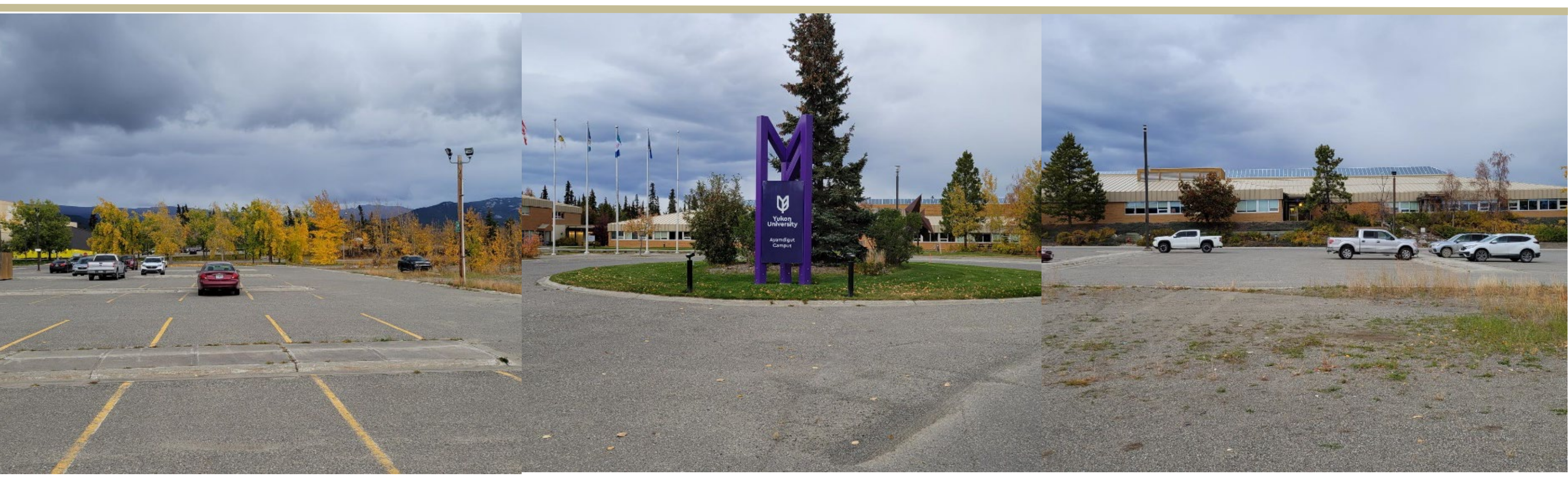
Geotechnical Site Evaluation Report
Polaris Project – New Science Building
Yukon University Whitehorse (Ayamdigut) Campus
Whitehorse, Yukon



PRESENTED TO

Yukon University

JANUARY 5, 2023
ISSUED FOR USE, REVISION 1
FILE: 704-ENG.WARC04016-02

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LIMITATIONS OF REPORT

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1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Yukon University (YU) to complete a geotechnical site evaluation for the Polaris Project, a new science building planned for the Yukon University Ayamdigut (Whitehorse) Campus.

This report presents the results of a geotechnical drilling program and recommendations for geotechnical design and construction of the proposed building foundation.

2.0 PROJECT DESCRIPTION

Tetra Tech previously completed a preliminary geotechnical evaluation for this development in 2021 (Tetra Tech File No. 704-ENG.WARC04016-01), attached in Appendix C. Tetra Tech also prepared a site description memorandum (issued August 23, 2022) describing the findings of the 2022 geotechnical drilling program and discussing preliminary development considerations.

Stantec Architecture Ltd. (Stantec) has been engaged by YU to design the Polaris building. The proposed building is located over the existing student parking lot, approximately shown on the attached Figure 1. We understand that this location may be adjusted slightly for final design. The proposed building is one storey tall and will not have a basement.

3.0 GEOTECHNICAL DRILLING AND TESTPITTING PROGRAMS

Tetra Tech retained Donjeck Drilling Ltd. (Donjeck) to complete a two-day geotechnical drilling program at the proposed Polaris building site on August 5 and 6, 2022. Six solid-stem auger boreholes were advanced to depths ranging from 7.6 to 9.1 m below ground surface (b.g.s.). Two hollow-stem auger boreholes were advanced to 12.2 m and 4.6 m b.g.s. Standard penetration testing (SPT) was completed at nominal 1.5 m intervals in the hollow-stem auger boreholes to assess soil consistency and recover disturbed soil samples. Disturbed grab samples were also collected from solid-stem auger boreholes.

Boreholes were logged in the field by Shawn Matthies, EIT, a junior geotechnical engineer from Tetra Tech's Whitehorse office. Samples were returned to Tetra Tech's Whitehorse laboratory for geotechnical index testing, including determination of natural moisture content on all samples and particle size distribution (sieve) testing on selected samples.

A standpipe piezometer was installed in the 12.2 m-deep borehole (BH22-07) to monitor groundwater levels. Remaining boreholes were backfilled using drill cuttings to restore the ground surface.

Subsequent to questions about fill detected on the site, Tetra Tech retained Glacier Drilling Ltd. to complete a targeted testpitting program (two testpits) to confirm the extent of known uncontrolled fill near the southwest corner of the Polaris building footprint. This testpitting program was completed on November 21, 2022.

4.0 SITE CONDITIONS

4.1 Surface Conditions

The proposed Polaris building site is presently being used as a student parking lot. The east site of the lot is paved with asphalt and slopes gently down toward the southeast corner. The west and southeast sides of the lot are surfaced with gravel, while the southwest side of the lot is surfaced with sandy, gravelly soil and grassy vegetation. The YU A-Wing building is adjacent to the site to the north. The ground to the south of the site slopes steeply down approximately 4 to 5 m toward undeveloped, mostly forested land. Spoil material and debris appear to have been pushed down this steep bank in several areas.

4.2 Subsurface Conditions

Surficial geology maps indicate that the YU Ayamdigut Campus is underlain by fluvial to glaciofluvial deposits (Bond, Morrison, & McKenna, 2005). Typical glaciofluvial deposits are composed of subrounded to rounded gravel and cobbles, sand, and relatively little silt or clay. Glaciofluvial soil was observed in all of the boreholes below a variable thickness of fill, sand, and/or organic soil. The glaciofluvial soil was often difficult to distinguish from granular fill which had similar composition and consistency to the native glaciofluvial soil.

Soil conditions are summarized below in Table 1. Borehole logs and laboratory testing results are included in Appendix B.

Table 1: Summary of Subsurface Soil Conditions

	BH22-01 (SSA)	BH22-02 (SSA)	BH22-03 (SSA)	BH22-04 (SSA)	BH22-05 (SSA)	BH22-06 (SSA)	BH22-07 (HSA)	BH22-08 (HSA)
Soil Description	**Depth range (m)**							
Gravelly sand to sandy gravel (fill)	–	0 – 0.7	0 – 0.7	0 – 0.1	0 – 0.6	–	–	–
Sand	–	0.7 – 2.1	–	0.1 – 2.6	0.6 – 2.2	–	–	–
Sand and silt with organic inclusions to organic silt	–	–	0.7 – 1.4	2.6 – 2.8	–	–	–	–
Sand with some silt and gravel	–	–	–	2.8 – 3.8	–	–	–	–
Glaciofluvial gravel and sand	0 – 9.1	2.1 – 9.1	1.4 – 9.1	3.8 – 9.1	2.2 – 7.6	0 – 7.6	0 – 12.7	0 – 5.0
Termination Depth	9.1 (target)	9.1 (target)	9.1 (target)	9.1 (target)	7.6 (target)	7.6 (target)	12.7 (target)	5.0 (refusal)

Soil conditions in the supplementary testpitting program consisted of silty sand fill with organic inclusions and construction debris below a surficial veneer of gravel. An angled contact with the previous natural ground surface was observed between about 1.5 and 4.5 m b.g.s. Natural ground consisted of a dark, organic silt veneer overlying glaciofluvial gravel and sand.

4.2.1 Groundwater

Groundwater was not encountered in any of the boreholes. The piezometer installed in BH22-07 was dry immediately after installation on August 6 and was still dry when rechecked on August 19.

4.2.2 Bedrock

Bedrock was not encountered in any of the boreholes and is not expected within the zone of influence of the proposed building.

4.2.3 Permafrost

Permafrost was not encountered in any of the boreholes and is not expected anywhere within the Site.

5.0 DISCUSSION AND RECOMMENDATIONS

Based on the soil conditions encountered throughout most of the site, typically consisting of compact to dense granular soil, we consider a thickened slab-on-grade foundation or shallow footings to be generally suitable for the proposed structure. Recommendations for both foundation types are included below.

Tetra Tech's preliminary site evaluation identified loose, uncontrolled fill on the south side of the parking lot, in addition to the fill placed to construct the parking area surface. Thick deposits of uncontrolled fill were not observed in the 2022 drilling program. A 2005 as-built water/sewer plan prepared by Quest Engineering Group and provided to Tetra Tech by YU (Appendix D) shows local topography prior to the placement of uncontrolled fill on the south end of the parking lot. Tetra Tech completed a targeted testpitting program to assess whether uncontrolled fill conforms to this boundary; we observed that uncontrolled fill does conform to the previous natural ground surface shown in the 2005 survey.

Part of the proposed building footprint overlaps this uncontrolled fill. When estimating material quantities for excavation and replacement during construction, all material present between the 2005 ground surface and the present-day ground surface can be considered loose, uncontrolled fill with organics and construction debris that is not suitable for re-use as compacted backfill. Any loose, uncontrolled fill underlying the building must be removed and replaced with compacted granular soil, per the recommendations in Section 5.1.

5.1 Site Preparation

Prior to construction, Tetra Tech recommends that the site be prepared in accordance with the following recommendations:

- The existing pavement and any unsuitable fill, debris, organics, soft, loose, wet, or otherwise deleterious material must be removed from the entire building footprint, plus at least 1.0 m outward in all directions.
- For a thickened slab-on-grade foundation:
  - At least 1.0 m of soil (measured from the underside of slab thickenings) should be excavated from the entire building footprint, plus at least 1.0 m outward in all directions, to expose gravelly glaciofluvial sands and gravels or compacted granular fill.
- For shallow footings:
  - At least 1.0 m of soil (measured from the underside of footings) should be subexcavated below footing areas, plus at least 0.6 m outward in all directions, to expose gravelly glaciofluvial sands and gravels or compacted granular fill.

  - At least 0.4 m of soil (measured from final grade) should be subexcavated below the entire building footprint, plus at least 1 m in all directions, to expose glaciofluvial sands and gravels or compacted granular fill.

- The southwest corner of building footprint extends into the loose, uncontrolled fill encountered in Tetra Tech's 2021 preliminary site investigation. All uncontrolled fill must be removed from the building footprint to expose compact, granular soil. This excavation should extend laterally outward a distance at least equal to the depth of the excavation, to a maximum of 3.0 m or as decided by the geotechnical engineer. The excavation to remove uncontrolled fill may be several metres deep, depending on the final building location. The uncontrolled fill is not considered to be suitable for reuse as structural backfill.

- Upon completion of site clearing and subexcavation, the exposed subgrade should be inspected by a qualified geotechnical engineer to confirm that suitable subgrade conditions have been achieved and make additional recommendations if required.

- Prior to backfilling and/or building construction, the exposed subgrade should be moisture conditioned and compacted to at least 98% of the standard Proctor maximum dry density (SPMDD).

- 80 mm pit run gravel should be placed in maximum 200 mm-thick lifts, moisture conditioned, and compacted to at least 98% SPMDD. 80 mm pit run gravel should conform to the gradation limits in Table 2. Glaciofluvial gravel and existing granular fill are considered suitable for reuse as fill.

- The topmost 150 mm immediately underlying cast-in-place concrete should be backfilled using 20 mm crushed basecourse gravel. Basecourse gravel should be moisture conditioned and compacted to at least 98% SPMDD. Basecourse gravel should conform to the gradation limits in Table 2.

Table 2: Recommended Gradations for Granular Fill Materials

80 mm Pit Run Gravel		20 mm Crushed Basecourse Gravel	
Particle Size (mm)	**% Passing by Mass**	**Particle Size (mm)**	**% Passing by Mass**
80.0	100	–	–
25.0	55 – 100	20.0	100
12.5	42 – 84	12.5	64 – 100
5.00	26 – 65	5.00	36 – 72
1.25	11 – 47	1.25	12 – 42
0.315	3 – 30	0.315	4 – 22
0.080	0 – 8	0.080	3 – 6

5.2 Foundation Design

Stantec advised that the Polaris building should be designed in accordance with the 2020 edition of the National Building Code of Canada (NBCC 2020).

5.2.1 Limit States Design

NBCC 2020 stipulates that foundation design must be carried out using limit states design (LSD) methods. Under LSD, a minimum of two loading cases must be considered by geotechnical and structural designers: the ultimate limit state (ULS) and the serviceability limit state (SLS). The ULS bearing resistance is the maximum pressure that can be applied to soil without causing bearing failure. The SLS bearing resistance represents the maximum allowable pressure to limit elastic settlement to a tolerable amount. Both ULS and SLS are highly dependent on soil properties, groundwater conditions, footing geometry, and burial depth.

Under LSD, resistance factors are applied to the calculated (unfactored) resistances to develop factored bearing resistances. Geotechnical resistance factors for shallow foundation design are:

- 0.5 for vertical bearing resistance (ULS);
- 1.0 for vertical bearing resistance (SLS); and
- 0.8 for horizontal (sliding) resistance.

