PIN-C Site Remediation Project, Bernard Harbour, Nunavut

Type B PHC Contaminated Soil Treatment Facility Plan

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SILA REMEDIATION

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Table of Contents

1 Introduction

Sila Remediation Inc. (Sila) has participated in the clean-up of numerous former radar and/or weather stations throughout Northern Canada, all similar in the type of work and the constraints presented by the PIN-C Site Remediation Project. On-site soil treatment was part of 7 of those projects completed by Sila.

Sila has undertaken the remediation of over 6,000,000 tons of soil, mainly using an ex-situ or in-situ biological process implemented within the context of small or large- scale projects and dealing with a wide variety of hydrocarbon contaminants: gasoline, diesel, kerosene, bunker, pentachlorophenol (PCP), polycyclic aromatic hydrocarbons (PAHs), transformer oil and heavy hydrocarbons, trichloroethylene, and used oil.

In the Arctic, Sila has constructed Type B PHC treatment facilities for the CAM-5, FOX-3, FOX-E, CAM-C and FOX-D DEW Line Sites as well as Padloping Island and Nottingham Island former radar stations clean-up projects, successfully treating over 20,000 m^3 of Type B PHC contaminated soil, which far exceeds the volume of Type B PHC soil to be treated for the PIN-C project. Sila, in collaboration with our Nunavik partner Nunatech, also operates an arctic-based hydrocarbon contaminated soil treatment facility in Kuujjuaq, treating over 2,000 m^3 of hydrocarbon contaminated soil per year using the biopile technology.

The following document is Sila's Type B PHC Soil Treatment Plan for the PIN-C Site Remediation Project. This Treatment Plan presents Sila's approach to complete the project including a discussion of the following topics:

— Selected method of PHC soil treatment;

— Required equipment and materials;

— Contaminated Soil Treatment Facility construction;

— Excavation of Type B PHC soil;

— Methodology for Type B PHC contaminated soil treatment;

— Schedule, sampling and laboratory testing;

— Monitoring of the Contaminated Soil Treatment Facility;

— Decommissioning of the Contaminated Soil Treatment Facility.

2 Selected Method of PHC Soil Treatment: Landfarming

Type B PHC contaminated soil will be treated in the on-site Contaminated Soil Treatment Facility (CSTF) through a process commonly known as landfarming. Landfarming is a biologically based approach that relies upon the stimulation of indigenous microorganisms already present in the soil to degrade the contaminants of concern. Although the conditions of northern regions may impose limitations in terms of bioremediation, psychrophilic microorganisms are typically well established in soils and are well adapted to the arctic climate. The basic principles of landfarming consist of performing various amendments to the contaminated soil, including nutrient application and physical processing to improve the soil matrix to increase microbial activity and thus accelerate biodegradation. The microorganisms essentially metabolize the contaminants, converting PHC to inert compounds such as carbon dioxide and water.

3 Required Equipment, Materials and Personnel

The following equipment, materials and personnel will be required for the CSTF construction, operation and decommissioning:

- Construction:
  - Excavator equipped with ditching bucket
  - Loader
  - Off-Road truck
  - Bulldozer
  - ATVs
  - Compactor
  - Burlap
  - Geotextile
  - LDPE Liner
  - Pumps
  - Monitoring wells
- Operation:
  - Excavator
  - Water Treatment Unit as required for run-off water
  - Nutrient spreader
  - Water trailer and pump for hydration
  - Sampling supplies and PPE (sample jars, stainless steel scope or plastic spoon, nitrile gloves, respirator, shovel, hard cooler, ice packs, etc.)
- Decommissioning:
  - Bulldozer
  - Excavator equipped with ditching bucket
  - Off-Road truck
- Human resources:
  - Heavy equipment operators
  - Surveyor
  - Hazardous Waste Specialist
  - Soil Remediation Specialist
  - Labourers

4 CSTF Construction

4.1 Construction

After site access roads have been upgraded, borrow areas commissioned and background testing performed by the PSPC Construction Representative (PCR), construction will begin on the CSTF. To initiate construction, the on-site Surveyor will first clearly define the boundaries of the facility and verify the original ground topography. Once the area has been approved by the PCR, a labour crew under the supervision of a Hazardous Waste Specialist will remove any debris from the area if present. When complete, a dozer will be used to blade the area to the desired grade. The excavator will prepare the area by removing boulders, snow, and the organic layer (if present). The organic layer will be placed aside and can be used on site during final regrading of disturbed areas to promote plant recolonization of these areas. Removed boulders will be placed aside and those of an appropriate size will be used later as rip rap to provide erosion control, if necessary.

