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VIA EMAIL: Jared.Buchko@pwgsc.gc.ca

Mr. Jared Buchko.
Manager, Environmental Engineering
Public Works and Government Services Canada
Telus Tower North
5th Floor, 10025 – Jasper Avenue
Edmonton, AB T5J 1S6

Dear Mr. Buchko:

Re: Intermediate DEW Line Site Restoration
FOX-C, Ekalugad Fiord, Nunavut

As part of the design services for the environmental restoration at the FOX-C, Ekalugad Fiord Intermediate DEW Line site, UMA Engineering Ltd. (UMA) has been retained by Public Works and Government Services Canada (PWGSC) to provide services related to the application for a Water Use License.

This purpose of this letter report is to provide a summary of the design rationale for the proposed disposal facilities at FOX-C.

BACKGROUND INFORMATION

UMA was retained by PWGSC in the summer of 2004 to provide engineering design services for the site restoration at the FOX-C, Ekalugad Fiord Intermediate DEW Line. The design incorporates the principles outlined in the INAC Protocol, which are summarized in the document "Abandoned Military Site Protocol" by Indian and Northern Affairs Canada (INAC) dated March 2005.

UMA completed the design and submitted tender drawings (Project No. 413759, Drawing No.'s C01 to C16 and S01 to S05) and specifications for the FOX-C restoration project in March 2005. The FOX-C site restoration was tendered in separate contracts for construction and provision of a camp and both were awarded to Qikiqtaaluk Corporation. It is understood that the contractor will utilize a temporary sewage lagoon for the camp at FOX-C.

The site restoration at FOX-C will incorporate the use of two types of specialized facilities for the disposal of on-site waste generated by the demolition of existing structures, removal of contaminated soils and site debris and landfill excavation. The disposal facilities proposed for FOX-C include two Non-Hazardous Waste Landfills and a Landfarm. These types of facilities have been successfully implemented at numerous other DEW Line Clean Up sites.

EBA Engineering Consultants Ltd. have conducted a geotechnical investigation for the Clean Up of the FOX-C DEW Line Site and their findings and recommendations are summarized in the report entitled "DEW Line Clean Up Project, FOX-C (Ekalugad Fjord) DEW Line Site, Geotechnical Investigation" dated November 2004.

A summary of the design rationale for the proposed sewage lagoon and disposal facilities at FOX-C is as follows:

SEWAGE LAGOON

A temporary sewage lagoon is required for the construction camp at FOX-C and the specific design requirements for this lagoon are outlined in the tender specifications for the camp contract. The proposed FOX-C sewage lagoon is shown in Drawing No. 413759-C17 and the design parameters are shown in the associated design memo.

The design requirements for a sewage lagoon include the placement of this facility at specific setback distances from camp facilities, drainage courses and water bodies. The sewage lagoon is lined with a 40 mil High Density Polyethylene (HDPE) liner and is specified to be placed downwind of the construction camp. The sewage lagoon utilizes a two cell system with each cell sized to independently accommodate capacity for one half of a construction season. Sewage from the camp will be handled with, at minimum, primary treatment (settling tank and lagoon) and discharged to the ground surface if it meets the requirements of the discharge criteria outlined below. If primary treatment is not sufficient for the sewage effluent to meet the discharge criteria, then further treatment will be required until the discharge criteria is met.

Table 1: Wastewater Discharge Criteria

Parameter	Criteria
Oil and Grease	None Visible
pH	6 to 9
Total Suspended Solids	180 mg/L
BOD	120 mg/L
Faecal Coliforms	10,000 CFU/dl

UMA considers that an unlined sewage lagoon, using the concept of a percolation basin, is a suitable design alternative for the FOX-C sewage lagoon outlined herein. Unlined sewage lagoons have been utilized at numerous other arctic military sites for similar applications and are generally easier to close and stabilize after their operational function is complete.

For closure of the sewage lagoon cells, the berms will be removed and the liner will be left in place and folded back to allow for complete burial. A minimum of 300 mm of fill will be placed over the area as outlined in Item 25 of the *Camp Sanitation Regulations (R.R.N.W.T. 1990)*.

NON-HAZARDOUS WASTE LANDFILLS

Two Non-Hazardous Waste (NHW) Landfills are required at FOX-C for the disposal of demolition debris, surface debris and excavated debris. The plan and section for the Upper Site NHW Landfill is shown on Drawings 413759-C04 and 413759-C10, respectively, while the plan and section for the Lower Site NHW Landfill is shown on Drawings 413759-C06 and 413759-C12, respectively.

