Volume 1 Annex V1-7 Type A Water Licence Applications

Package P4-14

Hope Bay Project Hydrocarbon Contaminated Material Management Plan

HOPE BAY PROJECT
HYDROCARBON CONTAMINATED MATERIAL MANAGEMENT PLAN

HOPE BAY, NUNAVUT

DECEMBER 2017

Hope Bay Project Hydrocarbon Contaminated Material Management Plan

Plain Language Overview:

This Plan describes how hydrocarbon contaminated materials, including water, snow or soils originating from operations or closure at the Hope Bay Project is to be managed. These materials will be relocated to a dedicated landfarm where they will be treated or temporarily stored, or relocated to an underground mine for permanent storage.

Hope Bay, Nunavut

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Revisions

Revision #	Date	Section	Changes Summary	Author	Approver
1	2010		Approved Plan under 2AM-DOH1323.	SRK	HBML
2	2014	Throughout	Changes to document structure for operational suitability and efficiency. TMAC as current licensee for the Hope Bay region.	SRK	TMAC
3	Jan 2017	Throughout	Changes to document structure for operational suitability and efficiency.	SRK	TMAC
4	Nov 2017	Throughout	Updated title to Hydrocarbon Contaminated Material Management Plan, previously Hope Bay Project Landfarm Management Plan. Updated to a belt-wide plan	SRK	TMAC

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Module

Module A: Boston LTA

Glossary

Term	Definition
BTEX	benzene, toluene, ethylbenzene and xylene
CALA	Canadian Association for Laboratory Accreditation Inc.
CCME	Canadian Council of Ministers of the Environment
CWS	Canada Wide Standards
DIPA	Diisopropanolamine
dS/m	deciSiemens per metre
EC	Electrical conductivity
EPD	Environmental Protection Division of the Nunavut Department of Environment
ESR	Environmental and Social Responsibility
HDPE	High-density polyethylene
INAC	Indigenous and Northern Affairs Canada
KIA	Kitikmeot Inuit Association
LTA	Land Treatment Area
NIRB	Nunavut Impact Review Board
NWB	Nunavut Water Board
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PID	Photoionization detector
PHC	Petroleum hydrocarbon
ppm	Parts per million
QA/QC	Quality Assurance and Quality Control
SAIC	Science Application International Corporation
SAR	Sodium adsorption ratio
THE	Total extractable hydrocarbon
TMAC	TMAC Resources Inc.
TPH	Total petroleum hydrocarbon
TSS	Total suspended solids
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compounds
WSCC	Workers Safety and Compensation Committee

1 Introduction

This Hope Bay Hydrocarbon Contaminated Material Management Plan (the Plan) has been prepared by TMAC Resources Inc. (TMAC) in accordance with various water licences held by TMAC associated with developments throughout the Hope Bay region. This plan has been prepared to replace the previously approved Hope Bay Project Landfarm Management Plan (2017a).

The Plan is intended primarily for use by TMAC and its contractors to ensure that best practices for minimizing potential environmental impacts and potential environmental liabilities with respect to hydrocarbon contaminated water, snow and soils (including crush rock from camp infrastructure and waste rock, herein referred to as soils) are followed, and that the conditions of the water licences are met.

This Plan is structured in a manner such that one document pertaining to storage and management of hydrocarbon contaminated materials is approved and implemented across all TMAC Hope Bay Project sites, while still addressing site- and licence-specific needs. Licence-specific requirements for monitoring have been based on the existingType A Water Licence 2AM-DOH1323 conditons. The exception is the Boston Land Treatment Area (LTA) facility approved under the existing Type B Water Licence 2BB-BOS1727, located at the existing Boston Camp Site. This facility is a temporary facility and is addressed in Module A of this Plan.

This plan is subject to annual reivew and will be updated as required.

1.1 Objectives

The objective of this Plan is to outline how hydrocarbon contaminated materials will be managed within the Hope Bay Project site.

Hydrocarbon contaminated water, snow and soils can be treated on site, or can be permanently stored undeground in closed areas of the mine voids. Treatment of hydrocarbon contaminated water and snow can readily be done at each site. Management of hydrocarbon contaminated soils will include relocation to a dedicated landfarm where it will be treated or temporarily stored, or relocation to an underground mine for permanent storage.

1.2 Relevant Legislation and Guidance

Worker health and safety and operational components of the Plan are part of TMAC's mine plan and come under the jurisdiction of the Nunavut Mines Inspector. Environmental elements of the Plan come under the jurisdiction of the Nunavut Water Board (NWB), the Nunavut Impact Review Board (NIRB) and other regulatory agencies.

Implementation of the Plan should be considered alongside the following relevant legislation in Table 1.1.

Table 1.1. List of federal and territorial regulations governing the Hope Bay Project Hydrocarbon Contaminated Material Management Plan

Regulation	Year	Governing Body	Relevance
Workers Safety and Compensation Commission (WSCC) Chief Mines Inspector as per Mine Health and Safety Act	1995	Government of Nunavut	Provides regulations for Workers Safety

1.3 Related Documents

Table 1.2. List of documents related to the Hope Bay Project Hydrocarbon Contaminated Material Management Plan

Document Title	Year	Relevance
Hope Bay Project Waste Rock and Ore Management Plan	2017	This Plan describes the approved procedures for disposing of hydrocarbon contaminated materials within an underground mine
Hope Bay Project Spill Contingency Plan	2017	This Plan describes the spill response procedures to be used at the Hope Bay Project
Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils (SAIC 2006).	2006	Provides guidance for siting, design, operation and monitoring of a landfarm for remediation of petroleum hydrocarbon contaminated soil

1.4 Plan Management

Revisions to the Plan can be triggered by activities such as changes in the mine plan, operational performance, personnel or organizational structure, mine ownership, regulatory or social considerations, and life cycle or design philosophy. The Plan is reviewed annually and is revised or updated as necessary in accordance with changing circumstances.

1.5 Roles and Responsibilities

Table 1.3 shows the roles and responsibilities for implementation of the Hydrocarbon Contaminated Material Management Plan.

Table 1.3. Roles and responsibilities

Role	Reponsibility
Mine General Manager	• Updating the Plan; and • Responsible for the management and operations of the facilities and for providing the necessary resources to manage the facilities.
Surface Manager (or designate)	• Implementing the Plan; • Providing on site resources to operate the facilities; • Conducting and documenting regular inspections; • Notifying Environmental and Social Responsibility (ESR) if water accumulation is noted in the facilities; • Ensuring that water treatment and discharge activities take place as requested by ESR and logs of discharge quantities and locations are provided to ESR; and • Providing input on the modifications in the design and the operation of the facilities.
Environmental Coordinator	• Updating the Plan; • Liaise with Indigenous and Northern Affairs Canada (INAC) inspector prior to removal of and placement of contaminated soils; • Ensuring water and soil sampling programs are completed as needed, and providing the necessary resources for completing these sampling programs; • Ensuring internal records are kept of the quantities of contaminated soils (source, material, contamination type and time) placed within the facilities; • Conducting and documenting Landfarm and LTA inspections; and • Keeping records of on site analysis, observations, photographs, water and soil discharge activities and laboratory analysis.

2 Landfarm Facilities

2.1 Doris Landfarm

The Doris Landfarm is located approximately 0.6 km north of the existing Doris Camp Area and is situated between the existing all weather road and Quarry 2 (Drawing LF-01, Attachment 1). Access to the Facility is gained via an 8.0 m wide access road originating immediately southwest of the Crusher Pad. The Doris Landfarm layout is shown in Drawing LF-02, Attachment 1.

2.2 Existing Boston Land Treatment Area

The Boston Land Treatment Area (LTA) facility approved under the existing Type B Water Licence 2BB-BOS1727 is located at the existing Boston Camp Site. Details for the management and monitoring of the existing LTA are located in Module A of this document.

2.3 Boston Landfarm

The Boston Landfarm is to be located on a crushed rock pad between then Boston process plant and Boston contact water pond #2 (Drawing BC-02, Attachment 1).

The Boston Landfarm will be similar to the existing landfarm at Doris. It will consist of three cells, one for contaminated snow and water, one for clean water (pending discharge) and one for contaminated soil. The Boston Landfarm layout is shown on Drawing BC-07, Attachment 1.

The design criteria for the landfarm are:

- Minimum clean water and soil pond containment volumes of 360 m^3;
- Minimum contaminated snow and water containment volume of 550 m^3;
- The floor of each cell will be sloped at 1% towards a sump;
- Each cell will be accessed via access ramps sloped at 5H:1V (11°);
- Each cell shall be lined with a geomembrane liner; and
- Landfarm berms will have:
  - A minimum of 3.4 m crest width,
  - Inner slopes of 2H:1V (26.5°), and
  - Outer slopes of 1.5H:1V (34°).

The landfarm berms will be constructed with geochemically suitable transition material, and bedding material. The landfarm cells will be lined with a textured high-density polyethylene (HDPE) liner sandwiched between two layers of non-woven geotextile. A 0.15 m thick layer of bedding material will be placed below the liner system and a 0.6 m thick layer of bedding material will be placed above the liner system. All materials should be placed and compacted in accordance with the Technical Specification.

3 Contaminated Material Management Strategies

Hydrocarbon contaminated materials will either be temporarily stored and treated in a dedicated landfarm facility or placed in an underground mine for permanent storage.

Landfarming is recommended for remediating petroleum hydrocarbon (PHC) contaminated materials, but not for all types of contamination. Only material containing the following hydrocarbons will be treated at a landfarm facility:

- Diesel fuel;
- Aviation gasoline (Avgas);
- Jet fuels (Jet A, Jet A-1, and Jet B); and
- Gasoline.

All other materials will be deemed inappropriate for landfarming and will ultimately be placed in an underground mine for permanent storage in accordance with the Hope Bay Project Waste Rock and Ore Management Plan (TMAC 2017b).

Contaminated Material Characterization

If the type of contamination in the material is unclear, it will be characterized to determine the appropriate management strategy and to determine the concentrations of contaminants present. Characterization will be conducted by collecting samples of the material for laboratory analysis, reviewing spill records or a combination of the two. Information recorded regarding the type and volume of the spill may reduce the required characterization sampling. Characterization may help to identify which chemical parameters should be monitored during the remediation process.

Table 3.1 shows the type of analyses recommended for contaminated material characterization with the Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils (SAIC 2006).

Table 3.1. Recommended Analyses Based on Suspected Soil Contamination[1]

Contaminant Source	Parameters Analyzed								
	Canadian Wide Standards (CWS) - Petroleum Hydrocarbon (PHC) Fractions	Benzene, Toluene, Ethylbenzene & Xylene (BTEX)	Total Petroleum Hydrocarbon (TPH) (Calculate)	Lead	Total Heavy Metals[2]	Chromium/Cadmium	Polychlorinated Biphenyl (PCB)	Phenols	Polycyclic Aromatic Hydrocarbons (PAH)
Unleaded gasoline	X	X	X		X				
Leaded gasoline, aviation gasoline	X	X	X	X	X				
Fuel oil, diesel, kerosene, jet fuel, mineral oil/spirits, motor oil	X	X	X		X				X
Petroleum solvents	X		X				X		
Crude oils, hydraulic fluids	X		X	X	X				X
Waste petroleum products	X	X	X	X	X	X	X	X	X

Notes: Source - Table adopted from SAIC (2006)
(1) Modified from Environment Canada, 1993
(2) Heavy metals analyses required to determine if constituents are not present at levels toxic to micro-organisms (>2500 ppm) (USEPA. 1994)

4 Soil Management

Contaminated soils that have been characterized and deemed appropriate for remediation in a landfarm facility will be managed as outlined below. Soils that are not appropriate for remediation in a landfarm facility will be placed in an underground mine for permanent storage.