Estimated borrow needs and sources for the CSTF construction are detailed the table below. Please use this as a reference throughout this section.

Task	Material Type	Source	Quantity (m^3)
Berms	Type 2	BA-02	200
Liner cover/base	Sand	BA-02	1,000

Once the grading of the 2,000 m^2 pad (graded natural ground) is complete, berm construction will begin. Type 2 material required for berm construction will be hauled from the borrow area to the CSTF with articulated trucks. The sand from BA-02 will be screened if necessary to ensure it meets the required gradation specifications for use as both the base layer beneath the geomembrane and the cover layer above it. The time required for screening is considered negligible and is not expected to impact the construction schedule. A dozer will spread the Type 2 material used for the berm in horizontal lifts not exceeding 250 mm. The lift height will be marked on the survey stakes with flagging tape to provide a guide to operators while spreading material. Every lift will be compacted using a roller compactor. Based on previous experience constructing facilities in the north with similar material, it is anticipated 2 – 3 passes with the compactor will be required to reach the desired compaction level. Once the first lift is finished and approved by the PCR, subsequent lifts will be placed until the desired berm height for this stage of the construction has been met. A crowned surface will be maintained throughout the construction of the berms to promote runoff of surface water.

The dimensions of the base layers and berms are detailed below and are available in Appendix A:

- Contaminated soil layer: 0.40 m
- Sand base layer (over liner): 0.30 m
- Sand cover layer (under liner): 0.30 m
- Total height of the berm: 1.0 m
- Freeboard: 0.30 m
- Crest width of berm: 1.0 m
- Side slopes of berm: 1H:1V slope
- Longitudinal slope of pad: 2%

Once construction of the berm is complete, an excavator with a smooth bucket will be used to shape the slopes of the berms to the desired angle. A grade laser and total station will be used to ensure the proper slope has been achieved.

With the completion of the berms, the CSTF will be prepared for the installation of the Texel TM-820P LDPE Liner and non-woven geotextile liners. At first, a 0.3 m thick lift of sand from BA-02 will be placed over the graded natural ground with the excavator. Geotextile will be hoisted by an excavator and unrolled by a team of labourers on top of that sand layer. Sandbags will be placed on the textile to hold it in place until it can be attached to adjoining pieces. With the first layer of geotextile in place, installation of the LDPE liner will begin. The LDPE liner will be custom fabricated in one piece only, thus avoiding the need for welding joints.

After the liner installation is complete, an additional overlapping layer of geotextile will be installed over the liner following the same procedures previously described and tied into the surrounding berm.

Before the CSTF can be operational, a 0.3 m thick lift of sand from BA-02 will be placed over the geotextile layer with the excavator. In order to maintain the integrity of the underlying geomembrane a ramp with a minimum thickness of 1.0 m will be constructed out of Type 2, to allow the excavator to access the interior of the cell. This method prevents any movement of the liner that can occur if material was to be pushed with a dozer.

In order to spread material across the entire facility, the excavator will create a pad of suitable thickness from which to work from, moving the pad of material as needed until the lift is complete. At no time will the excavator travel directly on the membrane, or on material less than 1 m in thickness. The surveyor will be on hand at all times to confirm the thickness of the lift. Any excess Type 2 will be removed from the facility.

To ensure only authorized personnel enter the treatment area, the following signage will be posted around the facility:

Caution, Contaminated Soil Treatment Area, Restricted Access.

Signage will be in both Inuinnaqtun and English.

4.2 Water Retention Pond Construction

As a mitigation measure in case of excess rainwater, a small retention pond of approximately 10 m x 18 m will be constructed next to the CSTF. The purpose of the pond is to hold any excess rainwater that could accumulate in the CSTF. This will prevent the soil being treated from being too wet and slowing down the treatment process. Two pipes will be installed between the CSTF and the pond so the excess water can flow to the pond by gravity. If any other excess ponded water is located within the CSTF and can be pumped, it will be discharged in the pond.

