Abandonment and Reclamation Plan, Fuel Tank Farm, Former Nanisivik Mine Site, Nunavut

Stantec

Report Prepared for:
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REPORT TO:

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ON

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Executive Summary

Jacques Whitford Stantec Limited ("Stantec") has been retained by Breakwater Resources Ltd to provide a report for submission to the Nunavut Water Board regarding the conceptual plan for Abandonment and Reclamation of the Fuel Tank Farm located at the former Nanisivik Mine in Nunavut.

This report outlines the conceptual plan, detailing the decommissioning/abandonment and reclamation of the fuel tank farm located at the former Nanisivik Mine site. The Abandonment and Reclamation Plan is a requirement of the Water License (No. 1AR-NAN0914, Part J, Item 2) issued for the site on April 1, 2009, by the Nunavut Water Board. The plan is to be prepared in accordance with to the *Mine Site Reclamation Guidelines of the Northwest Territories, 2007,* and is to be consistent with the INAC *Mine Site Reclamation Policy for Nunavut, 2002*.

The fuel tank farm at the former mine site is required to be decommissioned as per the stipulations contained within the water license, but moreover as part of the on-going environmental and corporate due diligence on behalf of Breakwater Resources Ltd. The fuel tank farm comprises 17 steel tanks of various sizes located in a lined and dyked enclosure, which is adjacent to the former location of the concentrate storage shed. There is sufficient storage for 13.9 million L of P60 diesel, 1.1 million L of Jet A1, and 0.6 million L of gasoline. Fuel was formerly stored for multiple users: mine operations; commercial aircraft; government support services; and as a Coast Guard fuel depot. It is understood that only one tank now contains fuel and that the others have been emptied of their contents. Some cleaning of the tanks to facilitate inspection has been carried out. No free phase petroleum product exists in any of the emptied tanks.

Initially, the tanks will be cleaned by an approved and certified contractor and then will be decommissioned in accordance with Territorial and Federal codes of practice. All tank farm infrastructures will be removed and the tank steel will be piled neatly on a staging area for shipment on sealift to a southern recycling location. The underlying HDPE liner inside the berm of the fuel tank farm will be cleaned, cut into pieces and buried in an on-site rubble pit. It is expected that limited soil impacted with hydrocarbons may exist under the fuel tank farm. Although the extent of the impacts is unknown at this time, previous investigations and remediation completed up to the berm surrounding the fuel tank farm indicate that impacts are limited to the footprint of the fuel tank farm impoundment (maximum estimated soil volume of 8000 m^3). Previous assessment and remediation programs in the tank farm area will be reviewed. Any potentially impacted area of concern not yet addressed by the previous assessments will be included within the proposed decommissioning assessment program. Following the removal of the tankage on the site and concurrent with the removal of the HDPE liner in the tank farm, a series of test pits will be excavated across the tank farm area. Test pits

will be excavated in a grid pattern of approximately 10 m x 10 m across the entire tank farm facility.

Soil samples from the test pits will be screened both with a PID meter and using the field test kit available (PetroFlag™ Total Petroleum Hydrocarbons (TPH) test kits or similar system), and will then be sent to a southern laboratory for analysis of Benzene, Toluene, Ethylbenzene, Xylenes (BTEX), Petroleum Hydrocarbons (Fractions F1 to F4) and polycyclic aromatic hydrocarbons (PAH). From the test pit investigation, areas of impacted soil will be determined and quantities of soil to be treated will be calculated so as to build the proper size and number of biopiles for soil remediation.

Approximately 400 to 500 m^3 of impacted soil will be placed within each biopile in the area to be designated the soil treatment facility. The area underneath the biopiles will be lined with LLDPE reinforced liner, and the tops will be tarped with HDPE to prevent saturation of the soils within each biopile.

Biopiles will be aerated mechanically, using an excavator to turn the soil. Soils will be monitored for moisture, nutrient, and microbial populations of hydrocarbon degraders. To facilitate the creation of optimal biopile conditions, a southern laboratory will monitor soil conditions data, and recommend amendments to the soil conditions, as required. Following the successful treatment of the soil in the biopiles to below the applicable criteria, the soils within the biopiles will be recycled on-site as fill material in areas of existing residual TPH impacts below the applicable criteria. All areas within the footprint of the former tank farm which meet the applicable remedial criteria will be re-contoured either as stated above or with clean approved borrow material. Local clean approved fill (shale) will be excavated or re-contoured from a borrow source near the remedial area with the use of the excavator and dump trucks. The trucks will haul the material to the site and the area will be re-contoured to grades that complement the surrounding drainage patterns and prevent the formation of standing water. Erosion control measures will be put in place to prevent silt migration to the adjacent water bodies during construction.

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1.0 INTRODUCTION

This report was prepared by Jacques Whitford Stantec Limited ("Stantec") and outlines the conceptual plan detailing the abandonment and reclamation of the bulk fuel storage facility ("fuel tank farm") located at the former Nanisivik Mine Site, near Artic Bay, Nunavut. The Abandonment and Reclamation Plan is a requirement of the Water License (No. 1AR-NAN0914, Part J, Item 2) issued for the site on April 1, 2009, by the Nunavut Water Board. The Abandonment and Reclamation plan is to be prepared in accordance with the *Mine Site Reclamation Guidelines of the Northwest Territories, 2007*, and is to be consistent with the INAC *Mine Site Reclamation Policy for Nunavut, 2002*. As per the Water License, the Abandonment and Reclamation plan is to include:

a. Detailed engineering designs, stamped by an Engineer, for the closure (where applicable);
b. Details on the collection and disposal of hydrocarbon residues within all tanks and pipes;
c. The process of dismantling and disposing of all tanks, pipes, pumps and liners including final disposal location;
d. Description of the final desired landscape;
e. Discuss potential closure issues and liabilities including anticipated costs of all remediation activities;
f. Identify a plan to delineate, treat and dispose of hydrocarbon contaminated soils located within, beneath and adjacent to the Fuel Tank Farm;
g. Confirmation of Soil Quality Remediation Objectives (SQRO's) for the tank farm area;
h. Consideration for disposal of liquid and/or hazardous waste in accordance with Government of Nunavut requirements or guidelines;
i. Confirmatory soil analysis for Total Petroleum Hydrocarbons (TPH);
j. Decontamination and removal procedures for the tank and liner;
k. Spill Contingency measure in accordance with Spill Contingency Planning and Reporting Regulations developed under the Environmental Protection Act (Nunavut); and,
l. Detailed implementation schedule for all tasks and activities.

