Report to:

**GOVERNMENT OF NUNAVUT DEPARTMENT OF COMMUNITY & GOVERNMENT SERVICES**

# Interim Abandonment and Reclamation Plan for the Kugaaruk Landfarm Facility

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TETRA TECH

Report to:

GOVERNMENT OF NUNAVUT DEPARTMENT OF COMMUNITY & GOVERNMENT SERVICES

# INTERIM ABANDONMENT AND RECLAMATION PLAN FOR THE KUGAARUK LANDFARM FACILITY

DECEMBER 2012

| | | | |
|---|---|---|---|
| Prepared by | | Date | 20-DEC-2012 |
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| Reviewed by | | Date | 20-DEC-2012 |
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| Authorized by | | Date | 20-DEC-2012 |
| CL/gs | Michel Grégoire, P.Eng. | | |

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# REVISION HISTORY

| REV. NO | ISSUE DATE | PREPARED BY AND DATE | REVIEWED BY AND DATE | APPROVED BY AND DATE | DESCRIPTION OF REVISION |
|---|---|---|---|---|---|
| 1 | December 2012 | C. Longobardi, 14-Dec-12 | B. Horning 19-Dec-12 | M. Gregoire 19-Dec-12 | Updated requirements to details as set by NWB Water License 1BR-KRK1112. Added DoE letter as an appendix. |
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# 1.0 BACKGROUND

In 2006, as part of an environmental soil remediation project undertaken on behalf of the Government of Nunavut, Department of Community and Government Services (GN-CGS), a landfarm was constructed in the vicinity of the Hamlet of Kugaaruk, Nunavut. The location of the landfarm is shown on Figure 1 in Appendix A. This facility was developed to treat petroleum hydrocarbon (PHC) impacted soil excavated from the former bulk fuel storage facility in Kugaaruk following removal of two large aboveground storage tanks (ASTs).

The landfarm consists of a soil treatment cell and a water retention cell. The cells are surrounded by a berm constructed of local granular material, with an interior berm separating the two cells. The base and interior walls of each cell are lined with an impermeable PHC resistant liner. The runoff water retention cell is designed to hold precipitation and melt water that has been in contact with the impacted soil in the treatment cell. Water which accumulates in the soil treatment cell flows downgradient through culverts in the interior berm into the runoff water retention cell. A general site plan of the landfarm facility is provided as Figure 2 in Appendix A.

In July 2007, approximately 2200 $m^3$ of PHC impacted soil was excavated from the former tank site and placed in the treatment cell of the landfarm. The contamination was determined to be primarily in the diesel fuel range of PHC fractions F1 to F4. As part of the ongoing facility maintenance and soil treatment, the soil is turned periodically to enhance aeration and natural biodegradation. Once completion of treatment has been confirmed through laboratory analyses and any required regulatory authorizations are received, the soil will be removed from the landfarm and transported to an approved final disposal location.

GN-CGS is proposing to leave the landfarm berms and liners in place for possible future re-use once the soil remediation process has been completed. In order to ensure that this empty facility does not represent a potential environmental risk to the surrounding environment, the procedure outlined in this document will be implemented. This interim plan has been developed in conformance with the *Guidelines for Abandonment and Restoration Planning for Mines in the Northwest Territories* (September 1990), and the Government of Nunavut, *Environmental Guideline for Contaminated Site Remediation* (March 2009), as required by Nunavut Water Board Water Licence No. 1BR-KRK1112. Based on the classification system for abandoned tailings disposal areas included in the 1990 guideline, the Kugaaruk landfarm would be considered as a “low impact” site. The proposed closure procedure for the landfarm would fall within the definition of a long term shutdown. All costs associated with the closure of the landfarm will be borne by the GN-CGS.