5.2.2 Bearing Resistance

Bearing resistance values are sensitive to soil conditions, groundwater conditions, and footing/slab thickening size and depth. Bearing resistances below were calculated for a variety footing sizes, for both 0.3 m-thick slab thickenings and 1.2 m-deep spread and strip footings. SLS bearing resistances were developed based on a tolerable elastic settlement of 25 mm.

Table 3: Unfactored Bearing Resistances

Footing Type	Footing Size	Preliminary Unfactored Bearing Resistance	
		ULS (kPa)	SLS (kPa)
0.3 m-thick slab thickening	0.9 m square	400	500
	1.5 m square	450	375
	2.0 m square	475	275
	0.4 m strip	275	500
	1.0 m strip	350	175
1.2 m-deep shallow footing	0.9 m square	750	500
	1.5 m square	750	375
	2.0 m square	750	275
	0.4 m strip	750	500
	1.0 m strip	750	175

Tetra Tech can be contacted to provide bearing resistances for additional slab thickening or footing configurations, if necessary. Significant differential settlement is not expected based on the soil conditions observed and the site preparation recommended in Section 5.1.

5.2.3 Modulus of Subgrade Reaction

The modulus of subgrade reaction is not a fundamental soil property, but rather an approach for structural engineers to model interactions between soil and structural elements. Similar to bearing resistance, the subgrade modulus is highly sensitive to load geometry, and must be developed iteratively by geotechnical and structural engineers.

Moduli of subgrade reaction are provided below in Table 4, for the same thickening and footing sizes considered in Table 3 (bearing resistance).

Table 4: Preliminary Moduli of Subgrade Reaction

Footing Type	Footing Size	Preliminary Modulus of Subgrade Reaction (MPa/m)
0.3 m-thick slab thickening	0.9 m square	41
	1.5 m square	25
	2.0 m square	18
	0.4 m strip	48
	1.0 m strip	12
1.2 m-deep shallow footing	0.9 m square	41
	1.5 m square	25
	2.0 m square	18
	0.4 m strip	48
	1.0 m strip	12

5.2.4 Lateral Earth Pressure

We understand that final site grading along the north side of the building may result in foundation walls acting as retaining walls up to 1 m high, and that structural design will consider lateral pressure exerted by the backfill placed around the building. Lateral earth pressure has been estimated and is presented on Figure 2, for static and seismic conditions, assuming that compacted granular fill is used as backfill around the building.

Lateral earth pressure for static conditions includes a minimum compaction stress of 12 kPa, to reflect “locked in” stresses generated by compaction of the backfill against the building wall. A traffic surcharge is also provided and should be applied where lanes or driveways are present within a few metres of the side of the building. Lateral earth pressure during seismic loading includes the earth pressure under static conditions, plus a seismic component that is based on the seismic hazard of the site.

Lateral earth pressure coefficients for at-rest, active, and passive conditions are presented below in Table 5.

Table 5: Lateral Earth Pressure Coefficients

Parameter	Recommended Value
K_0	0.43
K_a	0.27
K_p	3.69

5.2.5 Weeping Tile

Soil at the site is considered to be “free draining” and weeping tile is not required.

5.3 Seismic

NBCC 2020 stipulates that seismic design of new structures should consider a design earthquake event with a 2% probability of exceedance in 50 years (i.e., a return period of 2,475 years). NBCC 2020 also requires that a site designation be established for seismic design of new structures. Based on energy-corrected average standard penetration resistance ($\overline{N}_{60}$), we recommend that the site be classified as Site Class D, per Table 4.1.8.4.-B in NBCC 2020, corresponding to site designation X_D.

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NBCC 2020 interpolated seismic hazard values from Natural Resources Canada's online calculator are presented below in Table 6.

Table 6: NBCC 2020 Interpolated Seismic Hazard Values for 1:2,475-year Earthquake

$S_a(0.2, X_D)$	$S_a(0.5, X_D)$	$S_a(1.0, X_D)$	$S_a(2.0, X_D)$	$S_a(5.0, X_D)$	$S_a(10.0, X_D)$	$PGA(X_D)$	$PGV(X_D)$
0.552	0.622	0.453	0.293	0.125	0.0689	0.225	0.4132

5.4 Seasonal Frost

Seasonal frost-related ground movement can occur if the following three criteria are satisfied:

- Seasonal ground temperatures are below freezing,
- The soil is saturated or nearly saturated, with a source of ground moisture available to create ice lenses, and
- The soil is frost-susceptible.

The depth of seasonal frost penetration in Whitehorse is commonly assumed to be 2.4 m but can exceed 3 m in areas where snow is regularly cleared. Nearly-saturated to saturated soil conditions were not observed in the site investigation and are not expected to develop naturally. The glaciofluvial sand and gravel soil is not considered to be frost-susceptible.

Provided that the site preparation recommendations outlined in Section 5.1 are followed, seasonal frost protection (e.g., perimeter insulation) is not required and foundation elements can be positioned within the seasonal frost depth.

5.5 Concrete

All concrete should be designed, mixed, placed, and tested in accordance with the most recent editions of the Canadian Standards Association's CAN/CSA A23.1 and A23.2. According to these standards, concrete should be designed to satisfy minimum durability requirements that are defined by assigning an exposure class.

Concrete exposure class is dependent on the presence of chlorides, sulphates, freeze-thaw cycles, and/or saturated conditions. The following concrete exposure classes should be used for design:

- Exposure class F-2 should be used to design concrete footings, slabs, and concrete elements around the building exterior that may be exposed to freezing temperatures.
- Exposure class N should be used for interior concrete elements that will not be exposed to freezing temperatures.
- Exposure class C-1 (for structurally reinforced concrete) or C-2 (for non-structurally reinforced concrete) should be used to design concrete for exterior slabs, aprons, and sidewalks that may be exposed to freeze-thaw cycles and chlorides (e.g., de-icing chemicals).

5.6 Hardscaped Exterior Areas

We understand that the planned parking area is limited to the two existing gravel lots on the west side of the student parking area. This area is anticipated to be underlain by compact, granular soil practically from the surface.

In areas where compact, granular soil exists practically from the surface, the following site preparation should be carried out to ensure that near-surface loose/soft spots are compacted:

- Any debris, grass, topsoil, soft, loose, wet, or otherwise deleterious material should be removed from the parking lot footprint.
- At least 0.45m of soil (measured from the underside of concrete/asphalt pavement) should be excavated from the parking lot footprint, to expose gravelly glaciofluvial sands and gravels or compacted granular fill.
- Upon completion of site clearing and subexcavation, the exposed subgrade should be inspected by a qualified geotechnical engineer to confirm that suitable subgrade conditions have been achieved and make additional recommendations if required.
- The exposed subgrade should be moisture conditioned and compacted to at least 98% SPMDD.
- 80 mm pit run gravel should be placed in maximum 300 mm-thick lifts, moisture conditioned, and compacted to at least 98% SPMDD. 80 mm pit run gravel should conform to the gradation limits in Table 2. Glaciofluvial gravel and existing granular fill are considered suitable for reuse as fill.
- The topmost 150 mm immediately underlying concrete/asphalt pavement backfilled using 20 mm crushed basecourse gravel. Basecourse gravel should be moisture conditioned and compacted to at least 98% SPMDD. Basecourse gravel should conform to the gradation limits in Table 2.

In areas where compact, granular soil does not exist practically from the surface (none expected for the parking lot plan reviewed by Tetra Tech), the following site preparation should be carried out:

- At least 1.7 m of 80 mm pit run gravel should be placed in maximum 300 mm-thick lifts, moisture conditioned, and compacted to at least 95% SPMDD (below 1 m of final grade), or 98% SPMDD (within 1 m of final grade). 80 mm pit run gravel should conform to the gradation limits in Table 2. Glaciofluvial gravel and existing granular fill is considered suitable for reuse as fill.
- At least 150 mm of 20 mm crushed basecourse gravel should be placed immediately beneath all concrete/asphalt pavement. Basecourse gravel should be moisture conditioned and compacted to at least 98% SPMDD.

5.7 Radon Mitigation

Based on the Yukon Geological Survey report on radon in surficial soils in Whitehorse (Kishchuk et al., 2020) and that the proposed building that does not include a basement, we expect that radon mitigation is not required for the proposed development at the site. Tetra Tech has not conducted any site specific testing.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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REFERENCES

Bond, J., Morison, S. and McKenna, K. (2005). Surficial Geology of Whitehorse (NTS 105D/11), Yukon (1:50 000 scale). Yukon Geological Survey, Geoscience Map 2005-7.

Kishchuk, M.J., Lipovsky, P.S., Bond, J.D. and Gosse, J.C., (2021) Preliminary investigation of geological controls on radon concentration in surficial sediment in Whitehorse, Yukon (NTS 105D/11, 14). In: Yukon Exploration and Geology 2020, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 115–135.

Quest Engineering Group. (2005). As-Built Plan – Water and Sewer Services. Drawing prepared for City of Whitehorse. Issued on November 10, 2005. Quest Engineering Group File No. 5041 101_R8.dwg.

Tetra Tech Canada Inc. (2021). New Science Building Preliminary Geotechnical Evaluation – Yukon University, Whitehorse, Yukon. Report prepared for Yukon University. Issued July 14, 2021. Tetra Tech File No. ENG.WARC04016-01.

FIGURES

LEGEND

- 2021 PRELIMINARY SITE EVALUATION BOREHOLE
- 2022 BOREHOLE
- 2022 TESTPIT

0 25m

Scale: 1:750 @ 11"x17"

CLIENT

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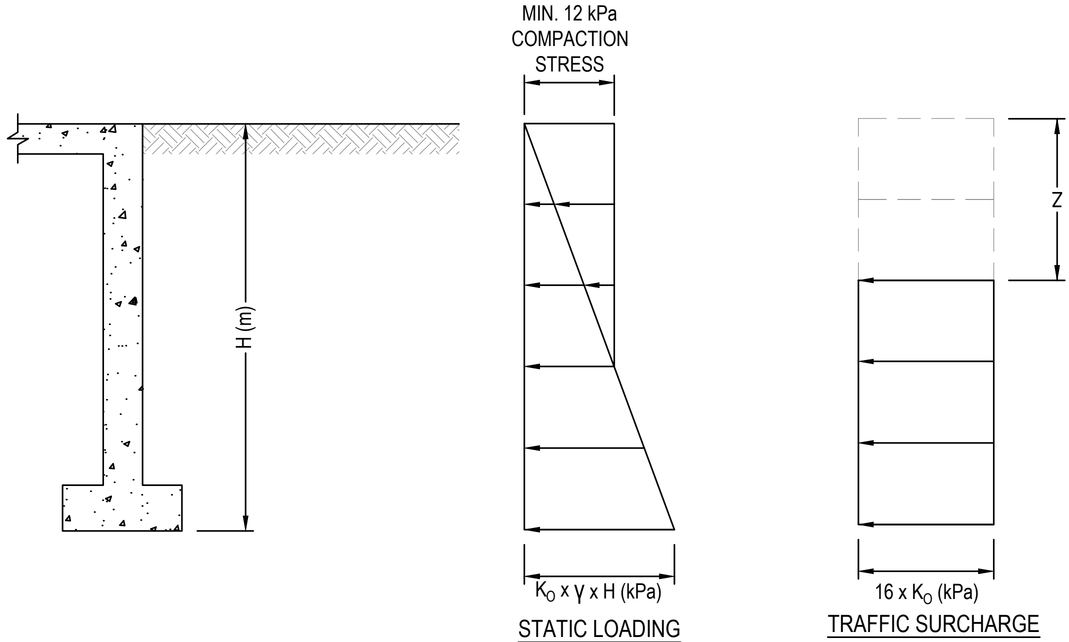
POLARIS BUILDING GEOTECHNICAL SITE EVALUATION
WHITEHORSE, YUKON

SITE PLAN SHOWING APPROXIMATE
BOREHOLE AND BUILDING OPTION LOCATIONS

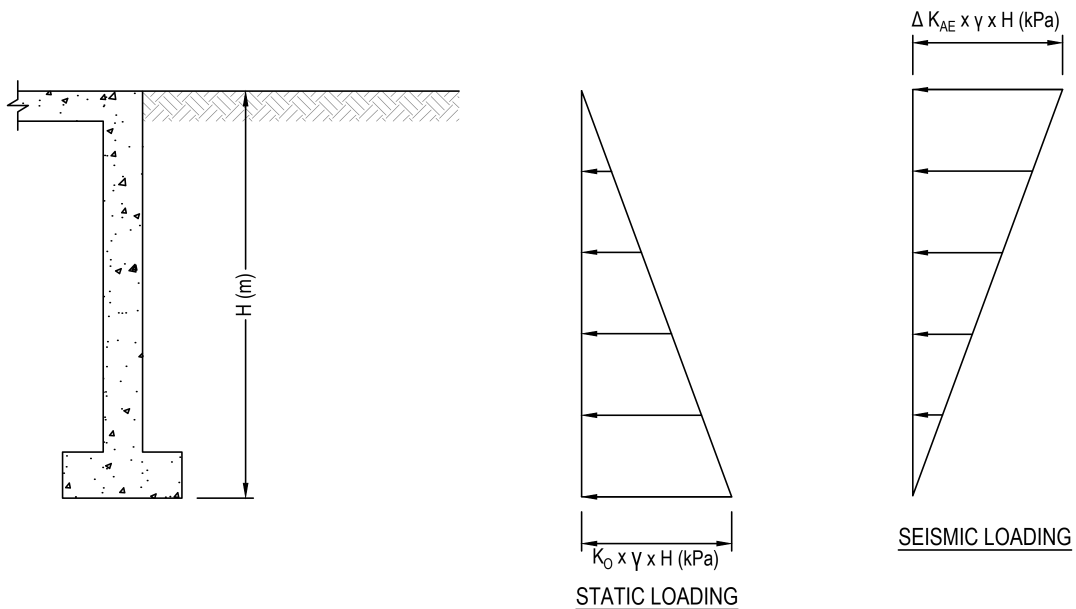
PROJECT NO.	DWN	CKD	REV
ENG.WARC04016-02	CB	SM	0

OFFICE	DATE
EBA-WHSE	August 22, 2022

Figure 1



STATIC CONDITIONS



SEISMIC CONDITIONS

PARAMETER	RECOMMENDED VALUE
K_O	0.43
γ (kN / m³)	23.5
Δ K_{AE}	0.163
H (m)	DEPTH TO UNDERSIDE OF FOOTING BELOW GROUND LEVEL
D (m)	HORIZONTAL DISTANCE FROM EDGE OF ROAD TO OUTSIDE OF BASEMENT WALL
Z (m)	2 x D

CLIENT

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POLARIS BUILDING GEOTECHNICAL SITE EVALUATION
WHITEHORSE, YUKON

LATERAL EARTH PRESSURE ON FOUNDATION WALLS

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PROJECT NO.	DWN	CKD	REV
ENG.WARC04016-02	CB	SAM	0

OFFICE	DATE
EBA-WHSE	November 1, 2022

Figure 2

APPENDIX A

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LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

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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 report, at or on the development proposed as of the date of the Professional Document requires a supplementary 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 investigate, address or consider and has not investigated, 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 and methods 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 historic 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 investigation 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

There is a direct correlation between construction activity and 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 are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as 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 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 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses 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 assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed 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.