2.0 BACKGROUND

The former Nanisivik Mine is located near the hamlet of Arctic Bay, on the south shore of Strathcona Sound on the northern coast of Baffin Island in Nunavut. The mine was operated by Breakwater Resources Ltd. and produced lead and zinc mineral concentrates from 1976 to 2002. During mine operation, lead and zinc mineral concentrates were trucked approximately three kilometres from the mill at the industrial complex to a storage shed at the dock area. Infrastructure at the dock area also included the fuel storage and dispensing facilities, a refuge station and a chemical storage area. The dock at Nanisivik and a portion of the land in the immediate vicinity ofthe dock are administered under a lease issued by the Department of Fisheries and Oceans. The infrastructure established at the dock included the fuel tank farm, which is described below.

Fuel Tank Farm

The fuel tank farm comprises 17 steel tanks of various sizes located in a lined and diked enclosure, which is adjacent to the former location of the concentrate storage shed. There is sufficient storage for 13.9 million L of P60 diesel, 1.1 million L of Jet A1, 0.6 million L of gasoline. Fuel was stored for multiple users: mine operations; commercial aircraft; government support services; and as a Coast Guard fuel depot. It is understood that only one tank now contains fuel and that the others have been emptied of their contents. Some cleaning of the tanks to facilitate inspection has been carried out. No free phase petroleum product exists in any of the emptied tanks.

Most other infrastructure at the former mine has been decommissioned. It was initially intended that the fuel tank farm might not be decommissioned, but would be sold to a private or Government entity in anticipation of the site redevelopment as an arctic deepwater fuel depot. It was recently decided that the fuel tank farm would not be sold to others and is therefore required to be decommissioned as per the stipulations contained within the water license. The decommissioning of the fuel tank farm is also a normal and expected part of the ongoing environmental and corporate due diligence on behalf of Breakwater Resources Ltd.

3.0 SCOPE OF WORK

The intent of this report is to outline the various phases involved in the abandonment and reclamation of the existing fuel tank farm at the former Nanisivik Mine Site. Following the approval of this conceptual Abandonment and Reclamation plan, a contractor or contractors will be engaged to complete the work.

As part of the closure of the Nanisivik Mine, infrastructure on the site has been removed and the land reclaimed. Where warranted, hydrocarbon and metal impacted soil has been removed and remediated. One remaining component of the infrastructure to be removed is the fuel tank farm. The fuel tank farm includes fourteen field-erected storage tanks and three shop-fabricated tanks that range in size from 50,000 L to nearly 11,000,000 L. The tanks are filled via a pipeline from the dock facility, which is approximately 200 m to the north. The tanks have contained a variety of products such as marine distillate, gasoline, diesel fuel and aviation fuel. The 17 tanks are all situated inside a lined earthen dyke.

To ensure the fuel tank farm is properly dismantled and disposed of and the site returned to as close to original conditions as possible, this conceptual Abandonment and Reclamation Plan has been prepared. The plan is to be used for the approval process and will be a necessary document for contractors bidding on the abandonment and reclamation work. The plan addresses the following concerns:

- Health and Safety
- Protecting the Environment
- Scope of Work / Work Procedures
- Site Reclamation

Health and safety is a major concern when working around equipment such as the pumps, piping and tanks that contain or previously contained flammable liquids. In addition to the typical workplace health and safety concerns, there is the potential of fire, explosions, burns, inhalation, asphyxiation, as well as specific concerns associated heavy equipment, heavy objects, sharp tools and general hot work practices (cutting, welding, etc.). As well, due to the remote nature of the site, a plan must be created on how to deal with work place injuries. Once the abandonment and reclamation project has been awarded, the contractor will be required to submit a detailed health and safety plan for review prior to the start of decommissioning and abandonment activities. The contractor will be responsible for enforcement of the Health and Safety plan during on-site activities.

Upon award of the project, the contractor will be required to submit a spill contingency plan. The spill contingency plan is to meet the requirements of the *Spill Contingency Planning and Reporting Regulations* developed under the *Environmental Protection Act (Nunavut)*. The protection of the environment is paramount. With the dismantling of any fuel storage and distribution system, there are concerns regarding potential spills. The contractor will provide written procedures for reducing potential for releases as well as procedures on how to assess and manage a release should one occur. This would include training for on-site personnel on proper containment techniques and who to contact in the event of an emergency. All plans prepared for this project will be submitted for review by the appropriate parties prior to commencing the work.

Should petroleum-impacted soil or soil water be encountered during the decommissioning process, the Abandonment and Reclamation Plan will detail how to properly handle the impacted material and how to implement proper remedial activities. Due to the remote nature of the site, on-site remediation of the soil will be implemented with biopiles. For impacted groundwater, the potential requirement for a water remediation system exists. These are proven techniques at other cold climate sites in Canada in remediating petroleum hydrocarbons.

This abandonment and reclamation plan will serve as guidance to the prospective contractor(s) regarding the general scope of work and the required end results. The contractor will provide a detailed scope of work regarding the specific methods to be used to achieve these results. The contractor's detailed scope of work will discuss all aspects of the project such as:

- Removal of the liquids and sludge in the pipes, pumps, equipment and the tanks;
- Safe procedures for degassing the pipes, pumps, equipment and the tanks;
- Safe procedures for cutting the pipes and tanks;
- Ensuring the contractor utilizes properly sized equipment for the project;
- Transportation of the liquids, sludge, liner and steel to an approved offsite facility; and,
- Ensuring the work is completed in compliance with all applicable codes, regulations, and best management practices.

Once the project is awarded, the plan would also require that the successful bidder provide detailed safe work procedures covering the entire work scope including some of the hazardous components of the project, such as cutting the steel of the pipes. These procedures would be reviewed by the owner for approval prior to the start of the project. Based on the current plan, detailed engineering designs are not considered necessary for closure.

An implementation schedule for the noted tasks and activities will be prepared once the project has been awarded; however, a preliminary schedule is provided in Table 1. The preliminary schedule includes a provision that the demobilization of equipment may not occur until 2011, as sealift will likely be required.