# 2.0 CLOSURE PROCEDURE

## 2.1 SOIL QUALITY MONITORING

The soil contained within the treatment cell is sampled annually to assess the PHC concentration levels. A grid pattern is established across the soil pile and a series of samples are taken at each grid point. A total of six composite samples are prepared with a minimum of four discrete soil samples from each grid line being used to make up one composite. The samples are submitted to an accredited laboratory to be analyzed for benzene, toluene, ethylbenzene and xylene (BTEX) and PHC fractions F1 to F4. The annual sampling is typically completed near the end of the treatment season.

The analytical results are compared to the applicable Environmental Quality Guidelines (EQG), as set by the Canadian Council of Ministers of the Environment (CCME) and the Government of Nunavut, for coarse grained surface soil on industrial sites. Note: The acceptable concentration of PHC fraction F2 has been modified from the EQG for the Kugaaruk landfarm facility by the Government of Nunavut Department of Environment, based on the intended end use of the treated soil as landfill cover at the Kugaaruk landfill. A copy of the regulatory correspondence to this effect is provided in Appendix C. The acceptable concentrations of hydrocarbon contaminants reflect the maximum concentrations presented in Appendix B, Table 1, of this plan. When the analytical results from a sampling event confirm that the PHC concentrations in all samples are below acceptable levels for the intended end use of the soil, remediation activities will be suspended.

## 2.2 SOIL REMOVAL

Upon receiving all required regulatory approvals, a schedule will be developed for excavation and removal of the remediated soil from the treatment cell. Rubber tired excavation equipment will be used to excavate the soil pile and place the material into trucks for removal from the site. Caution will be exercised to ensure that the cell liner is not damaged during the excavation. A dedicated spotter will be assigned to monitor the soil removal visually and direct the excavator to ensure that all treated soil and the uppermost portion of the underlying layer of granular material are removed.

Upon completion of the soil removal, the cell will be inspected and any areas where the impermeable liner is exposed will be subject to a visual examination for damage to the liner. Areas where a breach of the liner may have occurred will be marked for subsequent investigation and repair by a qualified contractor. All areas of exposed liner will then be covered with granular material for general protection. The surface profile will be established to minimize water ponding within the cell, and to ensure that any impounded water flows toward the drains leading to the retention cell.

## 2.3 RESIDUAL SOIL SAMPLING

After the soil removal is complete, a series of samples will be taken from the layer of granular material remaining over the synthetic liner. The grid pattern that was established for the soil sampling during the treatment operation will be used for this purpose. Six composite samples will be submitted for analysis of BTEX and PHC fractions F1 to F4. The analytical results are compared to the EQG, as set by the CCME and the Government of Nunavut, for coarse grained surface soil on parkland and wildland sites, respectively. The purpose of the sampling will be to confirm that no residual contaminants in excess of the levels shown in Appendix B, Table 2, are left within the treatment cell.

## 2.4 WATER REMOVAL

As part of the treated soil removal, the runoff water in the retention cell will be sampled and analyzed for the parameters specified in Nunavut Water Board Water License No. 1BR-KRK1112, Part J, item 7. The results of these analyses were then reviewed relative to those guidelines listed in Part D Item 4 of the Water Board license, as well as the CCME surface water guidelines, as listed in Appendix B, Table 3. Subject to approval of the regulator, the water will then be discharged to the ground surface via the splash pad located to the west of the runoff water retention cell. It is assumed that the scheduling of the soil removal will permit the sampling and discharge of the retention cell to be completed in the same year.

In the year following the soil removal and water discharge, the retention cell will be sampled again and discharged, subject to required approvals.

## 2.5 GROUNDWATER MONITORING

Groundwater samples will be taken from the six existing monitoring wells annually for two successive years following the removal of soil from the treatment cell. Samples will be analyzed for the parameters specified in Nunavut Water Board Water License No. 1BR-KRK1112, Part J, item 8. Results will be compared to applicable CCME groundwater quality guidelines, Ontario Ministry of the Environment groundwater guidelines for non-potable use, and to Alberta Environment groundwater remediation guidelines. Where the acceptable level of a contaminant's concentration varies among the different guidelines, the most stringent value will be applied. A summary of the currently applicable guidelines is presented in Appendix B, Table 3.

