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**Geotechnical Feasibility Assessment
Callison Industrial Subdivision Area
Land Disposition # 2005-0015
Dawson City, Yukon – 2017**



Prepared For: Yukon Government

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1.0 INTRODUCTION

Chilkoot Geological Engineers Ltd. was retained by *Yukon Government (YG)* to conduct a geotechnical feasibility assessment for a Land Disposition (#2005-0015) located just east of the Callison Industrial Subdivision in Dawson City, Yukon. The objective of the assessment was to determine the development potential of the study area from a geotechnical perspective.

The study area, which measures ~51 ha in size, is located ~ 6 km east of Dawson City, Yukon, as noted in Figure 1.

Authorization to proceed with the assessment was granted by YG - Program Manager, Rural Land Development, Mr.K.Fisher on September 5th, 2017. The field work was subsequently conducted on September 27th and 28th, 2017 in accordance with our August 27th, 2017 proposal.

As noted in our proposal, our assessment was preliminary in nature and so further geotechnical evaluation will be required through drilling/test pit methodologies to verify site specific geotechnical parameters if development is to proceed.

The findings of our assessment have been presented herein along with a description of our methodology which was utilized to conduct the work.

2.0 SCOPE-OF-WORK

As per YG's request, the land disposition was to be assessed from a geotechnical perspective in order to determine its development feasibility relative to industrial subdivision purposes. Specifically, our intent was to delineate regions within the disposition which may be suitable for development and provide general geotechnical recommendations regarding infrastructure development as may be deemed feasibility.



3.0 METHODOLOGY

Our methodology was comprised of a literature review and site reconnaissance.

3.1 Literature Review

A literature review was conducted to evaluate technical reports, surficial geology maps, topographical data, satellite imagery, a selection of aerial photos and other similar types of resources regarding the study area. This information was utilized to evaluate the regional conditions and detail the field work program.

The following sources of information were reviewed;

Technical Reports

- Geotechnical Investigation – Proposed Callison Subdivision Expansion – Dawson City, Yukon Territory (Report # 8002-132) prepared by *Hoggan Engineering & Testing (1980) Ltd.* in July of 1995.

The objective of the investigation was to retain subsurface geotechnical information through drilling methodologies to assess the feasibility of expanding the Callison Industrial Subdivision and provide recommendations regarding roadways, subsurface utilities and (commercial/light industrial) building foundation design and construction.

During their investigation, a total of thirteen (13) boreholes were advanced utilizing 150 mm Ø solid-stem augers to depths up to 6 meters. The *Hoggan* site plan which illustrates the locations of the boreholes relative to the land disposition (yellow outline) has been provided below;



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In brief, the *Hoggan* report indicated that the majority of their study area (black outline) was not suitable for industrial subdivision development due to the presence of low-lying areas, standing water, thickness of the organic mat and ice-rich permafrost. Their study however identified a small region of the study area which may be suitable for development, as noted in our interpretation of their findings (green outline).

A copy of the *Hoggan* report has been attached in Appendix A.

- Dawson Natural Landscape Hazards – Geoscience Mapping for Climate Change Adaptation Planning Report prepared by the *Northern Climate ExChange – Yukon Research Center – Yukon College* - B.Benkert, K.Kennedy, D.Fortier, A.Lewkowicz, L.Roy, K.Grandmont, I.de Grandpre, S.Laxton, L.McKenna and K.Moote, 2015.

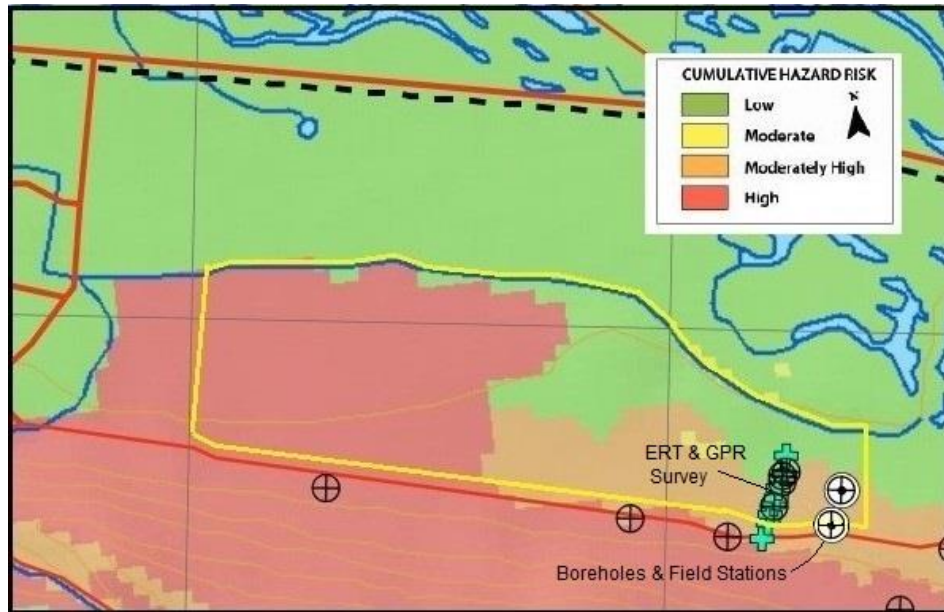
This report was compiled to serve as a baseline to allow for climate change adaptation planning as adverse effects of a warming environment have become a reality in northern Yukon. The intent was to generate a hazards map to help identify the potential for permafrost thaw, landslides and flooding. Their study area paralleled the limits of a 1:25,000 surficial geology map (Open File 2014-12) which has been described below (in Section 4.5).

The hazards report indicated that an approach was generated to consider local community concerns and infrastructure, disturbance history, permafrost distribution and characteristics, surficial geology conditions, hydrology and projections of future climate. Following the retention of scientific information and case studies, data related to slope angle, slope aspect, surficial materials and permafrost probability were input into a raster comprised of pixels which each represented 30 m². The hazard potential relative to each of these criteria was assigned and a map based upon a cumulative weighted risk was generated.

The report was clear to indicate that while the hazard map can serve as an initial guide to local conditions, there are limitations due to site specific conditions and so detailed site studies (e.g., geotechnical or engineering studies) would still be required.



The approximate limits of the land disposition have been superimposed on (a portion of) the hazards map and has been attached below.



In brief, the report indicated that the western half of the study area lies in a region which was identified as having a high potential relative to natural hazards. This was likely due to the ice-rich nature of the permafrost in the low-lying regions and poor stability of the north facing slopes. A moderately high hazard potential was identified in the south-eastern quadrant (likely for similar reasons). The north-east quadrant of the study area was identified as having a low natural hazard potential.

In addition to the hazard assessment, a series of electrical resistivity tomography (ERT) and ground penetrating radar (GPR) surveys were conducted on the land disposition as noted in the figure above. The results of the survey generally suggested that permafrost is located at relatively shallow depths of 0.5 meters. However, the ERT survey suggested the sub-surface soils located in the region of a forested area (located along the side of the transect) may be thawed. A drill-hole advanced along the transect noted ice-rich silty-sands to depths of 0.8 meters and frozen organic silts which overlay frozen silty sands (which contained varying amounts of gravel) to the depth of drill-hole termination (3.1 meters).



Figure 55 from the report illustrated and partially discussed the ERT results as follows;

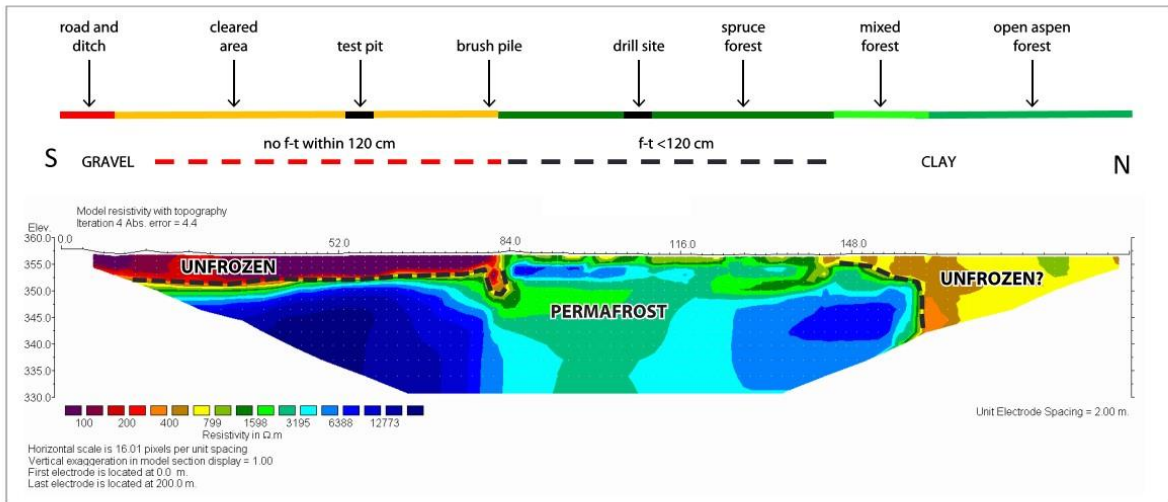


Figure 55. ERT profile DC_ERT02, which is 200 m long and runs south to north across a cleared area and into forest at the C-3B case study site (see Figure 54 for location). The profile has a maximum penetration depth of ~25 m. Likely areas of permafrost are outlined by black dashed lines; f-t = frost table.

Surficial Geology Map

A 1:25,000 surficial geology map (Open File 2014-12) entitled Surficial Geology, Dawson Region, Yukon – Parts of NTS 115O/14 & 15 and 116B/1, 2, 3 & 4 compiled by K.McKenna and P.Lipovsky - *Yukon Geological Survey* was reviewed to provide insight into the regional geomorphology.

A portion of this map and the corresponding limits of the study area has been provided in Section 4.5, below.

Bedrock Geology Map

A bedrock geology map, available through the *Yukon Geological Survey*, identified the regional bedrock types and characteristics within the study area. The map was entitled Yukon Bedrock Geology Map – Yukon Geological Survey – Open File 2016-1 - 1:1,000,000 scale compiled by M.Colpron, S.Israel, D.Murphy, L.Pigage, and D.Moynihan.

A more detailed delineation of these contacts was found on the *Yukon Geological Survey* website.



Topographical Information

The regional topography was assessed by viewing a 1:50,000 scale topographical map (116 B03 Dawson) and the *YG- Water Placer Atlas* website.

These maps showed the study area is predominately located in a low-lying area in the Klondike River Valley.

Aerial Photographs

A selection of aerial photographs were obtained from *YG – Energy, Mines and Resources* to allow for a more detailed assessment through airphoto terrain analysis.

The following airphotos were reviewed;

Flight Line	Photo No.	Date	Comments
G03070868	21-23	July 2003	1:40,000 scale
A28237	214-216	August 1995	1:20,000 scale
A27669	76-79	August 1990	1:10,000 scale
A27483	102-104	July 1989	24,500' altitude
WP8712	21-23	August 1987	1:8,000 scale
NW9584	82-84	May 1984	1:6,000 scale
A24704	48-51	1977	7,500' altitude
A23472	88-90	July 1973	6,000' altitude
A17155	96-98	August 1960	15,000' altitude

A selection of these aerial photographs has been attached as Appendix B.

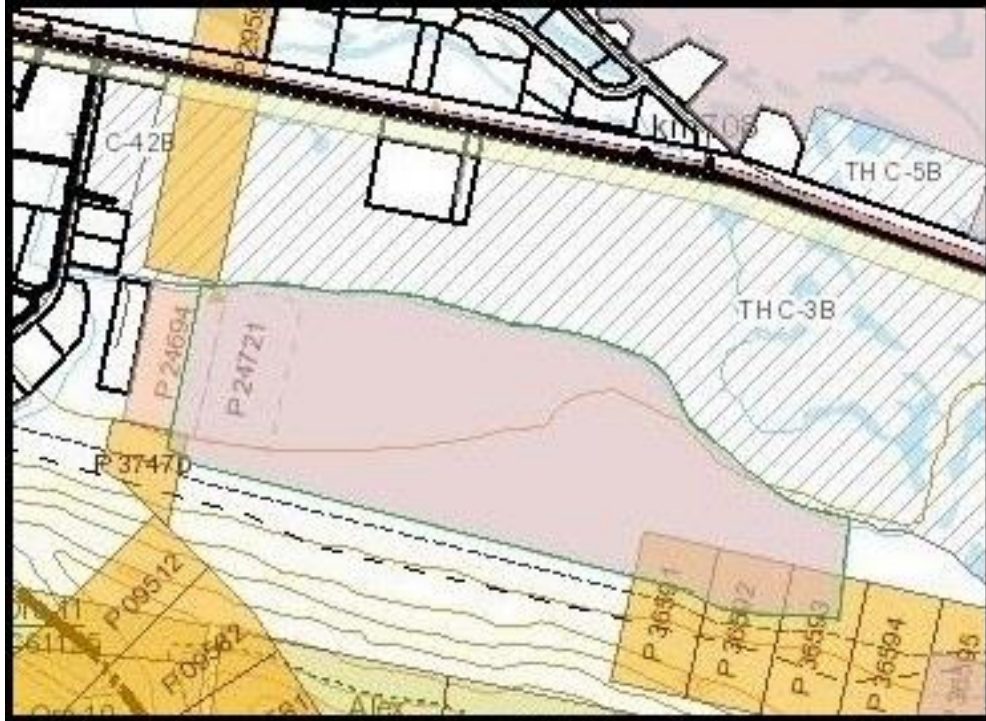
Satellite Imagery

A review of satellite imagery available from *Google Earth* allowed for an assessment of the site conditions relative to the more recent imagery. The imagery which was viewed was dated between September 2006 and September 2012.

Other Resources

The *Yukon Government – Water Placer Atlas* website was reviewed as it provided the boundaries of various land dispositions, mining claims, drainage regimes and other similar types of information. The corresponding boundaries of the land disposition have been illustrated on the *Water Placer Atlas* map as noted below;

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In brief, the map noted the presence of a number of active placer mining claims (P37470 & P36591-P36593) which are partially located within the land disposition. Two expired placer claims (P24694 & P24721) are located on the west side of the land disposition.

While none of these claims were being actively worked at the time of our site reconnaissance, the surficial organics covering portions of claims P36591-P36593 had been stripped and grubbed. The organic waste piles were pushed to the north on these claims. A 0.5 ha region located immediately west of P36591 has been cleared, possibly in error. The purpose of stripping the organic cover in these regions would be to promote thawed of the underlying frozen soils.

In addition to these mining claims, a leased land disposition (#2010-0506) is located immediately adjacent to the western side of the study area. This land disposition has been utilized as a 'topsoil' quarry (since 2011) and is shown below.



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3.2 Site Reconnaissance

A site reconnaissance was conducted by the undersigned on September 27th and 28th, 2017 to note geological features and other points of interest.

During this time, the region was traversed on foot such that the local field conditions and geological features could be observed.

Our observations were documented through a combination of field notes, GPS waypoints and photographs. These observations have been summarized in Section 4.0 – Site Conditions, below.



4.0 SITE CONDITIONS

4.1 Study Area

The study area, comprised of land disposition # 2005-0015, is located within the municipal limits of Dawson City, Yukon approximately 6 km east of the downtown core as noted in Figure 1.

4.2 Physiographic Region

The study area is part of the Boreal Cordillera Ecozone and lies within the Klondike Plateau immediately south-west of the Tintina Trench. The mountains in the region are of the Dawson Range, a sub-range of the Yukon (Mountain) Range which dominate much of central Yukon and eastern Alaska. These mountains rise to elevations in the order of 1500 meters. The terrain can be described as smooth, rolling, unglaciated terrain, which is incised by narrow, deep, V-shaped valleys.

Permafrost is extensive, discontinuous and overlain with turbid cryosols.

4.3 Site Description

The land disposition measures approximately 51 ha in size.

The general topography of the north half of the land disposition is best described as being flat, with only minor changes in elevation (< 1 meter). The southern portions of the study area are sloped (up to 15°) and ascend ~ 15 meters as one traverse to the south.

Located in the Klondike Valley, the prevailing elevation in the region of the study area is in the order of 340 meters. Higher mountainous terrain, with elevations up to 1000 meters, are located both north and south of the land selections on the ridges which define the valley.

While the majority of the land disposition is undeveloped, portions of the south-eastern quadrant have been partially cleared as part of mining activities (described in Section 3.1 – Other Resources, above).

Vegetation is comprised of a mixture of deciduous and boreal forests and transitional fen/bog areas. The understory consists of a variety of mosses, willow, shrubs and sedges.



While a vehicle trail parallels the southern periphery of the study area (between Callison and the Quigley Landfill) other than a trail which provides access to the topsoil quarry located on the western side, there's no direct vehicular access to the site. A series of overgrown exploration trails and pits crisscrossed the study area. At some locations, these disturbances resulted in the formation of thermokarst ponds, which are the result of thaw-degradation of the nearby areas following the disturbances.

A series of survey pins were encountered along the northern periphery of the study area. These survey pins (numbered CLS 1999 – L5 1098, etc.) were encountered at intervals which varied between ~ 30 and ~ 60 meters.

4.4 Geomorphology

The soils located within the study area are predominately comprised of glaciofluvial deposits which are thought to age to the late Wisconsin/Pleistocene. Glaciofluvial deposits in the Klondike Valley are derived from glacial meltwaters and generally consist of moderately to well sorted sands and gravels which are overlain with a veneer of organic deposits. These materials are generally found as peripheral terraces which lie adjacent to more recent Holocene fluvial deposits.

In addition to the glaciofluvial deposits, lobes of colluvial slope deposits extend into the southern realms of the study area (described as Soil Unit # 5 in Section 4.5, below).

Soil Stratigraphy

In general, the subsurface soil units which are typically encountered in the Klondike Valley can be classified as;

Peat/Organic Stratum;

which are wet and rich in organics and organic silts, which overlie;

Channel Deposits;

which are predominately silty in nature, but may contain finer clay sized materials and/or coarser interbedded granular materials, which overlie;

Valley Deposits;

which are predominately clean, coarse grained and contain cobble and possibly boulder sized materials.



Glaciation

Evidence shows that the Dawson area and Klondike Plateau have probably not been glaciated since Pre-Reid advances (2.65 Ma to > 200 Ka).

Permafrost

Dawson (and the study area) lies within the zone of extensive discontinuous permafrost (50-90%). The permafrost in this zone can vary from poorly bonded soils with non-visible ice to massive ice lenses ranging in size to tens of meters. Regionally the permafrost is probably more than 100 m thick with taliks (thawed subsurface) present beneath large rivers and lakes and beneath south-facing slopes.

Permanently frozen soils were encountered in each of the *Hoggan* boreholes which were advanced within the study area.

Watercourses

While several (potentially thermokarst) ponds are located within the limits of the study area, there were no signs of flowing watercourses. The exception to this were a series of small rivulets which flow across the trail which parallels the southern limits of the study area. These flows cross into the southern realms of the study area and dissipate into the organic soil cover.

The northern limit of the land disposition is bound by what may be a seasonal tributary of Jackson Gulch. There was no sign of water within this tributary at the time of our reconnaissance. However, regions of standing water were encountered throughout the study area.

The Klondike River flows to the west approximately 1000 meters north of the study area.