Table 1 Preliminary Schedule for the Abandonment and Reclamation of the Fuel Tank Farm

Activity	2009	2010				2011				2012				2013		
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Draft Report Submitted to Water Board For Review																
Regulatory comments /changes incorporated																
Final Report Submitted for Review																
Approval for Work Plan Obtained and Tender Let for Tank Decommissioning																
Award of Project																
Planning Phase and Field Season Preparation																
Tank Farm Decommissioning																
Test Pit Program and ESA																
Preliminary Site Preparation for Biopiles																
Remedial excavation																
Bioremediation																
Site Reclamation																

4.0 Recommended Soil Quality Remediation Objectives

The Canadian Council of Ministers of the Environment (CCME) *Canadian Environmental Quality Guidelines* (CEQG) (1999, updated on-line) provide guideline limits for contaminants in soil and water and are intended to maintain, improve, and/or protect environmental quality and human health at contaminated sites in general. These guidelines include numerical values for the assessment and remediation of soil and water in the context of agricultural, residential/parkland, commercial, and industrial land uses. Environmental soil and water quality guidelines are derived using toxicological data to determine the threshold level to key receptors. These criteria include the Recommended CCME Soil Quality Guidelines (SQG), and the Canadian Water Quality Guidelines (CCME CWQG).

The CEQG include guidelines for benzene, toluene, ethylbenzene, and xylenes (BTEX) in soil and water, but do not include guidelines for total petroleum hydrocarbons (TPH). Guidelines for petroleum hydrocarbons are provided in the *Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil* (CCME, 2008), which are also developed on the basis of land use. These guidelines are protective of both human health and ecological receptors. The guidance provides criteria for TPH based on subfractions (i.e., Fractions F1 to F4). The CEQG guideline provides soil criteria for some PAH parameters.

Based on the current and likely future land use in the area as an operational dock, the CCME commercial values are considered appropriately conservative for the fuel tank farm area. CCME guidance also takes soil type into consideration. Since the soils in the fuel tank farm area are predominately sand and gravel, values for coarse-grained soil are considered appropriate. Specific exposure pathways considered in the development of the CCME criteria were reviewed to determine which pathways are applicable for the site. This review in summarized in Table 2.

Table 2 Applicability of Exposure Pathways for Fuel Tank Farm, Former Nanisivik Mine

Exposure Pathway	Applicable?	Rationale
Direct Contact	Yes	Persons on the site could come into direct contact with soil
Vapour Inhalation (indoor)	No	There are currently no buildings at the site. The foreseeable future would not include the construction of buildings within 30 m of the impacted soil. Arctic construction techniques involve pile foundations with an air space under the buildings to prevent melting permafrost. This would also prevent vapour migration into the buildings (i.e., the CCME slab-on-grade and basement guidelines are not applicable).
Protection of Potable Groundwater	No	Groundwater in the area is not used as a potable water supply

Table 2 Applicability of Exposure Pathways for Fuel Tank Farm, Former Nanisivik Mine

Exposure Pathway	Applicable?	Rationale
		due to permafrost conditions.
Protection of Groundwater for Aquatic Life	No	The nearest surface water bodies (Twin Lakes Creek and Strathcona Sound) are more than 100 m from the impacted soil.
Nutrient Cycling	No	The CCME considered this pathway in the development of the generic criteria and has determined that there are currently insufficient data to allow derivation of guidelines based on nutrient cycling. However, the area is polar desert with negligible productivity. As a result, nutrient cycling is not considered a relevant pathway for this site.
Eco Soil Contact	Yes	Ecological receptors on the site could come into direct contact with soil at the surface (i.e., soil at depths < 1.5 m); given the shallow water table and permafrost conditions, exposure to soils at depths greater than 1.5 m is not expected.
Offsite Migration	No	This pathway is applicable when adjacent or nearby land use is more restrictive than the site. Since there is no residential or agricultural land use in the area, this pathway is not applicable.
Management Limits	Yes	The CCME have provided management limits that may be used in place of ecological criteria below 3 m depths, which reportedly include considerations such as free phase formation, explosive hazards, and buried infrastructure effects. It is unlikely that these uses or conditions would occur due to the prevailing permafrost conditions.

The CCME guidelines are based on a tiered approach to site management. Within this tiered approach, three tiers of increasing technical complexity (Tiers 1, 2 and 3) are available for the management of impacted sites, all of which provide protection of human health and the environment to achieve the same result of safe site closure. Tier 1 and 2 methods result in the selection of clean-up criteria that are protective of human health and the environment. Tier 3 may either result in the selection of clean-up criteria in the implementation of risk management techniques to reduce or eliminate exposure to the identified contaminants. As there is currently insufficient information to calculate Tier 3 criteria, the recommended SQROs are based on CCME generic guidelines (*i.e.,* Tier 1), for the pathways noted in Table 2. The recommended values are provided in Table 3.

Table 3 Recommended SQROs and Water Guidelines for Fuel Tank Farm

Parameter	CCME Guidelines (Soil) and Nunavut Discharge Guidelines (Water)		
	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Water (mg/L)
Benzene	110	360	-
Toluene	250	500	-
Ethylbenzene	300	600	-
Xylenes	350	700	-
TPH Fraction F1	320	700	15 (as grease, fat, oil)
TPH Fraction F2	260	1,000	
TPH Fraction F3	1,700	3,500	
TPH Fraction F4	3,300	10,000	
Anthracene	32	32	-
Benzo(a)pyrene	72	72	-
Fluoranthene	180	180	-

5.0 TANK FARM DECOMMISSSIONING PROCESS

The following section describes the process of dismantling and disposing of all tanks, pipes, pumps, and liners including final disposal location.

5.1 Tank Decommissioning and Disposal

5.1.1 Existing Infrastructure

There are a total of 17 steel above-ground storage tanks located within the fuel tank farm. The facility includes 14 field-erected storage tanks and 3 shop-fabricated tanks that range in size from 50,000 L to nearly 11,000,000 L. The tanks are filled via a pipeline from the dock facility, which is approximately 200 metres to the north. The tanks have contained a variety of products such as marine distillate, gasoline, diesel fuel and aviation fuel. The 17 tanks are all situated inside a lined earthen dyke. The dyke is constructed of gravel fill with a liner placed in the fill, over the berm and covered with gravel ballast.

