

Geotechnical investigation and environmental characterization

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Construction of a fixed aid to navigation

Île Sainte-Thérèse, Varennes, Québec

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Construction of a fixed aid to navigation Sainte-Thérèse Island, Varennes, Québec

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1 Introduction

1.1 Mandate and scope of the investigation

The **Canadian Coast Guard** has retained the services of **FNX-INNOV Inc.** to conduct a geotechnical investigation in conjunction with a summary environmental characterization for the construction of a fixed aid to navigation on Sainte-Thérèse Island in Varennes, Québec.

The purpose of the geotechnical investigation is to identify the nature and properties of the in-situ soils, as well as the groundwater conditions, since their characteristics influence the design and construction of the proposed work.

The purpose of the mandate's environmental investigation is to verify the contamination level of soils on the site prior to the installation of permanent equipment by the delegator.

This report provides a description of the site and the project, the methods used to carry out site and laboratory work, a summary of the results obtained, and our conclusions and recommendations with respect to the following:

Geotechnical component

- Parameters for calculating the geotechnical resistance and reaction of deposits (bearing capacity) and seismic site class required for foundation design in accordance with the 2015 National Building Code (NBC);
- Soil susceptibility to liquefaction using a simplified analysis;
- Temporary excavations ;
- Groundwater monitoring during construction;
- Drainage ;
- Preparation of foundation beds;
- Deep foundations;
- Reuse of materials; and
- General comments on precautions to be taken during construction.

Environment component

- Presence of contamination where permanent equipment is installed.

2 Project and site description

2.1 Site location

The proposed structure, the Deslauriers Island navigation light (rear light [RL]), will be located approximately 800 metres southwest of the Deslauriers Island navigation light (rear light) (LL2331.1) in the central portion of Sainte-Thérèse Island. The site is currently vacant, and features low-growing vegetation and mature trees in some areas. The site can be accessed by helicopter, ship or shore, as it is surrounded by the St. Lawrence River.



Figure 1 : Location of boreholes in line with the new RL (rear light) structure

The location of the study site is indicated on the site location plan included in Appendix A.

2.2 Project description

According to the document entitled “MANDAT D’ÉTUDE GÉOTECHNIQUE ET CAROTTAGE DE BÉTON” (Mandate for the geotechnical investigation and concrete coring – available in French only) and the construction plans for the structure that were supplied to us, the purpose of this project is to build a navigation light (RL) tower on Sainte-Thérèse Island. The proposed structure will be made of steel and will measure 80 feet in height. The tower foundation consists of concrete square footings measuring 6.7 m × 6.7 m × 0.6 m with four (4) pilasters measuring 0.76 m × 1.4 m. A GM-20 granular cushion measuring 7.3 m × 7.3 m × 0.3 m will be placed under the foundations.

Excavations will be 7.3 m × 7.3 m × 2.1 m deep. Backfilling of the foundations will be carried out with MG-112 granular material.



In the case of deep foundations, following the plan named « Fondation et ancrages, option '2' plan de montage », file number « 08733-18 », screw piles can be used to take up the load of the structure, i.e. 8 « DBA » type piles with a « DBA STABILIX » type head.

According to the plans received, the proposed foundation level will be approximately 1.8 m below the existing grade.



3 Geotechnical investigations

3.1 Field work

3.1.1 Site work

The geotechnical investigation work performed from July 3 to 5, 2023, involved:

- four (4) vertical boreholes with geotechnical and environmental soil sampling, identified as TF-01-23 to TF-04-23 and placed within the footprint of the proposed structure;
- one (1) dynamic cone penetration test to a depth of 12.0 m, identified as TF-01BIS-23;
- intact Shelby tube samples taken in the clay deposits in boreholes TF-01A-23 (borehole drilled to retrieve one Shelby tube only), TF-02-23 and TF-03-23;
- three (3) Nilcon vane shear profiles in the clay deposits in line with boreholes TF-01-23 to TF-03-23;
- the installation of two (2) water table observation tubes in boreholes TF-01-23 and TF-03-23, and survey of stabilized water level; and
- a levelling survey of the boreholes, including their location.

All field work was carried out under the constant supervision of an experienced technician. The information gathered is presented in the borehole logs included in Appendix B.

3.1.2 Elevation, location and levelling

The client has established the elevations of the boreholes on the study site.

The levelling and borehole location survey was carried out by **FNX-INNOV Inc.** personnel using a Leica Viva GPS (GS08 GNSS). The targets were linked to geodetic monuments using the NAD83 reference system. The accuracy of the measurements taken with this device is ± 15 mm in the X and Y positions, and ± 30 mm in the Z position. The coordinates are expressed using the Quebec plane coordinate system (S.C.O.P.Q.), zone 8.

Table 1 shows the geodetic coordinates of the surveyed borehole targets.

Table 1 Geodetic coordinates and elevations of the boreholes

Borehole No.	X (metres)	Y (metres)	Z (metres)
TF-01-23	307,387.41	5,060,871.74	4.41
TF-01BIS-23	307,386.90	5,060,871.45	4.41
TF-02-23	307,383.71	5,060,872.36	4.44
TF-03-23	307,391.28	5,060,870.49	4.40
TF-04-23	307,389.26	5,060,868.52	4.41

The borehole locations are shown in the figure in Appendix A.

3.1.3 Vertical boreholes and sampling

The vertical boreholes were drilled using the Geoprobe 7822DT, a track-mounted hydraulic drill featuring hollow-stem augers with an outside diameter of 200 mm, driven by rotation, and NW-size casing with an outside diameter of 89 mm



and an inside diameter of 76 mm, driven by rotation and washing. Boreholes TF-01-23, TF-02-23 and TF-03-23 reached a depth of 12.0 m, while borehole TF-04-23 reached a depth of 0.61 m.

During borehole drilling, samples were taken continuously and then at regular intervals to determine the stratigraphy of the various in-situ materials and soils. To accurately establish the stratigraphic profile and carry out in-situ soil tests, the materials and soils were sampled using the standard soil sampling method as outlined by the American Society for Testing and Materials (ASTM) D-15861 and the National Standard of Canada CAN/BNQ 2501-140. This sampling method measures the N_{spt} index, which is related to soil density, and can be used to estimate geotechnical parameters. A standard B caliber split-barrel sampler with an outside diameter of 51 mm was used for soil sampling and standard penetration tests. At the ground surface, an N caliber split-barrel sampler with an outside diameter of 63.5 mm and an inside diameter of 51 mm was also used to increase sample collection volume.

In clay soils, intact samples were taken using a 70 mm diameter thin-walled Shelby tube.

The vane shear profiles were measured using a Nilcon field vane shear tester, in accordance with Bureau de Normalisation du Québec (BNQ) standard 2501-200, with a designated measurement interval of 1.0 m.

Dynamic cone penetration tests were carried out in accordance with BNQ standard 2501-145. These tests consist in using a jarring device to drive in a standard 50 mm conical tip with a 63.5 kg mass, to measure the cone penetration indexes (N_c) obtained for each 300 mm penetration length. These cone penetration indexes (N_c) are used to assess the homogeneity and density of the soils encountered, and to determine the depth to refusal.

3.1.4 Material sampling

Materials (fills, soils and aggregates) were sampled in accordance with the procedures outlined in the “Environmental analysis sampling guide”² books and in booklets on sampling various media published by the *Centre d’expertise en analyse environnementale du Québec* [Quebec Centre of Expertise in Environmental Analysis] (CEAEQ). Observations and other relevant information are presented in the borehole logs in Appendix B.

For soils, unless a specific horizon is highly contaminated, sampling was generally carried out using a composite soil sample from each spoon. This sampling procedure provides a more representative environmental overview of each unit encountered. The environmental samples collected were immediately transferred to glass containers supplied by the laboratory for storage and transport. These clearly labelled containers were subsequently placed in a cooler with ice to be kept at a suitable temperature (<4°C) during transportation to the analysis laboratory accredited by CEAEQ.

Each sample underwent an organoleptic examination (odour, texture, colour, etc.) by an environmental expert.

One-time samples were taken in cases where volatile organic compounds (VOCs) needed to be analyzed. In accordance with the Addendum to the Environmental analysis sampling guide: Soil – Book 5, which addresses soil sampling methodology in the event of VOC contamination, soils for analysis were sampled using syringes and vials supplied by the laboratory.

Concurrently, corresponding fills, soils and aggregates were sampled for geotechnical laboratory tests. Prior to analysis or testing, the samples were examined (odour, texture, colour, etc.) by an expert in the field.

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM), D-1586, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.
2. MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L’ENVIRONNEMENT ET DES PARCS DU QUÉBEC [Quebec Department of Sustainable Development, the Environment and Parks], July 2008, Environmental analysis sampling guide, Book 1 – General, Centre d’expertise en analyse environnementale du Québec, 58 p., 3 appendices, Book 5 – *Échantillonnage des sols* [Soil sampling], Quebec, Centre d’expertise en analyse environnementale du Québec, current edition <http://www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage.htm>.



3.1.5 Groundwater instrumentation

Groundwater levels were measured using observation tubes installed in line with boreholes TF-01-22 and TF-03-22. The observation tubes are made of plastic (PVC), have an inside diameter of 19 mm, with a perforated lower section, and are used to measure the depth of stabilized groundwater.

The observation tube installation diagram is shown in the relevant borehole logs in Appendix B.

3.2 Laboratory tests

3.2.1 Geotechnical component

Soil samples collected during drilling were sent to our laboratory and subjected to visual identification by a geotechnical expert to outline the stratigraphic profiles presented in the borehole logs. In order to specify the nature and some physical and mechanical properties of the sampled soils, the tests listed in Table 2 were carried out on representative samples.

Table 2 Laboratory tests

Quantity	Test	Standard
2	Grain size distribution analysis by sieving	LC 21-040
4	Grain size distribution analysis by sedimentation	BNQ 2501-025
5	Natural water content (w)	BNQ 2501-170
4	Atterberg limits, 3 points	BNQ 2501-092
3	Undrained shear strength using a fall cone penetrometer	BNQ 2501-110
2	Soil corrosivity potential	ANSI/AWWA C105-A21.5-10

Laboratory test results are attached in Appendix C. All samples collected during drilling that were not used for laboratory tests will be retained until December 2023. Samples will be destroyed beyond this point, unless you indicate otherwise in writing.

3.2.2 Characterization component

To verify the contamination level of the soils present on the site, nine (9) soil samples including one (1) duplicate underwent chemical analyses for the following parameters: petroleum hydrocarbons F2-F4 and metals (17 metals).

The analysis methods used are set out in the certificates of chemical analysis in Appendix D.



4 Quality assurance / quality control program

A quality assurance / quality control (QA/QC) program was implemented as part of this mandate for both environmental field sampling and chemical laboratory analysis. The purpose of this program is to ensure the quality and reliability of the data obtained.

4.1 Field controls

A QA/QC program was implemented as part of this mandate for field sampling. The purpose of this program is to ensure the quality and reliability of the data obtained. Quality control measures include, but are not limited to, the following:

- Constant supervision of work;
- Prior calibration of measuring instruments;
- Cleaning of measuring and sampling instruments before collecting samples;
- Careful handling of sample containers and measuring equipment;
- Maintaining samples below 4 °C; and
- Collecting field duplicates for soils.

4.2 Laboratory controls

The Bureau Veritas analytical laboratory is accredited by the CEAEQ (No. 364) under the Quebec Analytical Laboratory Accreditation Program (PALA). This accreditation is subject to the application of a quality assurance program in compliance with CEAEQ's PALA (DR-12-PALA, 2012) which may include the following:

- Receipt, storage and routing of laboratory samples;
- Validation of analysis methods;
- Analysis of integrated controls, control samples, reference samples, procedural blanks and replicate samples;
- Compilation and validation of results; and
- Participation in inter-laboratory studies.

The results of the laboratory quality assurance program are presented in the certificates of chemical analysis in Appendix D.



5 Description of soils

5.1 Nature and properties of deposits

The information gathered during field and laboratory investigations is presented in the following paragraphs and summarized in tables 3 to 6.

Natural deposits

Natural deposits were encountered directly at the ground surface in line with all the boreholes. Two (2) distinct stratigraphic units were encountered in the natural soils:

Sand and silt / Silt and sand deposits

A sand and silt deposit was encountered at the ground surface of the natural deposits. This deposit is generally composed of root-bearing sandy silt to silty sand in some areas. The thickness ranges from 0.61 m to 0.91 m.

The compactness of the deposit is assessed as “very loose” to “loose,” with N_{spt} values ranging from 3 to 5.

Borehole TF-04-23 was interrupted in the silty sand deposit at the target depth of 0.61 m.

Clay and silt deposit

The natural sand and silt deposit sit at an average depth of 0.7 m on a clay and silt deposit. These soils are described as clay and silt to silt and clay containing traces of sand, and are brown or grey in colour. They are classified as “CH” according to the Unified Soil Classification System (USCS).

The consistency of the natural deposit is described as firm to stiff (Canadian Foundation Engineering Manual [CFEM], 2013), based on intact shear strength (S_u) values obtained from the vane shear profiles, with S_u values ranging from 44 and 80 kPa. Given the remoulded shear strength (C_{ur}) values obtained from the Swedish fall cone test, between 5.8 kPa and 11.0 kPa, the sensitivity index (S_t) of the deposit is between 7 and 14. Consequently, the sensitivity of the deposit is assessed as “sensitive” to “extra sensitive” (CFEM, 2013).

Boreholes TF-01-23 to TF-03-23 were interrupted in the natural clay deposits at a depth of 12.0 m.

Table 3 summarizes the properties of the clay and silt deposit.

Table 3 Clay and silt deposit property

Property	Typical Value
Natural water content (W)	50.2% to 59.0%
Unit weight (γ)	16.3 to 16.9 kN/m ³
Intact shear strength (C_u/S_u)	44.0 to 80.0 kPa
Remoulded shear strength (C_{ur}/S_{ur})	5.8 to 11.0 kPa
Sensitivity (according to CFEM, 2013)	Sensitive to extra sensitive
Liquid limit (W_L)	59% to 66%
Plastic limit (W_P)	24% to 25%
Plasticity index (I_P)	35% to 42%
Liquid index (I_L)	0.7 to 0.9
Consistency index (I_c)	0.1 to 0.3
Compression index (C_c)	0.92 to 1.42*
Recompression index (C_R)	0.04 to 0.05*



Preconsolidation stress (σ'_p) at a depth of 3.0	315 kPa*
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*Correlated value (Leroueil, S., Tavenas, F. and Le Bihan, J-P. (1983). *Propriétés caractéristiques des argiles de l'est du Canada* [available in French only], Canadian Geotechnical Journal, vol. 20, pp. 681–705).

Dynamic cone penetration test

A dynamic cone penetration test was carried out at borehole TF-01BIS-23 to a depth of 12.2 m without reaching refusal.



Table 4 Stratigraphy summary

Borehole No.	Elevation (m)	Natural Deposit (Silty Sand / Sandy Silt)			Natural Deposit (Clayey Silt / Silty Clay)			Bottom of Borehole	
		Dep. (m)	Elev. (m)	Thk. (m)	Dep. (m)	Elev. (m)	Thk. (m)	Dep. (m)	Elev. (m)
TF-01-23	4.41	0	4.41	0.61	0.61	3.80	> 11.43	12.04	-7.63
TF-02-23	4.44	0	4.44	0.61	0.61	3.83	> 11.43	12.04	-7.60
TF-03-23	4.40	0	4.40	0.91	0.91	3.48	> 11.13	12.04	-7.64
TF-04-23	4.41	0	4.41	≥ 0.61	-	-		0.61	3.80

Note: Dep.: Depth / Elev.: Elevation / Thk.: Thickness

Table 5 Laboratory soil test results

Borehole No. / Sample No.	Dep. (m)	Stratigraphic Unit	Undrained Shear Strength (kPa)		Water Content (%)	Atterberg Limit (%)*			Particle Size Distribution (%)				USCS Classification
			C _u (Intact)	C _{ur} (Remoulded)		W _L	W _P	I _P	Gravel (Ø > 5 mm)	Sand (0.08–5 mm)	Silt (2–80 µm)	Clay (Ø < 2 µm)	
TF-01-23/CF-1B	0.30–0.61	Sand and Silt Deposit	-	-	15.9	-	-	-	0	77.8	22.2		SM and/or SC
TF-03-23/CF-2A	0.61–0.91		-	-	24.3	-	-	-	0	55.0	45.0		
TF-01-23/CF-5	2.44–3.06	Clay and Silt Deposit	-	-	55.3	66	25	42	0	1.0	30.6	68.4	CH
TF-01-23/CF-15	10.06–10.67		-	-	59.0	-	-	-	0	0.5	20.9	78.6	
TF-01A-23/TS-2	3.05–3.66		80.0	5.8	57.2	62	24	38	-	-	-	-	
TF-02-23/CF-8	4.72–5.33		-	-	52.9	-	-	-	0	0.5	26.7	72.8	
TF-02-23/TS-7	3.81–4.42		80.0	11.0	50.2	59	24	35	-	-	-	-	
TF-03-23/TS-4	1.83–2.44		58.3	5.8	57.0	64	24	40	-	-	-	-	
TF-03-23/CF-7	3.96–4.57		-	-	51.4	-	-	-	0	0.7	27.6	71.7	

* W_L = Liquid limit / W_P = Plastic limit / I_P = Plasticity index



Table 6 Soil corrosivity test results

Borehole No.	Sample No.	Depth (m)	Stratigraphic Unit	Result	Corrosivity (>10)
TF-01-23	CF-4	1.83-2.44	Clay and Silt Deposit	14.0	Corrosive
TF-03-23	CF-5	2.44-3.05	Clay and Silt Deposit	23.5	Corrosive



6 Groundwater conditions

The water table was measured inside the observation tubes on July 4, 2023. The results obtained are presented in the following table:

Table 7 **Depth to groundwater**

Borehole No.	Ground elevation (m)	Groundwater (2023-07-04)	
		Depth (m)	Elevation (m)
TF-01-23	4.41	7.01	-2.60
TF-03-22	4.40	5.78	-1.38

On July 4, 2023, the depth to groundwater in the boreholes ranged from 5.78 m and 7.01 m, either at the geodetic elevation ranging from -1.38 m to -2.60 m, or within the clay deposit. Depending on the date of installation of the observation tubes and the date of the groundwater level survey, the latter may be non-stabilized as a result of the presence of non-permeable soils, i.e. clay deposits.

The groundwater conditions encountered in the boreholes correspond only to the locations and dates indicated, and are intended for information purposes only. They may vary according to season, local precipitation levels and human activity on the site or adjacent properties. Therefore, it is possible for these conditions to change over the course of the construction work.



7 Environmental characterization

7.1 Interpretation criteria – soils

As part of this investigation, the results of the laboratory chemical analyses have been compared with the Canadian Council of Ministers of the Environment's (CCME) Soil Quality Guidelines for the Protection of Environmental and Human Health, the current federal standards.

7.2 Results

7.2.1 Soils

The analytical results of the soil samples are presented in the certificates of chemical analysis in Appendix D and in tables 1 and 3 in Appendix E.

Petroleum hydrocarbons (F2-F4)

All samples analyzed showed petroleum hydrocarbon concentrations (F2-F4) below CCME agricultural criteria.

Metals (17 metals)

All samples analyzed had metal concentrations below CCME agricultural criteria, except for sample TF-02-23 CF-1B, which had a chromium (CR) concentration above CCME agricultural and residential criteria, but below CCME commercial and industrial criteria.

In light of these results, from an environmental perspective and based on CCME standards, the soils at TF-02-23 CF-1B are not compliant for agricultural use.

7.3 Interpretation of quality control test results

The relative deviation (%) between the results of the original sample (concentration A) and its duplicate (concentration B) is used to evaluate the quality control program. This variance is determined based on the following equation:

$$\text{Relative deviation (\%)} = \left(\frac{| \text{Concentration A} - \text{Concentration B} |}{\text{Average of concentrations A and B}} \right) \times 100$$

According to the information obtained from the CEAEQ, variability is acceptable when the original value and the duplicate value lie between the detection limit of the analytical method and up to ten (10) times the reported detection limit (RDL), or if the relative deviation is lower than 30%.

The relative deviation between sample TF-02-23 CF-1B and DUP 03 is greater 30% for several metal parameters (Ba, Co, Cr, Cu, Ni and Zn). However, the variations do not exceed 10 times the detection limits.

This deviation can be explained by the presence of silt on the site. This means that homogenization of the field sample was difficult and may partly explain the significant deviation observed.

In summary, the results of the quality control program implemented on the site reflect the reliability and reproducibility of the analytical results generated under this mandate. The results of the quality assurance program analyses performed by the laboratory reflect the integrity and precision of the equipment used to conduct the chemical analyses.



8 Recommendations for design

8.1 Project and site conditions summary

This investigation is part of the (proposed) project to build a navigation light (rear light) on Deslauriers Island, located 800 metres southwest of the Deslauriers Island navigation light (rear light) (LL2331.1) on Sainte-Therese Island, in Varennes, Quebec. According to the information provided by the client, the tower to be built will consist of a 24-metre-high steel structure. The foundations will consist of concrete square footings measuring 6.7 m x 6.7 m x 0.6 m.

The results of the drilling campaign revealed a natural deposit at the surface composed of sand and silt that contains roots and that has an average thickness of 0.7 m. Below this deposit is a firm to stiff clay deposit, classified as CH, with varying proportions of silt and traces of sand. All drilling was interrupted in the clay deposit at the target depth of 12.0 m, except for borehole TF-04-23, where sampling terminated in sand and silt deposits at a depth of 0.6 m.

The groundwater depth surveyed in the boreholes on July 4, 2023, ranged from 5.78 m to 7.01 m, that is, geodetic elevations ranging from -1.38 m to -2.60 m. Based on the date the observation tubes are installed or the groundwater level is surveyed, the groundwater level can be non-stabilized due to the presence of impermeable soil, such as a clay deposit.

