

ATTACHMENT 17
LANDFARM MANUAL

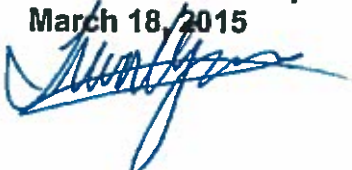
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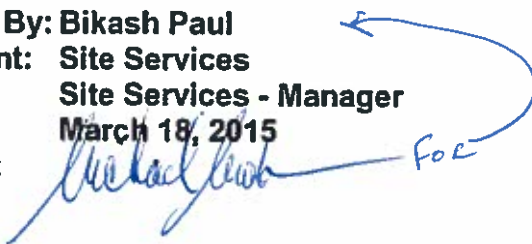
Baffinland Iron Mines Corporation

Landfarm Operation Maintenance and Monitoring Manual

BAF-PH1-320-T07-0005

Rev 0

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Attachment A – Site User Rules

Attachment B – Landfarming: Basic Processes and Principles

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1 PURPOSE AND SCOPE

The purpose of this manual is to outline and prescribe Standard Operating Procedures to ensure that Baffinland Iron Mine's Milne Port landfarm facility is operated in an efficient manner that is consistent with Baffinland's commitments to health, safety and environmental protection.

This manual has been designed to be used as a field reference document and training manual for classroom and self-instruction purposes. All employees with accountabilities and responsibilities as outlined in this manual are expected to be familiar with its use and location at the site. This manual contains the basic knowledge regarding responsibilities, environmental protection measures and regulations, safety practices and overall procedures for operating the Milne Port landfarm facility.

2 REQUIREMENTS

2.1 HAZARDS AND ADDITIONAL PERSONAL PROTECTIVE EQUIPMENT (PPE)

The following section provides the hazards, personal protective equipment (PPE), and safety and environmental equipment requirements associated with landfarm facility operation and maintenance activities.

2.1.1 HAZARDS

There are numerous hazards associated with the operation and maintenance of the landfarm. They include:

- Equipment collision or rollover
- Flying dust and small particles
- Petroleum hydrocarbon (PHC) vapor inhalation
- Spills

2.1.2 PERSONAL PROTECTIVE EQUIPMENT (PPE)

- Wear Standard P.P.E. - Safety glasses, hard hat, safety boots and reflective vest¹.
- Optional - Respirator fitted with an organic vapor cartridge(s) when dealing with heavily contaminated soils or when unusually high levels of hydrocarbon vapor may be present.

2.1.3 SAFETY AND ENVIRONMENTAL EQUIPMENT

- Spill kits (at landfarm and on mobile equipment)
- Radio Communication
- Optional - Gas monitor (for air quality testing)

¹ PPE is not required for operators inside enclosed cabs of heavy equipment.

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2.2 TRAINING, QUALIFICATIONS AND/OR CERTIFICATION

Any operator who may be working at the landfarm shall complete the documented training in this procedure and demonstrate their understanding of their responsibilities, and of the hazards and controls. Verification of training will be kept by the Training Department.

3 RESPONSIBILITIES

The following roles have specific accountabilities that must be met to ensure the Milne Port landfarm facility is operated in compliance with this manual. The following roles and responsibilities have been assigned to site personnel required to complete landfarm facility operations; however, this may not include all duties required to safely and successfully operate the facility.

3.1 SITE SERVICES MANAGER/ SUPERINTENDENT

The Site Services Manager, or the Site Services Superintendent in the Manager's absence, is accountable for the overall operation of the landfarm facility. Specifically, he/she shall:

- a. Implement and enforce this procedure.
- b. Plan and coordinate the use of the landfarm facility to conserve space and optimize remediation efficiency;
- c. Assist in the development, implementation and enforcement of landfarm specific safety protocols;
- d. Meet routinely with the Site Services Supervisor(s) to maintain proper control of the site and identify existing or anticipated problems considering the following:
 - i. Operational issues;
 - ii. Regulatory Requirements;
 - iii. Equipment issues; and
 - iv. Special operating instructions; e.g., inclement weather, repairs, fertilizer addition, etc.
 - e. Schedule routine work as required (e.g., snow removal, tilling and spreading, irrigation, etc.);
- f. Ensure that the need for any special operating conditions are identified and planned for in advance. This may include the identification of features (e.g. stockpiles) with stakes in advance of winter and the ground freezing;
- g. Coordinate a biannual summer earthworks inspection which shall be conducted by a geotechnical engineer.

