

December 20, 2018

Government of Yukon – Community Services
Land Development Branch C-14
PO Box 2703
Whitehorse, YT Y1A 2C6

ISSUED FOR USE
FILE: ENG.WARC03386-25
Via Email: christine.plante@gov.yk.ca

Attention: Ms. Christine Plante, MSc., P.GEO, Senior Project Manager

Subject: Geotechnical Evaluation – Phase 6
Whistle Bend Subdivision – Whitehorse, Yukon

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by the Government of Yukon – Community Services – Land Development Branch to complete a geotechnical evaluation for Phase 6 and a portion of Phase 7 of the Whistle Bend Subdivision.

This report summarizes the work completed and the conditions encountered, along with presenting recommendations to support final design.

2.0 GEOTECHNICAL INFORMATION FROM PREVIOUS EVALUATIONS

Prior to the current evaluation work, other geotechnical evaluations had been completed throughout the Phase 6/7 portion of the Whistle Bend Subdivision, including:

- Project No W14103567-18.003 - 2014: Three testpits were excavated along the glaciofluvial landform which parallels the west side of Wyvern Avenue in order to characterize the sand in this deposit and assess potential for reuse as non-frost susceptible backfill.
- Project No ENG.WARC03381-01– 2018: A single borehole was drilled to a depth of 9.5 m for foundation design of the lift station constructed on the corner of Wyvern Avenue and Leota Street. Standard Penetration Testing (SPT's) was performed at regular intervals throughout the depth of this borehole to confirm soil consistency (a measure of soil strength).

The testhole logs from the two projects mentioned in this section are presented in Appendix A of this report.

3.0 CURRENT SITE ASSESSMENT

On October 31, 2018, 8 boreholes were drilled throughout Phase 6; 2 boreholes were drilled along the east edge of Phase 7 (including the potential location of a storm water retention pond); and a single borehole c/w a groundwater monitoring well was advanced in the greenbelt along the east side of Casca West between Mascot street and the lane located north of Keno Way.

All boreholes were drilled to termination depths of between 4.5 m and 6.0 m (dependent upon the proposed depths of the deep utilities) with a truck mounted CME 75 drill rig contracted from Don Jeck Services of Whitehorse, Yukon. The drill rig was equipped with solid flight augers. Tetra Tech's site representative was Mr. Myles Plaunt, CET of Tetra Tech's Whitehorse office.

Disturbed grab samples were collected at regular intervals throughout the depth of each of the boreholes drilled. Samples were returned to the Whitehorse laboratory for natural moisture content determination along with index testing (sieves and hydrometers to determine particle size distribution characteristics of typical soils encountered along with Atterburg Limits to assess plasticity and soil permeability testing for the samples collected at the proposed storm water retention pond area in Phase 7).

Upon completion, all boreholes were backfilled to grade to ensure safe site conditions and UTM coordinate locations of the boreholes were recorded using a hand-held GPS unit.

The location of the current and previously completed testholes used for this evaluation are all presented on Figure 1, attached and as mentioned above, the detailed testhole logs are presented in Appendix A.

4.0 SITE DESCRIPTION & GEOTECHNICAL CONDITIONS

4.1 Site Access, Surface Conditions & Terrain

At the time of the current field investigation, the main roadway corridors, including Wyvern Avenue, Witch Hazel Drive and Vedder Avenue north of Witch Hazel Drive were cleared, grubbed and stripped. As well, the meadow area north of Leota Street and the previously cleared area along the east side of Phase 6 (along the storm water drainage trench) presented the opportunity to assess soil conditions close to Peep Street and Greenstreet West.

In general, Phase 6 is quite flat and the only terrain features noted were the glaciofluvial deposit along the west side of Wyvern Avenue and a smaller feature located along Vedder Avenue north of Witch Hazel Drive.

4.2 Subsurface Conditions

4.2.1 Soil Conditions

As expected, the entire area assessed (Phase 6 and the east side of Phase 7) is underlain by glaciolacustrine silt. The only feature where good quality sand can be recovered is along the west side of Wyvern Avenue as noted in testpits E01, E02 and E03 excavated in April, 2017.

4.2.2 Groundwater

Groundwater was not encountered in any of the current or historical testholes advanced within the study area. However, current conditions encountered during the 2018 Phase 3 D and 3E construction project suggests that there is still potential for groundwater to travel along existing deep utility corridors from one phase of development to another.

Prior to construction, contractors should be encouraged to complete a cursory testpitting program to assess whether additional dewatering will be required to execute their contract.

4.2.3 Seasonal Frost and Permafrost

No seasonal frost was encountered during the current drilling program and permafrost was not encountered (or anticipated) throughout the Phase 6 and 7 areas.

4.2.4 Bedrock

Bedrock has not been encountered in any of the deep boreholes drilled throughout the Whistle Bend Subdivision area.

5.0 RECOMMENDATIONS

5.1 Challenges Related To Deep Utility Construction

As expected the biggest challenge related to deep utility construction will be material reuse. Moisture contents of the majority of the glaciolacustrine silt samples collected during the current field investigation were over 20%, which is more than 3% above optimum moisture for the glaciolacustrine soils. In Boreholes 6-07; 7-01 and 7-02 (possible pond location), natural moisture contents of over 30% exist. This soil is acceptable as backfill, but moisture conditioning may be necessary (dried out in advance of reuse) to facilitate compaction. The contractor should be prepared to disturb the spoil piles or mix the soil with drier soils in an attempt to reduce the moisture content and make it suitable for use as backfill below 1.7 m in the deep utility trenches.

Soft, wet soil conditions below invert elevations will necessitate the use of bedding stone under and around pipes.

5.2 Underground Utilities Construction

The excavation of deep utility trenches must conform to Yukon *Occupational Health and Safety Regulations* guidelines. The fine-grained soils at depth throughout Phase 5 should not be prone to sloughing, therefore, trench side slopes cut to 0.75:1.0 (horizontal:vertical) should ensure safe, compliant, working conditions. If areas of instability are encountered, the contractor should relax the trench sideslopes as required.

All material excavated from the utility line trenches can be considered for backfill at depth. However, as mentioned above, material reuse will be dependent upon the management of spoil pile moisture contents.

Deep utility line backfill should be placed in 200 mm thick lifts and compacted to 95% of Standard Proctor Maximum Dry Density (SPMDD) for material placed below 1.0 m from grade and 98% of SPMDD for backfill placed in the final 1.0 m from grade.

It is recommended that a Class "B" pipe bedding configuration (commonly used on YG and City of Whitehorse projects with 150 mm of bedding under the pipe, beside the pipe and 300 mm above the pipe) be specified for this project. When compacted to at least 95% of SPMDD, this bedding configuration will ensure proper support and protection of the utility lines during backfill.

Bedding may be imported bedding sand in dry areas, or bedding stone in areas where wet and unstable conditions are encountered below invert elevations.

Imported bedding sand and stone should conform to the gradation specifications presented in Table 1.

Table 1: Recommended Pipe Bedding Materials Specifications

BEDDING SAND		25 mm BEDDING STONE	
Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass
10.000	100	25.000	100
5.000	80 – 100	20.000	70 - 100
2.000	55 – 100	12.500	55 – 100
0.630	25 – 65	10.00	30 – 80
0.250	10 – 40	5.000	0 – 40
0.080	2 – 15	2.000	0 – 10

Note: Gradation Limits From City of Whitehorse Servicing Standards Manual

5.3 Seasonal Frost Penetration

Based on the installation depths of the utility line piping, there will likely be some installation within the estimated depth of seasonal frost penetration. However, it is assumed that the civil consultant (Associated Engineering) has addressed this concern and the final design has appropriate mitigative measures.

5.4 Soil Corrosivity

5.4.1 Factors Contributing To Soil Corrosivity

Soil corrosivity and pipe corrosion are not considered to be directly measurable; however, research suggests that the main factors contributing to soil corrosivity include:

- Aeration – since well aerated soils generally have lower water retention properties (grain size) and better evaporation rates, loamy and sandy soils are desirable around ductile iron pipes and fittings. However, typical construction methods (the compaction process), will affect the aeration potential;
- pH – The acidity of a soil can lead to extreme corrosion rates and pitting. When pH levels are below 4.5 (very acidic) or above 9.1 (strongly alkaline), high corrosion loss rates can be expected;
- Moisture Content and Resistivity – Since water is one of the components necessary for electrochemical corrosion (along with oxygen and metal), the moisture content of the soil is probably the most important factor in assessing potential. Increased moisture contents will result in lower resistivity in soil and therefore increasing potential for corrosion. Interesting to note, however, research suggests that once the soil is saturated, the additional moisture has no increased effect on resistivity; and

- Temperature – Soils at or below freezing will have increased resistivity for a given moisture content and if this happens rapidly (which would be the case in the Yukon), the increase in resistivity corresponds to decreases in the corrosive potential of the soil.

5.4.2 Soil Corrosivity Testing

To assess potential for corrosivity, an analytical lab can perform a suite of tests that includes:

- Physical tests including Conductivity, percent of Moisture, pH, Redox Potential, and Resistivity;
- Leachable Anions and Nutrient testing including Chloride and Sulphide testing; and
- Anion and Nutrient testing including Sulphate testing.

5.4.3 Interpretation Of Corrosivity Results

Although soil corrosivity is not a directly measurable soil parameter, there are systems and methods that attempt to predict potential and the resulting corrosion of metallic pipe and fittings based on soil properties. Two of the more widely used methods are the American Waste Water Association (AWWA) 10 point scoring method that bases potential on the weighted aggregation of 5 soil properties. A second method that is used is the Spicklemire (2002) 25 point scoring method which is similar to the AWWA method but has additional factors. For the purpose of this exercise, the AWWA method will be used to assess potential. The five soil parameters used to calculate the weighted aggregation includes resistivity, pH, redox potential, sulphides and moisture content. If the total is greater than 10 points, protective measures such as cathodic protection of cast iron alloys is warranted.

As part of the Whistle Bend Phase 3D and 3E geotechnical evaluation, a composite sample of soil from various depths was submitted for testing. As mentioned in an April 26, 2018 email, the results were assessed using the AWWA 10-point scoring method and the total was between 2 and 3. Since this is well below the threshold of 10, no concerns are anticipated.

Based on the Phase 3D and 3E results, it is very likely that soil corrosivity throughout Phases 6 and 7 will not be an issue.

5.5 Pavement Structure

As with previously constructed phases of the Whistle Bend Subdivision, It is assumed that pavement structure design for Phase 6 will include 75 mm of asphalt; 150 mm of 20 mm crushed basecourse; 200 mm of 50 mm crushed sub-base; 500 mm of pit run sub-base and 800 mm of select sand for residential streets and for collectors, 100 mm of asphalt, along with the same thicknesses of the granular components will be used for design.

5.5.1 Roadway Construction Recommendations

All imported granular materials (crushed basecourse, crushed sub-base and pit run sub-base) must meet the gradation limits presented in Table 2. If non-compliant materials are proposed, a sample can be submitted to Tetra Tech for testing and an opinion regarding suitability for use can be supplied.

Table 2: Imported Gravel Gradation Specifications

20 mm CRUSHED BASECOURSE AGGREGATE		80 mm PIT RUN SUB-BASE AGGREGATE		50 mm CRUSHED SUB-BASE AGGREGATE	
Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass
20.000	100	80.000	100	50.000	100
12.500	64 – 100	25.000	55 - 100	25.000	55 - 100
5.000	36 – 72	12.500	42 - 84	12.500	42 - 84
2.500		5.000	26 - 65	5.000	26 - 65
1.250	12 – 42	1.250	11 - 47	2.500	
0.315	4 – 22	0.315	3 - 30	1.250	11 - 47
0.080	3 - 6	0.080	0 - 8	0.315	3 - 30
				0.080	0 - 8

Note: Gradation Limits From City of Whitehorse Servicing Standards Manual

All sub-base materials must be placed in lifts not exceeding 200 mm in thickness and the contractor should be prepared to moisture condition each lift to facilitate compaction. The crushed 20 mm basecourse aggregate can be placed in a single lift and final tight-blading and recompaction should be performed immediately prior to paving.

If soft areas are encountered during roadway reconstruction, additional subcut may be required (down to a dry, stable surface). When the subcut areas are being backfilled, all materials placed within the final meter must be compacted to at least 98% of SPMDD. For material placed below 1.0 m from finished grade, 95% of SPMDD is considered acceptable. All granular material placed as subcut backfill will have to be moisture conditioned to facilitate compaction.