8.1.1 Frost protection

For the City of Varennes area, given the average freezing index, the foundation burial depth for heated buildings must be at least 1.8 m of the finished grade for effective protection against frost heaving. However, for an unheated structure and in locations permanently cleared of snow, the frost depth may be 2.0 m. The installation of horizontal rigid insulation may be considered in lieu of the prescribed burial.

8.2 Soil corrosivity potential

The results of the laboratory analyses of representative samples of natural soils show the presence of corrosive soils—namely, a natural sand deposit with a corrosion rate of 14.0, or a natural clay deposit with a corrosion rate of 23.5. As a guideline, soils with a corrosivity potential above 10 are considered corrosive.

Therefore, the soils in the footprint of the proposed structure are generally corrosive and can cause damage to the cast-iron structure.

Nevertheless, as part of the project, the foundations will be made of reinforced concrete, which implies the elimination of the criterion of corrosiveness of the soil on the foundations.

8.3 Shallow foundations

The loads of the proposed tower may be transmitted to undisturbed stable natural clay and silt soils by conventional footings.

The minimum depth of burial for the foundations is 1.8 m below the finished grade, for effective protection from frost heave. However, in locations permanently cleared of snow, the frost depth could be 2.0 m. The installation of horizontal rigid insulation may be considered instead of the prescribed burial.



8.3.1 Preparation of the foundation bed

All disturbed, frozen or unstable soils below the planned foundation level must be fully excavated until intact natural deposit free of organic matter is achieved throughout the site.

The bottom of the excavations will need to be approved by a geotechnical engineer or their representative to ensure that all unwanted material has been removed and that the bedding is stable.

8.3.2 Excavation and groundwater control

Excavations up to a depth of ± 2.0 m from the existing grade will be conducted mainly in the natural sand and silt deposits and clay and silt deposits. The use of conventional equipment may be considered for the excavation work. Given the nature of the deposits, the use of a blade bucket (ditching bucket, no teeth) is recommended.

The groundwater level measured in the boreholes, depending on the survey date, is deeper than the projected bottom of the excavations, and anticipated water infiltrations are minimal to non-existent. Any water infiltration, as well as any runoff or precipitation, will need to be evacuated to ensure that the bottom of the excavations is well drained.

If the drainage conditions are respected, the temporary excavation slopes should not exceed 1.0 m vertical to 2.0 m horizontal (1.0 V : 2.0 H). The excavation slopes must be adjusted on site based on the conditions observed at the time of the work and based on the contractor's work methods. The temporary excavation walls must be uniform and, if applicable, clear of pebbles and/or boulders. Lastly, it is understood that, in the presence of instabilities, the slopes need to be reduced. If the excavations remain open for an extended period, the excavation walls will require appropriate protection against erosion through, for example, firmly secured tarps.

If slope grading cannot be conducted due to space restrictions or any other constraints, a temporary shoring system designed and sealed by an engineer will need to be considered. Table 8 presents the average geotechnical parameters to consider in the design of the temporary shoring system for the excavations.

Table 8 Geotechnical parameters – temporary shoring

Parameters	Sand and Silt Deposit	Clay and Silt Deposit ²
Unit weight (kN/m ³)	18.0	16.8
Submerged unit weight (kN/m ³)	8.2	7.0
Effective cohesion (kPa)	0	-
Undrained shear strength (kPa)	-	Note ³
Effective angle of internal friction (°)	28	0
Coefficient of active pressure (k_a) ¹	0.361	1
Coefficient of passive pressure (k_p) ¹	2.77	1
Coefficient of at-rest pressure (k_0) ¹	0.531	1

Note 1 : The parameters assume that the ground behind the shoring is flat ($\beta=0$).

Note 2 : Short-term parameters (undrained conditions).

Note 3 : The undrained shear strength values are presented in the borehole logs in Appendix B.

It should be noted that the wall must be free to deform in order to develop an active earth pressure state (rotation of **0.01 to 0.1** % of the wall height, non-rigid wall). The non-rigid wall should be designed to resist the active earth pressure by using coefficient k_a . If the wall cannot deform (rotation of **0** % of the wall height, rigid wall), it must be designed to resist a lateral earth pressure by using the coefficient of at-rest pressure k_0 . In all cases, the current standards and safety factors applicable to the type of work must be applied.



If the work is performed in winter, the designer will need to give special consideration to freezing/thawing and to additional pressure and movement that may be caused by the formation of ice lenses in the soils in the deposits behind the retaining walls.

Lastly, the temporary shoring system should be designed based on the site's geotechnical characteristics, groundwater conditions, climatic conditions, and the presence of nearby structures and infrastructure. The design of the structure (or the temporary slopes) will need take into account nearby structures (such as roads, underground infrastructure, existing buildings, etc.) and their susceptibility to settlement that could be caused by a lateral movement of the retaining walls and thus impact their vertical and horizontal support.

It is also important to maintain a distance at least equal to the excavation depth between the top of the embankment and the base of the material piles stored. Vehicle traffic near open trenches must also occur at a reasonable distance from the excavated area in order to minimize the impact of vibrations on the stability of the excavations.

In addition to these recommendations, all excavation conditions must meet the standards of "La Commission des normes, de l'équité, de la santé et de la sécurité du travail du Québec" (CNESST) so that the work can be performed safely for the workers.

8.3.3 Soil sensitivity to disturbance

Soils at the bottom of the excavations will consist of natural deposits composed predominantly of clay and having a natural water content ranging from 50 % to 59 %. These soils will therefore be highly sensitive to disturbance, and instabilities must be accounted for, especially if there is precipitation or if the bottom of the excavation is poorly drained. The contractor will need to take precautionary measures adapted to soil, groundwater and seepage conditions. Any unstable soils will need to be excavated prior to the placement of the sand cushion in accordance with the following paragraph.

A sand cushion will need to be placed beneath the foundations to prevent disturbance of the surficial layer of loose soils during the installation of formwork and reinforcement. The installation of material requiring compaction is not recommended on this type of soil; rather, it is recommended that a layer of 20-mm clear stone wrapped in a geotextile membrane or a layer of lean concrete (minimum thickness of 100 mm) be placed on the undisturbed soils before the formwork is installed.

It is recommended that the bottom of the excavation in line with the footings be approved by a geotechnical engineer or their representative to ensure that all unwanted material has been removed and that the bedding is stable.

8.3.4 Granular cushion

A clean cushion must be placed under the foundations in order to avoid disturbing the surface layer of loose soil during formwork and installation of reinforcement operations. The installation of a material requiring compaction is not recommended on this type of soil; Instead, it is recommended to place a layer of clean stone measuring 20 mm on a geotextile membrane or a layer of lean concrete (minimum 75 mm thick) at the level of the undisturbed soils before installing the formwork.

8.3.5 Geotechnical resistance

The recommendations that follow are in accordance with the National Building Code (NBC), 2015. Subsection 4.1.3 of the NBC sets out the requirement that the foundations be calculated in accordance with limit states design. The limit state requirements in the NBC, as well as those calculated under this project, are as follows:



- Ultimate limit state (ULS); and
- Serviceability limit state (SLS).

Ultimate limit state (ULS) concerns safety and relates mainly to failure mechanisms for a structure caused when bearing capacity limits are reached or in the event of collapse, overturning, sliding or a major foundation deformation. Serviceability limit state (SLS) corresponds to the mechanisms that limit or prevent the proposed usage of the structure, such as total and differential settlement.

The geotechnical resistance values at ultimate limit state (ULS) and serviceability limit state (SLS) provided in the following table are recommended for the sizing of the foundations placed on the stable and undisturbed natural deposit.

Table 9 Geotechnical resistance values – embedment at 2.0 m

Size of "B" footings (m)	6.7 x 6.7
ULS (kPa)	
Square footings	425
Weighted ULS – performance factor of 0.5 (kPa)	
Square footings	213
SLS – total settlement less than 25 mm (kPa)	
Square footings	40
SLS – total settlement less than 50 mm (kPa)	
Mat	75

The total settlement generated by such serviceability limit state pressures should be less than 25 mm for square footings and less than 50 mm for the mat. However, this settlement value presupposes that the bedding surfaces are free of disturbed soil. In locations where the finished grade will be raised in relation to the current level, special precautions should be taken. If this is the case, we will need to be notified.

8.3.6 Backfilling of foundations and permanent drainage

The backfilling of foundations to the ground surface must be done with drainage material containing less than 10 % particles finer than 80 µm, such as an MG-112. Such precautions help prevent excessive lateral pressure on the foundation walls and frost heave caused by fine-grained soils.

However, backfilling up to a height of around 600 mm in relation to the foundations can be carried out with a draining material containing less than 10 % of particles passing the 80 µm sieve, such as an MG 112, subsequently the soils excavated can be put back in place up to the surface of the land, provided that all soil containing organic matter is removed.

Or, the excavated soils can be put back in place up to the surface of the land, provided that thermal insulation is placed around the foundations.

8.4 Deep foundations

In locations where the geotechnical resistance is insufficient to install shallow foundations, the structure's loads may be transmitted to the soils through a pile system. Different types of piles are provided based on site conditions. In the context of this project, we are of the opinion that friction piles or screw piles could be considered.



8.4.1 Pile capacity

Friction piles will need to be driven to refusal through the clay and silt deposits. The criteria for hammer selection and driving refusal must be based on an ultimate load sufficient to provide an acceptable safety factor (equal to or greater than 2.0) with respect to the desired working load, in accordance with the driving formula in question. It should be noted that our site investigation work, which was interrupted at a depth of 12.0 m, did not allow us to meet the refusal or the termination of the cohesive deposit.

With respect to screw piles, the helices should be located in the stiff clay and silt deposit, from a depth of 2 m. The number and diameter of the helices, the central shaft diameter, and torque must be based on an ultimate load sufficient to provide a safety factor of 3 with respect to the desired working load.

The pile caps should be located at a minimum depth of 1.8 m from the ground surface in order to effectively protect them from frost heave.

8.4.2 Negative friction

Considering the thickness of the silty-clay layer likely to cause negative friction, and the fact that the shaft of the screw piles is generally of small diameter (≤ 165 mm), the negative friction is negligible.

8.4.3 Construction monitoring

We recommend that the installation of pile foundations be closely supervised by a laboratory to ensure the quality of the materials supplied and the compliance of the piles after installation (alignment, verticality, straightness, torque, etc.). All piles should be visually inspected to ensure that they are still in good condition.

Lastly, we also recommend that the services of a specialized pile contractor be retained to guarantee that the work will be carried out in compliance with good engineering practice and with the applicable NBC.

8.5 Seismic aspects

8.5.1 Seismic design

The soils encountered can be described as a firm to stiff clay and silt deposit with an estimated depth of 12.0 m. In light of these results, and based on the parameters in table 4.1.8.4a of the National Building Code, 2015, the investigation site is in Site Class D if conventional foundations are used, as the clay deposit has a soil undrained shear strength (C_u) in the range of 50 to 80 kPa.

8.5.2 Evaluation of liquefaction potential in the event of a major earthquake

The bedding will be underlain by natural clay and silt deposits. An evaluation of the liquefaction susceptibility of the natural deposit, composed of fine material (silt/clay), was conducted to determine the scope of the investigation. This field of analysis is relatively new and currently lacks consensus within the scientific community. Several authors with more or less similar approaches were consulted in an attempt to obtain an accurate picture of the risks in this case. The following technical sources provide an overview of the approach taken for cohesive deposits:

- Boulanger and Idriss. *Evaluating the potential for liquefaction or cyclic failure of silts and clays*. University of California, 2004; and
- LeBoeuf and Chahde. *Formation continue : « Analyse sismique des barrages en remblai »*. Université Laval, 2009.



All these approaches are based on the basic characteristics of plastic materials, namely, their natural water content, their liquid limit and their plasticity index. Based on these results, liquefaction susceptibility was evaluated using criteria from the different authors. The following table summarizes the conclusions to be made depending on the approach.

Table 10 Natural deposit liquefaction susceptibility

Author	Deposit Properties (W : 50.2 to 59.0 %/W _L : 59 to 66%/I _p : 35 to 42%)		
	Liquefiable	To Be Verified	Non-liquefiable
Seed et al. (2003)			X
Andrews and Martin (2000)			X
Polito and Martin (2001)			X
Bray and Sancio (2004)			X

The results show that, according to the deposit's plastic limit, the soils in place are not susceptible to liquefaction in response to a seismic event.

8.6 Reuse of in-situ material

Based on the results of the investigations, excavated material cannot be used under or in the immediate periphery of the structure to be built, if they generally contain more than 10% fine particles ($\varnothing < 80 \mu\text{m}$). However, it can be reused as supplementary fill material in locations with no compaction or drainage requirements, provided it is free of organic matter. Under this project, it will not be possible to reuse material from natural deposits.

However, these floors can be reused provided that the recommendations mentioned in section 8.3.5 are followed.

Nevertheless, we recommend that this material be verified and approved by a soil and material control laboratory to ensure that it meets the requirements of the current standards. In all cases, the reuse of backfill soils is also subject to the environmental policies and regulations in force at the MELCCFP.

8.7 Precautions during winter work

If excavation work is to be carried out in winter, special care must be taken to ensure that frost does not affect the properties of the existing soils and foundations. Consequently, there is a need to ensure that the soils making up a granular cushion, or those below the foundation level, are not subjected to frost. If frozen soils are present, they must be fully thawed and recompacted before an additional layer of granular backfill is placed or before the work continues. If the frost reaches a depth greater than 300 mm, the frozen soils must be excavated before the work can continue. If a structure under construction is affected by frost in the underlying soils, specific recommendations from a geotechnical engineer are required.

8.8 Environmental management of excavated material

The purpose of this mandate is to verify the contamination level of the soils on the site before the installation of permanent equipment by the delegator.

A total of nine (9) soil samples, including one (1) duplicate, have been analyzed for the following chemical parameters: petroleum hydrocarbons (F2-F4) and metals (17 metals).



All samples analyzed had metal concentrations below CCME agricultural criteria, except for sample TF-02-23 CF-1B, which had a chromium (CR) concentration above CCME agricultural and residential criteria, but below CCME commercial and industrial criteria.

In light of these results, from an environmental perspective and based on CCME standards, the soils at TF-02-23 CF-1B are not compliant for agricultural use.



9 Limitations

The results obtained from this geotechnical investigation are applicable only in relation to the assumptions and data used during the investigation and to the exploration limits and techniques. Any geotechnical conditions encountered during the project other than those outlined in this report should be verified by a geotechnical engineer, who will be able to determine their impact on the structure to be built and, if necessary, issue new recommendations.

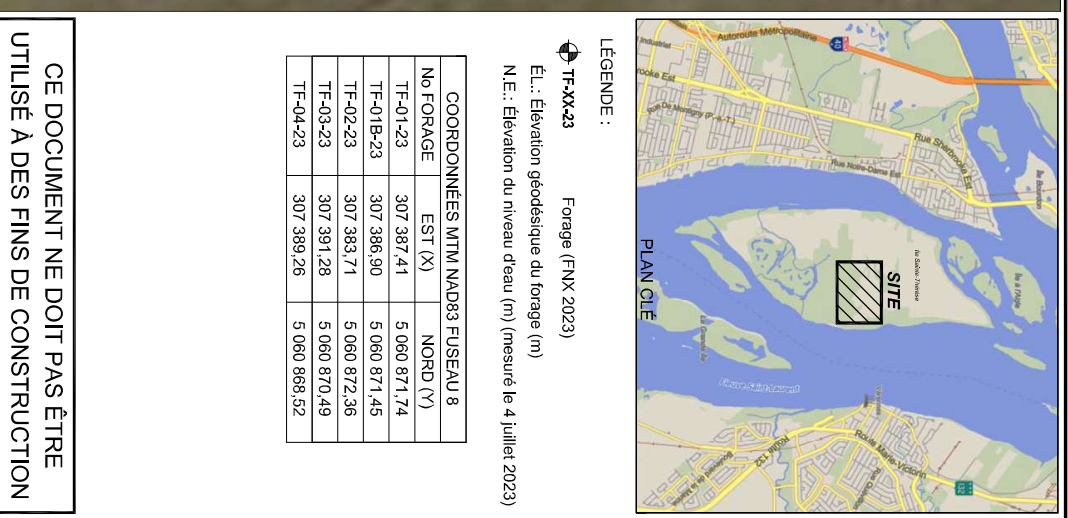
The groundwater conditions described in this report refer only to those observed at the locations and on the dates provided in this report. It is important to note that groundwater levels can be influenced by a number of factors, including precipitation, snowmelt and changes in the physical environment, and can therefore vary from season to season and from year to year.

All factual data, interpretations and recommendations in this report relate solely to the project described in this report and do not apply to any other project or site. This report has been prepared for the sole benefit of our client. We accept no responsibility or liability associated with the use of this report by a third party, and any ensuing decisions are under the strict responsibility of such third party.

If changes are made to the elevation, location, design and nature of the project, the conclusions and recommendations in our report cannot be considered valid unless the impact of said changes is assessed by **FNX-INNOV inc.** and the conclusions in the report are amended or confirmed in writing. It may be necessary to conduct new surveys and produce a new supplementary report.

Appendix A

Figure of Site and Borehole Locations



LÉGENDE :

 **TF-XX-23** Forage (FNX 2023)
 ÉL.: Élévation géodésique du forage (m)
 N.E.: Élévation du niveau d'eau (m) (mesuré le 4 juillet 2023)

No FORAGE	EST (X)	NORD (Y)
TF-01-23	307 387,41	5 060 871,74
TF-01B-23	307 386,90	5 060 871,45
TF-02-23	307 383,71	5 060 872,36
TF-03-23	307 391,28	5 060 870,49
TF-04-23	307 389,26	5 060 868,52

**CE DOCUMENT NE DOIT PAS ÊTRE
UTILISÉ À DES FINS DE CONSTRUCTION**



NO	ÉMS POUR COMMENTAIRE EMISSION	DATE	PAR
01	ÉMS POUR COMMENTAIRE EMISSION	2023-07-13	N.H. AKA&MM&JJ PAR

PRÉPARÉ: Nabil Hamad, Ing.
 VÉRIFIÉ PAR: Nabil Hamad, Ing.
 APPROUVÉ PAR: Ing.
 COLLABORATEUR(S): CH / Tech.
 DESSINE PAR: S. Boudreau, tech.
 DATE: 2023-07-13
 ÉCHELLE: 1:250
 UNITÉ: m
 DISCIPLINE: GÉOTECHNIQUE

PROJET:
 Étude géotechnique et caractérisation environnementale
 Aide fixe à la navigation
 Île Sainte-Thérèse, Varenne (Québec)

TITRE:
 Plan de localisation des forages



 PROJET: F2201386-006
 DESSIN NO: 01

Appendix B

Borehole Logs

Projet: Étude géotechnique et caractérisation environnementale, Aide fixe à la navigation	Localisation: Voir figure de localisation	N° sondage: TF-01-23
Cliant: Garde côtière canadienne	X: 307387.41	Page: 2 de 2
Site: Île Ste Therese, Varennes, Qc	Y: 5060871.74	Date début: 2023-07-03
N./réf.: F2201386-006	Type de sondage: FORAGE	Inspecteur: A. Boudalia, géo.
Figure: 01	Équipement: Geoprobe_7822DT	Profondeur: 12.04 m
	Tubage: NW	Carottier: N et B
		Élévation géodésique: 4.41 m

TYPE D'ÉCHANTILLON	TERMINOLOGIE QUALITATIVE	TERMINOLOGIE QUANTITATIVE	SYMBOLES	EAUX SOUTERRAINES									
CF Cuillère fendue	Argile < 0,002 mm	Traces < 10 %	Nspt Indice de pénétration standard (BNQ 2501-140)	<table border="1"> <thead> <tr> <th></th> <th>Date</th> <th>Profondeur</th> </tr> </thead> <tbody> <tr> <td>Lecture 1</td> <td>2023-07-04</td> <td>7.01 m</td> </tr> <tr> <td>Lecture 2</td> <td></td> <td>m</td> </tr> </tbody> </table>		Date	Profondeur	Lecture 1	2023-07-04	7.01 m	Lecture 2		m
	Date	Profondeur											
Lecture 1	2023-07-04	7.01 m											
Lecture 2		m											
CFC Échantillonnage continu	Silt 0,002 - 0,08 mm	Un peu 10 - 20 %	Ncorr N corrigé pour tenir compte du diamètre non standard										
CR Carottier à diamants	Sable 0,08 - 5 mm	Adjectif (...eux) 20 - 35 %	Nc Indice de pénétration au cône (BNQ 2501-145)										
TM Tube à parois minces	Gravier 5 - 80 mm	et (ex: et gravier) > 35 %	RQD Indice de la qualité du roc (%)										
TA Tarière	Cailloux 80 - 200 mm	mot principal Fraction dominante											
TS Tube shelby	Blocs > 200 mm												
EM Échantillon manuel													

ÉTAT DE L'ÉCHANTILLON	CARACTÉRISTIQUES MÉCANIQUES DES SOLS	INDICE DE QUALITÉ DU ROC	ESPACEMENT DES DISCONTINUITÉS
Remanié Intact (tube à parois minces) Perdu Carotté (forage au diamant)	COMPACTITÉ Très lâche 0 - 4 Lâche 4 - 10 Compacte 10 - 30 Dense 30 - 50 Très dense > 50	CONSISTANCE Très molle < 12 Molle 12 - 25 Ferme 25 - 50 Raide 50 - 100 Très raide 100 - 200 Dure > 200	Très serré < 20 mm Serré 20 - 60 mm Rapproché 60 - 200 mm Moyennement espacé 200 - 600 mm Espacé 600 - 2000 mm Très espacé 2000 - 6000 mm > 6000 mm

