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## SOLICITATION AMENDMENT MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise  
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<b>Title - Sujet</b> Hampton Harbour Approach	
<b>Solicitation No. - N° de l'invitation</b> EB144-192089/A	<b>Amendment No. - N° modif.</b> 003
<b>Client Reference No. - N° de référence du client</b> EB144-19-2089	<b>Date</b> 2018-11-23
<b>GETS Reference No. - N° de référence de SEAG</b> PW-\$PWA-110-5819	
<b>File No. - N° de dossier</b> PWA-8-80086 (110)	<b>CCC No./N° CCC - FMS No./N° VME</b>
<b>Solicitation Closes - L'invitation prend fin</b> <b>at - à 02:00 PM</b> <b>on - le 2018-12-04</b>	<b>Time Zone</b> <b>Fuseau horaire</b> Atlantic Standard Time AST
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<b>Signature</b>	<b>Date</b>

La modification no 003 vise à intégrer les éléments suivants :

Insérer :

Études géotechniques; rapport d'enquête pour le quai de Hampton (Nouvelle-Écosse)

Toutes les autres modalités et conditions demeurent les mêmes.



**GEOTECHNICAL INVESTIGATION  
HAMPTON WHARF  
HAMPTON, NOVA SCOTIA**

**Submitted to:**

**Public Works and Government Services Canada**  
1713 Bedford Row  
Halifax, Nova Scotia B3H 1T1

**Submitted by:**

Amec Foster Wheeler Environment & Infrastructure  
10000 Highway 100  
Dartmouth, Nova Scotia B3A 1K1

10 October 2017  
TV177001

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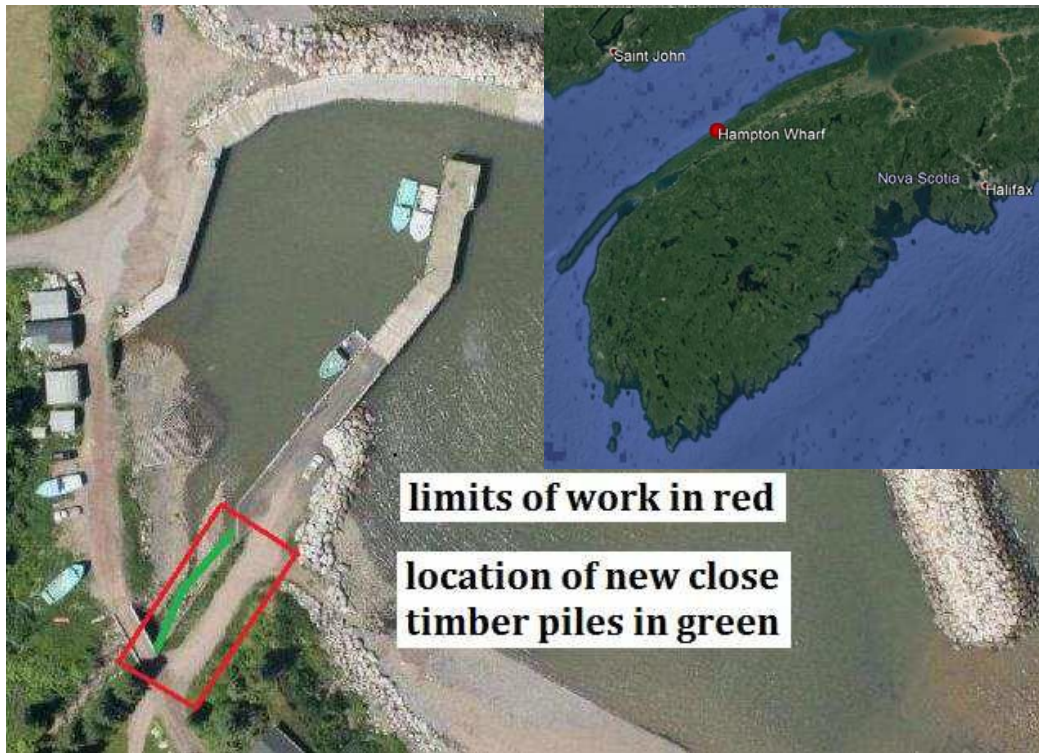


Figure 1: Site Location and Project Layout

During drilling of the borehole the conditions encountered were as follows. The  
 samples were placed in moisture-tight containers and taken to our laboratory for classification and  
 testing.