5.5.1 Granular Structure Under Sidewalks

The typical Tetra Tech granular structure recommendation for paved surfaces and exterior concrete has always been 1.7 m of non-frost susceptible material. This recommendation was not followed during the design and construction of Phases 1 and 2 and this practice was carried forward until the construction of Phases 3D/E and 4.

Anecdotal information from Associated Engineering and the City of Whitehorse has identified sections of sidewalk in previously constructed areas that are experiencing frost heave damage and possible damage from construction traffic.

Therefore, to minimize the risk of damage along sections of separate walkway routes, construction should be over 1.7 m of non-frost susceptible soil. Anything less becomes a risk management issue.

5.6 Concrete

All concrete should be cast onto a clean, level, compacted, granular surfaces. It is important that no loose and/or disturbed material be allowed to remain on the bearing surface. Bearing surfaces should consist of 20 mm crushed basecourse gravel which has been moisture conditioned and compacted to at least 98% SPMDD.

Tetra Tech recommends that all concrete be designed, mixed, placed, and tested in accordance with the most recent edition of the Canadian Standards Association (CSA) Standard CAN/CSA-A23.1 and A23.2. According to

these standards, concrete should be designed to at least satisfy the minimum durability requirements as defined by the exposure class.

The exposure class of the concrete is dependent on the presence or lack of chlorides, sulphates, freezing and thawing conditions, and the soil saturation. Based on the aforementioned conditions, the governing exposure class for all exterior concrete, including curb & gutter and sidewalks is C-2 which corresponds to a minimum compressive strength of 32 MPa and has 5% to 8% entrained air.

If shoulder season (early spring or late fall) construction is considered, Tetra Tech should be contacted and given the opportunity to review the contractor's cold weather concrete placement procedures.

6.0 FOUNDATION RECOMMENDATIONS

A Building Advisory was issued by The City of Whitehorse, Planning and Development on October 25, 2010. This advisory relates to *Drainage Standards for Building Foundations*. The requirements for drain rock, perimeter drainage systems and sump construction presented in the advisory will have to be followed for all foundations. The prescriptive measures are based on CSA and NBC specifications as summarized in the following sections.

6.1 Preserved Wood Foundation Recommendations

If the use of preserved wood foundations (PWF) is desired, a granular drainage layer will be required beneath all footings and basement slabs, in accordance with CAN-CSA S406, because of the impervious glaciolacustrine underlying material. If areas of free draining material are encountered it may be possible to remove the requirement for a gravel drainage layer (a geotechnical engineer should be consulted).

The granular drainage layer should be constructed using a clean crushed stone or screened drain rock material of maximum particle size 40 mm and having less than 10% sand (passing the 5 mm sieve). This layer shall be at least 125 mm thick and shall extend beyond the footing plate a minimum of 300 mm. The granular drainage layer shall drain to a sump which, in turn, shall drain to a point of final disposal beyond the building's footprint.

In accordance with CAN-CSA S406, the use of perimeter drainage tile or pipe is not recommended with PWF.

All backfill material placed within 600 mm of the foundation walls shall be free of deleterious debris, frozen materials, and boulders larger than 150 mm in diameter.

Existing soils can be used as backfill in service trenches so long as no cobbles are placed within one lift of any pipe installation and all backfill materials are compacted to at least 95% of SPMDD.

6.2 Concrete Foundation Recommendations

If the use of concrete foundations is desired, the drainage tile and pipe, granular drainage layers, drainage disposal and surface drainage specifications as per NBC 2005, Section 9.14 "Drainage" must be followed.

Full depth concrete foundations with concrete footings are required to have perimeter drainage tile which terminates in a sump pit. A sump pit is to be installed to assist in the removal of water from the foundation area (should water accumulation in the sump pit warrant it).

6.3 Foundations On Free Draining Soils

The prescriptive measures described above may not apply if adequate thicknesses of free draining soil exists below foundation elements. If underlying soils meet the conditions of “free draining” soils (as verified by geotechnical engineering staff capable of soil classification), the drainage layer and sump can be omitted.

However, since all of Phase 6 is underlain by frost susceptible glaciolacustrine soils, the prescriptive measures presented above will likely be necessary for all foundations.

7.0 FROST PENETRATION AND FROST HEAVE POTENTIAL

The underlying glaciolacustrine silt is considered to be very frost-susceptible. Therefore, Tetra Tech recommends insulating foundations to mitigate potential for seasonal frost-heave damage. General foundation insulation recommendations are presented on Figure 2. If different footing burial depths or insulation configurations are desired, Tetra Tech would be pleased to revise their insulation recommendations accordingly.

8.0 CONSTRUCTION TESTING AND MONITORING

All recommendations presented herein are site-specific and based on the assumption that there will be an adequate level of monitoring during construction. An adequate level of construction monitoring also provides opportunity to verify that the recommendations based on geotechnical data obtained from the testholes used for this evaluation is applicable to the entire site. Appropriate quality assurance and quality control (QA/QC) testing should be undertaken during construction to confirm that construction is completed in accordance with the recommendations provided in this report. For this project, appropriate QA/QC inspection and testing is considered to include:

- Laboratory testing on samples of proposed fill materials to confirm compliance to specified gradation requirements (by sieve analysis) and compaction (proctor moisture density testing) requirements;
- Compaction, concrete and asphalt testing during construction to ensure that project objectives are met; and,
- Geotechnical inspections of foundation excavations.

9.0 PROPOSED STORM WATER RETENTION POND – PHASE 7

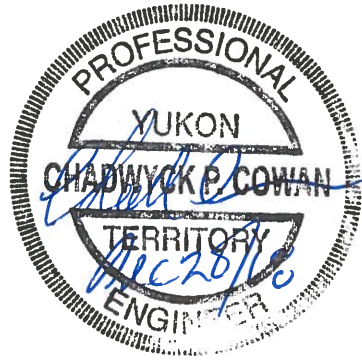
Laboratory testing of the samples collected in BH7-02 confirms that the glaciolacustrine soils at this location have significant clay content, are fairly plastic (USCS classification of CI) and have a hydraulic conductivity of 2.0E-07 cm/sec when compacted to 95% of standard proctor maximum dry density and 2.2E-07 cm/sec when compacted to 98% of standard proctor maximum dry density. This is encouraging if a natural soil liner is being considered for pond construction. As mentioned above, moisture contents of the soils at this location are over 30% and the optimum moisture content for this material is 20% (as confirmed by the attached standard proctor test result report form following the permeability results). For berm and liner construction, it is beneficial to have the soil at optimum moisture or above to minimize potential for piping and a compaction specification of 95% appears to be adequate.

This would not be an exfiltration pond. A discharge plan would have to be developed but the based on recent site reconnaissance completed for the “Future Areas” planning project, there is potential for discharge along the corridor identified in the Morison Hershfield report.

10.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the Government of Yukon and their agents. Tetra Tech Canada Inc. does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the Government of Yukon, or for any Project other than the proposed development at the subject site (Whistle Bend – Phase 6). Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix B. We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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PERMIT TO PRACTICE TETRA TECH CANADA INC.	
SIGNATURE	<i>Chad Cowan</i>
Date	<i>Dec 20/18</i>
PERMIT NUMBER PP003 Association of Professional Engineers of Yukon	

FIGURES

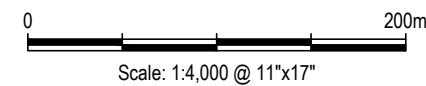
- Figure 1 Site Plan Showing Current & Historical Testhole Locations
- Figure 2 Commercial and Residential Foundation Insulation Details