# 3.0 CONTINGENCY FOR FURTHER TREATMENT

In the event that any of the final sampling procedures described in Section 2.0 of this plan reveal contaminants in soil or water exceeding applicable criteria, further remedial action may be required prior to the final closure of the landfarm.

## 3.1 RESIDUAL SOIL COVER

If a portion of the residual cover material remaining in the treatment cell is found to be impacted in excess of guideline limits presented in Appendix B, Table 2, of this plan, the area of impact will be delineated and an appropriate treatment plan implemented. Depending on the volume of material removed, this material may be removed to the depth of the upper geotextile liner by hand to minimize the potential for physical damage to the liner, and placed in containers for further biotreatment, or the residual soil will be left within the cell to allow further natural biodegradation. In this case, subsequent soil sampling would be required to confirm treatment levels, as previously described.

## 3.2 RETENTION CELL

If the water sample taken in the year following the removal of the treated soil reveals that contaminants are present in excess of applicable guidelines, a water treatment system will be deployed. During the set up and testing of the system, any treated discharge water will be directed back into the retention cell. When it is confirmed that the treated discharge will meet applicable limits, the cell will be pumped out using the same procedure as in previous years of the landfarm operation.

## 3.3 MONITORING WELLS

If contaminant concentrations exceeding the guideline limits are found in the monitoring well samples, a plan will be developed for delineation of any downgradient contaminant migration and for identification of the source of the groundwater impact. The details of the plan will be based on the pattern of exceedances found in the well sampling program, and in general accordance with the Government of Nunavut, *Environmental Guideline for Contaminated Site Remediation* (March 2009).

# 4.0 FINAL SITE ABANDONMENT

It is proposed that the landfarm berms, monitoring wells, access road, and splash pad be left in place for possible future use, once all required regulatory authorizations have been received. There are no other structures associated with the landfarm.

To alleviate the potential for excessive water accumulation within the landfarm berms, the downstream corner of the retention cell will be opened to allow the unimpeded outflow of water. The berm material in this area will be carefully removed to expose the synthetic liner. The liner will then be folded down inside the cell and covered with suitable granular material. The area where the berm is removed will be graded to facilitate the flow of water with minimal erosion of the exposed sides of the remaining berm. Rip rap will be used as required for this purpose.

No other modifications to the landfarm structure are proposed.

# 5.0 RESIDUAL ENVIRONMENTAL EFFECTS

Following the treatment and removal of all impacted soil and water from the landfarm, there will be no further potential for chemical contamination of the surrounding environment as result of the presence of the landfarm.

The berms and access road will continue to result in minor deviations of the local drainage pattern across the area. Since the construction of the landfarm, there has been no indication that the presence of the landfarm has resulted in increased flooding or erosion; therefore, the environmental effects associated with these minor alterations to the natural drainage pattern are not considered to be significant.

