Wednesday, July 25, 2007

Nunavut Water Board
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Attention: Mr. Joe Murdock
Technical Advisor

Re: Taloyoak Landfarm Project Water License Application

Dear Mr. Murdock:

In a preliminary technical review dated October 24th, 2006, the Nunavut Water Board requested further information relating to the application for water license **NWB4TAL**. The information follows the format of the review, addressing all 10 points.

1. *Introduction*

The landfarm was constructed in September 2002, and filled with contaminated soil during the same month. Mr. Robert Eno, of the Environmental Protection Service in the Department of Sustainable Development (Government of Nunavut), was contacted at that time and approved the project (correspondence attached). It was understood at that time, that no further approvals would be required.

2. *Landfarm Facility Sizing and Discharge*

a) The landfarm was sized based on a Phase III Environmental Site Assessment, conducted in 2000. That investigation estimated that 1700 m^3 of contaminated soil, at both the Bulk Fuel Storage Facility and re-supply areas would require remediation. Further details about the water storage are provided below.

b) The dimensions of the landfarm are 33 m by 33m, with a height of 1.8 m. Side slopes are 2.5:1 on the inside (and 2:1 on the outside). Based on these dimensions, the landfarm has a volume of 1474 m^3. (This value is smaller than the estimated volume of contaminated material (2a), as the material in the landfarm can be heaped above the level of the berms.) During the excavation, 750 m^3 of soil were excavated and placed in the landfarm, leaving at least 724 m^3 for water storage. The soils themselves also have a capacity to hold water. The excavated material was described as a sand and silty clay, with some pebbles and cobbles. The porosity of a coarse sand is estimated to be 38%

(http://cru.cahe.wsu.edu/CEPublications/pnw0475/pnw0475.html), giving rise to more water storage space.

Overflowing water in the landfarm is not typically a problem, especially in the north. The climate tends to be dry, and water is usually required over the course of the treatment season.

If they are to occur, high water levels will most likely occur in the spring, following snowmelt. If overflowing is imminent, water will be pumped from the landfarm, into holding tanks/drums. It is likely that the water will need to be added to the landfarm later in the season, to keep soils moist. Moisture in the soils is required to enhance biodegradation. The landfarm is intended to treat the contaminated soils, and any water that has come in contact with them.

Discharge of clean water from the landfarm is not usual practice. It would only occur if there is significant snow melt, and when analyzed, the water did not contain high concentrations of contaminants. Excess water would more than likely be placed into holding tanks/drums for re-application later in the summer.

c) Water will be re-circulated on the landfarm with the use of a pump and hose (provided by the contractor). Water will drain to the low corner (where the retention basin is located). The hose will be placed into the leachate collection pipe and water will be pumped from this collection area, and placed either back on the landfarm or in holding tanks/drums, for a later application.

Based on the climate data available from Environment Canada for Cambridge Bay (no data is available for Taloyoak), annual precipitation amounts to approximately 14 cm. Over an area of 33 m by 33m, this corresponds to a volume of 152 m^3 of rainwater each year. As indicated in 2(b), there is 724 m^3 of space available for water storage. It is anticipated that most of this water will evaporate over the warm season, and an annual accumulation of rainwater is not expected. If, in the event of a very wet year, the landfarm cannot hold the excess water, it will pumped into storage tanks/drums and re-applied at a later date.

The design life of the facility can be dependent on the size of the landfarm or the design life of the liner. If built large enough, landfarms can hold contaminated material from several sources over several years. Based on the liner used in this facility, a 30 mil (0.762 mm) Arctic Liner, the design life can range from about 10 to more than 50 years. (In the O&M Manual, the liner is described as a 300 mm Arctic Liner; however, this is likely a misprint.) When exposed to the sun, the design life is approximately 10 years, but when it is covered, as it is in this case, the design life can be greater than 50 years (information obtained from distributor). However, if the liner becomes torn during operation of the landfarm (i.e. tilling), the facility is no longer useful.