5.1.2 Decontamination of the Tanks and Disposal of Hydrocarbon Residues

Initially, decommissioning will involve the removal of all petroleum products from the tanks. Most of the tanks have now been cleaned of sludge and free phase petroleum products and absorbent material has been placed in the tanks. One tank still contains product; this product will be removed prior to demolition. Following the removal of the product and prior to demolition, the tanks will be cleaned with appropriate detergents and water/steam to remove any residual fuel adhering to the steel. The cleaning will include the purging of all petroleum products from the lines, pumps and sumps within the fuel tank farm. Prior to dismantling the infrastructure, all tanks and lines must be degassed to avoid the release of or ignition of hydrocarbon vapors during the decommissioning.

All water, fuel, and absorbent material generated from the cleaning process will be placed in barrels and shipped south for disposal at an approved southern treatment facility or treated using an on-site treatment system, which will include the use of oil/water separators and granular activated carbon, clay/carbon and silica sand filters.

5.2 Removal of the Tanks

To dismantle the tanks, it is anticipated that a large crane, dump trucks and flat bed tractor trailers will be used to handle the steel tank pieces from the dismantled tank. The tanks will be dismantled with the use of an excavator with hydraulic shears and also (if required) with the use of conventional plasma or acetylene cutting torches. All steel will be cut and stored in a manner and size such that it can then be transported from the site on ship. All tank steel will be taken off site and disposed in the south at a metal recycling facility.

Once the steel has been collected and stockpiled, the base of the tank will be pulled and cut in a similar fashion to the walls and roof of the tank. All piping will be cut into pieces or taken apart at the joints and the steel collected and stockpiled. As previously noted, the steel is to be transported from the site on sealift to a southern location for recycling.

5.3 Decontamination and Removal of Tank Farm Liner

Following the removal of the tank infrastructure, the liner will be removed from the facility. The liner is constructed of a single layer of high density polyethylene (HDPE). The liner is exposed in places inside the berm and in others is buried beneath gravel ballast. It is not known at this time if the liner is in place below the tanks or if it butts up to and is welded to the tank bases. In any case, the liner will be exposed and cleaned of any residual hydrocarbon and then cut into manageable pieces. As the cut-up pieces of liner are not hazardous waste material, they will be buried in an on-site rubble pit or shipped south for disposal. The rubble pit will remain open until the fuel tank farm decommissioning activities have been completed, likely in 2011. Effluent from the tank liner cleaning will be collected and treated with the on-site water treatment system. If it is not possible to treat the effluent from the cleaning effort, the liquid will be drummed and shipped south for proper disposal.

5.4 Delineation of Hydrocarbon Contaminated Soils in the Fuel Tank Farm Area

It is expected that limited amounts of soil impacted with petroleum hydrocarbons may exist under the fuel tank farm; the extent of the impacts is unknown at this time. However, based on the results of the remediation program completed in 2006 (SRK, 2009), it has been confirmed that the petroleum hydrocarbon impacts are limited to the footprint of the fuel tank farm (i.e., impacts identified downgradient of the fuel tank farm impoundment have been remediated). The presence of permafrost at depths of less than 2 m (and reported to extend to depths of up to 600 m) is expected to have limited the vertical migration of any hydrocarbon releases within the tank farm area. Based on the area of the fuel tank farm impoundment (approximately 4000 m^2), the potential volume of impacted soil is less than 8000 m^3.

Following the removal of the tankage on the site, and concurrent with the removal of the HDPE liner, a series of test pits will be excavated across the area in a grid pattern of approximately 10 m x 10 m. It is expected that the test pits will extend through the gravel fill to the level of the permafrost. In each test pit, samples of the soil will be obtained at regular intervals in the soil horizon and areas of potential hydrocarbon impacts (as identified based on visual and olfactory observations). All test pits will be logged as to geology and hydrogeology.

The soil samples will be screened in the field both with a PID meter and using a field test kit (PetroFlag™ Total Petroleum Hydrocarbons (TPH) test kits or similar system). Selected soil samples will be sent to a southern laboratory for analysis of Benzene, Toluene, Ethylbenzene, Xylenes (BTEX) and Petroleum Hydrocarbons (Fractions F1 to F4). A review of past analysis of soil adjacent to the tankfarm during the Phase II ESA indicates that PAH impacts were not detected in soil samples from the tank farm area submitted for analysis. Select samples from within the tank farm will be analyzed for the presence of PAH. If no detectable concentrations are noted, no further analysis for PAH will be carried out. If PAHs are present at concentrations greater than the guidelines provided in Table 3, PAH analysis will be included in the suite of analyses proposed to be carried out on the biopiles.

Findings of the test pit investigation will be used to determine the locations and quantities of impacted soil to be treated so as to build the proper size and number (if more than one) of biopiles for bioremediation of soil.

5.5 Petroleum Hydrocarbon Impacted Soil and Groundwater/Melt Water Removal

Once the tanks and liner have been removed and the site has been assessed with respect to the location and extent of hydrocarbon impacted soil, the soil must be removed. It is anticipated that an excavator would be used to remove the impacted soil. The excavator would remove the impacted soil and place the material in a truck to be hauled to the biopile. Once at the biopile, the trucks can end-dump directly upon a liner within the berms surrounding the pile. The liners are designed to accommodate the weight of machinery (truck or front end loader). The excavation will extend to a point at which sound permafrost is encountered or a clean soil boundary, whichever is encountered first. The remedial excavation will extend to the depth at which clean soil or soil meeting the established remedial criteria is encountered. This elevation will be identified in the test pit site assessment program.

5.6 Confirmatory Soil Analysis for TPH

A soil sampling plan to confirm the success of contaminated soil remediation will be established in a grid pattern across the site with sufficient sampling to confirm that boundary conditions of the remedial excavation meet the SQROs (as described in Section 5.4). The sampling will involve the on-site screening of soil using portable test kits, until such time as the boundary soil meets the SQROs. Following this, a series of confirmatory boundary soil samples will be collected and submitted to a southern accredited laboratory for the analysis of petroleum hydrocarbons (*i.e.*, BTEX and TPH as fractions F1 to F4) and PAH, if required as outlined in Section 5.4. The laboratory will be accredited by the Canadian Analytical Laboratories Association (CALA).