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# APPENDIX A

# *FIGURES*

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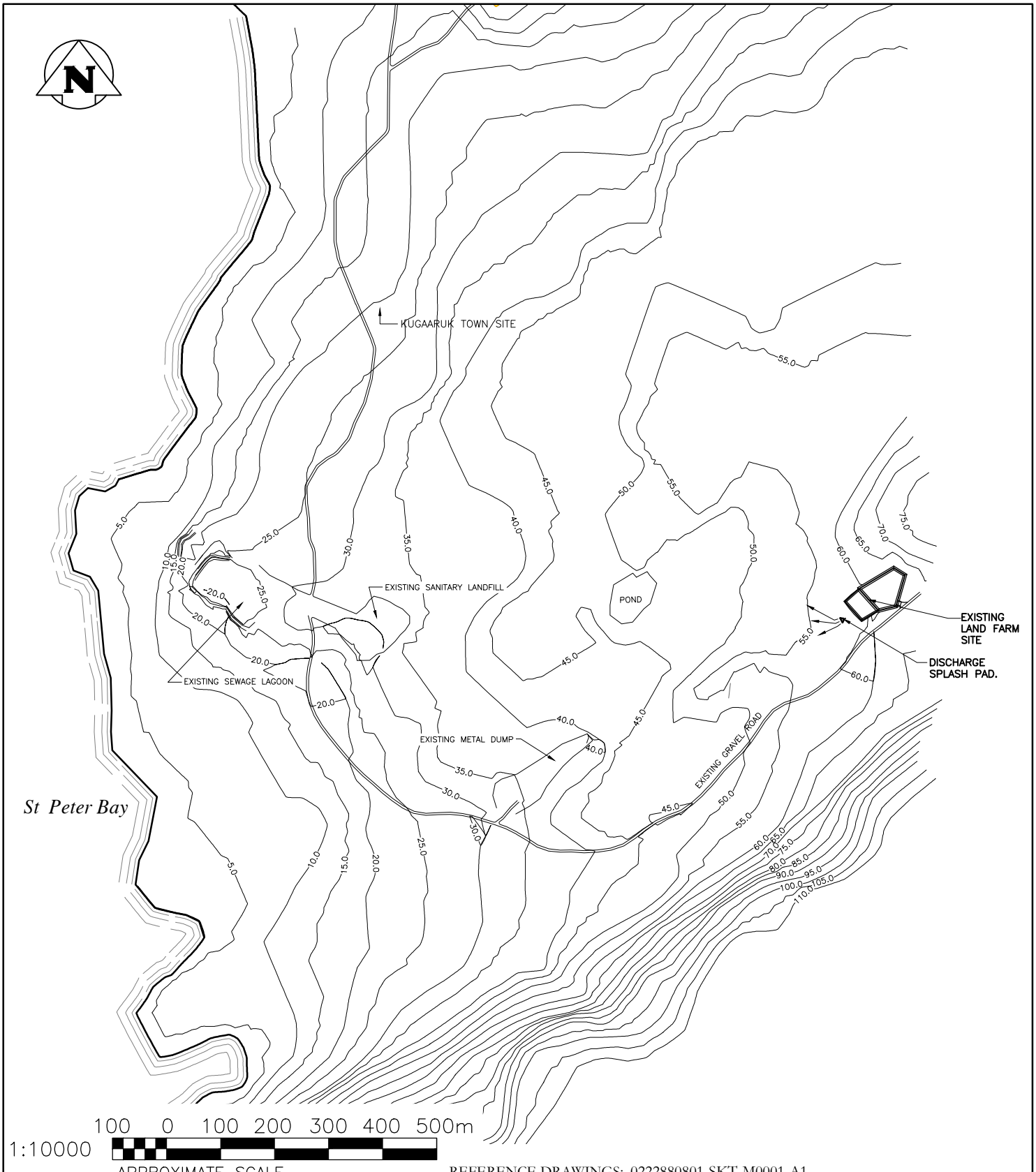


REFERENCE DRAWINGS: 0222880801-SKT-M0001-A1

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DATE: 12/04/03
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GOVERNMENT OF NUNAVUT



