

May 9, 2018

Government of Yukon
Department of Community Services
Infrastructure Development Branch
Box 2703 (C-13)
Whitehorse, YT Y1A 2C6

ISSUED FOR USE
FILE: ENG.WARC03386-03
Via Email: micheal.ukrainetz@gov.yk.ca

Attention: Mr. Mike Ukrainetz, Senior Project Manager

Subject: Desktop Geotechnical Evaluation – New Firehall
Mayo, YT

1.0 INTRODUCTION

1.1 Project Details

Tetra Tech Canada Inc. (Tetra Tech) was retained by Yukon Government – Department of Community Services (YG-CS) to complete a desktop geotechnical evaluation for the new firehall in Mayo, YT. The work was authorized by Mr. Mike Ukrainetz by way of signed Government contract C00042904, dated April 5, 2018.

1.2 Scope of Services

As presented in the email proposal submitted on April 4, 2018, Tetra Tech's scope of services for this project includes the following:

- Review available historical geotechnical information from projects completed in the vicinity of the project site;
- Prepare a desktop geotechnical report including:
 - Expected subsurface geotechnical conditions at the site
 - Preliminary geotechnical recommendations for design and installation of the building foundation, as well as geotechnical input related to associated works included in the overall project scope including, but not limited to, the following:
 - Temporary excavation slopes;
 - Gradation and compaction specification for backfill materials;
 - Site grading and drainage requirements;
 - Frost protection requirements; and
 - Seismic site classification for structural design.

2.0 METHOD OF STUDY

A review of available information was conducted in preparing this report. Information such as satellite imagery and previous geotechnical reports were used to interpret the anticipated subsurface conditions and prepare general recommendations for foundation design and construction.

Prior to preparing this report for the proposed new firehall project, Tetra Tech has neither advanced exploratory boreholes within the proposed firehall footprint, nor inspected the current site conditions. However, Tetra Tech has historical geotechnical information from the site and adjacent properties. All descriptions and recommendations presented herein are based solely upon the “desktop” study and Tetra Tech’s previous experience with working in this area in Mayo. Figure 1 shows the locations of Tetra Tech’s historical boreholes on and around the project site.

3.0 HISTORICAL GEOTECHNICAL DATA

Tetra Tech reviewed relevant geotechnical data from historical projects completed in the vicinity of the new firehall. Projects included (in chronological order):

- 1975: Mayo School – six boreholes drilled;
- 2005: Mayo YG Administration Building Thermistor Cable – one borehole drilled;
- 2011: Mayo Proposed Urban Infill Area A – two boreholes drilled, three testpits excavated; and
- 2016: Mayo Water Reservoir Expansion – two boreholes drilled.

Geotechnical conditions described in these reports have been used for the development of the geotechnical recommendations in this report. Historical testhole logs from the new firehall property are included in Appendix B.

4.0 SITE DESCRIPTION

4.1 Location

Mayo is located in the central Yukon, approximately 400 km north of Whitehorse, YT along the Klondike and Silver Trail highways. The project site is located on Block 32, 50642 CLSR, across 6th Avenue from the water treatment plant.

4.2 Anticipated Surface Conditions

Anticipated surface conditions have been assessed based on a review of Tetra Tech’s historical data from the area and Google Earth satellite imagery. Based on this information, the project site appears to be relatively flat and cleared with a mix of gravel and grass at surface, with larger trees are growing along the west edge of the project site.

4.3 Anticipated Subsurface Conditions

As noted above, a site-specific geotechnical investigation was not carried out for this project, therefore anticipated subsurface conditions at the project site are described only in general terms in the following subsections. Based on Tetra Tech’s review of past site investigations at the project site, the subsurface conditions are expected to consist mainly of an organic root mat overlying sand, underlain by gravel, underlain by silt. Bedrock is not anticipated to be encountered at the project site. Permafrost likely exists at depth, consistent with other areas of Mayo.

4.3.1 Organic Root Mat

A surficial organic root mat is anticipated at the project site. Based on historical data this layer is expected to contain fine grained soil and range in thickness from 0.1 to 0.2 m.

4.3.2 Sand

An alluvial sand is anticipated beneath the organic root mat. The sand is expected to be fine grained and silty and to range from 0.2 to 0.3 m in thickness.

