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Whale Tail Pit - Landfarm

Agnico Eagle Mines Limited

Design and Management Report

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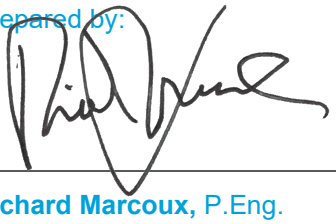
August 27, 2021

Prepared by:



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LIST OF REVISIONS

Revision				Revised Pages	Remarks
No.	By	Rev.	Date		
1	AEM Meadow bank Division	N/A	October 2018	N/A	Original document - Landfarm Design and Management Plan as Supporting Document submitted to Nunavut Impact Review Board for review and approval as part of Whale Tail Pit – Expansion Project.
2	RM	IG, RA, AP	August 2021	ALL	Revised document - Landfarm Design and Management Plan as Supporting Document submitted to Nunavut Impact Review Board for review and approval as part of Whale Tail Pit – Expansion Project.
3	RM	JP	August 2021	Sections 2.0 General Site Conditions and 3.5-table 3.1 are deleted. Title 4.0 : “Layout, Sections and Key Parameters” is added	Changed made after review by Jennifer Pyliuk

Acronyms

Agnico Eagle	Agnico Eagle Mines Limited
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
GN	Government of Nunavut
LDMP	Landfarm Design and Management Plan
NIRB	Nunavut Impact Review Board
NPAG	Non-Potentially Acid Generating
NWB	Nunavut Water Board
PAG	Potentially Acid Generating
PHC	Petroleum Hydrocarbon
PID	Photoionization Detector
RMMS	Responsible Mining Management System
TSF	Tailings Storage Facility
WRSF	Waste Rock Storage Facility

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1. Introduction

1.1 Scope of Work

SNC Lavalin was retained by Agnico Eagle to design the arrangement of the landfarm. This report describes the LANDFARM main components and design as required by the Water License 2AM-WTP1830 Part D Item 1. Construction drawings of the listed infrastructure are presented in Appendix A of this report.

The landfarm is proposed to be located just north of the Fuel Storage Facility and in close proximity with the IVR Attenuation Pond. The central location of the landfarm was chosen to minimize the footprint of the site and the transport distance of contaminated material from potential spill locations. The proposed landfarm was designed assuming that 1,000 m³ per year of PHC soils will need to be managed during the construction, and operation phases of the Project and 350 m³ of material per year during closure. Water accumulating in the landfarm will be either discharged directly to the receiving environment or directed to the IVR attenuation pond, dependent on water qualify results (Water License 2AM-WTP1830 Part F Item 8). The landfarm will have an impervious liner and no impacts on shallow groundwater are anticipated.

1.2 Executive summary

This report summarizes the site conditions, design basis, considerations, and criteria and presents the detailed design of the landfarm, including construction drawings and material quantities. Key considerations for the landfarm operation and monitoring are also discussed in this report.

The project site is located within the Southern Arctic terrestrial eco-zone in a zone of continuous permafrost. Continuous permafrost to depths of between 360 m to 495 m is expected at this site. The typical permafrost ground temperatures at the depths of zero annual amplitude (typically at a depth of below 15 m) are in the range of -5.0°C to -7.5°C in the areas away from lakes and streams.

On-site storage and remediation have been established as the preferred method for treatment of light petroleum hydrocarbon contaminated (PHC) soils and snow/ice that may be generated at the Whale Tail site. The landfarm is designed to receive soils, rock, snow, and ice contaminated with light petroleum hydrocarbons, such as diesel and gasoline, and also antifreeze.

The landfarm is designed to have an engineered rockfill pad and perimeter berms with a geomembrane liner system. A sump area is designated for landfarm internal water management. The sump area will temporarily store the runoff water from snowmelt and rainfall events before the water is pumped to either IVR attenuation pond or discharged to the environment, depending on water qualify results.

1.3 Purpose of Document

This report includes the final design and construction drawings for the landfarm. The landfarm is a surface-level soil remediation technology for petroleum contaminated soils that reduces concentrations of petroleum constituents through biodegradation to a level safe for human health and the environment. This technology involves spreading excavated contaminated soils in a thin layer on the ground surface and stimulating aerobic microbial activity within the soils through aeration. The enhanced microbial activity results in degradation of adsorbed petroleum product constituents through microbial respiration. Some petroleum product constituents volatize during the landfarming process.

To optimize contaminated soil management and reduce potential contamination, Agnico Eagle is proposing to build a landfarm at the Project site as approved under Water License 2AM-WTP1830.

The Landfarm Design and Management Plan (LDMP), updated version submitted with this Design Report,, focuses on minimizing the waste footprint on-site, and maximizing remediation potential through implementation of bioremediation experience and research carried out at the Agnico Eagle's Meadowbank Mine and Meliadine Gold Project sites. Onsite storage and remediation has been established as the preferred method for treatment of petroleum hydrocarbon (PHC) contaminated soil that may be generated at the Project site. Specifically, remediation through landfarming has been identified as the primary treatment option and, as such, is the focus of this Plan.

The objectives of this plan are to:

- provide an overview of the proposed contaminated soil management at the Project;
- describe the location and design criteria of the landfarm;
- define acceptable types of contaminated soils to be placed in the landfarm and conditions for removal of treated soil;
- define operating procedures and monitoring requirements, and;
- describe contingency options for alternate treatment/storage of PHC soil.

1.4 Related Documents

Spill prevention is the first stage in contaminated soil management at the Project. Documents containing information related to this Landfarm Design and Management Plan include:

- Spill Contingency Plan, and
- Emergency Response Plan.

Additional information is available as part of the Oil Pollution Emergency Plan, which is specific to spills at Agnico Eagle's Baker Lake Oil Handling Facility located in Baker Lake.

2. Design Basis

2.1 Site Location and Access

Agnico Eagle Mine Limited (AEM)-Meadowbank Complex is developing the Whale Tail Project in the Kivalliq Region of Nunavut (65°24'25" N, 96°41'50" W). The 99,878-hectare Amaruq property is located on Inuit-owned and federal crown land, approximately 55 km north of the Meadowbank mine. The Meadowbank mine is accessible from Baker Lake, located 70 kilometers to the south. The Whale Tail Project, a Meadowbank satellite deposit located on the Amaruq property is an expansion to the Approved Project (Nunavut Impact Review Board (NIRB) Project Certificate No. 008 and Nunavut Water Board (NWB) Type A Water License 2AM-WTP1830).

The original ground in the proposed landfarm location has a gentle slope of approximately 1.5%, is well drained. This location is suitable for the proposed landfarm.

Regular soil testing and sampling of the landfarmed soils will be conducted to monitor the remediation conditions and verify that the soils meet remediation objectives during and at the end of the working season. The environmental staff will advise of the remedial action for the landfarm if the remediation conditions need to be improved. A quality control/quality assurance (QA/QC) program is required during construction of the landfarm to ensure that construction-sensitive features of the design are achieved. The landfarm geotechnical performance should be regularly monitored during the landfarm operation with an annual geotechnical site inspection by the Designer or a qualified geotechnical engineer.

The overall site plan and the proposed location of the landfarm is shown on Figure 1 (see on the next page). This location was chosen due to its close proximity with the Fuel Storage Facility and potential synergies, and its proximity with potential spills locations. It is also located away from any receiving environment waterbody.