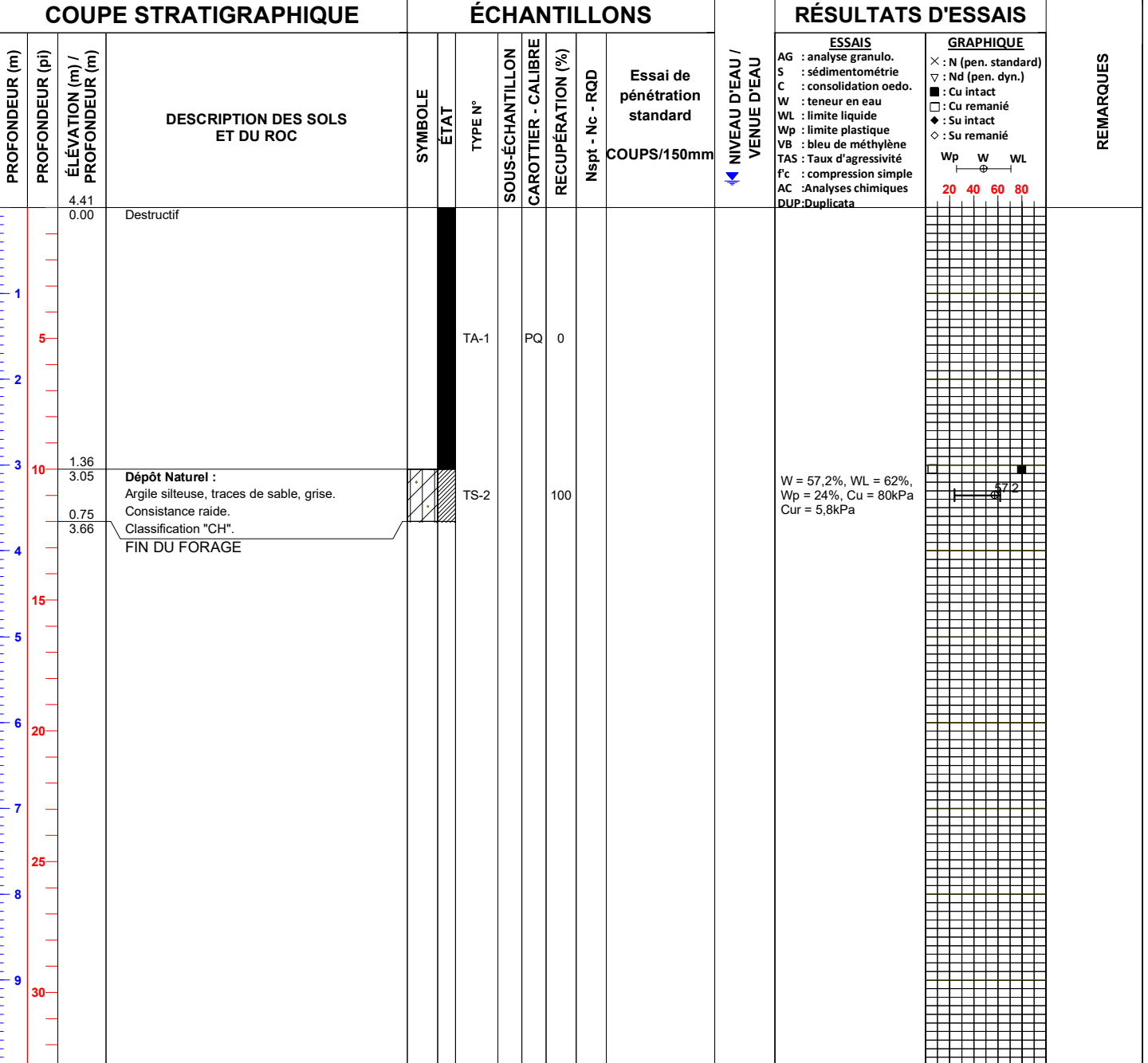
COUPE STRATIGRAPHIQUE			ÉCHANTILLONS					RÉSULTATS D'ESSAIS		REMARQUES				
PROFONDEUR (m)	PROFONDEUR (pi)	ÉLÉVATION (m) / PROFONDEUR (m)	SYMBOLE	ÉTAT	TYPE N°	SOUS-ÉCHANTILLON	CAROTTIER - CALIBRE	RECUPÉRATION (%)	Nspt - Nc - RQD		Essai de pénétration standard	COUPS/150mm	NIVEAU D'EAU / VENUE D'EAU	ESSAIS
													AG : analyse granulo. S : sédimentométrie C : consolidation oedo. W : teneur en eau WL : limite liquide Wp : limite plastique VB : bleu de méthylène TAS : Taux d'agressivité f'c : compression simple AC : Analyses chimiques DUP: Duplicata	X : N (pen. standard) ∇ : Nd (pen. dyn.) ■ : Cu intact □ : Cu remanié ◆ : Su intact ◇ : Su remanié
35						CF-15	B	100	0	0-0-0-1			S, W = 59,0%	
40		-7.63 12.04				CF-16	B	100	1	0-0-1-2				
40						CF-17	B	100	2	0-0-2-2				
40			FIN DU FORAGE											

Remarques générales: TAS : Taux d'agressivité des sols.	Vérifié par: Nabil Hraïmel, ing.
	Date: 2023-08-18

Projet: Étude géotechnique et caractérisation environnementale, Aide fixe à la navigation	Localisation: Voir figure de localisation	N° sondage: TF-01A-23
Cliant: Garde côtière canadienne	X: 307391.78	Page: 1 de 1
Site: Île Ste Therese, Varennes, Qc	Y: 5060861.32	Date début: 2023-07-04
N./réf.: F2201386-006	Type de sondage:	Inspecteur: A. Boudalia, géo.
Figure: 01	Équipement: Geoprobe_7822DT	Profondeur: 3.66 m
	Tubage:	Élévation géodésique: 4.41 m
		Carottier: PQ

TYPE D'ÉCHANTILLON	TERMINOLOGIE QUALITATIVE	TERMINOLOGIE QUANTITATIVE	SYMBOLES	EAUX SOUTERRAINES									
CF Cuillère fendue	Argile < 0,002 mm	Traces < 10 %	Nspt Indice de pénétration standard (BNQ 2501-140)	<table border="1"> <thead> <tr> <th></th> <th>Date</th> <th>Profondeur</th> </tr> </thead> <tbody> <tr> <td>Lecture 1</td> <td></td> <td>m</td> </tr> <tr> <td>Lecture 2</td> <td></td> <td>m</td> </tr> </tbody> </table>		Date	Profondeur	Lecture 1		m	Lecture 2		m
	Date	Profondeur											
Lecture 1		m											
Lecture 2		m											
CFC Échantillonnage continu	Silt 0,002 - 0,08 mm	Un peu 10 - 20 %	Ncorr N corrigé pour tenir compte du diamètre non standard										
CR Carottier à diamants	Sable 0,08 - 5 mm	Adjectif (...eux) 20 - 35 %	Nc Indice de pénétration au cône (BNQ 2501-145)										
TM Tube à parois minces	Gravier 5 - 80 mm	et (ex: et gravier) > 35 %	RQD Indice de la qualité du roc (%)										
TA Tarière	Cailloux 80 - 200 mm	mot principal Fraction dominante											
TS Tube shelly	Blocs > 200 mm												
EM Échantillon manuel													

ÉTAT DE L'ÉCHANTILLON	CARACTÉRISTIQUES MÉCANIQUES DES SOLS	INDICE DE QUALITÉ DU ROC	ESPACEMENT DES DISCONTINUITÉS
Remanié Intact (tube à parois minces) Perdu Carotté (forage au diamant)	COMPACTÉ Très lâche Lâche Compacte Dense Très dense	INDICE "N" 0 - 4 4 - 10 10 - 30 30 - 50 > 50	CONSISTANCE Très molle Molle Ferme Raide Très raide Dure
	Cu OU Su (kPa) < 12 12 - 25 25 - 50 50 - 100 100 - 200 > 200	QUALIFICATIF Très mauvaise Mauvaise Moyenne Bonne Excellente	RQD < 25 % 25 - 50 % 50 - 75 % 75 - 90 % 90 - 100 %
			Très serré < 20 mm Serré 20 - 60 mm Rapproché 60 - 200 mm Moyennement espacé 200 - 600 mm Espacé 600 - 2000 mm Très espacé 2000 - 6000 mm > 6000 mm



Remarques générales: **Cu : Résistance au cisaillement intact.**
Cur : Résistance au cisaillement remanié.

Vérifié par: Nabil Hraïmel, ing.
 Date: **2023-08-23**

Projet: Étude géotechnique et caractérisation environnementale, Aide fixe à la navigation	Localisation: X: 307386.90 Y: 5060871.45	N° sondage: TF-01BIS-23
Client: Garde côtière canadienne	Type de sondage: FORAGE	Page: 2 de 2
Site: Île Ste Therese, Varennes, Qc	Équipement: Geoprobe 7822DT	Date début: 2023-07-03
N./réf.: F2201386-006	Tubage: NW	Inspecteur: A. Boudalia, géo.
Figure:	Carottier:	Profondeur: 12.50 m
		Élévation géodésique: 4.41 m

TYPE D'ÉCHANTILLON	TERMINOLOGIE QUALITATIVE	TERMINOLOGIE QUANTITATIVE	SYMBOLES	Eaux SOUTERRAINES						
CF Cuillère fendue	Argile < 0,002 mm	Traces < 10 %	Nspt Indice de pénétration standard (BNQ 2501-140)	<table border="1"> <thead> <tr> <th>Date</th> <th>Profondeur</th> </tr> </thead> <tbody> <tr> <td>Lecture 1</td> <td>m</td> </tr> <tr> <td>Lecture 2</td> <td>m</td> </tr> </tbody> </table>	Date	Profondeur	Lecture 1	m	Lecture 2	m
Date	Profondeur									
Lecture 1	m									
Lecture 2	m									
CFC Échantillonnage continu	Silt 0,002 - 0,08 mm	Un peu 10 - 20 %	Ncorr N corrigé pour tenir compte du diamètre non standard							
CR Carottier à diamants	Sable 0,08 - 5 mm	Adjectif (...eux) 20 - 35 %	Nc Indice de pénétration au cône (BNQ 2501-145)							
TM Tube à parois minces	Gravier 5 - 80 mm	et (ex: et gravier) > 35 %	RQD Indice de la qualité du roc (%)							
TA Tarière	Cailloux 80 - 200 mm	mot principal Fraction dominante								
TS Tube shelby	Blocs > 200 mm									
EM Échantillon manuel										

ÉTAT DE L'ÉCHANTILLON	CARACTÉRISTIQUES MÉCANIQUES DES SOLS	INDICE DE QUALITÉ DU ROC	ESPACEMENT DES DISCONTINUITÉS
Remanié Intact (tube à parois minces) Perdu Carotté (forage au diamant)	COMPACTITÉ Très lâche 0 - 4 Lâche 4 - 10 Compacte 10 - 30 Dense 30 - 50 Très dense > 50	CONSISTANCE Très molle < 12 Molle 12 - 25 Ferme 25 - 50 Raide 50 - 100 Très raide 100 - 200 Dure > 200	RQD < 25 % 25 - 50 % 50 - 75 % 75 - 90 % 90 - 100 %

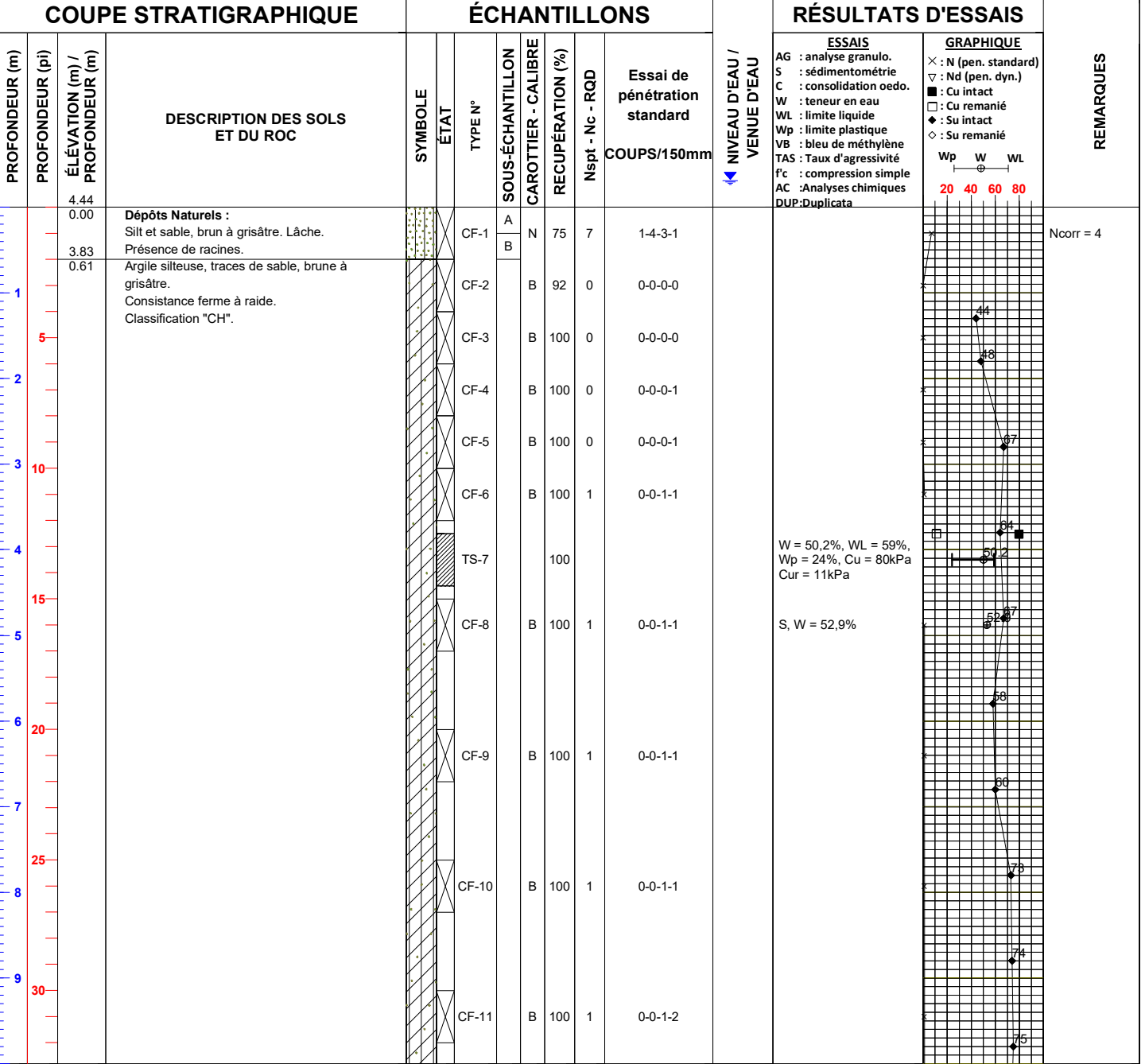
COUPE STRATIGRAPHIQUE			ÉCHANTILLONS					RÉSULTATS D'ESSAIS		REMARQUES				
PROFONDEUR (m)	PROFONDEUR (pi)	ÉLÉVATION (m) / PROFONDEUR (m)	SYMBOLE	ÉTAT	TYPE N°	SOUS-ÉCHANTILLON	CAROTTIER - CALIBRE	RECUPÉRATION (%)	Nspt - Nc - RQD		Essai de pénétration standard	COUPS/150mm	NIVEAU D'EAU / VENUE D'EAU	ESSAIS
11													AG : analyse granulo. S : sédimentométrie C : consolidation oedo. W : teneur en eau WL : limite liquide Wp : limite plastique VB : bleu de méthylène TAS : Taux d'agressivité f'c : compression simple AC : Analyses chimiques DUP: Duplicata	X : N (pen. standard) ∇ : Nd (pen. dyn.) ■ : Cu intact □ : Cu remanié ◆ : Su intact ◇ : Su remanié Wp — W — WL 20 40 60 80
12		-7.78 12.19												
13														
14														
15														
16														
17														
18														
19														

Remarques générales:	Vérifié par: Nabil Hraimel, ing. Date: 2023-08-15
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Projet: Étude géotechnique et caractérisation environnementale, Aide fixe à la navigation	Localisation: Voir figure de localisation	N° sondage: TF-02-23
Cliant: Garde côtière canadienne	X: 307383.71	Page: 1 de 2
Site: Île Ste Therese, Varennes, Qc	Y: 5060872.36	Date début: 2023-07-05
N./réf.: F2201386-006	Type de sondage: FORAGE	Inspecteur: A. Boudalia, géo.
Figure: 01	Équipement: Geoprobe_7822DT	Profondeur: 12.04 m
	Tubage: NW	Carottier: N et B
		Élévation géodésique: 4.44 m

TYPE D'ÉCHANTILLON	TERMINOLOGIE QUALITATIVE	TERMINOLOGIE QUANTITATIVE	SYMBOLES	EAUX SOUTERRAINES						
CF Cuillère fendue	Argile < 0,002 mm	Traces < 10 %	Nspt Indice de pénétration standard (BNQ 2501-140)	<table border="1"> <thead> <tr> <th>Date</th> <th>Profondeur</th> </tr> </thead> <tbody> <tr> <td>Lecture 1</td> <td>m</td> </tr> <tr> <td>Lecture 2</td> <td>m</td> </tr> </tbody> </table>	Date	Profondeur	Lecture 1	m	Lecture 2	m
Date	Profondeur									
Lecture 1	m									
Lecture 2	m									
CFC Échantillonnage continu	Silt 0,002 - 0,08 mm	Un peu 10 - 20 %	Ncorr N corrigé pour tenir compte du diamètre non standard							
CR Carottier à diamants	Sable 0,08 - 5 mm	Adjectif (...eux) 20 - 35 %	Nc Indice de pénétration au cône (BNQ 2501-145)							
TM Tube à parois minces	Gravier 5 - 80 mm	et (ex: et gravier) > 35 %	RQD Indice de la qualité du roc (%)							
TA Tarière	Cailloux 80 - 200 mm	mot principal Fraction dominante								
TS Tube shelby	Blocs > 200 mm									
EM Échantillon manuel										

ÉTAT DE L'ÉCHANTILLON	CARACTÉRISTIQUES MÉCANIQUES DES SOLS	INDICE DE QUALITÉ DU ROC	ESPACEMENT DES DISCONTINUITÉS
Remanié Intact (tube à parois minces) Perdu Carotté (forage au diamant)	COMPACTITÉ Très lâche 0 - 4 Lâche 4 - 10 Compacte 10 - 30 Dense 30 - 50 Très dense > 50	CONSISTANCE Très molle < 12 Molle 12 - 25 Ferme 25 - 50 Raide 50 - 100 Très raide 100 - 200 Dure > 200	QUALIFICATIF Très mauvaise < 25 % Mauvaise 25 - 50 % Moyenne 50 - 75 % Bonne 75 - 90 % Excellente 90 - 100 %
	INDICE "N" 0 - 4 4 - 10 10 - 30 30 - 50 > 50	Cu OU Su (kPa) < 12 12 - 25 25 - 50 50 - 100 100 - 200 > 200	RQD < 25 % 25 - 50 % 50 - 75 % 75 - 90 % 90 - 100 %
			Très serré < 20 mm Serré 20 - 60 mm Rapproché 60 - 200 mm Moyennement espacé 200 - 600 mm Espacé 600 - 2000 mm Très espacé 2000 - 6000 mm > 6000 mm



Remarques générales: **Cu : Résistance au cisaillement intact.**
Cur : Résistance au cisaillement remanié.