Groundwater

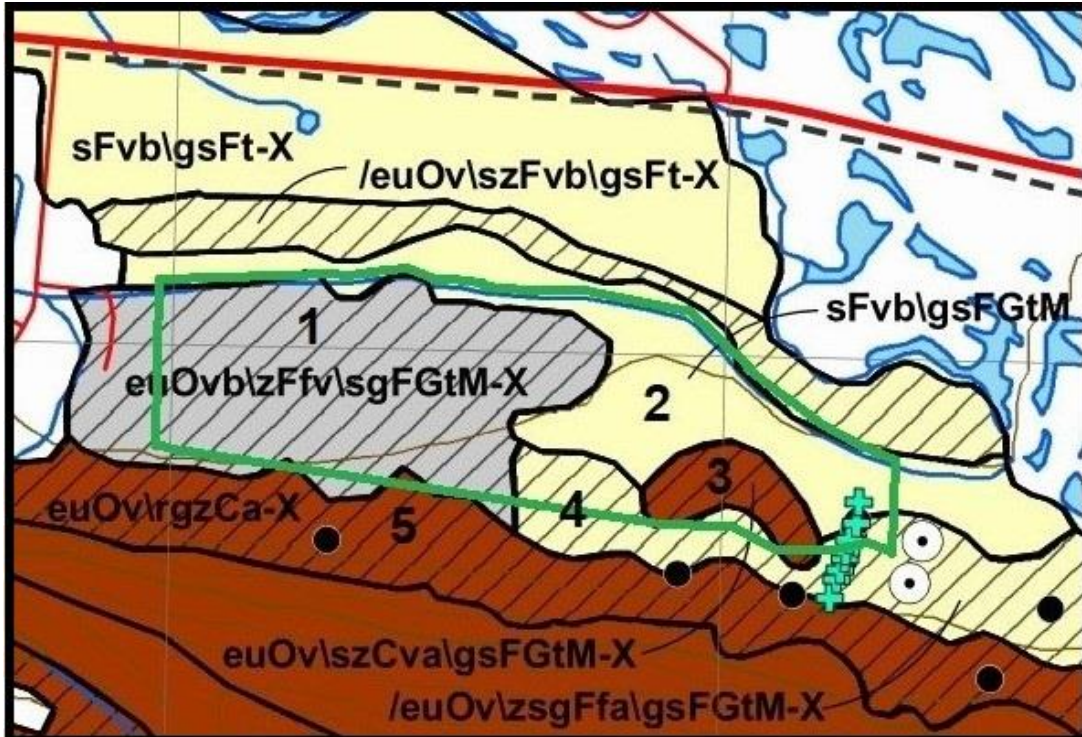
Shallow groundwater would be expected in the form of seepage zones and sheet-wash flows given the nature of the terrain and anticipated soil types. The groundwater elevation would closely parallel the local pond elevations but may be encountered at shallower elevations where perched conditions (and permafrost) may exist.

The direction of groundwater flow would likely be to the north-west, towards the Klondike River.



4.5 Surficial Geology

The distribution of the surficial deposits within the study area has been illustrated in the surficial geology map of Dawson (Open File 2014-12). The study area and the approximate distribution of the soil units (# 1 through # 5) have been illustrated on a selection of this map as noted below;



In brief, these soils can be described as;

Glacio-Fluvial Deposits

Soil Unit # 1 (euOvb\zFfv\sgFGtM-X -X)

The deposits in this soil unit were classified in BH 4-95, 5-95 & 8-95 of the *Hoggan* report as moss and grass cover which overlay up to 1.7 meters of peat. The peat deposits were underlain by frozen ice-rich glaciofluvial clayey silt, silt and sandy silts which extended to an average depth of 3.8 meters. These soils were underlain with frozen glacio-fluvial sands and gravels which contained cobble sized materials.

Soil Unit # 2 (sFvb\gsFGtM)

The deposits in this soil unit were encountered in boreholes BH 6-95, 7-95, 12-95 and 13-95 of the *Hoggan* investigation. These deposits were similar to those



encountered in Soil Unit # 1 with the exception that the peat deposits were notably absent. The frozen ice-rich glaciofluvial clayey silt, silt and sandy silts extended to an average depth of 1.1 meters (but ranged between 0.25 and 1.7 meters) below which frozen granular glacio-fluvial deposits were encountered. These granular deposits are thought to be thaw-stable.

Soil Unit #3 (euOv\szCva\gsFGtM-X)

The deposits in this soil unit were encountered in BH 10-95 of the *Hoggan* investigation. The soils were described as moss and grass cover which overlay up to 0.75 meters of peat. The peat deposits were underlain by frozen ice-rich glaciofluvial clayey silt, silt and sandy silts which extended to a depth of 3.95 meters. These soils were underlain with frozen glacio-fluvial sands and gravels which contained cobble sized materials.

Soil Unit #4 (euOv\zsgFfa\gsFGtM-X)

These deposits were encountered in BH 3-95 and 11-95 of the *Hoggan* investigation. These boreholes each encountered moss and grass cover which overlay up to 0.45 meters of peat. The peat deposits were underlain by frozen ice-rich glaciofluvial clayey silt, silt and sandy silts which extended to an average depth of 4.95 meters where frozen granular glacio-fluvial deposits were encountered.

Colluvial Deposits

Soil Unit #5 (euOv\rgzCa-X)

These deposits were encountered in BH 1-95, 2-95 and 9-95 of the *Hoggan* investigation. These boreholes encountered similar stratigraphy which on average could be described as 0.23 meters of moss which overlay frozen ice-rich silts (which contained varying amounts of clay, sand and gravel) to the 4.4 meter depth of borehole termination.

4.6 Bedrock Geology

In brief, the geology maps indicate that the site is underlain by predominately, green schist to lower amphibolite facis metamorphic rocks of the Yukon-Tanana Terrane. While the depth to bedrock in the low-lying valley regions will vary, it is understood that it is typically encountered at depths of 20 to 30 meters in this region of the Klondike Valley.



5.0 DISCUSSIONS

5.1 General Overview

Regionally, the existing lots within the Callison Industrial Subdivision are located in regions which coincide with the locations of pre-existing mine tailings. These mine tailings were levelled through cut/fill methodologies to create the subdivision which is present today. As such, given the absence of the mine tailings in the region of the land disposition and the presence of permafrost, the overall development potential of the land disposition for industrial purposes would be considered poor. Specifically, our observations suggest that only 13 of the 51 hectares are considered suitable for potential lot development relative to commercial and light industrial purposes. Additional assessment would be required to verify the suitability of this area for heavy industrial purposes.

The potentially developable region which we've identified would require additional geotechnical consideration (relative to standard construction methodologies) to allow for building construction and infrastructure development given the presence of permafrost. Of the permafrost deposits which are anticipated within the land disposition, it is the depth to an (anticipated thaw-stable) granular glacio-fluvial deposit which generally dictates its overall development feasibility (where present).

The presence of a thick organic mat and peat deposits will restrict development in much of the southern and western portions of the land disposition relative to the construction of surface utilities (ie roadways and industrial yard areas).

The presence of the permafrost will preclude the installation of septic fields within the land disposition.

5.2 Site Specific Considerations

For discussion purposes, we have classified the development potential of various areas within the land disposition relative to commercial and light industrial purposes as being either 'Poor, Marginal or Suitable' as noted in Figure 2.

A description of each level of classification has been provided below.

Of note, given the scale of mapping and geomorphology, 'Poor' conditions can be encountered throughout the study area and so ultimately development would need to be considered on a site-specific basis.

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In addition to the classification, some of these areas have been labeled with numbers for reference purposes in our discussions (ie Poor 1 = Poor Area 1, etc). The depths noted in our discussions have been assessed based upon information retained from the borehole logs provided in the *Hoggan* report.

Poor Regions

Development within these regions is not recommended given the presence of standing water, the thickness of organics and ice-rich soils and depth to (or absence of granular glacio-fluvial deposits).

The deposits within this region generally coincide with Soil Unit # 1 and # 3 through # 5.

Area 1

This region generally coincides with Soil Unit # 1 and will therefore not be suitable for development given the thickness of the organic peat deposits (which are known to measure up to 1.7 meters thick) and ~3.8 meter average depth to the granular glacio-fluvial deposits.



Area 2

This region generally coincides with Soil Unit # 4 and will therefore not be suitable for development given the steep slope aspects and the depth to the granular glacio-fluvial deposit of ~4.95 meters.





Area 3

This region generally coincides with Soil Unit # 3 and will therefore not be suitable for development given the thickness of the organic peat deposits (which are known to measure up to 0.75 meters thick) and ~ 3.95 meter average depth to the granular glacio-fluvial deposits.



Area 4

This region generally coincides with Soil Unit # 4 and will therefore not be suitable for development given the anticipated thickness of the organic peat deposits and depth to the granular glacio-fluvial deposit.

Marginal Regions

The deposits within these regions generally coincide with Soil Unit # 2. While this soil unit is known to harbor (what are thought to be thaw-stable frozen) granular glacio-fluvial deposits the development potential in these areas may be restricted due to the presence of steep slopes, size/configuration, presence of poor soil conditions and depth to the granular deposits.

Area 1

The marginal classification of this area would be due to the narrow ~ 30 meter width of this region and would therefore restrict development to the construction of surface works (roadways).





Area 2

The marginal classification of this area would be due to the steep slopes which are present in the higher elevations in the region and standing water at the lower elevations.



Area 3

The marginal classification of this area would be due to the increased potential of poor soil conditions (thickness of organic peat and depth to thaw-stable granular glacio-fluvial deposits).



Suitable Regions

The deposits within these regions coincide with Soil Unit # 2. These deposits should allow for commercial and light industrial lot development so long as the anticipated thaw-stable glacio-fluvial stratum is encountered at depths in the order of two (2) meters or less. In general, the region was comprised of open forest which contained the odd large tree (measuring up to 600 mm Ø).



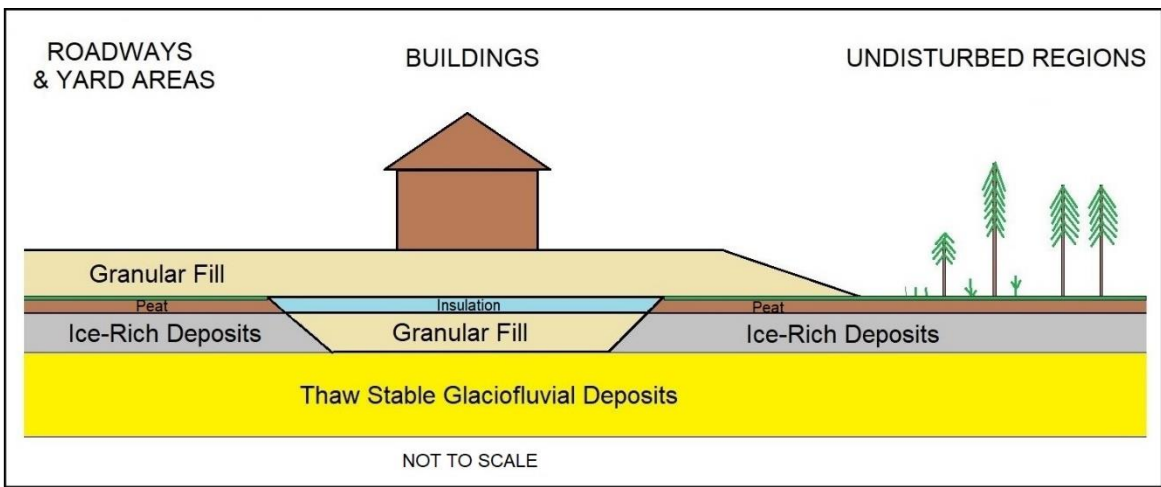


However, as regions of thick moss, standing water and forest blow-down areas where also encountered, the local soil conditions within this region are expected to vary.



Additional consideration may be required relative to potential roadway and lot design elevations in these regions. Specifically, as the roadways and yard areas would generally be constructed through importing (1.8 meters of granular) fill, additional fill would be required in the regions where buildings are to be constructed as generally cut-fill construction methodologies will be required in these areas.

A conceptual cross-section which illustrates the anticipated roadway/yard and building structure locations has been provided below;





5.3 Conceptual Development Plan

A conceptual development plan which illustrates potential roadway locations within the land disposition has been attached as Figure 3 for discussion purposes.

In brief, the primary roadway should traverse through the northern realms of the study area as the ground conditions are generally more suitable in this region. As a through road would be advantageous, the road could tie in to a number of areas as follows;

A & C

These stem roads could be tied into the existing trail which parallels the southern realms of the study area. The existing trail would need to be upgraded accordingly. Additional consideration would be required relative to the mining claims which these roads would need to traverse. Road C could access the south portions of the *YG – HPW – Dawson Yard* to allow for direct access to the Klondike Highway.

B

Alignment through this area would require joint cooperation with *Tr'ondëk Hwë'tch'in Hän Nation (TH)* to tie into the C-3B Land Selection where access to the Klondike Highway (and potentially *YG – HPW – Dawson Yard*) could be also be attained.

D

This area which lies within the *TH - C-3B Land Selection* is likely suitable for development and best accessed from the south.

In addition to the above noted considerations;

- Geotechnical development setbacks (in the order of 15 meters) should be observed from 'Poor' regions (or else steep slopes and/or regions of standing water) within the land disposition relative to building construction.
- Development should not occur in regions where steep slopes are present as potential thaw-degradation may result in destabilization of the slopes.
- The presence of the mining claims may partially restrict development of the land disposition.



6.0 RECOMMENDATIONS

The following recommendations have been provided assuming the soil deposits and site conditions are deemed favorable to allow for development following a subsurface geotechnical evaluation. Development should generally be restricted to regions where ‘Suitable’ and ‘Marginal’ development potentials have been identified as noted in Figure 2.

6.1 Surface Utilities

The soil conditions which are anticipated within these regions would be considered poor to fair relative to the installation of surface utilities (roadways and yard areas). The rating would vary depending upon the thickness of the organic deposits and ice-rich thaw susceptible soils which will be encountered at the roadway/yard locations.

Any roadways/yards or building sites will need to be constructed such that the underlying permafrost is maintained in a frozen state and the design grades are high enough to accommodate/promote surface drainage and any local water levels.

As permafrost is prevalent throughout much of the area, caution should be exercised where clearing is to be undertaken as the removal of the tree cover will result in thaw-degradation of the underlying soils. This will result in poor ground conditions if surface infrastructure is not immediately constructed, as the underlying fine-grained permafrost soils are susceptible to disturbance and thaw-degradation. The surficial organic mat should not be removed or disturbed during development.

In general, where favorable subsurface conditions are encountered, clean granular fills (which are not susceptible to frost action) should be utilized to create the roadway/yard structures. This granular material should be placed and compacted in uniform, level lifts. For preliminary design purposes, the thickness of these areas should measure no less than 1.8 meters. This thickness may need to be increased in regions where poor subsurface soil conditions are encountered or otherwise adjusted where more favorable soil conditions are encountered.

While the granular materials should be placed directly upon the surficial organics (such that the organics assist in thermal insulation of the underlying permafrost) the granular material should be separated from the surficial organics utilizing a geosynthetic filter cloth. Ideally, newly constructed roadways/yards should be left in-place for several years to allow for stabilization of the thermal regime. Additional work may be required



following/during this stabilization period (or as disturbances occur) to re-establish proposed design elevations.

6.2 Subsurface Utilities

The soil conditions which are anticipated within these regions will be unsuitable for the installation of conventional subsurface utilities. This is due to the difficulty which would be encountered during installation as the sub-surface soils are expected to be comprised of ice-rich permafrost which is not thaw stable. As such, the installation of subsurface infrastructure such as septic fields will not be possible.

If connection to municipal services is deemed feasible however, the design could incorporate a system similar to that installed in the downtown area of Dawson, which utilizes a series of super-insulated pipes to prevent heat from thawing the adjacent in-situ materials and to prevent these soils from freezing the services. These insulated services should be jacketed in corrugated steel pipes (CSP's) such that they are able to better withstand some amount of ground movement (heave/settlement) which would be anticipated.

If individual lot servicing is required, then septic holding tanks should be well insulated to prevent freezing from the adjacent soils and the weather. If required, water tanks should be fully incorporated into the heated buildings. Otherwise additional consideration would be required to assess the aquifer capacity relative to well installations and proximity to the Quigley Landfill.

6.3 Concrete Building Foundations

Any building foundations in these areas would need to extend to thaw-stable granular glacio-fluvial deposits. These deposits are thought to lie at depths < 2 meters in regions which have been classified as being 'Suitable' but will likely lie at greater depths in regions which have been classified as being 'Marginal'.

The building foundations in these areas could be comprised of either;

- monolithic footing/slab-on-grade (monolithic slab) foundation system founded upon an engineered (insulated) granular base which extends to the thaw-stable granular glacio-fluvial deposits, or



- pile foundation system which extends into the thaw-stable granular glacio-fluvial deposits and incorporates a system of grade beams and structural slabs to allow for commercial and light industrial floor loads.

In general, use of the monolithic slab foundation system would be economically viable in areas where thaw-stable granular glaciofluvial deposits are encountered at depths less than 2 meters. This would result in a granular pad thickness of approximately 4 meters in order to match adjacent yard elevations. Additional consideration would be required from a cost-benefit analysis if the depth to the thaw-stable sub-grade is greater than 2 meters.

Alternately, more technical foundations (which utilize either passive or active ground heat exchangers) could be considered, however, these types of foundation systems are typically complex and costly to install (and potentially maintain).

Building sites should incorporate minimum fifteen (15) meter setbacks from regions identified as having a 'Poor' development potential to allow for a factor of safety from potential long-term thaw degradation.

6.4 Additional Assessments

As the findings of our assessment is preliminary in nature, additional geotechnical evaluation(s) will be required to verify site specific parameters. In addition, future work should include the completion of a site survey, environmental site assessment and other technical studies/plans as described below.

Geotechnical Evaluations

A geotechnical evaluation utilizing sub-surface drilling (and potentially test pit excavation) methodologies should be conducted by qualified personnel prior to subdivision development to identify site specific geotechnical parameters related to surface and sub-surface infrastructure that may be associated with the envisioned conceptual plans. Caution will need to be exercised if test pit methodologies are utilized as the test pit locations may become geotechnical liabilities due to thaw-degradation which would likely occur following their excavation.

The evaluation should characterize the subsurface conditions and depth to the thaw stable glacio-fluvial deposits which are thought to lie at depths between 2 to 5 meters (but may lie at greater depths).



Site Survey

A detailed site survey (which extends beyond the limits of the study area) should be conducted to allow for additional evaluation from a geotechnical perspective as the scale of mapping provided in the 1:50,000 scale topographical map was too large to note site specific variations in local elevations.

The locations of the existing survey pins which were located along the northern periphery of the site (and potentially other areas) should be verified.

Environmental Site Assessment(s)

A Phase I Environmental Site Assessment (ESA) should be conducted to identify potential environmental liabilities which may be associated with the land disposition and adjacent properties.

Other Studies and Plans

A hydrogeological study should be conducted if water wells are to be installed within the study area. The intent of the study should be to assess the impacts upon the underlying aquifer and delineate any liabilities relative to the proximity to Quigley Landfill (and potentially other sources).

Conceptual land use plan should consider potential restrictions to development given the sites proximity to the Quigley Landfill, geotechnical setbacks and the presence of the various mining claims.

Other development plans should be compiled to identify site grading, surface drainage, erosion control and insect control requirements.



7.0 CONCLUSIONS

Regionally, the lots within the Callison Industrial Subdivision which have been developed are situated in areas which coincide with the locations of pre-existing mine tailings. These mine tailings were levelled through cut/fill methodologies to create the subdivision which is present today. As such, given the absence of mine tailings in the region of the land disposition and the prevalence of permafrost, the overall development potential of the land disposition for industrial purposes would be considered poor. Specifically, our observations suggest that only 13 of the ~ 51 hectares are potentially suitable for commercial and light industrial lot development as noted in Figure 2. Additional assessment would be required to verify the suitability of this area for heavy industrial purposes. Regardless, development will be challenging as permafrost is prevalent and must be maintained in a frozen state during construction and subdivision use.

The primary region where conditions may be suitable for development is where Soil Unit # 2 is encountered in the north-eastern quadrant of the study area. This region was classified as being 'Suitable' as the topography is generally level, it is locally higher than the surrounding areas and because suitable thaw-stable granular glacio-fluvial deposits are anticipated at depths < 2 meters.

Regions which have been classified as having a 'Suitable' or 'Marginal' development potential will require additional geotechnical consideration (relative to standard construction methodologies) to allow for building construction and infrastructure development given the presence of permafrost and potentially other conditions.