4.3.3 Gravel

An alluvial gravel expected to underlie the sand. The gravel is anticipated to be sandy and be approximately 5 m thick.

4.3.4 Silt

Underlying the gravel, a glaciolacustrine silt is anticipated. Based on historical data this layer is clayey and is expected from depths of approximately 6 m to previous completion depths in excess of 15 m. Tetra Tech's historical data in this area does not extend deeper than 15 m.

4.4 Anticipated Groundwater Conditions

Tetra Tech has historically encountered groundwater at the project site around 3.0 – 3.5 m depth. It should be noted that the groundwater table at the project site is hydraulically connected to the adjacent Stewart River and groundwater elevations will vary seasonally with the river level.

4.5 Anticipated Permafrost and Seasonal Frost Conditions

Tetra Tech has encountered permafrost at the project site in the silt at a depth of approximately 13.7 m.

Based on Tetra Tech's geotechnical experience in Mayo, permafrost is considered to be continuous under the entire town site. Permafrost is generally found within the glaciolacustrine silts, and sometimes within the alluvial surficial soils, depending upon if the area has been cleared of vegetation, or previously developed. Permafrost has been observed to contain up to 30% visible ice with ice crystals (Vx), random ice (Vr), or stratified ice (Vs) noted at some locations while permafrost with non-visible ice (Nbn or Nbe) was noted in other locations or between zones of visible ice. Ground temperatures measured during previous geotechnical evaluations (-0.5°C to -1.0°C) are typical of "warm permafrost", which is generally warmer than -2.0°C. Warm permafrost will always start to thaw after ground surface disturbance, and if the underlying soils are not thaw stable, ground surface and foundation settlement will occur. This has been documented throughout Mayo, and this site is typical of the conditions noted elsewhere in the community.

Based on the anticipated soil conditions at the project site, and regional climate data, the maximum depth of seasonal frost penetration under snow-free conditions is assumed to be approximately 3.5 m.

5.0 RECOMMENDATIONS

The presence of permafrost under this site is not expected to significantly affect the future performance of shallow foundations (concrete footings and slabs) constructed for the new firehall. This is primarily because the site has been cleared for a long time, and ground water was observed in nearly all testholes at a depth of about three metres or so. The presence of this water infers that the permafrost is naturally melting under the site, and it is likely that the rate of thaw and consolidation of the fine-grained soils at depth is slow enough to have minimal effects at the ground surface. However, this thaw will be occurring over the life of the structure, and the designers must be aware that future settlement is a possibility. The provision of additional reinforcing steel in the foundation to span and support any localized future settlement areas will assist in minimizing future distress.

5.1 Site Preparation

Based on the anticipated subsurface conditions, Tetra Tech believes that a monolithic slab-on-grade with thickened strip footings foundation system will be feasible for use at the project site. As such, site preparation for the new firehall should be completed in accordance with the following recommendations:

- The excavation for the new firehall must be completed within the existing cleared area at the project site. If trees around the edge of the site are to be cleared, the building footprint should not extend into the newly cleared areas to avoid the potential for thawing permafrost disturbed by clearing;
- The existing ground surface should be stripped and grubbed to remove the surficial organic root mat, then excavated to remove the overlying sand and expose the alluvial gravel (expected to be no greater than 0.5 m in depth) and;
- The excavation should be completed such that there is minimal disturbance to the soils encountered at the excavation base. If a deeper excavation is required, Tetra Tech recommends that excavation sidewalls be sloped no steeper than 1H:1V;
- The base of the excavation must be level so that an engineered fill pad of uniform thickness is created to support the firehall foundation;
- Upon completion of the excavation, the exposed subgrade should be inspected by a qualified geotechnical engineer to confirm that suitable ground conditions have been encountered and to provide additional recommendations if necessary;
- The sand removed during excavation is not suitable for reuse under the footprint of the new firehall, but may be suitable for reuse as fill for landscaped areas. Therefore, it should be stockpiled away from the excavation;
- The approved subgrade should be backfilled to with 80 mm pit run gravel, placed in maximum 200 mm lifts, moisture conditioned, and compacted to at least 98% Standard Proctor Maximum Dry Density (SPMDD) per ASTM D698;
- A minimum 150 mm thick layer of 20 mm crushed gravel basecourse should be placed immediately below the underside of the foundation. The basecourse should be moisture conditioned and compacted to at least 98% SPMDD. This will provide a smooth, level bearing-surface on which to cast the concrete foundations. The recommended gradations of both 80 mm pit run gravel and 20 mm crushed basecourse are provided below in Table 1;
- The final grade of the footprint of the new firehall should maintain positive drainage away from the foundation;
- The excavation must be protected from the inflow of surface water at all times; and

- Foundation elements should not be cast directly onto or over seasonally frozen soils.