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LEGEND

- ◆ - BOREHOLE LOCATION
- ⊕ - TESTPIT LOCATION



CLIENT



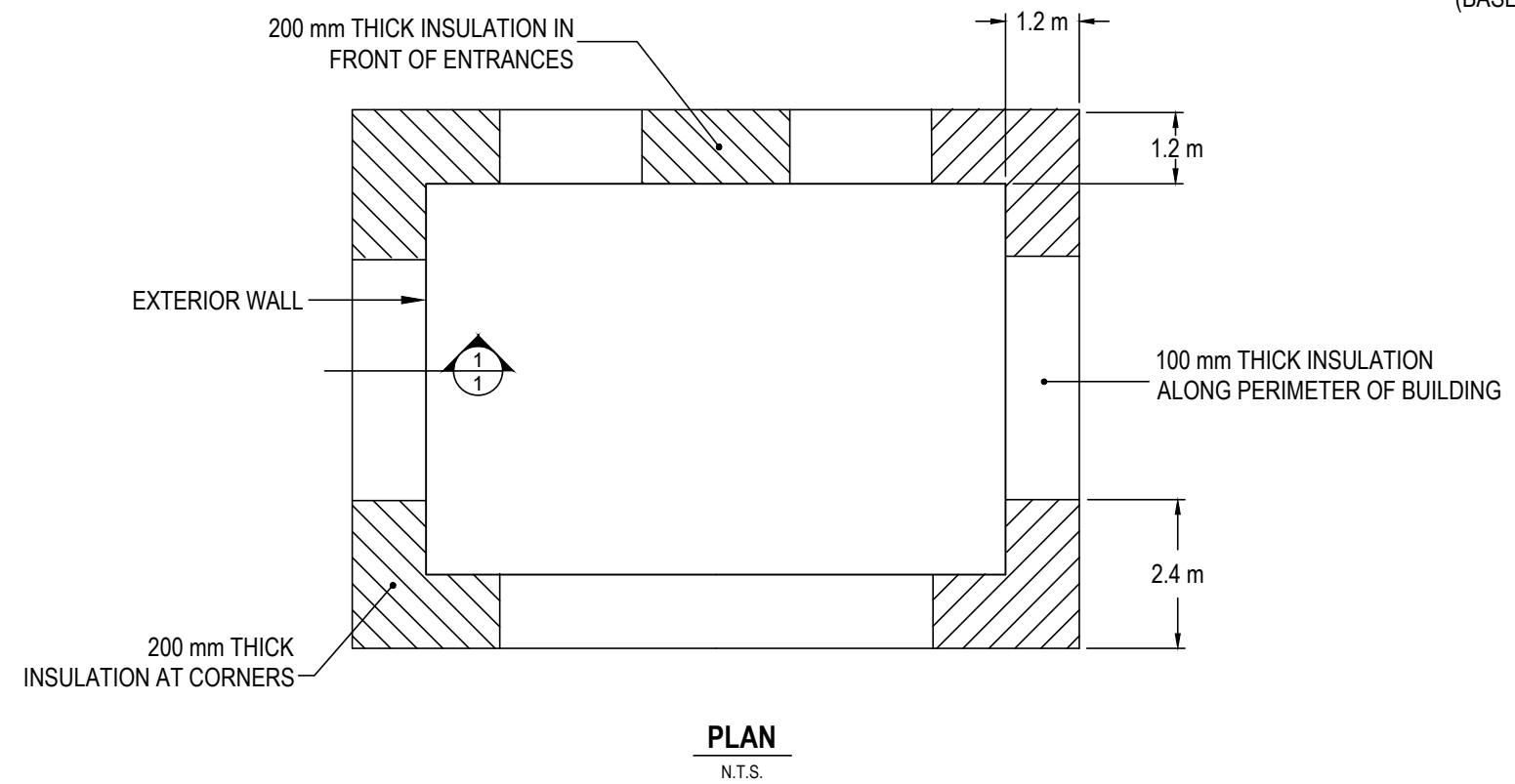
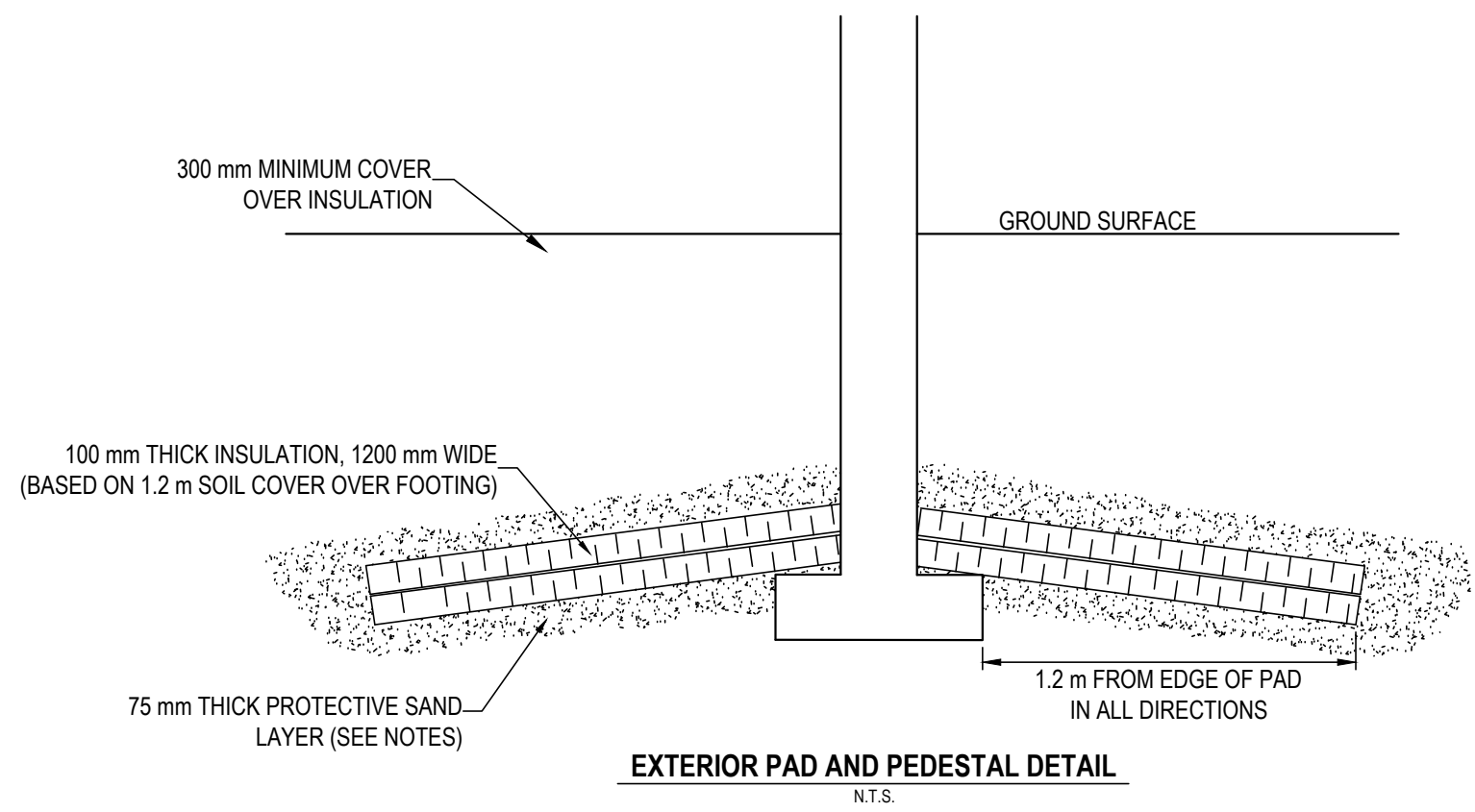
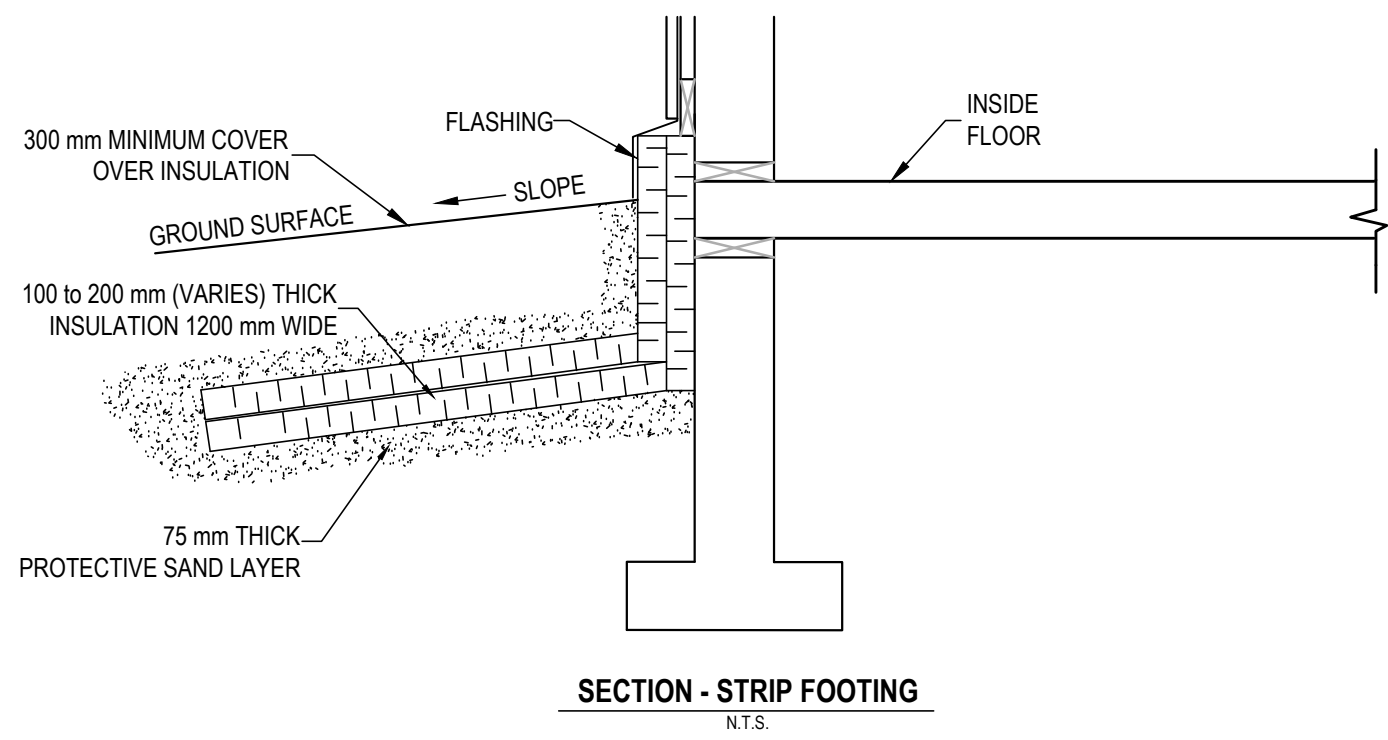
**2018 GEOTECHNICAL SERVICES
WHISTLE BEND PHASE 6**

SITE PLAN SHOWING TESTHOLE LOCATIONS

PROJECT NO. ENG.WARC03386-25	DWN CB	CKD MCP	REV 0
OFFICE EBA-WHSE	DATE November 7, 2018		

Figure 1

Q:\Whitehorse\Drawings\Whitehorse\ENG-WARC\ENGIN\WARC03386-25 Whistle Bend Phase 6 Geotech Services\ENG-WARC03386-25 Fig.2-RO.dwg [FIGURE 2] November 07, 2018 - 7:28:29 pm (BY: BUCHAN, CAMERON)



NOTES :

- INSULATION THICKNESS IS SITE SPECIFIC AND BASED ON SOIL CONDITIONS AND AMOUNT OF SOIL COVER ABOVE FOOTINGS.
- THE INSULATION (DOW CHEMICAL HI SERIES STYROFOAM OR POLYURETHANE OR APPROVED EQUIVALENT) SHOULD BE MOISTURE RESISTANT AND SUITABLE FOR BURIAL UNDER VEHICULAR TRAFFIC AREAS.
- A MINIMUM BEDDING THICKNESS OF 75 mm OF FINE TO MEDIUM GRAINED SAND SHOULD BE PLACED ABOVE AND BELOW THE INSULATION FOR PROTECTION.
- THIS PLAN IS NOT TO SCALE

CLIENT



**2018 GEOTECHNICAL SERVICES
WHISTLE BEND PHASE 6**

**COMMERCIAL AND RESIDENTIAL
FOUNDATION INSULATION DETAILS**



PROJECT NO. ENG.WARC03386-25	DWN CB	CKD MCP	REV 0
OFFICE EBA-WHSE	DATE November 7, 2018		

Figure 2

APPENDIX A

TESTHOLE LOGS & ACCOMPANYING LABORATORY TEST RESULT REPORT FORMS

**Government of Yukon -
Community Services**

Borehole No: 6-01

Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: 493555 E; 6738470 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	60	0
0		SAND - trace to some silt, damp, medium brown, medium sand, (300 mm thick)	Unfrozen		6.3				0
0.5		SILT - some clay to clayey, damp becoming moist by 1.5 metres							0.5
1									1
2	Solid stem auger								2
3		- moist to wet, soft			21.4				3
4									4
4.5		END OF BOREHOLE (4.50 metres)			25.3				4.5
5									5
6									6
7									7
7.5									7.5



Contractor: DonJeck Drilling

Completion Depth: 4.5 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 October 31

Logged By: MCP

Completion Date: 2018 October 31

Reviewed By: CC

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**Government of Yukon -
Community Services**

Borehole No: 6-02

Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: 493465 E; 6738405 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANICS - grass covered, black, (100 mm thick) SILT - some clay to clayey, moist, light olive grey, hint of mottling brown and grey near surface	Seasonally frozen			20	40	80	0
1	Solid stem auger	- slight moisture increase, dark olive grey			21.3				1
2					24.1				2
3					27.6				3
4					27.3				4
4.5		END OF BOREHOLE (4.50 metres)							15
5									16
6									17
7									18
7.5									19



Contractor: DonJeck Drilling

Completion Depth: 4.5 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 October 31

Logged By: MCP

Completion Date: 2018 October 31

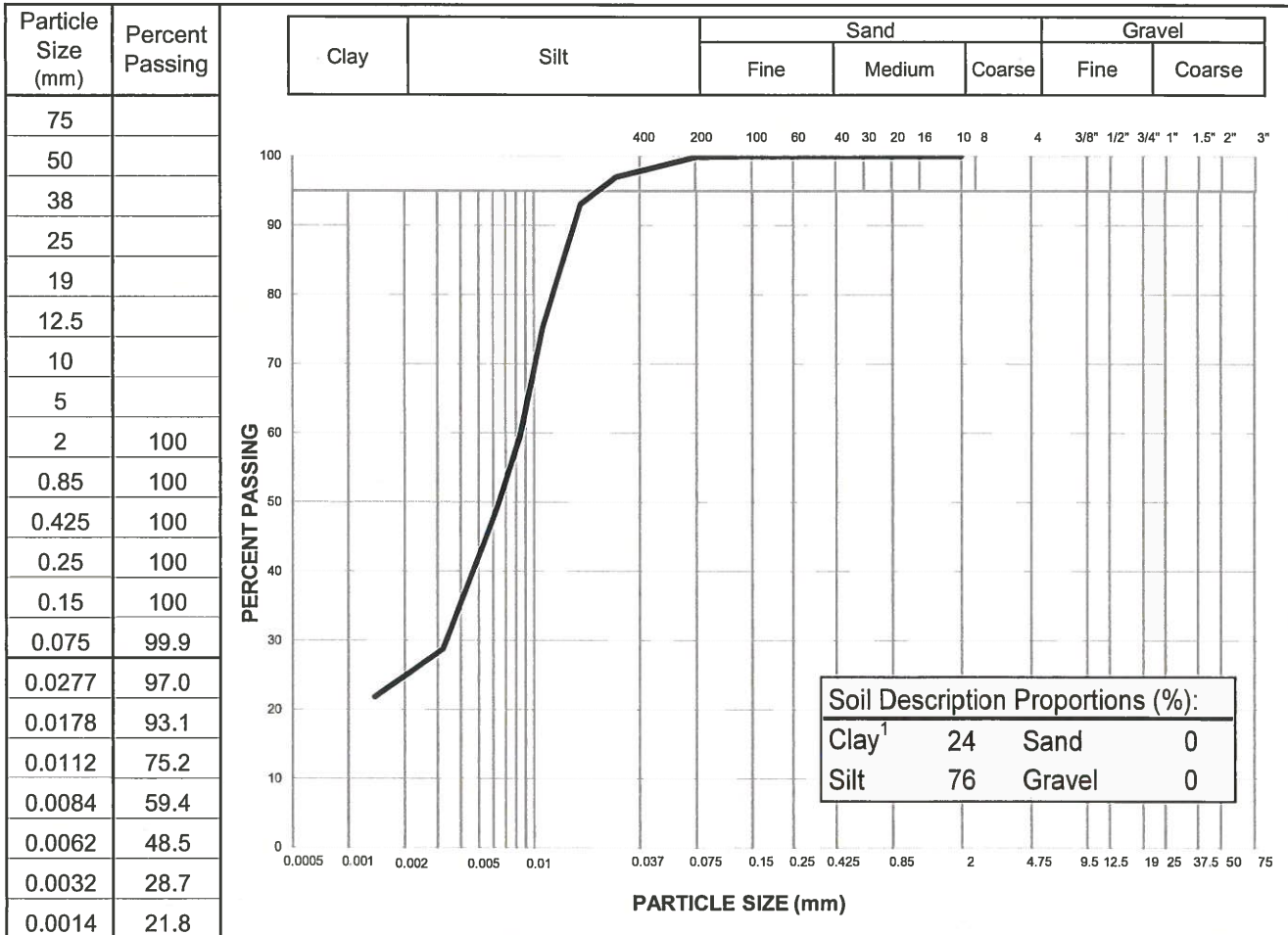
Reviewed By: CC

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PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Phase 6/7 Geotechnical Investigation	Sample No.:	SA03
Project No.:	ENG.WARC03386-25	Material Type:	-
Site:	Whistle Bend Subdivision	Sample Loc.:	BH6-02
Client:	YG - Community Services	Sample Depth:	3.0 m
Client Rep.:	Christine Plante	Sampling Method:	Grab
Date Tested:	November 11, 2018	By:	AT
Date Tested:	November 11, 2018	Date Sampled:	-
Soil Description ² :	SILT - clayey	Sampled By:	-
		USC Classification:	-
			Cu: #N/A
Moisture Content:	27.6%		Cc: #N/A



