FOX-3 LANDFARM DESIGN AND MANAGEMENT PLAN

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North Warning System & Assoc. Projects

Aerospace Equipment Program Directorate
455 Blvd de la Carrière
11th Floor
Gatineau, Québec
K1A 0K2

Prepared by

400 Cooper Street
Suite 3000
Ottawa, ON, K2P 2H8

CHANGE HISTORY

This sheet is a record of each issue of this document. When the revised document is issued, the previous issue is automatically superseded.

Revision	Date	Author	Pages Changed	Reason for Change
1	7-Oct-2021	A. Leslie	All	New Document

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1.0 INTRODUCTION

1.1 Overview

The Department of National Defence (DND) and/or Raytheon Canada (RC) occasionally has a requirement to remediate hydrocarbon spills on-site through landfarming at North Warning System (NWS) sites. RC is currently responsible for the care and custody of the NWS on behalf of DND. However, the current landfarm at FOX-3, Dewar Lakes, NU is under the care and custody of DND.

Landfarms are a common method for the ex-situ bioremediation of petroleum hydrocarbon (PHC) impacted soil in northern Canada. Landfarming involves spreading contaminated soil in an even layer (or in windrows) followed by stimulating aerobic microbial activity. Microbial activity may be stimulated by activities such as tilling, adjusting moisture content, adjusting pH and/or adding nutrients or other amendments. Landfarming is also known as land treatment, land spreading or cell bioremediation (FCSAP, 2013) and will be referred to as landfarming or landfarm in this document.

1.2 History

A landfarm was established at FOX-3 to remediate fuel spills which occurred in 2009 (prior to RC's care and custody of the NWS) and 2013. Environmental Science Group (ESG) was contracted by the DND North Warning System Office (NWSO) in 2016 to delineate both spills.

The landfarm was designed and constructed between 2017 and 2018. An overview of the design and monitoring plan was outlined by Defence Construction Canada (DCC) titled "FOX-3 Landfarm Management Plan 2017" and was submitted by DCC (on behalf of DND) to the Nunavut Water Board (DCC, 2017).

1.3 Scope

This document applies to the landfarm at FOX-3 and ensures compliance with the FOX-3 Nunavut Water Board water licence No. 8BC-FOD1828.

2.0 GENERAL INFORMATION

2.1 Location

FOX-3 is a Long Range Radar (LRR) site occupies about 1,643 hectares of land. The airstrip in the valley is approximately 152 m above sea level. The host Logistics Support Site (LSS) for FOX-3 is LSS-F, Sanirajak (Hall Beach). Flight time from the LSS is 3 hours 30 minutes by helicopter under normal conditions. An abandoned airstrip is located at this site, as well as a helipad. The airstrip requires minimal repair in order to be in suitable conditions for the annual C-130 airlift re-supply of fuel.

Infrastructure on site is located in two main areas connected by a gravel road: the main LRR station at the summit in the northwest ("Summit Area"), and the airstrip located in the southeast ("Airstrip Area"). For a general site plan see Figure A-2 in Annex A.

2.2 Climate

FOX-3 is situated near a chain of lakes in central Baffin Island, approximately 525 m above sea level. The total mean annual rain and snowfall are 115.7 mm and 166.4 cm, respectively. The majority of the precipitation falls from May to October. The mean annual temperature is 13.3 C, with the warmest month being July and the coldest months being January to March. Generally temperatures at this site are less extreme than in the coastal areas of Baffin Island.

2.3 Topography

The Summit (about 518 m above sea level) is in an area indicating general glacial scouring. Surface materials include bedrock, till, and fluvial materials with till being the most common. The area is strewn with boulders up to 1 m across. The airstrip area features fluvial deposits of gravels, sands, and silts. Vegetation is relatively scarce with some patches of wood rush, grass, and wildflowers. The wetter areas may consist of sedges and moss.

2.4 Soil and Geology

The bedrock-controlled topography of the area has been enhanced by glaciers that selectively eroded weaker rock layers and sculpted stronger ones. The entire area was covered by the Laurentide Ice Sheet during the late Wisconsinan and Holocene periods. Glacial ice flowed westward from the central plateau of Baffin Island towards Foxe Basin.

The project area is located well above the original marine washing limit, therefore, glacial till is the prevalent deposit type, with glaciofluvial, alluvial, glaciolacustrine and colluvial deposits present in portions of the site. Till is bouldery with a predominantly silty sand matrix, well graded and unsorted.