3.2 SITE SERVICES SUPERVISOR

The Site Services Supervisor, under the supervision of the Site Services Manager/Superintendent, is responsible for supervising all activities at the landfarm facility in accordance with this manual. Specifically, the Site Services Supervisor shall:

- a. Implement this procedure;
- b. Regularly brief the Site Services Manager/Superintendent on the status of routine operations and any potential issues;

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- c. Ensure that soils under remediation are spread evenly to a soil depth determined to optimize hydrocarbon degradation rates;
- d. Maintain thorough, accurate and detailed records of landfarm operations and additional requirements as determined;
- e. Provide timely response to incidents and inquiries to ensure the landfarm is operated in compliance with this procedure;
- f. Inspect and organize the landfarm facility layout;
- g. Direct site users to the proper stockpiles or dumping area according to the incoming soils' contaminant type;
- h. Perform all the duties of the landfarm Operator/Labourer in his/her absence;
- i. Restrict access to landfarm facility, closing and locking gate after use or as required.

3.3 LANDFARM OPERATOR/ LABOURER

The Landfarm Operator/Labourer, under the supervision of Site Services Supervisor, is responsible for executing the following tasks at the landfarm facility. Specifically the Operator/Labourer shall:

- a. Be trained and experienced in operating the mobile heavy equipment necessary for the work;
- b. Work in conjunction with the Site Services Supervisor in executing general facility operations according to this procedure;
- c. Prepare landfarm facility for summer treatment operations prior to freshet (e.g. snow removal, etc.);
- d. Apply water and/or nutrients to remediating soil under the direction of the Site Services Supervisor and the guidance of the Environment Department;
- e. Inspect incoming contaminated soils and direct site users to proper stockpiles according to contaminant type; and
- f. Assist the Environment Department in treating water collected in the facility sump and contaminated snow containment.
- g. Report all violations of site user rules (Attachment A) to their supervisors for further action and incident reporting.

3.4 ENVIRONMENT DEPARTMENT PERSONNEL

To ensure all employees and contractors are following the guidelines outlined in this manual, the Environment Department will conduct biweekly inspections of the Milne Port landfarm facility. In addition to conducting inspections, Environment personnel shall:

- a. Provide guidance to site personnel with regards to acceptable soils at the landfarm;
- b. Assist Site Services in optimizing soil remediation rates by monitoring parameters including:
 - i. Soil characteristics; grain size, soil texture, bulk density, moisture content and permeability;
 - ii. Residual petroleum hydrocarbon concentrations;
 - iii. Soil chemistry; nutrients, salts, pH; and
 - iv. Tilling frequency.
- c. Sample remediating soils throughout summer treatment season to monitor remediation progression;
- d. Assist Site Services in the treatment of water collected in the landfarm sump and contaminated snow containment;

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- e. Identify treated soils that meet remediation objectives and are acceptable for reintroduction to the environment;
- f. Liaise with regulators and stakeholders on matters related to landfarm operations (e.g. notification of planned reintroduction of remediated soil to the environment);
- g. Install groundwater wells and monitor groundwater quality along the perimeter of the landfarm facility; and
- h. Audit record keeping associated with landfarm facility operations.

4 DEFINITIONS

Landfarm: Bioremediation treatment facility that uses naturally occurring microorganisms (mainly aerobic) and soil aeration (tilling) to remediate soils impacted by petroleum hydrocarbon (PHC) spills.

Contact Water: All irrigation water, precipitation and snowmelt that collect within the landfarm sump.

