TERMS OF REFERENCE

DEW LINE LANDFILL MONITORING PROGRAM

- PIN-2 CAPE YOUNG
- PIN-3 LADY FRANKLIN POINT
- PIN-4 BYRON BAY
- CAM-M CAMBRIDGE BAY
- CAM-1 JENNY LIND ISLAND
- CAM-2 GLADMAN POINT
- CAM-3 SHEPHERD BAY
- CAM-4 PELLY BAY

DEW LINE SITES, KITIKMEOT REGION, NUNAVUT

DND PROJECT #: KITIK 16

ON BEHALF OF
THE DEPARTMENT OF NATIONAL DEFENCE
OF CANADA

BY

PUBLIC WORKS & GOVERNMENT SERVICES CANADA
EDMONTON, ALBERTA

5.2.5 Photographic records are to be taken (see Section 5.5), from ground and air, to document the general condition of the landfill and substantiate all recorded observations, including observations of no identified concern. The location of all photographic viewpoints will be referenced to existing monuments and shown on the figures. All photographs taken from the ground are to include a clear illustration of scale (e.g. measuring tape).

5.2.6 Inspect the condition of monitoring installations (wells and thermistors) associated with the landfill. Note and photograph any damage and specific repair requirements to ensure that sufficient information is available to allow for contracting out repair work. Complete all fields in the attached templates (Annex J1, J3, M).

5.2.3 Historical data will be provided to the successful proponent and is to be incorporated into the monitoring report. Evaluation of the information will include a comparison of existing features to features noted during previous monitoring events and a description of any changes, and their potential significance/impact on stability. A new name shall be provided for each new feature (do not reuse names previously used for other features no longer apparent on site). Document this comparative analysis in the monitoring report for each landfill.

5.2.7 Provide a detailed figure of each landfill area using the existing base drawings for reference. Identify all features identified in the Visual Inspection Checklist (Annex J1), as specified above. Illustrate features to scale, show differences from previous years with the use of visual tools (e.g. colour). Also provide an updated AutoCAD layer (see section 7.7).

5.3 Chemical Monitoring (Soil and Active Layer Water)

5.3.1 General

5.3.1.1 The soil and active water layer monitoring program consists of the collection, analysis, and interpretation of soil, and active layer water samples at pre-determined locations (see Annexes A to H, and Table 1). Wells will be used to determine hydraulic gradient where possible.

5.3.1.2 Carry out soil, and water sampling at the Landfills as indicated in Table 1, according to the schedule outlined in Figure 1.

5.3.1.3 Current and historical chemical data is to be assessed against background, baseline, baseline plus 3 standard deviations, and previous years of monitoring. Please note that historical data (background, baseline and previous monitoring information) will be provided in an Excel format to the successful proponent within 2 weeks of contract award.

5.3.1.4 The Excel document contains worksheets with instructions, and worksheets for soil and active layer results for each landfill at each site. The worksheets are locked, and chemical data needs to be copied and pasted in the correct order to the appropriate row from laboratory certificates of analysis. It is recommended that contracts with the laboratories include a requirement for electronic reporting of results in the format (parameter order) outlined in the Excel worksheets to minimize errors and facilitate worksheet population. The Excel worksheets also contain pre-populated trend graphs and data tables and trends can be printed from the Excel format and included as an Appendix to the Draft and Final Monitoring Reports.

5.3.1.5 Chemical concentrations are to be reported in the pre-programmed excel worksheets provided. Concentrations detected above comparison values outlined in 5.3.1.3 or in the Excel worksheets are to be flagged in the tables, on landfill plans/figures and discussed within the report.

5.3.1.6 Duplicates and blanks, as well as F4 fraction results must be shown in separate Consultant developed tables within the report.

5.3.1.7 Current year data is to be compared to historical year data. Trends will be automatically graphed using the Excel worksheets provided. Data and trends should be interpreted and discussed within the report.

5.3.1.8 Samples are to be collected in the laboratory recommended containers for the parameters being analyzed, kept and shipped in coolers at appropriate temperatures in accordance with laboratory requirements. Every effort should be made to ensure samples comply with holding times. Additional packing material may be required to ensure sample containers do not break during transport. Laboratory chain of custody forms are to be utilized.

5.3.1.9 Both the primary laboratory(s) and that specified for inter-laboratory comparison (refer to 5.3.5.3) shall be ISO 17025 certified for each element of analysis required under these TOR. Proof of current ISO 17025 certification for each laboratory for all relevant parameters shall be included with the Proposal submission and forms a mandatory requirement. A letter signed by each laboratory

to be used stating that they are ISO certified for all analysis requested in these TOR, for each medium will suffice. Please note that a complete list of all parameters and all mediums covered under this contract must be provided in the letter.

