APPENDIX ‘A’ - GEOTECHNICAL REPORT

Quality Engineering | Valued Relationships

Dillon Consulting Ltd.

Geotechnical Investigation Report for City of Winnipeg Community Resource Recovery Centres – Brady Road Site

Prepared for:

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R3T 0Y4

Project Number:
0022 010 00

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

January 17, 2014 Our File No. 0022 010 00

Mr. Ash Raichura, P.Eng.
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1558 Willson Place
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RE: Final Geotechnical Investigation Report for City of Winnipeg Community Resource Recovery Centres – Brady Road Site

TREK Geotechnical Inc. is pleased to submit our Final Geotechnical Investigation Report for the above noted project.

Please contact the undersigned if you have any questions. Thank you for the opportunity to serve you on this assignment.

Sincerely,

TREK Geotechnical Inc.
Per:

Michael Van Helden, Ph.D., P.Eng.
Geotechnical Engineer, Principal
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/mvh
Encl.

Revision History

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0	BSH	Dec 20, 2013	DRAFT Final Report
1	BSH	Jan 17, 2014	Final Report

Authorization Signatures

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Table of Contents

List of Tables

List of Drawings

List of Appendices

1.0 Introduction

This report summarizes the results of the geotechnical investigation completed by TREK Geotechnical Inc. (TREK) for the proposed Community Resource Recovery Centre (4R Depots) located at the Brady Road Resource Management Facility. The terms of reference for the investigation are included in the short-term consulting services agreement issued by Dillon on November 12, 2013. The scope of work includes a sub-surface investigation, laboratory testing, and the provision of recommendations for the design and construction for suitable foundation systems including piled foundations, spread footings, at-grade floor slabs (including exterior slabs), retaining walls and pavement sections.

2.0 Background and Existing Information

The construction of Community Resource Recovery Centres (4R Depots) is a part of the City of Winnipeg's Comprehensive Integrated Waste Management Plan (CIWMP). The sites are open to the public to receive all manner of residential materials wish to dispose of with a focus on source separation and division. At the time of the investigation, the site was relatively flat with grass vegetation and no existing infrastructure. The site location is shown on Drawing 01 (attached). The proposed development consists of access roads and parking areas, a weigh scale and associated scale house and waste disposal bin areas. The waste disposal bins will be situated at the base of a concrete retaining wall and founded on at-grade concrete slabs. A future re-use centre will also be developed to the south of the main site. An overview of the proposed site development (provide by Dillon) is shown on Drawing 01 (attached) and is based on the information provided by Dillon in Appendix A. It is our understanding that the scale house, and future re-use centre may be founded on shallow foundations or deep (piled) foundations, depending on their tolerance for seasonal movement. The weigh scale is anticipated to require deep foundations.

Existing information provided to TREK was reviewed and is included in Appendix A:

- **Appendix A – Geotechnical Report for Proposed New Entrance and Scale Facility – Brady Road Landfill (Earth Tech, May 5th, 2006):** Provides a site plan and test hole logs from a site investigation completed near the project location.
- **Final Concept Drawings for the Brady Road 4R Depot (Dillon, November 2013):** Provides overview of the proposed development features and layout.

3.0 Field Program

3.1 Sub-Surface Investigation

A subsurface investigation was undertaken on October 22nd and 23rd, 2013 under the supervision of TREK personnel to determine the soil stratigraphy and groundwater conditions at the site. Test holes were drilled using a Soilmec STM-20 truck mounted rig equipped with 508 mm diameter augers. Subsurface soils observed during the drilling were visually classified based on the Unified Soil Classification System (USCS). Other pertinent information such as drilling, groundwater and backfill conditions was also recorded. Samples retrieved during drilling included disturbed grab samples and relatively undisturbed Shelby tubes and were transported to TREK's laboratory in Winnipeg, Manitoba for further analysis. Laboratory testing consisted of moisture content determination on all samples. Undrained shear strength testing (pocket penetrometer, torvane and unconfined compression), unit weight determination and Atterberg Limits were also completed on select samples.

Ten test holes (TH13-01 to TH13-10) were drilled at the locations shown on Figure 01. Test Holes TH13-01 & 08 were advanced to Power Auger Refusal (PAR) and TH13-09 & 10 to 7.6 m below surface to evaluate subsurface conditions for piled foundations. The remaining test holes were relatively shallow (3.0 m depth) and completed to evaluate near surface conditions.

Test hole logs are attached in Appendix B and include soil descriptions, the elevation of soil units encountered and other pertinent information such as groundwater levels and sloughing conditions. Test hole locations and elevations were provided by Dillon and are presented on the test hole logs.

3.2 Sub-Surface Conditions

The subsurface stratigraphy in descending order from ground surface generally consists of clay (fill), silt and clay, silty clay and silt (till). The observed stratigraphy is consistent with previous (2006) geotechnical investigations performed at the site. A brief description of the soil units encountered at the test hole locations is provided below. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed test hole logs in Appendix B. Laboratory testing results are summarized on the test hole logs and included separately in Appendix C.

Clay (Fill)

Clay (fill) was encountered at surface in all test holes except TH13-04 & 09. The clay fill extends to depths ranging from 0.9 m to 1.5 m. The clay fill is generally silty, contains trace sand, trace gravel, trace rootlets, is grey, moist, stiff and of high plasticity. Moisture contents range from 26 % to 41 %, with an average of 31 %.

Silt and Clay

Silt and clay was encountered at surface in TH13-04 & 09 to 0.3 and 0.6 m below surface, respectively. Silt and clay was encountered below the clay (fill) in TH13-01 & 05 to a depth of 1.8 and 1.7 m below surface, respectively. Silt and clay was not encountered in the remaining six (6) test holes. The silt and clay is contains trace fine grained sand, is brown, moist, firm and of low plasticity. The moisture content of the silt ranges from 14 % to 22 % with an average of 17 %. Atterberg limit results from one sample indicate a plastic limit of 16 % and a liquid limit of 28 %. a 0.2 m thick layer of silt was encountered at about 1.7 m depth in test holesTH1 to TH4 of the 2006 geotechnical investigation. The silt and clay plots as a low plasticity clay on the A-line plasticity chart (Appendix C), although the degree of plasticity and clay content may vary.

Silty Clay

Highly plastic silty clay was observed in all test holes below the clay (fill) or silt. The clay extended to 11.3 m and 12.5 m below surface (Elev. 220.9 and 222.1 m) in TH13-01 & 08, respectively. The remaining eight test holes were terminated within the silty clay. The silty clay contains trace silt inclusions and trace organics at the clay fill contact. The silty clay is moist and mottled brown and grey, becoming grey at a depth of approximately 1.7 m below ground. The moisture content of the clay is generally consistent with depth, ranging from 22 % to 59 %, with an average of 47 %. Atterberg limit results from one sample indicate a plastic limit of 16 % and a liquid limit of 60 %.

Two unconfined compressive strength tests were performed resulting in undrained shear strengths of 34.1 and 91.3 kPa. Based on these tests and the results of torvane and pocket penetrometer tests, the consistency of the clay is considered firm to stiff, generally becoming softer with depth. Bulk unit weights of the clay range from 16.7 to 17.9 kN/m^3 with an average of 17.1 kN/m^3 based on seven samples.

Silt (Till)

Silt (till) underlies the silty clay at approximately 12.5 to 11.3 m depth based on test holes TH13-01 & 08. Power auger refusal was reached at depths between 13.1 and 12.1 m in test holes TH13-01 & 08. The silt (till) contains trace clay, trace sand to being sandy, trace gravel, is moist, light grey and is of no to low plasticity. Moisture contents of the silt (till) were 9.1, 8.5 and 7.3 %.

3.3 Seepage and Sloughing Conditions

Seepage and sloughing was not observed in any of the test holes. These observations are short term and should not be considered reflective of (static) groundwater levels in the silty clay, which would require monitoring over an extended period to determine. It is important to recognize that groundwater conditions may change seasonally, annually, or as a result of construction activities.

4.0 Foundation Recommendations

4.1 Limit States Design

Limit states design recommendations according to the National Building Code of Canada (NBCC, 2010) are provided below. Limit states design requires consideration of distinct loading scenarios comparing the structural loads to the foundation bearing capacity using resistance and load factors that are based on probabilistic reliability criteria. Two general design scenarios are evaluated corresponding to the serviceability and ultimate capacity requirements.

The **Ultimate Limit State (ULS)** is concerned with ensuring that the maximum structural loads do not exceed the nominal (ultimate) capacity of the foundation units. The ULS foundation bearing capacity is obtained by multiplying the nominal (ultimate) bearing capacity by a resistance factor (reduction factor), which is then compared to the factored (increased) structural loads. The ULS bearing capacity must be greater or equal to the maximum factored load. Table 1 summarizes the resistance factors that can be used for the design of piles as per the NBCC (2010) depending upon the method of analysis and verification testing completed during construction.

The **Service Limit State (SLS)** is concerned with limiting deformation or settlement of the foundation under service loading conditions such that the integrity of the structure will not be impacted. The Service Limit State should generally be analysed by calculating the settlement resulting from applied service loads and comparing this to the settlement tolerance of the structure. However, the settlement tolerance of the structure is typically not yet defined at the preliminary design stage. As such, SLS bearing capacities (or unit resistances) are provided that are developed on the basis of limiting settlement to approximately 25 mm or less. A more detailed settlement analysis should be conducted to refine the estimated settlement and/or adjust the SLS foundation capacity if a more stringent settlement tolerance is required.

Table 1. ULS Resistance Factors for Foundations (NBCC, 2010)

Case	Resistance Factor
Deep Foundation with bearing resistance to axial load based on semi-empirical analysis using laboratory and *in-situ* test data.	0.4
Deep Foundation with analysis using dynamic monitoring results (PDA Testing with CAPWAP Analysis)	0.5
Deep Foundation with analysis using static loading test results	0.6
Shallow Foundations for bearing resistance	0.5

4.2 Foundation Options

It is understood that, among other structures, a reinforced concrete retaining wall with a “saw-tooth” layout in plan view is proposed to provide a dumping area for waste disposal bins and that shallow foundations are preferred, if feasible. Recommendations are provided for shallow foundations (footings) although these should only be used if the structure can tolerate some seasonal differential movements. Alternatives for the retaining wall such as driven sheet piles should be considered and could decrease construction costs (recommendations for lateral earth pressures are provided in Section 6.0). Segmental block (geosynthetic reinforced earth) retaining walls are typically designed by the manufacturer, however TREK can provide a design review and external stability check if required. Deep foundations are recommended for any structures that may be sensitive to seasonal soil movements associated with freeze/thaw and/or wetting/drying cycles.