Notes: ¹ The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

² The description is visually based & subject to Tetra Tech description protocols

Specification: _____

Remarks: _____

Reviewed By: C.E.T.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



**Government of Yukon -
Community Services**

Borehole No: 6-03

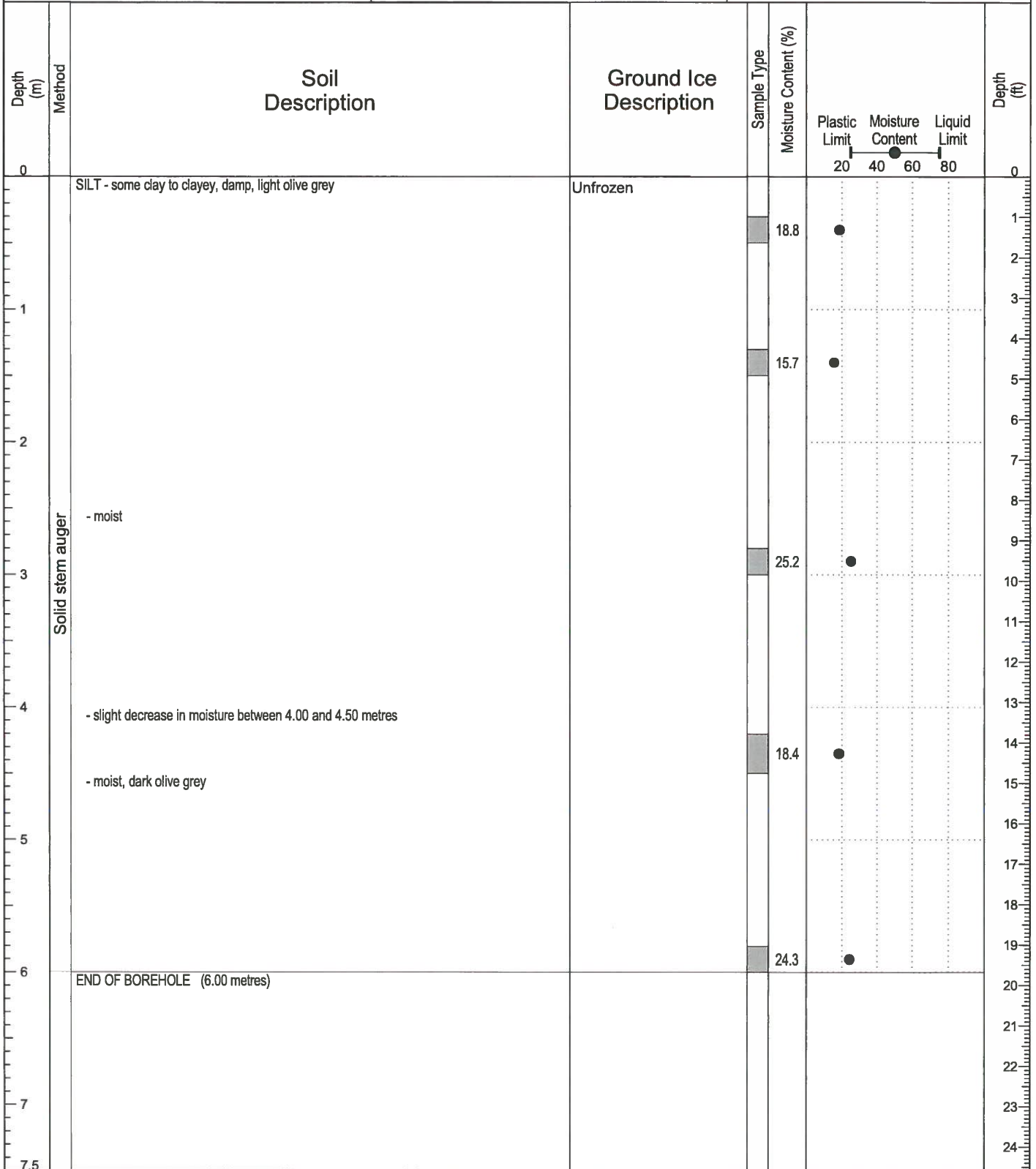
Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: 493575 E; 6738630 N; Z 8



Contractor: DonJeck Drilling

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 October 31

Logged By: MCP

Completion Date: 2018 October 31

Reviewed By: CC

Page 1 of 1

**Government of Yukon -
Community Services**

Borehole No: 6-04

Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: 493490 E; 6738805 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	60	0
0 to 4.5	Solid stem auger	SAND - silty, brown, fine sand, (200 mm thick) SILT - clayey, damp, light olive grey, fine sand	Seasonally frozen						
1.3					13.2				1
4.2					7.2				4
9.1					11				9
14.0					18.1				14
4.5		END OF BOREHOLE (4.50 metres)							15
7.5									24



Contractor: DonJeck Drilling

Drilling Rig Type: Truck Mounted CME 75

Logged By: MCP

Reviewed By: CC

Completion Depth: 4.5 m

Start Date: 2018 October 31

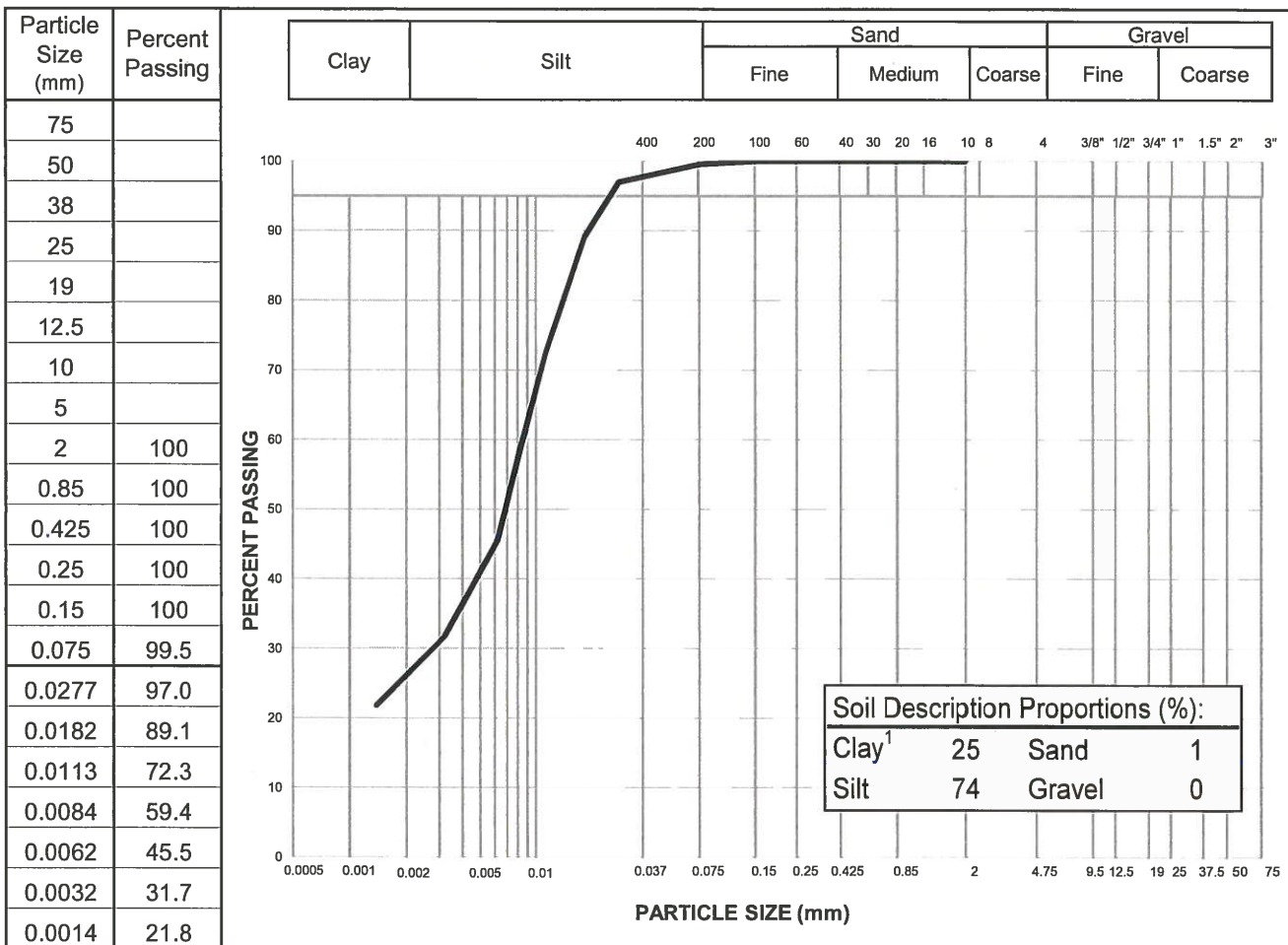
Completion Date: 2018 October 31

Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Phase 6/7 Geotechnical Investigation	Sample No.:	SA02
Project No.:	ENG.WARC03386-25	Material Type:	-
Site:	Whistle Bend Subdivision	Sample Loc.:	BH6-04
Client:	YG - Community Services	Sample Depth:	1.5 m
Client Rep.:	Christine Plante	Sampling Method:	Grab
Date Tested:	November 11, 2018	By:	AT
Soil Description ² :	SILT - clayey	Date Sampled:	-
		Sampled By:	-
		USC Classification:	-
		Cu:	#N/A
Moisture Content:	7.3%	Cc:	#N/A



Notes: ¹ The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
² The description is visually based & subject to Tetra Tech description protocols

Specification: _____

Remarks: _____

Reviewed By: C.E.T.

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**Government of Yukon -
Community Services**

Borehole No: 6-05

Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: 493500 E; 6738690 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	60	0
0 to 0.2		SAND - silty, brown, fine sand, (200 mm thick)	Seasonally frozen						
0.2 to 4.5	Solid stem auger	SILT - some clay, trace sand, damp, light olive grey, fine sand - clayey, moist, soft, dark olive grey			20.6				1
					10.6				4
					25.9				9
					24.3				14
4.5		END OF BOREHOLE (4.50 metre)							15
5									16
6									19
7									23
7.5									24



Contractor: DonJeck Drilling

Drilling Rig Type: Truck Mounted CME 75

Logged By: MCP

Reviewed By: CC

Completion Depth: 4.5 m

Start Date: 2018 October 31

Completion Date: 2018 October 31

Page 1 of 1

**Government of Yukon -
Community Services**

Borehole No: 6-06

Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: 493435 E; 6738625 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		SAND - silty, brown, (300 mm thick)	Seasonally frozen			20	40	80	0
0.3		SILT - some clay to clayey, moist, olive grey			18.3				1
0.6					23.3				2
1.0									3
1.5									4
2.0									5
2.5									6
3.0									7
3.3					11				9
3.6									10
4.0									11
4.5									12
5.0									13
5.4					16.6				14
5.7									15
6.0									16
6.3									17
6.6									18
6.9									19
7.2									20
7.5									21
7.8									22
8.1									23
8.4									24
8.7									25
9.0									26
9.3									27
9.6									28
9.9									29
10.2									30
10.5									31
10.8									32
11.1									33
11.4									34
11.7									35
12.0									36
12.3									37
12.6									38
12.9									39
13.2									40
13.5									41
13.8									42
14.1									43
14.4									44
14.7									45
15.0									46
15.3									47
15.6									48
15.9									49
16.2									50
16.5									51
16.8									52
17.1									53
17.4									54
17.7									55
18.0									56
18.3									57
18.6									58
18.9									59
19.2									60
19.5									61
19.8									62
20.1									63
20.4									64
20.7									65
21.0									66
21.3									67
21.6									68
21.9									69
22.2									70
22.5									71
22.8									72
23.1									73
23.4									74
23.7									75
24.0									76
24.3									77
24.6									78
24.9									79
25.2									80
25.5									81
25.8									82
26.1									83
26.4									84
26.7									85
27.0									86
27.3									87
27.6									88
27.9									89
28.2									90
28.5									91
28.8									92
29.1									93
29.4									94
29.7									95
30.0									96
30.3									97
30.6									98
30.9									99
31.2									100