5.3.1.10 All sampling techniques must conform to CCME Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites (1993 or most recent) and industry best practices (whichever is more stringent) and are to be outlined in the Proposal and Work Plan. Any deviation must be accepted in writing by the DND Project Manager prior to implementation.

5.3.1.11 Method detection limits employed by the laboratory must be lower than the minimum requirements presented in Annex I (Table I2-Minimum MDLs). In the event that the minimum MDLs cannot be achieved due to sample properties, an explanation and justification must be provided along with a discussion of associated impacts of the high MDL on the validity and usability of the results.

5.3.2 Soil Sampling

5.3.2.1 Collect a soil sample at 0 to 15 centimeters (cm) depth and at 40 to 50 cm depth, at the locations indicated on the Drawings. Use the Soil Sampling Log template (Annex J2- complete all fields) for each landfill. **Soil descriptions must be noted including any visual or olfactory observations, and discussed in the reports**.

5.3.2.2 If the specified sampling depth cannot be achieved following a reasonable attempt in the target sampling area, a sample shall be collected at or near the zone of refusal. All sampling depths shall be recorded and reported.

5.3.2.3 For collecting soil samples at monitoring well locations, collect soil samples within a 2 to 4 m radius of the monitoring well. Document the exact sample location. Do not collect samples immediately adjacent to the well or in previously disturbed locations. Collect soil samples prior to purging wells.

5.3.2.4 All soil sampling locations onsite must be backfilled at the conclusion of each monitoring event. A photograph of each test pit/sampling location will be taken during sampling and after backfilling is completed. Photographs are to be included in the Photographic Record detailed in Section 5.5 – Photographic Records below.

5.3.2.5 Collect soil samples with new contaminant free, single use disposable sampling utensils, or equipment decontaminated between each sampling event utilizing decontamination fluids appropriate to the parameters being sampled. If

utilizing decontaminated sampling equipment, address the potential for cross-contamination with appropriate quality assurance and quality control procedures (e.g. equipment blanks). Soil may be partially frozen, and sturdy equipment (e.g. shovel / pick axe) may be required to access soils at depth for sampling. Sampling utensils are to be disposed of or decontaminated between each sampling event. Single use sampling materials are considered waste after use (see Section 6.1.3).

5.3.2.6 Analyze soil samples for the following parameters:

- Petroleum Hydrocarbons (PHC) F1-F4 fractions, as represented as F1 (C6 to C10), F2 (>C10 to nC16), F3 (>C16 to C34), and F4 (>C34) as defined by CCME Tier I Method – Rev. 5 (or most recent) Analysis of Petroleum Hydrocarbons in Soil. In the Analytical Data Summary Table, the Consultant is to sum the F1-F3 fractions to obtain an analogous total petroleum hydrocarbon (TPH) concentration for information purposes. The analogous TPH result should be clearly described as different from an analyzed TPH result or field test kit TPH result.

Please note: The F4 fractions are to be reported by the consultant in a separate table within the report. The F4 fraction is not included in the Excel worksheets as there is no baseline to compare it to.

- Inorganic elements: arsenic, cadmium, chromium, cobalt, copper, lead, nickel, zinc, and mercury.
- PCBs (polychlorinated biphenyls – Total Aroclor analysis).

5.3.3. Groundwater Sampling

5.3.3.1 Collect groundwater (active layer) samples at the well locations as indicated on the Drawings. Note that DND will provide keys to the successful proponent and request that locks of a specific make and model be used for replacement to ensure one key will open all wells on site. Damaged locks should be replaced as required and should be the same make and model as the existing locks on site (G. Hjukstrom Limited, 7000PS-KA3, 40mm) to ensure that one key will open all monitoring wells and thermistors on site. The Consultant should be equipped for cutting malfunctioning locks and prepared to replace all locks on site

5.3.3.2 For each monitoring well complete all fields in the Monitoring Well Sampling Log (Annex J3).

5.3.3.3 Wells will be used to determine hydraulic gradient where possible.

5.3.3.4 Purge monitoring well prior to sampling.

5.3.3.5 Sample monitoring wells **using low-flow sampling techniques** to minimize sediment entrainment (EPA/540/S-95/504 or most recent). Maintain purge rate at 100 milliliters per minute (mL/min) or less. In the event that another sampling technique is proposed, identify how turbidity will be addressed to ensure samples are representative. Do not exceed recovery rate.