4.1 Management for Optimal Remediation

4.1.1 Placement of Contaminated Soil in Landfarm Facility

For optimal remediation of the contaminated soil, soil plots or windrows should be at a depth of 0.35 to 0.40 m with a maximum depth of 0.50 m. Soil depth will also be dependent on the equipment available for tilling and availability of space in the soil pond.

Trucks or equipment should not be allowed to drive in the landfarm ponds, except for when placing the material, because their weight will pack the soil making it more difficult to till. Compacting the soil may prolong the time to complete soil remediation. The contaminated soil should be tilled using equipment that will disperse soil clumps, mix, and aerate the deposited soil but not compact it (e.g. a backhoe, skid steer, disk, rototiller, etc.).

The soil should not be placed on a layer of snow or ice. If the soil base is saturated it will encourage glaciation which will slow melting in the spring and ultimately slow the remediation process during the short warm period. Contaminated soils excavated from site should be placed in the section of the soil pond with the highest elevation (away from the sump) in winter for spreading during the following spring and summer. Contaminated materials may also be placed in this area during periods when the landfarm is saturated in the spring and during rainy weather. Alternatively, contaminated material may be stored in containment (such as drums) until it can be processed in the landfarm.

The Environmental Coordinator will maintain a record of the amount of contaminated soil placed in the landfarm, the location of each contaminated soil batch by contaminant type, and the date of deposition. Copies of these records will be readily available for internal and external audits and for inspectors.

4.1.2 Tilling

A substantial amount of soil hydrocarbon remediation is achieved simply through the exposure to air and subsequent volatilization of the hydrocarbons. Additionally, most soil microorganisms degrade PHC better in an aerobic environment. Tilling provides aeration of the soil and re-distribution of nutrients and moisture which aids in the bio-remediation and volatilization processes. Tilling should therefore be conducted to aerate the soil and enhance remediation activities. Tilling should occur at least once per month in the summer months. Tilling should not occur during the winter months.

Tilling should occur when the soil moisture content is moderate (within the optimal range of 40% to 85%). Very dry soils should not be tilled until after irrigation to avoid dust generation. Wet soils do not benefit from tilling due to compaction of the soil by passing equipment. If soils appear muddy, or sticks to the tires of the equipment, it is too wet to till.

The tilling equipment operator must be careful not to till below the contaminated material and inadvertently damage or disturb the underlying HDPE liner. As per design, the landfarms are constructed with a slight gradient and therefore, extra care must be taken when tilling the soils. The depth to the liner should be carefully determined prior to beginning to till. Damage of the underlying liner, surrounding berms, or sump area must be reported to the Surface Manager and the Environmental Coordinator immediately.

4.1.3 Moisture Content, Nutrients and pH of the Soils

To ensure the effectiveness of the Facility at the start of the landfarming season, soil samples may be analyzed for nutrients, moisture, and pH content to achieve the most efficient remediation of PHC. Optimum conditions are as follows:

- Moisture content between 40 and 85%,
- A carbon:nitrogen:phosphorus ratio between 100:10:1 to 100:10:5, and
- Soil pH between 6 and 8 pH units.

Additional nutrient, moisture, or pH testing should occur during the summer season if soil conditions are suspected to differ from the start of the landfarming season, or at the discretion of the Environmental Coordinator.

The Landfarm Facilities will be monitored daily during freshet and after significant precipitation events and weekly during summer months by the Surface Manager and/or Environmental Coordinator to ensure that water build-up does not occur.

4.1.4 Product Addition for Optimal Landfarming

Landfarming remediation time can be reduced by maintaining optimal soil conditions for microbial PHC biodegradation and volatilization. If testing indicates that the landfarming conditions are not optimal for remediation, the following suggestions for amending soil conditions could be applied:

- Moisture: To increase moisture retention, organic matter may be tilled into the landfarm soil. Irrigating with sump water, freshwater, suitable water from other site containment areas, treated sewage effluent, and the application of fresh snow are also acceptable means of increasing soil moisture content. Recycled water from the sump should not be used for irrigation if there is a visible PHC sheen unless treated using absorbents, or avoided by drawing water from beneath the water surface.
- pH: The addition of lime will increase soil pH and addition of elemental sulphur will decrease pH.
- Nutrients: Fertilizer may be applied in solid form during tilling or in liquid form during irrigation to increase nitrogen and phosphorous concentrations. The use of slow-release fertilizers can reduce application frequency. Application of fertilizer can lower pH and increase salt concentrations, which can be harmful to micro-organisms.

- Soil texture: Bulking agents such as gypsum or sawdust can be added to clay soils to increase soil surface area for microorganism growth.

It is noted that soil amendments may reduce the potential post-treatment uses of the soil. Any soil product addition will be considered in approving post-treatment use.

4.1.5 Additional Analyses of the Soils During Remediation

Soil sampling to verify interim treatment results should also include BTEX and F1 to F4 hydrocarbon fraction analysis. Periodic measurement of the volatile organic compounds (VOC) concentrations with a photoionization detector (PID) is a useful indicator of remediation progress but should not be substituted for remediation verification sampling.

Biodegradation or landfarm remediation rates can slow down or cease all together due to excessive salt content, PHC concentrations, and other parameters present in the soils. If the rates of remediation decline or cease all together, the following parameters can be tested to help identify the source of the problem:

- Microbial population density test;
- TPH or total extractable hydrocarbons (THE);
- Total heavy metal concentration;
- Electrical conductivity (EC); and
- Sodium adsorption ratio (SAR).

Soils with parameter concentration of contaminants that exceed the following recommended levels shown in Table 4.1are not suitable for landfarming. Soils that are no longer suitable for landfarming will be placed in an underground mine for permanent storage in accordance with the *Hope Bay Project Waste Rock and Ore Management Plan*.

Table 4.1. Recommended concentrations to avoid unsuitable landfarming conditions

Parameter	Concentration
TPH or THE	< 3%
Total heavy metals	< 2500 ppm
EC	< 4 dS/m
SAR	< 6

4.2 Recovery of Soil from Landfarm Facility

Recovery of soil must be undertaken with adequate care and supervision such that the liner is not damaged.

Immediately following recovery of soil from the Landfarm, the liner should be inspected for damage. Any damage should be repaired prior to additional placement of contaminated materials and prior to the spring freshet.

4.3 Soil Remediation Sampling and Monitoring

The Environmental Protection Division (EPD) of the Nunavut Department of Environment has published the “Environmental Guideline for Contaminated Site Remediation - March 2009” (EPD 2009). This document provides an outline of the remediation criteria for PHC and other contaminants present in soils for Nunavut (Table 4.2). These guidelines are from “Interim Canadian Environmental Quality Criteria for Contaminated Sites” (CCME 1991) and “Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health” (CCME 1999 updated September 2007). TMAC will use the “industrial” land use remediation guidelines, as set out in Table 4.2 to determine when soil has been remediated to a level acceptable for removal from the landfarm facility. All remediated soils will be used in an industrial land use setting or placed in an underground mine for permanent storage in accordance with the *Hope Bay Project Waste Rock and Ore Management Plan* (TMAC 2017b).

Contaminated soil in the Facility will be sampled annually and prior to removal, at minimum, to determine the concentrations of contaminants within the soils being remediated. Soil will only be removed from the Facility when the remediation levels defined by the EPD (2009) are met, or if it is determined that the material cannot be successfully remediated and will subsequently be placed in an underground mine for permanent storage.

Sampling will be conducted by TMAC prior to any soil being removed from the landfarm to demonstrate that the soil has been successfully remediated. There are no CCME guidelines for density of soil sampling in a landfarm, therefore TMAC proposes that each separate area within the landfarm soil pond be divided into cells and sampled with a target density of 1 sample per 5 m^3 to adequately characterize the hydrocarbon and other parameter concentrations in the soil.

Soil samples will be collected from a depth ranging between 0 and 20 cm, with an additional sample being collected if the soil depth is greater than 20 cm. The location and depth of all soil samples collected will be recorded. The soil samples will be analyzed for the parameters shown in Table 4.2, including PHC fractions (Fractions F1, F2, F3, and F4), benzene, toluene, ethylbenzene, xylene (BTEX), total petroleum hydrocarbons (TPH), polychlorinated biphenyl (PCB), phenols, lead, and total metals using a 36 element ICP-MS scan. The soil sampling records and corresponding analytical results will be kept by the Environmental Coordinator and reported to the KIA and the NWB if requested.

Soil will only be removed from the Landfarm Facility and used on site following the consultation and approval by the KIA, Government of Nunavut Department of Environment and the Inspector. Remediated fine textured soils will be used for general reclamation purposes and initially on areas where the existing vegetative cover has been disturbed; coarse textured materials will be used in construction activities as needed, or possibly in reclamation activities if appropriate.

Table 4.2. Remediation criteria

Substance	Industrial (mg/kg soil)	
	Course	Fine
Conductivity [dS/m]	4	
pH	6 to 8	
Sodium Adsorption Ration (SAR)	12	
Antimony	40	
Arsenic (inorganic)	12[b]	
Barium	2000[c]	
Benzene		
Surface[w]	0.03[t,u]	0.0068[t,u]
Subsoil[w]	0.03[t,u]	0.0068[t,u]
Surface[x]	0.03[t,u]	0.0068[t,u]
Subsoil[x]	0.03[t,u]	0.0068[t,u]
Benzo(a)pyrene	0.7[f]	
Beryllium	8	
Cadmium	22[b]	
Chromium		
Total chromium	87[b]	
Hexavalent chromium (IV)	1.4[h]	
Cobalt	300	
Copper	91[b]	
Cynaide (free)	8.0[b]	
DDT (total)	12[ij]	
Diisopropanolamine (DIPA)[z]	180[b]	
Ethylbenzene		
Surface	0.082[t]	0.018[t,u]
Subsoil	0.082[t]	0.018[t,u]
Ethylene glycol	960[k]	
Fluoride (total)	2000	
Lead	600[b]	
Mercury (inorganic)	50[b]	
Molybdenum	40	
Naphthalene	22[h]	
Nickel	50[l]	
Nonylphenol (and its ethyloxylates)	14[p]	

Pentachlorophenol	7.6[b]	
Phenol	3.8[b]	
Polychlorinated biphenyls (PCB)	33[j,l]	
Polychlorinated di-benzo-p-dioxins/dibenzofurans (PCDD/Fs)	4 ng TEQ/kg[s]	
Propylene glycol	Insufficient Information[v]	
Selenium	2.9[b]	
Silver	40	
Sulfolane[z]	1[b]	
Tetrachloroethylene	0.6[f]	
Thallium	1[o]	
Tin	300	
Toluene		
Surface	0.37[t]	0.08[t]
Subsoil	0.37[t]	0.08[t]
Trichloroethylene	0.01[b,u]	
Uranium[z]	300[t]	
Vanadium	130[i]	
Xylenes		
Surface	11[t]	2.4[t]
Subsoil	11[t]	2.4[t]
Zinc	360	
Monocyclic Aromatic Hydrocarbons		
Chlorobenzene	10	
1,2-Dichorobenzene	10	
1,3-Dichorobenzene	10	
1,4-Dichorobenzene	10	
Styrene	50	
Phenolic Compounds		
Chlorophenols[1] (each)	5	
Nonchlorinated[2] (each)	10	
Polycyclic Aromatic Hydrocarbons (PAHs)		
Benzo(a)anthracene	10	
Benzo(b)fluoranthene	10	
Benzo(k)fluoranthene	10	
Dibenz(a,h)anthracene	10	
Indeno(1,2,3-c,d)pyrene	10	

Phenanthrene	50	
Pyrene	100	
Chlorinated Hydrocarbon		
Chlorinated aliphatics[3] (each)	50	
Chlorobenzenes[4] (each)	10	
Hexachlorobenzene	10	
Fractions		
Fraction 1 (C6 - C10)	320 (240[5])	320 (170[5])
Fraction 2 (>C10 - C16)	260	260 (230[5])
Fraction 3 (>C16 - C34)	1700	2500
Fraction 4 (>C34)	3300	6600

Source: EPD 2009, Table 1, A4.2 and A4.2

Notes:
(1) Subscript notes in Attachment 2

5 Water Management

Water management is focussed on surface water accumulation within the facilities. The facilities have no external catchment and there is no potential for groundwater contamination due to the liner and underlying permafrost at the site.