The borehole locations were established in the field by our personnel.

## 4 SUBSURFACE CONDITIONS

Details of the conditions encountered at the borehole locations are provided on the borehole  
 logs in Appendix A. The following section summarizes the conditions and describe them in  
 accordance with the unified classification system.

It should be noted that stratigraphic boundaries indicated on the borehole logs do not necessarily  
 represent a transition from one condition to another and do not necessarily indicate an exact line of geologic  
 change. Subsurface conditions may vary between and beyond the borehole locations.

### 4.1 Silty Sand with Cobbles

A layer of red brown sand with cobbles and small boulders was encountered from ground  
 surface at both the borehole locations. The thickness of this layer ranged from 0 m to 0 m.

Measured 'N' values in this layer ranged from 0 to 100 indicating a decrease to compacted conditions. The 100 N value is attributed to the presence of cobble.

## 4.4 Inferred Bedrock

Bedrock was inferred below the sandstone in 1 to 2 m depth below ground surface.

## 4.5 Groundwater Conditions

Groundwater was not observed during drilling of the borehole. However, the area is located in the tidal zone.

# 5 DESIGN RECOMMENDATIONS

## 5.1 General

It should be noted that the design recommendations for this project are provided for the guidance of the designer. The contractor bidding on or undertaking the work should make their own assessment of the site and interpretation of the recommendations provided so to effect their construction procedure and schedule.

As mentioned above, the existing closed face timber sheet pile wall on retention wall to support the wharf. The maximum retained depth of the wharf is about 2 m. The top of the sheet pile is tied back with tie rods to a concrete anchor wall. As mentioned above, the existing timber sheet pile has been damaged and tilted outward as a result of foundation settlement.

The following is understood:

- The proposed repair of the wharf will include installation of a new retention structure in front of the existing foundation wall to provide required lateral support for the existing wharf.
- The new retention structure will be constructed of precast treated timber sheet pile back to the existing concrete anchor wall.
- The new timber sheet pile will be 150 to 200 mm diameter and 200 mm butt diameter.
- The gap between the existing wall and the new retention structure will be filled with granular material.
- There will be no settlement on the sheet pile other than their own weight.

## 5.2 Timber Piles

### 5.2.1 Structural Design

After the 2003 Canadian Foundation Engineering Manual, the structural design of wood sheet pile must conform with the requirements of Section 10 of the National Building Code of Canada 2000. No special consideration needs to be taken to condition the sheet pile but special attention must be taken to protect the sheet pile end and head from damage due to drilling the sheet pile.

### 5.2.2 Penetration Depth

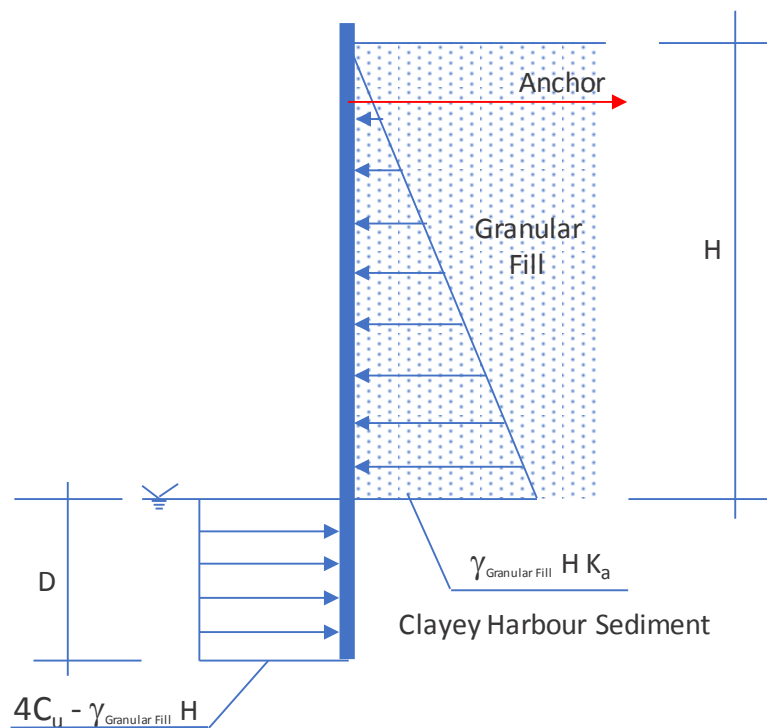
The 2003 Manual provides general guidance for determining penetration depth of flexible sheet pile retention walls similar to the proposed retention structure at location 1.