Site conditions, structure types and anticipated foundation loads make this site best suited for cast-in-place friction piles and driven pre-cast concrete piles as deep foundation options. Cast-in-place piles end-bearing in till may also be a suitable foundation option if increased pile loads are required; recommendations can be provided for this option if required.

4.2.1 Shallow Foundations

Provided seasonal movements relating to moisture changes in the soil are tolerable, a shallow (footing) foundation bearing on undisturbed silty clay would be an appropriate foundation system. To eliminate the effects from freeze/thaw footings should be placed below 2.4 m depth. Alternatively, footings above 2.4 m depth can be insulated to provide an equivalent level of frost protection. TREK can provide recommendations on insulation thickness and limits, if requested. Unrestrained differential soil movements associated with moisture changes can be expected to be in the order of 50 to 100 mm.

Based on the measured undrained shear strengths and the ULS resistance factors provided in Table 1, the ULS bearing capacity appropriate for design is 125 kPa. The SLS bearing capacity appropriate for design is 85 kPa and is based on settlements of less than 25 mm.

If increased bearing capacity is required beneath the footing, a compacted granular pad may be constructed below the base of the slab or thickened edge to distribute the contact load to maintain a ULS bearing pressure of 125 kPa and SLS bearing pressure of 85 kPa on the clay underlying the granular pad. In plan, the compacted granular pad should extend beyond the edge of the footing by at least the gravel thickness. The allowable bearing pressure on the gravel pad can be calculated using the following formulae:

ULS Bearing Capacity = 125 (w+d)/w

SLS Bearing Capacity = 85 (w+d)/w

where:
w = width of the footing (m)
d = depth of gravel below the footing (m)

The granular pad should be constructed using 50 mm down crushed limestone with the upper 100 mm of the granular pad constructed using 20 mm down crushed limestone as a levelling course. The crushed limestone should be compacted to a minimum of 98% SPMDD.

Additional considerations for the design and construction of footings are provided below.

1. The base width for footings should meet requirements established by the City of Winnipeg.
2. Organics, silts, fill soils, and any other deleterious material should be stripped such that the subgrade consists of native, undisturbed high plastic clay. Based on the exploration this could result in excavation of up to 2.0 m. Excavation should be completed by a backhoe equipped with a smooth bladed bucket in a manner which minimizes disturbance to the exposed subgrade. Care should be taken not to over-excavate and to minimize the subgrade disturbance at all times. Fill required to raise grades or for levelling should consist of a 20 mm down crushed rock compacted to 100% SPMDD.
3. The subgrade should be inspected by qualified geotechnical personnel prior to concrete placement.
4. Where soft or weak subgrade materials are identified by the geotechnical personnel, these areas should be repaired as directed by the geotechnical engineer. This may require excavation and placement/compaction of granular fill. A typical repair for this application would involve excavation to 300 mm below the design subgrade elevation, followed by backfilling and compaction using granular sub-base materials.

4.2.2 *Cast in Place Concrete Friction Piles*

Pile capacities for evaluation of the Ultimate and Service Limit States can be calculated based on the SLS and ULS (factored) unit resistances provided in Table 2. A ULS resistance factor of 0.4 was selected associated with resistances based on field observations and laboratory testing. The pile settlement under applied (unfactored) loads equal to the SLS pile capacity can be expected to be 25 mm or less. If required, a detailed settlement analysis can be provided by TREK once the final pile loads are known.

The SLS pile capacity should be calculated based on the skin friction resistance only, which is consistent with traditional friction pile design. The ULS pile capacity should be calculated based on the total pile capacity at ultimate (plunging) failure, which would consist of both skin friction and end-bearing components; factored ULS resistances for both are provided.

Table 2. Recommended Limit State Unit Resistances for Friction Piles

Soil	Depth (m)		ULS Resistance		SLS Skin Friction
	From	To	End-Bearing	Skin Friction	
Clay Fill / Frost Zone	0.0	2.	0	0	0
Silty Clay	2.	10.5	110 kPa	16 kPa	14 kPa

[1] ULS resistance = A Resistance Factor of 0.4 is applied.

Additional design and construction recommendations for cast-in-place concrete piles are provided below:

1. The weight of the embedded portion of the pile may be neglected.
2. The contribution from end bearing should be ignored.
3. Adhesion within the upper 2.4 m of the pile should be ignored to take into consideration potential shrinkage and environmental effects such as frost action over that depth. Shaft support within any fill materials should also be ignored. A skin friction of 12 kPa (resistance factor of 0.3 has been applied) should be used for calculating uplift resistance against live loads on the piles. A minimum pile length of 8 m should be used to resist uplift forces due to frost jacking.
4. Friction piles should not extend below Elev. 223.0 m to prevent piles from penetrating the underlying till. Should any piles penetrate the till unit, differential settlement between piles may occur.
5. Pile spacing should not be less than 2.5 pile diameters, measured centre to centre. If pile spacing must be closer than 2.5 pile diameters, TREK should be notified so that an evaluation of pile group effects can be performed.
6. Grade beams and pile caps should be constructed with a minimum 150 mm void space to minimize the effects of soil heave due to swelling or frost action.
7. All cast-in-place piles require reinforcement design by a qualified structural engineer for the anticipated axial, lateral and bending loads from the structure.
8. Based on observed conditions, sleeving of pile holes will likely be unnecessary. Seepage conditions at the time of construction may differ from that observed at the time of drilling, in particular from near surface layers (e.g. silt) and if seepage and sloughing conditions are observed during drilling of pile holes, sleeves should be used.
9. Drilling and concrete placement for the piles should be inspected by geotechnical personnel to verify the soil conditions and proper installation of the piles.
10. Prior to casting the pile, any groundwater within the shaft should be removed or controlled. If water is present the concrete should be placed using Tremie methods.
11. Concrete should be placed as soon as possible after drilling of the pile shaft.

4.2.3 Driven Pre-Cast Concrete Piles

Both SLS and ULS pile capacities are provided in Table 3 for precast concrete piles driven to practical refusal within the glacial till with the specified hammer and set criteria. Based on field observations and laboratory testing, the use of a resistance factor value of 0.4 has been applied to the estimated nominal end bearing value to arrive at the recommended ULS values provided in Table 3. A resistance factor of 0.6 may only be used for driven piles if a static pile load test is carried out at the site (which we anticipate will not be cost-effective). A resistance factor of 0.5 may only be used for driven piles if dynamic monitoring (e.g. PDA Testing with CAPWAP analysis) is carried out at the site during construction. If desired, TREK can provide recommendations on the number of piles to be used in either static or dynamic testing once a preliminary pile layout has been developed.

The SLS capacity provided in Table 3 will result in settlements of less than 25 mm. If a more stringent settlement criterion is required, a detailed settlement analysis can be provided by TREK once the final pile loads are known.

Table 3. Recommended Limit State Pile Capacities for Driven Precast Concrete Piles

Pile Type	Pile Size	ULS Capacity (kN)	SLS Capacity (kN)	Refusal Criteria (Blows/25 mm)
Driven Precast Piles	300 mm	580	445	5
	360 mm	800	625	8
	405 mm	1040	800	12

**Refusal criteria to be met on three consecutive sets using a hammer with a minimum rated energy of 40 kJ per blow*

Additional design and construction recommendations for driven precast concrete piles are provided below:

1. The weight of the embedded portion of the pile may be neglected.
2. The piles must be designed to withstand design loads, handling stresses, and driving forces during installation.
3. Pile spacing should not be less than 2.5 pile diameters, measured centre to centre. If pile spacing must be closer than 2.5 pile diameters, TREK should be notified so that an evaluation of pile group effects can be performed.
4. The piles should be specified to have cured for at least 7 days prior to driving.
5. To aid in pile alignment, reduce ground vibrations, and reduce pile heave during driving, pre-boring may be undertaken. The pre-bore depth should be less than 3 m and the pre-bore diameter should be no more than 50 mm larger than the pile diameter. If lateral resistance is required in the piles, the annulus surrounding the pre-bore section of the piles should be filled with lean mix concrete for compliance with the surrounding soil.
6. Piles should be driven continuously once driving is initiated to the required refusal criteria.
7. All piles driven within 5 pile diameters of the pile being driven should be monitored for pile heave during installation. If pile heave is observed, all piles should be checked. Piles that have heaved should be re-driven to the refusal criteria.
8. Where a steel follower is required to install piles below the surrounding ground surface, the refusal criteria should be increased by up to 50% in order to account for additional energy losses through the use of the follower. TREK should be contacted to provide recommendations in this regard during construction.
9. Inspection of the driven pile installation should be undertaken by qualified and experienced geotechnical personnel who are familiar with this type of pile installation.

10. Any piles damaged, misaligned an excessive amount or reaching premature refusal may need to be replaced. The structural designer should assess non-conforming piles to determine if they are acceptable.
11. Grade beams and pile caps should be constructed with a minimum 150 mm void space to minimize the effects of soil heave due to swelling or frost action.
12. Any existing structures, foundation components or concrete rubble encountered during construction should be excavated and removed to a depth of at least 0.5 m from the underside of grade beams and pile caps.

4.2.4 *Lateral Pile Loading*

The soil response (subgrade reaction) to lateral loads can be modeled in a simplified manner that assumes the soil around a pile can be simulated by a series of horizontal springs for the preliminary design of pile foundations. The soil behaviour can be estimated using an equivalent spring constant referred to as the lateral subgrade reaction modulus (k_s). For clays, the lateral subgrade reaction modulus is typically independent of depth or vertical overburden stress. Table 4 provides the recommended subgrade reaction modulus for the lateral load analysis.