APPENDIX B

BOREHOLE LOGS AND LABORATORY TESTING RESULTS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 TO 20%	0 to 4
Loose	20 TO 40%	4 to 10
Compact	40 TO 75%	10 to 30
Dense	75 TO 90%	30 to 50
Very Dense	90 TO 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (KPA)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

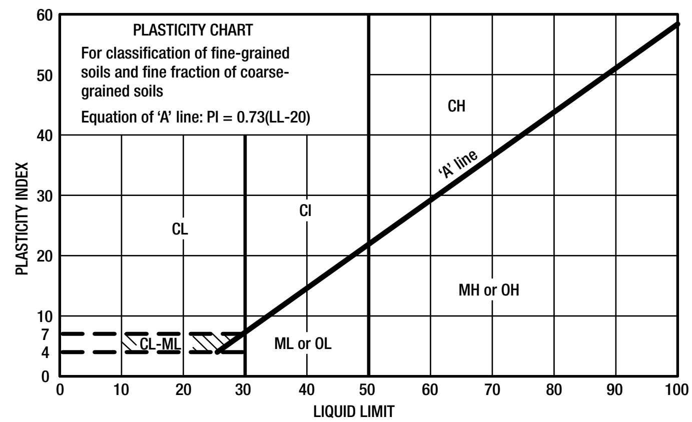
NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated - composed of thin layers of varying colour and texture.
Interbedded - composed of alternate layers of different soil types.
Calcareous - containing appreciable quantities of calcium carbonate.;
Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

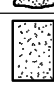
TETRA TECH

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE - GRAINED SOILS More than 50% retained on No. 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines. Less than 5% pass 75 µm sieve: GW, GP, SW, SP. More than 12% pass 75 µm sieve: GM, GC, SM, SC. 5% to 12% pass 75 µm sieve: Borderline classification requiring use of dual symbols	$C_u = D_{60} / D_{10}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly-graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below 'A' line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above 'A' line and plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines		$C_u = D_{60} / D_{10}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly-graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot above 'A' line and plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above 'A' line and plasticity index greater than 7	
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS	Liquid limit <50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity			
		Liquid limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
	CLAYS Above "A" line on plasticity chart negligible organic content	Liquid limit <30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays			
		Liquid limit 30-50	CI	Inorganic clay of medium plasticity, silty clays			
		Liquid limit >50	CH	Inorganic clay of high plasticity, fat clays			
	ORGANIC SILTS AND CLAYS	Liquid limit <50	OL	Organic silts and organic silty clays of low plasticity			
		Liquid limit >50	OH	Organic clays of medium to high plasticity			
HIGHLY ORGANIC SOILS			PT	Peat, muck and other highly organic soils	* Based on the material passing the 75 mm sieve † ASTM Designation D 2487, for identification procedure see D 2488 USC as modified by PFRA		

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
N	Nf	Poorly-bonded or friable	
	Nbn	No excess ice, well-bonded	
	Nbe	Excess ice, well-bonded	

VISIBLE ICE LESS THAN 50% BY VOLUME

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
V	Vx	Individual ice crystals or inclusions	
	Vc	Ice coatings on particles	
	Vr	Random or irregularly oriented ice formations	
	Vs	Stratified or distinctly oriented ice formations	

VISIBLE ICE GREATER THAN 50% BY VOLUME

ICE	ICE + Soil Type	Ice with soil inclusions	
	ICE	Ice without soil inclusions (greater than 25 mm thick)	

NOTES:

1. Dual symbols are used to indicate borderline or mixed ice classifications.
2. Visual estimates of ice contents indicated on borehole logs ± 5%
3. This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

LEGEND: Soil ☐ Ice ■

BOREHOLE KEYSHEET

Water Level Measurement

- Measured in standpipe, piezometer or well
- Inferred

Sample Types

- A-Casing
- Core
- Disturbed, Bag, Grab
- HQ Core
- Jar
- Jar and Bag
- 75 mm SPT
- No Recovery
- Split Spoon/SPT
- Tube
- CRREL Core

Backfill Materials

- Asphalt
- Bentonite
- Cement/ Grout
- Drill Cuttings
- Grout
- Gravel
- Sand
- Slough
- Topsoil Backfill
- Undisturbed

Lithology - Graphical Legend[1]

- Asphalt
- Bedrock
- Cobbles/Boulders
- Clay
- Coal
- Concrete
- Fill
- Gravel
- Limestone
- Mudstone
- Organics
- Peat
- Sand
- Sandstone
- Shale
- Silt
- Siltstone
- Conglomerate
- Topsoil
- Till

1. The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale

TETRA TECH

Yukon University

Borehole No: **BH22-01**

Project: Geotechnical Site Evaluation	Project No: ENG.WARC04016-02
Location: Yukon University Polaris Building	
Whitehorse, Yukon	UTM: 494700 E; 6734870 N; Z 8

Method: Solid stem auger

Depth (m)	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)
0	ASPHALT - (25 mm thick)	Unfrozen			
	SAND AND GRAVEL (FILL) - trace silt, fine to coarse grained sand, fine subangular gravel, damp, greyish brown, (150 mm thick)				
1	GRAVEL (POSSIBLE FILL) - sandy, some cobbles, fine to coarse grained gravel, fine to coarse grained sand, subrounded to rounded cobbles to 100 mm diameter, brownish grey - very grindy drilling		Grab	G01	2.2
2.5			Grab	G02	2.6
3	- rounded gravel, medium to coarse grained sand				
4			Grab	G03	1.9
4.5	- smooth drilling				
4.8	SAND (GLACIOFLUVIAL) - gravelly, trace to some silt, medium to coarse grained sand, fine rounded gravel, moist, brownish grey				
5.5			Grab	G04	2.7
7			Grab	G05	3.2
8.5	- some gravel, fine to coarse grained sand				
8.8			Grab	G06	4.2
9.1	END OF BOREHOLE (9.1 metres) Note: Target depth reached				

Plastic Limit / Moisture Content / Liquid Limit: 20 40 60 80

Contractor: Donjeck Drilling Ltd.	Completion Depth: 9.1 m
Equipment Type: Truck mounted CME-75	Start Date: 2022 August 5
Logged By: SAM	Completion Date: 2022 August 5
Reviewed By: CPC	Page 1 of 1

TETRA TECH

Yukon University

Borehole No: **BH22-02**

Project: Geotechnical Site Evaluation	Project No: ENG.WARC04016-02
Location: Yukon University Polaris Building	
Whitehorse, Yukon	UTM: 494657 E; 6734876 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0	Solid stem auger	ASPHALT - (25 mm thick)	Unfrozen					0
		SAND AND GRAVEL (FILL) - trace silt, fine to coarse grained sand, fine subangular gravel, damp, greyish brown, (125 mm thick)						2
1		GRAVEL (FILL) - sandy, trace silt, fine to coarse grained subrounded gravel, fine to coarse grained sand, damp, grey						4
		SAND - trace silt, fine grained sand, damp, yellowish brown			G07	3.9	●	
2								6
		SAND AND GRAVEL (GLACIOFLUVIAL) - trace silt, fine to coarse grained sand, fine to coarse grained subrounded gravel, damp, brownish grey						8
3		- fine grained gravel			G08	4.2	●	10
4					G09	3.4	●	12, 14
5		- medium to coarse grained sand						16
		- moist			G10	4.8	●	18
6								20
7					G11	5.8	●	22, 24
8		- fine to coarse grained sand						26
9					G12	4.8	●	28, 30
		END OF BOREHOLE (9.1 metres) Note: Target depth reached						
10–15								32–48

TETRA TECH

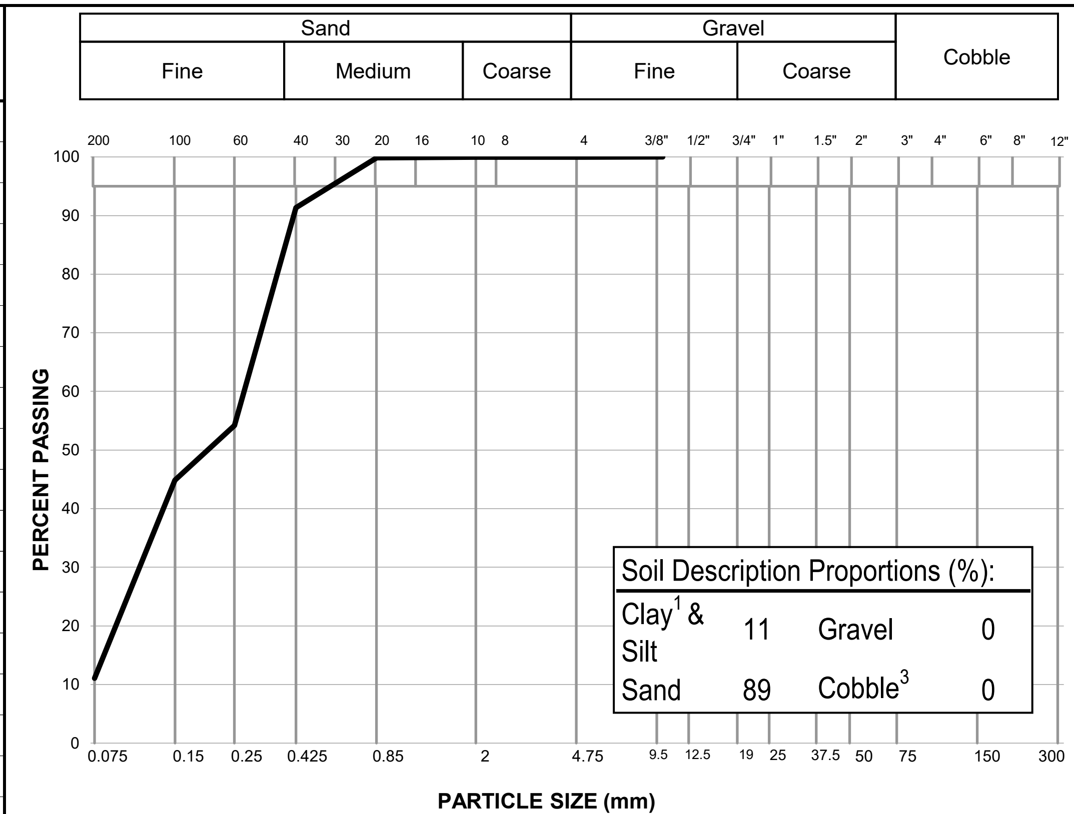
Contractor: Donjeck Drilling Ltd.	Completion Depth: 9.1 m
Equipment Type: Truck mounted CME-75	Start Date: 2022 August 5
Logged By: SAM	Completion Date: 2022 August 5
Reviewed By: CPC	Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Polaris Building		Sample No.:	G07	
Project No.:	ENG.WARC04016-02		Material Type:	Native Material	
Site:	-		Sample Loc.:	BH22-02	
Client:	Yukon Uiversity		Sample Depth:	1.4 - 1.5 m	
Client Rep.:	Martin Turpin		Sampling Method:	Grab	
Date Tested:	August 12, 2022	By: CP	Date Sampled:	August 5, 2022	
Soil Description[2]:	SAND - some silt		Sampled By:	SAM	
			USC Classification:	SM	Cu: #N/A
Moisture Content:	3.9%				Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	
19	
12.5	
10	100
5	100
2	100
0.85	100
0.425	91
0.25	54
0.15	45
0.075	11.1



Soil Description Proportions (%):			
Clay[1] & Silt	11	Gravel	0
Sand	89	Cobble[3]	0

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: E.I.T.