After 2003 Manual, two different methods can be used for design of precast anchor wall system, namely the "free-earth" and "fixed-earth" method. When the soft ground condition at the site, the



"free-earth" method can be considered more appropriate and suitable for design of single anchor wall system at Port of Mombasa. The "free-earth" method assumes that the wall acts as a beam supported at two points, the base of the wall and the anchor, and the pressure of the earth below the anchor bottom is free to rotate or translate throughout its bottom end.

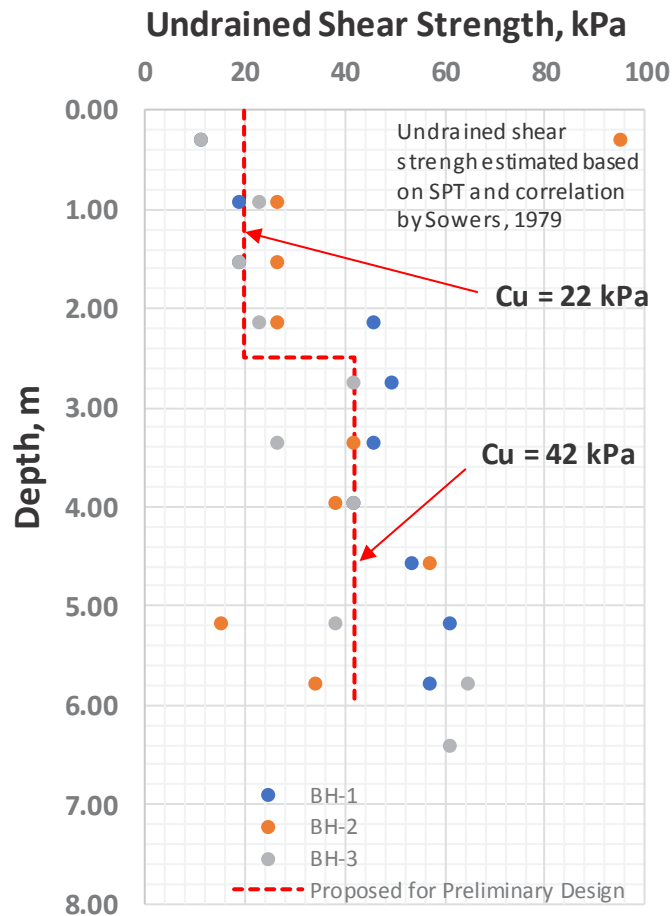
To determine the required depth of the penetration, the active earth pressure and water pressure on the retaining wall could be estimated from the characteristics of the anchor, the sediment water pressure distribution on the timber pile wall can be modified as shown below in Figure 3.



**Figure 3. Schematic lateral pressure distribution on anchored sheet pile wall in clay**

If the water traffic is present on the wall, the water pressure of that traffic on the retaining wall could be added to the pressure distribution presented above.

As shown on Figure 3, the active pressure coefficient, unit weight of granular fill and undrained shear strength of harbour sediment are required to estimate the water pressure on the wall or the purpose of retaining wall. The unit weight of granular fill can be assumed 20 kN/m<sup>3</sup> and 1 kN/m<sup>3</sup> respectively. The recommended for retaining design undrained shear strength of the harbour sediment is shown below on Figure 4.



**Figure 4. Proposed undrained shear strength of harbour sediment**

The required depth of penetration is determined from the moment equilibrium about the support contact. It is recommended to increase the estimated depth by 0.5 to 1.0 to provide an adequate factor of safety of 1.5 or more based on our preliminary estimate of penetration depth of the new timber pile. It could be that the

It is possible that the interference induced by the new pile may not fully develop due to the pile being due to the narrow space to be filled between the existing pile and the new timber pile. In the other hand, it is unclear how the existing pile and timber pile will interact with the new pile and the new timber pile will be difficult to model the condition accurately and the model is out of our current scope. Therefore, for the purpose of preliminary design, the full capacity of the pile on the new pile will be assumed to be acceptable and simplified to more conservative model.