The pond will be excavated to a depth of approximately 1.5 m below ground surface and the excavated material will be used to construct the berms. A 6-mil liner will be placed at the bottom of the pond and tied to the berms.

4.3 Monitoring Wells Installation

A total of 3 monitoring wells will be installed at the CSTF. This instrumentation will be installed by qualified personnel from Sila with the support of a surveyor. The PCR will be advised prior to the installation program to allow scheduling of inspection. Locations and depth of monitoring wells will be as specified by Sila's technical drawings and will be installed in accordance with these specifications, with installation procedures varying slightly if bedrock is encountered.

Sila will place large boulders around the well with an excavator to provide further protection to the wells. In the event bedrock is encountered, a cap of grout will be added to the base of the well to seal the well.

Please refer to Appendix A for drawings providing further details regarding the CSTF. The location of the facility, including the retention pond, will be confirmed after mobilization on site, once the site conditions are assessed.

5 Excavation of Type B PHC Soil

Excavation of Type B PHC contaminated soil will be carried out under the supervision of qualified personnel. Type B PHC contaminated soil excavations will take precedence to all other types of contaminated soil excavation as the treatment of Type B PHC soils has been identified on the critical path of the schedule for the project.

Excavation of Type B PHC soil areas will begin after the surveyor has clearly identified the area slated for cleanup and surface debris and obstructions have been removed. When possible, excavation will be carried out using an excavator equipped with a ditching bucket in an effort to provide a smooth base to ease confirmatory sampling operations and ensure that no contaminated soil is left behind. Soil excavation will begin at one end of the identified area and progress until completed. The soil will be excavated to the depth detailed in the specifications or as indicated on site by the PCR, removed only from within the specified limits indicated on the drawings and in a wide shallow pattern to promote air circulation within the excavation. In the event hydrocarbon fumes are present in the excavation, half-mask respirators with the appropriate cartridges (based on HEPA) will be provided to employees and VOC air testing may be performed. Soil will be loaded into trucks for transport to the CSTF. Truck drivers will complete a daily log detailing the number of and origin of all transferred loads of soil, and the weekly total will be included in Sila's weekly report.

Special care will be taken for excavations BP-1 and BP-2 located right beside DND's pipeline. The pipeline will be identified and its location reviewed with field staff before commencing any work in that area. The excavator and truck will work from the southwestern side of the excavations, making sure the pipeline is not in the way. A minimum setback distance of 2.0 m between the excavations and DND's pipeline will be respected at all time.

Under saturated ground conditions, special care will be taken with regards to grading the perimeter of the excavations to ensure that no sloughing or unstable ground conditions arise. When necessary, dewatering will be performed to prevent water from pooling in excavations; the water will be sampled and treated as necessary. Water will first be pumped into portable tanks and then treated using the mobile water treatment unit. Treated water will be discharged at a location approved by the PCR. When excavating in the vicinity of water drainage courses, sediment controls including silt fences, floating silt curtains and/or containment berms will be erected. If surface run-off is flowing into the area designated for excavation, berms will be erected to divert flow away from the excavation.

As the excavation work progresses, the PCR will be informed of the areas available for confirmatory sampling. Further excavations will be completed as directed by PCR staff and the areas will be backfilled and/or reshaped with approval. Backfilled areas will be reshaped to be consistent with the natural topography and to prevent standing water.

The contaminated soil area will be surveyed prior to and upon completion of the excavation operations. The surface level comparison from these two surveys will provide the volume of material excavated and therefore the pay-quantity.

