(In reply, please refer to)
Our File: 07-7400

January 26, 2009

Government of Nunavut
Department of Community and Government Services
Government of Nunavut
2nd floor, GNO 1045
P.O. Box 379
Pond Inlet, NU X0A 0S0

Attention: Mr. Bhabesh Roy, P. Eng.
Municipal Planning Engineer

Landfarm Operations & Maintenance (O&M) Manual
Landfarm, Pond Inlet, Nunavut

Dear Mr. Roy:

Dillon Consulting Limited is pleased to provide you with six copies of the Landfarm Operations & Maintenance (O&M) Manual for the facility designed to accept hydrocarbon contaminated soil in Pond Inlet, Nunavut.

We trust that this report meets your requirements, and look forward to your comments upon your review of this document. If you have any questions or require further information, please contact the undersigned at your convenience.

Yours truly,

Dillon Consulting Limited

Brad Mueller
Project Manager

Attachment

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Dillon Consulting
Limited

TABLE OF CONTENTS

LIST OF APPENDICES

1 INTRODUCTION

Dillon Consulting Limited (Dillon) was retained by the Government of Nunavut (GN), Department of Community and Government Services (CG&S), to develop the design, specifications and Operations and Maintenance (O&M) Manual for the landfarm facility in Pond Inlet, Nunavut.

1.1 Scope of Work and Objective

The scope of work of this project involves the design of a landfarm for the aerobic treatment of soils contaminated with petroleum hydrocarbons of a diesel/heating oil variety. The objective of this manual is to define the O&M procedures specific to this landfarm operation.

1.2 Landfarming Technology Overview

Landfarming has been used at many sites across the Northwest Territories and Nunavut. This process relies on biological degradation and volatilization to remove hydrocarbon-based compounds. To implement the landfarming process, the soil is generally spread in a thin layer (0.15 m - 0.30 m deep) over an area, and then tilled on a regular basis to promote aeration and stimulation of microbial activity. If the soil thickness is increased the process will work equally well, however, the duration of remediation will also increase. Similar to ex-situ biopile remediation, nutrients, moisture and microbes may be added to accelerate the biological degradation of hydrocarbon impacted soils. In some instances, landfarming must be performed over an impermeable liner to prevent the migration of contaminants (leachate) into the underlying native soil and ground water.

1.3 Facility Description

The subject landfarm cell is designed to accept hydrocarbon contaminated soil. No site specific information was used for the design of the landfarm. The landfarm was designed with an area of 1800 square meters and is located within a fenced area.

The cell is approximately 1.5 m in height from existing ground to top of berm and has an inside diameter (top crest of inside berms) of 47.3m by 21.3m in length and width respectively. The surrounding berm is constructed of recompacted native fill, and covered with an impermeable membrane that is keyed into the top of the berm on all four sides. The impermeable membrane is comprised of a 300 mm Arctic Liner® that is underlain and overlain by a 10 oz/yard Non-Woven Geotextile, and covered by 50 mm of fine granular material.

The slopes of the berm are 2.5:1 on the inside slope and 2:1 on the outside slope. A 1.2 m deep (7 m square) retention basin has been constructed in one corner of the landfarm containment berm, and filled with fine granular material. A 100 mm High Density Polyethylene (HDPE) perforated leachate collection

pipe is located at the bottom of the retention basin, connects to a solid pipe on the sloped face and runs to the top of the berm. The leachate collection pipe can be used to control moisture content by removing leachate or water from the retention basin and spraying back onto the contaminated soil.

2 OPERATIONS AND MAINTENANCE PROCEDURES

Landfarming is a full-scale bioremediation technology that requires the excavation of soil and the use of liners to prevent the leaching of contaminants into underlying soils and ground water. Controlling the soil conditions to optimize the rate of contaminant degradation can be achieved by manipulating moisture, aeration, pH, nutrients and bacterial counts. The O&M procedures listed below will help to optimize the rate of contaminant degradation and prevent leaching of contaminants from the landfarm site. The attached Biofarm Cell Operation and Maintenance Site Checklist and Summary Checklist (Appendix B) should also be completed every time the site is visited. The checklist is to be used to record site conditions and activities during every site visit, and helps track to progress of biodegredation.

2.1 Health and Safety

A Health and Safety Plan should be developed to provide comprehensive protection against all known and potential hazards. Specifically, it establishes policies and procedures to protect workers and the public from potential hazards posed by the facility and its operation. A Health and Safety Plan describes the potential hazards at the site, identifies the personnel responsible for health and safety issues, and describes actions to be taken to mitigate the identified hazards.

Where appropriate, on-site safety procedures and equipment should be determined. This pertains to fire extinguishers, first aid kits, telephones/radios, and emergency mustering points. All workers are required to abide by the provisions of this plan. Every worker is required to be familiar with the contents of the plan and adhere to its principles and procedures.

2.2 Snow, Water and Leachate Control

The use of a snow fence on the contaminated soil is not recommended due to the accumulation of excess moisture in the springtime as a result of melting snowdrifts. Excess moisture may facilitate movement of contaminated leachate and water runoff from the containment berm. Minimal amounts of snow should be allowed to accumulate to prevent movement of leachate from the containment berm.

Preventing the movement of contaminants out of the containment berm is imperative. The most critical time is in late spring early summer, when accumulations of snow are melting within the berm. Water collected within the berm should be inspected on a weekly basis during periods of snowmelt, and evaluated as to whether there is a possibility of overflow. If the water level within the containment berm is such that overflow is occurring or is imminent, the following actions should be undertaken:

The leachate collection pipe at the west end of the containment berm should be inspected to determine if hydrocarbon leachate is present at the base of the retention basin.

If leachate is present, water from the pooling area should be pumped into temporary holding tanks such as used 205 L drums or other available tanks. Enough water should be pumped out to stop the berm from over-flowing without emptying it.

If only clean water is present, then a sump pump suction hose should be placed into the water-filled trench at the freeboard of the berm, pumping water outside of the berm and onto the ground surface. Enough water should be pumped out to stop the berm from over-flowing without emptying it.

If no danger is identified, the state of the frozen contaminated soil should be observed and evaluated to commence the summer tilling process. The potential for leachate build-up in the collection pipe should be inspected on a monthly basis once tillage begins.