Solid stem auger

- decreasing moisture content

- becomes clayey, increasing moisture content

END OF BOREHOLE (6.00 metres)



Contractor: DonJeck Drilling

Drilling Rig Type: Truck Mounted CME 75

Logged By: MCP

Reviewed By: CC

Completion Depth: 6 m

Start Date: 2018 October 31

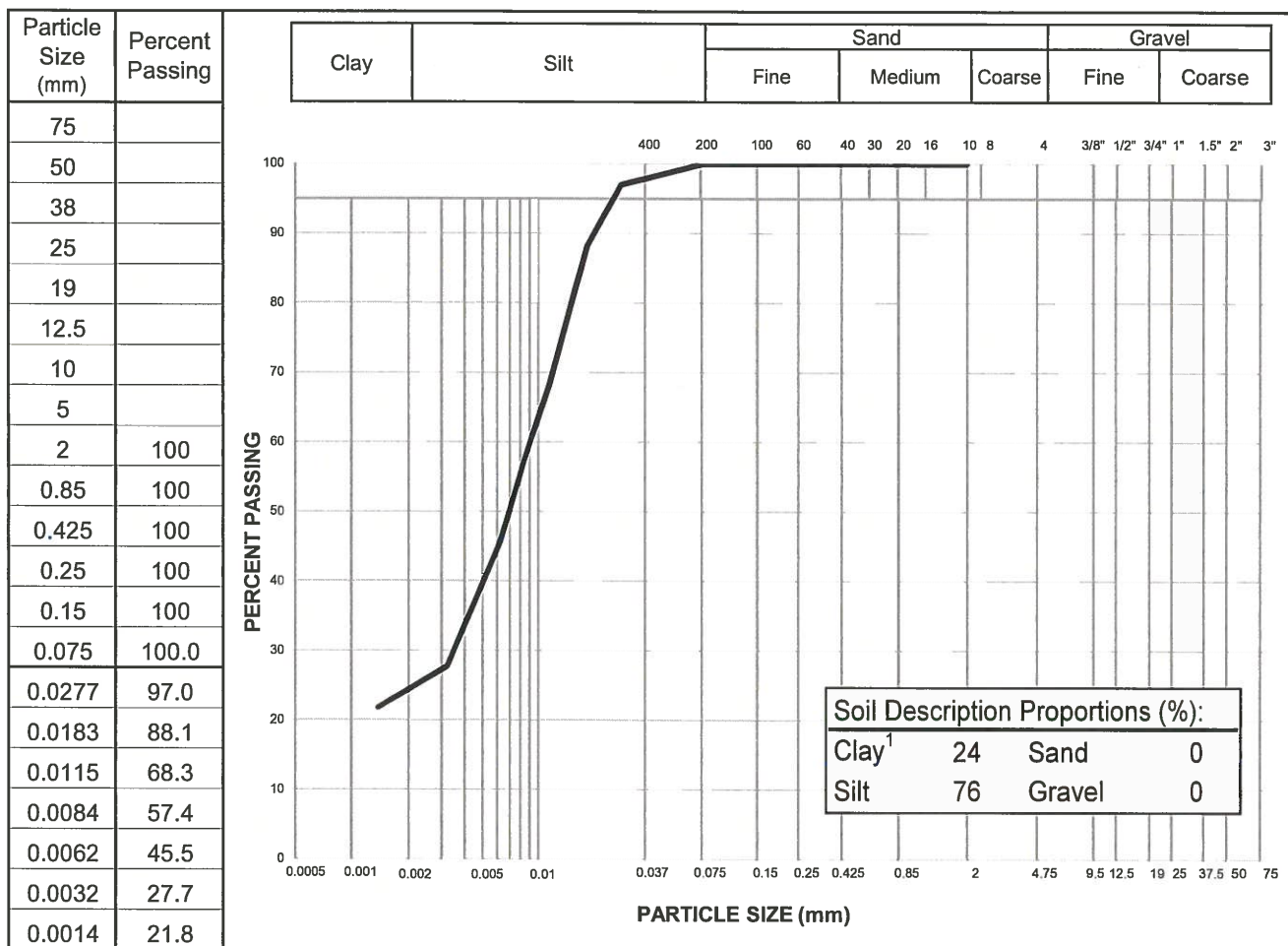
Completion Date: 2018 October 31

Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: Phase 6/7 Geotechnical Investigation	Sample No.: SA04
Project No.: ENG.WARC03386-25	Material Type: -
Site: Whistle Bend Subdivision	Sample Loc.: BH6-06
Client: YG - Community Services	Sample Depth: 4.5 m
Client Rep.: Christine Plante	Sampling Method: Grab
Date Tested: November 11, 2018 By: AT	Date Sampled: -
Soil Description ² : SILT - clayey	Sampled By: -
	USC Classification: -
	Cu: #N/A
Moisture Content: 16.6%	Cc: #N/A



Notes: ¹ The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
² The description is visually based & subject to Tetra Tech description protocols

Specification: _____

Remarks: _____

Reviewed By: C.E.T.

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**Government of Yukon -
Community Services**

Borehole No: 6-07

Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: 493355 E; 6738700 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		THIN SAND VENEER OVER SILT - (100 mm thick) SILT - some clay to clayey, damp to moist, light olive grey	Unfrozen						0
0.5	Solid stem auger	- moist, dark olive grey			20.9				0.5
1.5					11.7				1.5
2.5					26				2.5
3.5					27.8				3.5
4.5					33.1				4.5
5.5		- becomes clayey, increase in moisture content							5.5
6.0		END OF BOREHOLE (6.00 metres)							6.0
7.5									7.5



Contractor: DonJeck Drilling

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 October 31

Logged By: MCP

Completion Date: 2018 October 31

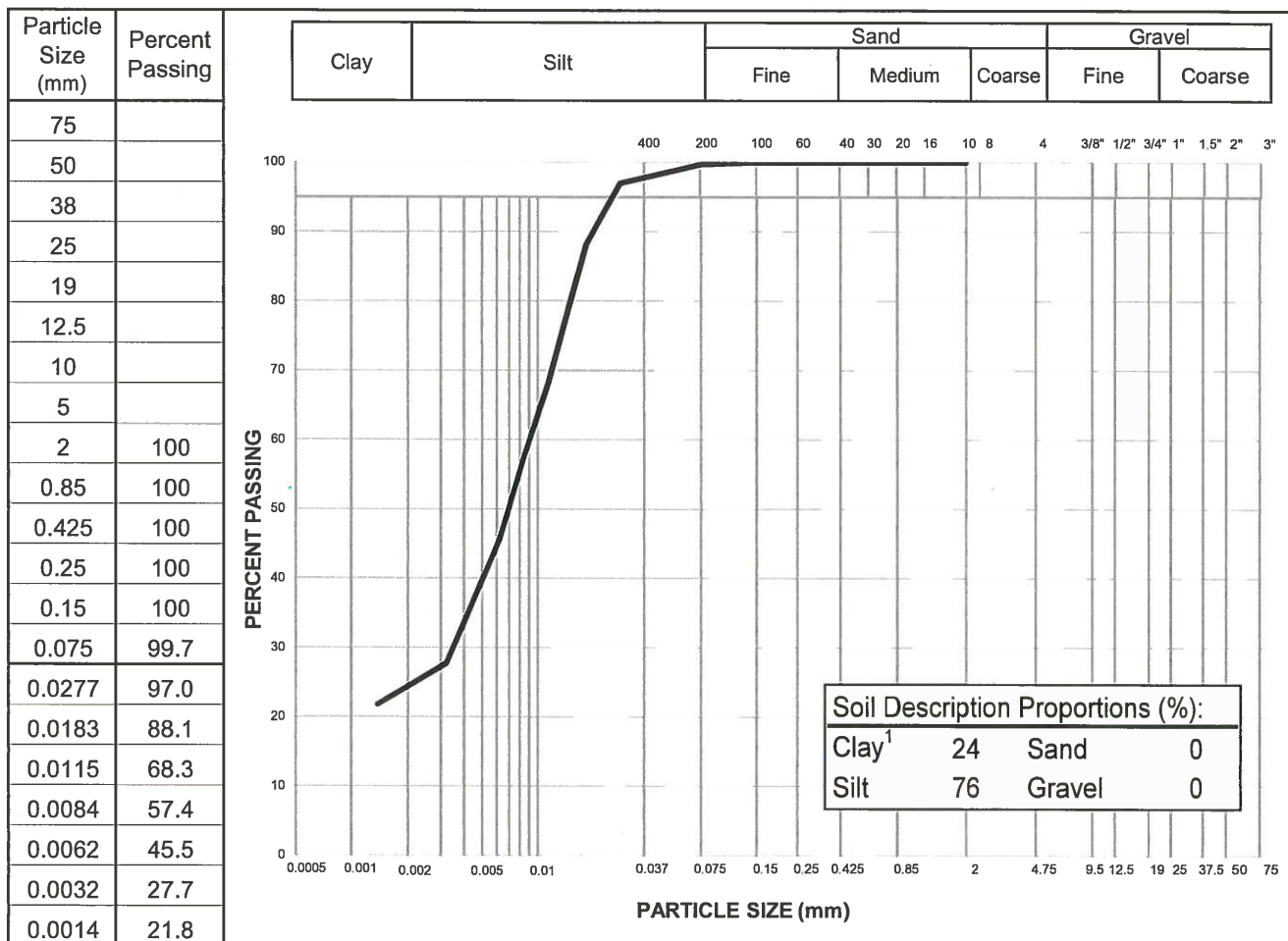
Reviewed By: CC

Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Phase 6/7 Geotechnical Investigation	Sample No.:	SA01
Project No.:	ENG.WARC03386-25	Material Type:	-
Site:	Whistle Bend Subdivision	Sample Loc.:	BH6-07
Client:	YG - Community Services	Sample Depth:	0.5 m
Client Rep.:	Christine Plante	Sampling Method:	Grab
Date Tested:	November 11, 2018	By:	AT
Soil Description ² :	SILT - clayey	Date Sampled:	-
		Sampled By:	-
		USC Classification:	-
		Cu:	#N/A
Moisture Content:	20.9%	Cc:	#N/A



Notes: ¹ The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
² The description is visually based & subject to Tetra Tech description protocols

Specification: _____

Remarks: _____

Reviewed By: C.E.T.