Development of regions which have been classified as having a 'Poor' development potential is not recommended as disturbance to these areas may result in undesirable thaw-degradation of the permafrost and/or excessive settlement in regions where thick organics are present.

Of the permafrost deposits which are anticipated within the land disposition, it is the depth to the granular glacio-fluvial deposits (in regions of Soil Unit # 2) which generally dictates the overall development feasibility. Specifically, if buildings are to be constructed on monolithic concrete slabs, the overlying peat and ice-rich fine-grained glacio-fluvial deposits would need to be removed to the depth of the underlying granular glacio-fluvial deposits. These granular deposits are thought to be thaw-stable and should allow for the construction of an engineered (and insulated) granular pad upon which a commercial or light industrial building can be constructed.



While geotechnical information retained from the 1995 *Hoggan Engineering and Testing (1980) Ltd.* geotechnical investigation indicated deleterious soils extended to an average depth of 1.1 meters in the region classified as having a ‘Suitable’ development potential, a cost-benefit analysis would be required to determine limitations relative to the depth of excavation and anticipated design elevations as these factors will vary. In general, building development may become cost prohibitive where the depth to the anticipated thaw-stable granular deposit exceeds 2 meters.

The roadways and yards would need to be established by placing ~ 1.8 meters of granular fill directly on the organic mat as the underlying soils will need to be maintained in a frozen state. The presence of a thick organic mat and peat deposits will restrict the construction of surface utilities (ie roadways/yards) as these soils are highly compressible.

The presence of the permafrost will preclude the installation of septic fields within the land disposition and so insulated septic holding tanks will be required if services are not otherwise provided.

Conceptual land use plan should consider potential restrictions to development given the sites proximity to the Quigley Landfill, geotechnical (building) setbacks from ‘Poor’ regions and the presence of the various mining claims.

A subsurface geotechnical evaluation should be conducted along with site surveys and other assessments to better identify site specific subdivision design parameters.



8.0 LIMITATIONS

This report is intended for the sole use of *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 comments contained herein reflect our best judgment in light of the information available to our firm at the time of our assessment. They are based upon our collation of available literature, observations made during our site reconnaissance, recognition of geomorphic features and generally accepted engineering practices.

Given the nature of our assessment and scale of mapping, the information contained herein will not be sufficient to assess all factors that may have an effect upon design and construction and so this should be considered from a project management perspective. As such our findings should be supplemented through subsequent geotechnical evaluations and other technical studies as may be required.

Due to the geomorphological nature of the deposits encountered, interpolations of subsurface conditions have not been made or implied other than for discussion purposes. The anticipated construction conditions have also been discussed, but only to the extent that they may influence design decisions. Suggestions of construction methods contained herein express our opinion and are not intended to direct contractors on how to carry out construction. Any reference to structures, roads or overall use of the land selections have been made for discussion purposes only. The actual use of the land disposition will need to be determined during the design process.

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



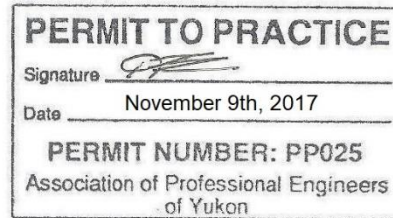
9.0 CLOSURE

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

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



Geotechnical Assessment
Land Disposition # 2005-0015 – Dawson City, Yukon – 2017
Figure 1 – Location of Study Area



Based map from Google Earth

Compiled November 1st, 2017 by T.Dhara, P.Eng.



Geotechnical Assessment
Land Disposition # 2005-0015 – Dawson City, Yukon – 2017
Figure 2 – Development Potential



Image © 2017 DigitalGlobe

Google Earth

Based map from Google Earth

Compiled November 4th, 2017 by T.Dhara, P.Eng.



Geotechnical Assessment
Land Disposition # 2005-0015 – Dawson City, Yukon – 2017
Figure 3 – Conceptual Development Plan (Potential Roadways)



Based map from Google Earth

Compiled November 7th, 2017 by T.Dhara, P.Eng.



Appendix A

Hoggan Engineering & Testing (1980) Ltd.

Geotechnical Investigation Report – July 1995

HOGGAN ENGINEERING & TESTING (1980) LTD.

**GEOTECHNICAL INVESTIGATION
PROPOSED CALLISON SUBDIVISION EXPANSION
DAWSON CITY, YUKON TERRITORY**

HOGGAN ENGINEERING & TESTING (1980) LTD.

REPORT NO: 8002-132

**GEOTECHNICAL INVESTIGATION
PROPOSED CALLISON SUBDIVISION EXPANSION
DAWSON CITY, YUKON TERRITORY**

JULY, 1995

**HOGGAN ENGINEERING & TESTING (1980) LTD.
14 BURNS ROAD
WHITEHORSE, YUKON
Y1A 4Y9**

HOGGAN ENGINEERING & TESTING (1980) LTD.

REPORT NO: 8002-132

GEOTECHNICAL INVESTIGATION
PROPOSED CALLISON SUBDIVISION EXPANSION
DAWSON CITY, YUKON TERRITORY

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GEOTECHNICAL INVESTIGATION

PROJECT: **Proposed Expansion
Callison Subdivision
Dawson City, Yukon Territory**

LOCATION:

CLIENT: **Government of Yukon
Community and Transportation Services
Engineering & Development Branch
Box 2703
Whitehorse, Yukon
Y1A 2C6**

ATTENTION: Mr. Jim Mayoh, Program Engineer

1.0 INTRODUCTION

This report presents the results of the geotechnical investigation for the Proposed Callison Industrial/Commercial Subdivision Expansion, Dawson City, Yukon Territory.

The proposed site extends 1300 metres east of the present east limit of Callison Subdivision within the Klondike River Valley. The proposed site extends between 400 metres to 1000 metres south of Klondike Highway.

The objective of the investigation was to obtain sufficient subsurface soil data to make an assessment regarding the feasibility for the construction of a proposed expansion to the Callison Subdivision. Specifically discussions and recommendations would be made for the following.

- 1) Roadway design and construction**
- 2) General comments for underground utility design and construction.
(suitability of existing soils with permafrost concerns)**
- 3) General comments for light industrial/commercial building foundation
construction.**

Authorization to proceed was received from Mr. Jim Mayoh, Program Engineer, Government of Yukon, Community and Transportation Services, Engineering and Development. Work was initiated on May 16, 1995 with field work initiated on May 19, 1995.

Field and Laboratory Testing

The field investigation consisted of drilling thirteen (13) test holes over the entire site. The locations of the test holes were chosen to identify subsurface and surficial soil units which may be encountered on the site. The locations were chosen initially from a thorough air photography review at a scale of 1:10,000. The test locations were then altered slightly, during the actual field work program, to account for accessibility of equipment.

The test holes were forwarded to maximum depths of between 4.70 metres and 5.95 metres with 9 of the 13 test holes terminated at shallower depths as a result of auger refusal. All test holes were drilled with a CME 75 drill rig (mounted on a FN60 Nodwell) using 150 millimetre solid stem augers and fish tail bits.

During the drilling, accurate bore hole logs were kept which included visual inspection and classification of all materials and the depths which they were encountered. Disturbed bad samples were obtained at various depths for the purpose of laboratory testing.

The laboratory testing program consisted of determining the moisture content of all bag samples. Also, on selected oven dried samples, further laboratory testing was undertaken to determine the grain size distribution of both fine and coarse grained soils and the Atterberg Limits of fine grained soils.

The test holes were field located using a Brunton Type hand held compass and metered hip chain. The relative locations of the test holes are shown on the attached site plan and air photograph laser copy.

3.0 SITE TOPOGRAPHY AND VEGETATION

The Proposed Callison Subdivision Expansion area encompasses an area of approximately 45 hectares. Within this area three distinct topographical and vegetation units were delineated. For discussion purposes we have labelled the **Areas, 1, 2, and 3**. The areas have been noted on the attached Site Sketch with characteristics, as follows, for the three areas.

Area 1 encompasses the base of a hill slope which occupies approximately fifty percent of the site and extends the full east-west length of the south side of site. The hill slope dips to the north at grades ranging from five percent to fifteen percent.

The vegetation cover consisted of moss and stunted black spruce which is typical of permafrost soil conditions. Further evidence of permafrost was seepage from thawing soils visible along the roadway which traverses the lower portion of the hill.

Area 2 is the low marsh area with free surface water. The marsh area is part of the Klondike River Valley bottom alluvium land formation which occupies thirty five percent of the investigated site.

The marsh area is level with local changes in grade of up to 0.5 metres. The ponding water has accumulated in local depressions which range in size to 10's of metres in diameter (nominal). No apparent drainage course(s) exist within the marsh area.

The vegetation cover is predominately moss with some grassy sections and the odd black spruce with vegetation variation to moss with low willow bushes on the perimeter of wet marsh areas.

No apparent drainage courses exist within **Area 2**.

Area 3 is located in the south-east portion of the site within the Klondike River Valley level bottom land and occupies approximately fifteen percent of the investigated area.

The area is marked by larger growths of mature willow with some mature spruce and birch and a ground cover which varies from moss to decomposing pine needles and leaves with some grass.

The ground in **Area 3** is generally level with local changes in grade of up to 0.5 metres. In general, **Area 3** is approximately 0.5 metres to 1.0 metres above the ground level of the surrounding wet marsh area.

No apparent drainage courses exist within **Area 3** and water was found to pocket in local low lying areas within the moss and in small ponds to metres in diameter (nominal).

4.0 SUBSURFACE SOIL CONDITIONS

The distinct topography and vegetation areas as noted in the previous section were found to highlight individual surficial soil units. The subsurface soil profiles encountered are given in detail on the individual test hole logs which are located in the Appendix of this report. However, for description purposes the general soil profiles are given below as they occur in **Areas 1, 2 and 3**.

Area 1 subsurface soil profiles were found at Test Hole locations 1-95, 2-95 and 9-95 located on the hill side slope. The subsurface soil profile consisted of a surface moss cover with an average thickness of 300 millimetres. Immediately underlying the moss the soils consisted of variable colluvium stratums which ranged between yellow-brown decomposing gravels to fine grained soils consisting of silts and clays, to a till like mixture of the above.

The soils were found to be frozen with visible ice throughout which varied from individual crystal to ice lenses to 15 millimetres in thickness. The soils were generally ice-rich with moisture contents ranging to 81.2 percent by weight with an average moisture content of 45 percent.

No free subsurface groundwater was encountered in **Area 1**.

Area 2 subsurface soil profiles were found at Test Hole locations 4-95, 5-95, 8-95 and 10-95 located in the wet open marsh areas with predominant moss and grass ground cover. The soil profile consisted of 150 millimetres to 450 millimetres of live moss and grass cover over a peat stratum with an average thickness of 1.10 metres and ranged in depth from 0.30 metres (TH 10-95) to 1.60 metres (TH 4-95). The surficial organic stratums were underlain by alluvial fine grained soils which varied between clayey silts, silts and sandy silts which extended to on average 3.5 metres below the ground surface and varied in depth to between 2.45 metres (TH 4-95) and 4.30 metres (TH 5-95). The fine grained soils were underlain by alluvial sands and gravels, which ranged to cobbles in size, that extended to the maximum depth of drilling at all locations. Due to the difficult drilling in the sands and gravels the average auger penetration was only 0.4 metres in this stratum.

Permanently frozen soils were found at the four test hole locations which extended from immediately below the moss and grass cover to the maximum depth of drilling. The frozen peat and fine grained soils were found to be ice-rich with moisture contents in the fine grained soils ranging to 59.1 percent by weight. Where samples of the underlying sands and gravels were obtained the material would generally be considered saturated but not ice-rich.

No free subsurface groundwater was encountered in **Area 2**.

Areas 3 subsurface soil profiles were found at Test Hole location 3-95, 6-95, 7-95, 11-95, 12-95 and 13-95 within the treed areas of the Klondike River Valley bottom. The soil profile was found to be similar to **Area 2** with the noted absence of the underlying peat stratum. The soil profile consisted of surface moss and topsoil materials with an average depth of 280 millimetres. The surface organic stratums were underlain by silts, and silty sands with possibly some clay which extended to on average 2.74 metres below the ground surface and ranged in depth between 0.25 metres (TH 7-95) and 5.20 metres (TH 11-95). The fine grained and silty sand materials were underlain by sands and gravels which extended to the maximum depth of drilling at the six test hole locations. With the exception of TH 11-95 drilling was halted due to auger refusal or very difficult drilling within the underlying granular stratum.

Permanently frozen soils were found at all test hole locations in **Area 3**, with only the top 0.3 metre to 1.0 metres of profile thawed. The fine grained and sandy soils ranged between ice-rich with moisture contents up to 67.3 percent by weight (TH 3-95) to damp and a moisture content of 8.0 percent (TH 13-95). The underlying sands and gravels, where samples were obtained, were found to be saturated but non-ice-rich.

No free subsurface ground water was encountered with **Area 3**.

5.0 DISCUSSION AND RECOMMENDATIONS

The following are general discussions regarding the suitability for development of the **Areas 1, 2, and 3**. The discussions are based on the soil conditions encountered and current standard design and construction practices.

5.1 Underground Utilities

The soils encountered in the Proposed Callison Expansion area would be considered poor to unsuitable for municipal water and sanitary sewer utility installations. The difficulty regarding design and installation would be with regards to the presence of ice-rich permanently frozen soils located in all portions of the site. For the more ice-rich soil total settlements in the magnitude of 200 millimetre per 1000 millimetre of thaw could be expected with consolidation of the peat stratum possibly up to 500 millimetres.

For preliminary purposes a design similar to that for the city of Dawson City may be considered. This design is based on maintaining the frozen soil stratum thus pipes are insulated to prevent heat from thawing the insitu materials and/or prevent the surrounding ground from freezing the service lines. Also the pipes are jacketed in corrugated steel pipe to help the line accommodate some ground movements (both heaving and subsidences).

Should the individual lot owners be required to service their own lots then water and sewage holding tanks should be insulated to prevent freezing from the permanently frozen soils. Also connecting pipes from the tanks should be designed to withstand both ground and tank heaving and subsidences.

The permanently frozen soils preclude the use of on-site sewage disposal.

5.2 Surface Utilities

The soils encountered within the development area would be considered fair to poor to unsuitable for surface utility construction. The fair rating would be for localized sections of **Area 3** (see soil profile TH 6-95, TH 7-95, TH 12-95 and TH 13-95) where there exists only a relatively shallow stratum of ice-rich soils or non-ice-rich soils overlying the underlying sand and gravel stratum.

In general, any roadway or lot construction on this site would have to be undertaken to ensure the maintenance of the frozen soil conditions and the placement of fill to raise the site above existing water levels and/or ditching to drain surface water.

A typical roadway or lot structure would be required to bridge the surface moss, peat and thawed surface soils and maintain the underlying frozen soils. For preliminary purposes the structure should consist of a 1.5 metre depth of suitable granular fill and the placement of a geosynthetic cloth.

The soils encountered during the drilling program would not be suitable as the road structure subgrade/fill material. A potential source for borrow material would be a free draining granular material which is not susceptible to detrimental frost action.

5.3 Commercial Building Foundation Construction

Area 1, 2 and Portions of 3 would generally be considered unsuitable for construction of commercial buildings.

For **Area 1**, the hill side slope, the soils may be subject to creep of the ice-rich soils. Further should thaw of the hill side slope materials occur large tracks of the slope may be destabilized.

For **Area 2 and Area 3** within the Klondike River Valley bottom land any building would have to be founded on the underlying sand and gravel stratum. This may be in the form of either i) **Monolithic Footing/Slab-On-Grade (monolithic slab) Foundation System** founded on an engineered granular base extending to the underlying granular stratum or ii) **Pile Foundation Founded Within The Underlying**

Granular Stratum with a system of grade beams and a structural floor sufficient to accommodate commercial and light industrial floor loadings.

For economic reasons, the suitability of developing in **Area 2 and Area 3** would be considered suitable where the underlying sands and gravels are found at relatively shallow depths. Relatively shallow depths to the underlying granular stratum of 1.70 metres, 0.25 metres and 1.85 metres were encountered at Test Hole locations 6-95, 7-95 and 12-95, respectively, which were situated within the north portion of designated **Area 3**. These shallow depths contrast the greater depths to the granular stratum of 4.70 metres, 4.30 metres and 5.20 metres at Test Hole locations 3-95, 5-95, and 11,95, respectively.

Alternately there are technically more advanced foundation systems that may be considered for specific ground conditions that involve mechanically cooling the ground. These systems would be economically unfeasible for standard building construction both in terms of initial cost and high on-going maintenance costs. As such they will not be discussed further in this report.

6.0 CONCLUSIONS

Overall the investigated area would be considered unsuitable regarding the development of a Light Industrial/Commercial Subdivision. This would be on the basis of infrastructure installation and construction such as roadways, underground utilities and light industrial/commercial building foundation construction.

The one area which may be potentially suitable would be a section of **Area 3** which encompasses Test Holes 6-95, 7-95, 12-95 and 13-95 located in the north-east portion of the site. This area was shown in general to have:

- i) An elevation slightly higher than the surrounding area thus has less free standing surface water.**
- ii) No substantial peat stratum underlying the surface moss, grass and top soil (relative to Area 2).**
- iii) Relatively shallow depth of underlying fine grained soils overlying the sand and gravel stratum.**
- iv) Relatively thaw stable (less ice-rich) nature of the underlying fine grained soils.**

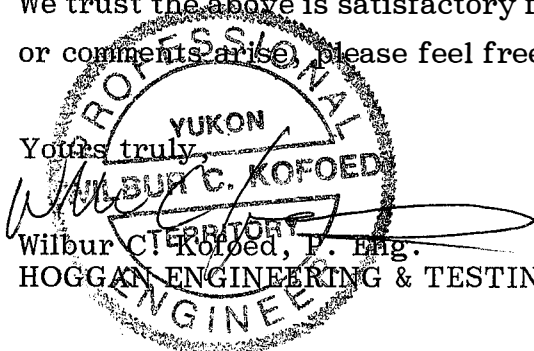
However, this area only encompasses an estimated of 4.5 hectares (10 percent of total investigated area) and is located 1200 metres east of Callison. Therefore servicing the small area through **Areas 1 and 2** may be cost prohibitive.

7.0 CLOSURE

The geotechnical investigation report has been prepared for the exclusive and confidential use of Government of Yukon, Community and Transportation Services, Engineering and Development Branch and applies only to the Proposed Callison Subdivision Expansion. The recommendations given are based on the subsurface soil conditions encountered during the field test program, current construction techniques, and generally accepted engineering practices. No other warrantee, expressed or implied, is used. Due to geological randomness of many soil formations, no interpolations of soil conditions between test holes have been made or implied. Soil conditions are known only at the test hole locations. Should other soils be encountered during construction or other information pertinent to the structure become available, the recommendations may be altered or modified in writing by Hoggan Engineering & Testing (1980) Ltd..

We trust the above is satisfactory for your purpose. However, should any questions or comments arise, please feel free to contact the undersigned.

Yours truly,



WILBUR C. KOFOED
WILBUR C. KOFOED, P. Eng.
HOGGAN ENGINEERING & TESTING (1980) LTD.

