REPORT NO: 6049 – 86

GEOTECHNICAL INVESTIGATION
PROPOSED LAUREL PHASE 2 SUBDIVISION
SE PORTION OF NE 31 – 51 – 23 – W4M
1710 – 17 STREET NW
EDMONTON, ALBERTA

May 2016

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GEOTECHNICAL INVESTIGATION

PROJECT: Proposed Laurel Phase 2 Subdivision

LOCATION: SE Portion of NE 31 – 51 – 23 – W4M
1710 – 17 Street NW
Edmonton, Alberta

CLIENT: CITY OF EDMONTON
C/O ISL ENGINEERING & LAND SERVICES LTD.
Suite 100, 7909 – 51 Avenue
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ATTENTION: Darin Hicks, P. Eng., CPESC

1.0 INTRODUCTION

This report presents the results of the subsurface investigation made on the site of the proposed Laurel Phase 2 Subdivision in Edmonton, Alberta. The development is understood to consist of a residential subdivision with fully serviced lots for single-family houses with basements. A maximum trench depth of 7.5 metres is assumed. The objective of the investigation was to determine the general subsurface soil profile and provide geotechnical recommendations for underground utility, road and foundation design. Environmental and previous land use issues are beyond the scope of this report.

Authorization to proceed was granted by Mr. Darin Hicks, P. Eng., CPESC of ISL Engineering & Land Services Ltd. (ISL). Permission to enter the site was granted by Mr. Greg Persson, P. Eng., from the City of Edmonton (City).

2.0 SITE DESCRIPTION AND DESKTOP STUDY

The subject site consists of the southeast portion of NE 31 – 51 – 23 – W4M, with a municipal address 1710 – 17 Street NW, Edmonton, Alberta. The site is approximately 54 acres in size. The site is bordered by a storm pond to the north, 17 Street NW to the east, another part of the Laurel Neighbourhood under construction to the south, and the new 24 Street NW under construction to the west.

Aerial Photography Review

Several sets of aerial photography taken between 1950 and 2008, covering the subject site and surrounding areas, were obtained from the Alberta Sustainable Resource Development Library. The photos were compared for any signs of changes and disturbances within the site, but the resolutions were low and observations were limited.

In 1950, the site was cleared. However, the farming pattern appeared irregular and much of the site appeared to be either pasture land or uncultivated land covered with wild vegetation. The site appeared uneven, with many local depressions across the site. At least one channel was visible, running in the northeast-southwest direction. A farm yard was located to the northwest and outside the subject site.

In 1962, more channels were visible across the site.

In 1976, most local depressions throughout the site had disappeared and were farmed over. A patch of trees appeared near the southwest corner of the site.

In 1987, the chains of local depressions along the northwest portion of the site and along 17 Street NW had reappeared. A channel that continued up stream to the south was draining into the local depression in the southwest portion of the site near 17 Street NW. Patches of trees appeared along the 17 Street NW in the southeastern limit of the site.

In 1997, water accumulations were visible in the local depressions.

In 2008, the farmed area had increased and the extents of the larger local depressions had reduced. The channels and the smaller local depressions had disappeared.

Overall, local depressions and channels covered much of the site. The disappearance and reappearance of the local depressions may indicate areas of fill. No obvious signs of human disturbances were noted in the air photos by 2008 prior to residential developments of the surrounding area.

Current Site Conditions

At the time of the current investigation in March 2016, spring thaw was underway and the ground was soft and wet. Much of the site was covered in wild vegetation. The site was cleared of large trees during the investigation. The local depressions and channels noted in the air photo review were relatively shallow, densely vegetated, with little to no water accumulations.

Parts of the site were disturbed. Shallow pits were found in the central portion of the site. Several soil stockpiles at least 3 metres high were located in the north portion and the south central portion of the site. Haul roads connecting to stockpiles were noted across the site.

The site was relatively lower than the surrounding areas. In particularly, the newly constructed 17 Street NW embankment to the east and neighbouring residential subdivisions to the south were built a few metres higher at the border of the site. The terrain was also considered uneven. Access to the site was gained off 24 Street NW. All-wheel drive vehicles were required to travel across the site.

Geotechnical Report Review

One report for a previous geotechnical investigation that covered the subject site was found in the City of Edmonton Library. The following report was reviewed.

1. *Meadows Neighborhood 4, Neighborhood Structure Plan, Hydro-Geotechnical Investigation, Edmonton, Alberta, dated January 2007, prepared by Thurber Engineering Ltd., file # 14-31-245*

Eight testholes in the above noted report were located within or near the subject site. The approximate locations of the testholes located within or near the subject site can be found in the attached site plan. The corresponding testholes logs from the above noted report are also attached and included in the current investigation.

Testing Record Review

No soil testing record from the subject site was found in our library. However, J. R. Paine & Associates Ltd. (JRP) had monitored and tested the soils in the neighboring subdivision to the south, including the marginal soil berm that was placed along the south boundary of the site in March 2016.

Coal Mine Atlas Review

No coal mining information of the area was found in the Alberta Coal Mine Atlas provided by the Alberta Energy Regulator. Coal mining related issues should not be a concern for this site and were not investigated further.

3.0 FIELD INVESTIGATION

The current soil investigation for the subject site was undertaken on March 7, 2016 utilizing a track mounted drill rig owned and operated by SPT Drilling Ltd. A total of four testholes were drilled to a depth of approximately 8.8 metres below the existing grade. The testhole locations were selected by our firm based on a preliminary lot layout provided by ISL. The testhole locations and elevations were later surveyed using a Trimble Geoexplorer 6000 GPS unit. The approximate locations of all testholes can be found on the attached site plan in the Appendix.

All testholes were advanced with 150 millimetre diameter solid stem augers in 1.5 metre increments. A continuous visual description, including the soil types, depths, moisture, transitions, and other pertinent observations, were recorded on site. Soil samples were collected at approximately 750 millimetre interval for laboratory testing. Standard Penetration Tests (SPT) complete with split spoon sampling were also taken at regular 1.5 metre intervals on all testholes. Where suitable soil was encountered, Shelby Tube samples were taken instead of SPT.

Following the drilling operation, slotted piezometric standpipes were installed in all four testholes for watertable level measurement. The testholes were backfilled with cuttings and bentonite was placed near the surface to prevent surface water infiltration.

As requested by the City and ISL, eleven shallow test pits were excavated throughout the site on March 21, 2016, using a hoe owned and operated by Sureway Construction Group Ltd. The test pit locations were selected and surveyed by ISL. The topsoil and marginal soil depths were measured at each test pit location.

As requested by ISL, ten additional test pits were dug within the four stockpiles on site on March 28, 2016, using a hoe owned and operated by Sureway Construction Group Ltd. The test pits were dug on top of the stockpiles to approximately 4.5 metres. A general description of the soil found in each test pit was recorded.

4.0 LABORATORY TESTING

Soil samples retrieved were bagged and returned to the laboratory for further testing. All samples were tested for moisture content. Representative samples were also tested to determine the liquid and plastic Atterberg limits, as well as soluble soil sulphate concentrations. Undisturbed Shelby tube samples, obtained at various depths, were tested for dry density and unconfined compressive strength. The results of all laboratory testing and field observations are provided on the attached testhole logs.

5.0 GEOLOGICAL AND SOIL CONDITIONS

According to GIS maps from Alberta Geological Survey, the local surficial geology of the area is classified as stagnant ice moraine deposit of Pleistocene age. The stagnant ice moraine deposit was described in the legend as mainly till with stratified glaciolacustrine sediments, from the collapse of melting stagnant ice along the glacial margin. It is also characterized by its hummocky topography. The general bedrock geology in the region was identified as the Horseshoe Canyon Formation of late Cretaceous age. The Horseshoe Canyon Formation generally comprised of grey feldspathic clayey sandstone and bentonitic mudstone, with scattered coal and bentonite beds of various thickness.

Detailed descriptions of the soils encountered are shown on the attached testhole logs in the Appendix. In general, the soil profile consisted of topsoil at the surface, followed by till-like clay and clay till to testhole termination depths.

Topsoil & Organic Clay

A variable amount of topsoil and organic clay were encountered at the surface in most testholes and test pits. In general, the topsoil encountered was silty and black. The organic clay encountered was considered silty, very moist, black, and contained some shell fragments. The measured topsoil depths at each testhole or test pit location are summarized below.

Table 1: Approximate Measured Topsoil & Organic Clay Depth	
Testhole / Test Pit	Topsoil / Organic Clay depth below existing grade (m)
06 - 03	0.8
06 - 04	0.3
06 - 05	0.3
06 - 6	0.4
06- 7	0.3
06 - 14	0.8
06 - 15	0.1
06 - 18	0.3
2016 - 1	none
2016 - 2	0.9
2016 - 3	0.5
2016 - 4	0.2
TP - 1	0.4
TP - 2	0.2
TP - 3	1.6
TP - 4	0.6
TP - 5	0.5
TP - 6	0.3
TP - 7	0.2
TP - 8	0.7
TP - 9	0.5
TP - 10	0.2
TP - 11	0.6

It is emphasized that topsoil depths are only measured at the testhole or test pit locations and may vary significantly away from testhole or test pit locations. The above summary does not include the topsoil and organic clay within the stockpiles.

Fill & Stockpiles

Four soil stockpiles were present on site. The locations of Stockpiles 1 to 4 can be found in the attached stockpile volume plan provided by ISL. At least two test pits were dug in each stockpile. However, only four test pits reached the bottom of the stockpile and exposed the native clay. The soils encountered in Stockpiles 1, 2, and 4 were a mixture of topsoil and marginal clay with a variable amount of organic content.

The soils encountered in all three test pits atop Stockpile 3 consisted of mostly greyish brown, silty, clay fill. In general, the clay fill was considered medium plastic, moist to very moist, stiff, and contained a trace of gravel and organic soil. A pocket of organic soil was encountered in one test pit. None of the test pits on Stockpile 3 reached the native soil.

Therefore, it is not known if the ground below the stockpile was stripped of topsoil prior to fill placement.

Clay & Clay Till

Native deposits of till-like clay were encountered near the surface in most testholes. In general, the upper till-like clay material was considered silty, sandy, medium plastic, moist, brown, and contained a trace of oxide. SPT "N" values between 5 and 42 blows per 300 millimetres of penetration were recorded, indicating a firm to hard consistency.

The till-like clay gradually transitioned into clay till at various depths in most testholes. In general, the clay till material was considered silty, medium plastic, moist, grey, and contained a trace of coal, oxide, and gravel. SPT "N" values between 7 and 31 blows per 300 millimetres of penetration were recorded, indicating a stiff to hard consistency.

Sand

Sand seams were encountered at various depths in Testholes 06-03 to 06-06, and 06-14. In general, the sand material was considered silty, fine to medium grained, and brown. The sand was considered loose to compact, with SPT "N" values between 9 and 19 blows per 300 millimetres of penetration recorded. Many of the sand seams encountered were also saturated.

Testhole Condition At Completion

Upon completion of drilling, minor sloughing conditions and immediate groundwater seepages observed in the testholes are summarized below.

Table 2: Groundwater Seepage And Sloughing Conditions At Completion

Testholes	Approximate Water Accumulation At Hole Bottom (m)	Approximate Slough Thickness At Hole Bottom (m)
06 - 03	4.2	3.9
06 - 04	0.5	none
06 - 05	13.4	1.5
06 - 06	9.9	1.1
06 - 07	11.6	2.7
06 - 14	12.5	2.0
06 - 15	dry	none
06 - 18	1.5	1.5
2016 - 1	dry	none
2016 - 2	7.0	none
2016 - 3	0.8	none
2016 - 4	dry	none

6.0 GROUNDWATER CONDITIONS

Watertable readings were taken within seven weeks after the completion of drilling. For all practical purposes, the highest recorded levels are chosen for the evaluation. The watertable readings and corresponding elevations are summarized below.

Table 3A: Previous Watertable Measurements

Testholes	Watertable Depth Below Ground Surface (m)			Ground Elevation (m)	Watertable Elevation (m)
	Nov 24, 2006	Jan 4 or 5, 2007	Jan 15, 2007		
06 - 03	1.36 (2 day)	1.04 (43 day)	n/a	714.47	713.43
06 - 04	6.93 (2 day)	4.70 (43 day)	n/a	718.25	713.55
06 - 05	9.43 (2 day)	3.13 (43 day)	n/a	718.08	714.95
06 - 06	4.20 (1 day)	1.54 (43 day)	n/a	716.27	714.73
06 - 07	2.36 (1 day)	2.08 (42 day)	n/a	716.24	714.16
06 - 14	n/a	1.72 (34 day)	n/a	715.28	713.56
06 - 15	n/a	n/a	3.09 (11 day)	715.60	712.51
06 - 18	2.56 (0 day)	2.16 (42 day)	n/a	716.79	714.63

Table 3B: Current Watertable Measurements

Testholes	Watertable Depth Below Ground Surface (m)			Ground Elevation (m)	Watertable Elevation (m)
	Mar 15, 2016 (8 day)	Mar 28, 2016 (21 day	Apr 12, 2016 (36 day)		
2016 - 1	7.16	5.48	4.19	717.00	712.81
2016 - 2	1.53	1.40	0.94	716.36	715.42
2016 - 3	2.50	2.15	2.18	716.38	714.23
2016 - 4	3.17	2.66	2.58	717.96	715.38

It should be noted that watertable levels might fluctuate on a seasonal or yearly basis with the highest readings obtained in the spring or after periods of heavy rainfall. The above 2016 watertable readings should reflect near the high seasonal level.

In general, the watertable of this site was considered high in most parts of the site. The measured watertable levels were within 3.0 metres below the existing grade in eight testholes. The watertable elevations were variable across the site.

7.0 RECOMMENDATIONS

7.1 Site Grading

1. Topsoil and organic clay are considered unsuitable to support footing foundation, slab-on-grade, or roads and walkways. All topsoil and organic soil should be completely stripped away, stockpiled, and reused for landscaping purposes only.

   Prior to stripping, areas of former local depressions and channels should be identified and closely inspected. More topsoil and organic soil should be expected within the local depressions and channels.

2. The existing fill encountered in Stockpile 3 appeared to contain only a trace of organic soil. Selected clean fill from this stockpile can be used for grading fill or engineered fill placement. Field judgment will be required to determine the suitability of any existing fill, including the stockpile, to be reused during grading operation.

3. Most of the native inorganic soils encountered near the surface were relatively stiff and should be adequate to support construction traffic. Conventional clearing and stripping should be suitable for most parts of the site. However, a hoe and trucks may be required to remove deeper organic soil within the former local depressions and channels.

4. The watertable levels were relatively high in most parts of the site. Design grade should be raised to avoid construction difficulties. No cut beyond stripping is recommended.

   Based on the preliminary cut/fill plan provided by ISL, minor to over 1 metre cuts are planned in the central and southeast portions of the site where the watertable depths may be reduced to within 2.0 metres below design grade. The expected high watertable may affect the construction of houses and roads as discussed in Sections 7.2 and 7.4.

5. Engineered fill may be considered in areas where low elevations necessitate deep fill zones. This option should be reviewed by our firm to evaluate site conditions and borrow material sources prior to implementation. Fill deeper than 4.0 metres should be reviewed by our firm to address potential settlement prior to construction.

   Engineered fill is soil that is placed in a controlled manner under the full-time inspection of a qualified soil technician. The fill should be placed in maximum 150 millimetre lifts and compacted to a minimum 98 percent of its Standard Proctor Density (SPD) near its optimum moisture content. All topsoil and non-engineered fill must first be stripped from the engineered fill area. Engineered fill placement requires full-time monitoring and extensive testing by the geotechnical consultant during construction. However, proper placement of engineered fill will negate the need for pile foundations in deep lot fill areas, and possibly reduce the foundation costs to the builders and developer.

Engineered fill requires the support of strong underlying soil. Most of the near surface native inorganic soils encountered in the testholes were considered suitable to support engineered fill. However, soft to firm soils were encountered near the surface in Testholes 06-03, 06-06, 06-14, 06-15, 06-18, and 2016-2. It should be noted that engineered fill construction is not possible in soft, very moist, underlying soils. Compacting the first lift of fill material over these soft underlying soils to the engineered fill standard may be impossible. Where a minimum fill depth condition is met, construction of a clay pad approximately of 300 to 500 millimetres in thickness will be required to obtain an adequate working platform. This pad should be compacted to a minimum of 98 percent of SPD where possible. The normal engineered fill lift thickness and compaction criteria mentioned above should be applied to successive lifts. To employ this method, a minimum of 1.0 metre of engineered fill must be placed on top of the clay pad. If this condition is not met, the fill would not be considered to have met engineered fill standards.

