



LABORATOIRES
D'EXPERTISES
DE QUÉBEC LTÉE
Géotechnique, environnement et
ingénierie des sols et matériaux

November 28, 2014

ARCOP/DFS/STGM Consortium of Architects
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Québec (Québec) G1H 7H1

To the attention of Mr. Jean-Yves Montminy

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**Subject: Reconstruction of the Québec City Armoury
Supplement to the geotechnical study report
File number: 2499-01**

Dear Mr. Montminy,

Reconnaissance
des sols
Essais en chantier
Essais en laboratoire
Expertises diverses
Litiges en construction
Études géotechniques
Stabilité de talus
Ingénierie des sols
et des matériaux
Auscultation des
ouvrages
Études
environnementales
Mécanique des
chaussées

As a supplement to our geotechnical study report issued on July 19, 2013 (Report No. 4956-00-01) and at your request, we hereby submit additional geotechnical recommendations that are relevant to the project's execution. The project originally planned for the construction of an underground parking garage behind the existing building. You are now considering the possibility of building an above-ground parking lot.

In this regard, the test pits performed using a hydraulic excavator and the archeological excavation wall sampling conducted on November 26 as well as December 4 and 5, 2013 as part of the *Exhaustive Environmental Characterization of Soils* study have provided samples that are representative of the fill material on this site.

Two sieve analyses were conducted on those samples. These analyses indicate that the fill material samples contain, respectively, 19.6% and 28.5% gravel, 56.7% and 60.6% sand as well as 10.9% and 23.7% silt and clay. The gravel portion is composed of rock fragments. These results are presented in Plate No. 1 enclosed with this report.

Unconsolidated deposit stratigraphy at the borehole sites from which the samples subjected to the sieve analyses were collected is provided in the appended test pit reports. The test pit location plan (Drawing No. 2499-01-01) is also enclosed. These documents are taken from the *Exhaustive Environmental Characterization*



Membre de l'Association
des consultants
et laboratoires experts





of Soils study, for which a report (Reference No. 2499-01-01) has recently been issued by our firm.

Given the presence of unconsolidated deposits as described above, we recommend that a road structure be built with the various layers presented in Table 1 below.

TABLE I
PROPOSED ROAD STRUCTURE

Layer	Material	Thickness (mm)	Compactness (%)
Asphalt	To be determined by the designer		
Upper base	MG-20 crushed aggregate	200 ¹	98
		300 ²	
Sub-base	MG-112 granular material	450	95

¹ For light traffic;

² For heavy traffic.

The road structure proposed above is submitted for reference purposes only, and was selected on the basis of a general knowledge of the base thicknesses used regionally and adjusted to the foundation soils identified. It is recommended that this road structure be validated using road design software by factoring in the projected traffic density.

As for the surface of the infrastructure, it should be graded in such a way that would allow any water that could penetrate the road structure to drain off.

All materials to be used in the road structure must meet the standards set forth in the most recent edition of Tome VII on materials, published by the Ministère des Transports du Québec, or the standards prescribed in standards BNQ and NQ that apply to this construction.

This report has been read and commented on by Mr. Raymond Juneau, senior geotechnical engineer.



We remain available to provide any additional information.

Yours truly,

LABORATOIRES D'EXPERTISES DE QUÉBEC LTÉE

Louis Morin, Eng.
#OIQ: 5016616
Project Manager

LM/mm

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GENERAL

EXPLANATION OF THE BOREHOLE RECORD FORM

FV-1003 (2011-05)

The object of the Borehole Record is to assemble all the field and laboratory data regarding the soil, bedrock and ground water conditions obtained during the investigation at each borehole.

PROFILE

Elevation: This column gives the elevation of boundaries between various geological strata. The elevation refers to the datum given in the general heading.

Description: Each geological stratum is described using the standard classification given below.

The proportion of each constituent part of the soil as defined by the grain size range is denoted by the terms given below. The compactness of granular soils is defined by the Standard Penetration Value and the consistency of cohesive soils by the shear strength.

Classification	Particle sizes
Clay	smaller than 0.002 mm
Silt	0.002 to 0.08 mm
Sand	0.08 to 5.00 mm
Gravel	5.00 to 80 mm
Cobbles	80 to 300 mm
Boulders	larger than 300 mm

Descriptive terms	Proportion
"trace"	1 to 10%
"some"	10 to 20%
Adjective (e.g. gravelly, silty)	20 to 35%
"and" (e.g. sand and gravel)	35 to 50%

Compactness	Standard Penetration Test "N" Value (blows per 0.3 m)
Very loose	0 to 4
Loose	4 to 10
Medium or compact	10 to 30
Dense	30 to 50
Very dense	over 50

Consistency	Shear strength (kPa)
Very soft	less than 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	over 200

Degree of plasticity	Liquid limit
Low	less than 30%
Medium	between 30 and 50%
High	more than 50%

Stratigraphy: In this column the hatching symbols follow the symbols of the United Soil Classification System. The basic soil types are designated by the following symbols:



GROUND WATER

The depth to ground water level as measured in the borehole is given in this column. The observation dates are given in the graph column at the right.