WCK/mf

APPENDICES

- **Appendix A**
- **Site Sketches**

- **Appendix B**
- **Soil Profile Logs**

- **Appendix C**
- **Laboratory Test Summary Sheets**

APPENDIX A
•Site Sketches

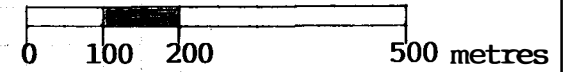
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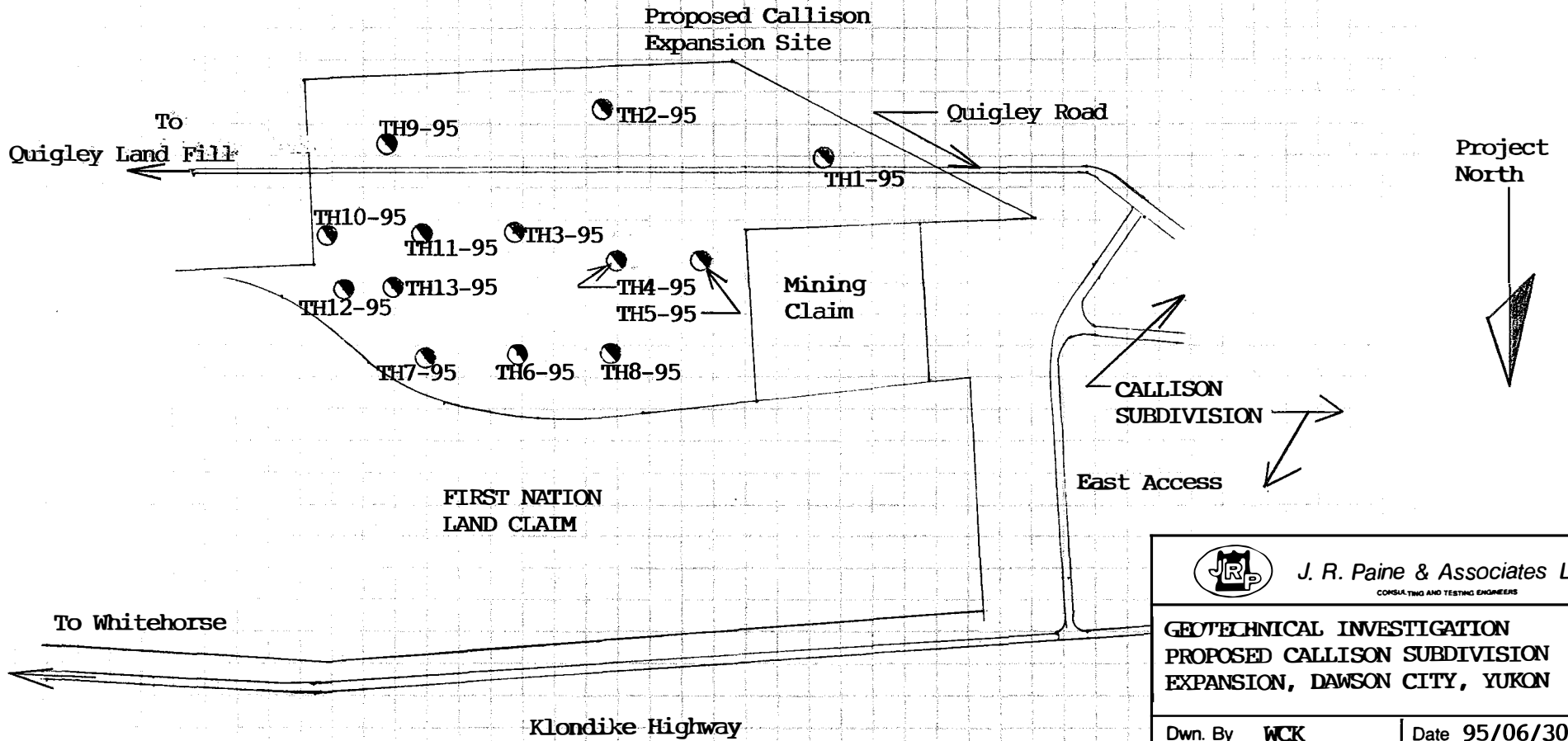
SITE SKETCH

-Test Hole Location

Scale



● Test Hole Location



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

**GEO TECHNICAL INVESTIGATION
PROPOSED CALLISON SUBDIVISION
EXPANSION, DAWSON CITY, YUKON**

Dwn. By WCK

Date 95/06/30

Scale AS SHOWN

Plate No. 1 of 2

SITE SKETCH

-Subsurface Soil Units

Scale



AREA 1 -Hill Side Slope
-Coluvium Depositions
-Moss, stunted black spruce

AREA 2 -Low Marsh Area
-Peat deposits
-Moss and grass

● Test Hole Location

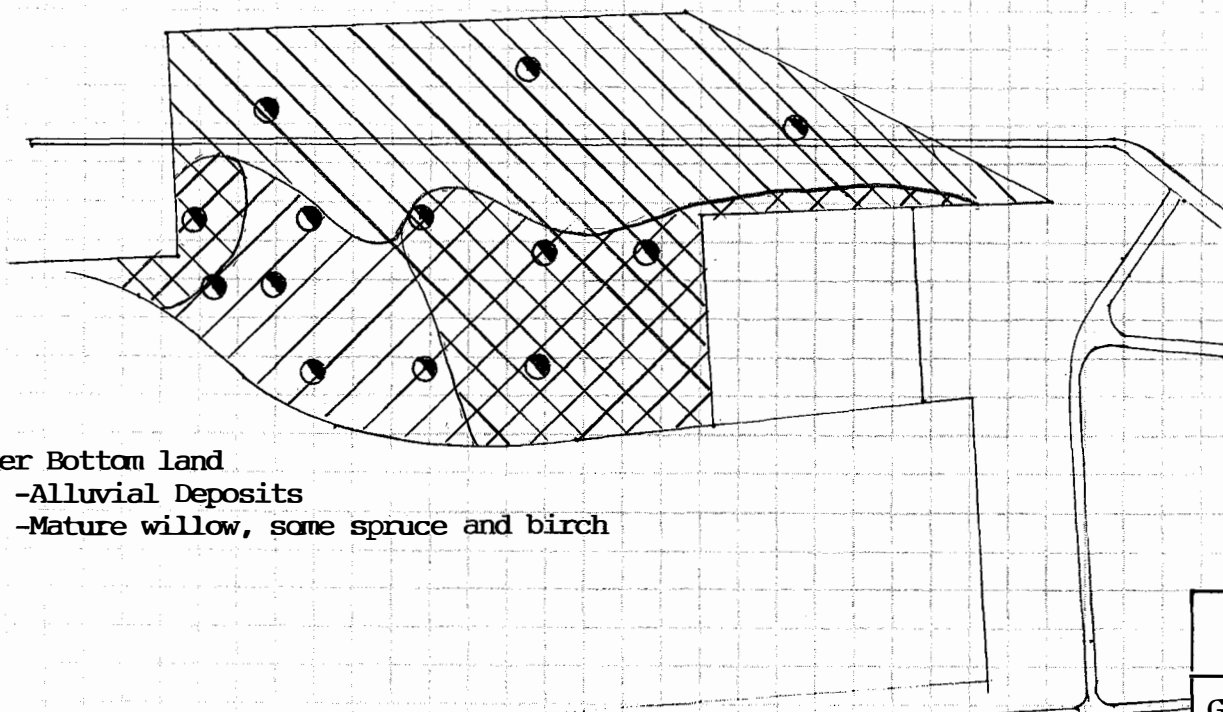
AREA 1



AREA 2



AREA 3



AREA 3 -River Bottom land
-Alluvial Deposits
-Mature willow, some spruce and birch

Project North



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

**GEOTECHNICAL INVESTIGATION
PROPOSED CALLISON SUBDIVISION
EXPANSION, DAWSON CITY, YUKON**

Dwn. By WCK

Date 95/06/30

Scale AS SHOWN

Plate No. 2 of 2

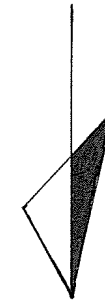


SITE SKETCH

⊙ Test Hole Location

--- Exploration Limit

Project North



CALLISON
SUBDIVISION

KLONDIKE
HIGHWAY

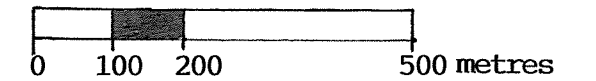
PROJECT: Geotechnical Investigation
Proposed Callison
Subdivision Expansion,
Dawson City, Yukon

CLIENT: Government of Yukon
Community & Transportation
Services
Engineering & Development
Branch

FILE #: 8002-132 (J.R.P.)

DATE: 1995/06/30

Scale



HOGGAN ENGINEERING & TESTING (1980) LTD.

APPENDIX B
•Soil Profile Logs

YTG, C&T, Eng. & Development branch

Callison Expansion

BOREHOLE NO: 1-95

CME75 Drill

5M South of Quigley Rd., 450M East

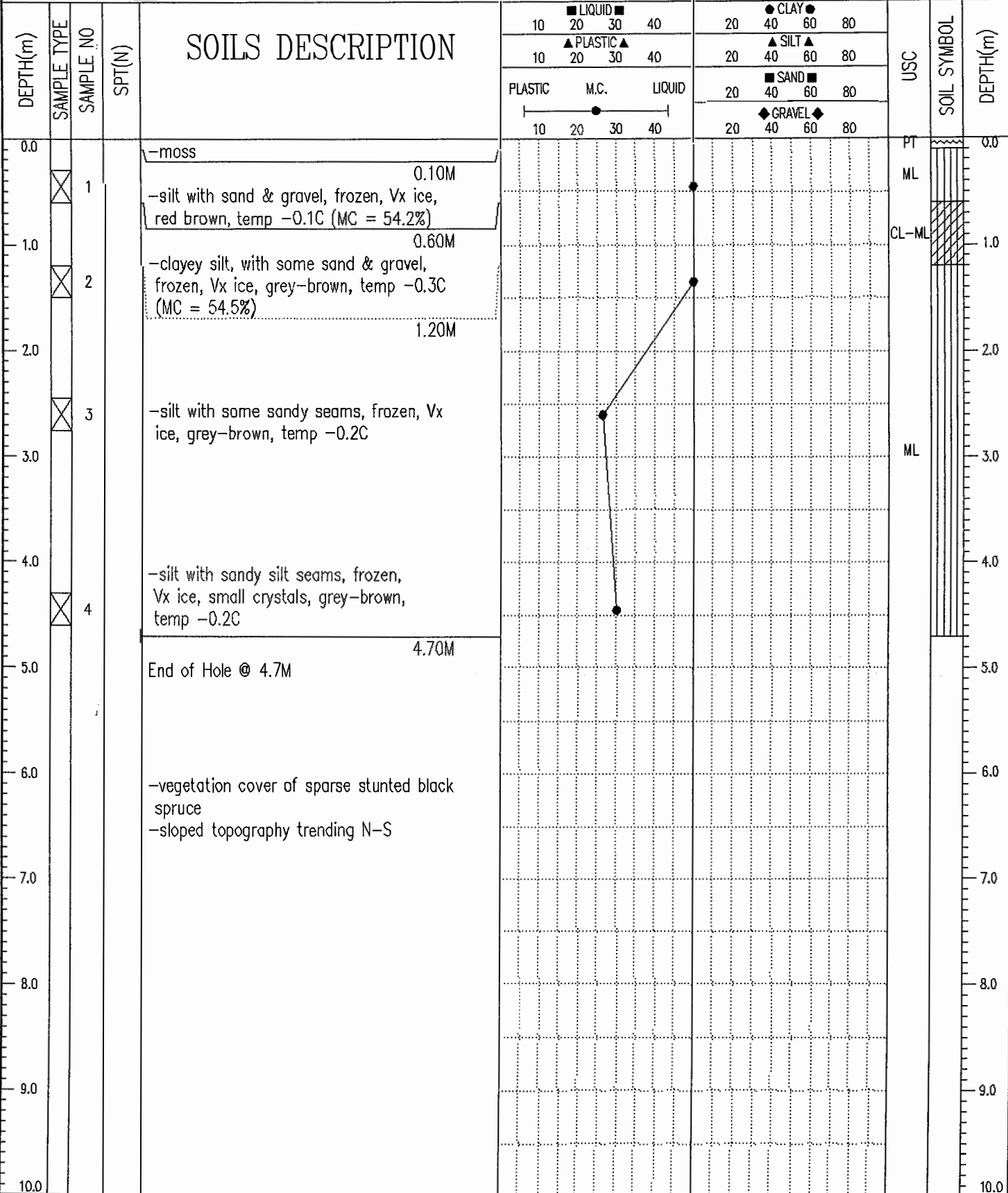
PROJECT NO: 8002-132

FN60 Nodwell mounted

of Callison

ELEVATION:

SAMPLE TYPE TUBE LOST AUGER BULK SPT CORE



J.R. Paine & Associates Ltd.
Whitehorse, Yukon

LOGGED BY: WCK

REVIEWED BY: WCK

Fig. No: 1

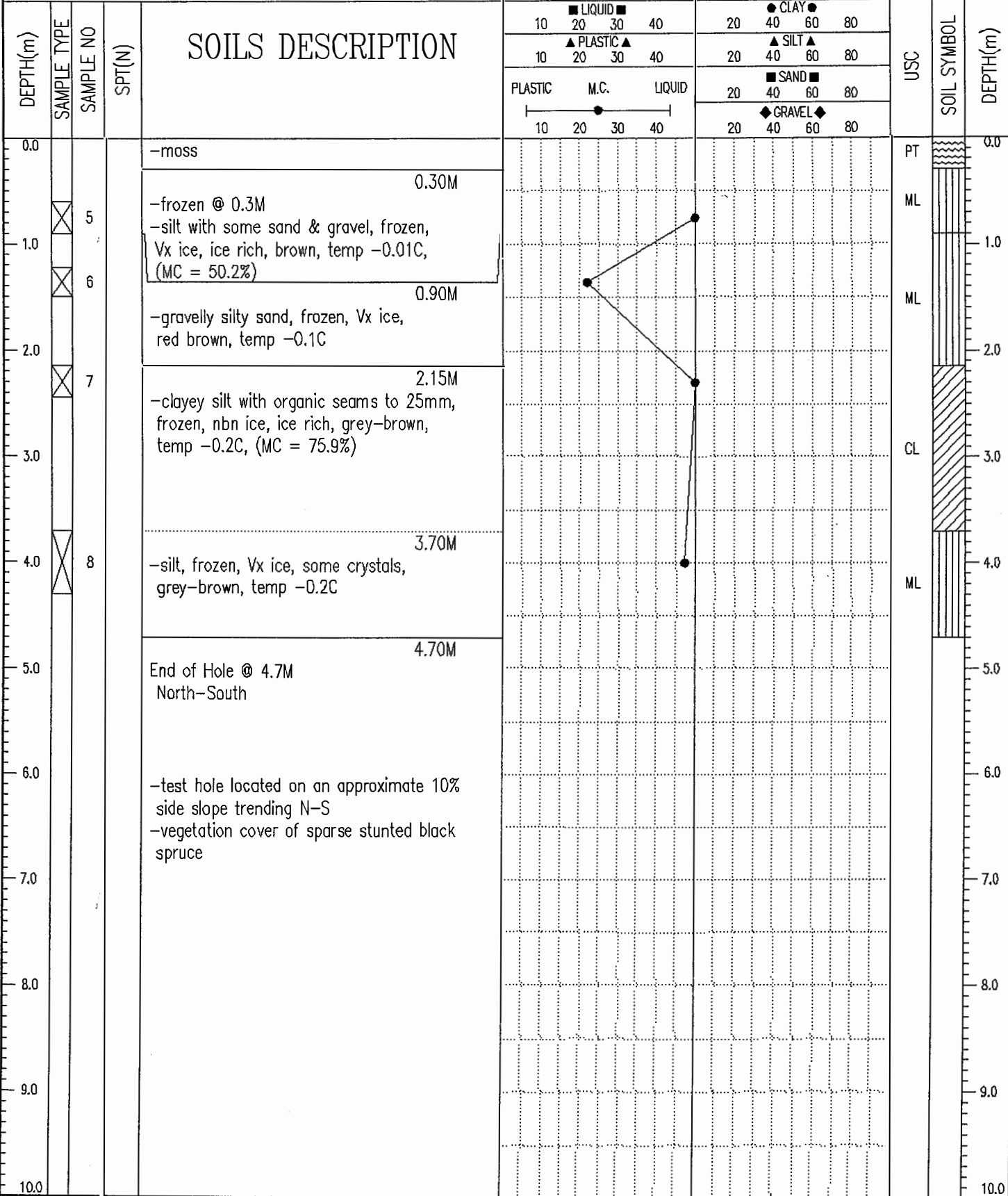
COMPLETION DEPTH: 4.7 m

COMPLETE: 95/05/20

Page 1 of 1

YTG, C&T, Eng. & Development branch	Callison Expansion	BOREHOLE NO: 2-95
CME75 Drill	950M South of Quigley rd. &	PROJECT NO: 8002-132
FN60 Nodwell mounted	800M East of Callison	ELEVATION:

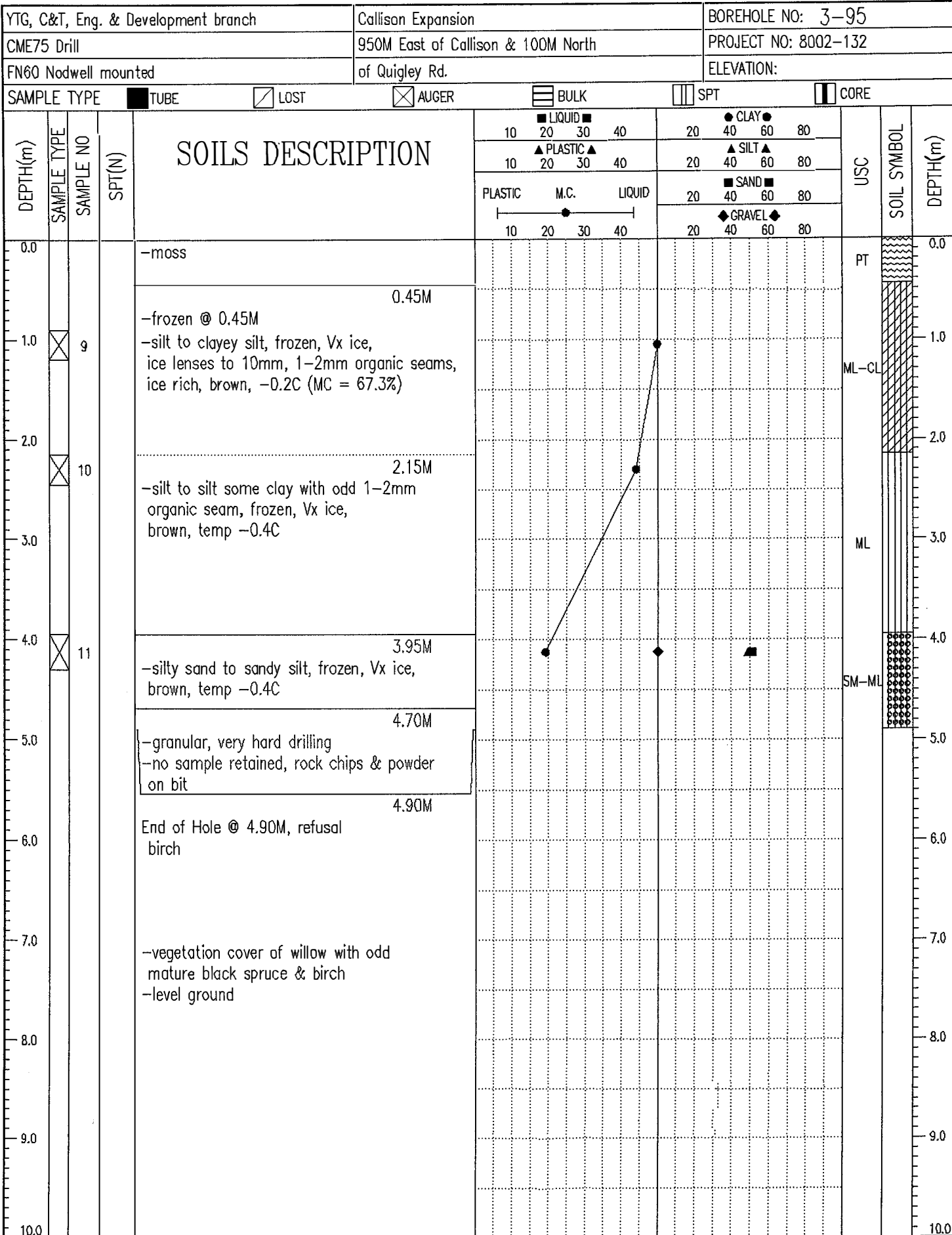
SAMPLE TYPE TUBE LOST AUGER BULK SPT CORE



J.R. Paine & Associates Ltd.
Whitehorse, Yukon

LOGGED BY: WCK
REVIEWED BY: WCK
Fig. No: 2

COMPLETION DEPTH: 4.7 m
COMPLETE: 95/05/20



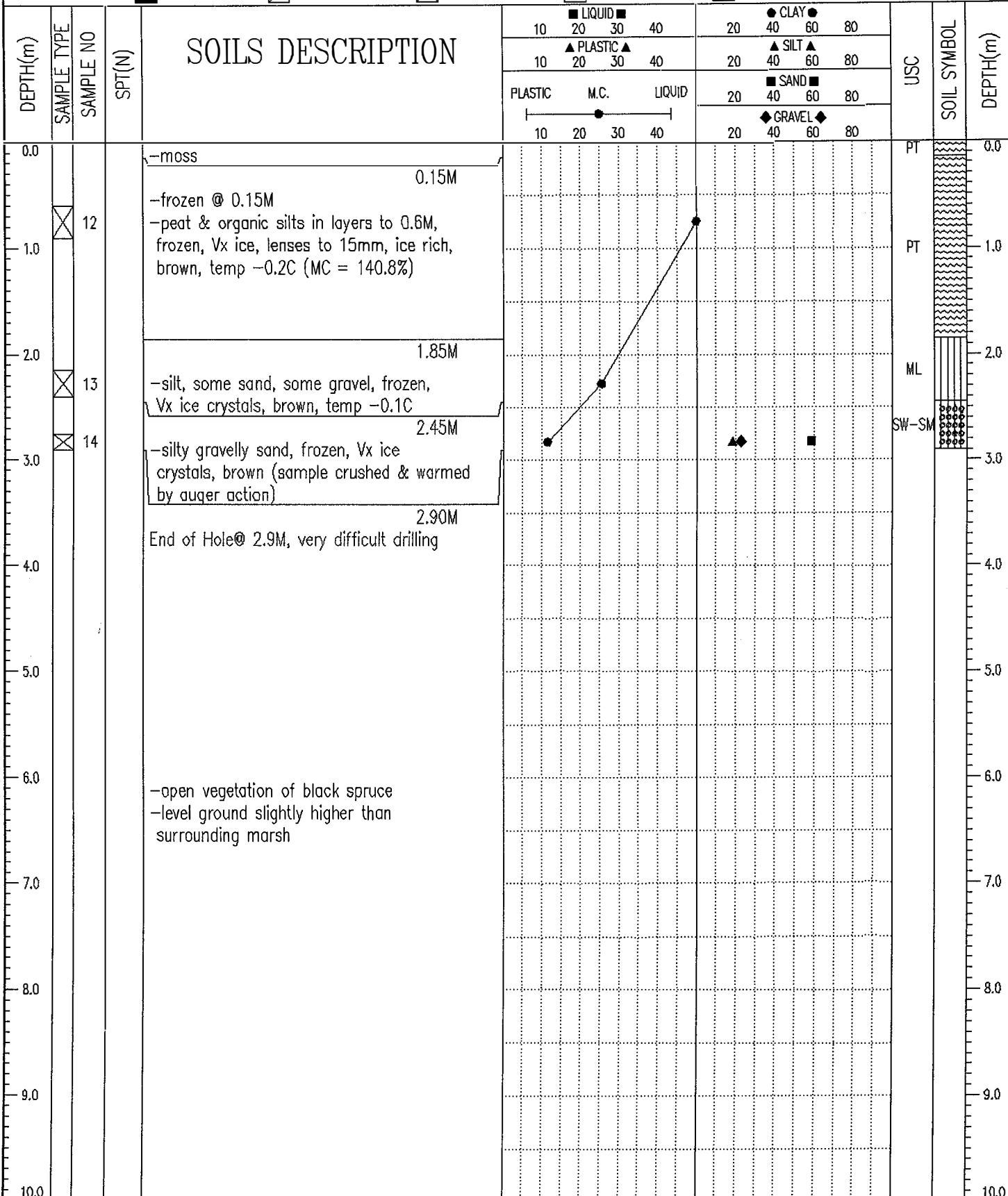
J.R. Paine & Associates Ltd.
Whitehorse, Yukon

LOGGED BY: WCK
REVIEWED BY: WCK
Fig. No: 3

COMPLETION DEPTH: 4.9 m
COMPLETE: 95/05/20

YTG, C&T, Eng. & Development branch	Callison Expansion	BOREHOLE NO: 4-95
CME75 Drill	785M East of Callison & 150M North	PROJECT NO: 8002-132
FN60 Nodwell mounted	of Quigley Rd.	ELEVATION:

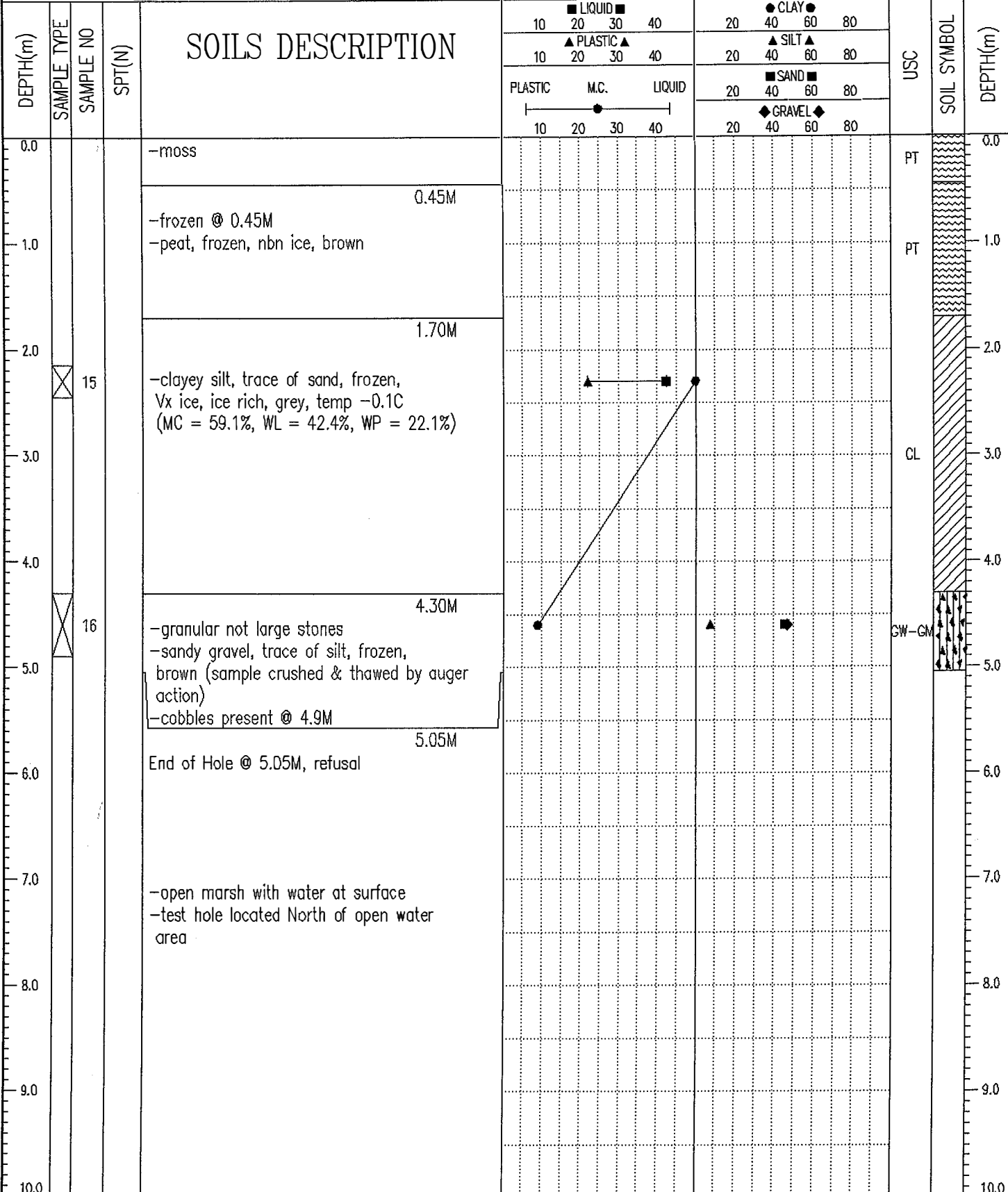
SAMPLE TYPE TUBE LOST AUGER BULK SPT CORE



J.R. Paine & Associates Ltd. Whitehorse, Yukon	LOGGED BY: WCK	COMPLETION DEPTH: 2.9 m
	REVIEWED BY: WCK	COMPLETE: 95/05/20
	Fig. No: 4	Page 1 of 1

YTG, C&T, Eng. & Development branch	Callison Expansion	BOREHOLE NO: 5-95
CME75 Drill	950M East of Callison & 150M North	PROJECT NO: 8002-132
FN60 Nodwell mounted	of Quigley Rd.	ELEVATION:

SAMPLE TYPE TUBE LOST AUGER BULK SPT CORE

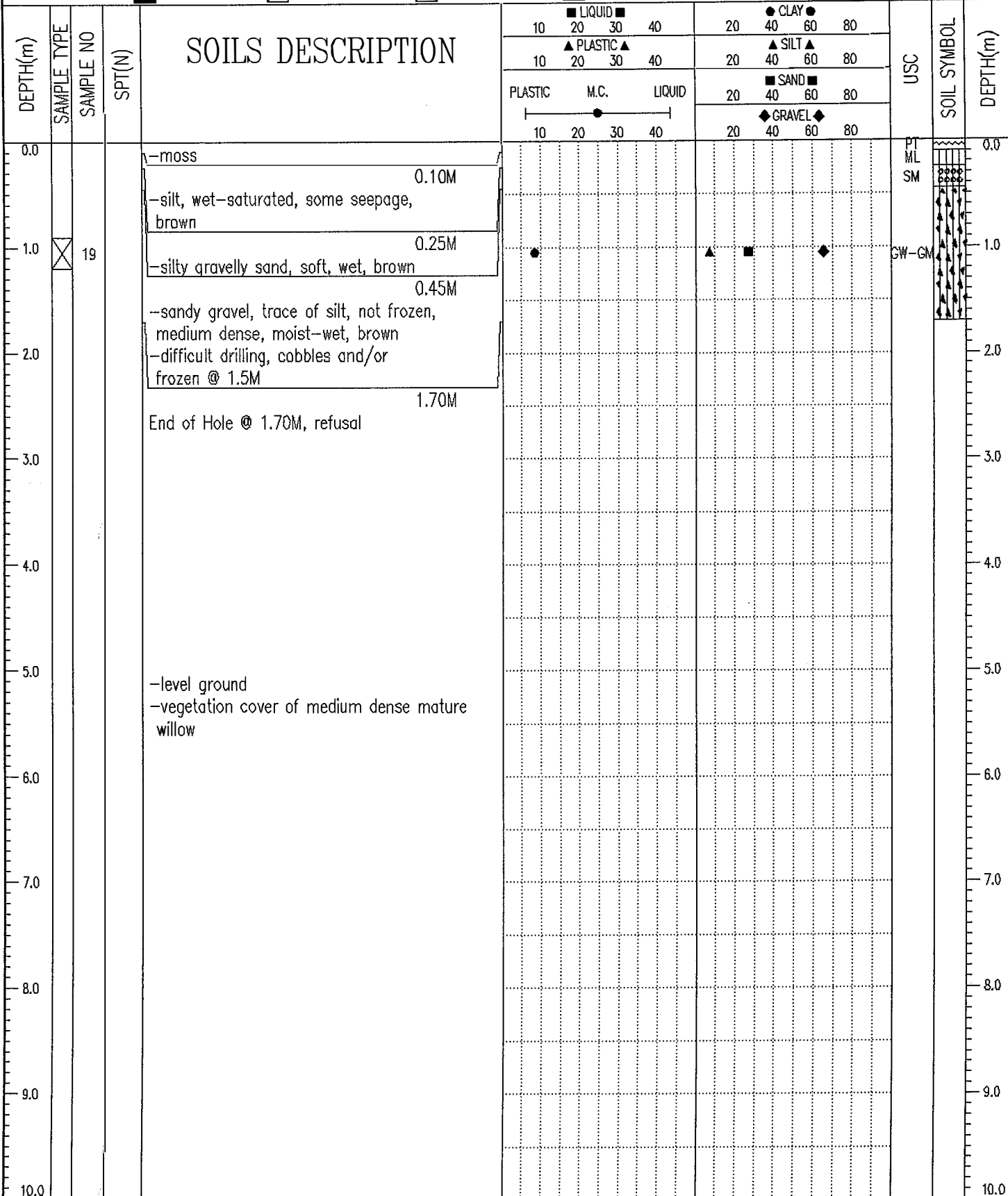


J.R. Paine & Associates Ltd. Whitehorse, Yukon	LOGGED BY: WCK	COMPLETION DEPTH: 5.1 m
	REVIEWED BY: WCK	COMPLETE: 95/05/20
	Fig. No: 5	Page 1 of 1

YTG, C&T, Eng. & Development branch		Callison Expansion		BOREHOLE NO: 6-95						
CME75 Drill		950M East of Callison & 300M North		PROJECT NO: 8002-132						
FN60 Nodwell mounted		of Quigley Rd.		ELEVATION:						
SAMPLE TYPE		<input type="checkbox"/> TUBE	<input type="checkbox"/> LOST	<input checked="" type="checkbox"/> AUGER	<input type="checkbox"/> BULK	<input type="checkbox"/> SPT	<input type="checkbox"/> CORE			
DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	SOILS DESCRIPTION				USC	SOIL SYMBOL	DEPTH(m)
				10 20 30 40 ▲ PLASTIC ▲ PLASTIC M.C. LIQUID 10 20 30 40	20 40 60 80 ● CLAY ● ▲ SILT ▲ 20 40 60 80 ■ SAND ■ ◆ GRAVEL ◆ 20 40 60 80					
0.0				-moss & peat				PT	0.0	
				0.45M						
1.0	<input checked="" type="checkbox"/>	17		-silt, trace to some sand, frozen, nbn ice trace of organics, brown, temp 0.0C				ML	1.0	
2.0	<input checked="" type="checkbox"/>	18		-sandy gravel, some silt, frozen, wet, brown (sample crushed & thawed by auger action)				GW-GM	2.0	
				-coarser more rock @ 2.45M						
3.0				2.60M					3.0	
				End of Hole @ 2.6M, very difficult drilling						
4.0									4.0	
5.0									5.0	
6.0				-level ground with free water on surface					6.0	
				-vegetation cover of willow with odd spruce, young to mature, and odd birch						
7.0									7.0	
8.0									8.0	
9.0									9.0	
10.0									10.0	
J.R. Paine & Associates Ltd.				LOGGED BY: WCK		COMPLETION DEPTH: 2.6 m				
Whitehorse, Yukon				REVIEWED BY: WCK		COMPLETE: 95/05/20				
				Fig. No: 6				Page 1 of 1		

YTG, C&T, Eng. & Development branch	Callison Expansion	BOREHOLE NO: 7-95
CME75 Drill	1100M East of Callison & 300M North	PROJECT NO: 8002-132
FN60 Nodwell mounted	of Quigley Rd.	ELEVATION:

SAMPLE TYPE TUBE LOST AUGER BULK SPT CORE



J.R. Paine & Associates Ltd. Whitehorse, Yukon	LOGGED BY: WCK	COMPLETION DEPTH: 1.7 m
	REVIEWED BY: WCK	COMPLETE: 95/05/21
	Fig. No: 7	Page 1 of 1

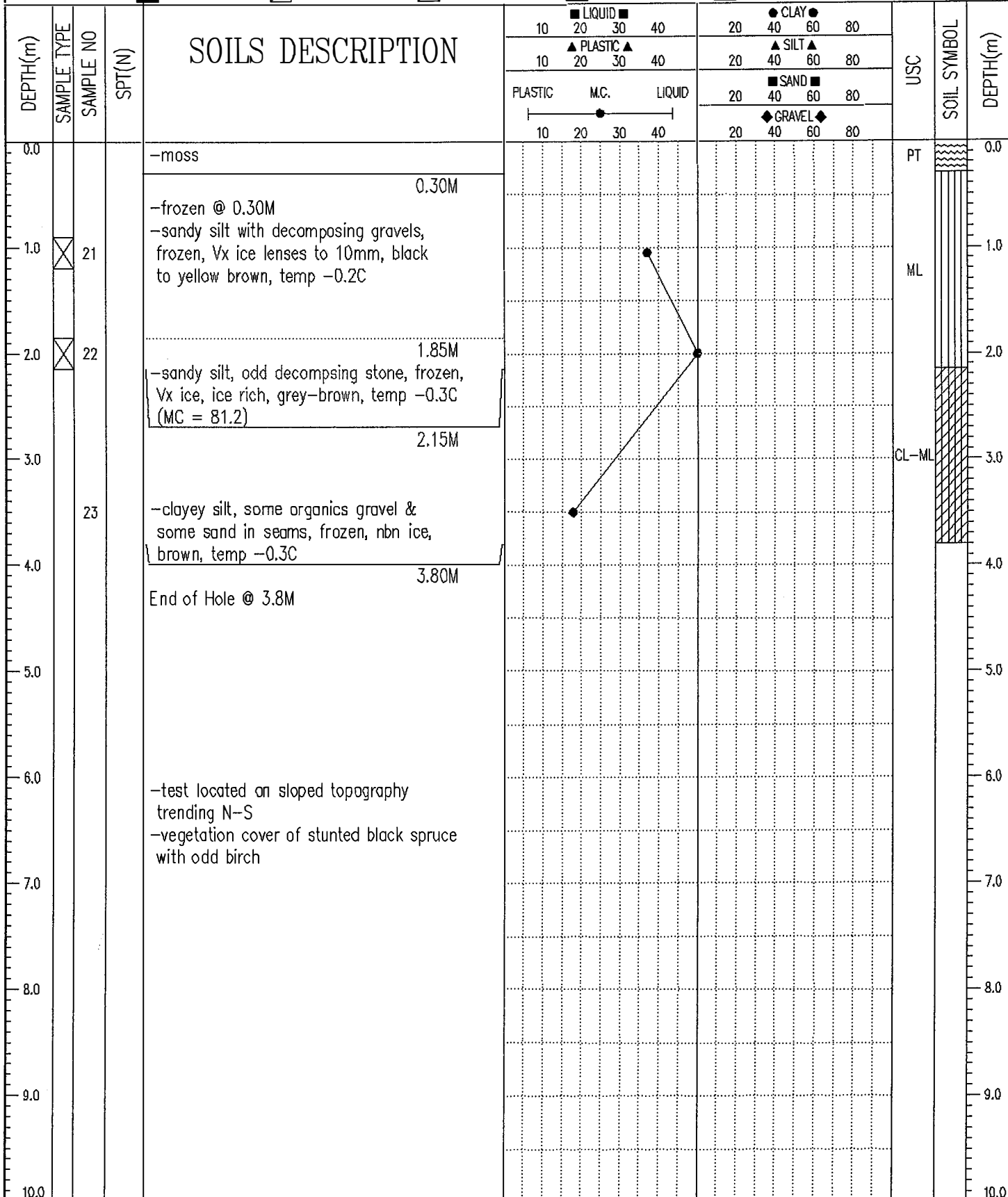
YTG, C&T, Eng. & Development branch	Callison Expansion	BOREHOLE NO: 8-95
CME75 Drill	800M East of Callison & 300M North	PROJECT NO: 8002-132
FN60 Nodwell mounted	of Quigley Rd.	ELEVATION:

SAMPLE TYPE TUBE LOST AUGER BULK SPT CORE

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	SOILS DESCRIPTION	LIQUID				CLAY				USC	SOIL SYMBOL	DEPTH(m)						
					10	20	30	40	20	40	60	80				20	40	60	80		
					PLASTIC				SILT												
					10	20	30	40	20	40	60	80									
					PLASTIC		M.C.		LIQUID		SAND										
					10	20	30	40	20	40	60	80	GRAVEL								
					10	20	30	40	20	40	60	80									
0.0				-moss												PT		0.0			
0.30M				-frozen @ 0.30M																	
1.0				-peat with silty seams, frozen, Vx ice lenses to 5mm, brown												PT		1.0			
1.50M				-silt with organic seams & inclusions, frozen, Vx ice crystals, brown, temp -0.1C																	
2.0			20													ML		2.0			
3.20M				-granular																	
3.20M				-no sample retained below 3.2M																	
3.35M				End of Hole @ 3.35M, refusal												GW		3.0			
4.0																		4.0			
5.0																		5.0			
6.0				-level ground with free water on surface														6.0			
6.0				-open vegetation with odd black spruce & birch														6.0			
7.0																		7.0			
8.0																		8.0			
9.0																		9.0			
10.0																		10.0			

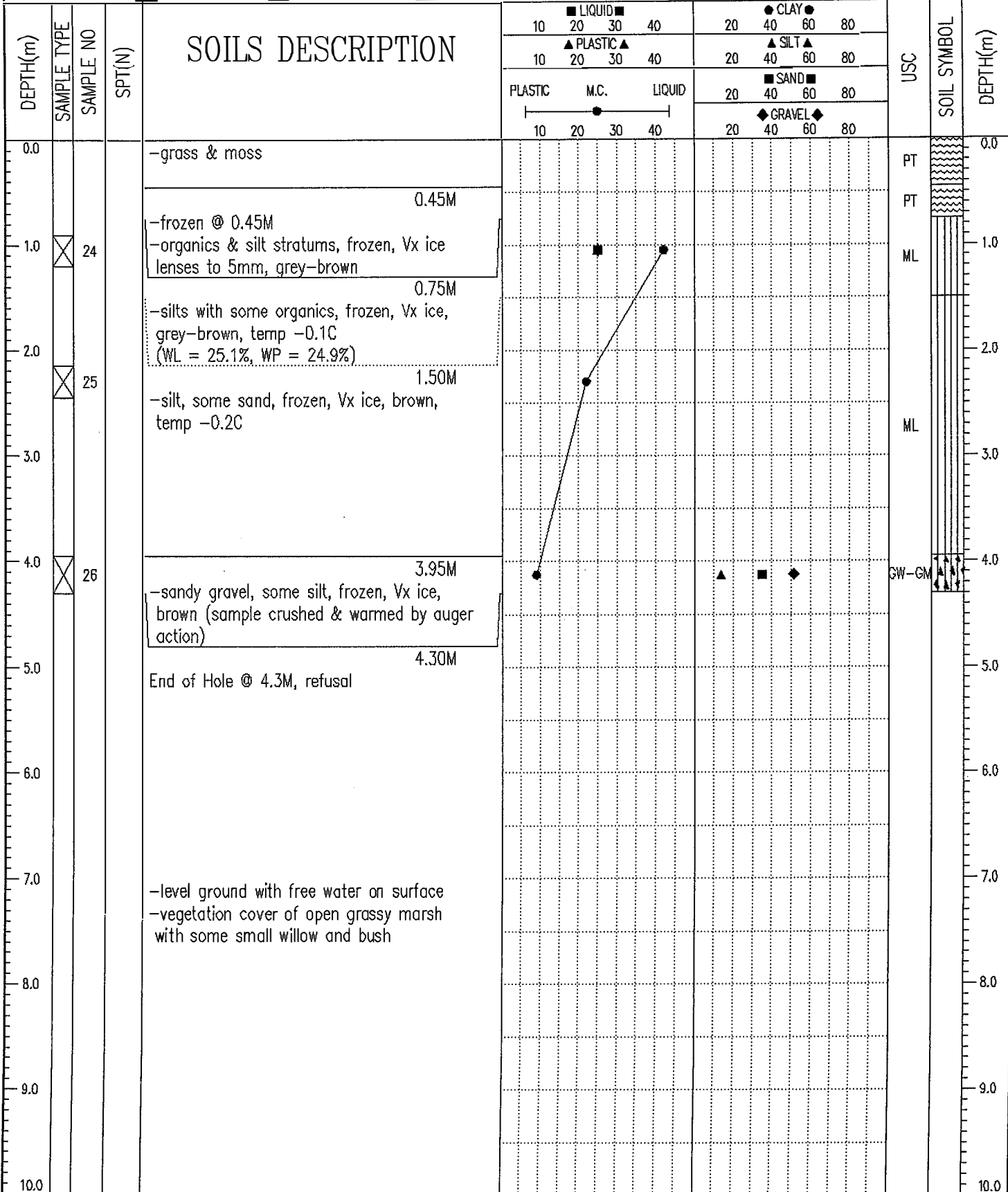
J.R. Paine & Associates Ltd. Whitehorse, Yukon	LOGGED BY: WCK	COMPLETION DEPTH: 3.4 m
	REVIEWED BY: WCK	COMPLETE: 95/05/21
	Fig. No: 8	Page 1 of 1

SAMPLE TYPE TUBE LOST AUGER BULK SPT CORE



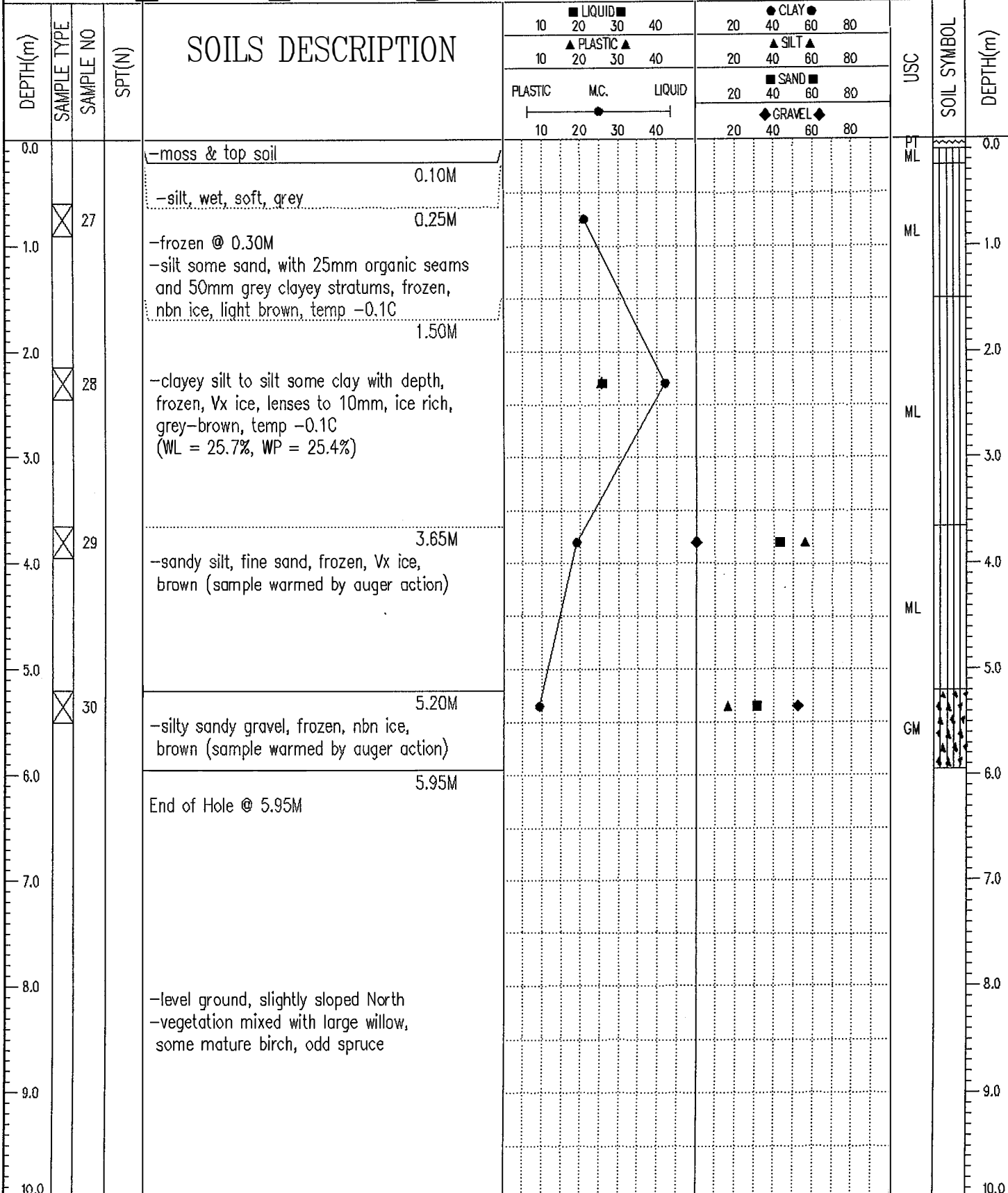
YTG, C&T, Eng. & Development branch	Callison Expansion	BOREHOLE NO: 10-95
CME75 Drill	1250M East of Callison & 100M North	PROJECT NO: 8002-132
FN60 Nodwell mounted	of Quigley Rd.	ELEVATION:

SAMPLE TYPE TUBE LOST AUGER BULK SPT CORE



J.R. Paine & Associates Ltd. Whitehorse, Yukon	LOGGED BY: WCK	COMPLETION DEPTH: 4.3 m
	REVIEWED BY: WCK	COMPLETE: 95/05/21
	Fig. No: 10	Page 1 of 1

SAMPLE TYPE TUBE LOST AUGER BULK SPT CORE



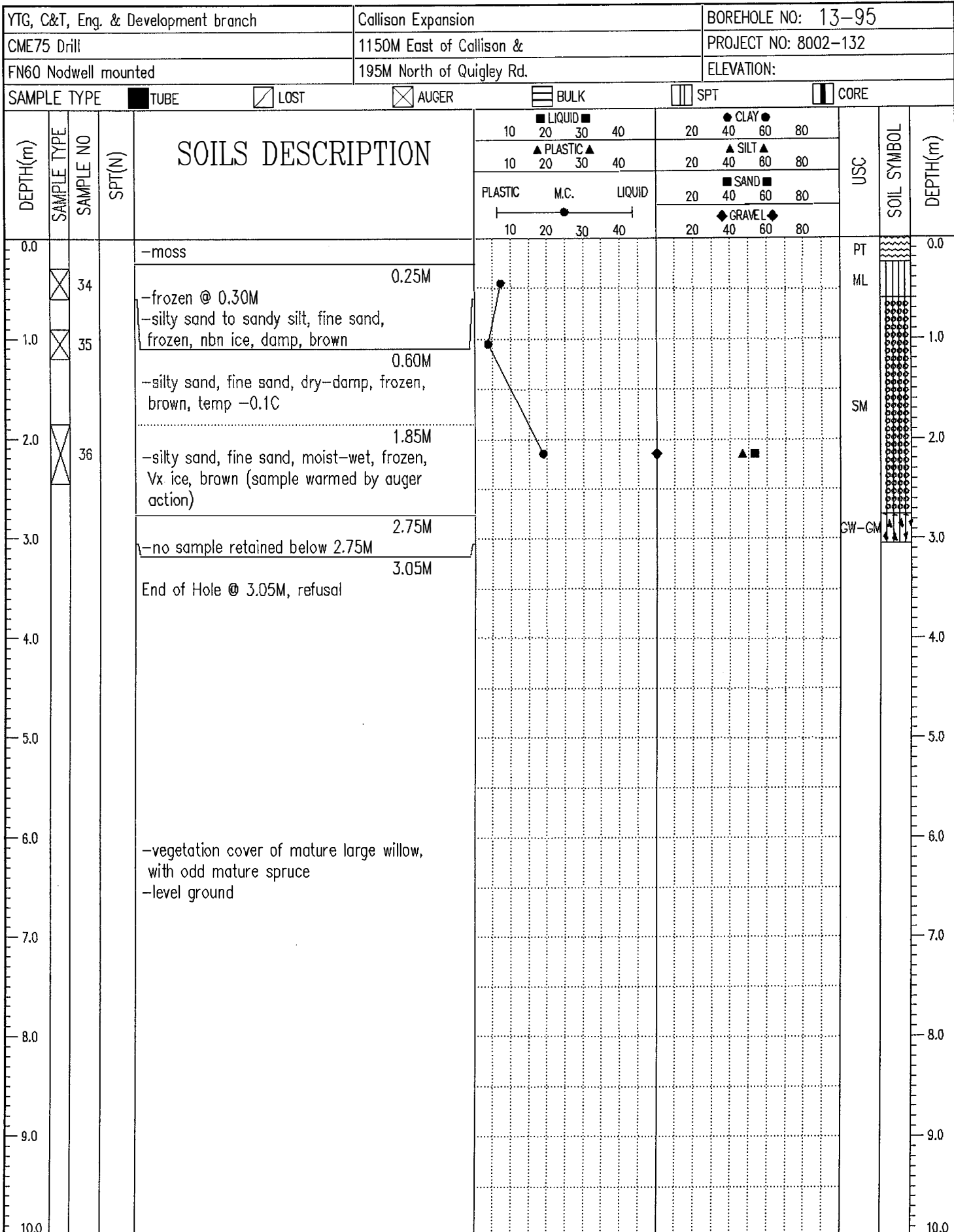
85/07/13 10:54AM

YTG, C&T, Eng. & Development branch		Callison Expansion		TEST PIT NO: 12-95													
CME75 Drill		1225M East of Callison & 195M North		PROJECT NO: 8002-132													
FN60 Nodwell mounted		of Quigley Rd.		ELEVATION:													
SAMPLE TYPE		<input checked="" type="checkbox"/> TUBE	<input type="checkbox"/> LOST	<input checked="" type="checkbox"/> AUGER	<input type="checkbox"/> BULK	<input type="checkbox"/> SPT	<input type="checkbox"/> CORE										
DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SOILS DESCRIPTION	LIQUID				CLAY				USC	SOIL SYMBOL	DEPTH(m)			
				10	20	30	40	20	40	60	80				20	40	60
				PLASTIC		M.C.		LIQUID		SILT		SAND					
				10	20	30	40	20	40	60	80	20	40	60	80		
				-----●-----				●									
				10	20	30	40	20	40	60	80	20	40	60	80		
0.0			-moss													0.0	
			0.30M														
			-silt, very soft, wet, grey-brown														
		31	-silt, trace to some sand, soft, moist, non-frozen, grey-brown														
1.0			0.90M														
			-frozen @ 0.90M														
		32	-sandy silt to silty sand, fine sand, frozen, nbn ice, brown														
2.0			1.85M														
			-sandy gravel, trace of silt, possible cobbles in size, frozen, nbn ice, brown														
		33															
3.0			2.90M														
			End of Hole @ 2.9M, very difficult drilling														
4.0																	
5.0																	
			-level ground														
			-vegetation cover of large willows, odd mature large spruce														
6.0																	
7.0																	
8.0																	

J.R. Paine & Associates Ltd.
Whitehorse, Yukon

LOGGED BY: WCK
REVIEWED BY: WCK
Fig. No: 12

COMPLETION DEPTH: 2.9 m
COMPLETE: 95/05/21



J.R. Paine & Associates Ltd.
Whitehorse, Yukon

LOGGED BY: WCK
REVIEWED BY: WCK
Fig. No: 13

COMPLETION DEPTH: 3.1 m
COMPLETE: 95/05/21

HOGGAN ENGINEERING & TESTING (1980) LTD.

APPENDIX C
•Laboratory Test Summary Sheets



J. R. Paine & Associates Ltd.

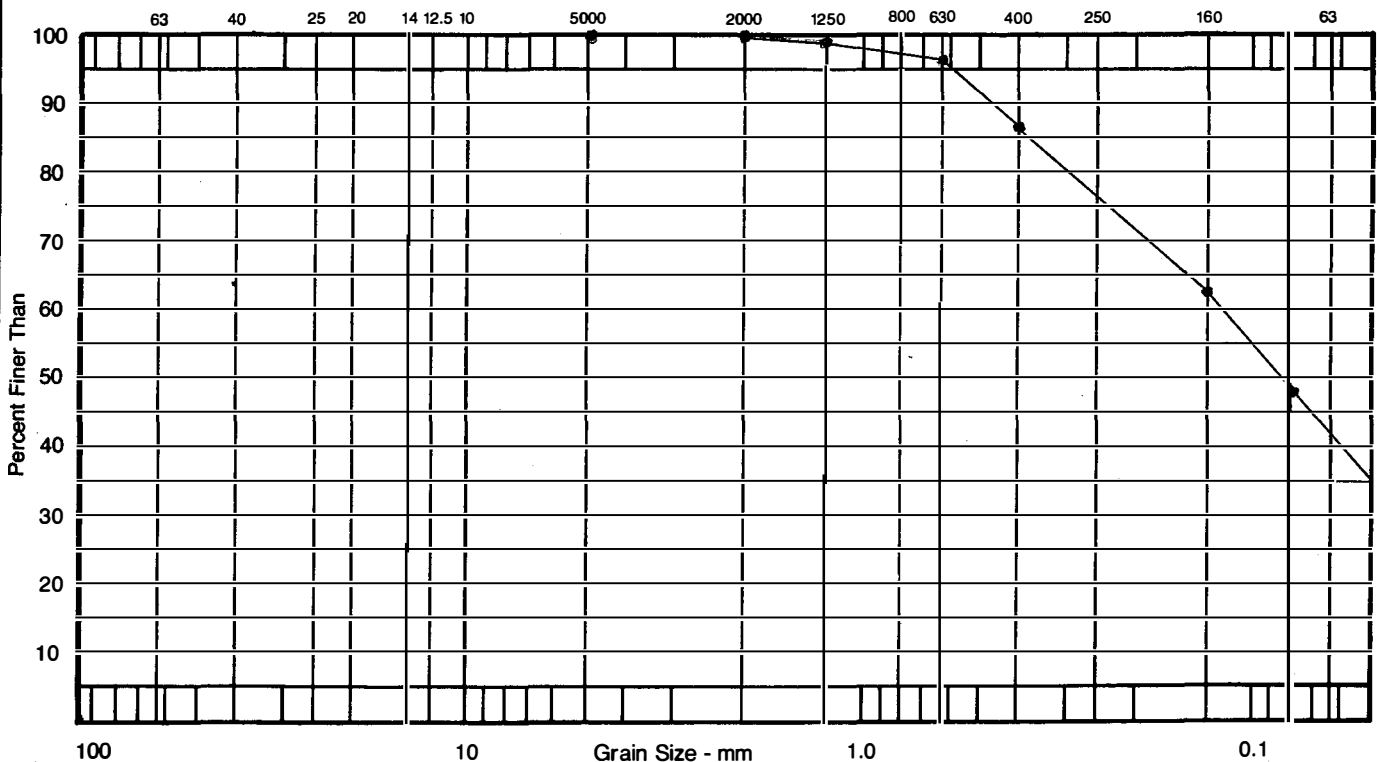
CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: YTG, Engineering & Development Branch
 Project: Callison Subdivision/Dawson City
 Sample: C-11 Depth: 4.0m
 Location: 950m east & 100m north of
Quigley Road TH#3-95 Made by: TD Job. No. 8002-132
 Ck'd by: WCK Date: 1995/06/06

Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
40000	40.0				
25000	25.0				
20000	20.0				
14000	14.0				
12500	12.5				
10000	10.0				100.0
5000	5.0				99.9
2000	2.0				99.9
1250	1.250				99.8
800	0.800				
630	0.630				96.4
400	0.400				87.2
315	0.315				79.3
160	0.160				63.2
80	0.080				48.9

Description of Sample
Silty Sand, Sandy Silt,
SM-ML
 Time of Sieving Min. 15
 Method of Preparation Dry Washed X
 Remarks
Gravel: 0.1%
Sand: 51.0%
Silt: 48.9%





J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: C-14 Depth: 2.8m
Location: 785m east & 150m north of
Quigley Road TH#4-95

