutes after the high level condition has cleared.

Screened wastewater flows by gravity from screw screen basin to the screen discharge tank (TNK-401) through 6" discharge pipe.

Alarms

If the clogged screen cannot be cleared after 5 minutes a high high level alarm (LSHH-402) will be triggered and will remain visible on the HMI until the alarm condition has cleared. The permissive to receive wastewater from the equalization tank (TNK-301) will be lost. **Operator intervention is required in the event of this alarm!**

In the event the SCR-401 motor trips off on overload an alarm will register on the HMI and the red beacon light will flash.

Screen Tank Level Control:

The screen discharge tank (TNK-401) is equipped with:

- (2) external discharge pumps (P-401 Duty and P-402 Standby)
- discharge pressure indicator (PI-401/ PI-402) to measure the discharge pressure
- motor current switch (YA-401 /YA-402)
- discharge tank (TNK-401) is equipped with a low level switch(LSL-402), high level switch (LSH-402) and a high high level switch (LSHH-202)

After completion of 4 cycles the standby pump will run for 1 cycle. Each time a pump starts the cycle count goes up. As long as the wastewater level in TNK-401 is above the low level switch level, the PLC will allow the operation of the discharge pumps (P-401/P-402) to transfer wastewater to the equalization tank (TNK-301).

Alarms

In the event the screen tank discharge pumps motor current switches (YA-201/YA-202) trip, an alarm will register on the HMI and the red beacon light will flash.

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Screen Cleaning:

A potable water connection to the screw screen compactor unit (SCR-401) is used to clean the screw screen. A solenoid valve (SV-401) is controlled on a timer to open the solenoid valve for 2 seconds every 60 minutes, with the goal of removing solid build up on the screw screen. Frequency of cycle can be changed through the HMI.

5.1.2.3 Aeration Tank (AERATION BLD-7902)

Function: Oxygen is added to the wastewater to ensure microorganism concentration is at optimum levels to metabolize contaminants. (i.e. oxidation of carbonaceous BOD; nitrification (conversion of TKN to NO_3-N).

One (1) aeration tank (TNK-501) located in BLD-7902 has an overall effective volume of 48 m^3, providing a hydraulic retention time of 16 hours. TNK-501 receives screened wastewater from the screen tank (TNK-401) of the post EQ screen module (SCR-401), return flow from the membrane tanks (TNK-601/ TNK-602), and supernatant from (TNK-901) of sludge dewatering module.

Blowers supply air to the submerged fine-bubble diffusers to ensure biological oxidation (aeration) and to keep solids in the water suspended. Mixed liquor is constantly re-circulated from the bottom of the tanks to the top through spray nozzles. This recirculation process is in place for foam suppression. Alum and soda ash chemical metering systems are in place to ensure regulation of aeration tank water pH and phosphorus levels.

The aeration tank (TNK-501) is equipped with:

- level, temperature, pH, and dissolved oxygen (DO) monitoring and control equipment.
- 2 electric immersion heaters (H-501/H-502) to keep the temperature of the biological process above 15-20° C.
- Blowers (B-501, B-502) equipped with VFD's to supply air to the fine-bubble air diffusers in (TNK-501)
- 30 EDI fine-bubble air diffusers
- Tank recirculation/sludge removal pump (P-503)
- Tank discharge pumps (P-501/P-502) transfer wastewater to the membrane tanks (TNK-601/TNK-602)
- Chemical Metering Systems – soda ash tank (TNK-6101) with dosing pump (P-6101) and alum tank (TNK-6102) with dosing pump (P-6102)

<u>Temperature Control</u>

The aeration tank (TNK-501) is heated via electric immersion heaters (H-501/H-502). Temperature in the tank is controlled via a local thermostat. Recommended temperature setting for TSL-301/TSL-302 is 15°C to 20°C.

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Alarms

If the Temperature Switch Low Low (TSLL-501) is tripped an alarm signal will register on the HMI and the flashing red beacon light will illuminate.

Note: As a low water level in the tank can cause damage to the heaters, the Level Switch Low Low (LSLL-501) is installed in the equalization tank to protect the immersion heaters and if tripped will shut the tank heaters off and initiate an alarm signal from the PLC.

Discharge Pump/Level Control

The aeration tank (TNK-501) has two (2) external transfer pumps (P-501, P-502). Pump (P-501) transfers wastewater to membrane tank (TNK-601) and pump (P-502) transfers wastewater to membrane tank (TNK-602).

Level transmitter (LT-501) indicates the liquor level in the aeration tank (TNK-501). As long as the level in the tank is above set point the PLC will allow the operation of both discharge pumps (P-501 or P-502).

Alarms

If the Level Switch High High (LSHH-501) is tripped an alarm will register on the HMI, the flashing red beacon light will illuminate and the equalization discharge pumps will be shut down or disabled from running for the duration of the high high level condition.

The aeration tank discharge pumps (P-501/P-502) have pressure indicators (PI-501/PI-502) to measure discharge pressure and motor current switches (YA-P501/YA-P502). The discharge pressure can be used to determine an estimation of the flow rate based on the pump curve.

Alarms

In the event the aeration tank discharge pumps motor current switches (YA-P501/YA-P502) trip, an alarm will register on the HMI and the red beacon light will flash.

Dissolved Oxygen Control

The aeration tank (TNK-501) is equipped with a dissolved oxygen (DO-501) sensor. The PLC is programmed to ensure the level of DO remains above 2 mg/L. If the level of DO falls below the set point value a 4-20 mA signal is sent to the VFD (VFD-501) that controls the speed of the blowers (B-501, B-502).The speed of the blowers is regulated to maintain the DO at set point level.

Alarms

In the event the Dissolved Oxygen level set point cannot be achieved within 15 minutes of the detection of the level being outside of the set point range a low DO alarm will register on the HMI and the red beacon warning light will illuminate. The duty blower will run at full speed for

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15 minutes to attempt to regain the oxygen level. If after 15 minutes the oxygen level has not returned to below set point the duty blower defaults to a manual speed setting until operator intervention is possible.

pH Control

A chemical dosing pump (P-6101) is provided to inject soda ash (Na_2CO_3) into the aeration tank (TNK-501) to maintain the pH at desired pH set point. If the pH measured by pH probe (PH-501) falls below set point, the PLC will turn the pump on for 30 seconds, turn the pump off for 30 seconds and repeat this cycle until tank pH has regained desired set point. The pump stroke must be set by the MBR system operator.

Alarms

In the event the pH level set point cannot be achieved a low or high pH alarm will register on the HMI and the red beacon warning light will illuminate. The system will continue to adjust to achieve set point pH throughout the duration of the alarm.

Phosphorus Concentration Control

A chemical dosing pump (P-6102) is provided to inject alum [$Al_2(SO_4)_3$]. The dosing pump will be stroked based on an influent volume set point entered on the HMI by the system user. Alum is used to remove phosphorus from the influent. The alum dosage volume is manually set locally at the metering pump by adjusting the pump stroke.

Foam Suppression

The aeration tank (TNK-501) is equipped with an external pump (P-503) and a spray nozzle system for foam suppression. The pump (P-503) has a pressure indicator (PI-503) measuring its discharge pressure. The flow is controlled by opening a manual gate valve installed in the foam suppression line. The foam suppression line is equipped with a de-ragger unit to prevent spray nozzles from plugging.

Sludge Dewatering Unit Supernatant Return

Supernatant can be returned to the aeration tank (TNK-501) if the MBR system is operating in conjunction with a sludge dewatering system. Supernatant will be returned as long as the aeration tank level is below the High Level set point. The PLC will shut down pump (P-503) for the duration of the return cycle.

Sludge Removal

A sludge removal pipeline is provided at a tee off of the aeration tank recirculation line, isolated by a manual ball valve. The manual isolation valve must remain closed at all times. To remove sludge the manual isolation valve is opened along with the manual isolation valve at the entrance of TNK-901, while P-503 is running.

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5.1.2.3 Membrane Filtration (TNK-601/602)

***Function*:** Mixed liquor filtration and supplemental biological oxidation.

Membrane filtration is comprised of a membrane tank and permeate extraction unit

Membrane unit includes:

- Two (2) membrane tanks, each tank is equipped with submersible membrane filtration module, level controls, gravity recycling line, drain, access hatch, viewing window, and sample port
- Blower unit for membrane tanks; each unit contains five (5) blowers and it is equipped with pressure indicator, pressure switch low alarm, and motorized three-way valve
- Recirculation pumps transferring mixed-liquor from the membrane tanks (TNK-601/TNK-602) to the aeration tank (TNK-501)

Permeate extraction unit includes:

- Permeate pumps (P-701/P-702) with VFD, current switches, pressure and flow rate control equipment, solenoid valves, and motorized valves
- Backwash tank (T-801) equipped with level control switches, submersible pump (P-801), and solenoid valve
- UV disinfection unit with two (2) UV lights (UV-751/UV-752)

Membrane Unit Operation

External pumps (P-501/P-502) housed in (BLD-7900) transfer mixed liquor from the aeration tank (TNK-501) to the membrane tanks (TNK-601/TNK-602). Each membrane tank contains One (1) MicroClear™ MB3-1 submerged membrane module (membrane cassettes are complete with stainless steel housing and permeate piping with header).

Each membrane tank is equipped with air diffusers for the purpose of scouring the membranes to assist in the prevention of membrane fouling.

Mixed liquor from the membrane tanks (TNK-601/TNK-602) is constantly recycled back to the aeration tank (TNK-501) by external pumps (P-601/ P-602) to maintain even biomass inventory within the aeration tank and membrane tanks.

Each of the respective pumps (P-601/P-602) are equipped with pressure indicators (PI-603/PI-604) to measure the discharge pressure of the pumps, and current switches (YA-601/YA-602). The membrane tanks are also equipped with gravity overflow lines that recycle mixed liquor back to the aeration tank (TNK-501).

Membrane Tanks Level Control

The membrane tanks (TNK-601/TNK-602) contain high level switches (LSH-601/LSH-602) which activate the permeate pumps (P-701/P-702) to start pulling permeate out of the membrane tanks (TNK-601/TNK-602).

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Alarms

The level switches high high alarm (LSHH-601/LSHH-602) inform the operator of an imminent overflow. It also shuts off the aeration tank discharge pumps (P-501/P-502) to prevent more mixed liquor from entering the membrane tank (TNK-601/TNK-602).

Recycle Pump Control

Recycle (RAS) pumps (P-601/P-602) recycle mixed liquor from membrane tanks (TNK-601/TNK-602) back to the aeration tank (TNK-501) as long as the discharge pumps (P-501/P-502) are on, water level switches in the membrane tanks (LSH-601/LSH-602) are ON, and there is no High High Level in aeration tank.

Alarms

In the event the RAS pumps motor current switches (YA-601/YA-602) trip, an alarm will register on the HMI and the red beacon light will flash.

Blower Units Control

The membrane air scouring blowers (B-601 to B-605 for TNK-601 and B-606 to B-610 for TNK-602) are connected to the air diffusers in the membrane tanks (TNK-601/TNK-602) respectively. The common airlines to the membrane tanks are equipped with a discharge pressure indicators (PI-601/PI-602) and a pressure switches (PSL-601/ PSL-602).

Each blower unit is also equipped with an electrically actuated three-way valve (MV-601/ MV-602) to direct the flow of air through medium air diffusers or coarse air diffuser. The valves (MV-601/MV-602) are installed with closed position switches (ZSC-601/ZSC-602) that is monitored by the PLC.

The blowers scouring the membranes:

- Operates continuously **(24/7)**
- Turned off for one minute every hour to relax the membranes

Coarse Air Diffuser Cycle

Under normal operation, air is directed through the medium air diffusers at the base of the membrane housing. If the level switch high (LSH-601) has not been reached in 30 minutes, the air is diverted to the coarse air diffusers in the membrane tank. Changing where air enters into the membrane tank (TNK-601) changes the direction of scouring, helping remove debris on the membrane modules/cassettes.

The air will be directed to the coarse air diffusers for the time interval set point entered through the HMI. The duration of the coarse air diffuser cycle time is adjustable up to 15 minutes, by changing the set point on the HMI screen to meet the particular plant operating conditions.

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Blower for scouring air must be on 24/7, as failure of air supply can lead to clogging of the air diffusers and membranes.

Alarms

If the pressure switches low alarm (PSL-601/PSL-602) are tripped, a signal will be sent to the PLC which will generate an alarm indicating a potential blowers (B-601 to B-610) malfunction which will cause the corresponding membrane permeate tank discharge pumps (P-701/P-702) to stop. This interlock is in place to prevent damaging the membranes.

Please note: At no time shall the vacuum pumps P-701/P-702 operate when the pressure switches (PSL-601/PSL-602) are active; this is to ensure that air for membrane scouring is available at all times, and to protect the membranes from fouling.

Permeate Extraction Unit Operation

Vacuum pumps (P-701/ P-702) draw the water through the membranes under a preset flow rate of 31.5 Lpm (at a design flux of 18 LMH). Permeate is run through UV system for final disinfection before entering permeate storage tank (TNK-811).

Permeate Flow Control

There are two (2) operational modes for permeate flow control, flow mode (constant flux mode) or vacuum mode (constant TMP mode).The operator has the option of selecting the permeate flow control mode on the screen. Flow transmitters (FT-701/FT-702) are installed on the permeate discharge line to measure the effluent flow from each membrane tank.

Flow Mode (default for newterra MBR)

- Normal permeate flow rate is 31.5 Lpm (corresponds to a design flux rate of 18 LMH)
- This setpoint is used for vacuum pumps (P-701/P-702) VFDs control
- The maximum permeate flow setpoint is 52.5 Lpm (corresponds to a maximum flux rate of 30 LMH)
- The operator has the option of changing the permeate flow rate on the screen, but the set point should not be greater than 31.5 Lpm under normal operating condition and cannot exceed 52.5 Lpm, at any given time

Note: If the vacuum reaches -0.250 bar the system automatically switches to Vacuum Mode.

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Vacuum Mode

There are two vacuum set points for the permeate withdrawal system:

- Normal vacuum rate to pull the permeate out at a pre-set vacuum setpoint of -0.100 bar
- Higher vacuum rate (-0.120 bar) is used when the EQ tank's high level (LSH-301) is on, signalling the MBR to run at a higher vacuum to keep up with the incoming water
- The highest vacuum of the permeate extraction system is -0.300 bar

Permeate Discharge Pump Control

The permeate discharge pumps (P-701/P-702) will run continuously as long as the high level switches (LSH-601/P-602) in the membrane tanks (TNK-601/TNK-602) are activated. Permeate withdrawal is done based on the preset permeate normal flow rate or vacuum rate.

If the level switch (LSH-301) in the equalization tank (TNK-301) is active for more than 5 seconds, permeate pumps (P-701/P-702) start increasing the permeate flow rate using the variable frequency drives (VFD-701/VFD-702). The trans-membrane pressure (TMP) indicated by vacuum transmitters (VT-701/VT-702) and the calculated permeability are displayed on the touch screen. The permeability is a key indicator of membrane fouling state.

Membrane Relax Cycle

- After every 9 minutes of permeate flow the permeate discharge vacuum pumps (P-701, P-702) will stop and the electrically actuated valves SV-701/SV-702 will open to release vacuum through the membranes.

- The resulting removal of vacuum in the system allows the membranes to relax for 1 minute.

Membrane Backwash Cycle

- When necessary conditions have been met the backwash tank sump pump (P-801) will be activated, permeate pumps (P-701/P-702) shut off and the backwash supply valves (MV-701/MV-702) open, to allow the reversal of flow over the membrane surface.

- The duration of the relax and backwash time is adjustable by changing the set point on the **HMI** screen to meet the particular plant operating conditions. A combination of backwash and relaxation (no permeation) is carried out for the best performance of the membranes.

- Maximum head required for backwash is **one meter**.
- During the entire backwash cycle, the scouring of the membranes is continuous.

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At design flow when the membrane discharge vacuum exceeds 0.2 bar/80" WC (transmitted by VT-701, and indicated locally at PI-701), or permeability drops rapidly to 50 LMH/bar, it is necessary to take the membrane tanks (TNK-601/TNK-602) offline for chemically enhanced backwash **(CEB)** cleaning (please refer to Section 7 of this O&M manual)..

The permeability is a key indicator of membrane fouling state. A permeability of less than 50 LMH/bar (or transmembrane pressure exceeding 0.2 bar) indicates a membrane chemical clean is required.

A chemical addition unit is provided in the building (BLD-7900) for membrane in-situ chemically enhanced backwash (CEB) and recovery cleaning. The unit includes:

- Citric acid tank (TNK-802) with chemical dosing pump (P-802)
- Sodium hypochlorite tank (TNK-803) with chemical dosing pump (P-803)

Backwash Tank

The backwash tank (TNK-801) has 3 level switches (LSL-801, LSH-801, LSHH-801). When the low level switch LSL-801 is tripped this indicates a low water level in the backwash tank. Solenoid valve (SV-801) will open to fill the tank to the high level switch (LSH-801).

Alarms

LSHH-801 indicates imminent overflow. An alarm signal will register on the HMI and the flashing red beacon light will illuminate. **Operator intervention is required**.

Disinfection System

The MBR permeate is run through UV system for final effluent disinfection. The disinfection system consists of two high intensity UVmax Lights (UV751/ UV752) installed in series. The UVmax lights provide disinfection with a UV dosage of 40 mJ/cm^2 and a flow rate of 303 L/min. This system is installed for protection in the event of a membrane breakthrough. The UV-Lights are connected to a solenoid safety (UVL-751, UVL-752) to restrict the flow in case the UV-Light system have been compromised.

Turbidity Meter

Turbidity transmitter (AIT-801) connected after the UV systems indicates the turbidity (solids content) in the treated effluent. High turbidity will activate an alarm as this can indicate possible breakthrough of the membranes.

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5.1.2.4 Permeate /Treated Effluent Building (EFFLUENT BLD-7905)

Function: Treated effluent storage**,** ammonia oxidation with calcium hypochlorite followed by dechlorination.

Prior to final discharge to the receiving water body the treated effluent will be tested. In the event the biological process upset occurs, due to a toxic shock load or cold weather, it may result in a discharge of ammonia or total nitrogen into the receiving water body. Therefore, calcium hypochlorite addition system is supplied as a stand-by solution for ammonia removal in the wastewater. The sodium bisulfite dosing system is used for dechlorination.

The treated effluent from UV lights is stored in four (4) identical storage tanks (TNK-811, TNK-812, TNK-813, TNK-814). All tanks are connected with 3" PVC pipes.

Calcium Hypochlorite Concentration Control

Chemical dosing system including calcium hypochlorite tank and dosing pumps (P-813 Duty / P-814 Standby) is provided to inject calcium hypochlorite [$Ca(ClO)_2$] to the tank (TNK-811). The calcium hypochlorite dosage rate is manually set locally at the metering pump by adjusting the pump stroke. The operator must determine what the dosage rate needs to be and manually set the stroke at the pump and enter influent flow rate set point through the HMI.

The calcium hypochlorite tank is equipped with low level switch alarm (LSLL-815) indicating if tank is empty; this is to protect dry running of the pumps (P-813/P-814).

Effluent Storage System Discharge pumps / Level control

The storage tanks have two (2) external pumps (P-811 Duty / P-812 Standby) for sending treated effluent to final discharge. Each pump is equipped with discharge pressure indicator (PI-811/ PI-812) to measure the discharge pressure and motor current switch (YA-811 /YA-812).

Tank (TNK-814) is equipped with a high level switch (LSH-814) and low level switch. As long as the water level in the tank is above the low level height, pumps (P-811/P-812) will run.

Alarms

All effluent storage tanks (TNK-811/TNK-812/TNK-813/TNK-814) are equipped with level switches alarm (LSHH-801/LSHH-802 /LSHH-803/LSHH-804) for indicating imminent overflow; an alarm signal will register on the HMI and the flashing red beacon light will illuminate, operator intervention is required.