3.0 LOCATION AND CONSTRUCTION OF FACILITIES

3.1 Location

The location for the construction of the landfarm facility at FOX-3 was based on the location of the previous landfarm facility which was constructed during the DEW Line Clean Up Project to remediation hydrocarbon-contaminated soil. Annex A contains a site map identifying the location of the landfarm, south of the main station. Originally, during the DEW Line Clean Up, the selection of this site was chosen for the level area which was present; also the design of a landfarm took into account several other factors, including geotechnical suitability which considers topography, soil conditions, natural drainage in the area, depth to bedrock or permafrost, groundwater, and adverse soil conditions that may affect permafrost and potential containment. Environmental considerations weighed heavily in the consideration for the location of the landfarm, these include the footprint of area required; the distance from ecologically sensitive areas, including marine and freshwater systems; the distance from water supplies; contaminated soil areas; geotechnical suitability; and the accessibility of the landfarm location during the remediation work.

3.2 Construction

During the construction of the landfarm facility berms were created around the area that contains the contaminated soil. The berms and the base of the facility were heavily compacted to a level of 95% compaction; this reduces the permeability of the granular fill. Once the 54.2 m by 78.6 m facility was prepared, the 600 m^3 of excavated hydrocarbon contaminated soil was added and spread in a thin layer of 0.4 m thickness and treated to facilitate a reduction in hydrocarbon concentrations through biodegradation and volatilization.

Remediation of contaminated soil by landfarming typically involves the addition of nutrients and water to the soil, followed by tilling to aerate the soil and stimulate microbial activity.

4.0 LANDFARM MANAGEMENT

4.1 General

In the event that the landfarm is actively used, the focus will be safety and environmental responsibility.

Landfarming typically involves the following:

1. Preparation of a engineered landfarm to receive and remediate contaminated soil;
2. Excavation of all contaminated soils;
3. Soil sampling of excavated material to characterize contaminants of concern;
4. Soil sampling of the base and side walls of the excavation to ensure all contamination is removed;
5. Back-fill and grade excavated areas;
6. Till contaminated soil within the landfarm until remediated to the appropriate CCME soil guideline (see Annex B for details);
7. Soil sampling will be conducted to ensure the remediation target is met; and,
8. Decommissioning of the landfarm.

4.2 Health and Safety

Employees working in the landfarm will be trained prior to commencement of work so that they are aware of the health and safety risks and mitigation measures. The landfarm is not easily accessible to the public.

There are four primary exposure pathways to chemicals within the landfarm:

a. Inhalation;
b. Ingestion;
c. Skin contact; and
d. Eye contact.

Because the landfarm is outside in open air, inhalation exposure can be mitigated. Ambient air concentrations of volatile organic compounds (VOCs) will be monitored periodically using a photoionizing detector (PID). In the case that PID readings are elevated respirators with combination filters will be worn.

Incidental ingestion, as well as skin and eye contact, will be prevented through appropriate worker training and personal protective equipment (PPE).

4.3 Operation

Prior to placing new material in the landfarm it will be characterized to ensure any contaminants of concern are appropriate for landfarming. Soil will then be placed into the landfarm cells in an even layer, ideally 30 to 75 cm thick.

After placing contaminated soil granular nutrients may be distributed over the surface. Moisture conditioning may be conducted, as required, by application of water spray to maintain optimum water content within the soil.

After application of nutrients, the full thickness of the soil may be tilled every five to ten days. During periods of heavy precipitation, tilling of the soil will be delayed until the soil is considered damp to a depth of 100 mm.

4.4 Environmental Control

Water runoff is captured within the landfarm due to the impervious liner and berms. In the event that water discharge is necessary water will be sampled and analyzed, prior to discharge, to ensure it meets the wastewater discharge criteria (see Table C-1 in Annex C).

The landfarm will be monitored weekly during summer months by the contractor to ensure proper operating conditions of soil moisture and aeration (i.e., moisture content around 5%, uncompacted

soil). Soil samples will be routinely collected and analyzed at a CALA-accredited laboratory to ensure that concentrations of hydrocarbons are decreasing. Headspace vapour readings using a PID may aid in determining frequency of laboratory analysis.

