PRELIMINARY REPORT

October 6, 2015

PRELIMINARY GEOTECHNICAL REPORT

Ogilvie Ridge Development Proposed Residential Area Alternate Surplus School Site Edmonton, Alberta

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by the City of Edmonton (COE) to carry out a geotechnical review and investigation and provide preliminary geotechnical engineering comments and recommendations as input to the considerations to develop a Medium Density Residential (MR) area at an Alternate Site within Ogilvie Ridge Park in Edmonton, Alberta (the Site).

The original scope of work for this project is outlined in Golder's proposal submitted to COE on February 5, 2015, and scope change submitted to COE on June 24, 2015.

The purpose of this investigation was to obtain subsurface soil and groundwater conditions at the Site, and based on Golder's interpretation of this information provide comments and preliminary recommendations on the geotechnical engineering aspects as input to the design and construction of the proposed development at Ogilvie Ridge Park. The current investigation was supplemented with the following information:

- Map 143, Surficial Geology of Edmonton (83H), Alberta Geological Survey.
- Map 600, Bedrock Geology of Alberta, Alberta Geological Survey.
- Report titled, "Proposed Petrolia Power Sub-Station," prepared by the City of Edmonton, dated January, 1978.
- Report titled, "An Assessment of Slope Stability, Neighbourhood 8, Riverbend – Terwilleger Heights," prepared by Hardy Associates Ltd., dated June, 1979.
- Report titled, "Geotechnical Investigation, Riverbend Neighbourhood 8, Subdivision Development," prepared by Hardy Associates Ltd., dated November 13, 1979.
- Report titled, "Proposed Air Shaft, Ogilvie Boulevard, West of Omand Drive," prepared by the City of Edmonton, dated May, 1985.
- Report titled, "Riverbend – Whitemud Creek, Top-of-Bank Study," prepared by Hardy BBT Ltd., dated May 15, 1989.
- Aerial Photograph AS136-60, April 1950, Alberta Environment and Sustainable Resources.
- Aerial Photograph AS1043-121, June 1969, Alberta Environment and Sustainable Resources.
- Aerial Photograph AS3590-41, June 1987, Alberta Environment and Sustainable Resources.
- Aerial Photograph AS5461B-255, October 2008, Alberta Environment and Sustainable Resources.

This report summarizes the factual results of the desktop review and Golder's geotechnical investigation and based on the interpretation of this information, provides preliminary geotechnical engineering comments and recommendations as input to the design and construction of the proposed MR area at Ogilvie Ridge Park.

The factual data, interpretations and recommendations provided in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, or if the project is not initiated within eighteen months of the date of the report, Golder should be given an opportunity to confirm that the recommendations are still valid.

Use of this report is subject to the conditions outlined in the *Important Information and Limitations of this Report* that follows the main text and forms an integral part of this document. The readers' attention is specifically drawn to this information, as it is essential for the proper use and interpretation of the report.

2.0 SITE AND PROJECT UNDERSTANDING

2.1 Project Understanding

It is understood that the COE is proposing to construct a Medium Density Residential area on an existing surplus school site located in the neighbourhood of Ogilvie Ridge on the southwest side of Edmonton, Alberta. The MR area would consist of 2 to 3 storey townhomes with a basement, one level of underground parking and additional parking in driveways or on the street. In addition, the MR area would contain a limited internal road network. The layout of the MR area within the Site is unknown at this time. The Site location is shown on Figure 1.

2.2 Site Description

The Site is within Ogilvie Ridge Park in Edmonton, Alberta in the Ogilvie Ridge neighbourhood. The surplus school site is located along Ogilvie Boulevard, near an existing EPCOR substation, as shown in Figure 1. The Site is located within the northwest quarter of Section 1, Township 52, Range 25, west of the 4th meridian. The legal land description for the Site is Lot 41MR, Block 111, Plan 852 0432. Ogilvie Ridge Park includes soccer fields, a playground, a parking lot, the Whitemud Creek Community Centre, and the One World Montessori School. The Site is bounded to the north and east by Ogilvie Boulevard, to the south by an access road to the EPCOR substation, and to the west by the substation.

The Site is generally level to gently sloping with no obvious dominant runoff direction. There is a moderately sloping hill to the soccer fields north of the Site with elevations approximately 1 m lower than that of the Site. The Site is bounded to the west by the EPCOR Substation that lies at approximately the same elevation as that of the Site. An existing baseball diamond lies within the site and is a grass-covered playing field with trees to the east and west boundaries as part of site landscaping.

3.0 DESKTOP STUDY

Aerial photographs are presented in Figure 2 to Figure 5. The Site was previously used as farmland and has since been developed into the current Ogilvie Ridge Park. As indicated by aerial photograph review, it is expected that a variable thickness of fill may be present at the Site due to development and general grading that occurred in the past;, however, the thickness of fill is expected to be minimal.

The aerial photograph review indicates that there may have been a low wetland area infilled during the development of the EPCOR Substation between 1969 and 1987. This wetland area extended approximately 30 m into Oglivie Ridge Park and was located at the south end of the park, just east of the developed substation. The wetland appears to have a length of a maximum of 100 m and is adjacent to another wetland to the southeast, which appears to be approximately 100 m in diameter. Based on a comparison of the 1987 photograph to the 2008 photograph, the remaining portion of the wetlands have been infilled during development

of Ogilvie Ridge and Hodson neighbourhoods. In addition, a small watercourse to the west of the Site was cut off between 1969 and 1987 during development. It appears that the creek has been infilled south of Ogilvie Ridge to allow for development of the substation and the park area.

A review of the reports supplied by COE around the Site area indicate that the surficial geology generally consists of clay underlain by silt, sand, and clay till further underlain by clayshale bedrock and sandstone. The reports nearest to the Site, for the substation and the air shaft, indicate interlayering of clay, silt, sand and till deposits. The bedrock was encountered at a depth of 3.1 m in one borehole, but was primarily encountered below depths of approximately 13 m in the area. Rafted bedrock was encountered in several boreholes, at depths ranging between about 13.1 and 16.6 m. Previous reports prepared for projects in proximity of the Site show records of sloughing of wet silt and sand during drilling. Furthermore, review of these previous reports indicates perched water tables observed using standpipe piezometers on site that coincide with seepage zones, occurring primarily in the sand layers.

The presence of wet silt and sand may present difficulties for foundation construction as seepage and sloughing can result in stability-related issues for excavations and slopes in these soils as well as during installation of certain types of foundation piles. Additionally, previous Record of Boreholes indicate that the subsurface conditions may not be suitable for end-bearing piles due to the measured lower soil strengths.

4.0 FIELD INVESTIGATION

The field investigation for the alternate site was carried out on July 29, 2015, at which time two (2) boreholes, designated as BH15-03 and BH15-04, were advanced to depths of 10.4 m each below the existing ground surface within the Site. The locations of the boreholes are shown on Figure 1.

All boreholes were advanced using a Unimog truck mounted drill rig, supplied and operated by Mobile Augers and Research Ltd. of Edmonton, Alberta. The boreholes were advanced to a depth of approximately 10.4 m below the existing ground surface. The boreholes were advanced using 150 mm diameter solid stem augers, with soil samples obtained at 1.5 m intervals of depth using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586-08a Standard Test Method for Standard Penetration Test). Grab samples were also obtained from the auger flights. A thin-walled Shelby tube sample was also taken within the cohesive material in Borehole BH15-01 (ASTM D1587-08 Standard Penetration for Thin-Walled Tube Sampling).

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations and standpipe piezometers were installed in both of the boreholes to permit monitoring of the groundwater levels. The piezometers consist of 25 mm diameter PVC pipe, with a slotted screen sealed with bentonite at a selected depth interval within the boreholes. The piezometer installation details and water level readings are indicated on the Record of Borehole Sheets in Appendix A. Soil cuttings were used to backfill the boreholes above the screened section and a near surface bentonite seal and flush-mounted protective road boxes were installed. Excess soil cuttings remaining after backfilling the boreholes were placed in soil bags. The soil bags were then removed from Site following the completion of drilling.

The field work was carried out under the full-time supervision of a member of Golder engineering staff who located the boreholes in the field, directed the sampling and in situ testing operations, and logged the boreholes.

The samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Edmonton for further examination and laboratory testing. Index and classification tests consisting of water content determinations, Atterberg limits, and particle size distribution testing were carried out on selected soil samples.

The approximate locations and ground surface elevations at the boreholes were recorded on site using a handheld GPS and were also surveyed by the COE following the geotechnical investigation. The borehole locations, including approximate UTM NAD83 northing and easting coordinates and approximate ground surface elevations referenced to geodetic datum obtained by survey, are presented on the Record of Borehole sheets and are summarized in the Table 1 and shown on Figure 1.

Table 1: Approximate Borehole Locations

Borehole Number	Approximate UTM NAD83 Northing (m)	Approximate UTM NAD83 Easting (m)	Approximate Ground Surface Elevation (m)	Borehole Depth (m)
BH15-03	5,926,767	330,077	677.9	10.4
BH15-04	5,926,728	330,002	678.0	10.4

5.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

5.1 Regional Geology

The Site is located south of Whitemud Drive in the west area of Edmonton, Alberta. Based on the Alberta Geological Survey Map 143, "Surficial Geology of Edmonton", the near surface geologic profile in the area of the proposed MR area consists of glaciolacustrine deposits of silt and clay. The silt and clay is composed of bedded silt and clay with minor sand and may be varved in places.

Regionally, the uppermost bedrock unit in the area consists of the Horseshoe Canyon Formation. According to Map 600, "Bedrock Geology of Alberta", the Horseshoes Canyon Formation generally consists of grey, feldspathic, clayey sandstone; grey bentonitic mudstone and carbonaceous shale; concretionary ironstone beds, scattered coal and bentonite beds of variable thickness; minor limestone beds, mainly non-marine.

5.2 Subsurface Conditions

As part of the subsurface investigation, two (2) boreholes were advanced in the proposed development Site. The detailed subsurface soil and groundwater conditions encountered in the boreholes advanced as part of the current investigation and the results of in situ and laboratory testing are presented on the Record of Borehole Sheets contained in Appendix A. The results of geotechnical and analytical laboratory testing are presented in Appendix B.

The soil descriptions provided in this report are based on accepted standard methods of classification and description routinely used in current geotechnical practice. The stratigraphic boundaries shown on the Record of Borehole Sheets are inferred from observations of drilling progress and from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions at the Site consist of a surficial layer of topsoil underlain by clay fill and further underlain by silty clay and a sand deposit. In Borehole BH15-03, a sandy silt deposit was encountered between the silty clay and sand. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

5.2.1 Topsoil

Topsoil was encountered immediately below the ground surface in both boreholes with a thickness of about 300 mm.

5.2.2 Fill

A layer of clay fill was encountered beneath the topsoil in both boreholes to depths of 1.8 m and 1.2 m in Boreholes BH15-03 and BH15-04, respectively. The fill consisted of clay containing some silt and trace amounts of sand. The fill was brown and contained oxidation staining. In addition, rootlets and organic material were observed throughout the layer.

The laboratory water contents measured on selected samples of the fill were between about 8 and 16 per cent. In general, the water content of the fill was near or dry of the plastic limit.

The measured Standard Penetration Test (SPT) “N” values within the fill were 16 and 21 blows per 0.3 m of penetration, suggesting a very stiff consistency.

5.2.3 Silty Clay

A silty clay deposit was encountered beneath the fill in both boreholes to depths of 6.4 m and 7.9 m in Boreholes BH15-03 and BH15-04, respectively. The silty clay contained trace amounts of sand and pockets of clay, silt, and sand, and contained coal fragments. At depths of 4.3 m and 6.7 in Boreholes BH15-03 and BH15-04, respectively, large sand pockets and sand seams were encountered within this deposit. The silty clay was brown and contained oxidation stains.

Atterberg limits testing was conducted on selected samples of the silty clay and measured plastic limits between about 15 and 17 per cent, liquid limits between about 28 and 43 per cent and corresponding plasticity indices between about 13 and 27 per cent. In general the lower liquid limits and plasticity indices were encountered at the base of the deposit. The plasticity results, which are plotted on Figure 6, indicate that the silty clay ranges from intermediate to low plasticity with depth.

The laboratory water contents measured on selected samples of the silty clay were between about 15 and 35 per cent, but were generally between about 15 and 25 per cent. In general, the water content was near or wet of the plastic limit.

The SPT “N” values measured within the silty clay were between 8 and 24 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency. In general, the SPT “N” value increased with depth, as shown in Figure 8.

5.2.4 Sandy Silt

A sandy silt deposit was encountered underlying the silty clay to a depth of 9.5 m in Boreholes BH15-03. The sandy silt deposit contained clay pockets and coal fragments. The sandy silt was brown and contained oxidation stains.

The laboratory water contents measured on selected samples of the silty clay till were between about 13 and 26 per cent.

The SPT "N" values measured within the sandy silt deposit were 58 and 54 blows per 0.3 m of penetration, suggesting a very dense relative density.

5.2.5 Sand

A sand deposit was encountered below the sandy silt in Borehole BH15-03 and below the silty clay in BH15-04 at depths of 9.5 m and 7.9 m, respectively. Both boreholes were terminated within this deposit at a depth of 10.4 m.

The sand deposit was comprised of fine to coarse-grained sand and contained coal fragments. The deposit was brown and contained oxidation stains.

The laboratory water contents measured on selected samples of the sand were between 16 and 24 per cent.

The SPT "N" values measured within the sand were between 16 and 30 blows per 0.3 m of penetration, indicating a compact to dense relative density. In general, the SPT "N" value increased with depth, as shown in Figure 8.

5.3 Groundwater Conditions

The observed/recorded water levels in the open boreholes following completion of drilling and in the standpipe piezometers are shown on the Record of Borehole sheets and are summarized as follows:

Table 2: Groundwater Conditions

Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date
BH15-03	677.9	8.1	669.8	July 29, 2015 (completion of drilling)
		6.7	671.2	August 21, 2015 (piezometer)
		6.8	671.1	September 2, 2015 (piezometer)
BH15-04	678.0	8.5	669.5	July 29, 2015 (completion of drilling)
		7.1	670.9	August 21, 2015 (piezometer)
		7.1	670.9	September 2, 2015 (piezometer)

Water was observed in the sandy silt deposit in Borehole BH15-03 and in the silty clay deposit in Borehole BH15-04 at the time of the water level measurements. Water seepage is also expected from the sand deposit.

The water level at the Site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring and following periods of heavy precipitation. Seasonally, the groundwater levels may rise higher that those levels observed in this investigation.

6.0 PRELIMINARY GEOTECHNICAL ENGINEERING COMMENTS AND RECOMMENDATIONS

This section of the report provides geotechnical engineering comments and preliminary recommendations as input to the design and construction of the proposed residential development within the existing Ogilvie Ridge Park. The preliminary recommendations are based on Golder's interpretation of the factual data obtained from the boreholes advanced as part of the current subsurface investigation at this Site, and has been supplemented with the information from the documents listed in Section 1.0. The interpretation and preliminary recommendations contained in this report are intended to provide the designers with sufficient information as input to the design and construction of the proposed residential development.

Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions may be required in the Contract Documents. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.1 Frost Susceptibility and Penetration Depth

The anticipated depth of frost penetration was estimated for the average properties for the in-situ soil materials encountered at the location of the advanced boreholes both based on the mean annual Air Freezing Index (AFI) and the 50 year return period Air Freezing Index of about 1475°C days and 2000°C days, respectively. It was assumed that the near surface soil comprises silty clay with a dry density of 16 kN/m^3 and a gravimetric water content of 20 per cent. The mean annual depth of frost penetration for the cohesive soils present on Site is estimated to be about 1.8 m, and the penetration for a 50-year return period is about 2.1 m. A design frost penetration depth of 2.4 m is recommended. These estimates were determined using the method outlined in the Canadian Foundation Engineering Manual (CFEM) (Canadian Geotechnical Society, 2006).

The U.S. Corps of Engineers have classified the frost susceptibility of soils based on soil type into four groups designated F1 to F4 in approximate order of increasing frost susceptibility and loss of strength during thaw. Frost effects should be considered in the design of structural elements that are sensitive to post construction movement such as foundations, or buried services that cannot be allowed to freeze. Frost heave is a potential concern at the bottom of foundation elements (i.e. shallow foundations, slabs-on-grade, grade beams, pile caps and roadways). Based on Atterberg Limits test results, the soils at the Site generally fall into group F3 indicating the soils are moderately susceptible to the development of ice lenses and subsequent frost heaves.

6.2 General Grading and Site Drainage

6.2.1 Subgrade Preparation

Based on the results of the geotechnical investigation in the area of the proposed MR area in Ogilvie Ridge Park, the near-surface soils consist of surficial topsoil underlain by high plastic lacustrine clay fill that is further underlain by native silty clay.

The proposed grading plan for the Site is currently unknown; however, any existing vegetation, topsoil, fill and other deleterious and unsuitable material should be removed during general site grading. The existing topsoil is not suitable for supporting the building foundations, floor slab or engineered fill. These materials will need to be completely removed from the building/engineered fill footprint. The recommendations for fill removal should be reviewed by a qualified geotechnical engineer once the grading plans are available.

The clay fill layer is generally high plastic with a water content that is near or below its optimum water content. Based on Table 15-1 from CFEM (2006), the clay deposit has a very high swelling potential. For slab-on-grade structures, it is recommended that the upper 500 mm to all of the high plastic clay be removed and replaced with engineered fill.

Prior to placing engineered fill, the exposed subgrade should be proof rolled in conjunction with an inspection by a qualified geotechnical engineer. The inspection should confirm that the exposed soils are native, undisturbed and competent, and have been adequately cleaned of existing unsuitable fills, ponded water and all disturbed, loosened, softened, organic and other deleterious material.