5.1 Water Management Strategies

5.1.1 Soil Pond

The water management strategy for the soil pond will focus on maintaining optimal moisture content conditions which will promote remediation within the soil. Excess water accumulating in the soil pond from spring melt and significant precipitation events will be passed through an oil separation (absorbent) treatment system and deposited into the snow pond. This will be accomplished by installing a pump in the soil pond sump to transfer water through the oil separation treatment system. The oil separation treatment system will be located on the berm between the soil and snow pond in such a manner to ensure that any leakage that may occur will report to the soil pond.

5.1.2 Snow Pond

The water management strategy for the snow pond is to keep the pond empty to the extent possible during the open water season (summer months) in order to provide a contingency for the storage of potentially contaminated water resulting from precipitation coming in contact with hydrocarbon contaminated material in the soil pond.

Water quality samples of water accumulating in the snow pond will be collected and submitted for laboratory analysis to determine if treatment with an oil separation treatment system is required. If discharge criteria are met without treatment (e.g., clean snow/precipitation accumulation), this water may be discharged directly to the environment following the necessary approvals and requirements for discharge to the environment outlined below.

If water accumulating in the snow pond is known/suspected to be hydrocarbon contaminated, or samples submitted for laboratory analysis do not meet the discharge criteria, water in the snow pond will be recirculated from the snow pond through an oil separation treatment system and back to the snow pond. If this method of treatment is used, no additional snow or water will be added to the snow pond to avoid adding additional contaminants to the pond.

Additional water quality samples will be collected post-treatment and submitted for laboratory analysis. Only once the water quality in the snow pond meets discharge criteria, verified through laboratory analysis, will it be discharged to the environment in accordance with the necessary approvals and requirements for discharge to the environment outlined below.

5.1.3 Clean Water Pond

Once water from the snow pond has been verified through laboratory analysis to meet discharge criteria it may be discharged to the environment as outlined below or transferred to the clean water pond for storage prior to discharge to the environment. This will be accomplished by placing a portable pump into the sump of the snow pond with the attached hose/piping laid across the berm so that any leakage that may occur will report back to the snow pond. Only water that is suitable for discharge to the tundra will be placed into the clean water pond.

5.2 Water Quality Verification and Discharge of Treated Water

Samples of water from the pond(s) will be collected, appropriately preserved and submitted to an accredited laboratory for analysis. No water will be discharged from the Facility until the results of the analysis are received and confirm that the water is suitable for discharge in accordance with discharge criteria outlined in existing Type A Water Licence 2AM-DOH1323 Part G, item 23(c), issued to TMAC by the NWB (Table 5.1) and a 10-day notification of discharge has been provided to the INAC Inspector.

Table 5.1. Landfarm Effluent Discharge Quality Limits

Parameter	Maximum Allowable Concentration (mg/L)
pH	6.0 - 9.0
Total Suspended Solids (TSS)	15.0
Total Oil & Grease	5 and no visible sheen
Total Ammonia-N	2.0
Total Lead	0.01
Benzene	0.37
Toluene	0.002
Ethyl Benzene	0.090

Once the INAC inspector has been provided with a 10-day notification and confirmation of the water quality is received, the water will be discharged to the tundra or at a location approved by the inspector in accordance with existing Type A Water Licence 2AM-DOH1323 Part G, item 23(d). This will be accomplished by installing a portable pump in the clean water or snow pond sump.

Alternatively, once confirmation is received that the water within the Facility is suitable for release, a vacuum truck may be used to remove the water from the pond for use in dust suppression on site access roads. This action would reduce the amount of clean water removed from lakes for dust suppression activities.

During pumping, care will be taken not to disturb any settled solids at the bottom of the source pond sump (if present) and pumping of the sump will only take place when conditions are suitable. In addition, the pump discharge should be positioned in a manner that minimizes erosion and siltation of the area downstream of the discharge location. Documentation of flow rates for water release, discharge volume, as well as erosion and vegetation changes at the release sites will be monitored.

If the water from a Landfarm Facility does not meet discharge criteria following treatment, the water from the pond will be re-treated until it meets discharge criteria or transferred to a Tailings Impoundment Area for disposal.

5.2.1 Pump Power Supply

The power supply to operate all temporary pumps used within the Facility will be provided by portable gas powered units. Each of the units are self-contained and will have “drip trays”.

6 Monitoring and Evaluation

TMAC will implement an inspection and monitoring program for each of the facilities. The objective is to ensure that each facility is functioning properly.

6.1 Spring Freshet and Post-Precipitation Event Inspection

During spring freshet, a visual inspection of the Landfarm Facility will be conducted once per day to verify water levels in each of the three ponds. The objective of the inspection will be to ensure that sufficient freeboard exists within the Facility to ensure that no hydrocarbon contaminated water exits the Facility and to decide on the most efficient time to commission the oil separation (absorbent) treatment system.

Similarly, during the open water season (summer), a visual inspection of the Facility will be completed weekly and after each significant precipitation event in order to ensure that sufficient freeboard exists within the Facility ensuring that no hydrocarbon contaminated water exits the facility.

Monitoring should note the use of ponds by any water dependent birds as per the Wildlife Mitigation and Monitoring Plan (TMAC 2017c).

6.2 Clean Water Discharge

6.2.1 Pre-Discharge Water Sampling and Quality Verification

No water will be discharged to the environment from the Landfarm Facility until the results of the sample analysis confirm that the water is suitable for release and the INAC Inspector has been notified. The results of this analysis will be retained on site and will be available for review upon request.

6.2.2 Visual Inspections during Discharge

Prior to commencing any discharge, the volume of water to be discharged will be calculated. The results will be recorded and the record maintained on site by the Environmental Coordinator.

During pumping to tundra, a visual inspection of the Landfarm Facility and pumping activities will be conducted daily by staff from either the surface or the environmental departments. These inspections are to ensure that all pumps and hosing/piping are operating properly and that the discharged water is not causing unacceptable erosion downstream. Additionally, flow, volume and duration of the discharge will be measured or calculated and recorded. All records will be maintained on site by the Environmental Coordinator.

6.3 Annual Geotechnical Inspection

A geotechnical inspection of each landfarm facility will be conducted by a qualified Geotechnical Engineer between July and September each year in accordance with existing Type A Water Licence 2AM-DOH1323 Part J, item 16(i). The inspection will be conducted in accordance with the Canadian Dam

Safety Guidelines where applicable and take into account all earthworks making up the facility, as well as the Facility itself.

6.4 Summary of Inspections and Monitoring

Table 6.1 and Table 6.2 provides summaries of the monitoring, inspection and sampling that will be undertaken during the operation of the Landfarm Facilities.

Table 6.1. Landfarm facility inspection and monitoring summary

Item	Responsibility	Purpose	Frequency	Required Records
Landfarm Treatment Operations Inspection	Surface Manager and/or Environmental Coordinator	Record keeping of treatment operations and berm performance for due diligence.	Once per day during spring freshet and after precipitation events. Weekly during open water season. Monthly at other times.	Inspection date and field notes, e.g., weather, and facility condition including any repairs required, odor noted, quantity of water accumulated in the ponds, water level of the ponds, and amount of freeboard. Record of any unauthorized discharges or deposits and follow-up action taken.
Soils Acceptance at Facility	Environmental Coordinator or delegate	To determine if soils are acceptable for treatment at the Landfarm Facility.	Once per spill, unless spilled material is known.	Soils origin and associated spill report number, if applicable. Field notes, e.g., sampling details, soil texture, moisture content, colour, odour. Location of soil placement in landfarm following placement approval.
Soil Sampling for Remediation Progress and Verification of Remediation	Environmental Coordinator or delegate	To provide interim indications of remediation progress and to determine if remedial objectives have been met.	Once per year. Additional sampling prior to discharge.	Field notes and sketch of location and depth of samples taken. Laboratory issued reports including QA/QC and chain of custody. Documentation proving compliance with discharge criteria, notification of discharge of soils to inspector, and fate of treated soils. Update of landfarm soil placement map as required.
Operation of Oil Adsorption (Separation) Treatment System	Surface Manager or delegate (operator)	To identify any maintenance requirements and minimize chances of unexpected discharges to the environment.	Once at the beginning of operation and once per day during operation.	Daily volume pumped and any field observations (e.g. location of discharge, flow, piping) to be provided to Environmental Coordinator.
Water Sampling prior to Discharge	Environmental Coordinator or delegate	To conform to Water License requirements.	As required prior to discharge.	Document notification of INAC Inspector (written notification at least 10 days prior to discharge) including estimate of volume to be pumped. Field notes including sampling details e.g. colour, and odour. Laboratory-issued reports including QA/QC and chain of custody.
Visual Monitoring During Discharge	Environmental Coordinator or delegate	To conform to Water License requirements.	Daily during discharge.	Field notes for discharge to tundra including flow, volume, and duration.
Geotechnical Inspection	Geotechnical Engineer	To identify any maintenance requirements.	Annually	Inspection of geotechnical performance of facility. Document recommendations of any repair/maintenance work. Record of any repair work made to the facility.

