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**Geotechnical Evaluation
Proposed Multi-Family Housing Unit
Carmacks, Yukon – 2015**



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1.0 INTRODUCTION

Chilkoot Geological Engineers Ltd. was retained by the *Yukon Government - Energy, Mines and Resources - Lands Branch* (YG) to conduct a geotechnical evaluation for an urban residential property located in Carmacks, Yukon. The subject property (site) is understood to be the location of a former church and is comprised of three adjacent lots. The site is situated approximately 180 kilometers from Whitehorse and 180 meters from the Yukon River as noted in Figure 1.

The purpose of the geotechnical evaluation was to assess the subsurface conditions at the site and provide geotechnical recommendations to assist in building foundation design for a multi-family housing unit(s). As a conceptual design for the housing unit(s) had not yet been determined at the time of our evaluation, our assessment focused upon determining the soil conditions at three readily accessible locations with the intent to provide general recommendations to allow for construction of envisioned two-story residential structures which would be founded upon conventional footings or slab-on-grade types of foundation systems. Additional geotechnical assessment should be conducted prior to construction to verify our restrictions and assumptions once the building design and location(s) have been determined.

Authorization to proceed with the work was granted on October 2nd, 2015 by Mr. Marcel Barrault, Project Manager – Rural Land Development. The field work was conducted on November 6th, 2015 in accordance with our September 21st, 2015 proposal.

A detailed description of the work programs that were conducted have been provided below along with our geotechnical discussions, recommendations and conclusions.



2.0 METHODOLOGY

Our work methodology was comprised of field and laboratory work programs.

2.1 Field Work Program

The field work program was comprised of a site reconnaissance, utility locates and drilling program.

Utility Locates

Northwestel, the *Yukon Energy Corporation* and *Yukon Government* were contacted prior to conducting the drilling program in order to verify that the region was clear of potential hazards. In brief, the proposed borehole locations were noted to be free of underground utilities.

Site Reconnaissance

A site reconnaissance was conducted immediately prior to drilling to note the field conditions. A description of our observations have been presented in Section 3.1 below.

Drilling Program

The drilling program was conducted on November 6th, 2015 utilizing a CME-750 drill mounted on an FN-60 Nodwell. The drill was owned and operated by *Donjek Drilling* and was employed under the direction of our firm.

The drilling program was comprised of advancing boreholes at three locations in order to obtain soil samples and characterize the subsurface conditions. Two of the boreholes (BH 1-15 and BH 2-15) were advanced utilizing 150 mm Ø solid-stem continuous flight augers. The third borehole (BH 3-15) was advanced utilizing 200 mm Ø hollow-stem continuous flight augers so that standard penetration test (SPT) methodologies could be employed.



The SPT's allowed for an assessment of the relative density of sub-surface soils by measuring the number of blows (N-value) required to drive a 50 mm diameter uncased sampler tube a distance of 300 mm utilizing a 63.5 kg hammer dropped from a height of 760 mm. These 'N' values allowed for correlation of the noted resistance relative to the materials density/consistency where thawed materials were encountered. The approximate correlation has been presented on the '*Notes on Soil Classification*' enclosed in Appendix A. In addition to assessment of the materials relative density, the testing allowed for the retention of relatively undisturbed samples to allow for more accurate characterization of the soil conditions.

While the two solid-stem boreholes were advanced to depths of ~ 9.14 meters below the adjacent ground surface, the hollow-stem borehole was advanced to a shallower depth of ~ 6.55 meters.

Borehole Locations & Survey

Given the generally level terrain encountered at the site, each of the boreholes was given an arbitrary elevation of 100.00 meters.

The location of each borehole was noted utilizing a hand-held GPS unit and were marked in the field utilizing wooden survey lathe. The approximate locations of the boreholes were subsequently plotted relative to prominent site features as noted on Figure 1.

Monitoring Well Installation

A 2" diameter ABS monitoring well was installed in BH 3-15 to a depth of approximately 6 meters below the existing ground surface to allow for future monitoring of the local groundwater conditions.



The lower 4.5 meters of the well was slotted and a silt sock was utilized to minimize the influx of fines and extend the life of the well. The annular space was backfilled with imported filter sand. The exception to this was above the slotted portions of the pipe where a bentonite plug was installed to seal the annular space in accordance with good installation practices. Access to the well was restricted through the installation of a high-visibility lockable steel casing which was concreted into the existing ground surface.

Soil Logs

During the drilling, field soil logs were maintained by our firms Sr. Soils Technician, Mr. Greg Keitel. This information was utilized along with visual observations and laboratory results to compile the Soil Logs which have been enclosed in Appendix A.

Sampling Program

Soil samples were retained at regular intervals during the drilling to allow for additional observations to be made under field and laboratory settings. The sampling frequency varied between the differing auger methodologies. Where solid-stem drilling was conducted, samples were retained directly from the auger flighting at a frequency of approximately 1 sample per meter. Samples retained during the hollow-stem drilling were generally retained at a frequency of approximately 1 sample per 1.5 meters of auger advancement utilizing a split-spoon sampler tube.

In all, a total of twenty-eight (28) samples were obtained during the investigation. This included four (4) split-spoon samples obtained from the hollow-stem borehole (BH 3-15) and twenty-four (24) grab samples obtained from the solid-stem boreholes (BH 1-15 & BH 2-15).

Once the soil samples were retained, they were described on the field soil logs and then sealed in air-tight plastic bags. The sample bags were numbered



sequentially in order to allow for laboratory analysis as described in Section 2.2, below.

Borehole Termination

The boreholes were all terminated within granular (glacio)fluvial deposits. Each of the solid-stem boreholes were terminated at a depth of ~9.14 meters below the ground surface. The hollow-stem borehole was terminated at a depth of ~6.55 meters below the ground surface.

Auger refusal was not encountered.

Each of the boreholes was noted to collapse to depths of approximately 2.4 to 2.5 meters below the adjacent ground surface.

The boreholes were subsequently backfilled utilizing the auger cuttings. Bentonite pellets were placed within 0.5 meters of the ground surface in accordance with good drilling practices to seal the boreholes from potential surface contaminants.

Photographs

Photos of the field work, soil samples and site conditions were taken during the course of the evaluation. A selection of these photos has been provided in Appendix C.



2.2 Laboratory Work Programs

Laboratory analysis was conducted in order to characterize the index properties and conditions of the retained soil samples. The analysis was conducted between November 7th and November 9th at our Whitehorse laboratory facilities and was comprised of moisture content and grain size distribution analysis.

The results of the moisture content analysis have been denoted as 'MC' (⊙ - Symbol) on the Soil Logs enclosed in Appendix A.

The Grain Size Distribution Analysis was conducted in order to assist in soil classification utilizing the *Unified Soils Classification System*. The results of the analysis have been summarized on the Soil Logs with the percent composition of fines (silt & clay), sand and gravel denoted with the symbols - ▲, ● & ■, respectively.



3.0 SITE CONDITIONS

3.1 Site Description

The subject property is located at the site of a former church in the Village of Carmacks approximately 180 kilometers north of Whitehorse, Yukon.

While several structures were noted in the *Google Earth* imagery, only one prominent structure was centrally located on the site at the time of our evaluation. With the exception of a few trails which traverse the site to allow for vehicle access, the majority of the site is moderately treed.

The topography of the site was noted to be level although minor variations were noted. As the site is located within 180 meters of the Yukon River the prevailing elevation is only slightly higher than that of the Yukon River.

A selection of site photos, which note the general site conditions, has been provided in Appendix C.

3.2 Sub-surface Conditions

Detailed descriptions of the soil stratigraphy that was encountered during our evaluation have been provided on the Soil Logs attached in Appendix A.

Soil Stratigraphy

Similar subsurface conditions and types of soils were encountered in each of the boreholes.