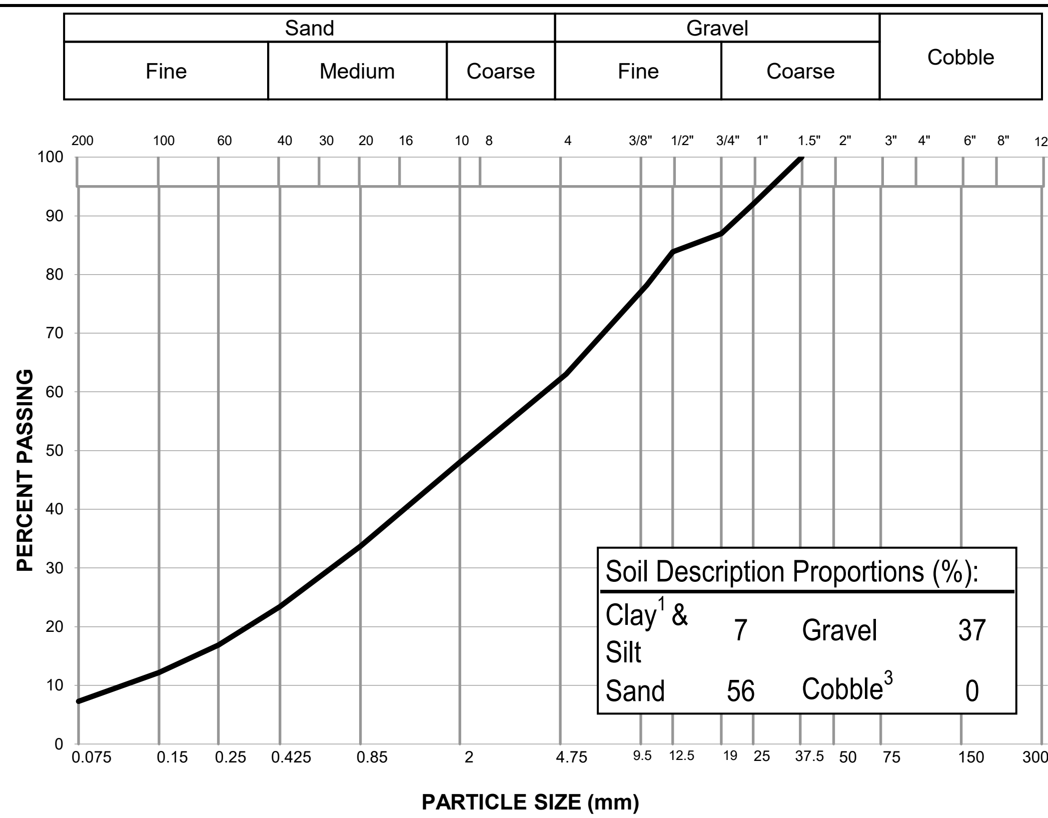
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Polaris Building	Sample No.:	G08
Project No.:	ENG.WARC04016-02	Material Type:	Native Material
Site:	-	Sample Loc.:	BH22-02
Client:	Yukon Uiversity	Sample Depth:	2.7 - 3.0 m
Client Rep.:	Martin Turpin	Sampling Method:	Grab
Date Tested:	August 12, 2022 By: CP	Date Sampled:	August 5, 2022
Soil Description[2]:	SAND and GRAVEL - trace silt	Sampled By:	SAM
		USC Classification:	SP Cu: 37.7
Moisture Content:	4.2%		Cc: 0.9

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	100
25	92
19	87
12.5	84
10	78
5	63
2	48
0.85	34
0.425	23
0.25	17
0.15	12
0.075	7.3



Soil Description Proportions (%):			
Clay[1] & Silt	7	Gravel	37
Sand	56	Cobble[3]	0

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: E.I.T.

Yukon University

Borehole No: **BH22-03**

Project: Geotechnical Site Evaluation	Project No: ENG.WARC04016-02
Location: Yukon University Polaris Building	
Whitehorse, Yukon	UTM: 494694 E; 6734841 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)
0	Solid stem auger	SAND (FILL) - gravelly, trace silt, fine to coarse grained sand, fine subrounded gravel, damp, brownish grey - no visible gravel, fine grained sand, yellowish brown	Unfrozen			
1		SAND AND SILT (FILL) - fine grained sand, damp, dark grey, black laminations, black organics and rootlet inclusions		Grab	G13	20
2		SAND AND GRAVEL (GLACIOFLUVIAL) - trace silt, fine to coarse grained sand, fine to coarse grained subrounded gravel, damp, greyish brown				
3		- medium to coarse grained sand		Grab	G14	2.4
4		SAND (GLACIOFLUVIAL) - gravelly, trace silt		Grab	G15	3.8
5				Grab	G16	3.9
7				Grab	G17	3.7
8		- fine to coarse grained sand		Grab	G18	3
9		END OF BOREHOLE (9.1 metres) Note: Target depth reached				

Plastic Limit — Moisture Content — Liquid Limit: 20 40 60 80

Depth (m): 0–15; Depth (ft): 0–48

TETRA TECH

Contractor: Donjeck Drilling Ltd.	Completion Depth: 9.1 m
Equipment Type: Truck mounted CME-75	Start Date: 2022 August 5
Logged By: SAM	Completion Date: 2022 August 5
Reviewed By: CPC	Page 1 of 1

Yukon University

Borehole No: **BH22-04**

Project: Geotechnical Site Evaluation	Project No: ENG.WARC04016-02
Location: Yukon University Polaris Building	
Whitehorse, Yukon	UTM: 494657 E; 6734851 N; Z 8

Method: Solid stem auger

Depth (m)	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)
0	SAND (FILL) - some gravel, trace silt, fine to medium grained sand, fine angular gravel, damp, brownish grey, occasional rootlet inclusions, (100 mm thick)	Unfrozen			
	SAND (POSSIBLE FILL) - trace silt, fine to medium grained sand, damp, brownish grey				
1			Grab	G19	5.7
2			Grab	G20	6
	- gravelly, some silt, fine to coarse grained rounded gravel, brown				
	ORGANICS - silty, black				
3	SAND (POSSIBLE FILL) - some silt, some gravel, fine to medium grained sand, fine to coarse grained rounded gravel, damp, brown				
4	SAND (GLACIOFLUVIAL) - gravelly, trace silt, fine to coarse grained sand, fine grained subrounded gravel, damp, grey		Grab	G21	3.5
5	- grindy drilling				
	- 100 mm thick brown silty seam		Grab	G22	5
6	- 100 mm thick brown silty seam				
7			Grab	G23	4
8					
9			Grab	G24	3.9
9.1	END OF BOREHOLE (9.1 metres) Note: Target depth reached				

Plastic Limit — Moisture Content — Liquid Limit (20, 40, 60, 80)

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Depth (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48

TETRA TECH

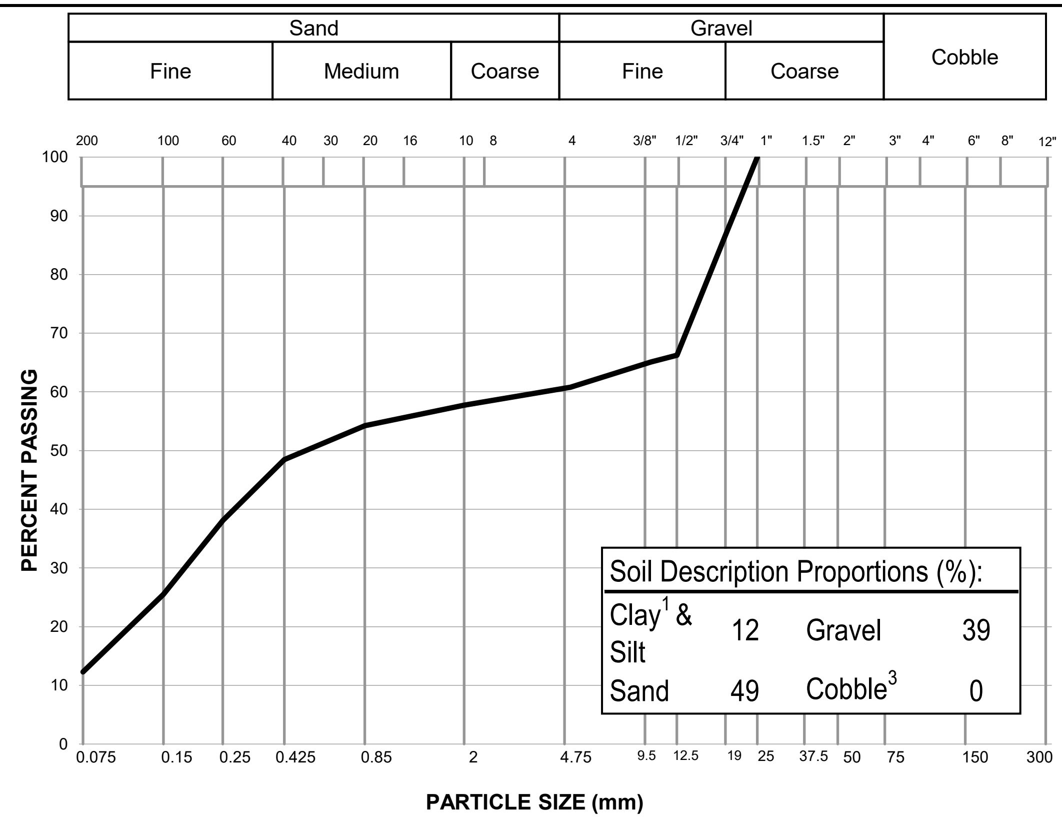
Contractor: Donjeck Drilling Ltd.	Completion Depth: 9.1 m
Equipment Type: Truck mounted CME-75	Start Date: 2022 August 5
Logged By: SAM	Completion Date: 2022 August 5
Reviewed By: CPC	Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Polaris Building	Sample No.:	G20
Project No.:	ENG.WARC04016-02	Material Type:	Native Material
Site:	-	Sample Loc.:	BH22-04
Client:	Yukon Uiversity	Sample Depth:	2.3 - 2.4 m
Client Rep.:	Martin Turpin	Sampling Method:	Grab
Date Tested:	August 12, 2022 By: CP	Date Sampled:	August 5, 2022
Soil Description[2]:	SAND and GRAVEL - some silt	Sampled By:	SAM
		USC Classification:	SP Cu: #N/A
Moisture Content:	6.0%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	100
19	87
12.5	66
10	65
5	61
2	58
0.85	54
0.425	48
0.25	38
0.15	25
0.075	12.3



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: E.I.T.

TETRA TECH

Yukon University

Borehole No: **BH22-05**

Project: Geotechnical Site Evaluation	Project No: ENG.WARC04016-02
Location: Yukon University Polaris Building	
Whitehorse, Yukon	UTM: 494632 E; 6734883 N; Z 8

Method: Solid stem auger

Plastic Limit, Moisture Content, Liquid Limit: 20, 40, 60, 80

Depth (m)	Soil Description	Ground Ice Description	Sample Number	Moisture Content (%)
0	ASPHALT - (25 mm thick)	Unfrozen		
	SAND AND GRAVEL - trace silt, fine to medium grained sand, fine to coarse grained subrounded gravel, damp, grey			
	- some cobbles			
~1.1	SAND - trace gravel, trace silt, fine to medium grained sand, fine grained subangular gravel, damp, yellowish brown		G25	3.6
	- no visible gravel			
	- trace gravel, grey			
~2.1	SAND (GLACIOFLUVIAL) - gravelly, medium to coarse grained sand, fine to coarse grained subrounded gravel		G26	2.9
	- no recovery to 4.57 metres			
	- some gravel		G27	2.8
	- gravelly		G28	2.8
7.6	END OF BOREHOLE (7.6 metres) Note: Target depth reached			

TETRA TECH

Contractor: Donjeck Drilling Ltd.	Completion Depth: 7.6 m
Equipment Type: Truck mounted CME-75	Start Date: 2022 August 5
Logged By: SAM	Completion Date: 2022 August 5
Reviewed By: CPC	Page 1 of 1

Yukon University

Borehole No: **BH22-06**

Project: Geotechnical Site Evaluation	Project No: ENG.WARC04016-02
Location: Yukon University Polaris Building	
Whitehorse, Yukon	UTM: 494676 E; 6734863 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0	Solid stem auger	ASPHALT - (25 mm thick)	Unfrozen					0
		SAND AND GRAVEL (POSSIBLE FILL) - trace silt, fine to coarse grained sand, fine to coarse grained subrounded gravel, damp, grey - some cobbles						2
1		SAND (GLACIOFLUVIAL) - gravelly, trace silt, occasional cobbles throughout, medium to coarse grained sand, fine to coarse grained subrounded gravel, damp, greyish brown		■	G29	3.6	●	4
2				■	G30	3.8	●	6, 8
3								10, 12
4				■	G31	2.8	●	14
5				■	G32	2.8	●	16, 18
6		SAND AND GRAVEL (GLACIOFLUVIAL) - trace silt						20, 22
7		GRAVEL (GLACIOFLUVIAL) - sandy, fine to coarse grained rounded gravel, medium to coarse grained sand, damp, grey		■	G33	2.7	●	24
8		END OF BOREHOLE (7.6 metres) Note: Target depth reached						26, 28
9								30, 32
10								34
11								36, 38
12								40
13								42, 44
14								46, 48
15								