Corrective maintenance to the landfarm facility will be noted during weekly inspections, and any repairs will be carried out promptly. The nature of the repairs required and when repairs were completed will be recorded in the weekly report.

Prior to exiting the landfarm, equipment will be cleaned off to ensure that contaminated soil is not spread outside the landfarm.

4.5 Landfarm Closure

Once the soil in the landfarm facility has been remediated to the CCME Canadian Soil Quality Standards, commercial coarse-grained soil, (CCME, 1999 r. 2018), (CCME, 2001 r. 2008) (see Annex B, Table B-1), and confirmatory testing of the soils verifies that the remediation objectives have been reached, the landfarm may be decommissioned.

Any wastewater will be sampled and analyzed to ensure that prior to discharge all wastewater conforms to Wastewater Discharge Criteria. Wastewater above the criteria will either be treated on site, or containerized for off-site disposal.

Remediated soil will be used as backfill in an area that is compatible with the selected guideline and land use type. If the landfarm is no longer required the perimeter berms will be regraded to prevent ponding within the former landfarm. Final grading will promote drainage away from the site and will match the surrounding terrain.

5.0 REFERENCES

CCME. (1999 r. 2018). *Canadian Environmental Quality Guidelines*. Retrieved February 1st, 2021, from Canadian Council of Ministers of the Environment (CCME): http://st-ts.ccme.ca/

CCME. (2001 r. 2008). *Canada Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil.* Canadian Council of Ministers of the Environment (CCME).

CCME. (2008). *Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil Technical Supplement.* Canadian Council of Ministers of the Environment (CCME).

Defence Construction Canada. (2017). *FOX-3 Landfarm Management Plan 2017.*

ECCC. (2014). *1981-2010 Climate Normals and Averages*. Retrieved from Environment Canada and Climate Change (ECCC): https://climate.weather.gc.ca/climate_normals/index_e.html

FCSAP. (2013). *Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils.* Federal Contaminated Sites Action Plan (FCSAP).

GN. (1999 r. 2009). *Environmental Guideline for Contaminated Site Remediation.* Department of Environment, Government of Nunavut (GN).

GSC. (2011). *Geological map of the Arctic (2159A).* Geological Survey of Canada (GSC).

INAC. (2008). *Abandoned Military Site Remediation Protocol: Volume I - Main Report.* Indian and Northern Affairs Canada (INAC), Northern Affairs Organization, Contaminated Sites Program.

NRCAN. (1995). Canada Permafrost (MCR 4177). In *The National Atlas of Canada 5th Edition.* Natural Resources Canada (NRCAN).