2.3 Aeration (Tillage)

The containment within the landfarm does not have a cover or shelter of any kind. This allows access to the soil for tillage purposes, increasing microbial activity and biodegradation of contaminants.

After the ground surface has completely thawed, it is recommended that the soil be tilled approximately every three to four weeks (for a total of five times per season) in order to aerate the soil. Tilling of the contaminated soil should continue until average daily temperatures drop below zero degrees Celsius. This will allow the soil microbes that degrade hydrocarbon contaminants to mix thoroughly in the soil, facilitate gas exchange, and increase the rate of metabolism of contaminants.

Early tillage of the soil (as soon as the soil has partially thawed) will increase the temperature of the soil, in addition to providing aeration. This will increase soil microbe activity for biodegradation of soil contaminants.

2.4 Temperature

Temperature has an affect on the biodegradation rates associated with hydrocarbon contaminated soil. Due to the design of a landfarming facility (relatively thin soil; approx. 1 m), soil temperature will vary due to daily and seasonal fluctuations. However, due to the extended daylight hours in Pond Inlet, soil temperatures should remain quite stable during the summer period. Microbial degradation rates are expected to double with every 10°C increase in temperature (Gunnison and Vicksburg, 1991). Soil temperature may be monitored and recorded using a standard glass thermometer inserted in to the soil.

2.5 Soil pH

PH is often used as a guide for the diagnosis of a soil. A soil's pH may influence the bioremediation process since soil microorganisms require a specific pH range to survive. Most bacteria function in a pH range between 5 and 9, with the optimum being slightly above 7 (Dragun, 1988). Very few soils will require dramatic adjustments of their pH. However, if soil pH drops below 5 (i.e., becomes acidic), crushed limestone or agricultural lime should be added. If the soil becomes too basic, sulfur, ammonium sulfate, or aluminum sulfate may be added during the next tilling even to maintain a neutral pH (i.e., close to 7).

Soil pH should be monitored twice a year (once each at the beginning and end of the summer months) following a regular tilling event. Soil pH is best monitored using field pH strips.

2.6 Moisture Control

Microorganisms require moisture to transport nutrients, to carry out metabolic processes, and to maintain cell structure. However, excessive moisture in soil is undesirable because: (a) oxygen availability is reduced by the high fraction of soil pore space occupied by water molecules, and (b) excess moisture increases leaching of contaminants and nutrients from the soil. Ideally, moisture content is considered optimal between 10 and 20% by weight for aerobically bioremediating soils (King et al., 1992).

Due to the extended hours of sunlight during arctic summers, the moisture content of the soil should be inspected during regular tillage events, or more frequently if necessary, to ensure that an optimal moisture content range is achieved. It is likely that the moisture content of the soil will decrease as the remediation proceeds.

The retention basin and leachate collection pipe should be used to control the moisture content within the berm. When the landfarm soils begin to dry, any leachate and/or water from the retention basin can be sprayed back onto the soil to increase moisture content. If water is not available from the retention basin, a water truck can be used to add moisture while tilling is occurring. Increasing moisture is best done by spraying water onto the soil at the same location and time as the tilling activity.

2.7 Nutrient Control

The three (3) principal nutrients necessary for effective bioremediation of hydrocarbon contaminants are carbon, nitrogen, and phosphorus. The ideal carbon to nitrogen to phosphorus (C:N:P) ratio should be 120:10:1 (Bryant, 1998). The contaminants and natural organic compounds in the soil typically provide an adequate amount of carbon for successful biodegradation, however, the availability of nitrogen and phosphorus may often be insufficient in comparison. This can be rectified through the application of fertilizers such as Ammonium Nitrate and Superphosphate® during the first and fourth tillage events.

This will help to increase the activity of the soil microbes that biodegrade soil contaminants by supplementing the nutrient source required for growth. The process of applying fertilizer over a period of two tillage events satisfies the optimal C:N:P ratio of 120:10:1, yet maintains nitrogen and phosphorus levels that are low enough not to be considered toxic to soil microbes. Although nitrogen containing Urea® (46:0:0, N:P:K) has a greater nitrogen weight fraction that Ammonia Nitrate and is available in slow-release polymer coated pills, it is not recommended for use on this project since the minimum required nutrient release temperature is approximately 10°C (thus limiting its effectiveness in colder months). The following table identifies nutrient sources, ratios and quantities that should be used:

Nutrient	Source	Bag Size	Weight Fraction	Nutrient Required	Total Bags	Bags/Tillage
Nitrogen	Ammonium Nitrate	25 kg	0.34	275 kg	33	17
Phosphorus	Superphosphate	25 kg	0.27	27.5 kg	4	2

A nutrient solution can be mixed using water and the indicated number of bags of each nutrient. The solution can be mixed in a 205 L drum, and sprayed onto the soil using a pump and hose during the tillage events. No more than three (3) bags should be mixed per 205 L of water. The process should be repeated six times for each tillage event. Water should be obtained from the collection basin, or from external sources such as a water truck.

The addition of nutrients should be conducted twice during each of the first and second summers, and should be in excess of the minimum 120:10:1 C:N:P ratio since a portion of the added nitrogen and phosphorus will not be biologically available to the soil microorganisms.

A total of 66 bags of Ammonium Nitrate (25 kg) and eight bags of Superphosphate® (25 kg), will be required for two years of operation. *It is critically important that these bags not be left outdoors. The bags need to be stored in a dry environment, preferably off the ground on wooden pallets, and separated from each other.*

2.8 Hydrocarbon Contaminant Monitoring

The hydrocarbon status of the soil should be tested annually to assess the efficiency of the remediation plan. Soil samples collected from contaminated material should be collected no later than mid September, during the tilling process. At this time, ambient air temperatures will still be such that vapour headspace readings are representative of contamination levels.

Samples should be collected from a depth that represents the centre of the material, and should be of a homogenous nature. Each sample taken should be split in two; one half placed into a re-sealable plastic bag, the other half into a laboratory prepared 125 ml glass jar with a Teflon lined lid. The jarred sample is to be placed on ice in a cooler pending possible laboratory analysis, and the bagged sample is allowed to warm for approximately 10 minutes prior to field screening for volatile organic vapours using a Gastech Tracetechtor - Model 1238 (Gastech) combustible gas detector operated in methane elimination mode.