Table 1: Recommended Gradation for Granular Fill Materials

80 mm Pit Run Gravel		20 mm Crushed Basecourse	
Particle Size (mm)	% Passing (by weight)	Particle Size (mm)	% Passing (by weight)
80	100	-	-
25	55 – 100	20	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 and Construction

5.2.1 Limit States Design

The 2015 edition of the National Building Code of Canada (NBCC 2015) stipulates that foundation design must be carried out using Limit State 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 and SLS bearing resistances are calculated differently. The ULS bearing resistance is the maximum pressure that can be applied to the soil without causing bearing failure. The SLS bearing pressure is the maximum allowable pressure required to limit the settlement to a tolerable amount. Both the ULS and SLS bearing resistances are highly dependent on soil properties and footing geometry, including the footing size, shape, and burial depth.

Resistance factors are applied to the calculated (unfactored) resistances to determine the maximum allowable factored design load. Geotechnical resistance factors for design of shallow foundations against vertical bearing failure (ULS), horizontal displacement (sliding under lateral loading), and overturning, per the NBCC 2015, are provided in Table 2.

Table 2: Geotechnical Resistance Factors - Shallow Foundations

Item	Resistance Factor
Vertical Bearing Resistance (ULS)	0.5
Sliding (ULS)	0.8
Overturning (ULS)	0.5

5.2.2 Foundation Recommendations

As noted above, a monolithic slab-on-grade with thickened strip footings is considered to be an acceptable foundation system for the new firehall. As such, design and construction of the foundation should be undertaken in accordance with the following recommendations:

- Strip footings refer to thickened areas within the structural slab-on-grade that are designed to provide the required bearing resistance under building loads. For the purpose of design, Tetra Tech has assumed a strip

footing thickness of 0.3 m and a minimum depth of cover of 0.3 m from finished grade to the underside of footing;

- Unfactored bearing resistances are provided based on minimum footing widths of 0.4 m. If significantly different footing sizes are preferred for this project, or if higher bearing resistance is required to support the design building loads, Tetra Tech should be notified to review and adjust the calculated bearing resistances as necessary; and
- An unfactored ULS bearing resistance of 230 kPa should be used for the new firehall foundation. An unfactored SLS bearing pressure of 500 kPa should be used for the new firehall foundation, based on an allowable elastic settlement of 16 mm, which is generally sufficient to limit total and differential settlement to tolerable levels for typical building projects.

As noted above, Tetra Tech recommends that additional reinforcement be designed into the monolithic slab-on-grade to accommodate for the potential for settlement of thawing permafrost at depth below the footprint of the new firehall. This additional reinforcement in the monolithic slab has been used elsewhere in similar sites in Mayo and may help to prevent significant damage to the foundation.

5.2.3 Seasonal Frost Protection

Seasonal ground frost-related movement is common in cold climates and occurs when three conditions are satisfied: the ground temperature is below freezing, frost-susceptible fine-grained soils are present, and the soil pore space is near 100% saturation. Based on Tetra Tech's historical data, the sand at the site of the new firehall is considered to be frost-susceptible, but the underlying gravel is not. The recommended site preparation includes removing the sand from the footprint of the new firehall, and if completed, Tetra Tech does not believe that additional measures to mitigate seasonal frost-related movements will be required. The non frost-susceptibility of the gravel must be confirmed once excavation is complete at the project site.

5.3 Site Grading

As noted above in Section 4.1, the final grade of the footprint of the new firehall should be elevated above the surrounding grade at least 300 mm to maintain positive drainage away from the building foundations. Ponding and/or infiltration of water adjacent to the building should be prevented as this could have detrimental effects on the performance of the building foundations. Roof runoff should be directed onto splash pads away from the building. This is particularly important in late fall just prior to freeze-up.