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Sodium Bisulfite Concentration Control

Chemical dosing system including sodium bisulfite tank and metering pumps (P-815 Duty / P-816 Standby) is provided to inject sodium bisulfite [$Na_2S_2O_5$] to the discharge line for effluent dechlorination. The sodium bisulfite dosage rate is manually set locally at the metering pump by adjusting the pump stroke. The operator must determine what the dosage rate needs to be and manually set the stroke at the pump and enter influent flow rate set point through the HMI.

The sodium bisulfite tank is equipped with low level switch alarm (LSLL-815/LSLL-816) indicating if tank is empty; this is to protect dry running of the pumps (P-815/P-816).

5.1.2.5 Sludge Treatment Module (SLUDGE BLD-7904)

Excess waste activated sludge (WAS) from the aeration tanks (TNK-501) is pumped to the sludge treatment module housed inside container (SLUDGE BLD-7904), Room#1 Cl1 Div 2.

Sludge treatment module includes:

- Polymer tank (TNK-902) with mixer (M-902), and polymer transferring pump (P-902)
- Sludge mixing tank (TNK-901) equipped with level control switch, mixer (M-901), and transferring pump (P-901)
- One (1) Filter Press unit equipped with air driven hydraulic pump, and sludge dumpster
- Supernatant tank (TNK-903) equipped with level control switches, and supernatant transferring pump (P-903)
- Air compressor (C-901) equipped with oil level switch and pressure switch; air compressor located in Room #2 GP of the building (SLUDGE BLD-7904)

Polymer preparation unit

The polymer unit is used for preparation and dosing polymer solution into the mixing tank (TNK-902) for sludge treatment. The batch-wise polymer preparation process includes:

- Hydration stage, when dry polymer is added to the tank for mixing with potable water
- Blending the polymer to a homogenous and activated solution, when the gentle agitation/mixing is provided
- Dosing the polymer activated solution into the sludge mixing tank (TNK-901) for sludge treatment using air diaphragm pump (P-902)

The mixer (M-902) and the pump (P-902) are driven by compressed air supplied by air compressor (C-901). Compressed air lines are equipped with pressure indicators (P-901/P902) to measure pressure in the air lines. The mixer (M-902) and the pump (P-902) are operated manually.

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Sludge mixing unit

The waste activated sludge is pumped from the aeration tank (TNK-501) into the mixing tank (TNK-901) where it is mixed with the polymer solution sent by pump (P-902) from the polymer tank (TNK-902). The sludge is mixed with polymer by submersible mixer (M-911). The mixer is driven by compressed air supplied by air compressor (C-901); compressed air line is equipped with pressure indicator (P-903) to measure pressure in the air line.

Alarm

The mixing tank (TNK-901) is equipped with level switches alarm (LSHH-901) indicating imminent overflow; an alarm signal will register on the HMI and the flashing red beacon light will illuminate, operator intervention is required. If the high high condition occurs an if the sludge transfer pump is running the PLC will shit P-503 off.

Treated (flocculated) sludge is transferred from mixing tank (TNK- 901) to the filer press (FP-901) by air diaphragm pump (P-901); compressed air line is equipped with pressure indicator (P-904) for measure pressure in the air line.

Filter press

The incoming treated sludge enters the filter press (FP-901) via the center feed pipe. The center feed plates contain a recess on either side of the plates. The cylinder will be shut closed (and hence compress the plates together) with the air driven hydraulic pump and then pressurized shut with approximately 4300 PSI of pressure. When the plates are closed, a cavity is created between the plates where the sludge will be captured.

The filtered water (supernatant) exits through the filter cloth (while the solids are captured within the clothed chambers) and goes to the supernatant tank (TNK-903) by gravity.

The feed pressure of the filter press (FP-901) may start at about 25 PSI, due to the low resistance of an empty filter press. As solids accumulate in the chambers of the filter press, the feed pressure will need to be increased to maintain a stroke count of about one stroke every 1-5 seconds or until a maximum feed pressure of 100 PSI is obtained.

Once the filter press (FP-901) is filled with sludge, the feed pump (P-901) and air driven hydraulic pump are shut off and the sludge blow down process will then commence for further water removal. The air enters via air valve into the sludge chamber via the upper left hand corner of the three button plates, and exits via the bottom right hand corner of the one button plates. This process will push excess water out through the outlet manifold.

Once the sludge blown down process is complete, the filter press is ready to be opened. To open the automatic filter press, reverse the air valve on the automatic pump to allow the pump to slowly pull open the pushing plate. For opening and closing the filter press the controls are right on the hydraulics for safety reasons. It is a forward, off, reverse lever.

Now that the plates are released, index the plates one by one, and most of the sludge will fall into the sludge dumpster below the press. A sludge spatula is provided to aid in the sludge removal.

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Once all plates are clean, the filter press (FP-901) is ready to be closed hydraulically. The three outlet manifold ball valves should be opened, the center feed pipe should be opened and the pump is ready to be turned on again.

Supernatant unit

The supernatant tank (TNK-903) receives spernatant from the filter press (FP-901). The tank is equipped with:

- Liquid level switches (LSL-902/LSH-902/LSHH-902)
- Pump (P-903) transferring supernatant from the supernatant tank (TNK-903) to the aeration tank (TNK-501) located in the building (AERATION BLD-7902); pump is equipped with current switch (YA-903) and pressure indicator (PI-903) for pressure control.

Level / Pump Operation and Control

The supernatant transferring pump (P-903) will run based on liquid level in the supernatant tank (TNK-903):

- Pump (P-903) run, when level switch LSL-902 is ON and YA- 903 is ON
- Pump (P-903) stops, when level switch (LSL-902) is OFF; this is to protect dry running of the pump

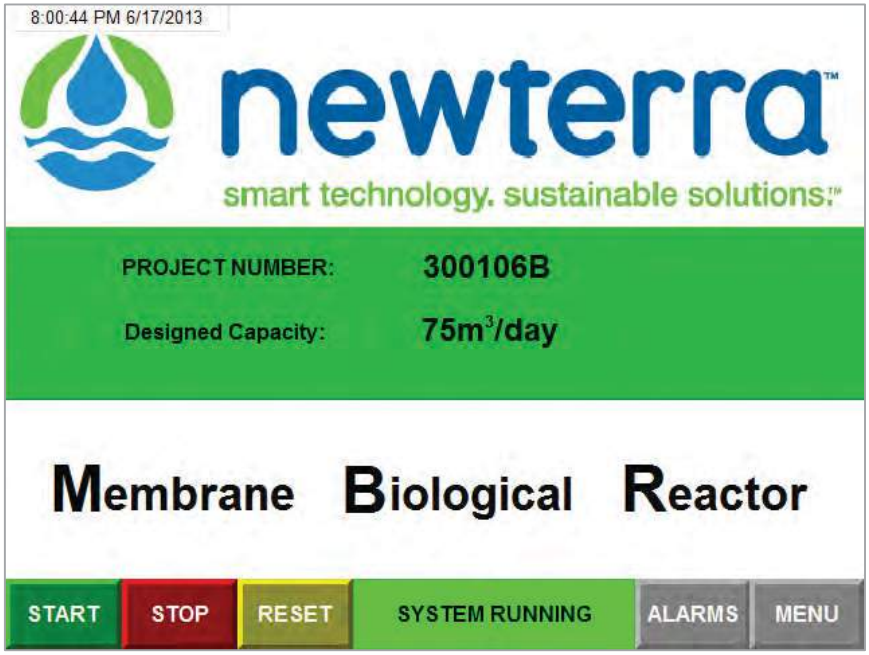
Alarms

LSHH-902 indicates the imminent overflow. Operator intervention is required.

5.2 Process Control System Touchscreen Operation

The MicroClear™ MBR system is designed to be fully automatic. Since the unit operates through a touchscreen, simply press the screen in an area where a button or text appears.

5.2.1 Main Control Screen



System Operation Commands

- **START** button puts the system in **RUN** mode
- **STOP** button stops the system operation. Some equipment continues to run even after this **STOP** button has been pressed, however the **E-STOP** button (located on the panel front) will stop all equipment
- **RESET** button is used to clear alarms after they have been addressed
- **SYSTEM ON (RUNNING) / SYSTEM OFF** indicates whether the system is currently in RUN mode or turned off
- **ALARM** button - when it is flashing red (it is on), it indicates an alarm is present in the system. Press **ALARMS** button to be routed to the alarm screen
- **MENU** button is used for screen navigation to show individual screens

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5.2.2 Process Screens

The main process screens are accessed from the main menu by pressing either the “BIOLOGY” button or the “MBR SYS” button.

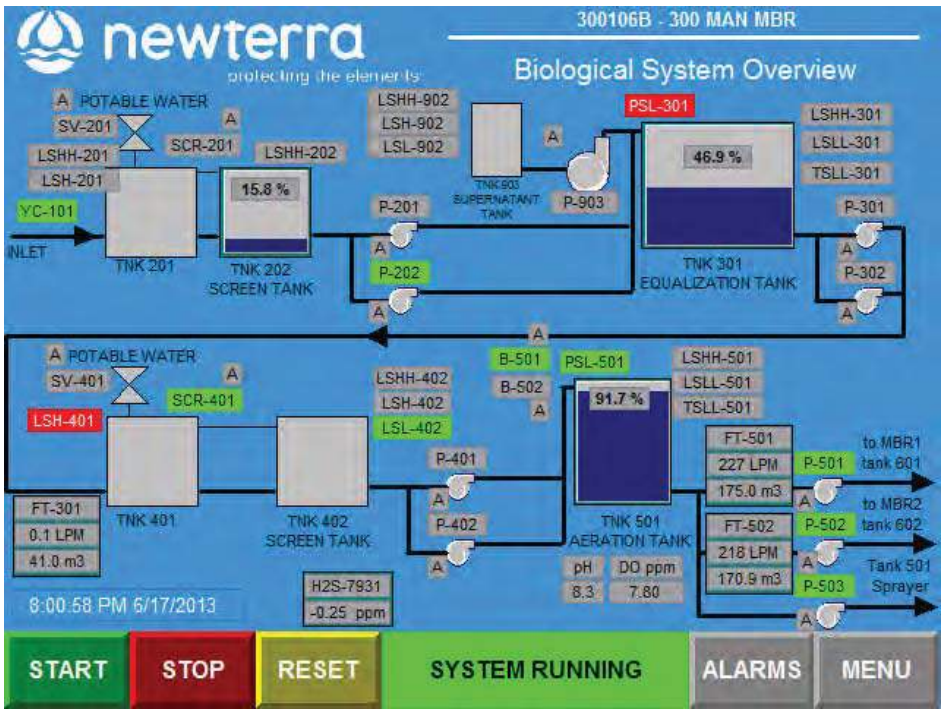
On the main process screens, switches are displayed as **Grey** when **OFF, Green** when **ON** and **Red** when in alarm condition.

- LSHH – level switch high high
- LSH – level switch high
- LSLL – level switch low low
- TSHH – temperature switch high high
- LSL – level switch low
- PSL – pressure switch low

Individual devices can be monitored and controlled from the process screens.

- The letter indicated beside a device shows the current operational status of that device (**H** for hand, **O** for off, **A** for automatic)
- Touching a device on the process screen will open an **HOA** popup for that device.
- Devices are shown in green if they are currently running

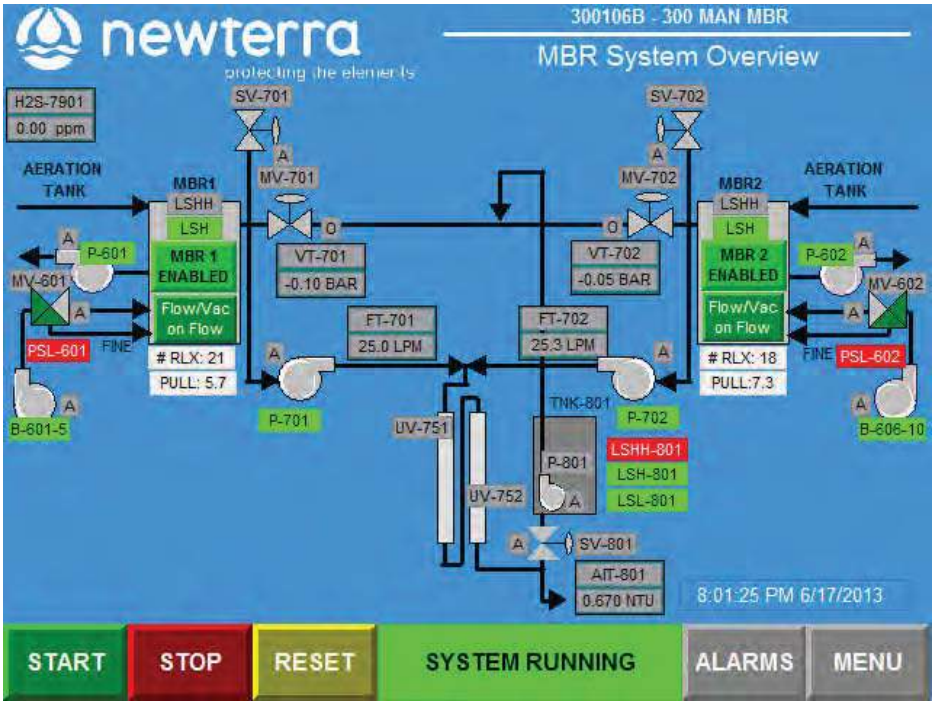
5.2.2.1 Biological System Overview Screen



On the Biological System Overview Screen the following equipment and parameters are displayed:

- Inlet screen module (SCR-201) including screen basin (TNK-201) connected with screen tank (TNK-202), pumps and controls
- Equalization module including EQ tank (TNK-301) with controls, blowers; EQ tank level is displayed in %
- The second screen module (SCR-401) including screen basin (TNK-401) connected with screen tank (TNK-402), pumps and controls
- Aeration Tank (TNK-501) with all interconnecting piping, pumps and controls. Aeration tank level is displayed in % , dissolved oxygen (DO) and pH is displayed for the tank
- Status of blowers, pumps, level switches, flow transmitters and H_2S detector are displayed

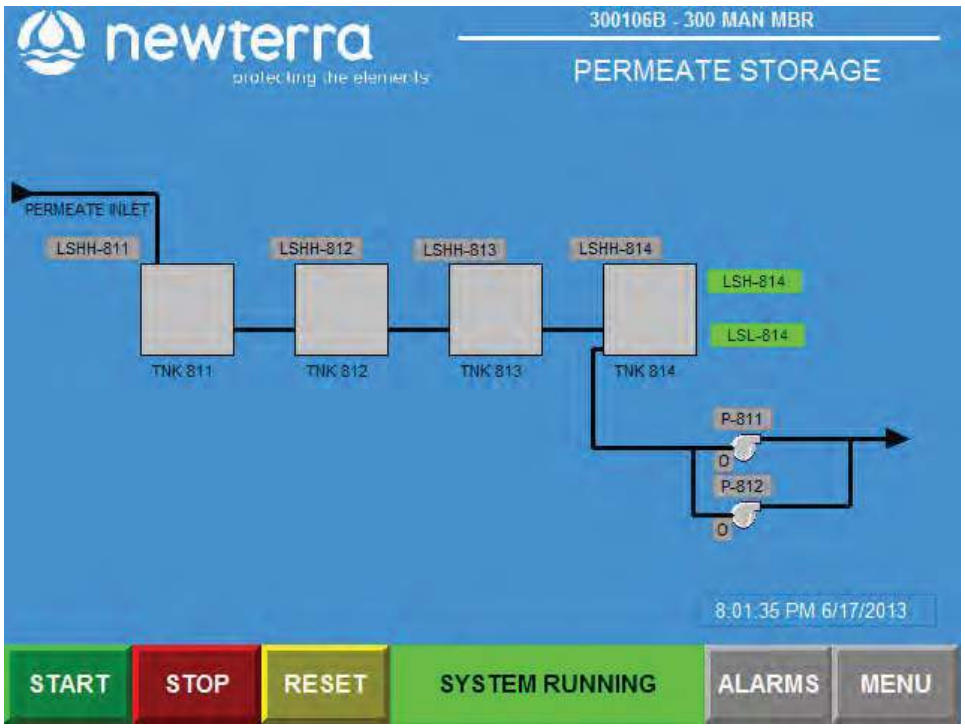
5.2.2.2 Membrane Filtration System (MBR) Overview Screen



On this screen the following equipment and parameters are displayed:

- Membrane Tanks (TNK-601 and TNK-602), and Backwash Tank (TNK-801) with all interconnecting piping
- Permeate flow and vacuum are indicated for both membrane systems
- The number of relaxes performed in the current cycle is displayed
- The time on the current pull cycle is displayed
- Status of blowers, pumps, level switches, flow transmitters and H_2S detector are displayed
- The time on the current pull cycle

5.2.2.3 Permeate Storage Module Overview Screen

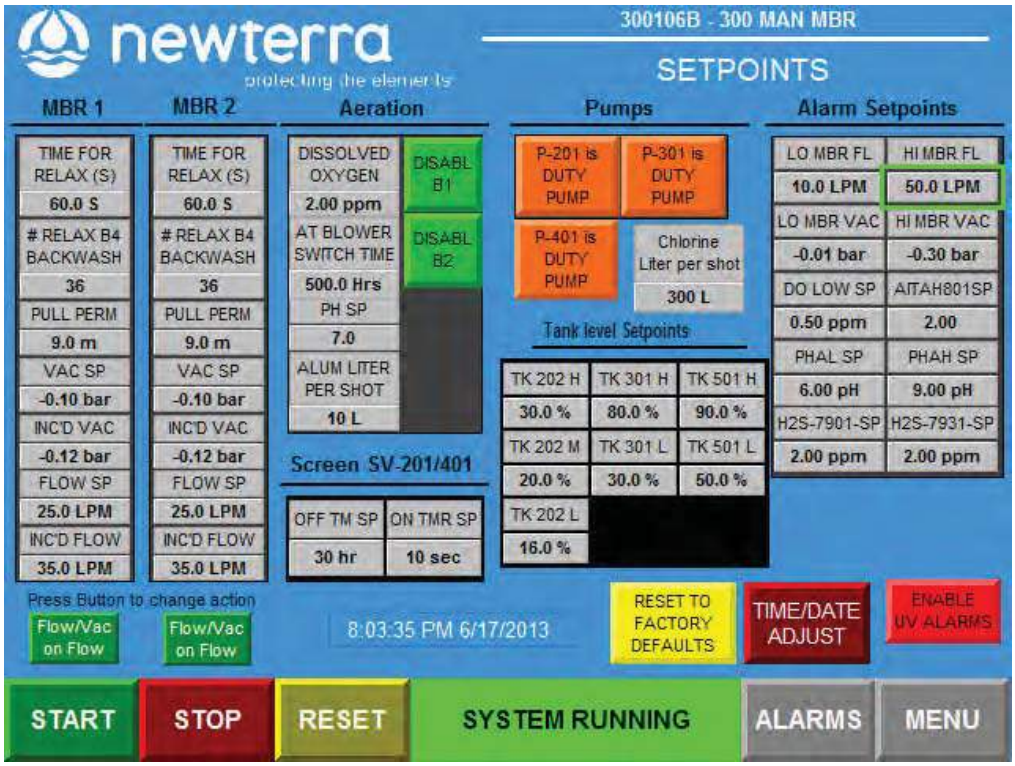


On this screen the following equipment and parameters are displayed:

- Permeate Storage Tanks (TNK-811/TNK-812/TNK-813/TNK-814) with all interconnecting piping and pumps
- Status of level switches and pumps are displayed

5.2.3 Process Setpoints Screen

The **Setpoints Screen** is accessed from the main menu by pressing the **"SETPOINTS"** button. This screen allows optimization of the system operation. Once the system is correctly set up, these values **should not be changed**.