TETRA TECH

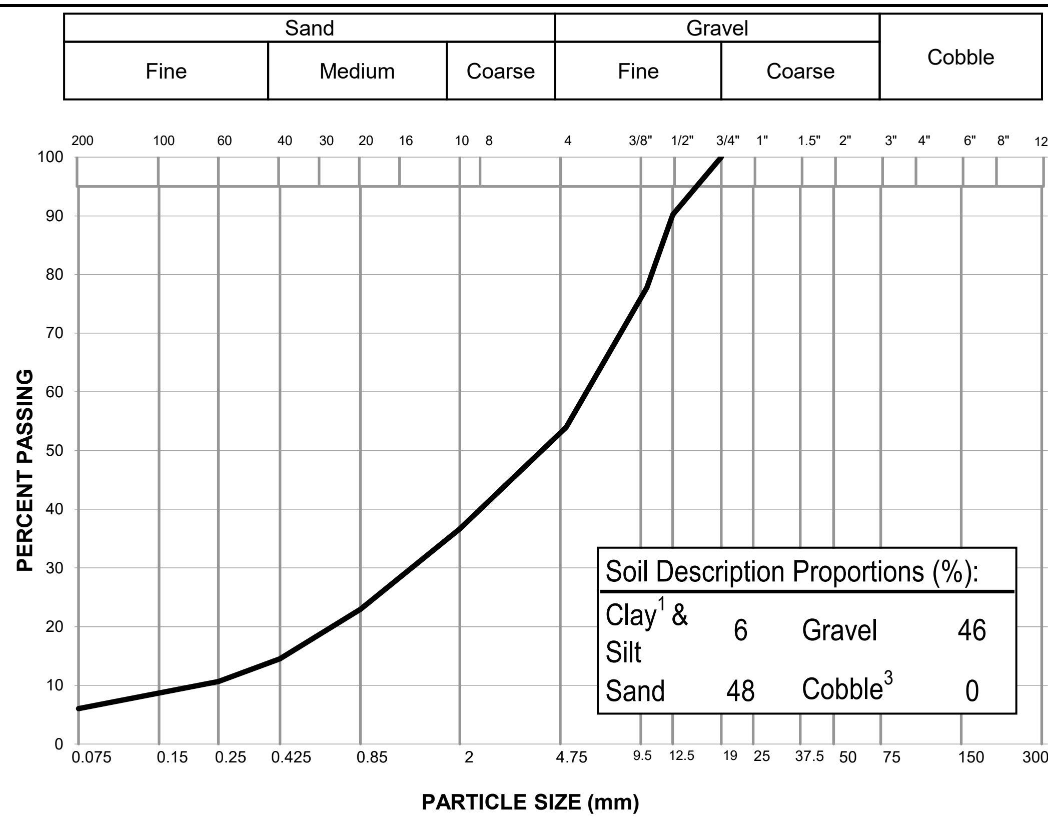
Contractor: Donjeck Drilling Ltd.	Completion Depth: 7.6 m
Equipment Type: Truck mounted CME-75	Start Date: 2022 August 5
Logged By: SAM	Completion Date: 2022 August 5
Reviewed By: CPC	Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Polaris Building	Sample No.:	G31
Project No.:	ENG.WARC04016-02	Material Type:	Native Material
Site:	-	Sample Loc.:	BH22-06
Client:	Yukon Uiversity	Sample Depth:	4.0 - 4.3 m
Client Rep.:	Martin Turpin	Sampling Method:	Grab
Date Tested:	August 12, 2022 By: CP	Date Sampled:	August 5, 2022
Soil Description[2]:	SAND and GRAVEL - some silt	Sampled By:	SAM
		USC Classification:	SW Cu: 28.9
Moisture Content:	2.8%		Cc: 1.5

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	
19	100
12.5	90
10	78
5	54
2	37
0.85	23
0.425	15
0.25	11
0.15	9
0.075	6.0



Soil Description Proportions (%):			
Clay[1] & Silt	6	Gravel	46
Sand	48	Cobble[3]	0

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: E.I.T.

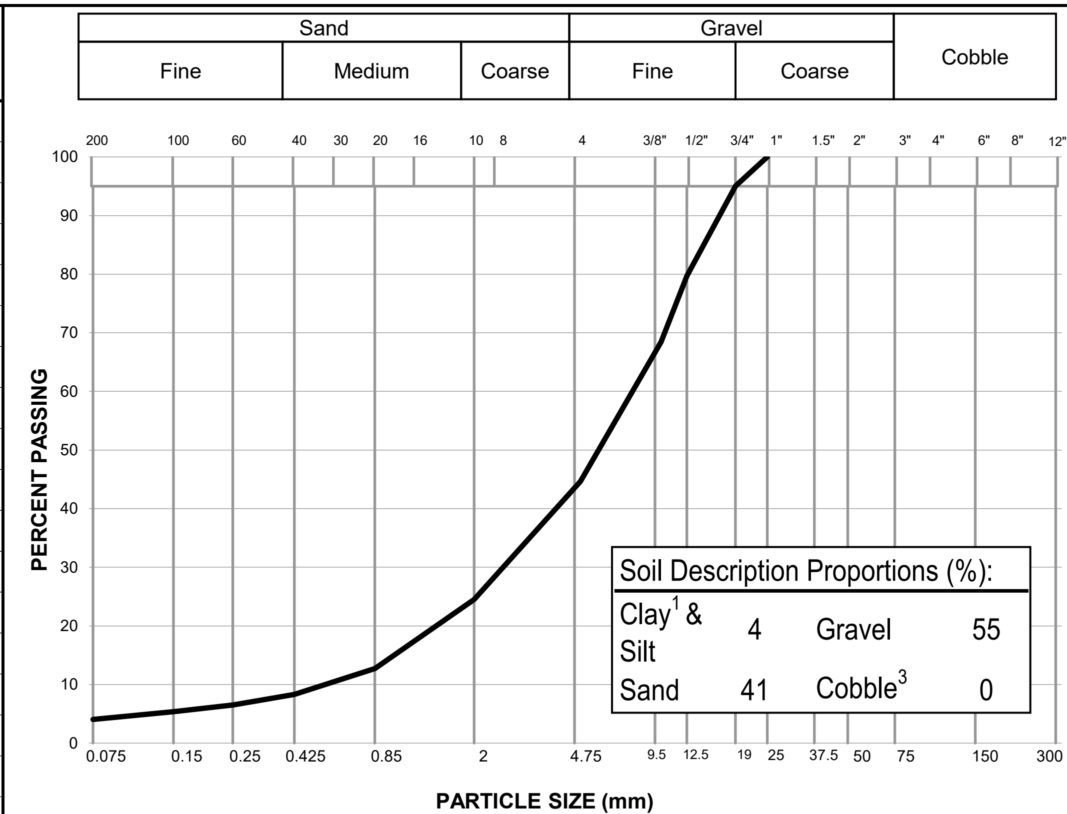
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Polaris Building	Sample No.:	G33
Project No.:	ENG.WARC04016-02	Material Type:	Native Material
Site:	-	Sample Loc.:	BH22-06
Client:	Yukon Uiversity	Sample Depth:	7.0 - 7.3 m
Client Rep.:	Martin Turpin	Sampling Method:	Grab
Date Tested:	August 12, 2022 By: CP	Date Sampled:	August 5, 2022
Soil Description[2]:	GRAVEL and SAND - trace silt	Sampled By:	SAM
		USC Classification:	GW Cu: 14.0
Moisture Content:	2.7%		Cc: 1.6

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	100
19	95
12.5	80
10	68
5	45
2	25
0.85	13
0.425	8
0.25	6
0.15	5
0.075	4.0



Soil Description Proportions (%):			
Clay[1] & Silt	4	Gravel	55
Sand	41	Cobble[3]	0

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: E.I.T.

TETRA TECH

Yukon University

Borehole No: **BH22-07**

Project: Geotechnical Site Evaluation | Project No: ENG.WARC04016-02

Location: Yukon University Polaris Building

Whitehorse, Yukon | UTM: 494632 E; 6734864 N; Z 8

Columns: Depth (m) | Method | Soil Description | Ground Ice Description | Sample Type | Sample Number | SPT (N) | Moisture Content (%) | ■ SPT (N) ■ 20 40 60 80 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80 | Standpipe | Depth (ft)

Method: SSA (0 to about 1.5 m); Hollow stem auger (below that)

Ground Ice Description: Unfrozen

Soil Description:

- ASPHALT - (25 mm thick)
- SAND AND GRAVEL (FILL) - trace silt, fine to coarse grained sand, fine subrounded gravel, damp, light brown
  - very dense
- SAND AND GRAVEL (POSSIBLE FILL) - trace silt, fine to coarse grained sand, fine to coarse grained subrounded gravel, damp, compact, light brown
  - very grindy drilling
- GRAVEL (GLACIOFLUVIAL) - sandy, trace silt, fine to coarse grained sand, fine to coarse grained subrounded gravel, damp, dense, grey
  - greyish brown
  - no recovery from SPT
  - trace sand, no visible silt, compact, grey
  - SPT refusal on suspected cobble or boulder
  - sandy, trace silt, fine grained gravel, brownish grey
- GRAVEL AND SAND (GLACIOFLUVIAL) - trace silt, fine to coarse grained sand, fine subrounded gravel, damp, loose, brownish grey
  - fine to coarse grained gravel, dense

END OF BOREHOLE (12.7 metres)
Standpipe installed to 12.1 metres
Note: Target depth reached

Approx. Depth (m)	Sample Number	SPT (N)	Moisture Content (%)
1.7	S34	49	3.2
3.3	S35	28	2
4.2	S36	41	2.2
4.8	S37	43	2.5
6.3		15	
7.9	S38	10	1.3
9.2	S39	50/ 75mm	2.5
10.9	S40	8	2
12.5	S41	34	2

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Depth (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48

TETRA TECH

Contractor: Donjeck Drilling Ltd.	Completion Depth: 12.7 m
Equipment Type: Truck mounted CME-75	Start Date: 2022 August 6
Logged By: SAM	Completion Date: 2022 August 6
Reviewed By: CPC	Page 1 of 1

Yukon University

Borehole No: **BH22-08**

Project: Geotechnical Site Evaluation	Project No: ENG.WARC04016-02
Location: Yukon University Polaris Building	
Whitehorse, Yukon	UTM: 494674 E; 6734879 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	■SPT (N)■ 20 40 60 80 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	Depth (ft)
0	SSA	ASPHALT - (25 mm thick)	Unfrozen						0
	SSA	SAND AND GRAVEL (GLACIOFLUVIAL) - some cobbles, trace silt, fine to coarse grained sand, fine to coarse grained subrounded gravel, damp, brownish grey							
	Hollow stem auger	- SPT refusal on suspected cobble				50/ 100mm			
	Hollow stem auger	- cobbles throughout, fine grained gravel, compact			S42	12	2.7		
	Hollow stem auger	SAND (GLACIOFLUVIAL) - gravelly, trace silt, cobbles throughout, fine to coarse grained sand, fine grained subrounded gravel, damp, dense, brownish grey			S43	33	2.2		
		END OF BOREHOLE (5.0 metres) Note: Stopped due to refusal on suspected cobble or boulder							

Depth scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Depth scale (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48

TETRA TECH

Contractor: Donjeck Drilling Ltd.	Completion Depth: 5 m
Equipment Type: Truck mounted CME-75	Start Date: 2022 August 6
Logged By: SAM	Completion Date: 2022 August 6
Reviewed By: CPC	Page 1 of 1

APPENDIX C

TETRA TECH'S 2021 PRELIMINARY GEOTECHNICAL SITE EVALUATION REPORT

July 14, 2021

ISSUED FOR USE
FILE: 704-ENG.WARC04016-01
Via Email: mturpin@yukonu.ca

Yukon University
PO Box 2799
500 University Drive
Whitehorse, YT Y1A 5K4

Attention: Martin Turpin
Director, Construction Management

Subject: New Science Building Preliminary Geotechnical Evaluation
Yukon University, Whitehorse, Yukon

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Yukon University (YU) to complete a preliminary geotechnical evaluation for a proposed new science building at the Ayamdigut (Whitehorse) Campus. This report provides preliminary recommendations for the design and construction of the planned science building.

Authorization to complete this work was provided by way of Yukon University contract No. P0010473.

2.0 AUGER DRILLING PROGRAM

Tetra Tech retained Donjeck Drilling to carry out a geotechnical drilling program using a truck mounted CME-75 drilling rig. The drilling program was completed on June 10, 2021.

Four solid stem auger boreholes and one hollow stem auger borehole were advanced to depths ranging from 6.0 to 7.95 m below existing ground surface. Approximate borehole locations are shown on Figure 1.

Standard Penetration Testing (SPT) was carried out at nominal 1.5 m intervals in the hollow-stem auger borehole to obtain SPT blow counts (N-values). SPT N-values provide an indication of the relative density of subsurface soils.

The boreholes were logged in the field by Shawn Matthies, EIT, from Tetra Tech's Whitehorse office. Disturbed soil samples were collected and returned to Tetra Tech's Whitehorse laboratory for geotechnical index testing, including determination of natural moisture content on all samples and particle size distribution (sieve) testing on selected samples.

Upon completion of drilling, boreholes were backfilled with drill cuttings to restore the original ground surface.

Tetra Tech Canada Inc.
61 Wasson Place
Whitehorse, YT Y1A 0H7 CANADA
Tel 867.668.3068 Fax 867.668.4349

3.0 SITE CONDITIONS

3.1 Surface Conditions

The subject site is presently used as a student/overflow parking lot. The northeast area is surfaced with asphalt and the northwest area is surfaced with crushed gravel. The south area of the site has no prepared parking surface; however we understand it has been used as overflow parking in the past. The site is fairly level with a slight grade to the south away from existing structures.

We understand that part of the subject site has been used as a material dump during the construction of other Yukon University developments, resulting in uncontrolled fill being placed on the south side of the site. The present student parking lot and overflow lot have been built up above the natural ground surface. The south side of the subject site is approximately 4-5 m above the inferred natural ground.

3.2 Subsurface Conditions

BH21-01, BH21-02, and BH21-05 were drilled in the main student parking area. Conditions encountered in these boreholes were generally consistent and are summarized in Table 1.