Table 6.2. Landfarm facility sampling summary

Item	Responsibility	Purpose	Frequency	Parameter/Sampling Required	Remediation Values
Soil Acceptance at Facility	Environmental Coordinator or delegate	To determine if soils are acceptable for treatment at the Landfarm Facility.	Once per spill, unless spilled material is known.	Soil: • Quantity • PHC Fractions • BTEX • TPH • Lead • Total heavy metals • PBC • Phenols • PAHs	N/A
Soil Sampling for Remediation Progress	Environmental Coordinator or delegate	To provide interim indications of remediation progress of PHC and to determine source of slow down or cease of landfarm remediation rates.	As deemed helpful during remediation.	Soil (remediation of PHC): • Moisture content • carbon:nitrogen:phosphorus ratio • pH • BTEX • Fractions (F1 to F4) • VOC Soil (source of slow down or cease in remediation rates): • Microbial population density test • TPH or THE • total heavy metal concentration • EC • SAR	• Moisture between 40 and 85% • carbon:nitrogen:phosphorus ratio 100:10:1 to 100:10:5 • Soil pH between 6 and 8 pH units • Microbial population density test minimum heterotrophic plate count 10^3 CFU/g • TPH or THE < 3% • total heavy metals < 2500 ppm • EC < 4 dS/m • SAR < 6
Soil Sampling for Verification of Remediation	Environmental Coordinator or delegate	To determine if remedial objectives have been met.	Once per year.	Soils for discharge: • Parameters listed in Table 4.2 • 1 sample per 5 m^3 of material collected from depth of 0-20 cm. Additional sample if soil depth >20 cm	• Remediation criteria listed in Table 4.2
Water Sampling prior to Discharge	Environmental Coordinator or delegate	To conform to Water License requirements.	As required prior to discharge.	Water: • pH • TSS • Total oil and grease • Total ammonia • Total lead • Benzene • Toluene • Ethyl Benzene	• Discharge limits listed in Table 3.1

6.5 Documentation and Reporting

6.5.1 Annual Geotechnical Inspection Report

TMAC will submit to the NWB a geotechnical engineer's inspection report within sixty (60) days of completion of the annual geotechnical inspection in accordance with existing Type A Water Licence 2AM-DOH1323 Part J, item 17. That report will include the results of the assessment of the Landfarm Facility and include a cover letter from TMAC outlining an implementation plan to address recommendations made by the geotechnical engineer in his/her report.

6.5.2 Clean Water Discharge - Volume and Quality

In the event that water is discharged to the environment, TMAC will report the volume of water discharged from the Landfarm Facility and the results of the analysis of the water released. This information will be provided in the monthly monitoring report submitted in accordance with existing Type A Water Licence 2AM-DOH1323 Part J, item 19.

An annual report will be submitted in accordance with existing Type A Water Licence 2AM-DOH1323 Part B, item 4 by March 31 of the following year. The annual report will satisfy the requirements in Schedule B that pertain to the Landfarm.

6.5.3 Soil Treatment Reporting

A report will be submitted presenting the results of the soil treatment testing utilised in verification of remediation prior to removing remediated soils from the facility.

6.6 QA/QC Procedures for Soil and Water Sampling

Quality assurance and quality control (QA/QC) is a set of operating principles that, if strictly followed during sample collection and analysis, will produce data of known and legally defensible quality. A high level of quality assurance can be achieved by applying the following principles:

- Personnel involved in sampling and analysis are trained and competent;
- Sampling and testing equipment are calibrated regularly and are kept in good working condition;
- Standard procedures are implemented for the collection and transportation of samples, based on acceptable and approved operating practices;
- Use of Canadian Association for Laboratory Accreditation Inc. (CALA) certified external laboratories to conduct chemical analyses;
- QC programs are developed and implemented, based on recognized best operating practice, to assess the quality of the analytical data and provide warning of unacceptable analytical or samplers errors;
- Prompt remedial action is taken when deficiencies are identified; and

- Analytical results and QC program results are reported internally and externally using standard procedures. Including field blanks, travel blanks, duplicates, etc.

Sampling procedures include:

- Using clean sampling gloves for each sample;
- Cleaning sampling equipment between each sample;
- Collecting samples using bottles and jars provided by the laboratory following the instructions provided by the laboratory for each parameter type;
- Labelling sample containers clearly with the sample station, date, time, and analysis requested;
- Keeping samples cool and dark during storage and shipment to the laboratory; and
- Checking field notes for accuracy and completeness at the end of each sampling session.

Detailed QA/QC procedures are available in the Quality Assurance and Quality Control Plan (TMAC 2017d).

7 Contingences

Should additional new contaminated material not be able to be placed underground for any reason, and therefore require storage that exceeds the capacity of the site facility, a temporary lined facility may be required to store the excess material. If this is not possible the material will be packaged for off-site disposal at a licenced remediation/disposal facility.

8 Facilities Closure

The facilities will be decommissioned at mine closure, upon closure of the existing site Camp or upon construction of a new facility as a replacement. The liner system will be removed and the berms graded to promote positive drainage across the site. Remaining contaminated soils will be stored underground within an underground mine is accordance with the Hope Bay Project Waste Rock and Ore Management Plan.

Details of the closure of each landfarm facility are available in the relevant Closure and Reclamation Plans.

9 References

[CCME] Canadian Council of Ministers of the Environment, 1991. Interim Canadian Environmental Quality Criteria for Contaminated Sites.

[CCME] Canadian Council of Ministers of the Environment, 2007. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Originally published in 1999, updated in 2007.

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[EPD] Environmental Protection Division, 2009. Environmental Guideline for Contaiminated Site Remediation. Published March 2009.

Government of Nunavut. 1995. Consolidation of Mine Health and Safety Act (Nunavut). S.N.W.T. 1994, c.25; In force December 15, 1995; SI-014-95. As Amended by Northwest Territories Statues: S.N.W.T. 1996, c.9; In force April 16, 1996. As Amended by Statues Enacted Under Section 76.05 of Nunavut Act: S.N.W.T. 1998, c.34; In Force April 1, 1999.

[SAIC] Science Applications International Corporation, 2006. Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils. Science Applications International Corporation. March. Project No. 11953.B.S08.

SRK Consulting (Canada) Inc. 2016. Hope Bay Project Groundwater Management Plan. Report Prepared for TMAC Resources Inc. August 2016.

TMAC Resources Inc., 2017a. Landfarm Management and Monitoring Report, Hope Bay, Nunavut. January 2017.

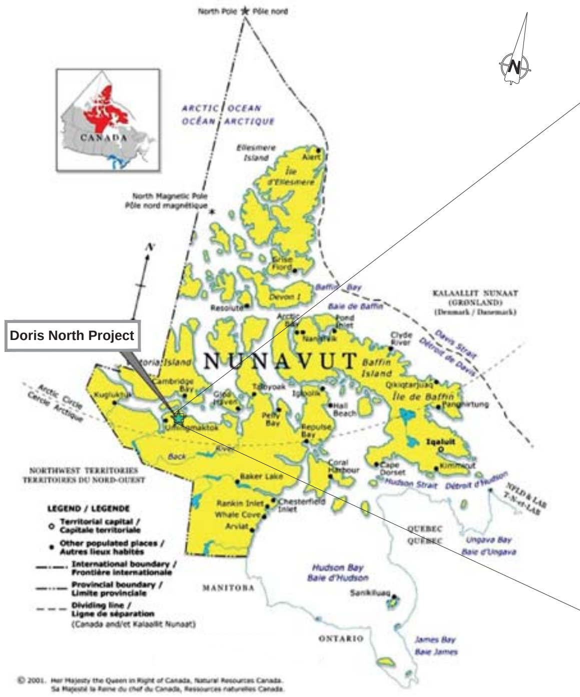
TMAC Resources Inc., 2017b. Waste Rock and Ore Management Plan, Hope Bay, Nunavut. November 2017/

TMAC Resources Inc., 2017c, Madrid—Boston of the Hope Bay Project, FINAL ENVIRONMENTAL IMPACT STATEMENT, Volume 8 Annex 3 Wildlife Mitigation and Monitoring Plan. December 2017.

TMAC Resources Inc. 2017d. Quality Assurance and Quality Control Plan, Hope Bay, Nunavut. January 2017.

USEPA. 1994. "Chapter V" in How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers. (EPA 510-B-94-003; EPA 510-B-95-007; and EPA 510-R-04-002). October 1994.

Attachment 1: Layout Drawings of Facilities



TERRITORIAL LOCATION

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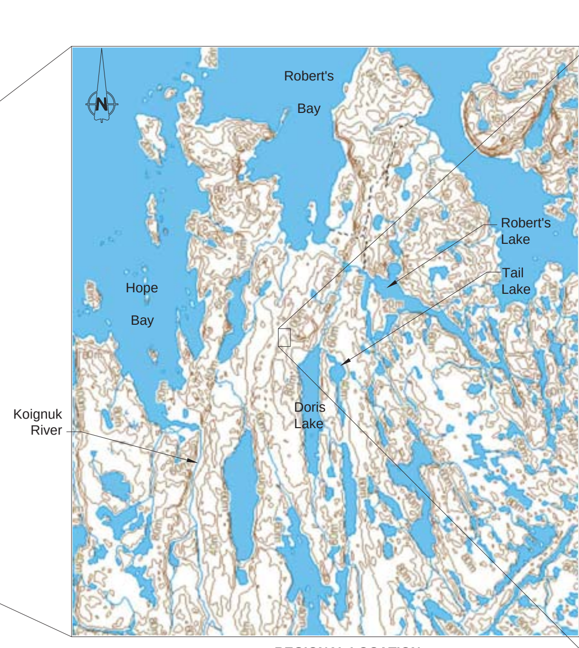

REGIONAL LOCATION

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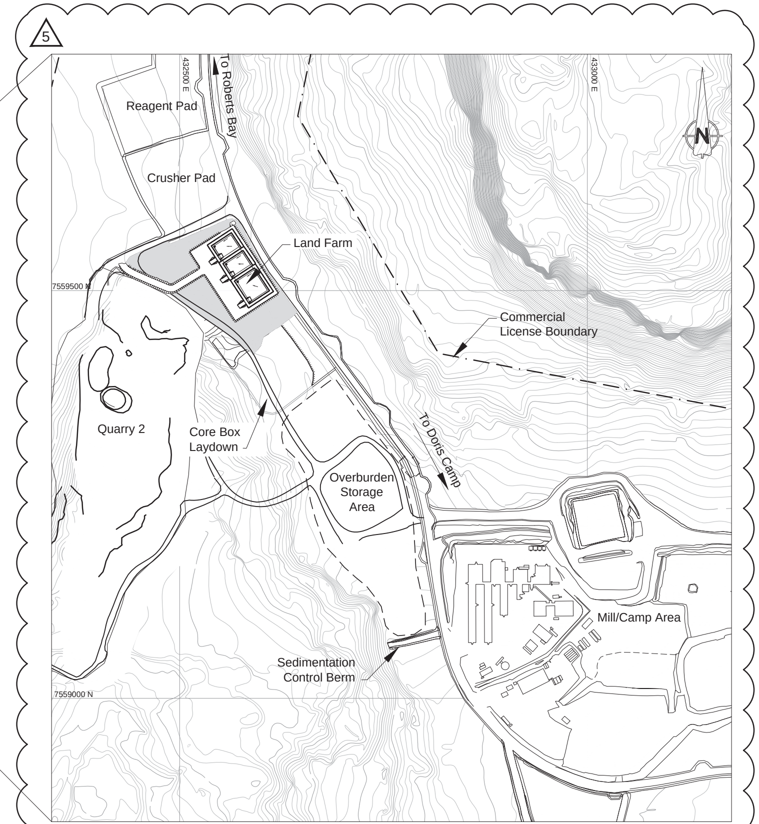

SITE LOCATION

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Scale in Metres

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REFERENCE DRAWINGS			

NO.	DESCRIPTION	CHK'D	APP'D	DATE
5	GENERAL REVISIONS TO NEW O.G.	JBK	EMR	06/28/11
4	ISSUED FOR CONSTRUCTION	LW	EMR	08/09/10
3	ISSUED FOR CONSTRUCTION	IM	EMR	04/27/10
2	ISSUED FOR COMMENT	LW	EMR	02/08/10
1	WATER LICENSE REVIEW	PM	EMR	02/01/10

REVISIONS

Original Drawings Stamped and Signed by Engineer

This drawing is uncontrolled when printed unless stamped and signed with original ink and recorded on a Distribution Register.