Vérfié par: Nabil Hraimel, ing.
 Date: 2023-08-15

Projet: Étude géotechnique et caractérisation environnementale, Aide fixe à la navigation	Localisation: Voir figure de localisation	N° sondage: TF-02-23
Cliant: Garde côtière canadienne	X: 307383.71	Page: 2 de 2
Site: Île Ste Therese, Varennes, Qc	Y: 5060872.36	Date début: 2023-07-05
N./réf.: F2201386-006	Type de sondage: FORAGE	Inspecteur: A. Boudalia, géo.
Figure: 01	Équipement: Geoprobe_7822DT	Profondeur: 12.04 m
	Tubage: NW	Carottier: N et B
		Élévation géodésique: 4.44 m

TYPE D'ÉCHANTILLON	TERMINOLOGIE QUALITATIVE	TERMINOLOGIE QUANTITATIVE	SYMBOLES	Eaux souterraines						
CF Cuillère fendue	Argile < 0,002 mm	Traces < 10 %	Nspt Indice de pénétration standard (BNQ 2501-140)	<table border="1"> <thead> <tr> <th>Date</th> <th>Profondeur</th> </tr> </thead> <tbody> <tr> <td>Lecture 1</td> <td>m</td> </tr> <tr> <td>Lecture 2</td> <td>m</td> </tr> </tbody> </table>	Date	Profondeur	Lecture 1	m	Lecture 2	m
Date	Profondeur									
Lecture 1	m									
Lecture 2	m									
CFC Échantillonnage continu	Silt 0,002 - 0,08 mm	Un peu 10 - 20 %	Ncorr N corrigé pour tenir compte du diamètre non standard							
CR Carottier à diamants	Sable 0,08 - 5 mm	Adjectif (...eux) 20 - 35 %	Nc Indice de pénétration au cône (BNQ 2501-145)							
TM Tube à parois minces	Gravier 5 - 80 mm	et (ex: et gravier) > 35 %	RQD Indice de la qualité du roc (%)							
TA Tarière	Cailloux 80 - 200 mm	mot principal Fraction dominante								
TS Tube shelby	Blocs > 200 mm									
EM Échantillon manuel										

ÉTAT DE L'ÉCHANTILLON	CARACTÉRISTIQUES MÉCANIQUES DES SOLS	INDICE DE QUALITÉ DU ROC	ESPACEMENT DES DISCONTINUITÉS
Remanié Intact (tube à parois minces) Perdu Carotté (forage au diamant)	COMPACTITÉ Très lâche 0 - 4 Lâche 4 - 10 Compacte 10 - 30 Dense 30 - 50 Très dense > 50	INDICE "N" 0 - 4 Très molle 4 - 10 Molle 10 - 30 Ferme 30 - 50 Raide > 50 Très raide Dure > 200	QUALIFICATIF RQD < 25 % Très mauvaise 25 - 50 Mauvaise 50 - 75 Moyenne 75 - 90 Bonne 90 - 100 Excellente
	CONSISTANCE Cu OU Su (kPa) < 12 12 - 25 25 - 50 50 - 100 100 - 200 > 200	ESPACEMENT DES DISCONTINUITÉS Très serré < 20 mm Serré 20 - 60 mm Rapproché 60 - 200 mm Moyennement espacé 200 - 600 mm Espacé 600 - 2000 mm Très espacé 2000 - 6000 mm > 6000 mm	

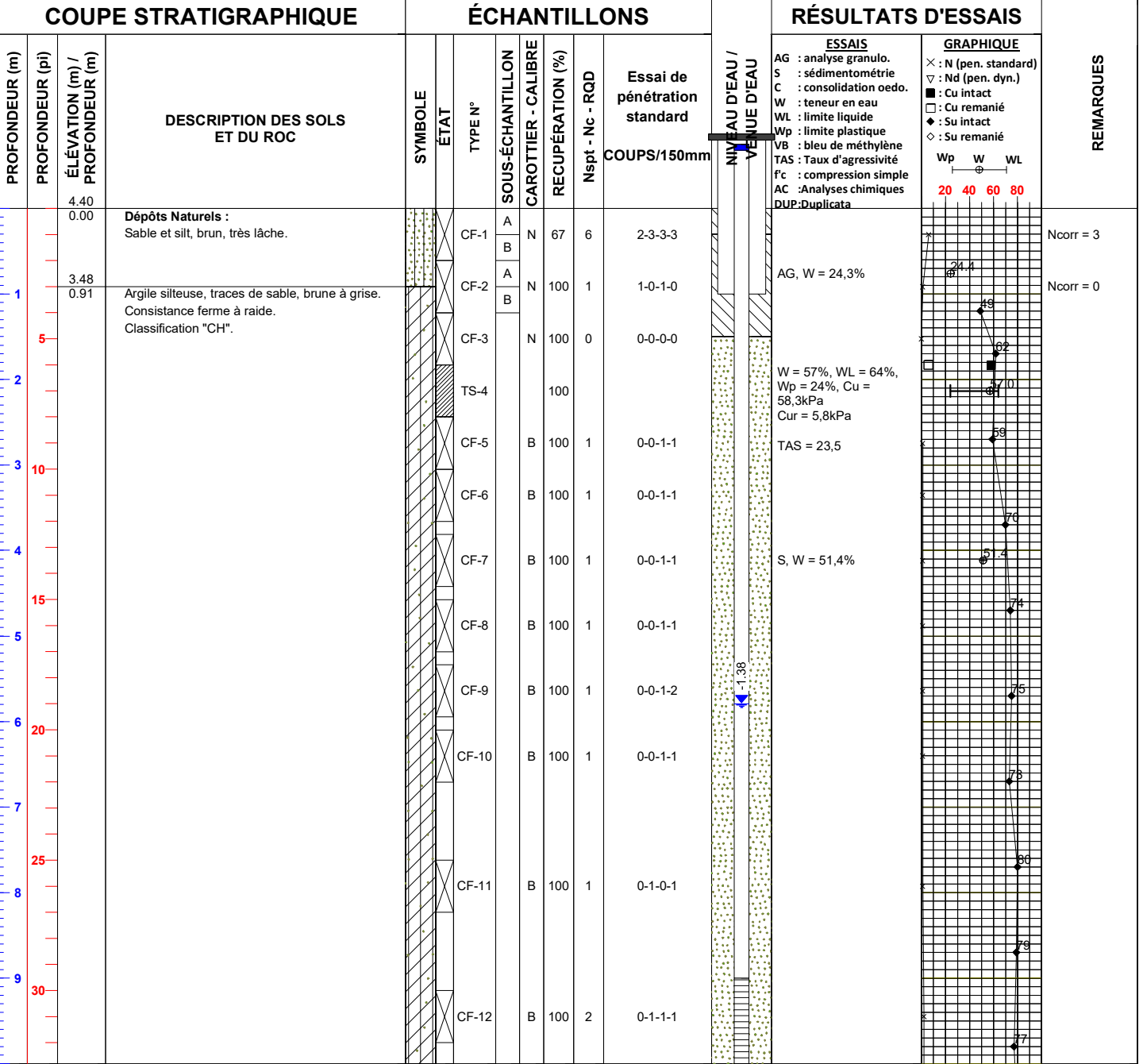
COUPE STRATIGRAPHIQUE			ÉCHANTILLONS					RÉSULTATS D'ESSAIS		REMARQUES				
PROFONDEUR (m)	PROFONDEUR (pi)	ÉLÉVATION (m) / PROFONDEUR (m)	SYMBOLE	ÉTAT	TYPE N°	SOUS-ÉCHANTILLON	CAROTTIER - CALIBRE	RECUPÉRATION (%)	Nspt - Nc - RQD		Essai de pénétration standard	COUPS/150mm	NIVEAU D'EAU / VENUE D'EAU	ESSAIS
11													AG : analyse granulo. S : sédimentométrie C : consolidation oedo. W : teneur en eau WL : limite liquide Wp : limite plastique VB : bleu de méthylène TAS : Taux d'agressivité f'c : compression simple AC : Analyses chimiques DUP: Duplicata	X : N (pen. standard) ∇ : Nd (pen. dyn.) ■ : Cu intact □ : Cu remanié ◆ : Su intact ◇ : Su remanié Wp W WL 20 40 60 80
12		-7.60 12.04				CF-12	B	100	1	0-0-1-2				
12						CF-13	B	100	2	0-1-1-2				
40			FIN DU FORAGE											
13														
14														
15														
16														
17														
18														
19														

Remarques générales: Cu : Résistance au cisaillement intact. Cur : Résistance au cisaillement remanié.	Vérifié par: Nabil Hraïmel, ing. Date: 2023-08-15
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Projet: Étude géotechnique et caractérisation environnementale, Aide fixe à la navigation	Localisation: Voir figure de localisation	N° sondage: TF-03-23
Cliant: Garde côtière canadienne	X: 307391.28	Page: 1 de 2
Site: Île Ste Therese, Varennes, Qc	Y: 5060870.49	Date début: 2023-07-04
N./réf.: F2201386-006	Type de sondage: FORAGE	Inspecteur: A. Boudalia, géo.
Figure: 01	Équipement: Geoprobe_7822DT	Profondeur: 12.04 m
	Tubage: NW	Carottier: N et B
		Élévation géodésique: 4.40 m

TYPE D'ÉCHANTILLON	TERMINOLOGIE QUALITATIVE	TERMINOLOGIE QUANTITATIVE	SYMBOLES	EAUX SOUTERRAINES						
CF : Cuillère fendue	Argile < 0,002 mm	Traces < 10 %	Nspt : Indice de pénétration standard (BNQ 2501-140)	<table border="1"> <thead> <tr> <th>Date</th> <th>Profondeur</th> </tr> </thead> <tbody> <tr> <td>Lecture 1 : 2023-07-04</td> <td>5.78 m</td> </tr> <tr> <td>Lecture 2</td> <td>m</td> </tr> </tbody> </table>	Date	Profondeur	Lecture 1 : 2023-07-04	5.78 m	Lecture 2	m
Date	Profondeur									
Lecture 1 : 2023-07-04	5.78 m									
Lecture 2	m									
CFC : Échantillonnage continu	Silt 0,002 - 0,08 mm	Un peu 10 - 20 %	Ncorr : N corrigé pour tenir compte du diamètre non standard							
CR : Carottier à diamants	Sable 0,08 - 5 mm	Adjectif (...eux) 20 - 35 %	Nc : Indice de pénétration au cône (BNQ 2501-145)							
TM : Tube à parois minces	Gravier 5 - 80 mm	et (ex: et gravier) > 35 %	RQD : Indice de la qualité du roc (%)							
TA : Tarière	Cailloux 80 - 200 mm	mot principal Fraction dominante								
TS : Tube shelby	Blocs > 200 mm									
EM : Échantillon manuel										

ÉTAT DE L'ÉCHANTILLON	CARACTÉRISTIQUES MÉCANIQUES DES SOLS	INDICE DE QUALITÉ DU ROC	ESPACEMENT DES DISCONTINUITÉS
Remanié Intact (tube à parois minces) Perdu Carotté (forage au diamant)	COMPACTITÉ Très lâche 0 - 4 Lâche 4 - 10 Compacte 10 - 30 Dense 30 - 50 Très dense > 50	CONSISTANCE Très molle < 12 Molle 12 - 25 Ferme 25 - 50 Raide 50 - 100 Très raide 100 - 200 Dure > 200	RQD Très serré < 25 % Serré 25 - 50 % Rapproché 50 - 75 % Moyennement espacé 75 - 90 % Espacé 90 - 100 % Très espacé > 100 %



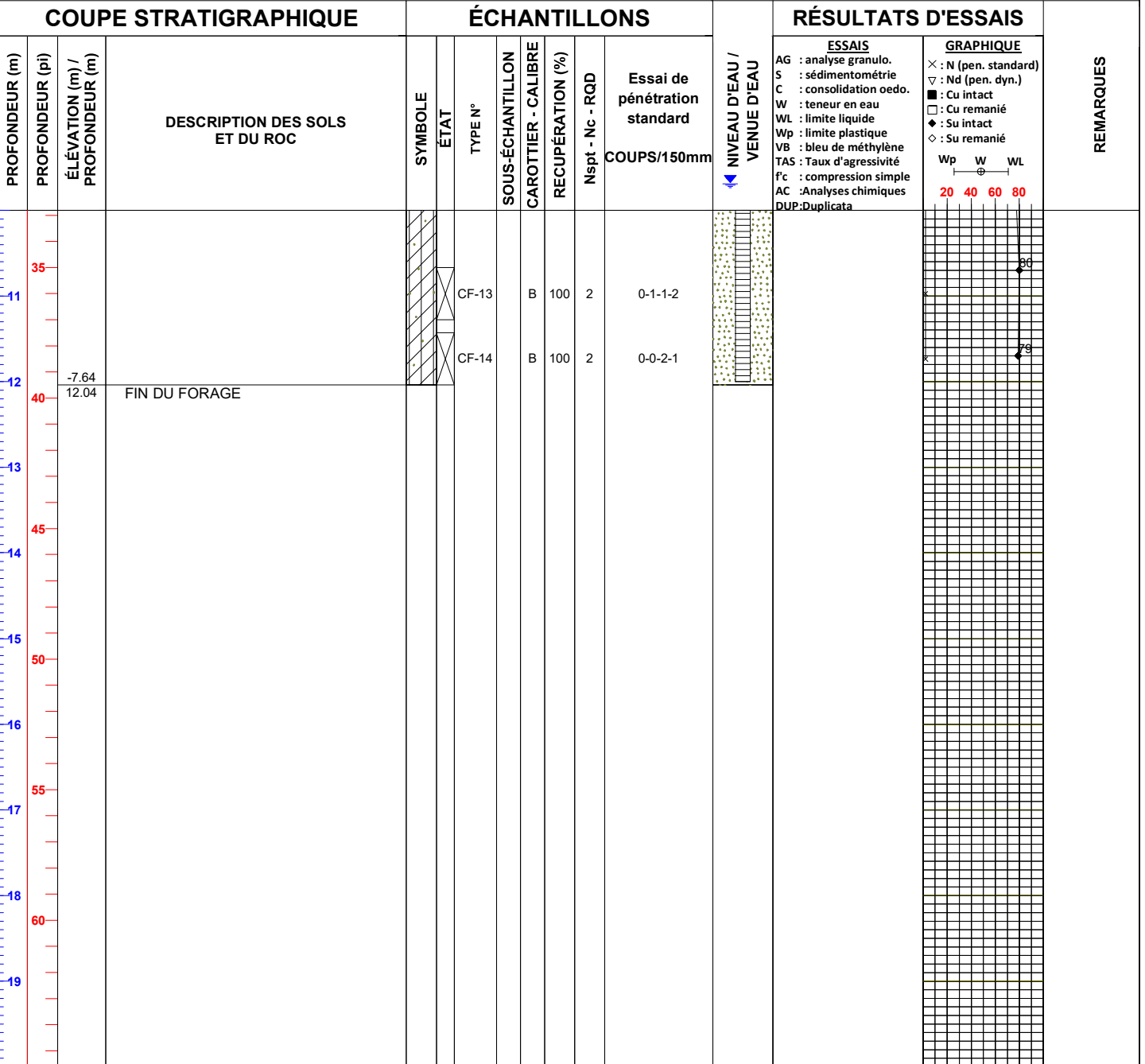
Remarques générales: **Cu** : Résistance au cisaillement intact.
Cur : Résistance au cisaillement remanié.
TAS : Taux d'agressivité des sols.

Vérifié par: Nabil Hraïmel, ing.
 Date: 2023-08-18

Projet: Étude géotechnique et caractérisation environnementale, Aide fixe à la navigation	Localisation: Voir figure de localisation	N° sondage: TF-03-23
Cliant: Garde côtière canadienne	X: 307391.28	Page: 2 de 2
Site: Île Ste Therese, Varennes, Qc	Y: 5060870.49	Date début: 2023-07-04
N./réf.: F2201386-006	Type de sondage: FORAGE	Inspecteur: A. Boudalia, géo.
Figure: 01	Équipement: Geoprobe_7822DT	Profondeur: 12.04 m
	Tubage: NW	Carottier: N et B
		Élévation géodésique: 4.40 m

TYPE D'ÉCHANTILLON	TERMINOLOGIE QUALITATIVE	TERMINOLOGIE QUANTITATIVE	SYMBOLES	EAUX SOUTERRAINES						
CF Cuillère fendue	Argile < 0,002 mm	Traces < 10 %	Nspt Indice de pénétration standard (BNQ 2501-140)	<table border="1"> <thead> <tr> <th>Date</th> <th>Profondeur</th> </tr> </thead> <tbody> <tr> <td>Lecture 1 2023-07-04</td> <td>5.78 m</td> </tr> <tr> <td>Lecture 2</td> <td>m</td> </tr> </tbody> </table>	Date	Profondeur	Lecture 1 2023-07-04	5.78 m	Lecture 2	m
Date	Profondeur									
Lecture 1 2023-07-04	5.78 m									
Lecture 2	m									
CFC Échantillonnage continu	Silt 0,002 - 0,08 mm	Un peu 10 - 20 %	Ncorr N corrigé pour tenir compte du diamètre non standard							
CR Carottier à diamants	Sable 0,08 - 5 mm	Adjectif (...eux) 20 - 35 %	Nc Indice de pénétration au cône (BNQ 2501-145)							
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EM Échantillon manuel										

ÉTAT DE L'ÉCHANTILLON	CARACTÉRISTIQUES MÉCANIQUES DES SOLS	INDICE DE QUALITÉ DU ROC	ESPACEMENT DES DISCONTINUITÉS
Remanié Intact (tube à parois minces) Perdu Carotté (forage au diamant)	COMPACTITÉ Très lâche 0 - 4 Lâche 4 - 10 Compacte 10 - 30 Dense 30 - 50 Très dense > 50	INDICE "N" 0 - 4 Très molle 4 - 10 Molle 10 - 30 Ferme 30 - 50 Raide > 50 Très raide Dure > 200	ESPACEMENT DES DISCONTINUITÉS Très serré < 20 mm Serré 20 - 60 mm Rapproché 60 - 200 mm Moyennement espacé 200 - 600 mm Espacé 600 - 2000 mm Très espacé 2000 - 6000 mm > 6000 mm



Remarques générales: **Cu : Résistance au cisaillement intact.**
Cur : Résistance au cisaillement remanié.
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Vérifié par: Nabil Hraïmel, ing.
 Date: 2023-08-18

Projet: Étude géotechnique et caractérisation environnementale, Aide fixe à la navigation	Localisation: Voir figure de localisation	N° sondage: TF-04-23
Cliant: Garde côtière canadienne	X: 307389.26	Page: 1 de 1
Site: Île Ste Therese, Varennes, Qc	Y: 5060868.52	Date début: 2023-07-05
N./réf.: F2201386-006	Type de sondage: FORAGE	Inspecteur: A. Boudalia, géo.
Figure: 01	Équipement: Geoprobe_7822DT	Profondeur: 0.61 m
	Tubage: NW	Carottier: N
		Élévation géodésique: 4.41 m

TYPE D'ÉCHANTILLON	TERMINOLOGIE QUALITATIVE	TERMINOLOGIE QUANTITATIVE	SYMBOLES	EAUX SOUTERRAINES						
CF Cuillère fendue	Argile < 0,002 mm	Traces < 10 %	Nspt Indice de pénétration standard (BNQ 2501-140)	<table border="1"> <thead> <tr> <th>Date</th> <th>Profondeur</th> </tr> </thead> <tbody> <tr> <td>Lecture 1</td> <td>m</td> </tr> <tr> <td>Lecture 2</td> <td>m</td> </tr> </tbody> </table>	Date	Profondeur	Lecture 1	m	Lecture 2	m
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TA Tarière	Cailloux 80 - 200 mm	mot principal Fraction dominante								
TS Tube shelby	Blocs > 200 mm									
EM Échantillon manuel										

ÉTAT DE L'ÉCHANTILLON	CARACTÉRISTIQUES MÉCANIQUES DES SOLS	INDICE DE QUALITÉ DU ROC	ESPACEMENT DES DISCONTINUITÉS
Remanié Intact (tube à parois minces) Perdu Carotté (forage au diamant)	COMPACTITÉ Très lâche 0 - 4 Lâche 4 - 10 Compacte 10 - 30 Dense 30 - 50 Très dense > 50	CONSISTANCE Très molle < 12 Molle 12 - 25 Ferme 25 - 50 Raide 50 - 100 Très raide 100 - 200 Dure > 200	RQD Très serré < 20 mm Serré 20 - 60 mm Rapproché 60 - 200 mm Moyennement espacé 200 - 600 mm Espacé 600 - 2000 mm Très espacé 2000 - 6000 mm > 6000 mm

COUPE STRATIGRAPHIQUE			ÉCHANTILLONS					RÉSULTATS D'ESSAIS		REMARQUES			
PROFONDEUR (m)	PROFONDEUR (pi)	ÉLÉVATION (m) / PROFONDEUR (m)	SYMBOLE	ÉTAT	TYPE N°	SOUS-ÉCHANTILLON	CAROTTIER - CALIBRE	RECUPÉRATION (%)	Nspt - Nc - RQD		Essai de pénétration standard	NIVEAU D'EAU / VENUE D'EAU	ESSAIS
		4.41										AG : analyse granulo. S : sédimentométrie C : consolidation oedo. W : teneur en eau WL : limite liquide Wp : limite plastique VB : bleu de méthylène TAS : Taux d'agressivité f'c : compression simple AC : Analyses chimiques DUP: Duplicata	× : N (pen. standard) ▽ : Nd (pen. dyn.) ■ : Cu intact □ : Cu remanié ◆ : Su intact ◇ : Su remanié Wp W WL 20 40 60 80
		0.00											
		4.10											
		0.30											
		3.80											
		0.61											
1													
5													
2													
3													
4													
15													
5													
6													
20													
7													
8													
25													
9													
30													

Remarques générales:	Vérifié par: <u>Nabil Hraïmel, ing.</u> Date: <u>2023-08-15</u>
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Appendix C

Laboratory Test Reports

RAPPORT D'ESSAIS POUR L'ANALYSE DE LA CORROSIVITÉ DU SOL
ANSI/AWWA C105/A21.5-10

N° Dossier: F2201386-006-004 **Sondage:** TF-01-22
Client: TPSGC **Échantillon:** CF-4
Projet: ETG_île Ste-Thérère - Environnement **Profondeur:** 1,83-2,44m
Prélevé par: Abdelkarim Boudalia, tehn.
Prélevé le : 2023-07-05

RÉSULTATS DE L'ANALYSE

Essais	Résultats		Pointage
Résistivité	ohms-cm	735	10
pH		7,8	0
Rédox	mV	154	0
Sulfures	Positif		2
	Traces	X	
	Négatif		
Humidité	Élevée	X	2
	Moyenne		
	Pauvre		
Sous-total, taux d'agressivité du sol			14
Ajustements*			0
Taux d'agressivité du sol**			14

*Ajustements: En présence de sulfures, advenant le cas d'un potentiel d'oxydoréduction faible ou négatif combiné à un pH compris entre 6,5 et 7,5, il est nécessaire d'ajouter 3 points au sous-total calculé.

**Taux d'agressivité du sol ≥ 10 indique un caractère corrosif du sol pour les structures en fonte.

REMARQUES

Sol corrosif pour les structures en fonte

Préparé par: Marc-André Simard
 Marc-André Simard, chef de laboratoire

Date: 2023-08-18

Approuvé par: Marc-André Simard
 Marc-André Simard, chef de laboratoire

Date: 2023-08-18

RAPPORT D'ESSAIS POUR L'ANALYSE DE LA CORROSIVITÉ DU SOL
ANSI/AWWA C105/A21.5-10

N° Dossier: F2201386-006-004
Client: TPSGC
Projet: ETG_île Ste-Thérère - Environnement

Sondage: TF-03-22
Échantillon: CF-5
Profondeur: 2,44-3,05m
Prélevé par: Abdelkarim Boudalia, tehn.
Prélevé le : 2023-07-05

RÉSULTATS DE L'ANALYSE

Essais	Résultats		Pointage
Résistivité	ohms-cm	503	10
pH		7,3	0
Rédox	mV	-42	5
Sulfures	Positif	X	3,5
	Traces		
	Négatif		
Humidité	Élevée	X	2
	Moyenne		
	Pauvre		
Sous-total, taux d'agressivité du sol			20,5
Ajustements*			3
Taux d'agressivité du sol**			23,5

*Ajustements: En présence de sulfures, advenant le cas d'un potentiel d'oxydoréduction faible ou négatif combiné à un pH compris entre 6,5 et 7,5, il est nécessaire d'ajouter 3 points au sous-total calculé.