Material for use as engineered fill may consist of either suitable low to intermediate plastic imported cohesive material or granular material compacted in layers not exceeding 150 mm loose lifts and to at least 100 per cent Standard Proctor Maximum Dry Density (SPMDD) as per ASTM D698 Standard Test Methods for Laboratory

Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600kN-m/m^3)). The fill should be placed at water contents between optimum and 2 per cent wet of optimum to minimize the potential for swelling due to placement of "dry" material. The placement of engineered fill should be monitored by a geotechnical engineer on a full-time basis. The top surface of the engineered fill should be protected as necessary from construction traffic, and should be sloped to provide positive drainage for surface water during the construction period.

It is recommended that the final grade of the Site be sloped so that surface water is directed away from the buildings, structures and excavations. Groundwater level measurements from the current investigation and the desktop study indicate a high groundwater level. As a result, foundation drains for buildings should be considered to allow for groundwater fluctuation. The drains should be provided for all below-grade walls and should consist of a continuous, perforated PVC drain pipe, surrounded with 20 mm drain rock and completely encapsulated in a nonwoven geotextile filtration layer. The geotextile should be installed in accordance with the manufacturer's recommendations.

Full-time monitoring and compaction testing should be provided during any subgrade preparation, fill placement or proof-rolling to confirm that the specifications are being achieved. Qualified geotechnical personnel, independent of the contractor, should perform this monitoring and testing.

Prior to backfilling operations, the SPMDD of the excavated soils and of potential borrow sources should be determined. This information is required for quality control purposes during backfilling and compaction operations.

Unnecessary trafficking, disturbance and water content changes (wetting or drying) of the subgrade should be avoided. A large sheepsfoot compactor or similar that imparts a kneading-type compactive effort should be used to achieve suitable levels of compaction of the silty clay to clay soils. A vibratory roller-compactor should be used for compacting granular fill.

6.2.2 Suitability of Re-Using Excavated Soils as Fill

Based on the information presented on the Record of Borehole Sheets contained in Appendix A, the majority of the soils encountered in the top 1.8 m of Borehole BH15-03 and top1.2 m of Borehole BH15-04 consists of high plastic clays containing root fibres, which are not suitable for re-use as engineered fill. It is expected that if engineered fill is required for the Site development, then suitable imported fill material would be needed for this purpose.

6.3 Feasible Foundation

6.3.1 Cast-In-Place Concrete Piles

Based on the subsurface conditions encountered, straight shaft cast-in-place concrete friction piles are considered feasible at the Site. Given the variability of strength in the clayey foundation soils and the lack of a distinct till layer, the Site may not be suitable for end-bearing piles and should be designed for shaft friction only.

Seepage was observed during the current field investigation in both boreholes due to the presence of wet sand pockets, sandy sand deposits, and wet sand deposits. Seepage was also encountered within wet silts and sands in boreholes advanced during previous investigations in close proximity to the Site. Therefore, temporary casing will be required during construction to seal off zones where seepage and possible subsequent sloughing may occur. In areas where wet sand zones or softer clay are encountered, it may be necessary to extend the length of the friction piles, and the temporary casing to achieve the design pile capacity.

For preliminary design, a factored shaft friction resistance of 30 kPa may be used within the silty clay deposit soils and a factored shaft friction resistance of 50 kPa may be used within the sand deposit soils. These values must be confirmed during the detailed design phase. The skin friction resistance within the upper 2 m below final grade should be ignored in the calculation of the unfactored pile resistance, as it is assumed that this material will not offer resistance due to disturbance during construction. Skin friction resistance of the clay fill layer encountered during the site investigation has not been considered, as it is expected that this layer will be less than 2 m thick. Adfreeze, minimum pile length and reinforcement considerations will need to be addressed during detailed design.

It should be noted that the recommended axial capacity of the concrete piles assume that the base of the drilled shaft is free of any loose or softened soil, the soil is relatively undisturbed over the design length of the pile and that the concrete can be placed in dry conditions. The piling contractor should be prepared to remove any loose or wet material from the base prior to placing the concrete. Concrete placement by tremie techniques may be required if groundwater seepage into the piles cannot be controlled during construction.

Full-time inspection by qualified geotechnical personnel during pile installation is recommended to maintain pile driving records. It is recommended that each pile be reviewed and approved by the geotechnical engineer in charge of the design to confirm that the required pile capacity is achieved.

6.3.2 Continuous Flight Auger Piles

From a geotechnical perspective, continuous flight auger (CFA) piles may be considered a more feasible foundation alternative at the Site. Similar to cast-in-place concrete piles, CFA piles are cast-in-place; however the holes are advanced using hollow-stem augers, reducing the effects of water seepage, and then pressure grouted. These piles are heavily influenced by operator factors, such as over churning.

For preliminary design, a factored shaft friction resistance of 30 kPa may be used within the clay deposit soils and a factored shaft friction resistance of 50 kPa may be used within the sand deposit soils. These values must be confirmed during the detailed design phase. Adfreeze, minimum pile length and reinforcement considerations will need to be addressed during detailed design.

Full-time inspection by qualified geotechnical personnel during pile installation is recommended to maintain pile records. It is recommended that each pile be reviewed and approved by the geotechnical engineer in charge of the design to confirm that the required pile capacity is achieved.

6.3.3 Slab-on-Grade/Structurally Supported Slabs

Slab-on-grade floors could be utilized for lightly loaded structures; however, settlements should be anticipated.

The exposed subgrade materials should be reviewed at the time of construction to confirm the soil conditions at the underside of slab design grade, and to better determine the material suitability for appropriate subgrade preparation and slab-on-grade support.

The slab-on-grade should be supported on at least 150 mm of compacted, free-draining, well-graded 19 mm minus crushed gravel base course, placed over competent subgrade soils. The compacted base course material should be uniformly compacted to at least 100 per cent SPMDD as per ASTM D698. The exposed subgrade soils should be proof-rolled prior to placement of base course gravel. Soft or other unsuitable materials should be excavated and backfilled with suitable, well-compacted, approved earth backfill materials.

External (unheated) concrete slabs (i.e. ramps) may be subject to vertical movement as a result of frost heave action. Potential slab heave may be reduced by appropriate surface and sub-slab drainage control and insulation. Should the potential for frost action movement not be acceptable, additional recommendations related to the use of insulation and of less frost susceptible soils will be required to minimize or prevent frost penetration.

Alternatively, if a slab-on-grade is not considered desirable, then the slab should be structurally supported by the cast-in-place concrete pile or continuous flight auger pile foundation system. As with slab-on-grade systems, a layer of at least 150 mm thickness of free-draining, well-graded 19 mm minus crushed gravel that is uniformly compacted to at least 100 per cent SPMDD, should be placed beneath the slab.

6.4 Excavation and Construction Groundwater Control

Excavations will typically extend through the existing stiff to very stiff clay fill and firm to stiff native silty clay. All temporary and permanent excavations, including trenches should be carried out in accordance with the guidelines outlined in the Alberta Occupational Health and Safety Regulation (OH&S), specifically Part 32, which deals with excavation and tunnelling (2009). Based on the OH&S, the clay is classified as “likely to crack or crumble”.

It is recommended that temporary excavations (i.e. those that are open for a relatively short time period) be developed with side slopes no steeper than 1 horizontal to 1 vertical (1H:1V) within the clay fill layer and native silty clay deposit. Flatter side slopes will be required if seepage is encountered or if the excavations extend below the groundwater level. Excavations should be monitored frequently by qualified geotechnical personnel; if signs of suspected instability are observed, shallower slope angles may be required.

The stockpiling or storage of excavation spoils, construction materials or heavy equipment should not be permitted within 3 m of the crest of excavation slopes to prevent overloading of the crest and reduce the potential for slope movements.

If the excavations are maintained above the groundwater level, some minor groundwater seepage may occur from within cohesionless interlayers or lenses within the native deposits. However, it is expected that such seepage volumes will be minor and could be adequately controlled by pumping from properly filtered sumps within the excavations. Excavations below a depth of about 6.1 m, or into the native sand deposit, may experience significant groundwater seepage sloughing.

Should seepage or wet zones be encountered during excavation, flatter temporary and permanent slopes may be required. If the seepage or wet zones are encountered below the toe of the slope, the groundwater may be managed using ditches and properly filtered sump and pump systems. Water removed from excavations should be directed toward a suitable discharge location.

Control of surface water should be maintained at all times and surface water should be directed away from all excavations and exposed subgrade soils.

6.5 Water Soluble Sulphate Content and Cement Type

A total of two water soluble sulphate content tests were completed on samples retrieved from the current drilling investigation. The test results are contained in Appendix B and indicate that water soluble sulphate concentrations were less than 0.05 per cent, indicating a negligible presence of water soluble sulphates. However, past experience indicates that the sulphate content in the lacustrine clay can vary significantly with depth. As a result, greater sulphate contents than measured in the laboratory are considered possible within the clay deposit. A summary of the results of the water soluble sulphate testing is provided in Table 3 and contained in Appendix B.

Table 3: Analytical Test Results

Borehole/ Sample No.	Depth (m)	pH	Soluble Sulphates (%)	Chloride Concentration (mg/L)	Electrical Resistivity (Ohm-cm)
BH14-04 AS3	3.0 – 3.4	8.21	<0.05	<5.0	2690
BH14-04 AS9	6.1 – 6.4	7.89	<0.05	<5.0	2940

Based on past experience and soil testing in the area, it is recommended that the Site be classified as an S-3 exposure class. For design purposes, type MS or MSb cement is recommended for all concrete in contact with soil. To enhance durability, an appropriate quantity of entrained air, as per CSA A23.1-09, Clause 4.1.1.3, is recommended for all concrete exposed to freezing and thawing. Based on an S-3 exposure class, the maximum water-to-cementing material ratio of 0.50 is recommended, with a minimum specified compressive strength of 30 MPa at 56 days. Imported soils should be tested for compatibility with the recommended cement type. Prior to detailed design, water soluble sulphate testing should be conducted to confirm the sulphate content.

6.6 Seismic Site Classification

The seismic response of the Site was classified according to the National Building Code of Canada 2005 (NBCC), which categorizes the soil conditions into 6 types - Class ‘A’ to ‘F’. This classification is based on the average shear wave velocity, SPT “N” values, or undrained shear strength over the top 100 ft (30 m) of the soil profile.

No boreholes were drilled to depths over 30 m at the proposed Site. However, it is expected that consideration in selecting the seismic site classification will be dominated by the silty clay within the upper 10 m. Based on the SPT profile in the boreholes, the Site is categorized as Class ‘E’ to Class ‘D’ according to NBCC 2005.

7.0 CLOSURE

The preliminary recommendations presented in this report are made based on Golder's interpretation of subsurface conditions encountered during the geotechnical investigation, a review of existing information for the area, and Golder's present understanding of the project requirements. Should any conditions at the Site be encountered which differ from those addressed, we require that we be notified immediately in order to permit re-assessment of our recommendations.

We trust that the information presented in this report meets your present requirements. If you have any questions, please contact the undersigned at your convenience.

GOLDER ASSOCIATES LTD.

APEGA Permit to Practice #P5122

October 6, 2015

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Geotechnical Engineer

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Principal, Senior Geotechnical Engineer

SN/NK/LG/nk

n:\active\2014\1376 geotechnical 2014\4-projects\14-11943 - coe-ogilvie ridge-edmonton\3. analysis and reporting\3. reporting\3. final\alternative site\1411943 rpt 15oct06 coe ogilvie ridge development - alternate site.docx

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Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface

conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

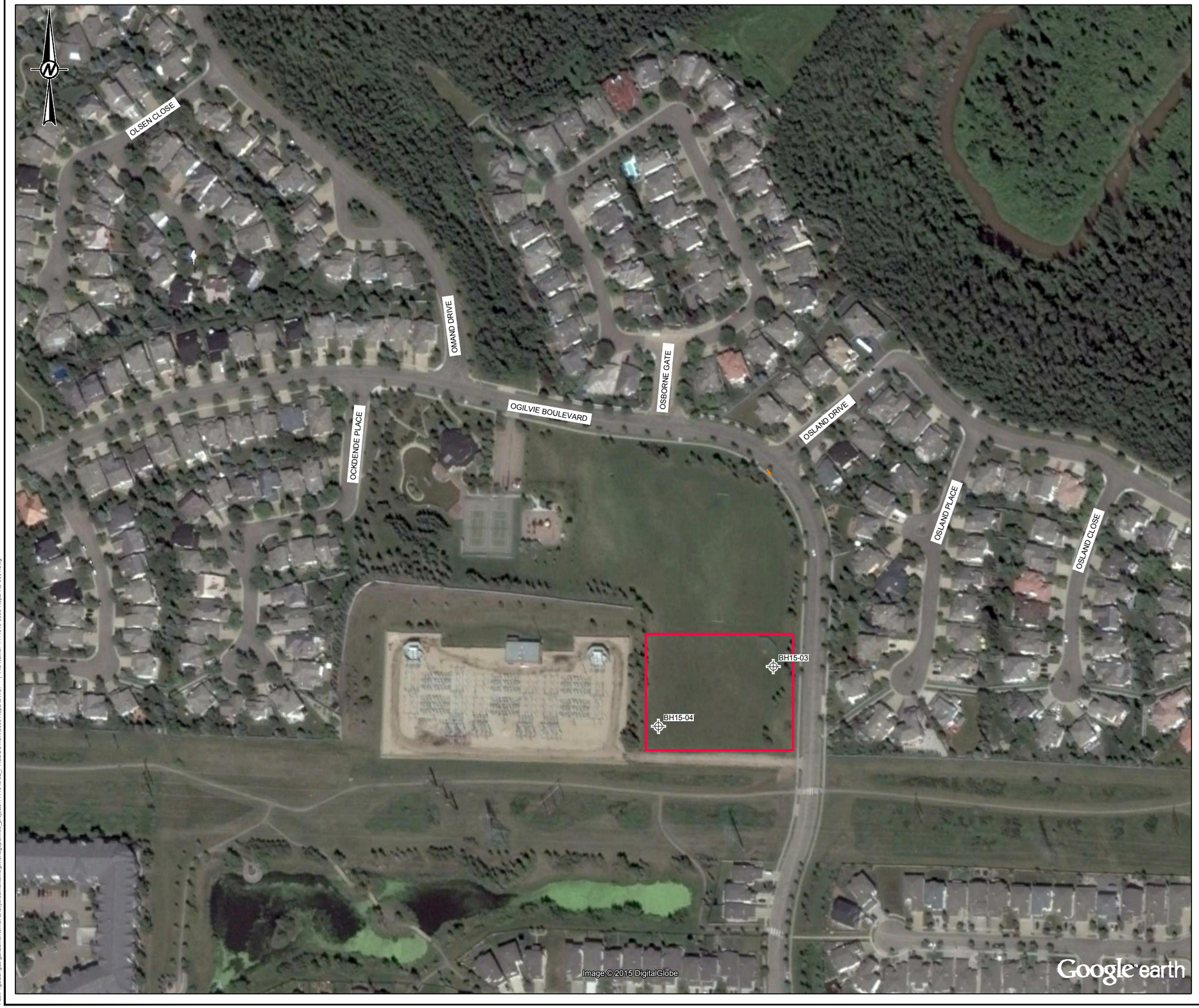
Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

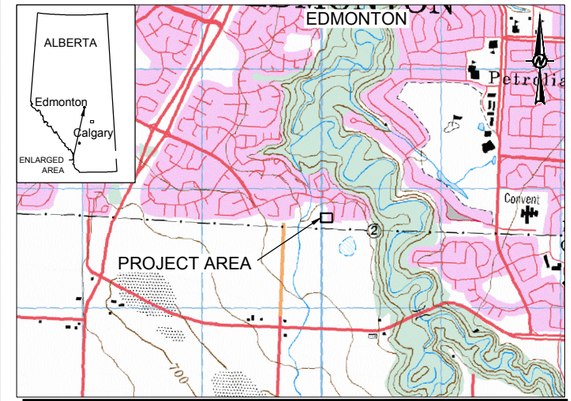
Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.



LEGEND

APPROXIMATE BOREHOLE LOCATION

SITE LOCATION



KEY MAP

NOT TO SCALE

REFERENCE(S)

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TOPOGRAPHIC MAPS 83H05 OBTAINED FROM CanMatrix © 1995 HER MAJESTY THE QUEEN IN RIGHT OF CANADA. DEPARTMENT OF NATURAL RESOURCES. ALL RIGHTS RESERVED.
DATUM: NAD83, PROJECTION: ZONE 12.