The soils were comprised of (glacio)fluvial deposits which were overlain with organics and organic silts which generally measured up to 100 mm thick (although thicker



deposits were encountered in BH 3-15). The composition of the (glacio)fluvial deposits varied with depth. In general, the deposits were comprised of fine grained silts which overlay granular deposits.

Fine Grained Deposits

The fine grained deposits were encountered to depths of ~1.5 and 2.2 meters, in BH 1-15 and 2-15, respectively. The discontinuous sampling in BH 3-15 indicated that these deposits extended to at least ~2 meters below the existing grade at that location (but was less than ~3 meters).

The laboratory analysis classified the fine grained deposits as silt which contained varying amounts of sand and up to a trace of gravel. The moisture content of the deposits ranged between 14.5 and 28.1 percent (by weight), indicating generally damp to moist soil conditions.

Granular Deposits

The laboratory analysis classified the granular deposits as sandy gravels which overlay gravelly sands (although the sandy gravel unit was not directly noted in BH 3-15). The granular deposits contained rounded cobbles and possibly boulder sized materials.

The gravelly sands were encountered at depths of 4.3 and 8.3 meters in BH 1-15 and BH 2-15, respectively. Each of the boreholes were terminated within the gravelly sands. While the gravelly sand contained up to a trace of silt, the overlying sandy gravel was noted to be silty in BH 2-15 at a depth of 4.2 meters in BH 2-15.

The moisture content of the underlying granular deposits varied. In general, where these soils were encountered above the groundwater table (< 3 m), the moisture content averaged 5.0 percent, indicating damp soil conditions. Where



these soils were encountered below the groundwater table (> 3 m), higher moisture contents averaging 11.4 percent were encountered. These higher moisture contents are indicative of wet to saturated soil conditions.

Relative Density

The SPT 'N'-values obtained in BH 3-15 allowed for an assessment of the materials relative density. In general, the values noted an increase in the relative density with depth as follows;

<i>Depth (m)</i>	<i>N-Value</i>	<i>Relative Density</i>	<i>USCS</i>	<i>Description</i>
0.0 to 0.45	25	Firm	ML	Silt
1.52 to 1.97	36	Stiff	ML	Sandy Silt
3.05 to 3.50	45	Dense	SP	Gravelly Sand
6.1 to 6.55	60	Very Dense	SP-SM	Gravelly Sand trace Silt

Groundwater

Groundwater was encountered in each of the boreholes at a depth of approximately 3.0 meters. The groundwater level was measured at a depth of ~2.95 meters below the ground surface in the monitoring well immediately following its installation.

Given the sites proximity and elevation relative to the Yukon River, the groundwater flow rates are expected to be considerable. The groundwater elevation will be directly related to seasonal fluctuations in the Yukon River. As groundwater elevations are typically lower during the winter months, the depth to the groundwater is expected to be less than 3 meters during the summer months.

Frozen Soils

There was no evidence of permanently frozen soils in any of the boreholes which were advanced. However, as the boreholes were advanced in the winter, seasonally frozen



soils were encountered in each of the boreholes to depths of approximately 0.6 meters below the ground surface.

Cobbles and Boulders

Rounded cobbles in size to 150 mm were encountered within the granular (glacio)fluvial deposits in each of the boreholes. The auger action of the drill suggests that potentially boulder sized materials may be encountered within these deposits.

Bedrock

There was no indication of bedrock in any of the boreholes that were advanced.



4.0 DISCUSSIONS

4.1 General

The subsurface conditions encountered at the proposed site will be suitable to allow for construction of the anticipated multi-family housing unit utilizing standard construction methodologies provided the site is prepared in accordance with the recommendations provided herein. Specifically, as the organic and near surface fine grained silt deposits are frost susceptible and have a poor bearing capacity, they will need to be removed from within the building load envelope to depths of approximately 2 meters.

Given the nature of channel infilling mechanisms which are associated with (glacio)fluvial deposition, other deleterious materials (such as organic deposits, trees, etc.) may be present within the building load envelope(s) and so additional geotechnical assessment should be conducted once a building design and proposed location has been determined to verify the anticipated conditions. While the assessment should ideally involve auger drilling methodologies, a test pit program (conducted beyond the periphery of the proposed load envelope) could also be considered.

Considering the presence of the dense to very dense non-frost susceptible granular (glacio)fluvial deposits which were encountered below the fine grained (glacio)fluvial deposits (at depths of ~1.5 to 2.2 meters below the adjacent grades) provisions should be incorporated to allow for removal of all the overlying fine grained deposits in order to eliminate potential long-term liabilities.

If fine grained soils are encountered at the base of the excavation, then additional consideration will be required as these soils typically have a lower soil bearing capacity relative to the granular soils which are anticipated. Additional consideration may also be required if the groundwater elevation is found to be shallower than 3 meters as its



proximity to (or presence within) the base materials may also reduce the soil bearing capacity. Caution will need to be exercised during construction given the proximity to the watertable and so wheeled equipment should not be allowed within the limits of the excavation during construction. The groundwater elevation should be monitored on a regular basis to better characterize the groundwater regime.

The resulting excavation should be backfilled utilizing approved structural fill until a suitable granular pad is prepared in accordance with the recommendations provided herein. A monolithic slab-on-grade or footing type of foundation system can subsequently be constructed to allow for the multi-family housing unit(s).

As the site has been historically developed, additional consideration may be required where future development coincides with the location of former building(s), potential septic field(s) and other utilities. In general, these regions will require the removal of disturbed soils and remaining infrastructure and subsequent backfill with structural fill.

The drainage in the region of the site should be carefully controlled as the near surface fine grained materials are moisture sensitive and subject to a loss of strength if they become wet/saturated or are disturbed.



4.2 Seismic Site Response

The site was classified for seismic site response in accordance with the *2010 National Building Code of Canada*, based upon the information obtained during the field work program. In general, the classification is based upon the type of soils that are located below the intended structure as follows:

CLASS	SOIL TYPE
A	hard rock
B	rock
C	dense soil or soft rock
D	stiff soil
E	>3 m of 'soft soil'
F	Others (liquefiable, peat, etc.)

Based upon the presence of the dense to very dense granular (glacio)fluvial soils which were encountered at the anticipated sub-grade elevation, the site would be classified as a Class C site.



5.0 RECOMMENDATIONS

5.1 Foundation Types

Conventional two-story multi-family housing units may be supported by a monolithic slab or (continuous or spread) footing (and slab-on-grade) types of foundation systems founded upon an approved granular base constructed in accordance with recommendations contained herein. Additional geotechnical consideration will be required if a crawlspace is incorporated into the design as the groundwater regime has not been fully characterized and thus shallow groundwater may be encountered.

5.2 Allowable Bearing Pressure

The net allowable bearing pressure should not be greater than 155 kilopascals for a monolithic slab foundation constructed upon the dense to very dense granular (glacio)fluvial deposits as described herein.

The net allowable bearing pressure should not be greater than 125 kilopascals for conventional strip footings and 145 kilopascals for spread footing types of foundation systems founded upon the dense to very dense granular (glacio)fluvial deposits as described herein.

If the fine grained (glacio)fluvial soils are encountered at the sub-grade elevation(s), then the bearing values should be reduced. While additional geotechnical assessment would be required in this event, based upon the relative density of the silt materials encountered in BH 3-15 at a depth of 1.5 to 2.0 meters, the net allowable bearing pressure should be no greater than;

135 kilopascals for a monolithic slab foundation

100 kilopascals for conventional strip footings, and

120 kilopascals for spread footings.

These figures include the total of all live and dead loads.

5.3 Frost Protection

As a minimum, the underside of the footings should be placed at a depth of no less than 1.8 meters below the top of the prevailing adjacent exterior grade to allow for adequate frost protection.

If isolated spread footings are required, the footings should have a frost protection equivalent to 2.2 meters of earthen cover as measured from the underside of the footing. The amount of earthen cover can be reduced if protective insulation is adequately incorporated into the design.

If a monolithic slab is to be considered, then the thickness of the underlying granular pad should measure no less than 1.8 meters thick.