5.4 Concrete

Concrete should be cast onto a clean, level, compacted, granular bearing surface. It is important that no loose and/or disturbed material be allowed to remain on the bearing surface. As noted above in Section 4.1.1, foundation bearing surfaces should consist of 20 mm crushed basecourse, moisture conditioned and compacted to at least 98% SPMDD.

Tetra Tech recommends that all concrete be designed, mixed, placed, and tested in accordance with the most recent edition of the Canadian Standards Association (CSA) Standard CAN/CSA-A23.1 and A23.2. According to these standards, concrete should be designed to at least satisfy the minimum durability requirements as defined by the exposure class.

The exposure class of the concrete is dependent on the presence or lack of chlorides, sulphates, freezing and thawing conditions, and the soil saturation. Based on these conditions, the governing exposure class for the

foundation system will be “F-2”. If the concrete will be exposed to any specialized chemicals used in the operation and maintenance of the new firehall it is recommended that Tetra Tech be given the opportunity to review the concrete class recommendation.

If winter construction is considered, Tetra Tech should be contacted and given the opportunity to review the contractor’s winter concrete placement procedures.

5.4.1 Seismic Site Classification

NBCC 2015 requires that a seismic site classification be established for proposed buildings. As such, Tetra Tech recommends that the site for the new firehall be considered Site Classification E, per Table 4.1.8.4.A in NBCC 2015.

6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Yukon Government – Department of Community Services 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 Government – Department of Community Services, 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.

7.0 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.

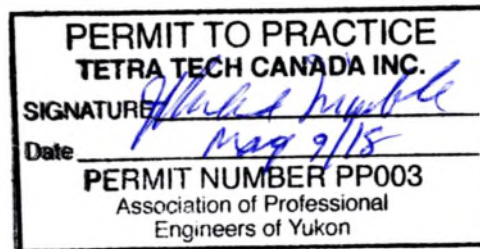


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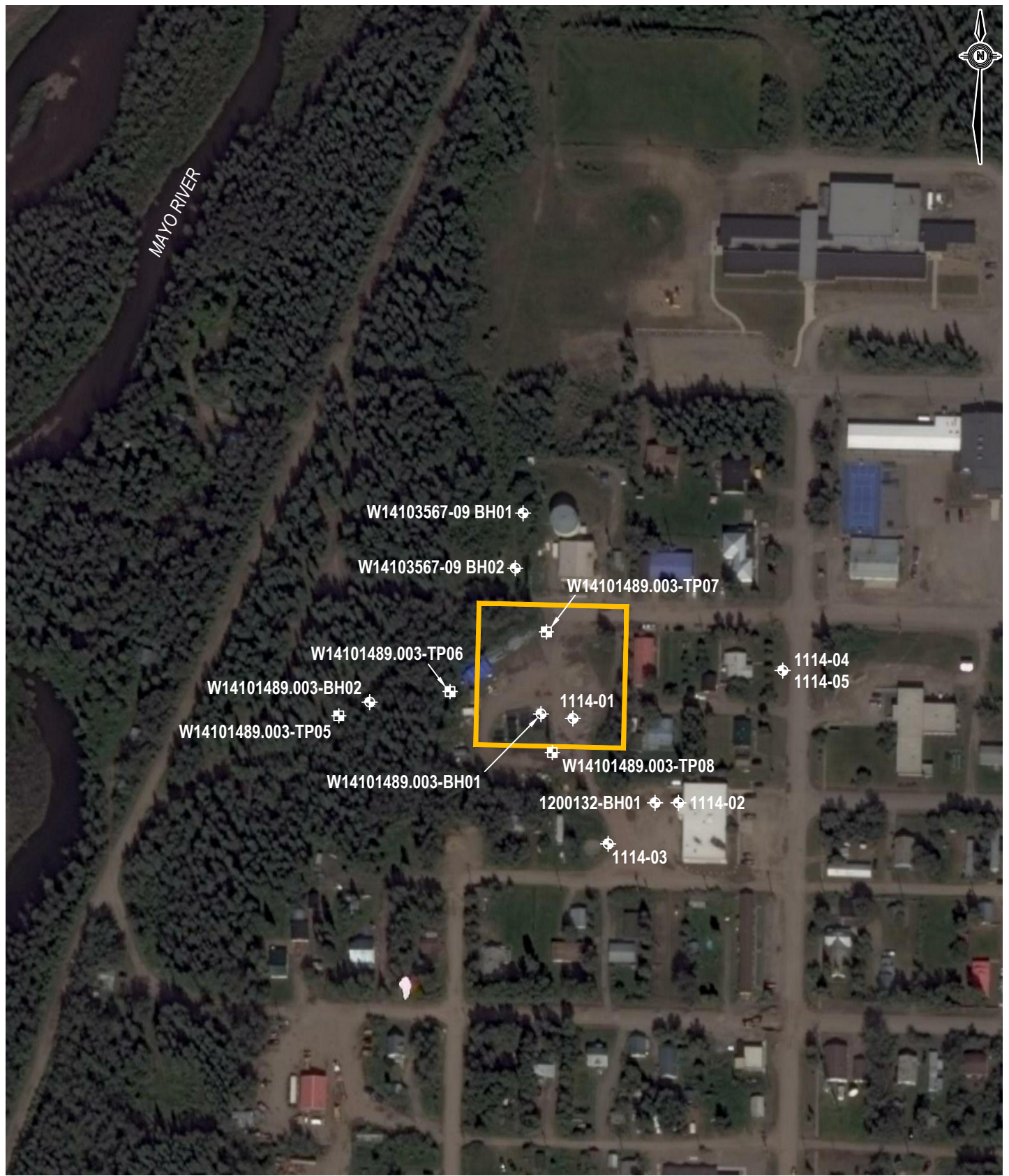
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FIGURES