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**Government of Yukon -
Community Services**

Borehole No: 6-08

Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: 493358 E; 6738565 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		SILT - clayey, damp, light olive grey	Unfrozen			20	40	80	0
1	Solid stem auger	- becomes SILT AND CLAY, increase in moisture content, dark olive grey	Unfrozen		16				1
2					9.1				2
3					25.8				3
4					28.9				4
5					25.9				5
6		END OF BOREHOLE (6.00 metres)							6
7									7
7.5									7.5



Contractor: DonJeck Drilling

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 October 31

Logged By: MCP

Completion Date: 2018 October 31

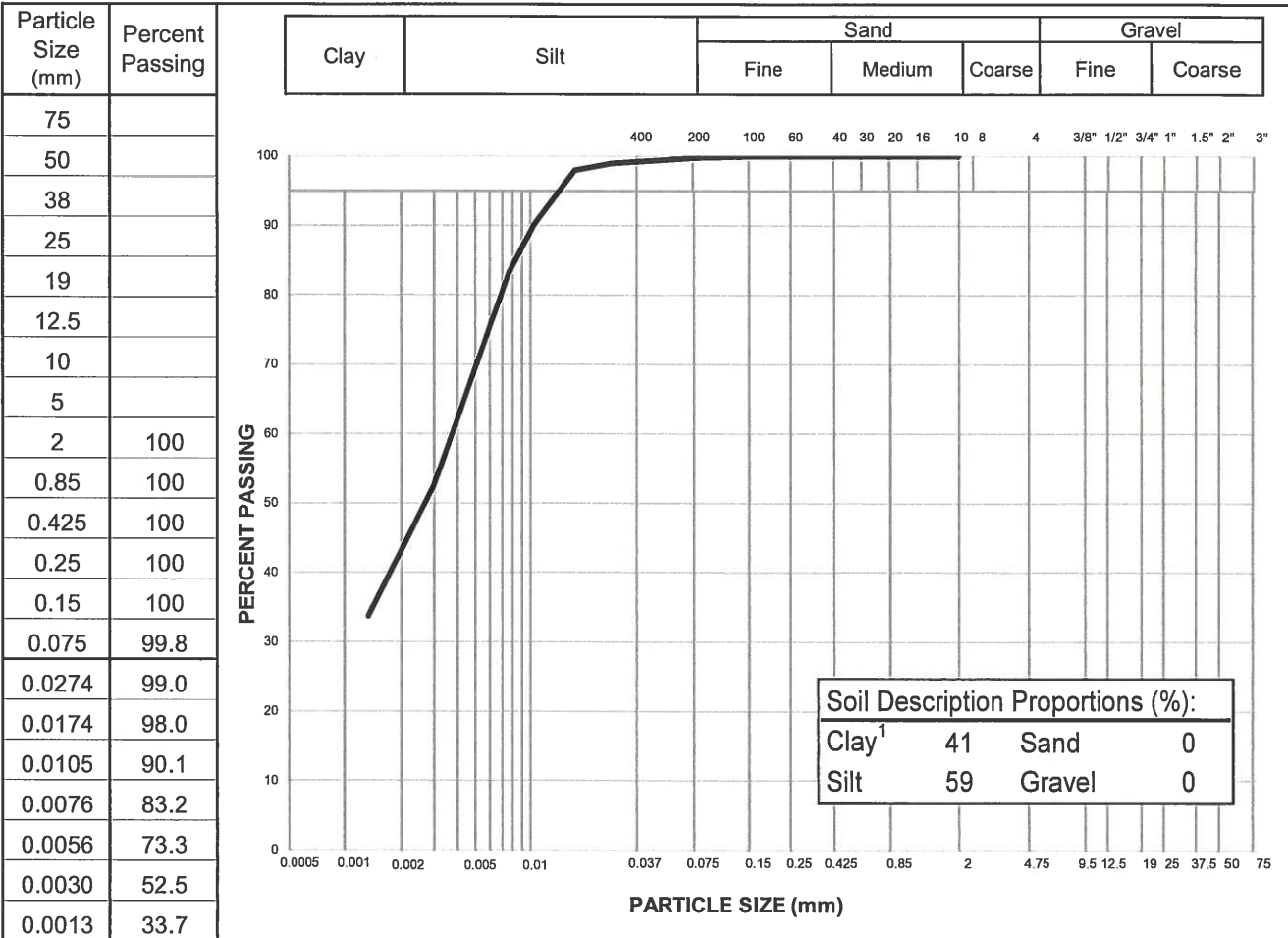
Reviewed By: CC

Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: Phase 6/7 Geotechnical Investigation	Sample No.: SA05
Project No.: ENG.WARC03386-25	Material Type: -
Site: Whistle Bend Subdivision	Sample Loc.: BH6-08
Client: YG - Community Services	Sample Depth: 6.0 m
Client Rep.: Christine Plante	Sampling Method: Grab
Date Tested: November 11, 2018 By: AT	Date Sampled: -
Soil Description ² : SILT and CLAY	Sampled By: -
	USC Classification: -
	Cu: #N/A
Moisture Content: 25.9%	Cc: #N/A



Notes: ¹ The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
² The description is visually based & subject to Tetra Tech description protocols

Specification: _____

Remarks: _____

Reviewed By: C.E.T.

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Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	80	0
0 to 0.3	Solid stem auger	SAND - trace to some silt, damp, medium brown, fine sand	Unfrozen		6.8				0.3
0.3 to 1.0		SILT - clayey, moist, firm, light olive brown			25.7				1.0
1.0 to 3.8		- becomes SILT AND CLAY, increase in moisture content, dark olive grey			28.7				3.8
3.8 to 5.8					32.2				5.8
5.8 to 6.0					32.3				6.0
6.0 to 7.5		END OF BOREHOLE (6.00 metres)							7.5



Contractor: DonJeck Drilling

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 October 31

Logged By: MCP

Completion Date: 2018 October 31

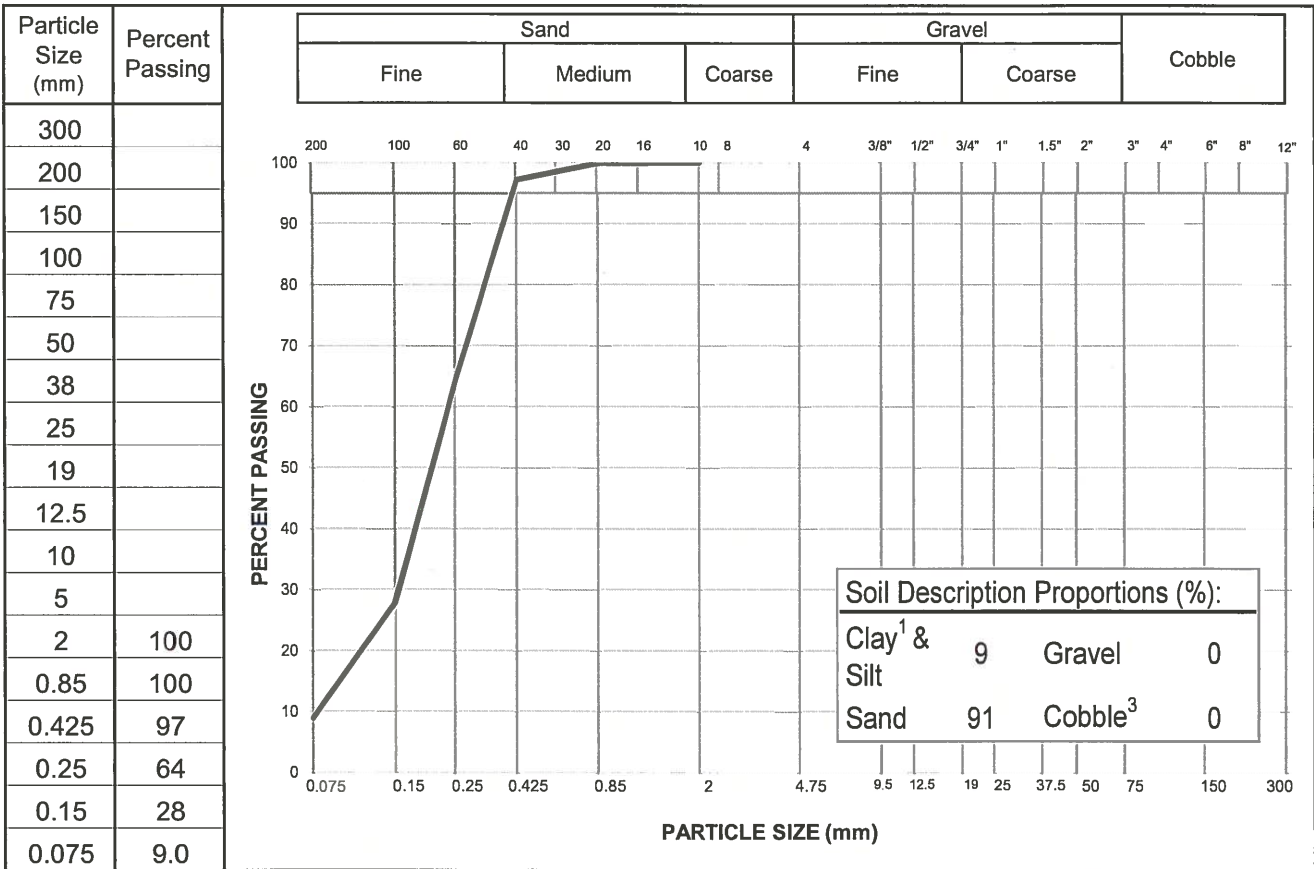
Reviewed By: CC

Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

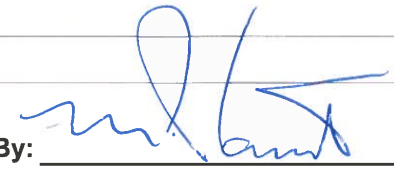
Project:	Phase 6/7 Geotechnical Investigation	Sample No.:	-
Project No.:	ENG.WARC03386-25	Material Type:	-
Site:	Whistle Bend Subdivision	Sample Loc.:	BH7-1
Client:	YG - Community Services	Sample Depth:	0.5 m
Client Rep.:	Christine Plante	Sampling Method:	Grab
Date Tested:	November 8, 2018	By:	GK
Date Tested:	November 8, 2018	Date Sampled:	-
Soil Description ² :	SAND - trace silt	Sampled By:	-
		USC Classification:	-
		Cu:	3.0
Moisture Content:	6.8%	Cc:	1.3



Notes: ¹ The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
² The description is visually based & subject to Tt WM4400 description protocols
³ If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: _____

Remarks: _____

Reviewed By:  C.E.T.

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**Government of Yukon -
Community Services**

Borehole No: 7-02

Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: E; N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		SILT - clayey, moist, firm, softer with depth, olive grey	Unfrozen			20	40	80	0
1	Solid stem auger	- becomes SILT AND CLAY, moist to wet, soft			21.4				1
2									2
3									3
4									4
5									5
6									6
7									7
7.5									7.5

END OF BOREHOLE (6.00 metres)
Note: Drilled in proposed dry pond location



Contractor: DonJeck Drilling

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 October 31

Logged By: MCP

Completion Date: 2018 October 31

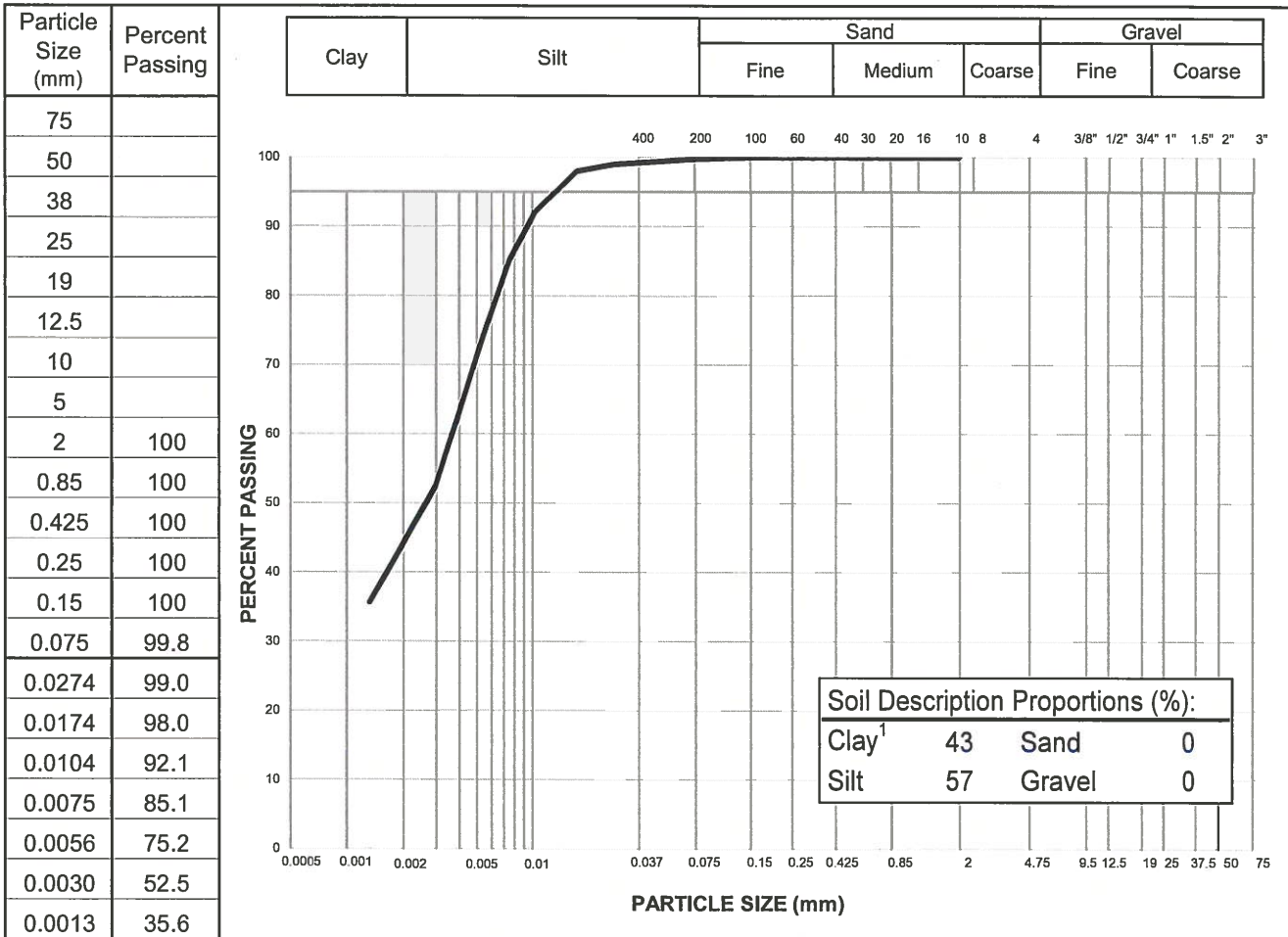
Reviewed By: CC

Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: Phase 6/7 Geotechnical Investigation	Sample No.: -
Project No.: ENG.WARC03386-25	Material Type: -
Site: Whistle Bend Subdivision	Sample Loc.: BH7-2
Client: YG - Community Services	Sample Depth: 1.5 - 3.0 m
Client Rep.: Christine Plante	Sampling Method: Grab
Date Tested: November 11, 2018 By: AT	Date Sampled: -
Soil Description ² : SILT and CLAY	Sampled By: -
	USC Classification: -
	Cu: #N/A
Moisture Content: 29.9%	Cc: #N/A



Notes: ¹ The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
² The description is visually based & subject to Tetra Tech description protocols

Specification: _____

Remarks: _____

Reviewed By: C.E.T.