ANNEX A. FOX-3 SITE PLANS AND LANDFARM LOCATION

Figure A-1: FOX-3 Site Plan and Topography

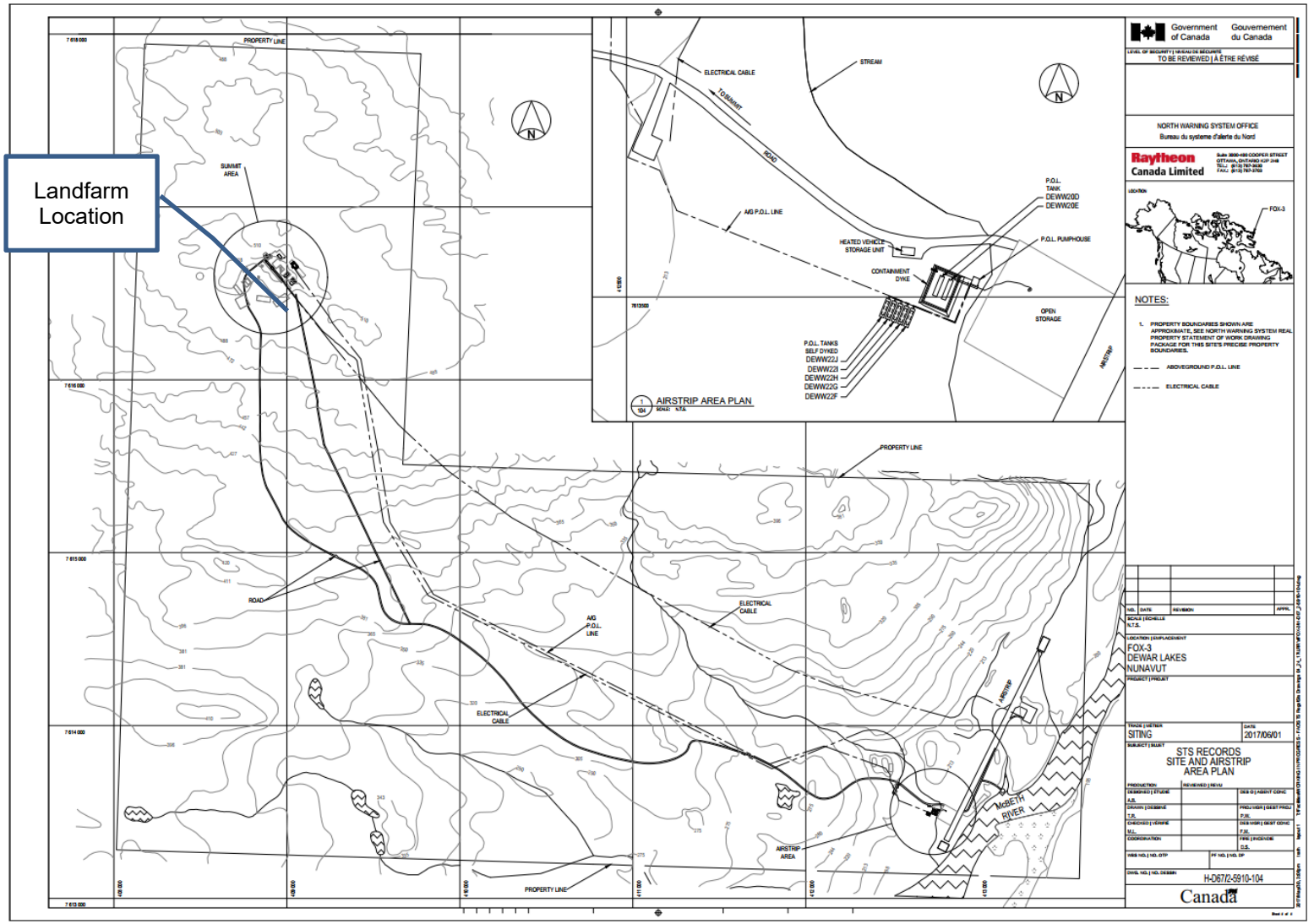


Figure A-2: Landfarm Layout Plan (AECOM, 2018).