5 PROTOCOL

5.1 FACILITY DESIGN, LOCATIONS AND LAYOUT

The Milne Port landfarm facility was designed in accordance with Environment Canada's Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils to ensure both the protection of the environment and the health and safety of all personnel. It is located north of Milne Port Quarry 1 (MP-Q1) along the former Tote Road access. The facility consists of two containments, a landfarm containment and a contaminated snow containment (figure 1):

- The layout of the landfarm consists of a lined, containment area for stockpiling and remediating contaminated soils, a sump in the southwest corner for contact water collection and a ramp in the southeast corner for transporting soils in and out of the facility. It is designed to accommodate approximately 3,383 m³ of contaminated soils.
- Located on the east side of the landfarm, the contaminated snow containment is designed to store contaminated snow and ice generated from spills during the winter months. It is designed to hold 929 m³ of snow and ice (assuming a freeboard of 30 cm) and is accessed by a ramp on the south side.

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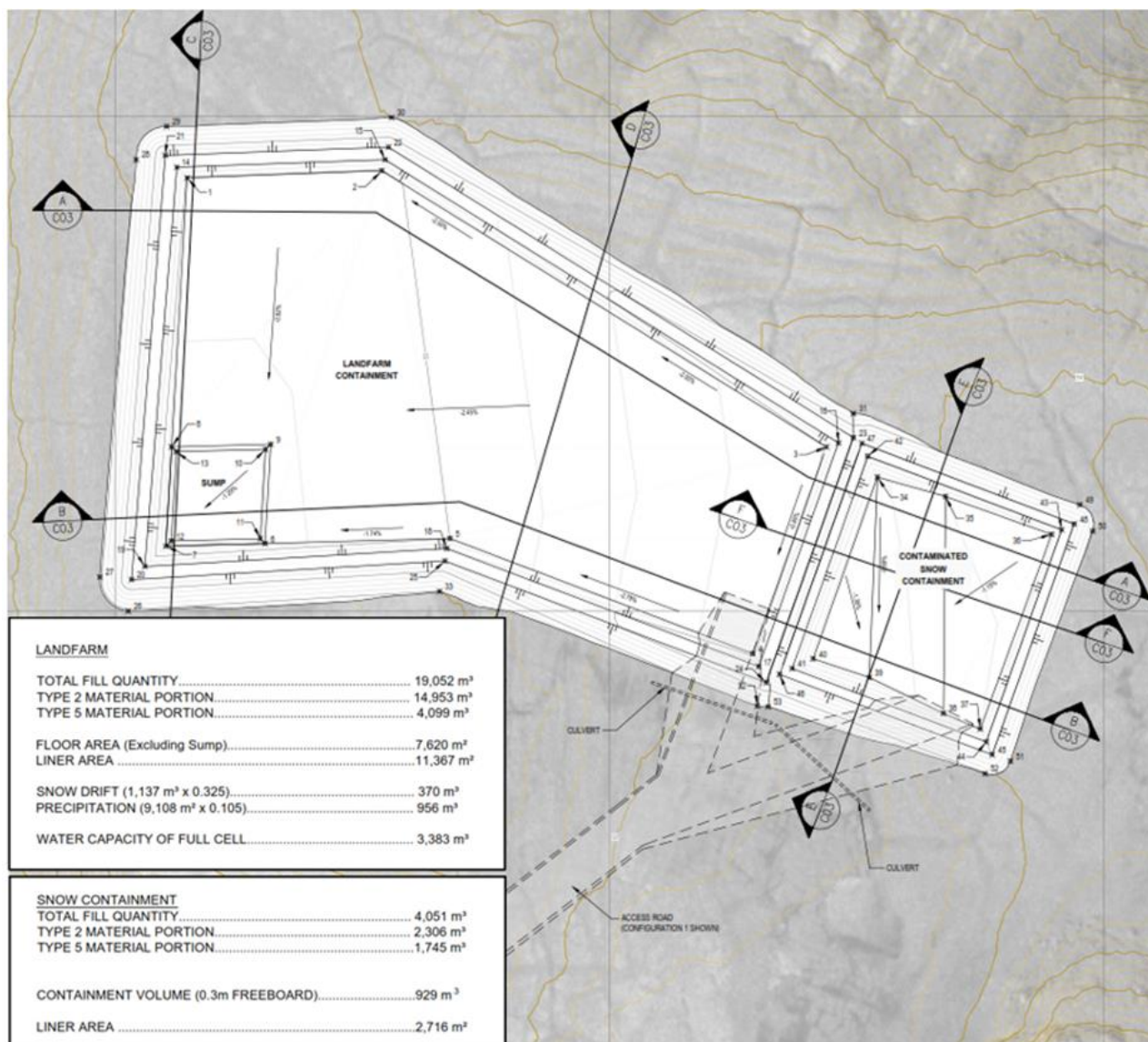