5.4 Differential Movements

Foundations constructed in accordance with the recommendations contained herein may experience differential movements in the order of (+/-) 20 mm.

5.5 Deleterious Materials & Founding Strata

As the near surface fine grained (glacio)fluvial deposits are frost susceptible and may contain varying amounts of organics they should be removed from within the building load envelope until the underlying dense to very dense granular (glacio)fluvial deposits are exposed at the sub-grade elevation (approximately 1.5 to 2.2 meters below the prevailing grades).



If large cobbles or boulders are encountered at the sub-grade elevation, then they should be removed and replaced with structural fill as described below.

Considering the presence of good bearing non-frost susceptible granular deposits which were encountered below the fine grained (glacio)fluvial deposits (at depths of ~1.5 to 2.2 meters below the adjacent grades) additional provisions should be incorporated to allow for their removal in order to eliminate potential long-term liabilities.

The excavation of these materials will allow for subsequent backfill utilizing non-frost-susceptible materials in accordance with Section 5.8 – Structural Fill

The excavated materials can be utilized as general purpose (non-structural) fill so long as the materials are thawed and are compacted to approximately 95% of the materials corresponding maximum proctor density at (or near) the materials optimum moisture content.

5.6 Excavations

Excavations should be conducted utilizing a heavy tracked excavator equipped with a smooth lipped (clean-up) bucket in order to minimize disturbance of the sub-grade materials. While excavation difficulties are not expected, large boulders could be encountered and so this should be considered.

Loose, disturbed, remolded or slough materials should not be allowed to remain in prepared excavation(s). If a suitable founding surface cannot be prepared through mechanical means, then hand cleaning may be necessary.

The sub-grade materials are subject to a loss of strength if they are disturbed (or become wet/saturated) and as such, equipment should not be allowed to operate directly on the sub-grade surfaces. The exceptions to this would be tracked equipment and drum



compactor. The use of the vibratory mode on the drum compactor should be carefully considered. Static rolling would be advised during placement of the initial lifts of structural fill.

The contractor should be prepared to adjust their construction methodology and excavation profiles as soil and site conditions dictate.

5.7 Excavation Limits

The excavation limits will be governed by the proposed building elevation and those of the founding strata (dense to very dense granular (glacio)fluvial deposits).

The excavation limits should be defined by the theoretical loading footprint which can be described as a 1:1 slope which extends outwards from the building perimeter until the founding (granular) strata has been attained (plus 1 meter horizontally). This angle of repose should be reduced to 2 horizontal to 1 vertical (or less) in regions where fine grained (or saturated) deposits are encountered.

The base of the excavation(s) should be prepared in such a manner that the sub-grade elevation does not vary. The entire excavation should be excavated to the lowest elevation at which the dense granular (glacio)fluvial deposits are encountered.

5.8 Structural Fill

5.8.1 Monolithic Slab

The monolithic slab should be founded upon structural fill, comprised of an approved, clean, inorganic, well graded sand and gravel mixture.

The granular pad should measure at least 1.8 meters thick and constructed in such a manner that the underside of the concrete slab lies above the prevailing adjacent grades.



The granular pad should be comprised of the following;

UNIT	THICKNESS	COMPACTION ^B	COMPOSITION
Base	200 mm	100 %	20 mm minus crushed granular aggregate, overlying
Sub-base	1600 mm ^A	100 %	80 mm minus sub-base course aggregate, overlying
Sub-grade	NA	98 %	approved native sub-grade materials

Notes; ^A –

The thickness of this unit should be uniform through-out the building load envelope and extend to the underlying dense to very dense granular (glacio)fluvial deposits.

A clean, well graded ‘pit run’ material (with maximum particle size of 150 mm) can be considered below a depth of 0.7 meters below the underside of the concrete slab.

^B – Indicates percent compaction relative to the materials Proctor maximum dry density at (or near, $\pm 2\%$) its optimum moisture content.

The above noted structure assumes the presence of a 200 mm thick reinforced concrete slab.

5.8.2 Footings

The footing components should be founded upon a 150 mm thick layer of approved 20 mm minus crushed granular aggregate compacted to a minimum of 100 % of the materials corresponding maximum Proctor dry density at (or within $\pm 2\%$ of) the materials optimum moisture content.

Interior backfill (below slab components) should be comprised of approved non-frost susceptible granular aggregate compacted to a minimum of 100 % of the materials corresponding maximum Proctor dry density at (within $\pm 2\%$ of) the materials optimum moisture content. The backfill should be comprised of a minimum of 200 mm of 80 mm minus granular aggregate which is overlain with a 100 mm thick layer of 20 mm minus crushed granular aggregate.

5.9 Backfill Requirements

A recommended grain size distribution for the specified imported (structural) fills has been provided in Appendix B - Imported Fill Specifications.

All materials should be placed in uniform, level lifts that do not exceed 150 mm thick, as measured following compaction.

The thickness of the granular pad (or footing leveling course) should be uniform throughout the load envelope to minimize the potential for differential settlement.

Exterior backfill around footing columns (and wall components) should be comprised of non-frost susceptible granular aggregates with particle sizes less than 80 mm. This material should be compacted to a minimum of 95 % of the materials corresponding maximum Proctor dry density at (within $\pm 2\%$ of) the materials optimum moisture content, unless otherwise over-ridden by recommendations provided herein.

The difference in height of the backfill between the interior and exterior sides of (footing) wall components should not measure greater than 150 mm during construction such that undesirable lateral forces are not induced. Permission from the structural consultant should be obtained if this criteria is to exceed design parameters.



Considering that backfill will be conducted adjacent to vertical (footing) walls, the compaction effort should be applied with equipment that will not compromise the foundations integrity. This may require utilizing light hand-operated compaction equipment and reducing the lift thicknesses.

Exterior backfill work in these regions should not be conducted until approval is obtained from the structural consultant.

Typically backfill adjacent to wall components should not be conducted until seven (7) days have elapsed from the time of concrete placement such that adequate concrete strengths are attained.

As groundwater may be located within close proximity to the sub-grade elevations and construction backfill, caution should be exercised such that the sub-grade and imported construction fills are not disturbed as a loss in strength may occur. Specifically, vibratory compaction during the initial lifts of structural backfill should be restricted and so static rolling may be required during the initial phases of construction.

5.10 Cement

All concrete work should conform to *Canadian Standards Association (CSA)* standard CAN/CSA – A23.1 and A23.2. According to the standard, the concrete should be designed to satisfy the minimum environmental durability requirements as defined by its exposure class. The exposure class is dependent upon the presence of chlorides and sulphates, freezing/thawing conditions and degree of soil saturation.

Based upon the results of the chemical analysis, the potential for sulphate attack from the surrounding native materials would be negligible. The aggressiveness of the imported materials should be verified at the time of construction.



Concrete subject to frequent freeze-thaw cycles and/or deicing chemicals and should be designed in accordance with C.S.A. A23.1-94, Section 15.

Normal Portland cement (C.S.A. Type 10), should be used in all concrete work in direct contact with the soil.

The concrete should have a minimum 28-day compressive strength of 25 megapascals and be air entrained (4 to 6 percent). This assumes a maximum aggregate size of 20 mm.

5.11 Structural Breaks & Reinforcing

Structural breaks and reinforcing (rebar) should be integrated into the foundation to control cracking and allow for differential movements caused by soil volume changes of the underlying soil.

Additional measures should be incorporated into the design if dynamic and/or point loads are expected. This should include thickening and reinforcing the areas of the slab that may be subjected to these additional forces.

The slab component(s) of the footing types of foundations should be structural separated from other the foundation components.

5.12 Vapor Barrier

A non-deteriorating vapor barrier should be placed beneath the concrete to prevent desiccation of the sub-base materials and promote concrete hydration.