DRAWING DESCRIPTION
# FIGURE 1: LANDFARM FACILITIES TOPOGRAPHICAL AREA MAP KUGAARUK, NUNAVUT

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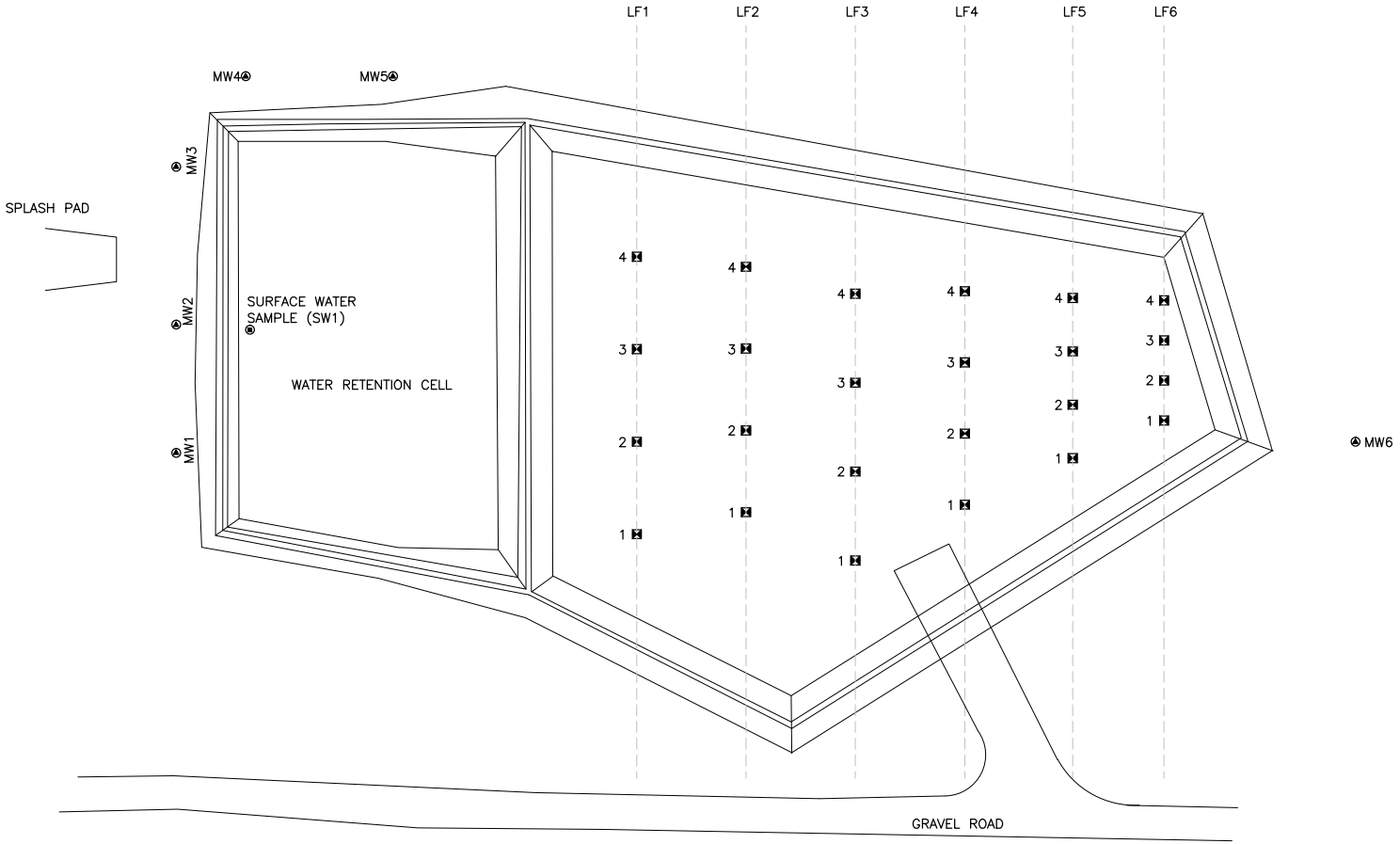
A (8.5" x 11")




LEGEND
- SOIL SAMPLE LOCATION
- SOIL SAMPLING LINE
- MONITORING WELL
- SURFACE WATER SAMPLE

REFERENCE DRAWINGS: 0222880801-SKT-V0004-A4

0 10 20 30 40 50 m
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DRAWING DESCRIPTION
# FIGURE 2: SITE PLAN SHOWING LANDFARM DEVELOPMENT KUGAARUK, NUNAVUT

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AL (11" x 8.5")