0 50 100
1:2,500 (APPROX.) METRES

CLIENT
CITY OF EDMONTON

PROJECT
OGILVIE RIDGE DEVELOPMENT
ALTERNATE SURPLUS SCHOOL SITE
EDMONTON, AB

TITLE
SITE AND BOREHOLE LOCATION PLAN

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-06
PREPARED	DP
DESIGN	SN
REVIEW	NK
APPROVED	LG

PROJECT No.	CONTROL	Rev.	FIGURE
1411943	5000-HS-REPB-0001	A	1

LEGEND

SITE LOCATION

NOT TO SCALE

CLIENT
CITY OF EDMONTON

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-06
PREPARED	SN
DESIGN	SN
REVIEW	NK
APPROVED	LG

PROJECT
OGILVIE RIDGE DEVELOPMENT
ALTERNATE SURPLUS SCHOOL SITE
EDMONTON, AB

TITLE
AIR PHOTO AS136-60
APRIL 1950

PROJECT No.	Rev.	FIGURE
1411943	**0**	**2**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0

LEGEND

SITE LOCATION

NOT TO SCALE

CLIENT
CITY OF EDMONTON

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-06
PREPARED	SN
DESIGN	SN
REVIEW	NK
APPROVED	LG

PROJECT
OGILVIE RIDGE DEVELOPMENT
SURPLUS SCHOOL SITE
EDMONTON, AB

TITLE
AIR PHOTO AS1043-121
JUNE 1969

PROJECT No.	Rev.	FIGURE
1411943	**0**	**3**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0

NOT TO SCALE

LEGEND

SITE LOCATION

CLIENT
CITY OF EDMONTON

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-06
PREPARED	SN
DESIGN	SN
REVIEW	NK
APPROVED	LG

PROJECT
OGILVIE RIDGE DEVELOPMENT
SURPLUS SCHOOL SITE
EDMONTON, AB

TITLE
AIR PHOTO AS3590-41
JUNE 1987

PROJECT No.	Rev.	FIGURE
1411943	**0**	**4**

LEGEND

SITE LOCATION

NOT TO SCALE

CLIENT
CITY OF EDMONTON

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-06
PREPARED	SN
DESIGN	SN
REVIEW	NK
APPROVED	LG

PROJECT
OGILVIE RIDGE DEVELOPMENT
SURPLUS SCHOOL SITE
EDMONTON, AB

TITLE
AIR PHOTO AS5461B-255
OCTOBER 2008

PROJECT No.	Rev.	FIGURE
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
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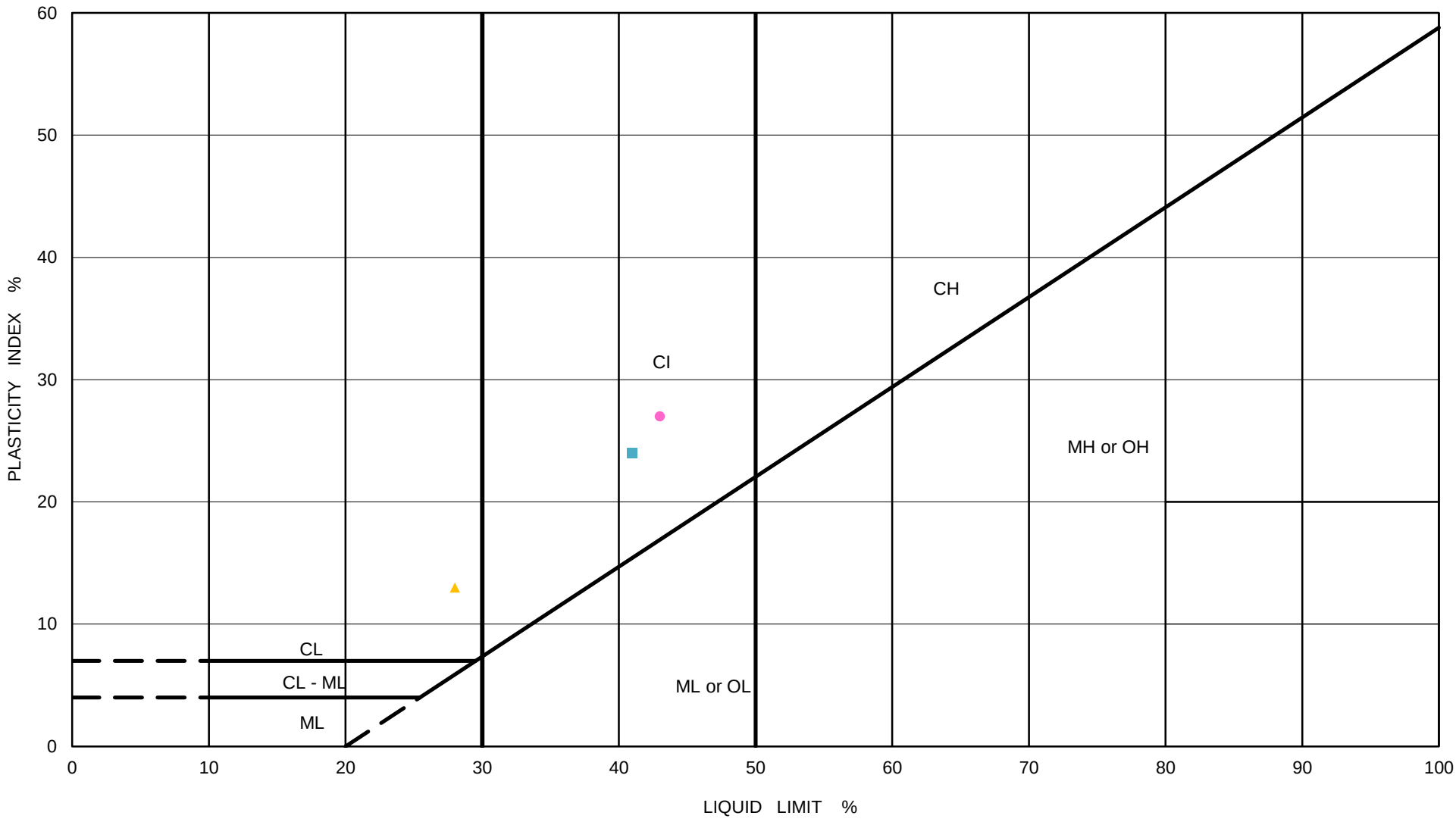

● BH15-04 SS4 Silty Clay

■ BH15-04 SS8 Silty Clay

▲ BH15-04 AS11 Silty Clay

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CITY OF EDMONTON

CONSULTANT
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YYYY-MM-DD	2015-10-06
PREPARED	SN
DESIGN	SN
REVIEW	NK
APPROVED	LG

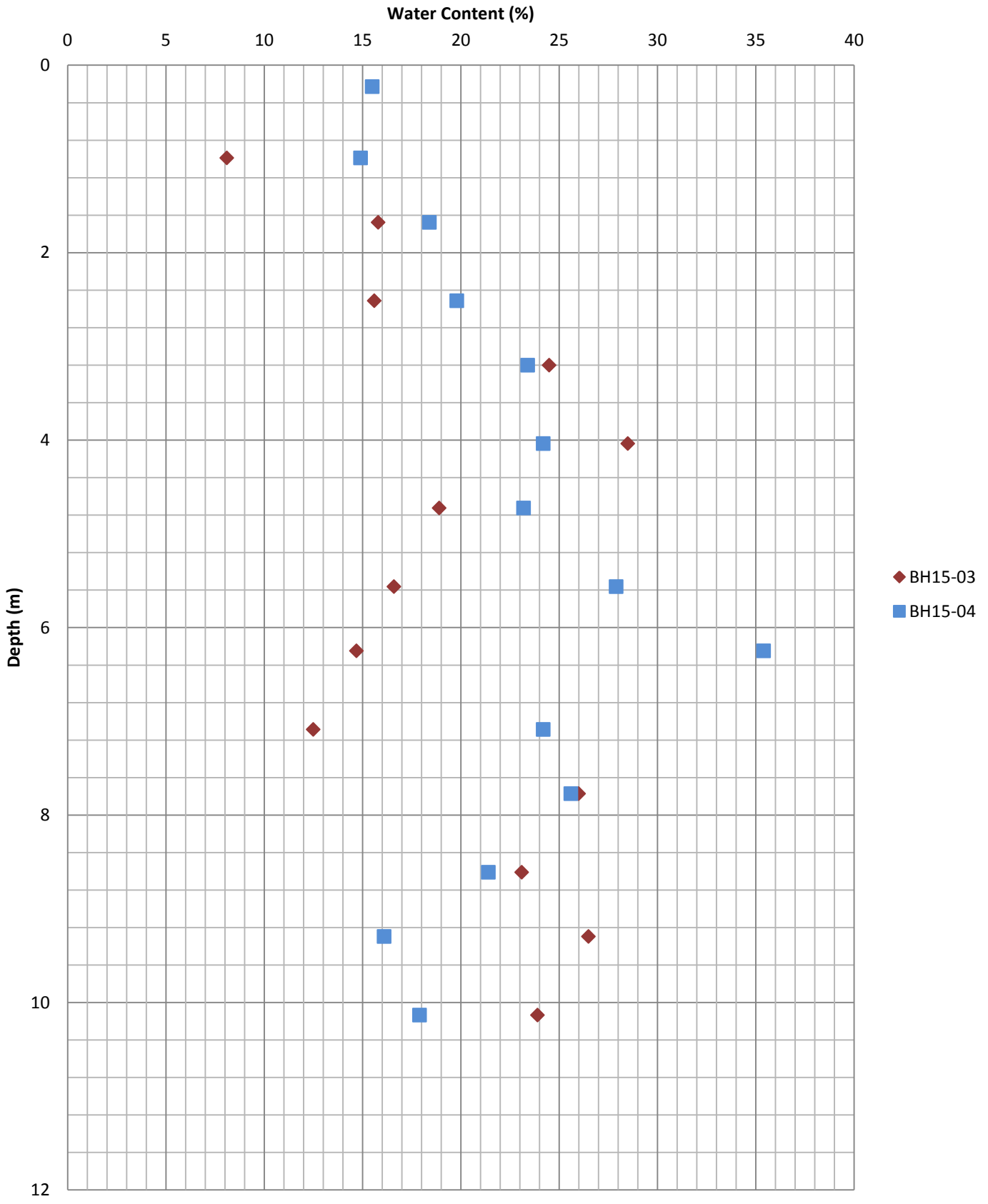
PROJECT
OLGIIVIE RIDGE DEVELOPMENT
ALTERNATE SURPLUS SCHOOL SITE
EDMONTON, ALBERTA

TITLE
PLASTICITY CHART
Silty Clay

PROJECT No.
1411943

Rev.
A

6



CLIENT
CITY OF EDMONTON

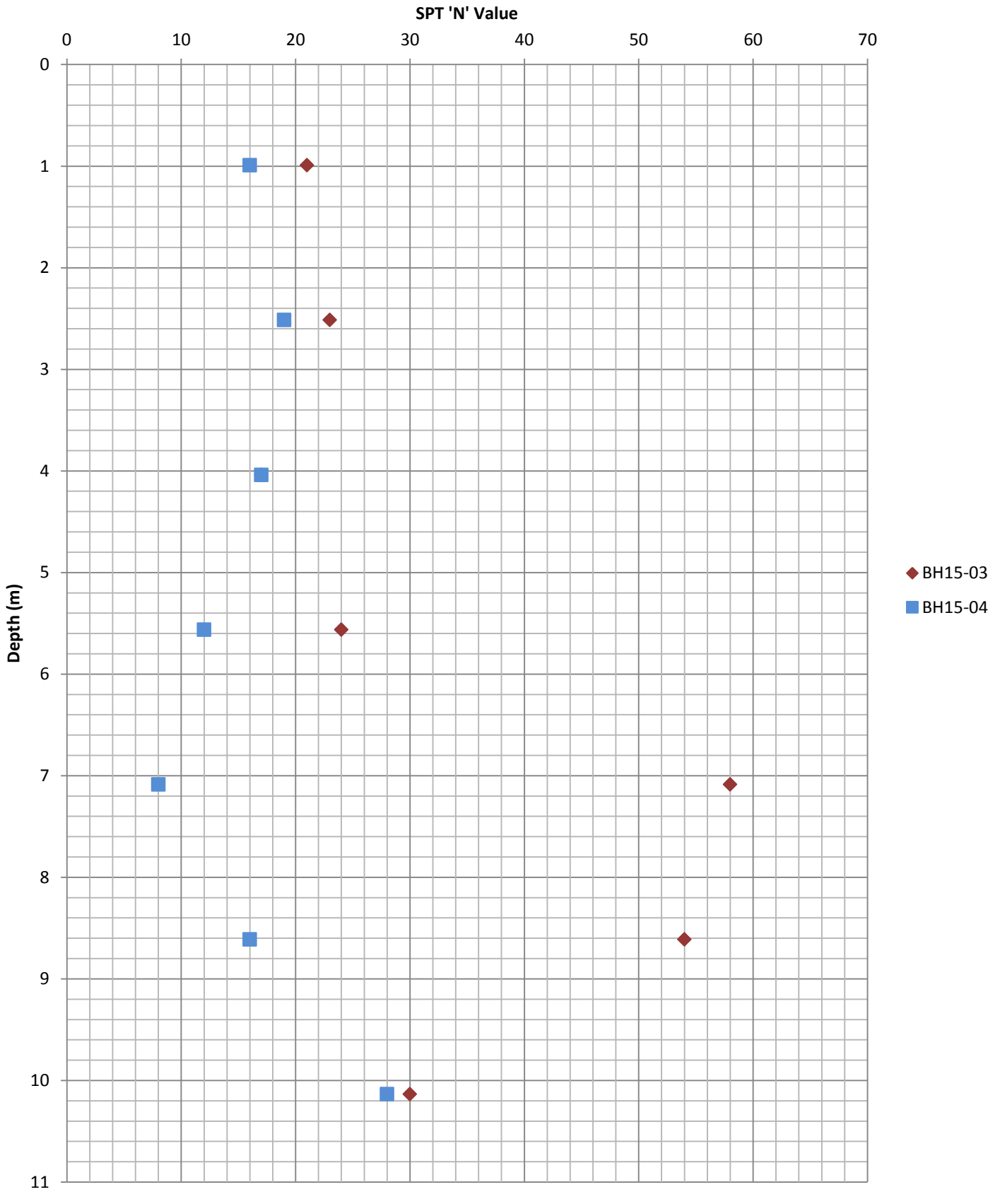
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-06
PREPARED	SN
DESIGN	SN
REVIEW	NK
APPROVED	LG

PROJECT
OGILVIE DEVELOPMENT
ALTERNATE SURPLUS SCHOOL SITES
EDMONTON, ALBERTA

TITLE
WATER CONTENT VERSUS DEPTH

PROJECT No. **1411943**
Rev. **A**
FIGURE No. **7**



CLIENT
CITY OF EDMONTON

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-06
PREPARED	SN
DESIGN	SN
REVIEW	NK
APPROVED	LG

PROJECT
OGILVIE DEVELOPMENT
ALTERNATE SURPLUS SCHOOL SITES
EDMONTON, ALBERTA

TITLE
SPT "N" VALUE VERSUS DEPTH

PROJECT No. **1411943**
Rev. **A**
FIGURE No. **8**

APPENDIX A

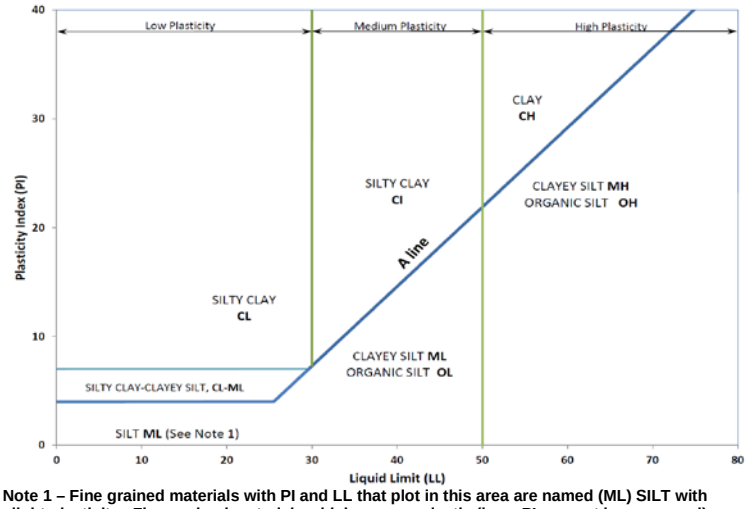
Record of Borehole Sheets

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil		Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
					Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)		Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
					Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
					Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
				Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
					None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)		Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
				Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
				Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures								30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat								75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to ~~or~~ indicate~~s~~ a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

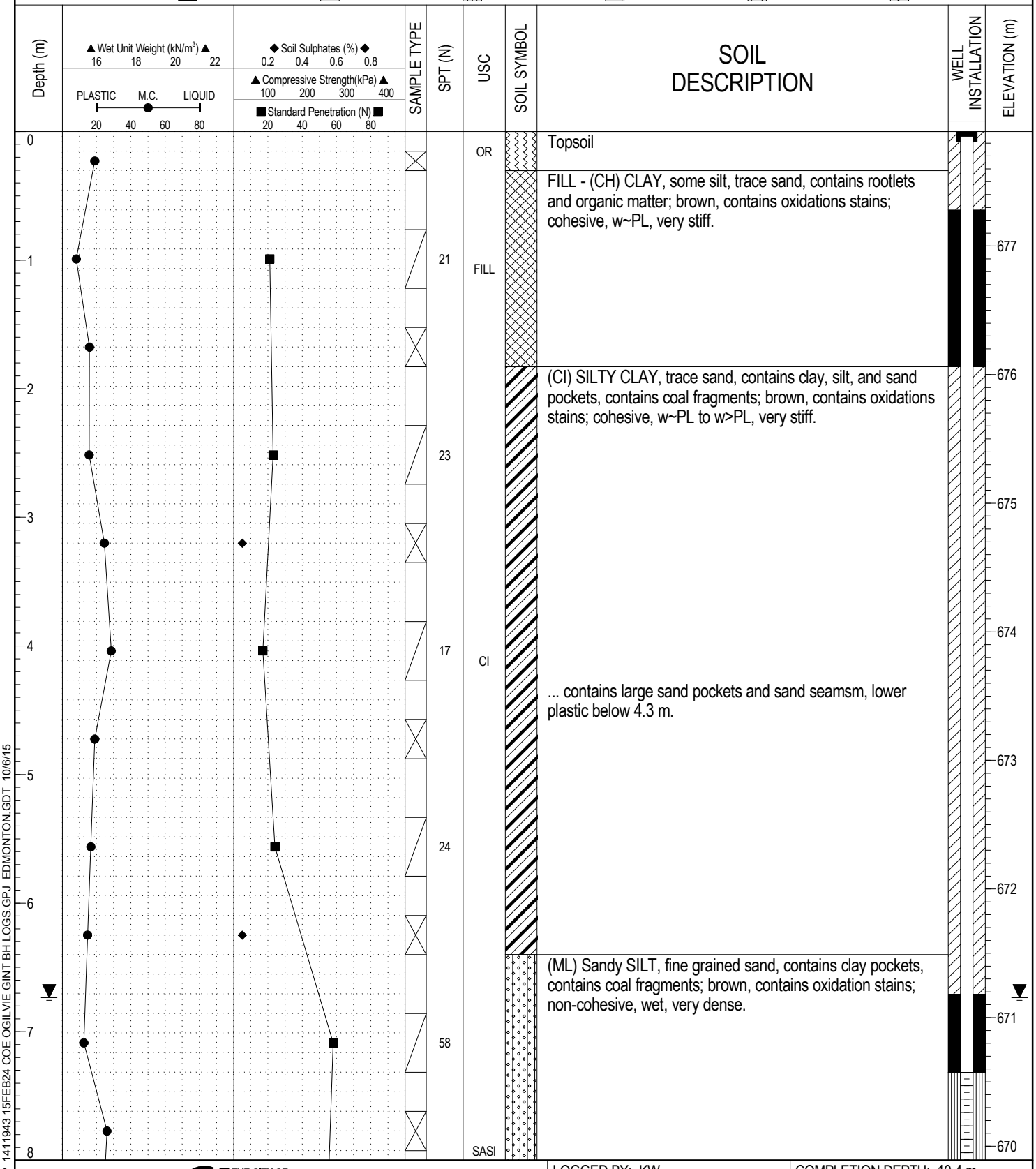
Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

Ogilvie Ridge Development	Drilling Co: Mobile Augers and Research Ltd.	BOREHOLE NO: **BH15-03**
Transportation Services	UTM ZONE: - N5926767 E330077	PROJECT NO: 1411943
START DATE: 7/29/15	NAD83, UTM ZONE 12	ELEVATION: 677.89 m

SAMPLE TYPE: Shelby Tube; Drive Sample; Auger Sample; No Recovery; A Casing; Cored Sample

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND



Topsoil

FILL - (CH) CLAY, some silt, trace sand, contains rootlets and organic matter; brown, contains oxidations stains; cohesive, w~PL, very stiff.