See the table on the following page for the description of setpoints.

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newterra MBR Operational Setpoints Description

Process Location	Setpoint	Value	Description
Inlet Screen Module (SCR-201)	OFF TMR SP	30 hr	Setpoint for the amount of time when solenoid valve (SV-201) used for potable water delivery for screen cleaning is closed (OFF)
	ON TMR SP	10 sec	Setpoint for the amount of time when solenoid valve (SV-201) used for potable water delivery for screen cleaning is open (ON)
The second Screen Module (SCR-401)	OFF TMR SP	30 hr	Setpoint for the amount of time when solenoid valve (SV-401) used for potable water delivery for screen cleaning is close (OFF)
	ON TMR SP	10 sec	Setpoint for the amount of time when solenoid valve (SV-401) used for potable water delivery for screen cleaning is open (ON)
Membranes	TIME FOR RELAX (S)	60 sec	Setpoint for the amount of time the membrane relaxes between pulls, in seconds (shown for MBR 1 & MBR 2)
	# RELAX B4 BACKWASH	36	Setpoint for the number of relaxes before a backwash is triggered.
	PULL PERM MBR 1	9 min	Setpoint for the amount of time (in minutes) the system pulls permeate from TNK-601 before relaxing
	PULL PERM MBR 2	9 min	Setpoint for the amount of time (in minutes) the system pulls permeate from TNK-602 before relaxing
	VAC 1 SP	-0.10 bar	Setpoint for the vacuum in TNK-601 (in bar) the system will put on the membrane under normal operating conditions
	VAC 2 SP	-0.10 bar	Setpoint for the vacuum in TNK-602 (in BAR) the system will put on the membrane under normal operating conditions
	INC'D 1 VAC	-0.12 bar	Setpoint for the vacuum in TNK-601 (in bar) the system will put on the membrane when the system is experiencing a high flow (typically controlled by a high level in the EQ tank)
	INC'D 2 VAC	-0.12 bar	Setpoint for the vacuum in TNK-602 (in bar) the system will put on the membrane when the system is experiencing a high flow (typically controlled by a high level in the EQ tank)

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Process Location	Setpoint	Value	Description
Membranes	FLOW 1 SP	25.0 LPM	Normal flow setpoint for permeate flow rate (in LPM) in TNK-601. Under normal operation the system will default to this setpoint
	FLOW 2 SP	25.0 LPM	Normal flow setpoint for permeate flow rate (in LPM) in TNK-602. Under normal operation the system will default to this setpoint
	INC'D 1 FLOW	35.0 LPM	Increased Flow setpoint for permeate flow rate (in LPM) in TNK-601. If LSH-301 is activated the system will use the Increased Flow setpoint.
	INC'D 2 FLOW	35.0 LPM	Increased Flow setpoint for permeate flow rate (in LPM) in TNK-602. If LSH-301 is activated the system will use the Increased Flow setpoint.
Aeration Tank	DISSOLVED 0XYGEN	2.00 ppm	Setpoint for the amount of dissolved oxygen in ppm in the aeration tank
	AT BLOWER SWITCH TIME	500.0 Hrs	Setpoint for switching between aeration tank blowers under normal operation. The switch time is usually 500hrs.
	pH SP	7.0	Setpoint for the pH level in the aeration tank
	ALUM LITER PER SHOT	10 L	Setpoint for the amount of alum (L) added in the aeration tank
Tank Level Setpoint	TK 202 H	30.0 %	Setpoint for the high level (in %) for the screen tank (TNK-202)
	TK 202 M	20.0 %	Setpoint for the medium level (in %) for the screen tank (TNK-202)
	TK 202 L	16.0 %	Setpoint for the low level (in %) for the screen tank (TNK-202)
	TK 301 H	80.0 %	Setpoint for the high level (in %) for the equalization tank (TNK-301)
	TK 301 L	30.0 %	Setpoint for the low level (in %) for the equalization tank (TNK-301)
	TK 501 H	90.0 %	Setpoint for the high level (in %) for the aeration tank (TNK-501)
	TK 501 L	50.0 %	Setpoint for the low level (in %) for the aeration tank (TNK-501)

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newterra MBR Alarm Setpoints Description

Alarm Setpoints	LO MBR FL	10.0 LPM	If the discharge flow is below this setpoint for more than 5 minutes, an alarm will be initiated.
	HI MBR FL	50.0 LPM	If the discharge flow is higher this setpoint for more than 5 minutes, an alarm will be initiated.
	LO MBR VAC	-0.01 bar	If the vacuum on the membrane is below this setpoint for more than 60 seconds, an alarm will be initiated.
	HI MBR VAC	-0.30 bar	If the vacuum on the membrane is higher this setpoint for more than 60 seconds, an alarm will be initiated.
	DO LOW SP	0.50 ppm	If the dissolved oxygen in the aeration tank is below this setpoint for more than 15 minutes, an alarm will be initiated.
	AITAH801SP	2.0 ppm	If the % solids in the aeration tank is above this setpoint an alarm will be initiated.
	PHAL SP	6.00 pH	If the pH in the aeration tank is below this setpoint for more than 15 minutes, an alarm will be initiated.
	PHAH SP	9.00 pH	If the pH in the aeration tank is higher this setpoint for more than 15 minutes, an alarm will be initiated.
	H_2S-7901-SP	2.00 ppm	If the concentration of detected H_2S reaches this setpoint for more than 5 minutes, an alarm will be initiated.
	H_2S-7931-SP	2.00 ppm	If the concentration of detected H_2S reaches this setpoint for more than 5 minutes, an alarm will be initiated.

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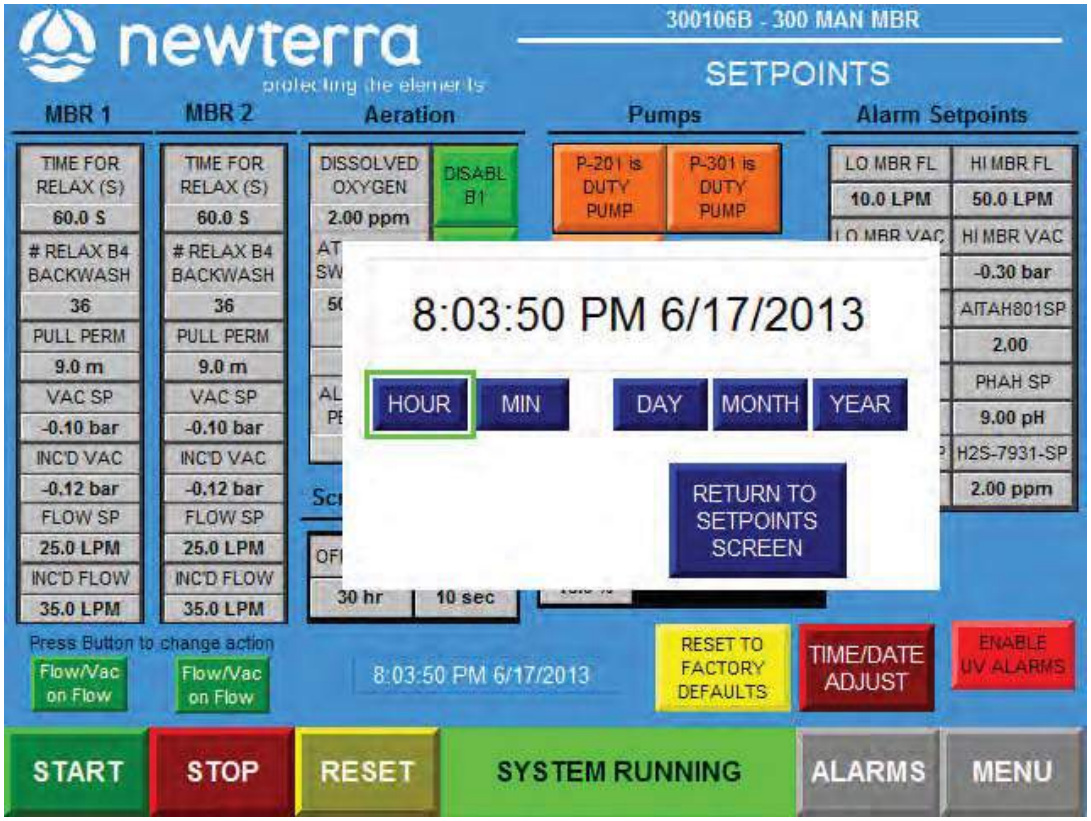
The following screen shows **setpoints** modification procedure. **Setpoints** should only be modified under the direction of **newterra** engineers to prevent damaging the membranes.

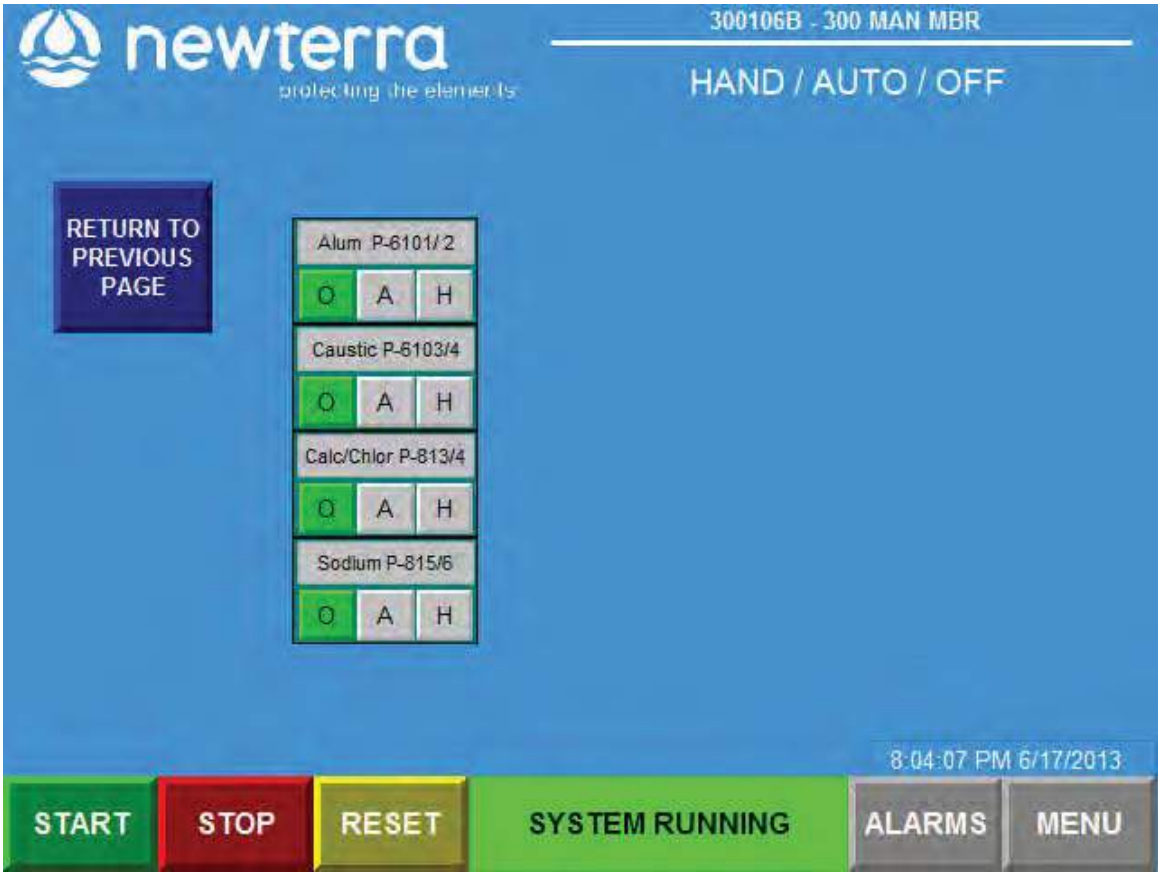
RESET TO FACTORY DEFAULT (yellow button) - Pressing this button will reset all process and alarm setpoints to the default values at the factory.



5.2.4 System HAO's (HAND /AUTOs/ OFF)

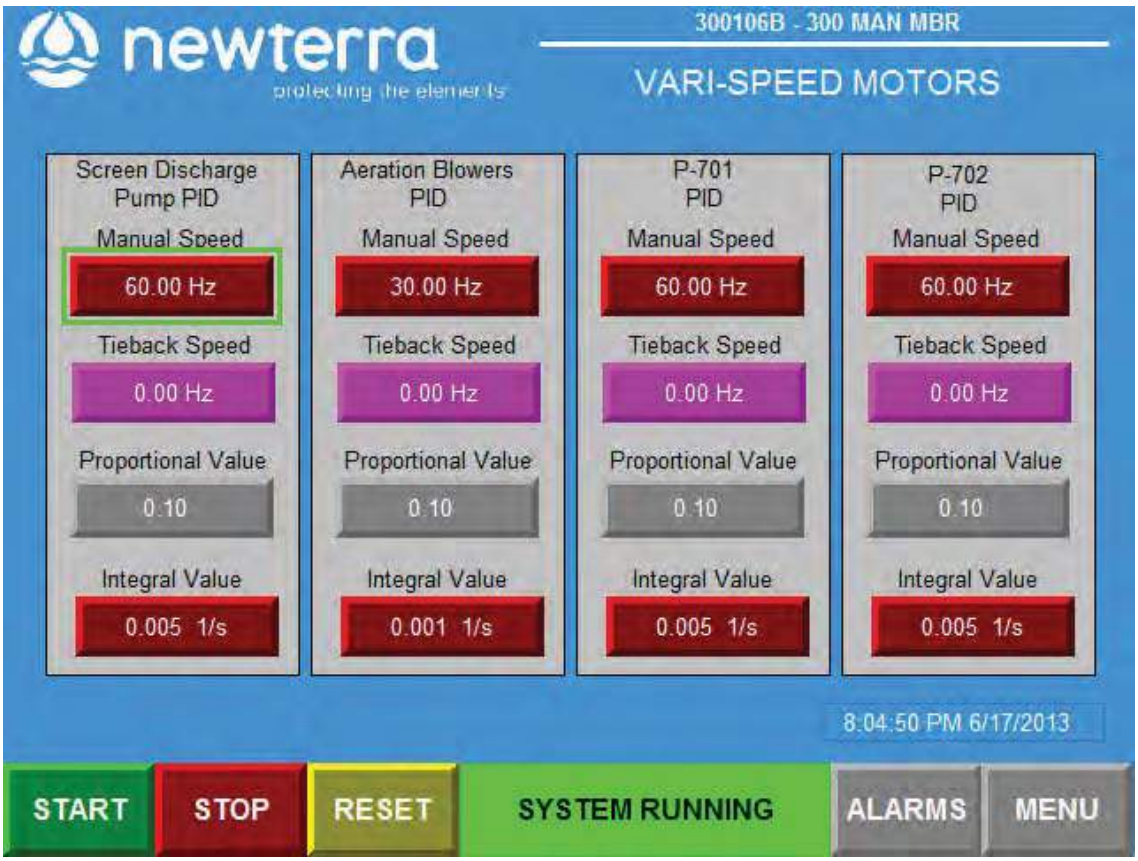
The **Hand / AUTO / OFF** screen is accessed from the main menu by pressing the "**HAO**" button.

- Each PLC controlled motor or valve in the system has **a Hand/Auto/Off (HAO)** Switch to control its operation. This screen displays all the system HAO's
- For normal operation, all switches should be in the **AUTO (A)** position
- The **HAND (H)** position of a switch is used for testing and troubleshooting of the system. As a safety precaution to prevent damage to equipment, the equipment will operate for two minutes in hand mode and will then return to the **OFF (O)** position



5.2.5 Motor Info Control Screen

The following screen shows the status of the VFD's and their PID control values.



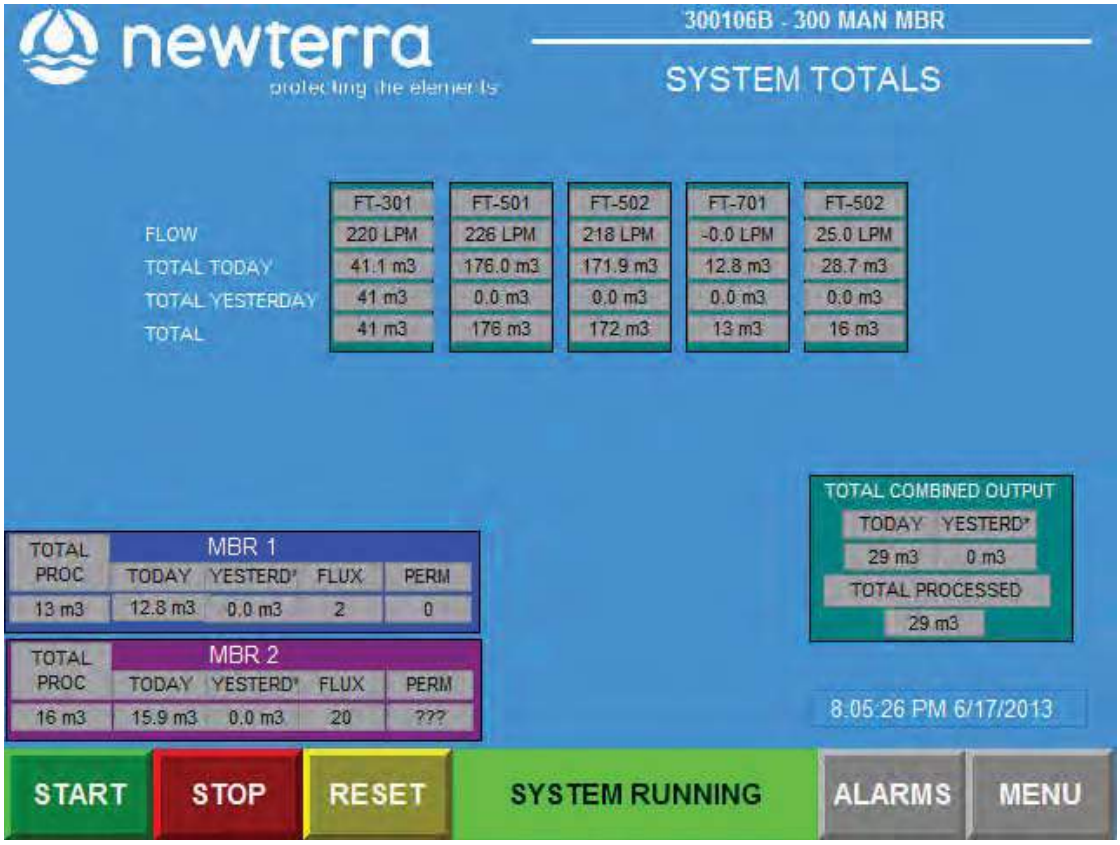
5.2.6 Moto Hours Control Screen

Motor Hours screen is accessed from the main menu by pressing the “Motor Hours” This screen shows the total number of hours that each motor can run.

- When the SERVICED button is pressed, it resets the hours since service to zero (0)
- When the REPLACED button of a motor is pressed, it resets the total hours to zero (0).