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# APPENDIX B

# *TABLES*

**TABLE 1**

**Kugaaruk Treated Soil Environmental Quality Guideline**

| Parameter | Maximum Concentration (mg/kg) |
|---|---|
| **BTEX**[1] | |
| Benzene | 180 |
| Toluene | 250 |
| Ethylbenzene | 300 |
| Xylenes | 350 |
| **Petroleum Hydrocarbons**[2, 3] | |
| **Fraction 1** ($C_6$ to $C_{10}$) | 320 |
| **Fraction 2** ($C_{10}$ to $C_{16}$) | 1000[4] |
| **Fraction 3** ($C_{16}$ to $C_{34}$) | 1700 |
| **Fraction 4** (>$C_{34}$) | 3300 |

Notes:

[1]Canadian Council of Ministers of the Environment (CCME), Canadian Environmental Quality Guidelines, 2007 (coarse-grained surface soils, eco-soil contact pathway).

[2]CCME, Canada-Wide Standards for Petroleum Hydrocarbons in Soil, May 2008 (for fractions F1 to F4 values for surface, coarse-grained soils).

[3]Government of Nunavut, Environmental Guideline for Contaminated Site Remediation, March 2009, (industrial land use setting, tier 1 criteria for course-gained soil).

[4]Revison of F2 fraction from 260 mg/kg to 1000 mg/kg approved by Nunavut Department of Environment, Jan. 28, 2010, based on soil being used as landfill cover material.

| TABLE 2<br><br>Kugaaruk Residual Soil Environmental Quality Guideline | |
|---|---|
| **Parameter** | **Maximum Concentration (mg/kg)** |
| **BTEX**[1] | |
| Benzene | 31 |
| Toluene | 75 |
| Ethylbenzene | 55 |
| Xylenes | 95 |
| **Petroleum Hydrocarbons**[2, 3] | |
| **Fraction 1** ($C_6$ to $C_{10}$) | 30 |
| **Fraction 2** ($C_{10}$ to $C_{16}$) | 150 |
| **Fraction 3** ($C_{16}$ to $C_{34}$) | 300 |
| **Fraction 4** (>$C_{34}$) | 2800 |

Notes:

[1]Canadian Council of Ministers of the Environment (CCME), Canadian Environmental Quality Guidelines, 2007 (coarse-grained surface soils, eco-soil contact pathway).

[2]CCME, Canada-Wide Standards for Petroleum Hydrocarbons in Soil, May 2008 (for fractions F1 to F4 values for surface, coarse-grained soils).

[3]Government of Nunavut, Environmental Guideline for Contaminated Site Remediation, March 2009, (industrial land use setting, tier 1 criteria for course-gained soil).

| TABLE 3<br><br>Surface Water and Groundwater Environmental Quality Guideline | |
|---|---|
| **Parameter** | **Maximum Concentration (mg/L)** |
| **Metals** | |
| Aluminium (Al) - Total | N.G. |
| Arsenic (inorganic) (As) - Total | 0.005[1] |
| Cadmium (Cd) - Total | 0.000017[1] |
| Calcium (Ca) - Total | N.G. |
| Chromium (Cr) - Total | 0.0089[1] |
| Cobalt (Co) - Total | 0.1[3] |
| Copper (Cu) - Total | 0.023[3] |
| Iron (Fe) - Total | 0.3[4] |
| Lead (Pb) - Total | 0.032[3] |
| Magnesium (Mg) - Total | N.G. |
| Manganese (Mn) - Total | N.G. |
| Mercury (Hg) - Total | 0.000026[1] |
| Nickel (Ni) - Total | 1.6[3] |
| Potassium (K) - Total | N.G. |
| Zinc (Zn) - Total | 0.03[4] |
| **Routine** | |
| Alkalinity - Total | N.G. |
| Ammonia Nitrogen | 0.019[1] |
| Chlroide ($Cl^-$) | 640[1] |
| Hardness | N.G. |
| Nitrate+Nitrite ($NO_3^-$ + $NO_2^-$) | N.G. |
| pH | 6.0 to 9.5[5] |
| Phosphorus (P) - Total | N.G. |
| Sodium (Na) - Total | 2300[3] |
| Sulfate ($SO_4^{2-}$) | N.G. |
| Total Suspended Solids | 50[5] |
| Conductivity (in mS/cm) | N.G. |
| **BTEX** | |
| Benzene | 0.37[1] |
| Toluene | 0.002[1] |
| Ethylbenzene | 0.09[1] |
| Xylenes | 18[2,4] |
| **Petroleum Hydrocarbons[2, 3]** | |
| F1 - BTEX (>$nC_6$ - $nC_{10}$) | 9.8[4] |
| F2 (>$nC_{10}$ - $nC_{16}$) | 1.3[4] |
| F3 (>$nC_{16}$ - $nC_{34}$) | 0.5[3] |
| F4 (>$nC_{34}$) | 0.5[3] |