The majority of lateral resistance will typically be offered by the upper 5 to 10 m of soil, depending on the relative stiffness of the pile and soil units. Void spaces surrounding piles due to pre-boring activities should be in-filled with lean-mix concrete to ensure compliance with the surrounding soil.

Table 4. Recommended Values for Lateral Subgrade Reaction Modulus (K_s)

Soil	Depth (m)		K_s (kN/m^3)
	From	To	
Fill Soils, Silts, and Clays	0.0	11	2700/d[1]

[1] d is the pile diameter in metres.

As part of detailed design, a more rigorous lateral pile and group analysis that incorporates the material and section properties of the pile, final lateral deflection criteria and a more realistic elastic-plastic model of the soil response to loading can be carried by TREK out to confirm the lateral load capacity of the piles and pile group, if required.

5.0 Grade Supported Concrete Floor Slabs

It is understood that the proposed new structures may include grade supported concrete slabs. Some vertical deformation of grade supported slabs should be expected due to moisture and volume changes of the underlying clay soils. Additionally, floor slabs in unheated areas will be subject to additional movements from freeze/thaw of the subgrade soils. The following recommendations are provided to reduce or accommodate potential movements of the slab:

1. Organics, silts, fill soils and any other deleterious material should be stripped such that the subgrade consists of native high plastic silty clay. Excavation should be completed with a backhoe equipped with a smooth bucket and operating from the edge of the excavation in order to minimize disturbance to the exposed subgrade. Care should be taken not to over-excavate and to minimize the subgrade disturbance at all times.
2. Any existing structures, foundation components or concrete rubble encountered during construction should be removed to 0.5 m below the design subgrade elevation or in their entirety at pile locations and backfilled with compacted base course material.
3. The sub-grade should be protected from freezing, drying, or inundation with water. If any of these conditions occur the sub-grade should be moisture conditioned as appropriate, scarified and re-compacted to 95% of Standard Proctor Maximum Dry Density (SPMDD).
4. After excavation, the subgrade should be inspected by qualified geotechnical personnel. The subgrade should be proof-rolled with a fully loaded tandem axle truck to detect weak or soft areas. Soft areas should be repaired by sub-excavating to a maximum depth of 0.3 m below the sub-grade level, covered in geo-textile and backfilled with well graded granular compacted to 98% SPMDD.
5. Fill required to raise grades should consist of well graded granular fill compacted to 98% SPMDD.
6. The granular base should consist of well-graded crushed rock compacted to 98% of SPMDD. The granular section should consist of a minimum of 150 mm of crushed limestone base material (19 mm down) overlying 150 mm of crushed limestone sub-base material (50 mm to 75mm down). In unheated areas, the thickness of granular sub-base material should be increased to 250 mm. The granular base should be placed and compacted in lifts not exceeding 150 mm thickness.
7. To minimize changes in soil moisture beneath grade supported floor slabs, the discharge from roof leaders and run-off from exposed slabs should be directed away from the structures.
8. To accommodate slab movements, it may be desirable to provide control joints to reduce random cracking and isolation joints to separate the slab from other structure elements (e.g. grade beams). Allowances should be made to accommodate vertical movements of light-weight structures (e.g. partitions) bearing on the slab.
9. Consideration should be given to providing a sub-floor drainage system consisting of a perimeter weeping tile drain.

6.0 Lateral Earth Pressure

The magnitude of lateral earth pressures from retained soil against permanent walls will depend on the backfill material type, method of placing, compacting the backfill and the magnitude of horizontal deflection of the wall after the backfill is placed. It is recommended that free draining granular soil be used as backfill against permanent walls to improve drainage properties and minimize the potential of lateral frost heave loading. A sub-drainage system consisting of filter-wrapped drainage pipe backfilled with clean gravel should be used at the base of the wall backfill to prevent the build-up of hydrostatic pressures behind the wall structures. Cohesive soils should not be used as backfill behind permanent walls as these soils could generate excessive lateral earth pressures from swelling. For cantilever retaining walls founded below grade, earth pressures due to native soils would be acting on both sides of the embedded portion of the wall.

Table 5 provides earth pressure coefficients and bulk unit weights for compacted granular backfill as well as native clays and silts. An active pressure coefficient (K_a) should be used to calculate lateral loads from retained soils where structures which are free to translate horizontally by at least 0.2 percent of the retaining wall height. An at-rest earth pressure coefficient (K_o) should be used where structures are not free to translate. An appropriate surface surcharge should also be included in the earth pressure distribution to account for surface loads. The active pressure coefficient (K_a) can be used to calculate the component of lateral loads on wall structures due to surcharge loads. A passive earth pressure coefficient (K_p) can be used for lateral earth pressures acting on the down-slope side of retaining structures to resist lateral wall movement, provided soil strains of 2 to 5% can be mobilized. In this regard, actual earth pressures acting on the down-slope face may be between the at-rest and passive earth pressure conditions and TREK should be involved in the selection of lateral earth pressures for final design. The effective (buoyant) unit weight should be used to calculate the earth pressures due to soils below the groundwater table. In this regard, a groundwater table at original ground surface should be assumed for the purposes of preliminary design.

Table 5. Recommended Parameters for Lateral Earth Pressure Calculations

Soil	Bulk Unit Weight	Earth Pressure Coefficient		
		Active (K_a)	At-Rest (K_o)	Passive (K_p)
Granular Backfill	22 kN/m^3	0.3	0.4	3.0
Native Soils (Silts and Clays)	17 kN/m^3	0.5	0.65	2.0

Over-compaction of the backfill soils adjacent to walls may result in earth pressures that are considerably higher than those predicted in design. Compaction of the granular fills within about 1.5 m of retaining walls should be conducted with a light hand operated vibrating plate compactor and the number of compaction passes should be limited. A maximum compacted density of 92% of Standard Proctor Maximum Dry Density (SPMDD) should be specified for fill placed adjacent to walls. Granular backfill placed downslope of retaining walls and within 3 m of the retaining wall should be compacted to 100% of SPMDD. Backfilling procedures should be reviewed during construction to verify that they are consistent with the design assumptions.

7.0 Foundation Concrete

Based on TREK's experience with soils in the Winnipeg area the degree of exposure for concrete subjected to sulphate attack is classified as severe according to Table 3, CSA A23.1-09 (Concrete Materials and Methods of Concrete Construction). Accordingly, all concrete in contact with the native soil should be made with high sulphate-resistant cement (HS or HSb). Furthermore, the concrete should have a minimum specified 56 day compressive strength of 32 MPa and have a maximum water to cement ratio of 0.45 in accordance with Table 2, CSA A23.1-09 for concrete with severe sulphate exposure (S2). Concrete which may be exposed to freezing and thawing should be adequately air entrained to improve freeze-thaw durability in accordance with Table 4, CSA A23.1-09.

8.0 Pavement Design

Recommendations for asphalt pavement structure for residential traffic areas and areas that will be subjected to heavier vehicular loads (operational traffic) such as access roads and loading areas are provided in Table 6.

Table 6. Recommended Sections for Asphalt Pavements

Material	Layer Thickness		Compaction Requirements
	Car Parking Areas	Heavy Vehicular Loads	
Asphalt	75 mm	75 mm	98% Marshall Density
20 mm down limestone or recycled concrete	150 mm	150 mm	100% of SPMDD
50 mm down limestone	250 mm	350 mm	98% of SPMDD
Non-Woven Geotextile (Geotex 801 or equivalent)	Optional	Required	Install as per manufacturer's recommendations

1. Organics, silts, fill soils, and any other deleterious material should be stripped such that the subgrade consists of native high plastic silty clay. Excavation should be completed with a backhoe equipped with a smooth bucket and operating from the edge of the excavation in order to minimize disturbance to the exposed subgrade. Care should be taken not to over-excavate and to minimize the subgrade disturbance at all times.

   As an alternative, consideration could be given to removing surficial silts and organics and leaving the existing clay (fill) in place. In this case additional movement resulting from volume changes in the clay (fill) soils should be expected. To minimize the effects of leaving the fill in place the upper 0.3 m of fill should be scarified and re-compacted to 95% of SPMDD.

2. The subgrade should be protected from freezing, drying, or inundation with water. If any of these conditions occur the subgrade should be moisture conditioned as appropriate, scarified and re-compacted to 95% of SPMDD.
3. After excavation, the subgrade should be inspected by qualified geotechnical personnel. The subgrade should be proof-rolled with a fully loaded tandem axle truck to detect weak or soft areas. Soft areas should be repaired by sub-excavating to a maximum depth of 0.3 m below the sub-grade level, covered in geo-textile and backfilled with 50 or 100 mm down crushed limestone compacted to 98% SPMDD.
4. Fill required to raise grades should consist of well graded granular fill compacted to 98% SPMDD. 100 or 150 mm down well graded granular would be appropriate for use.

9.0 Drainage

Drainage adjacent to site buildings or structures should promote runoff away from the structures. A minimum slope of about 2% should be used for both landscaped and paved areas immediately around structures. All paved areas should be provided with minimum slopes of 2% to improve long-term drainage. All roof leaders should be extended sufficiently away from the building walls.