In addition, engineered fill requires fill depth differentials across the building footprint of less than 1.5 metres. This may be a limiting factor in some area, due to the uneven nature of the existing ground. In some cases, removal of native material may allow for the minimum fill depth or the maximum fill differential conditions to be met. However, this may not always be the most economical solution.

6. The native till-like clay and clay till encountered throughout the site would be suitable as engineered fill material. The moisture contents of the till-like clay were variable, from slightly above to over 15 percent above the plastic limit. Therefore, a variable amount of drying would be required for the till-like clay to meet the compaction specifications. The moisture contents of the clay till were mostly within 5 percent above the plastic limit, with isolated wetter zones. Therefore, a minor to moderate amount of drying would be required for the clay till to meet the compaction specifications.

The sand material encountered in Testholes 06-03 to 06-06, and 06-14 should not be used as patches of grading fill along with clay fill to ensure uniformity. However, a minor amount of sand can be thoroughly mixed with clay to be used as grading fill.

7.2 Residential Housing

1. The native inorganic soils encountered throughout this site are considered satisfactory for supporting wood framed single-family dwellings utilizing standard concrete footing foundations. Engineered fill would also be considered suitable for footing support. Soft to firm soils were encountered near the surface in Testholes 06-03, 06-06, 06-14, 06-15, 06-18, and 2016-2. It should be noted that the bearing capacity of soft materials in isolated areas may fall below the minimum 75 kilopascals required for applying the Alberta Building Code Section 9. In such cases, wider footings will be required.
2. No loose, disturbed, remoulded or slough material should be allowed to remain in the open footing excavations. Hand cleaning is advised if an acceptable surface cannot be prepared by mechanical equipment. In order to reduce the disturbance to the bearing surface, a backhoe operating remotely from the bearing surface should advance all basement excavations.
3. Footing excavations should be protected from rain, snow and influx of groundwater. If minor groundwater seepage or rain covered the excavation floor, all water accumulation and water softened materials should be removed from the footing bearing surface prior to concrete placement. If major groundwater seepage due to the high watertable or heavy precipitation flooded the basement excavation, temporary dewatering including a sump and pump will be required. Footings must not be constructed underwater.
4. Proper lot grading away from the houses must be provided to minimize the ingress of surface water into the subsoil. Further lot grading recommendations are provided in Section 7.5.
5. All houses will require at least 1.5 metres of earthen cover to prevent potential frost heave problems, and to minimize movements associated with seasonal variations in moisture content. The amount of cover should be increased to 2.0 metres for exterior isolated footings or for footings of non-continuously heated structures.

6. Final lot grading is not known at this time. If general lot grading will produce areas of fill extending in depth below that of the footing elevation, it is strongly recommended that qualified geotechnical personnel inspect the house excavations. Generally, it is not recommended that footings be constructed on non-engineered fill. In such cases, the following alternatives are commonly recommended:
    - Removal of the fill down to native soil and backfill with a compacted granular material. A normal footing foundation may then be utilized.
    - Utilize a pile foundation.
7. The soils encountered at this site are generally considered suitable for cast-in-place pile installation. Immediate groundwater seepage was encountered in nine testholes. Sloughing conditions were also encountered in six testholes. If groundwater seepage or significant sloughing conditions are encountered during pile drilling, casing may be required. At the very least, pile concrete should be on-site during the pile drilling to allow for immediate concrete placement.

    Sand seams were encountered at various depths in three testholes, where casing will likely be required to control the sloughing conditions.
8. The factored soil skin friction resistance for pile design should be determined on a lot by lot basis.
9. At a minimum, peripheral exterior weeping tile lines will be required for all houses. All lines should be placed at or slightly below footing elevation and connected to ensure positive drainage to an approved system. The weeping tile lines will require a filter sock with a suitable clean tile rock drainage filter, with a minimum of 150 millimetres of rock around the line, all encompassed with a non-woven geotextile for separation.

    Based on the preliminary cut/fill plan, high watertable levels near the typically basement excavation depth of 2.0 metres is expected in many areas. More recommendations on groundwater and drainage issues are provided in Section 7.5.
10. All backfill against foundation walls should be inorganic material and should be moderately compacted with care taken not to over compact the fill and generate excessive lateral pressure. The backfill should be placed in lifts not great than 150 millimetres after compaction. It is recommended that floor joists be placed prior to backfilling in order to minimize any detrimental effects on the foundation walls caused by soil compaction.

11. The time span between the start of excavation to installation of basement footings, walls, peripheral weeping tile and backfilling operations should be minimized in order to prevent any problems developing within the excavation due to ingressing of ground or surface waters or desiccation of the subsoil.
12. During cold weather construction, it is essential that all interior fill and load bearing materials remain frost free. Recommended cold weather construction practices, with respect to hoarding and heating of the forms and the fresh concrete, should be followed. In order to minimize the potential frost heave problems, the interior of the building must be heated as soon as the walls have been poured. The period in which the excavation is left open due to freezing conditions should be as short as possible. If doubts remain as to the suitability of the foundation during construction, the builder should consult a qualified geotechnical engineer. Due to the high watertable, frost heave potential is increased and diligence with this item is emphasized.
13. The native inorganic till-like clay and clay till encountered near the surface of this site are considered suitable for slab-on-grade support. Engineered fill would also be adequate to provide slab-on-grade support.

    A 150 millimetre thick layer of clean granular material and a non-deteriorating vapour barrier should be placed immediately below the floor slab to prevent desiccation of the subgrade material.

7.3 <u>Underground Utilities</u>

1. The native till-like clay and clay till encountered throughout the site were generally considered satisfactory for the installation of underground utilities. The sand seams encountered may cause some trenching difficulties. Topsoil and all other organic materials should be separated from the inorganic soils, and should not be re-used as trench backfill.
2. Immediate groundwater seepage was encountered in nine testholes. The watertable levels were within 3.0 metres from the surface in all eight testholes. Wet sand seams were also encountered in three testholes. Minor to moderate amount of groundwater seepage should be expected for trenches below the watertable. Saturated conditions will likely be encountered in the trenches in at least some areas. More recommendations on groundwater issues are provided in Section 7.5.

3. Open cut trenching techniques should be feasible for this site. Standard trenching cutback angles of approximately 45 degrees from the vertical are expected to be adequate for the native till-like clay and clay till. Trenching within any wet sand will require increased cutback angles of more than 45 degrees in order to remain stable. The optimum cutback angles for utility trenches should be determined in the field during construction. Exact stable slope values cannot be pinpointed without detailed and extensive analysis. For this reason, this information should be used as a guideline only. Part 32 of the Occupational Health and Safety Regulation should be strictly followed, except were superseded by this report.

   If slope instability and significant groundwater seepage are encountered during construction, temporary cages and significant dewatering may be required to keep the trench open. Opening a long section of a trench for a long period of time is not recommended.

4. Temporary surcharge loads, such as spill piles, should not be allowed within 5.0 metres of an unsupported excavation face, while vehicles and machineries should be kept back at least 1.0 metre. All excavations should be checked regularly for signs of sloughing or failures, especially after rainfall periods.

5. To reduce pipe loading, trench widths should be minimized but be compatible with safe construction operations. The trench width must be wide enough to accommodate pipe bedding and compaction equipment.

6. Pipe bedding procedures should adhere to the City of Edmonton Design And Construction Specifications (City's Standard). The backfill material immediately beneath and above the pipe should be an approved bedding sand material where conditions allow. This material should be hand placed and hand tamped, with care taken to fill the underside of the pipe. If groundwater seepage or saturated conditions are encountered in trenches, washed rocks with geotextile separator are recommended for pipe bedding. The washed rock and geotextile configuration should be determined in the field during construction. The expected need for this configuration is moderate for this site.

7. The estimated factored bearing capacities of the soil encountered at various depths in each testhole for thrust blocks are summarized below:

Table 4: Thrust Block Bearing Capacity vs. Soil Depth			
Factored Bearing Capacity	0 kPa	50 kPa	minimum 72 kPa
Testhole	Soil Depth (m)		
06 - 03	0 - 0.8	0.8 - 2.4	2.4 - 14.9
06 - 04	0 - 0.3	n/a	0.3 - 14.9
06 - 05	0 - 0.3	n/a	0.3 - 19.5
06 - 06	0 - 0.4	0.4 - 2.3	2.3 - 11.9
06 - 07	0 - 0.3	n/a	0.3 - 19.5
06 - 14	0 - 0.8	0.8 - 2.2	2.2 - 14.9
06 - 15	0 - 0.1	2.4 - 3.8	0.1 - 2.4 & 3.8 - 11.6
06 - 18	0 - 0.3	0.3 - 3.1	3.1 - 14.9
2016 - 1	n/a	n/a	0 - 8.8
2016 - 2	0 - 0.9	0.9 - 3.4	3.4 - 8.8
2016 - 3	0 - 0.5	n/a	0.5 - 8.8
2016 - 4	0 - 0.2	n/a	0.2 - 8.8

For typical pipe depth of 3.0 metres, the waterline will be situated within the near surface till-like clay and clay till. The factored bearing capacity of most of the near surface till-like clay and clay till should meet the minimum 72 kilopascals as required by EPCOR. Engineered fill to be placed during the construction will also meet the minimum factored bearing capacity of 72 kilopascals specified by EPCOR. However, thrust blocks should not be founded on any existing non-engineered fill or organic soil.

It is emphasized that soil conditions may vary away from the testhole locations. Soft to firm soils were encountered in many testholes, where the soil bearing capacity would fall to 50 kilopascals. Where variable soil condition is encountered during construction, thrust block excavation should be inspected accordingly to confirm the bearing capacity prior to placement of concrete.

8. Trench backfill procedures should adhere to the City of Edmonton Design And Construction Specifications (City's Standard). All trench backfill to be placed above bedding material should be placed in maximum 300 millimetre compacted lifts. The following chart summarizes the trench backfill compaction requirements found in the City's Standard for trenches under existing or proposed road, alley, walk, street or similar structure and within a distance from such structure equal to trench depth.

Table 5: Trench Backfill Compaction Requirement Options		
Backfill Zone	Standard Criteria	One Point Criteria
Within 1.5 m below subgrade	minimum 98% SPD	minimum 100% OPPD
More than 1.5 below subgrade	minimum 95% SPD	minimum 97% OPPD
SPD = corresponding Standard Proctor Density		
OPPD = corresponding One-Point Proctor Density (with maximum moisture criteria)		

Based on our experience in construction of the surrounding neighbourhoods in the past, no major compaction issues were noted using the one-point criteria. Therefore, the one-point criteria should be applicable for this site as well. Uniform backfill is required by the City's Standard and also recommended by our firm.

9. The following table compares the native moisture content of the clay materials encountered at the time of investigations, with different moisture content criteria for trench backfill at this site. It should be noted that moisture contents varied significantly within the site. More Atterberg Limit testing will be required at the time of construction to confirm these results.

Table 6: Trench Backfill Maximum Moisture Content Criteria

Testhole Number	Sample Depth m	Liquid Limit %	Plastic Limit %	Field Moisture Content %	Plasticity Index (PI) %	Maximum Moisture Content Criteria: Uniform Backfill		Conventional Backfill		PL+10 Criteria	
						PL+PI/2	+/- Criteria	PL+PI/3	+/- Criteria	PL+10	+/- Criteria
06 - 06	1.6	44.0	15.0	32.0	29.0	29.5	2.5	24.7	7.3	25.0	7.0
06 - 14	1.6	47.5	17.0	27.0	30.5	32.3	-5.3	27.2	-0.2	27.0	0.0
2016 - 1	3.1	34.8	12.4	18.4	22.4	23.6	-5.2	19.9	-1.5	22.4	-4.0
2016 - 2	7.6	31.5	12.0	16.2	19.5	21.8	-5.6	18.5	-2.3	22.0	-5.8
2016 - 3	1.5	36.3	12.1	18.4	24.2	24.2	-5.8	20.2	-1.8	22.1	-3.7
2016 - 4	4.6	35.3	13.1	17.6	22.2	24.2	-6.6	20.5	-2.9	23.1	-5.5

Notes:
- City specifications state that when the plasticity index criteria for maximum moisture content exceeds 10 percent over the plastic limit, the plastic limit plus 10 percent shall govern.
- All values of under the criteria are percentages.
- Chart shows only the moisture content of samples tested for Atterberg Limits. See testhole logs for all moisture content data

The moisture contents of the till-like clay were variable, from slightly above to over 15 percent above the plastic limit. Therefore, a variable amount of drying should be expected to attain adequate compaction. The moisture contents of the clay till were mostly within 5 percent above the plastic limit, with isolated wetter zones. Therefore, a minor to moderate amount of drying should be expected to attain adequate compaction. Weather conditions should be considered during trench backfill operations.

Increased drying is recommended for the top 1.5 metres of the trench backfill, in order to improve conditions for the construction of surface utilities. Increased drying may also reduce subgrade preparation costs.

10. It should be noted that the ultimate performance of the trench backfill is directly related to the consistency and uniformity of the backfill compaction, as well as the contractor's underground construction procedures. In order to achieve this uniformity, the lift thickness

and compaction criteria should be strictly enforced. The quality of the trench backfill compaction affects the subgrade and pavement design.

7.4 Surface Utilities

1. The soil conditions encountered throughout this site is considered generally fair for the construction of roads, curbs, and sidewalks. However, the expected high watertable level will affect the pavement structure. Topsoil and all other organic materials should be removed prior to construction of roads, sidewalks and other surface utilities.
2. The native till-like clay and clay till encountered were medium plastic and were considered slightly to moderately frost susceptible. Typically, a watertable within 3.0 metres of the road surface is required for significant frost heave to occur. The closer the watertable is to the surface, the higher is the frost heave potential. The measured watertable levels in eight testholes were within 3.0 metres below the existing grade, the potential for frost heave will be moderate. Raising the design grade is recommended in the high watertable areas to reduce frost heave potential.

   To minimize frost heave or long-term subgrade softening concerns, an attempt can be made to lower the watertable. This may be accomplished by using sub-drains, usually consisting of perforated pipe and manhole inlets, to collect groundwater below the road area. More recommendations on lowering the watertable are provided in Section 7.5.
3. Cement stabilization is the recommended subgrade preparation. The minimum subgrade preparation of 10 kilogram of cement per square metre of road subgrade mixed to 150 millimeters depth and recompacted to a minimum 100 percent of SPD at optimum moisture content should be expected.

   The subgrade should be proof rolled prior to stabilization to determine the exact cement content needed. Observations during underground construction would also help determine the subgrade treatment required. If soft native soil or wet subgrade due to rainfall is present, increased cement stabilization (25 to 30 kilograms per square metre of subgrade to 300 millimetres in depth) may be applicable. Replacement of the very soft soil with drier clay material to obtain a more stable and stronger subgrade would also be an option.

The subgrade should be proof rolled after final compaction. Any areas showing visible deflections should be inspected and repaired. If cement stabilization fails to produce an adequate subgrade, upgraded pavement structures with an additional gravel base may be required.

4. It is important that subgrade soils not be allowed to dry excessively when exposed, and moisture contents are kept slightly over optimum. As the same time, care must be taken not to allow any excess moisture into these soils. Weather conditions should be considered during construction.
5. A minimum cross slope of 2.0 percent on the subgrade surface should be constructed and maintained to ensure proper drainage of water away from the road structure.
6. Surface water will often collect within the granular base, causing subgrade softening and pavement damage. Therefore, it is recommended that wick drains be installed in the gravel road base at the curb bottom locations. The wick drains must be properly attached to the catch basins.
7. The following staged pavement structures are recommended. An estimated California Bearing Ratio (CBR) of 2.5 to 3.0 percent is used in the design, as well as a design life of 20 years.

Table 7A: Recommended Staged Roadway Structures (Low Watertable Area)

	Traffic Loading	Local ($3.6x10^4$ ESALs)	Minor Collector ($1.8x10^5$ ESALs)	Major Collector ($3.6x10^5$ ESALs)
Stage 1	Asphaltic Concrete Crushed Gravel (3-20)	65 mm (10mm-LT) 200 mm	75 mm (10mm-LT) 250 mm	75 mm (10mm-HT) 325 mm
Stage 2	Asphaltic Concrete	35 mm (10mm-LT)	35 mm (10mm-LT)	35 mm (10mm-HT)
Note:	10mm-LT = City of Edmonton Asphaltic Concrete Mix Type 10 mm - Light Traffic 10mm-HT = City of Edmonton Asphaltic Concrete Mix Type 10mm - High Traffic 3-20 = City of Edmonton Aggregate Designation 3 Class 20 All granular base material should be compacted to 100 percent of the Standard Proctor Density in maximum 150 mm lifts.			