5.13 Insulation

The fine grained (glacio)fluvial deposits are frost susceptible and so frost protection in the form of perimeter insulation or thickness of structural fill (or soil cover) is required to reduce the risk of undesirable movements due to frost action if these soils are present at the sub-grade elevation. The thickness of the insulation should be increased in regions where there may be a higher loss of heat such as the corners of the structure.

The minimum frost protection requirements for the foundation types have been outlined in Section 5.3, above.

Provisions should be included to protect the subsoils from excessive desiccation in regions where there is an intense degree of concentrated heat (such as potential boiler areas). Insulation should be incorporated in these areas so as to limit soil volume changes to tolerable amounts.

5.14 Inclement Weather

The sub-grade, excavations and construction materials should be protected from drying, freezing, rain, snow, surface waters and groundwater at all times. Protective tarps should be utilized to protect the sub-grade and construction materials from desiccation, freezing and precipitation.

The fine grained (glacio)fluvial deposits are moisture sensitive and so construction operations may need to cease or be altered at times of precipitation until drier weather conditions prevail.

The fine grained (glacio)fluvial deposits are frost susceptible and so it is critical that construction work is conducted during the summer months.



The foundation work should be closed to the weather and heated prior to the onset of any freezing temperatures for the remainder of the buildings life-span.

5.15 Site Survey

A detailed survey should be undertaken by qualified personnel to assist the design team in establishing the building elevation(s) and site grading profiles. Any references to elevations contained herein are for discussion purposes only.

5.16 Surface and Groundwater

Groundwater was encountered during our evaluation at a depth of ~3 meters below the prevailing ground surface. As seasonal fluctuations may affect the flow regime the Contractor should be prepared to undertake construction dewatering to ensure a dry working area. The monitoring well installed in BH 3-15 should be checked prior to and during construction to better characterize the potential groundwater conditions.

Surface and groundwater should be removed from excavations at all times during foundation preparation. The surrounding surfaces should be graded so as to direct water away from the excavation.

Ditches

Ditches should be incorporated into the design and construction phases to control perimeter drainage.

Site Grading

The surrounding areas should be graded to direct surface water away from the building structure and foundation/excavations. Typically, a 2 percent slope which extends a minimum of 5 meters away from the building perimeter will be sufficient for this purpose.

Exterior backfill comprised of a low permeability soil or surface cover should be placed around the perimeter of the foundation following concrete placement. The low permeability soil/surface cover will assist in directing surface waters away from the foundation and limits of the excavation. The backfill should be placed to protect the sides of the concrete pad and prevent undermining of the slab during periods of heavy precipitation/run-off.

Eaves troughs

Eaves troughs should be incorporated into the roof structure. The outlets from the roof drains should extend a minimum of 3.0 meters away from the building structure such that the discharge is directed away from the structure(s).

5.17 Temporary Stockpiles

Stockpiled materials that may be utilized during construction should be protected from segregation and the ingress of snow, rain and surface waters.

5.18 Subsurface Utilities

As sub-surface (water/sewer) utilities are to be installed, the pipes should be embedded in bedding sand which conforms to the grain size specifications provided in Appendix C.

The utility pipes should be established on a base of bedding sand which measures 300 mm thick. The bedding sand should extend a minimum of 300 mm on all sides of the pipe. The material should be compacted to a minimum of 95% of the materials corresponding Proctor density at (or near) the materials optimum moisture content.

If sub-grade conditions are poor, then the use of (clear stone) drain rock encased in geotextile filter fabric can be utilized in lieu of the bedding sand.

The (glacio)fluvial deposits will generally be suitable for use as trench backfill in non-structural areas so long as these materials are not frozen, however, cobbles larger than 150 mm in size should not be placed within 1 meter of the pipe. The trench backfill should be comprised of an approved pit run in regions where trenches intersect the building load envelope.

Trench backfill materials should be placed in lifts which do not exceed 200 mm as measured following compaction. The material should be compacted to a minimum of 95% of the materials corresponding maximum Proctor dry density at (or near) the materials optimum moisture content. The compaction effort should be increased to a minimum of 98 % of the materials corresponding maximum Proctor dry density in regions where the sub-surface utilities cross roadways/parking areas or other regions where loading envelopes may be affected.

5.19 Roads & Parking Areas

The structure for roads and parking areas should be comprised of;

UNIT	THICKNESS	COMPACTION ^B	COMPOSITION
Base	150 mm	100 %	20 mm minus crushed granular aggregate, overlying
Sub-base	350 mm ^A	98 %	80 mm minus sub-base course aggregate, overlying
Geotextile ^C	NA	NA	approved filter fabric
Sub-grade	NA	95 %	approved native sub-grade materials

Notes; ^A – If additional fill is required to meet the anticipated design elevations or if heavy loads (ie water trucks) are anticipated, then a clean, well graded ‘pit run’ material with maximum particle size of 150 mm should be utilized below the sub-base materials.

^B – Indicates percent compaction relative to the materials Proctor maximum dry density at (or near, $\pm 2\%$) its optimum moisture content. All materials should be placed in uniform, level lifts that do not exceed 150 mm thick, as measured following compaction.

^C – The use of geotextile fabric should be considered if poor subgrade materials are encountered or if additional structural support is required.

A recommended grain size distribution for the specified imported fills has been provided in Appendix B – Imported Fill Specifications.

5.20 Culvert Installations

Depending upon the final design elevations and area grading profiles, the installation of culverts may be required to facilitate area drainage, particularly at the entrances to the site.

5.21 Construction Monitoring and Testing

During construction, qualified geotechnical personnel should monitor the excavation(s) and side slopes and inspect all sub-grade surfaces prior to backfill to verify that the materials noted at the sub-grade elevation are consistent with those identified in this report. They should be present at the time that the founding soil is exposed such that any potential geotechnical liabilities can be readily identified. In addition, they should verify the applicability of the recommended allowable soil bearing capacities which have been provided herein.

Materials testing and inspection services should be conducted by qualified personnel during excavation, backfill and foundation construction to verify the suitability of the



sub-grade, imported structural fills and foundation works. The work should include in-situ field density (compaction) testing of imported fills, inspection of the rebar and concrete testing.

5.22 Temporary Excavations & Worker Safety

Worker safety is paramount.

Temporary excavations to conventional depths at this site should comply with current regulations under the *Yukon Workers Compensation Board - Occupational Health & Safety Act*.

The excavation sidewall (slope) stability will be dependent upon the material characteristics, configuration of the excavation and length of exposure. In general, side slopes cut at 1:1 (horizontal/vertical) should allow for adequate stability provided that the depth of the excavation does not exceed 2 meters. Otherwise side slopes should be cut at 2:1 (horizontal/vertical). If these parameters are to be exceeded, then they should be verified and monitored by qualified geotechnical personnel during the time of construction.

Slope stability will be poor if wet/saturated materials, fills or clean granular materials are encountered and more gradual cut slopes may be required in these areas to minimize the potential for slope failure.



6.0 CONCLUSIONS

The subsurface conditions encountered at the proposed site will be suitable to allow for construction of the anticipated multi-family housing unit utilizing standard construction methodologies provided the site is prepared in accordance with the recommendations provided herein. Specifically, as the organic and near surface fine grained silt deposits are frost susceptible and have a poor bearing capacity, they will need to be removed from within the building load envelope to depths of approximately 2 meters to allow for construction of monolithic slab-on-grade or else footing types of foundation systems. Given the nature of channel infilling mechanisms which are associated with (glacio)fluvial deposition, other deleterious materials (such as organic deposits, trees, etc.) may be present within the building load envelope(s) and so additional geotechnical assessment should be conducted once a building design has been determined to verify the anticipated conditions.

Considering the presence of the dense to very dense non-frost susceptible granular (glacio)fluvial deposits which were encountered below the fine grained (glacio)fluvial deposits (at depths of ~1.5 to 2.2 meters) provisions should be incorporated to allow for removal of all the overlying fine grained deposits in order to eliminate potential long-term liabilities.