**Taux d'agressivité du sol ≥ 10 indique un caractère corrosif du sol pour les structures en fonte.

REMARQUES

Sol corrosif pour les structures en fonte

Préparé par: Marc-André Simard
 Marc-André Simard, chef de laboratoire

Date: 2023-08-18

Approuvé par: Marc-André Simard
 Marc-André Simard, chef de laboratoire

Date: 2023-08-18

Rapport d'analyse en laboratoire

Analyse granulométrique par tamisage et par sédimentation

LC 21-040 - Analyse granulométrique

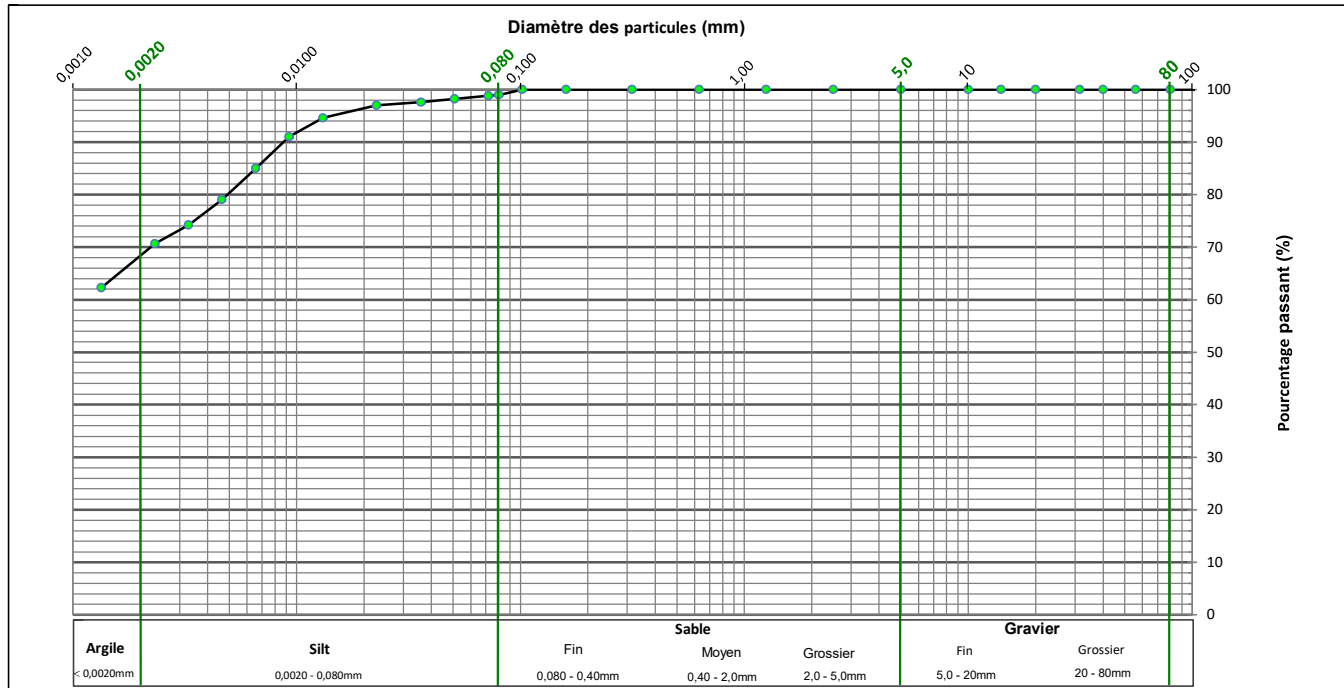
BNQ 2501-025 - Sol - Analyse granulométrique des sols inorganiques

Rapport no. : 1679-2

Laboratoire no. : 23-06857



Diamètre (mm)	Passant (%)
112	100
80	100
56	100
40	100
31,5	100
20	100
14	100
10	100
5	100
2,5	100
1,25	100
0,630	100
0,315	100
0,160	100
0,1018	100,0
0,080	99,0
0,0720	98,8
0,0509	98,2
0,0360	97,6
0,0228	97,0
0,0131	94,6
0,0093	91,0
0,0066	85,0
0,0046	79,0
0,0033	74,2
0,0023	70,7
0,0013	62,3
% Gravier:	0
% Sable:	1,0
% Silt*:	30,6
% Argile:	68,4
Cu:	
Cc:	
D10:	
D15:	
D30:	
D50:	
D60:	
D85:	0,0066



Analyses complémentaires - Propriétés physiques et mécaniques		
Analyses	Norme	Résultats

N° Dossier: F201386-006-004	Sondage: TF-01-23	Description: Argile, silteux, traces de sable
Client: TPSGC	Échantillon: CF-5	Desc. qualitative (Inscrire seulement si la courbe granulométrique est complète)
Projet: ETG_ile Ste-Thérèse-Environnement	Profondeur: 2,44 à 3,06 m	Remarques:
	Prélevé par: Abdelkarim Boudalia (4051)	*Inclus le pourcentage d'argile lorsque ce dernier n'est pas précisé
Site:	Prélevé le : 2023-07-05	

Préparé par : Luis Octavio Galvez Cossio, chef de laboratoire pri

Vérfié par :

Luis Galvez Cossio
Luis Octavio Galvez Cossio, chef de laboratoire principal

Date: 2023-07-31

Rapport d'analyse en laboratoire

Analyse granulométrique par tamisage et par sédimentation

LC 21-040 - Analyse granulométrique

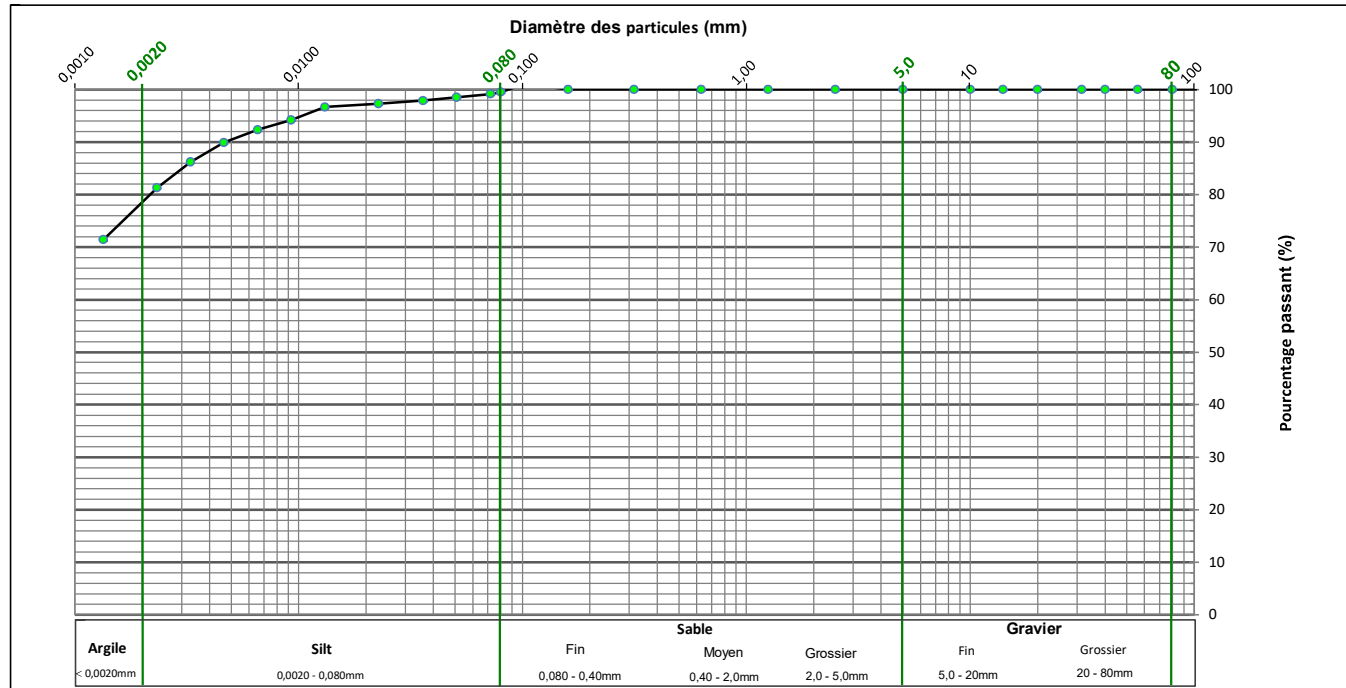
BNQ 2501-025 - Sol - Analyse granulométrique des sols inorganiques

Rapport no. : 1679-3

Laboratoire no. : 23-06859



Diamètre (mm)	Passant (%)
112	100
80	100
56	100
40	100
31,5	100
20	100
14	100
10	100
5	100
2,5	100
1,25	100
0,630	100
0,315	100
0,160	100
0,1018	101,0
0,080	99,5
0,0720	99,1
0,0509	98,5
0,0360	97,9
0,0228	97,3
0,0131	96,7
0,0093	94,2
0,0066	92,4
0,0046	89,9
0,0033	86,2
0,0023	81,3
0,0013	71,4
% Gravier:	0
% Sable:	0,5
% Silt*:	20,9
% Argile:	78,6
Cu:	
Cc:	
D10:	
D15:	
D30:	
D50:	
D60:	
D85:	0,0030



Analyses complémentaires - Propriétés physiques et mécaniques		
Analyses	Norme	Résultats
Détermination de la teneur en eau (BNQ)	BNQ 2501-170	59,04%

N° Dossier: F201386-006-004	Sondage: TF-01-23	Description: Argile, silteux, Desc. qualitative (Inscrire seulement si la courbe granulométrique est complète)
Client: TPSGC	Échantillon: CF-15	Remarques:
Projet: ETG_ile Ste-Thérèse-Environnement	Profondeur: 10,06 à 10,67 m	
	Prélevé par: Abdelkarim Boudalia (4051)	
	Prélevé le : 2023-07-05	*Inclus le pourcentage d'argile lorsque ce dernier n'est pas précisé

Préparé par : Luis Octavio Galvez Cossio, chef de laboratoire pri

Vérfié par :

Luis Octavio Galvez Cossio
Luis Octavio Galvez Cossio, chef de laboratoire principal

Date: 2023-07-28

Rapport d'analyse en laboratoire

Analyse granulométrique par tamisage et par sédimentation

LC 21-040 - Analyse granulométrique

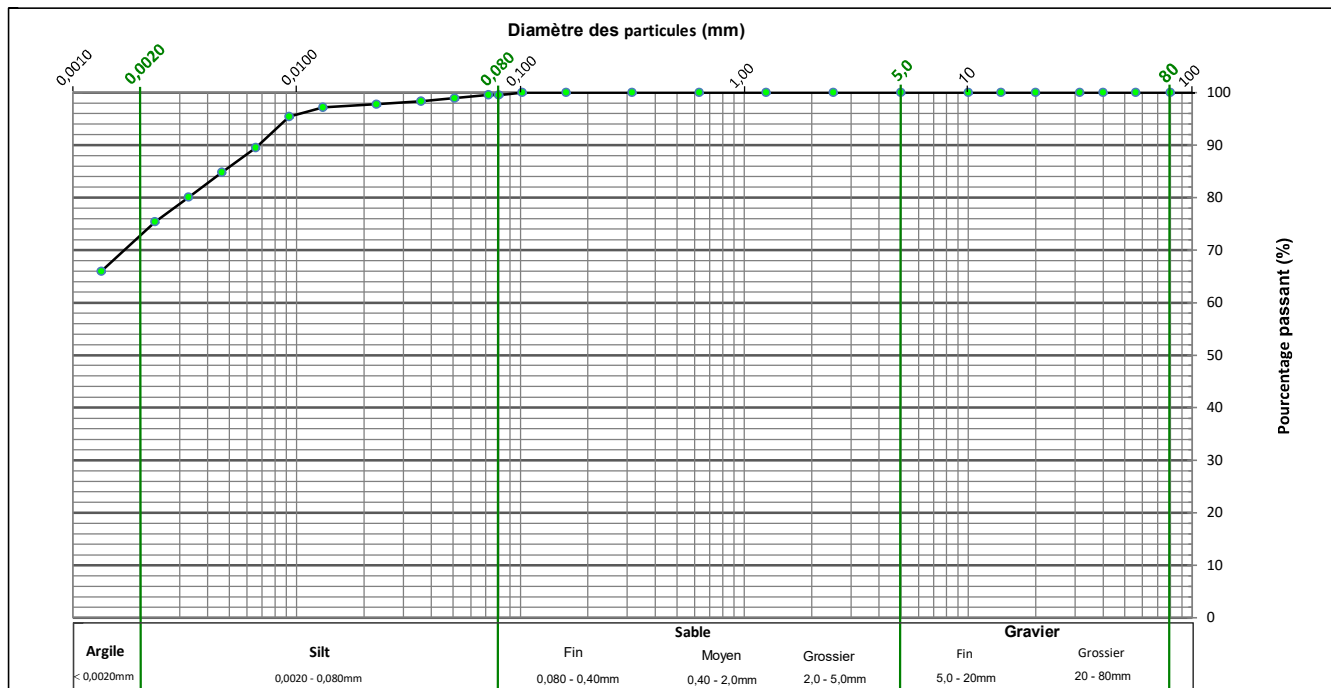
BNQ 2501-025 - Sol - Analyse granulométrique des sols inorganiques

Rapport no. : 1679-4

Laboratoire no. : 23-06862



Diamètre (mm)	Passant (%)
112	100
80	100
56	100
40	100
31,5	100
20	100
14	100
10	100
5	100
2,5	100
1,25	100
0,630	100
0,315	100
0,160	100
0,1018	100,0
0,080	99,5
0,0720	99,5
0,0509	99,0
0,0360	98,4
0,0228	97,8
0,0131	97,2
0,0093	95,4
0,0066	89,5
0,0046	84,8
0,0033	80,1
0,0023	75,4
0,0013	66,0
% Gravier:	0
% Sable:	0,5
% Silt*:	26,7
% Argile:	72,8
Cu:	
Cc:	
D10:	
D15:	
D30:	
D50:	
D60:	
D85:	0,0047



Analyses complémentaires - Propriétés physiques et mécaniques		
Analyses	Norme	Résultats
Détermination de la teneur en eau (BNQ)	BNQ 2501-170	52,91%

N° Dossier: F201386-006-004	Sondage: TF-02-23	Description: Argile, silteux
Client: TPSGC	Échantillon: CF-8	Desc. qualitative (Inscrire seulement si la courbe granulométrique est complète)
Projet: ETG_ile Ste-Thérèse-Environnement	Profondeur: 4,72 à 5,33 m	Remarques:
	Prélevé par: Abdelkarim Boudalia (4051)	*Inclus le pourcentage d'argile lorsque ce dernier n'est pas précisé
Site:	Prélevé le : 2023-07-05	

Préparé par : Luis Octavio Galvez Cossio, chef de laboratoire principal

Vérfifié par :

Luis Galvez Cossio
Luis Octavio Galvez Cossio, chef de laboratoire principal

Date: 2023-07-28

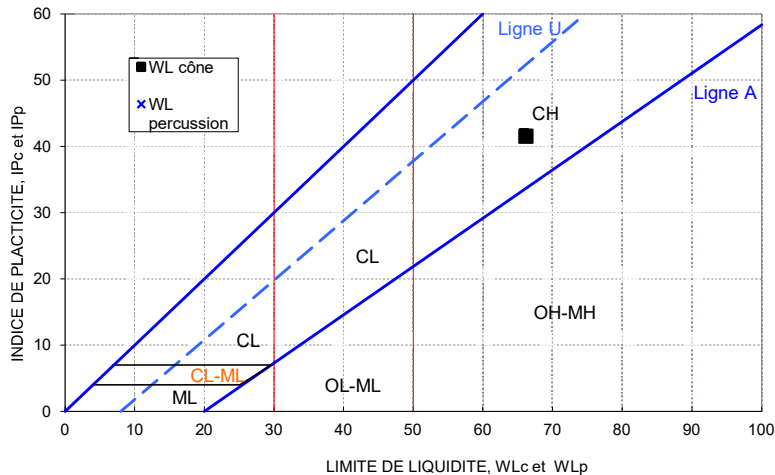
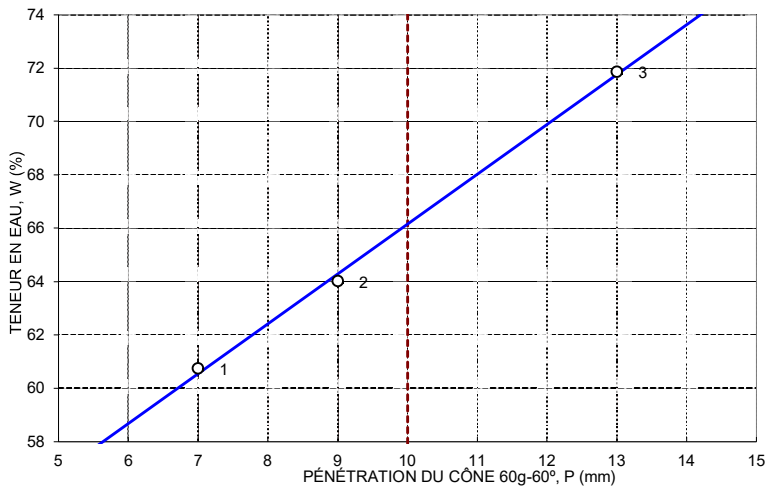
N° Dossier: F2201386-006-004
Client: TPSGC

Sondage: TF-01-23
Échantillon: CF-5
Profondeur(m): 2,44 à 3,06
Prélevé par: Abdelkarim Boudalia (4051)
Prélevé le: 2023-07-05
Analysé le: 2023-07-28
Analysé par: Malika Ladjel, tech.

Projet: ETG_Ile Ste-Thérèse-Environnement

Norme :	BNQ 2501-092	Teneurs en eau		Naturelle		Limite de plasticité	
Préparation:	Cône						
Séchage:	Aucun	Masse totale humide	40,27	40,72	13,86	13,45	
Tamissage:	Aucun	Masse totale sèche	26,43	26,52	11,36	11,00	
Méthode opér.:	Selon art. 5.2	Tare no	P590	P388	P505	P454	
Mode opér.:	Plusieurs points	Masse de la tare	1,13	1,11	1,12	1,10	
Assèchement	<input type="checkbox"/>	Teneur en eau	54,7	55,88	24,41	24,75	
Addition d'eau	<input checked="" type="checkbox"/>	Valeur moyenne		Wn = 55,3		Wp = 24,6	

Limite de liquidité								
Point no	1	2	3	4	5	6	7	8
Pénétration cône 60g - 60°	7,0	9,0	13,0					
Nb de percussions								
Masse totale humide	38,08	39,07	41,05					
Masse totale sèche	24,11	24,26	24,35					
Tare no	P092	P329	474					
Masse de la tare	1,11	1,12	1,11					
Teneur en eau	60,74	64,00	71,86					



RÉSULTATS D'ESSAI		
Teneur en eau naturelle		
Teneur en eau globale	Wn :	55,3
Limite de liquidité		
Au cône tombant	WLC :	66
Limite de plasticité		
	Wp :	25
Indice de plasticité		
Au cône tombant	IPc :	42
Indice de liquidité		
Au cône tombant	ILc :	0,7
Méthodes opératoires:		
Art.5.2: Sols cohérents sans particules supérieures à 400µm		
Art.5.3: Sols cohérents avec particules supérieures à 400µm		
Art.5.4: Sols pulvérulents		
La classification du graphique provient de l'abaque de la norme ASTM D 2487		
Remarques:		

Préparé par: Luis Galvez-Cossio, Tech, chef labo pr.

Vérifié par:
 Luis Galvez-Cossio, Tech, chef

Date: 2023-07-31

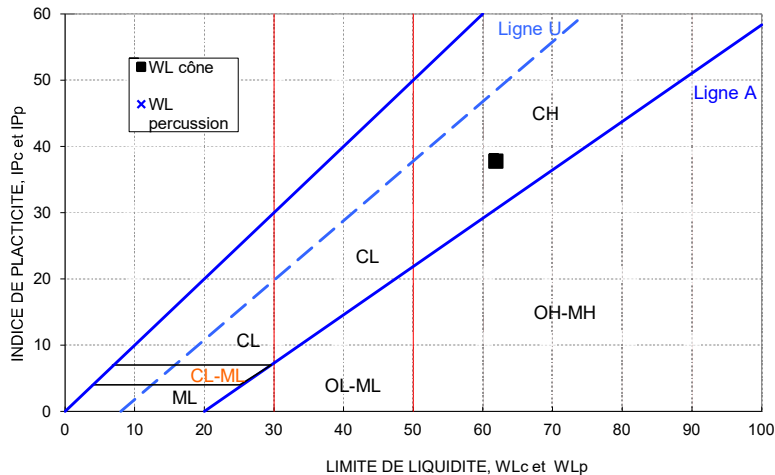
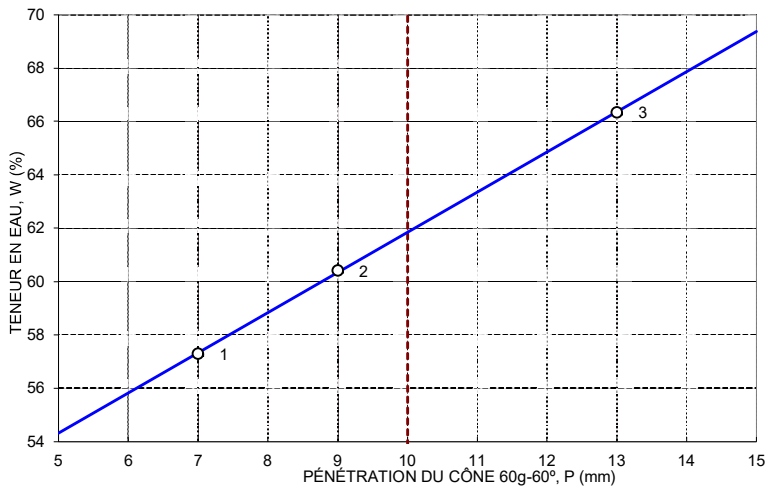
N° Dossier: F2201386-006-004
 Client: TPSGC

Sondage: TF-01A-23
 Échantillon: TS-2
 Profondeur(m): 3,05 à 3,66
 Prélevé par: Abdelkarim Boudalia (4051)
 Prélevé le: 2023-07-05
 Analysé le: 2023-07-28
 Analysé par: Malika Ladjel, tech.