10.0 Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation, laboratory testing, geometries). Soil conditions are natural deposits that can be highly variable across a site. If subsurface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work or standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

Drawings

TREK
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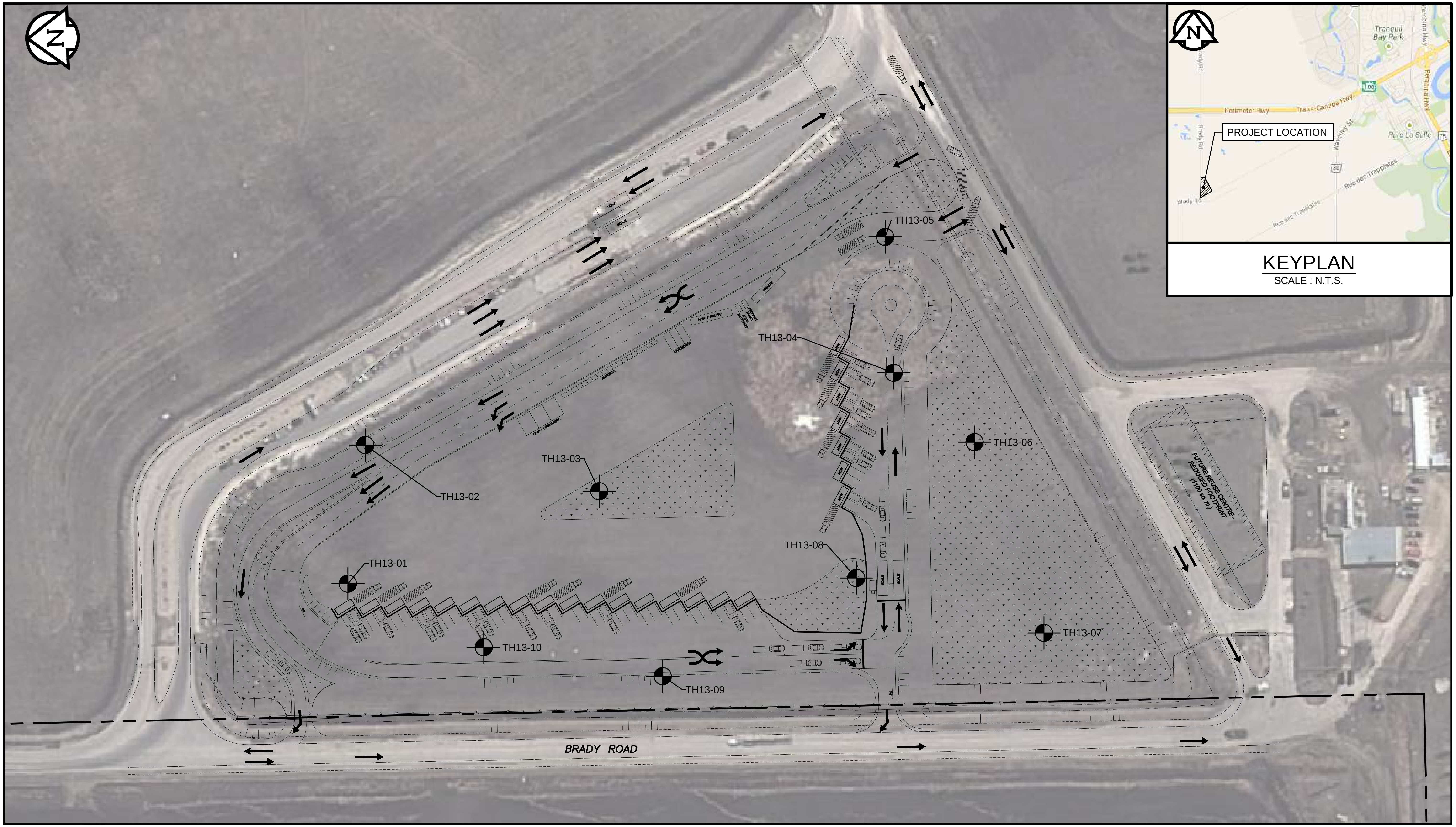
0022 010 00
Dillon Consulting Ltd.
City of Winnipeg Resource Recovery Centres

Tabloid (279mm x 432mm)

PLOT: 16/01/2014 10:56:00 AM

FILE NAME: 0022 010 00_RI.dwg



0 12.5 25 37.5 50m
SCALE : 1:1250 (279mm x 432mm)

LEGEND :

⌖	TEST HOLE (TREK, OCTOBER 22 AND 23, 2013)
— - - —	APPROXIMATE PROPERTY LINE

NOTES :

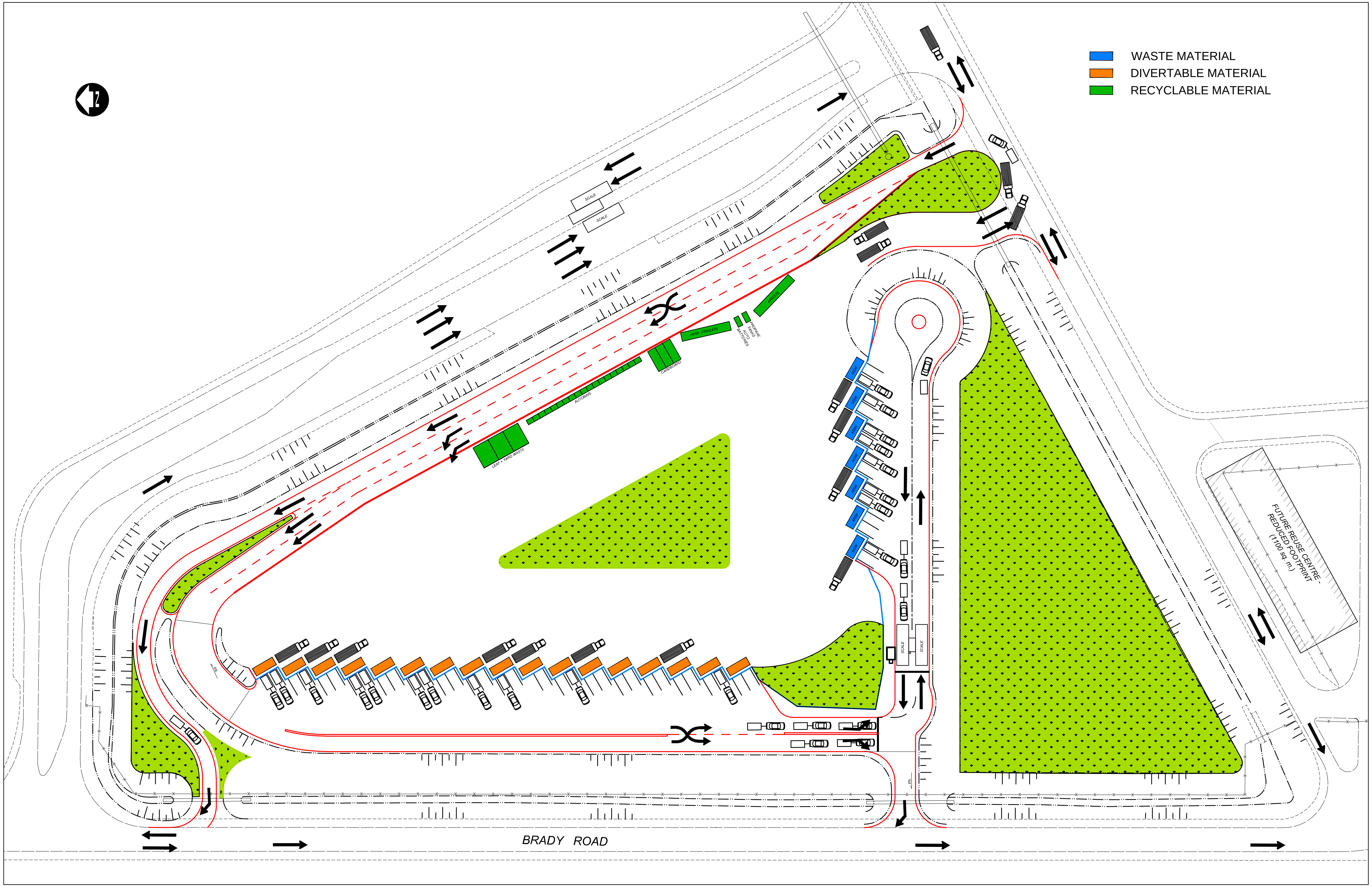
1. AERIAL IMAGE FROM GOOGLE EARTH, MAY 2, 2013

Drawing 01

Test Hole Location Plan
Brady Road

Appendix A

Existing Information



PLAN

DILLON CONSULTING

NOVEMBER 2013

SCALE 1:500

TITLE

4R DEPOT - BRADY ROAD
OPTION 3b

DRAWING NO.

REF-16

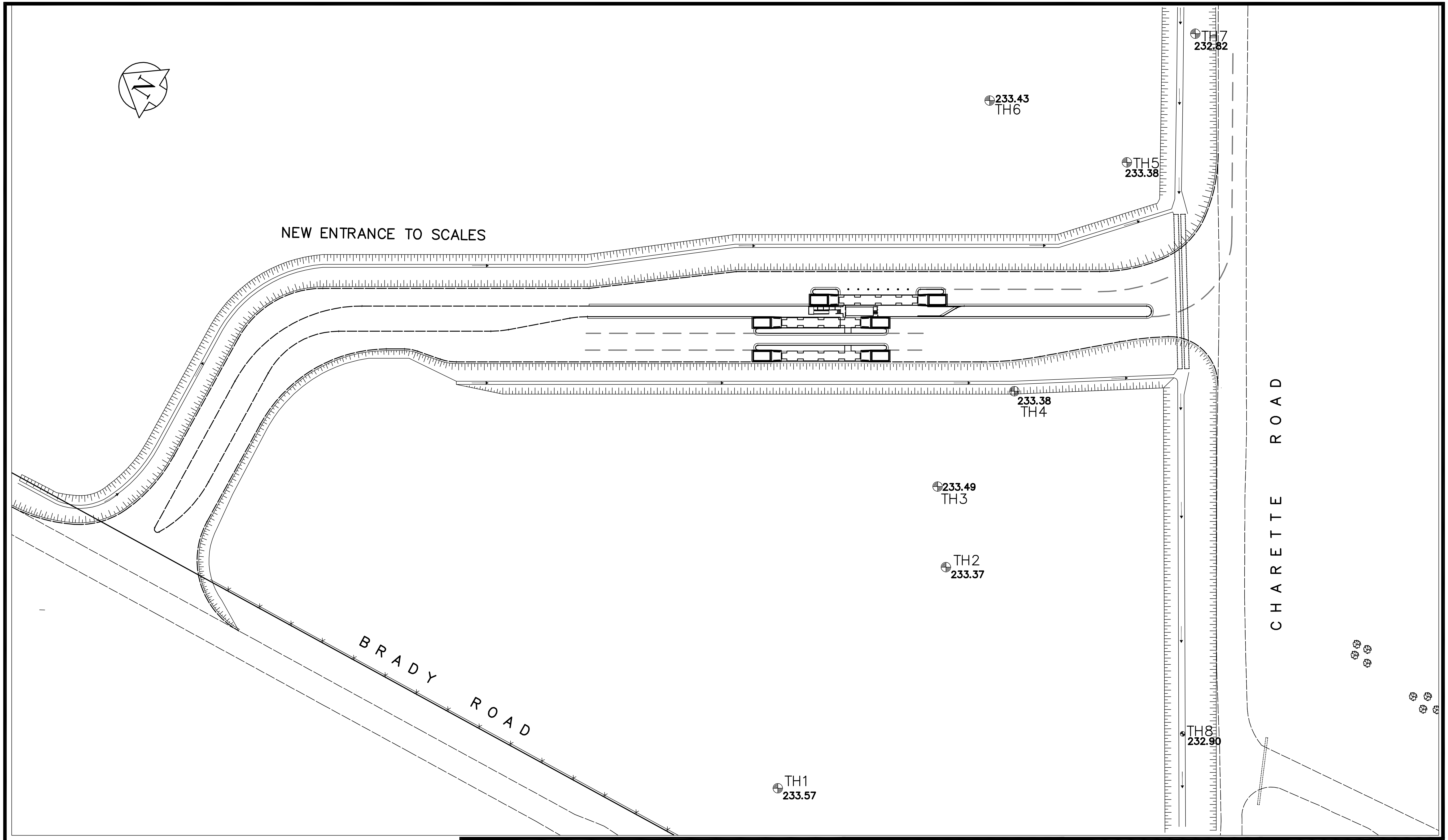
G:\CAD\138224\02-Civil\09-Reference Internal\REF-16_BRRMF_option3b.dwg