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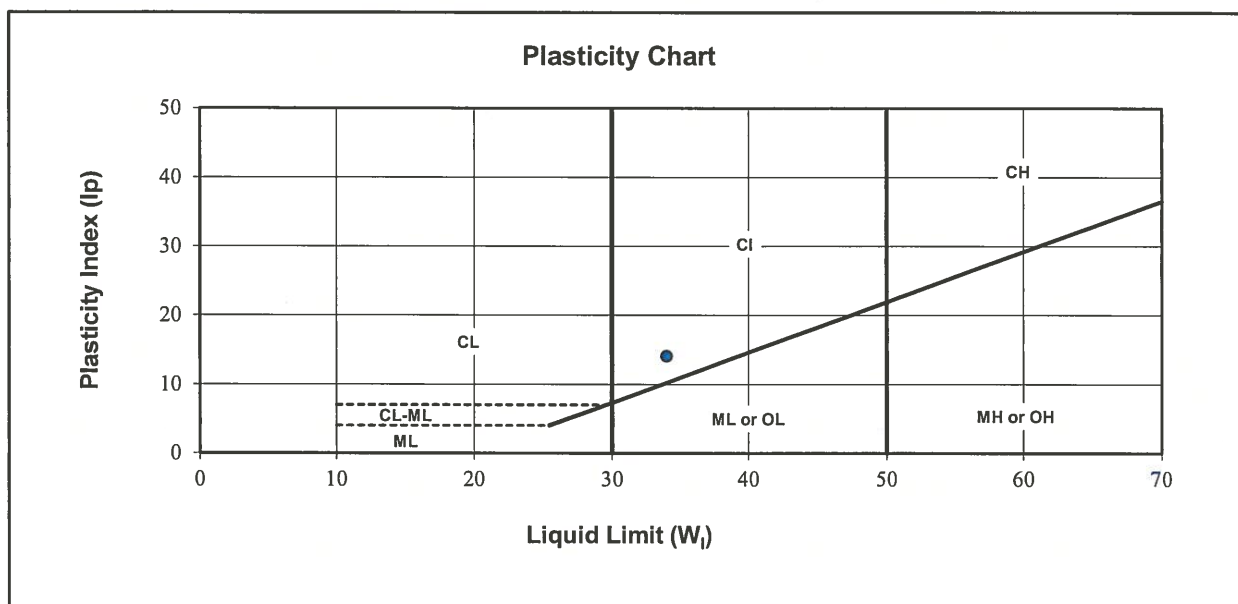


ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project: <u>Phase 6/7 Geotechnical Investigation</u> <u>Whistle Bend Subdivision</u> Project No: <u>ENG.WARC03386-25</u> Client: <u>YG - Community Services</u> Attention: <u>Christine Plante</u> Email: <u>Christine.Plante@gov.yk.ca</u>	Sample Number: <u>-</u> Borehole Number: <u>BH7-2</u> Depth: <u>1.5 - 3.0 m</u> Sampled By: <u>-</u> Tested By: <u>AT</u> Date Sampled: <u>-</u> Date Tested: <u>November 11, 2018</u>
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Sample Description: SILT and CLAY



Liquid Limit (W _l):	<u>34</u>	Natural Moisture (%):	<u>29.9</u>
Plastic Limit:	<u>20</u>	Soil Plasticity:	<u>Medium</u>
Plasticity Index (I _p):	<u>14</u>	Mod.USCS Symbol:	<u>CL</u>

Remarks: _____

Reviewed By: C.E.T.

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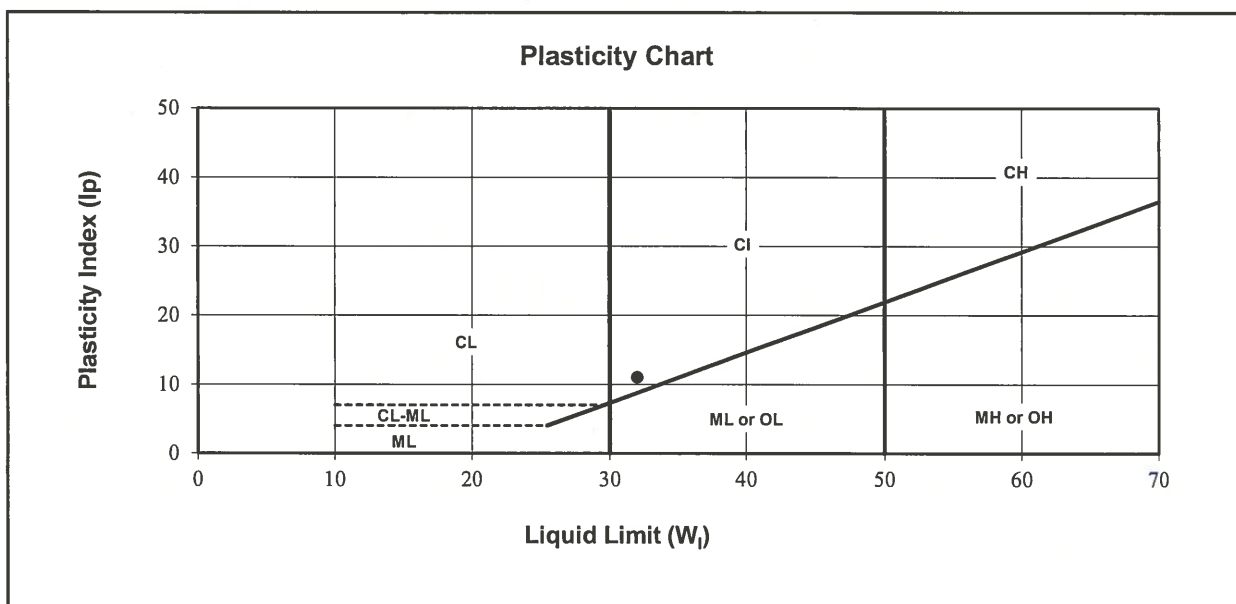


ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project: <u>Phase 6/7 Geotechnical Investigation</u> <u>Whistle Bend Subdivision</u> Project No: <u>ENG.WARC03386-25</u> Client: <u>YG - Community Services</u> Attention: <u>Christine Plante</u> Email: <u>Christine.Plante@gov.yk.ca</u>	Sample Number: <u>-</u> Borehole Number: <u>BH7-2</u> Depth: <u>3.0 - 4.5 m</u> Sampled By: <u>-</u> Tested By: <u>AT</u> Date Sampled: <u>-</u> Date Tested: <u>November 11, 2018</u>
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Sample Description: SILT - clayey



Liquid Limit (W _l):	<u>32</u>	Natural Moisture (%):	<u>31.8</u>
Plastic Limit:	<u>21</u>	Soil Plasticity:	<u>Medium</u>
Plasticity Index (I _p):	<u>11</u>	Mod.USCS Symbol:	<u>Cl</u>

Remarks: _____

Reviewed By:  C.E.T.

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CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST REPORT

ASTM D5084

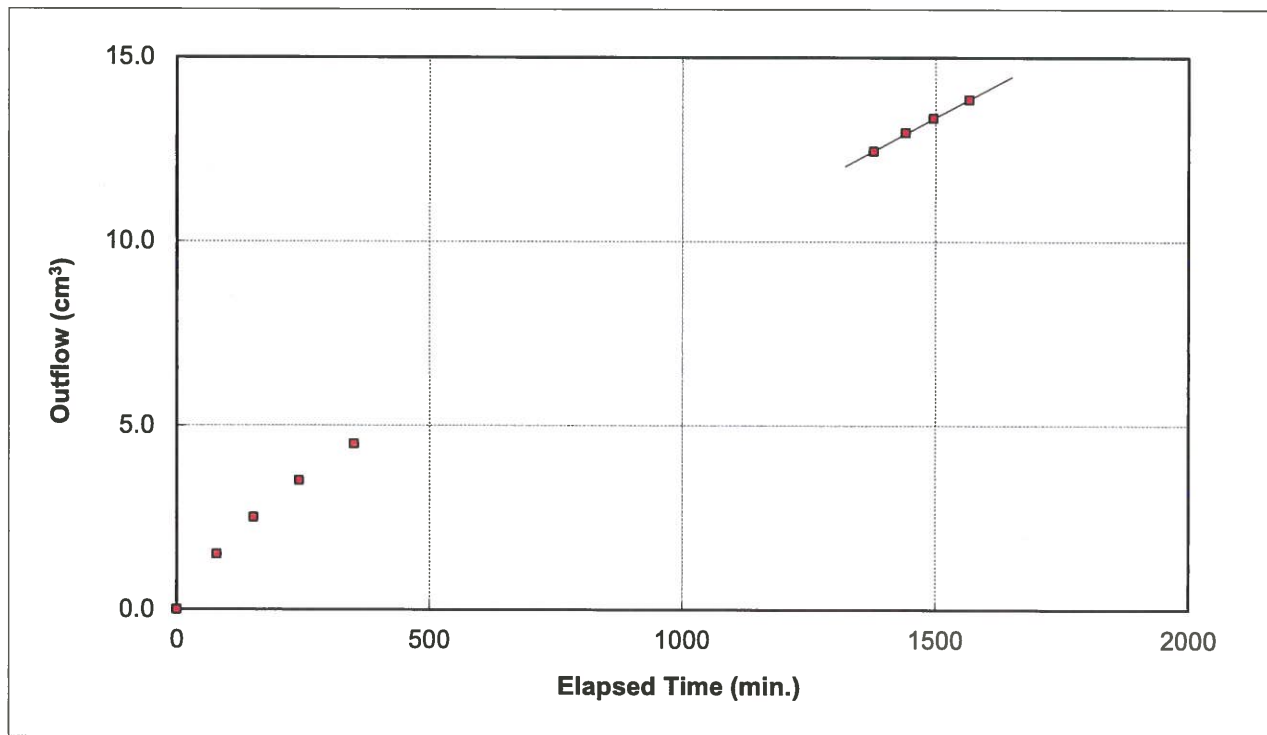
Project: <u>Whistle Bend Subdivision Phase 6/7</u>	Test No.: <u>P-1</u>
Project No.: <u>ENG.WARC03386-25</u>	Borehole No.: <u>BH 7-02</u>
Client: <u>Government of Yukon</u>	Depth: <u>0.0-6.0 m</u>
Attention: <u>Christine Plante</u>	Date Tested: <u>November 28, 2018</u>
	Tested By: <u>TD</u>

Soil Description: CLAY, silty, trace sand, grey

	Initial	Final
Moisture Content (%)	22.4	23.8
Dry Density (kg/m ³)	1631	1661
Compaction SPD (if applicable)	95.4%	97.1%

Sample Height =	<u>5.077</u> cm
Sample Diameter =	<u>7.048</u> cm
Head Differential =	<u>7</u> kPa
Flow Q =	<u>1.2E-04</u> cm ³ /sec
Hydraulic Gradient i =	<u>14.07</u>
Area of Sample A =	<u>39.01</u> cm ²

Hydraulic Conductivity k_{20} = <u>2.2E-07</u> cm/sec



Remarks: _____

Reviewed By: *JPR* P.Eng.