Based on the preliminary cut/fill plan, the watertable will be within 2.0 metres from the design grade in the southeast portions of the site. Therefore, the following increased pavement structures are recommended to handle the effect of watertable fluctuation in high watertable area. The final grading should be reviewed to confirm the extents and the need for increased pavement structures.

Table 7B: Recommended Staged Roadway Structures (High Watertable Area)				
	Traffic Loading	Local ($3.6x10^4$ ESALs)	Minor Collector ($1.8x10^5$ ESALs)	Major Collector ($3.6x10^5$ ESALs)
Stage 1	Asphaltic Concrete Crushed Gravel (3-20)	65 mm (10mm-LT) 300 mm	75 mm (10mm-LT) 350 mm	75 mm (10mm-HT) 425 mm
Stage 2	Asphaltic Concrete	35 mm (10mm-LT)	35 mm (10mm-LT)	35 mm (10mm-HT)
Note:	10mm-LT = City of Edmonton Asphaltic Concrete Mix Type 10 mm - Light Traffic 10mm-HT = City of Edmonton Asphaltic Concrete Mix Type 10mm - High Traffic 3-20 = City of Edmonton Aggregate Designation 3 Class 20 All granular base material should be compacted to 100 percent of the Standard Proctor Density in maximum 150 mm lifts.			

No traffic loading data was provided to our firm at this time. The stated Equivalent Single Axle Load (ESAL) values for different roadway designations were obtained from City of Edmonton. Our firm should be advised if more traffic loading information becomes available and the pavement design should be modified accordingly.

8. It is recommended that all areas beyond the back of curb/sidewalk be landscaped as soon as possible to avoid water permeating into the subgrade from free standing puddles.

7.5 Groundwater & Drainage Issues

1. The natural groundwater levels recorded at the site were high in most parts of the site. Immediate groundwater seepages were encountered in nine testholes. Ingressing water and saturated soil conditions should be expected in trenches below the watertable in at least parts of this site. Moderate dewatering effort may be required and construction delays should be expected. The amount of groundwater seepage encountered will depend on the excavation depth below the watertable and the soil stratum encountered.
2. Temporary to continuous dewatering consisting of in-trench sumps and pumping would likely be sufficient to handle moderate groundwater seepage from the wet clay soil below the watertable. However, groundwater seepage rates into utility trenches would be relatively fast if wet sand seams are encountered. More aggressive dewatering cannot be ruled out for deep trenches. The lateral extent and connectivity of the water bearing sand soil is a factor in the amount of groundwater flow and this is not fully known at this time.

3. One option to lower the watertable is to hydraulically connecting the bedding materials to the manholes, or leaving the gaskets off the storm sewer connections during construction, allowing groundwater to seep into the sewer. When employing this method, it is important to wrap the joints in filter cloth to prevent silting.

   Another option is to install perforated drain connected to the storm manholes. The exact configuration and need for the sub-drains should be determined during construction. The need for long-term dewatering effort will depend on the grading design.
4. Foundation drain services are required for all lots in this subdivision as per City of Edmonton requirements and are also recommended by our firm. Where house basements and footing foundations are near or below the watertable, upgraded foundation drainage to include a washed rock slab base, as well as interior and exterior weeping tile is recommended. A schematic drawing depicting the recommended drainage measures is attached. Frequent pump operations should also be expected. If footings are more than 1.0 metre above the high seasonal watertable, standard house drainage measure should be sufficient. The need for upgraded foundation drainage should be determined on a lot by lot basis.
5. Water dispersed on the property from the roof leaders should not be allowed to accumulate against the foundation walls. To ensure positive drainage, the soil surface of all lots should be made sloping away from all buildings. This will require a positive lot grading of at least five percent away from the foundation walls for a minimum of 1.5 metres. In cases where the lot drainage runs from the back of the lot to the front, runoff should be kept 1.2 metres away from the house.
6. Clay is the preferred backfill material around the basement walls. This serves to reduce water penetration into the backfill, and subsequently into the weeping tile system. The till-like clay and clay till encountered throughout the site are suitable for this purpose.

7.6 <u>Storm Water Management Facility</u>

1. It is understood no storm water management facility (SWMF) is planned within the subject site.

7.7 Cement

Tests on selected soil samples indicated negligible to moderate concentrations of water soluble soil sulphates in the near surface clay deposits. The following alternatives are advised to address the sulphate content:

1. Underground Concrete Pipe

   Concrete used for all underground pipes must be constructed of C.S.A. Type HS, sulphate resistant hydraulic cement.

2. Curbs and Sidewalks

   All concrete for surface improvements such as sidewalks and curbs may be constructed using CSA Type GU, General Use Portland cement.

3. Foundation Construction

   Based on C.S.A. Standards A23.1-14, class of exposure S-3 should be applied to the design requirements for concrete in contact with the soil and susceptible to sulphate degradation. The class S-3 exposure requires Type HS, sulphate resistant hydraulic cement with a minimum 56 day concrete strength of 30 MPa, as well as other requirements as given in the noted C.S.A. guideline. However, individual locations may show higher or lower concentrations of soluble soil sulphate, and thus additional soil testing on particular lots may prove valuable.

   All concrete subject to freeze thaw must be air entrained with 5 to 7 percent air. Other exposure conditions and structural requirements should be considered when choosing a minimum strength for the concrete. Concrete should conform to CSA Standards A23.1-14 and A23.2-14.

8.0 CLOSURE

This report has been prepared for the exclusive and confidential use of ISL Engineering & Land Services Ltd., City of Edmonton, and their authorized agents. Use of this report is limited to the subject residential development only. The recommendations given are based on the subsurface soil conditions encountered during testhole drilling, current construction techniques and generally accepted engineering practices. No other warranty, expressed or implied, is made. Due to geological randomness of many soils formations, no interpolation of soil conditions between or away from the testholes has been made or implied. Soil conditions are known only at the testhole location. Should other soils be encountered during construction or other information pertinent becomes available, the undersigned should be contacted as the recommendations may be altered or modified.

We trust this information is satisfactory. If you should have any questions, please contact our office.

Respectfully Submitted,

Hoggan Engineering & Testing (1980) Ltd.

PROFESSIONAL ENGINEER
JOHN TSOI
ALBERTA

May 9, 2016

John Tsoi, P.Eng.

PERMIT TO PRACTICE
HOGGAN ENGINEERING & TESTING (1980) LTD.
Signature R. Evans
Date May 9, 2016
PERMIT NUMBER: P 3691
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Reviewed by: Rick Evans, P. Eng.

Manager, Geotechnical Engineering

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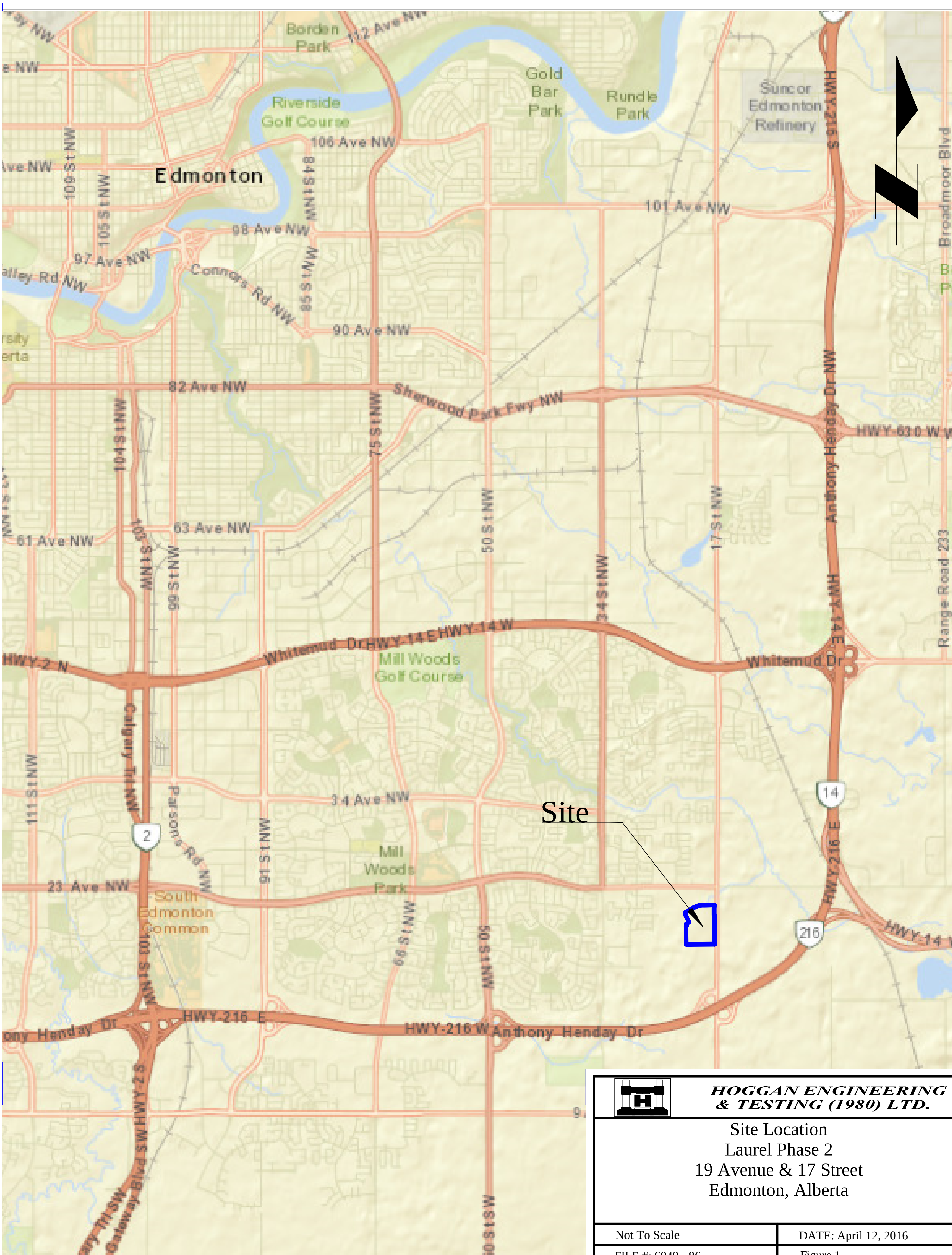
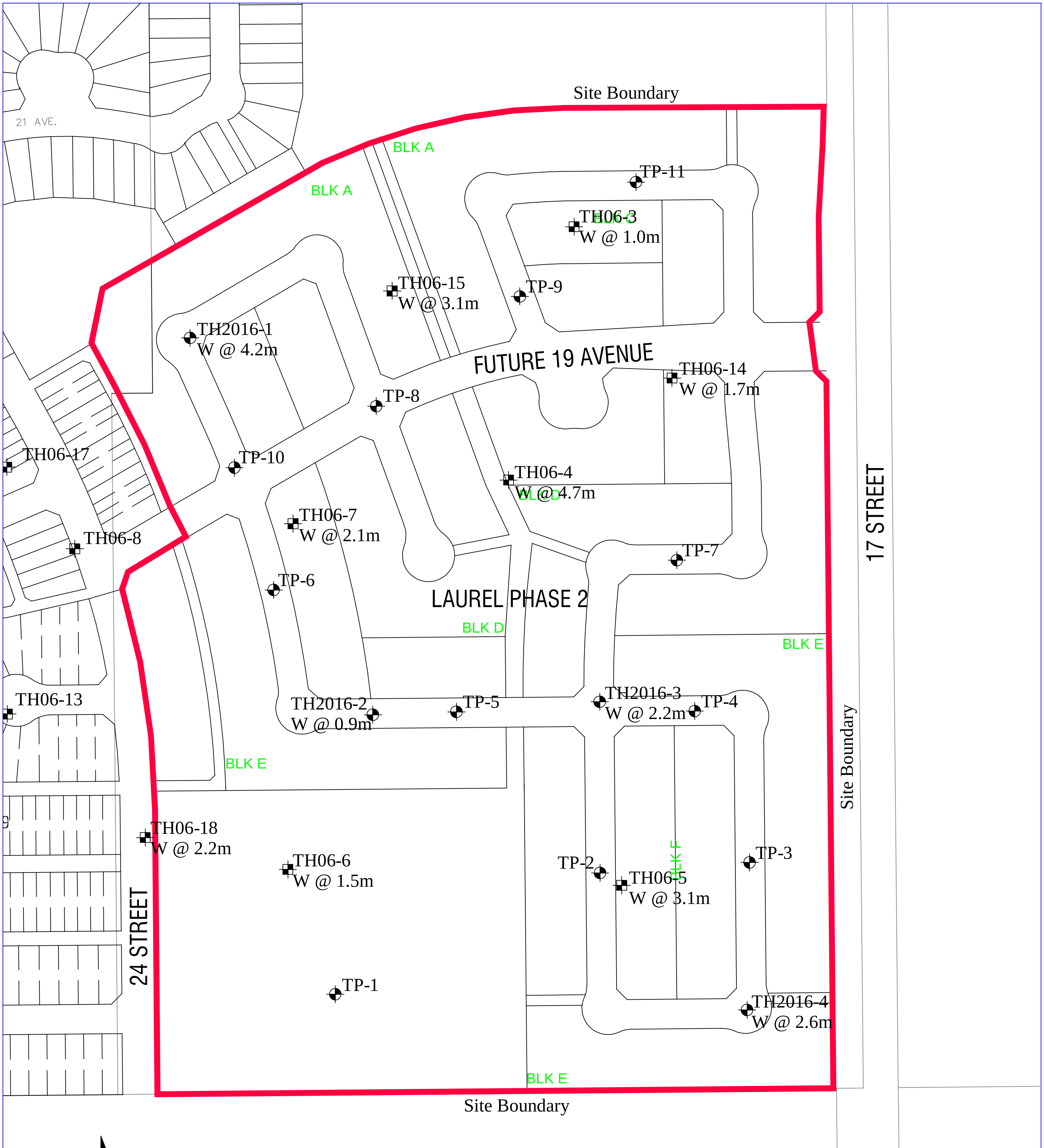
APPENDIX



HOGGAN ENGINEERING & TESTING (1980) LTD.

Site Location
Laurel Phase 2
19 Avenue & 17 Street
Edmonton, Alberta

Not To Scale	DATE: April 12, 2016
FILE #: 6049 - 86	Figure 1



LEDEND

TH = testhole number

TP = test pit number

W = watertable depth

HOGGAN ENGINEERING & TESTING (1980) LTD.

Approximate Testhole Locations
Laurel Phase 2
19 Avenue & 17 Street
Edmonton, Alberta

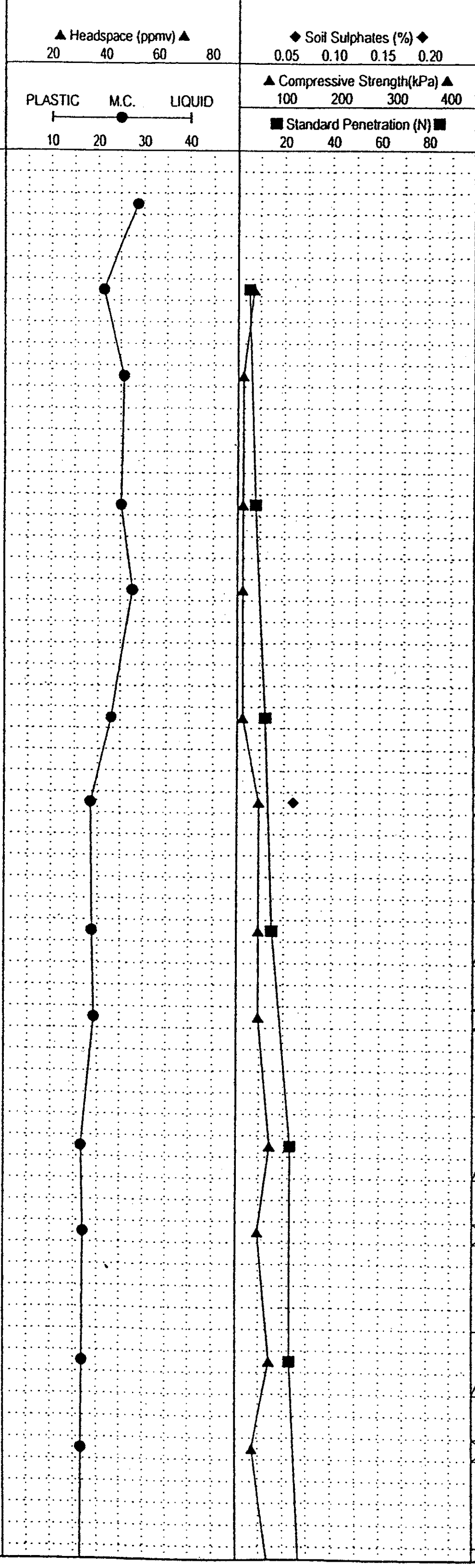
(base drawing provided by ISL Engineering & Land Services Ltd.)