The volume of water of 5.0 m^3/day is quite high, and it is not expected that this volume will be required. However, if a dry year were to occur, water would be required to keep the soils moist. This volume is high for that situation.

d) The landfarm has been built such that the bottom is graded to a low corner, where the retention basin is located. The retention basin is approximately 3.5 m by 3.5 m and 1.1 m deep, and filled with granular material. Should water start to accumulate along the toe of the berm, it will be pumped from this retention basin and be re-applied to the soils in the landfarm.

e) The removal of snow from the top of the landfarm will be based on a visual assessment. It will only occur when there are large drifts, and the top portion is easy to remove. This clean snow should not need special disposal procedures. Snow that has been mixed with the soil in the landfarm, as determined visually, will not be removed. If only a thin layer of snow exists on top of the landfarm, it will not be removed. Contaminated snow will remain in the landfarm for treatment.

3. Health and Safety Plan

A health and safety plan has been prepared and is attached to this letter.

4. Further Detail of Southwest Corner

In addition to the description in the O&M Manual (Section 1.3 Facility Description) and the record drawings of the facility, no further details are available for this southwest corner. The perforated 100 mm HDPE pipe has been laid along the bottom of the retention basin, for water collection. A solid pipe has been attached to this perforated pipe, running along the sloped face of the berm, to the top of the berm. To pump out water, a hose can be placed down the solid portion of the pipe, to reach the water in the retention basin.

5. Soil Deposit and Operation into Landfarm Facility

As the landfarm was constructed in 2001, and the personnel involved are no longer available for contact, this question will be answered based on common practices. Generally movement of vehicles inside the landfarm is kept to a minimum, as that is what could cause a tear. There are a couple of methods of depositing soil into the landfarm, to ensure the liner is not torn:

- A back hoe could be placed just inside the landfarm. Trucks transporting the contaminated soil to the landfarm would deposit their loads just outside the landfarm. The back hoe would reach over the berm to the pile of sand, and deposit it inside the berm.
- A central road can be constructed down the middle of the landfarm, with thicker layer of compacted granular material. All equipment would travel along this roadway. A back hoe would spread soil to either side.
- Only select vehicles with broader weight distribution would be used inside the landfarm.

As the design drawings do not show the present of a central road, and equipment available is limited in Taloyoak, it is likely that the first method was used. An engineer was on-site for the construction of the landfarm, and no tears in the liner were noted.

6. Nutrient Control and Monitoring

The following table summarizes the lab results of samples taken during the Phase III Environmental Site Assessment, conducted in 1999. Closure samples were taken during the excavation in 2001, however samples were taken to ensure all contaminated material had been removed, and are not representative of the material placed in the landfarm. It should be noted that the Phase III ESA was conducted prior to the adoption of the fraction guidelines by CCME (F1: C6-C10, F2: >C10 – C16, F3: >C16 – C34 and F4: >C4), so results were compared to the total petroleum hydrocarbon industrial guideline of 2500 ppm.

Table 1: Summary of Soil Characterization Results

Parameter	Units	Sample ID and Location				Guideline
		TAL-11	TAL-22	TAR-6	TAR-14	
		Tank Farm	Tank Farm	Re-Supply Line	Re-Supply Line	
Benzene	ppm	0.08	<0.05	<0.05	<0.05	5
Toluene	ppm	10	<0.1	<0.1	<0.1	0.8
Ethylbenzene	ppm	3.5	<0.1	<0.1	0.1	20
Xylene	ppm	95	<0.1	0.5	0.5	20
C6-C10	ppm	645	<10	<10	166	NS
C11-C16	ppm	2800	2200	1800	2100	NS
C17-C33	ppm	400	1000	1400	600	NS
C34-C50	ppm	<50	<50	200	<50	NS
TPH	ppm	3845	3200	3400	2866	2500

As assumptions are made during the nutrient requirement calculations, it is easiest to work backwards from the given information, and then determine if the assumptions make sense. In this case, it has been recommended that 275 kg of nitrogen be added, and 27.5 kg of phosphorus. Keeping a carbon:nitrogen:phosphorus (C:N:P) ratio of 120:10:1, there would need to be 3300 kg of carbon in the landfarm.