PROFESSIONAL ENGINEER'S STAMP

srk consulting

DESIGN: CB/JBK	DRAWN: NV/JBK	REVIEWED: EMR
CHECKED: JBK	APPROVED: EMR	DATE: June. 28, 2011

FILE NAME: 1CH008.033–Land Farm_LocationMap.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.033 SRK DWG NO.: LF-01

Doris North Project

DRAWING TITLE: Land Farm Location Map

NEWMONT DRAWING NO.	SHEET	REVISION NO.
HB+D-CIV-CIV-OND-0032	2 OF 9	5

J:\01_SITES\Hope.Bay\!ACAD\2011 Drawings\Land Farm\1CH008.033–Land Farm_LocationMap.dwg

NOTES

1. The Contractor is not responsible to obtain all necessary permits and approvals for the Works; however, the Contractor must confirm that such approvals have been obtained from the Owner prior to proceeding with any construction.
2. Topographic contour data for the terrain model was provided by the Contractor.
3. The co-ordinate system is UTM NAD 83, Zone 13.
4. All dimensions are in metric units, unless specifically mentioned.
5. Typical details are Not to Scale (NTS) unless specifically mentioned.
6. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
7. Notes and specifications on any drawings in this set apply equally to all drawings in the set.
8. All work is to be set out prior to the start of any construction, according to the Stake-Out Tables or 3D surface files provided. Should there be any difference between the co-ordinates provided and the field location, the Engineer is to be informed immediately.
9. Subsurface soil conditions have not been confirmed at this location. SRK has been verbally informed of the conditions by the Owner. It is understood that foundation conditions consist of about 1m of random overburden fill which has been leveled using a dozer, overlying ice-rich marine silt and clay permafrost, possibly up to 20m thick. The random fill was originally placed as frozen lumps of soil mixed with snow and ice with random quantities of quarry rock. This fill was allowed to thaw in and was subsequently leveled. The fill was not compacted, and no quality control was carried out. SRK has informed the Owner of the risks associated with founding the land farm on this leveling pad without undertaking further geotechnical investigation.
10. The scope of work described in these drawings specifically exclude all electrical and mechanical elements.

LEGEND

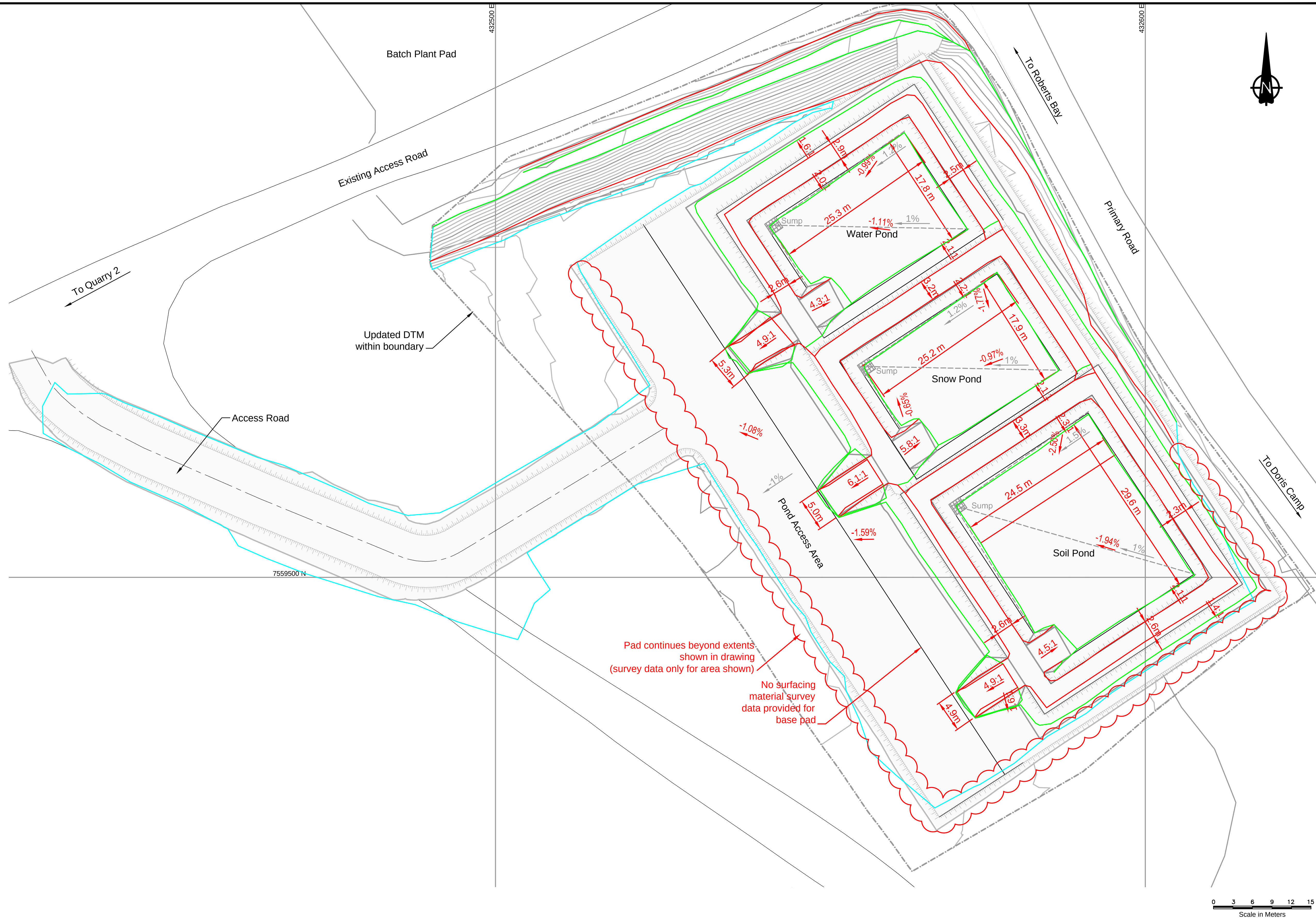
- As-built Crest
- As-built Toe
- As-built Extent of ROQ

As-built Containment

- Soil Pond As-built volume = 325 m^3 at El. 56.75 m
- Snow Pond As-built volume = 195 m^{3}at El. 56.45 m
- Water Pond As-built volume = 186 m^3 at El. 55.93 m

Note

* As built capacities calculated from within crush surface final down from the low point of the liner crest (i.e. liner freeboard/containment elevation).



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				5	GENERAL REVISIONS TO NEW O.G.	JBK	EMR	06/28/11
				4	ISSUED FOR CONSTRUCTION	IM	EMR	08/09/10
				3	ISSUED FOR CONSTRUCTION	IM	EMR	04/27/10
				2	ISSUED FOR COMMENT	LW	EMR	02/08/10
				1	WATER LICENSE REVIEW	PM	EMR	02/01/10
				0	ISSUED FOR REVIEW	TG	EMR	12/17/09
DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE					
REFERENCE DRAWINGS				REVISIONS				

This drawing is uncontrolled when printed unless stamped and signed with original ink and recorded on a Distribution Register.

PROFESSIONAL ENGINEERS STAMP

srk consulting

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CHECKED: MMM | APPROVED: EMR | DATE: APR. 20, 2012
FILE NAME: 1CH008.033–Land Farm_GA.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

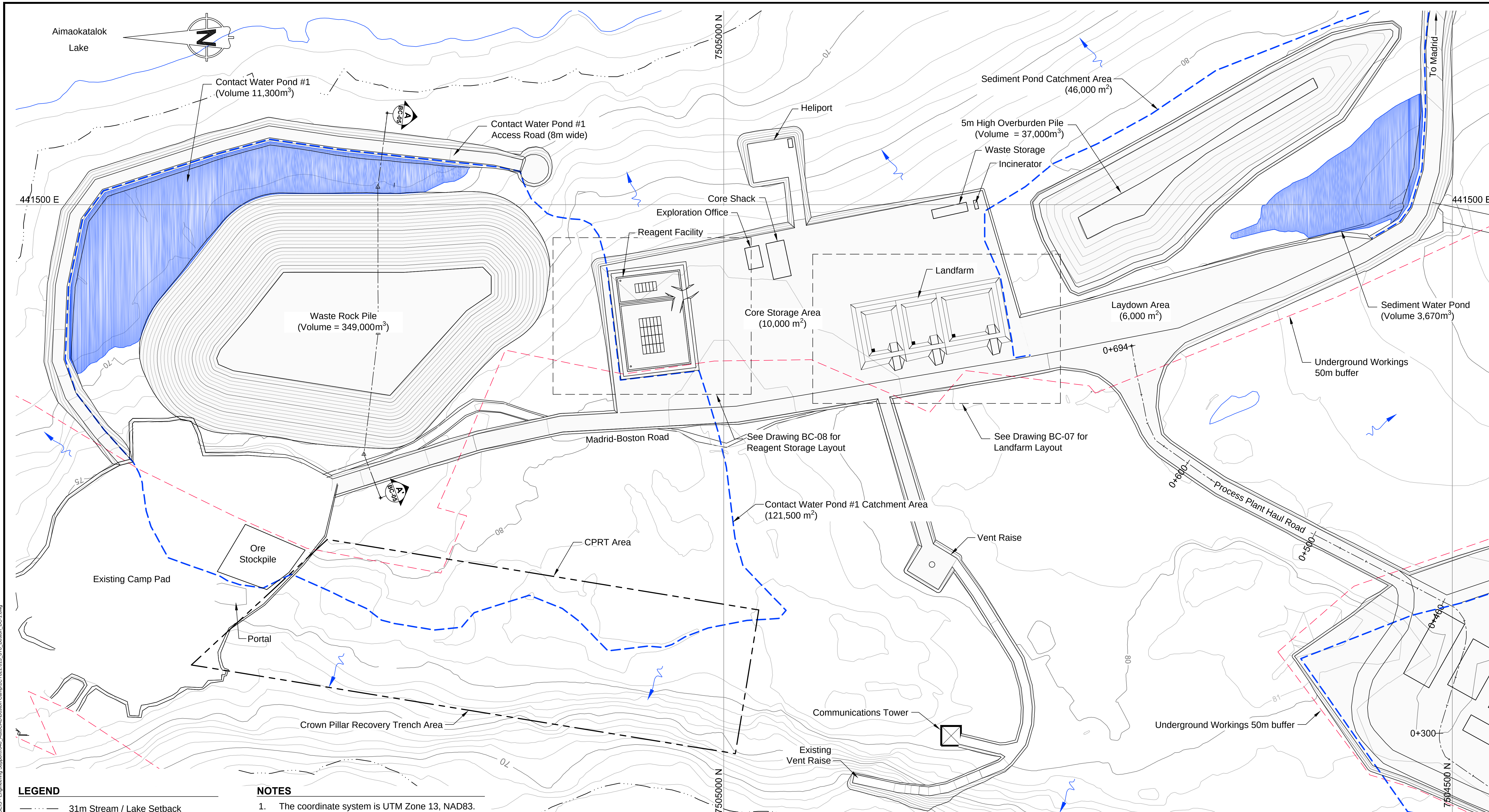
SRK JOB NO.: 1CH008.033/.058 | SRK DWG NO.: LF-02

Doris North Project

DRAWING TITLE: Land Farm General Arrangement

NEWMONT DRAWING NO.: HB+D-CIV-CIV-OND-0033 | SHEET 3 OF 9 | REVISION NO. AB

J:\01_SITES\Hope.Bay\!ACAD\2011 Drawings\Land Farm\As-builts\1CH008.033-Land Farm_GA.dwg



LEGEND

- 31m Stream / Lake Setback
- 50m Underground Workings Buffer
- Non-Contact Water Flow

NOTES

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.
3. Contour labels are oriented facing upslope.