Projet: ETG_Ile Ste-Thérèse-Environnement

Norme :	BNQ 2501-092	Teneurs en eau	Naturelle	Limite de plasticité		
Préparation:	Cône					
Séchage:	Aucun	Masse totale humide	43,94	35,33	14,11	14,31
Tamissage:	Aucun	Masse totale sèche	28,26	22,94	11,57	11,77
Méthode opér.:	Selon art. 5.2	Tare no	P135	P316	P206	P265
Mode opér.:	Plusieurs points	Masse de la tare	1,10	1,11	1,11	1,12
Assèchement	<input type="checkbox"/>	Teneur en eau	57,7	56,76	24,28	23,85
Addition d'eau	<input checked="" type="checkbox"/>	Valeur moyenne	Wn =	57,2	Wp =	24,1

Limite de liquidité								
Point no	1	2	3	4	5	6	7	8
Pénétration cône 60g - 60°	7,0	9,0	13,0					
Nb de percussions								
Masse totale humide	35,24	36,41	38,82					
Masse totale sèche	22,82	23,12	23,78					
Tare no	P584	P472	P565					
Masse de la tare	1,14	1,12	1,11					
Teneur en eau	57,29	60,41	66,34					



RÉSULTATS D'ESSAI

Teneur en eau naturelle

Teneur en eau globale **Wn :** 57,2

Limite de liquidité

Au cône tombant **WLc :** 62

Limite de plasticité

Wp : 24

Indice de plasticité

Au cône tombant **IPc :** 38

Indice de liquidité

Au cône tombant **ILc :** 0,9

Méthodes opératoires:

Art.5.2: Sols cohérents sans particules supérieures à 400µm

Art.5.3: Sols cohérents avec particules supérieures à 400µm

Art.5.4: Sols pulvérulents

La classification du graphique provient de l'abaque de la norme ASTM D 2487

Remarques:

Préparé par: Luis Galvez-Cossio, Tech, chef labo pr.

Vérifié par: Luis Galvez-Cossio, Tech, chef

Date: 2023-07-31

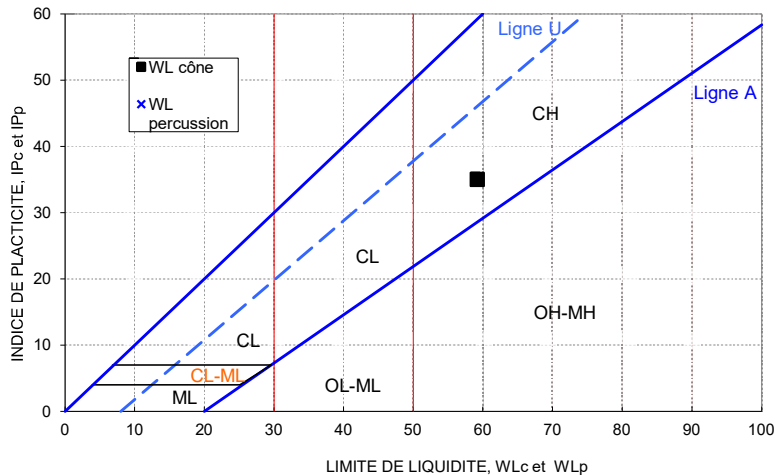
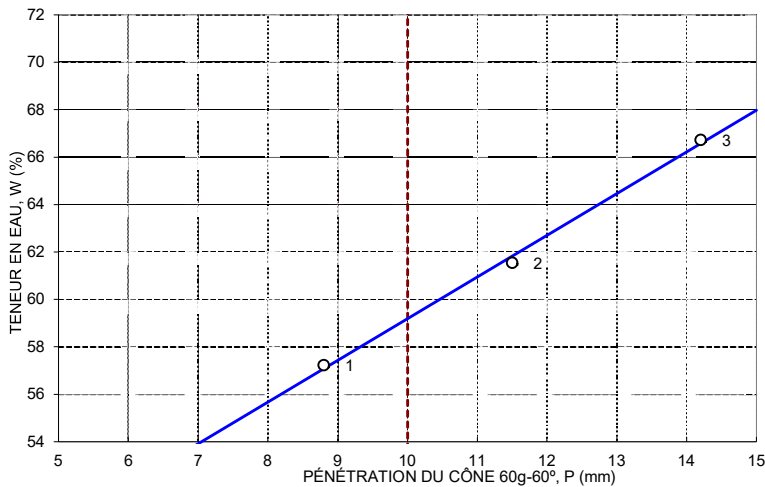
N° Dossier: F2201386-006-004
Client: TSPSG

Sondage: TF-02-23
Échantillon: TS-7
Profondeur(m): 3,81 à 4,42
Prélevé par: Abdelkarim Boudalia (4051)
Prélevé le: 2023-07-05
Analysé le: 2023-07-28
Analysé par: Malika Ladjel, tech.

Projet: ETG_Ile Ste-Thérèse-Environnement

Norme :	BNQ 2501-092	Teneurs en eau		Naturelle		Limite de plasticité	
Préparation:	Cône						
Séchage:	Aucun	Masse totale humide	51,25	44,72	14,32	14,50	
Tamissage:	Aucun	Masse totale sèche	34,34	30,29	11,76	11,89	
Méthode opér.:	Selon art. 5.2	Tare no	P128	P221	P052	P619	
Mode opér.:	Plusieurs points	Masse de la tare	1,12	1,12	1,13	1,11	
Assèchement	<input type="checkbox"/>	Teneur en eau	50,9	49,47	24,08	24,21	
Addition d'eau	<input checked="" type="checkbox"/>	Valeur moyenne	Wn =	50,2	Wp =	24,1	

Limite de liquidité								
Point no	1	2	3	4	5	6	7	8
Pénétration cône 60g - 60°	8,8	11,5	14,2					
Nb de percussions								
Masse totale humide	39,33	37,44	41,98					
Masse totale sèche	25,42	23,60	25,62					
Tare no	P182	P132	P066					
Masse de la tare	1,11	1,11	1,10					
Teneur en eau	57,22	61,54	66,72					



RÉSULTATS D'ESSAI		
Teneur en eau naturelle		
Teneur en eau globale	Wn :	50,2
Limite de liquidité		
Au cône tombant	WLc :	59
Limite de plasticité		
	Wp :	24
Indice de plasticité		
Au cône tombant	IPc :	35
Indice de liquidité		
Au cône tombant	ILc :	0,7
Méthodes opératoires:		
Art.5.2: Sols cohérents sans particules supérieures à 400µm		
Art.5.3: Sols cohérents avec particules supérieures à 400µm		
Art.5.4: Sols pulvérulents		
La classification du graphique provient de l'abaque de la norme ASTM D 2487		
Remarques:		

Préparé par: Luis Galvez-Cossio, Tech, chef labo pr.

Vérfié par: Luis Galvez-Cossio, Tech, chef

Date: 2023-07-31

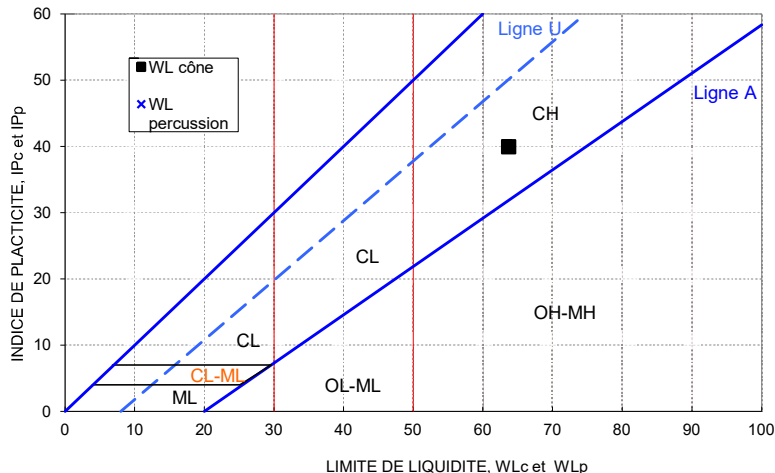
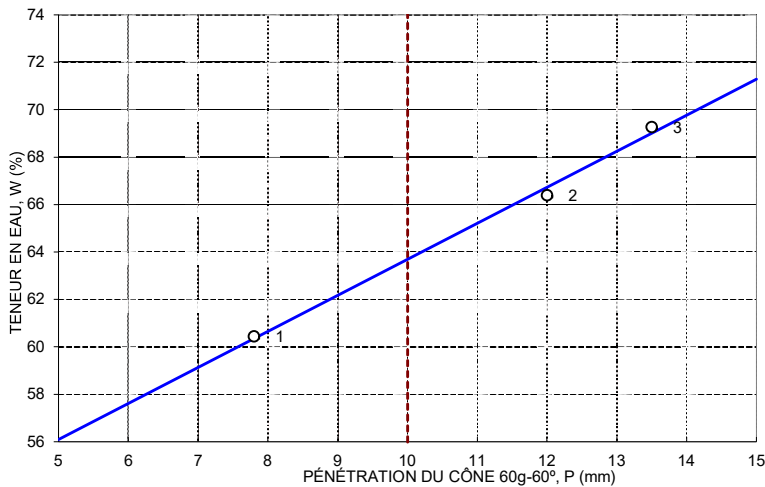
N° Dossier: F2201386-006-004
Client: TPGC

Sondage: TF-03-23
Échantillon: TS-4
Profondeur(m): 1,83 à 2,44
Prélevé par: Abdelkarim Boudalia (4051)
Prélevé le: 2023-07-05
Analysé le: 2023-07-28
Analysé par: Malika Ladjel, tech.

Projet: ETG_Ile Ste-Thérèse-Environnement

Norme :	BNQ 2501-092	Teneurs en eau		Naturelle		Limite de plasticité	
Préparation:	Cône						
Séchage:	Aucun	Masse totale humide	46,07	43,80	13,97	14,50	
Tamissage:	Aucun	Masse totale sèche	29,79	28,28	11,52	11,92	
Méthode opér.:	Selon art. 5.2	Tare no	P304	P333	P468	P292	
Mode opér.:	Plusieurs points	Masse de la tare	1,11	1,13	1,11	1,11	
Assèchement	<input type="checkbox"/>	Teneur en eau	56,8	57,16	23,54	23,87	
Addition d'eau	<input checked="" type="checkbox"/>	Valeur moyenne		Wn = 57,0		Wp = 23,7	

Limite de liquidité								
Point no	1	2	3	4	5	6	7	8
Pénétration cône 60g - 60°	7,8	12,0	13,5					
Nb de percussions								
Masse totale humide	39,15	36,29	37,64					
Masse totale sèche	24,82	22,25	22,70					
Tare no	P482	P608	P366					
Masse de la tare	1,11	1,10	1,13					
Teneur en eau	60,44	66,38	69,26					



RÉSULTATS D'ESSAI		
Teneur en eau naturelle		
Teneur en eau globale	Wn :	57,0
Limite de liquidité		
Au cône tombant	WLC :	64
Limite de plasticité		
	Wp :	24
Indice de plasticité		
Au cône tombant	IPc :	40
Indice de liquidité		
Au cône tombant	ILc :	0,8
Méthodes opératoires:		
Art.5.2: Sols cohérents sans particules supérieures à 400µm		
Art.5.3: Sols cohérents avec particules supérieures à 400µm		
Art.5.4: Sols pulvérulents		
La classification du graphique provient de l'abaque de la norme ASTM D 2487		
Remarques:		

Préparé par: Luis Galvez-Cossio, Tech, chef labo pr.

Vérfié par: Luis Galvez-Cossio, Tech, chef

Date: 2023-07-31

Rapport d'analyse en laboratoire
Résistance au cisaillement (Méthode du cône suédois)

BNQ 2501-110 - Sol - Résistance au cisaillement

Rapport no. : 1679-11

Laboratoire no. : 23-06860



Numéro de dossier : F2201386-006-004

Sondage: TF-01A-23

Client : **TPSGC**

Échantillon: TS-2

Projet : ETG_Ile Ste-Thérèse-Environnement

Profondeur(m): 3,45

Tableau des résultats

Sondage	Échantillon	Profondeur	Teneur en eau naturelle	Pénétration				Teneur en eau		Résistance au cisaillement(Cu)		Sensibilité(St)
				Intact	Cône	Remanié	Cône	Intact	Remanié	Intact	Remanié	
		(m)	(%)	(mm)		(mm)		(%)	(%)	(Kpa)	(Kpa)	
TF-01A-23	TS-2	3,5	55,3	7,0	400g/30°	5,5	60g/60°	50,1	60,2	80,00	5,83	13,7

Remarques:

Préparé par: Luis Galvez-Cossio, Tech, chef labo pr.

Vérifié par:

Luis Galvez-Cossio, Tech, chef labo pr.

Date: 2023-07-31

Notes : Le résultat s'applique exclusivement à l'échantillon analysé.

Ce rapport ne doit pas être reproduit, sinon en entier, sans l'autorisation écrite de FNX-INNOV.

Rapport d'analyse en laboratoire
Résistance au cisaillement (Méthode du cône suédois)

BNQ 2501-110 - Sol - Résistance au cisaillement

Rapport no. : 1679-12

Laboratoire no. : 23-06861



Numéro de dossier : F2201386-006-004

Sondage: TF-02-23

Client : TPSGC

Échantillon: TS-7

Projet : ETG_Ile Ste-Thérèse-Environnement

Profondeur(m): 4,35

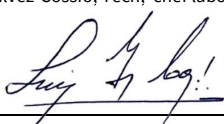
Tableau des résultats

Sondage	Échantillon	Profondeur	Teneur en eau naturelle	Pénétration				Teneur en eau		Résistance au cisaillement(Cu)		Sensibilité(St)
				Intact	Cône	Remanié	Cône	Intact	Remanié	Intact	Remanié	
		(m)	(%)	(mm)		(mm)		(%)	(%)	(Kpa)	(Kpa)	
TF-02-23	TS-7	4,4	50,2	7,0	400g/30°	4,0	60g/60°	50,8	49,9	80,00	11,03	7,3

Remarques:

Préparé par: Luis Galvez-Cossio, Tech, chef labo pr.

Vérfifié par:


Luis Galvez-Cossio, Tech, chef labo pr.

Date: 2023-07-31

Notes : Le résultat s'applique exclusivement à l'échantillon analysé.

Ce rapport ne doit pas être reproduit, sinon en entier, sans l'autorisation écrite de FNNX-INNOV.

Rapport d'analyse en laboratoire
Résistance au cisaillement (Méthode du cône suédois)

BNQ 2501-110 - Sol - Résistance au cisaillement

Rapport no. : 1679-13

Laboratoire no. : 23-06864



Numéro de dossier : F2201386-006-004

Sondage: TF-03-23

Échantillon: TS-47

Profondeur(m): 2,35

Client : **TPSGC**

Projet : ETG_Ile Ste-Thérèse-Environnement

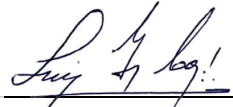
Tableau des résultats

Sondage	Échantillon	Profondeur	Teneur en eau naturelle	Pénétration				Teneur en eau		Résistance au cisaillement(Cu)		Sensibilité(St)
				Intact	Cône	Remanié	Cône	Intact	Remanié	Intact	Remanié	
		(m)	(%)	(mm)		(mm)		(%)	(%)	(Kpa)	(Kpa)	
TF-03-23	TS-47	2,4	57,0	8,2	400g/30°	5,5	60g/60°	55,7	56,6	58,30	5,83	10,0

Remarques:

Préparé par: Luis Galvez-Cossio, Tech, chef labo pr.

Vérifié par:


Luis Galvez-Cossio, Tech, chef labo pr.

Date: 2023-07-31

Notes : Le résultat s'applique exclusivement à l'échantillon analysé.

Ce rapport ne doit pas être reproduit, sinon en entier, sans l'autorisation écrite de FNX-INNOV.

Appendix D

Chemical Analysis Certificates

CERTIFICAT D'ANALYSES OFFICIEL : M2308010-V1
DEMANDE D'ANALYSE :208812
Date d'émission du certificat : 2023-08-01

FNX-INNOV Inc.
 433, rue Chabanel Ouest, 12e étage
 Montréal, Québec
 H2N 2J8
 Attention : Alexandre Leblanc

Date de réception : 2023-07-11
 Nom et no projet : F2201386-006
 Nom du préleveur : A. Boudalia
 Bon de commande : DA051479

Analyses	Quantité	Méthode de référence	Méthode interne
Humidité / siccité	9	MA. 100 - S.T. 1.1	ILCE-030
Balayage métaux	9	MA. 200 - Mét 1.2	ILCE-069
Hydrocarbures pétroliers F1 à F4	9	Externe	---
Congélation des échantillons à -20C	9	Aucune	Aucune

Notes :

- Ce certificat d'analyse est la seule référence valide et les résultats présentés ont préséance en cas de différence avec tous autres documents transmis .
- Tous les résultats d'analyses provenant de matrice solide sont calculés sur une base sèche , à moins d'avis contraire.
- Les critères présentés sur ce certificat, le cas échéant, ainsi que la comparaison des résultats d'analyses à ceux-ci est à titre indicatif seulement. De plus, les critères ABC se réfèrent aux critères du secteur Basses-Terres du Saint-Laurent, à moins d'avis contraire.
- Groupe EnvironeX détient toutes les accréditations requises pour l'analyse des paramètres présentés sur ce certificat, à moins d'avis contraire.

Légende :

LR : Limite rapportée

PNA : Paramètre non accrédité

¹ Analyse réalisée par EnvironeX Québec

MR : Matériaux de référence

TNI : Colonies trop nombreuses pour être identifiées

² Analyse réalisée par EnvironeX Longueuil

N/A : Non applicable

TNC : Colonies trop nombreuses pour être comptées

³ Résultats en annexe

Méthode Interne : CHM ou MBIO (méthodes QC) ; ILCE ou ILME (méthodes LG)

* Analyse réalisée en sous-traitance externe

CERTIFICAT D'ANALYSES OFFICIEL - RÉSULTATS

No d'échantillon Environex :		6129543	6129546	6129550	6129552	6129554	6129555	6129556
Nature :		Sol	Sol	Sol	Sol	Sol	Sol	Sol
Date de prélèvement :		2023-07-03	2023-07-03	2023-07-05	2023-07-05	2023-07-04	2023-07-04	2023-07-05
Identification de l'échantillon client :		TF01-23 CF-1 (a)	TF01-23 CF-1 (b)	TF02-23 CF-1 (a)	TF02-23 CF-1 (b)	TF03-23 CF-1 (a)	TF03-23 CF-1 (b)	TF04-23 CF-1 (a)
Paramètre	Unité							
Argent (Ag)	mg/Kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic (As)	mg/Kg	<1.5	2.7	<1.5	2.9	<1.5	<1.5	<1.5
Bore (B)	mg/Kg	<10	<10	<10	<10	<10	<10	<10
Barium (Ba)	mg/Kg	78	53	46	138	63	31	65
Beryllium (Be) (PNA)	mg/Kg	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5
Cadmium	mg/Kg	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Cobalt (Co)	mg/Kg	<10	<10	<10	16	<10	<10	<10
Chrome (Cr)	mg/Kg	24	25	15	70	21	15	21
Cuivre (Cu)	mg/Kg	<10	15	<10	33	<10	<10	<10
Molybdène (Mo)	mg/Kg	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Nickel (Ni)	mg/Kg	12	17	10	42	10	10	10
Plomb (Pb)	mg/Kg	17	<10	<10	<10	16	<10	14
Antimoine (Sb) (PNA)	mg/Kg	<1	<1	<1	<1	<1	<1	<1
Selenium (Se)	mg/Kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Étain (Sn)	mg/Kg	<5	<5	<5	<5	<5	<5	<5
Zinc (Zn)	mg/Kg	43	38	27	81	36	26	36
Mercur	mg/Kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

No d'échantillon Environex :		6129557	6129558					
Nature :		Sol	Sol					
Date de prélèvement :		2023-07-05	2023-07-05					
Identification de l'échantillon client :		TF04-23 CF-1 (b)	DUP 03					
Paramètre	Unité							
Argent (Ag)	mg/Kg	<0.5	<0.5					
Arsenic (As)	mg/Kg	<1.5	3.0					
Bore (B)	mg/Kg	<10	<10					
Barium (Ba)	mg/Kg	31	91					
Beryllium (Be) (PNA)	mg/Kg	<0.5	0.6					
Cadmium	mg/Kg	<0.6	<0.6					
Cobalt (Co)	mg/Kg	<10	11					
Chrome (Cr)	mg/Kg	12	46					
Cuivre (Cu)	mg/Kg	<10	24					
Molybdène (Mo)	mg/Kg	<1.5	<1.5					
Nickel (Ni)	mg/Kg	<10	28					
Plomb (Pb)	mg/Kg	<10	<10					
Antimoine (Sb) (PNA)	mg/Kg	<1	<1					
Selenium (Se)	mg/Kg	<0.5	<0.5					
Étain (Sn)	mg/Kg	<5	<5					
Zinc (Zn)	mg/Kg	21	58					
Mercur	mg/Kg	<0.20	<0.20					

CERTIFICAT D'ANALYSES OFFICIEL - RÉSULTATS

No d'échantillon EnvironeX :	6129543	6129546	6129550	6129552	6129554	6129555	6129556
Nature :	Sol	Sol	Sol	Sol	Sol	Sol	Sol
Date de prélèvement :	2023-07-03	2023-07-03	2023-07-05	2023-07-05	2023-07-04	2023-07-04	2023-07-05
Identification de l'échantillon client :	TF01-23 CF-1 (a)	TF01-23 CF-1 (b)	TF02-23 CF-1 (a)	TF02-23 CF-1 (b)	TF03-23 CF-1 (a)	TF03-23 CF-1 (b)	TF04-23 CF-1 (a)
Paramètre	Unité						
Congélation des échantillons de sol à -20°C	-	Fait	Fait	Fait	Fait	Fait	Fait

No d'échantillon EnvironeX :	6129557	6129558					
Nature :	Sol	Sol					
Date de prélèvement :	2023-07-05	2023-07-05					
Identification de l'échantillon client :	TF04-23 CF-1 (b)	DUP 03					
Paramètre	Unité						
Congélation des échantillons de sol à -20°C	-	Fait	Fait				

No d'échantillon EnvironeX :	6129543	6129546	6129550	6129552	6129554	6129555	6129556
Nature :	Sol	Sol	Sol	Sol	Sol	Sol	Sol
Date de prélèvement :	2023-07-03	2023-07-03	2023-07-05	2023-07-05	2023-07-04	2023-07-04	2023-07-05
Identification de l'échantillon client :	TF01-23 CF-1 (a)	TF01-23 CF-1 (b)	TF02-23 CF-1 (a)	TF02-23 CF-1 (b)	TF03-23 CF-1 (a)	TF03-23 CF-1 (b)	TF04-23 CF-1 (a)
Paramètre	Unité						
Pourcentage d'humidité	%	17.3	20.3	15.9	23.1	16.1	14.6

No d'échantillon EnvironeX :	6129557	6129558					
Nature :	Sol	Sol					
Date de prélèvement :	2023-07-05	2023-07-05					
Identification de l'échantillon client :	TF04-23 CF-1 (b)	DUP 03					
Paramètre	Unité						
Pourcentage d'humidité	%	14.8	20.3				

No d'échantillon EnvironeX :	6129543	6129546	6129550	6129552	6129554	6129555	6129556
Nature :	Sol	Sol	Sol	Sol	Sol	Sol	Sol
Date de prélèvement :	2023-07-03	2023-07-03	2023-07-05	2023-07-05	2023-07-04	2023-07-04	2023-07-05
Identification de l'échantillon client :	TF01-23 CF-1 (a)	TF01-23 CF-1 (b)	TF02-23 CF-1 (a)	TF02-23 CF-1 (b)	TF03-23 CF-1 (a)	TF03-23 CF-1 (b)	TF04-23 CF-1 (a)
Paramètre	Unité						
* CCME F2-F4	-	Annexe	Annexe	Annexe	Annexe	Annexe	Annexe

* Cette analyse a été effectuée en sous-traitance.