6 Methodology for Type B PHC Contaminated Soil Treatment

To initiate bio-remediation activities, the excavated impacted soil will be uniformly spread within the CSTF to a maximum thickness of approximately 400 mm. Special care will be taken in grading the soil in order to prevent water accumulation in the treatment area. With information available from the tender documents, the granular nutrients that will be distributed evenly over the surface using a cyclone-type spreader is evaluated at a rate of 880 kg N/hectare. This application rate will increase the nitrogen concentration in the impacted soil to approximately 150 mg-N/kg (dry weight basis), a level considered optimal considering the initial PHC concentrations, the clean-up objectives, and the soil characteristics. The selected slow-release fertilizer is a sulfur-coated urea formulation with minimum nitrogen content of 20% by weight. Prior to use, the fertilizer will be stored inside a marine container to prevent precipitation from modifying its characteristics. Safety Data Sheets (SDS) will be provided to on-site personnel prior to handling nutrients and will be available at all times in the storage container. Following application of the granular fertilizer, the full thickness of the contaminated soil will be tilled using an excavator, taking care not to disturb the underlying granular fill. If the initial moisture content of the soil is lower than 10%, water will be applied to increase the soil moisture to an appropriate level for bioremediation. Based on Sila's experience with similar soil investigated in the area, it is anticipated that moisture content between 10 and 15% will be required to achieve optimal bioremediation conditions. However, this range could be modified following observations by our qualified Soil Remediation Specialist during the excavation of the contaminated soil on the site.

During the course of treatment, the full thickness of the contaminated soil will be tilled once every 5 days using an excavator. During periods of precipitation, tilling of the soil will be discontinued until the top 100 mm of soil has dried to the appropriate moisture content. Finally, the direction of tilling will be alternated between lengthwise, crosswise and diagonally in order to optimize soil mixing. Tilling operations will be adjusted according to weather conditions and may be carried out at shorter intervals.

Different options are available in the event PHC soils do not reach treatment objectives, or additional soils are discovered through confirmatory sampling, two of these options are discussed below. Proper discussion and approvals will need to take place with project stakeholders to determine the best approach for the project.

The first option in the event soil from the PIN-C site does not meet treatment objectives is to carry out additional tilling events and add nutrients to help treatment. As discussed in Section 7, soil sampling to monitor treatment progress will also be done at shorter intervals.

The second option in the event soil from the PIN-C site does not meet treatment objectives two weeks prior to the expected arrival of the sealift is to send the soil off site for disposal, following the same containerization, handling and off-site disposal procedures outlined for Tier I and Tier II soils which is described below.

Soils destined for off-site disposal will be placed in BWI Bulk Bags and labelled appropriately. The bulk bags are Transport Canada Approved, United Nations approved and ISO 9001:2008 certified. BWI Bulk Bags capacity is 1.0 m^3. Soil will be containerized using the excavator with the assistance of two labourers to place and open bags, under the supervision of the Hazardous Waste Specialist. Any rocks greater than 200 mm will be removed from the soil and used as backfill after any adhered soil has been removed.

Each soil container will be given an identifying label by the Hazardous Waste Specialist. The label will indicate the origin of the soil (excavation name), the container number, the waste stream in addition to the packaging date. The labels are printed on polyester paper, which is resistant to tearing, breakdown in UV light and able to maintain its integrity after several seasons in the Arctic as proven on past projects.

Prior to moving the soil bags to the TWSA, the integrity of the containers will be inspected by the Hazardous Waste Specialist for any signs of rips, leaks, or tears, and any non-conforming bags will be placed in larger overpack bags. From the excavation, soil bags will be transferred to the TWSA with heavy equipment to await demobilization. The bags will be evenly spaced, with a minimum of 1-metre space on each side to allow for easy inspection and identification. They will be segregated based on contaminant type.

The containerized soils that do not meet the treatment objectives will be transported south on the sealift and disposed of at Signaterre Environnement in Mascouche, Quebec.

All soil containers will be tracked with the Master Waste Datasheet.

7 Schedule, Sampling and Laboratory Testing

Based on the average temperatures of Bernard Harbour, it is anticipated that bioremediation of the PHC contaminated soil will occur between mid-June to end of August 2026. This timeframe is expected to be sufficient to meet the cleanup objectives for the soil excavated during the project. Furthermore, the nutrient application rate may be adjusted after the reception of analytical results throughout the treatment period.

Prior to the construction of the CSTF, baseline soil samples will be collected from the planned area of the treatment pad following the protocols defined in Section 6.1.6 of the INAC Abandoned Military Site Remediation Protocol (AMSRP), 2009. Since the treatment area at the Site will be 2,000 m², a 6 x 6m grid size will be used with one composite sample taken from each grid area. The first samples collected from the treatment area will all be submitted to an analytical lab (Bureau Veritas in Edmonton) for PHC analysis in soil following the CCME procedure. The total PHC concentrations will be determined by summing fractions F1 to F3.