If fine grained soils are encountered at the base of the excavation, then additional consideration will be required as these soils typically have a lower soil bearing capacity relative to the granular soils which are anticipated. Additional consideration may also be required if the groundwater elevation is found to be shallower than 3 meters as its proximity to (or presence within) the base materials may also reduce the soil bearing capacity.

Additional geotechnical consideration will be required if a crawlspace is incorporated into the design as the groundwater regime has not been fully characterized and shallow

groundwater may be encountered. Caution will need to be exercised during construction given the proximity to the watertable and so wheeled equipment should not be allowed within the limits of the excavation during construction. The groundwater elevation should be monitored on a regular basis (through the monitoring well installed in BH 3-15) to better characterize the groundwater regime.

As the site has been historically developed, additional consideration may be required where future development coincides with the location of former building(s), potential septic field(s) and other utilities.

The drainage in the region of the site should be carefully controlled as the near surface fine grained materials are moisture sensitive and subject to a loss of strength if they become wet/saturated or are disturbed.



7.0 LIMITATIONS

This report is intended for the sole use of the *Yukon Government*. No portion of this report may be used as a separate entity; it is intended to be read in its entirety. Any use of this report by a third party is the responsibility of such third party. The recommendations provided herein are based upon the subsurface conditions encountered at the time of our investigation, current construction techniques and generally accepted engineering practices. The content within this report reflects our best judgment in light of the information available to *Chilkoot Geological Engineers Ltd.* at the time of report preparation.

The anticipated construction conditions have been discussed, but only to the extent that they may influence design decisions. Any references to construction methods contained herein, express our opinion and are not intended to direct contractors on how to carry out construction. Prospective contractors should be aware that the presented data may not be sufficient to assess all factors that may have an effect upon construction. The locations of sub-surface utilities should be confirmed by the retained contractor prior to construction.

It is important to emphasize that a geotechnical investigation is, in fact, a random sampling of a site and that our comments are made based upon the results obtained at the borehole and sample locations. Due to the geomorphological nature of the deposits encountered, interpolations of native subsurface conditions between the test locations have not been made or been implied. The elevations noted herein are for discussion purposes only.

Should unexpected subsurface conditions be encountered during construction, our firm should be notified immediately in order to confirm the suitability of our recommendations. If required, our firm may alter or modify our recommendations at such time.

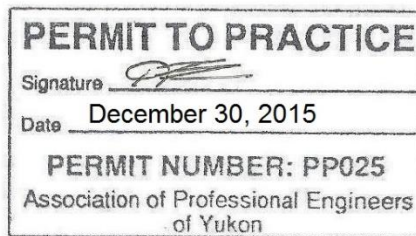
8.0 CLOSURE

Thank you for providing our firm with the opportunity to conduct the above noted geotechnical evaluation.

We trust that the information we have provided will be suitable for your purposes, however, if you should have any questions or concerns, please feel free to contact the undersigned at your convenience.

Respectfully Submitted,

CHILKOOT GEOLOGICAL ENGINEERS LTD.



Tares Dhara, P.Eng.

Senior Geotechnical Engineer

TD/td



FIGURE 1

Site & Borehole Locations



Geotechnical Evaluation
Proposed Multi-Family Housing Unit – Carmacks, Yukon – 2015
Figure 1 – Site and Borehole Locations



Based map modified from Google Earth Imagery - Not to Scale.
Locations are Approximate

Compiled Dec.20, 2015 by T.Dhara



APPENDIX A

Borehole Soil Logs



NOTES ON SOIL LOGS

Soil Description

The soil is named after its principal component and modified by other components as follows;

<u>Percent of Component</u>	<u>Modifier</u>
> 15 %	XXX - ey
11% to 15%	some XXX
5% to 10%	trace XXX

Examples;

<u>SILT</u>	<u>SAND</u>	<u>GRAVEL</u>	<u>Description</u>
6	32	62	Sandy Gravel trace Silt
55	6	39	Gravelly Silt trace Sand
43	36	21	Silty Gravelly Sand

Note: In the cases where the coarse fraction (sand & gravel) comprise > 50% of the sample, then the larger component of the coarse fraction becomes the principal component.

Undrained Shear Strength of Cohesive Soils

Consistency	Undrained Shear Strength	
	p.s.f	kN/m ²
Very Soft	< 375	<20
Soft	375-750	20-40
Firm	750-1500	40-75
Stiff	1500-3000	75-150
Very Stiff	3000-6000	150-300
Hard	>6000	<300



Relative Density (Qualitative Classification)

Cohesive Soils

- Very Soft - Exudes between fingers when squeezed by hand
- Soft - Moulded by light finger pressure
- Firm - Moulded by strong finger pressure
- Stiff - Cannot be moulded by fingers – Can be indented by thumb
- Very Stiff - Can only be indented by thumbnail
- Hard - Cannot be indented by thumbnail

Granular Soils

- Very Loose - Considerable sidewall sloughage noted
- Loose - Some sidewall sloughage noted – Easy digging
- Compact/
Medium-Dense - Unimpeded excavation – little to no sidewall sloughage
- Dense - Considerable effort required during excavation – Stable vertical sidewalls
- Very Dense - Extreme difficulty in excavation

Soil Log - Sample Type

Symbol

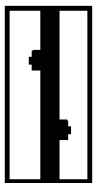
Test Pitting

Drilling



Grab Sample
Retained from
excavation sidewall
or base

Auger Sample
Retained from
Auger flighting



Bucket Sample
Retained from
leading edge of
excavator bucket

Split-Spoon Sample
Retained from
Split-Spoon Sampler
tube



Relative Moisture

Described as - *dry, damp, moist, wet* or *saturated* - relative to the principal soil matrix.

For example, a moisture content of 10 percent may be classified as ‘*moist*’ for a coarse grained soil (sand or gravel) but ‘*damp*’ for a fine grained (silt) soil.

The moisture content is recorded as a percentage (%) of the weight of water within the soil sample relative to the dry weight of the sample.

Recovery

Refers to the (linear) amount of sample retained after driving the Split Spoon (SPT) sampler tube 18 inches.

Recorded as a percentage (i.e. 12 inch sample/18 drive = 66 %)

N-Value

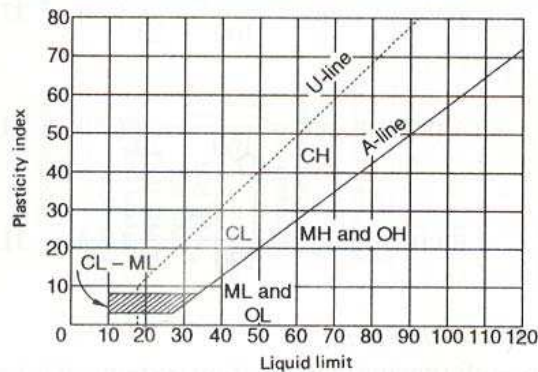
Refers to the total number of blows required to drive the Split Spoon sampler tube the final 12 inches of the 18 inch drive.