Prior to field use the Gastech must be calibrated using hexane at two points: 400 parts per million by volume (ppm) and 40% of the lower explosive limit (LEL). Volatile hydrocarbon vapours are measured using a fixed-volume headspace technique, in which the bagged soil sample is punctured and the headspace hydrocarbon vapour levels measured. The highest headspace vapour level observed is recorded in ppm or % LEL, as appropriate. For report consistency, headspace vapour levels recorded in % LEL are to be converted to ppm by multiplying by 100. The soils can be adequately characterized by collecting 15 samples, evenly distributed throughout the containment berm, and field screened using the above-mentioned techniques. Based on measured headspace vapour concentration, appearance and odour, three soil samples are to be submitted to a certified laboratory for analysis of hydrocarbon constituents.

Samples are to be collected by hand using single-use nitrile gloves for sampling quality assurance. Soil samples are also to be analyzed for moisture, pH, TPH, nitrogen, and phosphorus.

3 SUMMARY

Dillon was retained by the Government of Nunavut (GN), Community and Government Services (CGS), to develop an Operations and Maintenance (O&M) Manual for the landfarm cell facility designed to accept hydrocarbon contaminated soil in Pond Inlet, Nunavut. This manual was developed along with the landfarm cell design drawings and specifications.

Bioremediation of the hydrocarbon-contaminated soils within the constructed cell will require a combination of soil management strategies including snow removal, tillage, irrigation, moisture monitoring, fertilization, pH control, leaching control, and hydrocarbon monitoring. Utilizing the protocol outlined in this manual will help to optimize the rate of biodegradation of soil contaminants in the cell. The following table summarizes all activities, which need to be undertaken during the minimum first two years of the facility operations. The attached Biofarm Cell Operation and Maintenance Site Checklist and Summary Checklist (Appendix B) should also be completed every time the site is visited to track progress within the cell.

Landfarm Operations and Maintenance: Procedural Checklist

Procedure	When	Action	Frequency
Health and Safety	At the beginning of every season:	Site personnel should conduct a review of the Health and Safety Plan. All personnel should review and understand the site hazards, understand actions to be taken to mitigate hazards, actions to be taken in case of an emergency, and know the locations of safety equipment.	Once per year
	During summer operations:	Understand site hazards, and check proper operation of safety equipment.	Every time on site
Snow, Water and Leachate Control	Just prior to spring thaw:	If excess snow accumulations have occurred within the berm, snow removal will be conducted to minimize the potential of the movement of water/leachate from the berm.	Once per year
	During spring thaw:	Check and record water level within the berm and degree of soil thawing	Twice per month
	During summer operations:	Check and record water level within the berm and check for leachate in soil retention basin.	During tillage activities
Tillage	When soil is thawed (June to September):	Thoroughly turn over soil to a minimum depth of 1 meter, or to the minimum depth of the buffer layer protecting the underlying liner, whichever is less. If the buffer material is encountered during tillage, adjust tillage depth accordingly.	Every 3 to 4 weeks, for a total of 5 times per season.
Soil pH Control	During summer months (June to September):	Check and record soil pH using soil pH kit (should be between 5 – 7). If below 5 add lime.	During first tillage and fourth tillage events.

Landfarm Operations and Maintenance: Procedural Checklist

Procedure	When	Action	Frequency
Moisture Control	During summer months (June to September):	Check and record soil moisture using probe. Make visual observation, (dry/damp/moist wet). Soil should be moist.	During every tillage activity
Nutrient Control	During summer months (June to September)	Mix nitrogen and phosphorus nutrients as required in 205 L drum, add water and spray onto soil.	During first tillage and fourth tillage events.
Hydrocarbon Monitoring	During summer months (August)	Collect and field screen 15 soil samples from soil volume; submit 3 samples of laboratory analyses for moisture, pH, TPH, nitrogen and phosphorus. Record hydrocarbon vapour emission field screening results.	During fourth tillage event.

It is recommended that operations at this landfarm cell be conducted for a minimum of two years, after which the analytical results can be evaluated, and a future course of action be determined. A total of 66 bags of Ammonium Nitrate (25 kg) and eight bags of Superphosphate® (25 kg) will be required for two years of operation.

It is critically important that these bags not be left outdoors. The bags need to be stored in a dry environment, preferably off the ground on wooden pallets, and separated from each other.

4 CLOSURE

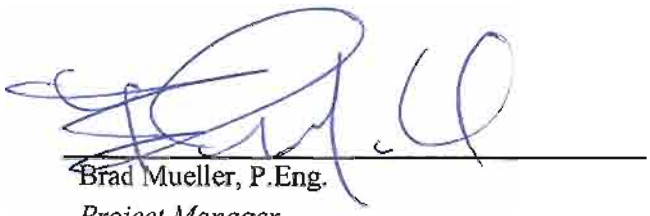
This report was prepared exclusively for the purposes, project, and location outlined in the report. The report is based on information provided to, or obtained by Dillon as indicated in the report, and applies solely to the proposed design. As no site specific information was available for the preparation of this report, details on the nature of the contaminated soils are not included. Rather, Dillon's report represents a reasonable review of available information within an established work scope and schedule.

This report was prepared by Dillon for the sole benefit of the Client and is not to be relied upon by any other party without Dillon's express written consent. The material in it reflects Dillon's best judgement in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We trust this submission meets your requirements. If you have additional questions please contact the undersigned at your convenience.