0 10 20 30 40 50
Scale in Metres

NO.	DESCRIPTION	CHK'D	APP'D	DATE
C	Issued for Discussion	KK	EMR	7Dec17
B	Issued for Discussion	MMM	EMR	16Nov16
A	Issued for Discussion	MMM	EMR	8Jul16

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: TSF | DRAWN: NV | REVIEWED: TSF
CHECKED: MMM | APPROVED: EMR | DATE: Dec. 2017
FILE NAME: 1CT022.013_670_Boston_BC-1.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:
Boston Waste Rock and Overburden Piles

DRAWING NO.: BC-02 | SHEET: 3 of 18 | REVISION NO.: C

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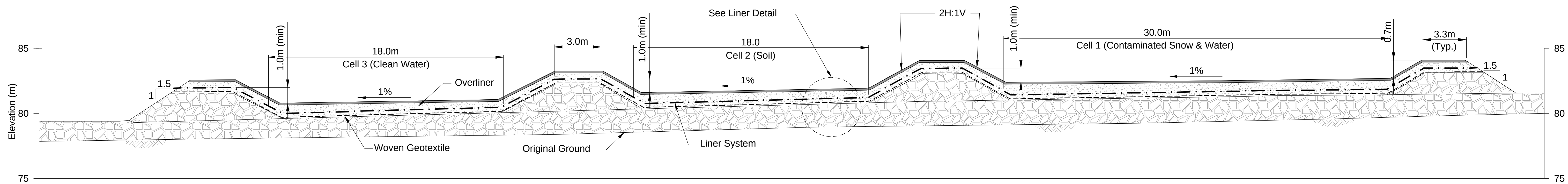

G
-
CROSS SECTION G - G'

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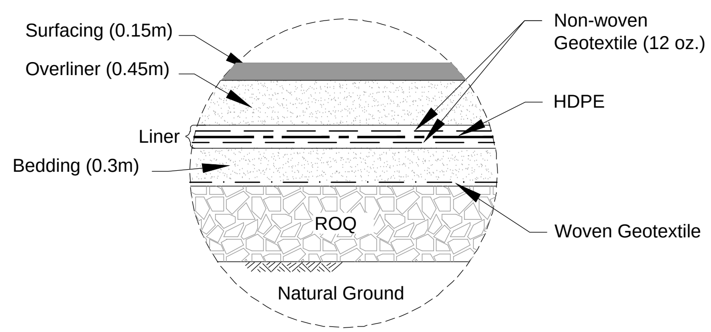
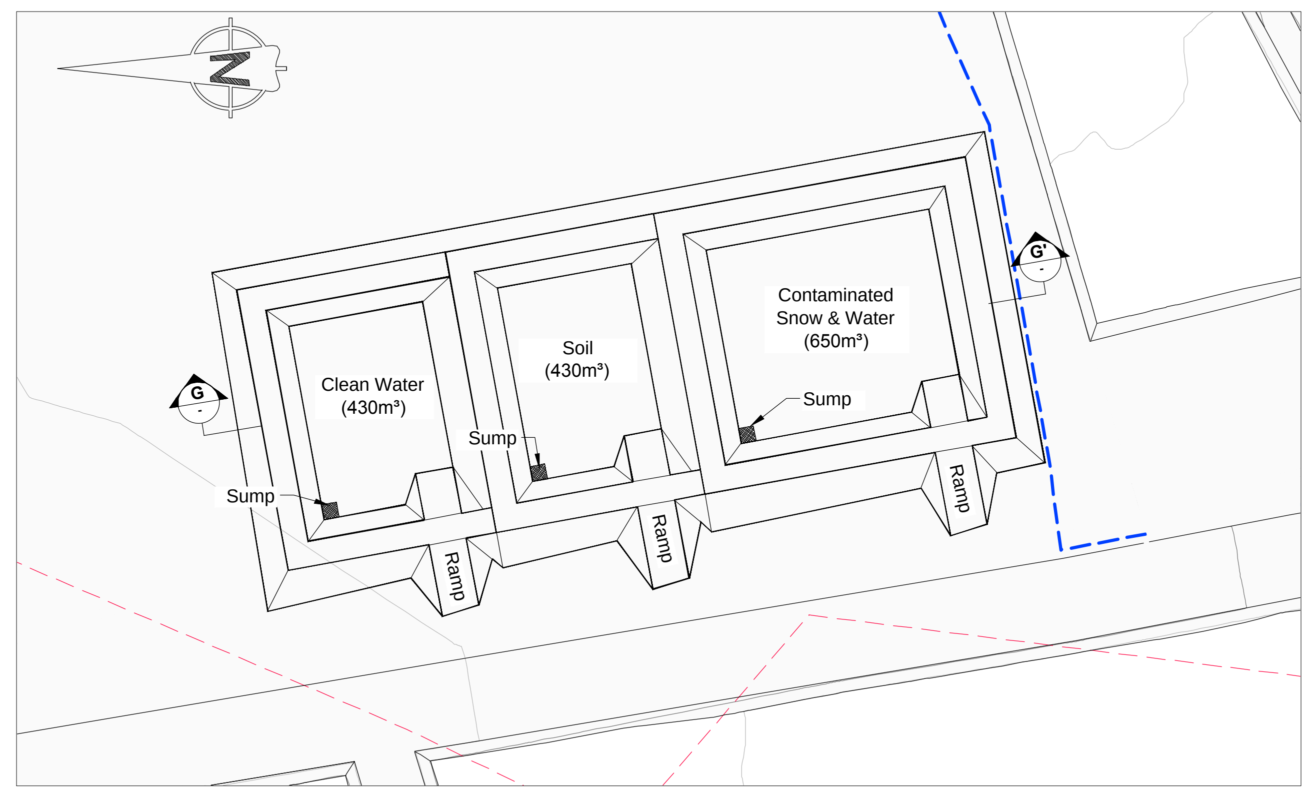
Scale in Metres



LANDFARM LINER TYPICAL DETAIL
(NTS)



LANDFARM PLAN VIEW

0 5 10 15 20 25
Scale in Metres

LEGEND

- Surfacing Material
- Bedding Material
- Run of Quarry Material
- Liner System

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
				B	Issued for Discussion	KK	EMR	7Dec17

REFERENCE DRAWINGS | REVISIONS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: TSF | DRAWN: NV | REVIEWED: TSF
CHECKED: MMM | APPROVED: EMR | DATE: Dec. 2017

FILE NAME: 1CT022.013_670_Boston_BC-1.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Surface Infrastructure

DRAWING TITLE:

Landfarm Plan and Section

DRAWING NO. BC-07 | SHEET 8 of 18 | REVISION NO. B

Attachment 2: Remediation Criteria Table Subscript Notes

Notes (Table 6):

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health are published in "Canadian Environmental Quality Guidelines (CCME, 1999, updated 2007).

SQG_E = Soil Quality Guideline for Environmental Health

SQG_{HH} = Soil Quality Guideline for Human Health *

For guidelines derived prior to 2004, differentiation between soil texture (coarse/fine) is not applicable.

[a] Guidelines released in 1997 were originally published in a working document entitled "Recommended Canadian Soil Quality Guidelines" (CCME 1997) and have been revised, edited and reprinted here. Guidelines revised/released in 1999 are published here for the first time.

[b] Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_E. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de novo* guideline for this land use, derived in accordance with the soil protocol (CCME 1996; 2006).

[c] Data are insufficient/inadequate to calculate an SQG_{HH}, a provisional SQG_{HH}, an SQG_E or a provisional SQG_E. Therefore, the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.

[d] Data are sufficient and adequate to calculate only a provisional SQG_E. It is greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.

[e] Data are sufficient and adequate to calculate an SQG_{HH} and a provisional SQG_E. Both are greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.

[f] Data are sufficient and adequate to calculate an SQG_{HH} and a provisional SQG_E. Both are less than the corresponding interim soil quality criterion (CCME 1991). Therefore, the interim soil quality guideline supersedes the soil quality criterion for this land use.

[g] The soil-plant-human pathway was not considered in the guideline derivation. If produce gardens are present or planned, a site-specific objective must be derived to take into account the bioaccumulation potential (e.g. adopt the agricultural/wildland guideline as objective). The off-site migration check should be recalculated accordingly.

[h] Data are sufficient and adequate to calculate only a provisional SQG_E, which is less than the existing interim soil quality criterion (CCME 1991). Therefore, the provisional soil quality guideline supersedes the interim soil quality criterion for this land use.

[I] Data are sufficient and adequate to calculate only an SQG_E. An interim soil quality criterion (CCME 1991) was not established for this land use therefore, the SQG_E becomes the soil quality guideline.

[j] In site-specific situations where the size and/or the location of commercial and industrial land uses may impact primary, secondary or tertiary consumers, the soil and food ingestion guideline is recommended as the SQG_E.

[k] Data are sufficient and adequate to calculate only a provisional SQG_E.

[l] Data are sufficient and adequate to calculate only an SQG_E, which is less than the interim soil quality criterion (CCME 1991) for this land use. Therefore the SQG_E becomes the soil quality guideline for this land use.

[m] Data are sufficient and adequate to calculate only an SQG_E, which is greater than the interim soil quality criterion (CCME 1991) for this land use. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.

[n] Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_{E}. The provisional SQG_{HH} is equal to the SQG_{E} and to the existing interim soil quality criterion (CCME 1991) and thus becomes the soil quality guideline for this land use.

[0] Data are sufficient and adequate to calculate a provisional SQG_{HH} and an SQG_{E}. The provisional SQG_{HH} is less than SQG_{E} and thus becomes the soil quality guideline for this land use.

[p] Data are sufficient and adequate to calculate only an SQG_{E}. An interim soil quality criterion (CCME 1991) was not established for these substances therefore, the SQG_{E} becomes the soil quality guideline.

[q] Data are sufficient and adequate to calculate only a provisional SQG_{HH} which is less than the existing interim soil quality criterion (CCME 1991). Thus the provisional SQG_{HH} becomes the soil quality guideline for this land use.

[r] Data are sufficient and adequate to calculate only a provisional SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use therefore, the provisional SQG_{HH} becomes the soil quality guideline.

[s] Data are sufficient and adequate to calculate only an SQG_{HH}. An interim soil quality criterion (CCME 1991) was not established for this land use therefore, the SQG_{HH} becomes the soil quality guideline.

[t] Data are sufficient and adequate to calculate an SQG_{HH} and an SQG_{E}. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de* novo guideline for this land use.

[u] This guideline may be less than the common limit of detection.

[v] Data are sufficient and adequate to calculate only a provisional SQG_{FWAL} (Soil Quality Guideline for Freshwater Aquatic Life). This value is 6,210 mg/kg.