Sampling of the soils being remediated within the CSTF will consist of one (1) composite sample composed of five (5) subsamples. A grid system will be used to split the CSTF into 6m x 6m sections each containing approximately 14 m^3 of soil based on the average thickness of the lift; the sub-samples will be taken at random from within these sections to form one (1) sample per section. Based on this protocol, 56 samples will be taken from the facility and submitted to an analytical lab (Bureau Veritas) for PHC analysis in soil following the CCME procedure. The total PHC concentration will be determined by summing PHC fractions F1 to F3.

The subsequent sampling events will be performed after 2, 4 and 6 weeks of treatment to monitor the effectiveness of the contaminated soil treatment process. When choosing sample locations for analysis, consideration will be given to areas of previously high concentrations. The remediation objective will be attained once all sample results or the means of a duplicate sample meet the clean-up objective of below 2,500 mg/kg for the sum of fractions F1 to F3.

If weather conditions are such that excessive precipitation significantly hampers treatment efficacy, temporary membranes will be laid down over the CSTF when heavy precipitation occur. Run-off water will be directed out of the CSTF without passing through the retention pond since the water will not have been in contact with the soil being treated.

8 Monitoring of the CSTF

8.1 Soil Quality Monitoring

After the soil is successfully remediated, sampling will be performed to determine if the underlying soil has been contaminated as a result of the remediation activities. The sampling will follow the same protocol as described above for baseline sampling and the samples will be taken in the same relative location as determined by a total station (each sample will be marked relative to a reference monument during the baseline sampling). Test pits will be dug with an excavator to sample soil at the appropriate depth of 0.15 m.

8.2 Groundwater Quality Monitoring

According to the AMSRP, groundwater monitoring during construction and post-construction is to be carried out to monitor the groundwater quality around landfill areas, such as non-hazardous waste landfills, regarded landfills, landfills with leachate containment and Tier II soil disposal facilities. Groundwater quality around facilities used for Type B PHC soil treatment is usually monitored during the construction period and wells are decommissioned together with the facility once the soil is treated. Additionally, the depth of the monitoring wells is usually based on the anticipated maximum depth of thaw.

Prior to the commissioning of the facility, baseline samples will be taken at all of the monitoring wells (three wells) and analyzed for total PHC. The results will be the baseline values upon which the monitoring program will be based.

Sampling and analysis will be carried out again at the end of the treatment process. Values obtained will be compared to the baseline values.