With regards to the soil quality within the biopiles themselves, a 6 kilogram composite soil sample (providing an average sample of the contaminated material at the site based on 16 subsample locations) will be collected. The soil sample will be sent to the National Research Council of Canada (NRC) – Biotechnology Research Institute (BRI) for a number of laboratory analyses concerning bacterial populations. NRC-BRI will continue to monitor soil conditions data from the composite soil samples will be provided from the biopiles, and will recommend amendments (such as nutrient additions) to the soil conditions, if required.

6.0 TREATMENT AND DISPOSAL OF HYDROCARBON CONTAMINATED SOILS

Petroleum hydrocarbon contaminated soils will be treated on-site using bioremediation. This section provides details of site selection, and biopile design, operation, maintenance, and decommissioning.

6.1 Site Location Considerations

A number of factors were considered with respect to the soil remediation location, including site topography, probability of future monitoring and sampling of the soil/groundwater, facility access routes, adjacent water bodies, site drainage patterns, and the location of the contaminated soil in relation to the soil remediation facility.

The area directly southeast of the current tank farm was selected for the soil remediation facility. It is our opinion that this location represents the most practical location for the treatment pad. Engineering controls (i.e., drainage ditches, an underflow dam, retention/collection pond, LLPDE liners and effluent treatment system) will protect adjacent water bodies from impacts. The tank farm has been in place for over 30 years and through monitoring carried out by SRK Consulting and AECOM, no impacts arising from fuel handling or minor spills have ever migrated to Twin Lakes Creek or Strathcona Sound. This indicates that migration times for these fuel products between the tank farm and the nearby aquatic receptors are long; greater than 30 years. It is therefore unlikely that handling contaminated soil in engineered containment cells at the proposed location could, over the short term of the treatment process, result in impacts to these aquatic receptors.

The selection of the area was based on the following factors:

- Ease of accessibility – The soil remediation facility can be accessed by ATV, truck, or snowmobile from the main roadway on the east side of the tank farm. It is well graded for accessibility, and can easily be maintained. A lateral access road will need to be extended from the main road around the site (see Drawing No. 1056201-1, attached for the facility access routes).
- Its location in relation to surface water bodies – The freshwater (and fishless) Twin Lakes Creek is located cross gradient of the soil remediation facility at a distance of 130 m to the west, and salt water of the Strathcona Sound is located downgradient to the north of the facility a distance of approximately 320 m (see Drawing No. 1056201-1, for adjacent surface water bodies).
- Site topography and drainage patterns – The area in the vicinity of the soil remediation facility is relatively flat sloping slightly to the north and has been graded and maintained as an equipment staging area. It has an established slope/drainage pattern, which will be maintained once the biopiles are constructed in the soil remediation facility.

- Surface and subsurface monitoring – The easy accessibility of the biopiles within the soil remediation facility enables an effective scheduled soil monitoring program. Dug monitoring wells, constructed by placing piezometers within an excavation and subsequently backfilling, are also proposed within the vicinity of the soil remediation facility to enable the monitoring and sampling of groundwater in this area, (see Drawing 1056201-1 for biopile locations and proposed monitoring well locations).
- The area can easily accommodate additional biopiles should unexpected volumes of impacted soil be encountered. At present, Drawing 1056201-1 indicates 16 biopiles, which should more than accommodate the amount soil requiring remediation at the site.
- The area will not infringe on any other potential uses of the equipment laydown area and the concrete pad (former concentrate storage shed). Historically, the dock area was sufficient to accommodate both the Canadian Coast Guard (CCG) and the mining operations. Therefore, Breakwater expects that there is adequate space for any foreseeable use by the CCG while the biopiles are in operation. However, Breakwater remains committed, as always, to full cooperation with any other interested parties.

6.2 Site Topography

The topography of the soil remediation facility will be graded in preparation for the individual biopiles and the lay down area. A uniform and consistent topography is desired with minimal slope. The area is currently unused and is relatively flat. The main lay down area slopes slightly to the north-northeast. This flow direction will be maintained when the area is re-graded for the biopiles.

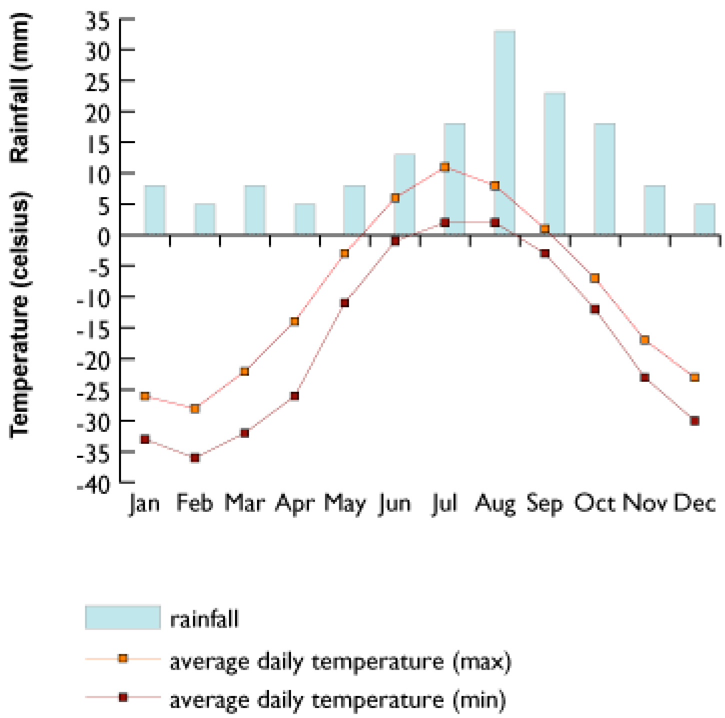
6.3 Site Assessment Considerations

As part of site assessment considerations, the following details are provided.

6.3.1 Hydrological/Climate Assessment

The north coast of Baffin Island is considered a polar desert. The annual snowfall in the area is about 72 cm and the annual rainfall is about 8 cm. Winters temperatures in January and February range from -33 to -36 ºC (minimums), while summer temperatures in June and July range from 6 to 11 ºC (maximums). Relative humidity ranges from 75 to 85 percent throughout the year with generally no more than 6 wet days a month. The exception to this is in August where there can be as many as 10 wet days in the month. Ice will begin to form in October and will begin to thaw in mid-July. Total darkness occurs from mid-November for two and a half months, ending at the end of January. Total daylight occurs from the beginning of May for three and a half months until the middle of August.