Respectfully submitted,

Dillon Consulting Limited



Brad Mueller, P.Eng.
Project Manager

5 REFERENCES

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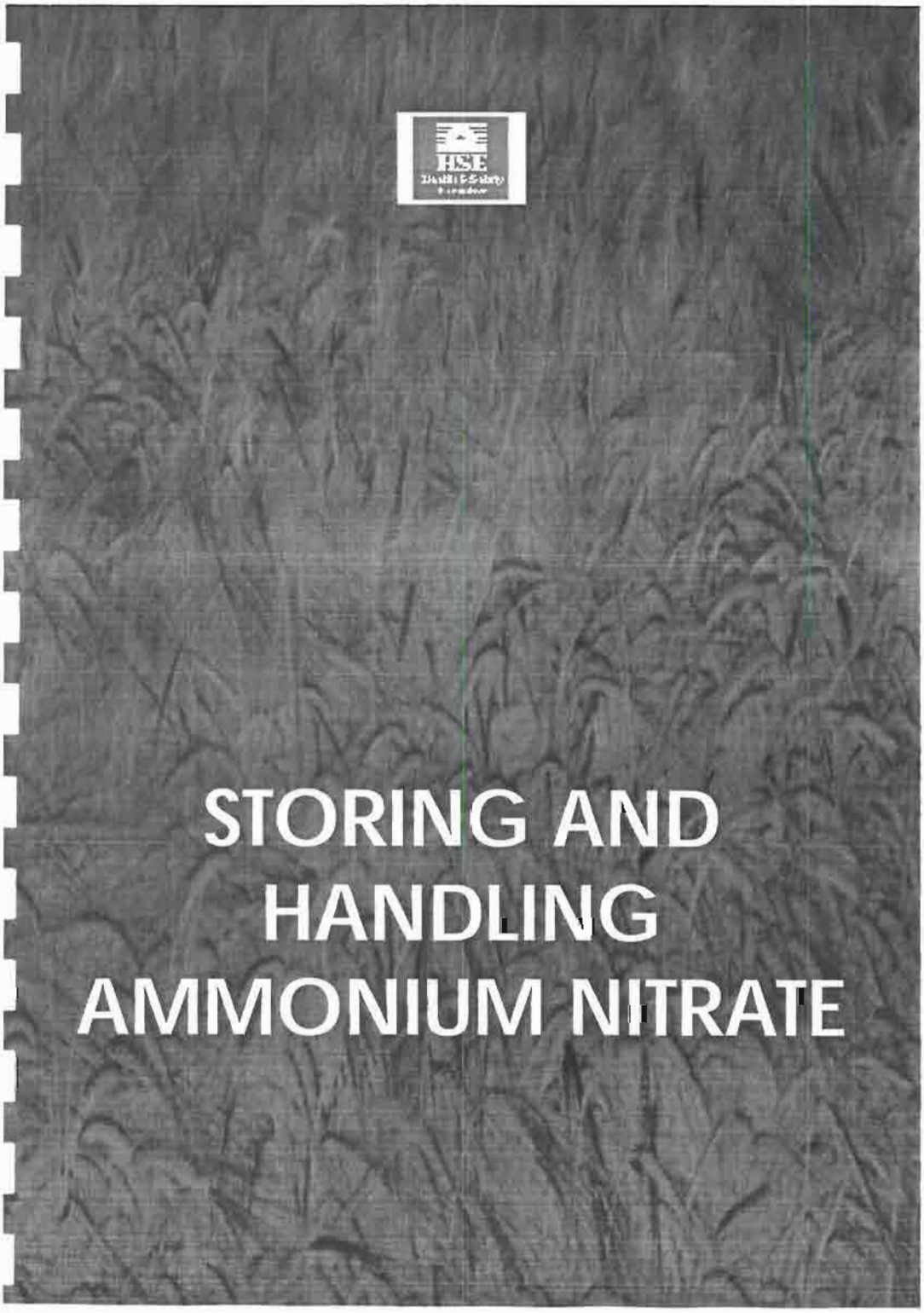
APPENDIX A

SAFETY INFORMATION


HSE
STORING AND
HANDLING
AMMONIUM NITRATE

INTRODUCTION

The Health and Safety at Work etc Act 1974 imposes general duties to ensure that workers and others are protected against risks to their health and safety from work activities. This leaflet has therefore been produced to help duty holders to ensure the safe storage and handling of ammonium nitrate at, for example, harbours, merchant stores and manufacturers' premises. The main use of ammonium nitrate is as a fertiliser, marketed either as prills (small spheres) or granules. The different types of ammonium nitrate fertiliser are described at the end of this leaflet.

This leaflet does not apply to the following, although many of the general principles may still be relevant:

- transport;
- ammonium nitrate classified as an explosive and assigned to Class 1 of the UN classification system. This would be subject to controls under the Explosives Act 1875;
- storage of ammonium nitrate fertilisers in quantities below 1 tonne, provided good housekeeping standards and sensible separation from incompatible materials are maintained. For fertilisers that contain 28% or less nitrogen (see the label or other hazard information) this limit is raised to 50 tonnes.

PROPERTIES AND HAZARDS

Ammonium nitrate has a melting point of 170°C and decomposes above 210°C. It is not in itself combustible but, as it is an oxidising agent, it can assist other materials to burn, even if air is excluded.

Ammonium nitrate will not explode due to the friction and impact found in normal handling, but it can be detonated under heat and confinement or severe shock. For example, in a fire, pools of molten ammonium nitrate may be formed and if the molten mass becomes confined (eg in drains, pipes, plant or machinery) it could explode, particularly if it becomes contaminated.

In a fire, all types of ammonium nitrate may melt and decompose with the release of toxic fumes (mainly oxides of nitrogen) which may be yellow or brown. Most types do not continue to decompose once the fire has been extinguished. However, when some types of ammonium nitrate fertilisers (cigar burners) are heated they undergo a smouldering (self-sustaining) decomposition that can spread throughout the mass to give substantial toxic fumes, even when the initial heat source is removed.

The risk of fire or explosion is greatly increased if ammonium nitrate is mixed with combustible or incompatible materials, such as powdered metals, alkali metals, urea, chromium or copper salts, organic and carbonaceous materials, sulphur, nitrites, alkalis, acids, chlorates and reducing agents (consult data sheets to establish if a substance has reducing properties).

PRECAUTIONS

The precautions described here are primarily designed to minimise the risk of explosion, however they can also reduce the risks associated with oxidising properties and the release of toxic fumes in a fire.

Fertilisers that contain 28% or less nitrogen (see the label or data sheets for the percentage of nitrogen present) do not normally present an explosion hazard and therefore, to identify the precautions required, ammonium nitrate based fertilisers can be divided into two groups:

- Fertilisers that contain more than 28% nitrogen. Most of these are straight ammonium nitrate types, although they include a small number of compound fertilisers.
- Fertilisers that contain 28% or less nitrogen. Compound fertilisers form the major proportion of this group. The straight nitrogen types are usually a mixture of ammonium nitrate with limestone or similar inert materials.