Scale 1:3000	DATE: April 12, 2016
FILE #: 6049 - 86	Figure 2

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-03**
CLIENT: CITY OF EDMONTON	LOCATION: N5924415.60, E41747.18	PROJECT NO: 14-31-245
START DATE: 22/11/2006		ELEVATION: 714.47 (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

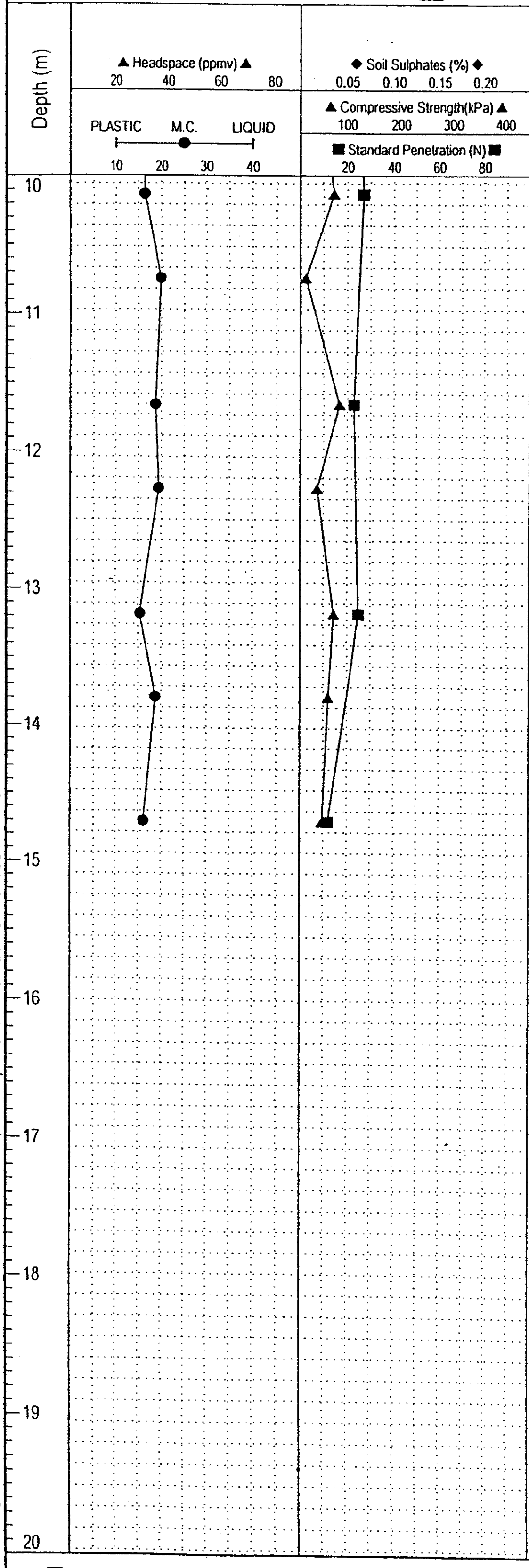


Depth (m)	SPT (N)	USC	SOIL DESCRIPTION	ELEVATION (m)
0			ORGANIC CLAY black, granular, some silt and shells, trace gravel	
		OL		714
1	5	CI	CLAY firm, grey, silty, some oxides, trace sand	
		CI	-becomes brown, very silty, trace oxides	713
2				
	8	CI	-becomes stiff	712
3		CI		
				711
4	12	CI		
		CI	CLAY (TILL) very stiff, grey, silty, some sand, trace gravel, clay shale, and coal	710
5				
	15	CI		709
6		CI		
				708
7	23	CI		
		CI		707
8				
	23	CI		706
9		CI		
				705
10				

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: TH06-03
CLIENT: CITY OF EDMONTON	LOCATION: N5924415.60, E41747.18	PROJECT NO: 14-31-245
START DATE: 22/11/2006		ELEVATION: 714.47 (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 DESCRIPTION	ELEVATION (m)
10	Drive	27	CI	CLAY (TILL) - CONTINUED	
	Auger		SC	SAND grey, fine to medium grained, clayey, silty	704
11				CLAY (TILL) very stiff, grey, sandy, some silt, trace pebbles, coal, gravel, and clay shale	
	Drive	23	CI		703
12	Auger		CI		702
13	Drive	25	CI	-some gypsum pockets	
	Auger		CI		701
14	Drive	12	CI	-becomes stiff	700
15				END OF TEST HOLE AT 14.9m UPON COMPLETION: (Below ground surface) -Slough at 11.0m -Water at 10.7m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -November 24, 2006 = 1.4m -January 4, 2007 = 1.0m	699
16					698
17					697
18					696
19					695
20					

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

THE CITY OF Edmonton — Transportation & Streets Engineeering Services Section

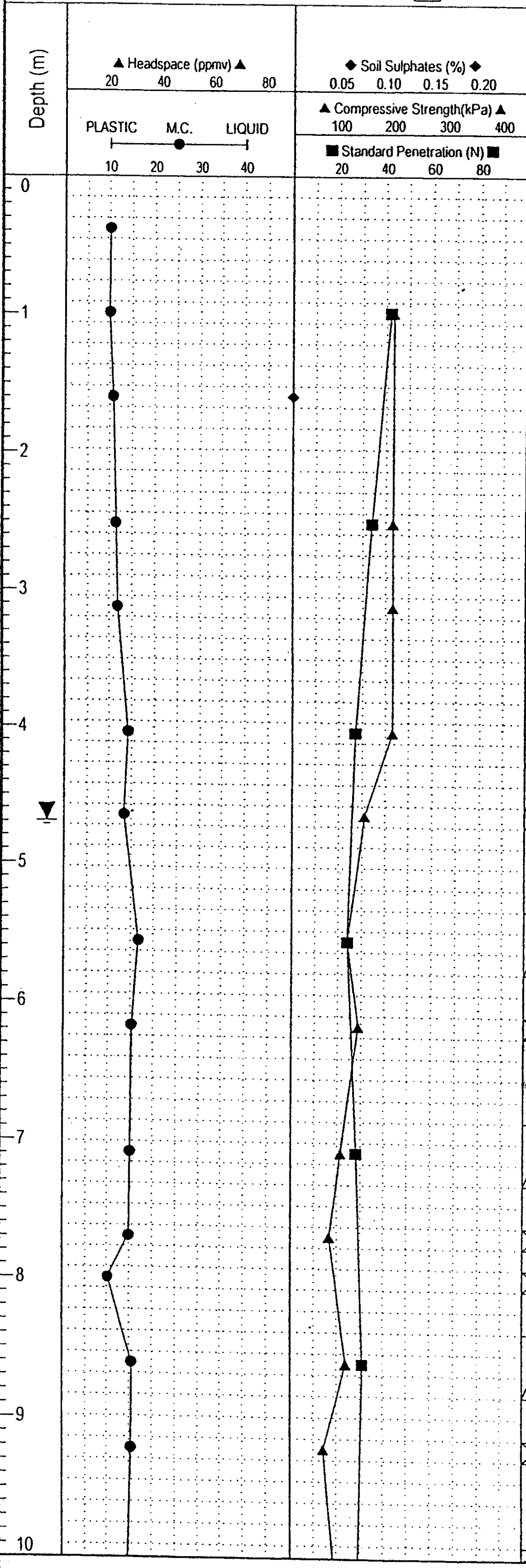
THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LOGGED BY: EMS	REVIEWED BY: KEF	COMPLETION DEPTH: 14.9 m
		COMPLETION DATE: 22/11/06

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-04**
CLIENT: CITY OF EDMONTON	LOCATION: N5924269.49, E41709.29	PROJECT NO: 14-31-245
START DATE: 22/11/2006		ELEVATION: 718.25 (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



Approx. Depth (m)	SAMPLE TYPE	SPT (N)	USC	SOIL DESCRIPTION
0				TOPSOIL, black, silty, trace sand and rootlets
0.35	Auger		CI	CLAY hard, brown, very silty, sandy, some oxides
1.0	Drive	42	CI	-trace organics
1.6	Auger		CI	
2.5	Drive	34	CI	-becomes TILL-LIKE, trace gravel
3.15	Auger		CI	CLAY (TILL) very stiff, brown, sandy, some silt, trace coal, gravel, and oxides
4.1	Drive	27	CI	-trace clay shale inclusions
4.65	Auger		CI	-some coal
5.6	Drive	24	CI	
6.2	Auger		CI	-becomes grey - brown mottling
7.1	Drive	28	CI	-becomes dark grey, silty, trace sand pockets and clay shale
7.7	Auger		CI	
8.05	Auger		SP	SAND brown, fine to medium grained, trace silt
8.6	Drive	31	CI	CLAY (TILL) hard, dark grey, silty, sandy, trace coal, pebbles, gravel, sand pockets, and clay shale
9.3	Auger		CI	

ELEVATION (m): 718, 717, 716, 715, 714, 713, 712, 711, 710, 709

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

THE CITY OF Edmonton — Transportation & Streets Engineeering Services Section

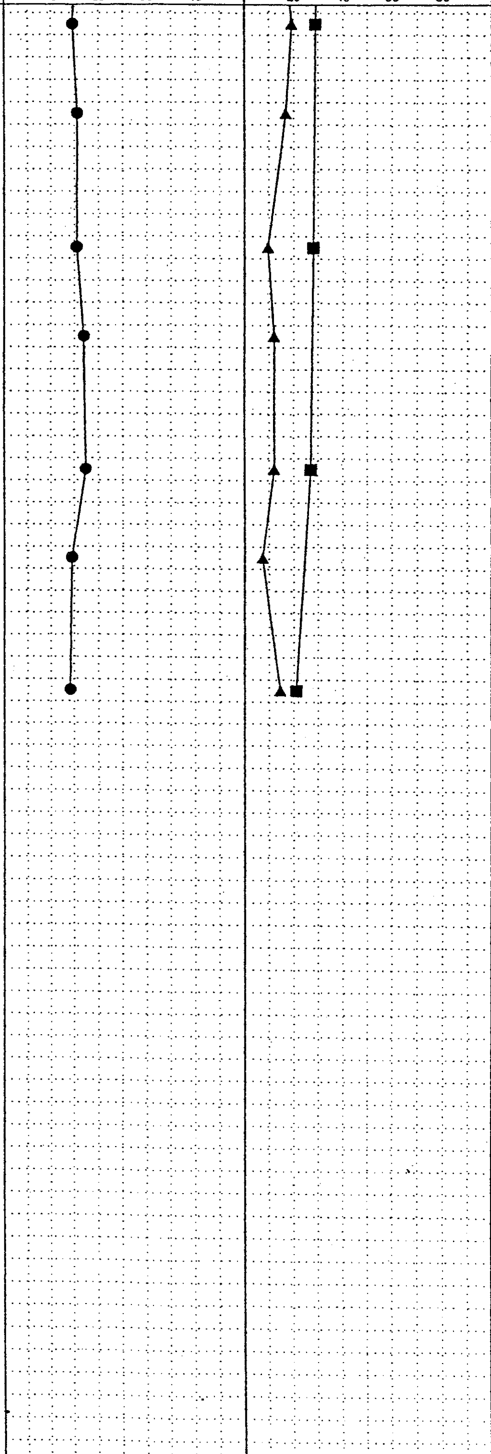
THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LOGGED BY: EMS	REVIEWED BY: KEF	COMPLETION DEPTH: 14.9 m
		COMPLETION DATE: 22/11/06

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-04**
CLIENT: CITY OF EDMONTON	LOCATION: N5924269.49, E41709.29	PROJECT NO: 14-31-245
START DATE: 22/11/2006		ELEVATION: 718.25 (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 DESCRIPTION	ELEVATION (m)
10	Drive Sample	29	CI	CLAY (TILL) - CONTINUED -becomes very stiff, trace sand and silt lenses -seepage at 10.1m	708
	Auger Sample		CI		
11					707
	Drive Sample	28	CI		
12	Auger Sample		CI		706
13	Drive Sample	27	CI		705
	Auger Sample		CI		
14					704
	Drive Sample	21	CI	-occasional sand lenses	
15				END OF TEST HOLE AT 14.9m UPON COMPLETION: (Below ground surface) -No slough -Water at 14.4m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -November 24, 2006 = 6.9m -January 4, 2007 = 4.7m	703
16					702
17					701
18					700
19					699
20					

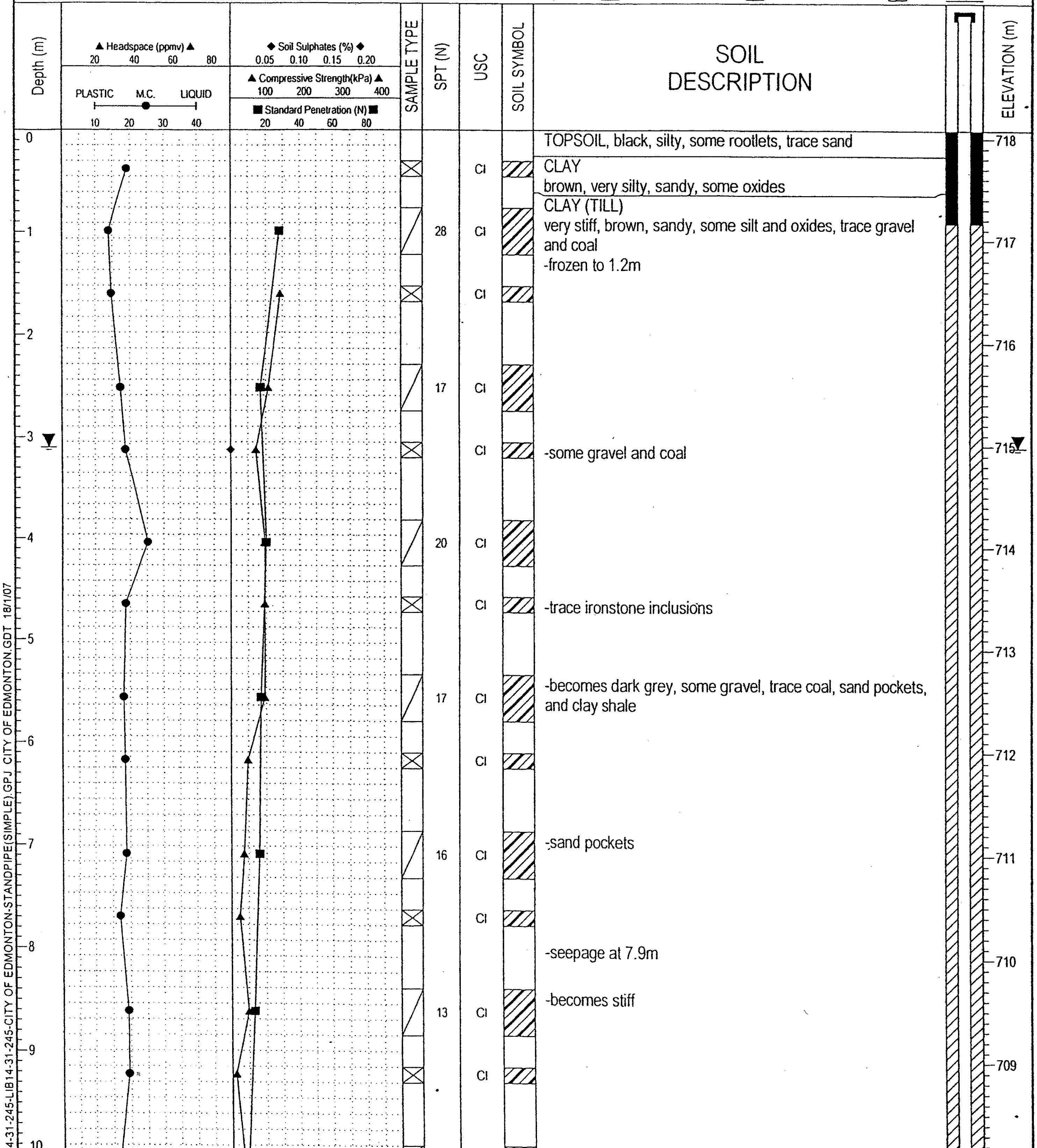
SLOTTED PIEZOMETER

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-05**
CLIENT: CITY OF EDMONTON	LOCATION: N5924035.75, E41771.63	PROJECT NO: 14-31-245
START DATE: 22/11/2006		ELEVATION: 718.08 (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