Figure 1 – Landfarm and Contaminated Snow Containment Facility

5.2 ACCEPTABLE SOIL CRITERIA

- Impacted soils destined for the landfarm shall be inspected to ensure the material is acceptable for treatment.
- All hydrocarbon contaminated soils are accepted at the landfarm (e.g. diesel, Jet-A, hydraulic oil).

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- In case of major hydrocarbon spills or spills of unknown substance, soils should be sampled prior to being introduced in the landfarm and should meet the following chemical acceptability criteria² :
 - Total PHCs less than 4%;
 - Electrical conductivity <4 dS/m; sodium adsorption ratio (SAR) <6;
 - pH greater than 5 and less than 10; and
 - CCME metals up to Tier 1 values or up to natural background concentrations
- Salts contaminated soil shall not be deposited in the landfarm. They may be harmful to biodegradation in high concentrations.
- Rock fragments and cobble exceeding 100 mm (4 in.) in diameter shall not be deposited at the landfarm. They have the potential to damage the containment liner during tilling.
- Acceptable soil types and criteria shall be posted at the entrance of the facility and the unloading or stockpiling area.

5.3 ACCEPTABLE SNOW CRITERIA

- Hydrocarbon contaminated snow and ice shall be deposited in the contaminated snow containment.
- Sewage contaminated snow and ice shall not be deposited in the snow containment. It should be deposited in the Milne Port Polishing Waste Stabilization Ponds (PWSPs).

5.4 STOCKPILING

- Soils should be separated into stockpiles according to contaminant type.
- Each stockpile shall be clearly labelled with signage in order to direct trucks unloading contaminated material to the proper location at the facility.
- The Landfarm Operator/Labourer shall ensure that adequate signage and barricades are in place at the required locations at the beginning of each day and relocate signs and barricades as required at the end of each day.

5.5 CELL DEVELOPMENT, SOIL THICKNESS AND TILLING

- **Cell development:** Soil should be tilled as it is spread, continuing until all of the intended soil has been deposited to ensure that the material is well-mixed and aerated.
- **Soil thickness:** Remediating soil should have an approximate soil depth of 30 cm (12 in.) and should maintain a 2 m (6 ½ ft.) perimeter from the inside toe of the berm.

² These characteristics detail the optimal chemical composition of suitable landfill soils and will be used as a guideline in determining treatability of soils generated by spills.

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- **Optimum soil condition:** Landfarm soil should be loose and moist. During the summer treatment season, the soils should be tilled every week. Optimizing the moisture content will enhance biodegradation and avoid dust generation.
- **Dry soil:** Very dry soils should not be tilled. The landfarm should be irrigated prior to tilling to increase the soil moisture content to 40% to 85% of the soils' water-holding capacity.
- **Wet soil:** Soils that are too wet should not be tilled. Passing equipment over wet or saturated soils could compact the material, reducing aeration and overall microbial activity. If soils appear muddy, or stick to the tracks of the tilling equipment, the soils are too wet to process.
- **Tilling equipment:** All tilling should be done with a plow pulled by a tracked skid steer to reduce soil compaction and optimize soil aeration. To avoid unnecessary soil compaction, only tilling equipment shall be permitted on remediating soil plots while actively tilling.