### 5.2.3 Negative Friction (down drag)

After the new pile is installed through the stratum of cohesive soil, the downward movement of the consolidated sediment will cause a drag on the pile. The downward drag may cause settlement and reduce the capacity of the pile. However, based on our

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Construction of Refractory  
October 2017

understand there will be no vertical load on the new pile other than their own weight. Therefore potential settlement and reduced capacity of the new timber pile due to down drag will be minimal to no impact on the structural integrity of the wharf.

#### 5.2.4 Installation of Timber Piles

A 100M 100mm when driven wood pile low-velocity hammer blow should be used for embedding and in the case of termite hammer should be retracted immediately after the first incorporation of soft cushion in the case block. The rate of the hammer used for the driven depends on experience and on a number of factors. Commonly the weight of the pile, the diameter of head and toe, the length and the compactness. The hammer-rated energy should be about 1000 Joules and should not exceed 1000 Joules equal to 1000 Newton metre (the pile head diameter in metre).

The pile head should be protected with protection in the form of a tee and the toe should be protected with a steel tee. Driven pile Timber pile cannot withstand hard driven. Hard driven will lead to the destruction of the pile. To avoid this, driven must be stopped when resistance to penetration is encountered. The set criteria should not exceed 100mm.

Our understanding is that the new retention wall will not be used to tie back and therefore no dredging is required. At the bottom of the trench should be excavated in the harbour bottom to accommodate installation of the new timber pile. Our understanding is that the proposed trench will be offset 1 to 2 m from the base of existing wall and approximately 0.5 m deep. The trench is required to remove large cobbles and boulders from the harbour bottom that may obstruct the driven operation. The trench should be backfilled with granular fill following the completion of new pile installation.

### 5.3 New Granular fill

#### 5.3.1 Fill Gradation

The new granular fill to be placed between the new and the existing pile should consist of rock fill between 20 and 100 mm in size.

#### 5.3.2 Consolidation Settlement under the New Fill

The new fill placed between two walls, existing and new, will introduce additional weight on the soft harbour sediment causing it to settle. The settlement process comprises of three components: immediate settlement, consolidation settlement and secondary compression creep. The magnitude of each component varies depending on the nature and properties. The consolidation settlement dominates in saturated or near saturated fine grain soils.

To accurately estimate the consolidation settlement under the new fill, advanced field monitoring program combined with advanced laboratory testing is required. However, a program and testing is outside of the current scope.

Based on our preliminary estimate, the consolidation settlement under the new fill not expected to exceed 20 cm with consolidation to be completed within four years or less. The estimate were made based on the following assumption:

- The thickness of the new fill 1 m
- Offset distance between the new and the existing timber pile wall 0.5 m or less

- The thickness of the soft clastic sediment range between 0 and 10 m and the sediment underlain by low permeable bedrock
- The confining conditions of the soft clastic sediment were controlled based on subsided emersion

A geotechnical investigation is required on the limited amount of site. The recommendation contained in this report is based upon the condition encountered at the borehole location. It could in condition be encountered which differ from those at the borehole location. We request that we be notified immediately in order to permit revision of our recommendation.

This work has been undertaken in accordance with normal accepted electronic engineering practice. No other warrantable error is identified or implied. The limitation of this report is referred to in Appendix A. Advice was given to third parties of this information or information on or decision made based on the true reliability of such third parties. Amec is not a dealer or acceptor of no responsibility for damage suffered by third parties as a result of decision made or action based on this report.

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**AMEC Foster Wheeler Environment & Infrastructure**  
A division of AMEC Foster Wheeler Americas Limited

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## **APPENDIX A**

### **BOREHOLE LOGS**

## GENERAL REPORT NOTES

### STANDARD PENETRATION TEST—SPT

The standard penetration values are recorded on the Borehole Records as N values. The N values are the number of blows required to advance a standard, 50 mm diameter, split spoon sampler a distance of 305 mm into the soil using a 63.5 kg hammer freely falling a distance of 760 mm.

### DYNAMIC CONE PENETRATION TEST----DCPT

This is a similar procedure to that used in driving a standard 50 mm split spoon sampler except that a cone is driven rather than a soil sampler. A variety of cones can be used. Often the cones are 51 mm diameter with a 60 degree taper from the tip.