Table 1: Summary of Subsurface Stratigraphy in Main Parking Area

Soil Unit	Depth below existing ground surface		
	BH21-01	**BH21-02**	**BH21-05**
ASPHALT	0 – 0.1 m	–	–
SAND and GRAVEL (FILL)	0.1 – 2.3 m	0 – 1.5 m	0 – ~3.0 m
SAND (possible FILL)	2.3 – 3.0 m	1.5 – 3.2 m	~3.0 – 3.2 m
SAND and GRAVEL - trace silt, occasional cobbles	3.0 – 6.0 m	3.2 – 6.0 m	3.2 – 7.95 m
End of borehole	6.0 m (target depth)	6.0 m (target depth)	7.95 m (practical refusal)

The surficial SAND and GRAVEL (FILL) was likely placed during initial site grading when the parking area was developed. The SPT taken in this unit (S22) yielded an N-value of 11, indicating “compact” material. No SPTs were completed entirely within the SAND unit (S23 was taken through the contact between the SAND and the lower SAND and GRAVEL). SPT N-values in the lower SAND and GRAVEL also indicate “compact” material, with values ranging from 14 to 27 (from S24 to S26).

Boreholes BH21-03 and BH21-04 were advanced in the overflow parking area to the south. Both boreholes encountered suspected fill.

In BH21-03, brown gravelly SAND (FILL) with some silt was encountered to a depth of 5.1 m. Trace organics and occasional woody debris were present throughout this unit. This material showed very low drilling resistance, suggesting that it was placed without compaction; this is consistent with our understanding that this area was used as a material dump. Below this FILL, a layer of SAND with some silt (probable natural ground) was encountered from 5.1 m depth to the bottom of the borehole at 7.5 m depth. A 100 mm thick layer of volcanic ASH intersected the SAND at a depth of 6.9 m below existing ground surface.

BH21-04 encountered 0.3 m of SAND with some gravel and silt at the surface, underlain by SAND with trace to some silt to the bottom of the borehole at 6.0 m depth. Some of this SAND is likely native fill placed to create a level site surface, however an interface between fill and natural ground was not identified.

3.2.1 Groundwater

Groundwater was not encountered in any of the boreholes.

3.2.2 Permafrost

Permafrost was not encountered in any of the boreholes and is not expected in the vicinity of the subject site.

3.2.3 Bedrock

Bedrock was not encountered in any of the boreholes.

4.0 DISCUSSION AND RECOMMENDATIONS

YU has advised that the precise location and size of the building is still under consideration, and that the present preferred area is on the west side of the student parking lot. Since the soil conditions between the student parking lot and the overflow lot are highly variable, geotechnical recommendations will depend on the final building footprint. Generally, a shallow foundation system should be suitable for the proposed development, however some site preparation will be required. Positioning the building away from the present overflow lot would allow for less intensive site preparation.

A detailed geotechnical evaluation should be carried out once the footprint and size of the building have been decided. The site investigation should provide information on subsurface conditions at each of the building corners, and SPT should be carried out in the SAND material to assess relative density and evaluate liquefaction susceptibility.

A testpitting program could also be considered to delineate the boundary between the compact SAND and GRAVEL and the loose uncontrolled FILL. This information would be beneficial in estimating the quantity of material that would need to be removed, and in assessing whether the final proposed footprint falls within the area of uncontrolled FILL.

4.1 Site Preparation

The following recommendations are presented to provide a general picture of expected site preparation requirements. These recommendations should be revised in the detailed geotechnical evaluation following a conceptual building design.

- In the present overflow parking area, excavate all uncontrolled FILL materials within the footprint of the building and/or any other structural surfaces (e.g., generator slabs or propane tank slabs);
- In the present student parking area, excavate all of the SAND material within the footprint of the building and/or any other structural surfaces to expose the underlying natural SAND and GRAVEL;

- The base of the excavation should extend horizontally at least 1.5 m from the foundation perimeter in all directions. Excavation sidewalls should be sloped in accordance with the most recent edition of Occupational Health and Safety Regulations;
- The uncontrolled FILL and the SAND are not considered suitable for reuse as structural backfill. They may be suitable for non-structural (e.g., landscaping) applications;
- The exposed subgrade should be inspected by a qualified geotechnical engineer to confirm that suitable ground conditions have been encountered;
- The approved subgrade should be moisture conditioned (if necessary) and compacted to:
  - 95% of the Standard Proctor Maximum Dry Density (SPMDD), if the subgrade is greater than 1 m below any structural bearing surfaces; or
  - 98% SPMDD, if the subgrade is within 1 m of any structural bearing surfaces.
- The excavation should be backfilled using 80 mm pit run gravel ("engineered fill") conforming to the specification in Table 2. This pit run should be placed in lifts not exceeding 200 mm in thickness, moisture conditioned, and compacted to:
  - 95% SPMDD, for material greater than 1 m below any structural bearing surfaces; or
  - 98% SPMDD, for material within 1 m of any structural bearing surfaces.
- A 150 mm thick layer of 20 mm crushed basecourse gravel conforming to the specification in Table 2 should be placed immediately below the underside of all concrete elements to provide a level, uniform bearing surface; and
- Finished grades should be sloped to promote positive drainage and direct surface runoff away from the building foundations.

Table 2: Recommended Granular Material Specifications

80 mm Pit Run Gravel (Engineered Fill)		20 mm Crushed Basecourse Gravel	
Particle Size (mm)	**% Passing by Mass**	**Particle Size (mm)**	**% Passing by Mass**
80.0	100	–	–
25.0	55 – 100	20.0	100
12.5	42 – 84	12.5	64 – 100
5.00	26 – 65	5.00	36 – 72
1.25	11 – 47	1.25	12 – 42
0.315	3 – 30	0.315	4 – 22
0.080	0 – 8	0.080	3 – 6

4.2 Foundation Design

Shallow foundations consisting of spread or strip footings are considered to be acceptable foundation types for the subject site. They should be designed in accordance with the following recommendations:

- For preliminary design, foundations on compact sand and gravel can be sized using a preliminary design unfactored bearing resistance of 400 kPa (Canadian Geotechnical Society, 2006). This recommendation assumes that the site preparation described above is carried out;
- Bearing resistance is highly sensitive to soil properties and footing geometry (e.g., burial depth, footing size, footing shape, etc.). Building-specific bearing resistance values should be developed once these elements are known; and
- Concrete foundation elements should not be cast directly onto or over seasonally frozen soils, and the soils under the foundation must not be allowed to freeze during construction.

4.3 Seismic Considerations

4.3.1 Site Classification

The 2015 edition of the National Building Code of Canada (NBCC 2015) requires that a site classification be established for seismic design of new structures, based on average soil properties in the upper 30 m ("site stiffness"). Based on the SPT N-values observed during the drilling program, Tetra Tech recommends that the site be considered Site Classification D, per Table 4.1.8.4.A (National Research Council of Canada, 2015).

4.3.2 Liquefaction Susceptibility

Seismic loading can result in a loss of strength in soils, which is known as seismic liquefaction for granular, non-plastic ("sand-like") soils, and cyclic softening for fine-grained, plastic ("clay-like") soils. Liquefaction of sand-like soil is characterized be a severe, sudden loss of soil strength; cyclic softening of clay-like soil is also characterized by a loss of strength but is generally less severe and occurs less suddenly than liquefaction of sand-like soil.

The ASH layer was the only fine-grained (possibly clay-like) soil encountered during drilling. Since this layer is thin (100 mm), liquefaction of this unit is of low concern.

Liquefaction of sand-like soils typically requires the presence of saturated (or nearly saturated) soil conditions. These conditions were not observed in our investigation, however fluctuation of the groundwater table could result in these conditions being present at depth. Depending on the proximity of the building to the edge of the valley slope, liquefaction of the SAND in the valley may also need to be considered. Liquefaction of this material could cause a slope failure and damage to the proposed structure. The detailed geotechnical evaluation should collect information (e.g., SPTs in the valley SAND) to characterize this risk, if the building is to be constructed near the edge of the slope.

4.4 Seasonal Frost Considerations

Seasonal frost-related ground movement is common in cold climates and occurs when all of the following conditions are satisfied:

- The ground temperature is at or below 0°C;
- Frost susceptible soils are present; and
- Soil pore space is at or near 100% saturation.

Several of the soils encountered are considered to be frost susceptible. However, saturated or nearly saturated conditions were not observed, indicating that seasonal frost-related movement should be minimal. As well, the topography of the surrounding area (i.e., presence of the nearby valley) will limit the possibility of saturated conditions being sustained within the frost penetration depth at the subject site. Frost protection measures such as perimeter insulation should not be required.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Yukon University and their agents. Tetra Tech Canada Inc. (operating as Tetra Tech) 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 Yukon University, or for any Project other than the proposed development at the subject site. 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 or Contractual Terms and Conditions executed by both parties.

6.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

PROFESSIONAL
YUKON
CHADWYCK P. COWAN
TERRITORY
ENGINEER

July 14/21

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PERMIT TO PRACTICE
TETRA TECH CANADA INC.
SIGNATURE ______
Date July 14/21
PERMIT NUMBER PP003
Association of Professional
Engineers of Yukon

FIGURES

LEGEND

- BOREHOLE LOCATION

0 100m

Scale: 1:2,000 @ 8.5"x11"

CLIENT

Yukon University

TETRA TECH

PRELIMINARY GEOTECHNICAL EVALUATION
YUKON UNIVERSITY NEW SCIENCE BUILDING
WHITEHORSE, YUKON

SITE PLAN SHOWING BOREHOLE LOCATIONS

PROJECT NO.	DWN	CKD	REV
ENG.WARC04016-01	CB	SM	0
OFFICE	DATE		
EBA-WHSE	June 23, 2021		

Figure 1

Q:\Whitehorse\Data\0201drawings\Whitehorse\ENG-WARC\ENGWARC04016-01 Yukon University New Science Building Geotech Evaluation\ENG.WARC04016-01 Fig.1-R0.dwg [FIGURE 1] June 23, 2021 - 6:29:49 pm (BY: BUCHAN, CAMERON)

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

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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.

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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

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. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

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.

APPENDIX B

BOREHOLE LOGS AND LABORATORY TEST RESULTS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 TO 20%	0 to 4
Loose	20 TO 40%	4 to 10
Compact	40 TO 75%	10 to 30
Dense	75 TO 90%	30 to 50
Very Dense	90 TO 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (KPA)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

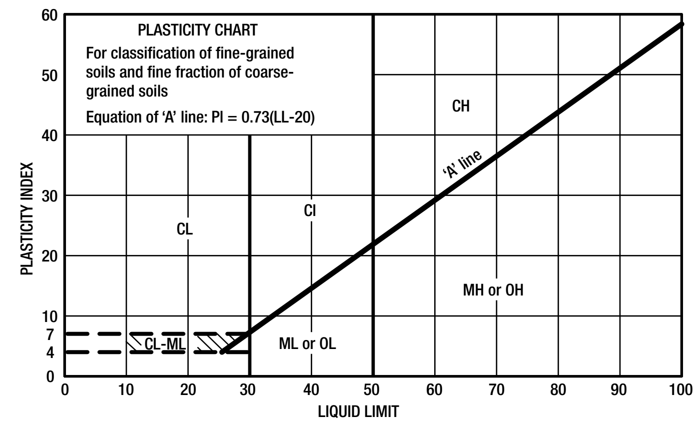
NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated - composed of thin layers of varying colour and texture.
Interbedded - composed of alternate layers of different soil types.
Calcareous - containing appreciable quantities of calcium carbonate.;
Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE - GRAINED SOILS More than 50% retained on No. 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines: Less than 5% pass 75 µm sieve GW, GP, SW, SP; More than 12% pass 75 µm sieve GM, GC, SM, SC; 5% to 12% pass 75 µm sieve Borderline classification requiring use of dual symbols	$C_u = D_{60} / D_{10}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly-graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below 'A' line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above 'A' line and plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines		$C_u = D_{60} / D_{10}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly-graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot above 'A' line and plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above 'A' line and plasticity index greater than 7	
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS	Liquid limit <50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity			
		Liquid limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
	CLAYS Above "A" line on plasticity chart negligible organic content	Liquid limit <30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays			
		Liquid limit 30-50	CI	Inorganic clay of medium plasticity, silty clays			
		Liquid limit >50	CH	Inorganic clay of high plasticity, fat clays			
	ORGANIC SILTS AND CLAYS	Liquid limit <50	OL	Organic silts and organic silty clays of low plasticity			
		Liquid limit >50	OH	Organic clays of medium to high plasticity			
HIGHLY ORGANIC SOILS			PT	Peat, muck and other highly organic soils			

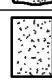


* Based on the material passing the 75 mm sieve

† ASTM Designation D 2487, for identification procedure see D 2488 USC as modified by PFRA

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
N	Nf	Poorly-bonded or friable	
	Nbn	No excess ice, well-bonded	
	Nbe	Excess ice, well-bonded	

VISIBLE ICE LESS THAN 50% BY VOLUME

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
V	Vx	Individual ice crystals or inclusions	
	Vc	Ice coatings on particles	
	Vr	Random or irregularly oriented ice formations	
	Vs	Stratified or distinctly oriented ice formations	

VISIBLE ICE GREATER THAN 50% BY VOLUME

ICE	ICE + Soil Type	Ice with soil inclusions	
	ICE	Ice without soil inclusions (greater than 25 mm thick	

NOTES:

1. Dual symbols are used to indicate borderline or mixed ice classifications.
2. Visual estimates of ice contents indicated on borehole logs ± 5%
3. This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

LEGEND: Soil ☐ Ice ■

BOREHOLE KEYSHEET

Water Level Measurement

- Measured in standpipe, piezometer or well
- Inferred

Sample Types

- A-Casing
- Core
- Disturbed, Bag, Grab
- HQ Core
- Jar
- Jar and Bag
- 75 mm SPT
- No Recovery
- Split Spoon/SPT
- Tube
- CRREL Core