5.2.7 System Totals

The **System Totals** Screen is accessed from the main menu by pressing the **"TOTALS"** button

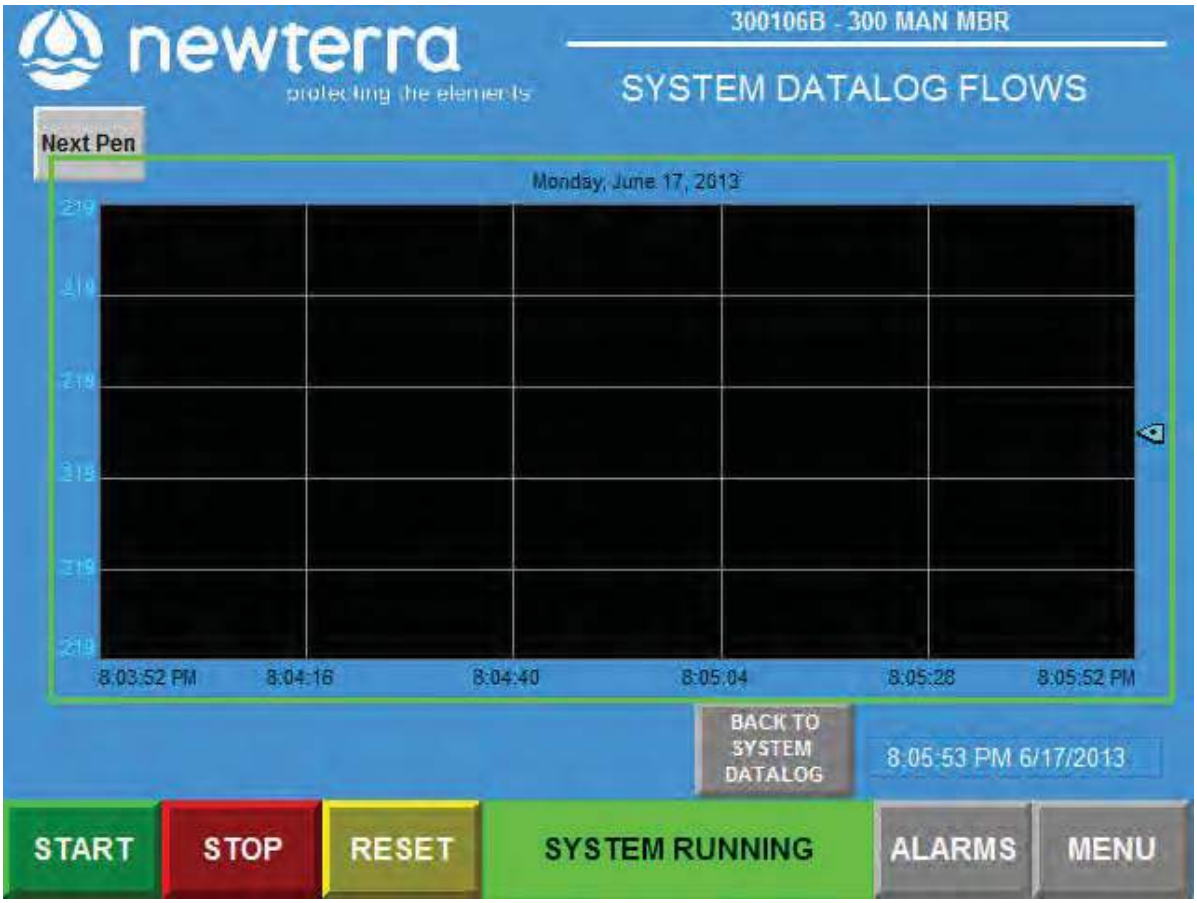


This screen is used to show:

- The total amount of water processed through the process train, and also current (today) amount and amount of water processed yesterday
- Flux (**J**) for membrane unit expressed in **LMH (L/m²·h)**
- Permeability **(K)** for membrane unit expressed in **LMH/bar**

5.2.8 System Data Log Screens

- The following screens show how system is setup with extensive dada log to keep a history of the performance.
- It shows real time data log of critical process operating parameters
- This information is saved on a USB stick that is located on the front of the control panel
- The LOG INTERVAL setting determines how often data points are stored. The factory default setting is 600 seconds



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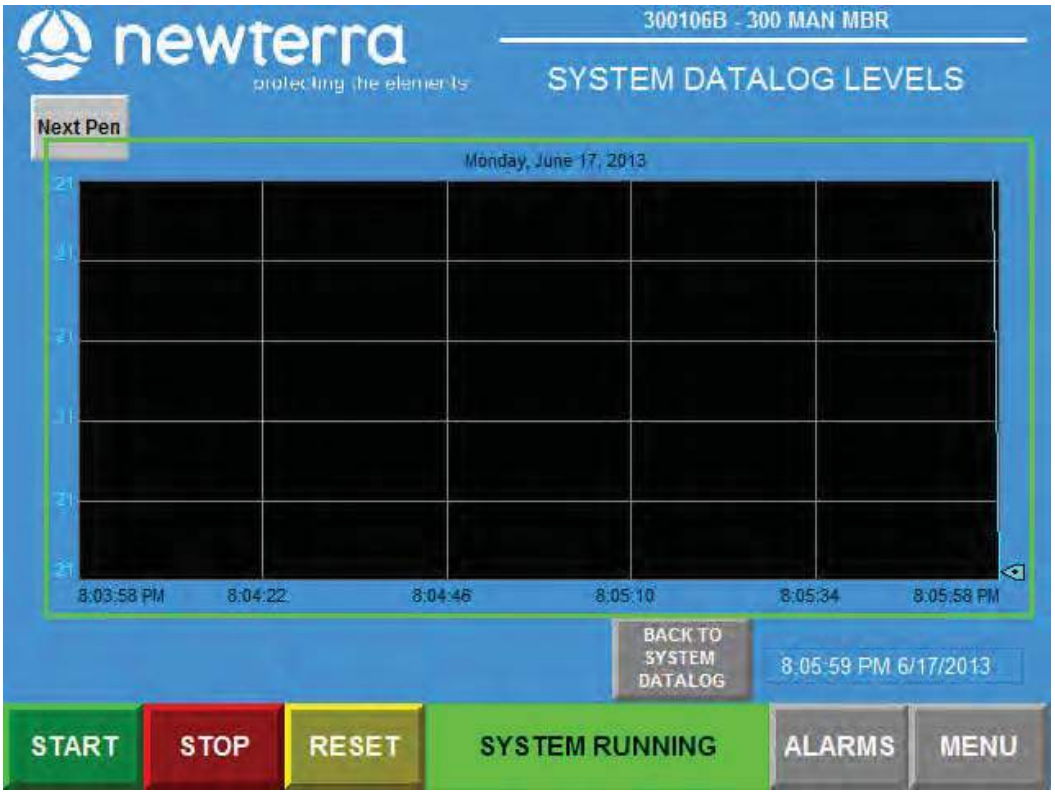

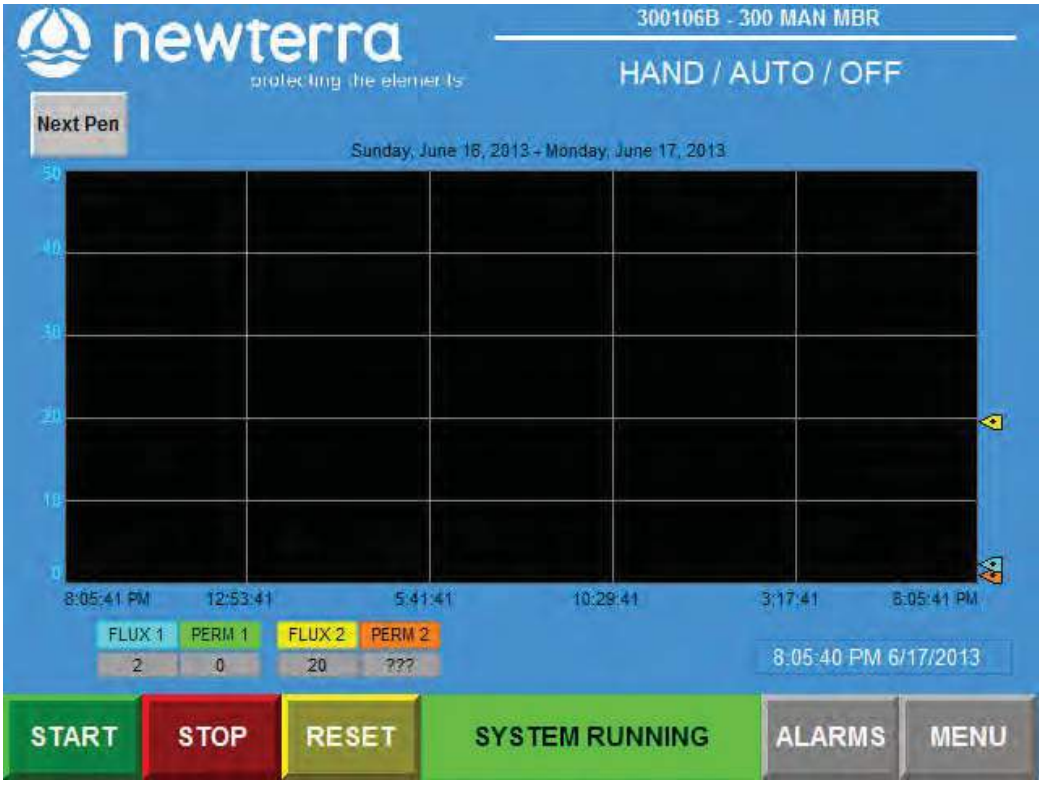

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6.0 PLANT START-UP, OPERATING GUIDELINES AND MONITORING

6.1 Plant Start-Up

Mechanical & Electrical Start-up Procedure:

- If the system is being started for the first time, work your way through the **newterra Pre-Commissioning Test Checklist** presented in **Appendix C** of this O&M Manual.
- If the kill switch on the panel (red mushroom shaped button) is pulled out, then push it in to confirm that the MBR system is off.
- Push the reset button on the operator interface to reset all alarms.
- Make sure there are no obstructions over any moving parts, for example a jacket laying on a belt drive.
- Put all HAND/OFF/AUTO switches to AUTO **(A)** mode.
- Pull the kill Button (red button on panel) out to start the process.
- Push the start button on the Operator Interface.

Process Start-up:

Seeding

The procedure for determining the amount of seed sludge required for process start-up, and methods for seeding the system are as follows:

1. Calculate the volume of seed sludge required to ensure that there is a minimum of 3,000 mg/L MLSS in the membrane tank. The volume of seed sludge required can be calculated with the following formula.

$$V_s = \frac{3000 \times V_t}{MLSS_s}$$

V_s: Total volume of seed sludge for MBR system (m^3)
V_t: Total volume of process tanks in MBR system (m^3)
$MLSS_s$: MLSS concentration of seed sludge from a similar treatment system (mg/L)

2. Arrange for delivery of fresh seed sludge from an activated sludge system employing a suspended growth type process. If it is possible, obtain seed sludge from a facility treating a similar wastewater and operated with similar processes (nitrification etc).

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3. Drain the water used for clean water testing from the reactor, if the returned activated sludge (MLSS<10,000 mg/L) is used. Do not drain the water after clean water testing, if the dewatered sludge is used.

4. **Screen all seed sludge with the 2 mm basket screen** before the sludge is transferred to the aeration or membrane tanks **to remove gross solids and rags and hair**.

5. Remove grit from the screen if required.

6. Once the tanks are fully seeded in aeration tank and membrane tank is turned on, the system can start to work. Do not waste sludge, as membrane filtration continues, until the MLSS in the aerobic or membrane tank becomes concentrated to the targeted concentration. The system will be started at a reduced design flow/loading initially per **newterra** start-up schedule.

7. Foaming may occur during start-up, which is normal. However, after a period of time (1 week), the foam should disappear. Foaming can be addressed by water spraying, food based defoamer **(silicone based defoamer is strictly prohibited**) addition, or aeration minimization in the membrane tank.

8. If a defoamer is required, contact **newterra ltd**. for recommendation of an acceptable antifoaming agent and dosing quantities.

9. Process start-up and adaptation periods can last for two or three weeks.

10. If fresh activated seed sludge is not available, **newterra** can supply dry cultures bacteria (a consortia group of different kinds of bacteria) for start-up. Please consult newterra ltd; quantities of dry bacteria and procedure of seeding will be confirmed by newterra technical representative during commissioning / start-up period.

ATTENTION	No untreated wastewater should enter the membrane tank. Make sure wastewater is completely biologically treated before it gets to the membrane tank

ATTENTION	It is advisable to start the MBR system with a minimum MLSS concentration of 3,000 mg/L to minimize foaming. The seed sludge should come from a plant which has a screen of 2 mm. It is critical to screen the seed sludge with 2 mm perforated screen prior to seeding for membrane protection.

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6.2 System Operating Guidelines and Monitoring

6.2.1 Operating Guidelines

The operators are expected to run the MBR system at all times in accordance with the maintenance, operational procedures and details specified in this manual. The following two tables provide operating parameters that can be easily maintained, and define the range of operating values.

There may be situations where the system needs to operate outside of the conditions covered in this manual. If these conditions develop, please consult newterra ltd. to discuss operation and methods to optimize performance.

Generally, the following points can be used to operate the MBR system properly:

1. The MBR system is designed to treat wastewater with specified influent characteristics.
2. Never operate the MBR tank below the minimum membrane submerged level. It is necessary to maintain a minimum of 250 mm liquid level above the membrane modules to ensure they are wet at all times and to allow for proper filtration.
3. Always supply the required amount of air for scouring to the membrane module.
4. Always filter wastewater at or below design flow rate.
5. Periodically, relax the membranes by ending filtration while allowing the membrane aeration scour to operate continuously and initiate backwash operation during membrane relaxation (default relaxation mode preset in PLC - permeation continues for 9 min and stops for 45 sec, and backwash the membrane).
6. Always operate the MBR in accordance with the parameters listed in the following tables.
7. Clean the membranes in-place with a dilute chemical in accordance with **Section 7** of the O&M Manual.

Membrane Filtration Operational Conditions

Parameter	Recommended Value	Notes
Diffuser Relaxation	10 minutes/day	Effluent filtration must be turned off, blower shuts down for 10 mins/day
Relax Time	1 min/10 min	Filtration must be off and blower are operating continuously
Backwahing	48 cycles	Built-in backwash mode during relaxation mode
In-situ Chemically Enhanced Backwash (CEB)	200 ppm as NaOCl	Requires 3 L to fully backwash one MCXL cassette. Frequency of CEB may vary. Refer to Membrane Cleaning Section 7.3 for cleaning procedure.

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Avg Flux Rate	15 LMH (9 gpd)	Average flux rate with permeation 9 minutes out of 10 minutes
TMP	< 0.2 bar (2.9 psi)	Membranes to be cleaned once the TMP exceeds 0.2 bar (2.9 psi)

MBR – Recommended Biological Operational Conditions

Parameter	Recommended	Range	Notes
MLSS (mg/L)	10,000	8,000 – 15,000	Never operate the membranes if MLSS < 3,000 mg/l. Sludge wasting should be undertaken as required to maintain target MLSS
Temperature (°C)	15 - 35	10 – 35	Avoid sudden changes in temperature. Minimum operating temperature is 15 °C
pH (s.u.)	6.8 - 8.5	6.0 – 9.0	Membrane module can handle a change in pH, however it is recommended to keep pH between 6.8 - 8.5
Aeration Tank, DO (mg/L)	≥ 2.0	1.0 – 8.0	This can be maintained by adjusting the volume of air supplied to the aeration tank
Viscosity (mPa-s)	Not applicable	0 – 300	–
Membrane Tank to Aeration Tank Recirculation	400%	200 – 600%	–
F:M (kg BOD/kg MLSS/d)	0.1	0.03 – 0.2	F:M = [Flow (m^3/d) x BOD conc (mg/l)] / [Process volume (m^3) x MLSS conc (mg/l)]
F:M (kg COD/kg MLSS/d)	0.15	0.05 – 0.3	F:M = [Flow (m^3/d) x BOD conc (mg/l)] / [Process volume (m^3) x MLSS conc (mg/l)]
SRT	> 15	12 – 50	

Process Troubleshooting Guide is presented in **Appendix M** of this O&M Manual.

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6.2.2 Sampling

To ensure accurate system monitoring and the validity of laboratory test data, samples must be collected as outlined below. These are only recommended guidelines. It is imperative that scheduled testing protocols are performed in compliance with local regulatory agency requirements. Composite samples of the MBR systems may need to be sent out to a certified laboratory for testing, based on the local regulatory requirements

Monitoring and Testing Requirements

Parameter***	Influent	Aeration Tank	Membrane Tank	MBR Effluent
Flow rate	D (PLC)			D (PLC)
Fat, Oil and Grease (FOG)	AR			AR
Alkalinity	AR			
Biological Oxygen Demand (BOD)	W			W
Total Suspended Solids (TSS)	W			W
Total Kjeldahl Nitrogen / Total Nitrogen (TKN / TN)	M			AR
Ammonia Nitrogen(NH_4-N)				AR
Nitrate Nitrogen (NO_3-N)				AR
Total Phosphorus (TP)	W			W
Mixed Liquor Suspended Solids (MLSS)			W	
Mixed Liquor Volatile Suspended Solids (MLVSS)			AR*	
Temperature		D (PLC)		
pH	AR	D (PLC)		W
Dissolved Oxygen (DO)		D (PLC)		
Filterability			TW	
Turbidity				AR**
Fecal Coliform / *E-Coli*				W

Legend: D = daily; W = weekly; TW = three times weekly; M = monthly; AR = as required.

* If MLVSS /MLSS ratio of a minimum of 0.7 is detected, MLVSS testing can be done periodically, on an "as required" basis.

**The effluent should be routinely checked for any signs of problem. Normally, the effluent is reasonably clear, colourless, and odourless. If the effluent becomes turbid, testing should be carried out required.

*** Explanation and definition of abbreviations, acronyms and terms used in the manual are presented in **Appendix G – Glossary & Terms and Appendix H – Biological Treatment & Monitoring Parameters.**

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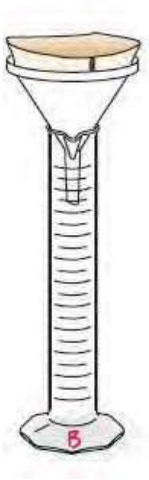
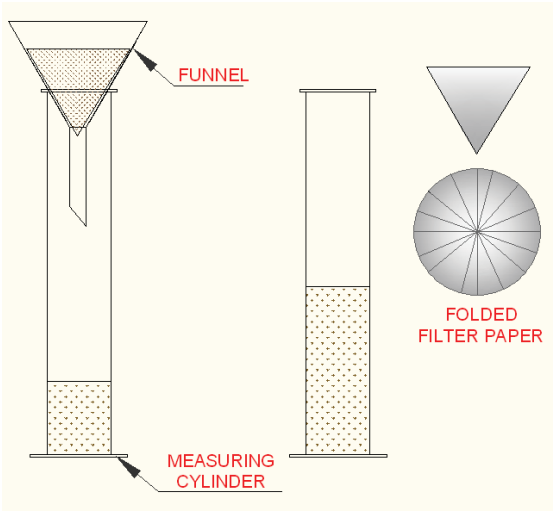
Filterability Test

The objective of the filterability test is to evaluate the condition of the working biomass. This is assessed by measuring the volume of filtrate passing through the filter paper. If filtrate is greater than 10 mL/10 min, then biomass filterability is acceptable; however, if it is less than 10 mL/10 min, modifications to the plant operating condition are required to prevent premature membrane fouling.

Laboratory Glassware and Filter Paper





Apparatus:

Filterability Kit is distributed by **newterra ltd (Part # 24146).**

Filterability Kit includes:

- Filter paper distributed;
- Funnel (75 mm diameter recommended);
- 2 - 50 mL graduated cylinder;

Stop watch

Measurement Procedure:

1. Pleat filter paper by folding in half, quarters etc.
2. Line the funnel with pleated filter paper and place the funnel in the graduated cylinder.
3. Collect 50 mL of activated sludge sample in a beaker and stir.
4. Pour the 50 mL sample into the funnel.
5. Start timer when the first drop of water filtered through the filter paper.
6. After 10 minutes of filtration, record the level of filtrate in the graduated cylinder.

Filterability (FT)	Action	State of urgency
> 10 ml	Excellent, no action req'	
5 - 10 ml	Tweak process operation	
< 5 ml	Process adjustment req	**Contact newterra ltd.**

6.2.3 Record Keeping

An essential component of quality control in any facility is sound record keeping. A log book covering the entire treatment system performance should be maintained, updated, and readily accessible to all operators. The log book should be used to record observations, set point alterations, and unusual conditions.

