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NUNATTA ENVIRONMENTAL SERVICES INC.

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PROTECTING OUR ARCTIC ENVIRONMENT

Interim Abandonment& Restoration Plan

Hydrocarbon-Impacted Soil Landfarm Facility
1575 Federal Road.
City of Iqaluit, Nunavut

Water Licence Number - NWB4NUN0511-Type "B"

Prepared for:

Nunavut Water Board
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This Interim Abandonment and Restoration Plan is considered a live document and will be updated as new protocols and procedures are developed or required.

1.0 Introduction

Nunatta Environmental Services Inc. (Nunatta) owns and operates a Hydrocarbon-Impacted Soil Landfarm Facility within the City of Iqaluit, Nunavut.
The facility is located at 1575 Federal Road, Industrial Park, within the limits of the City of Iqaluit on Lot 1, Block 229.
The NWB License number for the Hydrocarbon-Impacted Soil Landfarm Facility is NWB4NUN0511 "B"

This treatment facility is commonly referred to as the 'landfarm'. Nunatta's operations consist of accepting soils impacted with petroleum products at various concentrations at the landfarm's geosynthetic lined platform (Cells) and with addition of fertilizers, aeration, and moisture control, allow indigenous soil microorganisms to degrade petroleum products to braking them down into compounds such as water, carbon dioxide and hydrogen sulfide. Soils accepted at the landfarm are contaminated with diesel, gasoline and various automotive and construction/mining oils.
The site where the land farm is located is in the industrial part adjacent the old metal dump where all old equipment and cars and trucks were junked. Many rotting barrels of unknown products are still visible on adjacent properties around the landfarm and through out the dump site to the west of our fences. Records show the landfarm site was used as crushing grounds for any old waste barrels and storage of unclaimed product.
One water test well located in the north east corner of the lot has always tested high in hydro carbons it is believed this is contamination from previous operation conducted at this site. At present time Nunatta Environmental Services has no plans to close its landfarm but should that be the case in the future the following is a procedure to guide through its closure.

This Interim plan has been developed and all costs accrued with closure will be borne by Nunatta Environmental Services Inc.
At present the landfarm has 10,000 cubic metres of soil within its containment cells.
The primary contaminant is Diesel Fuel (P50). The majority of this contaminated soil has been excavated from clean up of home heating tank leaks and industrial site spills.

The treatment is on going at the land farm during summer months. The soil is screened free of rocks and stones and then treated with fertilizer and aerated (turned over) as weather permits. The time to degrade the hydrocarbons varies depending on concentrations and soil activity which includes both Microbial and mechanical. It is estimated that this landfarm will require 6 years to remove most soils, providing aeration activity is ongoing. The residual soil next to the liner might require more time either in a separate cell or it could be spread thin within an existing cell. With proper aeration and treatment, it is estimated that 2-3 years will be required to remediate this remaining soil. Samples taken in the spring and fall of each year will guide the amount of activity required for quickest results.
Once the treatment process is complete and has been confirmed with Laboratory Analysis and all regulatory personal notified, the soil can removed and used in Landfill cover or road construction or should soil meet CCME standards ,soil can be used any place earth is required, **s**uch as cover material over demolished berms.

2.0 Annual Soil Aeration Procedure

The soils in the cells require breaking up to allow micro organisms to break down hydrocarbons into harmless components. This requires addition of fertilizers, moisture and good aeration. This is best achieved when soils are put through a screening plant and stacked in windrows. In consultation with Professor Steven Sicilliano, of the Department of Soil Science, University of Saskatchewan, Saskatoon, with whom Nunatta has been consulting with Professor Sicillliano, who specializes in Arctic Soils, Microbial Ecology and Toxicology, (See Biography page 9).

Nunatta has developed a unique aeration process to take into account the specific environmental conditions in Iqaluit which apply to the landfarm. The process involves constructing windrows 3-4 metres high in each cell covering the length of the cell. These windrows allow water to move through the piles, which helps to nourish microbial life. With the increased surface area, the outer layer thaws and can be scraped with the excavator in the spring of the year. That exposes remaining frozen ground, allowing it to melt faster and allows superior aeration for the next layer of soil.

This process should be repeated as often as weather permits. Experience has show 2-3 rotations a summer will reduce containment time to approx 5 years for Diesel (P50) contaminated soils. Proper testing and addition of fertilizer has to be maintained to achieve best results.