5.3.3.6 Monitor and record conductivity, pH, turbidity and temperature during purging including final values. Do not sample groundwater until values for these parameters have stabilized. If the well runs dry during the first attempt, return in subsequent days while still on site, to collect the sample (if possible based on logistics plan). Otherwise, recover un-stabilized sample if possible and ensure that interpretation of results considers the limitations from the sampling event.

5.3.3.7 Use contaminant free single use sampling materials for each sampling location or decontaminate equipment (outside and inside surfaces) between each sampling event utilizing decontamination fluids appropriate to the contaminants being sampled. If utilizing decontaminated sampling equipment address the potential for cross-contamination with appropriate quality assurance and quality control procedures (e.g. some equipment blanks).

5.3.3.8 **Do not** leave sampling materials in wells (they will freeze and damage the wells). Sampling equipment is to be disposed of or decontaminated between each sampling event. Single use sampling materials are considered waste after use (see Section 6.1.4).

5.3.3.9 **Do not** field-acidify or preserve samples collected for metals. Petroleum hydrocarbon (PHC) samples (F1-F4) can be preserved if required by CCME. Should preservation of the PHC samples be conducted, ensure adherence to the Transportation of Dangerous Goods Act and its regulations if applicable to the preservatives selected.

5.3.3.10 **Do not** filter samples.

5.3.3.11 Where sufficient groundwater is found, sample bottles are to be filled during a single collection event.

5.3.3.12 The following groundwater analyses are required. Prioritize the sampling in the following order:

- Petroleum Hydrocarbons (PHC) : F1 fraction.
- Inorganic elements – total concentrations: arsenic, cadmium, chromium, cobalt, copper, lead, nickel, zinc and mercury. Samples are not to be filtered (which is why low turbidity is so important) or preserved.
- Petroleum hydrocarbons (PHC): F2-F4 fractions. Note: in the Analytical Data Summary Table, the Consultant is to sum up the F1-F3 fractions to obtain an analogous TPH petroleum hydrocarbon (TPH) concentration for information purposes.

Please note: The F4 fractions are to be reported by the consultant in a separate table within the report. The F4 fraction is not included in the Excel worksheets as there is no baseline to compare it to.

- PCBs (polychlorinated Biphenyls – Total Aroclor analysis).

5.3.4 Sampling of areas of potential environmental concern.

5.3.4.1 The consultant shall ensure to bring sufficient sampling equipment and sample containers to allow for the collection of additional soil and surface water samples presenting potential evidence of impact, should they be encountered on or adjacent to the landfills being monitored at the time of the site visit.

5.3.4.2 The location of additional samples shall be recorded and a photographic record shall be taken of the potentially impacted media.

5.3.4.3 Samples collected to represent additional potential areas of concern will be submitted to the laboratory “on Hold” until approval has been received by DND to proceed with analysis.

5.3.5 Chemical Quality Assurance and Quality Control (QA/QC) Requirements

5.3.5.1 Demonstrate that adequate measures will be and have been taken to ensure good QA/QC procedures throughout the course of the project, consistent with the requirements outlined in Annex K. This shall be addressed in the Consultant’s Proposal Submission, confirmed in the Work Plan and documented in detail in the monitoring report.

5.3.5.2 Establish appropriate Quality Assurance/Quality Control (QA/QC) procedures for soil and active layer water sampling and analyses to ensure accuracy, precision and **representativeness** of results. The QA/QC program shall include an inter-laboratory and intra-laboratory comparison of results. Refer to Annex K of these TOR for QA/QC requirements. Refer to CCME reference documents for recommended sampling and analyses procedures.

5.3.5.3 Intra-laboratory QA/QC (the same laboratory) does not require additional duplicates. For the inter laboratory comparison (the second laboratory), 10% field duplicates (soil and groundwater) should be analyzed. The Consultant must report both intra and inter laboratory results including all duplicates and other QA/QC measures and discuss their significance.

5.3.5.4 The laboratory QA/QC results should include at a minimum a discussion of the following with the certificates of analyses, and how any deviations may impact results:

- The condition of the samples they received (e.g. temperature of the cooler, moisture content, legibility of labels, chain of custody);
- Sample containers, i.e. were appropriate containers used for the parameters being analyzed, and what was their integrity upon receipt at the laboratory;
- Holding times;
- Head space, and/or use of preservatives (where relevant);
- Laboratory QA/QC, blanks, duplicates, relative percent difference, and any other relevant result or observations that could impact the interpretation of results. All laboratory qualifying data must be reported by the laboratory in the certificate of analysis outlining any limitations or considerations in interpreting results. This shall be discussed in the monitoring report.

5.4 Thermal Monitoring

5.4.1 Geothermal analyses were carried out as part of the design to predict the length of time required for permafrost aggradation through landfills requiring leachate containment and for Tier II disposal facilities.