APPENDIX ‘A’

GEOTECHNICAL REPORT

APPENDIX 'A' - GEOTECHNICAL REPORT

The geotechnical report is provided to aid in the Contractor's evaluation of soil conditions. The information presented is considered accurate at the locations shown on the Drawings and at the time of drilling. However, variations in soil conditions may exist between test holes and fluctuations in groundwater levels can be expected seasonally and may occur as a result of construction activities. The nature and extent of variations may not become evident until construction commences.



no.	yy-mm-dd	revision	by	app.
2	07/06/11	REV. TESTHOLES NO. & ADDED ELEV.	PAAP	
1	06/19/06	REVISED GEOM BASED ON C.O.W.	BC	

EarthTech

Earth Tech (Canada) Inc. Winnipeg, Manitoba 204.477.5381

BRADY ROAD LANDFILL
TEST HOLE LOCATIONS

designed
drawn BC
checked
approved
scale N.T.S.
yy-mm-dd 05-26-06
project no. 91605
drawing no. RT02
rev. 1

L:\work\91000\91605\02a-CAD\TRA\Ref-In\RT-02.dwg 07-06-22 07:13am Layout:Layout1 peter.poels

FORM 11x17
REV. 05-05-03

DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 1	Project No. 262839
PROJECT:	BRADY ROAD SCALES AND SCALE HOUSE	DATE OF INVEST.: June 20, 2006	
CLIENT:	EARTH TECH	DRILL : SUBTERRANEAN 400 mm AUGER	

SAMPLE NO.	DEPTH (m)	ELEV. (m)	SYM	SOIL DESCRIPTION
	0.00	233.57		
	0.50	233.07		0.00-0.20 TOPSOIL , CLAY TOPSOIL OVER BLACK CLAY, 0.20-0.45 SILT, TAN GREY, DAMP TO DRY
	1.00	232.57		0.45-1.52 CLAY BROWN, STIFF, SILTY, HIGH PLASTIC
	1.50	232.07		
	2.00	231.57		1.52-1.68 SILT, LAYERED 1.67-3.05 CLAY BROWN, STIFF, SILTY, HIGH PLASTIC
	2.50	231.07		
	3.00	230.57		
	3.50	230.07		END OF TEST HOLE AT 3.05 IN BROWN STIFF CLAY

MOISTURE CONTENT (%)

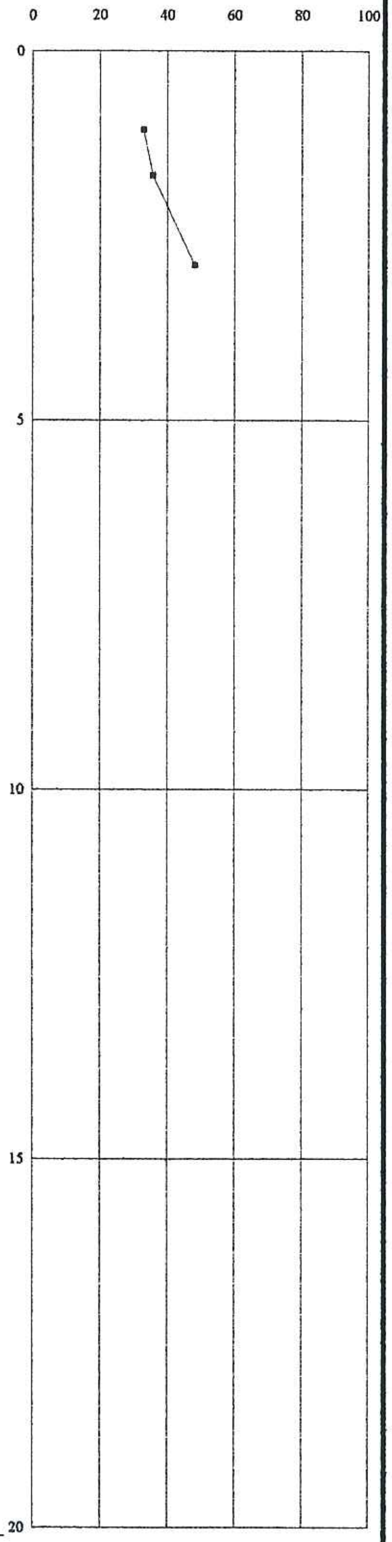
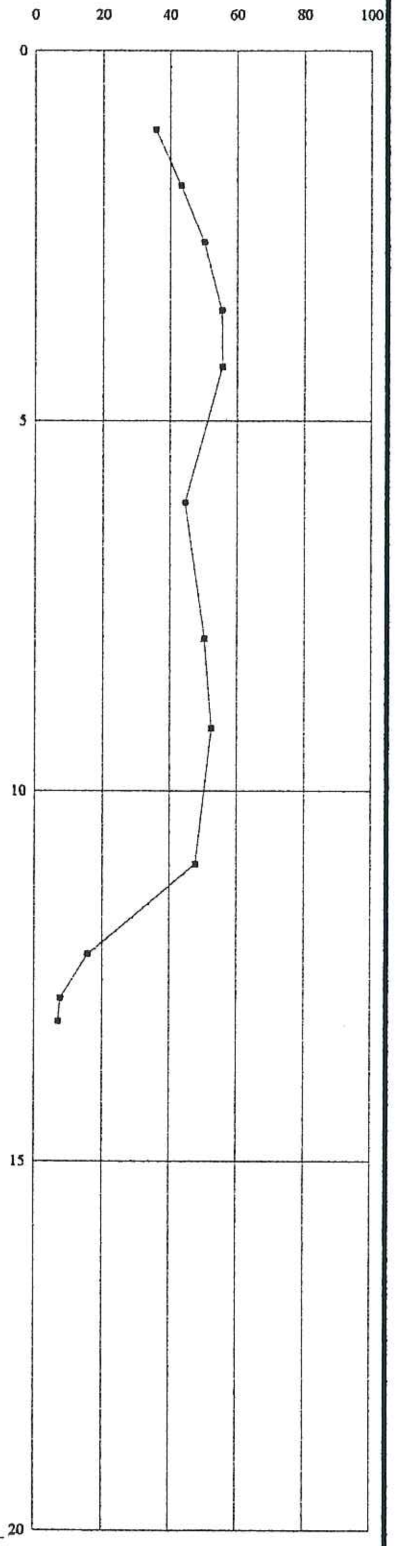


FIGURE 2

DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 2	Project No. 262839
PROJECT:	BRADY ROAD SCALES AND SCALE HOUSE	DATE OF INVEST.: June 20, 2006	
CLIENT:	EARTH TECH	DRILL : SUBTERRANEAN 400 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	233.57		
	0.50	233.07		0.00-0.10 TOPSOIL, 0.10-0.20 SILT, TAN GREY DRY 0.20-1.37 CLAY
	1.00	232.57		BROWN, STIFF, SILTY, HIGH PLASTIC
	1.50	232.07		1.37-1.52 SILT , TAN, LAYERED 1.52-12.04 CLAY
	2.00	231.57		BROWN, STIFF, SILTY, HIGH PLASTIC
	2.50	231.07		
	3.00	230.57		
	3.50	230.07		
	4.00	229.57		
	4.50	229.07		BROWN, MEDIUM, HIGH PLASTIC, SILTY, Qu-55.1 kPa TRACE SULPHATES, TRACE SAND Pp-71.8 kPa INCLUSIONS, TRACE ROOTLETS, Tv-74.2 kPa SOMR FINE LAYERING W -16.32 Kn/m
	5.00	228.57		
	5.50	228.07		
	6.00	227.57		
	6.50	227.07		
	7.00	226.57		
	7.50	226.07		
	8.00	225.57		GREY, STIFF, HIGH PLASTIC, SILTY Qu-130.5 kPa TRACE SILT, SAND AND GRAVEL Pp-76.6 kPa INCLUSIONS Tv-57.5 kPa W -16.92 Kn/m
	8.50	225.07		
	9.00	224.57		
	9.50	224.07		
	10.00	223.57		
	10.50	223.07		
	11.00	222.57		GREY, MEDIUM, HIGH PLASTIC, SOME SILT Qu-87.2 kPa TRACE SILT, SAND AND GRAVEL Pp-86.2 kPa INCLUSIONS Tv-57.5 kPa W -17.10 Kn/m
	11.50	222.07		
	12.00	221.57		
	12.50	221.07		12.04-13.11 GLAIAL SILT TILL VERY UPPER PART OF TILL SANDY/GRAVELLY, WATER BEARING SILT MATRIX WITH SAND AND GRAVEL, DENSE (+), SOME COBBLES AND BOULDERS, MORE DENSE WITH DEPTH AT 13.0 DENSE TO VERY DENSE
	13.00	220.57		
	13.50	220.07		END OF TEST HOLE AT 13.11 IN VERY DENSE GLACIAL SILT TILL