AMMONIUM NITRATE AND AMMONIUM NITRATE FERTILISERS

This section concerns ammonium nitrate and ammonium nitrate fertilisers that contain more than 28% nitrogen.

The risk of an explosion is increased by a combination of the following:

- heating ammonium nitrate (eg in a fire);
- contamination;
- serious confinement (eg in drains or enclosed parts of equipment).

To minimise the risk of explosion it is therefore important to take precautions against each of these situations.

The Fertilisers Regulations 1991, as amended, require all straight ammonium nitrate fertiliser with more than 28% nitrogen, sold for final use in the UK, to be packaged and meet certain quality criteria, minimising the risk of contamination and therefore explosion.

Storage areas

Ammonium nitrate should normally be stored in single storey, dedicated, well-ventilated buildings that are constructed from materials that will not burn, such as concrete, bricks or steel. Clean the store before it is used for ammonium nitrate.

However, in some circumstances, such as where the stores are located near to densely populated areas, it may be better to store ammonium nitrate outside, provided it is in a secure area away from combustible materials and sources of contamination. Such outdoor storage can remove or reduce the risk of, for example, fires due to electric lights and other equipment. However, if ammonium nitrate is stored outdoors it may be necessary to consider methods to prevent it deteriorating due to sunlight or water (eg covering it with sheets or shrink-wrapping and ensuring that water can run away from the storage area).

Avoid drains, channels or pits where molten ammonium nitrate from a fire could become confined. Where the presence of drains, etc is unavoidable, they should be protected so that molten ammonium nitrate cannot run into them.

Locate storage away from possible sources of heat, fire or explosion, such as oil storage, gas pipelines, timber yards, flammable liquids, flammable solids and combustible materials.

Arson and faulty or damaged electrical equipment are major risk factors for warehouse fires, so prevent unauthorised access to the store. Ensure regular inspection and maintenance of electrical equipment and fittings. Damage from animals can be limited by implementing a pest control system.

Stacks

Self-confinement of straight ammonium nitrate in large stacks can increase the risk of a detonation of the whole stack in a fire, so limit stacks to a maximum of 300 tonnes. This limit may be raised at purpose-built stores at manufacturing sites, provided that the other recommendations in this leaflet are followed and the material complies with the quality specification in the Fertilisers Regulations 1991.

Keep straight ammonium nitrate of relatively low density (ie non-fertiliser grade below 900 kg/m^3 - see the label or other documents)

to stacks of approximately 2 m high and 3 m wide, but again this limit may be raised at purpose-built stores.

To help prevent fires and other heat sources from affecting stored ammonium nitrate, and to allow access to stacks in an emergency, leave a space of at least 1 m between stacks and between the stack and the walls, roof or any electric lights or heating pipes. Check the height of doors, beams and electrical equipment in relation to that of any lifting equipment used, such as fork-lift trucks.

Do not allow ammonium nitrate, including when molten in a fire, to come into contact with materials such as flammable liquids, powdered metals, acids, chlorates, nitrates, zinc, copper and its salts, oils, grease, gas cylinders and chemicals of incompatible or unknown properties. Do not store ammonium nitrate in the same building as such materials.

When it is absolutely necessary to store urea and ammonium nitrate products in the same building, keep them in such a manner that they cannot mix with each other in any likely accident. This can be achieved by keeping the materials in separate bays which have walls that extend at least 1 m beyond the limit of storage of each material.

Do not store ammonium nitrate that contains more than 28% nitrogen in the same stack as other products.

On farms, separate ammonium nitrate fertiliser from hay, straw, grain, feedstuffs, or other combustible materials by a suitable fire break, such as a distance of at least 5 m or a barrier of inert material of at least 1.5 m (eg one pallet) width.

General precautions

For ease of movement and stability of the stacks keep 50 kg bags palletised. To prevent spillage and contamination make sure that the bags have been completely sealed on filling, are made of a material that is impermeable to water or oil, and are strong enough to withstand damage during normal storage, handling and conveyance. Paper packaging alone is therefore unsuitable. It is recommended that 50 kg bags have microvents to avoid ballooning and consequent instability in stacks.

Where wooden pallets are used check that they are not damaged or significantly contaminated. Do not store unused pallets in, or against the walls of, the store because of the increased risk of fire affecting the ammonium nitrate. Where it is necessary to keep the pallets in the store, separate them from the ammonium nitrate by a suitable fire break or partition.

APPENDIX B

SITE CHECKLIST

BIOFARM CELL OPERATION AND MAINTENANCE SITE CHECKLIST

	Actions	Check	Comments
1	**DATE (dd/mm/yyyy)**		
2	**Identify Site Hazards**		
3	**Check First Aid Equipment**		
4	**Check Fire Extinguisher**		
5	**Snow Removal:** (Late Spring)		
6	**Snowmelt:** Check water level within berm		
7	**Snowmelt:** Check degree of soil thawing		
8	**Operation:** Check water level within berm		
9	Tillage: (every 3 to 4 weeks)		
10	**Soil pH:**		
11	**Addition of Lime ?** (Yes or No)		
12	**Soil Moisture:** visual observation (dry/damp/moist/wet)		
13	**Addition of Nitrogen**		
14	**Addition of Phosphate**		
15	**Soil Sampling / Monitoring**		

