WARDROP

May 1, 2006

0222880802-LTR-V0001-00

Mr. Joe Murdoch
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0E 1J0

Dear Mr. Murdoch

Subject Proposed Soil Landfarm, Hamlet of Kugaaruk, Your File NWB4KRK

The Nunavut Department of Public Works and Services has directed Wardrop to provide responses to the issues raised in your Preliminary Technical Review, dated October 19, 2005, of the Water Licence Application submitted for the Kugaaruk Landfarm Project. The responses have been prepared in the same sequence as the issues in your review document.

1. Discharge from the water retention area will be achieved with the use of a gasoline driven pump with a rated capacity of 100 to150 gallons per minute. The pump will be set up immediately adjacent to the landfarm, with a short suction hose running into the retention cell. The hose will be fitted with floating basket intake to prevent any unnecessary disturbance of the granular material on the base of the cell.

   It has now been confirmed by our client that the proposed sewage lagoon and landfill, shown in earlier drawings as being adjacent to the landfarm, will not be constructed at this location. Therefore, the plan for discharge of the water retention cell will be to construct a splash pad approximately 25 m southwest of the landfarm. The splash pad will be constructed of rock and concrete and will be configured to allow the discharge water to dissipate through natural drainage patterns downstream to the west. Water would be conveyed to the splash pad by hose or temporary pipe laid on the ground during the discharge period.

   Initially it is proposed that the retention cell be discharged after spring melt and again in mid-August to ensure that sufficient capacity is available for severe weather events. It is estimated that total pumping time per discharge event will be in the order of 60 hours, depending on the actual volume of liquid in the cell. Pumping will occur only during daylight hours while the operation is monitored.

   Water quality sampling will be undertaken prior to any discharge operations to confirm that the water meets applicable criteria.

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2. The berm cross sections depicted in Drawing 01–4109–C1002 provide the accurate dimensions. The effective interior height of the soil cell berm is 1.1 m, taken from the upper surface of the prepared base to the uppermost elevation of the liner system at the top of the berm. The interior of the water retention cell is 1.5 m from the top of the cell base to the upper elevation of the liner system in the berm. The elevations are most clearly shown on cross-sections A and B on the drawing.

3. The earthworks for the landfarm were conducted by Kudlik Construction. The berms were constructed of screened local overburden material. Once the berm profiles were prepared, the liner system was installed by qualified staff from Layfield Environmental Systems Ltd. The liner consisted of Layfield LP10 geotextile underlay and a 60-mil textured HDPE geomembrane. An LP10 overlay was installed in the soil treatment cell and the water retention cell. Copies of the Certificates of Acceptance of Soil Subgrade Surface and the Certificate of Final Inspection and Acceptance and the specification sheets for the geotextile and geomembrane materials are attached.

   The liner system was installed September 13 – 17, 2004. Wardrop staff conducted an inspection of the facility on September 24, 2004. The inspection report indicated that the final cover and grading of the base of the cells was acceptable.

4. The spacing between the edge of the contaminated soil in the treatment cell and the culverts through the interior berm is intended to minimize sediment blockage of the drains and particulate deposition in the water retention cell. The slope of the soil in the cell as depicted on Drawing C1001 is obviously not realistic. When the soil is initially deposited in the treatment cell, a separation of approximately one metre will be maintained along the interior berm between the culvert inlets and the soil pile. The soil pile will be configured in at least a 3:1 slope along the side closest to the interior berm to minimize erosion into the culvert. Part of the regular maintenance procedure during tilling of the soil will include pulling back any soil accumulations in the immediate vicinity of the interior berm.

5. The Reviewer is correct in noting that the design capacity of the water retention cell may not be sufficient in the case of an extremely wet year exceeding the ten year figures submitted with the original proposal. The design is based on the assumption that the cell will be pumped out once per year. Wardrop is confident that for typical precipitation amounts, the current design is adequate. As an added contingency, Wardrop is proposing that the retention cell be pumped out after spring melt and again in mid to late August. Using the climate data from 1997 as the worst case scenario, the increased pumping frequency would still allow for a safety margin of at least 20% on the cell capacity.

   In addition to the increased pumping frequency, it should be noted that somewhat over 50% of the precipitation in the Kugaaruk area is in the form of snow. If half of the snow accumulation is removed from the landfarm before spring melt, available water retention capacity is increased by at least 25%.