Relative Density based upon SPT ‘N’ Value

Non-cohesive (Granular) Soil		Cohesive (Clayey) Soils	
Relative Density	Blows per Foot (N-value)	Consistency	Blows per Foot (N-value)
<i>Very Loose</i>	< 5	<i>Very Soft</i>	0 to 2
<i>Loose</i>	5 to 9	<i>Soft</i>	3 to 4
<i>Compact</i>	10 to 29	<i>Firm</i>	5 to 8
<i>Dense</i>	30 to 50	<i>Stiff</i>	9 to 15
<i>Very Dense</i>	> 50	<i>Very Stiff</i>	16 to 30
		<i>Hard</i>	> 30

Unified Soil Classification System
(ASTM Designation D-2487)

Major division	Group Symbols	Typical Names	Classification Criteria	
Coarse-grained soils More than 50% retained on No. 200 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 GP Poorly graded gravels and gravel-sand mixtures, little or no fines GM Silty gravels, gravel-sand-silt mixtures GC Clayey gravels, gravel-sand-clay mixtures	$C_u = D_{60}/D_{10}$ Greater than 4 $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for GW Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line and plasticity index greater than 7
		Gravels with fines	SW Well-graded sands and gravelly sands, little or no fines SP Poorly graded sands and gravelly sands, little or no fines SM Silty sands, sand-silt mixtures SC Clayey sands, sand-clay mixtures	$C_u = D_{60}/D_{10}$ Greater than 6 $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for SW Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line and plasticity index greater than 7
		Clean sands	ML Inorganic silts, very fine sands, rock flour, silty or clayey fine sands CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays OL Organic silts and organic silty clays of low plasticity MH Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts CH Inorganic clays of high plasticity, fat clays OH Organic clays of medium to high plasticity	Check plasticity chart
	Sands More than 50% of coarse fraction passes No. 4 sieve	Sands with fines	Silty and Clays Liquid limit 50% or less	Silty and Clays Liquid limit greater than 50%
		Sands with fines		
	Fine-grained soils 50% or more passes No. 200 sieve	Silty and Clays Liquid limit 50% or less	Silty and Clays Liquid limit greater than 50%	Check plasticity chart
		Silty and Clays Liquid limit greater than 50%		
	Highly organic soils	Pt	Peat, muck and other highly organic soils	Fibrous organic matter; will char, burn, or glow



Note: U-line represents approximate upper limit of LL and PI combinations for natural soils

Plasticity chart for the classification of fine-grained soils.
Tests made on fraction finer than No. 40 sieve.

Unified Soil Classification System

Figure 18. UNIFIED SOIL CLASSIFICATION SYSTEM

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BOREHOLE LOG

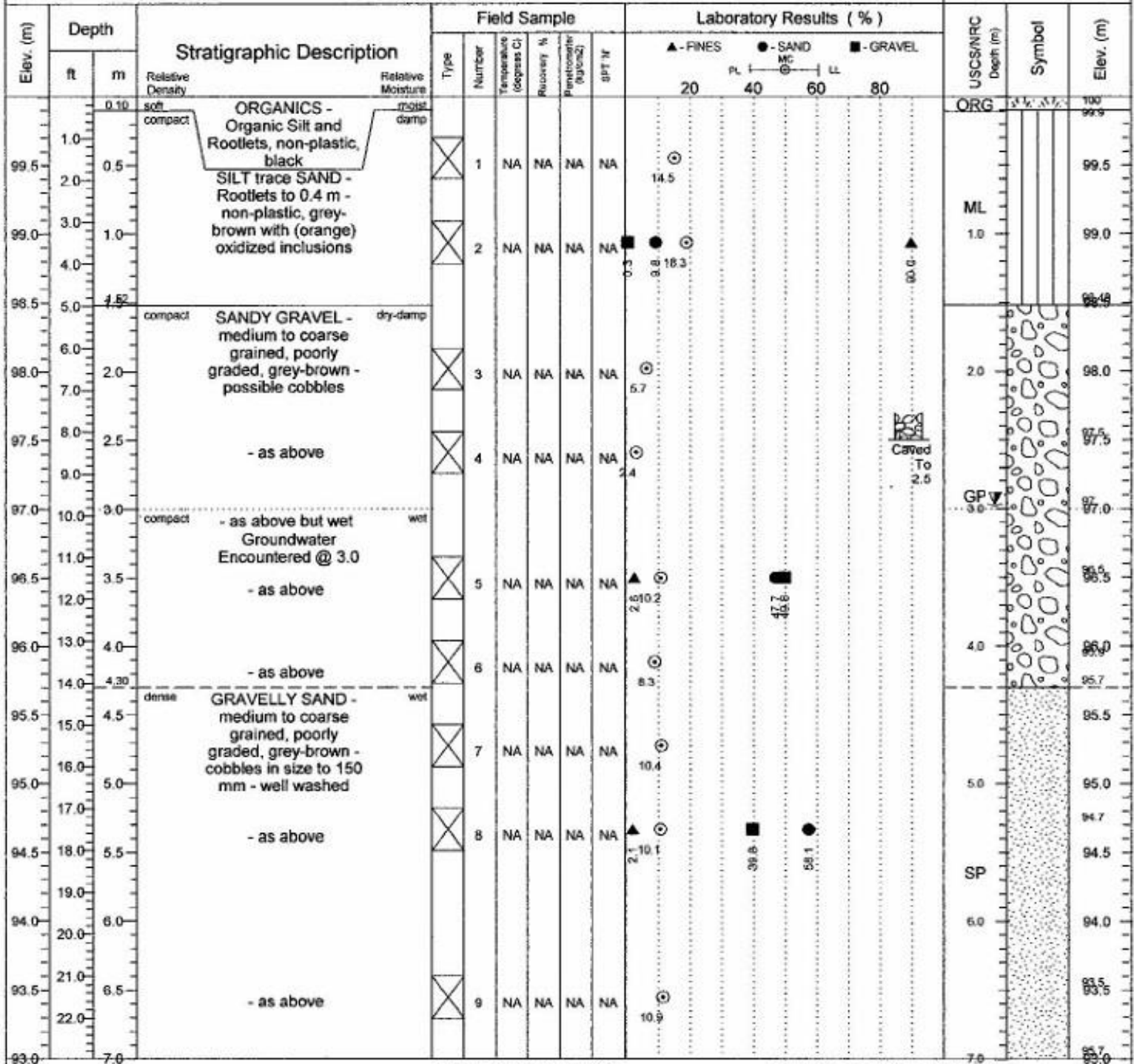
Client : Yukon Government - Energy, Mines & Resources
Location : Carmacks, Yukon
Project : Geotechnical Evaluation - Multi-Family Housing Unit

Date Drilled: November 6, 2015
Elevation : 100.00 meters
Depth of BH: 9.14 meters
Instrumentation: NA

BOREHOLE

1-15

Sheet 1 of 2



Drilled By : Donjek Drilling
Drill Type : CME 750 (FN60)

Auger Type : 150 mm Solid Stem
Bit Type : Fish Tail

Logged By : G. Keitel
Date : November 6, 2015

Data Entry By : T. Dhara, P. Eng.
Date : December 5, 2015

Reviewed By :
Date : December 10, 2015

Water Level(s)
 During Drilling
 After Drilling
 At End of Drilling

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5B Bennett Road, Whitehorse, Yukon
(867) 335-5804 chilkoote@northwestel.net



BOREHOLE LOG

Client : Yukon Government - Energy, Mines & Resources
Location : Carmacks, Yukon
Project : Geotechnical Evaluation - Multi-Family Housing Unit
Chilkoote Project No. :

Date Drilled: November 6, 2015
Elevation : 100.00 meters
Depth of BH: 9.14 meters
Instrumentation: NA

BOREHOLE

1-15

Sheet 2 of 2

Elev. (m)	Depth		Stratigraphic Description	Field Sample					Laboratory Results (%)				USCS/NRC Depth (m)	Symbol	Elev. (m)		
	ft	m		Type	Number	Temperature (degrees C)	Recovery %	Permeability (optional)	SPT 'N	▲ - FINES	● - SAND	■ - GRAVEL				PL	MC
92.5	24.0	7.5	GRAVELLY SAND - medium to coarse grained, poorly graded, grey-brown - cobbles in size to 150 mm - well washed - Easy Drilling	⊗	10	NA	NA	NA	NA							92.5	
92.0	26.0	8.0															92.0
91.5	28.0	8.5		- as above	⊗	11	NA	NA	NA	NA	▲	●					91.5
91.0	29.0	9.0	- as above	⊗	12	NA	NA	NA	NA	▲	●						91.0
90.5			End of Borehole Groundwater Encountered @ 3.0 m below the ground surface Borehole terminated at 9.14 m. below the existing ground surface.													90.5	
90.0																90.0	
89.5																89.5	
89.0																89.0	
88.5																88.5	
88.0																88.0	
87.5																87.5	
87.0																87.0	
86.5																86.5	
86.0																86.0	