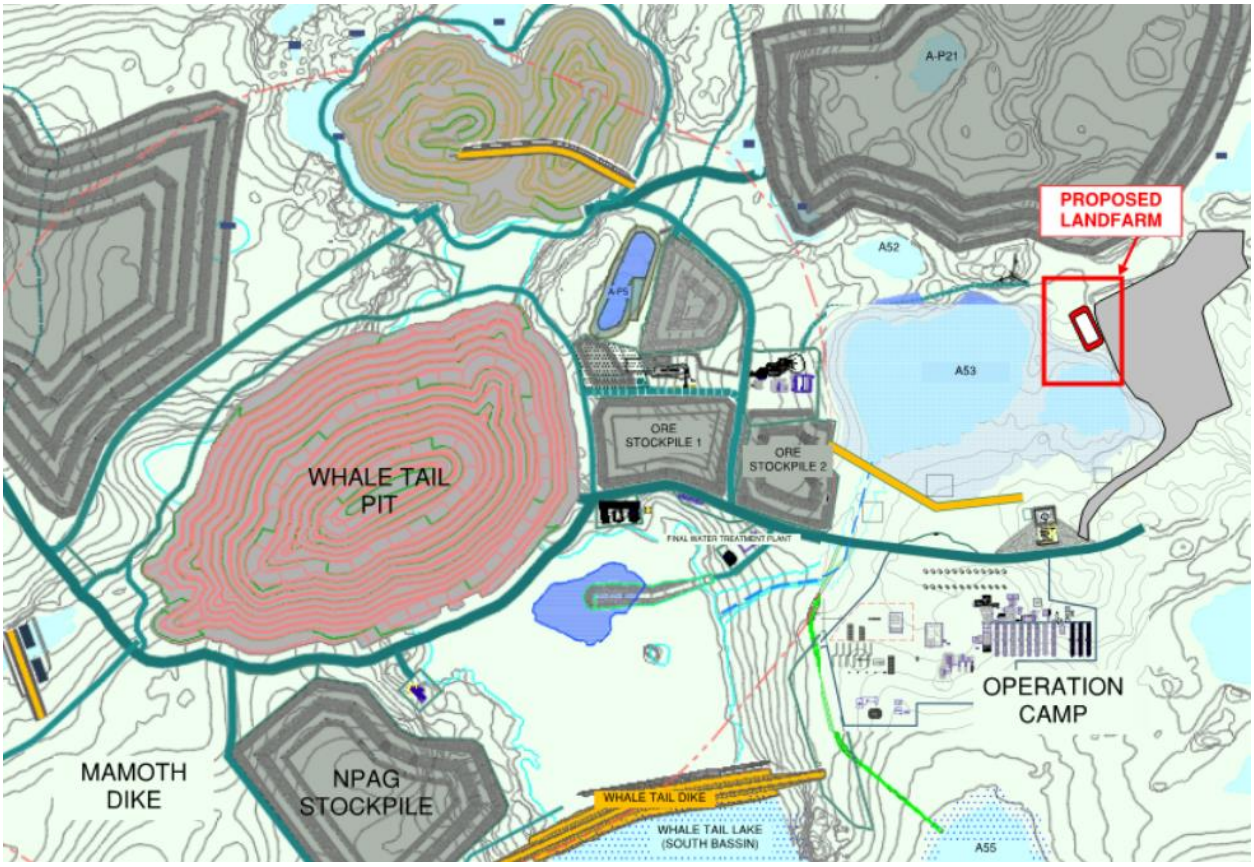


Figure 1: LANDFARM Location

2.2 Site Facilities

Agnico Eagle Mines Limited — Meadowbank Complex (Agnico Eagle) developed the Whale Tail Pit project, on a satellite deposit located on the Amaruq property, to expand mining and milling operations at the Meadowbank mine.

Conventional open pit mining is underway on the Whale Tail deposit. Access to the site is by a 64 kilometer road from the Meadowbank mine. On-site facilities include a power plant, maintenance facilities, fuel storage tank farm, arsenic water treatment plant, wastewater treatment plant (STP), drinking water treatment, as well as accommodation and cooking facilities for employees. Currently, Whale Tail Pit operations include the Whale Tail open pit, development of the IVR open pit, and underground operations.

2.3 Background

In the event of a spill, on-site storage and remediation is the most practical and efficient method in handling contaminated soil, particularly in an isolated location such as the Project. Any PHC contaminated soils generated during the construction, operation, and closure phases will be adequately managed. Soils contaminated with light PHCs, such as diesel, will be treated on-site in a landfarm. This method involves spreading, mechanical mixing, and placing the contaminated soil in windrows within a containment area and promoting conditions favorable for the volatilization and aerobic microbial degradation of hydrocarbons.

Materials contaminated with heavy hydrocarbons (e.g., grease), will need to be segregated, packaged, and shipped south for treatment and/or disposal.

A landfarm options analysis prepared for Agnico Eagle by Golder (2007) identified factors relevant to landfarming in the north. This includes environmental factors and physical properties of the soil that affect microbial growth and rates of biodegradation, including temperature, pH, soil moisture, nutrient content, salinity, and soil particle size.

Although rates of biodegradation decline with temperature, landfarming is still a feasible technique in Arctic climates as demonstrated by the Meadowbank landfarm. Degradation in the north is typically restricted because microbial activity stops between 0 to -5 degrees Celsius (°C) restricting biodegradation to the months of June to September. Nevertheless, degradation was reported at 90% over two summers on Resolution Island (Paudyn et al. 2008).

2.4 Soil Volume Requirements

At the Meadowbank mining operation, it was estimated during the design phase of the landfarm that the volume of PHC soils would be between 300 and 350 m³ per year. Similar assumptions were made at the Meliadine site during the design phase, but experience showed that the volume of soil entering the landfarm yearly is higher than expected when large spills occur. Therefore, the proposed landfarm at Whale Tail was designed assuming that 1,000 m³ per year of PHC soils will need to be managed during the construction, and operation phases of the Project. During closure, 350 m³ of material per year is expected to enter the landfarm. Similar to the Meadowbank and Meliadine designs, it was assumed that a yearly volume of 500 m³ of contaminated ice and snow would require management and the landfarm was designed to account for this volume.

Based on experience, it is estimated that soils contaminated with light end PHCs will require four (4) full summer seasons for complete remediation. Ethylene glycol or antifreeze is expected to largely biodegrade within one (1) year (Dobson 2000). When remediated, the soils will be removed from the landfarm and used on-site or placed in the Waste Rock Storage Facility (WRSF).

3. Design of Landfarm

3.1 Key Design Considerations

The landfarm is designed based on the following key considerations:

- The landfarm will have a raised base with perimeter containment berms, constructed over the original ground with no excavation to avoid disturbing the permafrost foundation. Removal of surficial organics/peat layer is only required to reduce potential excess thaw settlement if the organics/peat layer is frozen when the overlying fill is placed during construction;

- A geomembrane liner system will be enclosed in the landfarm base and perimeter berms to contain drainage/ leachate and runoff water from the PHC soils and thawing snow/ice in the landfarm;

- The landfarm base will have a gentle slope, generally parallel to the original ground surface, which has a slope of approximately 0.5%. This will lessen construction material volumes and promote natural drainage towards the lower portion of the landfarm;

- A sump area will be located in the lower portion of the landfarm to temporarily collect the drainage and runoff water. A low filter berm around the sump area will be constructed to help reduce soil particles in the water flowing into the sump area;

- The water in the landfarm sump will be tested prior to removal from the sump and either pumped to the IVR attenuation pond or discharged to the tundra if water quality meets the requirement of the Water License Part F Item 8. The landfarm sump will be empty by the end of each pumping season before winter shut down.

4. Plan Layout, Sections, and Key Parameters

The Landfarm design drawings are presented in Appendix A. Drawings 61-740-230-206 show the landfarm location and layout plans. Drawings 66-740-230-207 present the landfarm typical design section and sections through the landfarm. Table 4.1 summarizes the key design parameters for the landfarm.

Table 4-1 Landfarm Design Criteria

Parameter	Value
Potential volume of PHC per year during construction and operation	1000 m³
Potential volume of PHC per year during closure	350 m³
Potential volume of contaminated snow/ice per year	500 m³
Remediation time	4 years
Estimated snowmelt water equivalent in spring freshet for a 1 in 100 wet precipitation year	171 mm
Thickness of PHC in containment facility	1.5 m
Facility Structure	2.0 m
Facility base thickness	350 m³
Side Slopes of Berm (inside)	3 (H):1(V)
Side Slopes of Berm (outside)	2 (H):1(V)
Berm Crest Width	4 m
Berm Height	2.6 to 4.8 m
Berm Crest Elevation	270.000
Geomembrane Liner Crest Elevation	269.650
Landfarm Footprint Area	10 000 m²

To prevent movement of contaminants from the landfarm facility into groundwater and the surrounding environment, it will have an impervious liner.