3.0 Soil Removal from Treatment Cells

Once Laboratory sample tests indicate soil concentrations meet CCME requirements, soils can be removed from the treatment cells. The use of an Excavator with a straight edged bucket has been found to be most effective when working close to cell liners. Piling soils using Rubber tired Loaders has also been found to the most effective method of filling trucks for removing soils from the site.

Prior arrangements with city landfill site will be required to ensure timing of removal. Due to the quantity of soil contained at the landfarm, removal might have to be spread out over a whole summer to empty a cell. Due to different degradation times of the cells this process will require up to five years to rid the landfarm cells of all contents.

It is necessary to employ a watcher to guide the excavator operator when digging gets close to the liner. A depth guideline of approx 12 inches or 1/3 of a metre of soil will be left on top of liner. If this cell is to be used to contain residual soils (soils close to liner which have not been treated) this layer will require hand digging to save the liner from damage.

Proper hydrocarbon breakdown is difficult to achieve without the proper microorganism activity.Soils located close to liner have been packed tight and water and air have been kept from feeding microorganisms. Once the overburden of soils has been removed and this soil is broken up the microorganisms will begin to breakdown hydrocarbons and allow the soil to be removed from Landfarm much quicker than simply leaving them undisturbed.

If reluctant contaminants are encountered that do not respond to our remediation process, these soils will be containerized and shipped to an approved disposal facility

4.0 Standard operating Procedure for Water Sampling

4.1 Test well Sampling

An inertia system such as Waterra is used for purging and sampling a groundwater monitoring well. Equipment required includes polyethylene tubing and a foot valve.

- Nitrile gloves are worn to handle the tubing and to attach a foot valve to the bottom of the polyethylene tube.
- The foot valve and tubing are inserted into the well until it reaches the bottom of the well.
- The tube is cut so that approximately 0.5 to 1 m extend**s** above top of the well.
- The polyethylene tubing is not permitted to touch the ground.
- The tubing is moved up and down, forcing water up the tubing. .
- The foot valve and tubing are stored inside the well for subsequent use by folding the tube to fit inside the well.

4.2 Surface water sampling

Depending upon the depth of the water body, one or more samples may be collected at each location.
Clean, laboratory-supplied containers are immersed in the water body just below the surface and be allowed to fill.
Disturbance of bottom sediments will be avoided.
Samples will be packed carefully into laboratory-supplied containers of the appropriate type and with the appropriate preservative for the test parameters.
Any information on colour, turbidity, odour will be noted.
Shallow sub surface samples will be obtained by immersing the bottle to the desired depth and open the lid.
Surface water samples for laboratory analysis will be collected in appropriately labeled containers and stored in coolers with ice (at approximately 4°C) while in transit to an accredited laboratory.

4.3 Water Quality Monitoring

The water from melt waters in the cells has to be dealt with as this water has had the chance of coming in contact with contaminated soils. In Iqaluit the soil freezes before the snow arrives and the snow melts before the ground thaws so the contamination is very slight in melt waters. Still the water must be treated as contaminated.
Melt water is pumped out to keep it from breaching the cell walls. Water is stored in large tanks along side of cells. This water can now be sampled and the sent to the lab for analysis and corrective measure taken. All tanks are to be emptied prior to freeze up to save tank rupture from freezing action of water.

Samples will be sent to an approved Laboratory for analysis and results kept on file at landfarm.

In order to document the chemical characteristics of the soil**,** samples will be analyzed for the following parameters

- Total Petroleum Hydrocarbons (CCME PHC- F1 to F4 fractions)
- B-tex
- Total Petroleum Hydrocarbons (TPH)
- Poly Aromatic Hydrocarbons (PAH)
- Heavy Metals (HM - Cd, Cr, Cu, Ni, Zn and Pb)
- PCB

5.0 Standard Operating Procedure for Soil Sampling

There are two common methods of soil sampling: grab samples and composite samples. A grab sample is a sample taken from one specific location, at one time. A composite sample is a combination of smaller samples taken at different locations or at different times. For the identification of hydrocarbon contamination, grab samples should be taken.

The sampling proceed**s** from the least contaminated to the most contaminated site.

The number of field samples that are required, as well as the type and size of the sample vial, is dependent upon the type of contaminant that is being sampled

To prevent loss of volatiles, samples gathered from freshly exposed soil and preserved as soon as possible, after the excavation.