The following bar chart for **Arctic Bay, Nunavut** (32 km to the east) shows the yearly average weather condition readings including rain, average maximum daily temperature and average minimum temperature.



Source: http://www.bbc.co.uk/weather/world/city_guides/results.shtml?tt=TT000960

6.3.2 Chemical Storage

There are limited solid and liquid chemicals used as part of the soil remediation program that are required to be stored on-site, as follows:

- Solid: diammonium phosphate (DAP) fertilizer – approximately 50 x 25 kg bags; bentonite and grout - approximately 10 x 15 kg bags
- Liquid: sample bottle and test kit preservatives/fixers – less than 10 L

These supplies will be stored on site in a temporary shelter (sea can) for the duration of the bioremediation activities, after which they will be removed from the site.

6.3.3 Site Stratigraphy

Based on previous inspection of work carried out in the fuel tank farm and dock area, the site is generally overlain with a layer of glacial-fluvial sand and gravel with cobbles, which is for the most part loose and unconsolidated. Permafrost is generally encountered at a depth of 1.5 to 1.8 m below the ground surface. The fuel tank farm area is located on this sand and gravel deposit, and the area is built up with a sand and gravel fill. Significant fill material has also been used to construct the gravel berms surrounding the fuel tank farm.

6.3.4 Permafrost

Nanisivik is situated in an area of continuous permafrost in Canada. In general, the permafrost layer on site was encountered at a depth of 1.5 to 1.8 m from the surface of the active zone, and is reported to reach depths of 600 m in the region. At the location of the biopile treatment area, the permafrost layer is located within the sand and gravel deposit. The glacial till and fill making up the active zone is generally frozen from the last week in September until late July, with melt beginning in the first week of June. The active zone melt will be managed with drainage ditches running along the exterior perimeter of the treatment cell area and the interior area will be graded to the ditches with a general flow to the north.

6.3.5 Municipal Zoning or Land-Use Planning

It is understood that the biopile/soil remediation undertaking does not have any conformity issues regarding its applicability to Municipal zoning and/or land use planning regulations at the former Nanisivik Mine, as there are no municipal regulations in place. The land has been in industrial use for more than 30 years.

6.4 Soil Storage and Treatment Design Considerations

6.4.1 Biopile Design Details

Stantec has carried out numerous remedial projects using biopiles in the Canadian Arctic, and can attest to the technologies success in the north. Most recently we installed 15 large scale biopiles at a remote DND military radar site in Nunavut. The biopiles contain approximately 12,000 m^3 of impacted soil, most of which now meets guidelines after two years of treatment. A smaller scale project was completed in Cambridge Bay for Transport Canada where we successfully treated 500 tonnes of hydrocarbon contaminated soil at a remote transmitter site. The soil was treated in two biopiles for 4 seasons and then used as surficial fill once the clean-up criteria were met. We continue to treat annually, 1000's of tonnes of contaminated soil at a former gold mine site North of Yellowknife. Throughout the working field season, windrows are constructed and nutrients added to soil taken from various clean-up operations at the former mine site. The piles are aerated and kept moist with nutrient addition as needed. Once the soil meets guidelines it is reused as fill in other suitable areas of the site. This work has been ongoing successfully for several seasons.

Each biopile constructed on-site will be composed of a soil pile, 28.5 m long, 2.0 m high and 8 m wide. Overall biopile volume at completion is estimated to be 400 to 500 m^3. The number of biopiles required will depend upon the assessment of the hydrocarbon impacts beneath the fuel tank farm. The area underlying the biopiles will be graded in preparation for the 34 mil linear low density polyethylene (LLDPE) reinforced liners that underlie the base and sides of the piles. Gravel berms will be constructed around the perimeter of each biopile (and covered with the same LLDPE lining the base) in order to contain any precipitation collected within the biopiles/lay down area, as well as to contain the soils placed within the areas. A 22 mil HDPE liner will be placed over each completed biopile to keep precipitation from saturating the piled soils.

6.4.2 Water Treatment Design Details

While the biopile area is being operated, overland flow will be diverted to prevent contact with contaminated soil. Water accumulating within the liner areas will be collected and samples submitted for analysis. The results will be compared to guideline values. Should an exceedance occur, the water will be pumped to a treatment system, consisting of various filter media, prior to discharge.

Overland flow is considered to be water which falls in the treatment or lay down area but not water which falls directly on the biopiles. The area will be graded with positive drainage away from the lined cells, usually to a small retention pond and outlet with an underflow dam and silt curtain constructed with hay bales and non-woven geotextile.

Water which falls within the treatment cells will be captured by the impermeable LLDPE liner and will be removed as it accumulates. Treatment cell design allows for approximately 1 m of free board in the bottom of the liner where the water can accumulate. Water will be pumped using a portable diesel pump from a sump or low area in the liner and placed in a 1500 gallon PVC flex tank. Once the flex tank is full, the water will be pumped at approximately 5 gpm through a series of treatment vessels filled with filter sand, then with granular activated clay-carbon (GACC) and then with granular activated carbon (GAC). The sand will filter out the suspended solids in the water extending the life of the GACC and GAC filters. The GACC will then filter out the majority of the hydrocarbon compounds and the GAC will polish the effluent to ensure compliance and guard against breakthrough of the compounds. If dissolved metals become a problem in the effluent, a zeolite filter will be added following the GAC filter. The filter system will be housed in a portable building with a generator and small heater to keep the system from freezing. An insulated sea container or small wooden shed will be used to house the filter vessels and pumps.

Effluent water from the retention pond and pre- and post- treatment system will be samples at regular intervals and analyzed to ensure discharge criteria are met and to monitor the condition of the filter media. The system will be designed such that a number of redundant filters will be placed in series so that when the hydrocarbon breakthrough occurs in the primary filter, latter filters will capture the impacts until the primary media is replaced.

Impacted melt water and precipitation encountered during the remedial excavation of the tank farm will be directed by tanker truck or through pumps and hoses to the treatment system. The treatment system can be constructed so as to be completely portable, in which case, the system can be located at the excavation when needed, then moved to the biopile area. To mitigate the creation of a large amount of water to be treated in the excavation, only a small area will be dug at any given time and then contoured once boundary sampling is acceptable. The treatment system will be modified somewhat depending upon the quality of the water in the excavation, but may require two large scale sand pre-filters to remove the majority of the fine sand and silt generated during excavation. The same level of compliance analysis will be carried out for the remedial excavation dewatering as with the biopile collection water.

