PROTECTING OUR ARCTIC ENVIRONMENT

NUNATTA ENVIRONMENTAL SERVICES INC.

SITE OPERATIONS MANUAL

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

Water Licence Number - NWB4NUN0511-Type "B"

Prepared by:

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This Site Operating Manual (SOM) contains general instructions on how the landfarm facility conducts operations at the site.
This SOM is considered a live document and will be updated as new protocols and procedures are developed or required

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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 1BR-NUN1217

GPS coordinates N 63-45-43.8

W 068-32-49.7

Topographical map # 025N15

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 breaking 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 throughout 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.

The treatment is on going here during summer months the soil has be screened free of rocks and stones and then treated with fertilizer and aerated (turned over) as often as weather and time permit. The time needed to degrade the hydrocarbons varies depending on concentrations and microbial activity. We estimate this landfarm will require 4 years to remediate most soils, providing aeration activity is ongoing. The residual soil next to the liner is never disturbed and will at some point be excavated and mixed with soil from an existing cell. With proper aeration and treatment 2-3 years should remediate this remaining soil. Samples taken spring and fall will guide in the amount of activity required for quickest results.
Once the treatment process is complete and has been confirmed with Laboratory Analysis and all regulatory personnel are notified the soil can be removed and used in Landfill cover or road construction or should meet Canadian CCME standards ,soil can be used any place earth is required, such 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 plants to remove rocks and cobbles down to ¾ of an inch then stacked in long windrows. This process should be repeated throughout the warm months as often as weather permits. Experience has show 2-3 rotations a summer will reduce remediation time to less than 5 years for Diesel (P50) contaminated soils. The addition of a custom blended fertilizer has to be maintained to achieve best results.

3.0 Landfarm Treatment Cells

Currently, there are 4 treatment platforms (cells) at the landfarm, identified as Cells 1, 2, 3 and 4. Cell #1 is our receiving cell all material is brought into this cell and fertilizer is added as well as soil which has been in our facility to inoculate the new soil with bacteria which is responsible for the production of Enzymes and they remediate the soil. The soil when thawed is but through a shaker to remove all large rocks down to 3 inch or 75mm this reduces the soil volume by 1/3 or in some cases by ½.
Screened soils removed from cell #1 go into cell #4 to allow more room for incoming contaminated soil. This soil is piles high in a windrow for maximum surface area. From cell #4 soil is retreated with fertilizer based on soil sample results to guide in choosing the correct amount then it is put through a Rotary screening plant reducing particulate size down to less than ¾ inch or 20mm. From here the soil is put into small piles inside cell #3 where it will winter over. The removal of stones from 3 inch to ¾ inch (75mm to 20mm) further reduces the volume by additional ¼ to 1/3 resulting in much less than originally accepted into the landfarm.

All Cells are lined by a geosynthetic material (High Density Polyethylene –30 mil HDPE material) these liners were welded at the manufacturing plant and their purpose is to prevent petroleum products mixed in the soils from seeping into the ground water. The new liner for cell #2 is 40 Mil in thickness and will be installed in the summer of 2018 or 2019 if weather allows.
The design used in the construction of all cells was an approved engineered drawing by Dillon Engineering (Picture shown on page 19)
Cell #1 60 meters X 30 meters, wall height 1 meter.

This is where soils entering the land farm are dumped and piled to await the screening process to remove construction debris and large rocks. There is ample room between soil and walls to allow collection of melt waters. Water pump out points are located on the SE and SW corners. Water is contained on one of the many tanks on site to be used to keep soils wet should it be a dry summer

Cell #2 50 meters X 25 meters, wall height 1 meter:
Contains rocks removed from soils stored in cell #1.
Cobbles are as small as ¾ inch and rocks vary up to a couple feet in diameter.

Cell #3 90 meters X 30 meters, wall height is 1.5 meters:

This is the final or finishing cell. Here all large stones and debris have been removed and all fresh hydrocarbons reduced to weathered status. Fertilizers have been added and soils are piled into small shapes resembling pyramids allowing as much surface area as possible.
This cell will undergo more frequent aeration and soils will leave the land farm from this cell, when the remediation process is complete. Laboratory sampling is used to verify when the process is complete and Government of Environment staff will sample and release soil when they feel it is acceptable.

Cell #4 60 meters X 25 meters, wall height is 1.5 meters:
Snow, overflow material and excessive water is stored in this cell. Soils will be piled in here when they are cleaned of large rocks and treatment process will begin. Plan is to allow as much room as possible for surface run off water storage. Large surface area is idea for evaporation of surplus water.