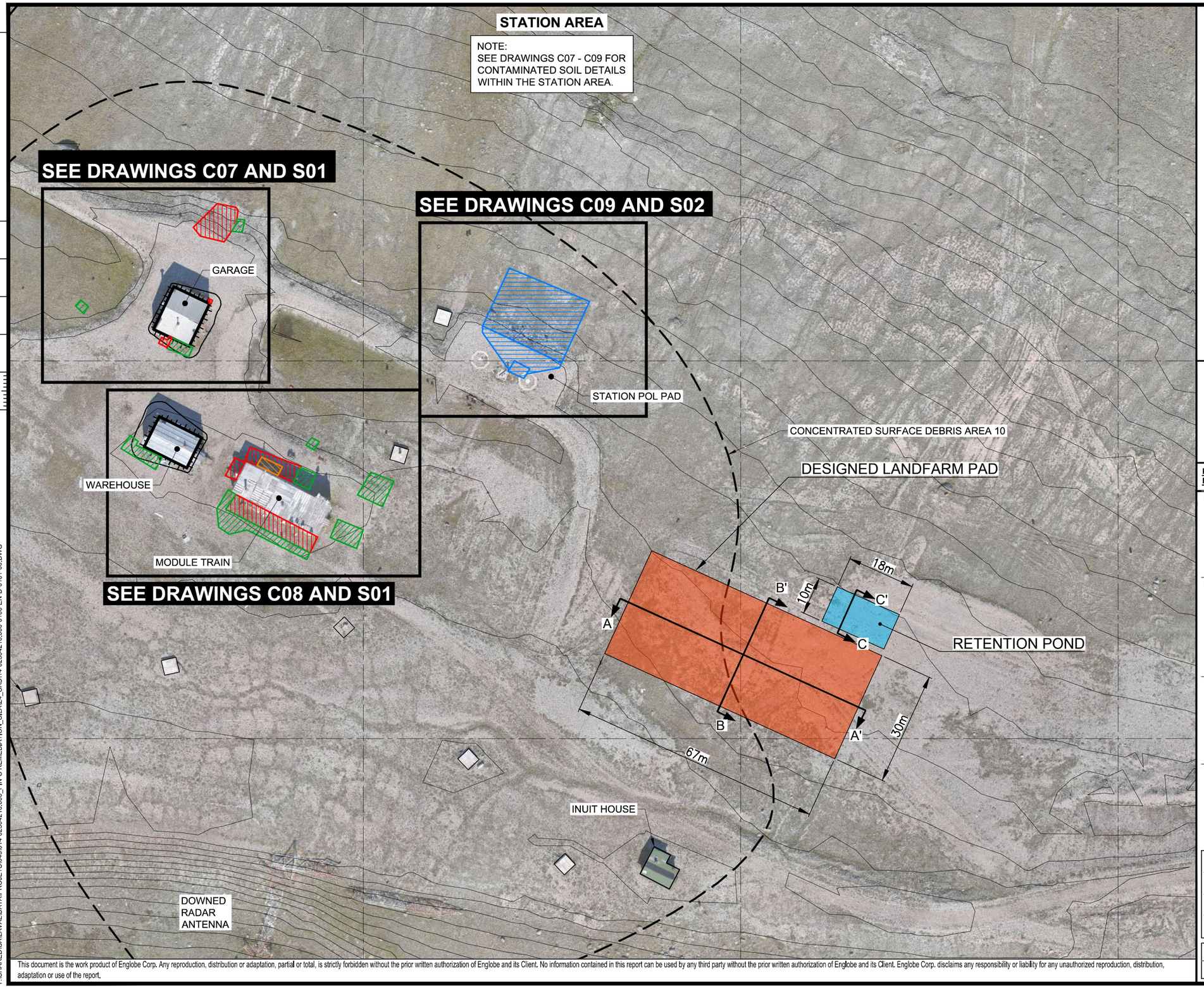
9 Decommissioning of the CSTF

Upon receiving confirmation that the PHC contaminated soil is remediated, the Contaminated Soil Treatment Facility will be decommissioned. A dozer will be used to remove the layer of contaminated soil and then used to remove the 0.3 m layer of Type 2 to expose the underlying liner and geotextile. An excavator will be used to remove the liners, which will be cut into more manageable sections. The geotextile and LDPE Liner will be containerized and sent south for disposal.

The remaining berms and granular material will be reshaped to match the natural terrain and promote positive drainage. Any remaining nutrients from treatment activities and the organic layer previously removed and put aside will be spread over the newly reshaped area to promote re-vegetation by indigenous flora. If needed and suitable for the task, treated soil, and granular fill may be used as backfill for various site areas.

Any remaining water in the retention pond will be sampled for PHC and will be treated if necessary. Treated and/or clean water will be discharged at a location approved by the PCR.

Appendix A
Drawings of Treatment Facility



LEGEND

- PROPERTY / RESERVE BOUNDARY
- DND RESERVE
- CONCENTRATED SURFACE DEBRIS PERIMETER
- REGRADE TOP OF SLOPE
- REGRADE TOE OF SLOPE
- KNOWN SURFACE DEBRIS AREA
- BURIED DEBRIS EXCAVATION
- TIER I CONTAMINATED SOIL
- TIER II CONTAMINATED SOIL
- HAZARDOUS CONTAMINATED SOIL
- TYPE B PHC CONTAMINATED SOIL

SEAL

Reference : Public works and government servces canada, Bernard Harbour, NU, Pin-c Remediation Project, Station area Site plan, R.116928.015, C03,D, 2024-12-17