   In terms of spraying some water back over the treatment cell, the intention is to inoculate the water with bacteria that are expected to be present in the soil mass.

5. (cont'd)

The increased bacterial content in the water will promote the breakdown of the residual hydrocarbons. This approach has been used for landfarms where water retention capacity is not an issue. In the case of the Kugaaruk landfarm, the recirculation system is an applicable option only as long as the volume of water being stored is not near the design capacity of the retention cell. In a situation where residual hydrocarbons are still present in the impounded water, and the recirculation approach is not feasible, the use of commercially available treatment systems, such as Calgon's Cyclesorb HP activated carbon filters, would be required. These stainless steel units are designed for shipping by road or air. They contain one ton of activated carbon and are rated for flow-through of 60 gallons per minute. Some preliminary field testing would likely be required to establish the pumping rate which provides adequate contact time in the filter to achieve the required treatment level. Wardrop's approach would be to use more aggressive treatment methods as opposed to attempting to retain the water for a longer period of time.

6. A number of excerpts from the Phase III Environmental Site Assessment Report prepared by Dillon Consultants (Feb. 9, 2001) have been attached to provide the requested information on the nature of the material to be deposited in the landfarm.

   Wardrop's statement regarding the low probability of snow cover being impacted by contaminants is based partially on a review of the laboratory data referred to above and partially on our technical understanding of contaminant transport mechanisms for hydrocarbons in soil.

   The only common methods by which hydrocarbons in soil will migrate upward is through volatilization or through wicking action of free phase liquid hydrocarbons in the soil. Since the majority of hydrocarbons in this particular soil mass fall into the F2 (C11-C16) range, the vapour pressure would be relatively low even during summer conditions. This is supported by the Hydrocarbon Vapour Emissions recorded in the field by Dillon. In winter conditions, when snow cover is present, the soil mass is frozen and the probability of vapour loss from the soil pile would be virtually zero. The Dillon report did not note the presence of free phase liquid hydrocarbons in any of the boreholes, therefore physical absorption of hydrocarbons into the snow cover does not appear to be a factor.

   The plan for snow removal would not include stripping all snow cover down to the soil layer. A sufficient buffer layer would be maintained to ensure that the landfarm liners are not damaged and that the contaminated soil is not inadvertently removed. In practical terms, snow removal would only involve drifted snow along the interior of the berms.

7. It is proposed that initial soil samples be taken in the upper 300-mm depth of the treatment cell immediately upon completion of delivery of the contaminated soil to the landfarm. These samples will serve as the baseline for comparison with future samples. If samples taken in subsequent years do not show appreciable reductions after two full treatment seasons, commercially available bacterial and/or enzyme amendments will be added to the soil at the start of the third season.

7. (cont'd)

Amendment products would be obtained from firms with cold climate experience, such as HobbsMillerMaat Envirotech (www.hmmenvirotech.com). These products, when used in conjunction with effective soil aeration, are designed to enhance the natural degradation of the hydrocarbon molecules in the soil. Prior to selecting a particular product, soil tests would be conducted to ascertain the nature of the microbial colonies present in the soil. Enhanced biotreatment may also require that some water from the retention cell be sprayed over the soil to maintain adequate moisture levels. Regular tilling of the soil would also be required to ensure adequate aeration.

The six- to nine-year design life was based on the assumption that treatment of each 300-mm soil layer would require at least two, and possibly three treatment seasons. This timeframe is based on Wardrop's past experience with soil remediation projects, and on statements included in the Dillon Report. Kudlik Construction reported similar timeframes from their experience on other projects in northern climates. Due to the number of variables that can affect landfarming operations, none of these timeframes can be stated with absolute certainty.

8. Only rubber tired equipment will be permitted to work within the treatment cell. Standard earth moving practices will be employed for spreading soil within the cell. The initial truckloads of soil will be dumped immediately inside the access ramp. The earth moving equipment will then push the soil out across the base of the cell. This process will continue until there is a uniform cover of soil over the cell base. The operator will be instructed to minimize any traffic over the base of the cell before soil is deposited. Subsequent loads will be contoured to ensure that the soil mass is crowned in the centre and slopes off toward the edges to facilitate good drainage. The operator will be instructed to slope the soil pile so that the toe of the pile just meets the inside toe of the cell berm. There will be little or no overlap between the soil pile and berms surrounding the treatment cell.