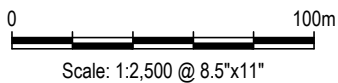
Figure 1 Site Plan Showing Historical Testhole Locations

Q:\Whitehorse\Data\Drawings\Mayo\ENG.WARC03386-03 New Firehall Geotech Evaluation\ENG.WARC03386-03 Fig.1-R0.dwg [FIGURE 1] April 17, 2018 - 2:30:04 pm (BY: BUCHAN, CAMERON)



LEGEND

- ▭ - PROPERTY LOCATION
- ⊕ - BOREHOLE LOCATION
- ⊕ - TESTPIT LOCATION



CLIENT



**NEW FIREHALL GEOTECHNICAL EVALUATION
MAYO, YUKON**

**SITE PLAN SHOWING
HISTORICAL TESTHOLE LOCATIONS**

PROJECT NO. ENG.WARC03386-03	DWN CB	CKD TM	REV 0
OFFICE EBA-WHSE	DATE April 17, 2018		

Figure 1

APPENDIX A

TETRA TECH / YUKON GOVERNMENT LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL – YUKON GOVERNMENT

1.1 USE OF DOCUMENT AND OWNERSHIP

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

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

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

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

1.3 STANDARD OF CARE

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

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

1.4 DISCLOSURE OF INFORMATION BY CLIENT

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

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

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

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

1.6 GENERAL LIMITATIONS OF DOCUMENT

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

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

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

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

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

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

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

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

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

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

1.9 LOGS OF TESTHOLES

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

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

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

1.11 PROTECTION OF EXPOSED GROUND

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

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

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

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

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

1.14 OBSERVATIONS DURING CONSTRUCTION

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

1.15 DRAINAGE SYSTEMS

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

1.16 DESIGN PARAMETERS

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

1.17 SAMPLES

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

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

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

APPENDIX B

HISTORICAL TESTHOLE LOGS

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.

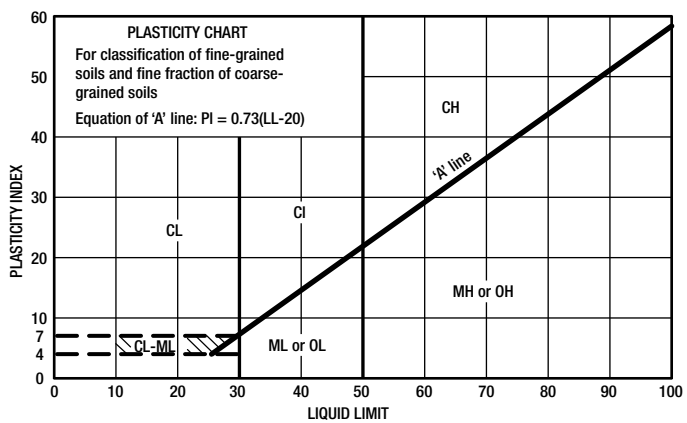
Calcareous - containing appreciable quantities of calcium carbonate.;