Drilled By : Donjek Drilling
Drill Type : CME 750 (FN60)

Auger Type : 150 mm Solid Stem
Bit Type : Fish Tail

Water Level(s)
 During Drilling After Drilling
 At End of Drilling

Logged By : G. Keitel
Date : November 6, 2015

Data Entry By : T. Dhara, P. Eng.
Date : December 5, 2015

Reviewed By:
Date : December 10, 2015

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BOREHOLE LOG

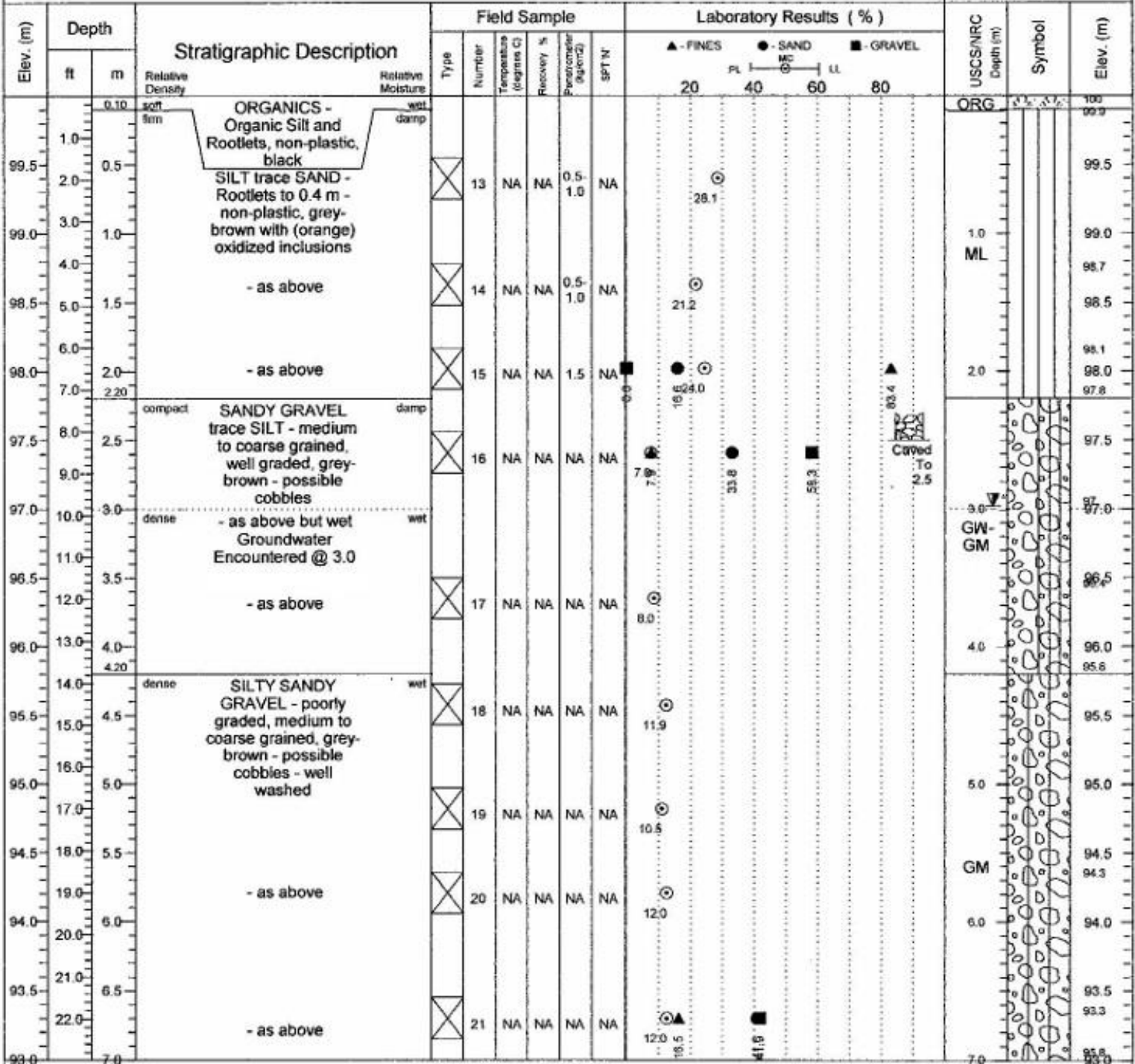
Client : Yukon Government - Energy, Mines & Resources
Location : Carmacks, Yukon
Project : Geotechnical Evaluation - Multi-Family Housing Unit

Date Drilled: November 6, 2015
Elevation : 100.00 meters
Depth of BH: 9.14 meters
Instrumentation: NA

BOREHOLE

2-15

Sheet 1 of 2



Drilled By : Donjek Drilling
Drill Type : CME 750 (FN60)

Auger Type : 150 mm Solid Stem
Bit Type : Fish Tail

Water Level(s)
 During Drilling
 After Drilling
 At End of Drilling

Logged By : G. Keitel
Date : November 6, 2015

Data Entry By : T. Dhara, P. Eng.
Date : December 5, 2015

Reviewed By :
Date : December 10, 2015

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BOREHOLE LOG

Client : Yukon Government - Energy, Mines & Resources
Location : Carmacks, Yukon
Project : Geotechnical Evaluation - Multi-Family Housing Unit

Date Drilled: November 6, 2015
Elevation : 100.00 meters
Depth of BH: 9.14 meters
Instrumentation: NA

BOREHOLE

2-15

Sheet 2 of 2

Elev. (m)	Depth		Stratigraphic Description	Field Sample						Laboratory Results (%)				USCS/NRC Depth (m)	Symbol	Elev. (m)
	ft	m		Type	Number	Temperature (°C)	Recovery %	Penetration (kg/cm ²)	SPT 'N'	PL	MC	LL	GC			
92.5	24.0	7.5	SILTY SANDY GRAVEL - poorly graded, medium to coarse grained, grey-brown - possible cobbles - well washed	X	22	NA	NA	NA	NA							92.5
92.0	26.0	8.0		X	23	NA	NA	NA	NA							
91.5	28.0	8.5	GRAVELLY SAND - medium to coarse grained, poorly graded, grey-brown - cobbles in size to 150 mm - well washed	X	24	NA	NA	NA	NA							91.5
91.0	29.0	9.0								4.1	17.6	22.7	73.2			91.0
90.5			End of Borehole Groundwater Encountered @ 3.0 m below the ground surface Borehole terminated at 9.14 m. below the existing ground surface.													90.5
90.0																90.0
89.5																89.5
89.0																89.0
88.5																88.5
88.0																88.0
87.5																87.5
87.0																87.0
86.5																86.5
86.0																86.0

Drilled By : Donjek Drilling
Drill Type : CME 750 (FN60)