MOISTURE CONTENT (%)



DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 3	Project No. 262839
PROJECT: BRADY ROAD SCALES AND SCALE HOUSE CLIENT: EARTH TECH		DATE OF INVEST.: June 20, 2006 DRILL : SUBTERRANEAN 400 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)
	0.00	233.49
	0.50	232.99
	1.00	232.49
	1.50	231.99
	2.00	231.49
	2.50	230.99
	3.00	230.49
	3.50	229.99
	4.00	229.49
	4.50	228.99
	5.00	228.49
	5.50	227.99
	6.00	227.49
	6.50	226.99
	7.00	226.49
	7.50	225.99
	8.00	225.49
	8.50	224.99
	9.00	224.49
	9.50	223.99
	10.00	223.49
	10.50	222.99
	11.00	222.49
	11.50	221.99
	12.00	221.49
	12.50	220.99
	13.00	220.49
	13.50	219.99

SYM

SOIL DESCRIPTION

0.00-0.08 TOPSOIL
0.08-0.20 SILT
0.20-1.52 CLAY
BROWN, STIFF, SILTY, HIGH PLASTIC

1.52-1.67 SILT, TAN, LAYERED
1.67-12.20 CLAY
BROWN, STIFF, SILTY, HIGH PLASTIC

AT 2.7 TRACE SILT, SAND AND FINE GRAVEL INCLUSIONS

GREY, SILTY, HIGH PLASTIC, SOME SILT LAYERINGS, TRACE SILT, SAND AND GRAVEL INCLUSIONS, FIRM TO STIFF

Qu-98.4 kPa
Pp-76.6 kPa
Tv-62.2 kPa
W -17.35 Kn/m

GREY, FIRM, HIGH PLASTIC, SOME SILT, TRACE SILT, SAND, AND GRAVEL INCLUSIONS, SOME GRAVEL STONE TO 25 mm DIAMETER

Qu-80.2 kPa
Pp-67.0 kPa
Tv-57.5 kPa
W -16.66 Kn/m

12.20-12.80 GLACIAL SILT TILL
SILT MATRIX WITH SAND AND GRAVEL, SOME COBBLES AND BOULDERS, MORE DENSE WITH DEPTH

END OF TEST HOLE AT 12.80 IN VERY DENSE GLACIAL SILT TILL

MOISTURE CONTENT (%)

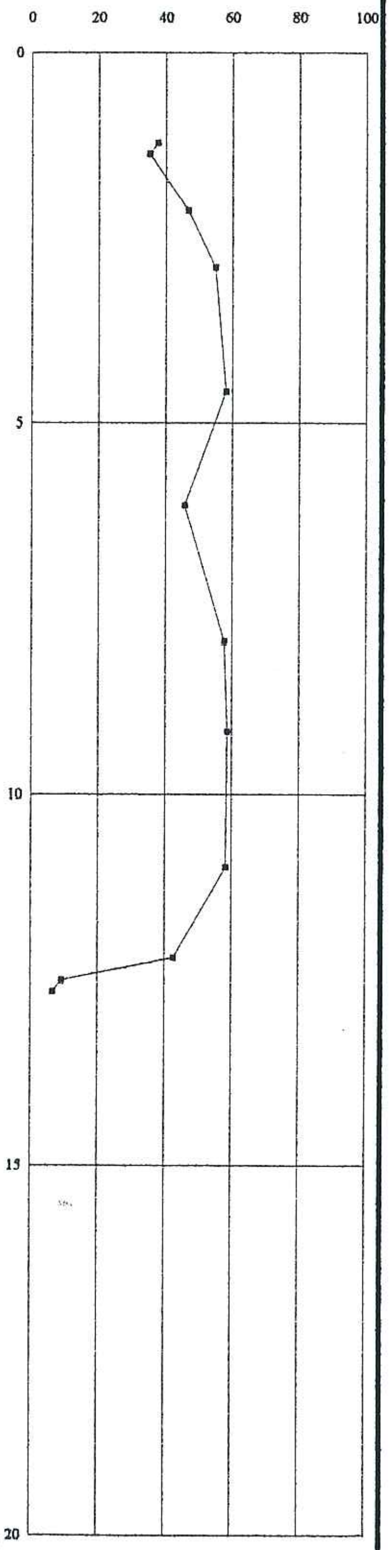


FIGURE 4

DYREGROV CONSULTANTS

Logged/Dwn.: TH
Checked: AOD

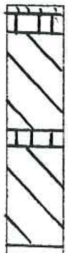
Test Hole No. 4
Project No. 262839

PROJECT: BRADY ROAD SCALES AND SCALE HOUSE
CLIENT: EARTH TECH

DATE OF INVEST.: June 20, 2006
DRILL : SUBTERRANEAN 400 mm AUGER

SAMPLE NO.	DEPTH (M)	ELEV. (M)
	0.00	233.38
	0.50	232.88
	1.00	232.38
	1.50	231.88
	2.00	231.38
	2.50	230.88
	3.00	230.38
	3.50	229.88

SYM



SOIL DESCRIPTION

0.00-0.10 TOPSOIL
0.10-0.45 SILT, TAN GREY, DAMP TO DRY
0.45-1.82 CLAY
BROWN SILTY, STIFF, HIGH PLASTIC

1.82-1.98 SILT, TAN, LAYERED
1.98-3.20 CLAY
BROWN, SILTY, STIFF, HIGH PLASTIC

END OF TEST HOLE AT 3.20 IN BROWN CLAY

MOISTURE CONTENT (%)

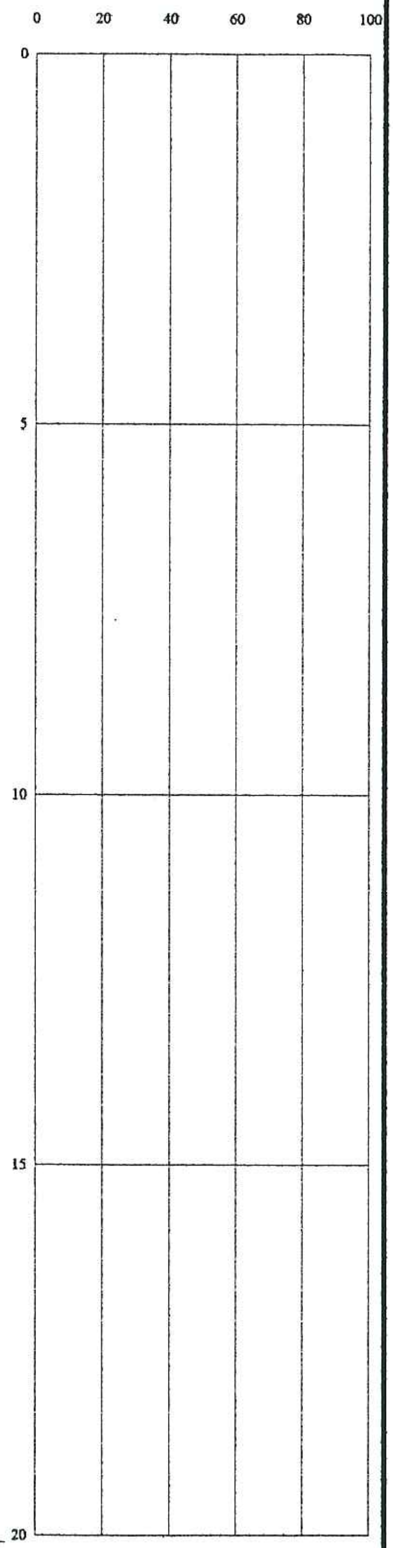


FIGURE 5

DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 5	Project No. 262839
PROJECT: BRADY ROAD SCALES AND SCALE HOUSE CLIENT: EARTH TECH		DATE OF INVEST.: June 20, 2006 DRILL : SUBTERRANEAN 400 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	233.38		
	0.50	232.88		0.00-0.20 TOPSOIL 0.20-1.22 CLAY BROWN, STIFF, SILTY, HIGH PLASTIC
	1.00	232.38		
	1.50	231.88		1.22-1.37 SILT, TAN, LAYERED 1.37-3.05 CLAY BROWN, SILTY, STIFF, HIGH PLASTIC
	2.00	231.38		
	2.50	230.88		
	3.00	230.38		
	3.50	229.88		
	4.00	229.38		END OF TEST HOLE AT 3.05 IN BROWN CLAY

MOISTURE CONTENT (%)

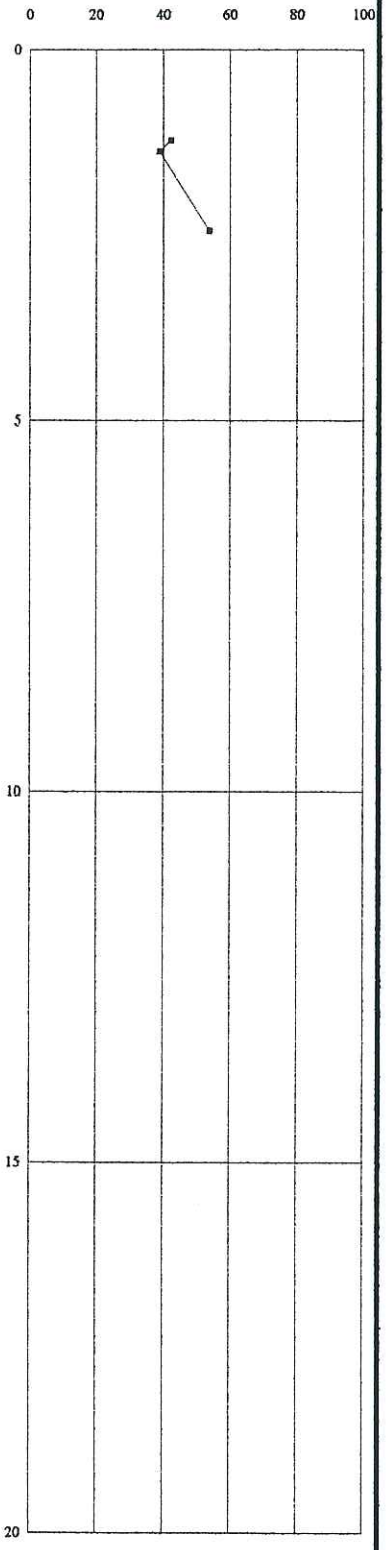


FIGURE 6

DYREGROV CONSULTANTS

Logged/Dwn.: TH
Checked: AOD

Test Hole No. 6

Project No. 262839

PROJECT: BRADY ROAD SCALES AND SCALE HOUSE
CLIENT: EARTH TECH

DATE OF INVEST.: June 20, 2006
DRILL : SUBTERRANEAN 400 mm AUGER

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	233.43		0.00-0.11 TOPSOIL 0.11-1.68 CLAY BROWN, SILTY, STIFF, HIGH PLASTIC
	0.50	232.93		
	1.00	232.43		
	1.50	231.93		
	2.00	231.43		1.68-1.83 SILT, TAN, LAYERED 1.83-3.05 CLAY BOWN, SILTY, STIFF, HIGH PLASTIC
	2.50	230.93		
	3.00	230.43		
	3.50	229.93		END OF TEST HOLE IN BROWN CLAY
	4.00	229.43		