Backfill Materials

- Asphalt
- Bentonite
- Cement/ Grout
- Drill Cuttings
- Grout
- Gravel
- Sand
- Slough
- Topsoil Backfill

Lithology - Graphical Legend[1]

- Asphalt
- Bedrock
- Cobbles/Boulders
- Clay
- Coal
- Concrete
- Fill
- Gravel
- Limestone
- Mudstone
- Organics
- Peat
- Sand
- Sandstone
- Shale
- Silt
- Siltstone
- Conglomerate
- Topsoil
- Till

1. The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale

TETRA TECH

Yukon University

Borehole No: **21-BH01**

Project: Science Building Prelim. Geotechnical Evaluation	Project No: ENG.WARC04016-01
Location: Yukon University	
Whitehorse, Yukon	UTM: 494616 E; 6734879 N; Z 8

Method: Solid stem auger

Depth (m)	Soil Description	Ground Ice Description	Sample Number	Moisture Content (%)
0	ASPHALT - (100 mm thick)	Unfrozen		
	SAND AND GRAVEL (FILL) - some silt, well graded, damp, brown grey, grindy drilling		G01	2.5
			G02	4.1
	SAND (POSSIBLE FILL) - some silt, damp, brown grey, fine sand		G03	5.1
	SAND AND GRAVEL - trace silt, occasional cobbles, well graded, damp, grey, very grindy, subrounded gravel, cobbles to 100 mm diameter		G04	4.9
			G05	4.6
6	END OF BOREHOLE (6.0 metres) Note: Stopped due to target depth			

Plastic Limit — Moisture Content — Liquid Limit (20, 40, 60, 80)

Contractor: Donjeck Drilling	Completion Depth: 6 m
Drilling Rig Type: Truck mounted CME-75	Start Date: 2021 June 10
Logged By: SAM	Completion Date: 2021 June 10
Reviewed By: CPC	Page 1 of 1

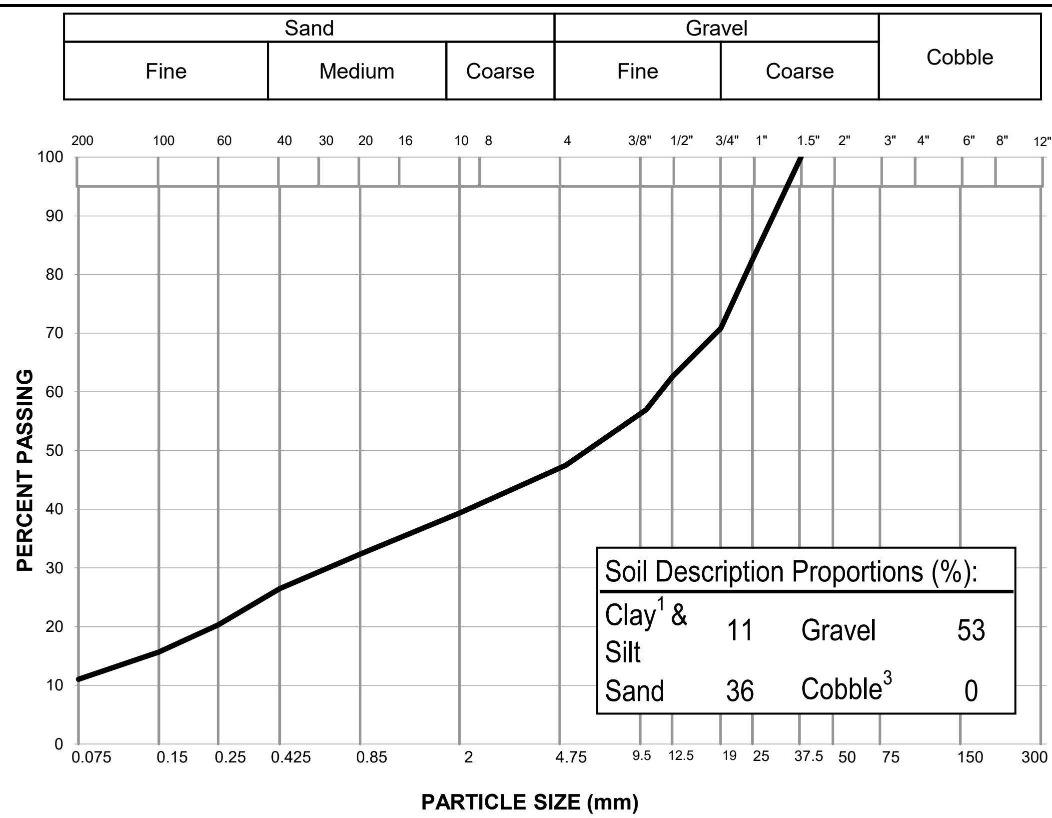
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	YU New Science Building	Sample No.:	G02
Project No.:	ENG.WARC04016-01	Material Type:	-
Site:	Yukon University	Sample Loc.:	BH21-01
Client:	Yukon University	Sample Depth:	1.4 m
Client Rep.:	Martin Turpin	Sampling Method:	Grab
Date Tested:	June 15, 2021 By: FC	Date Sampled:	June 10, 2021
Soil Description[2]:	GRAVEL and SAND - some silt	Sampled By:	SAM
		USC Classification:	GP Cu: #N/A
Moisture Content:	4.1%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	100
25	83
19	71
12.5	63
10	57
5	47
2	39
0.85	32
0.425	26
0.25	20
0.15	16
0.075	11.0



Soil Description Proportions (%):

Clay[1] & Silt	11	Gravel	53
Sand	36	Cobble[3]	0

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: P.Eng.

Yukon University

Borehole No: **21-BH02**

Project: Science Building Prelim. Geotechnical Evaluation	Project No: ENG.WARC04016-01
Location: Yukon University	
Whitehorse, Yukon	UTM: 494567 E; 6734877 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0	Solid stem auger	SAND AND GRAVEL (FILL) - some silt, well to moderately graded, damp, brown grey	Unfrozen					0
1.3				Grab	G06	3.8	●	
1.5		SAND (POSSIBLE FILL) - silty, trace gravel, damp, brown grey, fine sand						
1.9				Grab	G07	4.9	●	
		- gravelly, well to moderately graded, subrounded gravel						
2.8				Grab	G08	4.1	●	
3.2		SAND AND GRAVEL - trace silt, well graded, damp, grey, very grindy, fine gravel						
4.3				Grab	G09	3.5	●	
5.8				Grab	G10	3.3	●	
6		END OF BOREHOLE (6.0 metres) Note: Stopped due to target depth						20

Depth scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Depth scale (ft): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32

TETRA TECH

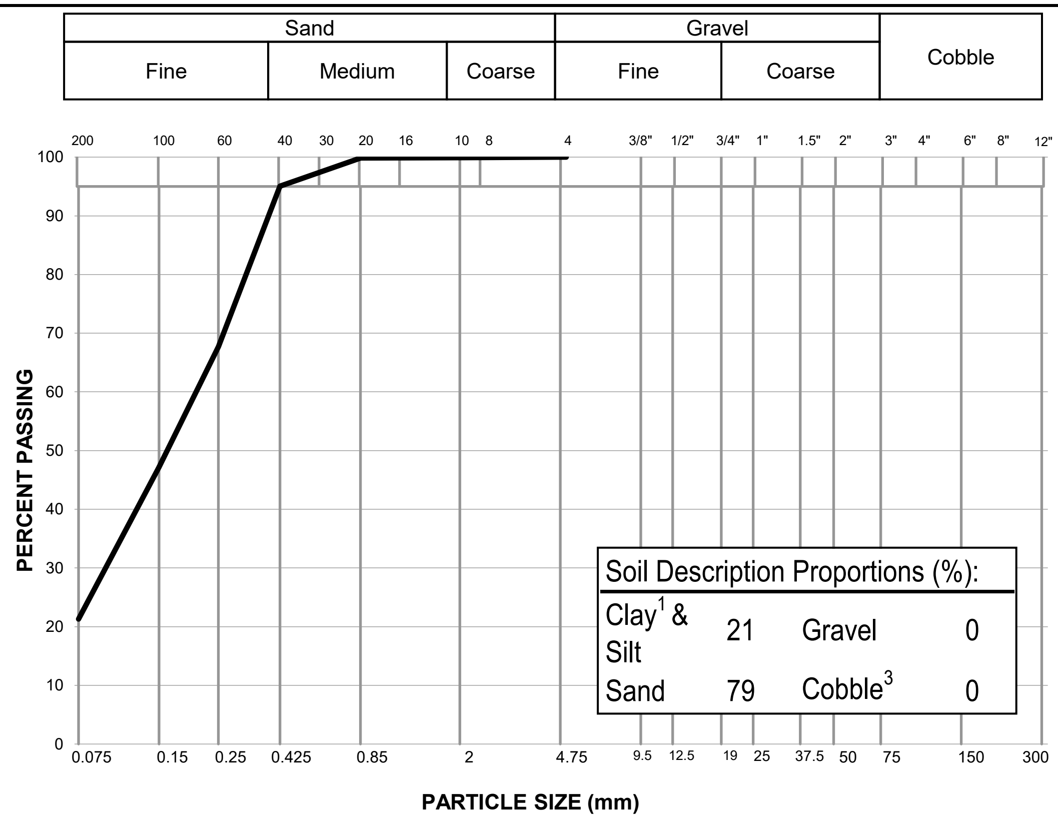
Contractor: Donjeck Drilling	Completion Depth: 6 m
Drilling Rig Type: Truck mounted CME-75	Start Date: 2021 June 10
Logged By: SAM	Completion Date: 2021 June 10
Reviewed By: CPC	Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	YU New Science Building			Sample No.:	G07
Project No.:	ENG.WARC04016-01			Material Type:	-
Site:	Yukon University			Sample Loc.:	BH21-02
Client:	Yukon University			Sample Depth:	2.0 m
Client Rep.:	Martin Turpin			Sampling Method:	Grab
Date Tested:	June 15, 2021	By:	FC	Date Sampled:	June 10, 2021
Soil Description[2]:	SAND - silty			Sampled By:	SAM
				USC Classification:	SM Cu: #N/A
Moisture Content:	4.9%				Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	
19	
12.5	
10	
5	100
2	100
0.85	100
0.425	95
0.25	68
0.15	47
0.075	21.3



Soil Description Proportions (%):			
Clay[1] & Silt	21	Gravel	0
Sand	79	Cobble[3]	0

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: ______________________ P.Eng.

TETRA TECH

Yukon University

Borehole No: **21-BH03**

Project: Science Building Prelim. Geotechnical Evaluation	Project No: ENG.WARC04016-01
Location: Yukon University	
Whitehorse, Yukon	UTM: 494578 E; 6734843 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0	Solid stem auger	SAND (FILL) - gravelly, some silt, occasional organics (rootlets) throughout, moist, brown, fine to medium sand, fine to medium gravel	Unfrozen					0
				Grab	G11	22.7	●	2
1		- 75 mm thick black organic layer						
		- woody debris						
3				Grab	G12	10.7	●	9
		- moist to wet						
4				Grab	G13	10.8	●	14
5		SAND - some silt to silty, moist, brown grey, fine sand		Grab	G14	7.7	●	17
7		ASH - white, brown laminations		Grab	G15	24.8	●	23
		SAND - some silt to silty, moist, brown grey, fine sand		Grab	G16	8.2	●	24
7.5		END OF BOREHOLE (7.5 metres) Note: Stopped due to target depth						
10								32

TETRA TECH

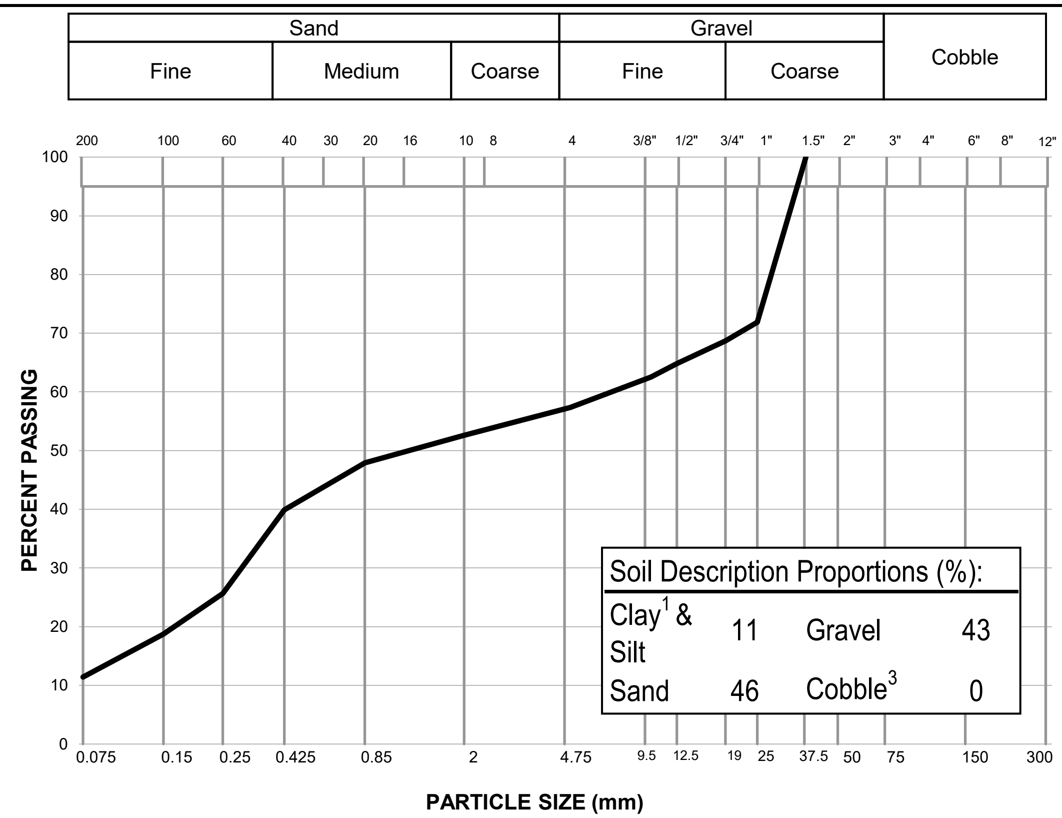
Contractor: Donjeck Drilling	Completion Depth: 7.5 m
Drilling Rig Type: Truck mounted CME-75	Start Date: 2021 June 10
Logged By: SAM	Completion Date: 2021 June 10
Reviewed By: CPC	Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	YU New Science Building	Sample No.:	G12
Project No.:	ENG.WARC04016-01	Material Type:	-
Site:	Yukon University	Sample Loc.:	BH21-03
Client:	Yukon University	Sample Depth:	2.9 m
Client Rep.:	Martin Turpin	Sampling Method:	Grab
Date Tested:	June 15, 2021 By: FC	Date Sampled:	June 10, 2021
Soil Description[2]:	SAND and GRAVEL - some silt	Sampled By:	SAM
		USC Classification:	SP Cu: #N/A
Moisture Content:	10.7%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	100
25	72
19	69
12.5	65
10	63
5	57
2	53
0.85	48
0.425	40
0.25	26
0.15	19
0.075	11.4



Soil Description Proportions (%):			
Clay[1] & Silt	11	Gravel	43
Sand	46	Cobble[3]	0

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: ____________ P.Eng.