Table 4-2 shows the growth and stabilization of the volume of PHC considering remediation over four (4) years and the maximum volume of contaminated material that is anticipated to be stored over a period of 22 years.

The size of the landfarm was based on the design criteria (Table 2-1), the estimated volume of material (Table 4-2), and the requirement to turn over the surface of the piles during the summer months. The designed footprint of the landfarm will be 10,000 m². Contaminated material will be piled 1.5 m so that the material is below the crest height of the perimeter berm. The maximum accumulated quantity of contaminated material in the landfarm at any one time is expected to be 5,500 m³.

Table 4-2 Volume of Petroleum Hydrocarbon Contaminated Material in the Landfarm

Design Criteria	Estimated PHC Produced (m^3)	Accumulated PHC in Landfarm for Remediation (m^3)	Treated PHC Removed from Landfarm (m^3)	Hydrocarbon Contaminated Snow or Ice to Landfarm (m^3)	Maximum Accumulated PHC in Landfarm (m^3)
-1	1000	1000		500	1500
1	1000	2000		500	2500
2	1000	3000		500	3500
3	1000	4000		500	4500
4	1000	5000	1000	500	5500
5	1000	5000	1000	500	4850
6	350	4350	1000	500	4200
7	350	3700	1000	500	3550
8	350	3050	1000	500	2900
9	350	2400	1000	500	2250
10	350	1750	350	500	2250
11	350	1750	350	500	2250
12	350	1750	350	500	2250
13	350	1750	350	500	2250
14	350	1750	350	500	2250
15	350	1750	350	500	2250
16	350	1750	350	500	2250
17	0	1400	350	500	1900
18	0	1050	350	500	1550
19	0	700	350	500	1200
20	0	350	350	0	350
21	0	0	350	0	0

4.1 Sump Design for Water Management

The sump area was designed to collect leachate/drainage and runoff from the PHC soils during landfarm operation. The water collected in the sump will be regularly tested and pumped to either IVR attenuation pond or discharged to the tundra, depending on water quality results.

5. Construction of Landfarm

5.1 Construction Materials

The construction materials for the landfarm will include the following:

- Run-of-mine Rockfill (sourced from the waste rock from mine development);
- Transition Rockfill (processed from the waste rock from mine development);
- Granular Fill (processed from the waste rock from mine development or natural eskers);
- Bituminous Geomembrane liner.

The waste rock from the mine development, fill materials sourced from the rock, and overburden materials will be NAG and have low potential of ML.

The landfarm drawings for construction are presented in Appendix A. Materials specifications for the landfarm, will be presented in a table 5.1.

Table 5-1 Estimated in-place Material Quantities for Construction of Landfarm

Item	Estimated In-Place Quantity after Compaction and Installation	Material Source and Key Specifications
Run-of-Mine Rockfill (0-1000 mm)	13 962 m³ (see Note 1)	To be sourced from run-of-mine rock stockpiles or mine operation; maximum particle size of 1000 mm.
Transition Rockfill (0-200 mm)	3 892 m³	To be processed from the rock stockpiles or other sources approved by the Design Engineer and the Owner; maximum particle size of 200 mm.
Granular Fill or Esker Sand (0-20 mm)	4 538 m³	To be processed from the rock stockpiles or other sources approved by the Design Engineer and the Owner; maximum particle size of 20 mm; fines (<0.08 mm) content of 4 to 10%.
Bituminous Geomembrane Liner	5 600 m²	Type Coletanche ES-2 to be ordered by Agnico Eagle
Organics/Peat Layer Excavation (if frozen during construction)	3 000 m³ (see Note 1)	Frozen organics or peat material

Note 1: Run-of-Mine Rockfill (0-1000 mm) material is assumed to be placed after excavation and removal of frozen organics/peat layer with an assumed average thickness of 0.3 m.

It should be noted that the actual quantities could be different from those estimated due to the following reasons:

- The actual thickness of the frozen organics/peat layer could be different than assumed, and;
- Field observations during construction may lead to design and construction related modifications, which may in turn affect the quantities.

5.2 Water Management and Erosion Control during Construction

Based on the current landfarm construction schedule, the landfarm fill materials will be placed in later summer or early fall when the surficial organics/peat layer is unfrozen. Under this condition, no foundation excavation is required for the landfarm construction. Foundation excavation (removal of surficial organics/peat layer) over the landfarm footprint is only required when the surficial organics/peat layer is frozen during fill placement for the landfarm construction.

Therefore, there will be no or minimal requirement for seepage and erosion control during removal of frozen organics/peat layer (if needed).

Runoff water from the rockfill materials during landfarm construction is expected under a rainfall event. The runoff will naturally flow. As a result, a separate water collection system is not required.

5.3 Quality Control and Quality Assurance

QA / QC control on the field will be implemented by Agnico Eagle construction personnel dedicated to the construction of the LandFarm structure.

All construction defects will be taken care of and corrected according to the appropriate measures, as the work progresses.

Upon the completion of the construction activities, an as-built construction report will be prepared and submitted to the regulators within 90 days after construction is completed. The report should provide all relevant supporting documentation compiled during implementation of the QA/QC plan. The construction report will include, but not be limited to the following:

- Construction drawings based on the as-built survey information of the surface of all materials placed;
- Actual construction quantities;
- Liner system installation details;
- All testing records, a summary of all test sample location, collection methods, and test results;
- Summary of the construction issues and resolution applied;
- Report on construction and design changes made during construction; and;
- Installation details of any required instrumentation or monitoring devices, if any.

5.4 Surveying Requirements

A Survey Contractor will be retained to carry out as-built surveying and documentation to verify quantities and produce as-built drawings.

The Survey Contractor will carry out but not be limited to the following tasks,:

- Survey original ground within the landfarm footprint prior to the commencement of construction.
- During and after construction, the following tasks will be performed:
    - Provide staking to guide construction;
    - Survey the as-built conditions of excavations and fills including different material boundaries as required;
    - Survey any measurement for payment items;
    - Provide quantities of excavations and fill materials on critical stages or as required;
    - Provide AutoCAD drawings showing three-dimensional (3D) lines and surfaces of the excavations and fill materials at critical stages of construction or as required, and;
    - Provide the as-built AutoCAD drawings showing 3D lines and surfaces of the excavations and fill materials after the completion of each structure.
- During the operation of the landfarm, the water elevation in the sump should be regularly surveyed and documented.

6. Landfarm Operation and Maintenance

6.1 Landfarm Operation Management

The operation of the landfarm needs to be managed to produce effective and consistent results. The operation and maintenance of the landfarm is the responsibility of the site environmental personnel and includes the following components:

- Safety and environmental protection measures;
- Soil acceptance procedures including oversize boulders/rocks handling;
- Day-to-day landfarm operation procedures, including initial soil handling, tilling and moisture conditioning, addition of nutrients, and removal of treated soils;
- Operation of snow/ice storage area;
- Managing internal contact water, including operation and maintenance of the sump pumping systemr;
- Sampling and quality control of remediated soils;
- Leakage and seepage (if any) monitoring, and;
- Reporting.

6.2 Acceptable Materials

6.2.1 Contaminants

The landfarm facility will only treat and/or store light PHC contaminated soils that have been generated through mine-related activities at the Project. Material from other sites will not be accepted without approval from the NWB, Crown-Indigenous Relation and Northern Affairs Canada (CIRNAC) Water Resources Officers and the Kivalliq Inuit Association.