Ditches will be dug along the perimeters of the soil remediation facility in order to facilitate drainage of the area.

6.4.3 Precipitation

As mentioned in section 6.3.4, the north coast of Baffin Island is considered a polar desert. The annual snowfall in the area is about 72 cm and the annual rainfall is about 8 cm. Summer temperatures in June and July range from 6 to 11 ºC (maximums). Relative humidity ranges from 75 to 85 percent throughout the year with generally no more than 6 wet days a month. The exception to this is in August where there can be as many as 10 wet days in the month. As such, contingency must be made to handle the excess rainfall which may fall on the area during the wetter periods, especially in August. Typically, most of the precipitation that falls on the piles will be used to keep the soil at the optimum moisture content of 40 to 60 % of field capacity. A landfarm constructed at the mine previously experienced a net evaporation condition throughout the treatment period and any excess water was needed to augment the soil moisture. If a period of heavy precipitation is forecast, typically the biopiles would be covered with individual tarps and the excess water from the ditches and retention pond pumped through the treatment system, if required. In our experience, the water diverted during a significant rainfall event would meet guideline values, and biopiles remain covered until fair weather returns, at which point they would be uncovered.

6.4.4 Background Soil Sampling

Background soil samples will be collected from the soil remediation facility area prior to its construction. These background samples will act as a guide in future sampling events of the same locations upon site decommissioning. It is proposed that background samples taken from outside of the actual laydown footprint of the biopliles and laydown area will be collected annually in order to monitor the soil quality of the area. This will enable Stantec to proactively plan the maintenance of the soil remediation facility in order to maintain the soil quality of the area throughout its operation.

6.4.5 Barriers and Outside Site Access

The soil remediation facility is located in a relatively remote area in Baffin Island, although the public, dock users, hunting parties *etc*. could have access to it. A form of barriers, snow fence, chain link fence or the like may be required to limit access to the area during treatment.

As a precautionary measure for the soil remediation facility, a sign outlining the purpose, potential risks, and projected duration of the facility is proposed to further enhance the safety of the area. The sign will be written in both English and Inukitut

6.4.6 Facility Location on the Site

The closest bodies of water include the aforementioned Twin Lakes Creek located 130 m west and crossgradient, and Strathcona Sound, located approximately 320 metres north and downgradient of the soil remediation facility

6.4.7 Alternative Remediation

Remediation of petroleum hydrocarbon impacts in soil has been successfully achieved through the use of biopiles at a number of sites in the Arctic, most notably at the DEW Line sites. In the unlikely event that the soil remediation facility does not succeed in lowering the concentration of petroleum hydrocarbons (PHC) within the biopiled soils to less than the SQROs, the soil will be remediated with an alternative remedial option to achieve the approved clean up objective. The soil may have to be shipped off-site (most likely on large barges) to an approved disposal facility or alternatively, a more aggressive on site approach, such as low temperature thermal oxidation or ex-situ chemical oxidation, would be applied.

A bench scale biotreatability study of the soil to be placed in the biopiles will be performed prior to placing soil in the facility. The study will determine the existence of petroleum degrading micro-organisms and nutrient levels in the soil. The study will recommend the optimal nutrient and moisture condition amendments for the soil based on the hydrocarbon chemistry and expected rates of mineralization.

6.5 Operation and Maintenance Considerations

6.5.1 Soil Quality Monitoring

Soil quality on site will be monitored via two separate analyses.

PetroFlag™ Total Petroleum Hydrocarbons (TPH) test kits will be used to screen impacted soil in the field. Soils with concentrations of TPH in excess of SQROs will be stockpiled and transported by truck to the biopiles. Soils with TPH concentrations below the SQROs will be temporarily stockpiled and used as contour material for the excavated areas. Prior to transportation to the biopiles, contaminated soil would be screened using an excavator to remove large rocks (>30-cm diameter).

As mentioned above, background soil quality samples will collected from the area occupied by the soil remediation facility. Based on soil vapour concentrations, field observations, and PetroFLAG ™ test kit results, selected soil samples will be submitted to an accredited laboratory for analysis of Benzene, Toluene, Ethylbenzene, Xylenes (BTEX) and Petroleum Hydrocarbons (Fractions F1 to F4).

6.5.2 Biopiling Procedure

Approximately 400 to 500 m^3 of impacted soil will be placed within each biopile at the soil treatment facility. The area underneath the biopile will be lined with LLDPE reinforced liner, and the tops will be tarped with HDPE to prevent saturation of the soils within each biopile. For an illustration of the proposed soil remediation facility layout, see Drawing No. 105620-1.

Biopiles will be aerated mechanically, using an excavator to turn the soil. Soils will be monitored for moisture, nutrient, and microbial populations of hydrocarbon degraders. Typically, a ratio for every 100 kg TPH is 10 kg nitrogen: 1 kg phosphorus :1 kg potassium (100:10:1:1) when building a biopile. To facilitate the creation of optimal biopile conditions, a southern laboratory will monitor soil conditions and recommend specific nutrients to be added as amendments.

6.6 Final Desired Landscape

Following the successful treatment of the soil in the biopiles to below the applicable criteria, the soils within the biopiles will be recontoured on-site as fill material in areas of existing residual TPH impacts below the SQROs. All areas within the footprint of the former tank farm which meet the applicable remedial criteria will be backfilled both as stated above and with clean approved borrow material. The area will be capped and graded to match as closely as possible the existing conditions of the surrounding land. The biopile liner(s) will be removed and crated for off-site disposal and the area returned to grade and conditions that match the surrounding lands.

Immediately following the remedial excavation and the collection of acceptable boundary soil samples, the excavated area will be re-contoured. Both the excavation and re-contouring may need to be carried out in zones and stages such that a large area is not left exposed at any one time. If required, local clean approved fill (shale) will be excavated from a borrow source near the remedial area with the use of the excavator and dump trucks. The trucks will haul the material to the site and the fuel tank farm area will be re-contoured to grades that complement the surrounding drainage patterns and prevent the formation of standing water. Erosion control measures will be put in place to prevent silt migration to the adjacent water bodies during construction.