TETRA TECH

Yukon University

Borehole No: **21-BH04**

Project: Science Building Prelim. Geotechnical Evaluation	Project No: ENG.WARC04016-01
Location: Yukon University	
Whitehorse, Yukon	UTM: 494629 E; 6734837 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0	Solid stem auger	SAND (FILL) - some silt, some gravel, damp, brown grey, fine to medium sand, fine gravel	Unfrozen					0
		SAND - trace to some silt, occasional gravel, damp, brown grey, fine to medium sand, fine to medium gravel						
1		- woody debris		Grab	G17	8.5	● 8.5	
		- trace gravel for 300 mm, fine gravel						
2								
3				Grab	G18	4.6	● 4.6	
4				Grab	G19	5.2	● 5.2	
5								
6				Grab	G20	8.9	● 8.9	
6		END OF BOREHOLE (6.0 metres) Note: Stopped due to target depth						20
7								
8								
9								
10								

Depth (ft) scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32

TETRA TECH

Contractor: Donjeck Drilling	Completion Depth: 6 m
Drilling Rig Type: Truck mounted CME-75	Start Date: 2021 June 10
Logged By: SAM	Completion Date: 2021 June 10
Reviewed By: CPC	Page 1 of 1

Yukon University

Borehole No: **21-BH05**

Project: Science Building Prelim. Geotechnical Evaluation	Project No: ENG.WARC04016-01
Location: Yukon University	
Whitehorse, Yukon	UTM: 494590 E; 6734877 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
0	Solid stem auger	SAND (FILL) - gravelly, some silt, damp, brown grey, fine to medium sand, fine gravel	Unfrozen				
~0.9				Grab	G21		3
~1.7				SPT	S22	11	3.4
3.0		SAND - trace to some silt, damp, brown grey					
3.2		SAND AND GRAVEL - some cobbles, trace silt, well graded, damp, grey, very grindy, fine subrounded gravel, cobbles to 100 mm diameter raised by auger flights					
~3.2				SPT	S23	43	4.3
~4.3				SPT	S24	27	2.1
~6.2				SPT	S25	14	2.4
~7.7				SPT	S26	17	1.8
7.95		END OF BOREHOLE (7.95 metres) Note: Stopped due to refusal					

Chart columns: ■ SPT (N) 20 40 60 80; Plastic Limit, Moisture Content ●, Liquid Limit 20 40 60 80; Depth (ft) 0–32.

TETRA TECH

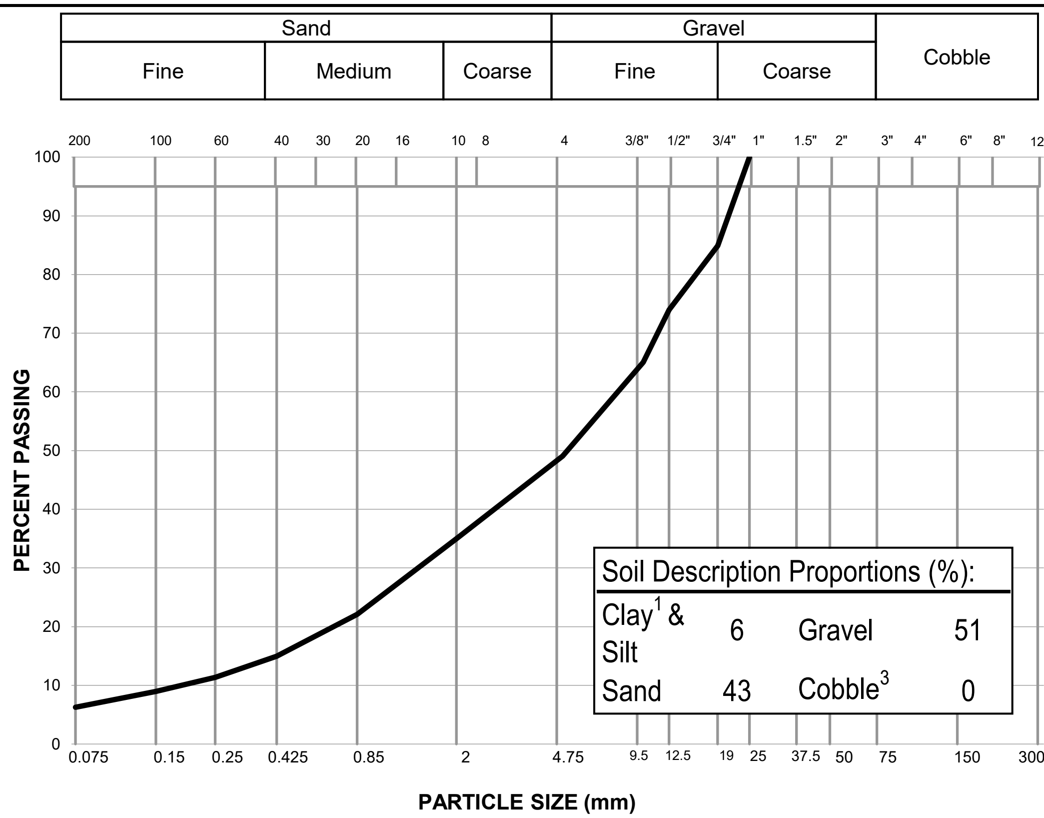
Contractor: Donjeck Drilling	Completion Depth: 7.95 m
Drilling Rig Type: Truck mounted CME-75	Start Date: 2021 June 10
Logged By: SAM	Completion Date: 2021 June 10
Reviewed By: CPC	Page 1 of 1

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	YU New Science Building	Sample No.:	S24
Project No.:	ENG.WARC04016-01	Material Type:	-
Site:	Yukon University	Sample Loc.:	BH21-05
Client:	Yukon University	Sample Depth:	4.2 m
Client Rep.:	Martin Turpin	Sampling Method:	Grab
Date Tested:	June 15, 2021 By: FC	Date Sampled:	June 10, 2021
Soil Description[2]:	GRAVEL and SAND - trace silt	Sampled By:	SAM
		USC Classification:	GW Cu: 43.5
Moisture Content:	2.1%		Cc: 1.5

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	100
19	85
12.5	74
10	65
5	49
2	35
0.85	22
0.425	15
0.25	11
0.15	9
0.075	6.3



Soil Description Proportions (%):			
Clay[1] & Silt	6	Gravel	51
Sand	43	Cobble[3]	0

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:

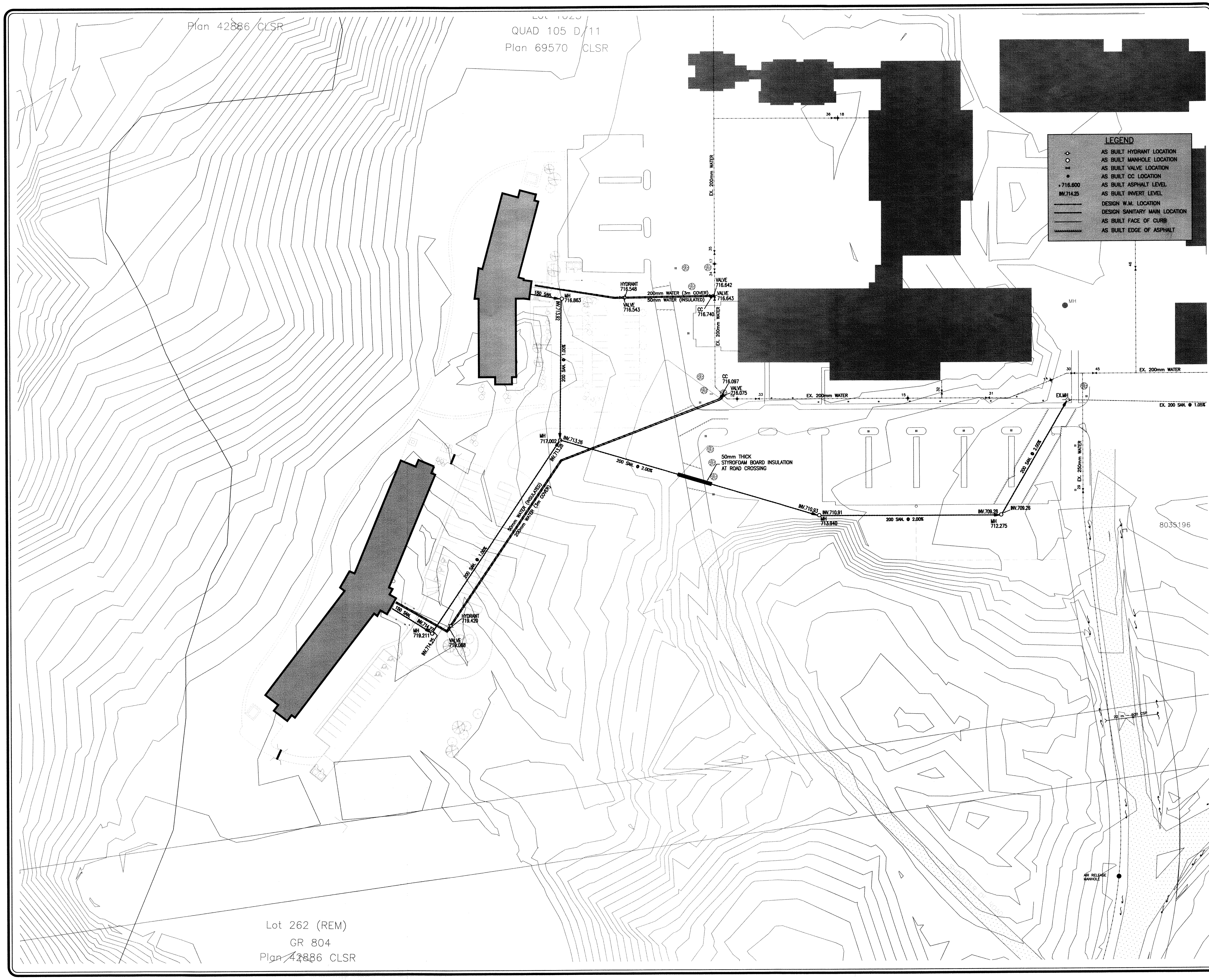
Remarks:

Reviewed By: P.Eng.

TETRA TECH

APPENDIX D

QUEST ENGINEERING GROUP'S 2005 AS-BUILT WATER/SEWER PLAN



XREFS

GENERAL NOTES

1. WATERMAINS
   200mm C-900 DR 18
   50mm TYPE K COPPER/INSULATED
2. SEWERMAINS
   200mm PVC DR35
   150mm PVC DR28
3. ALL UTILITY SERVICE INSTALLATIONS TO THE CITY OF WHITEHORSE SERVICING STANDARDS.
4. ASPHALT RESTORATION
   -50mm A.C. OVER 150mm BASE COURSE
5. SUPPORT EXISTING TREES, POLES, SIGNS AS REQUIRED DURING CONSTRUCTION AND TIE-INS.

CITY OF WHITEHORSE DESIGN APPROVALS

DIRECTOR OF MUNICIPAL SERVICES — DATE

CITY ENGINEER — DATE

MANAGER OF PUBLIC WORKS — DATE

REVISIONS :

NO.	DATE	ENG.	DESCRIPTION
01	MAY19 2005	RMS	FOR DISCUSSION
02	JUN13 2005	RMS	REVISED UTILITY LAYOUT
03	JUN20 2005	RMS	REVISED UTILITY LAYOUT
04	JUL13 2005	RMS	REVISED UTILITY LAYOUT
05	JUL14 2005	RMS	ISSUED FOR TENDER
06	AUG 5 2005	RMS	ISSUED FOR CONSTRUCTION
07	AUG22 2005	RMS	REVISED NOTES
08	NOV.10 2005	RMS	AS BUILT INFO. ADDED

Quest Engineering Group
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ATHLETES VILLAGE

AS BUILT PLAN WATER AND SEWER SERVICES

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