Site Visit Conducted By: _____

BIOFARM CELL OPERATION AND MAINTENANCE - SUMMARY CHECKLIST

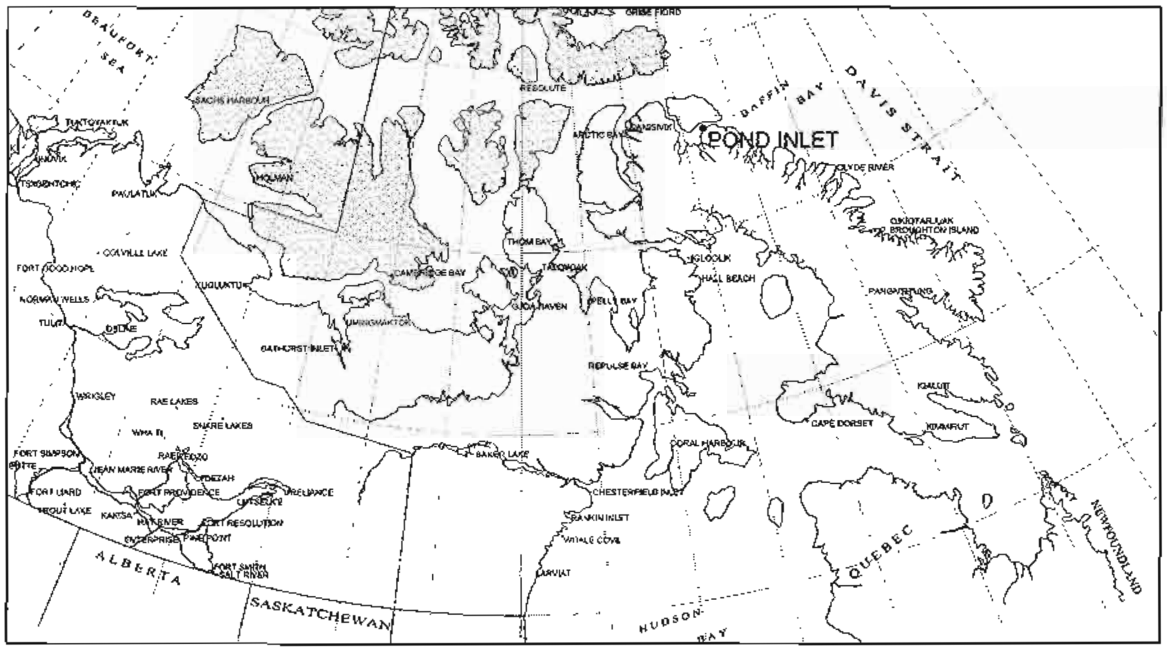
Date (dd/mm/yyyy)	Health and Safety			Snow, Water and Leachate Control					Tillage: (every 3 to 4 weeks)	pH		Moisture	Nutrient Addition		Soil Sampling / Monitoring	Site Personnel Initials
	Identify Site Hazards	Check First Aid Equipment	Check Fire Extinguisher	**Spring:** If significant quantities of snow present within berm (REMOVE SNOW)	**Snowmelt:** Check water level within berm	**Snowmelt:** Check degree of soil thawing	**Operation:** Check water level within berm	**Operation:** Check for leachate in collection pipe		**Soil pH**	**Addition of Lime ?** (Yes or No)	**Soil Moisture:** visual observation (dry/damp/moist/wet)	**Nitrogen:** Urea (# of bags)	**Phosphorus:** Superphosphate (# of bags)		

APPENDIX C

DRAWINGS

THE GOVERNMENT OF NUNAVUT
COMMUNITY AND GOVERNMENT SERVICES

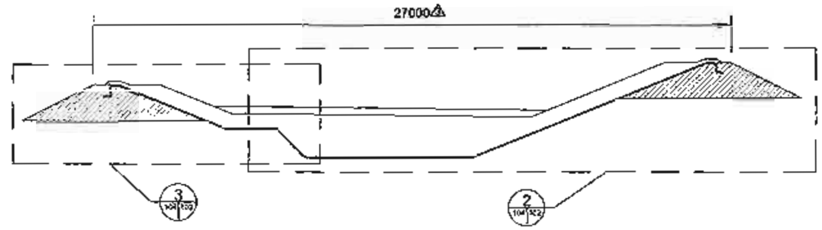
PROJECT: POND INLET LANDFILL CONSTRUCTION - RECORD DRAWINGS
LOCATION: PONE INLET, NU
PROJECT NO: 07-7400-1000
DATE: JANUARY 2009



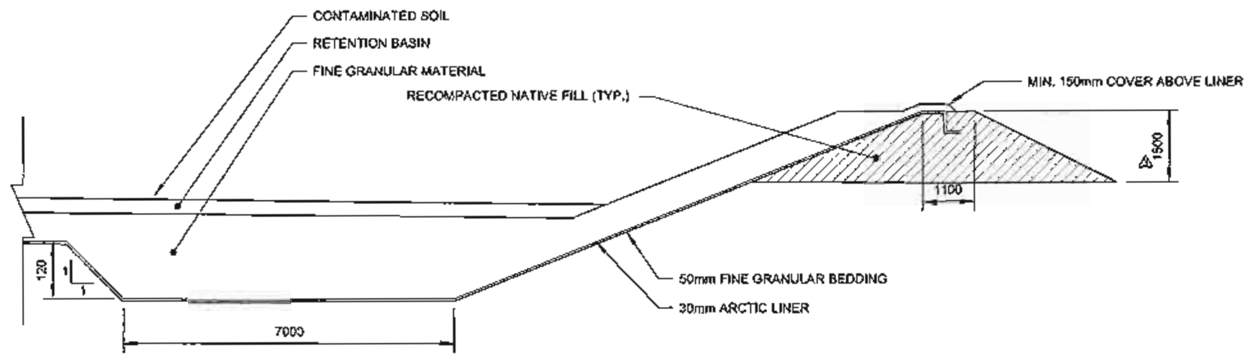
List of Drawings	
Sheet Number	Sheet Title
100	Cover
101	Lagoon Plan
102	Lagoon Sections and Details
103	Chain Link Fence and Monitoring Well Details

DILLON CONSULTING

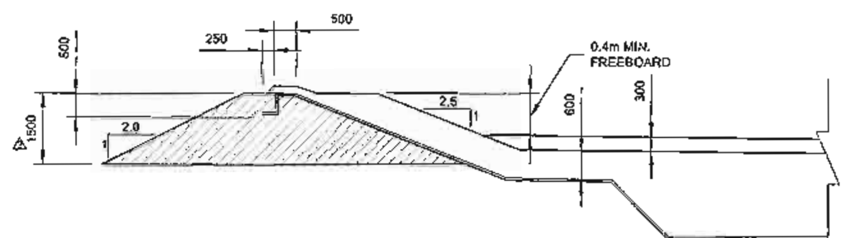
DRAWING NUMBER 100



LANDFARM SECTION
SCALE 1:200



LAND FARM DETAIL
SCALE 1:100



LAND FARM DETAIL
SCALE 1:100

NOTES:

1. DIMENSIONS IN MILLIMETERS UNLESS NOTED OTHERWISE.

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RECORD DRAWING

CHANGE	DATE	DESCRIPTION	CHECK
△	01/28/09	RECORD DRAWINGS	GS
2	05/17/07	ISSUED FOR TENDER	GS
1	08/05/05	ISSUED FOR CLIENT REVIEW	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	TPW	GS	JAN 2009

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 010
DILLON CONSULTING LIMITED

PROFESSIONAL ENGINEER
REGISTERED
G. STRONG
NWT

Nunavut

PROJECT

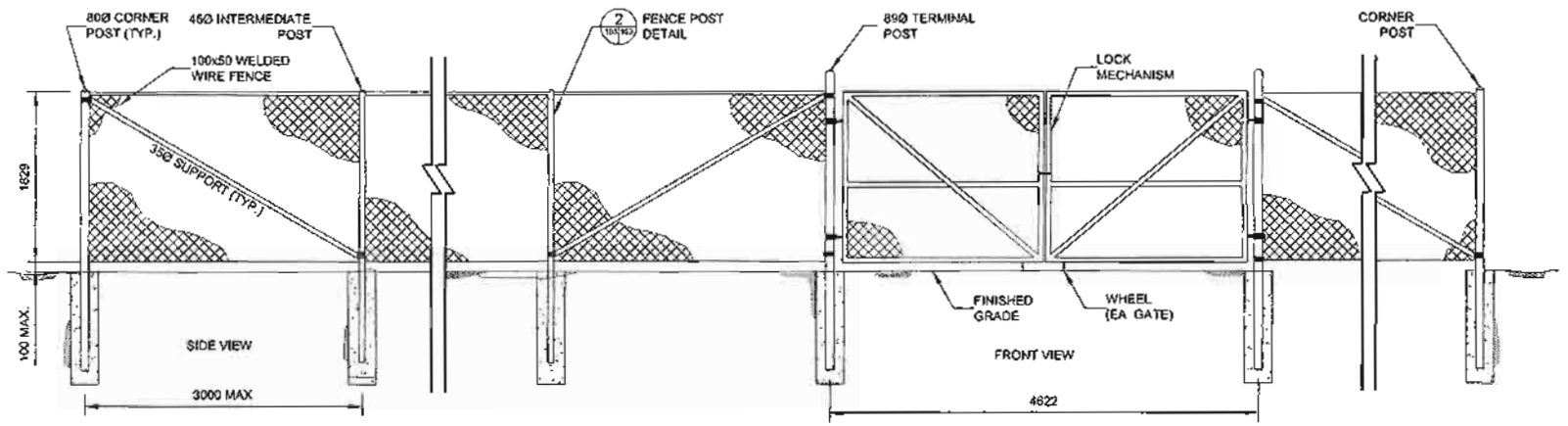
GOVERNMENT OF NUNAVUT
POND INLET LANDFILL
CONSTRUCTION

TITLE

LAGOON SECTIONS AND DETAILS

DILLON CONSULTING

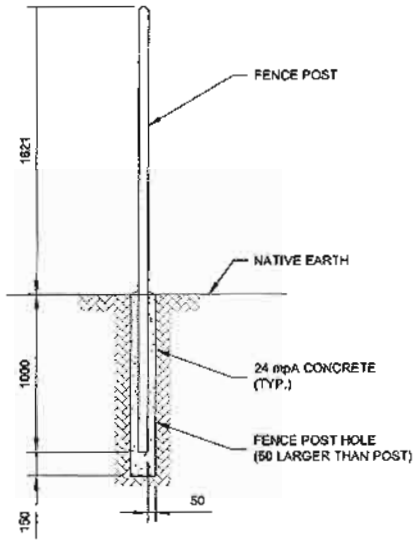
SCALE	AS SHOWN
DILLON PROJECT NUMBER	07-7400-1000
CLIENT PROJECT NUMBER	07-7400-1000
DRAWING NUMBER	102



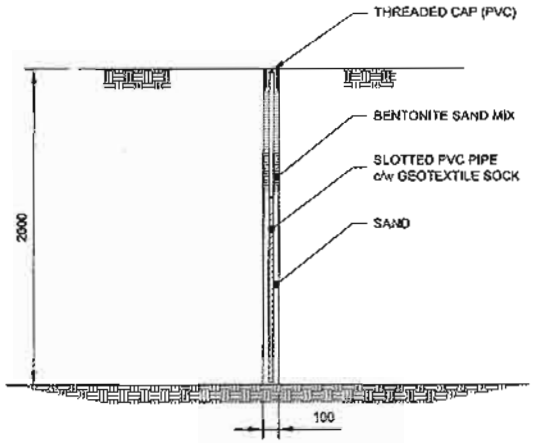
1 CHAIN LINK FENCE DETAIL
SCALE 1:50

NOTES:

1. DETAIL SHOP DRAWINGS TO BE SUBMITTED OF FENCING SYSTEM FOR REVIEW AND APPROVAL.
2. PADLOCK AND TWO KEYS TO BE PROVIDED FOR EACH GATE - ALL LOCKS KEYED ALIKE.
3. ALL FENCING TO BE HOT DIPPED GALVANIZED.
4. GATE AND CORNER POSTS TO BE SET INTO CONCRETE BASE. PROVIDE DIAGONAL BRACING @ 30m INTERVALS AND AT CORNER POSTS.
5. INTERMEDIATE POSTS TO BE MAX. 3000 c/c SPACING OR AS RECOMMENDED BY FENCING SUPPLIER.