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST REPORT

ASTM D5084

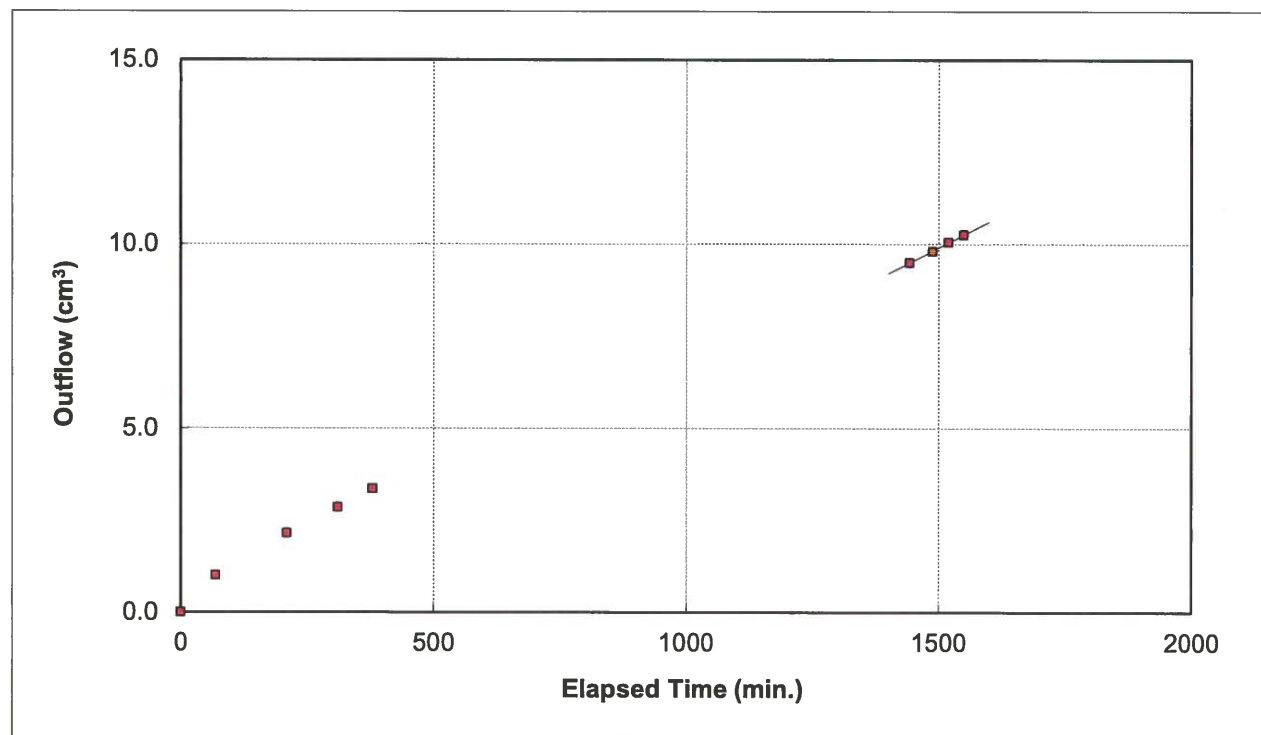
Project: <u>Whistle Bend Subdivision</u>	Test No.: <u>P-2</u>
Project No.: <u>ENG.WARC03386-25</u>	Borehole No.: <u>BH 7-02</u>
Client: <u>Government of Yukon</u>	Depth: <u>0-6.0 m</u>
Attention: <u>Christine Plante</u>	Date Tested: <u>December 5, 2018</u>
	Tested By: <u>TD</u>

Soil Description: CLAY, silty, trace sand, grey

	Initial	Final
Moisture Content (%)	22.3	24.7
Dry Density (kg/m ³)	1612	1626
Compaction SPD (if applicable)	94.3%	95.1%

Sample Height =	<u>5.129</u> cm
Sample Diameter =	<u>7.075</u> cm
Head Differential =	<u>7</u> kPa
Flow Q =	<u>1.2E-04</u> cm ³ /sec
Hydraulic Gradient i =	<u>13.93</u>
Area of Sample A =	<u>39.31</u> cm ²

Hydraulic Conductivity k_{20} = 2.0E-07 cm/sec



Remarks: _____

Reviewed By: IPR P.Eng.

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Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Moisture Content (%)			Depth (ft)	
					Plastic Limit	Moisture Content	Liquid Limit		
0					20	40	60	80	0
0 to 1	Excavator	ORGANIC ROOT MAT - organic, brown, (100 mm thick) SILT AND SAND - some fibrous organics throughout, uniformly graded, brown, fine sand	Seasonally frozen						0 to 3
1 to 3		- olive grey, 100 mm thick silt lens SAND - trace silt, brownish grey, fine to medium sand							3 to 10
3 to 3.5		SILT (GLACIOLACUSTRINE) - trace clay, damp, olive brown	Unfrozen						10 to 12
3.5 to 7.5		END OF TESTPIT (3.5 metres)							12 to 24



Contractor: Canyon City Construction

Completion Depth: 3.5 m

Drilling Rig Type: Doosan Tracked Excavator

Start Date: 2017 April 4

Logged By: MCP

Completion Date: 2017 April 4

Reviewed By: MCP

Page 1 of 1

Government of Yukon

Testpit No: E-02

Project: Whistle Bend Ph 6/7 Borrow Assessment

Project No: W14103567-18.003

Location: Phases 6/7 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 493350 E; 6738485 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANIC ROOT MAT - black, (100 mm thick) SILT AND SAND - trace of fibrous organics throughout, uniformly graded, brown, fine sand	Seasonally frozen		20	40	80	0
1	Excavator	SAND - trace silt, brownish grey, fine sand	Unfrozen					1
2		- damp						2
3								3
4								4
5		5						
6		END OF TESTPIT (5.0 metres)					6	
7							7	
7.5							7.5	



Contractor: Canyon City Construction

Completion Depth: 5 m

Drilling Rig Type: Doosan Tracked Excavator

Start Date: 2017 April 4

Logged By: MCP

Completion Date: 2017 April 4

Reviewed By: MCP

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Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0	Excavator	ORGANIC ROOT MAT - organic, brown and black, (100 mm thick) SILT AND SAND - trace of fibrous organics throughout, uniformly graded, brown, fine sand	Seasonally frozen					0
1		SAND - trace silt, brownish grey, fine sand					1	
2							2	
3							3	
4							4	
5		- 800 mm thick silt pocket, discontinuous					5	
6							6	
7			Unfrozen				7	
8							8	
9							9	
10							10	
11							11	
12							12	
13							13	
14							14	
15							15	
16							16	
17		END OF TESTPIT (5.0 metres)					17	
18							18	
19							19	
20							20	
21							21	
22							22	
23							23	
24							24	



Contractor: Canyon City Construction

Completion Depth: 5 m

Drilling Rig Type: Doosan Tracked Excavator

Start Date: 2017 April 4

Logged By: MCP

Completion Date: 2017 April 4

Reviewed By: MCP

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Associated Engineering

GLOBAL PERSPECTIVE.
LOCAL FOCUS

Borehole No: BH18-01

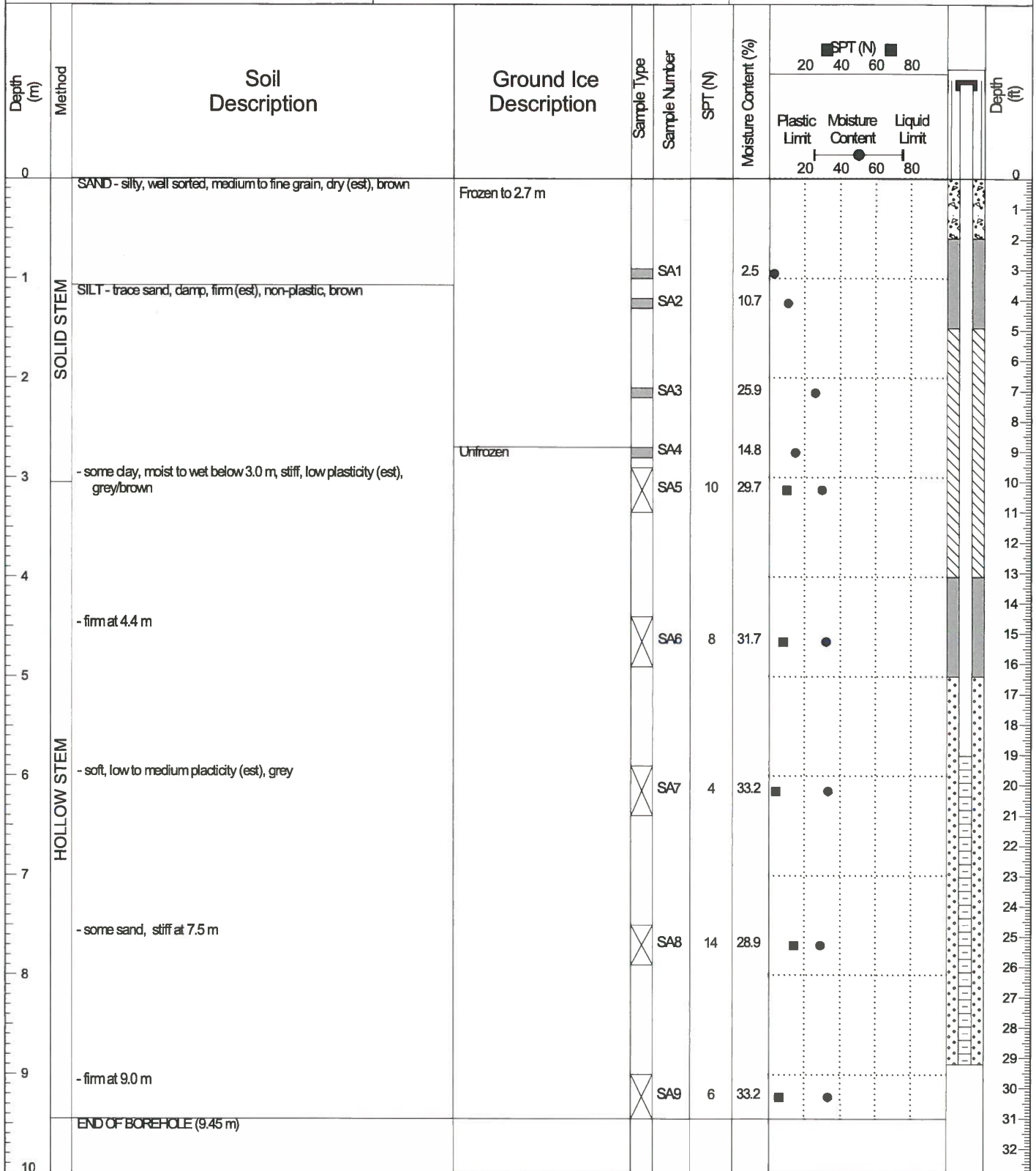
Project: WHISTLEBEND LIFT STATION

Project No: 704-ENG.WARC03381-01

Location: KENO WAY AT LEOTA ST.

WHITEHORSE, YT

UTM: 493397 E; 6738327 N; Z 8 NAD83



TETRA TECH

Contractor: DONKEK DRILLING

Completion Depth: 9.45 m

Drilling Rig Type: TRUCK MOUNTED CME75

Start Date: 2018 February 22

Logged By: TTP

Completion Date: 2018 February 22

Reviewed By: MP

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**Government of Yukon -
Community Services**

Borehole No: 3D/E

Project: Geotechnical Evaluation - Whistle Bend Phase 6

Project No: ENG.WARC03386-25

Location: Whistle Bend Subdivision - Phase 6

Whitehorse, Yukon

UTM: 493980 E; 6738102 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)			3D/E	Depth (ft)
				Plastic Limit	Moisture Content	Liquid Limit		
0		SAND - trace to some silt, damp, brown, medium sand	Unfrozen	20	40	80		0
1	Solid stem auger	- increasing moisture content						1
2							2	
3		SILT - clayey, wet, soft, mottled brown and grey at upper interface with sand						3
4		- dark grey						4
5								5
6		END OF BOREHOLE (6.00 metres) Monitoring well installed to 5.30 metres						6
7								7
7.5								7.5



Contractor: DonJeck Drilling

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 October 31

Logged By: MCP

Completion Date: 2018 October 31

Reviewed By: CC

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APPENDIX B

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL – YUKON GOVERNMENT

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (**Yukon Government**) as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of the Yukon Government or TETRA TECH. It is acknowledged that the Yukon Government, the Client, may reproduce the report freely for internal usage.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.