(CI) SILTY CLAY, trace sand, contains clay, silt, and sand pockets, contains coal fragments; brown, contains oxidations stains; cohesive, w~PL to w>PL, very stiff.

... contains large sand pockets and sand seamsm, lower plastic below 4.3 m.

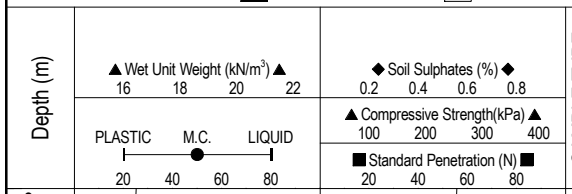
(ML) Sandy SILT, fine grained sand, contains clay pockets, contains coal fragments; brown, contains oxidation stains; non-cohesive, wet, very dense.

LOGGED BY: KW	COMPLETION DEPTH: 10.4 m
REVIEWED BY: NK	COMPLETION DATE: 7/29/15

Ogilvie Ridge Development	Drilling Co: Mobile Augers and Research Ltd.	BOREHOLE NO: **BH15-03**
Transportation Services	UTM ZONE: - N5926767 E330077	PROJECT NO: 1411943
START DATE: 7/29/15	NAD83, UTM ZONE 12	ELEVATION: 677.89 m

SAMPLE TYPE: Shelby Tube; Drive Sample; Auger Sample; No Recovery; A Casing; Cored Sample

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND



Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	WELL INSTALLATION	ELEVATION (m)
8							
		54					
9							669
					(SP) SAND, fine to coarse grained, contains coal fragments; brown, contains oxidation stains; non-cohesive, wet, dense.		
10		30	SP				668
					END OF BOREHOLE		
					1. Borehole advanced using 152 mm solid stem augers.		
11							667
					2. Borehole open to a depth of 7.4 m on completion of drilling.		
					3. Water level in open borehole at 7.3 m on completion of drilling.		
12							666
					4. Water levels in standpipe piezometer measured as follows:		
					Date / Depth (m) / Elev (m) Jul 29, 2015 / 8.1 / 669.8 Aug 21, 2015 / 6.7 / 671.2 Sep 2, 2015 / 6.8 / 671.1		
13							665
14							664
15							663
16							662

THE CITY OF Edmonton

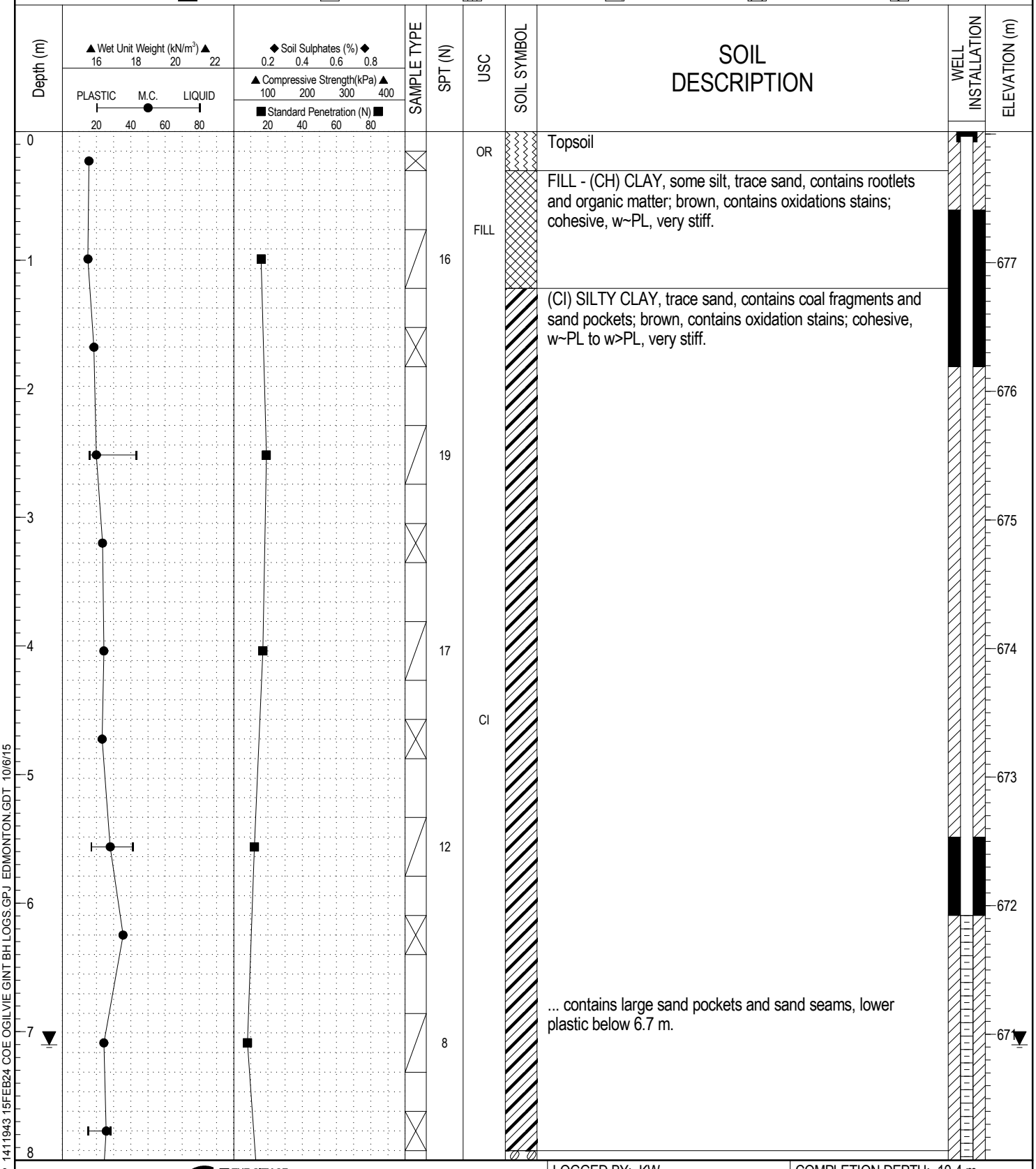
LOGGED BY: KW	COMPLETION DEPTH: 10.4 m
REVIEWED BY: NK	COMPLETION DATE: 7/29/15

STANDPIP 1411943 15FEB24 COE OGILVIE GINT BH LOGS.GPJ EDMONTON.GDT 10/6/15

Ogilvie Ridge Development	Drilling Co: Mobile Augers and Research Ltd.	BOREHOLE NO: **BH15-04**
Transportation Services	UTM ZONE: - N5926728 E330002	PROJECT NO: 1411943
START DATE: 7/29/15	NAD83, UTM ZONE 12	ELEVATION: 678.02 m

SAMPLE TYPE: Shelby Tube; Drive Sample; Auger Sample; No Recovery; A Casing; Cored Sample

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

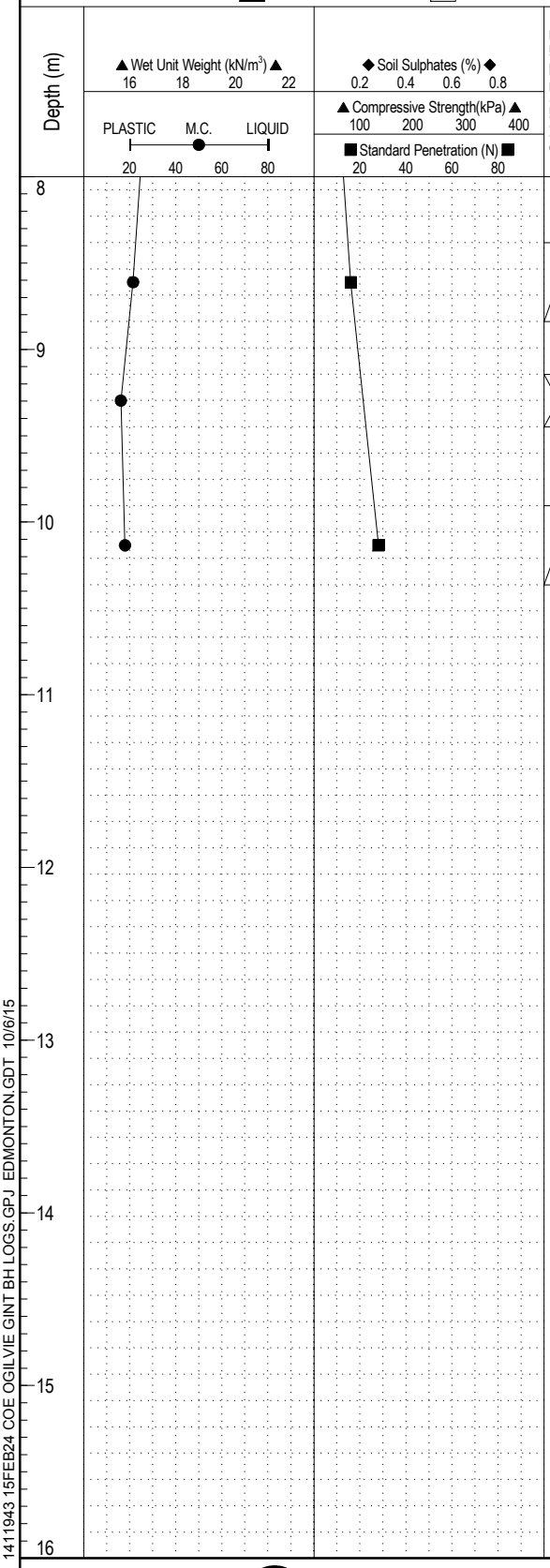


LOGGED BY: KW	COMPLETION DEPTH: 10.4 m
REVIEWED BY: NK	COMPLETION DATE: 7/29/15

Ogilvie Ridge Development	Drilling Co: Mobile Augers and Research Ltd.	BOREHOLE NO: **BH15-04**
Transportation Services	UTM ZONE: - N5926728 E330002	PROJECT NO: 1411943
START DATE: 7/29/15	NAD83, UTM ZONE 12	ELEVATION: 678.02 m

SAMPLE TYPE: Shelby Tube; Drive Sample; Auger Sample; No Recovery; A Casing; Cored Sample

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND



SOIL DESCRIPTION

(SP) SAND, fine to coarse grained, trace gravel, trace fines, contains coal fragments; brown, contains oxidation stains; non-cohesive, wet, compact.

... very stiff silty clay lens from 8.8 m to 9.8 m.

WELL INSTALLATION

ELEVATION (m)
669
668
667
666
665
664
663

END OF BOREHOLE

1. Borehole advanced using 152 mm solid stem augers.

2. Borehole open to a depth of 9.1 m on completion of drilling.

3. Water level in open borehole at 7.6 m on completion of drilling.

4. Water levels in standpipe piezometer measured as follows:

Date	Depth (m)	Elev (m)
Jul 29, 2015	8.5	669.5
Aug 21, 2015	7.1	670.9
Sep 2, 2015	7.1	670.9

THE CITY OF Edmonton

LOGGED BY: KW	COMPLETION DEPTH: 10.4 m
REVIEWED BY: NK	COMPLETION DATE: 7/29/15

APPENDIX B

Laboratory Test Results

Atterberg Limits (ASTM D 4318)

Project No.:	14-11943	Phase:	4000
Short Title:	COE - Ogilvie Ridge Development	Lab No.:	E092-18
Tested By:	MD	Date:	7-Aug-15

Borehole: BH15-04 Sample No.: AS4 Depth: 0.76 - 1.22 m

Liquid Limit Determination:

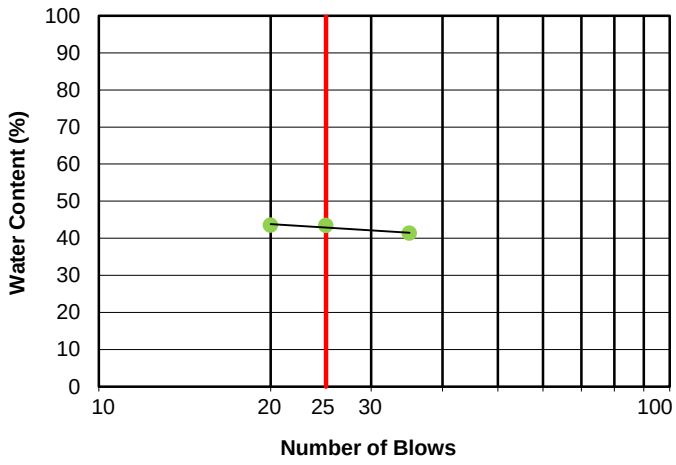
Trial No.	1	2	3
No. of Blows	35	25	20
Mass of wet sample + tare (g)	24.65	28.58	26.32
Mass of dry sample + tare (g)	21.89	24.72	23.23
Mass of tare (g)	15.22	15.84	16.13
Weight of Water (g)	2.76	3.86	3.09
Weight of dry soil (g)	6.67	8.88	7.1
Water Content (%)	41.4	43.5	43.5

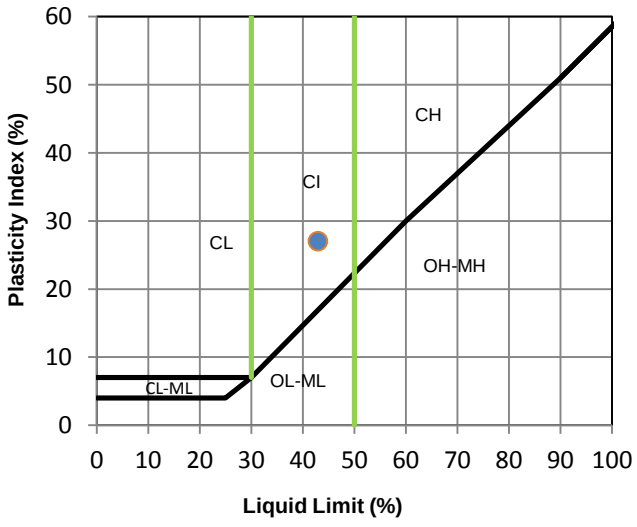
Natural Water Content:

As Received Water Content (%)	19.8%

Plastic Limit Determination:

Mass of wet sample + tare (g)	25.02	24.88
Mass of dry sample + tare (g)	23.77	23.57
Mass of tare (g)	15.99	15.32
Weight of Water (g)	1.25	1.31
Weight of dry soil (g)	7.78	8.25
Water Content (%)	16.07	15.88
Average Water Content (%)		15.97





Liquid Limit =	43	%
Plastic Limit =	16	%
Plasticity Index =	27	

Comments: _____

Reviewed: _____

Atterberg Limits (ASTM D 4318)

Project No.:	14-11943	Phase:	4000
Short Title:	COE - Ogilvie Ridge Development	Lab No.:	E092-22
Tested By:	MD	Date:	7-Aug-15

Borehole: BH15-04 Sample No.: SS8 Depth: 3.81 - 4.27 m

Liquid Limit Determination:

Trial No.	1	2	3
No. of Blows	35	27	22
Mass of wet sample + tare (g)	26.68	31.38	31.49
Mass of dry sample + tare (g)	23.23	27.81	27.3
Mass of tare (g)	14.48	18.98	17.23
Weight of Water (g)	3.45	3.57	4.19
Weight of dry soil (g)	8.75	8.83	10.07
Water Content (%)	39.4	40.4	41.6