   Wardrop personnel will be on site during placement of the soil to ensure that the procedure does not compromise the liner system and that the shape of pile optimizes the opportunity for natural biodegradation of the contaminants.

   In reference to protecting the integrity of the liner, it should also be noted that the impermeable geomembrane in the treatment cell is covered by 15 cm of sand, then a layer of geotextile and the another 15 cm protective layer of sand. Once the tilling operation is working on the last soil layer, the operator will be able to see the change in soil texture when the top layer of cover material is encountered. Even if this layer is penetrated, it will be very obvious to the operator if the tilling equipment starts to contact the top layer of geotextile. While it would be preferred that geotextile layer remain intact, incidental minor damage at that stage would not impair the permeability of the cell.

9. The confirmatory soil-sampling program for the soil mass in the treatment cell will be designed to measure the concentrations of the contaminants of interest in the upper 300 mm in an unbiased manner and with an acceptable degree of precision.

9. (cont'd)

The soil mass to be characterized by each sampling program will be somewhat in excess of 1000 m^3. Based on guidelines issued by the Province of Manitoba, a total of six composite samples are required to confirm the soil quality for this volume of material. This is an increased number of samples from that described in the original application. In order to establish sampling locations, six longitudinal segments will be designated by the dividing the northwest exterior berm into six equal lengths and then extending a perpendicular line to the opposite side of the cell. For segments with a length of 50 m or less, four discrete samples will be taken from equidistant points along the centre line of the segment. For segments over 50 m in length, an additional discrete sample will be taken for every 10 m or less. Samples will be taken with appropriate hand tools to the depth of the soil layer being treated. Standard field methods for decontamination of sampling equipment will be used.

The individual discrete samples for each segment will be split and half of the sample will be labelled and archived for follow-up if required. The other half of the individual samples for each segment will be combined and physically mixed to produce a homogeneous composite. Half of the composite will be labelled and archived and the other half will be prepared for lab submission. Samples will be analyzed for BTEX and F1 to F4 hydrocarbons. The lab results will be reviewed in relation to applicable CCME environmental quality criteria. The degree of statistical analysis to be applied will be dependent on the variability of the results from the six samples.

Assuming that a Water Licence is issued relatively soon, soil placement in the cell will commence in July 2006. If this timeframe is met, baseline samples will be taken immediately upon completion of placement of the soil in the cell, and the first confirmatory samples would be taken late in the 2007 treatment season. If the results are found to be acceptable, the soil layer characterized by the sampling program would be removed early in 2008 and the process would continue with the middle layer, and so on, until all treated soil is removed. The landfarm can then be decommissioned or left intact for future use by Hamlet if required. If the 2007 samples indicate that the CCME criteria have not been met, the enhanced treatment procedure described in Section 7 above would be considered.

10. The locations of the five downgradient groundwater monitoring wells are shown on Drawing C1001. The purpose of the groundwater monitoring well network is to confirm that there is no subsurface migration of contaminants from the landfarm. Monitoring wells will be installed later in the summer when frost-free conditions in the overburden are optimum. The decision to drill or excavate the wells sites will be dependent on the availability of equipment in the community. Wells will be a standard sandpoint design with the screened section extending from near surface to refusal on either permafrost or bedrock.

As indicated in the earlier submission, groundwater wells will be checked for the presence of water when the retention cell water samples are taken. If groundwater is found in any of the wells, samples will be taken for analysis. In the case where the retention cell is sampled twice in a year, the groundwater

10. (cont'd)

    samples will be taken during the latter sampling event. Groundwater samples will be analyzed for BTEX and F1 to F4 hydrocarbons. In the event that the lab results indicate seepage from the landfarm, further investigations will be conducted to identify the cause of the seepage, and corrective action will be initiated. A decision will be made in the field as to whether the recharge rate in the wells allows for complete purging of the wells prior to sampling.

11. Sealed versions Drawings C1001 and C1002 are attached as per your comments.

We trust that this submission adequately addresses the issues raised in your Technical Review. If any further clarification is required, please contact me. Our client is anxious to begin remedial work in the Kugaaruk in 2006 that requires access to the landfarm.

Thank you for your consideration.

Sincerely

WARDROP ENGINEERING INC.

David Ediger, P.Eng.
Senior Environmental Engineer

Approved by

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Lorne Stone, Principal
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Copy Nunavut Department of Public Works and Services

Attachment