No d'échantillon EnvironeX :	6129557	6129558					
Nature :	Sol	Sol					
Date de prélèvement :	2023-07-05	2023-07-05					
Identification de l'échantillon client :	TF04-23 CF-1 (b)	DUP 03					
Paramètre	Unité						
* CCME F2-F4	-	Annexe	Annexe				

* Cette analyse a été effectuée en sous-traitance.


France Luneau, Chimiste, Site Longueuil




Manal Seif, Chimiste, Site Longueuil



CERTIFICAT D'ANALYSES OFFICIEL - CONTRÔLE QUALITÉ

Paramètre	Unité	Blanc	LR	MR obtenu %	MR écart acceptable %	Date d'analyse
Argent (Ag)	mg/Kg	<0.5	0.5	108%	80 - 120%	7/19/2023
Arsenic (As)	mg/Kg	<1.5	1.5	95.8%	80 - 120%	7/19/2023
Bore (B)	mg/Kg	<10	10	97%	80 - 120%	7/19/2023
Barium (Ba)	mg/Kg	<10	10	99%	80 - 120%	7/19/2023
Beryllium (Be) (PNA)	mg/Kg	<0.5	0.5	102%	80 - 120%	7/19/2023
Cadmium	mg/Kg	<0.6	0.6	99.4%	80 - 120%	7/19/2023
Cobalt (Co)	mg/Kg	<10	10	100%	80 - 120%	7/19/2023
Chrome (Cr)	mg/Kg	<10	10	105%	80 - 120%	7/19/2023
Cuivre (Cu)	mg/Kg	<10	10	99%	80 - 120%	7/19/2023
Molybdène (Mo)	mg/Kg	<1.5	1.5	103%	80 - 120%	7/19/2023
Nickel (Ni)	mg/Kg	<10	10	98%	80 - 120%	7/19/2023
Plomb (Pb)	mg/Kg	<10	10	100%	80 - 120%	7/19/2023
Antimoine (Sb) (PNA)	mg/Kg	<1	1	100%	80 - 120%	7/19/2023
Selenium (Se)	mg/Kg	<0.5	0.5	98.7%	80 - 120%	7/19/2023
Étain (Sn)	mg/Kg	<5	5	105%	80 - 120%	7/19/2023
Zinc (Zn)	mg/Kg	<10	10	93%	80 - 120%	7/19/2023
Mercure	mg/Kg	<0.20	0.2	97.6%	80 - 120%	7/19/2023

Échantillons EnvironeX associés : **6129543, 6129546, 6129550, 6129552, 6129554, 6129555, 6129556, 6129557, 6129558**

OFFICIAL CERTIFICATE OF ANALYSIS : 3637326

WORK REQUEST : 100228638

Report Date : 2023-07-20

EnvironeX
 2325, boul. Fernand-Lafontaine
 Longueuil, QC
 J4N 1N7
 Attention : Sample Reception

Reception Date : 2023-07-13
 Project : 6129543
 Sampler : NA
 PO Number : 6129543
 Temperature : 19 °C

Analysis	Quantity	External Method
PHCs F2-F4 (Soil, GC-FID)	1	CCME Petroleum Hydrocarbons in Soil, Tier 1 Method

Sample status upon receipt :

7065650

Compliant

Notes :

- All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise stated.
- Eurofins Environment Testing Canada Inc. is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at <https://directory.cala.ca/>
- Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline or regulatory limits listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official guideline or regulation as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Legend :		
RL : Reporting limit	N/A : Not applicable	* : Analysis conducted by external subcontracting
QC : Reference material (QC)	1 : Results in annex	^ : Analysis not accredited

OFFICIAL CERTIFICATE OF ANALYSIS - RESULTS

Client : Environex
Project : 6129543

Reception Date: 2023-07-13

Eurofins Sample No :		7065650						
Matrix :		Soil						
Sampling Date :		2023-07-03						
Client Sample Identification :		6129543						
Petroleum Hydrocarbons	RL	Unit						
PHCs F2-F4 (Soil, GC-FID)								
F2 (C10 to C16)	2	ug/g	<2					
F3 (C16 to C34)	20	ug/g	<20					
F4 (C34 to C50)	20	ug/g	<20					
5-alpha-Androstane (surrogate)	1	%	60					

Approved by : R. Zafari
Raheleh Zafari,
Ottawa, Environmental Chemist, PhD

OFFICIAL CERTIFICATE OF ANALYSIS - QUALITY CONTROL

Client : EnvironeX
Project : 6129543

Reception Date: 2023-07-13

Parameter	Unit	RL	Blank	QC		Matrix Spike		Duplicate	
				Recovery %	Range %	Recovery %	Range %	RPD %	Range %
PHCs F2-F4 (Soil, GC-FID)									
<i>Method : Petroleum Hydrocarbons (Soil, GC-FID). Internal method: OTT-O-PHC-WI45386.</i>									
F2 (C10 to C16)	ug/g	2	<2	102	80-120	107	60-140	-	0-30
F3 (C16 to C34)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
F4 (C34 to C50)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
Associated Samples : 7065650								Prep Date: 2023-07-17 Analysis Date: 2023-07-20	

Where RPD % is reported as "-" the calculation is not available because one or both of the duplicates is within 5 times the RL.

Notes:

- 1) The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
- 2) Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
- 3) Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
- 4) Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
- 5) F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
- 6) Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
- 7) Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
- 8) Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
- 9) *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.
- 10) Where F4G-sg is reported, the F4G extract has been cleaned with silica gel.

OFFICIAL CERTIFICATE OF ANALYSIS nRES1 LTS

Client : Environex
Project : 6129546

Reception Date: 2023-07-13

Eurofins Sample No :		726P66W					
Matrix :		Soil					
Sampling Date :		2023-07-03					
Client Sample Identification :		6129546					
HPDR	MLMC	BSYTR	G-T4R	VU	RL	1 vD	
HbCu F8rFe (Sr M/GCrFla)							
F2 (C10 to C16)		2	ug/g	<2			
F3 (C16 to C34)		20	ug/g	<20			
F4 (C34 to C50)		20	ug/g	<20			
5-alpha-Androstane (surrogate)		1	%	65			

Approved by : R. Zafari
Raheleh Zafari,
Ottawa, Environmental Chemist, PhD

OFFICIAL CERTIFICATE OF ANALYSIS QUALITY CONTROL

Client : Environex
Project : 6129546

Reception Date: 2023-07-13

H-t-c pnt	Unit	RL	Blank	QC		Matrix Spike		Duplicate	
				Recovery %	Range %	Recovery %	Range %	RPD %	Range %
Hb Cu F8rFe (Sr MgCrFla)									
<i>Method : Petroleum Hydrocarbons (Soil, GC-FID). Internal method: OTT-O-PHC-WI45386.</i>									
F2 (C10 to C16)	ug/g	2	<2	102	80-120	107	60-140	-	0-30
F3 (C16 to C34)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
F4 (C34 to C50)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
Associated Samples : 7065668								Prep Date: 2023-07-17 Analysis Date: 2023-07-20	

Where RPD % is reported as "-" the calculation is not available because one or both of the duplicates is within 5 times the RL.

Notes:

- 1) The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
- 2) Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
- 3) Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
- 4) Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
- 5) F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
- 6) Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
- 7) Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
- 8) Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
- 9) *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.
- 10) Where F4G-sg is reported, the F4G extract has been cleaned with silica gel.

OFFICIAL CERTIFICATE OF ANALYSIS nRESULTS

Client : Environex
Project : 6129550

Reception Date: 2023-07-13

Eurofins Sample No :		716P672					
Matrix :		Soil					
Sampling Date :		2023-07-05					
Client Sample Identification :		6129550					
HPDR	MLMC	BSYTR	G-T4R	VU	RL	UV	LD
HbCu F0rFe (Sr M/GCrFla)							
F2 (C10 to C16)		2	ug/g	<2			
F3 (C16 to C34)		20	ug/g	<20			
F4 (C34 to C50)		20	ug/g	<20			
5-alpha-Androstane (surrogate)		1	%	70			

Approved by: R. Zafari
Raheleh Zafari,
Ottawa, Environmental Chemist, PhD

OFFICIAL CERTIFICATE OF ANALYSIS nQUALITY CONTROL

Client : Environex
Project : 6129550

Reception Date: 2023-07-13

H-t-c pPt	Unit	RL	Blank	QC		Matrix Spike		Duplicate	
				Recovery %	Range %	Recovery %	Range %	RPD %	Range %
Hb Cu F0rFe (Sr X)IGCrFla)									
<i>Method : Petroleum Hydrocarbons (Soil, GC-FID). Internal method: OTT-O-PHC-WI45386.</i>									
F2 (C10 to C16)	ug/g	2	<2	102	80-120	107	60-140	-	0-30
F3 (C16 to C34)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
F4 (C34 to C50)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
Associated Samples : 7065671								Prep Date: 2023-07-17 Analysis Date: 2023-07-20	

Where RPD % is reported as "-" the calculation is not available because one or both of the duplicates is within 5 times the RL.

Notes:

- 1) The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
- 2) Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
- 3) Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
- 4) Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
- 5) F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
- 6) Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
- 7) Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
- 8) Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
- 9) *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.
- 10) Where F4G-sg is reported, the F4G extract has been cleaned with silica gel.

OFFICIAL CERTIFICATE OF ANALYSIS nRESQLTS

Client : Environex

Project : 6129552

Reception Date: 2023-07-13

Eurofins Sample No :		716P677					
Matrix :		Soil					
Sampling Date :		2023-07-05					
Client Sample Identification :		6129552					
HPDR	ML	bsytr g-t4r vu	RL	Qv	D		
HbCu F0rFe (Sr M/GCrFla)							
F2 (C10 to C16)			2	ug/g	<2		
F3 (C16 to C34)			20	ug/g	<20		
F4 (C34 to C50)			20	ug/g	<20		
5-alpha-Androstane (surrogate)			1	%	95		

Approved by :



Raheleh Zafari,
Ottawa, Environmental Chemist, PhD

Client : Environex
Project : 6129552

Reception Date: 2023-07-13

H-t-c pDpt	Unit	RL	Blank	QC		Matrix Spike		Duplicate	
				Recovery %	Range %	Recovery %	Range %	RPD %	Range %
Hb Cu F0rFe (Sr X)IGCrFla)									
<i>Method : Petroleum Hydrocarbons (Soil, GC-FID). Internal method: OTT-O-PHC-WI45386.</i>									
F2 (C10 to C16)	ug/g	2	<2	102	80-120	107	60-140	-	0-30
F3 (C16 to C34)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
F4 (C34 to C50)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
Associated Samples : 7065677								Prep Date: 2023-07-17 Analysis Date: 2023-07-20	

Where RPD % is reported as "-" the calculation is not available because one or both of the duplicates is within 5 times the RL.

Notes:

- 1) The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
- 2) Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
- 3) Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
- 4) Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
- 5) F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
- 6) Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
- 7) Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
- 8) Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
- 9) *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.
- 10) Where F4G-sg is reported, the F4G extract has been cleaned with silica gel.

OFFICIAL CERTIFICATE OF ANALYSIS : 3637328

WORK REQUEST : 100228648

Report Date : 2023-07-20

EnvironeX
 2325, boul. Fernand-Lafontaine
 Longueuil, QC
 J4N 1N7
 Attention : Sample Reception

Reception Date : 2023-07-13
 Project : 6129554
 Sampler : NA
 PO Number : 6129554
 Temperature : 19 °C

Analysis	Quantity	External Method
PHCs F2-F4 (Soil, GC-FID)	1	CCME Petroleum Hydrocarbons in Soil, Tier 1 Method

Sample status upon receipt :

7065679

Compliant

Notes :

- All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise stated.
- Eurofins Environment Testing Canada Inc. is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at <https://directory.cala.ca/>
- Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline or regulatory limits listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official guideline or regulation as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Legend :		
RL : Reporting limit	N/A : Not applicable	* : Analysis conducted by external subcontracting
QC : Reference material (QC)	1 : Results in annex	^ : Analysis not accredited

OFFICIAL CERTIFICATE OF ANALYSIS - RESULTS

Client : Environex
Project : 6129554

Reception Date: 2023-07-13

Eurofins Sample No :		7065679					
Matrix :		Soil					
Sampling Date :		2023-07-04					
Client Sample Identification :		6129554					
Petroleum Hydrocarbons	RL	Unit					
PHCs F2-F4 (Soil, GC-FID)							
F2 (C10 to C16)	2	ug/g	<2				
F3 (C16 to C34)	20	ug/g	<20				
F4 (C34 to C50)	20	ug/g	<20				
5-alpha-Androstane (surrogate)	1	%	102				

Approved by : R. Zafari
Raheleh Zafari,
Ottawa, Environmental Chemist, PhD

OFFICIAL CERTIFICATE OF ANALYSIS - QUALITY CONTROL

Client : Environex
Project : 6129554

Reception Date: 2023-07-13

Parameter	Unit	RL	Blank	QC		Matrix Spike		Duplicate	
				Recovery %	Range %	Recovery %	Range %	RPD %	Range %
PHCs F2-F4 (Soil, GC-FID)									
<i>Method : Petroleum Hydrocarbons (Soil, GC-FID). Internal method: OTT-O-PHC-WI45386.</i>									
F2 (C10 to C16)	ug/g	2	<2	102	80-120	107	60-140	-	0-30
F3 (C16 to C34)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
F4 (C34 to C50)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
Associated Samples : 7065679								Prep Date: 2023-07-17 Analysis Date: 2023-07-20	

Where RPD % is reported as "-" the calculation is not available because one or both of the duplicates is within 5 times the RL.

Notes:

- 1) The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
- 2) Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
- 3) Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
- 4) Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
- 5) F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
- 6) Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
- 7) Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
- 8) Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
- 9) *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.
- 10) Where F4G-sg is reported, the F4G extract has been cleaned with silica gel.

OFFICIAL CERTIFICATE OF ANALYSIS nRESQLTS

Client : Environex
Project : 6129555

Reception Date: 2023-07-13

Eurofins Sample No :		7169601					
Matrix :		Soil					
Sampling Date :		2023-07-04					
Client Sample Identification :		6129555					
Parameter	RL	Qv	D				
PHCu F2rF4 (Sr M/GCrFla)							
F2 (C10 to C16)	2	ug/g	<2				
F3 (C16 to C34)	20	ug/g	<20				
F4 (C34 to C50)	20	ug/g	<20				
5-alpha-Androstane (surrogate)	1	%	71				

Approved by: R. Zafari
Raheleh Zafari,
Ottawa, Environmental Chemist, PhD

Client : Environex
Project : 6129555

Reception Date: 2023-07-13

P-t-c pPt	Unit	RL	Blank	QC		Matrix Spike		Duplicate	
				Recovery %	Range %	Recovery %	Range %	RPD %	Range %
PHCu F2rF4 (Sr M/GCrFla)									
<i>Method : Petroleum Hydrocarbons (Soil, GC-FID). Internal method: OTT-O-PHC-WI45386.</i>									
F2 (C10 to C16)	ug/g	2	<2	102	80-120	107	60-140	-	0-30
F3 (C16 to C34)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
F4 (C34 to C50)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
Associated Samples : 7065680								Prep Date: 2023-07-17 Analysis Date: 2023-07-20	

Where RPD % is reported as "-" the calculation is not available because one or both of the duplicates is within 5 times the RL.

Notes:

- 1) The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
- 2) Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
- 3) Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
- 4) Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
- 5) F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
- 6) Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
- 7) Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
- 8) Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
- 9) *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.
- 10) Where F4G-sg is reported, the F4G extract has been cleaned with silica gel.

OFFICIAL CERTIFICATE OF ANALYSIS nRESULTS

Client : Environex
Project : 6129556

Reception Date: 2023-07-13

Eurofins Sample No :		706e682						
Matrix :		Soil						
Sampling Date :		2023-07-05						
Client Sample Identification :		6129556						
Parameter	RL	Unit	Result					
PHCu F2rF4 (Sr M/GCrFla)								
F2 (C10 to C16)	2	ug/g	<2					
F3 (C16 to C34)	20	ug/g	<20					
F4 (C34 to C50)	20	ug/g	<20					
5-alpha-Androstane (surrogate)	1	%	85					

Approved by: R. Zafari
Raheleh Zafari,
Ottawa, Environmental Chemist, PhD

OFFICIAL CERTIFICATE OF ANALYSIS nQUALITY CONTROL

Client : Environex
Project : 6129556

Reception Date: 2023-07-13

P-t-c ppt	Unit	RL	Blank	QC		Matrix Spike		Duplicate	
				Recovery %	Range %	Recovery %	Range %	RPD %	Range %
PHCu F2rF4 (Sr M/GCrFla)									
<i>Method : Petroleum Hydrocarbons (Soil, GC-FID). Internal method: OTT-O-PHC-WI45386.</i>									
F2 (C10 to C16)	ug/g	2	<2	102	80-120	107	60-140	-	0-30
F3 (C16 to C34)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
F4 (C34 to C50)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
Associated Samples : 7065682								Prep Date: 2023-07-17 Analysis Date: 2023-07-20	

Where RPD % is reported as "-" the calculation is not available because one or both of the duplicates is within 5 times the RL.

Notes:

- 1) The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
- 2) Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
- 3) Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
- 4) Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
- 5) F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
- 6) Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
- 7) Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
- 8) Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
- 9) *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.
- 10) Where F4G-sg is reported, the F4G extract has been cleaned with silica gel.

OFFICIAL CERTIFICATE OF ANALYSIS nRESKLTs

Client : Environex
Project : 6129557

Reception Date: 2023-07-13

Eurofins Sample No :		7U64690						
Matrix :		Soil						
Sampling Date :		2023-07-05						
Client Sample Identification :		6129557						
PpDr Mmc Hsytr g-tbr vu	RL	KvD						
PHCu F1rFe (Sr M/GCrFla)								
F2 (C10 to C16)	2	ug/g	<2					
F3 (C16 to C34)	20	ug/g	<20					
F4 (C34 to C50)	20	ug/g	<20					
5-alpha-Androstane (surrogate)	1	%	91					

Approved by : R. Zafari
Raheleh Zafari,
Ottawa, Environmental Chemist, PhD

OFFICIAL CERTIFICATE OF ANALYSIS nWKALITY CONTROL

Client : Environex
Project : 6129557

Reception Date: 2023-07-13

P-t-c pPt	Unit	RL	Blank	QC		Matrix Spike		Duplicate	
				Recovery %	Range %	Recovery %	Range %	RPD %	Range %
PHCu F1rFe (Sr)MIGCrFla)									
<i>Method : Petroleum Hydrocarbons (Soil, GC-FID). Internal method: OTT-O-PHC-WI45386.</i>									
F2 (C10 to C16)	ug/g	2	<2	102	80-120	107	60-140	-	0-30
F3 (C16 to C34)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
F4 (C34 to C50)	ug/g	20	<20	102	80-120	107	60-140	-	0-30
Associated Samples : 7065698								Prep Date: 2023-07-17 Analysis Date: 2023-07-20	

Where RPD % is reported as "-" the calculation is not available because one or both of the duplicates is within 5 times the RL.