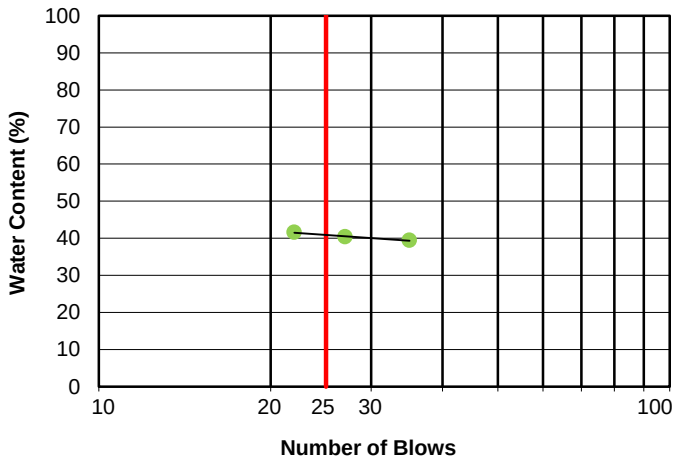
Natural Water Content:

As Received Water Content (%)	27.9%

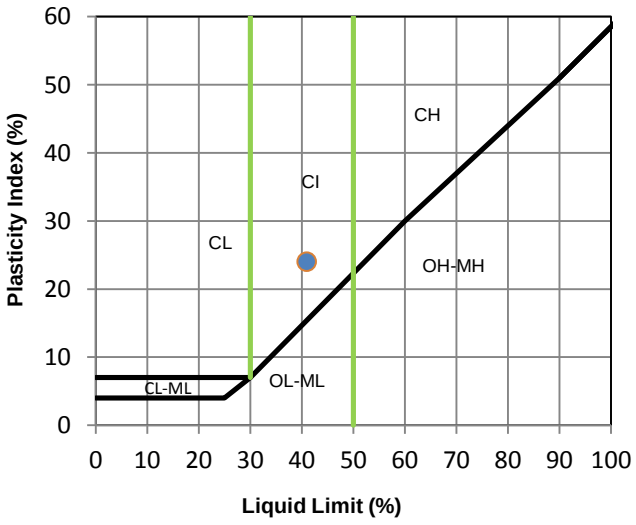
Plastic Limit Determination:

Mass of wet sample + tare (g)	23.60	23.93
Mass of dry sample + tare (g)	22.34	22.72
Mass of tare (g)	15.14	15.71
Weight of Water (g)	1.26	1.21
Weight of dry soil (g)	7.20	7.01
Water Content (%)	17.50	17.26
Average Water Content (%)		17.38

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	41	%
Plastic Limit =	17	%
Plasticity Index =	24	

Comments: _____

Reviewed: _____

Atterberg Limits (ASTM D 4318)

Project No.:	14-11943	Phase:	4000
Short Title:	COE - Ogilvie Ridge Development	Lab No.:	E092-25
Tested By:	MD	Date:	7-Aug-15

Borehole: BH15-04 Sample No.: AS11 Depth: 5.59-5.79m

Liquid Limit Determination:

Trial No.	1	2	3
No. of Blows	29	25	20
Mass of wet sample + tare (g)	28.28	28.82	26.98
Mass of dry sample + tare (g)	25.53	25.81	24.37
Mass of tare (g)	15.78	15.22	15.33
Weight of Water (g)	2.75	3.01	2.61
Weight of dry soil (g)	9.75	10.59	9.04
Water Content (%)	28.2	28.4	28.9

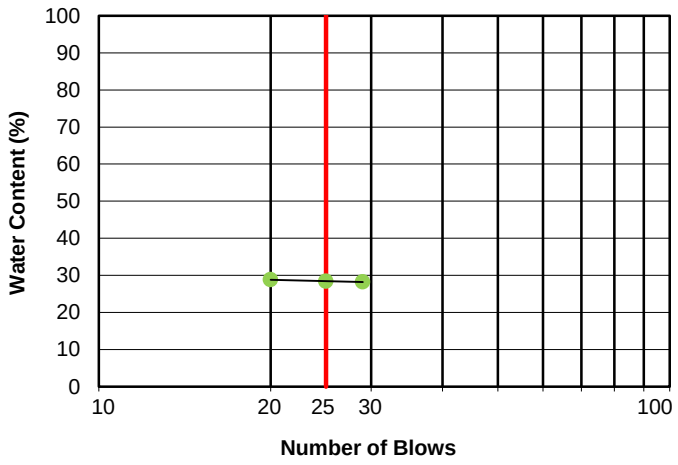
Natural Water Content:

As Received Water Content (%)	25.6%

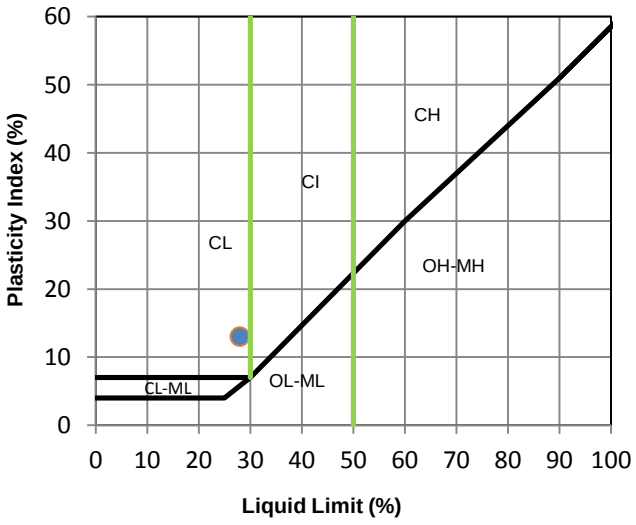
Plastic Limit Determination:

Mass of wet sample + tare (g)	25.71	25.00
Mass of dry sample + tare (g)	24.47	23.72
Mass of tare (g)	16.09	15.59
Weight of Water (g)	1.24	1.28
Weight of dry soil (g)	8.38	8.13
Water Content (%)	14.80	15.74
Average Water Content (%)		15.27

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	28	%
Plastic Limit =	15	%
Plasticity Index =	13	

Comments: _____

Reviewed: _____

GOLDER ASSOCIATES LTD
ATTN: NIKOL KOCHMANOVA
16820 107 Ave NW
EDMONTON AB T5P 4C3

Date Received: 06-AUG-15
Report Date: 20-AUG-15 12:41 (MT)
Version: FINAL

Client Phone: 780-996-5133

Certificate of Analysis

Lab Work Order #: L1653654

Project P.O. #: NOT SUBMITTED
Job Reference: 1411943/4000
C of C Numbers: 10-326075
Legal Site Desc:

Jessica Spira, Env. Tech. DIPL
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1653654-1 BH15-04 AS5							
Sampled By: CLIENT on 06-AUG-15 @ 10:00							
Matrix: BAG							
Miscellaneous Parameters							
Chloride (Cl)	<5.0		5.0	mg/kg	15-AUG-15	17-AUG-15	R3247796
Resistivity	2690		1.0	ohm cm		17-AUG-15	R3248072
Total Sulphate Ion Content	<0.050		0.050	%	18-AUG-15	18-AUG-15	R3249284
pH (1:2 soil:water)	8.21		0.10	pH		19-AUG-15	R3249253
L1653654-2 BH15-04 AS9							
Sampled By: CLIENT on 06-AUG-15 @ 10:00							
Matrix: BAG							
Miscellaneous Parameters							
Chloride (Cl)	<5.0		5.0	mg/kg	15-AUG-15	17-AUG-15	R3247796
Resistivity	2940		1.0	ohm cm		17-AUG-15	R3248072
Total Sulphate Ion Content	<0.050		0.050	%	18-AUG-15	18-AUG-15	R3249284
pH (1:2 soil:water)	7.89		0.10	pH		19-AUG-15	R3249253

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-1:5-DI-COL-ED	Soil	Chloride (Cl)	APHA 4500 Cl E-Colorimetry
PH-1:2-ED	Soil	pH 1:2 H2O Extract	CSSS 16.2 - PH OF 1:2 WATER EXTRACT
RESISTIVITY-PASTE-CL	Soil	PASTE RESISTIVITY	ASTM G57-95A

This analysis is carried out using procedures adapted from ASTM G57-95a (2001) "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method". In summary, 200 to 500 grams of sample is mixed with deionized water as required to create a saturated paste. The sample is then placed directly into a four electrode resistivity soil box and measured for resistivity using a resistivity meter.

SO4-T-CSA-A23-ED	Soil	Total Sulphate Ion Content	CSA INTERNATIONAL A23.2

Total sulphate content is determined by mixing soil with water then hydrochloric acid, and digesting just below boiling point, for 15 minutes. Analysis by ion chromatography follows.
NOTE: the CSA-A23 method states that for a total sulphate ion content greater than 0.2%, sulphate ion content shall be determined on the basis of a water extraction. This water extraction requires the total sulphate ion content result to calculate the correct ratio for the water extraction.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

10-326075

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1653654 Report Date: 20-AUG-15

Client: GOLDER ASSOCIATES LTD
16820 107 Ave NW
EDMONTON AB T5P 4C3
Contact: NIKOL KOCHMANOVA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-1:5-DI-COL-ED	**Soil**							
Batch R3247796								
WG2150239-2 IRM		**SALINITY_SOIL5**						
Chloride (Cl)			156.2	G	%		70-130	17-AUG-15
WG2150239-1 MB								
Chloride (Cl)			<5.0		mg/kg		5	17-AUG-15
PH-1:2-ED	**Soil**							
Batch R3249253								
WG2152671-1 IRM		**SALINITY_SOIL5**						
pH (1:2 soil:water)			7.22		pH		7.11-7.71	19-AUG-15
WG2152671-3 LCS								
pH (1:2 soil:water)			4.0		%		3.7-4.3	19-AUG-15
WG2152671-4 LCS								
pH (1:2 soil:water)			7.02		pH		6.7-7.3	19-AUG-15
WG2152671-5 LCS								
pH (1:2 soil:water)			10.0		%		9.7-10.3	19-AUG-15
RESISTIVITY-PASTE-CL	**Soil**							
Batch R3248072								
WG2151330-2 DUP		**L1654921-3**						
Resistivity		5320	5830		ohm cm	9.0	25	17-AUG-15
WG2151330-1 IRM		**SAL-STD8**						
Resistivity			109.3		%		80-120	17-AUG-15
SO4-T-CSA-A23-ED	**Soil**							
Batch R3249284								
WG2152109-2 CRM		**1880A_CEMENT**						
Total Sulphate Ion Content			88.6		%		60-140	18-AUG-15
WG2152109-3 DUP		**L1653654-1**						
Total Sulphate Ion Content		<0.050	<0.050	RPD-NA	%	N/A	30	18-AUG-15
WG2152109-1 MB								
Total Sulphate Ion Content			<0.050		%		0.05	18-AUG-15

Quality Control Report

Workorder: L1653654 Report Date: 20-AUG-15

Client: GOLDER ASSOCIATES LTD
16820 107 Ave NW
EDMONTON AB T5P 4C3
Contact: NIKOL KOCHMANOVA

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
G	QC result did not meet ALS DQO. Refer to narrative comments for further information.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

10- 326075

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

Page ____ of ____

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company:	Golder Associates Ltd.	Standard: ✓ Other (specify):		X Regular (Standard Turnaround Times - Business Days)
Contact:	Nikol Kochmanova	Select: PDF ✓ Excel ✓ Digital Fax		Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address:	16820 107 Ave	Email 1:	nikol_kochmanova@golder.com	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Edmonton, AB T5P 4C3	Email 2:	ktews@golder.com	Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone:	780 483 3499 Fax: 780 483 1574			

Invoice To	Same as Report ? (circle) (Yes) or No (if No, provide details)	Client / Project Information	
	Copy of Invoice with Report? (circle) (Yes) or No	Job #:	14 1943 / 4000
Company:		PO / AFE:	
Contact:		LSD:	
Address:			
Phone:	Fax:	Quote #:	
Lab Work Order # (lab use only)	L1653654	ALS Contact:	Sampler:

Analysis Request (Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	PSA	resistivity	chlorides	water soluble sulphates (SO4)	Number of Containers
AS5	BH15-04 AS5	06-Aug-15	10:00	Bag	/	/	/	/	
AS9	BH15-04 AS9	06-Aug-15	10:00	Bag	/	/	/		

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natu

L1653654-COFC

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: K. Tews	Date:	Time:	Received by: MD	Date: 06/08/15	Time: 12:43pm	Temperature: NA °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

APPENDIX C

Record of Borehole Sheets from Previous Investigations

IMC CONSULTING GROUP INC./CARMA	TOP-OF-BANK SETBACK EVALUATION	BOREHOLE : 1
	RIVERBEND-WHITEMUD CREEK,EDMONTON	PROJECT No: EG06774
B-61,TRACK/HOLLOW STEM AUGER		ELEVATION 687.77 (m)

SAMPLE TYPE: SHELBY TUBE | NO RECOVERY | SPT TEST | GRAB SAMPLE | SPLIT PEN | CORE SAMPLE

DEPTH (m)	USC	SOIL SYMBOL	SOIL/ROCK DESCRIPTION	SAMPLE TYPE	SPT (N)	▲ POCKET PEN (kPa) ▲ 200 400 600 800 / ■ STANDARD PEN (N) ■ 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	OTHER TEST COMMENTS	DEPTH (m)
0.0			TOPSOIL FILL,silty,clayey,black,rootlets					0.0
			CLAY FILL,silty,high plastic,grey-brown,				Frozen to 0.6 m	
1.0			CLAY,silty,high plastic,mottled grey brown,slickensides,silt pockets and stringers		33			1.0
			nugget structure,rust stringers,very stiff					
2.0			occasional pebble,fine sand pockets					2.0
			occasional med grained clean sand pockets and stringers		U1		pp = 425 kPa	
3.0			faint, discontinuous, slickensides, randomly oriented		19			3.0
			blocky structure,occasional coal pocket					
4.0			finely laminated structure,slickensides, silt pockets,coal stringers		21			4.0
5.0								5.0
					U2			
6.0					16			6.0
7.0					12			7.0
8.0								8.0
					U3		pp = 180 kPa	
9.0			very silty,sensitive medium plastic clay bands,interbedded with high plastic clay bands,stiff		12			9.0
10.0					12			10.0
11.0								11.0
					U4		pp = 130 kPa	
12.0			stiff,medium plastic,grey,very sensitive, high plastic clay pockets		11			12.0
13.0								13.0
					9			
14.0			SAND,fine grained,silty,compact,saturated grey-brown, FREE WATER at 13.5 m				▽ 15 days	14.0
					U5		No Recovery	
15.0			CLAY TILL,silty,sandy,very stiff to hard, grey-brown,pebbles,siltstone nodules,sand pockets,mudstone nodules		100		N= 100 blows for 225 mm	15.0
16.0								16.0

Hardy BBT Limited Edmonton, Alberta	End of Borehole 21.0 m	Drilled 06/04/89
	Logged By HH	Figure
		Page 1 of 2

IMC CONSULTING GROUP INC./CARMA	TOP-OF-BANK SETBACK EVALUATION	BOREHOLE : 1
	RIVERBEND-WHITEMUD CREEK,EDMONTON	PROJECT No: EG06774
B-61.TRACK/HOLLOW STEM AUGER		ELEVATION 667.77 (m)

SAMPLE TYPE: SHELBY TUBE | NO RECOVERY | SPT TEST | GRAB SAMPLE | SPLIT PEN | CORE SAMPLE

DEPTH (m)	USC	SOIL SYMBOL	SOIL/ROCK DESCRIPTION	SAMPLE TYPE	SPT (N)	▲ POCKET PEN (kPa) ▲ 200 400 600 800 / ■ STANDARD PEN (N) ■ 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	OTHER TEST COMMENTS	DEPTH (m)
16.0			CLAY TILL, silty, sandy, very stiff to hard, grey-brown, pebbles, sand pockets siltstone nodules, mudstone nodules		U6			16.0
17.0					71			17.0
18.0			CLAY SHALE,silty,very hard,medium to high plastic,grey-brown,coal chips,silt pockets		99			18.0
19.0			carbonaceous, high plastic,very hard, brown,coal pockets,bentonitic sand pockets					19.0
20.0			hard,high plastic,grey,		125		N= 125 blows for 250 mm	20.0
21.0			carbonaceous,medium-high plastic,hard, brown to black,coal pockets		114		N= 114 blows for 250 mm	21.0
22.0			End fo Hole at 21.0 m Standpipe installed Slotted from 9.0 - 21 m depth Bentontite seal from 8 - 8.7 m depth Hole dry at completion of drilling					22.0
23.0								23.0
24.0								24.0
25.0								25.0
26.0								26.0
27.0								27.0
28.0								28.0
29.0								29.0
30.0								30.0
31.0								31.0
32.0								32.0

Hardy BBT Limited Edmonton, Alberta	End of Borehole 21.0 m	Drilled 06/04/89
	Logged By HH	Figure
		Page 2 of 2

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT: TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN. | CKD. | LOGGED R.Mc | DATE LOGGED May 10, 1979 | JOB NO. B4539-1 | HOLE HA 15

WATER CONTENT - % w_p - □ w - ○ w_l - △
10 20 30 40 50 60

DEPTH FT | M

SOIL SYMBOL

SOIL DESCRIPTION

DATUM GEODETIC

SURFACE ELEV. 668.864 m

SOIL SAMPLES: CONDITION | TYPE | PENETRATION RESISTANCE

TYPE OF DRILL
Solid
Stem 1.25 m
Probe Hole

OTHER TESTS

FT	M	
		TOPSOIL
		CLAY: silty, high plastic, stiff to very stiff, brown, rootlets, rust stains, occasional coarse sand particles, white salt pockets
5	1	
	2	
10	3	mottled brown and grey,
	4	
15		very stiff
	5	
20	6	grey, occasional ironstone deposits
	7	stiff, occasional pebbles to 8 mm ø
25		
	8	
30	9	
		till-like, traces of fine sand, medium plastic, pebbles, coal pieces, moist
	10	stiff to firm, medium plastic, grey, moist
35		