Client

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

Project

PIN-C Site Remediation Project

Bernard Harbour, Nunavut

Title

Figure 1
Contaminated Soil Treatment Facility Location

SILA REMEDIATION

Discipline: Geoenvironment		Prepared by: Z. Pomares	Verified by: Z. Pomares
Scale: 1:1,000		Drawn by: M.-A. Girard	Approved by: A. Leclair
Date: 2025-05-28		Figure no.: 1 of 2	
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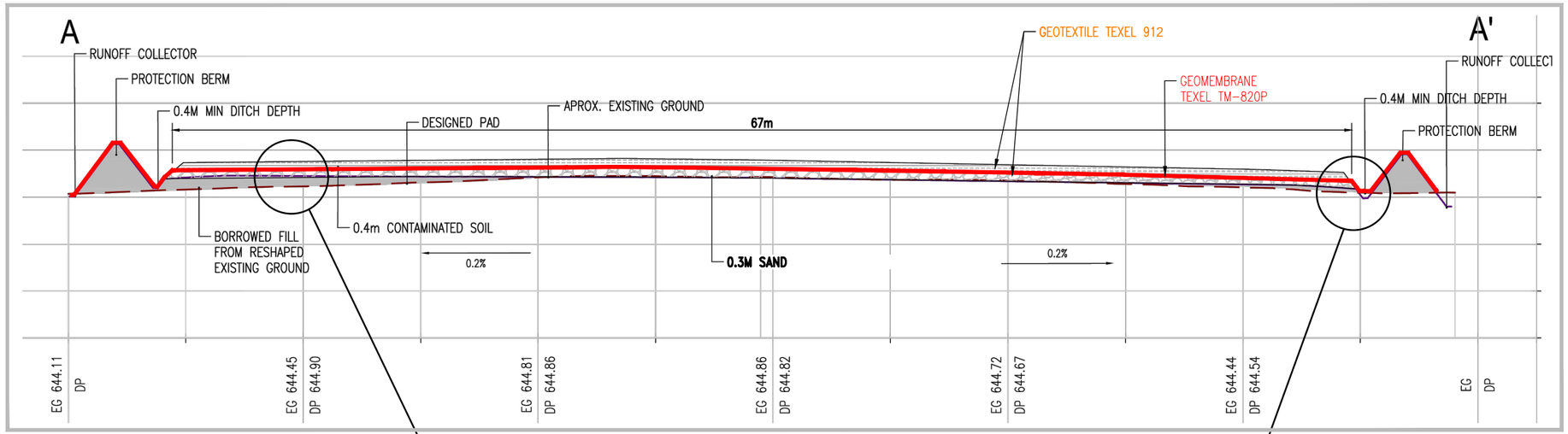