SAMPLES

Condition: The location, length and condition of each sample is shown in this column. The sample condition is defined by the symbols in the general heading.

Number & type: Each sample of the borehole is designated by the number as shown in this column. The sample type is also shown by a symbol that refers to the legend given in the general heading.

Recovery: Soil sample and rock core recoveries are given in percent of the penetration of the sampler. The sample length is equal to the distance from the top of the sample to the cutting edge irrespective of whether the lower part of the sample is lost.

R.Q.D.: The Rock Quality Designation is obtained by summing up the total length of core recovered but counting only those pieces of core which are 10 cm in length or longer, given in per cent of the core run.

$$R.Q.D. = \frac{\sum li \geq 10 \text{ cm}}{Lcr}$$

TESTS

Laboratory tests and results of *in-situ* tests are shown in this column at their corresponding depths.

Standard Penetration Test Values, commonly designated as "N" values, are given in this column. This value is obtained by dropping a 63.5 kg hammer onto the drill rods from a height of 760 mm. The number of blows necessary to produce the penetration of the last 305 mm of the 51 mm standard split spoon sampler is regarded as the "N" value.

GRAPH

Any pertinent observations noted during drilling and in the laboratory are given in the column. Also shown graphically are the results of Atterberg limits and moisture content tests as well as those of the 51 mm cone dynamic penetration test when performed. This latter penetration test consists in the continuous driving of a 51 mm diameter 60 degrees cone under constant energy, generally 475 joules, and thus differs from the Standard Penetration Test.



TEST PIT REPORT

Number: 2499-01
Hole #: PE-19
Elevation:
Total depth: 2,00 m
Date: 2013-12-04

Project: EXTENSIVE ENVIRONMENTAL CHARACTERIZATION OF SOILS
Location: MANÈGE MILITAIRE DE QUÉBEC

Equipment used: CAT 308 E
Volume du godet : Technician: W.C.
Duration of excavation:
Easy: Average: Difficult:

Depth (m)	Samples			Description	Str	Cobbles and boulders (% and diameter)	End of pit: Refusal
	loc.	no.	Tests				
0,20				Asphalt.			
0,50		1-VR		Fill: Gray gravel, some sand, and trace of silt.			
1,00		2-VR	ACH	Fill: Brown sand, some gravel, trace of silt.			
2,00		3-VR	ACH DUP Ag	Fill: Gravelly sand, some silt. The gravel portion corresponds to rock fragments.		Cobbles (15%, 100mm)	
2,00				End of the excavation wall, which corresponds to bedrock.			

Symbols

- Groundwater level
- TA : Taken with auger
- VR : Manually taken
- Ag : Grain size analysis (sieving)
- Sed : Grain size analysis (se)
- ACH : Chemical analysis
- Wc : Water content
- LI : Liquid limit
- PI : Plastic limit

Groundwater: Non observed
Depth: m
Water infiltration: None
Pit dimension:
Wall: Steady
Depth: m
Comments: Archaeological excavation wall.



TEST PIT REPORT

Number: 2499-01

Hole #: PE-24

Elevation:

Total depth: 1,60 m

Date: 2013-12-05

Project: EXTENSIVE ENVIRONMENTAL CHARACTERIZATION OF SOILS

Location: QUÉBEC CITY ARMOURY

Equipment used: CAT 308 E

Duration of excavation:

Volume du godet :

Technician: W.C.

Easy: Average: Difficult:

Depth (m)	Samples			Description	Str	Cobbles and boulders (% and diameter)	End of pit: Refusal
	loc.	no.	Tests				
1	1-VR			Asphalt. (0,10m)		Cobbles. (5%, 100mm)	
				Fill: Gray sandy gravel, trace of silt. Presence of mortar, asphalt, glass, and brick debris. (0,55m)			
2	2-VR		ACH DUP	Fill: Dark brown silty and gravelly sand. The gravel portion corresponds to rock fragments. (1,60m)			
				End of the test pit. Bedrock reached.			