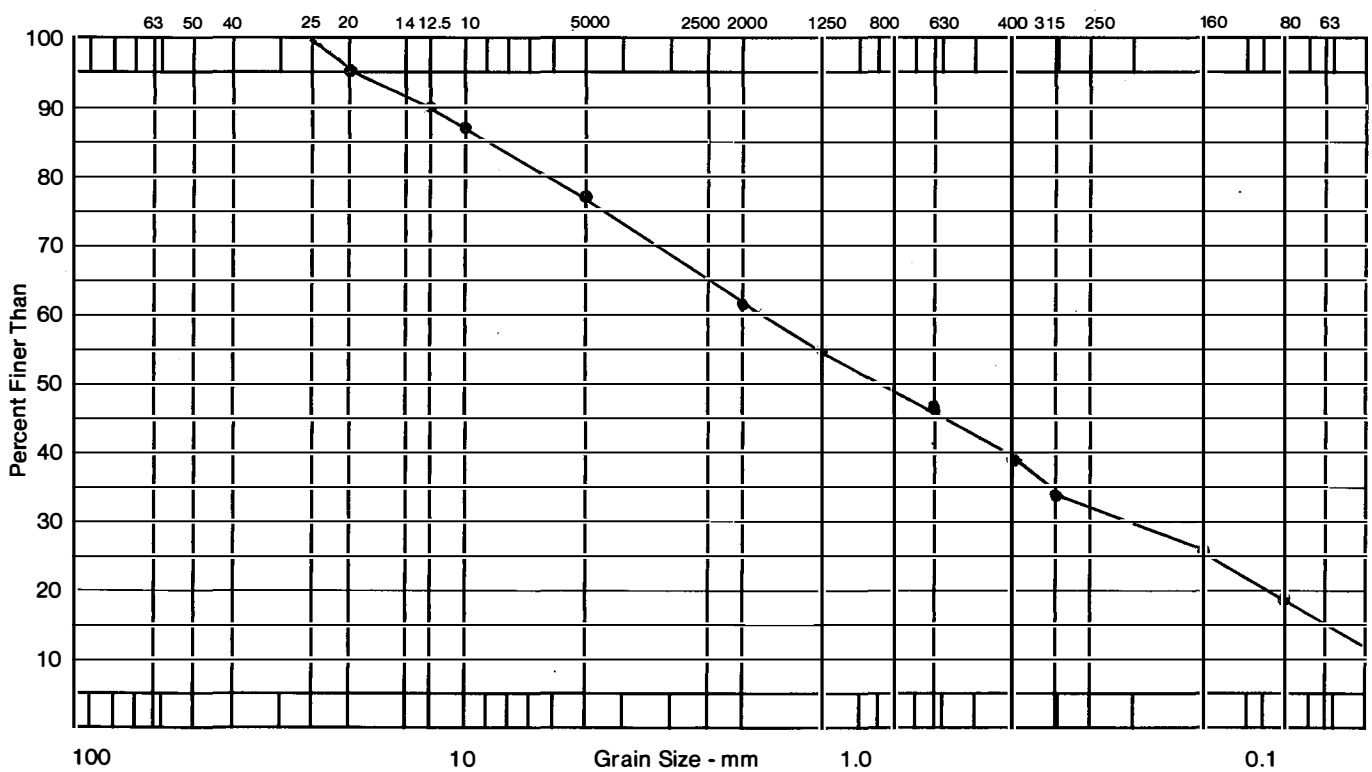
Client: YTG, Engineering & Development Branch
Project: Callison S subdivision/Dawson City
Made by: TD Job No.: 8002-132
Ck'd by: WCK Date: 1995/06/06

Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
50,000	50.0				
40,000	40.0				
25,000	25.0				100.0
20,000	20.0				95.1
12,500	12.5				90.2
10,000	10.0				86.9
5,000	5.0				77.2
2,500	2.5				
2,000	2.0				61.9
1,250	1.25				55.3
800	0.800				
630	0.630				46.5
400	0.400				38.8
315	0.315				34.2
160	0.160				25.7
80	0.080				18.5

Description of Sample _____
Silty, Gravelly Sand, SW-SM

Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X
Remarks _____
Gravel: 22.8%
Sand: 58.7%
Silt: 18.5%





J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: YTG, Engineering & Development Branch
 Sample: C-16 Depth: 4.5m Project: Callison Subdivision/ Dawson City
 Location: 950m east & 150m north of Made by: TD Job No.: 8002-132
Quigley Road TH#5-95 CK'd by: WCC Date: 1995/06/06

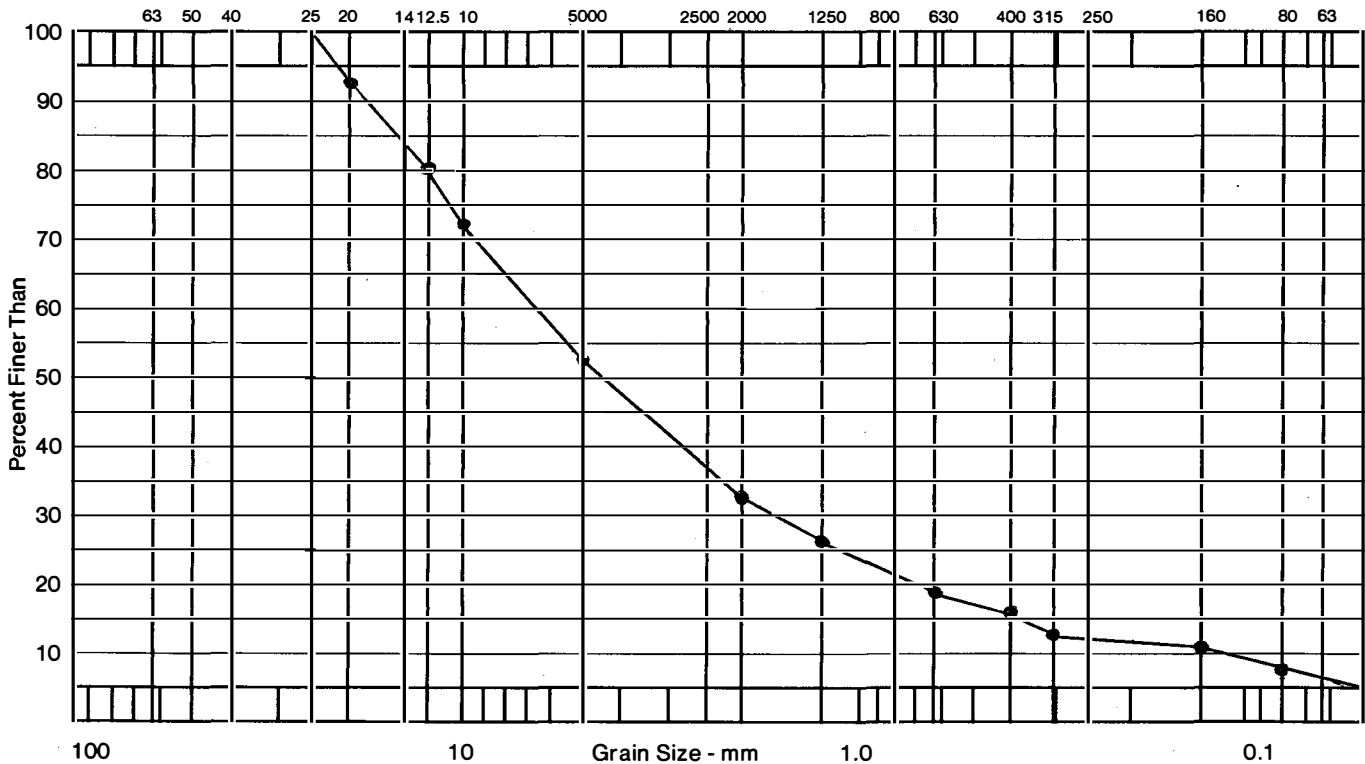
Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
50,000	50.0				
40,000	40.0				
25,000	25.0				100.0
20,000	20.0				93.2
12,500	12.5				80.4
10,000	10.0				72.5
5,000	5.0				53.1
2,500	2.5				
2,000	2.0				33.6
1,250	1.25				26.0
800	0.800				
630	0.630				19.0
400	0.400				15.4
315	0.315				13.6
160	0.160				10.4
80	0.080				7.6

Description of Sample _____
Sandy Gravel, trace of Silt,
GW-GM

Method of Preparation _____ Dry _____ Washed X
 Remarks _____

Gravel: 46.9%
Sand: 45.5%
Silt: 7.6%

Time of Sieving _____ Min. 15





J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: C-18 Depth: 2.2m

Client: YTG, Engineering & Development Branch

Location: 950m east & 300m north of

Project: Callison Subdivision/Dawson City

Quigley Road TH#6-95

Made by: TD Job No.: 8002-132

CK'd by: WCL Date: 1995/06/06

Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
50,000	50.0				
40,000	40.0				
25,000	25.0				100.0
20,000	20.0				93.3
12,500	12.5				73.3
10,000	10.0				67.5
5,000	5.0				49.1
2,500	2.5				
2,000	2.0				35.1
1,250	1.25				27.4
800	0.800				
630	0.630				21.1
400	0.400				19.2
315	0.315				17.2
160	0.160				14.1
80	0.080				11.5

Description of Sample _____

Method of Preparation _____ Dry _____ Washed X

Sandy Gravel, trace of Silt,
GW-GM

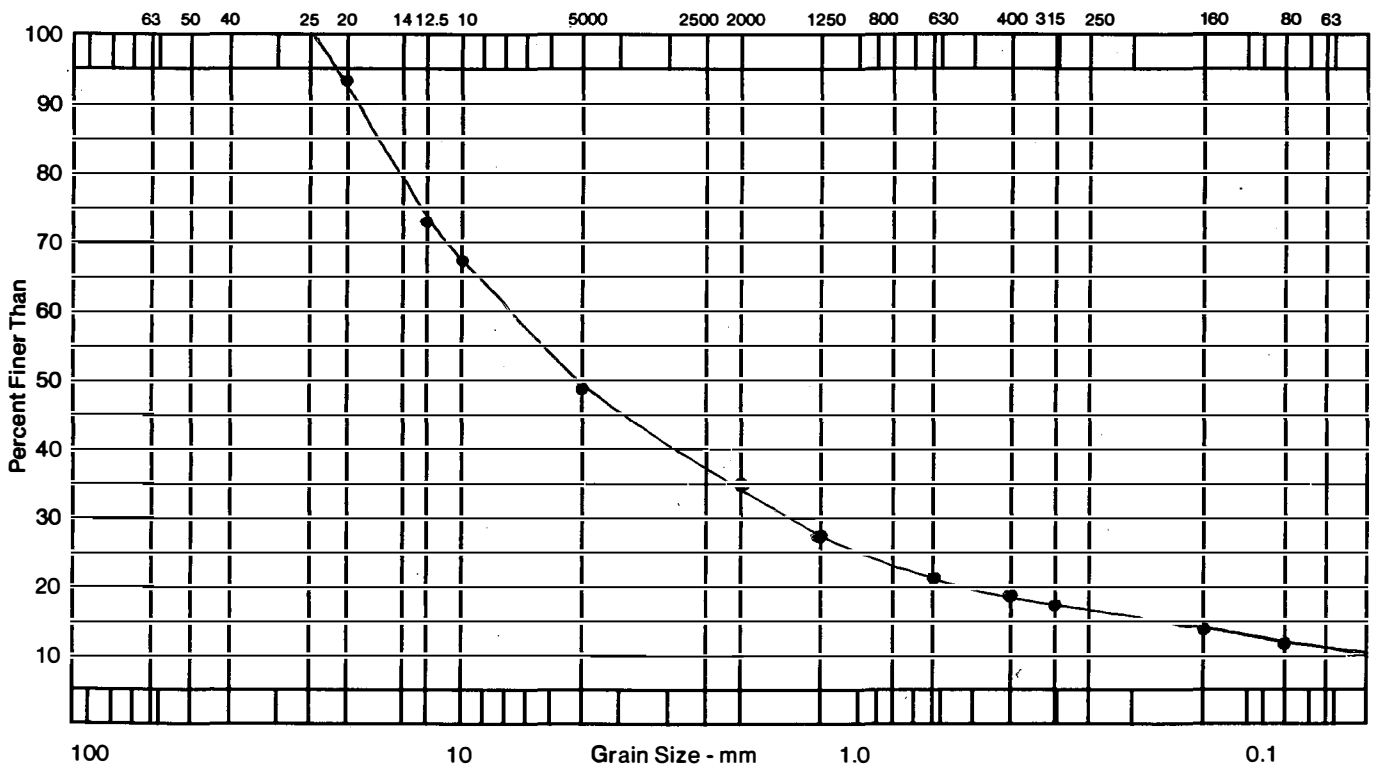
Remarks _____

Gravel: 50.9%

Sand: 37.6%

Silt: 11.5%

Time of Sieving _____ Min. 15





J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

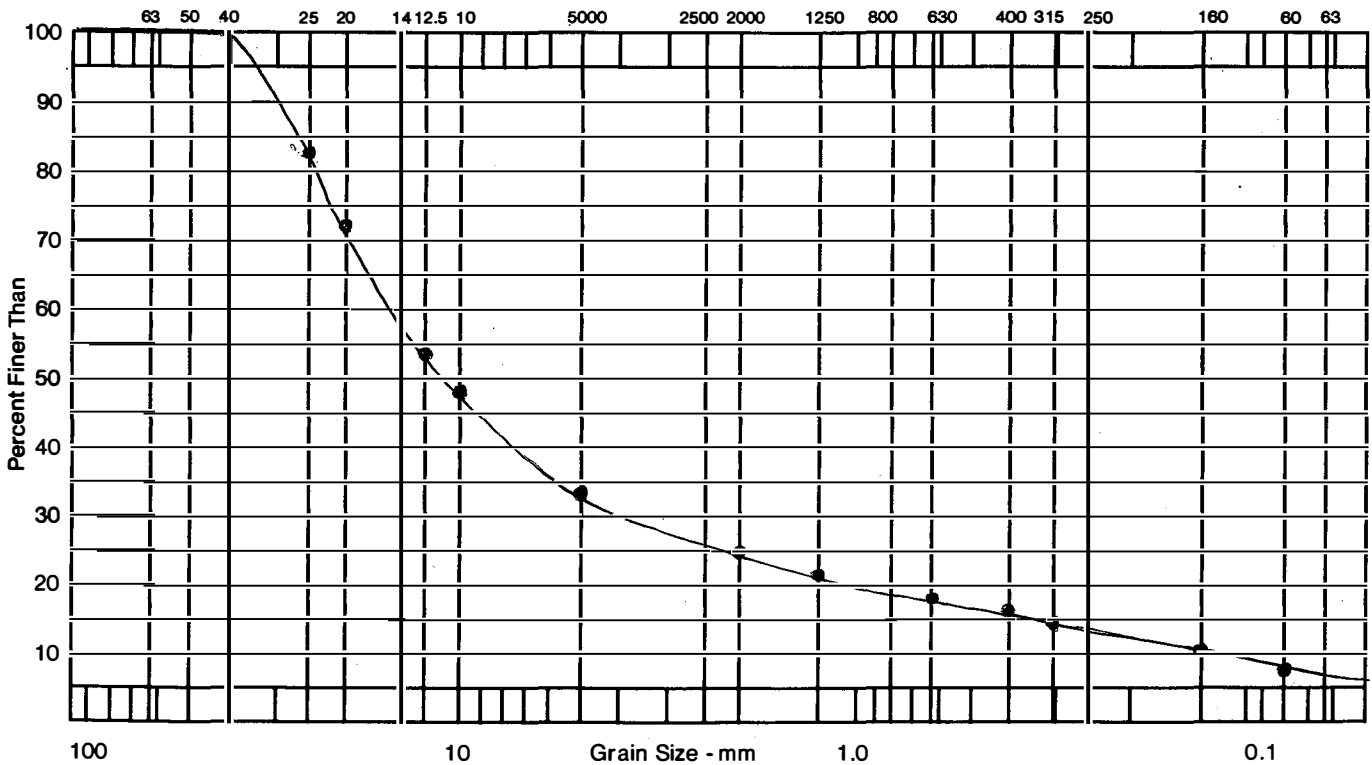
SCREEN ANALYSIS

Client: YTG, Engineering & Development Banch
 Project: Callison Subdivision/Dawson City
 Sample: C-19 Depth: 1.0m
 Location: 1100m east & 300m north of
Quigley Road TH#7-95
 Made by: TD Job No.: 8002-132
 CK'd by: W.C.L. Date: 1995/06/06

Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
50,000	50.0				
40,000	40.0				100.0
25,000	25.0				82.0
20,000	20.0				72.2
12,500	12.5				53.7
10,000	10.0				48.5
5,000	5.0				34.3
2,500	2.5				
2,000	2.0				25.0
1,250	1.25				21.7
800	0.800				
630	0.630				18.5
400	0.400				16.1
315	0.315				14.4
160	0.160				10.5
80	0.080				7.2

Description of Sample _____
Sandy Gravel, trace of Silt,
GW-GM
 Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X
 Remarks _____
Gravel: 65.7%
Sand: 27.1%
Silt: 7.2%





J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: YTG, Engineering & Development Branch
 Sample: C-26 Depth: 4.0m Project: Callison Subdivision/Dawson City
 Location: 1250m east & 100m north of Made by: TD Job No.: 8002-132
Quigley Road TH#10-95 Ck'd by: wsc/K Date: 1995/06/07

Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
50,000	50.0				
40,000	40.0				
25,000	25.0				100.0
20,000	20.0				86.5
12,500	12.5				76.0
10,000	10.0				63.5
5,000	5.0				48.6
2,500	2.5				
2,000	2.0				36.6
1,250	1.25				32.2
800	0.800				
630	0.630				28.0
400	0.400				25.4
315	0.315				23.4
160	0.160				18.6
80	0.080				13.7

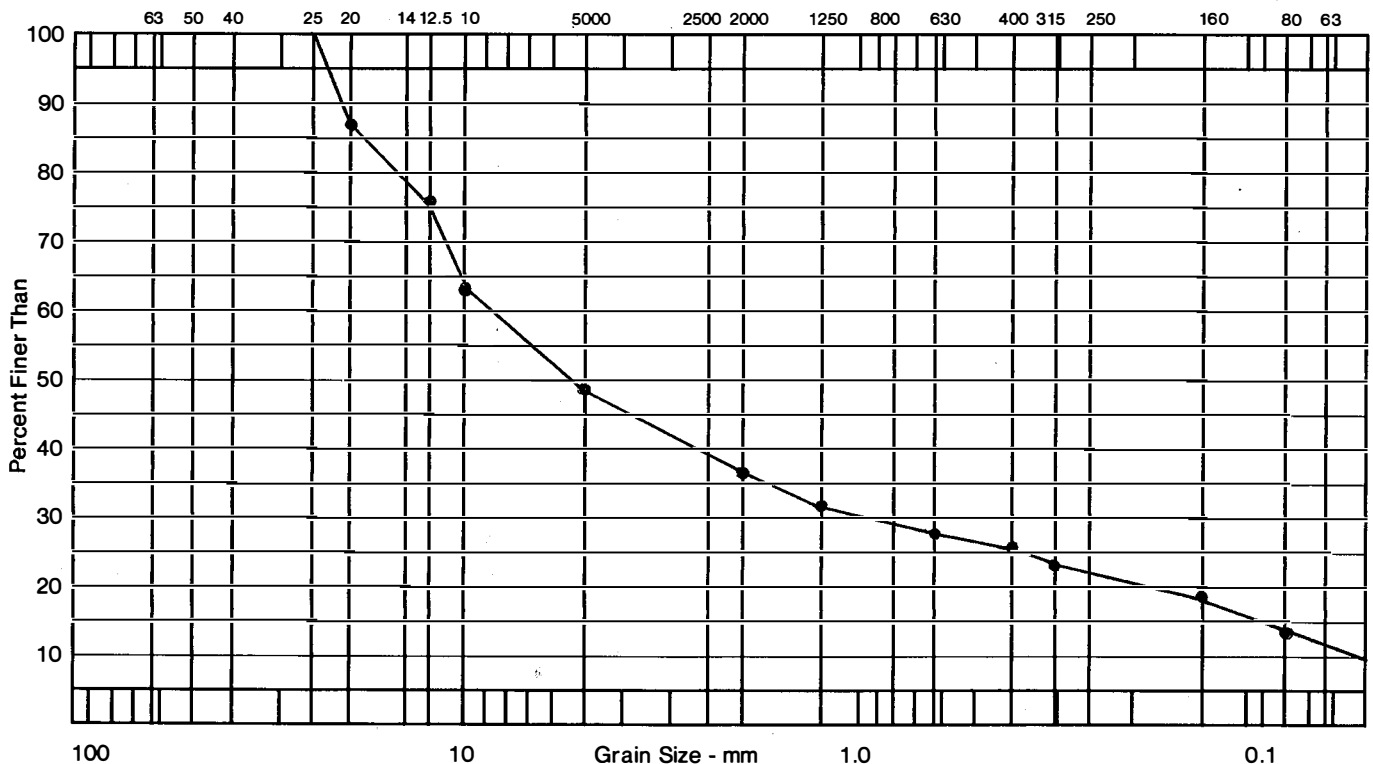
Description of Sample _____

Sandy Gravel, some Silt,
GW-GM

 Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X
 Remarks _____

Gravel: 51.4%
Sand: 34.9%
Silt: 13.7%





J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: YTG, Engineering & Development Branch
 Sample: C-29 Depth: 3.8M Project: Callison Subdivision/Dawson City
 Location: 1100m east & 100m north of Made by: TD Job No.: 8002-132
Quigley Road TH#11-95 CK'd by: WCK Date: 1995/06/06