Seal

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN. | CKD. | LOGGED R.Mc | DATE LOGGED May 10, 1979 | JOB NO. B4539-1 | HOLE HA 15 (cont'd)

WATER CONTENT - % w_p - ⊡ w - ⊙ w_l - △
10 20 30 40 50 60

DEPTH FT | DEPTH M | SOIL SYMBOL

SOIL DESCRIPTION
DATUM GEODETIC
SURFACE ELEV. 668.864 m

SOIL SAMPLES: CONDITION | TYPE | PENETRATION RESISTANCE

TYPE OF DRILL
Solid Stems

OTHER TESTS

(May 10/79)

June 4/79

FT	M	Description
36	11	CLAY (CONT'D): silty, medium to high plastic, stiff to firm, grey, trace of free water
40	12	
	13	
45	14	SAND: silty, fine to medium grained, compact, uniform, grey, free water
50	15	
	16	
55	17	CLAY (SHALE) (REWORKED): silty, hard, high plastic, dark grey,
		CLAY (TILL): silty, sandy, medium plastic, very stiff, grey, pebbles to 8 mm, occasional coal pieces,
60	18	
	19	coal chunks, shale nodules, medium clean sand pockets
65	20	
	21	
70		CLAY (SHALE): silty, high plastic, hard

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN.	CKD.	LOGGED R.Mc	DATE LOGGED May 10, 1979	JOB NO. B4539-1	HOLE HA 15 (cont'd)

WATER CONTENT - % w_p - □ w - ○ w_L - △
10 20 30 40 50 60

DEPTH FT	DEPTH M	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLES: CONDITION	SOIL SAMPLES: TYPE	SOIL SAMPLES: PENETRATION RESISTANCE	TYPE OF DRILL	OTHER TESTS
			DATUM *GEODETIC*				*Solid Stems*	
			SURFACE ELEV. *668.864 m*					
71	22		*CLAY (SHALE) (CONT'D): silty, high plastic, hard*					
			END OF HOLE @ 22 m					
75	23							
	24							
80								
	25							
85	26							
	27							
90								
	28							
95	29							
	30							
100								
	31							
105	32							

THE CITY OF Edmonton
MATERIALS & TESTING SECTION

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT Proposed Shaft
Omand Drive - Ogilvie Boulevard

DWN. D.P. | CKD. Dusty | PROJECT NO. 422036 | DATE 85-04-30 | HOLE NO. 85-30 | PLATE NO. 1

WATER CONTENT % ● Plastic Limit ⟷ Liquid Limit (20 40 60 80)
COMPRESSIVE STRENGTH (kPa) UNCONFINED ▲ (100 200 300 400)

DEPTH m	SOIL PROFILE / CLASSIFICATION	SOIL SYMBOL	SAMPLE CONDITION	TYPE	DEPTH (ft)
	GROUND SURFACE ELEVATION (m): 670.639				
1	Clay — Brown CH Moist -Silty -Highly plastic -Grey clay lenses -Frozen to 1.2m -Nuggetty top 1.4m -Blocky 1.4 to 3.7m -Rust stains -Slickensided -Root holes after 3.4m -Thin sand lens at 4.6m			AS	2
					4
2					6
				U	8
3				DS	10
					12
4				U	14
	Silt — Brown mL Moist -Clayey -Rust stains -Low plastic -Wet 4.6 to 5.2m, damp after 7.3m -Traces of till after 7.3m			DS	16
5					18
				U	20
6				DS	22
					24
7				U	26
				DS	28
8					30
	Sand — Brown SP Wet -Medium to fine grained -Gravelly 8.8 to 9.5m			DS	32
9	Hit a rock				
10	Grey, Clay Till				

16 18 20 22 — Wet Unit Weight kN/m³ ○
10 20 30 40 — Standard Penetration N = □

PLATE NO. 1

501 5845A

THE CITY OF Edmonton
MATERIALS & TESTING SECTION

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT Proposed Shaft
Omand Drive - Ogilvie Boulevard

DWN. D.P. | CKD. | PROJECT NO. 422036 | DATE 85-05-01 | HOLE NO. 85-30 | PLATE NO. 2

WATER CONTENT % ● Plastic Limit ⟷ Liquid Limit
20 40 60 80

COMPRESSIVE STRENGTH (kPa) UNCONFINED ▲
100 200 300 400

DEPTH m	SOIL PROFILE / CLASSIFICATION	SOIL SYMBOL	SAMPLE CONDITION	TYPE	DEPTH (ft)
	GROUND SURFACE ELEVATION (m): 670.639				
10	Grey CL Moist -Clay till, silty, sandy, pebbles, coal lumps -Very stiff			U	34
	▽				
	Brown Waterbearing Sand, medium grained			DS	36
11				AS	
	Grey, clay till				38
	Grey Waterbearing -Sand -Medium grained			U	
12				DS	40
					42
13					
	-Grey, clay till			U	44
	Grey Waterbearing Sand, medium grained			DS	46
14				AS	
	-Grey clay till				48
15				DS	
	Grey Waterbearing -Sand				50
					52
16					
					54
	-Grey clay till				
17					56
	-Grey clay till mixed with grey clay shale				
				U	58
18				DS	60
	Grey Wet -Sand				
19					62
	Till Grey CL Moist -Clay till, sand lenses			U	64

N=98

16 18 20 22
Wet Unit Weight kN/m³ ○

10 20 30 40
Standard Penetration N = □

PLATE NO. 2

501 5845A

THE CITY OF Edmonton
MATERIALS & TESTING SECTION

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT Proposed Shaft
Omand Drive - Ogilvie Boulevard

DWN. D.P. | CKD. | PROJECT No. 422036 | DATE 85-05-01 | HOLE No. 85-30 | PLATE No. 3

WATER CONTENT % ● Plastic Limit ⟷ Liquid Limit
20 40 60 80

COMPRESSIVE STRENGTH (kPa) UNCONFINED ▲
100 200 300 400

DEPTH m

SOIL PROFILE
CLASSIFICATION
GROUND SURFACE ELEVATION (m): 670.639

DEPTH m	SOIL PROFILE / CLASSIFICATION	SOIL SYMBOL	SAMPLE CONDITION	TYPE	DEPTH (ft)
20	Till -Waterbearing sand			DS	66
	Grey CL Moist -Clay, silty, sandy, pebbles -Medium plastic -Hard				68
21	QU=518 kPa N=58			U	
				AS	70
22					72
				U	74
23				DS	76
	Coring started at 24.2m				78
24	Bedrock Grey Damp -Silty clay shale			U DS	80
	N=62 for 15cm Grey Damp -Sandstone			RC	
25					82
	-Silty clay shale -Siltstone 25.6 to 25.65m -Carbonaceous 25.6 to 26.4m -Bentonitic 26.4 to 26.5m -Carbonceous 27.0 to 27.3m, 28.0 to 28.5m, traces of coal		75 %	RC	84
26			100 %	RC	86
			110 %	RC	88
27			100 %	RC	90
					92
28				RC	94
			100 %	RC	
29					96
	Grey Sandstone				

16 18 20 22
Wet Unit Weight kN/m³ ○

10 20 30 40
Standard Penetration N = □

% - Amount of core recovery

PLATE NO. 3

501 5845A

THE CITY OF Edmonton
MATERIALS & TESTING SECTION

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT Proposed Shaft
Omand Drive - Ogilvie Boulevard

DWN. D.P.	CKD.	PROJECT NO. 422036	DATE 85-05-01	HOLE NO. 85-30	PLATE NO. 4

WATER CONTENT % ●
Plastic Limit ⊢——⊣ Liquid Limit
20 40 60 80

COMPRESSIVE STRENGTH (kPa) UNCONFINED ▲
100 200 300 400

DEPTH m

SOIL PROFILE
CLASSIFICATION
GROUND SURFACE ELEVATION (m): 670.639

DEPTH m	SOIL PROFILE / CLASSIFICATION	SOIL SYMBOL	SAMPLE CONDITION	TYPE	DEPTH (ft)
	Bedrock — Grey Sandstone		80%	RC	98
30					100
	-Silty clay shale		100 %	RC	
31	-Carbonaceous 31.0 to 31.3m 31.5 to 32.0m		100 %	RC	102
			100 %	RC	104
32					106
	-Grey -Sandstone -Limestone intrusions		100 %	RC	108
33	-Clay shale, silty -Bentonitic 32.8 to 33.0m		100 %	RC	110
	-Carbonaceous 33.0 to 33.9m 34.2 to 34.8m -contains green bentonite 34.8 to 35.2				
34			100 %	RC	112
			100 %	RC	114
35					116
			85%	RC	
36					118
			100 %	RC	120
37					122
	No recovery			RC	
					124
38					126
39					128

16 18 20 22
Wet Unit Weight kN/m³ ○

10 20 30 40
Standard Penetration N = □

% = amount of core recovery

PLATE NO. 4

501 5845A

THE CITY OF Edmonton
MATERIALS & TESTING SECTION

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT Proposed Shaft
Omand Drive - Ogilvie Boulevard

DWN. D.P. | CKD. | PROJECT NO. 422036 | DATE 85-05-02 | HOLE NO. 85-30 | PLATE NO. 5

WATER CONTENT % ● Plastic Limit — Liquid Limit (20 40 60 80)
COMPRESSIVE STRENGTH (kPa) UNCONFINED ▲ (100 200 300 400)

GROUND SURFACE ELEVATION (m): 670.639

DEPTH m	SOIL PROFILE / CLASSIFICATION	SOIL SYMBOL	SAMPLE CONDITION	TYPE	DEPTH (ft)
39	Bedrock No recovery				128
					130
40					
	Grey Damp -Clay shale, silty -Carbonaceous 41.3 to 42.0m		100 %	RC	132
41	-Siltstone lens 41.7 to 41.75m		100 %	RC	134
	-Highly bentonitic green-white 42.0 to 42.7m				136
	-Bentonitic 42.7 to 43.0m		100 %	RC	
42	-Highly bentonitic 43.8 to 44.5m				138
			100 %	RC	
					140
43					
			60%	RC	142
			85%	RC	144
44					
					146
	No recovery				
45					148
					150
46	End of Hole 46.0m				
					152
47					

16 18 20 22 — Wet Unit Weight kN/m³ ○

10 20 30 40 — Standard Penetration N = □

% = amount of core recovery

PLATE NO. 5

501 5845A

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN. CP/JF | CKD. | LOGGED ME | DATE LOGGED May 2/79 | JOB NO. B4539.1 | HOLE HA7(cont'd)

WATER CONTENT - % w_p - ⊡ w - ○ w_l - △ (10 20 30 40 50 60)

DEPTH FT | DEPTH M | SOIL SYMBOL

SOIL DESCRIPTION

DATUM GEODETIC

SURFACE ELEV. 671.524 m

SOIL SAMPLES: CONDITION | TYPE | PENETRATION RESISTANCE

TYPE OF DRILL

OTHER TESTS

FT	M	Description	Condition	Type	Penetration Resistance	Other Tests
71	22	SHALE(cont'd): silty, high plastic, hard,		U 15		
				D	100	for 75 mm
75	23	END OF HOLE AT 22.5 m				
	24					
80						
	25					
85	26					
	27					
90						
	28					
95	29					
	30					
100						
	31					
105	32					

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN. CP/JF | CKD. | LOGGED ME | DATE LOGGED May 2/79 | JOB NO. B4539.1 | HOLE HA-7 (cont'd)

WATER CONTENT - % w_p - ⊡ w - ○ w_l - △ (10 20 30 40 50 60)

DEPTH FT M | SOIL SYMBOL | SOIL DESCRIPTION | SOIL SAMPLES: CONDITION, TYPE, PENETRATION RESISTANCE | TYPE OF DRILL

DATUM *GEODETIC*

SURFACE ELEV. *671.524 m*

FT	M	Description	Sample	Type	Penetration Resistance	Other Tests
36	11	*CLAY(TILL):(cont'd): silty, sandy, medium plastic, very stiff, mottled grey and brown*	U 8			pp = 430 kPa+ (4.5 tsf+)
			D		88	
40	12					
	13		U 9			pp = 430 kPa + (4.5 tsf+)
			D		81	
45	14	*SHALE(RAFTED): very silty, medium plastic, hard, grey, blocky,*				
			U 10			pp = 430 kPa + (4.5 tsf+)
	15	*CLAY(TILL): silty,sandy, medium plastic, hard, grey, coal pieces, occasional sand partings, pebbles to 40 mm ø*	D		45	on rock
50						JUNE 4/79 ▽
			U 11			q_u = 334 kPa ϵ_f = 6.7 % pp = 335 kPa γ_d = 1854 kg/m³
	16		D		46	
55						
	17					
		sand lens , fine grained, dense, saturated	U 12			
	18	*pebbles to 10 mm ø*	D		49	
60						
	19	*shale inclusions*	U 13			(MAY 7/79) pp = 420 kPa ▽ (4.4 tsf)
			D		39	
65						
	20	*SHALE: silty, high plastic, hard, blocky,grey,bentonitic, sandstone inclusions and lenses, carbonaceous*	U 14			pp = 430 kPa + (4.5 tsf+)
	21		D		91	
70						

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TEST HOLE LOG

PROJECT: TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN.	CKD.	LOGGED	DATE LOGGED	JOB NO.	HOLE
CP/JF		ME	April 30/79	B4539.1	HA-5

DATUM: GEODETIC
SURFACE ELEV.: 664.679 m
TYPE OF DRILL: Solid And Hollow Stem
0.5m

WATER CONTENT - % w_p - ○ w - ⊙ w_L - △
10 20 30 40 50 60

DEPTH FT	DEPTH M	SOIL SYMBOL	SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
			TOPSOIL:				
	1		CLAY: silty,sandy, high plastic stiff to very stiff, brown, blocky, rust stains, rootlets white salts		U_1		pp = 430 kPa+ (4.5 tsf+)
5					D	25	
	2		dark brown				
			rust stains		U_2		pp = 410 kPa (4.3 tsf)
10	3		occsional gypsum crystals, occasional silt and very fine grained sand lenses and pockets		D	19	
	4		very silty, medium plastic, stiff, occasional sand partings		U_3		pp = 335 kPa (3.5 tsf)
15					D	13	
	5				U_4		pp = 280 kPa (2.9 tsf)
20	6		occasional pebbles and coal chips		D	26	
	7				U_5		
25			CLAY(TILL): silty,sandy, medium plastic, hard, greyish brown, shale inclusions, sand partings, coal pieces, pebbles to 10mm ø		D	43	
	8				U_6		pp = 430 + kPa (4.5 tsf+)
30	9		grey		D	55	
	10				U_7		pp = 410 kPa (4.3 tsf)
35					D	45	

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT
TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN. CP/JF | CKD. | LOGGED ME | DATE LOGGED April 30/79 | JOB NO. B4539.1 | HOLE HA-5(cont'd)

DATUM GEODETIC

SURFACE ELEV. 664.679 m

WATER CONTENT - % w_p - □ w - ⊙ w_l - △ (10 20 30 40 50 60)

DEPTH FT	DEPTH M	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLES CONDITION	SOIL SAMPLES TYPE	SOIL SAMPLES PENETRATION RESISTANCE	TYPE OF DRILL / OTHER TESTS
36	11		CLAY(TILL): (cont'd): silty, sandy, medium plastic, hard, grey				OTHER TESTS
			fractured, rust-stained joints,		U_8		pp = 430 kPa+ (4.5 tsf+)
40	12				D	29	
	13				U_9		pp = 430 kPa+ (4.5 tsf+)
45					D		
	14		SHALE: clayey, silty, hard, medium to high plastic, blocky, grey, carbonaceous				
					U_{10}		pp = 430 kPa + (4.5 tsf+)
50	15				D	90	JUNE 4/79 ▼
							MAY 7/79 ▼
	16						
					U_{11}		pp = 430 kPa + (4.5 tsf+)
55					D	120	
	17		END OF HOLE AT 16.8 m				
60	18						
	19						
65	20						
	21						
70							

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN. CP/JF | CKD. | LOGGED ME | DATE LOGGED May 1/79 | JOB NO. B4539.1 | HOLE HA-6(cont'd)

DATUM GEODETIC

SURFACE ELEV. 672.188 m

WATER CONTENT - % w_p - □ w - ⊙ w_l - △ (10 20 30 40 50 60)

DEPTH FT	DEPTH M	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLES CONDITION	SOIL SAMPLES TYPE	SOIL SAMPLES PENETRATION RESISTANCE	OTHER TESTS
36	11		CLAY(TILL):(cont'd): silty, sandy, medium plastic, hard, pebbles and cobbles				
					U 8		
40	12		SAND: silty, fine grained, uniform, dense, brown		D	54	
	13		trace of water				M.A.
					U 9		
45			SILT: sandy, low plastic, very dense, brown and grey, carbonaceous, trace of clay		D	59	
	14						
			rust stains, greyish brown ▼		U 10		
50	15		SAND: silty, fine to medium grained, dense, brown, coal pieces		D	35	
	16						
			grey and brown clay inclusions		U 11		
55	17				D	35	
							May 2/79 ▼
	18				U 12		May 7 & June 4/79 ▼ pp = 297 kPa
60			CLAY(TILL): silty, sandy, medium plastic, very stiff, grey, coal pieces, occasional shale inclusions, pebbles to 15mm ø		D	38	(3.8 tsf)
	19						
					U 13		pp = 364 kPa
65					D	31	(3.8 tsf)
	20						
	21		rafted shale, very stiff, high plastic, grey		U 14		pp = 345 kPa
70					D	39	(3.6 tsf)