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	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines GW, GP, SW, SP GM, GC, SM, SC 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	



* 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				VISIBLE ICE LESS THAN 50% BY VOLUME			
GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	IMAGE	GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	IMAGE
N	Nf	Poorly-bonded or friable		V	Vx	Individual ice crystals or inclusions	
	Nbn	No excess ice, well-bonded			Vc	Ice coatings on particles	
	Nbe	Excess ice, well-bonded			Vr	Random or irregularly oriented ice formations	
					Vs	Stratified or distinctly oriented ice formations	
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.				VISIBLE ICE GREATER THAN 50% BY VOLUME			
LEGEND: Soil Ice 				ICE	ICE + Soil Type	Ice with soil inclusions	
				ICE	ICE	Ice without soil inclusions (greater than 25 mm thick)	

BOREHOLE LOG PERMAFROST REGION

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE	GROUND ICE CONDITION	MOISTURE CONTENT % ●							
				SPT RESISTANCE ▲							
				10	20	30	40	50	60	70	
2	Silt - medium to dark brown - some clay to clayey - low plastic		Unfrozen								
4	GRAVEL - medium brown - sandy, trace of silt - moist - fine to medium grained - trace of oxides - 65% Gravel - 27% Sand - 8% Silt - sloughing - very sandy - trace of silt - fine grained - medium to coarse sand - clean	X	Frozen								
6		X	Frozen								
8				Unfrozen							
10											
12			/								
14											
16			X								
18			X								
20			X								
22											
24	SILT - medium grey - clayey - low plastic										
26	- wet - firm to stiff	/									
28											
30	- trace of clay - non to low plastic	/									
32											



PROJECT
Mayo School

Site #1


DATE 5/24/74
LOGGED BY JK
ELEVATION _____
DEPTH 51½

HOLE NO.
1114-01
SHEET
1 of 2

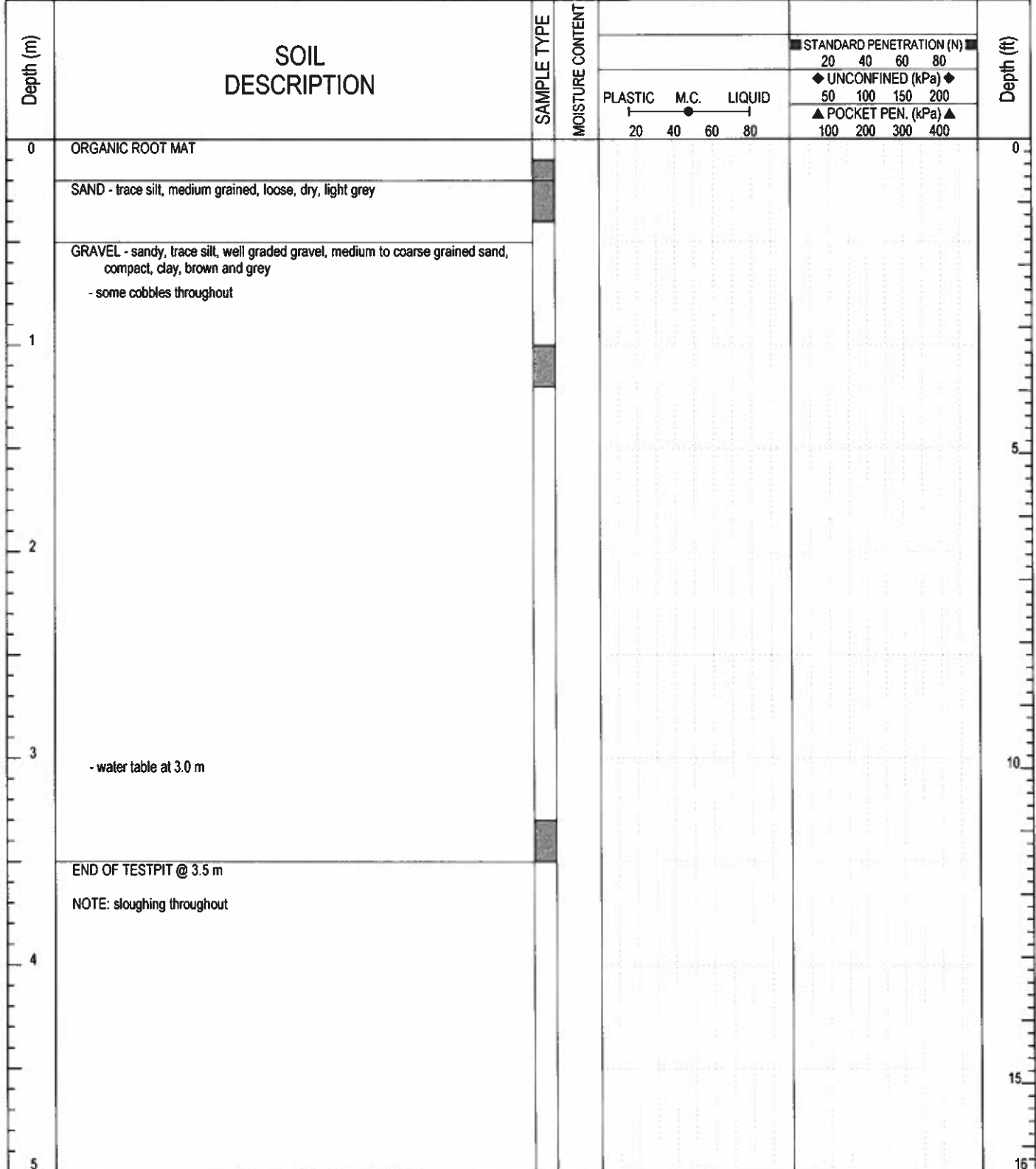
Geotechnical Evaluation	CLIENT: YG - Community Services	PROJECT NO. - BOREHOLE NO.
Mayo Urban Infill Area A	DRILL: Nodwell CME 75 w/ hollow stem augers	W14101489.003-BH01
Mayo, YT	7052215N; 455375E; Zone 8	

SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED	<input checked="" type="checkbox"/> NO RECOVERY	<input checked="" type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SPT (N)	MOISTURE CONTENT	PLASTIC M.C. LIQUID			STANDARD PENETRATION (N)				Depth (ft)
					20	40	60	80	20	40	60	
0	TOPSOIL											0
0 - 3.5	GRAVEL - sandy, trace silt, well graded sub-rounded gravel, medium to coarse grained sand, compact, dry, brownish grey											0 - 11.5
3.5 - 4.3	- becomes wet around 3.5 m - gravel becomes poorly graded											11.5 - 14.1
4.3 - 5.5	- 100 mm hydraulic slough at 4.3 m	<input checked="" type="checkbox"/>	16	11.8	●				■			14.1 - 18.0
5.5 - 8.0	- gravel becomes angular around 5.5 m - sand is mainly coarse grained around 5.5 m - colour changes to medium to dark grey around 5.5 m	<input checked="" type="checkbox"/>	57	8.8	●				■			18.0 - 26.2
8.0 - 9.3	SILT - trace clay, trace sand, non-plastic, very moist, stiff, dark grey	<input checked="" type="checkbox"/>	14	22.4	●				■			26.2 - 30.4
9.3	END OF BOREHOLE @ 9.3 m	<input checked="" type="checkbox"/>	7	25.4	●				■			30.4

 EBA Engineering Consultants Ltd.	LOGGED BY: JSB	COMPLETION DEPTH: 9.3m
	REVIEWED BY: JRT	COMPLETE: 3/29/2011
	DRAWING NO:	Page 1 of 1

Urban Infill Phase 2 - Geotechnical Evaluation	CLIENT: YG - Department of Community Services	PROJECT NO. - TESTPIT NO.
Area "A"	EXCAVATOR: Cat 325	W14101489-TP07
Mayo, YT	7052223N; 455398E; Zone 8	
SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input checked="" type="checkbox"/> SPT	<input type="checkbox"/> A-CASING <input type="checkbox"/> SHELBY TUBE <input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE <input type="checkbox"/> PEA GRAVEL <input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT <input type="checkbox"/> DRILL CUTTINGS <input type="checkbox"/> SAND



	LOGGED BY: JSB	COMPLETION DEPTH: 3.5m
	REVIEWED BY: JRT	COMPLETE:
	DRAWING NO:	Page 1 of 1