| TABLE 3<br><br>Surface Water and Groundwater Environmental Quality Guideline | |
|---|---|
| **Parameter** | **Maximum Concentration (mg/L)** |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | |
| 1-Methyl Naphthalene | 13[3] |
| 2-Methyl Naphthalene | 13[3] |
| Acridine | 0.0044[1] |
| Acenaphthene | 0.0058[1] |
| Acenaphthylene | 0.0460[4] |
| Anthracene | 0.000012[1] |
| Benzo(a)anthracene | 0.000018[3] |
| Benzo(a)pyrene | 0.000015[1] |
| Benzo(b)fluoranthene | 0.00700[3] |
| Benzo(b&j)fluoranthene | 0.00048[4] |
| Benzo(ghi)perylene | 0.00017[4] |
| Benzo(k)fluoranthene | 0.00048[4] |
| Chrysene | 0.00140[4] |
| Dibenzo(a,h)anthracene | 0.00026[4] |
| Fluoranthene | 0.00004[1] |
| Fluorene | 0.00300[1] |
| Indeno(1,2,3-cd)pyrene | 0.00021[4] |
| Naphthalene | 0.00110[1] |
| Phenanthrene | 0.00040[1] |
| Pyrene | 0.000025[1] |
| Quinoline | 0.00340[1] |
| **Miscellaneous Organic Parameters** | |
| Oil and Grease | 15 & no sheen[5] |
| Phenols | 0.004[1] |

Notes:

[1]Canadian Council of Ministers of the Environment (CCME), Canadian Environmental Quality Guidelines (CEQG), September 2007, in a commercial/industrial land use setting, for the protection of aquatic life pathway.

[2]Summation of m, p, and o-Xylene concentrations.

[3]Ontario Ministry of the Environment (MOE), Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act (March 9, 2004), for non-potable water conditions (Table 3).

[4]Alberta Environment, Alberta Tier 2 Soil and Groundwater Remediation Guidelines, August 2008, in a Commercial/Industrial land use setting, for the protection of aquatic life pathway (course-grained soil).

[5]Limits provided by Keim, Aboriginal Affairs and Northern Development Canada (AANDC), Aug 30, 2010.

N.G. = No Guideline

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# APPENDIX C

# *REGULATORY CORRESPONDENCE*

**Department of Environment**

**Avatiligiyiit**

**Ministère de l'Environnement**

28 January 2010

Mr. David Ediger
Senior Environmental Engineer
Wardrop Engineering Inc.
400-386 Broadway,
Winnipeg, Manitoba. R3C 4M8

Dear Mr. Ediger

**Re: Request for Revision to Soil Quality Limits - Your letter dated January 21, 2010**

In your letter of 21 January 2010 provided me with the following information:

- Wardrop has been engaged by the Department of Community and Government Services (CGS) to manage 2200$m^3$ of hydrocarbon-contaminated soil excavated from a former tank farm.
- Soil samples collected in Sept 2009 indicate concentrations of hydrocarbons in the F2 range from 900 - 2600 ppm (figures rounded).
- This exceeds the GN criteria of 260 ppm in the F2 range (ref.Table A3-1, *Environmental Guideline for Contaminated Site Remediation*) for coarse-grained soil on industrial sites.
- Your client, CGS, wishes to use this soil as landfill cover and is seeking a revision of the threshold limit from 260 ppm to 1000 ppm.