5.6 WATER MANAGEMENT AND MONITORING

5.6.1 IRRIGATION AND ROUTINE OPERATION

- **Sump water:** Contact water that accumulates in the sump from precipitation or snowmelt may be recycled as irrigation water to increase soil moisture or to suppress dust within the landfarm area during dry periods.
- **Sheen:** Recycled water from the sump should not contain any PHC sheen. If a sheen is observed it should be removed with absorbents or avoided by drawing water from beneath the water surface.
- **External water requirements:** As per the Type A Water License No. 2AM-MRY1325, Part E, Item 5, MBR effluent or treated water from the Milne Port PWSP may be used to irrigate dry soil, if such waters meet their respective appropriate discharge criteria. Consumption of fresh water should be avoided.

5.6.2 WATER TREATMENT AND DISCHARGE CRITERIA

- The level of contact water within the landfarm sump shall be monitored and maintained within the determined range during the summer months to maintain adequate freeboard and avoid flooding the soils undergoing treatment.
- Contact water should be drained prior to freeze-up in September.
- All water from the landfarm sump and contaminated snow containment pond shall be sampled and analysed prior to discharge to ensure the water quality meets the landfarm discharge criteria outlined in Baffinland's Type A Water License No. 2AM-MRY1325, Part F, Item 24, Table 9.
- All water that does not meet discharge criteria shall be treated using the onsite mobile Oily Water Treatment System (OWTS). All water sampling shall be conducted in accordance with Baffinland's Surface Water Sampling QA/QC Plan.

5.6.3 GROUNDWATER MONITORING

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- Groundwater monitoring wells shall be installed around the perimeter of the landfarm facility to ensure the structural integrity of the facility's containment liner throughout facility operations.
- Groundwater wells shall be sampled at a minimum of once annually, between mid-August and mid-September when groundwater monitoring becomes possible.
- All sampling groundwater sampling shall be conducted in accordance with Baffinland's Surface Water Sampling QA/QC Plan.

5.7 SOIL MANAGEMENT AND MONITORING

5.7.1 REMEDIATION OBJECTIVES

- Remediation objectives for impacted soils shall be determined by the source of contamination and the subsequent use of the remediated soils.
- Tier 1 criteria for PHC and metals parameters will be used as a minimum to determine soil remediation objectives, as outlined in the Government of Nunavut Environmental Guideline for Site Remediation (2009), as per Baffinland's Type A Water Licence No. 2AM-MRY1325, Part J, Item 6.
- Analysis of additional parameters will depend on the source of contamination.

5.7.2 SOIL SAMPLING AND ANALYSIS

- At the beginning of each summer treatment season, soils shall be evaluated for optimal nutrient, moisture and pH conditions.
- Soil sampling should be conducted throughout the treatment season to characterize soil additions from recent spills and monitor the progression of PHC degradation in soils undergoing remediation.
- Parameters may include soil bulk density, salts, moisture content, field capacity, and nutrients.
- All soil samples shall be collected using best industry practices and in accordance with the principles outlined in Baffinland's Surface Water Sampling QA/QC Plan.

5.7.3

- Any transport of soils out of the landfarm shall be preapproved by the Environment Department.
- The use of remediated soil for back fill or general site grading may be carried out only upon consultation and approval by the Government of Nunavut, Department of Environment and an Inspector, as per Baffinland's Type A Water License No: 2AM-MRY1325, Part J, Item 6.

5.7.4 WINTER MANAGEMENT AND FRESHET PREPARATION

- **Winter management:** Contaminated soil can be stockpiled up to 5 m (15 yd.) to minimize the amount of contact precipitation.

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- **Freshet preparation:** Snow and ice accumulated within the landfarm that has not come in contact with the underlying contaminated soil can be removed and placed outside the landfarm facility to melt.
- Approximately 10 cm (4 in.) of contact snow cover should remain on all surfaces during the snow removal process.
- If the landfarm soils are disturbed, contact snow should remain in the landfarm area and be deposited in the sump to melt.
- Snow accumulation within the sump area should be removed to within 10 cm (4 in.) of the ice surface.