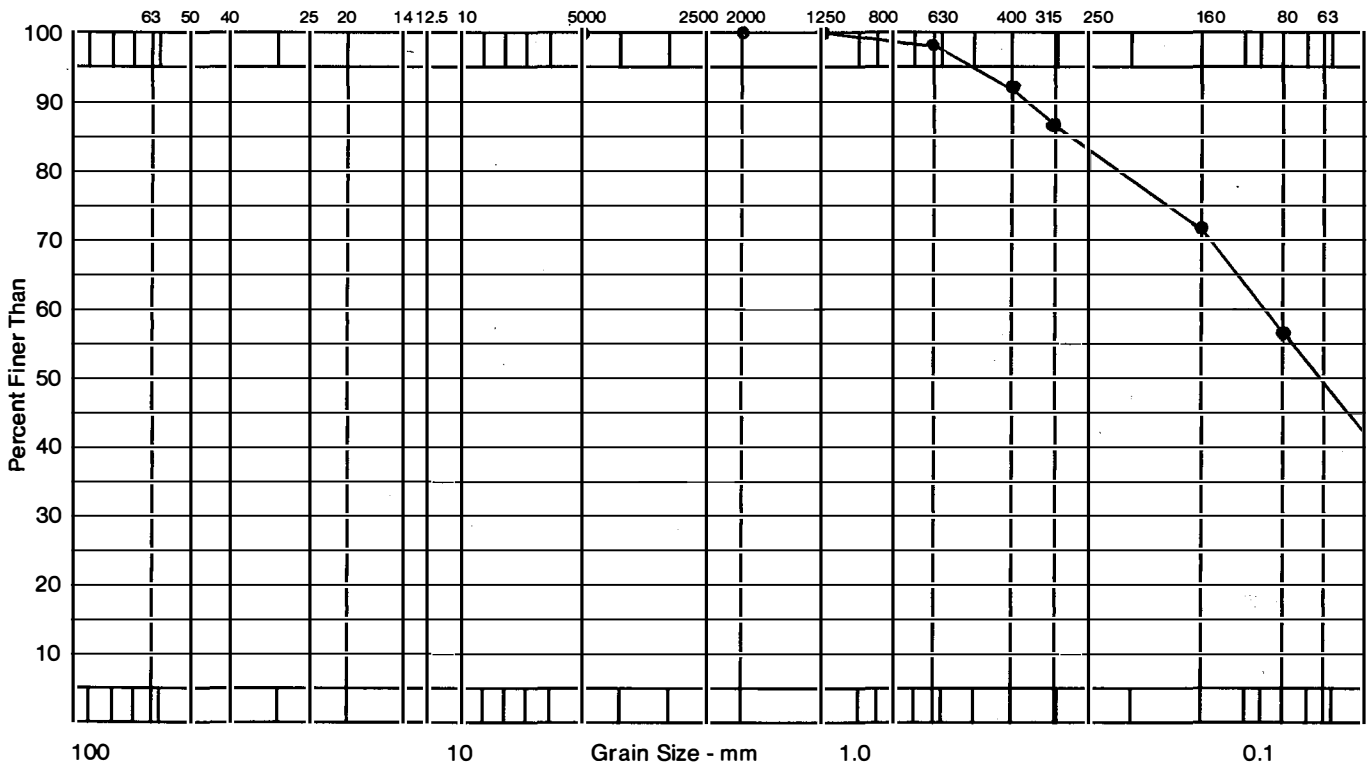
Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
50,000	50.0				
40,000	40.0				
25,000	25.0				
20,000	20.0				
12,500	12.5				
10,000	10.0				100.0
5,000	5.0				99.9
2,500	2.5				
2,000	2.0				99.8
1,250	1.25				99.6
800	0.800				
630	0.630				97.6
400	0.400				92.0
315	0.315				86.5
160	0.160				71.8
80	0.080				56.1

Description of Sample _____

Sandy Silt, ML

 Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X
 Remarks _____
Gravel: 0.1%
Sand: 43.8%
Silt: 56.1%





J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

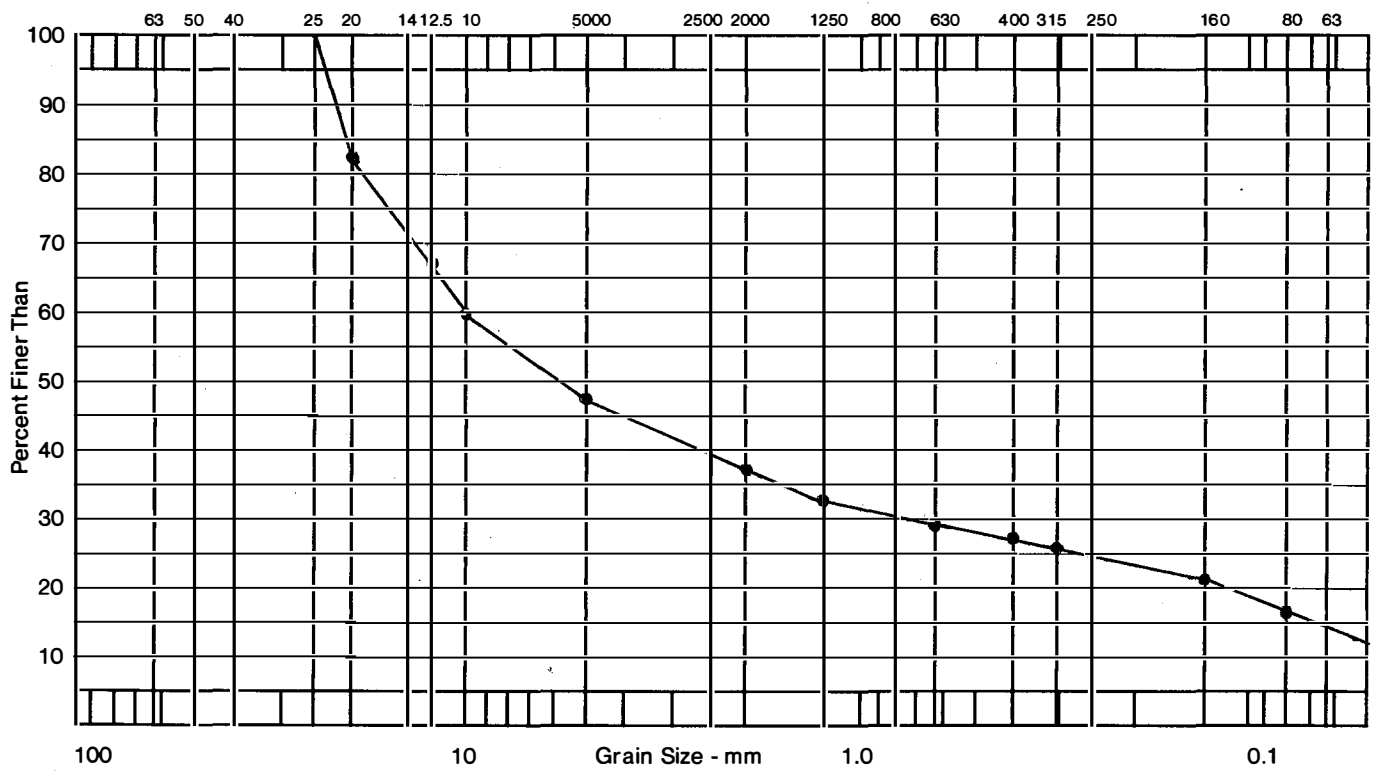
Client: YTG, Engineering & Development Branch
 Sample: C-30 Depth: 5.2m Project: Callison Subdivision/Dawson City
 Location: 1100m east & 100m north of Made by: TD Job No.: 8002-132
Quigley Road TH#12-95 Ck'd by: W C/C Date: 1995/06/07

Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
50,000	50.0				
40,000	40.0				
25,000	25.0				100.0
20,000	20.0				82.6
12,500	12.5				67.1
10,000	10.0				59.7
5,000	5.0				47.6
2,500	2.5				
2,000	2.0				37.7
1,250	1.25				33.3
800	0.800				
630	0.630				29.4
400	0.400				26.9
315	0.315				25.3
160	0.160				21.3
80	0.080				16.3

Description of Sample _____
Silty, Sandy Gravel, GW-GM

Method of Preparation _____ Dry _____ Washed X
 Remarks _____
Gravel: 52.4%
Sand: 31.3%
Silt: 16.3%

Time of Sieving _____ Min. 15





J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Sample: C-33 Depth: 2.0m
Location: 1250m east & 200m north of
Quigley Road TH#12-95

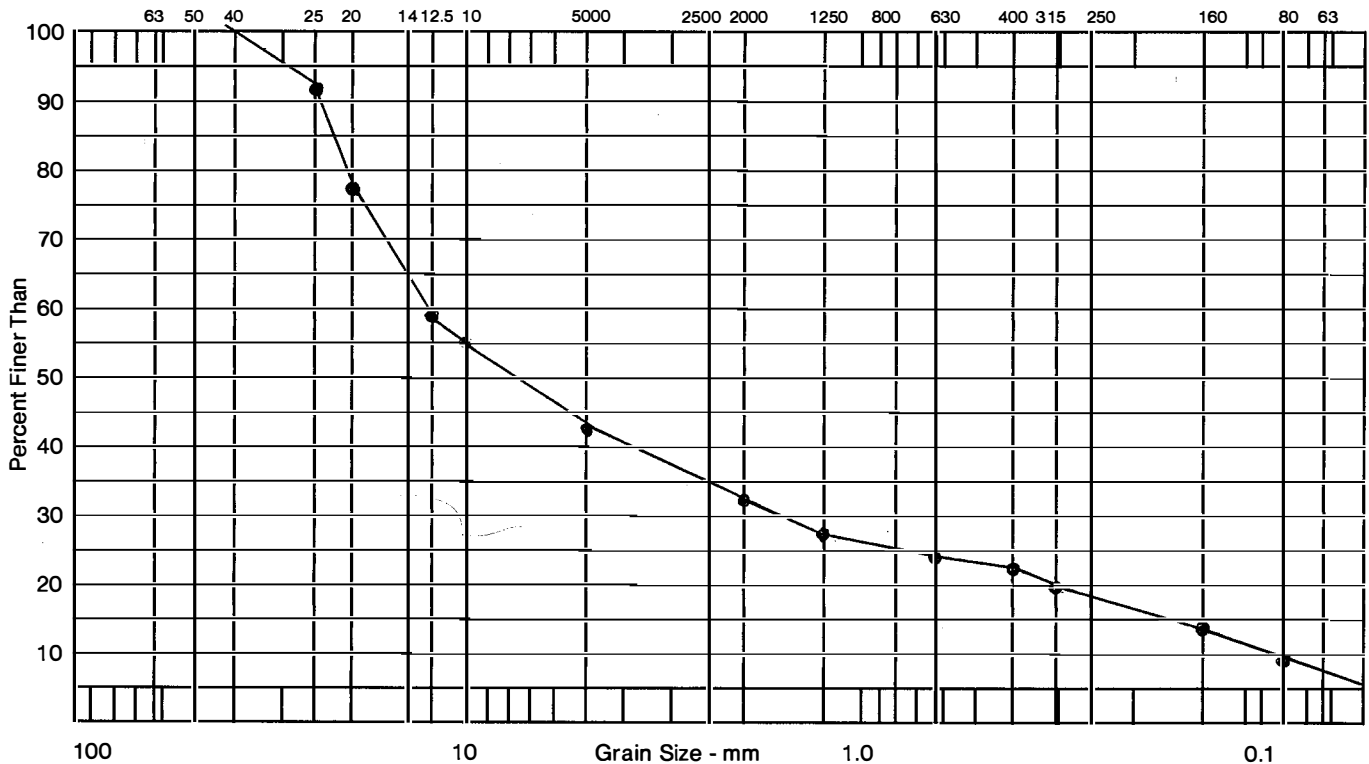
Client: YTG, Engineering & Development Branch
Project: Callison Subdivision /Dawson City
Made by: TD Job No.: 8001-132
Ck'd by: wc/c Date: 1995/06/07

Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
50,000	50.0				
40,000	40.0				100.0
25,000	25.0				91.5
20,000	20.0				77.4
12,500	12.5				59.1
10,000	10.0				54.8
5,000	5.0				43.7
2,500	2.5				
2,000	2.0				32.3
1,250	1.25				28.1
800	0.800				
630	0.630				24.6
400	0.400				22.0
315	0.315				19.9
160	0.160				13.9
80	0.080				9.7

Description of Sample _____
Sandy Gravel, trace of Silt,
GW-GM

Method of Preparation _____ Dry _____ Washed X
Remarks _____
Gravel: 56.3%
Sand: 34.0%
Silt: 9.7%

Time of Sieving _____ Min. 15





J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

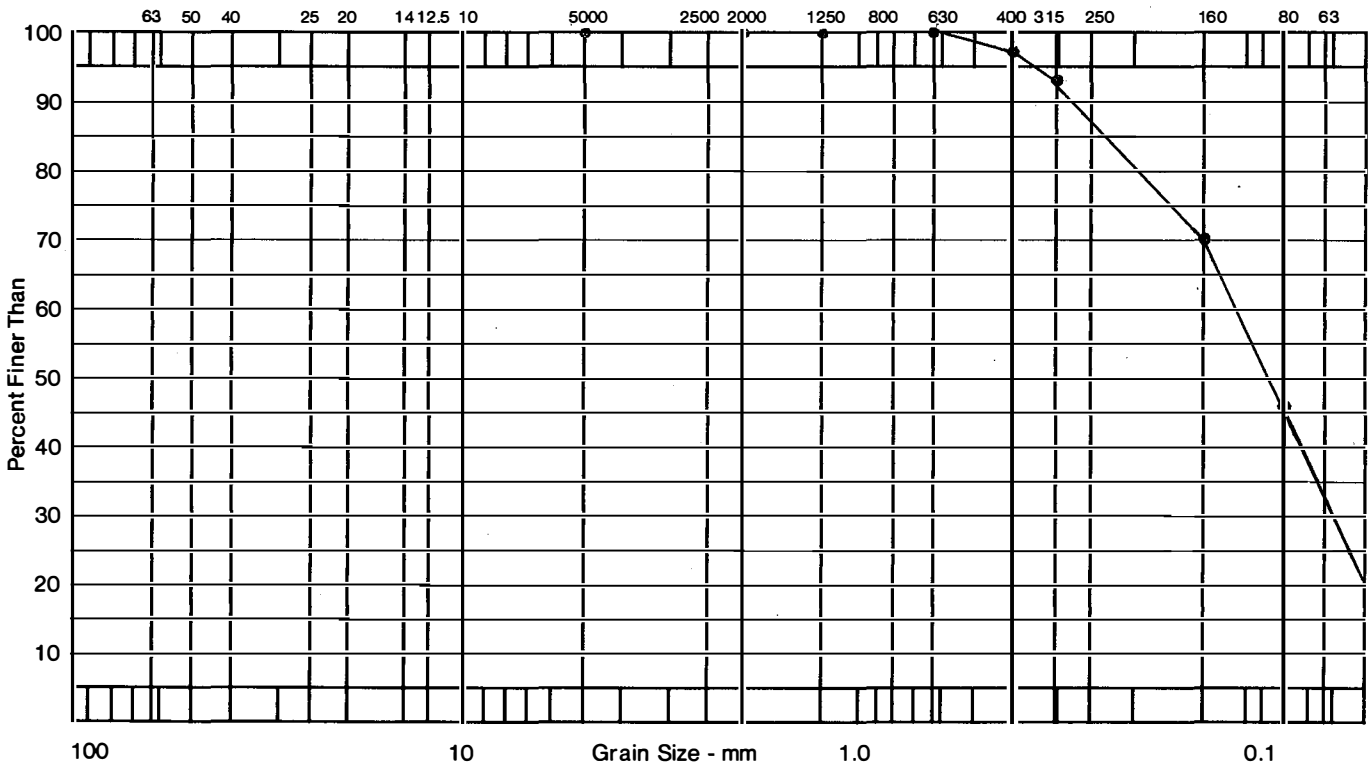
Client: YTG, Engineering & Development Branch
 Sample: C-36 Depth: 2.0M Project: Callison Subdivision/Dawson City
 Location: 1150m east of Callison & 195m north of Quigley Road TH#13-95 Made by: TD Job No.: 8002-132
 CK'd by: WCK Date: 1995/06/07

Sieve No.	Size of Opening MM	Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
50,000	50.0				
40,000	40.0				
25,000	25.0				
20,000	20.0				
12,500	12.5				
10,000	10.0				
5,000	5.0				100.0
2,500	2.5				
2,000	2.0				99.9
1,250	1.25				99.7
800	0.800				
630	0.630				99.2
400	0.400				97.2
315	0.315				93.4
160	0.160				70.0
80	0.080				46.5

Description of Sample _____
Silty Sand, SM

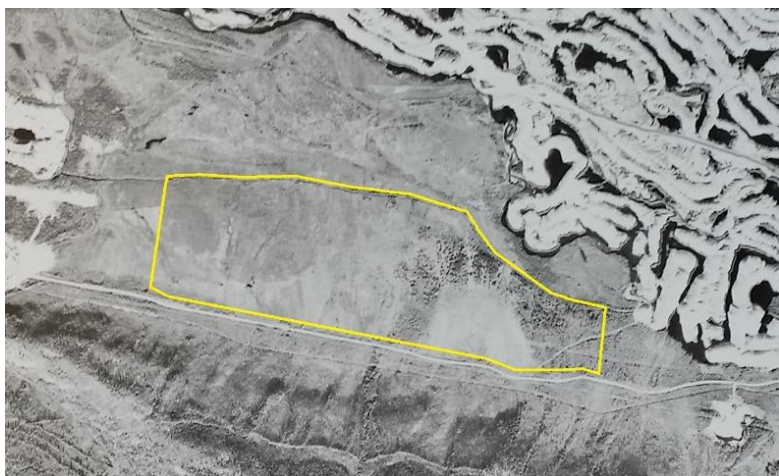
 Time of Sieving _____ Min. 15

Method of Preparation _____ Dry _____ Washed X
 Remarks _____
Gravel: 0.0%
Sand: 53.5%
Silt: 46.5%





Geotechnical Assessment
Land Disposition # 2005-0015 – Dawson City, Yukon – 2017
Appendix B – Selection of Airphotos



1960



1977



1984



1990