Wardrop/CGS has requested this revision based on the following arguments:

- The GN standard (which is derived from CWS) is based on eco-soil contact which does not take into account the relative sterility of some Arctic soils where there is little to no biological activity (this is a greatly simplified summary of Wardrop's argument).
- The proposal to use the land-farmed soil as landfill cover renders the remaining contaminants in the soil largely unavailable to the environment.
- In general, the eco-contact pathway criteria is not applicable to this situation.

The GN's *Environmental Guideline for Contaminated Site Remediation* provides for some flexibility in prescribing what measures are required to remediate a contaminated site.

In considering your request, I consulted both the GN's Guide and specifically table A3-3; Indian and Northern Affairs *"Abandoned Military Site Remediation Protocol"*, Vol 1 & Vol 2; as well as discussed the issue with several colleagues in the environmental engineering field.

After reviewing your request and proposal, DoE has arrived at the following conclusions:

- DoE agrees with Wardrop with respect to the applicability of the CWS eco-contact criteria for the F2 range as it relates to this to this particular situation only.

- The parameters proposed by Wardrop/CGS – that is, 1000 ppm in the F2 range – conform to the Management Limit parameter listed in Table A-3-3 of GN's *Environmental Guideline for Contaminated Site Remediation* and further, are well within those parameters listed in INAC's *Abandoned Military Site Remediation Protocol*.

- INAC's guide sets the threshold value at 2500 ppm for "Type B" hydrocarbons for the protection of wildlife, including birds; the latter being the receptors most likely to be exposed to the soil within a secure landfill. Wardrop's proposed limit of 1000 ppm falls well within that parameter.

- By convention, the parameters listed in Table A3-1 of the GN's *Environmental Guideline for Contaminated Site Remediation* indicate to what level the concentration of hydrocarbon contamination must be reduced in a location where the remaining soil – which is still essentially contaminated; albeit at concentrations deemed to be acceptable – is readily available to all receptors and further, is in direct contact with surrounding uncontaminated soils. Under the scenario proposed by Wardrop/C&GS, the contaminated soil will be isolated from all receptors – save for birds and small mammals – but at concentrations well within acceptable limits for those receptors.

- A few of the expert advisors that I consulted suggested that the very action of moving the soil from the land farm and spreading it over the landfill will result in a further decline in F2 concentration.

- DoE's only outstanding concern pertains to the possibility of offsite migration (from the landfill) of the remaining contaminants within the soil to be used as landfill cover. Based on our most recent telephone discussion, this concern may have already been addressed given the recent sampling of runoff from the landfarm which yielded non-detect for hydrocarbons. Nevertheless, DoE would have a greater level of confidence if Wardrop/CGS could provide a brief discussion on the ultimate fate of the remaining hydrocarbons within the soil matrix. On that note can Wardrop provide a volumetric estimate on how much fuel is locked into the soil at 1000 ppm?

Based on the above conclusions, DoE believes that using the material for landfill cover poses an extremely low risk, if any, to the environment therefore DoE is prepared to allow Wardrop/C&GS to proceed as proposed: that is, to reduce the concentration of the hydrocarbons in the contaminated soil to 1000 ppm; after which it will be used solely as landfill cover material.

***It should be understood this revision of the F2 limit from 260 ppm to 1000 ppm applies only to this situation and does not constitute a blanket approval to repeat this practice for other applications. DoE will continue to evaluate such requests on a case by case basis.***

If you have any questions please do not hesitate to contact me.

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