5.8 SUMMARY OF INSPECTIONS AND REPORTING

Table 6.1 summarizes the documentation and due diligence required to ensure compliance throughout the landfarm operations. All site personnel responsible for completing landfarm facility operations shall be familiar with documentation and reporting requirements.

Table 6.1 – Monitoring Summary and Documentation

Item	Purpose	Responsible Party	Frequency	Type of Record(s)
General Operations	Record keeping of treatment operations	Site Services and Environment	Ongoing	• A working log detailing the following: - Dates, volumes (m³) and source of soils entering and exiting facility - Start and end date of soils under remediation - Dates and volumes of contact water treated, discharged and recycled - Dates, volumes and source of soil amendment additions (e.g. wastewater effluent, fertilizer) • A current layout sketch identifying origin and contaminant type of remediating soils and stockpiles • Photographic record.
Soil Sampling	Characterization and acceptance at landfarm	Environment	As required (e.g. major spill, spill of unknown substance)	• Soils origin and associated spill report. • Field notes detailing sampling methodology, soil texture, moisture content, odor and suspected contaminants. • Laboratory-issued analysis reports including QA/QC and chain of custody. • Documentation of fate of rejected soils. • Record of any treatability tests done.

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Item	Purpose	Responsible Party	Frequency	Type of Record(s)
Soil Sampling	Remediation Progress Monitoring Determination of amendment additions	Environment	Monthly during the frost-free months	- Field notes detailing sampling methodology, sample location and depth, soil texture, moisture content and odor. - Photographic record. - Laboratory-issued reports including QA/QC and chain of custody. - Summary tabulation of results. - Analysis of percent removal of PHC constituent treated and treatment time.
Soil Sampling	Verification of remediation	Environment	Once per year at the end of the season Otherwise, as circumstances require	- Field notes and sketch detailing sampling methodology, sample location and depth, soil texture, moisture content and odor. - Photographic record. - Laboratory-issued reports including QA/QC and chain of custody. - Summary tabulation of results. - Analysis of percent removal of PHC constituent treated and treatment time. - Documentation of fate of treated soils including date and volume (m³).
Contact and Contaminated Water Sampling	Conformity to Water License requirements Remediation Progress Monitoring	Environment	Monthly, or as required	- Document notification to Inspector (written notification at least 10 days prior to discharge). - Field notes detailing: - Discharge start and stop times - Date and time of samples taken - Daily discharge volumes (m³) - Photographic record of OWTS setup - Laboratory-issued reports including QA/QC, chain of custody and summary tabulation of results.
Groundwater Monitoring and Sampling	Groundwater quality assessment	Environment	At least once per year	- Laboratory-issued reports including QA/QC, chain of custody and summary tabulation of results - Field notes detailing sampling methodology, date and time of sampling, depth of active layer, weather and condition of wells. - Trend analysis (after a minimum of four years of data, if applicable).
Construction Summary Report	As-built and construction report as per Water License.	Projects	Submit to Nunavut Water Board within 90 days of completion of construction	- Construction field notes and observations. - Record and as-built drawings. - Monitoring well installation details. - Summary of any geotechnical testing, compaction, moisture content, particle size analysis.

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Item	Purpose	Responsible Party	Frequency	Type of Record(s)
Site Safety Inspections	Hazards identification	Health and Safety	Weekly	- Any unsafe condition/near-miss/incident reports and records. - Any unsafe conditions reported by workers must be reported to the Safety Department immediately for prompt action.
Geotechnical Inspection	Earthworks integrity and maintenance requirements identification	Site Services Engineering Consultants	Biannually during the summer	- Inspection of geotechnical performance of facility. - Berm performance with emphasis on observations of cracking or any signs of instability - Document recommendations of any repair/maintenance work. - Record of any repair work made to the facility.