The following products may be treated in the landfarm if used onsite and spilled on soil:

- diesel fuel;
- gasoline;
- aviation fuel (Jet A);
- hydraulic oil;
- other light oil (e.g. engine oil, lubricating oil), and;
- Ethyl Glycol (antifreeze).

In the event that the contaminant source is unknown, soil samples will be analyzed for PHCs and possibly additional contaminants prior to placement in the landfarm. These additional parameters could include total metals, oil and grease, and volatile organic compounds. Analysis for additional compounds will be determined by the Environment Department on a case-by-case basis. Concentrations of contaminants will be compared to the site background values (for metals) and/or criteria in the Government of Nunavut (GN) Guidelines for Contaminated Site Remediation (GN, 2009). If this analysis indicates soil contamination above background or GN guidelines with any substances not approved for landfarming (i.e. non-PHC contaminants), the spill material will not be placed in the landfarm. This is to ensure PHC contaminated soils are not contaminated with other products.

Spills of > 100 L of non-PHC material (e.g. solvents, glycol) will be placed in drums and stored in the site Hazmat area for shipment south to approved facilities during barge season. Spills of non-PHC material < 100 L will be placed in the Meadowbank Tailings Storage Facility (TSF) or placed in drums and stored in the site Hazmat area for shipment south to approved facilities during barge season.

6.2.2 Grain Size

Bioremediation of very coarse-grained larger soil material is inhibited as it does not readily retain moisture. However, volatilization will occur more rapidly (SAIC 2006). It has been noted that this material likely contains lower concentrations of contaminants due to a lower volume: surface area ratio and can typically be screened out prior to landfarming (SAIC 2006). As a result, soils and rock material with fine grain size will be separated from larger-grained material, where possible. This will occur at the spill location or in the landfarm using a screen sieve, should it prove necessary. The two soil fractions will be handled separately in the landfarm.

6.3 Contaminated Soil Additions

Soil contaminated with the above-described petroleum hydrocarbon materials will be excavated and transported to the landfarm facility in dump trucks or in roll-off containers. Care will be exercised to ensure that the entire spill is excavated (verified by olfactory and visual assessment, or sampling if necessary) and that none of the contaminated material is lost during transport. All material collected (coarse and fine) from spill locations will be deposited at the landfarm to be remediated.

6.4 Contaminated Snow

For spills < 100 L, PHC-contaminated snow will be placed in a designated area of the landfarm and treated as contact water after snowmelt.

For spills > 100 L, PHC-contaminated snow will be excavated and stored in labeled drums. After snow melt, the contaminated water will be pumped through the site's oil-water separator (carbon filter) to remove PHC residue. The treated water will be sampled per Part F, Item 8 of the Water License 2AM-WTP1830, and discharged to the tundra if water quality meets Water Licence criteria. If criteria are not met, water will be treated as hazardous material and shipped south. Also, after snowmelt, visible product will be cleaned up with absorbent pads or booms.

6.5 Remediation

Remediation of fine-grained PHC-contaminated soil in landfarms occurs naturally through volatilization and aerobic microbial degradation. Soil aeration and nutrient amendment are recognized as methods of improving rates of remediation. While it is recognized that pH, salinity, moisture content, and microbial population density also contribute to rates of degradation, these factors will not be explicitly investigated or managed unless remediation rates are too slow to allow meeting targets set for closure.

6.5.1 Absorbent Materials

Coarse-grained soils are not readily bio-remediated, but concentrations of PHC contaminants may still be reduced through volatilization. Oil absorbent pads will be used to help remove visible product from coarse-grained material. Used absorbent materials will be incinerated.

6.5.2 Aeration

To promote aerobic conditions throughout the windrows, soil will be mixed mechanically with earth-moving equipment. This turnover of soil piles will occur at least once per year, during the summer months. The presence of coarse material also helps creating gaps within the piles which will increase aeration and help degradation of PHC.

6.5.3 Soil Moisture

Prior to turning, site personnel will ensure that soil is not so dry as to generate significant dust, nor overly saturated. If soil is too dry, non-contaminated water from within the landfarm containment area will be used as a moisture source and sprayed on the piles. If no accumulated water is available, water from a freshwater supply will be used. If the windrows are saturated, aeration will be delayed until the moisture content is reduced.

6.5.4 Nutrient Amendment

The use of sewage sludge as a nutrient amendment does not only provides the benefit of nutrients, but also adds organic matter to help retain moisture and microorganisms. Furthermore, the use of sewage sludge produced on-site helps to reduce the waste footprint of the mine by re-directing this material from disposal facilities and avoids needing to import a chemical fertilizer. Sewage sludge will be placed in the landfarm on an as needed basis. The excess will be stored in the WRSF.

6.6 Removal of Soil from the Landfarm

6.6.1 GN Remediation Guidelines

Prior to removal of the finer grained soil from the landfarm, soil samples will be analyzed to ensure they meet GN guidelines, as described below.

The GN remediation criteria are characterized for agricultural/wildlife, residential/parkland, commercial, and industrial land uses. At the Project, remediation to agricultural/wildlife criteria is targeted; however, if these criteria cannot be met, industrial criteria will be followed.

The GN remediation criteria for coarse-grained soils will be applied. Table 6-1 presents the applicable Tier 1 criteria for coarse-grained soil, assuming agricultural/wildlife or industrial land uses.

Table 6-1 Summary of relevant GN Tier 1 Soil Remediation Criteria for Surface Soil

Identification	Land Use Criteria (mg/kg)	
	Agricultural/Wildlife	Industrial
Benzene	0.03	0.03
Toluene	0.37	0.37
Ethylbenzene	0.082	0.082
Xylene	11	11
PHC Fraction 1	30	320
PHC Fraction 2	150	260
PHC Fraction 3	300	1,700
PHC Fraction 4	2,800	3,300

6.6.2 Sampling and Analysis

Landfarm windrows will be sampled annually at the end of the summer season to determine if remediation objectives have been met. Representative composite samples will be taken of each windrow to estimate remaining PHC concentrations. For each 10 m of windrow length, one composite sample will be collected, each consisting of three surface sub-samples and three sub-samples at 1 m depth. Sub-samples will be taken approximately 3.3 m apart and will be taken from both sides of the windrow.

Degradation rates are assessed regularly to estimate the total remediation time required for PHC-contaminated soil under these conditions. If remediation to GN guidelines is feasible within the timeframe, landfarm operations will continue, with aeration and nutrient amendments as

described above. If rates of total petroleum hydrocarbons degradation are not sufficient through this method, alternate options could be further investigated (see Section 4).

6.6.3 Soil Removal

Coarse-grained material will be assessed after segregation from mechanical screening has been started, by Environment Department technicians for PHC product and odors. A photoionization detector (PID) monitor may be employed to assist in petroleum-hydrocarbon based vapor detection. When PHC vapors are no longer detected, the material will be removed and sent to the WRSF to be disposed of as potentially acid generating (PAG) material. This material will be capped with non-potentially acid generating (NPAG) material at closure, allowing freeze-back and permanent encapsulation to occur (Agnico Eagle 2018).

When sample analysis of fine-grained material at the end of a season indicates that concentrations of contaminants are below GN guidelines, a soil pile or the appropriate section of a pile will be deemed acceptable for removal from the facility. Interim monitoring may be conducted through measurements of head-space with a portable instrument (e.g. flame ionization detector), but samples will be confirmed by an accredited laboratory prior to soil removal.

Soil remediated to agricultural/wildland criteria will be appropriately delineated by Environment Department staff, and stockpiled outside the landfarm for use in site works or reclamation activities. Soil remediated to industrial-use criteria will be removed from the landfarm and placed in the WRSF as PAG material.

6.7 Water Management

6.7.1 Snow Management

Non contaminated snow will be removed as much as possible during winter to minimize the quantity of spring melt water inside the berm. Care will be taken to ensure contaminated snow/soil is not disturbed by leaving a base layer of snow (no less than 10 cm) in place. Following snowmelt any contaminated product left from winter spill clean-up operations will be padded up. The base soil in these areas will be excavated and added to existing remediation windrows as soon as possible after snow melt to minimize migration into the facility substrate.