The Landfarm layout

The landfarm layout sits on relatively flat land but is slightly sloped to the North. The cells are installed with a grade of approximately (1%) so the surface water accumulates along the eastern and southern edges of the cells #1, #2, #3.
Cell #4 is graded to the North East corner to allow ease of pumping water back into the other cells or to reach our discharge point.

The height of the fuel-impacted soil placed in the treatment cells will vary but could be as high as 3 meters above ground level.

Cell #1 is piled high and is flat topped.

Cell #2 is currently being cleaned out. All rocks have been removed and most of the soil put into cell #1 for treatment in summer of 2018. There is some soil left which did not thaw out during the summer of 2017 and our plan is to finish digging it all out during summer of 2018 so it might be possible to install the new 40 Mil liner.

Cell #3 is the last cell before soil is removed from landfarm. It has the biggest surface area large collection area for water and ease of access for loaders and trucks. Soils are placed in this cell after all rocks and cobbles have been removed and this soil has appearance of sand but with a soft tilth and rich feel. Flowers and other plants grow in this soil benefiting from the added fertilizer and warmth as this soil is dark in colour and collect heat from the sun more readily. The soil is piles so it can be exposed to sun and wind to speed up remediation so the more surface area the faster the thawing process in the spring. An excavator is used to scrape away the thawed surface soils exposing

the frozen core to the elements allowing us to put it through the screening plant much sooner in the summer season.
Wind erosion has not been a problem in the last couple years as the weather has been very cold and wet. Should dust begin to blow it will be controlled by pumping water from the holding tanks onto the soil piles.

Cell #4 The main use for this cell at this time is to provide storage of soil exiting cell #1 with stones 3 in (75mm) and small still contained in the soil to overwinter. Because of the level surface after we clean out soil it is good for barrel storage and to contain snow brought in over the winter from things like broken hydraulic lines or damaged fuel lines.

The geomembranes used for the Cell construction was purchased from Layfield Plastics, Alberta.
Layfield plastics, fusion welded 5 meter wide geomembrane strips to achieve the required cell widths and lengths, they are then folded, protection wrapped then crated and shipped. The large bundles require special handling practices and a lot of manpower to install.

Quality assurance and quality control documents are supplied by the geomembrane manufacturers and are kept on file at the landfarm.

4.0 Soil Treatment

Proper soil aeration, moisture, and added ingredients are essential to optimize bioremediation. Custom blended fertilizers are added to the soil and then soils are put through screening plants to allow oxygen incorporation into the piles. This is done to ensure that aerobic conditions prevail below soil surface. Using a belt stacker also ensures the soils do not get packed like they do when handles by a bucket often being dumped in a large lump which packs the soil.
Soil aeration starts as soon as soils have thawed and continue until the freezing takes place.The frequency of soil aeration depends on factors such as soil moisture, temperature and weather and other work taking place at land farm.

5.0 Equipment list

Equipment used during the operation of landfarm

- Eliptical course material screening plant set to 3" inch output
- 2010 Roto-Screen R450 portable trommel : screen installed ¾ inch
- Loader 2.8 cu/yd Case 621C,
- Eexcavator 2.0 cu/yd John Deere 892DLC
- Conveyors 50 ft belt stacker
- Pumps and hoses 2"inch
- Generator 600 Volt to operate big shaker plant

All fuels and lubricants required to operate equipment are kept on site. Maintenance and repairs are done in house by Nunatta staff. Shop floor has no drain, this ensures all fuel/oil spills are contained and cleaned up.

Diesel fuel storage is an approved fuel tank protected from equipment impact by large bollards. Pumps used are approved fuel pumps and 40 pound fire extinguisher is in place at all times. Power to pump is disconnected when fuel is not being pumped. Spill kit is present at tank for diesel and heating oil.

Gasoline is contained in 20L containers. Since no large equipment uses gasoline only small engines on pumps and generators gasoline is purchased as needed.

See MSDS (Material Safety Data Sheet) in Operations manual Appendix A.

6.0 Soil Testing Requirements

All soils have been impacted with fuel oil typically from residential or commercial fuel spills (i.e. heating oils and diesel fuels. Chemical testing is done on all soils where contamination is not a known source. These soils are kept separate until lab results are in. Most of the soils brought to land farm are from spill sites Nunatta is cleaning up and tests are taken at the site, results of these tests confirm the hydrocarbon content. Additional testing is done spring and fall on all cells at land afarm to determine degrgation rate and fertilizer requirements to assist us in speeding up the reclamation process on landfarmed soils.