6 REFERENCES AND RECORDS

- Government of Nunavut. Department of Sustainable Development. Environmental Protection Service. Environmental Guideline for Contaminated Site Remediation. March 2009.
- Environment Canada. Federal Contaminated Sites Action Plan (FCSAP): Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils. ISBN no. 978-1-100-22284-4. Cat. No. En14-19/3-2013E-PDF. 2013.
- Nunavut Water Board - Type A Water Licence No: 2AM-MRY1325
- EBA. Preliminary Hydrocarbon Impacted Soils Storage and Landfarm Facility – Operations, Maintenance and Monitoring Plan. EBA File No. E14101092. Milne Inlet, September 2011.
- EBA. Laboratory Biotreatability Study to Evaluate Biodegradation of Petroleum Hydrocarbons. SiREM Ref: TL0307B. Milne Inlet, July 2012.
- Waste Management Plan (BAF-PH1-830-P16-0028)
- Hazardous Materials and Hazardous Waste Management Plan (BAF-PH1-830-P16-0011)

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Attachment A

Landfarm Facility User Rules

1. **RESTRICTED ACCESS – ONLY SITE SERVICES PERSONNEL ARE ALLOWED TO ENTER THIS FACILITY.**
2. Only HYDROCARBON contaminated snow and soil are accepted at this facility.
3. Incinerator, hazardous and/or landfill waste are **NOT** accepted at this facility.
4. All placement of soil and contaminated snow in the facility must be preapproved by Site Services Supervisor prior to dumping.
5. Vehicles shall follow posted speed limits and directions to the unloading area - **Unloading in other areas is strictly prohibited.**
6. No unloading by rapid acceleration or deceleration is permitted.
7. All spills are to be stopped if safe to do so, and immediately reported to the Site Services Supervisor.
8. Personal Protective Equipment (PPE) is required to be worn at the facility.
9. In case of Emergency – Immediately contact the Site Services Supervisor or call a Code 1, if necessary, providing your location, your name and the nature of the emergency.

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Attachment B

LANDFARMING - BASIC PROCESSES AND PRINCIPLES

The Milne Port landfarm is a bioremediation treatment facility that remediates soils impacted by PHC spills and releases. Remediation is achieved by spreading contaminated soil in a thin layer (30 – 45 cm) across the landfarm area and allowing two natural processes to remove the PHCs from the soil: (1) PHC degradation by naturally occurring microorganisms; and (2) chemical volatilization.

The breakdown of PHC by aerobic microbial degradation is the dominant process of the two and results in three main end products: water, carbon dioxide and microorganism protein. The stimulation of microbial growth and activity for the removal of PHCs is accomplished primarily through the addition of air and nutrients. Microorganisms that degrade PHCs require optimal quantities of water, oxygen, and macronutrients (carbon, nitrogen, hydrogen, oxygen, sulphur, phosphorus, potassium, and magnesium), and have an ideal soil pH between 6 and 8. In addition, excessive salt compounds reduce the osmotic potential of the soil and can slow, or even halt biodegradation. Salts that are harmful to biodegradation in excessive concentrations include sodium chloride and particular fertilizer amendments.

The overall effectiveness of landfarming depends on the following three main parameters:

1. Soil characteristics; grain size, soil texture, bulk density, moisture content and permeability;
2. Type of petroleum hydrocarbon or contaminant; and
3. Climatic conditions.

Soil characteristics influence the rate of at which impacted soils remediate by affecting several factors including PHC retention, water holding capacity, surface area, permeability and bioavailability. Most soil microorganisms that breakdown PHCs in a landfarm require an aerobic environment, making remediation of soil with low permeability, such as clay, more difficult. Because of this, tilling is conducted to loosen and aerate the soils in order to enhance microbial activity.

Moreover, the type of PHCs present in impacted soils is one of the main factors that determines the amount of time required for remediation. Soils impacted by diesel and/or Jet-A remediate significantly faster than soils contaminated with hydraulic and engine oils due to the differences among the PHCs chemical composition.

Climatic conditions including rainfall, snow, wind effects and temperature also influence remedial efficiency. Rain and snow melt will change the moisture content of the treated soil which in turn can alter the activity of the microorganisms responsible for PHC degradation. In contrast, wind and low humidity have the potential to increase water evaporation and dry out remediating soil. Maintaining the moisture content of impacted soils within a range of 40% to 85% of the soil's water-holding capacity will enhance biodegradation and avoid dust generation.

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