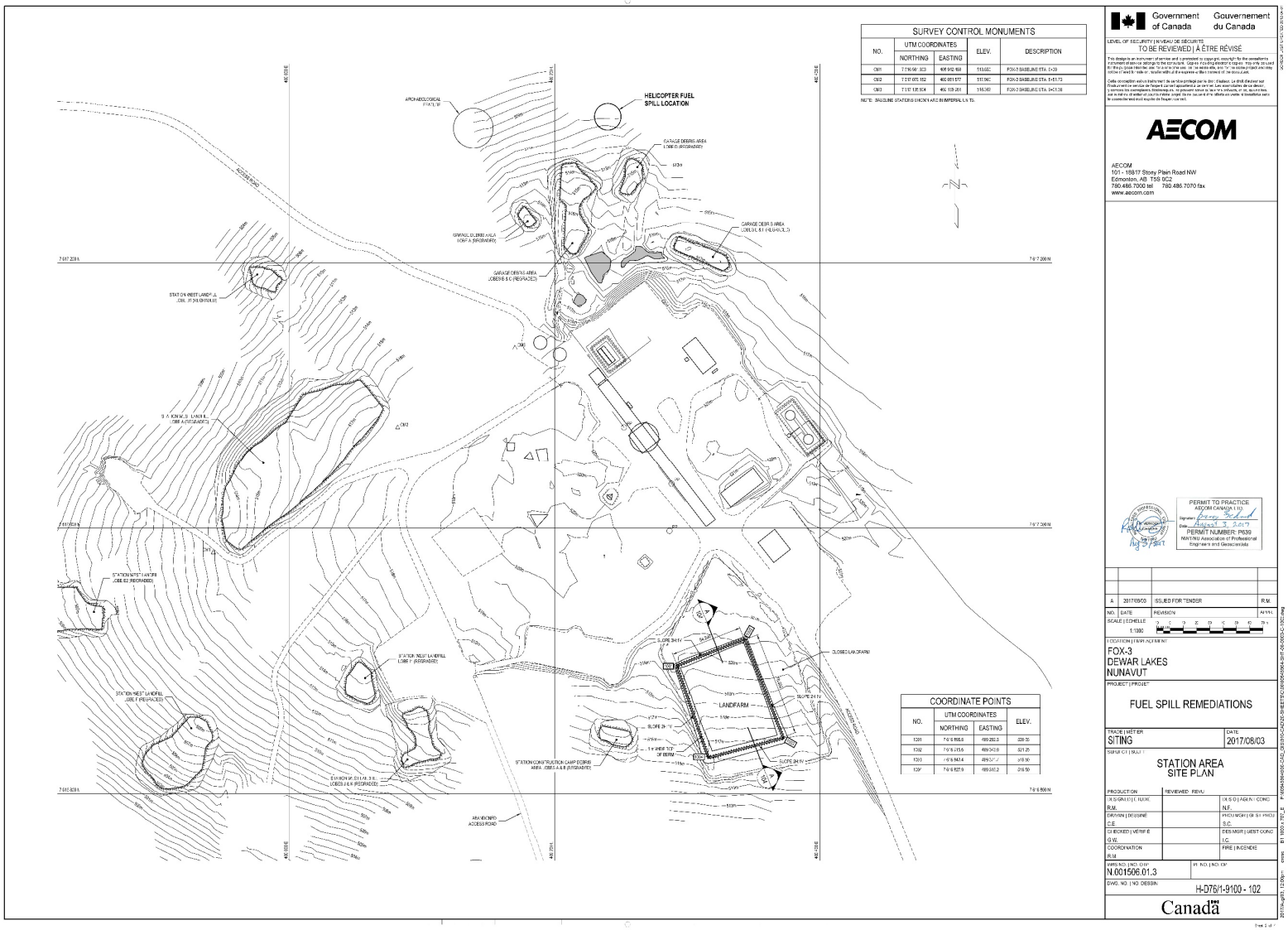
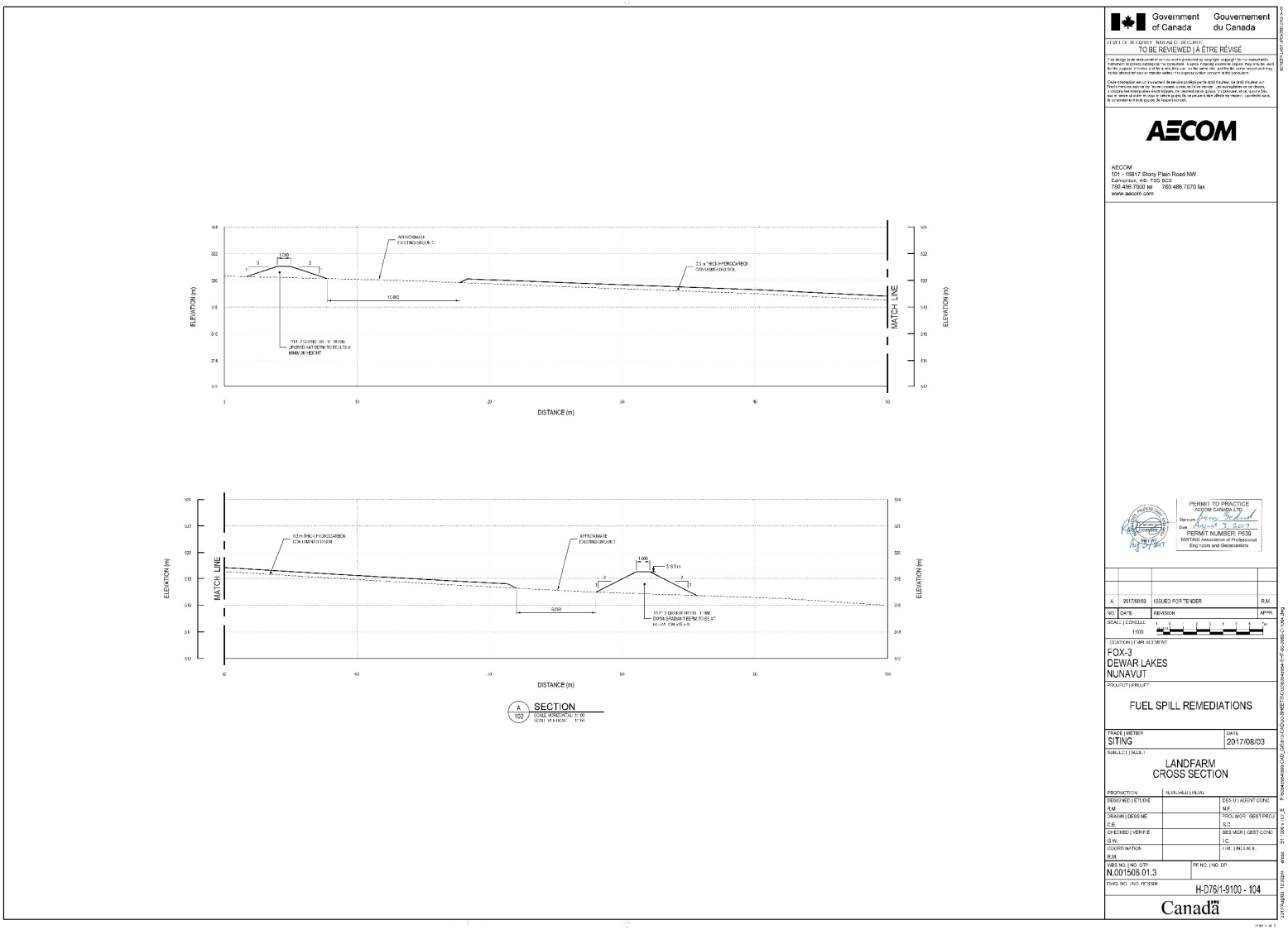