### SAMPLE TYPE ABBREVIATION USED ON BOREHOLE LOGS

S.S.	Split spoon	S. H.	Shelby tube	W.S.	Wash sample
A.S.	Auger sample	R. C.	Rock Core	P.	Sample pushed

### SOIL DESCRIPTION

The standard terminology to describe cohesionless soils includes the compactness condition as generally determined by the SPT.

The standard terminology to describe cohesive soils includes the consistency, which is based on various methods of determining undrained shear strength, and by SPT


Cohesionless Soils.		Cohesive Soils		
<u>Condition</u>	<u>N Values</u>	<u>Consistency</u>	<u>N Values</u>	<u>Undrained Shear Strength, kPa</u>
Very loose	0 – 4	Very soft	0 – 2	< 12.5
Loose	4 – 10	Soft	2 – 4	12.5 - 25
Compact	10 – 30	Firm	4 – 8	25 – 50
Dense	30 – 50	Stiff	8 – 15	50 - 100
Very Dense	> 50	Very stiff	15 – 30	100 – 200
		Hard	>30	>200

### NOTE

The soil conditions, profiles, comments, conclusions and recommendations found in this report are based upon samples recovered during the field work. Soils are heterogeneous materials, and, consequently, variations may be encountered at site locations away from where the samples were obtained. During construction, competent, qualified personnel should verify that no significant variations exist from those described in the report.

# LOG OF BOREHOLE BH1

SHEET 1 OF 1


PROJECT No.: <b>TV177001</b>	ELEVATION: ---	
CLIENT: <b>PWGSC</b>	DATUM:	
PROJECT NAME: <b>PRO Delhaven &amp; Hampton</b>	METHOD: <b>SS / Auger</b>	
LOCATION: <b>Hampton Warf</b>	DIAMETER: <b>100 mm</b>	
DATE DRILLED: <b>9-14-17</b>	WATER LEVEL:	
LOGGED BY: <b>A. Gale</b>	CONTRACTOR: <b>Nova Drilling</b>	

DEPTH (m)	ELEVATION (m)	STRATIGRAPHIC DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES					UNDRAINED SHEAR STRENGTH					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE or RQD%	OTHER TESTS	Δ Peak (kPa)		▲ Residual						
										20	40	60	80					
										STANDARD PENETRATION TEST Blows/0.3m								
0										20	40	60	80	●	10	20	30	
		Red / Brown, silty SAND with cobbles, small boulders and clay			SS	1	25	3		●								
1		Red / Brown, sandy silty CLAY (CL-ML)			SS	2	500	5		●								
					SS	3	425	5		●								
2					SS	4	600	12	S, L, M	●								
					SS	5	225	13		●								
3					SS	6	225	12		●								
					SS	7	600	11		●								
4					SS	8	450	14		●								
					SS	9	250	16		●								
5					SS	10	450	15		●								
6					SS	11	200	77 / 400mm		●								
		Inferred Grey, sand stone bedrock			AU										>>●			
		End of Borehole @ 6.7 m																

GEOTECHNICAL BOREHOLE TV177001\_HAMPTON WHARF.GPJ AMEC HALIFAX.GDT 10/18/17

# LOG OF BOREHOLE BH2

SHEET 1 OF 1

PROJECT No.: <b>TV177001</b>	ELEVATION: ---	
CLIENT: <b>PWGSC</b>	DATUM:	
PROJECT NAME: <b>PRO Delhaven &amp; Hampton</b>	METHOD: <b>SS / Auger</b>	
LOCATION: <b>Hampton Warf</b>	DIAMETER: <b>100 mm</b>	
DATE DRILLED: <b>9-14-17</b>	WATER LEVEL:	
LOGGED BY: <b>A. Gale</b>	CONTRACTOR: <b>Nova Drilling</b>	


DEPTH (m)	ELEVATION (m)	STRATIGRAPHIC DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES					UNDRAINED SHEAR STRENGTH					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT		
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE or RQD%	OTHER TESTS	△ Peak (kPa)		▲ Residual							
										20	40	60	80						
										STANDARD PENETRATION TEST Blows/0.3m								WATER CONTENT (%)	
0																			
		Red / Brown, silty SAND with cobbles, small boulders and clay			SS	1	100	25											
1		Red / Brown, sandy silty CLAY (CL-ML)			SS	2	325	7											
					SS	3	325	7											
2					SS	4	500	7											
					AU														
3					SS	5	25	11											
					SS		0	10											
4					SS	6	350	15											
5					SS	7	300	4											
					SS	8	450	9											
6																			
7		Red / Brown, sandy CLAY with occasional cobbles			AU														
8																			
		End of Borehole @ 8.8 m																	