SPT (N)	USC	SOIL DESCRIPTION
		TOPSOIL, black, silty, some rootlets, trace sand
	CI	CLAY brown, very silty, sandy, some oxides
28	CI	CLAY (TILL) very stiff, brown, sandy, some silt and oxides, trace gravel and coal -frozen to 1.2m
	CI	
17	CI	
	CI	-some gravel and coal
20	CI	
	CI	-trace ironstone inclusions
17	CI	-becomes dark grey, some gravel, trace coal, sand pockets, and clay shale
	CI	
16	CI	-sand pockets
	CI	
		-seepage at 7.9m
13	CI	-becomes stiff
	CI	

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

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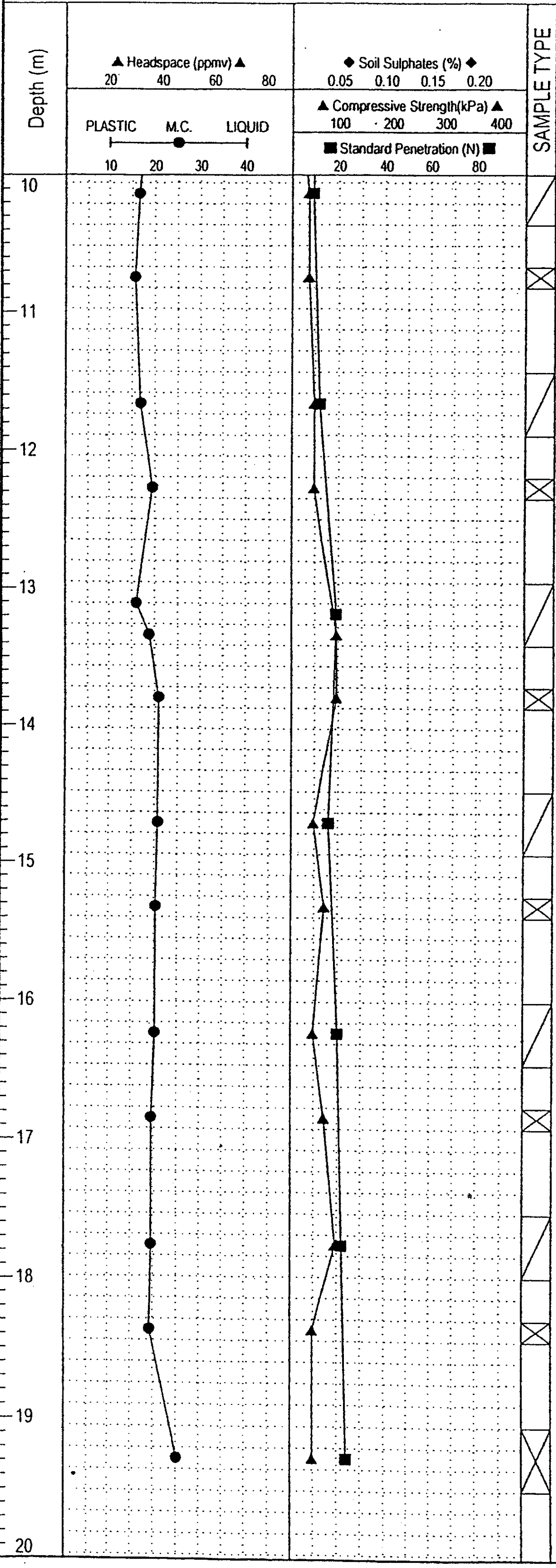
LOGGED BY: EMS	REVIEWED BY: KEF	COMPLETION DEPTH: 19.5 m
		COMPLETION DATE: 22/11/06

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-05**
CLIENT: CITY OF EDMONTON	LOCATION: N5924035.75, E41771.63	PROJECT NO: 14-31-245
START DATE: 22/11/2006		ELEVATION: 718.08 (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



SPT (N)	USC	SOIL DESCRIPTION
9	CI	CLAY (TILL) - CONTINUED -becomes very silty, some silt partings
	CI	
12	CI	-some sand lenses
	CI	-some silt, gravel, and coal
19	SP	SAND compact, grey, fine to medium grained, saturated, some silt
	CI	CLAY (TILL) very stiff, grey, sandy, some silt, pebbles, gravel, coal, and sand pockets, trace clay shale
	CI	
16	CI	
	CI	
20	CI	
	CI	
22	CI	UPON COMPLETION: (Below ground surface) -Slough at 18.0m -Water at 6.1m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -November 24, 2006 = 9.4m -January 4, 2007 = 3.1m
	CI	
24	CI	
		END OF TEST HOLE AT 19.5m

SLOTTED PIEZOMETER

ELEVATION (m): 708, 707, 706, 705, 704, 703, 702, 701, 700, 699

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

THE CITY OF Edmonton

Transportation & Streets
Engineeering Services Section

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

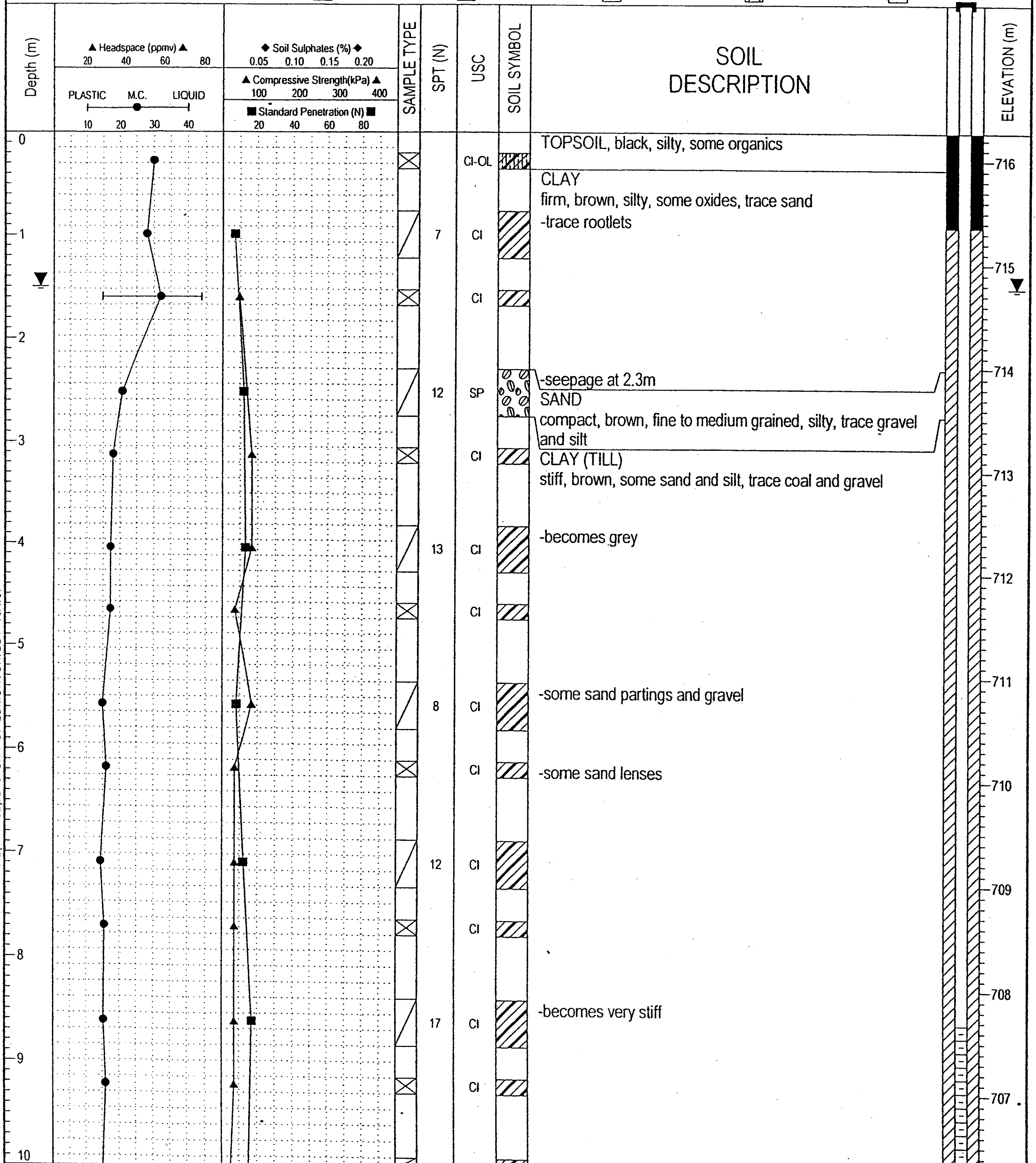
LOGGED BY: EMS | REVIEWED BY: KEF

COMPLETION DEPTH: 19.5 m
COMPLETION DATE: 22/11/06

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-06**
CLIENT: CITY OF EDMONTON	LOCATION: N5924043.31, E41580.18	PROJECT NO: 14-31-245
START DATE: 23/11/2006		ELEVATION: 716.27 (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



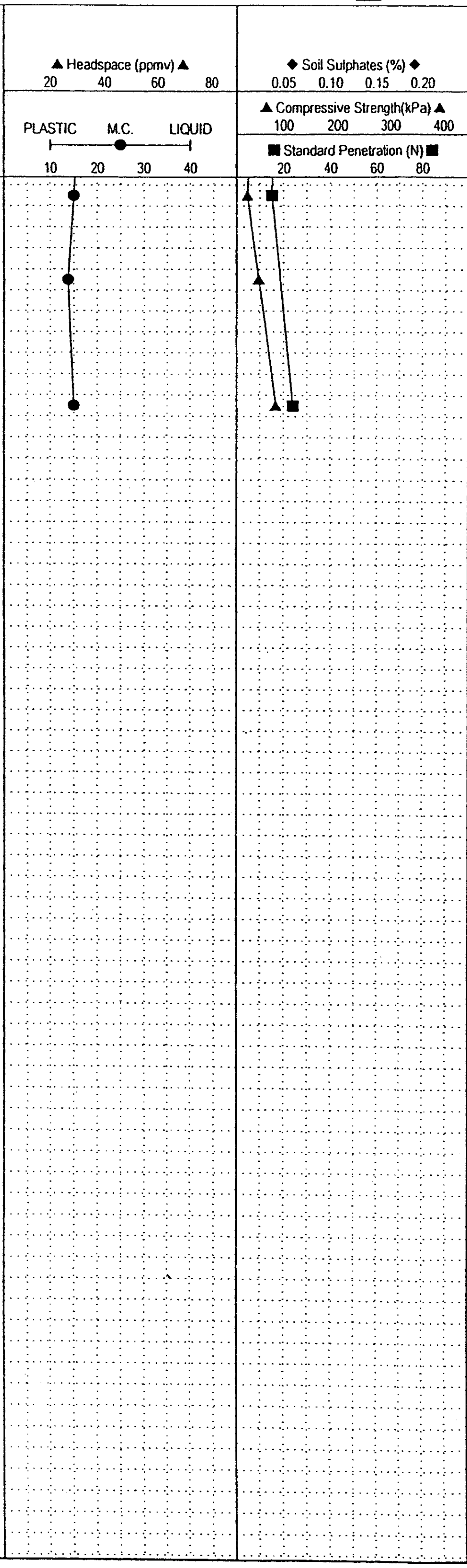
Depth (m)	SPT (N)	USC	SOIL DESCRIPTION
0–0.35		CI-OL	TOPSOIL, black, silty, some organics
0.35			CLAY firm, brown, silty, some oxides, trace sand -trace rootlets
1	7	CI	
1.6		CI	
2.3			-seepage at 2.3m
2.5	12	SP	SAND compact, brown, fine to medium grained, silty, trace gravel and silt
3.1		CI	CLAY (TILL) stiff, brown, some sand and silt, trace coal and gravel
4	13	CI	-becomes grey
4.6		CI	
5.5	8	CI	-some sand partings and gravel
6.2		CI	-some sand lenses
7	12	CI	
7.7		CI	
8.6	17	CI	-becomes very stiff
9.3		CI	

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-06**
CLIENT: CITY OF EDMONTON	LOCATION: N5924043.31, E41580.18	PROJECT NO: 14-31-245
START DATE: 23/11/2006		ELEVATION: 716.27 (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

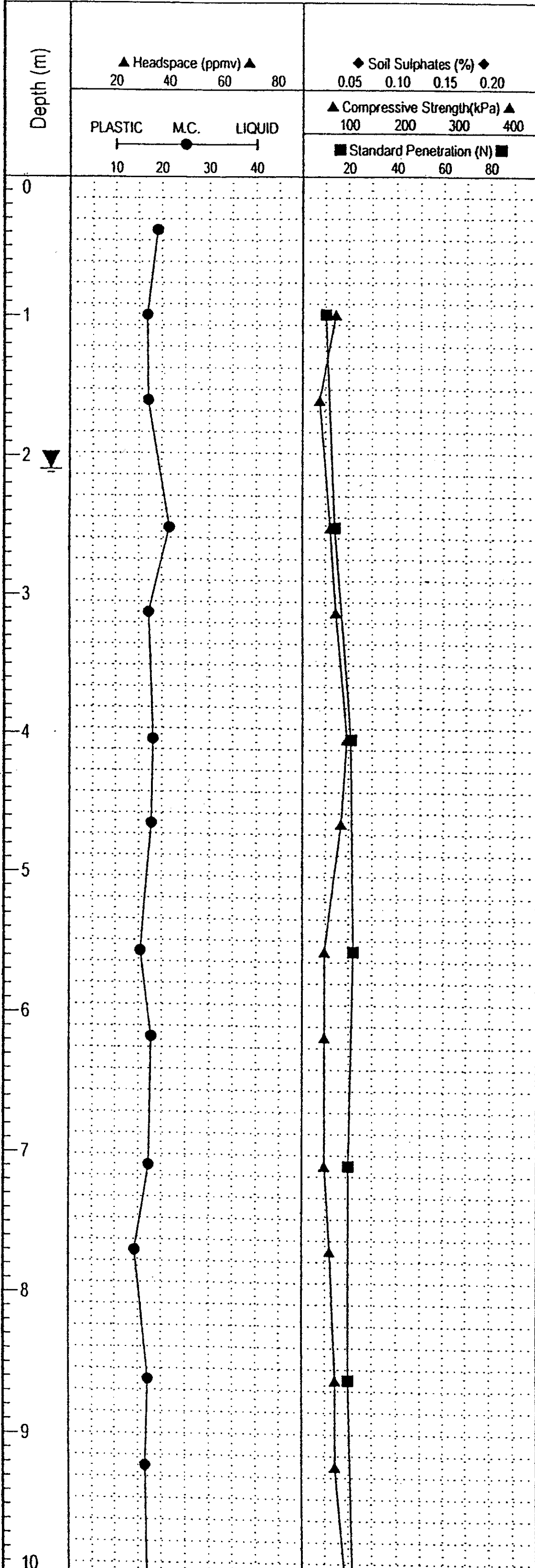
Depth (m)	▲ Headspace (ppmv) ▲ / PLASTIC M.C. LIQUID	◆ Soil Sulphates (%) ◆ / ▲ Compressive Strength(kPa) ▲ / ■ Standard Penetration (N) ■	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10			Drive Sample	15	CI		CLAY (TILL) - CONTINUED		706
			Auger Sample		CI				
11									705
			Drive Sample	24	CI				
12							END OF TEST HOLE AT 11.9m UPON COMPLETION: (Below ground surface) -Slough at 10.8m -Water at 2.0m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -November 24, 2006 = 4.2m -January 5, 2007 = 1.5m		704
13									703
14									702
15									701
16									700
17									699
18									698
19									697
20									



PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-07**
CLIENT: CITY OF EDMONTON	LOCATION: N5924243.32, E41584.33	PROJECT NO: 14-31-245
START DATE: 23/11/2006		ELEVATION: 716.24 (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