6.7.2 Water Management

While the landfarm will have an impermeable liner, visual inspections by the Environment Department will be conducted for seepage of contact water coming through the perimeter berm, or the accumulation of water within the containment berm. This will be conducted on a weekly basis starting after freshet and continuing until October when water is likely to be present. In the event of water accumulation or seepage, the ponded water will be analyzed for Water License 2AM-WTP1830 Schedule 1 Table 1 Group 4 monitoring parameters prior to discharge to the adjacent IVR Attenuation Pond. If the water quality from

Landfarm, at monitoring station ST-WT-27, do not exceed the effluent quality limits set in Water License Part F Item 8, water will be pumped to land. If water quality doesn't meet the discharge criteria, water will not be discharged directly to the receiving environment and will be collected and directed to the IVR attenuation pond. Alternatively, ponded water will be sprayed on the windrows to increase moisture content, as required. Water accumulating in the landfarm will not be discharged to the receiving environment, if water quality result set in the Water License are not met..

6.7.3 Landfarm Closure and Reclamation

After removal of all remediated soil and prior to closure and reclamation of the landfarm, the berm and base will be sampled on a 10 m grid to determine if these soils are free from PHC contamination. Results of this analysis will be compared to GN criteria set out in Table 3-1. No excavation will be necessary if agricultural/industrial criteria are met. If industrial criteria are used, the landfarm will be covered with 2 m of waste rock or other material used for reclamation. The surrounding berm will be breached to avoid water accumulation on the landfarm.

6.7.4 Summary of Activities

A summary of landfarm activities including monitoring of the physical condition and potential environmental impacts of the landfarm is provided in Table 6-2 on the next page. An annual report will be prepared indicating the volume of material added to the facility, amount of material removed, disposal or reuse location, all analysis results, volume and type of nutrient addition, visual inspection results, and volume of contact water pumped. This information will be appended to Agnico Eagle's Annual Report.

Table 6-2 Summary of landfarm activities and records to be kept

Activity	Analysis	Frequency	Record
Excavation of spill and transport of contaminated material	If unsure of full excavation - F1-F4, BTEX	As needed	Date, time and location of spill and excavation; estimated quantity of excavated soil; storage/disposal location of excavated soil, if applicable; any evidence of remaining product
Contaminated soil additions to landfarm	If contaminant source unknown, F1-F4, BTEX, metals, oil and grease, VOCs (at discretion of Environment Department)	Prior to soil addition at facility	Date and time; quantity of soil; original location; landfarm location; spill/excavation record # or storage container label
Soil aeration	N/A	Min. once during summer	Date and time of the aeration; location; soil condition (moisture, odour, etc.)
Soil treatment with sewage sludge as nutrient supplement	Visual inspection to ensure proper incorporation	At least once during summer on selected windrows	Date and time; location in landfarm any odour notice during aeration
Ponded contact water	Water Licence 2AM-WTP1830 Group 4	Prior to any dewatering, if re-used in landfarm, no sampling necessary	Date and time, location, laboratory report
Sampling for progress of remediation	Hydrocarbon vapour in headspace (by PID); F1-F4 BTEX (laboratory)	Vapour – as needed; Laboratory - annually	Date and time; location; odour; laboratory report
Soil removal from landfarm	Removal subject to meeting GN crieria	Once GN criteria are met	Date and time; location; quantity of soil removed; final location
Identification of maintenance requirements	Visual inspection of landfarm	Twice over the summer	Inspected areas; condition of berm and base; previously unidentified safety concerns

7. Contingency Options

This section describes the contaminated soil management plan, should a large spill event occur, or if landfarm treatment proves not successful.

7.1 Large Spill Event

A large spill event producing a quantity of soil that cannot be contained in the landfarm could happen and thus the landfarm is designed to hold a greater quantity of contaminated soil as is expected to be produced. In this case, soils will be placed in a temporary storage area. A temporary stockpile area would be set up in another location as approved by the NWB. As space becomes available, the soil would be added to the landfarm.

7.2 Alternate Treatment Options

Should landfarm treatment not perform as anticipated and it is evident that rates of degradation are not sufficient to meet GN Tier 1 criteria within the life-of-mine and the anticipated closure, the following alternative treatment options will be considered. Implementation will be after development of a more detailed protocol and approval of a revised plan by the NWB.

7.2.1 Soil Amendment

Since pH, salinity, moisture content and microbial population density all affect rates of biodegradation by microbes, these factors may be monitored and adjusted through soil amendments if they are not found to be optimal (see SAIC, 2006). In addition, the height of soil windrows could be reduced to maximize air exposure if space in the facility allows.

7.2.2 Tier 2 – Modified Criteria Approach

According to the GN Environmental Guideline for Contaminated Site Remediation (GN, 2009), in cases where site conditions, land uses, receptors or exposure pathways are different from those assumed in the development of the Tier 1 criteria, modified criteria may be permitted. This process requires the collection of site-specific information on exposure and risk estimates, and is subject to GN approval. For this Project, landfarmed soils will be encapsulated in the WRSF rather than used in surface applications, as assumed in Tier 1, reducing the likelihood of exposure to any remaining contamination. Therefore, the Tier 2 approach could be warranted if Tier 1 criteria cannot be met. Any consideration for this approach would be based on soil sampling results and science based information.

7.2.3 Thermal Desorption

In the thermal desorption process, excavated soils are heated in a chamber to rapidly volatilize PHCs. Gases produced are consumed in an oxidation unit, and particulate matter removed (baghouse). Soil, free of any contamination, can then be replaced, or used in site reclamation or construction processes. The other advantage of this approach is that this equipment is mobile and could be brought to any spill site for remediation activities (e.g. spills along the All Weather Access Road). This method is described by Environment and Climate Change Canada (2002).

7.2.4 Direct Placement in the WRSF

Another option for management of contaminated soil if bioremediation proves not effective would be the direct placement of this material in a WRSF. Although the use of PHC contaminated soils in these storage areas is not optimal, the quantity generated on-site is small in comparison to the quantity of waste rock. While this method would not result in the treatment of soil, it is a viable contingency option because it would allow for the safe disposal of the contaminated material. Encapsulation and freeze-back would occur, eliminating any movement of contaminants. Over time, this material would undergo natural degradation. Consideration of this option would also include a suitable monitoring program for PHCs, which would be incorporated into the Closure and Reclamation Plan.

7.2.5 Direct Placement or encapsulation in the Meadowbank TSF

Disposal or encapsulation of the contaminated soil in the Meadowbank TSF could be a potential option. Freeze-back would occur, eliminating any movement of contaminants. Over time, this material would undergo natural degradation.

8. Preliminary construction schedule

Construction is planned to begin November 1 and finish November 29, 2021.

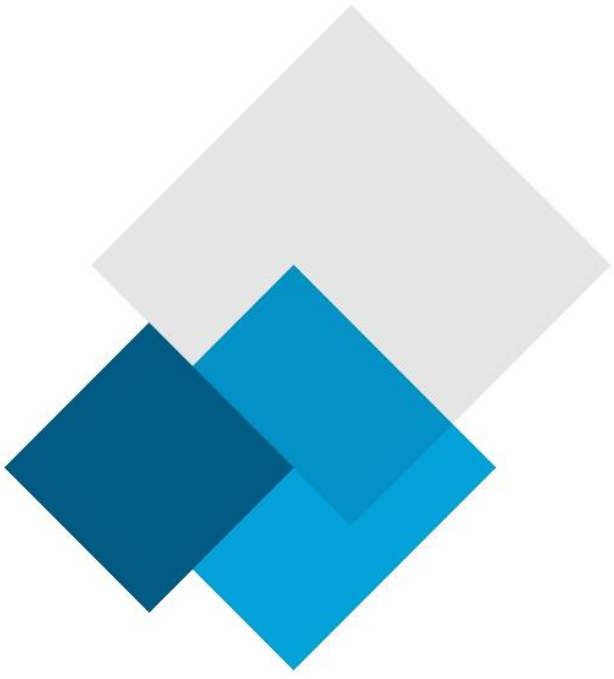
9. References

- Agnico Eagle (Agnico Eagle Mines Limited). 2018. Waste Rock Management Plan. Submitted to the Nunavut Impact Review Board. May 2018.
- Dobson S. 2000. Ethylene Glycol: Environmental Aspects. Concise international chemical assessment document #22. World Health Organization.
- ECCC (Environment and Climate Change Canada). 2002. Technical Assistance Bulletin #13: Soil Remediation: Low Temperature Thermal Desorption Available at: http://publications.gc.ca/collections/collection_2014/ec/En163-1-13-eng.pdf
- GN (Government of Nunavut). 2009. Environmental Guideline for Contaminated Soil Remediation. Government of Nunavut, Department of Environment, Environmental Protection Service.