For each wet chemistry parameter analysis, a separate work-sheet has to be prepared. Work-sheet data for at least the previous year should be kept for possible consultation.

The second step in quality control is to train all operators to follow an established procedure for each test. Identical samples should be periodically tested for any parameter by different operators, and the variability among results should be compared. Consistent variability in results may lead to the technique improvement of operators.

Duplicate analysis of a sample should also regularly be done. And, split samples should regularly be sent to an outside accredited laboratory and analysis results should be compared with those done in-house.

In addition to summary sheets, it is highly recommended that data should be entered into prepared Excel spread-sheets. Spread-sheets greatly aid in the data presentation and manipulation, and would be of immeasurable value when report writing is required.

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6.2.4 Process Trending

Other than pre-planned process changes or major upsets, process modifications should be based on trends shown in the process data. A trend is nothing more than an indication of real change in a process parameter over time. A trend chart is simply a graph of data being trended.

As the graph changes, upward or downward trends are detectable. Smoothing trends by graphing the 3-, 7-, or 30-day average of the data allows the trend to be shown more clearly. Because the individual data point may be questionable, the actual value of data point are less important compared with the trend regarding the process monitoring.

Trend graphs are a part of the Excel data spread-sheet; the operator can trend and analyse many parameters in just a few minutes in order to assess process performance.
When a trend is identified, its indication to the process can be evaluated, and corrective action may be carried out, if needed. Statistically, the more data points there are in a trend chart, the more reliable the trend.

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7.0 SYSTEM MAINTENANCE

CAUTION: Shut off all electrical power before working on the mechanical or electrical equipment.

The system should be routinely checked for any signs of operational problems. Such problems could include, but are not necessarily limited to, abnormally high peak flows, unpleasant odour, and diffuser clogging, and so on.

7.1 Plant Visual Checks

Noise	During normal operation, there is a uniform humming sound at the plant. In case of an unusual noise, it could be an indication that the blower needs maintenance or repairs.
Smell	The MicroClear™ MBR is an aerobic system. During normal operation, the system has an earthy smell similar to that of a well-maintained compost pile. If other odours are noticed, the aeration process may not be operating or the system has been overloaded. Check the DO manually and the blower to verify proper operation.
Sight	Normally, the effluent is reasonably clear, colourless, and odourless. If the effluent becomes turbid, there is a pin hole in the membrane or a leakage in the piping. Take the unit out of operation and investigate. **Check uniformity of membrane air distribution periodically to ensure air scoring is effective across all membrane plates.**

7.1.1 Air Scouring Patterns in Membrane Tanks

Membrane air scouring check is essential procedure for **newterra** MBR WWTP. Air scour has to be observed for uniformity of bubbling action all across the membrane module/cassette on regular basis.

A visual inspection of the aeration patterns should be performed with the liquid level 2-3" (5 – 7.5 cm) above the permeate pipe.

Proper air scouring in membrane tank

Uneven aeration in membrane tank

It is easy to observe aeration patterns through clear window in membrane tank. Operator should note any unusual patterns of air distribution. The visual inspection also should be performed before any membrane cassette removal from membrane tank. Operator has to check for:

- damage of air diffusers - if this occurs, empty the tank and fix the diffuser;
- air leakages - if this occurs, tighten up the fittings.

If there is insufficient air scouring, localized dewatering (**clogging, sludging, caking and plugging**) may occur and may in turn lead to membrane fouling.

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7.2 Schedule for Routine Operation and Maintenance Checkups (if Applicable)

Location	Item	Day	Week	Month	Quarter	Year	Comments
HEADWORKS	**Inspect and maintain grease trap in the kitchen of the work/mining camp**		X	X*			*Kitchen grease trap(s) should be checked weekly and cleaned monthly to ensure proper performance.
	Inspect lift station with sump pumps		X				
	Remove grease from lift stations and top of PC tank		X				
PROCESS	**Perform visual check**	X					Refer to Plant Visual Checks
	Check for proper wasting to sludge system		X				
	Record permeate flow rate	X					
	Record DO in the aeration tank	X					
	Record pH in the aeration tank	X					
	Record vacuum pressure at the membranes	X					Normal range: 0.07 – 0.15 bar (28" -61" WC)
Note: When the vacuum at the membranes reaches 0.2 bar/2.9 psig/80" WC), stop the permeation and perform recovery cleaning (please see procedure separately)							
MECHANICAL & PROCESS	**Inspect membranes and permeate withdrawal system**		X				1 hour
	Clean and calibrate the DO sensor			X			1 hour
	Inspect and maintain valves & fittings for leaks		X				
	Clean manually Fine Screen and direct solids to primary settling/sludge holding tank		X				may require daily cleaning during start-up (subject to PI502 reading)
	Membrane in-situ cleaning				X		2-4 hours
	Remove membrane module for mechanical cleaning and inspection					X	Drain membrane tank. Roll out membrane cassette. Remove membranes and inspect. (1 -2 days)
	Visual inspection of air bubbles in the equalization, aeration and membrane tanks		X				Replace diffusers if big uneven bubbles/high turbulence is found.

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Location	Item	Day	Week	Month	Quarter	Year	Comments
MECHANICAL & PROCESS	**Remove, inspect and maintain diffusers in equalization, aeration and membrane tanks**					X	This involves a complete draining of tanks (1-2 days)
	Pump out solids collected in the primary settling/sludge holding tank for offsite disposal				X		
	Check and record UV instrumentation: % Transmissivity vs required minimum; Remaining Lamp Life; Total Days of Operation		X				
	Inspect and maintain pump bearings			X			
	Check blower operation (if vibrating)		X				
	Check time clock setting		X				
	De-ragger (foam suppression unit)						may require daily cleaning during start-up
	Inspect functionality of baseboard heater				X		
	Check ventilation systems for container					X	
ELECTRICAL	**Check electrical leads**				X		
	Inspect and maintain breakers, fuses, resets and anodes			X			
	Check motor mounting bolts			X			
	Clean dust away from electric motor			X			
	Check PLC and control panel functionality		X				

All connections (hoses, hose clamps, camlocks) have to be checked periodically (on a monthly basis) to make sure all of them are in good conditions.

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7.2.1 De-ragger operation and maintenance cleaning

Please refer to the drawing presented in **Appendix A** of this O&M Manual.

De-ragger is part of the anti-foaming system which is provided in the system for foam suppression in the aeration tank. The main purpose of a de-ragger in this system is to avoid the spray nozzles clogging by catching fibres and other impurities found in the recirculation water pumped through the system.

De-ragger is simple equipment consisting of a PVC clear pipe, a nylon bristle brush installed in the pipe, and a fernco coupling for quick disconnection. During the water spraying process the brush (with a sliding fit in the pipe) catches fibres and other impurities
.
When the de-ragger is filled with impurities, perform maintenance as follows:

- Turn off P-503 operation.
- Close 2' PVC isolation valve and open 1' PVC drain valve and drain the content to a 20-L pail.
- Disconnect fernco coupling.
- Remove brush and rinse with clean water.
- Close the drain valve and reassemble the fernco coupling.
- Make sure all connections are tight.
- Open isolation valve.
- Turn on P-503 operation.

7.2.2 Polymer Make-up Instructions

Please refer to the P&I Diagram presented in **Appendix A** of this O&M Manual.

1. Fill polymer make up tank (conical bottom mixing tank) with 100L clean water
2. Open air mixer speed valve by turning valve one and a half revolutions (1 ½) to allow mixer to run at high speed
3. Slowly add 1 cup (~250ml) of Powdered CC4509 polymer into vortex beside mixer shaft (keep bag sealed when not in use)
4. Run mixer on high speed for 5 min
5. Reduce mixer speed to low by turning value back to half (1/2) a revolution open, continue mixing for 45 min
6. Polymer is now ready to use

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7.3 Membrane Cleaning

7.3.1 Membrane In-situ Chemically Enhanced Backflush (CEB)

Chemical cleaning is only to be carried out by qualified and trained personnel! Chemicals can lead to serious injuries. Always wear personal protective equipment (PPE) when handling chemicals! Obey the chemical safety handling procedure as listed in the Material Safety Data Sheets.

It is recommended that in-situ CEB be carried out before the TMP exceeds 0.2 bar (or permeability drops rapidly to 50 LMH/bar) This is typically done once every couple weeks/months depending on biomass characteristics and system operating condition.

On certain occasions, membrane module/cassette may need to be physically inspected for membrane integrity if membrane permeability performance is not recovered after the cleaning (i.e., suspect of membrane deterioration); please refer to subsection **7.3.3**.

The maximum backwash pressure of MicroClear™ MCXL filter is 0.1 bar or equivalent to a 100 cm water line. Only use gravity force to perform the backflush.

Note: Membrane have a maximum active chlorine tolerance of 100,000 ppm.h.

For better cleaning performance, it is recommended:

- Potable water (permeate is acceptable if potable water is unavailable)
- Water temperature is above 20 ^{0}C (better cleaning efficiency if water temperature ranges from 20 to 30 ^{0}C)

Procedure

Note: Only clean (backwash) one membrane tank at time.

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***Step 1: Cleaning with sodium hypochlorite (NaOCl)* - 3L cleaning solution required per MCXL cassette for in-situ CEB. The CEB is performed manually.**

1) Press the disable membrane button on the screen.

2) Open valve (SV-801) and allow water to fill up the backwash tank (T-801) to LSH-801 level.

3) Close valve (SV-801).

4) Add concentrated NaOCl into the backwash tank to a concentration of 500 mg/L (acceptable range of 200 to 1,000 mg/L).

Volume of concentrated NaOCl required can be calculated with the following formula,

$$V_x = \frac{V_m \times 0.05}{C_s}$$

V_m: Volume of the solution (Gallon, or Litre), equal to 3 L multiplying the number of MCXL cassettes;
C_s: Concentrated NaOCl concentration (%)
V_x: Volume of concentrated NaOCl required (Gallon, or Litre)

5) Open valve (MV-701 or MV-702) and inject chemical solution by pump (P-801) into membrane tank (TNK-601 or TNK-602) until reach LSL-801 level in backwash tank. (T-801).

6) Soak the membranes in NaOCl solution for 1-2 h. Adjust air scour in interval, if necessary, to control potential foaming.

7) Resume normal operation by turning off the disable membrane button. Check permeability. Normal permeability after cleaning: 150 to 300 LMH/bar.

8) Repeat the cleaning procedures if the normal permeability value is not attained.

Step 2: Cleaning with Citric Acid – only required in case of inorganic fouling caused by the high hardness.

Rinse membrane filter thoroughly with potable water to completely remove NaOCl solution before treatment with citric acid. Mixing NaOCl with citric acid releases toxic chlorine gas!

1) Repeat the above steps with 0.2% citric acid solution (a max of 2%)

7.3.2 Membrane Recovery Cleaning

The membrane recovery cleaning is to be done once a year at a minimum. On certain occasions, membrane cassette may need to be inspected for membrane integrity (suspect of membrane deterioration, membrane permeability performance does not recover after the cleaning, etc.).

Disable operation of the dedicated membrane tank that needs to be cleaned by pressing the disable membrane button on the screen.

For better cleaning performance, it is recommended:

- Potable water is used
- Water temperature is above 20 ^{0}C (better cleaning efficiency if water temperature ranges from 20 to 30 ^{0}C)

Procedure

Step 1: Cleaning with Sodium Hypochlorite (NaOCl)

1. Drain all mixed liquor from the membrane tank to the sump/recycle back to the process tanks.

2. Clean (wash down) the membrane tank with potable water and drain the dirty liquid to the sump/recycle back to headwork.

3. Turn off air scour, fill the membrane tank with potable water until the membranes are completely covered, and add NaOCl into the membrane tank to a concentration of 500 mg/L as free chlorine (max. 1,000 mg/L). Turn on air scour for 5 min to mix the solution and turn it off during membrane soak.

   Volume of NaOCl required can be calculated with the following formula:

$$V_x = \frac{V_m \times 0.05}{C_s}$$

V_m: Volume of membrane tank (Gallon, or Litre)
C_s: NaOCl concentration (%)
V_x: Volume of NaOCl required (Gallon, or Litre)

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4. Keep the membranes soaked for a min 12 hours in the NaOCl solution (longer soak time required if severe fouling is evident). Air scour can be on intermittently during soak time (5 min every 4 hrs).

5. Drain spent NaOCl solution to the sump/recycle to headwork.

6. Rinse membrane filter thoroughly with potable water and drain the entire tank. Rinse waters are drained to the sump/recycle back to the headwork.

Step 2: Cleaning with Citric Acid – only required in case of inorganic fouling caused by the high hardness

Rinse membrane filter thoroughly with potable water to completely remove NaOCl solution before treatment with citric acid. Mixing NaOCl with citric acid releases toxic chlorine gas!

1. Fill the membrane tank with potable water, turn on scouring air, and add citric acid to pH 2.0. Turn off air scour when the pH of 2.0 is reached.
2. Keep the membranes soaked in the citric acid solution for 2 hours (longer soak time required if severe fouling is evident).
3. Drain spent citric acid solution, rinse membranes thoroughly with potable water and drain all the rinse waters. Spent citric acid solution and rinse waters are drained to the sump/recycle back to headwork.

Step 3: ***Resume normal operation***

Step 4: Checking Permeability on Clean Water

Normal permeability after cleaning: 150 to 300 LMH/bar.

Repeat the cleaning procedures If normal permeability is not achieved.

Note: Membrane maintenance (CEB) and recovery cleaning has to be recorded according to Membrane Cleaning Log Sheet presented in Appendix K of the manual.

7.3.3 Membrane Physical Check

WARNING: ***A membrane cassette that has been in operation weighs more than dry membrane cassette before installation.***
Failure to comply with the instructions provided in this manual can cause equipment & property damage or severe personal injury, and will render the warranty null and void.

To remove membrane module from membrane tank

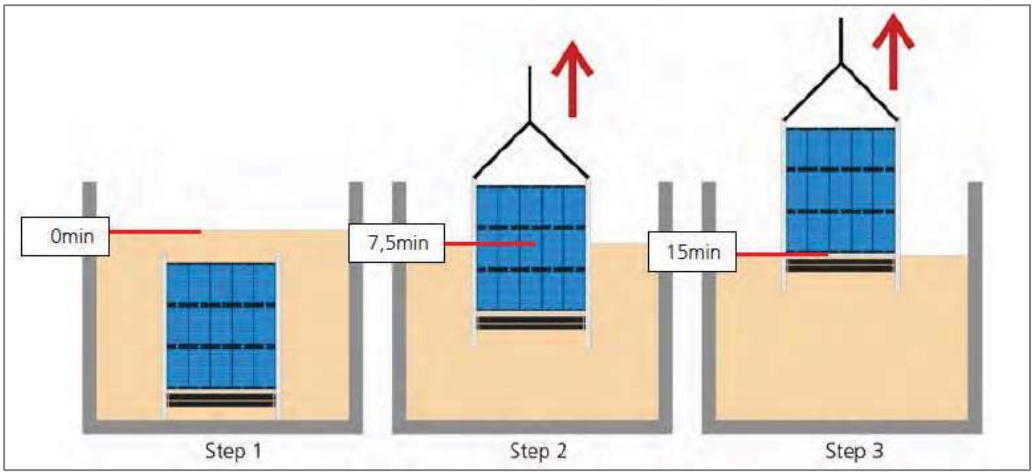
This procedure is required if the membranes are being inspected as part of routine maintenance for physical check or being replaced.

Once membrane inspection or replacement has begun, it must be completed promptly. It is important that the membrane DO NOT DRY OUT OR FREEZE during this procedure.

1. Lifting the membrane cassette out of a tank or emptying a tank should take at least 5 min. For each single filter layer.

MicroClear™ Membrane Module	Filter Layers	Acceptable time for membrane filter lifting out of the membrane tank or empting the tank
MB2- series	2	10 min
MB3- series	3	15 min
MB4- series	4	20 min (module must be separated in to 2 parts)
MB5- series	5	25 min (module must be separated in to 2 parts)

Note: Non observance will lead to damage of the filters because of exceeding the maximum backwash pressure.



Schematic of MicroClear™ membrane module lifting / emptying of the membrane tank

Membrane module replacement

If membranes require changing *v*erify membrane modules are secure within the membrane tanks after re-installing the modules – i.e. verify wheel chocks are in the correct location and that there is no lateral movement (less than an inch) of the membrane modules on the wheel tracks in the tank.

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8.0 SHUT DOWN

8.1 Temporary Shut Down

A temporary shutdown for a few days requires continuous aeration of the biomass to keep the DO level at least 2 mg/L and continues biomass recycle between the bioreactors.

8.2 Permanent Shut Down / Winterizing

Permanent shut-down is required if system operation stops at least for 2 weeks without inflow. Permanent Shut Down includes the following procedure:

- Perform membrane cleaning before permanent shut down / winterizing.
- Drain all tanks.
- Remove membranes and winterize
    - For short term storage (up to 6 months): soak membranes in 10 ppm NaOCl solution, and membranes are not allowed to dry out), never expose the membrane unit to frost, dust, rain, or direct sunlight.
    - For long term storage: soak membranes in preservation solution - 20 % glycerin solution (by weight).The glycerin will pass through the membrane via diffusion and provides pore protection from freezing and from drying out.
- Disassemble all PVC ball valves and drain any water inside (open and close to ensure trapped water escapes).
    - Leave all valves ½ open during reinstallation
- Open all drain valves and leave open.
- Clean and reinstall all sprayer nozzles.
- Find all check valves and make sure water is not being held by valve (Wet/Dry Vac works well here).
- Drain / remove all pumps from tanks, ensure no water is left inside the pump.
- Use RV biodegradable Antifreeze to
    - Refill any check valve
    - Dump in 2 (qty) 4-L bottles in each tank
- Remove pH and DO probes (if unit is equipped) and store with membranes in a heated area ensure probes are kept wet.
- Remove power from system.

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Double check and ensure that there is no water left in any pipes, fittings etc. If it is not possible to remove the water fill with antifreeze.

Glycerine Solution Solution Components and Solution Make-Up

1. Chemicals:
Technical Glycerin (86.5%)
Distilled water

2. Solution make-up procedure:

Dissolve technical glycerin (86.5%) in water and homogenize according the following table.

Preservation Solution 20 % Glycerin	Technical Glycerin [86,5%]	Distilled Water
[kg]	[kg]	[kg]
1	0.23	0.75
10	2.3	7.5
100	23	75
1000	230	750

The preservation solution has a density of 1,045 g/cm^3. The concentration of preservation solution can be tested and corrected with a density meter.

Membrane preservation procedure

- Allow the membrane unit to soak in preservation solution for a few hours.
- Remove the membrane unit and allow excess glycerin to drain.
- Shrink wrap the unit with a thick (1.5 mm) plastic bag and seal membrane unit using a hand sealer or tape.

For long term storage preserved unit should be stored in a cool (4^{0}C - 20^{0}C), dry area, away from direct sunlight and protected from accidental damage.

Re-commissioning the unit is straight forward. Once unit is lowered into MBR Tank, first start the aeration, then the permeate pump. In order to let all the traces of glycerin in the permeate to dissipate, make the arrangement for the permeate to recycle back to the aeration tank for the first half hour.

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1325 California Avenue, Brockville, ON K6V 5Y6
200 555 11th Ave SW, Calgary, AB, T2R 1P6
(800) 420-4056 / www.newterra.com

9.0 SERVICE & SUPPORT

Commissioning and Start-up

newterra MicroClear™ MBR System's **commissioning & start-up** is the last step of the **newterra** project execution process. Experienced engineers and technicians are available to assist clients in these procedures including system initial set up and primary start-up and providing all performance tests according to the pre-commissioning checklist.

Initial on-site training program is an important part of the commissioning service as well. During on-site training, **newterra** technical representative will cover process monitoring, system operation, maintenance, and troubleshooting activities related to the **newterra** ™MBR System. Customized training packages are available. Contact **newterra** for more information.