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN. CP/JF | CKD. | LOGGED ME | DATE LOGGED May 1/79 | JOB NO. B4539.1 | HOLE HA-6

TYPE OF DRILL: Solid and Hollow Stem ↓ 0.2m

DATUM GEODETIC

SURFACE ELEV. 672.188 m

WATER CONTENT - % w_p - ▣ w - ○ w_l - △ (10 20 30 40 50 60)

DEPTH FT	DEPTH M	SOIL SYMBOL	SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
			TOPSOIL:				
			CLAY: silty, high plastic, brown, rootlets, blocky				
	1				U_1		pp = 430 kPa + (4.5 tsf+)
5			coal pieces, very sandy, pebbles to 10mm Ø, rust stains, trace of white salts		D	50	
	2				U_2		
			sand lenses				
			SAND: silty, very fine grained, uniform, compact, light brown		D	29	
10	3						
	4				U_3		
15			gravel inclusions to 30mmØ, more silty, dense		D	38	
	5				U_4		
20	6		~~hit~~ rock				
	7				U_5		
25					D	38	
	8		CLAY (TILL): silty, sandy, medium plastic, hard, grey, gypsum crystals, rust stains, fractures, shale inclusions, coal pieces, occasional silt and fine grained sand lenses/ pockets, pebbles to 5mm Ø, cobbles to 200 mmØ		U_6		pp = 380 kPa (4.0 tsf)
30	9				D	56	
	10				U 7		pp = 430 + kPa (4.5 tsf+)
35					D	57	

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT: TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN. CP/JF | CKD. | LOGGED ME | DATE LOGGED May 2/79 | JOB NO. B4539.1 | HOLE HA-7

DATUM GEODETIC

SURFACE ELEV. 671.524 m

TYPE OF DRILL: Solid and Hollow Stems

0.6m

WATER CONTENT - % (10 20 30 40 50 60) w_p - □ w - ○ w_l - △

DEPTH FT	DEPTH M	SOIL SYMBOL	SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
			TOPSOIL:				
	1		CLAY: silty, high plastic, stiff to very stiff, nuggety, mottled brown, white salts, rootlets,		U_1		pp = 430 +kPA (4.5 tsf+)
5					D	44	
	2		rust stains,				
7.2					U_2		pp = 350 kPa (3.7 tsf)
			light brown, trace of sand, occasional fractures		D	16	
10	3				U_3		pp = 316 kPa (3.3 tsf)
	4		occasional very fine sand and silt pockets, trace of coal, ironstone concrections, pebbles to 15mm Ø, more silt, medium plastic		D	12	M.A.
15	5				U_4		q_u = 122 KPa; ϵ_f = 6.4 %; pp = 250 kPa (2.6 tsf); γ_d = 1471 kg/m³
					D	18	
	6		CLAY (TILL): silty, sandy, sand lenses, dense, fine grained, low to medium plastic, pebbles, coal pieces, shale inclusions		U_5		
20	7				D	86 for 150 mm	M.A.
25	8		SAND: silty, uniform, very fine grained, dense, light brown, occasional clay inclusions		U_6		pp = 430 kPa + (4.5 tsf+)
	9		CLAY (TILL): very sandy, low plastic, hard, brown, pebbles to 10 mm Ø, coal pieces		D	hit	rock
30	10				U_7		pp = 430 +kPa (4.5 tsf+)
			greyish brown, medium plastic		D	115	
35			rust stains, sand lenses				

HARDY ASSOCIATES (1978) LTD.

TEST HOLE LOG

PROJECT TOP OF BANK SETBACK STUDY
NEIGHBOURHOOD 8
RIVERBEND, TERWILLEGAR HEIGHTS

DWN. CP/JF | CKD. | LOGGED ME | DATE LOGGED May 1/79 | JOB NO. B4539.1 | HOLE HA-6(cont'd)

WATER CONTENT - % w_p - ⊡ w - ⊙ w_l - △ (10 20 30 40 50 60)

DEPTH FT M

SOIL SYMBOL

SOIL DESCRIPTION

DATUM GEODETIC

SURFACE ELEV. 672.188 m

SOIL SAMPLES: CONDITION | TYPE | PENETRATION RESISTANCE

TYPE OF DRILL

OTHER TESTS

FT	M	SOIL DESCRIPTION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
71	22	CLAY(TILL):(cont'd): silty, sandy, medium plastic, coal pieces, rust stains			
		pebbles to 20 mm Ø	U	15	pp = 364 kPa (3.8 tsf)
			D	67	
75	23	SHALE: clayey, very silty, hard, grey, carbonaceous, blocky			
					May 1/79 ▽
	24	less silty	U	16	pp = 430 kPa+ (4.5 tsf+)
80				58 for 150 mm	
	25				
			U	17	pp = 430 kPa+ (4.5 tsf+)
85	26		D	100 for 75 mm	
		END OF HOLE AT 25.8 m			
	27				
90					
	28				
95	29				
	30				
100					
	31				
105	32				

CITY OF EDMONTON
MATERIALS TESTING DIV.

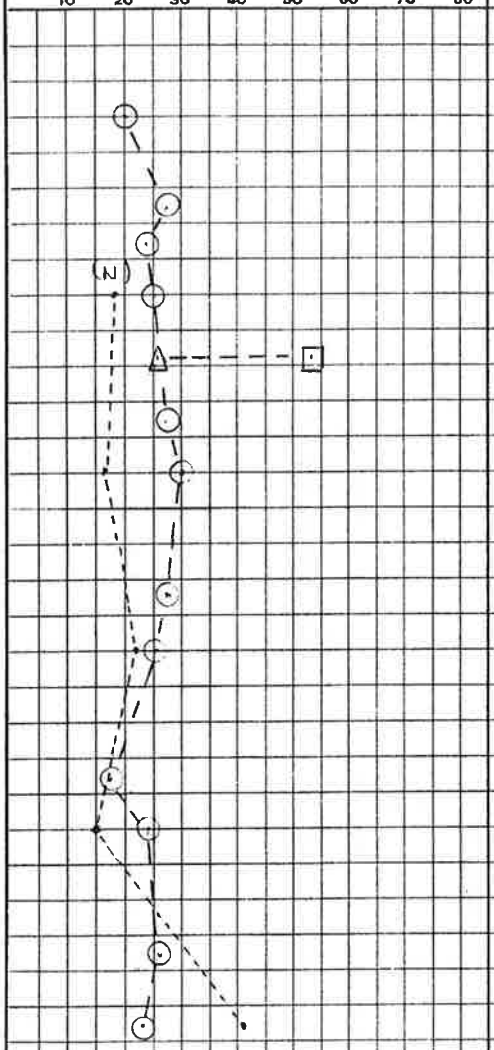
TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. | CKD. F. S. | JOB NO. | DATE Dec. 22/77 | HOLE No. 1 | PLATE No. 1

Moist. Cont. ○ Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%) STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80



DEPTH ELEV. FT.	CLASSIFICATION (GROUND SURFACE ELEV. 2253.8)	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
	TOPSOIL 0'-4"					
2	CLAY Brn. (Frost to 1'.) Trace organic. Traces of salts. Damp.				M	
4						
6					M	
			Qu=1.9		U	
8	(Rust stained till 7'-9').		N=19		DS	
10	(C @ 9' - 10.5')		No Qu		U	
12	Mottled: Grey plastic & brown silty. Traces of till. Slicken sides.		Qu=1.3		U	
			N=16		DS	
14	9' - 16'					
16						
	TILL (Weathered 16' - 18.5') Dk. brn. silty.		Qu=1.2		U	
18			N=22		DS	
20	Rust stains. 16' - 20'.					
	Grey, siltier.		Qu=1.3		U	
22	Sand filled fractures. 20 - 23.5'					
24			N=15		DS	
	CLAY Very silty. Moist & soft. ▽					
26						
	SAND Grey.				M	
28	Water at 26'.		N=41		DS	
30	Fine grained 26' - 30'.					
32	Wet, dense.					
34						
36	Coarse grained 30' - 49'.					
38						
40						
42						
44						

PLATE No. 1

CITY OF EDMONTON
MATERIALS TESTING DIV.

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. G.M. | CKD. FS | JOB NO | DATE Dec 22/77 | HOLE NO. 1 | PLATE NO. 2

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80

DEPTH / ELEV. FT.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLES: SAMPLE COND.	SAMPLES: TYPE	DEPTH SCALE
	GROUND SURFACE ELEV. 2253.8					
46	SAND *Grey, wet, dense, coarse grained.*					
48					M	
50	SHALE *Grey, stiff, damp.*					

Immediately after drilling hole open to 24'.
Water level at 14'.

NOTE:

At 11'-12'

γt = 117.3 lb/ft^3
γd = 92.2 lb/ft^3

At 16'-17'

γt = 124.4 lb/ft^3
γd = 97.5 lb/ft^3

At 21'-22'

γt = 121.5 lb/ft^3
γd = 103.2 lb/ft^3

Atterberg Limit @ 9'-10.5'
Liquid Limit = 53.39%
Plastic Limit = 25.39%
Plastic Index = 28.00%

PLATE NO. 2

CITY OF EDMONTON
MATERIALS TESTING DIV.

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. G.M. | CKD. F.S. | JOB No. | DATE Dec 21/77 | HOLE No. 2 | PLATE No. 3

Moist. Cont. ○ Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%) STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80

DEPTH ELEV. FT.	SOIL PROFILE CLASSIFICATION	SOIL SYMBOL	SAMPLES OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
	GROUND SURFACE ELEV. 2255.4					
	TOPSOIL 0 - 4".					
2	CLAY Mottled brown, & grey, Silty, firm, damp, plastic, slicks. Frost to 3'.			X	CS	
4						
6				X	CS	
	Brown, very silty Till layers, slicks. Mottled brown & grey.		Qu=0.8		U	
8			N=15		DS	
10						
12			Qu=1.3		U	
			N=14		DS	
14	SILT Dark grey. Clayey.					
16			Qu=1.3		U	
18	Platey.		N=8		DS	
20	TILL Grey, highly plastic, soft to firm, damp. Weathered.					
22			Qu=0.7		U	
			N=8		DS	
24	SILT Grey, glacial. Clayey.					
26			N=9		DS	
28	▽ (Water at 27.5').					
30	Few lenses brn. sandy silt.					
32			N=12		DS	
34	SAND Light brown, wet.					
36			N=7-?		DS	
38						

Immediately after drilling hole open to 27'.
Water level at 16'.

Note:

At 6'-7'
γt = 124.3 lb/ft.^{3}
γd = 94.8 lb/ft.^{3}

At 11'-12'
γt = 124.2 lb./ft^3
γd = 94.2 lb./ft^3

At 21'-22'
γt = 119.5 lb./ft.^{3}
γd = 97.2 lb/ft.^{3}

PLATE No. 3

CITY OF EDMONTON
MATERIALS TESTING DIV.

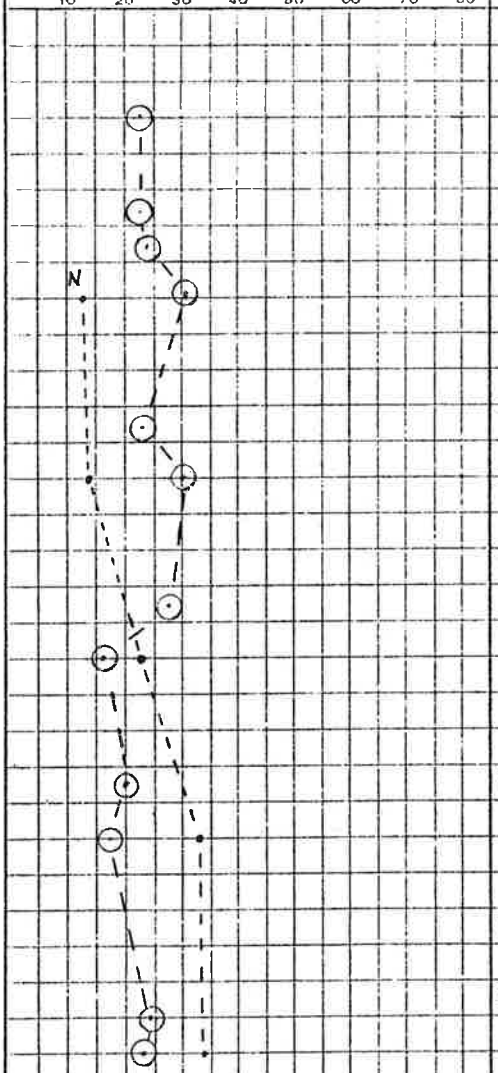
TEST HOLE LOG & LABORATORY TEST DATA

PROJECT PETROLIA SUBSTATION

DWN. G.M.	CKD. FS	JOB NO.	DATE Dec 22777	HOLE NO. 3	PLATE NO. 4

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80



DEPTH FT.	ELEV.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
		SOIL PROFILE		SAMPLES			
		GROUND SURFACE ELEV. 2262.5					
		TOPSOIL 0 - 4"					
2		CLAY Brown, firm, damp Frost to 3'.					
4					X	CS	
6					X	CS	
		Silty, soft to firm, rust spots, coal specks.		Qu=1.3		U	
8				N=13		DS	
10							
12		Very Silty, soft to firm, moist, rust lenses.		Qu=1.3		U	
				N=14		DS	
14		SAND Clayey wet.					
		TILL Silty streaks, large rust lenses, pebbles, firm, moist					
16				Qu=1.4		U	
18		Large silty layers.		N=22		DS	
20		Softer					
22		SAND Light brown, damp to moist, dense.				U	
				N=33		DS	
24		SILT Brown, moist, soft. Water at 26'.					
26		Wet. Till layers.					
28				Qu=0.8		U	
30		Easy to drill.		N=34		DS	
32							

Immediately after drilling hole open to 28'
Water level at 27'.
In 3 days water level at 9'.

NOTE:

At 6'-7'	At 16'-17'
γt = 125.7 lb/ft^3.	γt = 120.0 lb/ft^3.
γd = 101.1 lb/ft^3.	γd = 94.2 lb/ft^3.

At 11'-12'
γt = 126.8 lb/ft^3.
γd = 102.9 lb/ft^3.

PLATE NO. 4

CITY OF EDMONTON
MATERIALS TESTING DIV.

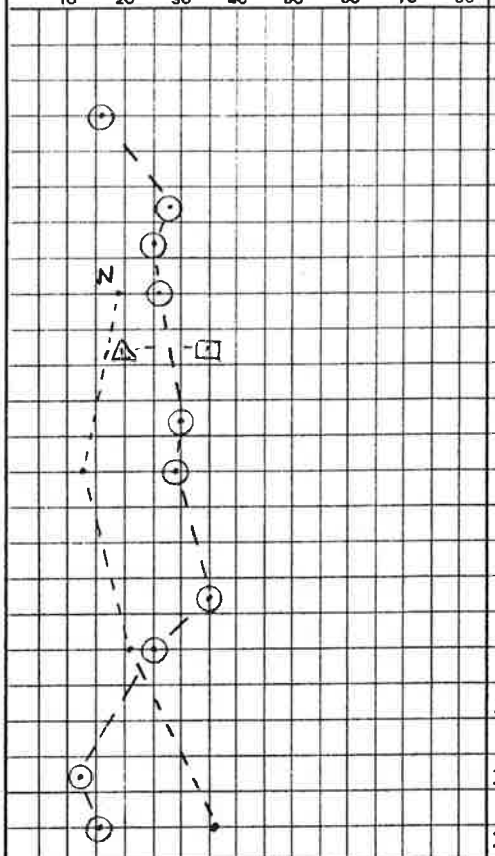
TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. G.M. | CKD. | JOB No. | DATE Dec 21/77 | HOLE No. 4 | PLATE No. 5

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80



DEPTH ELEV. FT.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
	GROUND SURFACE ELEV. 2263.7					
	TOPSOIL 0 - 4"					
2	CLAY *Brown, silty. Frost to 3'. Firm, dry to damp. Silty.*			X	CS	
4						
6				X	CS	
	Mottled brown & grey, sand lenses.		Qu=1.9		U	
8			N=19		DS	
	(C @ 9'-10').		No Qu		U	
10	SILT *Firm to soft, till layer rust lenses, moist. Till pockets to 6" thick.*					
			Qu=1.7		U	
12			N=13		DS	
14						
16						
	TILL *Brown, soft to firm, moist, silt layers. Particles of highly plastic clay. 45° Fracture.*		Qu=1.4		U	
18			N=21		DS	
	Sand lenses.		*Broke up			
20						
			Qu=*		U	
22			N=36		DS	
24						

END OF HOLE 23.5'
Immediately after drilling hole open to 23.5. Dry. After 3 days water level at 16'.

NOTE:

At 6'-7'

$\gamma t = 119.4$ lb/ft^3.
$\gamma d = 95.2$ lb/ft^3.

At 11'-12'

$\gamma t = 117.4$ lb/ft^3.
$\gamma d = 90.1$ lb/ft^3.

At 16'-17'

$\gamma t = 119.3$ lb/ft^3.
$\gamma d = 88.1$ lb/ft^3.

Atterberg Limit at 9'-10'

Liquid = 34.87%

Plastic = 19.67%
Plastic Index = 15.20%

PLATE No. 5

CITY OF EDMONTON
MATERIALS TESTING DIV.