- Golder (Golder Associates Ltd). 2007. Technical Memorandum: Landfarm Option Analysis, Meadowbank Gold Project, Nunavut. Prepared for: Agnico-Eagle Mines Ltd. August 23, 2007.
- Paudyn K, Rutter A, Kerry Rowe R and Poland J.S. 2008. Remediation of hydrocarbon contaminated soils in the Canadian Arctic by landfarming. Cold Regions Science and Technology. 53(1): p. 102-114.
- SAIC (Science Applications International Corporation), 2006. Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils. Final report presented to: Contaminated Sites Division and Emergencies Engineering Technologies Office (EETO), Environmental Technology Centre, Environment Canada. SAIC Canada Project #: 11953.B.S08. CM #.
- Tetra Tech, 2017. Design Report for Landfarm, Revision A, Meliadine Gold Project, Nunavut, Prepared for: Agnico-Eagle Mines Ltd. June 9, 2017.
- Agnico Eagle (Agnico Eagle Mines Limited). 2018. Whale Tail Pit-Expansion Project, version 1. Submitted to the Nunavut Impact Review Board for review and approval. October 2018.

Appendix A

Construction drawings
61-696-230-001_0 and 61-696-230-002_0



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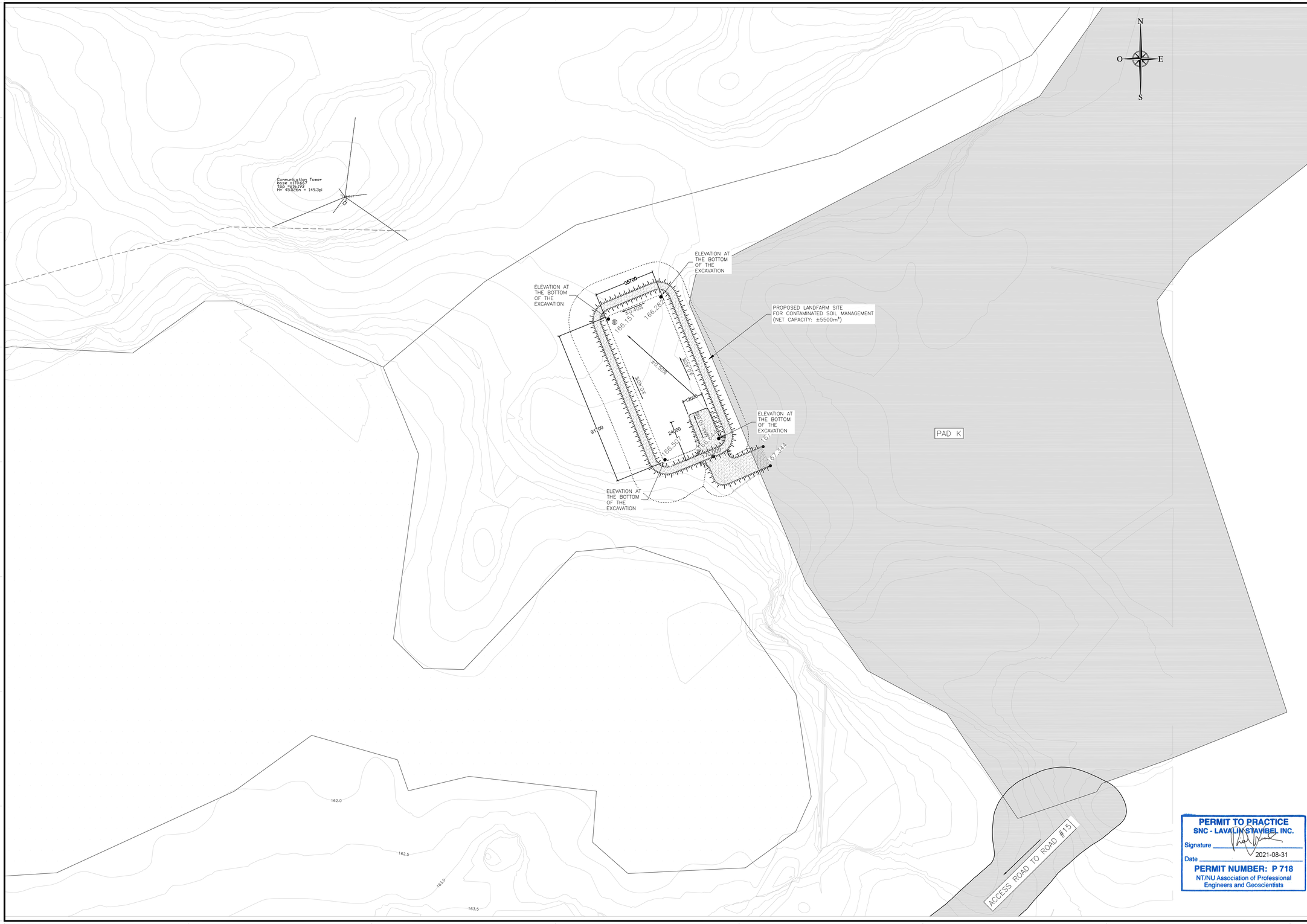

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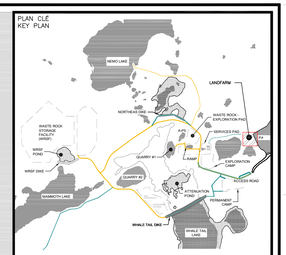
KEY PLAN



CONSTRUCTION ROADS 2017:
CONSTRUCTION ROADS 2018:

NOTES GÉNÉRALES / GENERAL NOTES

POUR APPROBATION
FOR APPROVAL
AGNICO EAGLE
DATE : 2021-08-10

SNC·LAVALIN
SNC-Lavalin Stavibel inc.
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Project # : 671087-0000

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

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3	2021-07-28	ISSUED FOR APPROVAL	R.M.	R.M.	R.M.
2	2019-05-01	ISSUED FOR CONSTRUCTION	R.M.	R.M.	R.M.
1	2019-04-29	ISSUED FOR APPROVAL	R.M.	R.M.	R.M.
0	2018-04-15	ISSUED FOR APPROVAL	R.M.	R.M.	R.M.