[w] 10^{-5} incremental risk.

[x] 10^{-6} incremental risk.

[y] Unless otherwise indicated supporting documents are available from the National Guidelines and Standards Office, Environment Canada.

[z] Supporting documents are available from the Canadian Council of Ministers of the Environment.

Note: Source – “Government of Nunavut” and “Environmental Guideline for Contaminated Site Remediation”

Notes (Table 6):

All values are in mg/kg soil unless otherwise indicated.

Interim remediation criteria were published in 1991 in "Interim Canadian Environmental Quality Criteria for Contaminated Sites (CCME, 1991).

These interim remediation criteria are considered generally protective of human and environmental health and were based on experience and professional judgement.

These interim criteria (CCME, 1991) should only be used when soil quality guidelines based on the CCME soil protocol (CCME, 1996; 2006) have not yet been developed for a given chemical. Also, because the interim remediation criteria were not developed using the soil protocol and its integral checks, they cannot be modified through the site specific remediation objective procedure.

1 = Chlorophenols include

Chlorophenol isomers (ortho, meta, para)

Dichlorophenols (2,6- 2,5- 2,4- 3,5- 2,3- 3,4-)

Trichlorophenols (2,4,6- 2,3,6- 2,4,5- 2,3,4- 3,4,5-)

Tetrachlorophenols (2,3,5,6- 2,3,4,5- 2,3,4,6-)

2 = Nonchlorinated phenolic compounds include

2,4-dimethylphenol

2,4-dinitrophenol

2-methyl 4,6-dinitrophenol

Nitrophenol (2-,4-)

Phenol

Cresol

3 = Aliphatic chlorinated hydrocarbons include

Chloroform

Dichloroethane (1,1- 1,2-), Dichloroethene (1,1- 1,2-)

Dichloromethane

1,2-dichloropropane, 1,2-dichloropropene (cis and trans)

1,1,2,2-tetrachloroethane, tetrachloroethene

Carbon tetrachloride

Trichloroethane (1,1,1- 1,1,2-), trichloroethene

4 = Chlorobenzenes include

All trichlorobenzene isomers

All tetrachlorobenzene isomers

Pentachlorobenzene

5 = Where applicable, for protection against contaminated groundwater discharge to an adjacent surface water body or for protection of potable groundwater.

Note: Source – "Government of Nunavut" and "Environmental Guideline for Contaminated Site Remediation"

HOPE BAY PROJECT HYDROCARBON CONTAMINATED MATERIAL MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Module A: Boston LTA

Revision History

Revision #	Date	Section	Summary of Changes	Author	Approver
1	2012	All	Approved Plan under 2BB-BOS0712.	SRK	HBML
2	2017	Throughout	Changes to document structure for operational suitability and efficiency Changes operating approach to no longer treat contaminated soils, but to only provide for temporary storage.	SRK	TMAC
3	2017	Introduction	Inclusion as a Module of the Hydrocarbon Contaminated Material Management Plan. Previously a Module to the Landfarm Management and Monitoring Plan.	SRK	TMAC

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Glossary

Term	Definition
BTEX	benzene, toluene, ethylbenzene and xylene
CALA	Canadian Association for Laboratory Accreditation Inc.
CCME	Canadian Council of Ministers of the Environment
CWS	Canada Wide Standards
EC	electrical conductivity
EPD	Environmental Protection Division of the Nunavut Department of Environment
ESR	Environmental and Social Responsibility
HDPE	high density polyethylene
INAC	Indigenous and Northern Affairs Canada
LTA	Land Treatment Area
NWB	Nunavut Water Board
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHC	petroleum hydrocarbon
QA/QC	Quality Assurance and Quality Control
SAR	sodium adsorption ratio
TMAC	TMAC Resources Inc.
TPH	total petroleum hydrocarbon

A1 Introduction

This Hydrocarbon Contaminated Material Management Plan Module A: Boston LTA (the Module) has been prepared by TMAC Resources Inc. (TMAC) in accordance with various water licences held by TMAC associated with developments throughout the Hope Bay region.

This Module will become redundant following construction of the Boston Landfarm after which point, hydrocarbon contaminated materials, including water, snow or soils originating at Boston will be managed in accordance with the overarching *Hydrocarbon Contaminated Material Management Plan.*

The Module is intended primarily for use by TMAC and its contractors to ensure that best practices for minimizing potential environmental impacts and potential environmental liabilities with respect to hydrocarbon contaminated water, snow and soils (including crush rock from camp infrastructure and waste rock, herein referred to as soils) are followed, and that the conditions of water licences are met. The Module has been prepared as part of the renewal of Water License 2BB-BOS1217 and is to be implemented under the renewed license.

The Boston land treatment area (LTA) facility is located at the Boston Camp Site, approximately 20 m south west of the tank farm (Figure 1).

The Boston LTA was constructed in the summer of 2003 in response to three separate diesel fuel spills that occurred in 2003. The facility was designed and constructed, under the supervision of EBA Engineering Consultants Ltd., on top of the native esker materials that underlie the Boston Site. The construction stratigraphy of the facility consists of native esker material overlain by crushed waste rock, which is in turn overlain by Bentomax matting followed by a high-density polyethylene (HDPE) liner. The physical dimensions of the LTA are approximately 20 m x 30 m, with berms constructed to an average height of 0.75 m. The facility is intended to contain a maximum of 450 m^3 of material within its 600 m^2 area (Figure 2).

A1.1 Objective

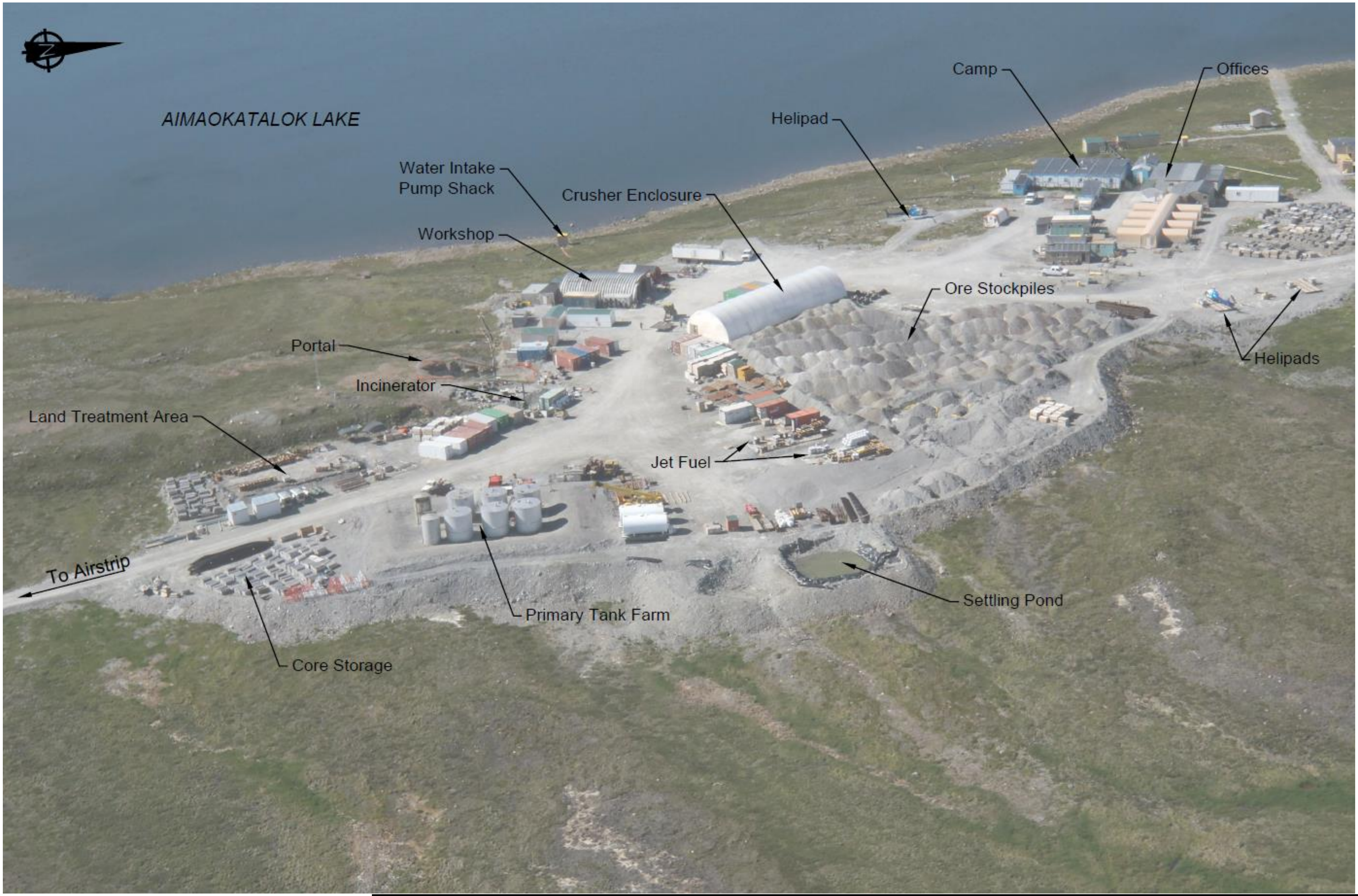
Treatment of hydrocarbon contaminated water and snow can readily be done on site; however, treatment of hydrocarbon contaminated soils (including waste rock and ore) should, when possible be relocated to the Doris Mine for disposal underground, or alternately for temporary storage in the Doris Landfarm. The objective of this module is therefore to outline how these contaminated materials will be managed at the Boston Site prior to transport to the Doris Landfarm.

A1.2 Related Documents

Table 1 lists the documents related to the Hydrocarbon Contaminated Material Management Plan Module A: Boston LTA.