Symbols

- Groundwater level
- TA : Taken with auger
- VR : Manually taken
- Ag : Grain size analysis (sieving)
- Sed : Grain size analysis (se)
- ACH : Chemical analysis
- Wc : Water content
- LI : Liquid limit
- PI : Plastic limit

Groundwater: Non observed

Pit dimension:

Comments:

Depth: m

Wall: Steady

Water infiltration: None

Depth: m



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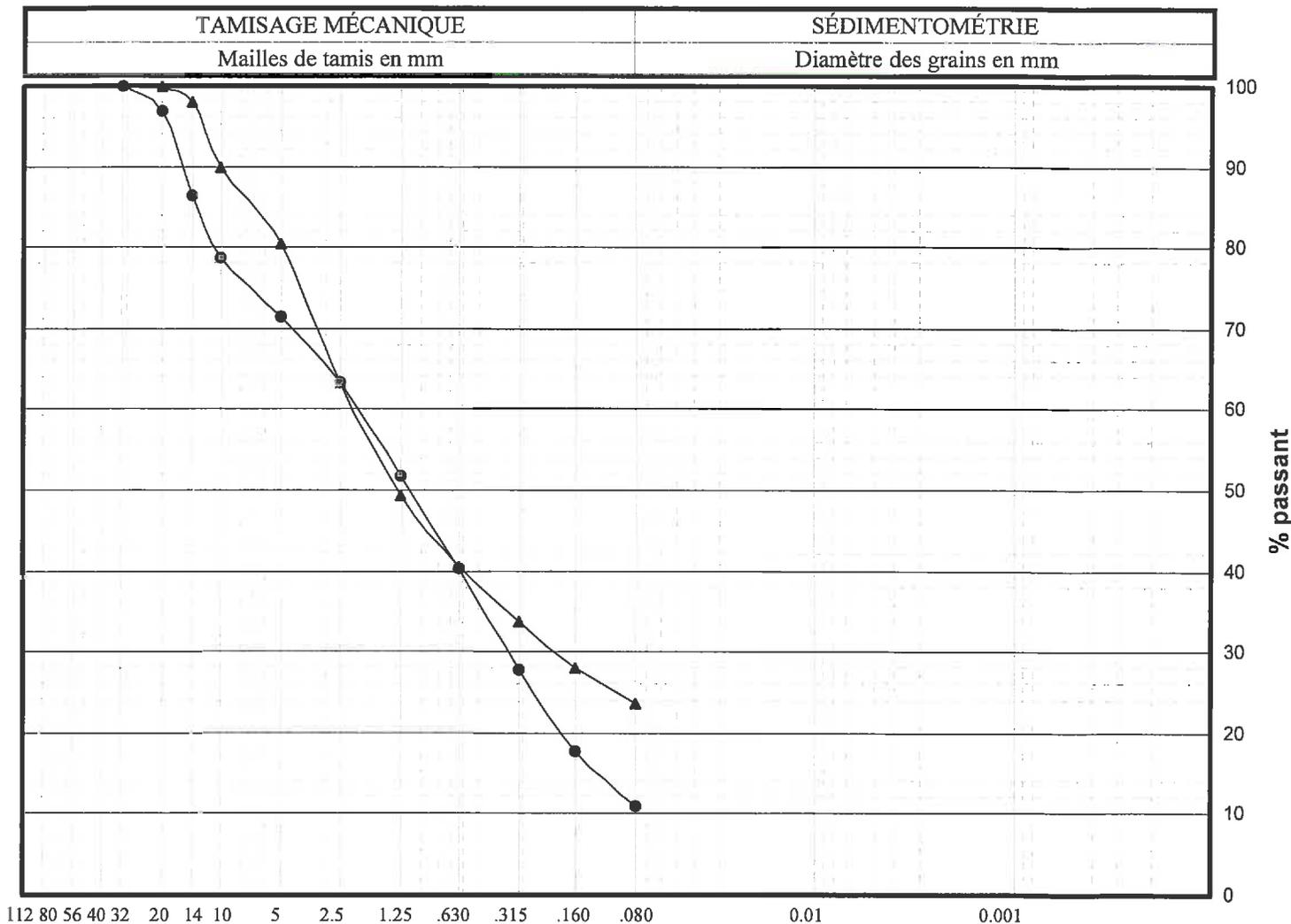
Normes LC 21-040
NQ 2501-025
CAN-BNQ 2501-070