REVISIONS

PERMIT TO PRACTICE
SNC - LAVALIN STAVIBEL INC.
Signature
Date 2021-08-31
PERMIT NUMBER: P 718
NT/NU Association of Professional Engineers and Geoscientists

APPROVED PROFESSIONAL ENGINEER
MARCOUX
LICENSEE
NT/NU
2021.08.31

TITRE / TITLE
AGNICO EAGLE – WHALE TAIL (AMARUQ)
CONTAMINATED SOIL MANAGEMENT
LANDFARM
GENERAL VIEW

DESSINÉ PAR DRAWN BY	FRANCIS ROSE, T.P	DATE 2018-04-01
VÉRIFIÉ PAR CHECKED BY	RICHARD MARCOUX, ING.	2018-04-01
APPROUVÉ PAR APPROVED BY	RICHARD MARCOUX, ING.	2018-04-01
ÉCHELLE SCALE	1:1000	DATE 2018-04-01
NO. DESSIN DRAWING NO.	61-740-230-206	
NO. PROJET PROJECT NO.	61	REVISION 4 / FEUILLE / SHT 1 / 1

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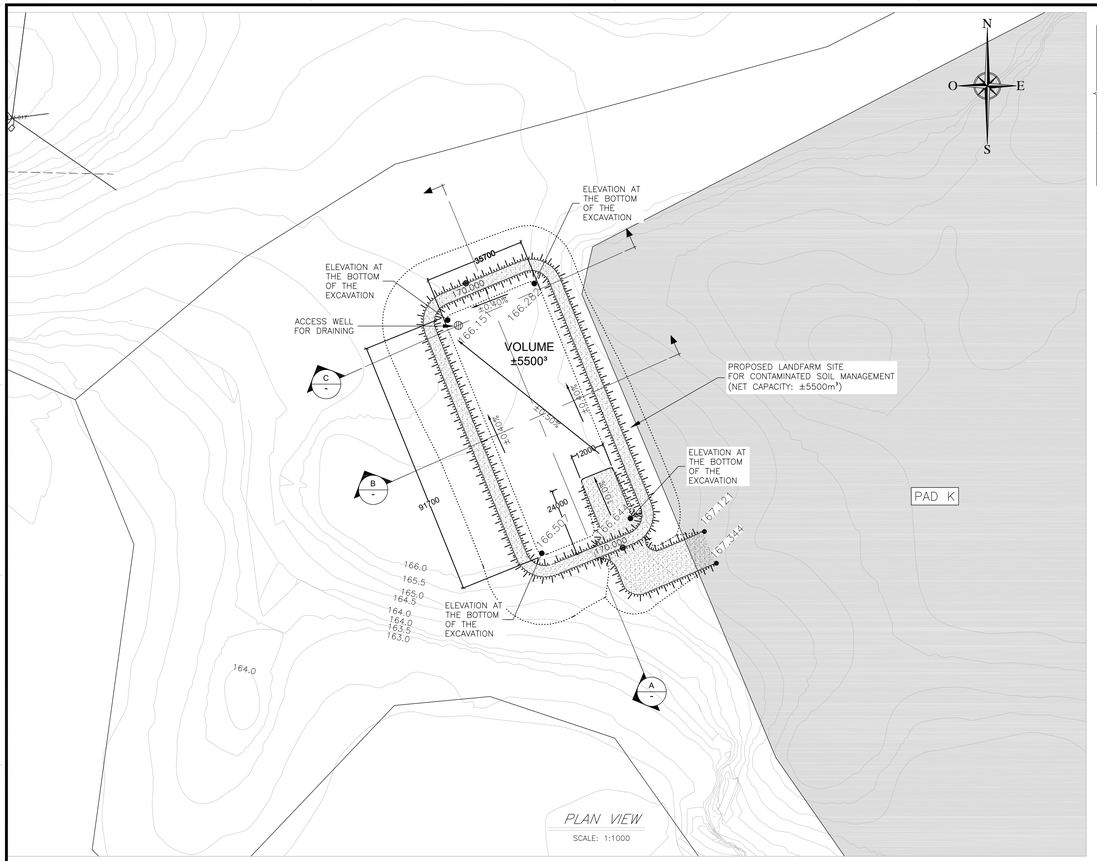

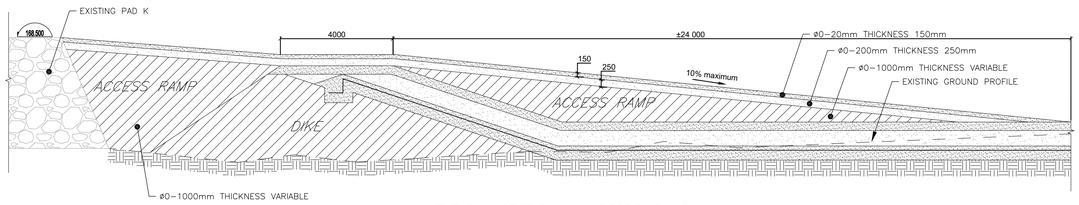

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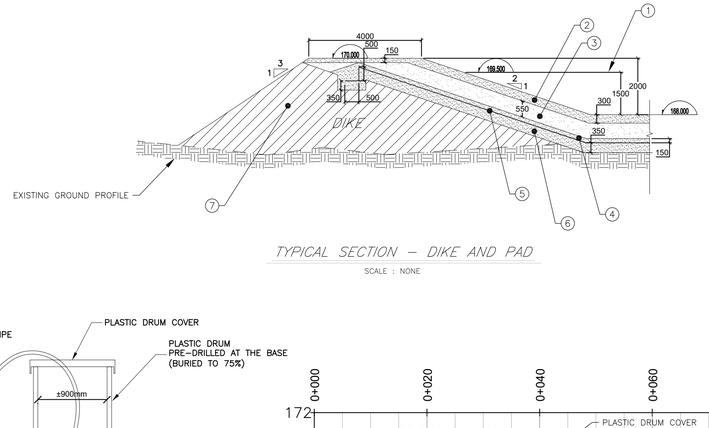


TYPICAL SECTION – DIKE AND PAD

SCALE : NONE

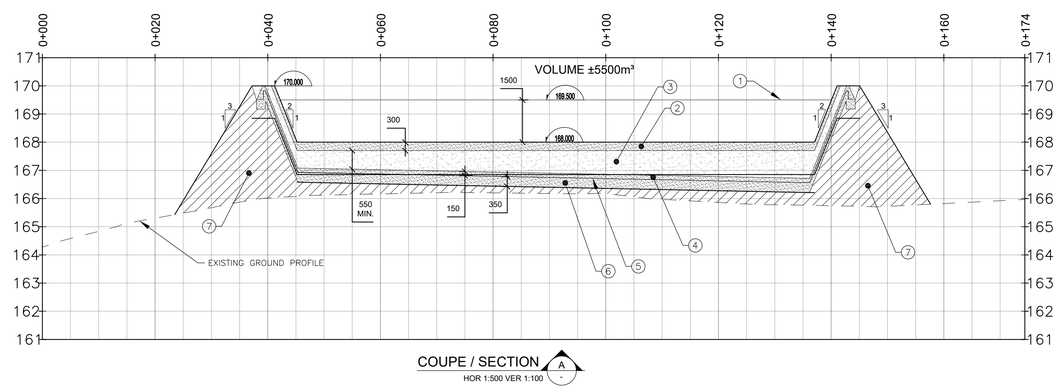
ACCESS WELL FOR DRAINING

SCALE : NONE

COUPE / SECTION C

HOR 1:500 VER 1:100

#	THICKNESS	DESCRIPTION	UTILITY
1	1500mm	MAXIMUM THICKNESS DESIGN HEIGHT FOR ACCUMULATION OF CONTAMINATED SOIL	USEFUL HEIGHT OF CONTAMINATED SOIL STORAGE FOR THE LANDFARM
2	300mm	GRANULAR FILL OR ESKER SAND (0–20 mm) COMPACTED	SURFACE LAYER FOUNDATION
3	550mm MIN.	TRANSITION ROCKFILL (0–200 mm) COMPACTED	PROTECTION LAYER AGAINST PERFORATION OF THE GEOMEMBRANE BY HEAVY MACHINERY
4	150mm	GRANULAR FILL OR ESKER SAND (0–20 mm) COMPACTED	UPPER PROTECTION LAYER OF THE GEOMEMBRANE
5	4mm	BITUMINOUS GEOMEMBRANE (BGM) – TYPE COLETANCHE ES–2 OR APP. EQ.	IMPERVIOUS SURFACE
6	350mm	GRANULR FILL OR ESKER SAND (0–20 mm) COMPACTED	BEDDING OF THE GEOMEMBRANE
7	VARIABLE	RUN–OF–MINE (0–1000 mm) COMPACTED	BASIN PERIPHICAL DIKE