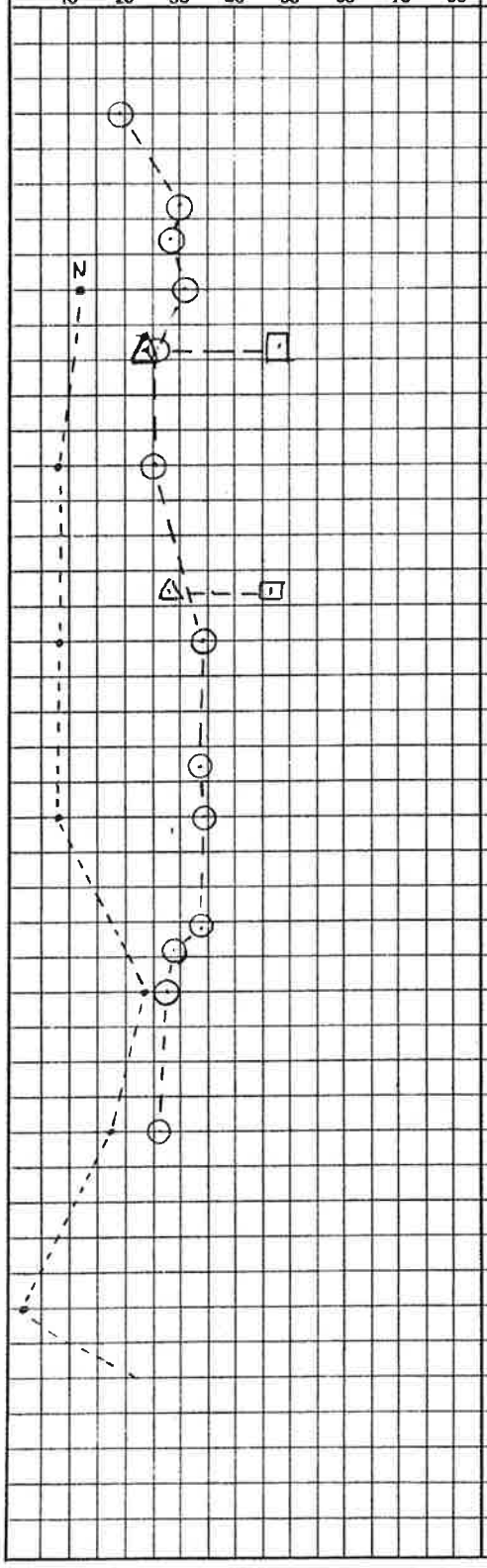
TEST HOLE LOG & LABORATORY TEST DATA

PROJECT PETROLIA SUBSTATION

DWN. G.M.	CKD.	JOB NO.	DATE Dec 22/77	HOLE NO. 5	PLATE NO. 6

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80



DEPTH ELEV. FT.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
	GROUND SURFACE ELEV. 2255.5					
	TOPSOIL 0 - 4"					
2	CLAY Brown, grey lenses, firm, damp. Traces of organic material to 2'. Frost to 3'.					
4				X	CS	
6				X	CS	
	Mottled brown and grey, sandy, slicks. Large rust lense.		Qu=1.3		U	
8			N=12		DS	
	Till layer 8.5 to 9'. C @ 9'-10.5' (Brown, silty. Traces of till 9'-11')		No Qu		U	
10						
12			Qu=1.3		U	
			N=8		DS	
14						
16	C @ 16' - 17' Soft to firm.		No Qu		U	
18			N=8		DS	
20	Till layers, rust lenses silty.	P				
22	SILT Grey, soft, clayey, Till layers. Moist.		Qu=0.7		U	
			N=7		DS	
24						
26						
	SAND Wet, loose		Broke up		U	
28	SILT Water at 28'.		N=24		DS	
30	Light brown, wet, soft, sand layers.					
32			N=17		DS	
34						
36						
			N=?		DS	
38	Grey, firm.					
40						
42	Very dense, moist to wet					
44	Cont'd					

PLATE NO. 6

CITY OF EDMONTON
MATERIALS TESTING DIV.

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. G.M. | CKD. ES | JOB NO. | DATE Dec 22/77 | HOLE NO. 5 | PLATE NO. 7

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80

DEPTH ELEV. FT.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
	GROUND SURFACE ELEV. 2255.5					
46	SILT Grey, very dense, moist to wet, sand layers, Till layers.					
48			N=100+		DS	
50						
52						
54						
56						
58	End of Hole. 57.5'. Immediately after drilling hole open to 25'. Dry. After 15 days water level @18.7'. Hole open to 20.3'. After 18 days water level @18.5'. Hole open to 20.3'.					

NOTE:

At 6'-7'

$\gamma t = 126.2$ lb/ft^3
$\gamma d = 98.4$ lb/ft^3

At 26' - 27'

$\gamma t = 118.6$ lb/ft^3
$\gamma d = 88.1$ lb/ft^3

Atterberg Limit @ 9'-10.5'
Liquid Limit = 47.92%
Plastic Limit = 24.92%
Plastic Limit = 23.00%

Atterberg Limit at 16'-17'
Liquid Limit = 46.75%
Plastic Limit = 27.25%
Plastic Index = 19.50%

PLATE NO. 7

CITY OF EDMONTON
MATERIALS TESTING DIV.

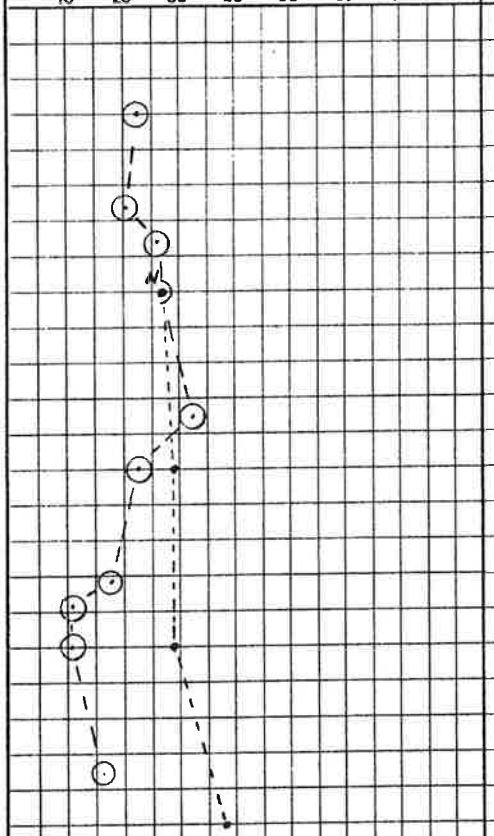
TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. G.M. | CKD. | JOB NO. | DATE Dec 21/77 | HOLE NO. 6 | PLATE NO. 8

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80



DEPTH ELEV. FT.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
	SOIL PROFILE / **SAMPLES**					
	GROUND SURFACE ELEV. 2262.8					
	TOPSOIL 0-4"					
2	CLAY *Brown, grey lenses, damp. Frost to 3'.*					
4				X	CS	
6				X	CS	
			Qu=0.6		U	
8			N=27		DS	
10	TILL *Firm to stiff, damp, coal specks, rust layers*	b				
	SILT *Brown, clayey, firm, damp, rust lenses*		Qu=0.8		U	
12						
14	TILL *Sandy, firm, damp.*		N=29		DS	
	SAND *Brown, loose, Till layers rust layer.*		*Broke up			
16	*Silt layer, dense.*		Qu-*		U	
18			N=29		DS	
20	TILL *Dark grey, stiff, damp.*		** Broke up			
			Qu-**		U	
22			N=38		DS	
24	End of Hole 23.5					

Immediately after drilling hole open to 23.5. Dry.
After 3 days dry.

NOTE:

At 6'-7'
γt = 123.8 lb/ft^3.
γd = 97.7 lb/ft^3.

At 11'-12'
γt = 118.1 lb/ft^3.
γd = 89.1 lb/ft^3.

PLATE NO. 8

CITY OF EDMONTON
MATERIALS TESTING DIV.

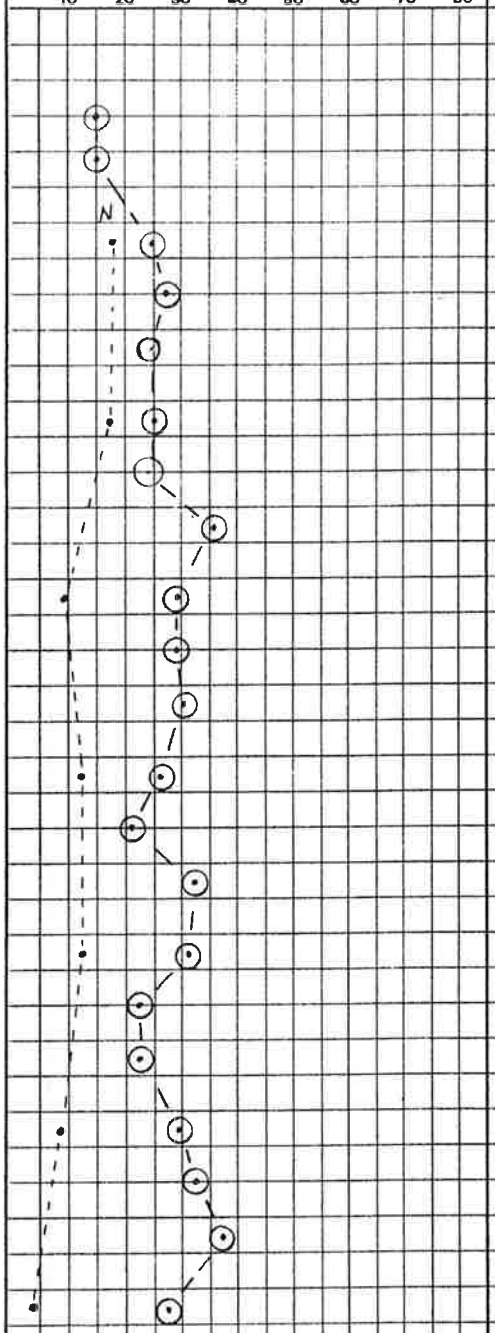
TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. G.M. | CKD. | JOB No. | DATE Jan 4/78 | HOLE No. 7 | PLATE No. 9

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80



DEPTH ELEV. FT.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
	GROUND SURFACE ELEV. 2259.1					
	TOPSOIL 0-5"					
2	CLAY *Dark brown, silty, root fibres, trace organic Frost to 3'.*		Qu=1.3		U	
4					CS	
6	*Brown, streaks of grey (CL) Silty streaks. Nuggetty-weathered.*		N=18		DS	
8			Qu=1.2		U	
10					CS	
12	TILL *Dark brown, silty, streaks of rust. Rust stained fractures.*		N=17		DS	
14			Qu=1.6		U	
	CLAY *Dark brown, quite silty. Streaks of rust.*				CS	
16	SILT Dark brown, lake deposit Percolated appearance.		N=9		DS	
18	TILL *Dark brown, silty, rust stains.* Percolated appearance.		Qu=1.1		U	
20	SILT *Dark brown, highly plastic clay imbedded. Rust stains.*				CS	
22	TILL Dark grey, very few small rocks Verticle rust stain fractures.		N=12		DS	
	SILT *Dark grey, rust stained layers. slightyly clayey.*		Qu=1.2		U	
24	*Clayey.*				CS	
26	*Platey.*		N=12		DS	
28	TILL *Dark grey, silty, clayey. Thin streaks of light grey fine sand.*		Qu=1.4		U	
30					CS	
32	SILT ▽ *Dark grey, moist. Water at 32'. Sand layer 32' to 33'.* Loose, wet. Under Artesian Pressure.		N=8		DS	
34			Qu=1.2		U	
	Saturated, Will slough if disturbed.				CS	
36			N=4		DS	
38	END OF HOLE 37.0'. After 2 days water level at 12.5'. After 5 days water level at 11.3'. Hole open to 20.5'.					

PLATE No. 9

CITY OF EDMONTON
MATERIALS TESTING DIV.

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. G.M. | CKD. | JOB No. | DATE Jan 4/78 | HOLE No. 7 | PLATE No. 10

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80

SOIL PROFILE		SAMPLES				
DEPTH / ELEV. FT.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
	GROUND SURFACE ELEV. 2259.1					

NOTE:

At Depth 7.5' - 8.5'
t = 126.2 lbs/ft^3
d = 99.0 lbs/ft^3

At Depth 12.5' - 13.5'
t = 121.9 lbs/ft^3
d = 98.3 lbs/ft^3

At Depth 17.5' - 18.5'
t = 116.7 lbs/ft^3
d = 90.2 lbs/ft^3

At Depth 22.5' - 23.5'
t = 121.8 lb/ft^3
d = 100.5 lb/ft^3

At Depth 27.5' - 28.5'
t = 129.6 lb/ft^3
d = 106.2 lb/ft^3

At Depth 32.5' - 33.5'
t = 115.9 lb/ft^3
d = 87.5 lb/ft^3

CITY OF EDMONTON
MATERIALS TESTING DIV.

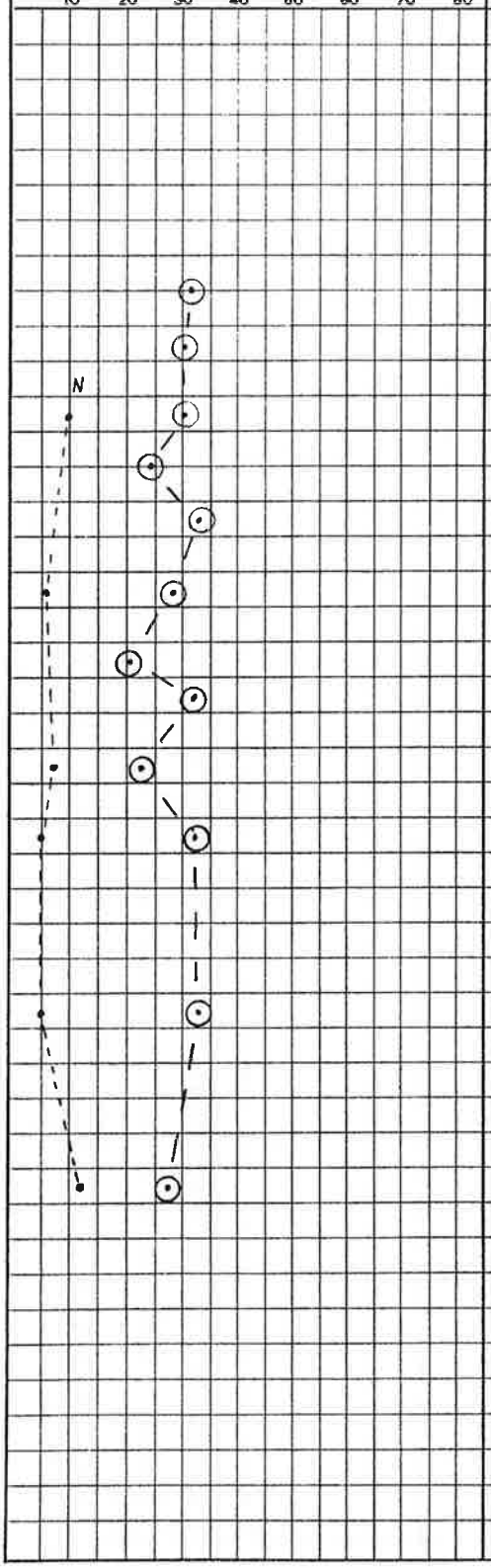
TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. G.M. | CKD. | JOB NO. | DATE Jan 4/78 | HOLE NO. 8 | PLATE NO. 11

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80



DEPTH ELEV. FT.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE
	GROUND SURFACE ELEV. 2252.5				
	TOPSOIL 0-7"				
2	CLAY *Dark brown, streaks of grey, silty streaks (CL), firm, damp.*				
4					
6					
8			Qu=1.6		U
10	*Weathered, nuggetty.*				CS
12	*Platey, traces of till.*		N=10		DS
14			Qu=1.9		U
	SILT *Glacial, rust stained, dark grey, moist, firm.*				CS
16	*Clayey, quite moist.*		N=6		DS
18	TILL *Dark grey, quite moist.*		Qu=1.6		U
	SILT *Dark grey, soft, clayey, moist.*				CS
20	*Seepage @ interface.*				
22			N=7		DS
24			N=5		DS
26					
28					
30			N=5		DS
32	▽ *Water at 32'.*				
	SAND *Grey, silt layers. Saturated, dense.*				
34			N=12		DS
36					
38	*Sand creeping into hollow stem auger.*				
40					
42					
44	Cont'd				

PLATE NO. 11

CITY OF EDMONTON
MATERIALS TESTING DIV.

TEST HOLE LOG & LABORATORY TEST DATA

PROJECT: PETROLIA SUBSTATION

DWN. G.M. | CKD. fs. | JOB NO. | DATE Jan 4/78 | HOLE No. 8 | PLATE No. 12

Moist. Cont. ○
Liq. Lmt. □ Plas. Lmt. △

MOISTURE CONTENT (%)
STANDARD PENETRATION (N)
10 20 30 40 50 60 70 80

DEPTH ELEV. FT.	CLASSIFICATION	SOIL SYMBOL	OTHER TESTS	SAMPLE COND.	TYPE	DEPTH SCALE
	GROUND SURFACE ELEV. 2252.5					
	SAND *Saturated, dense.*					
46						
48						
	END OF HOLE 47.5'					
	After 2 days water level at 19.6'. Hole open to 19.5'.					
	After 5 days water level at 18.3'. Hole open to 19.5'.					
	NOTE:					
	At Depth 7.5' - 8.5'					
	t = 120.6 lbs/ft^3					
	d = 91.8 lbs/ft^3					
	At Depth 12.5' - 13.5'					
	t = 129.4 lbs/ft^3					
	d = 103.7 lbs/ft^3					
	At Depth 17.5' - 18.5'					
	t = 136.1 lb/ft^3					
	d = 112.6 lb/ft^3.					

PLATE No. 12

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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