5.4.2 The thermal monitoring system provides measurement of sub-surface ground temperatures. The thermal monitoring system consists of thermistor strings (beads), at select intervals, to provide ground temperatures at various locations within the landfills. These strings are attached to automated dataloggers that allow for data collection.

5.4.3 Inspect the condition of the monitoring installations associated with the landfill using the Thermistor Inspection Report template provided in Annex M (complete all fields). Note any damage and specific repair requirements to allow for repair in the future. Record the datalogger manufacturer model and serial numbers. The Consultant is to bring the datalogger user guide (to be provided to the successful proponent within two weeks of contract award) and spare batteries to the site. Batteries can be purchased from Lakewood System, the datalogger manufacturer.

- A site specific hazard assessment (for each DEW line site);
- Roles and responsibilities of personnel on-site;
- Applicable training requirements and verification of training (based on hazard assessment);
- Emergency procedures;
- Working in harsh environmental conditions (e.g. weather, insects), and any associated considerations (e.g. delays);
- Working in remote locations;
- Wildlife safety and monitoring (e.g. polar bears, etc.);
- Personal protective clothing and equipment requirements (PPE); note steel toed boots and not shoes are required;
- Communication equipment and procedures on site and off site; and
- Accidents, medical emergencies, personnel injury and sickness.

Note: Emergency shelters equipped with rations, cots, blankets and communication devices are present on active NWS sites. The emergency shelters at the long range radar sites are located within the garage/heated vehicle storage buildings. The shelters at the short range radar sites are located in the technical services buildings. These sites are video monitored and access to the vestibule of an emergency shelter will trigger an alarm and the occupant will be seen on video. From here they will either be contacted through a PA system or will have to use a phone in the vestibule (with instructions on who to call). If the situation is deemed an emergency by North Bay NWS ops, an access code will be provided to enter the shelter. These sites are to be used in case of emergency only.

7.3 *Logistics & Work Plan*

7.3.1 Prepare and submit for acceptance a Logistics & Work Plan six weeks prior to field work activities. The Logistics and Work Plan must include a specific section for each site. Where deficiencies or edits are noted by the DND review team, the consultant will submit a revised Logistics and Work Plan addressing these issues. The Logistics & Work Plan must be finalized at least 3 weeks in advance of scheduled field work. The plan must address at a minimum, but not be limited to, the following:

- Access to the site and on site transportation (including transportation of equipment and/or materials, TDG, etc.. required to complete the work);
- Accommodations, water and food supply while on site;
- Expected duration on site and back-up plan for managing delays;
- Access and transportation to work areas at the site;
- Communication methods on site and off site;

- Monitoring event timing (must ensure that monitoring is carried out during the period of maximum active layer thaw; monitoring shall occur in August);
- The Consultant's planned dates for conducting the on-site inspection and for delivery of each deliverable;
- Approach for adhering to the Nunavut Water Board Water Use License (WUL), and/or a Land Use Permits terms and conditions;
- A signed waiver (template to be provided prior to fieldwork) from the Consultant Representative; and
- Detailed approach and methodology (including QA/QC) that will be followed in the field for technical components (thermal, chemical (soil and active layer water), visual and photographic)).
- Detailed approach and methodology to be followed for deliverable preparation to achieve the project requirements. Include a section on QA/QC.

7.4 *Progress Reporting*

7.4.1 Notify the DND project manager by email, as soon as possible, for each monitoring event, of: i) any deviations to the field work schedule; and ii) the date the field work has been completed and staff have been demobilized from each site. Please note that DND has obligations to report this information.

7.4.2 Within two weeks of completion of the field inspection, submit a brief summary Field Work Progress Report for each site outlining:

- Summary of the field inspection activities completed;
- the start and end dates of the field inspection at each site and for each landfill;
- field personnel involved, respective roles and responsibilities and Inuit registry numbers as applicable;
- any deviations from TOR, Proposal or from the Logistics & Work Plan;
- a description of any issues encountered and actions taken;
- a list of significant visual observations for each landfill;
- a table indicating each monitored location at each landfill and a summary of the samples collected (note if a sample was not collected for all parameters or at the planned sample location this should be explained)
- a field sketch showing sample locations and significant features;
- raw thermistor data;
- laboratory certificates of analysis
- copy of raw field notes
- a summary of battery replacement activities and list of any dataloggers brought south for repairs.

Annex K: Quality Assurance / Quality Control Procedures for Analyses

1. General: The consultant will ensure that sampling data and analytical results are interpretable and representative through a rigorous conformance to analytical Quality Assurance and Quality Control (QA/QC). At a minimum, the Consultant shall ensure that the analytical QA/QC procedures outlined in this Annex are followed.