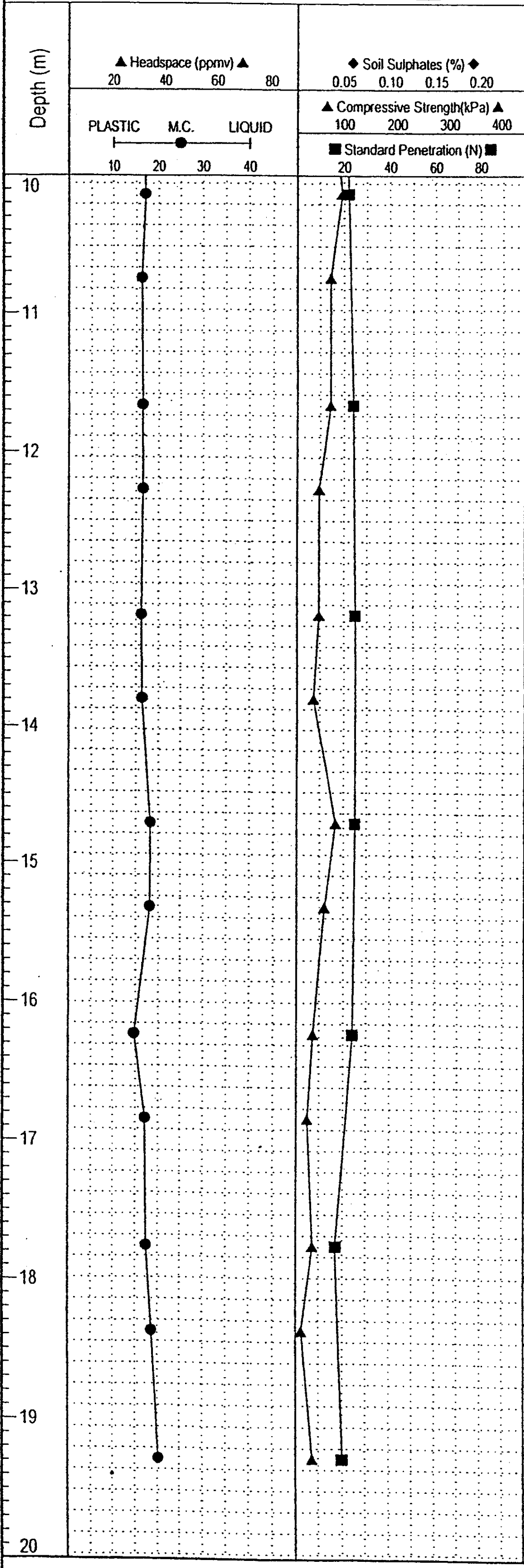
SAMPLE TYPE	SPT (N)	USC	SOIL DESCRIPTION
			TOPSOIL, black, silty, some rootlets, trace sand
Auger		CI	CLAY brown, silty, very sandy, some oxides
Drive	10	CI	CLAY (TILL) stiff, brown, sandy, some silt and oxides, trace coal and gravel
Auger		CI	
Drive	14	CI	-trace organic lenses
Auger		CI	-becomes grey, trace ironstone
Drive	21	CI	-becomes very stiff
Auger		CI	
Drive	22	CI	-becomes silty, some gravel, trace clay shale inclusions
Auger		CI	
Drive	20	CI	
Auger		CI	-some gravel
Drive	20	CI	
Auger		CI	

ELEVATION (m): 716, 715, 714, 713, 712, 711, 710, 709, 708, 707

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: TH06-07
CLIENT: CITY OF EDMONTON	LOCATION: N5924243.32, E41584.33	PROJECT NO: 14-31-245
START DATE: 23/11/2006		ELEVATION: 716.24 (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



SAMPLE TYPE	SPT (N)	USC	SOIL DESCRIPTION
Drive	22	CI	CLAY (TILL) - CONTINUED
Auger		CI	-some gravel up to 50mm diameter
Drive	24	CI	
Auger		CI	
Drive	25	CI	
Auger		CI	
Drive	25	CI	
Auger		CI	
Drive	24	CI	
Auger		CI	-wet sand lenses from 16.6m to 16.8m
Drive	17	CI	UPON COMPLETION: (Below ground surface) -Slough at 16.8m -Water at 7.9m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -November 24, 2006 = 2.4m -January 4, 2007 = 2.1m
Auger		CI	
Drive	20	CI	
			END OF TEST HOLE AT 19.5m

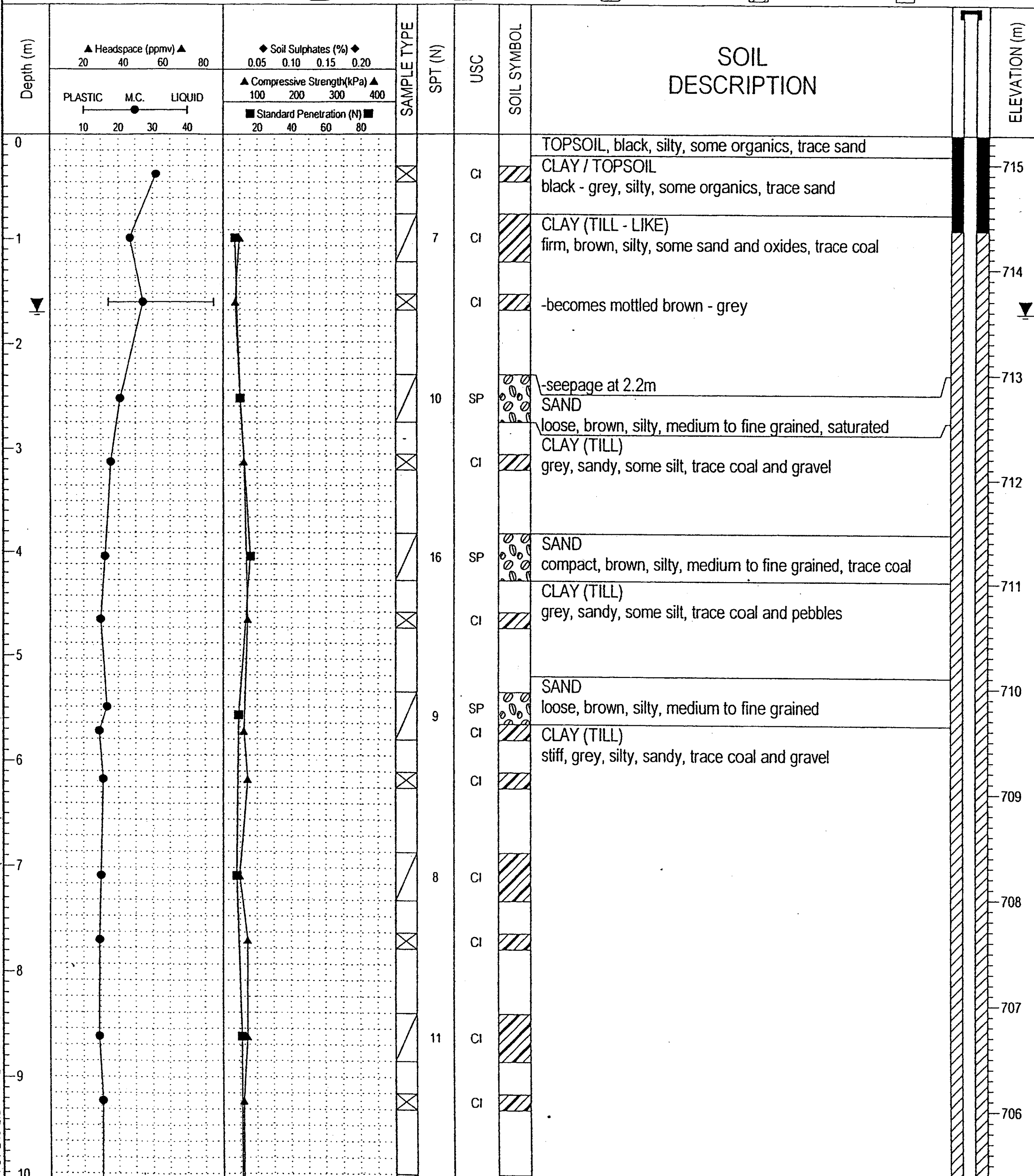
SLOTTED PIEZOMETER

ELEVATION (m): 706, 705, 704, 703, 702, 701, 700, 699, 698, 697

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: TH06-14
CLIENT: CITY OF EDMONTON	LOCATION: N5924329.52, E41801.89	PROJECT NO: 14-31-245
START DATE: 1/12/2006		ELEVATION: 715.28 (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)	SPT (N)	USC	SOIL DESCRIPTION
0			TOPSOIL, black, silty, some organics, trace sand
		CI	CLAY / TOPSOIL black - grey, silty, some organics, trace sand
1	7	CI	CLAY (TILL - LIKE) firm, brown, silty, some sand and oxides, trace coal
		CI	-becomes mottled brown - grey
2	10	SP	-seepage at 2.2m
			SAND loose, brown, silty, medium to fine grained, saturated
3		CI	CLAY (TILL) grey, sandy, some silt, trace coal and gravel
4	16	SP	SAND compact, brown, silty, medium to fine grained, trace coal
		CI	CLAY (TILL) grey, sandy, some silt, trace coal and pebbles
5	9	SP	SAND loose, brown, silty, medium to fine grained
		CI	CLAY (TILL) stiff, grey, silty, sandy, trace coal and gravel
6		CI	
7	8	CI	
		CI	
8	11	CI	
9		CI	
10			

Elevation (m): 715, 714, 713, 712, 711, 710, 709, 708, 707, 706

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

THE CITY OF Edmonton — Transportation & Streets Engineeering Services Section

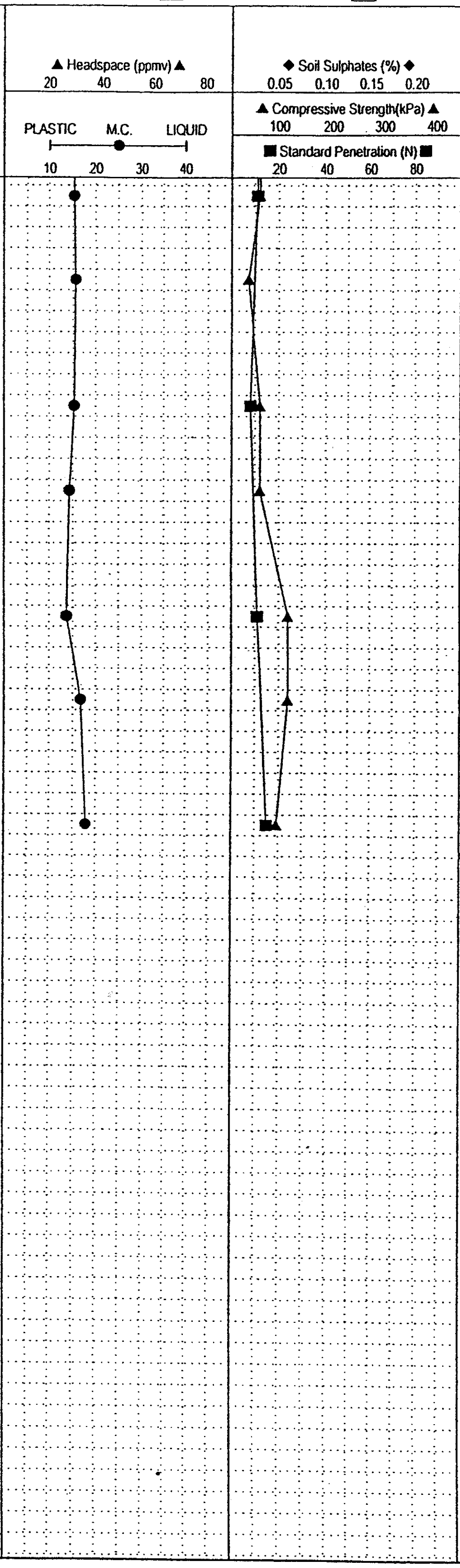
THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LOGGED BY: EMS	REVIEWED BY: KEF	COMPLETION DEPTH: 14.9 m
		COMPLETION DATE: 1/12/06

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-14**
CLIENT: CITY OF EDMONTON	LOCATION: N5924329.52, E41801.89	PROJECT NO: 14-31-245
START DATE: 1/12/2006		ELEVATION: 715.28 (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)	SPT (N)	USC	SOIL DESCRIPTION	ELEVATION (m)
10	11	CI	CLAY (TILL) - CONTINUED	705
		CI		
11				704
	8	CI	-100mm thick sand lenses	
12		CI		703
13	11	CI		702
		CI		
14				701
	15	CI	-becomes very stiff	
15			END OF TEST HOLE AT 14.9m UPON COMPLETION: (Below ground surface) -Slough at 12.9m -Water at 2.4m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -January 4, 2007 = 1.7m	700
16				699
17				698
18				697
19				696
20				

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

THE CITY OF Edmonton — Transportation & Streets Engineeering Services Section

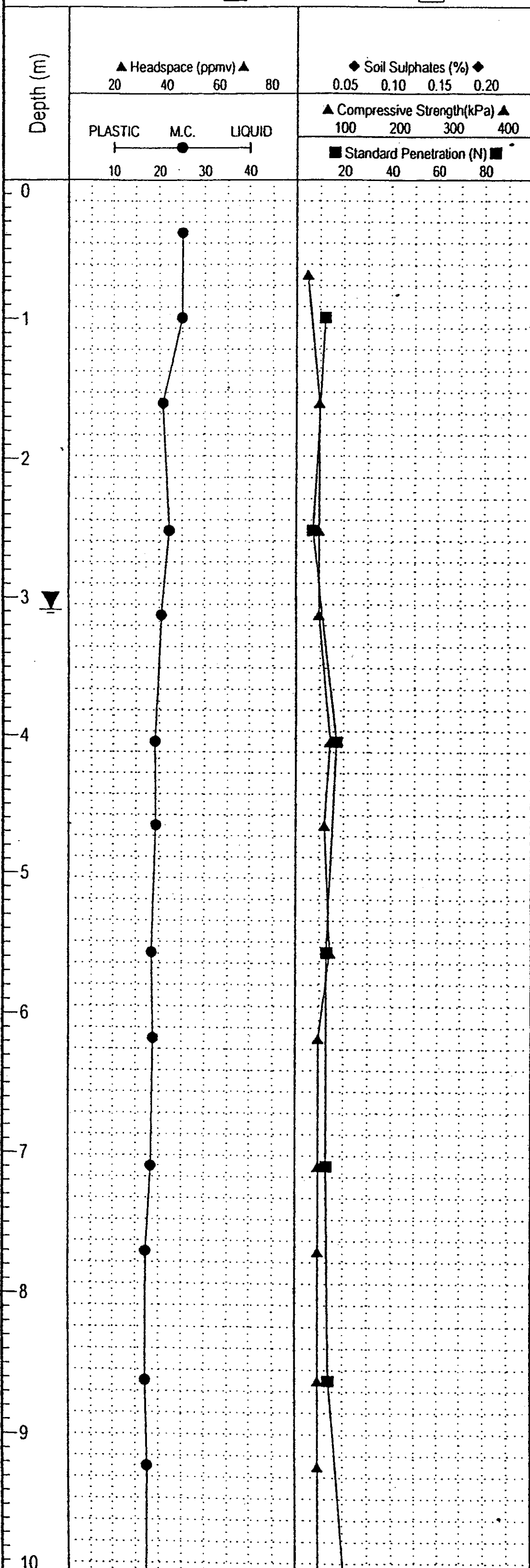
THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LOGGED BY: EMS	REVIEWED BY: KEF	COMPLETION DEPTH: 14.9 m COMPLETION DATE: 1/12/06

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-15**
CLIENT: CITY OF EDMONTON	LOCATION: N5924377.96, E41642.96	PROJECT NO: 14-31-245
START DATE: 4/1/2007		ELEVATION: 715.6 (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



SAMPLE TYPE	SPT (N)	USC	SOIL DESCRIPTION
			TOPSOIL, black, roots and rootlets
Auger		CI	CLAY stiff, dark brown, silty, sandy, some organics / staining, trace gravel, coal, and oxides
Auger		CI	
Drive	12	CI	CLAY (TILL) stiff, mottled brown - grey, some gravel, occasional grey silt lenses, oxides, coal, and clay shale nodules
Auger		CI	
Drive	7	CI	-becomes firm
Auger		CI	
Drive	17	CI	-becomes very stiff
Auger		CI	-becomes grey
Drive	13	CI	-becomes stiff, some oxide staining
Auger		CI	-no staining
Drive	13	CI	
Auger		CI	-occasional cobbles
			-seepage at 8.1m
Drive	14	CI	
Auger		CI	