Based on the conceptual abandonment and reclamation plan for the fuel tank farm, on-going liabilities after reclamation are not expected. Estimated costs for all remediation activities, including soil treatment, cannot be determined until after the contractor quotes have been obtained and the confirmatory soil analyses have been completed to determine the quantity of soil requiring remediation. As noted previously, completion of the abandonment and reclamation of the fuel tank farm is considered an on-going environmental and corporate due diligence on behalf of Breakwater Resources Ltd., who are assuming responsibility for the costs associated with the scope of work described herein.

7.0 CLOSING

This report has been prepared by Rob McCullough, BES., CET., CESA, and Tania Noble Sharpe, M.Eng., P.Eng., and was reviewed by Malcolm Stephenson, Ph.D for the sole benefit of Breakwater Resources Ltd./CanZinco Limited, and may not be relied upon by any other person or entity without the express written consent of Jacques Whitford Stantec Limited (Stantec) and Breakwater Resources Ltd./CanZinco Limited. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Any use that a third party makes of this report, or any reliance on decisions made based on it, are the responsibility of such third parties. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made, or actions taken, based on this report.

The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Conclusions and recommendations presented in this report should not be construed as legal advice.

The conclusions presented in this report represent the best technical judgment of Stantec based on the data obtained from the work. The conclusions are based on the site conditions observed by Stantec at the time the work was performed at the specific testing and/or sampling locations, and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on the soil and groundwater conditions, as well as the history of the site reflecting natural, construction and other activities. In addition, analyses have been carried out for a limited number of chemical parameters, and it should not be inferred that other chemical species are not present. Due to the nature of the investigation and the limited data available Stantec cannot warrant against undiscovered environmental liabilities.

Where information has been supplied to Stantec from other consultants, whether presented in this report or not, it has not been used in interpretation leading to conclusions and recommendations, unless that information has been verified through investigations carried out by Stantec.

If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

Respectfully submitted,

JACQUES WHITFORD STANTEC LIMITED

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Principal, Project Manager

Malcolm Stephenson, Ph.D.
Principal

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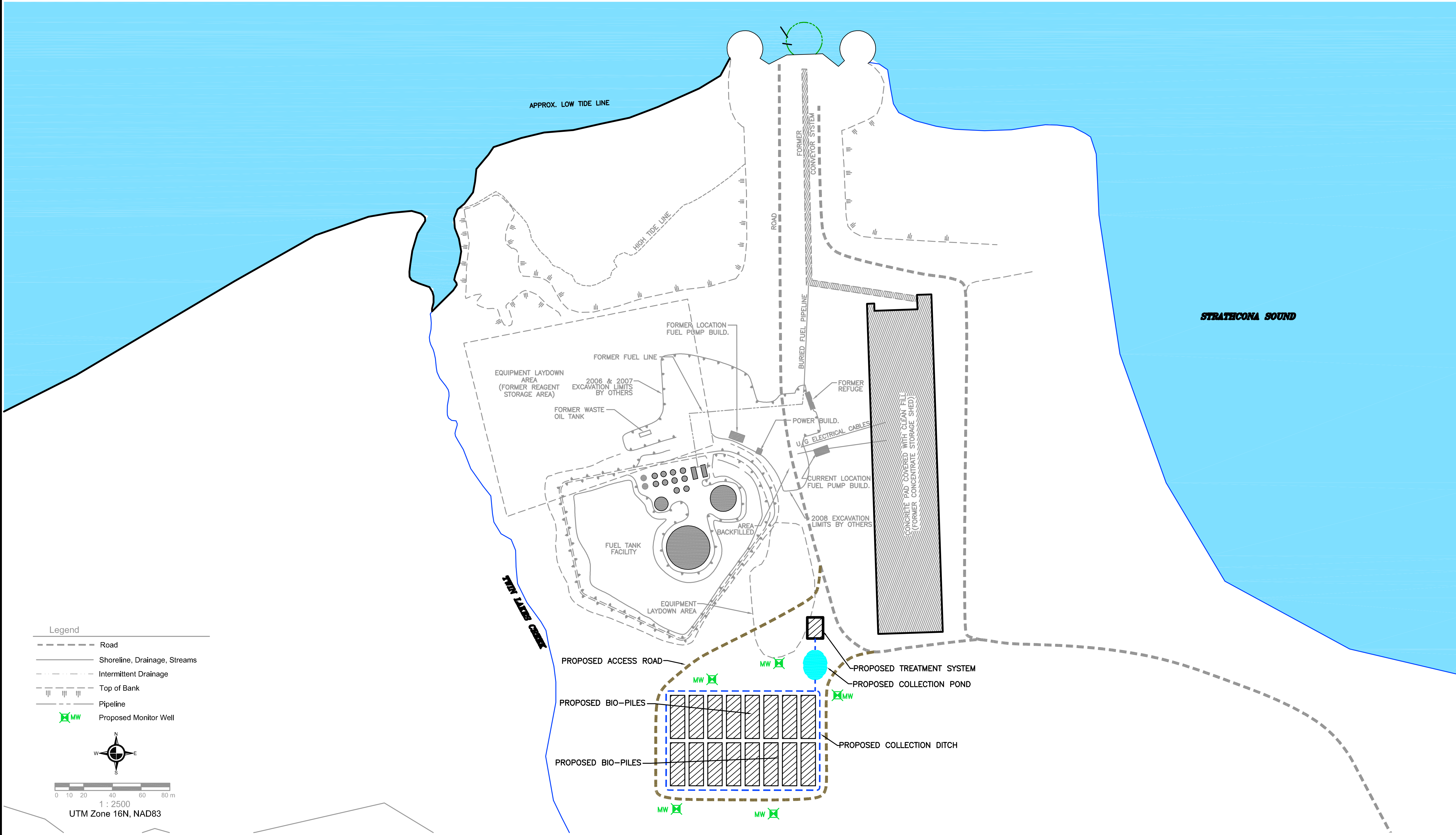

Stantec

REFERENCE:
SRK CONSULTING ENGINEERS & SCIENTISTS
FIG. No. 3 REV. B, PROJECT No.
1CB002.001 DATED 2009/01/16

SCALE :	BAR SCALE
DATE :	2009/10/07
DRAWN BY :	P.J.SOO
APPROVED BY :	

CANZINCO LIMITED
SITE REMEDIATION
DOCK AREA
NANISIVIK MINE, NUNAVUT

SITE PLAN AND PROPOSED
BIO-PILE LOCATIONS

DRAWING NO. 1056201-1

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