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

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

7.0 Water Testing Requirements

The existing water licence requires the following be tested prior to release to the environment. Nunatta has begun to evaporate off a lot of its water by making ponds in the soil piles early in the summer and filling these ponds with the excess water. The sun and wind as well as the wicking of the soil reduces our water by up to hundreds of liter per day.

Should we need to discharge water the following is what NWB has requested but tested for in order to release the contained water.

Total Petroleum Hydrocarbons (CCME PHC- F1 to F4 fractions)
B-tex
Total Petroleum Hydrocarbons (TPH)
Poly Aromatic Hydrocarbons (PAH)
pH
Suspended solids
Nitrate-Nitrite
Phenols
Hardness
Sodium
Magnesium
Chloride
Copper
Iron
Mercury
Zinc
Aluminum
Cobalt
Potassium
Calcium
Cadmium
Chromium
Lead
Nickle
Phosphorous
Manganese
Arsenic
Oil and Grease
Ammonia Nitrogen
Conductivity

8.0 Reject Rock Management

Impacted soils enter the landfarm into Cell #1 where cobbles and rocks are screened out.
Rocks and cobbles are removed down to ¾ inch.
These rocks are piles into cell #2 to weather off any soils or hydrocarbons that might be adhered. The freezing thawing action and wetting, drying action as well as movement of air will expel soils and hydrocarbons from the stones. These will be tested and if confirmed clean will go to the crushers here in town to be used in gravel for road building. The smaller rocks will require additional time to expel contaminates and will be re screened again to further reduce soil count and when they are found to be clean they will be used around land farm for land leveling, road building. The screened out soil will be added to one of the cells.
This procedure was developed from consultations with Dr. Steve Siciliano, Professor of Soil Toxicology, University of Saskatchewan.
During the summer of 2017 approximately 800 $m^{3\ of}$ rock rejects have been extracted from the landfarm and will be crushed.

9.0 Treated Soil Disposal Plan

- Nunatta anticipates that the contaminated soil treatment will require 4-5 summer seasons to lower TPH concentrations to CCME's residential or commercial levels. Once treated, if acceptable by the applicable legislation the remediated soil will be disposed of as follows:

- Sent to the municipal landfill for daily cover use

- Foundation material for road construction

- Used to back fill excavation sites where spills have occurred and are being cleaned up

- Used as inoculants for incoming soils.

  *Proper hydrocarbon breakdown is difficult to achieve without the proper microorganisms. Once these microorganisms have become established in the soil it is faster to inoculate incoming soil.
  This will speed up the breakdown of hydrocarbons and allow soil to be removed from Landfarm much quicker than waiting for these organisms to develop on there own each time new soil is added to the pile.

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.

10.0 Water Use and Management

Water Collection

The Cells consist of perimeter berms (walls) designed to allow for snowmelt and rainwater to be collected and contained along the cell's perimeter the water is intercepted by the berm and can therefore not leave the site. Snow and ice are addressed once summer thaw begins. The accumulated water along the cell's perimeter is monitored and if close to overflow it is pumped either into tanks or into a cell which will accommodate this excess.

The surface water is managed by one of the following methods

- Surface water is absorbed by the contaminated soil;

- Excess surface water accumulating along the cell's perimeter will be contained and filtered with a activated carbon filter and where hydrocarbons are in abundance, water will be passed through modified clay then, polished in the activated carbon filters. Water will then be tested for hydrocarbons and when acceptable levels are reached notification to proper authorities will be given along with approved Laboratory test results and permission to pump out sought.

- The water is pumped into tanks and store for use in maintaining soil moisture levels and dust control.
  Tank capacities on land farm at present exceed 15,000 Gallons
  or 68,000 L

- Accumulated water evaporates under sun and wind action. The more surface area the faster the evaporation takes place for this reason we like to keep water in cells as much as possible to speed up process. When possible we add water to soil piles as an aid in making water levels lower without the huge expense of polishing. Micro organisms need water and by adding water to the soils we attempt to satisfy their requirements as well as control dust issues.

11.0 Water Treatment and Discharge to the Environment

Rainwater collected from treatment Cells will have been in contact with contaminated soil. This rainwater will contain varying low concentrations of diesel, fuel oil or gasoline depending on what contaminated the soil.
Other water is brought to the land farm to be polished so it can be released into the environment. This water is from contaminated sites where water has pooled and must be removed in order to allow excavation to continue.
Contaminated water is transported to the landfarm in either barrels (205 litre barrels) or large tanks (5000 litre) water will be passed through a water/oil separator and will be dumped into one of our cells to be used for dust control or for moisture control within the soil piles.

Each year prior to freeze up all hydrocarbon contaminant removed from water is containerized and shipped south to an approved disposal facility for disposal.