Auger Type : 150 mm Solid Stem
Bit Type : Fish Tail

Water Level(s)
 ▽ During Drilling ▽ After Drilling
 ▽ At End of Drilling

Logged By : G. Keitel
Date : November 6, 2015

Data Entry By : T. Dhara, P.Eng.
Date : December 5, 2015

Reviewed By:
Date : December 10, 2015

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BOREHOLE LOG

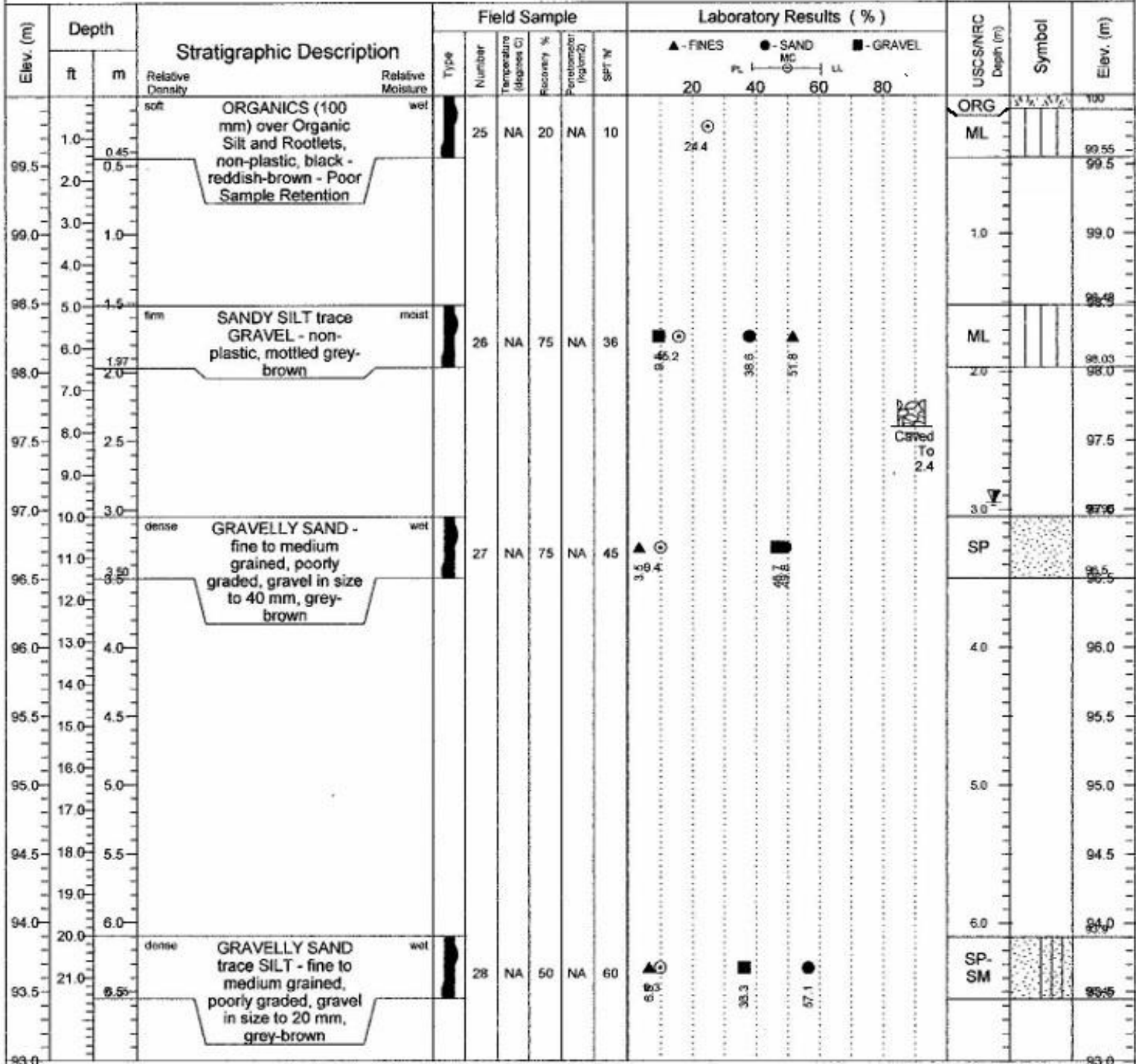
Client : Yukon Government - Energy, Mines & Resources
Location : Carmacks, Yukon
Project : Geotechnical Evaluation - Multi-Family Housing Unit

Date Drilled: November 6, 2015
Elevation : 100.00 meters
Depth of BH: 6.55 meters
Instrumentation: 2" Monitoring Well

BOREHOLE

3-15

Sheet 1 of 2



Drilled By : Donjek Drilling
Drill Type : CME 750 (FN60)

Auger Type : 200 mm Hollow Stem
Bit Type : Carbide Button

Water Level(s)
 During Drilling
 After Drilling
 At End of Drilling

Logged By : G. Keitel
Date : November 6, 2015

Data Entry By : T. Dhara, P. Eng.
Date : December 5, 2015

Reviewed By:
Date : December 10, 2015

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(867) 335-5804 chilkoot@northwestel.net



BOREHOLE LOG

Client : Yukon Government - Energy, Mines & Resources
Location : Carmacks, Yukon
Project : Geotechnical Evaluation - Multi-Family Housing Unit

Date Drilled: November 6, 2015
Elevation : 100.00 meters
Depth of BH: 6.55 meters
Instrumentation: 2" Monitoring Well

BOREHOLE

3-15
Sheet 2 of 2

Elev. (m)	Depth		Stratigraphic Description	Field Sample						Laboratory Results (%)				USCS/NRC Depth (m)	Symbol	Elev. (m)	
	ft	m		Type	Number	Temperature (degrees C)	Recovery %	Penetration (kg/cm ²)	SPT/N	▲ - FINES	● - SAND MC	■ - GRAVEL	PL				MC
92.5			End of Borehole Groundwater Encountered @ 2.95 m below the ground surface 2" Monitoring well installed to 6.4 m below the existing ground surface Borehole terminated at 6.55 m. below the existing ground surface.													92.5	
92.0																	92.0
91.5																	91.5
91.0																	91.0
90.5																	90.5
90.0																	90.0
89.5																	89.5
89.0																	89.0
88.5																	88.5
88.0																	88.0
87.5																	87.5
87.0																	87.0
86.5																	86.5
86.0																	86.0

Drilled By : Donjek Drilling
Drill Type : CME 750 (FN60)

Auger Type : 200 mm Hollow Stem
Bit Type : Carbide Button

Logged By : G. Keitel

Data Entry By : T. Dhara, P. Eng.

Reviewed By:

Date : November 6, 2015

Date : December 5, 2015

Date : December 10, 2015

Water Level(s)

During Drilling After Drilling
 At End of Drilling



APPENDIX B

Specifications for Imported Fill

CHILKOOT GEOLOGICAL ENGINEERS LTD.



APPENDIX B

Recommended Grain Size Distribution for Imported Fill

Gran E Pit Run	
Sieve Size (mm)	% Passing By Wt
200	100
80	75-100
25	55-100
12.5	42-84
5	26-65
1.25	11-47
0.315	3-30
0.08	2-13
LA Abrasion 35 % Max Loss	

80 mm minus Sub-base	
Sieve Size (mm)	% Passing By Wt
80	100
25	60-100
12.5	40-90
5	20-65
1.25	9-35
0.315	3-15
0.08	0-8
LA Abrasion 35 % Max Loss	

Clear Stone	
Sieve Size (mm)	% Passing By Wt
28	100
20	70-100
12.5	55-100
10	30-80
5	0-40
2	0-10
NA	NA
LA Abrasion 35 % Max Loss	

Bedding Sand	
Sieve Size (mm)	% Passing By Wt
10	100
5	80-100
2	55-100
0.63	25-65
0.25	10-40
0.08	2-10

20 mm minus Base Course	
Sieve Size (mm)	% Passing By Wt
20	100
12.5	64-100
5	36-72
1.25	12-42
0.315	4-22
0.08	3-6

Class I Rip-Rap	
Sieve Size (mm)	% Passing By Wt
450	100
350	80
300	50
200	20

Class II Rip-Rap	
Sieve Size (mm)	% Passing By Wt
800	100
600	80
500	50
300	20

Class III Rip-Rap	
Sieve Size (mm)	% Passing By Wt
1200	100
900	80
800	50
500	20



APPENDIX C

Selection of Photos



Photo # 1 (left)
BH 1-15 - 0 to 1.5 m
Samples # 1 & # 2



Photo # 2 (right)
BH 1-15 - 4.5 to 6.1 m
Samples # 7 & # 8

Photo # 3 (below)
Site conditions at BH 1-15 facing west.



Photo # 4 (below)
Site conditions at BH 2-15 facing south-east.



Photo # 5 (right)
BH 3-15
Samples # 28 @ 6.1 m
Gravelly Sand trace Silt