Post commissioning Services

A comprehensive range of post commissioning services is available from within **newterra** beyond system design and installation. Specific services are included:

- Technical support (including after-hours emergency telephone support).
- Spare parts order and delivery.
- Training program.
- Plant optimization and upgrades.
- Telemetry control and monitoring.
- Assistance in preparing system performance reports (process data monitoring & analysis).
- Preventive maintenance cleaning (including membrane cleaning).
- System audits for reviewing the performance of all MBR subsystems and the efficiency.

1. **Technical support** is available to assist in troubleshooting of **newterra** MBR system during normal working hours 8:30 am to 5:00 pm (Eastern Time Zone for **newterra** ltd.). Telephone service is available via **1.800.420.4056**.

Emergency **24/7 telephone technical support –** This will be activated upon subscribing to **newterra's** 24/7 technical support service.

If problem cannot be resolved through telephone or e-mail supports, **newterra** engineers are available for site visit.

Appendix E -
Steensby and Rail Camps Freshwater Supply, Sewage and Wastewater – Plans for Future Work

There will be no construction and development of Steensby and the Rail camps in the near future. Updates to these sections of the Plan will be done when required and will be included in a future Annual Report to NWB as required by Part B, Item 4 of existing Type A Water Licence (2AM-MRY1325 Amendment No. 1). Block Flow Diagrams for Steensby and Railway Camps will be updated when required.

A.1 Freshwater

A.1.1 Freshwater System Process Description

A.1.1.1 Steensby Port Site

Currently, there are no construction activities planned for Steensby Inlet. During the future construction phase the on-site population will be approximately 600 people. Half the camp personnel will be accommodated on a barge which will be equipped with potable water treatment systems. The potable system onboard the barge will be a reverse osmosis based system. The full configuration will include coagulation, filtration by media filter, reverse osmosis and chemical disinfection. The remaining personnel will be accommodated by a land based potable water treatment system. This system will continue to operate during the operation phase while the barge based system will only be used during the construction phase.

The existing fresh water equipment will not be used and a new fresh water distribution system will be installed. The fresh water demand for construction and operation are shown on the drawing Steensby Site - Water Supply Balance Block Flow Diagram in Appendix C.

For the land based system, a heated and insulated pump house will be built at Lake ST347 with duty/standby pumps to deliver fresh water to a fresh water tank (located in close proximity to the new potable water treatment plant). Water from this tank will be used to provide fire water as well as meet the fresh water requirements of the site. A stand pipe within the tank will ensure that fire water is always available in the tank. Some fresh water requirements such as road dust suppression, stockpile dust suppression, concrete and explosives manufacturing will be provided directly from nearby lakes using a vacuum truck.

The land based potable water treatment scheme will consist of coagulation followed by media filtration and disinfection by ultraviolet radiation. The water will then undergo a secondary disinfection by sodium hypochlorite injection to ensure residual chlorine content at the point of use. The applicable guidelines specify minimum required levels of chlorine residual free chlorine. The barge based potable water treatment scheme will include the same equipment as well as a membrane based system to desalinate the seawater source.

A.1.1.2 Mid-Rail Site

Currently, there are no construction activities planned for the Mid-Rail Site. During the future construction phase, the on-site population will be approximately 200 people. A new potable water treatment system and fresh water distribution system will be put in place to support the construction phase operations. The fresh water demand for construction and operation are shown on the drawing Mid-Rail - Water Supply Balance Block Flow Diagram in Appendix C.

A heated and insulated pump house will be built at an adjacent Unnamed Lake with duty/standby pumps to deliver fresh water to a fresh water tank during summer. During the winter, water will be trucked from Ravn Camp Lake to the fresh water tank. This tank will be located in close proximity to the new potable water treatment plant. Water from this tank will be used to provide fire water as well as meet the fresh water requirements of the site. A stand pipe within the tank will ensure that fire water is always available in the tank. Some fresh water requirements such as road dust suppression and tunnel drilling will be provided directly from nearby lakes by vacuum truck.

The potable water treatment scheme will consist of coagulation followed by media filtration and disinfection by ultraviolet radiation. The water will then undergo a secondary disinfection by sodium hypochlorite injection to ensure residual chlorine content at the point of use. The applicable guidelines specify minimum required levels of chlorine residual free chlorine.

A.1.1.3 Ravn River Site

Currently, there are no construction activities planned for the Mid-Rail Site. During the future construction phase, the on-site population will be approximately 400 people. A new potable water treatment system and fresh water distribution system will be put in place to support the construction phase operations. The fresh water demand for construction and operation are shown on the drawing Ravn River - Water Supply Balance Block Flow Diagram in Appendix C.

A heated and insulated pump house will be built at Ravn Camp Lake with duty/standby pumps to deliver fresh water to a fresh water tank (to be located in close proximity to the new potable water treatment plant). Water from this tank will be used to provide fire water as well as meet the fresh water requirements of the site. A stand pipe within the tank will ensure that fire water is always available in the tank. Some fresh water requirements such as road dust suppression and tunnel drilling will be provided directly from nearby lakes by vacuum truck.

The potable water treatment scheme will consist of coagulation followed by media filtration and disinfection by ultraviolet radiation. The water will then undergo a secondary disinfection by sodium hypochlorite injection to ensure residual chlorine content at the point of use. The applicable guidelines specify minimum required levels of chlorine residual free chlorine.

A.1.1.4 Cockburn Tunnels Camp Site (Cockburn North Camp)

Currently, there are no construction activities planned for the Cockburn Tunnels Camp Site. During the future construction phase, the on-site population will be approximately 100 people. A new potable water treatment system and fresh water distribution system will be put in place to support the construction phase operations. The fresh water demand for construction and operation are shown on the drawing Cockburn Lake Tunnels Camp - Water Supply Balance Block Flow Diagram in Appendix C.

A heated and insulated pump house will be built at Cockburn Lake with duty/standby pumps to deliver fresh water to a fresh water tank (located in close proximity to the new potable water treatment plant). Water from this tank will be used to provide fire water as well as meet the fresh water requirements of the site. A stand pipe within the tank will ensure that fire water is always available in the tank. Some fresh water requirements such as road dust suppression and tunnel drilling will be provided directly from nearby lakes by vacuum truck.

The potable water treatment scheme will consist of coagulation followed by media filtration and disinfection by ultraviolet radiation. The water will then undergo a secondary disinfection by sodium hypochlorite injection to ensure residual chlorine content at the point of use. The applicable guidelines specify minimum required levels of chlorine residual free chlorine.

A.1.1.5 Cockburn South Camp Site

Currently, there are no construction activities planned for the Cockburn South Camp Site. During the future construction phase, the on-site population will be approximately 400 people. A new potable water treatment system and fresh water distribution system will be put in place to support the construction phase operations. The fresh water demand for construction and operation are shown on the drawing Cockburn South - Water Supply Balance Block Flow Diagram in Appendix C.

A heated and insulated pump house will be built at Cockburn Lake with duty/standby pumps to deliver fresh water to a fresh water tank (located in close proximity to the new potable water treatment plant). Water from this tank will be used to provide fire water as well as meet the fresh water requirements of the site. A stand pipe within the tank will ensure that fire water is always available in the tank. Some fresh water requirements such as road dust suppression and tunnel drilling will be provided directly from nearby lakes by truck.

The potable water treatment scheme will consist of coagulation followed by media filtration and disinfection by ultraviolet radiation. The water will then undergo a secondary disinfection by sodium hypochlorite injection to ensure residual chlorine content at the point of use. The applicable guidelines specify minimum required levels of chlorine residual free chlorine.

A.2 Sewage Treatment

A.2.1 Sewage Treatment Process Description

A.2.1.1 Steensby Site

During the construction and operation phase the camp population will increase to approximately 600 people. There is no planned construction at Steensby Site in the immediate future.

During construction start-up, sewage generated by the workforce will be treated in an existing sewage treatment plant that is on-site but not yet installed. During the construction phase, 300 people will be accommodated by a temporary sewage treatment system in place for the construction period. In addition, the temporary sewage treatment plant will be designed to process raw or partially treated sewage from the Cockburn Lake rail camps which will be conveyed to the Steensby temporary sewage treatment facility by truck. The remaining workforce will be accommodated by a permanent sewage treatment system which will remain in service during the operation phase.

These sewage treatment plants will be housed in a temperature controlled areas and as such their performance will not be negatively impacted by arctic conditions.

Effluent from the sewage treatment plants will be stored in effluent tanks. The effluent tanks will have a hydraulic retention time of two days (at minimum) based upon nominal flows. It is intended that the effluent tank will be at a low level during operation such that if sampling indicates that the effluent quality does not meet the applicable criteria further discharge can be prevented for a period in excess of a day to allow this effluent to be mixed, retreated, and retested. In addition this retention volume will allow for a minimal amount of recirculation through the STP using any spare STP capacity. This will improve the quality of the final effluent in the tank. The volume is sufficient to allow for periodic sampling and testing of the treated effluent before discharge or reuse. The new permanent sewage treatment facility will be RBC based technology or superior. Treated effluent will be discharged to the ocean.

The equalization tank that feeds the temporary sewage treatment plant will be sized to accommodate the sewage from the Cockburn Lake and Cockburn South rail camps. The rail camp sewage will be added during periods of low sewage generation at Steensby in order to reduce excessive surge volumes building up in the tank.

The sludge generated will be dewatered using a mechanical dewatering device such as belt filter or filter press and then incinerated. Sludge cake will be stored in an animal proof secure area. Odour generation will be limited because the sludge will be aerobically digested, dewatered and incinerated regularly such that the sewage cake is not stored for significant periods. Odour control carbon vents will be installed where deemed necessary. The incinerator design will consider the solids content of the sludge from the dewatering device.

The equalization tank that feeds the new sewage treatment plant will be sized to accommodate the sewage from the Cockburn Lake and Cockburn South rail camps. The rail camp sewage will be added during periods of low sewage generation at Steensby in order to reduce excessive surge volumes building up in the tank.

The sludge generated will be dewatered using a mechanical dewatering device such as belt filter or filter press and then incinerated. Sludge cake will be stored in an animal proof secure area. Odour generation will be limited because the sludge will be aerobically digested, dewatered and incinerated regularly such that the sewage cake is not stored for significant periods. Odour control carbon vents will be installed where deemed necessary.

A.2.1.2 Mid-Rail and Ravn River Sites

Sewage waste generated at the Ravn River and Mid-Rail camps and Sewage generated at the Cockburn North and Cockburn South camps can only be transported and treated at either the Mine Site Sewage Treatment Facility or the Steensby Port Sewage Treatment Facility, unless otherwise approved by the Board in writing.

Sewage generated at these sites will mainly be conveyed to the Mary River permanent sewage treatment facility by truck. During the first year when there will only be access to the camp via an ice road, sewage can only be trucked from January to April. During the remaining months the sewage will be stored. There would be an opportunity to partially or fully treat sewage prior to storage. Sewage storage facilities may be aerated to prevent the waste from becoming septic (generating odours and noxious gases). Sludge will form and settle in the facility depending on how long the sewage resides there. This sludge will be withdrawn and delivered separately to the dewatering system at the Mine Site. Given the quantity of waste to be moved or stored every effort will be made to reduce this volume by using low flow showers and toilets and potentially segregating gray water to be treated and reused as urinal flush water. Other potential waste minimization techniques will also be reviewed. These will be evaluated during the detailed design. In addition the surrounding water bodies will be modelled and sampled to potentially support having sewage treatment and waste discharge near the camp sites. An additional amendment to the Type A Water Licence would be required to support this option.

The equalization tank at Mary River will be sized to provide sufficient residence time for freshly added sewage from the Mid-Rail or Ravn River to mix with sewage generated at the Mine Site. Given that sewage generation follows diurnal patterns the sewage from the remote sites will be added during the low generation periods at the Mine Site.

A.2.1.3 Cockburn Tunnels (Cockburn North) and Cockburn South Sites

Sewage generated at these sites will be conveyed to the Steensby permanent sewage treatment facility by truck. Raw to partially treated sewage will be conveyed to Steensby Inlet by means of established roads along the rail alignment or by ice road. Depending on the volume of sewage to be stored at site, the

sewage storage facilities will be sized accordingly. At the north camp there will only be access to the camp via an ice road and as such sewage can only be trucked from January to April. During the remaining months the sewage will be stored. Sewage storage facilities will be aerated to prevent the waste from becoming septic (generating odours and noxious gases). There will be the opportunity to partially or fully treat sewage prior to storage. Sludge will form and settle in the facility depending on how long the sewage resides there. This sludge will be withdrawn and delivered separately to the dewatering system at the Steensby site. Given the quantity of waste to be moved every effort will be made to reduce this volume by using low flow showers and toilets and potentially segregating gray water to be treated and reused as urinal flush water. Other potential waste minimization techniques will also be reviewed. These will be evaluated during the detailed design. In addition the surrounding water bodies will be modelled and sampled to potentially support having sewage treatment and waste discharge near the camp sites. An additional amendment to the Type A Water Licence would be required to support this option.

The equalization tank at Steensby will be sized to provide sufficient residence time for freshly added sewage from the Cockburn Tunnels (Cockburn North) and Cockburn South camps to mix with sewage generated at the Steensby site. Given that sewage generation follows diurnal patterns the sewage from the remote sites will be added during the low generation periods at the Steensby site.

A.2.1.4 Design Considerations from 'Lessons Learned'

Previous studies have recommended the use of Polishing Waste Stabilization Ponds (i.e. Mary River Project Appendix 10D-3 Wastewater Management Plan SD-EMMP-003, March 31, 2010) followed by a secondary waste polishing system. The existing infrastructure at the Mine Site and Milne Port include these ponds in part to allow for secondary treatment of the sewage treatment plant (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 a secondary polishing system will not be required in the future.

The new systems will be installed with temporary storage ponds for off-spec water but will not require secondary polishing for the following reasons:

- The proposed new STPs will be based on membrane technology. This technology produces better quality effluent, is less susceptible to the impact of varying loads and has shorter start-up periods.
- The STP trains will be better able to handle upsets by using the available spare capacity to operate the equipment at more conservative flow rates.
- The existing equipment (at the Mine Site) was designed to meet a phosphorus discharge criteria of 0.5 mg/L. The new STPs shall be designed to meet a much lower phosphorus discharge criteria of <0.1 mg/L.

Sewage Treatment equipment vendors will be assessed based upon their experience producing equipment for arctic environments.

A.2.2 Oily Water/Wastewater Treatment Process Description

The process descriptions for both oily water/wastewater treatment systems for Steensby are described in the section that follows.

A.2.2.1 Steensby Site

Future Construction and Operation Phase

Oily water may be generated from the following sources (this neglects minor oily water generated from accidental spills which will be handled by the Spill Response Plan):

- Vehicle maintenance and wash facilities (i.e. truck wash, equipment and floor wash down water).
- Fuel tank farm run-off.
- Emulsion plant wash water.
- Freight dock.
- Airstrip.

The vehicle maintenance and wash facility will have a sump located in close proximity to the maintenance facilities. Wash water produced in the maintenance facility (truck washing, equipment and floor washdown) will flow by gravity and be collected in the local sump. Suspended material in the wastewater will settle in the sump. Free oil in the wastewater will be removed by an oil/water separator system in order to meet the required oil discharge limits. The waste will then be further treated in the oily water treatment plant by activated carbon and clay to meet other specific parameters. The effluent will then be pH adjusted, if required, to meet discharge criteria.

Treated effluent from the oily water treatment plant will be pumped to discharge, or recycled and reused as washdown water at the maintenance shops. The separated waste oil will be stored in a local tank. Periodically, the oil will be drained and shipped off site or incinerated. Accumulated suspended solids will be periodically removed and sent to the landfarm for treatment, if necessary.

Run-off from the tank fuel storage areas will have to be treated by the mobile oily water separator system that will be used as needed. The resulting water will be discharged directly to the receiving body (Steensby – Ocean). The water will be periodically tested such that if any parameter is out of compliance the water will be removed by vacuum truck and treated in the vehicle maintenance shop wastewater treatment plant.

Run-off water from the freight dock will be collected and treated in a manner similar to the treatment scheme for the run-off from the tank fuel storage areas.

The emulsion plant shall be supplied with its own wastewater treatment plant which utilizes an evaporation system to evaporate the water leaving solid residue and oil. This residue will be tested for

toxicity and if necessary taken off-site for disposal at a licensed facility otherwise the waste will be land filled.

Run-off water from the air strip run-off also has the potential for some oily water content. As such, this water will be collected through a drainage system and transported as needed by vacuum truck to the vehicle maintenance shop wastewater treatment plant.

Small amounts of propylene glycol will be used for de-icing of aircraft. The spent propylene glycol will be collected, stored in containers and sent by ship off-site to a licensed treatment/disposal facility. Some interim treatment of the spent propylene glycol may occur to reduce the overall waste volume generated. This will be evaluated during the detailed design.

Some dust suppression solution will be applied to roads at the Steensby site. The suppressant will be DL-10. This is an asphalt based emulsion and as such some water will be consumed for the dilution of the solution. This is an approved dust suppressant as specified by the Nunavut Department of Sustainable Development Environmental Protection Service (Environmental Guideline for Dust Suppression).

In addition some Calcium Chloride solution will be used for drilling activities. The spent brine will be applied to nearby roads as a dust suppressant. This is an approved dust suppressant as specified by the Nunavut Environmental Protection Service. Treated oily water will be blended with treated sewage and discharged or discharged directly based on sampling.

A.2.2.2 Rail Camps

Two tunnels are to be built along the railway and a small amount of water will be consumed in the tunnelling operation. Calcium Chloride brine solution is used for tunnelling. This waste brine generated during the tunnelling will be collected and disposed of as per the Waste Management Plan for Construction, Operation and Closure. In addition some Calcium Chloride solution will be used for drilling activities.

Appendix F -
Polishing Waste Stabilization Ponds (PWSP) Effluent Discharge Plan

Technical Memorandum

To: Jim Millard, Baffinland Iron Mines

From: Dave Ellis, P.Eng., AMEC
Jered Munro, AMEC

Date: March 27, 2012

Subject: PWSP Effluent Discharge Plan

Baffinland Iron Mines Corporation (BIM) has retained AMEC Environment & Infrastructure (AMEC) to prepare this plan for the management, treatment, and disposal of the wastewater stored in the polishing/ waste stabilization ponds (PWSPs) at the Milne Inlet and Mary River facilities.

This plan updates the previous plan presented March 2010. To the extent possible, the discharge plans and options presented herein are flexible with a view to accommodating various seasonal operating requirements.

AMEC was retained by BIM in 2009 to develop and design a polishing treatment system for treating the effluent from the Mary River sanitary treatment system stored in the three PWSPs at that site. This memorandum identifies the following:

- the design criteria,
- overall discharge approach,
- the polishing system treatment components and functionality, and
- the sampling and performance monitoring plan.

This PWSP effluent discharge plan remains largely unchanged from the 2009 plan.

POLISHING SYSTEM DESIGN CRITERIA

Discharge Quality

The design criteria for the effluent discharge quality are defined in the water licence issued by the Nunavut Water Board, Licence 2BB-MRY1114 dated April 5, 2011 and are summarized below:

Table 1: Discharge Criteria of PWSP Effluent

Parameter	Discharge Criteria (Maximum Concentration of any Grab Sample)	
Location	**Mary River WWTF**	**Milne Inlet WWTF**
BOD_5	30 mg/ L	100 mg/L
TSS	35 mg/L	120 mg/ L
Faecal Coliform	1,000 CFU/100mL	10,000 CFU/100mL
Oil and Grease	No visible sheen	No visible sheen
pH	Between 6.0 and 9.5	Between 6.0 and 9.5
Toxicity	Final effluent not acutely toxic	Final effluent not acutely toxic
Ammonia[1]	N/A	N/A
Total Phosphorus[2]	0.5 – 1.0 mg/L	N/A

AMEC Environment & Infrastructure
A division of AMEC Americas Limited
900 Maple Grove Road, Unit 10
Cambridge, ON N3H 4R7
Tel 519-650-7100
Fax 519-653-6554
www.amec.com

Notes: 1. No specific criteria for ammonia, but effluent must be acutely non-toxic.
2. The range set for total phosphorus discharge target levels to Sheardown Lake were set based on results of the mass loading model developed by North South Consultants.