Prior to releasing any water into the environment, it must be polished clean. We accomplish this by passing it through a filtering medium of modified clay and activated

carbon. The clay has the ability to remove as much as 5 times the hydrocarbons as activated carbon but it does not polish the waters to meet CCME standards. Carbon will polish the waters to meet regulatory requirements so it will be used as a final filter to assure the CCME requirements are met. Discharged water is tested to be sure the carbon filter has not reached its breaking point. Nunatta keeps activated carbon in stock and is able to replace spent carbon when the breaking point is met. Filtering vessels are purchased as complete units from (ERE) Environmental Remediation Equipment Inc. (ERE) an environmental specialist in site remediation and wastewater treatment, and Nunatta undertakes ongoing maintenance of these units.
When concentrations of hydrocarbons are low we use only activated carbon filtering.

All water to be discharged is sampled, (Be it runoff or filtered water) and when CCME levels are achieved, test results are forwarded to Inspectors at INAC and when granted permission all waters will be pumped out through activated carbon filters even if it meets CCME standards to guard against accidental contamination.

Water stored in the holding tanks for the summer months is pumped out before winter. This allows room for spring runoff/melt containment and to prevent tanks from being ruptured by the freezing action of the water.

12.0 Standard Operating Procedure for Water Sampling

12.1 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 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.

12.2 Surface Water Sampling

Depending upon the depth of the water body, one or mare samples may be collected at each location.
Clean, laboratory-supplied containers should be immersed in the water body just below the surface and be allowed to fill.
Disturbance of bottom sediments should be avoided.
Samples should 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, odor should be noted.

Shallow sub surface samples may also be obtained by immersing the bottle to the desired depth and open the lid.
Surface water samples for laboratory analysis should be collected in appropriately labeled containers and stored in coolers with ice (at approximately 4°C) while in transit to an accredited laboratory. In order to document the chemical characteristics of the water, samples will be analyzed for the following parameters twice a year.

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

13.0 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 should proceed 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 should be gathered from freshly exposed soil and preserved as soon as possible, after the excavation.

13.1 Procedure for Soil Sampling

- Clean gloves should be worn and should be changed before each new sample is collected.
- Completely fill each sample vial so that no headspace exists. Minimize aeration and air contact.
- Clean threads of jar thoroughly.
- Cap the vial.
- Label the vial.
- Place on ice in a covered cooler or refrigerate (do not freeze)
- Complete the necessary documentation

In order to document the chemical characteristics of the soil samples will be analyzed for the following parameters twice yearly. 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

14.0 Sample Handling and Transport

Keep samples cool (4 degrees C) and in the dark. Use ice cubes or crushed ice to chill samples as soon as they are collected, and ice packs to maintain internal temperatures in shipping containers. Deliver samples to the laboratory as soon as possible after collection.

15.0 Chain of Custody Requirements

This procedure describes the requirements for completing a chain of custody for environmental sampling.

To ensure timely and complete laboratory analysis, the chain of custody must be properly completed. Records of the chain of custody must also be kept for auditing purposes. The following is a guideline to proper recording practices.

Project Contact information includes address where results and invoice are to be sent, telephone and fax numbers of the contact in case the laboratory has questions regarding the sample(s) or analytical request.

Site and Sampler information includes site name and/or location, project number and name(s) of individuals collecting the samples.

Additional info should include submission date, laboratory quote number, any additional forms in which the results are required (e.g. fax, electronic).

Sample Details should include for each sample submitted sample identification, sample date and time, sample matrix (groundwater, surface water, soil, sediment, etc.), number of containers filled, any field filtering and preservation completed, any lab filtering and/or preservation required, requested analyses.

Special Instructions includes any required detection limits, specific methodology, hazards of the sample(s) to laboratory personnel.

Required Guidelines includes indicating to which criteria or guidelines the results will be compared and allows the laboratory to aim for the required detection limits.

Include the date that the results are required, be specific (not 'ASAP' or 'next week').

Also include any other information that may be useful to the laboratory in the 'Notes' area.

When the sampler gives the samples to another individual (e.g. courier, laboratory staff) he/she must complete the 'Relinquished by' section including the date, time and signature and the person who accepts the samples must complete the 'Received by' section including the date, time and signature.

Every time the samples are given to another individual the 'Relinquished by' and the 'Received by' sections must be completed until the samples are received by the laboratory.