The selected location for the Lower Site NHW Landfill at FOX-C is an area approximately 1200 meters northeast of the lake along the access road. The Lower Site NHW landfill footprint covers an area of about 3,500 square

meters and construction of this landfill will require the placement of approximately 4,000 cubic meters of suitable borrow material for the perimeter berms and landfill cap. The useable airspace in the Lower Site NHW Landfill is 1,100 cubic meters, which allows for the waste, intermediate fill and a 10% contingency. The final landfill surface is sloped to drain to the southwest.

The selected location for the Upper Site NHW Landfill at FOX-C is the Mid-Station Pad. The NHW landfill footprint covers an area of about 5,300 square meters and construction of this landfill will require the placement of approximately 9,500 cubic meters of suitable borrow material for the perimeter berms and landfill cap. The useable airspace in the Upper Site NHW Landfill is 6,100 cubic meters, which allows for the waste, intermediate fill and a 10% contingency. The final landfill surface sits on a natural saddle and has split drainage to the north and south.

The types of wastes acceptable for disposal in the NHW landfills include: non-hazardous debris, Tier I contaminated soils, F3 and F4 fraction hydrocarbon contaminated soils (where applicable), polyethylene-wrapped creosote timbers and double-bagged asbestos. These wastes are placed in 0.5 meter lifts to a maximum of 2 meters in total height. A minimum 0.15 meter thick intermediate cover layer is to be placed and compacted onto each 0.5 meter lift of waste material.

Design considerations and parameters for the NHW Landfills are as follows:

Waste Characterization – The waste materials to be disposed of in the NHW Landfill are to consist of non-hazardous waste only and may include wood, metal, empty crushed barrels, concrete and double bagged asbestos. Native borrow sourced materials and soils with low level contamination are used for intermediate fill.

Surface Water run-on and run-off control – The final surface of the NHW Landfill is to be graded to provide positive drainage to prevent ponding and infiltration. The slope of the landfill is designed to minimize the potential for erosion of the landfill cover.

Leachate Control – Because the landfill contents will consist of non-hazardous debris, the design intent is to control the leachate in a NHW Landfill rather than completely eliminate it. The design factors contributing to the control of leachate include:

- Only "Dry Waste" will be placed in the NHW Landfill;
- The short arctic summer will limit the time that any potential water infiltration can occur;
- The landfill cover will be compacted and graded to promote surface runoff; and,
- Proposed NHW Landfills have been sited in areas where natural overland runoff is minimal.

Frost Jacking – Frost jacking occurs when debris in landfilled materials are subject to freeze thaw cycles; intermediate soil layers include fine grained frost susceptible soils such as fine sand or silt and there is access to free water. In order to minimize the potential for frost jacking, the NHW landfills are designed using good drainage practices and intermediate and cover soils are specified to be frost stable materials.

Biological Odour and Methane Gas Control – Odour and methane gas are typically generated in municipal landfills in the south and are the result of biological decomposition of domestic waste. The potential for the generation of odour and methane gas at a DEW Line Landfill is considered low because the volume of domestic waste to be landfilled is typically small and the waste is generally at a lower temperature under arctic conditions.

Settlement of Landfill Surface – In order to minimize settlement and ground subsidence, the debris in the NHW Landfill is crushed during placement and intermediate soil layers are placed within the debris to minimize void spaces in the landfill. Upon completion of placement of debris and intermediate fill, the landfill is capped with a minimum 1.0 m thickness of cover consisting of compacted granular fill.

Siting – Potential sites for the NHW landfills were identified and evaluated in the geotechnical investigation undertaken by EBA Engineering Consultants Ltd. The sites were evaluated based on several factors, including: size of the area available, proximity to demolition areas and borrow sources, suitability of soil and groundwater conditions, surface water run-on potential and drainage conditions, topographic conditions, and setback distances from natural water bodies.

Granular Borrow Construction Materials – Potential granular borrow areas were identified and evaluated in the geotechnical investigation undertaken by EBA Engineering Consultants Ltd. EBA also provides gradation requirements for all granular materials to be used for the construction of the landfills. If the native borrow materials do not meet the gradation limits specified, then selective mining or processing of these materials will be required. The gradation requirements are provided to ensure suitable landfill performance based on the desired soil properties related to compaction, stability, erosion resistance, settlement, etc.