Figure A-3: Landfarm Cross Section (AECOM, 2018).



ANNEX B. SOIL GUIDELINES

Table B-1: CCME guidelines for coarse-grained soil (Canadian Soil Quality Guidelines (CCME, 1999 r. 2018) and Canada-Wide Standards for PHC in Soil (CCME, 2001 r. 2008))

Grouping	Parameter	Land Use: Commercial	Land Use: Industrial
Metals and Inorganics	Arsenic	*12*	*12*
	Barium	*2000*	*2000*
	Cadmium	*22*	*22*
	Chromium (total)	*87*	*87*
	Copper	*91*	*91*
	Cobalt	*300*	*300*
	Lead	260	600
	Mercury	24	50
	Nickel	*89*	*89*
	Zinc	*410*	*410*
PHCs	PHCs F1 (C6 to C10)	320	320
	PHCs F2 (C>10 to C16)	260	260
	PHCs F3 (C>16 to C34)	1700	2500
	PHCs F4 (C>34 to C50+)	3300	6600
VOCs	Benzene	*0.03*	*0.03*
	Toluene	*0.37*	*0.37*
	Ethylbenzene	*0.082*	*0.082*
	Xylene	*11*	*11*
Other	Phenol	*3.8*	*3.8*
	PCBs	*33*	*33*

Grey Italic – Indicates the industrial and commercial guidelines are the same
Units: mg/kg

Notes:

1. Guideline values for PHCs are in reference to the Canada-Wide Standards for PHC in Soil (CCME, 2001 r. 2008). The other values are in reference to the Canadian Soil Quality Guidelines (CCME, 1999 r. 2018).
2. Guideline values for PHCs refer to surface soils (between 0 and 3 mbgs) (CCME, 2008).
3. Parameter groups recommended by FCSAP (2013) for spills of unleaded gasoline, leaded gasoline and/or aviation gasoline include: metals and inorganics, PHCs and VOCs. These parameters may be used for the initial screening to establish contaminants of concern. Additional parameters, such as the ones listed as “Other”, may be used if other contaminants are suspected. If containments of concern are established confirmatory sample analysis may only include specific parameters.

ANNEX C. WASTEWATER DISCHARGE CRITERIA

Table C-1: Landfarm wastewater discharge criteria as listed in Nunavut Water Board licence No. 8BC-FOD1828, Part D.

Parameter	Wastewater Discharge Criteria (µg/L)
pH	6 to 9 (pH units)
Oil and Grease	5000
Arsenic (total)	100
Cadmium (dissolved)	10
Chromium (dissolved)	100
Cobalt (dissolved)	50
Copper (dissolved)	200
Lead (dissolved)	50
Mercury (total)	0.6
Nickel (dissolved)	200
PCB (total)	1000
Phenols	20
Zinc (total)	500
Benzene	370
Toluene	2
Ethylbenzene	90