Table 3: Documents Related to the Hydrocarbon Contaminated Material Management Plan Module A: Boston LTA

Document Title	Year	Relevance
Hydrocarbon Contaminated Material Management Plan	2017	Overarching Management Plan document
Hope Bay Project Waste Rock and Ore Management Plan	2017	This module describes the approved procedures for disposing of hydrocarbon contaminated materials within the underground mine



srk consulting

MAC RESOURCES

Hydrocarbon Contaminated Materials Management Plan Module A: Boston LTA

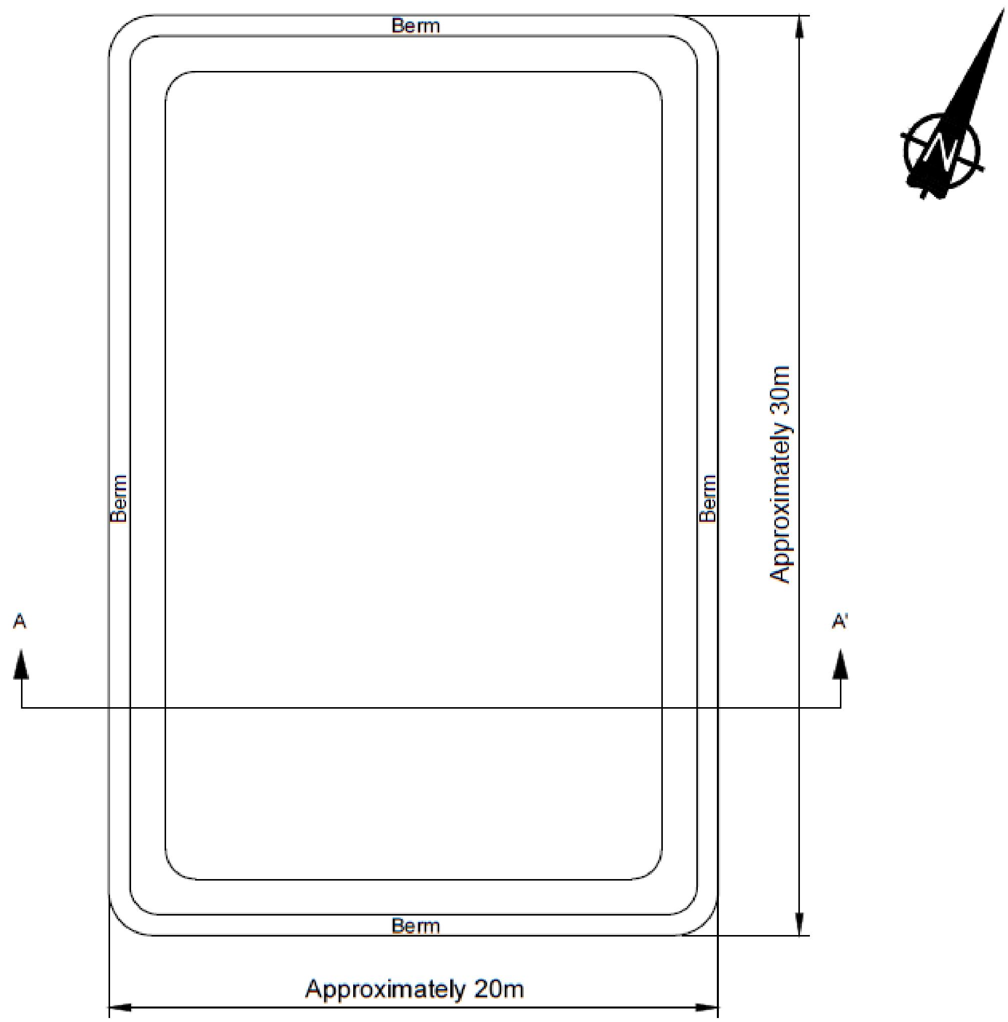
Boston Location

Job No: 1CT022.013

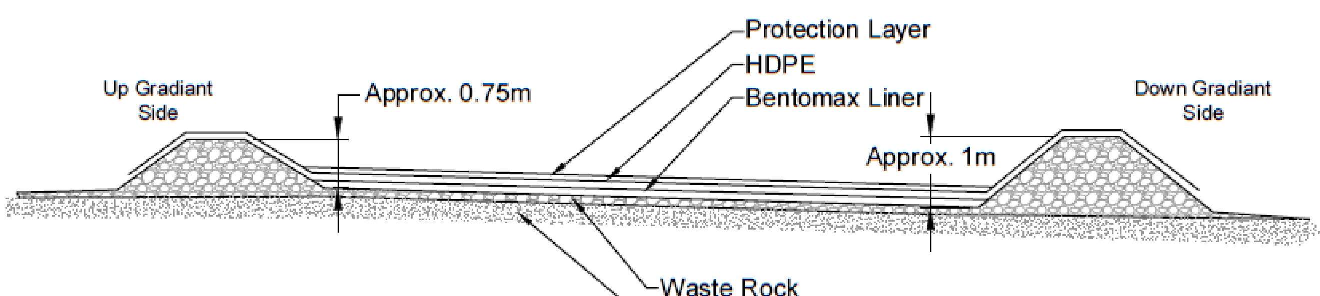
Filename: 1CT022.013_HCCMMP_Figure1_Rev1.pptx

Hope Bay Project

Date:	Approved:	Figure:
November 2017	EMR	1



Plan View



NOTE:
Bentomax Liners and HDPE Material shown seperately for clarity

Cross Section A-A'

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MAC RESOURCES

Hydrocarbon Contaminated Materials Management Plan Module A: Boston LTA

Land Treatment Area Details

Job No:1CT022.013

Filename: 1CT022.013_HCCMMP_Figure2_Rev1.pptx

Hope Bay Project

Date:	Approved:	Figure:
November 2017	EMR	2

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A2 Land Treatment Area Management

A2.1 Soil Management

Hydrocarbon contaminated materials will be temporarily stored at the Boston LTA. Prior to placement in the LTA, the contaminated materials will be characterized to determine if the contaminated soil is suitable for treatment at the Doris Landfarm, is required to be disposed of underground in the Doris Mine, or packaged for off-site disposal at a licenced remediation/disposal facility.

The Hydrocarbon Contaminated Material Management Plan presents the type of analyses recommended for contaminated soil characterization.

The material currently contained within the Boston LTA was placed by Miramar in 2003 after three diesel spills that occurred at the camp. This material will be relocated to Doris Mine as described in this module. The emptied facility will become the LTA.

A2.1.1 Placement of Contaminated Material Land Treatment Area

New hydrocarbon contaminated materials should when possible be transported directly to the Doris Mine where they will be stored underground, or temporarily stored in Doris Landfarm. If this is not possible, the material must be transported to, and temporally stored in the Boston LTA.

The Environmental Coordinator will maintain a record of the amount of contaminated material placed in the LTA and the location of each batch of contaminated material by contaminant type and date of deposition. Copies of these records must be readily available for internal and external audits and for inspectors.

A2.1.2 Recovery of Contaminated Material from Land Treatment Area

Recovery of contaminated material must be undertaken with adequate care and supervision such that the LTA liner is not damaged.

Immediately following recovery of contaminated material from the LTA, the LTA liner should be inspected for damage. Any damage should be repaired prior to additional placement of contaminated materials and prior to the spring freshet.

A2.2 Water Management

A2.2.1 Precipitation

The precipitation and temperature profile for the Boston area was taken from the baseline meteorology data compiled for the Doris project. The average monthly air temperature is typically above 0°C between June and September with the peak in July and below freezing between October and May with the coldest temperatures usually occurring in February. The mean annual precipitation adjusted for under-catch is approximately 207 mm with 41% occurring as rain between May and October and 59% as snow through the remainder of the year (Miramar, 2007).

The Boston LTA has a footprint of approximately 600 m^2 (including the berm footprint) providing a total precipitation collection area of 600 m^2 from which water must be collected and treated. Mean precipitation ranges from 94 mm to 207 mm, with only about 41% falling as rain. Annual lake evaporation (typically occurring between June and September) is about 220 mm. Consequently, the mean annual volume of precipitation runoff expected to be collected is as follows:

$$56\ m^3 \text{ to } 124\ m^3 = (600\ m^2 \text{ (LTA area) x (mean precipitation in mm/1,000))}$$

The majority of this runoff will be lost through wind movement of snow, sublimation and evaporation. These losses have not been considered for the purposes of estimating the maximum potential volume of water to be treated through the oil adsorption system. Offsetting sublimation and evaporation losses from within the liner of the tank farm and LTA treatment facilities will be contaminated snow brought to the facility for remediation (estimated at approximately 3 m^3 per year) (Miramar, 2007).

The LTA does not have a sump; therefore, precipitation collects in the lowest areas. This pooled water will be removed to a temporary holding tank, if required, for treatment through the oil adsorption treatment system.

A2.2.2 Water Sampling and Monitoring

Prior to the discharge of water from the LTA, a water sample will be collected and analyzed for comparison to the water licence BOS-6 discharge criteria for pH, total suspended solids, total oil and grease, benzene, toluene, ethylbenzene and lead as per the existing and/or future revisions of the Type B Water Licence discharge criteria for BOS-6. This sample can be collected pre- and/or post-Oil Adsorption Treatment. If discharge criteria are met, INAC will be notified and discharge will commence ten days after notification or upon receipt of INAC approval.

The water sampling records will be kept by the ESR Department and reported to the NWB in the monthly monitoring reports.

A3 Monitoring and Evaluation

TMAC will implement an inspection and monitoring program for the Boston LTA during frost-free seasons. The objective is to ensure that the facility is functioning properly.

A3.1 Annual Inspections

Maintenance of the LTA is essential for ensuring its effectiveness. Table 2 shows the items to be inspected.

Table 4: Inspection Components for the Boston Land Treatment Area

Item	Responsibility	Purpose	Frequency	Required Records
LTA Operations Inspection	Surface Manager (or designate)	Record keeping of treatment operations and berm performance for due diligence	During spring freshet, or after rainfall events.	• Inspection checklist and field notes including date, weather, and facility condition including any repairs required, odour noted, quantity of water accumulated and amount of freeboard. • Record of berm performance with emphasis on observations of cracking or any signs of instability.
Water Sampling Prior to Discharge	Environmental Coordinator or delegate	To conform to Water License requirements	As required prior to discharge	• Document notification of INAC Inspector (written notification at least ten days prior to discharge). • Record depth of water in LTA. • Calculate approximate water volume to be discharged. • Laboratory-issued reports including QA/QC and summary tabulation of results. • Record of any unauthorized discharges or deposits and follow-up action taken. • Photographic record.
Geotechnical Inspection	SRK Geotechnical Engineer	To identify any maintenance requirements	Annually	• Inspection of geotechnical performance of facility. • Document recommendations of any repair/maintenance work. • Record of any repair work made to the facility.

A3.2 Documentation and Reporting

As required by Part J, Section 21 of the Water Licence, a Monitoring Program summary report shall be submitted to the NWB for review within thirty (30) days following the month being reported and shall include sample analysis from Station BOS-6.

As required by Part B, Section 9 of the Water Licence, an Annual Report must be filed by March 31 of the following year that includes:

- The annual quantities in cubic meters of all contaminants and soil types from all locations that are placed within the landfarm facility; and
- Tabular summaries of all data generated under the Monitoring Program.

A3.3 QA/QC Procedures for Water Sampling

Quality assurance and quality control (QA/QC) procedures for water sampling are outlined in the *Hydrocarbon Contaminated Material Management Plan*.

Detailed QA/QC procedures are available in the Quality Assurance and Quality Control Plan (TMAC 2017).

A4 Contingencies

Should additional new contaminated material require storage at Boston that exceeds the capacity of the LTA, a temporary lined facility may be required to store the excess material. This is considered unlikely as the primary management is transport to Doris and only when this is unavailable should new material be stored at Boston LTA.

In the event that the LTA is at capacity and water levels rise rapidly as a result of unprecedented snowmelt or precipitation, excess water will be pumped to a temporary holding tank or the Containment Pond.

A5 Land Treatment Area Closure

The Boston LTA will be decommissioned at mine closure, upon closure of the existing Boston Camp, or upon construction of a new LTA. The liner system will be removed and the berms graded to promote positive drainage across the site. Remaining contaminated soils will be transported to Doris for treatment or disposal or managed within a new LTA at Boston.

Details of LTA and Boston facilities closure is available in the Boston Closure and Reclamation Plan (SRK 2017).

A6 References

Government of Nunavut. 1995. Consolidation of Mine Health and Safety Act (Nunavut). S.N.W.T. 1994, c.25; In force December 15, 1995; SI-014-95. As Amended by Northwest Territories Statues: S.N.W.T. 1996, c.9; In force April 16, 1996. As Amended by Statues Enacted Under Section 76.05 of Nunavut Act: S.N.W.T. 1998, c.34; In Force April 1, 1999.

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2BB-BOS1217 – Boston Type B Water Licence.