Landfill Design Parameters – A typical NHW Landfill for a DEW Line site restoration project consists of perimeter berm and cap constructed with granular borrow materials. The perimeter berm has maximum exterior and interior slopes of 3H:1V and 1.5H:1V, respectively, with a minimum top width of 2 meters. When the landfill is filled, a minimum 1.0 meter thick cap is provided. The berm and final cap are placed in thin lifts (less than 300 mm loose thickness) and compacted to a minimum of 95% of standard proctor maximum dry density. The final cap surface is sloped to between 2% and 4% and contoured to match existing topography. No liner is required since the design intent is to control the generation of leachate from a NHW disposal facility. Permanent monitoring wells will be installed around the perimeter of the NHW Landfills to allow for future environmental monitoring in these areas to confirm the design parameters.

Landfill Operation – A long term operation and maintenance program will be developed for the NHW Landfills at FOX-C during site restoration activities. An operation and maintenance manual will be provided and finalized upon completion and closure of the NHW Landfills and will include record drawings for these facilities.

LANDFARM

The INAC Protocol requires soil exceeding the hydrocarbon criteria to be treated in-situ or ex-situ or capped and left in place to attenuate naturally. Soils contaminated with F1 and F2 petroleum hydrocarbon constituent fractions require in-situ or ex-situ treatment based on their environmental risk. In this regard, UMA has provided the design of a Hydrocarbon Soils Treatment Facility or Landfarm. Treatment of hydrocarbon contaminated soils by landfarming is a very economical and environmentally sound solution, in that no specialized equipment or skills are required and the treatment objectives can be achieved using typical earthworks construction equipment.

The construction of the landfarm will consist of site preparation, placement of exterior berms, excavation of drainage ditches and placement of an interior granular leveling course. The perimeter berms will be constructed with a select finer grained soil to facilitate improved containment. The leveling course is placed to provide a working surface for treatment activities. The landfarm is sized to allow the hydrocarbon soils to be spread out to a thickness of 400 mm to facilitate suitable aeration for treatment. If additional hydrocarbon soils, requiring treatment, are identified during construction, an additional landfarm cell can be constructed adjacent to the existing landfarm. Ditches and berms are provided to minimize run-on from outside of the landfarm and control

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runoff from within the landfarm. Temporary groundwater monitoring wells will be provided to facilitate environmental monitoring during landfarming activities.

The operation of the landfarm will include the application of nutrient along with tilling and moisture conditioning of the treatment soils. These activities are essential to ensure adequate conditions for microbial growth are achieved. Granular nutrients are applied uniformly to the contaminated soils at a rate sufficient to achieve the optimum nitrogen loading, which is determined by testing of the contaminated soils during treatment. Fresh water is to be sprayed over the soil until the optimum moisture content (generally between 10 and 15%) is attained. Tilling of the contaminated soil is specified to occur at 10 days intervals and at 5 day intervals should periods of warm or dry weather be encountered. Conversely, during periods of wet weather, tilling will be delayed until the treatment soils have adequately dried out. Runoff from within the landfarm will be tested and released only if it meets the discharge criteria outlined previously in Table on in this letter report. Otherwise, the runoff will be treated to meet the discharge criteria.

The selected location for the Landfarm is about halfway between the Lake and Beach Areas along the access road at the lower site. There is only about 400 cubic meters of hydrocarbon soil that requires treatment and as such, the landfarm footprint is quite small at about 2,500 square meters. The construction of the landfarm will require the placement of approximately 1,800 cubic meters of suitable borrow material for the perimeter berms and leveling course. The final landfarm surface is sloped to drain to the southwest.

When the hydrocarbon contaminated soils have been treated sufficiently and tested to meet the remediation criteria, the landfarm will be closed. The treated soil will be consolidated on one side of the landfarm to a maximum depth of 1 meter. The landfarm will then be capped with a minimum of 0.3 m of clean fill from the berms outside the consolidation area. Additional cover soil will be added until a minimum of 300 mm depth is achieved over the entire landfarm consolidation area. The cover will be compacted to minimum of 95% Standard Proctor Maximum Dry Density. The final surface of the landfarm will be graded to promote effective surface runoff from the area. The temporary groundwater monitoring wells will be abandoned by backfilling them with a suitable bentonite grout mixture.

CLOSURE

We trust this meets your current requirements. If you require additional information or clarification, please call myself or Rudy Schmidtke at 780-486-7000.

Respectfully Submitted,

UMA Engineering Ltd.

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BWF:mr

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