The phosphorus limit was confirmed to not be detrimental to the receiving aquatic environment by North/South Consultants, who employed modelling software to predict the effects of the effluent discharge based on the maximum design parameters listed in Table 1.

Following Part I, Items 4 and 5, the water licence requires sampling of the effluent from the PWSPs to be completed once prior to discharge, and every four weeks thereafter, for the following parameters:

- Biochemical oxygen demand (BOD),
- Total suspended solids,
- pH,
- Faecal coliform, and
- Oil and grease (visual).

Toxicity testing on treated effluent is required to be completed once annually during open water season at the final discharge point in accordance with the following tests:

- Acute lethality to Rainbow Trout (Oncorhynchus mykiss) as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13.
- Acute lethality to Daphnia magna as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14.

The discharge criteria remain largely unchanged from the previous licence 2BB-MRY0710 with the notable exception that the current licence specifies the compliance parameters in terms of "maximum concentration of any grab sample" as compared to the previous licence which listed compliance parameters as "maximum average" concentrations.

Discharge Flow

The design polishing system flow rate was originally determined based on a desired operating schedule of 24 hours per day, 7 days per week, for a duration of 3 weeks. The combined storage volume contained in the Mary River PWSPs No. 2 and 3 was estimated at approximately 6 million liters (~1.5 MUSG).

The flow rate of 375 L/min (100 USgpm) was set as the nominal design flow rate for the polishing system. This design flow rate was used to select the required chemical dosing equipment and was used for initial planning purposes based on an assumed 75% uptime rate and a discharge of 75% of the design flow rate.

The effluent discharge pipe to Sheardown Lake is a 3" diameter, HDPE pipe that is approximately 1.5 km long. To achieve the 100 USgpm design flow rate through the long discharge pipe requires considerable discharge pressure be developed at the pump discharge. Practical limitations in operating gas-powered centrifugal pumps in series have prevented the planned flow rate from being achieved.

The Milne PWSP is estimated to hold approximately 0.5 million litre (approximately 130,000 USgals) of combined RBC sludge, grey water, and snow melt.

OVERALL PWSP DISCHARGE APPROACH

Once the water in the PWSPs begins to thaw in late May, a sample from each of the PWSPs is submitted for analysis of the regulated effluent criteria parameters. Depending on the water quality confirmed in the respective PWSP, discharge may commence, as detailed below.

Option #1—Spring Discharge

If the PWSP melt water sample is in compliance with the regulated criteria, Baffinland will commence discharge of the compliant effluent.

Once discharge has commenced, Baffinland will field test for pH, and turbidity and complete confirmatory sampling using bench-top screening methods to monitor the effluent quality. Discharge will be discontinued following established Standard Operating Procedures (SOPs) if any of the tests approach effluent criteria limits.

Sheardown Lake remains ice covered during the Spring Discharge. This ice cover requires a hole be augered through the ice and a temporary discharge pipe installed. The temporary discharge pipe conducts the effluent to a point below the ice to prevent erosion or sediment entrainment due to the discharge flow. At the completion of the Spring Discharge the temporary pipe is removed from Sheardown.

The quality of the water in the Milne PWSP has typically been such that the spring melt water has been compliant with the criteria without further polishing treatment.

Option #2—Summer Polishing Treatment and Discharge

If the water quality in the PWSPs does not meet all effluent discharge criteria, then the effluent would be treated using all or part of the polishing treatment system, depending on the particular parameters of concern. During the start-up of the polishing treatment system, the effluent is discharged back into a PWSP. The treated effluent would not be discharged until laboratory analytical results confirmed that the polishing treatment system was producing compliant effluent.

Following confirmation of effluent quality, the polishing system is operated and the treated water discharged to Sheardown Lake until the PWSPs have been emptied or weather conditions become unfavourable for treatment.

Should the Milne PWSP water require further polishing treatment, it can be transferred to Mary River for treatment and discharge through the Mary River PWSP system.

POLISHING TREATMENT SYSTEM COMPONENTS AND FUNCTIONALITY

The polishing treatment system was designed to provide additional treatment for total suspended solids (TSS) and total phosphorus (TP) removal, as well as pH control.

The polishing system contains the following unit processes, as shown in the attached Process Flow Diagram, PFD-01 (Attachment A) and the attached photographs (Attachment B). A more detailed description and photographs are included in the system Operation and Maintenance Manual.

Influent Pump and Flow Meter

A pump draws from one of the ponds and feeds water at a design flow of 100 USgpm. A flow meter with totalizer is used to monitor this influent flow. Flow to the polishing system can be controlled by throttling the influent pump speed or by adjusting a 3-inch ball-valve that bleeds water back into the pond.

Chemical Addition

Water treatment chemicals were added to the influent water to aid in the treatment process. The following chemicals were used in the 2009 and 2011 polishing system:

- Aluminum sulphate (commonly called “alum”), and
- A polymer, marked “Polyfloc AP1138” by the manufacturer, GE Betz Inc.

Aluminum Sulphate (Alum) Addition

Aluminum sulphate is added to achieve three goals:

- Precipitation of soluble phosphorous to a solid,
- Coagulation of algae and other suspended solids, and
- Reduction of pH.

Alum is dosed into the influent pipe by means of a chemical metering pump and then mixed in the flocculator piping to promote precipitation and coagulation chemical reactions and achieve flocc formation.

Polymer Addition

Polymer is added, after the alum, to further enhance the formation of larger solids allowing them to separate more quickly from the bulk liquid once in the DAF tank. The polymer serves as a flocculant which promotes the agglomeration of smaller coagulated solids into larger flocs. These larger flocs are more readily removed by downstream processes.

Polymer is added in a similar fashion as the aluminum sulphate, with mixing in the flocculator piping before entrance into the DAF.

Dissolved Air Flotation (DAF) System

Water containing alum and polymer is combined with a recirculating stream of water which is supersaturated with dissolved air. As the dissolved air comes out of solution, microscopic air bubbles are formed on the flocculated solids, thus increasing their buoyancy. These buoyant solids float to the surface and can be easily skimmed off.

Air Dissolving Pump

The dissolved air flotation (DAF) system is comprised of a number of components. The heart of the system is a Hellbender-brand air dissolving pump. This pump is specifically designed to accept large amounts of air mixed with water, and operates under high pressure to dissolve and shear the air into fine micro bubbles. When the high pressure, air-rich, stream meets the lower pressure flocculated influent water, dissolved air comes out of solution forming small air bubbles. These small bubbles attach to the flocculated solids causing them to rise to the surface once inside the DAF tank.

DAF Tank

Influent water that has already been combined with the air-rich recirculation water is distributed across the width of the rectangular DAF tank through a relatively large, 6-inch diameter distribution header. This large inlet header is used to minimize water entrance velocity and facilitate a quiescence of the water in the tank.

These quiescent conditions in the DAF tank allow the buoyant solids to float to the surface. Solids are periodically skimmed off the top of the tank, over a collection beach, into a sludge trough. The sludge trough discharges collected solids by gravity to two large totes for disposal.

At the opposite end of the DAF tank from the inlet is the outlet. Clarified water is collected through a 4-inch diameter effluent header located halfway up the height of the tank. The clarified water is directed to the final effluent clear-well tanks.

Floated Solids Storage and Pumping

Two parallel solids holding tanks have been provided to capture the floated solids. A pump is used to pump the float solids into PWSP No. 1 for storage.

Final pH Adjustment

Two effluent clear-well tanks are connected in series so that the water can be pH adjusted with sodium bicarbonate, if needed.

Final Filtration

If desired, the effluent can be passed through a final filtration process prior to discharge.

Effluent Pumping and Flow Monitoring

Clarified water is pumped through Tsurumi brand trash pumps, that discharge into the 3-inch Sheardown discharge pipeline. The treated water discharge flow is measured using a flowmeter with totalizer.

SAMPLING AND PERFORMANCE MONITORING

During operation, the treatment system is attended on a continuous basis. Samples of the daily field logs are attached (Attachment C). Attachment C.1 is the daily field log used during the spring discharge, when there is little or no treatment of the PWSP water required. Attachment C.2 is used when the full polishing system is required as may be necessary during late summer.

The polishing system is controlled using field testing devices for pH and turbidity measurement. Adjustments were made to the aluminum sulphate and sodium bicarbonate dosing pumps to control the pH and the polymer dosing pump was used to control the turbidity (indicative of total suspended solids-TSS). Physical inspection of the DAF inlet and discharge streams, as well as the consistency of the floated solids layer, indicated to the operators how well the system was operating. In the event of a suspect test result, a bypass valve is used to redirect effluent back to the PWSP while the system operation was adjusted and retested.

A summary of the PWSP external lab and in-house analysis program can be found in tables (2) and (3).

Table 1 – On-site lab analysis parameters and schedule.

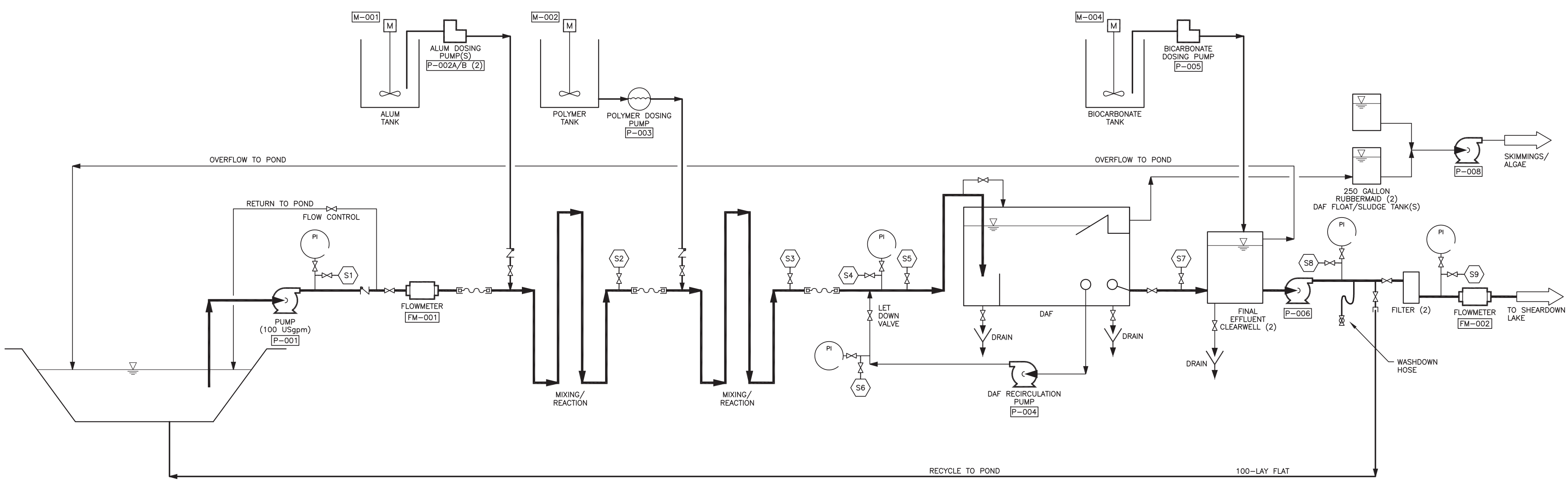
In House Analysis	Daily (onsite lab)	Hourly (in field)
pH	✓	✓
Temperature	✓	✓
Turbidity	✓	✓
TP	✓	
Ammonia	✓	
COD	✓	

Table 2 – External lab analysis parameters and schedule.

External Lab Analysis	Pre Discharge	Middle of Discharge	Every Week
BOD	✓		✓
COD	✓		✓
TSS	✓		✓
TP	✓		✓
Fecal Coliforms	✓		✓
Toxicity	✓	✓	
O&G	✓		✓

Attachment A

PWSP Polishing System Process Flow Diagram (PFD-01)



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Plot Time: Mar 23, 2012 – 11:43am, Plotted By: Dell Survey2

CAUTION: THIS PLAN MAY BE REDUCED 0 25mm 50mm ORIGINAL SCALE

NO.	REVISION	DATE	APRVD
0	O&M REVISIONS	08/10	

DRAWN JR AUG 2010
DESIGNED JW AUG 2010
CHECKED
REVIEWED

Baffinland Iron Mines Corporation

amec

AMEC ENVIRONMENTAL AND INFRASTRUCTURE
900 MAPLE GROVE ROAD
UNIT 10
CAMBRIDGE, ONT, Canada N3H 4R7
Fax: (519) 653-6554
Phone: (519) 650-7100

PROCESS FLOW AND INSTRUMENTATION DIAGRAM
BAFFINLAND IRON MINES
POND WASTEWATER TREATMENT
DISSOLVED AIR FLOATATION SYSTEM

DATE: MARCH 2012
SCALE: N.T.S.
SHEET: 1 OF 1 SHEETS
PROJ No: TR1662
P&ID-01

Appendix G -
Mobile Oily Water Separator (OWS) Manual

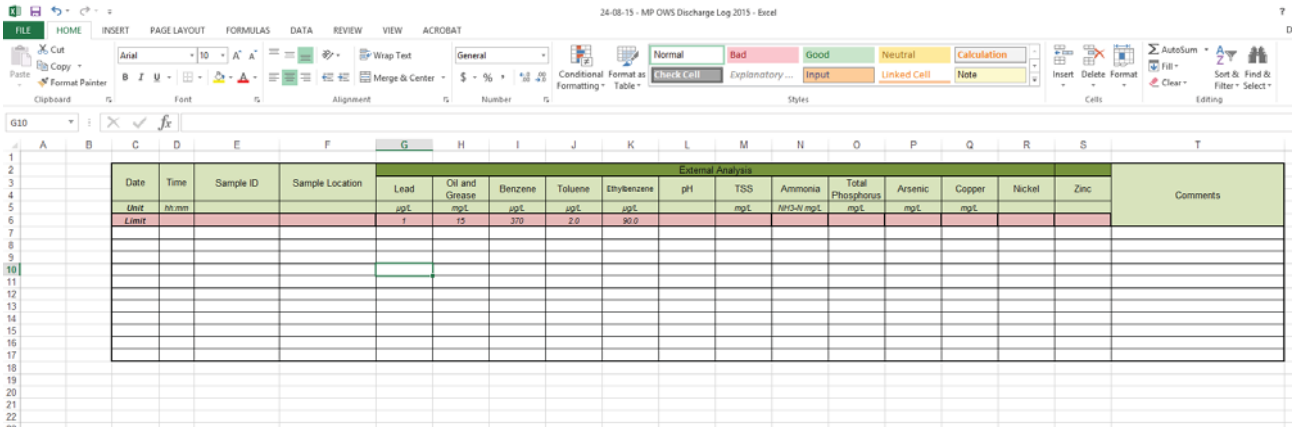
(See BAF-PH1-830-T07-0001)

Appendix H -
MMER Sampling and Reporting Requirements Memo (Minnow)

Monitoring Group	Station			Parameters	Bottles	Total Bottles	Notes
Group 1	All water taking and discharge			Water withdrawal/discharge volumes in cubic meters			Daily
Group 2	MS-01 MS-01a	MP-01 MP-01a	SP-01 SP-01a	pH, TSS alkalinity, BOD TKN, N-NH3, TP, COD O&G Faecal coliforms (effluent only)	1 x 1L Plastic or glass for on site analysis of pH and TSS 1 x 1L Plastic for alkalinity, BOD 1 x 250mL glass with H2SO4 preservative for NH3, TKN, TP, COD 2 x 500mL glass with HCL preservative for Oil & Grease 1 x 300mL sterile PET with sodium thiosulfate filled to shoulder for feacal coliforms	6 Effluent 5 Influent	On Site
Group 3	MS-01 MS-01a MS-MRY-04 MS-MRY-04a MS-06+ MS-07 MS-08 MS-09 MS-MRY-09 MS-MRY-10 MQ-C	MP-01 MP-01a MP-Q1	SP-01 SP-01a SP-03 SP-07	Acute Toxicity	1 x 20L pail a. Acute lethality to Rainbow Trout, *Oncorhynchus mykiss* (as per Environment Canada's Environmentla Protection Series Biological Test Method EPS/1/RM/13) b. Acute lethality to *Daphnia magna* (as per Environment Canada's Environmentla Protection Series Biological Test Method EPS/1/RM/14)	1	Sterile Aquatox Pail
Group 4	MS-02	MP-02 MP-03	SP-02	pH, TSS, TDS N-NH3, TP benzene, ehtylbenzene, toluene O&G total metals: As, Cu, Pb, Ni, Zn	1 X 1L plastic or glass for on site lab analysis of pH and TSS 1 X 250ml glass bottle with H2SO4 preservative for NH3 3 X 40ml septa vials with no headspace for benzene, ethylbenzene and toluene 2 X 500ml glass with HCL preservatives for oil and grease 1 X 125ml HDPE with HNO3 preservative	8	On Site
Group 5	MS-03 MS-04 MS-05 (add TSS) MS-MRY-6	MP-03 MP-04 (add TSS)	SP-04 SP-05 SP-06 (add TSS)	pH, TSS benzene, ethylbenzene, toluene Total Lead (Pb) O&G total petroleum hydrocarbons (TPH)	1 x 1L plastic or glass for on-site lab analysis of pH and TSS 3 X 40ml septa vials with no headspace and sodium bisulfate preservative for BTE, TPH (F1) 1 X 125ml HDPE with HNO3 preservative for total lead 2 X 500ml glass bottles with HCL preservative for Oil & Grease 2 X 500ml amber glass bottles with sodium bisulfate preservative for TPH (F2-F4)	9	On Site
Group 6	MS-MRY-13A MS-MRY-13B		SP-08	pH, TSS, TDS alkalinity, conductivity, DOC O&G phenols, TOC total petroleum hydrocarbons (TPH - F1) total petroleum hydrocarbons (TPH - F2-F4) total full list of metals total mercury	1 X 1L plastic or glass for on site analysis of pH and TSS, turbidity, TDS 1 X 1L Plastic for alkalinity conductivity, DOC 2 X 500ml glass with HCL preservative for oil & grease 1 X 250ml glass with H2SO4 preservative for phenols(4AAP), TOC 3 X 40ml septa vials with no headspace and sodium bisulfate preservative for TPH (F1) 2 X 500ml amber glass bottles with sodium bisulfate preservative for TPH (F2-F4) 1 X 125ml HDPE with HNO3 preservative for total metals 1 X 120ml square glass with HCL preaservative for total mercury.	12	On Site
Group 7	MS-06+ MS-07 MS-09 MS-MRY-09 MS-MRY-10 MS-MRY-11 MS-08 MS-08-US MS-MRY-10a	MP-07?	SP-07	pH, TSS, TDS, turbidity alkalinity, hardness, DOC, sulphate, fluoride, chloride TKN, N-NH3, N-NO3, TOC, TP Total Full List Metals Dissolved Full List Metals Total mecury Dissolved mercury	1 X 1L plastic or glass for on site analysis of pH and TSS, turbidity, TDS 1 X 1L Plastic for alkalinity, anions, DOC 1 X 250ml glass with H2SO4 preservative for tkn,nh3,toc, TP 1 X 125ml HDPE with HNO3 for total metals 1 X 125ml HDPE field filtered and preserved with HNO3 preservative for dissolved metals 1 X 120ml square glass with HCL for total mercury 1 X 120ml glass field filtered and preserved with HCL for dissolved mercury	7	On Site
Group 7a	MS-MRY-10a MS-08-US MS-08						
Group 8	MS-C MQ-C	MP-C MP-Q1		N-NH3 N-NO3, conductivity pH, TSS O&G	1 X 1L plastic or glass for on site analysis of pH and TSS, turbidity 1 X 250ml glass with H2SO4 preservative for NH3 1 X 1L plastic or glass for NO3, conductivity 2 X 500ml glass with HCL preservative for oil & grease.	5	On SIte