GEOTECHNICAL BOREHOLE TV177001\_HAMPTON WHARF.GPJ AMEC HALIFAX.GDT 10/18/17



# LOG OF BOREHOLE BH3

SHEET 1 OF 1

PROJECT No.: <b>TV177001</b>	ELEVATION: ---	
CLIENT: <b>PWGSC</b>	DATUM:	
PROJECT NAME: <b>PRO Delhaven &amp; Hampton</b>	METHOD: <b>SS / Auger</b>	
LOCATION: <b>Hampton Warf</b>	DIAMETER: <b>100 mm</b>	
DATE DRILLED: <b>9-14-17</b>	WATER LEVEL:	
LOGGED BY: <b>A. Gale</b>	CONTRACTOR: <b>Nova Drilling</b>	

DEPTH (m)	ELEVATION (m)	STRATIGRAPHIC DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES					UNDRAINED SHEAR STRENGTH △ Peak (kPa)    ▲ Residual				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE or RQD%	OTHER TESTS	STANDARD PENETRATION TEST Blows/0.3m				W <sub>p</sub>	W	W <sub>L</sub>
										20	40	60	80	10	20	30
0		Red / Brown, silty SAND with cobbles, small boulders and clay			SS	1	100	3		●						
1		Red / Brown, sandy silty CLAY (CL-ML)			SS	2	125	6		●						
					SS	3	600	5		●						
2					SS	4	375	6		●						
					SS	5	225	11		●						
3					SS	6	125	7		●						
					SS	7	125	11		●						
4					AU	8										
					SS	9	250	10		●						
5					SS	10	500	17	S, M	●						
6					SS	11	400	16		●						
		End of Borehole @ 6.7 m														