16.0 Packaging and Handling of Samples

16.1 Packing Bottles

- Label all the bottles to be sent to the lab for analyses. Double check the labels are properly filled out using a pen or marker that is not water-soluble. Do not write on the septum of Forty (40mL) BTEX/Vials. If you do write on the cover always double check, so that the bottle and cap have the same sample ID.
- Forty (40 mL) vials should be wrapped in bubble wrap. Three 40 mL vials usually fit into the laboratory supplied bubble wrap pouch. To prevent breakage, place the vials so that there is no room for movement.
- One (1) litre, or 500 mL bottles should be wrapped individually in small bubble wrap.
- Fifty (150) mL soil jars should be placed one on top of each other in a ziplock bag. Seal the bags and tape tight.

16.2 Packing Coolers

- Check the cooler to see if it has a water drain outlet at the bottom, seal it with tape to prevent water from leaking out. (Couriers will refuse to ship a leaking cooler)
- Place a large piece of thick bubble wrap on the bottom of the cooler; make sure there is adequate bubble wrap so as to extend up the sidewalls of the cooler.
- Line the cooler with two large industrial strength garbage bags (one inside the other) so that all the packing will be performed in the bags.
- The bottles should be placed in such a way that they do not touch each other. As a general rule all bottles should be placed in an upright position.
- If you are packing soil jars, placing a layer of bubble wrap between every row of samples.
- If there is any void space it should be filled with a layer of bubble wrap.
- Remove the last sheet from the filled out Chain of Custody form (COC). Place the remaining page of the COC in a ziplock bag and place it inside the cooler on top of everything. Only one COC is required even if there are more than one cooler.

- Close the lid, wrap the cooler with sufficient packing tape at all points of entry.
- Place a shipping label (usually supplied by lab), indicate 1 of 2, or 2 of 3, etc. if there is more than one cooler being sent on the same waybill.

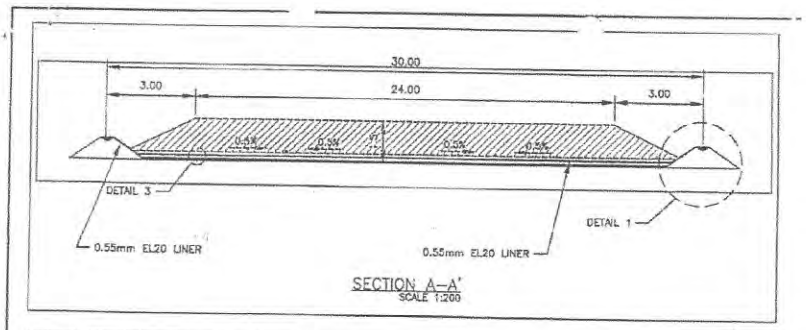
17.0 Photos of Landfarm Operations

Soil piled into windrows for maximum aeration and faster thawing.

Water storage tank, screening Plant and excavator

Shaker used to remove stone greater than 2 inch

Excavator and rotary screen working in cell#2.
Windrows in Cell #3 behind equipment.
Metal dump in distance, located beyond landfarm fence.



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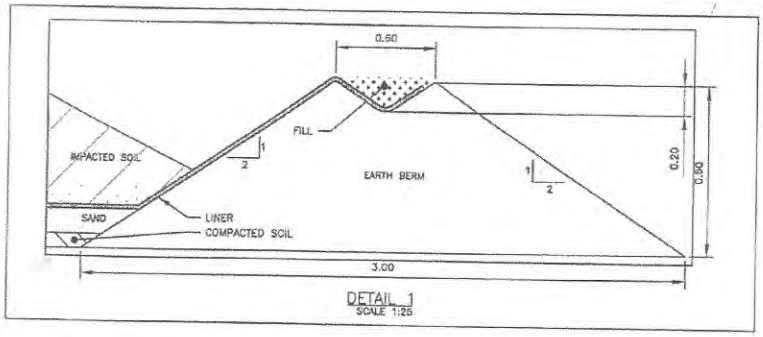
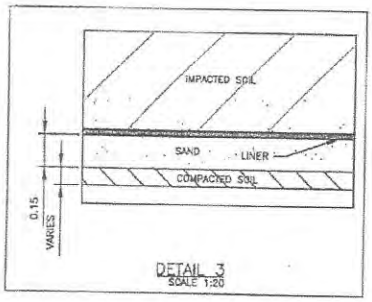


DETAIL 1
SCALE 1:25



DETAIL 3
SCALE 1:20

DILLON CONSULTING

TITLE:	SECTION & DETAILS
SITE:	LAND FARM IQALUIT, NUNAVUT
CLIENT:	NORTHERN FUTURES
PROJECT NO.	00-7944
SCALE:	AS SHOWN
DATE:	JULY 2000
FIGURE NO.	3
REVISION NO.	0

All Cells were constructed using this template.