1.1 Laboratories must have ISO 17025 certification for all parameters of analysis and relevant media.

1.2 The consultant must incorporate a series of external checks to assess the performance of the analytical laboratory. As a minimum, these shall include:

1.2.1 Use of an appropriate coding system for submitting blind duplicates to the analytical laboratory. A chain of custody will be established to trace the movement and handling of samples from the field to their final destinations.

1.2.2 Submission of blind field duplicates for at least 10% of samples are to be submitted to the Consultant's 2nd Laboratory for an inter-laboratory comparison. The field duplicate shall be collected from a relatively homogeneous substrate such that the expected composition of the sample and its duplicate are similar. When analyte concentrations vary by 30% or more, the Consultant will need to provide an explanation.

1.3 The analytical laboratory must incorporate and report the results of internal checks used to assess the reliability, accuracy and reproducibility of the data on the certificate of analysis. As a minimum the checks shall include:

1.3.1 Analyses of samples in batches.

1.3.2 Each batch will include the analyses of one sample of standard or certified reference material, or spiked standards where these are not available.
a. Each batch will include at least one analytical (lab) duplicate; and
b. Each batch will include at least one analytical blank.

1.3.3 Acceptable QA performances are as follows:
a. For organic analyses, all analytical duplicates are to exhibit less than 20% relative standard deviation on average, and no more than 30% for a specific set.
b. For inorganic elements, all analytical duplicates must exhibit less than 15% relative standard deviation on average, and no more than 20% for a specific set
c. Analytical results for all reference materials or spiked standards must be within 10% of certified values for inorganic elements or 30% of certified values for organic compounds
d. All analytical blanks should be below the detection limits used for the analyses.

1.4 Review of the analytical data shall take place in concert with external QA checks (inter-laboratory duplicates) and internal checks (analytical duplicates, reference materials, spiked standards, analytical blanks (e.g. field blanks, equipment blanks, travel blanks) and shall be reported in the Monitoring Report. Internal laboratory QA data must also be included within the Monitoring Report. The certificates of analyses should include a description of how any of these items may impact the interpretation of results obtained:

a. The condition of the samples they received (e.g. temperature of the cooler, moisture content, legibility of labels, chain of custody);
b. Sample containers – were appropriate containers used;
c. Holding times;
d. Head space, and confirmation that preservatives were NOT used;
e. Confirmation that the samples were NOT filtered.
f. Integrity of sample containers;

g. Laboratory QA/QC, duplicates, blanks and RPD results;
h. Any other relevant observations that could impact interpretation of results. Note, all laboratory qualifying data must be reported outlining any limitations or considerations in result interpretation.

Annex I

DEW Line Clean-up Criteria for soil & Minimum Laboratory Method Detection Limit Requirements

DEW Line Clean-up Criteria (DCC) Soil[2]		
Parameter	**Tier I (ppm)**	**Tier II (ppm)**
Arsenic (total)	-	30
Copper (total)	-	100
Cadmium (total)	-	5
Cobalt (total)	-	50
Chromium (total)	-	250
Nickel (total)	-	100
Lead (total)	200	500
Mercury (total)	-	2
Zinc	-	500
PCBs[1]	1	<5, <50

Note 1: Soil containing PCB concentrations in excess of 50 ppm are regulated under the Canadian environmental Protection Act.

Note 2: DCC for soil established as part of DEW Line Clean-up project protocol.

Total Petroleum Hydrocarbons were not included in the original DCLU protocol but have subsequently been added to the clean-up requirements as a result of negotiations between DND and the NTI. The evaluation of the clean-up requirements for hydrocarbon contaminated areas was conducted on a case by case basis for site where TPH exceeded 2500 ppm.

Ref: DEW Line Clean-up Project, Landfill Monitoring Plan, UMA Engineering Ltd, February 1999.

Minimum MDLs for monitoring program			
Parameter		**Soil (mg/kg)**	**Groundwater (mg/L)**
Arsenic (total)		<1	<0.001
Cadmium (total)		<0.5	<0.0001
Chromium (total)		<1	<0.001
Cobalt (total)		<1	<0.0005
Copper (total)		<1	<0.005
Lead (total)		<1	<0.0001
Mercury (total)		<0.1	<0.0001
Nickel (total)		<1	<0.001
Zinc		<1	<0.005
PCBs		<0.05	<0.05
Petroleum Hydrocarbons	PHC F1	<7	<0.025
	PHC F2	<4	<0.1
	PHC F3	<8	<0.1
	PHC F4	<6	<0.1