2 FENCE POST DETAIL
SCALE 1:20



3 MONITORING WELL DETAIL
SCALE 1:20

NOTES:

1. DIMENSIONS IN MILLIMETERS UNLESS NOTED OTHERWISE.

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RECORD DRAWING
Jan 26/09

CHANGE	DATE	DESCRIPTION	CHECK
3	01/26/09	RECORD DRAWINGS	GS
2	05/17/07	ISSUED FOR TENDER	GS
1	04/06/06	ISSUED FOR CLIENT REVIEW	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	TPW	GS	JAN 2009

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 010
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER
G. STRONG
NWT

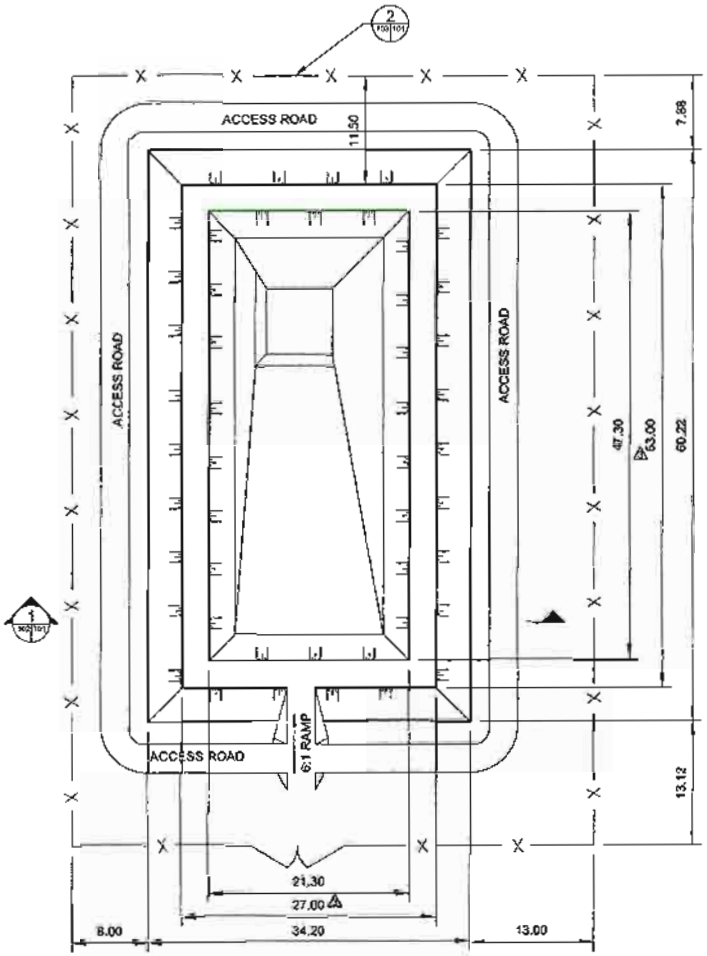
Nunavut

PROJECT
GOVERNMENT OF NUNAVUT
POND INLET LANDFILL
CONSTRUCTION

TITLE
CHAIN LINK FENCE AND MONITORING WELL DETAILS

DILLON CONSULTING

SCALE	AS SHOWN
DILLON PROJECT NUMBER	07-7400-1000
CLIENT PROJECT NUMBER	07-7400-1000
DRAWING NUMBER	103



NOTES:

FINE GRANULAR BEDDING AND EMBANKMENT (RECOMPACTED NATIVE FILL) COMPACTED TO 95% OF PROCTOR DENSITY AT THE DISCRETION OF THE SITE ENGINEER.

CONTAMINATED SOILS FROM SPILL AREA STOCKPILE WILL BE EXCAVATED AND HAULED ALONG DESIGNATED ROUTE AND DEPOSITED AT THE SOIL REMEDIATION FACILITY LOCATED AT THE COMMUNITY LANDFILL AREA.

SCOPE OF WORK FOR SOIL REMEDIATION PROJECT:

EXCAVATE SOILS AT THE STOCKPILE AS INDICATED. MATERIALS HAULED TO FACILITY ARE TO BE DISTRIBUTED IN TREATMENT CELL TO A MAXIMUM THICKNESS OF 300mm.

CONTAMINATED SOILS TO BE REMEDIATED BY PERIODIC TILLAGE AS PER SPECIFICATIONS.

TO MAINTAIN THE CONTAMINATED SOILS AT OPTIMUM MOISTURE CONTENT, WATER COLLECTED FROM THE LEACHATE COLLECTION SYSTEM IS TO BE SPRAYED IN THE CELL. EXCESS WATER IS TO BE PUMPED FROM THE LEACHATE COLLECTION SYSTEM AND DEPOSITED IN ACCORDANCE WITH THE GENERAL REQUIREMENTS SECTION OF THE SPECIFICATION AND THE APPLICABLE REGULATIONS.

EXCAVATIONS AT THE RESUPPLY AREA TO BE BACK FILLED AFTER ALL CONTAMINATED MATERIALS HAVE BEEN REMOVED AND CERTIFIED "CLEAN" BY THE OWNER.

FOLLOWING SUCCESSFUL REMEDIATION OF ALL CONTAMINATED SOILS, ALL REMEDIATED SOILS FROM TREATMENT CELLS ARE TO BE HAULED AND SPREAD IN A LOCATION SPECIFIED BY THE CONSULTANT ON SITE.

FOLLOWING REMOVAL OF CONTAMINATED SOILS FROM TREATMENT FACILITY, DECOMMISSION SOIL REMEDIATION FACILITY AND RESTORE ALL CONSTRUCTION AND OPERATION AREAS TO CONDITION EQUAL TO OR BETTER THAN WHICH EXISTED PRIOR TO CONSTRUCTION.

SEE SPECIFICATION FOR FURTHER DETAILS AND INSTRUCTIONS.

NOTES:

DIMENSIONS IN METERS UNLESS NOTED OTHERWISE.

RECORD DRAWING

CHANGE	DATE	DESCRIPTION	CHECK
4	01/26/09	RECORD DRAWINGS	GS
2	05/17/07	ISSUED FOR TENDER	GS
1	03/08/06	ISSUED FOR CLIENT REVIEW	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	TPW	GS	JAN 2009

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 010
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER
G. STRONG
NWT

Nunavut

PROJECT

GOVERNMENT OF NUNAVUT
POND INLET LANDFILL
CONSTRUCTION

TITLE

LAGOON PLAN

DILLON CONSULTING

SCALE	AS SHOWN
DILLON PROJECT NUMBER	07-7400-1000
CLIENT PROJECT NUMBER	07-7400-1000
DRAWING NUMBER	101

EDIT DATE: 27.01.2009 PLOT DATE: 27.01.2009 ACAD FILE: 413w:\cad\07\7400\work\07100-work.dwg