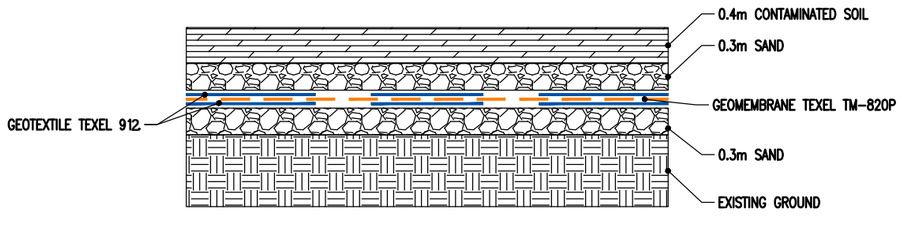

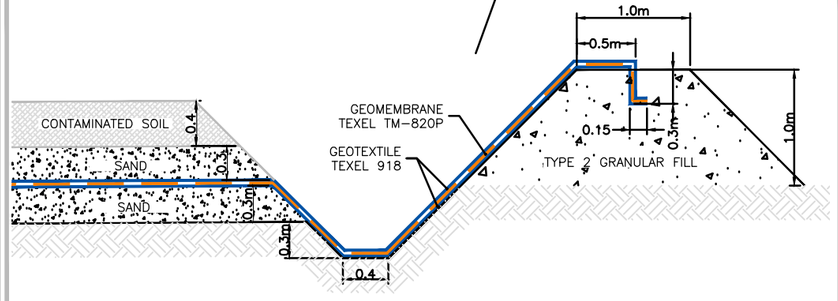

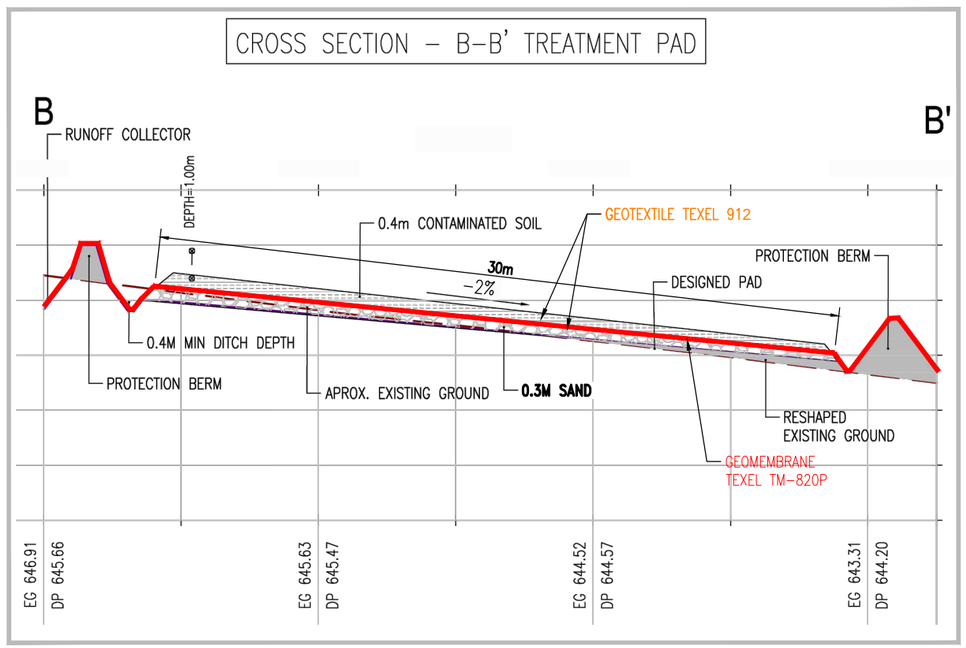

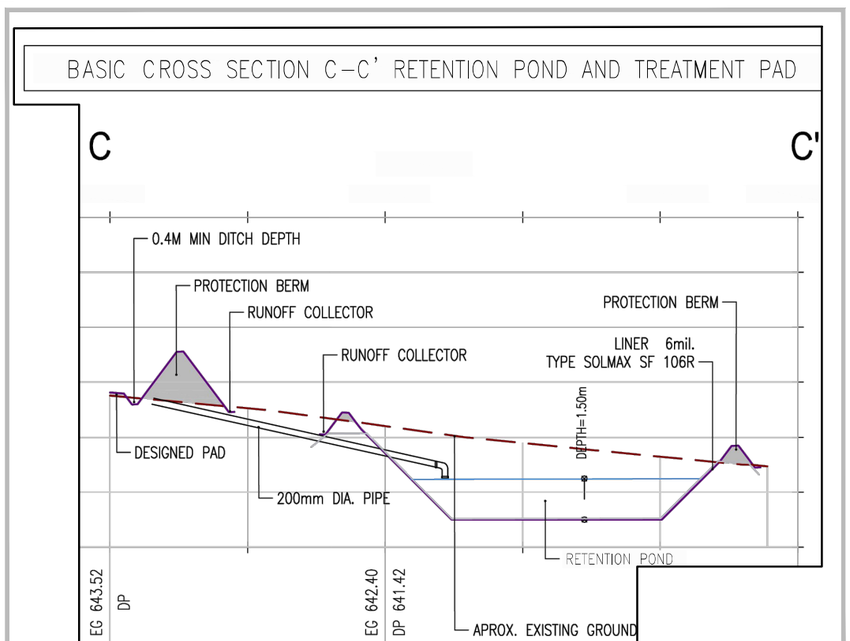

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Title

Figure 2
Cross Section and Details

SILA REMEDIATION

Discipline: Geoenvironment		Prepared by: Z. Pomares	Verified by: Z. Pomares
Scale: None		Drawn by: M.-A. Girard	Approved by: A. Leclair
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