APPENDIX F –

OWS DISCHARGE LOG - EXTERNAL RESULTS SHEET



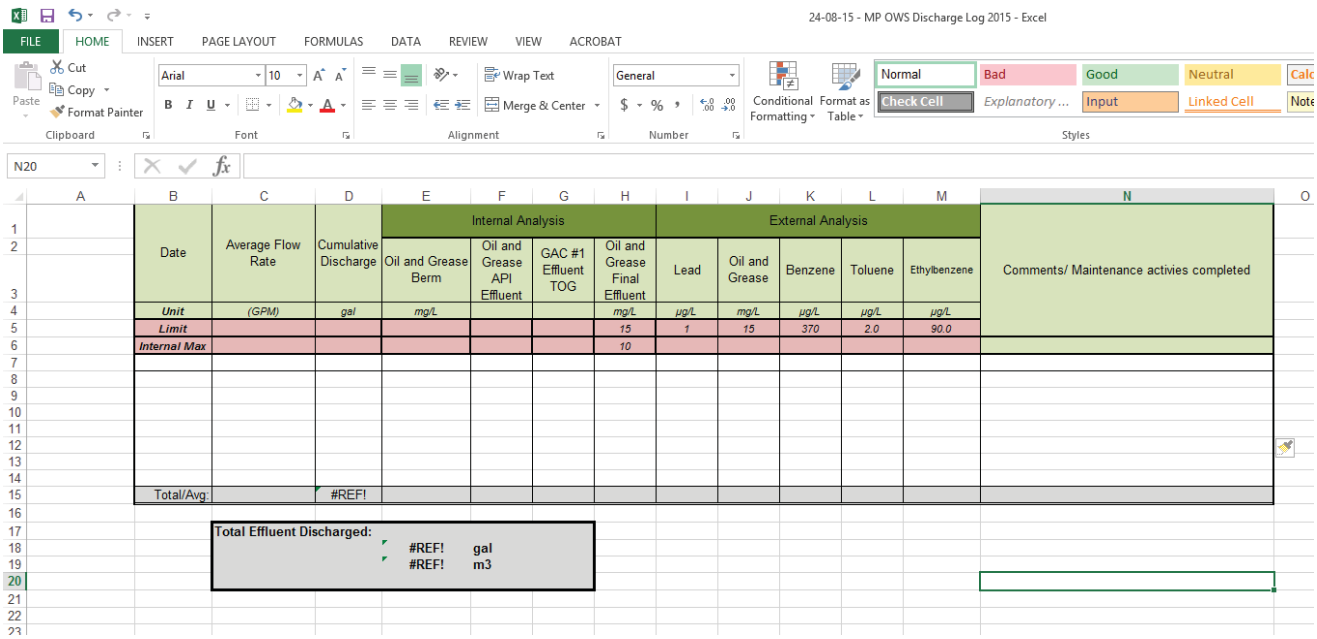
Date	Time	Sample ID	Sample Location	External Analysis													Comments
				Lead	Oil and Grease	Benzene	Toluene	Ethylbenzene	pH	TSS	Ammonia	Total Phosphorus	Arsenic	Copper	Nickel	Zinc	
Unit	hh:mm			µg/L	mg/L	µg/L	µg/L	µg/L		mg/L	NH3-N mg/L	mg/L	mg/L	mg/L			
Limit				1	15	370	2.0	90.0									

Electronic file located on Mine Site Environmental Server:

FINAL File System\2.0 ENV MANAGEMENT, MONITORING PLANS (BIM INTERNAL)\2.08 Oily Water Separators

APPENDIX G –

OWS DISCHARGE LOG – SUMMARY SHEET



Electronic file located on Mine Site Environmental Server:

FINAL File System\2.0 ENV MANAGEMENT, MONITORING PLANS (BIM INTERNAL)\2.08 Oily Water Separators

Appendix H -
MMER Sampling and Reporting Requirements Memo (Minnow)

Memorandum

Date: May 20, 2015

To: Jim Millard (Baffinland Iron Mines Corp.)

c.c.: Oliver Curran (Baffinland Iron Mines Corp.), Cynthia Russel and Pierre Stecko (Minnow Environmental Inc.).

From: Paul LePage (Minnow Environmental Inc.)

RE: Overview of MMER Sampling and Reporting

The Mary River Project is expected to become subject to the Metal Mining Effluent Regulations (MMER) under Canada's *Fisheries Act* in June 2015 upon the release of a cumulative amount of greater than 50 cubic meters (m^3) of effluent per day to the receiving environment. As a result, under the MMER, Baffinland Iron Mines Corporation (Baffinland) will be required to initiate Effluent and Water Quality Monitoring studies.

Minnow Environmental Inc. (Minnow) has prepared this memorandum to provide an overview of the information that must be submitted to Environment Canada once the Mary River Project becomes subject to the MMER. This memorandum has been organized according to the timeline for which the ensuing monitoring information is initially due to Environment Canada to meet Baffinland's MMER obligations.

Information Required Within 60 Days of Initiation of Effluent Discharge

Information that must be submitted to Environment Canada within 60 days following the release of effluent above the trigger level (i.e., 50 m^3/day) includes the following:

- Name and address of the mine owner and operator;
- Name and address of the mine parent company;
- Final discharge point(s) plans, specifications, and general description;
- Final discharge point(s) coordinates, reported in latitude and longitude degrees, minutes and seconds; and,
- Name of water body receiving final effluent discharge(s).

For the Mary River Project, the final discharge points may initially include MS-09 (East Pond) and MS-06 (Ore Stockpile Runoff) locations. The MS-09 pond will collect runoff

from the Early Revenue Phase (ERP) waste rock stockpile, whereas the MS-06 pond will collect surface runoff from mine site infrastructure and treated sewage water. Notably, effluent from sewage treatment facilities is not required to be monitored/reported under the MMER, but there may be requirements for monitoring to meet Baffinland's territorial (permitting) obligations. It is also noteworthy that records regarding effluent flow monitoring equipment (e.g., model numbers and year, manufacturer specifications for key equipment/components) and a calibration log must be maintained by the mine, but this information is not required to be routinely reported to Environment Canada.

The information indicated above must be submitted to the Environment Canada MMER Authorization Officer assigned to the Mary River Project, as follows:

Ms. Susanne Forbrich, Regional Director
Environmental Protection Operations Directorate
Prairie and Northern Region
Eastgate Offices
9250 – 49th Street
Edmonton, AB T6B 1K5
Susanne.forbrich@ec.gc.ca
(780) 951 - 8866

Sampling Required Following Initiation of Effluent Discharge

Effluent and water quality monitoring must be initiated upon the mine becoming subject to the MMER, and consists of:

- effluent deleterious substances monitoring;
- effluent acute toxicity testing;
- effluent volume monitoring;
- effluent characterization;
- effluent sublethal toxicity testing; and,
- receiving environment water quality.

Effluent deleterious substance (and pH) monitoring must be conducted weekly, at least 24 hours apart, at the final effluent discharge point during periods of effluent discharge. Analytical parameters measured for deleterious substance monitoring, required laboratory detection limits, and monthly mean limits are provided in Table 1. Baffinland will not be required to monitor effluent cyanide concentrations, as long as this substance is not used as a process reagent within the operations area. In addition, the monitoring frequency for radium-226 may be reduced in the event that concentrations are below 0.037 Bq/L for 10 consecutive sampling events.

Table 1: Effluent monitoring frequency and parameters associated with deleterious substances, acute toxicity and characterization monitoring components under the MMER.

Monitoring Component	Monitoring Frequency	Substance	Method Detection Limit[a]	Mean Monthly Limit
Deleterious Substances	weekly	Arsenic	0.010 mg/L	0.50 mg/L
		Copper	0.010 mg/L	0.30 mg/L
		Lead	0.010 mg/L	0.20 mg/L
		Nickel	0.010 mg/L	0.50 mg/L
		Zinc	0.010 mg/L	0.50 mg/L
		Total Suspended Solids	2.0 mg/L	15.0 mg/L
		Radium-226[b]	0.01 Bq/L	0.37 Bq/L
		pH	-	-
Acute Toxicity	Monthly	Rainbow Trout – Pass/Fail	-	-
		Daphnia magna – Pass-Fail	-	-
Effluent Characterization	four-times per year	Aluminum	0.05 mg/L	-
		Cadmium	0.00001 mg/L	-
		Iron	0.1 mg/L	-
		Mercury[b]	0.001 mg/L	-
		Molybdenum	0.005 mg/L	-
		Ammonia	0.05 mg/L	-
		Nitrate	0.05 mg/L	-
		Hardness	1 mg/L	-
		Alkalinity	2 mg/L	-
		Specific Conductance	-	-
Effluent Sublethal Toxicity	two-times per year	Fathead minnow	-	-
		Ceriodaphnia	-	-
		Duckweed	-	-
		Green alga	-	-

[a] Method detection limits for deleterious substances stipulated under the MMER, whereas those for effluent characterization are recommended by Minnow to allow comparison to relevant guidelines (e.g., Canadian Water Quality Guidelines)

[b] Sampling frequency can be reduced once the mine can demonstrate radium-226 concentrations less than 0.037 Bq/L over 10 consecutive sampling events, and mercury concentrations less than 0.0001 mg/L over 12 consecutive sampling events.

Acute toxicity testing must be conducted monthly, during periods of effluent discharge, to assess the influence of mine effluent on rainbow trout and *Daphnia magna* based on 'Pass/Fail' endpoints. Should samples be shown to be acutely lethal (i.e., ≥50% mortality), sampling frequency must be increased.

Effluent volume must be monitored in cubic meters (m^3), and reported in m^3/day, m^3/month and m^3/year, as appropriate. The effluent volume data will be used to calculate monthly loadings for each of the deleterious substances.

Effluent characterization must be conducted four times each calendar year, not less than one month (30 days) apart, while the mine is depositing effluent. In the event that effluent is discharged for only short periods each calendar year, the monitoring frequency will be reduced. It is recommended that effluent characterization be conducted at the same time as monitoring for deleterious substances and, if possible, receiving environment water quality monitoring. The list of substances required for effluent characterization is included in Table 1.

Effluent sublethal toxicity sampling must initially be conducted two-times annually using the effluent that contributes the greatest loadings of deleterious substances to the receiving environment. For each sampling event, sublethal toxicity tests must be conducted using fathead minnow (*Pimephales promelas*; 7-day survival and growth test), a cladoceran invertebrate (*Ceriodaphnia dubia*; 7-day survival and reproduction test), duckweed (*Lemna minor*; 7-day growth inhibition test), and a green alga (*Psuedokirchneriella subcapitata*; 3-day growth inhibition test) using standard test methods (Environment Canada 2007a,b,c, 2011).

Receiving environment water quality monitoring must be conducted four times each calendar year, not less than one month (30 days) apart, while the mine is depositing effluent. At a minimum, the sampling areas for receiving environment water quality monitoring at the Mary River Project must include an effluent-exposed station situated downstream of the effluent discharge(s) and a reference station located upstream of any mine effluent-related influences. Monitoring requirements for the receiving environment monitoring include field measurements of water temperature, dissolved oxygen, pH and specific conductance, as well as sampling for the substances required for deleterious substance and effluent characterization monitoring (see Table 1).

In terms of initiation of effluent and receiving environment water quality sampling, the following schedule is indicated in the MMER:

Deleterious Substances:	Within one week of the mine becoming subject to MMER.
Effluent Acute Toxicity:	Within one month of the mine becoming subject to MMER.
Effluent Volume:	Within one week of the mine becoming subject to MMER.

Effluent Characterization: Within six months of the mine becoming subject to MMER.
Effluent Sublethal Toxicity: Within six months of the mine becoming subject to MMER.
Receiving Water Monitoring: Within six months of the mine becoming subject to MMER.

For practicality, effluent volume should be monitored daily. In addition, given that effluent is likely to be discharged over a relatively short period of ice-free conditions from approximately June to September at the Mary River Project, the effluent characterization, effluent sublethal toxicity and receiving environment water quality monitoring must all be completed within six months of the Mary River Project becoming subject to the MMER. Thus, Baffinland must be prepared to organize and conduct this sampling in the summer 2015 open-water period.

Reporting Schedule and Content

Effluent monitoring reports are due to the Environment Canada Authorization Officer for all tests and monitoring conducted during each calendar quarter not later than 45 days after the end of the quarter, and annually not later than March 31st of the following calendar year. The quarterly reports will include all information related to effluent deleterious substances and pH (concentration and monthly mean concentration data), the number of days effluent was discharged and the volume of effluent discharged (monthly), mass loadings estimates from effluent for the deleterious substances, effluent acute toxicity data, effluent characterization data, effluent sublethal toxicity data and receiving environment water quality monitoring data. These reports will generally be provided electronically, with the analytical data also required to be entered into the Regulatory Information Submission System (RISS) database. A hypothetical schedule for sampling and reporting, based on an initial effluent discharge date of 30 June 2015, is provided as Table 2.

For the annual effluent and water quality monitoring report, key information that should be provided to the Authorization Officer includes:

a) The dates on which each sample was collected for effluent characterization, sublethal toxicity testing and water quality monitoring:

- four dates for effluent characterization (4 times per calendar year and not less than 1 month apart), while the mine is depositing effluent;
- four dates for water quality monitoring (4 times per calendar year and not less than 1 month apart), while the mine is depositing effluent;
- dates for sublethal toxicity testing (2 times each calendar year for 3 years and once each year after the third year, with the first testing to occur on an effluent sample collected not later than 6 months after the mine becomes subject to the MMER). The sublethal toxicity testing date(s) should match the date(s) for

Table 2: Example sampling and reporting schedule for Baffinland's Mary River Project under a hypothetical effluent discharge date of June 30, 2015.

Component		Sampling Initiation	Sampling Frequency (when discharging)	Year 1 Reporting Period				
				First Quarter Report	Second Quarter Report	Third Quarter Report	Fourth Quarter Report	Annual Report
				July, Aug, Sept 2015	Oct, Nov, Dec 2015	Jan, Feb, Mar 2016	Apr, May, Jun 2016	Jun 30 to Dec 31 2015
Effluent	Deleterious Substances and pH	July 1st - 8th, 2015	every week[a]	13 weeks of data; 3 monthly averages	13 weeks of data; 3 monthly averages	no effluent discharge likely (freeze-up)	no effluent discharge likely (freeze-up)	26 weeks of data; 6 monthly averages
	Acute Toxicity	July 1st - 8th, 2015	every month	3 sampling events	1 sampling event (assume Nov, Dec freeze up)	no effluent discharge likely (freeze-up)	no effluent discharge likely (freeze-up)	4 sampling events
	Effluent Volume (datalogger?)	July 1st - 8th, 2015	daily	continuous data 3 monthly averages	continuous data for Oct monthly averages	no effluent discharge likely (freeze-up)	no effluent discharge likely (freeze-up)	3 months of continuous data; 4 monthly averages
	Effluent Characterization Sampling	July 2015	four times annually[b]	3 sampling events[b]	1 sampling event (assume Nov, Dec freeze up)	no effluent discharge likely (freeze-up)	no effluent discharge likely (freeze-up)	4 sampling events[b]
	Sub-lethal toxicity	July 2015	twice annually[b]	2 sampling events	none required	no effluent discharge likely (freeze-up)	no effluent discharge likely (freeze-up)	2 sampling events
Receiving Environment	Downstream (effluent-exposed) Station	July 2015	four times annually[b]	3 sampling events[b]	1 sampling event (assume Nov, Dec freeze up)	no effluent discharge likely (freeze-up)	no effluent discharge likely (freeze-up)	4 sampling events[b]
	Upstream (reference) Station	July 2015	four times annually[b]	3 sampling events[b]	1 sampling event (assume Nov, Dec freeze up)	no effluent discharge likely (freeze-up)	no effluent discharge likely (freeze-up)	4 sampling events[b]
MMER Reporting	Reporting Date	-	-	due by Nov. 14, 2015	due by Feb. 14, 2016	due by May 15, 2016	due by July 15, 2016	due by Mar 31, 2016

[a] Weekly monitoring samples must be collected a minimum of 24 hours apart

[b] Sampling events must be spaced at least one month (30 days) apart from one another, and thus fewer than four sampling events may occur in instances in which effluent is discharged over short periods.

effluent characterization, as the sublethal toxicity sample must be an aliquot of the effluent characterization sample; and,

- if the required number of tests were not conducted, indicate the reason why (i.e., the number of days that the effluent was being discharged or the habitat conditions that prevented the collection of effluent characterization and/or water quality monitoring samples).

b) The locations of the final discharge points from which samples were collected for effluent characterization, noting that effluent characterization is conducted at all identified final discharge points (FDPs).

c) The location of the final discharge point from which samples were collected for sublethal toxicity testing and the data on which the selection of the final discharge point was based:

- Indicate from which FDP the effluent was collected for the sublethal toxicity testing and why that FDP was chosen for mines with more than one FDP (e.g., effluent that discharges into a sensitive receiving environment, has the greatest mass loading).

d) The latitude and longitude of sampling areas for receiving environment water quality monitoring, in degrees, minutes and seconds, and a description that is sufficient to identify the location of the sampling areas (possibly supplemented with maps).

e) The results of effluent characterization, sublethal toxicity testing and water quality monitoring:

- Include the results from all analyses completed on effluent (chemical and physical parameters), sublethal toxicity testing and receiving environment water quality monitoring.
- Include results from all required parameters, as well as any optional site-specific parameters that were measured.
- For sublethal toxicity testing, the laboratory reports should be included as an appendix in the annual report.

f) The methodologies used to conduct effluent characterization and water quality monitoring, and the related method detection limits:

- Some sampling methods are outlined in the Guidance Document for the Sampling and Analysis of Metal Mining Effluent: Final Report available at http://dsp-psd.pwgsc.gc.ca/Collection/En49-24-1-39E.pdf.

- Indicate the methodology used (e.g., inductively coupled plasma combined with mass spectrometry [ICP-MS], graphite furnace atomic absorption spectrometry [GFAAS]) for effluent characterization and water quality monitoring.
- Indicate the method detection limits for the methodology used—for MMER deleterious substances, the method detection limits identified in Table 1 should be met. Note that the Canadian Council of Ministers of the Environment's Canadian Environmental Quality Guidelines (e.g., Water Quality Guidelines for the Protection of Aquatic Life) or additional territorial/site-specific water quality guidelines should also be considered for comparisons of the receiving environment water quality monitoring.

g) A description of quality assurance and quality control measures that were implemented and the data related to the implementation of those measures:

Conclusions

I trust the information provided in this memorandum provides you with sufficient overview of the MMER sampling and reporting that Baffinland will be required to fulfil to meet its MMER obligations. Once organized, Minnow would be happy to review your monitoring schedules to verify that MMER compliance will be met. Should you require further details or wish to discuss any aspect of this information, please do not hesitate to contact me at your convenience.

Paul LePage, M.Sc.
Senior Project Manager / Aquatic Biologist
Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9
Tel : (905) 873-3371 ext. 226
Fax: (905) 873-6370

References

Environment Canada. 2007a. Biological Test Method: Test of Reproduction and Survival Using the Cladoceran *Ceriodaphnia dubia*. Environmental Technology Centre, Ottawa, Ontario. Environmental Protection Series. Report EPS 1/RM/21. Second Edition. February 2007.

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Appendix I – Oily Water Treatment Plant (For Vehicle Wash Water) O & M Manuals

(Available upon request)