MOISTURE CONTENT (%)

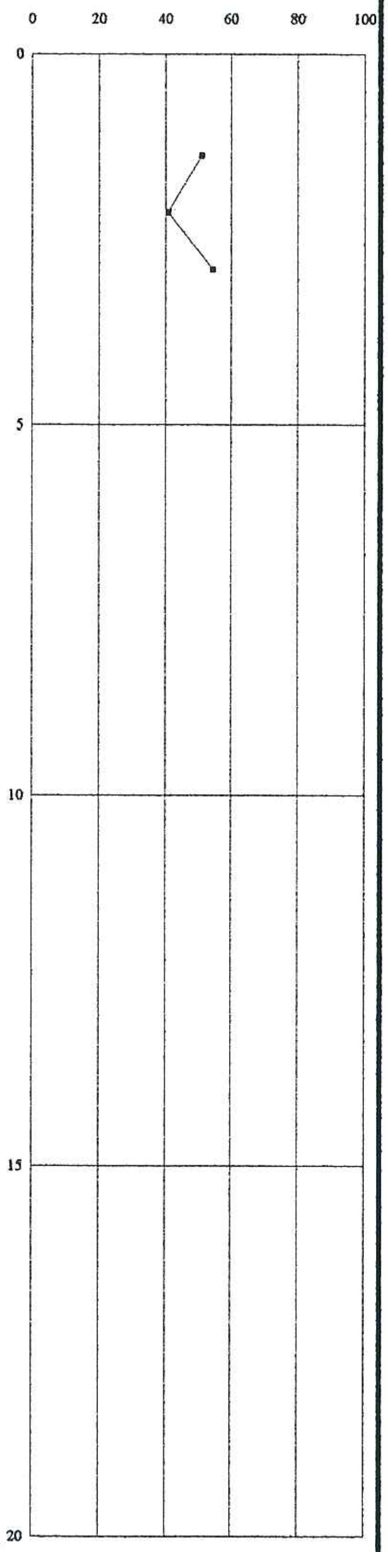
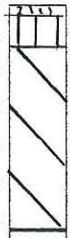


FIGURE 7

DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 7	Project No. 262839
PROJECT: BRADY ROAD SCALES AND SCALE HOUSE CLIENT: EARTH TECH		DATE OF INVEST.: June 20, 2006 DRILL : SUBTERRANEAN 400 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)
	0.00	233.82
	0.50	233.32
	1.00	232.82
	1.50	232.32
	2.00	231.82
	2.50	231.32
	3.00	230.82
	3.50	230.32
	4.00	229.82

SYM



SOIL DESCRIPTION

0.00-0.13 TOPSOIL
0.13-0.61 SILT, TAN, DAMP
0.61-3.05 CLAY
BROWN, SILTY, STIFF, HIGH PLASTIC

END OF TEST HOLE AT 3.05 IN BROWN CLAY

MOISTURE CONTENT (%)

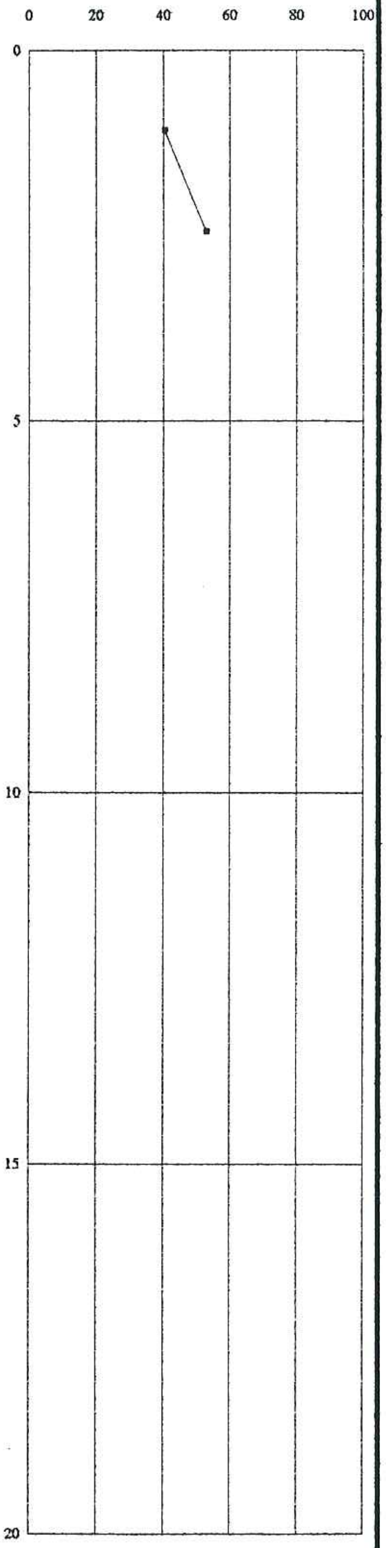


FIGURE 8

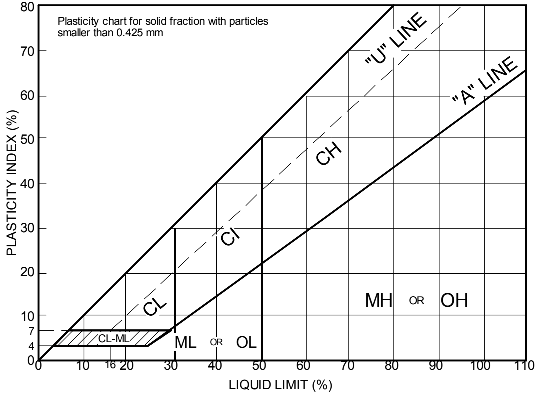
Appendix B

Test Hole Logs

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria		
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW	●	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows: Less than 5 percent...... GW, GP, SW, SP More than 12 percent...... GM, GC, SM, SC 6 to 12 percent...... Borderline case4s requiring dual symbols*	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	○	Poorly-graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM	▥	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			GC	▨	Clayey gravels, gravel-sand-silt mixtures		Atterberg limits above "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW	∴	Well-graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	⁘	Poorly-graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	▥	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols
			SC	▨	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML	▥	Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	Plasticity Chart 		
			CL	▨	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	☰	Organic silts and organic silty clays of low plasticity			
	Silts and Clays (Liquid limit greater than 50)		MH	▮	Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts			
			CH	▰	Inorganic clays of high plasticity, fat clays			
			OH	≋	Organic clays of medium to high plasticity, organic silts			
	Highly Organic Soils		Pt	⁂	Peat and other highly organic soils	Von Post Classification Limit	Strong colour or odour, and often fibrous texture	

Particle Size			
Material		ASTM Sieve sizes	mm
Sand	Coarse	#10 to #4	2.00 to 4.75
	Medium	#40 to #10	0.425 to 2.00
	Fine	#200 to #40	0.075 to 0.425
Silt or Clay		< #200	< 0.075

Particle Size			
Material		ASTM Sieve Sizes	mm
Boulders		> 12 in.	> 300
Cobbles		3 in. to 12 in.	75 to 300
Gravel	Coarse	3/4 in. to 3 in.	19 to 75
	Fine	#4 to 3/4 in.	4.75 to 19

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

■	Asphalt	▧	Bedrock (undifferentiated)	○	Cobbles
⁘	Concrete	⊞	Limestone Bedrock	●	Boulders and Cobbles
▩	Fill	☰	Cemented Shale	▥	Silt Till
		▨	Non-Cemented Shale	▨	Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

⧨ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Sub-Surface Log

Test Hole TH13-01

1 of 2

Client: Dillon Consulting Ltd.

Project Name: City of Winnipeg Resource Recovery Centres

Contractor: Subterranean Ltd.