GEOTECHNICAL BOREHOLE TV177001\_HAMPTON WHARF.GPJ AMEC HALIFAX.GDT 10/18/17

## **APPENDIX B**

### **LAB TEST RESULTS**

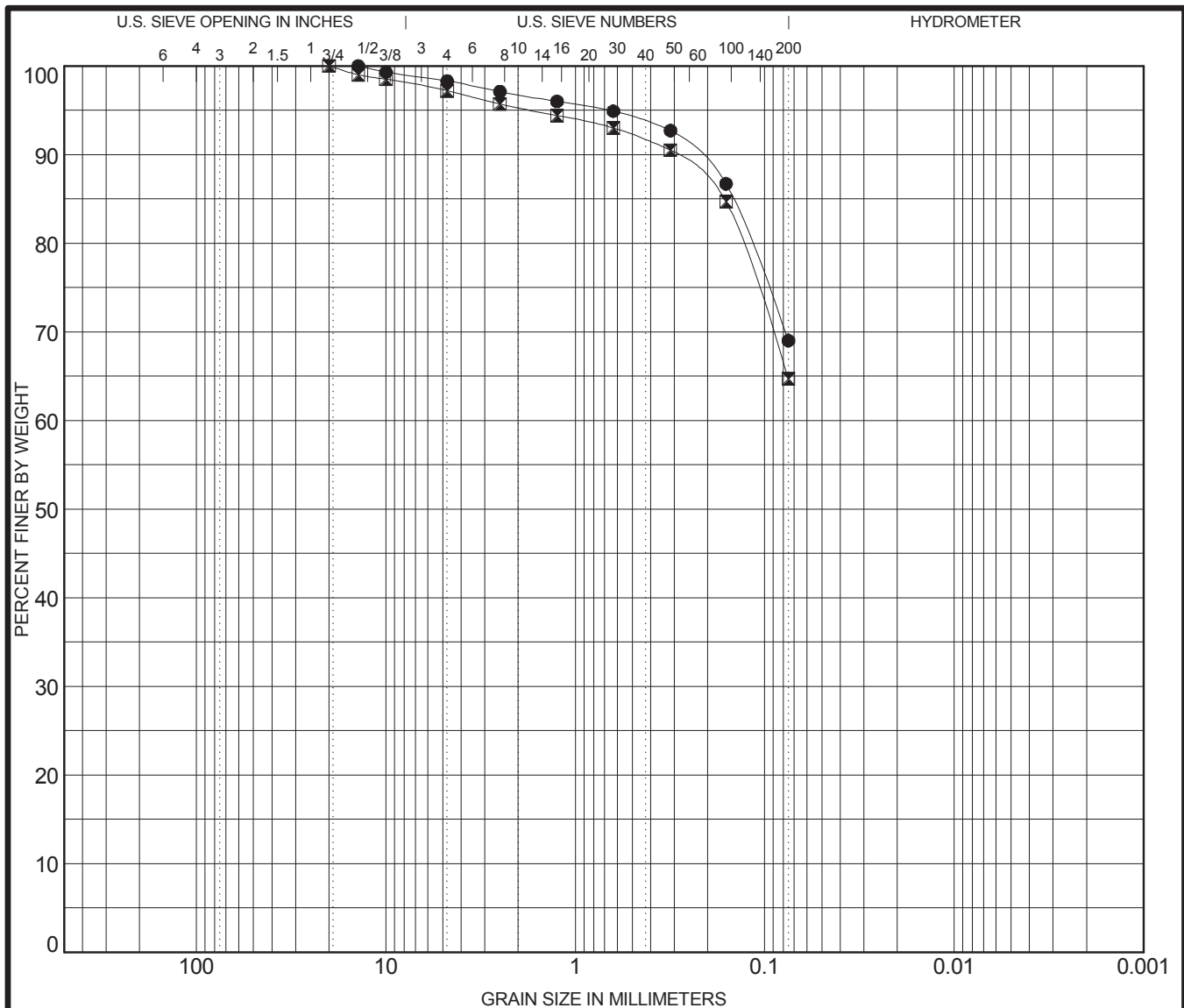


# Appendix B. Summary of Laboratory Results

Project No.: TV177001  
Client: PWGSC  
Project Name: PRO Delhaven & Hampton  
Location: Hampton Warf

GENERAL INFORMATION:		SAMPLING:		LAB TEST STATISTICS:	
Number of BH/TP:	3	Auger Cuttings	4	Moisture Content:	2
Total Length of Drilling:	22.3 m	Split Spoon	30	Atterberg Limits:	1
				Sieve Analysis:	2
				Hydrometer Analysis:	0

Borehole	Depth (m)	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	% Silt and Clay	Class-ification	Water Content (%)	Dry Density (Mg/m <sup>3</sup> )	Void Ratio
BH1	2.13	20	13	7	1.7	29.3	69.0	CL-ML	20.0		
BH3	5.79				2.8	32.5	64.7	CL-ML	18.1		



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification				LL	PL	PI	Cc	Cu
●	BH1	2.13 m	SANDY SILTY CLAY(CL-ML)				20	13	7	
✕	BH3	5.79 m	SANDY SILTY CLAY(CL-ML)							
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay	
●	BH1	2.13 m	14			1.7	29.3	69.0		
✕	BH3	5.79 m	20			2.8	32.5	64.7		

## GRAIN SIZE DISTRIBUTION

Project No.: TV177001

Client: PWGSC

Project Name: PRO Delhaven & Hampton

Location: Hampton Warf



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## **APPENDIX C**

### **REPORT LIMITATIONS**

## **REPORT LIMITATIONS**

The conclusions and recommendations given in this report are based on information determined at the test hole location. The information contained herein in no way reflects on the environment or effect of the project unless otherwise stated. Subsurface and groundwater conditions between and beyond the test hole may differ from those encountered at the test hole location and conditions may become different during construction which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the geotechnical engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the test hole.

The design recommendations given in this report are applicable only to the project described in the test and then only if constructed substantially in accordance with the details stated in this report. Since a detailed design of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations and that assumptions made in our analysis are valid.

The comments made in this report relating to potential construction problems and possible methods of construction are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine the effect of construction methods and costs for estimating the effects of surface to or for further information and uncertainties. The contractor bidding on this project or undertaking the construction should therefore make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normal accepted geotechnical engineering practice. No other warranties are made or implied.

Anyone who is a third party user of this report or in reliance on or decisions to be made based on the report is responsible for such third parties. Amec Foster Wheeler Environment & Infrastructure accepts no responsibility for damages suffered by a third party as a result of decisions made or actions based on this report.