From the results in Table 1, the average hydrocarbon concentration is 3328 mg C/kg soil. Dividing the mass of carbon (3300 kg C) by this concentration produces a mass of 1,000,000 kg of soil in the landfarm. Approximately 750 m^3 of soil were transferred into the landfarm, therefore the density of the material would be 1330 kg/m^3. The following table summarizes densities for certain materials (taken from the following website: http://www.simetric.co.uk/si_materials.htm):

Table 2: Densities of Materials

Material	Density (kg/m^3)
Loose sand	1442
Wet sand	1922
Sand with gravel (dry)	1650
Sand with gravel (wet)	2020
Clay - dry excavated	1089
Clay – wet excavated	1826

As the excavated material was classified as sand and silty clay, with some pebbles and cobbles, a density of 1300 kg/m^3 does not seem unreasonable. Therefore, the amount of nitrogen and phosphorous required is reasonable.

To ensure the C:N:P ratio is kept as close to 120:10:1 as possible, samples will be collected just prior to aeration to determine if further nutrient addition will be required. This will occur twice over the course of the summer. Samples will be analyzed for hydrocarbons, as well as nutrient concentrations and calculations similar to the above will be conducted to determine if sufficient nutrients remain in the soil for biodegradation of the hydrocarbons.

If analytical results indicate hydrocarbon concentrations in the soil are below guidelines, decommissioning of the landfarm facility will be recommended. It is unlikely that some "clean" material will be removed prior to all material being considered "clean", as the landfarm is not that full (see calculations in 1(a)). If clean material were to be removed, a thorough sampling program would be implemented, and then the surface soils would be scraped away with an excavator, the depth of which would be determined by the sampling program.

A soil vapour survey will be conducted prior to collecting samples, to determine the location of the samples. The landfarm will be divided into a grid, with squares approximately 5 m by 5 m. At each grid point, a vapour reading will be taken with a hydrocarbon vapour reader. Locations with the highest vapour readings will be targeted for sample collection. Samples will be collected towards the bottom of the pile (as this material will likely have higher concentrations of hydrocarbons). The exact depth will be determined during sampling.

7. *Contingency to Counter Mishaps in Treatment Process and Capacity*

If, after 2 years of treatment, sample results indicate that hydrocarbon concentrations have not decreased below recommended guidelines, another year of treatment will be recommended. If hydrocarbon concentrations appear to be reaching a plateau, where no more biodegradation will take place, the following options will be considered:

- Remove upper layer of "clean" soil (following receipt of sample results), so lower layers can be exposed to oxygen, and biodegradation will be promoted;
- Re-assess nutrient concentrations, and adjust if necessary;
- Consider bioaugmentation, to increase numbers of microorganisms in the landfarm;
- Cover landfarm, to increase temperatures, and extend treatment season. This will increase activity of micro-organisms.

8. *Groundwater Monitoring*

No groundwater monitoring is currently being conducted in the vicinity of the landfarm. As no tears in the liner were noted during soil placement, and aeration of the landfarm has not yet occurred, it is unlikely that holes in the liner have developed.

9. Engineering Drawings and Proctor Compaction

Stamped and signed drawings have been attached to this letter, as well as a stamped and signed copy of the final report.

Proctor compaction is usually measured in the field with a nuclear densometer. Due to the shipping limitations of this instrument, it is often not used for simple projects in the north. It is likely that the field engineer determined the proctor compaction by visual observations in this case.

10. Ammonium Nitrate and SuperPhosphate Location

The nutrients are currently being stored at the Hamlet garage. About 30 25-kg bags are being stored outdoors, in a sealed crate. According to the Hamlet SAO, there is no access to outdoor weather. The individual, plastic bags have not been opened, and remain in good condition.

Yours truly,

Navjit Sidhu, EIT
Project Officer