COUPE / SECTION A

HOR 1:500 VER 1:100

ESTIMATED QUANTITIES :

FOR CONTAINMENT BASIN :

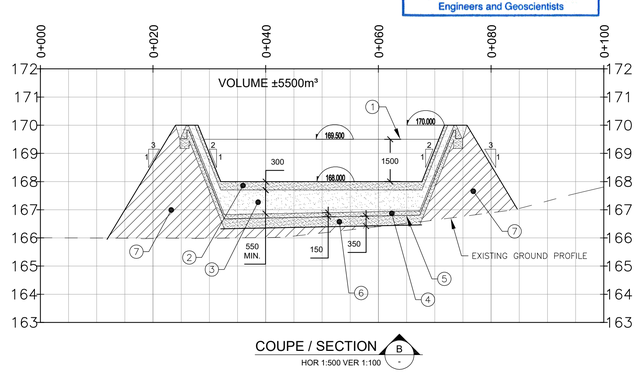
- GRANULAR FILL OR ESKER SAND (0–20 mm) = ±4375m³
- TRANSITION ROCKFILL (0–200 mm) = ±3620m³
- RUN–OF MINE ROCKFILL (0–1000 mm) = ±13210m³

FOR RAMP ACCESS :

- GRANULAR FILL OR ESKER SAND (0–20 mm) = ±163m³
- TRANSITION ROCKFILL (0–200 mm) = ±272m³
- RUN–OF MINE ROCKFILL (0–1000 mm) = ±752m³

BITUMINOUS GEOMEMBRANE :

- TYPE COLETANCHE ES–2 = ±5600m³



COUPE / SECTION B

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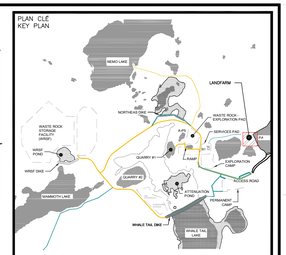
PERMIT TO PRACTICE
SNC - LAVALIN STAVIBEL INC.
Signature
Date 2021-08-31
PERMIT NUMBER: P 718
NT/NU Association of Professional Engineers and Geoscientists

PLAN CLÉ
KEY PLAN



CONSTRUCTION ROADS 2017:
CONSTRUCTION ROADS 2018:

NOTES GÉNÉRALES / GENERAL NOTES

POUR APPROBATION
FOR APPROVAL
AGNICO EAGLE
DATE : 2021-08-10

SNC·LAVALIN
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Tél. : 819 764-5181 Fax : 819 797-0158
www.snclavalin.com

Project # : 671087-0000

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
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AGNICO EAGLE

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3	2021-07-28	ISSUED FOR APPROVAL	R.M.	R.M.	R.M.
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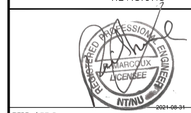
0	2018-04-15	ISSUED FOR APPROVAL	R.M.	R.M.	R.M.

REVISIONS



TITRE / TITLE

AGNICO EAGLE – WHALE TAIL (AMARUQ)
CONTAMINATED SOIL MANAGEMENT
LANDFARM
SECTIONS AND TYPICAL DETAILS
BITUMINOUS GEOMEMBRANE (BGM)

DESSINÉ PAR DRAWN BY	FRANCIS ROSE, T.P	DATE 2018-04-01
VÉRIFIÉ PAR CHECKED BY	RICHARD MARCOUX, ING.	2018-04-01
APPROUVÉ PAR APPROVED BY	RICHARD MARCOUX, ING.	2018-04-01
ÉCHELLE SCALE	INDIQUÉE	DATE 2018-04-01

NO. DESSIN
DRAWING NO. 61-740-230-207

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61	4	2 / 2

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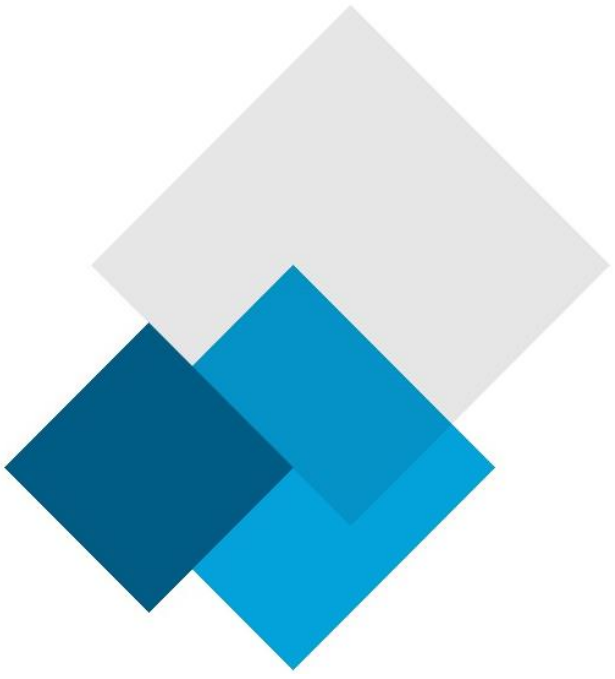
Appendix B

Technical Specifications for Bituminous Geomembrane



8, Avenue Félix d'Hérelle
75016 Paris - FRANCE
www.coletanche.com

Mise à jour le :
15/01/2018
Annule et remplace :
26/08/2016
Code :
1876901
Lieu de fabrication
Courchelettes (59-France)
Réf. Technique :
FT AXTER ES2 ASTM

FICHE TECHNIQUE

COLETANCHE ES 2

PRESENTATION

COLETANCHE ES 2 est une géomembrane bitumineuse, à base de bitume élastomère.
Les dimensions nominales des rouleaux sont 5.10m x 80m. - Autres largeurs sur demande.

UTILISATION

Sollicitations mécaniques moyennes :
- Terrils de grandes hauteurs,
- Bassins hydrauliques,
- Bassins pour effluents individuels,
- Canaux,
- Aires industrielles.

La validation de votre choix de produit doit se faire sur consultation.

MISE EN ŒUVRE

Par soudure au chalumeau ou autre procédé similaire.

STOCKAGE

En aucun cas stockés à même le sol. Prévoir des supports adaptés (parpaings, glissières, madriers de bois) d'une hauteur minimale de 35 cm à placer sous les extrémités du mandrin.

COMPOSITION *(à titre indicatif)*

Armature (g/m²) :	Voile de Verre	50
Armature (g/m²) :	Géotextile	250
Liant (g/m²) :	Elastomère	4300
Finitions surface (g/m²) :	Sable	250
Finitions sous-face (g/m²) :	Polyester	15

CARACTERISTIQUES

		NORME	UNITES	MOYENNE	Minimum
Dimensions	Longueur	-	*m*	80	79
	Largeur		*m*	5.10	5.01
Epaisseur sur produit fini		*ASTM D 5199*	mm	4.00	*3.60*
Masse surfacique		*ASTM D 3776*	kg/m²	4.85	*4.30*
Résistance à la déchirure	Sens Long	*ASTM D 4073*	N	825	*619*
	Sens Travers			700	*525*
Propriété en traction :	Sens Long	*ASTM D 7275*	kN/m	27	*20.3*
	Sens Travers			24	*15*
Propriété en traction : Allongement maximal	Sens Long		%	50	*35*
	Sens Travers			50	*35*
Résistance au poinçonnement statique		*ASTM D 4833*	N	530	*477*
Souplesse à basse température	Sens Long	*ASTM D 5147*	°C	-20	*-15*
	Sens Travers			-20	*-15*
Transmission de la vapeur d'eau		*ASTM E 96*	*m/s*	6.10^{-14}	
Perméabilité aux gaz		*ASTM D 1434-82*	*m³/m²/j/atm*	$< 3.10^{-14}$	