- Clean gloves are be worn and are changed before each new sample is collected.
- Each sample vial is filled so that no headspace exists. Aeration and air contact is minimized.
- Threads of jars are thoroughly cleaned.
- Vials are capped.
- Vials are labelled.
- Vials are placed on ice in a covered cooler or refrigerated not frozen(do not freeze)
- The necessary documentation is completed

6.0 Soil Quality Monitoring

In order to document the chemical characteristics of the soil samples will be analyzed for the following parameters twice a year, once at thaw and again before freeze up. The samples will be sent to an approved Laboratory for analysis and results kept on file at landfarm.

- Total Petroleum Hydrocarbons (CCME PHC- F1 to F4 fractions)
- Heavy metals (6)
- Mercury
- PCB
- PAH
- Microbial type and count
- Nitrogen, Phosphorus, Potassium

7.0 Residual Soil

A portion of the residual cover material remaining in the treatment cell might be found to be impacted in excess of guideline limits**. In this situation,** the area of impact will be removed to the depth of 12 inches from the cell liner. Some of this work will require removal by hand shovel to minimize the potential for damage to the liner. Depending on the volume of material removed, the impacted soil can either be placed in containers and sent to an approved disposal facility for destruction or for further biotreatment, in a fully enclosed biocell which will be constructed within the current treatment cell. The option of leaving the residual soil spread in the existing cell to allow further natural biodegradation will also be considered.

8.0 Residual Soil Sampling

After the top layer of soil is removed, a series of samples will be taken from the layer of soil (12 inches) remaining over the synthetic liner. These Composite samples will be submitted for analysis of BTEX and F1 to F4 Petroleum Hydrocarbons. The purpose of the sampling will be to confirm that no residual contaminants in excess of the levels are left within the treatment cells.

9.0 Water Discharged from Cell

Immediately following the soil removal, the water in the remaining in the cell will be sampled and analyzed for BTEX and F1 to F4 Petroleum Hydrocarbons. Subject to approval of the regulator, the water will then be discharged or filtered to meet standards then released into the Environment.

10.0 Groundwater Monitoring

Water samples will be taken from the monitoring wells annually for two successive years following the removal of soil from the treatment cell. Samples will be analyzed for the parameters specified in Water Licence No. NWB4NUN0511. Results will be compared to applicable CCME surface water quality guidelines and to Nunavut Environment groundwater remediation guidelines.

11.0 Contingency for Impacted Soil or if Monitoring well exceeds Canadian Council of Ministers of the Environment (CCME) Standards

If contaminant concentrations exceeding the guideline limits are found in the monitoring well samples or after liner has been taken up, a plan will be developed for delineation of any downgradient contaminant migration for the identification of the source of the groundwater impact. The details of the plan will be based on the pattern of concentrations exceeding the guideline limits found in the well sampling program. The soils contaminated by the leak will be put into the cell containing the residual soils from cell decommissioning or they will be containerised and shipped to a disposal facility.

12.0 Final Site Modifications

It is assumed that the landfarm berms will be levelled and the land will be used for other Industrial operations. The existing building is well constructed and can be used as a shop and offices for a number of business options and the land has potential as a storage area as it is all securely fenced and gated.

Siciliano, Steven D.

Position: Professor
Email: steven.siciliano@usask.ca
Website: http://soiltox.com/
Department: Soil Science
Expertise: Arctic Soils, microbial ecology, toxicology
Bio:

Education: B.Sc. Biochemistry (Concordia), Ph.D. Toxicology (Saskatchewan)

Research:

We have four key initiatives in the Poles devoted to exploring how soil and human health are linked.

• Exploring how soil ecosystems communicate with one another.
• Understanding how the amount of liquid water in frozen affects pollutants and biogeochemistry.
• Working with the citizens of the City of Iqaluit in the Lower Base Region to investigate what sort of and how many pollutants are in the soil around their homes.
• Archiving polar soil samples for future generations.

Not all of our research projects involve traveling across the globe! We are also active in studies involving soil and water quality and greenhouse gases in Saskatchewan and across the prairies.

Selected Publications:

Siciliano SD, AN Schafer, MAM Forgeron, I Snape. 2008. Hydrocarbon contamination increases the liquid water content of frozen Antarctic soils. Environmental Science and Technology 42:8324-8329.