Notes:

- 1) The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
- 2) Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
- 3) Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
- 4) Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
- 5) F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
- 6) Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
- 7) Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
- 8) Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
- 9) *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.
- 10) Where F4G-sg is reported, the F4G extract has been cleaned with silica gel.

OFFICIAL CERTIFICATE OF ANALYSIS nRESULTS

Client : Environex
Project : 6129558

Reception Date: 2023-07-20

Eurofins Sample No :		v0e28v2						
Matrix :		Soil						
Sampling Date :		2023-07-05						
Client Sample Identification :		6129558						
PpDr lpcg Hustr 5-tbr i m	RL	Ui xD						
PHCMF4rF7 (Sr x) GCrFla)								
F2 (C10 to C16)	2	ug/g	<2					
F3 (C16 to C34)	20	ug/g	<20					
F4 (C34 to C50)	20	ug/g	<20					
5-alpha-Androstane (surrogate)	1	%	75					

Approved by : R. Zafari
Raheleh Zafari,
Ottawa, Environmental Chemist, PhD

Client : Environex
Project : 6129558

Reception Date: 2023-07-20

P-t-g pPpt	Unit	RL	Blank	QC		Matrix Spike		Duplicate	
				Recovery %	Range %	Recovery %	Range %	RPD %	Range %
PHCmF4rF7 (Sr n) GCrFla)									
<i>Method : Petroleum Hydrocarbons (Soil, GC-FID). Internal method: OTT-O-PHC-WI45386.</i>									
F2 (C10 to C16)	ug/g	2	<2	97	80-120	-	60-140	-	0-30
F3 (C16 to C34)	ug/g	20	<20	97	80-120	108	60-140	-	0-30
F4 (C34 to C50)	ug/g	20	<20	97	80-120	108	60-140	-	0-30
Associated Samples : 7085975								Prep Date: 2023-07-25 Analysis Date: 2023-07-27	

Where RPD % is reported as "-" the calculation is not available because one or both of the duplicates is within 5 times the RL.

Notes

- 1) The laboratory method complies with CCME Tier 1 reference method for PHC in soil. It is validated for laboratory use.
- 2) Where the F1 fraction (C6 to C10) and BTEX are both measured, F1-BTEX is reported.
- 3) Where the F2 fraction (C10 to C16) and naphthalene are both measured, F2-naphthalene is reported.
- 4) Where the F3 fraction (C16 to C34) and PAHs* are both measured, F3-PAH is reported.
- 5) F4G is analyzed if the chromatogram does not descend to baseline before C50. Where F4 (C34 to C50) and F4G are both reported, the higher result is compared to the standard.
- 6) Unless otherwise stated in the sample comments, the following criteria have been met where applicable:
 - nC6 and nC10 response factors within 30% of response factor for toluene;
 - nC10, nC16, and nC34 response factors within 10% of each other;
 - C50 response factors within 70% of nC10 + nC16 + nC34 average; and,
 - Linearity is within 15%.
- 7) Unless otherwise stated in the sample comments, sampling requirements and analytical holding times have been met.
- 8) Gravimetric heavy hydrocarbons (F4G) cannot be added to the C6 and C50 hydrocarbons.
- 9) *PAHs = phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene.
- 10) Where F4G-sg is reported, the F4G extract has been cleaned with silica gel.

Appendix E
Results Tables

Tableau : Sols - Résultats des analyses chimiques - F2-F4

Projet: Construction d'une aide fixe à la navigation
île Sainte-Thérèse, Varenne, Québec
No projet FNX : F2201386-006

Cient: Garde côtière canadienne

Paramètres	Sols Usage Agricole, Résidentiel, Institutionnel, industriel, commercial ¹	Concentrations mesurées (mg/kg)									
		TF-01-23 CF-1A	TF-01-23 CF-1B	TF-02-23 CF-1A	TF-02-23 CF-1B	DUP 03	TF-03-23 CF-1A	TF-03-23 CF-1B	TF-04-23 CF-1A	TF-04-23 CF-1B	
	Type de sol	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	
	Profondeur	0,00 - 0,30 m	0,30 - 0,61m	0,00 - 0,30 m	0,30 - 0,61m	0,30 - 0,61m	0,00 - 0,30 m	0,30 - 0,61m	0,00 - 0,30 m	0,30 - 0,61m	
	Certificat	3637326	3637308	3637316	3637333	3645934	3637328	3637322	3637332	3637337	
No échantillon laboratoire	6129543	6129546	6129550	6129552	6129558	6129554	6129555	6129556	6129557		
Limites (µg/g) Table 1 Usage Agricole, Résidentiel, Institutionnel, Industriel, Commercial	2023-07-03	2023-07-03	2023-07-05	2023-07-05	2023-07-05	2023-07-04	2023-07-04	2023-07-05	2023-07-05		
Hydrocarbures pétroliers											
Hydrocarbures Pétroliers F2	10	<2	<2	<2	<2	<2	<2	<2	<2	<2	
Hydrocarbures Pétroliers F3	240	<20	<20	<20	<20	<20	<20	<20	<20	<20	
Hydrocarbures Pétroliers F4	120	<20	<20	<20	<20	<20	<20	<20	<20	<20	

Legende :

XX

Explications:

TF-XX-XX No échantillon
2022-04-XX Date d'échantillonnage

Notes:

1. Valeurs tirés des normes de l'Ontario sur les sols, l'eau souterraine et les sédiments en vertu du la partie XV,1 de la Loi sur la protection de l'environnement

Tableau : Sols - Programme d'assurance contrôle et qualité - F2-F4

Projet: Construction d'une aide fixe à la navigation
 île Sainte-Thérèse, Varenne, Québec
 No projet FNX : F2201386-006

Cliant: Garde côtière canadienne

Paramètres	Sols Usage Agricole, Résidentiel, Institutionnel, industriel, commercial ¹	Concentrations mesurées (mg/kg)		
		TF-02-23 CF-1B	DUP 03	ER ²
	Type de sol	Dépôts naturels	Dépôts naturels	
	Profondeur	0,30 - 0,61m	0,30 - 0,61m	
	Certificat	3637333	3645934	
	No échantillon laboratoire	6129552	6129558	
Limites (µg/g) Table 1 Usage Agricole, Résidentiel, Institutionnel, Industriel, Commercial	2023-07-05	2023-07-05		
Hydrocarbures pétroliers				
Hydrocarbures Pétroliers F2	10	<2	<2	N/A
Hydrocarbures Pétroliers F3	240	<20	<20	N/A
Hydrocarbures Pétroliers F4	120	<20	<20	N/A

Legende :

X.X

Explications:

TF-XX-XX No échantillon
 2022-04-XX Date d'échantillonnage

Notes:

- Valeurs tirés des normes de l'Ontario sur les sols, l'eau souterraine et les sédiments en vertu de la partie XV.1 de la Loi sur la protection de l'environnement
- Écart relatif (Concentration A - Concentration B)/(Moyenne Concentration A et B) *100

N/A: Non applicable

Tableau : Sols - Résultats des analyses chimiques

Projet: Construction d'une aide fixe à la navigation
 Ile Sainte-Thérèse, Varenne, Québec
 No projet FNX : F2201386-006

Client: Garde côtière canadienne

Paramètres	Critères génériques ou valeurs limites ¹				Concentrations mesurées (mg/kg)								
					TF-01-23 CF-1A	TF-01-23 CF-1B	TF-02-23 CF-1A	TF-02-23 CF-1B	DUP 03	TF-03-23 CF-1A	TF-03-23 CF-1B	TF-04-23 CF-1A	TF-04-23 CF-1B
	Type de sol				Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels	Dépôts naturels
	Profondeur				0,00 - 0,30 m	0,30 - 0,61m	0,00 - 0,30 m	0,30 - 0,61m	0,30 - 0,61m	0,00 - 0,30 m	0,30 - 0,61m	0,00 - 0,30 m	0,30 - 0,61m
	Certificat				M2308010-V1	M2308010-V1	M2308010-V1	M2308010-V1	M2308010-V1	M2308010-V1	M2308010-V1	M2308010-V1	M2308010-V1
No échantillon laboratoire				6129543	6129546	6129550	6129552	6129556	6129554	6129555	6129556	6129557	
				Agricole	Résidentielle/Parc	Commerciale	Industrielle						
				2023-07-03	2023-07-03	2023-07-05	2023-07-05	2023-07-05	2023-07-04	2023-07-04	2023-07-05	2023-07-05	
MÉTAUX (et métalloïdes)													
Argent (Ag)	20	20	40	40	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic (As)	12	12	12	12	<1.5	2.7	<1.5	2.9	3	<1.5	<1.5	<1.5	<1.5
Bore (B)	2	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Baryum (Ba)	750	500	2 000	2 000	78	53	46	138	91	63	31	65	31
Beryllium (Be)	4	4	8	8	<0.5	<0.5	<0.5	0.6	0.6	<0.5	<0.5	<0.5	<0.5
Cadmium (Cd)	1.4	10	22	22	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Cobalt (Co)	40	50	300	300	<10	<10	<10	16	11	<10	<10	<10	<10
Chrome total (Cr)	64	64	87	87	24	25	15	70	46	21	15	21	12
Cuivre (Cu)	63	63	91	91	<10	15	<10	33	24	<10	<10	<10	<10
Molybdène (Mo)	5	10	40	40	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Nickel (Ni)	45	45	89	89	12	17	10	42	28	10	10	10	<10
Plomb (Pb)	70	140	260	600	17	<10	<10	<10	<10	16	<10	14	<10
Antimoine (Sb)	20	20	40	40	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sélénium (Se)	1	1	2.9	2.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Étain (Sn)	5	50	300	300	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc (Zn)	250	250	410	410	43	38	27	81	58	26	36	36	21
Mercure (Hg)	6.6	6.6	24	50	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

Legende :
XX

Explications:
 TF-XX-XX No échantillon
 2022-04-XX Date d'échantillonnage

Notes:
 1. Valeurs tirées des Recommandations pour la qualité des sols, environnement et santé humaine tenu par le Conseil canadien des ministres de l'environnement (CCME)

Tableau : Sols - Résultats des analyses chimiques

Projet: **Construction d'une aide fixe à la navigation
île Sainte-Thérèse, Varenne, Québec**
No projet FNX : **F2201386-006**

Client: **Garde côtière canadienne**

Paramètres	Critères génériques ou valeurs limites ¹				Concentrations mesurées (mg/kg)		
					TF-02-23 CF-1B	DUP 03	ER ²
	Type de sol				Dépôts naturels	Dépôts naturels	
	Profondeur				0,30 - 0,61m	0,30 - 0,61m	
	Certificat				M2308010-V1	M2308010-V1	
No échantillon laboratoire				6129552	6129558		
	Agricole	Résidentielle/Parc	Commerciale	Industrielle	2023-07-05	2023-07-05	
MÉTAUX (et métalloïdes)							
Argent (Ag)	20	20	40	40	<0.5	<0.5	N/A
Arsenic (As)	12	12	12	12	2.9	3	3.39
Bore (B)	2	-	-	-	<10	<10	N/A
Baryum (Ba)	750	500	2 000	2 000	138	91	-41.05
Beryllium (Be)	4	4	8	8	0.6	0.6	0.00
Cadmium (Cd)	1.4	10	22	22	<0.6	<0.6	N/A
Cobalt (Co)	40	50	300	300	16	11	-37.04
Chrome total (Cr)	64	64	87	87	70	46	-41.38
Cuivre (Cu)	63	63	91	91	33	24	-31.58
Molybdène (Mo)	5	10	40	40	<1.5	<1.5	N/A
Nickel (Ni)	45	45	89	89	42	28	-40.00
Plomb (Pb)	70	140	260	600	<10	<10	N/A
Antimoine (Sb)	20	20	40	40	<1	<1	N/A
Sélénium (Se)	1	1	2.9	2.9	<0.5	<0.5	N/A
Étain (Sn)	5	50	300	300	<5	<5	N/A
Zinc (Zn)	250	250	410	410	81	58	-33.09
Mercuré (Hg)	6.6	6.6	24	50	<0.20	<0.20	N/A

Legende :

XX

Explications:

TF-XX-XX	No échantillon
2022-04-XX	Date d'échantillonnage

Notes:

- Valeurs tirés des Recommandations pour la qualité des sols, environnement et santé humaine tenu par le Conseil canadien des ministres de l'environnement (CCME)
- Écart relatif (Concentration A - Concentration B)/(Moyenne Concentration A et B) *100

N/A: Non applicable

Appendix F

Management Grid for Excavated Soils, Regulation Respecting Contaminated Soil Storage and Contaminated Soil Transfer Stations and Regulation Respecting the Reclamation of Residual Materials

Annexe 5 : Grille de gestion des sols excavés

La grille de gestion des sols excavés ne s'applique, pour les critères supérieurs à A, que pour une contamination de nature anthropique. Si la concentration naturelle dans le sol est supérieure à A, la gestion des sols contenant cette concentration naturelle est considérée comme équivalente à celle attribuable au critère A.

≤ critère A¹

Utilisés sans restriction sur tout terrain.

< critère B (valeurs limites de l'annexe I du RPRT)

1. Ailleurs que sur le terrain d'origine, les sols ne peuvent être déposés que sur des sols dont la concentration en contaminants est égale ou supérieure à celle des sols remblayés (article 4 du RSCTSC) et s'ils n'émettent pas d'odeurs d'hydrocarbures perceptibles.
2. Aux mêmes conditions, déposés sur ou dans des terrains destinés à l'habitation s'ils sont utilisés comme matériau de remblayage dans le cadre de travaux de réhabilitation de terrains faits conformément à la LQE.

≤ critère B (valeurs limites de l'annexe I du RPRT)

1. Valorisés sur le terrain d'origine ou sur le terrain à partir duquel a eu lieu l'activité à l'origine de la contamination.
2. Valorisés comme matériau de recouvrement journalier ou final dans un lieu d'enfouissement technique (LET) ou comme matériau de recouvrement hebdomadaire ou final dans un lieu d'enfouissement en tranchée ou comme recouvrement mensuel ou final dans un lieu d'enfouissement de débris de construction ou de démolition, conformément au REIMR aux conditions des articles 42, 50, 90, 91, 105 ou 106.
3. Valorisés comme recouvrement final dans un lieu d'enfouissement de sols contaminés (LESC) aux conditions décrites à l'article 38 du RESC ou valorisés dans un système de captage des gaz prévu à l'article 13 du RESC.
4. Valorisés comme recouvrement final d'un lieu de dépôt définitif de matières dangereuses aux conditions de l'article 101 du RMD.
5. Valorisés comme matériau de recouvrement final dans un système de gestion qui comporte le dépôt définitif par enfouissement de déchets de fabriques de pâtes et papiers, aux conditions de l'article 116 du Règlement sur les fabriques de pâtes et papiers (RFPP).
6. Valorisés sur un lieu d'élimination nécessitant un recouvrement, aux conditions prévues au certificat d'autorisation en vertu de l'article 22 de la LQE.
7. Valorisés avec ou sans MRF, comme matériau apte à la végétation dans des projets de restauration d'aires d'accumulation de résidus miniers² ou dans la couverture de lieux visés par le RFPP, le RESC ou le RMD. Ne doit dégager aucune odeur d'hydrocarbures perceptible. Dans le cas d'ajout de MRF, le projet doit être autorisé et respecter le *Guide sur l'utilisation de matières résiduelles fertilisantes pour la restauration de la couverture végétale de lieux dégradés*³.
8. Valorisés comme couche de protection d'une géomembrane utilisée dans un système multicouche lors de la restauration d'une aire d'accumulation de résidus miniers générateurs d'acide².

9. Éliminés dans un lieu d'enfouissement visé par le RESC.
10. Éliminés dans un LET, un lieu d'enfouissement en tranchée, un lieu d'enfouissement en milieu nordique, un lieu d'enfouissement de débris de construction ou de démolition ou un lieu d'enfouissement en territoire isolé, conformément à l'article 4 du REIMR.

≥ critère B et ≤ critère C

1. Utilisés sur le terrain d'origine comme matériau de remblayage à la condition que les concentrations mesurées respectent les critères ou valeurs limites réglementaires applicables aux sols selon l'usage et le zonage.
2. Valorisés comme matériau de recouvrement dans un LET ou comme matériau de recouvrement hebdomadaire dans un lieu d'enfouissement en tranchée, aux conditions des articles 42, 50 ou 90 du REIMR. Ces conditions incluent notamment que les concentrations de composés organiques volatils soient égales ou inférieures aux critères B.
3. Traités sur place ou dans un lieu de traitement autorisé.
4. Éliminés dans un lieu d'enfouissement visé par le RESC.

< annexe I du RESC

1. Utilisés pour remplir des dépressions naturelles ou des excavations sur le terrain d'origine lors de travaux de réhabilitation aux conditions prévues dans le plan de réhabilitation approuvé dans le cadre d'une analyse de risques (dossiers GTE), à la condition que les C_{10} - C_{50} et les COV respectent les critères d'usage.
2. Traités sur place ou dans un lieu de traitement autorisé.
3. Éliminés dans un lieu d'enfouissement visé par le RESC.

≥ annexe I du RESC

1. Décontaminés sur place ou dans un lieu de traitement autorisé et gestion selon le résultat obtenu. Si cela est impossible, éliminés dans un lieu d'enfouissement visé par le RESC pour les exceptions mentionnées à l'article 4.1° a, b ou c.


Cas particuliers

1. Des sols contaminés peuvent être utilisés, à condition de ne dégager aucune odeur d'hydrocarbures perceptible, pour la construction d'un écran visuel ou antibruit dont l'utilité est démontrée :
 - a. Sur un terrain résidentiel avec des sols du terrain d'origine :
 - i. dont les concentrations sont $\leq B$;
 - ii. dont les concentrations sont $\leq C$, lors de travaux de réhabilitation sur le terrain réalisés conformément au plan de réhabilitation approuvé dans le cadre d'une analyse de risque (dossiers GTE), sous les mesures de confinement, à condition que les sols contiennent des concentrations $\leq B$ en C_{10} - C_{50} et en composés organiques volatils (COV)⁴;
 - iii. dont les concentrations sont < annexe I du RESC, lors de travaux de réhabilitation sur le terrain réalisés conformément au plan de réhabilitation approuvé dans le cadre d'une analyse de risque (dossiers GTE), sous les mesures de confinement, à condition que les sols en place soient de niveau $> C$ et que les sols déposés contiennent des concentrations $\leq B$ en C_{10} - C_{50} et en COV⁴;

- b. Sur un terrain commercial/industriel avec des sols du terrain d'origine :
- i. dont les concentrations sont $\leq C$;
 - ii. dont les concentrations sont $\leq C$, lors de travaux de réhabilitation sur le terrain réalisés conformément au plan de réhabilitation approuvé dans le cadre d'une analyse de risque (dossiers GTE), sous les mesures de confinement;
 - iii. dont les concentrations sont $<$ annexe I du RESC, lors de travaux de réhabilitation sur le terrain réalisés conformément au plan de réhabilitation approuvé dans le cadre d'une analyse de risque (dossiers GTE), sous les mesures de confinement, à condition que les sols en place soient $> C$, et que les sols déposés contiennent des concentrations $\leq C$ en C_{10} - C_{50} et en COV^4 .
2. La valorisation de sols contaminés dans un procédé en remplacement d'une matière vierge est possible aux conditions de l'autorisation.
 3. Les sols $\geq B$ peuvent être acheminés sur les aires de résidus miniers, s'ils sont contaminés exclusivement par des métaux ou métalloïdes résultant des activités minières de l'entreprise responsable de l'aire, aux conditions de l'autorisation délivrée par le Ministère (article 6 du RSCTSC).
 4. Les sols $\geq B$ peuvent être acheminés dans un lieu de dépôt définitif de matières dangereuses aux conditions du certificat d'autorisation détenu par ce lieu pour recevoir des sols.

Note : S'il y a présence de matières résiduelles dans les sols, se référer à la figure 12 de la section 7.7.2.

1. S'il est établi que la concentration naturelle dans le sol importé est supérieure au critère A et à la concentration du sol récepteur, il est recommandé au propriétaire du terrain récepteur de garder une trace du remblayage (localisation, niveau de contamination, provenance des sols importés), de façon à ce qu'il puisse, le cas échéant, démontrer qu'il ne s'agit pas d'une contamination anthropique. Faute de l'existence d'une telle trace, le Ministère considérera que les sols ont été contaminés par l'activité humaine et ils devront donc être gérés comme tels. Advenant le cas où les concentrations naturelles excèdent largement les critères génériques recommandés pour l'usage qui est fait du terrain récepteur, un avis sur les possibles risques à la santé et l'à-propos du remblayage avec de tels sols pourra être demandé à la direction de santé publique.
2. Ne s'applique pas aux sols contaminés = B, à moins que ces sols n'aient d'abord transité par un lieu visé à l'article 6 du Règlement sur le stockage et les centres de transfert de sols contaminés. Les sols excavés $\geq B$ ne peuvent en effet être acheminés directement que dans des lieux légalement autorisés à les recevoir et listés à l'article 6 du RSCTSC.
3. Il faudra toutefois s'assurer que la valorisation de sols A-B, auxquels on aura ajouté des matières fertilisantes ou non, entraîne un effet bénéfique, par exemple, sur la croissance de la végétation, et que ces sols répondent à un besoin réel, l'ajout de sols n'étant pas essentiel dans tous les cas de restauration minière. Il sera possible de s'assurer du bien-fondé du projet de valorisation et de son contrôle dans le cadre du certificat d'autorisation délivré préalablement à sa réalisation.
4. L'écran visuel ou antibruit doit être recouvert de 1 m de sols $\leq A$ ou de 40 cm $\leq A$ aux endroits recouverts d'une structure permanente (asphalte ou béton). Il est possible d'utiliser des MRF dans la couche apte à la végétation selon les orientations du *Guide sur l'utilisation des matières résiduelles fertilisantes pour la restauration de la couverture végétale des lieux dégradés* si la résultante est $\leq A$.



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