ELEVATION (m): 715, 714, 713, 712, 711, 710, 709, 708, 707, 706

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

THE CITY OF Edmonton — Transportation & Streets Engineeering Services Section

THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LOGGED BY: MW	REVIEWED BY: KEF	COMPLETION DEPTH: 11.6 m
		COMPLETION DATE: 4/1/07

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-15**
CLIENT: CITY OF EDMONTON	LOCATION: N5924377.96, E41642.96	PROJECT NO: 14-31-245
START DATE: 4/1/2007		ELEVATION: 715.6 (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)	Headspace (ppmv) 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Soil Sulphates (%) 0.05 0.10 0.15 0.20 / Compressive Strength(kPa) 100 200 300 400 / Standard Penetration (N) 20 40 60 80	SAMPLE TYPE	SPT (N)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SLOTTED PIEZOMETER	ELEVATION (m)
10			Drive Sample	21	CI		CLAY (TILL) - CONTINUED -becomes very stiff		
			Auger Sample		CI				705
11									
			Auger Sample		CI				
			No Recovery		CI				704
							END OF TEST HOLE AT 11.6m UPON COMPLETION: (Below ground surface) -No slough -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -January 4, 2007 = Dry -January 15, 2007 = 3.1m		
12									703
13									702
14									701
15									700
16									699
17									698
18									697
19									696
20									

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

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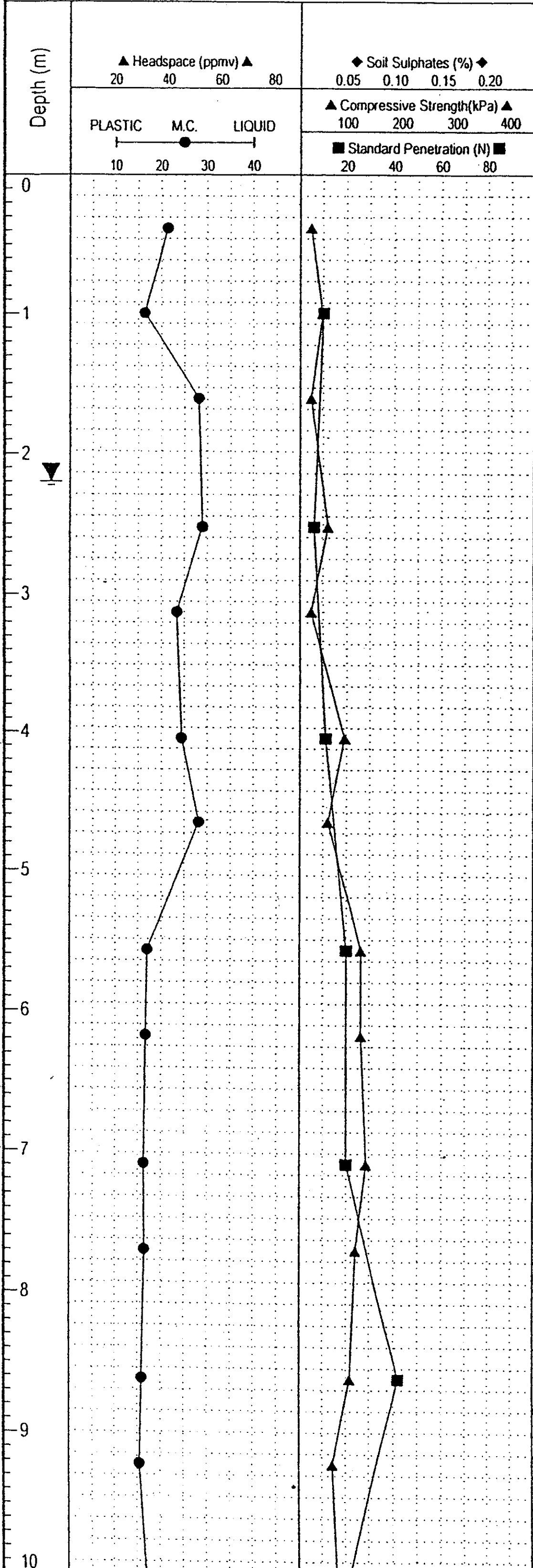
LOGGED BY: MW	REVIEWED BY: KEF	COMPLETION DEPTH: 11.6 m
		COMPLETION DATE: 4/1/07

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-18**
CLIENT: CITY OF EDMONTON	LOCATION: N5924060.91, E41495.93	PROJECT NO: 14-31-245
START DATE: 24/11/2006		ELEVATION: 716.79 (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 DESCRIPTION
0				TOPSOIL, black, trace fine grained sand and rootlets
0.3	Auger		CI	CLAY (TILL - LIKE) firm to stiff, brown, trace silt, gravel, and rootlets
1.0	Drive	10	CI	-becomes mottled grey - brown, trace sand, organics, and coal
1.6	Auger		CI	-wet sand and silt lenses -seepage at 1.5m
2.5	Drive	6	CI	
3.1	Auger		CI	CLAY TILL stiff, brown, trace sand, gravel, and oxides
4.0	Drive	11	CI	
4.6	Auger		CI	-becomes grey
5.6	Drive	20	CI	-becomes very stiff, trace coal and clay shale
6.2	Auger		CI	
7.1	Drive	20	CI	
7.7	Auger		CI	
8.6	Drive	42	CI	-hard
9.3	Auger		CI	-trace coarse grained sand pockets

ELEVATION (m): 716, 715, 714, 713, 712, 711, 710, 709, 708, 707

STANDPIP 14-31-245-LIB14-31-245-CITY OF EDMONTON-STANDPIPE(SIMPLE).GPJ CITY OF EDMONTON.GDT 18/1/07

THE CITY OF Edmonton

Transportation & Streets
Engineeering Services Section

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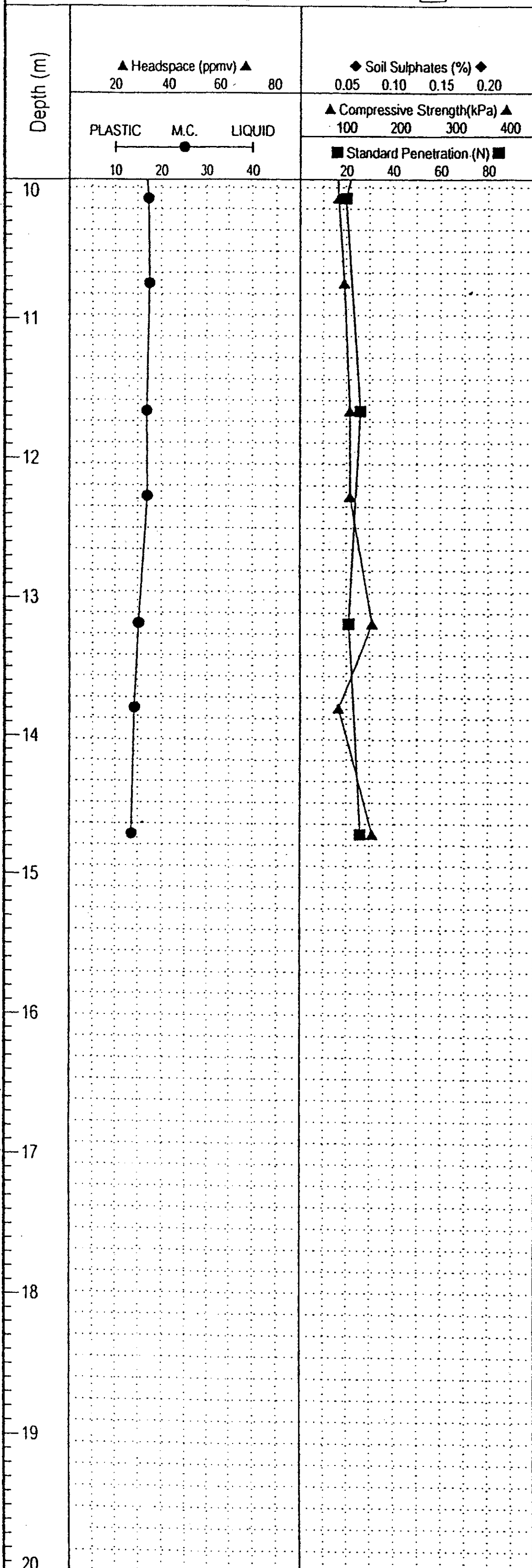
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

LOGGED BY: CSG	REVIEWED BY: KEF
COMPLETION DEPTH: 14.9 m	COMPLETION DATE: 24/11/06

PROJECT: MEADOWS NEIGHBOURHOOD 4	Mobile Augers & Research Ltd.	BOREHOLE NO: **TH06-18**
CLIENT: CITY OF EDMONTON	LOCATION: N5924060.91, E41495.93	PROJECT NO: 14-31-245
START DATE: 24/11/2006		ELEVATION: 716.79 (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



SAMPLE TYPE	SPT (N)	USC	SOIL DESCRIPTION
Drive Sample	20	CI	CLAY (TILL) - CONTINUED
Auger Sample		CI	
Drive Sample	26	CI	
Auger Sample		CI	-trace medium to coarse grained sand pockets
Drive Sample	21	CI	
Auger Sample		CI	
Drive Sample	26	CI	-trace medium to coarse grained sand lenses

END OF TEST HOLE AT 14.9m
UPON COMPLETION: (Below ground surface)
-Slough to 13.4m
-Water at 13.4m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-November 24, 2006 = 2.6m
-January 5, 2007 = 2.2m

SLOTTED PIEZOMETER

ELEVATION (m): 706, 705, 704, 703, 702, 701, 700, 699, 698, 697

PROJECT: Laurel Phase 2	PROJECT NO: 6049 - 86	BOREHOLE NO: **2016 - 1**
CLIENT: ISL Engineering & Land Services Ltd.	DRILL METHOD: Solid Stem Auger	ELEVATION: 717 m
OWNER: City of Edmonton	LOCATION: As per site plan	

SAMPLE TYPE: SHELBY TUBE, CORE SAMPLE, SPT SAMPLE, GRAB SAMPLE, NO RECOVERY

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

Depth (m)	USC	SOIL DESCRIPTION	SPT (N)	M.C. (%)	OTHER DATA	Elevation (m)
0	CI	**CLAY TILL** : silty, sandy, medium plastic, moist, frozen, brown, trace coal, oxide, and gravel		17, 16.7		
1		Below 0.9 m - very stiff	13	18.1, 16.3		716
2			9	16.3, 17.7		715
3				18.4 (12.4 – 34.8), 17.7	P.L. = 12.4 L.L. = 34.8 M.C. = 18.4 **Soluble Sulphates:** Negligible	714
4			16	17.1, 17.7		713
5		Below 5.5 m - grey, trace sand and gravel		17.1, 17.6	**Shelby Tube:** QU: 260 kPa DD: 1828 Kg/m^3 MC: 17.6 %	712
6				18, 17.4		711
7			16	16.8, 17.1		710
8		At 8.5 m - wet sand seam	15	16.6, 17.1		709
9		**END OF TESTHOLE @ 8.8 m.** No water and no slough on completion of testhole. Slotted standpipe installed to 8.19 m. 8 day waterlevel reading: 7.16 m bgs. 21 day waterlevel reading: 5.48 m bgs. 36 day waterlevel reading: 4.19 m bgs.				708
10						707
11						706
12						

POCKET PEN. (kPa) 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

SLOTTED PIEZOMETER

4.19

712.81

HOGGAN ENGINEERING & TESTING (1980) LTD.
17505 - 106 Avenue
Edmonton, AB T5S 1E7
Phone: (780) 489-0700
Fax: (780) 489-0800

LOGGED BY: J Tsoi	COMPLETION DEPTH: 8.84 m
REVIEWED BY: R Evans	COMPLETION DATE: 7/3/16

PROJECT: Laurel Phase 2		PROJECT NO: 6049 - 86	BOREHOLE NO: **2016 - 2**
CLIENT: ISL Engineering & Land Services Ltd.	DRILL METHOD: Solid Stem Auger		ELEVATION: 716.36 m
OWNER: City of Edmonton	LOCATION: As per site plan		

SAMPLE TYPE: SHELBY TUBE, CORE SAMPLE, SPT SAMPLE, GRAB SAMPLE, NO RECOVERY

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

Depth (m) / Water Level	SOIL SYMBOL	USC	SOIL DESCRIPTION	SAMPLE TYPE	SPT (N)	POCKET PEN. (kPa) ▲ 100 200 300 400 / PLASTIC M.C. LIQUID 20 40 60 80	OTHER DATA	SLOTTED PIEZOMETER	Elevation (m)
0		OR	**ORGANIC CLAY** : silty, very moist, frozen, black Below 0.3 m - firm to stiff			47.2			716
0.94			900 mm			33.9			715.42
1		CI	**CLAY** : silty, sandy, medium plastic, very moist to wet, firm, grey and brown, trace oxide, till-like		5	24.4			715
						21.6			
2						20.7			714
			Below 2.4 m - water in hole			19	**Shelby Tube:** QU: 118 kPa DD: 1789 Kg/m^3 MC: 19.0 %		
3			3.4 m			19.7			713
		CI	**CLAY TILL** : silty, medium plastic, moist, stiff, grey, trace coal, oxide, gravel			19.1			
4					9	19.5			712
						17.5			
5						17			711
					12				
6						17			710
			At 6.7 m - wet sand seam			17.9			
7					15	17			709
						16.2 (12 – 31.5)	P.L. = 12.0 L.L. = 31.5 M.C. = 16.2 **Soluble Sulphates:** Negligible		
8						16.7			708
					12	17			
9			**END OF TESTHOLE @ 8.8 m.** 7 m of water and no slough on completion of testhole. Slotted standpipe installed to 8.46 m. 8 day waterlevel reading: 1.53 m bgs. 21 day waterlevel reading: 1.4 m bgs. 36 day waterlevel reading: 0.94 m bgs.						707
10									706
11									705
12									

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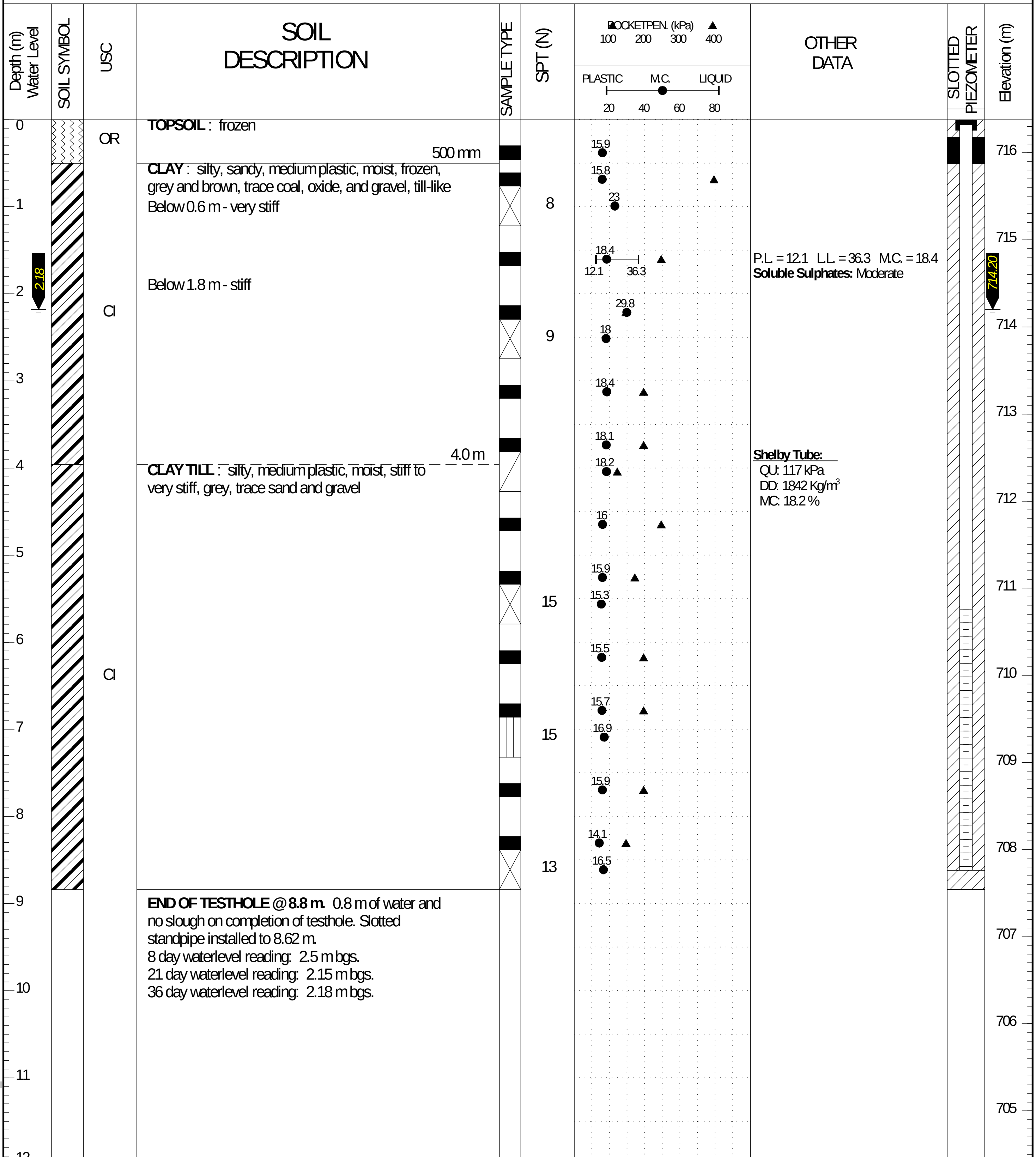
Edmonton, AB T5S 1E7
Phone: (780) 489-0700
Fax: (780) 489-0800