Planche no.: 1

ANALYSE GRANULOMÉTRIQUE

Soumis à : ARCOP/DFS/STGM
Projet : Geotechnical Complement
Québec City Armoury

No. de projet : 2499-01
échantillon : 2499-01-001
2499-01-002



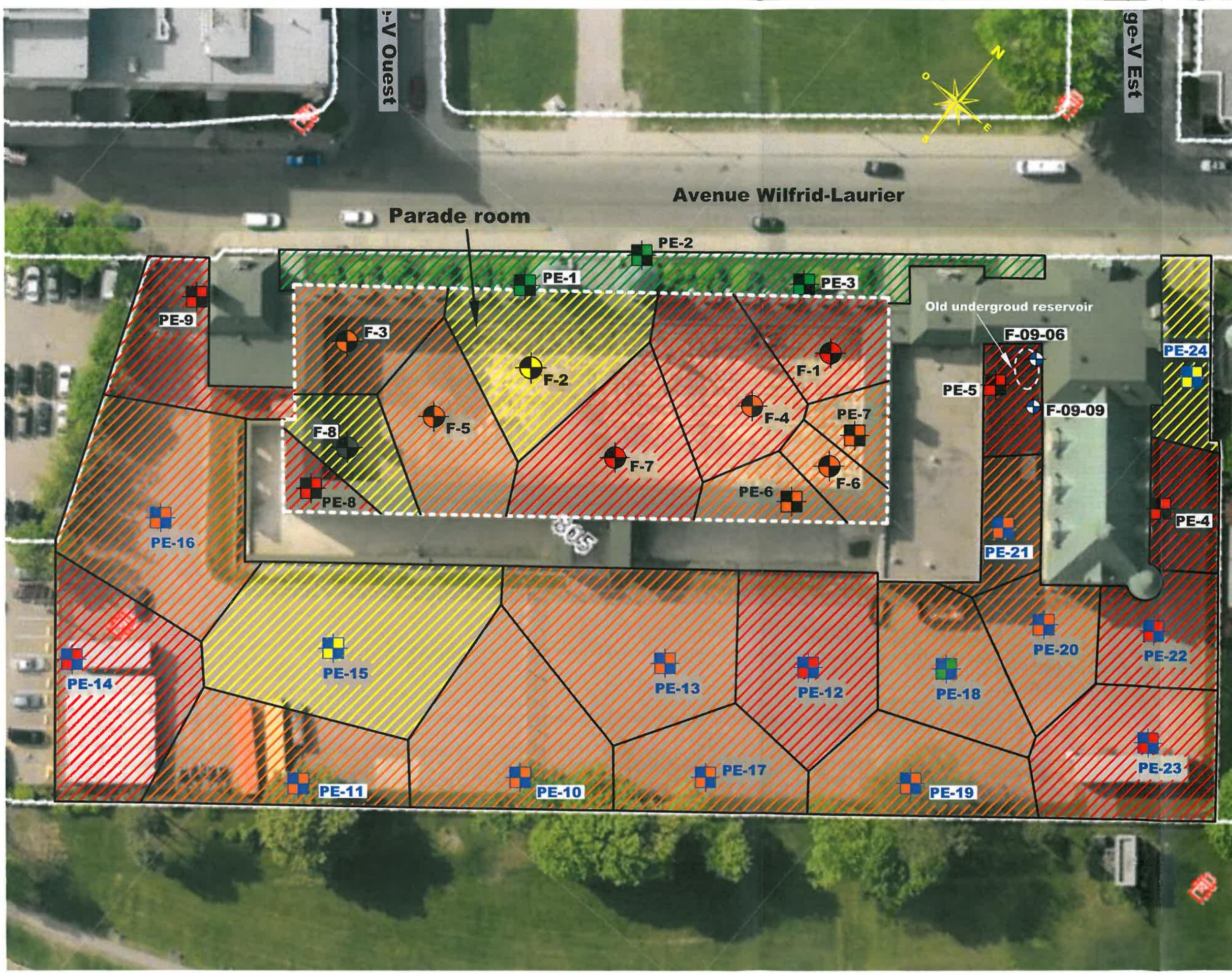
GROS		FIN		GROS		MOYEN		FIN		SILT		ARGILE	
GRAVIER				SABLE									

FORAGE	ÉCHANTILLON	PROFONDEUR (m)	DESCRIPTION
● PE-19	3-VR	1,0 à 2,0	Gravelly sand, some silt.
▲ PE-23	3-VR	0,75 à 1,75	Silty sand, some gravel.
● GRAV.= 28,5%		▲ GRAV.= 19,6%	
SABLE= 60,6%		SABLE= 56,7%	
SILT = 10,9%		SILT = 23,7%	

Remarques

Approuvé par : Joël Moir

Date : 2014-07-20



Legend:

- Parade room
- PE-10 Test pits carried out in November and December 2013
- PE-4 Test pits carried out in June 2013
- F-2 Boreholes drilled in May 2013
- F-2 Boreholes drilled in 2009 (approximate location)

Soil contamination ranges

<A	A-B
B-C	>C

Prepared for:
ARCOP/DFS/STGM Consortium

Prepared by:



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Seal:



Project Title:
Exhaustive Environmental Characterization of Soils, Québec City Armoury Québec (Québec)

Drawing Title:
Sounding Locations and Soil Contamination Distribution with Respect to the MDDELCC's "Policy"

Drawing: D.S. / F.L.	Scale: 1:500	Project No.: 2499-01
Verified: L.C. / F.L.	Date: November 2014	Drawing No.: 2499-01-01