LOGGED BY: J Tsoi
REVIEWED BY: R Evans
COMPLETION DEPTH: 8.84 m
COMPLETION DATE: 7/3/16

PROJECT: Laurel Phase 2	PROJECT NO: 6049 - 86	BOREHOLE NO: **2016 - 3**
CLIENT: ISL Engineering & Land Services Ltd.	DRILL METHOD: Solid Stem Auger	ELEVATION: 716.38 m
OWNER: City of Edmonton	LOCATION: As per site plan	

SAMPLE TYPE: SHELBY TUBE, CORE SAMPLE, SPT SAMPLE, GRAB SAMPLE, NO RECOVERY

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



Depth (m)	USC	Soil Description	Other Data
0 – 0.5	OR	**TOPSOIL** : frozen (500 mm)	
0.5 – 4.0	CI	**CLAY** : silty, sandy, medium plastic, moist, frozen, grey and brown, trace coal, oxide, and gravel, till-like Below 0.6 m - very stiff Below 1.8 m - stiff	P.L. = 12.1 L.L. = 36.3 M.C. = 18.4 **Soluble Sulphates:** Moderate
4.0 – 8.8	CI	**CLAY TILL** : silty, medium plastic, moist, stiff to very stiff, grey, trace sand and gravel	**Shelby Tube:** QU: 117 kPa DD: 1842 Kg/m^3 MC: 18.2 %

END OF TESTHOLE @ 8.8 m. 0.8 m of water and no slough on completion of testhole. Slotted standpipe installed to 8.62 m.
8 day waterlevel reading: 2.5 m bgs.
21 day waterlevel reading: 2.15 m bgs.
36 day waterlevel reading: 2.18 m bgs.

HOGGAN ENGINEERING & TESTING (1980) LTD.
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Edmonton, AB T5S 1E7
Phone: (780) 489-0700
Fax: (780) 489-0800

LOGGED BY: J Tsoi	COMPLETION DEPTH: 8.84 m
REVIEWED BY: R Evans	COMPLETION DATE: 7/3/16

PROJECT: Laurel Phase 2	PROJECT NO: 6049 - 86	BOREHOLE NO: **2016 - 4**
CLIENT: ISL Engineering & Land Services Ltd.	DRILL METHOD: Solid Stem Auger	ELEVATION: 717.96 m
OWNER: City of Edmonton	LOCATION: As per site plan	

SAMPLE TYPE: SHELBY TUBE, CORE SAMPLE, SPT SAMPLE, GRAB SAMPLE, NO RECOVERY

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

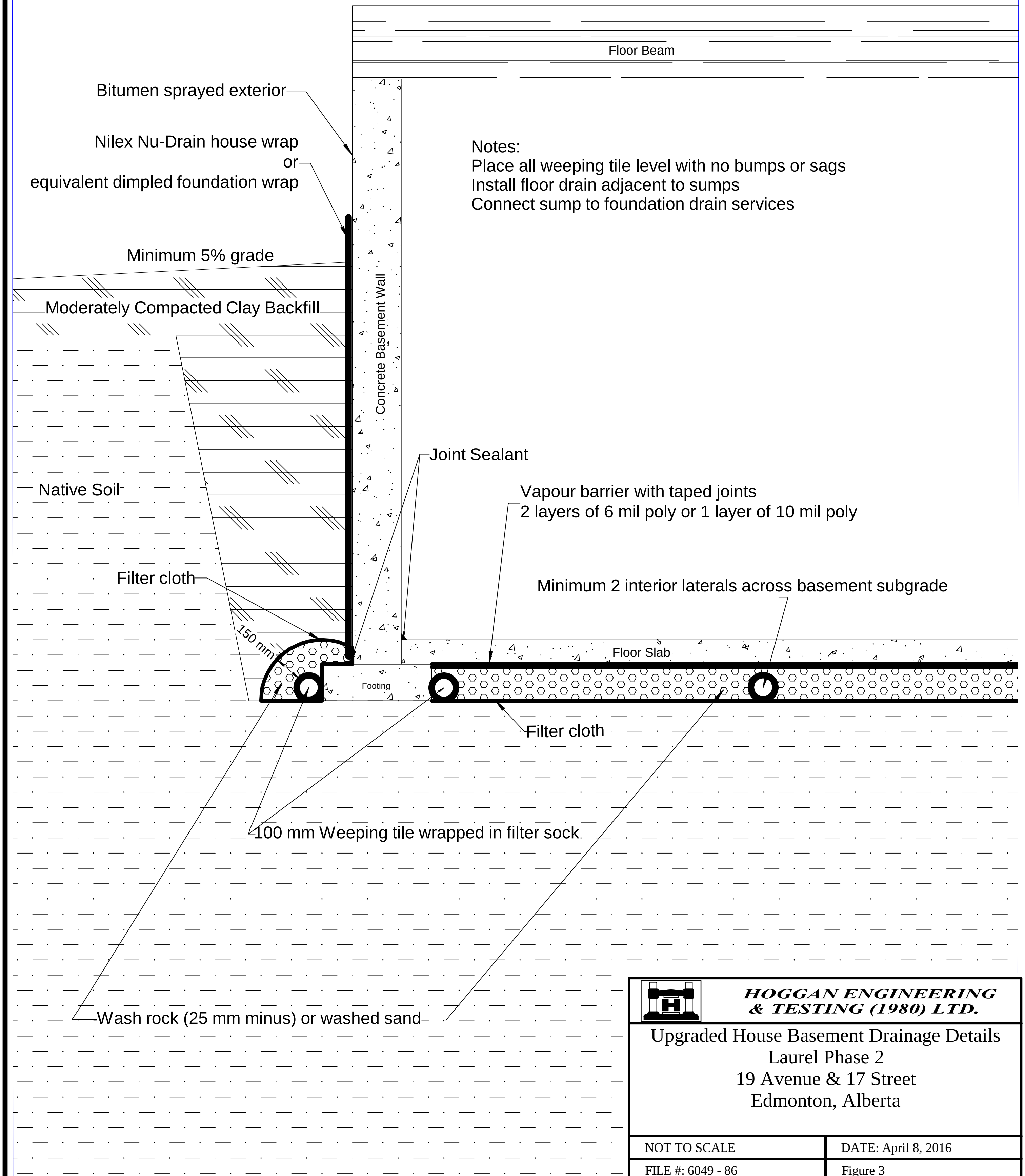
Depth (m)	USC	SOIL DESCRIPTION	SPT (N)	POCKET PEN. (kPa) / PLASTIC M.C. LIQUID	OTHER DATA	Elevation (m)
0	OR	**TOPSOIL** 200 mm				
		CLAY: silty, sandy, medium plastic, moist, frozen, brown, trace oxide, till-like		21.7		
				15.1		
1				12.4	**Shelby Tube:** QU: 266 kPa; DD: 1805 Kg/m^3; MC: 12.4 %	717
		Below 1.2 m - stiff to very stiff, trace white residue		23		
2				16.6		716
	CI		12	16.8		
3				17.8		715
				18.7		
4			14	17.7		714
				17.6 (13.1 – 35.3)	P.L. = 13.1 L.L. = 35.3 M.C. = 17.6; **Soluble Sulphates:** Negligible	
5		5.2 m				713
		CLAY TILL: silty, medium plastic, moist, very stiff, grey, trace coal and gravel	13	17.9		
6				16.6		712
				17.2		
7	CI		14	16.9		711
		Below 7.3 m - sandy, stiff		17.1		
8				16.6		710
			11	15.4		
9		**END OF TESTHOLE @ 8.8 m.** No water and no slough on completion of testhole. Slotted standpipe installed to 8.12 m. 8 day waterlevel reading: 3.17 m bgs. 21 day waterlevel reading: 2.66 m bgs. 36 day waterlevel reading: 2.58 m bgs.				709
10						708
11						707
12						

Water level: 2.58 (depth); 715.38 (elevation)

SLOTTED PIEZOMETER

HOGGAN ENGINEERING & TESTING (1980) LTD.
17505 - 106 Avenue
Edmonton, AB T5S 1E7
Phone: (780) 489-0700
Fax: (780) 489-0800

LOGGED BY: J Tsoi	COMPLETION DEPTH: 8.84 m
REVIEWED BY: R Evans	COMPLETION DATE: 7/3/16

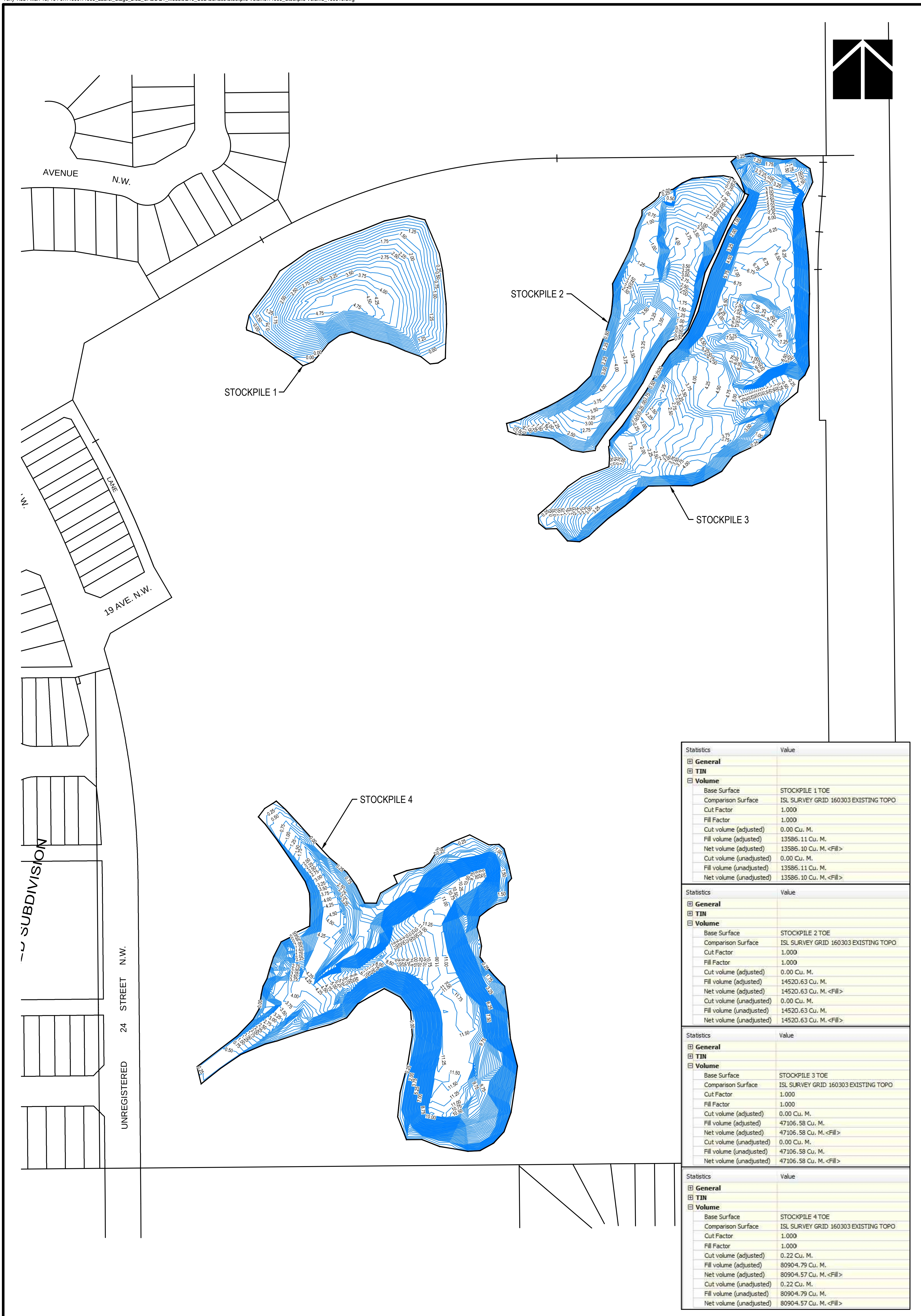


HOGGAN ENGINEERING & TESTING (1980) LTD.

Upgraded House Basement Drainage Details
Laurel Phase 2
19 Avenue & 17 Street
Edmonton, Alberta

NOT TO SCALE	DATE: April 8, 2016
FILE #: 6049 - 86	Figure 3

Tony Tieu / Mar. 18, 16 / J:\14600\14663_Laurel_Stage_2\02_CADD\21_Models\210_C3D\Surface\Stockpile Volume\14663_Stockpile Volume_160318.dwg



Statistics	Value
⊞ General	
⊞ TIN	
⊟ Volume	
Base Surface	STOCKPILE 1 TOE
Comparison Surface	ISL SURVEY GRID 160303 EXISTING TOPO
Cut Factor	1.000
Fill Factor	1.000
Cut volume (adjusted)	0.00 Cu. M.
Fill volume (adjusted)	13586.11 Cu. M.
Net volume (adjusted)	13586.10 Cu. M. <Fill>
Cut volume (unadjusted)	0.00 Cu. M.
Fill volume (unadjusted)	13586.11 Cu. M.
Net volume (unadjusted)	13586.10 Cu. M. <Fill>

Statistics	Value
⊞ General	
⊞ TIN	
⊟ Volume	
Base Surface	STOCKPILE 2 TOE
Comparison Surface	ISL SURVEY GRID 160303 EXISTING TOPO
Cut Factor	1.000
Fill Factor	1.000
Cut volume (adjusted)	0.00 Cu. M.
Fill volume (adjusted)	14520.63 Cu. M.
Net volume (adjusted)	14520.63 Cu. M. <Fill>
Cut volume (unadjusted)	0.00 Cu. M.
Fill volume (unadjusted)	14520.63 Cu. M.
Net volume (unadjusted)	14520.63 Cu. M. <Fill>

Statistics	Value
⊞ General	
⊞ TIN	
⊟ Volume	
Base Surface	STOCKPILE 3 TOE
Comparison Surface	ISL SURVEY GRID 160303 EXISTING TOPO
Cut Factor	1.000
Fill Factor	1.000
Cut volume (adjusted)	0.00 Cu. M.
Fill volume (adjusted)	47106.58 Cu. M.
Net volume (adjusted)	47106.58 Cu. M. <Fill>
Cut volume (unadjusted)	0.00 Cu. M.
Fill volume (unadjusted)	47106.58 Cu. M.
Net volume (unadjusted)	47106.58 Cu. M. <Fill>

Statistics	Value
⊞ General	
⊞ TIN	
⊟ Volume	
Base Surface	STOCKPILE 4 TOE
Comparison Surface	ISL SURVEY GRID 160303 EXISTING TOPO
Cut Factor	1.000
Fill Factor	1.000
Cut volume (adjusted)	0.22 Cu. M.
Fill volume (adjusted)	80904.79 Cu. M.
Net volume (adjusted)	80904.57 Cu. M. <Fill>
Cut volume (unadjusted)	0.22 Cu. M.
Fill volume (unadjusted)	80904.79 Cu. M.
Net volume (unadjusted)	80904.57 Cu. M. <Fill>

ISL Engineering and Land Services

LAUREL STAGE 2

STOCKPILE VOLUME PLAN

14663

1:2000 0 20 40 60m

MARCH 18, 2016