Method: 508 mm Auger, Soilmec STM-20 Truck Mount

Project Number: 0022 010 00

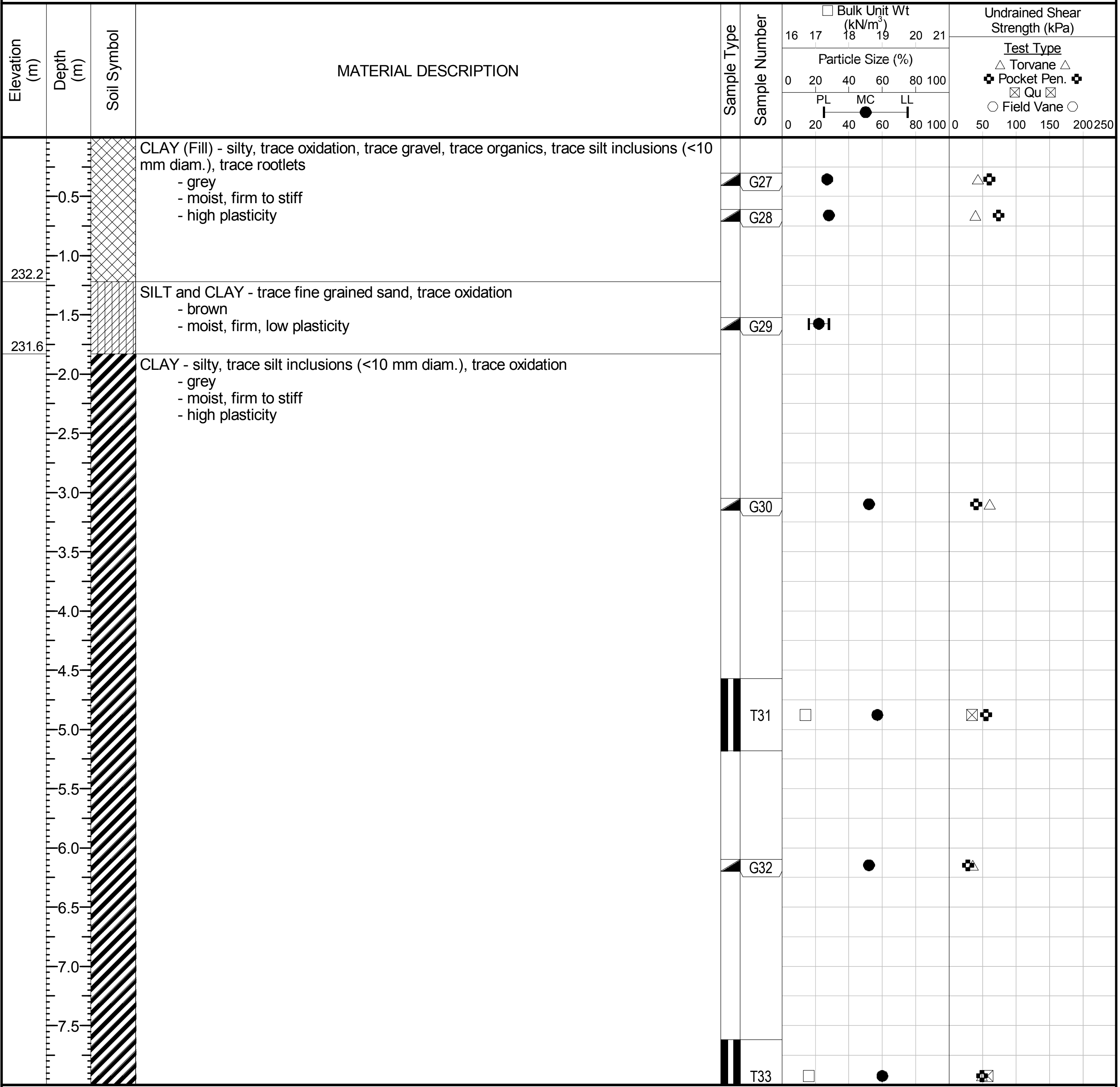
Location: UTM N-5513103, E628710 (Brady Site)

Ground Elevation: 233.40 m

Date Drilled: 22 October 2013

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▩ Fines ▨ Clay ▥ Silt ⛆ Sand ● Gravel ◌ Cobbles ⬤ Boulders



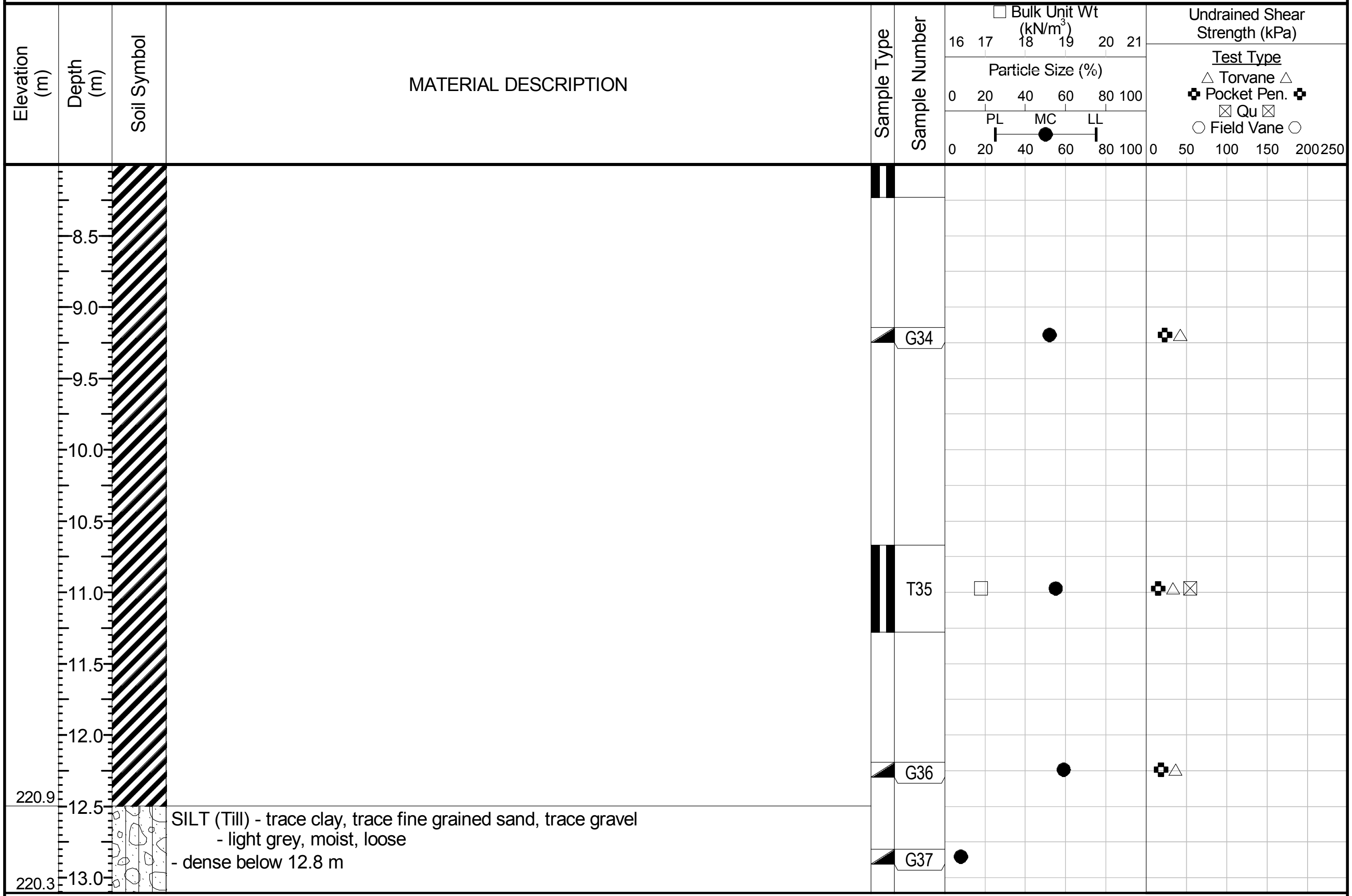
CLAY (Fill) - silty, trace oxidation, trace gravel, trace organics, trace silt inclusions (<10 mm diam.), trace rootlets
- grey
- moist, firm to stiff
- high plasticity

SILT and CLAY - trace fine grained sand, trace oxidation
- brown
- moist, firm, low plasticity

CLAY - silty, trace silt inclusions (<10 mm diam.), trace oxidation
- grey
- moist, firm to stiff
- high plasticity

Logged By: Beta Taryana **Reviewed By:** Michael Van Helden **Project Engineer:** Michael Van Helden

Sub-Surface Log



SILT (Till) - trace clay, trace fine grained sand, trace gravel
- light grey, moist, loose
- dense below 12.8 m

POWER AUGER REFUSAL AT 13.1 m in SILT (Till)
Notes:
1) No sloughing or seepage observed.
2) Test hole backfilled with auger cuttings to surface.

Logged By: Beta Taryana **Reviewed By:** Michael Van Helden **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH13-02

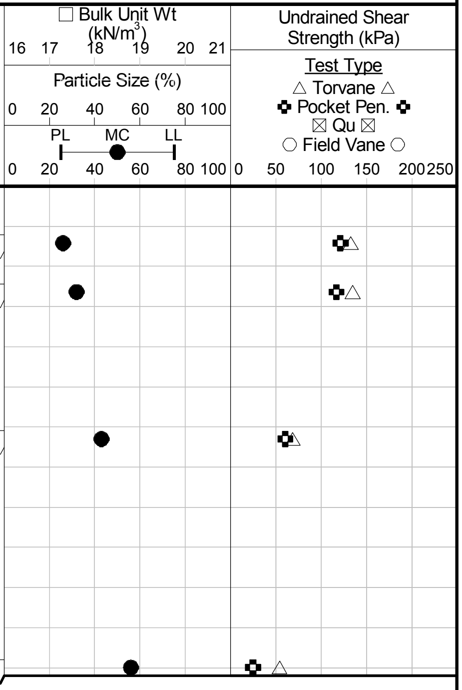
1 of 1

Client: Dillon Consulting Ltd.
Project Name: City of Winnipeg Resource Recovery Centres
Contractor: Subterranean Ltd.
Method: 508 mm Auger, Soilmec STM-20 Truck Mount
Project Number: 0022 010 00
Location: UTM N-5513097, E628758 (Brady Site)
Ground Elevation: 233.40 m
Date Drilled: 22 October 2013

Sample Type: Grab (G) Shelby Tube (T) Split Spoon (SS) Split Barrel (SB) Core (C)

Particle Size Legend: Fines Clay Silt Sand Gravel Cobbles Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
	0.5 1.0 1.5	CLAY (Fill) - silty, trace organics, trace rootlets, trace oxidation, trace gravel - dark grey - moist, stiff - high plasticity	G G G	G38 G39 G40
231.7 230.4	2.0 2.5 3.0	CLAY - silty, trace silt inclusion (<5 mm diam.), trace oxidation - grey - moist, firm - high plasticity	G	G41



END OF HOLE AT 3.0 m in CLAY
Notes:
1) No sloughing or seepage observed.
2) Test hole backfilled with auger cuttings to surface.

Logged By: Beta Taryana
Reviewed By: Michael Van Helden
Project Engineer: Michael Van Helden

Test Hole TH13-03

1 of 1

Sub-Surface Log

Client: Dillon Consulting Ltd.

Project Number: 0022 010 00

Project Name: City of Winnipeg Resource Recovery Centres

Location: UTM N-5513016, E628742 (Brady Site)

Contractor: Subterranean Ltd.

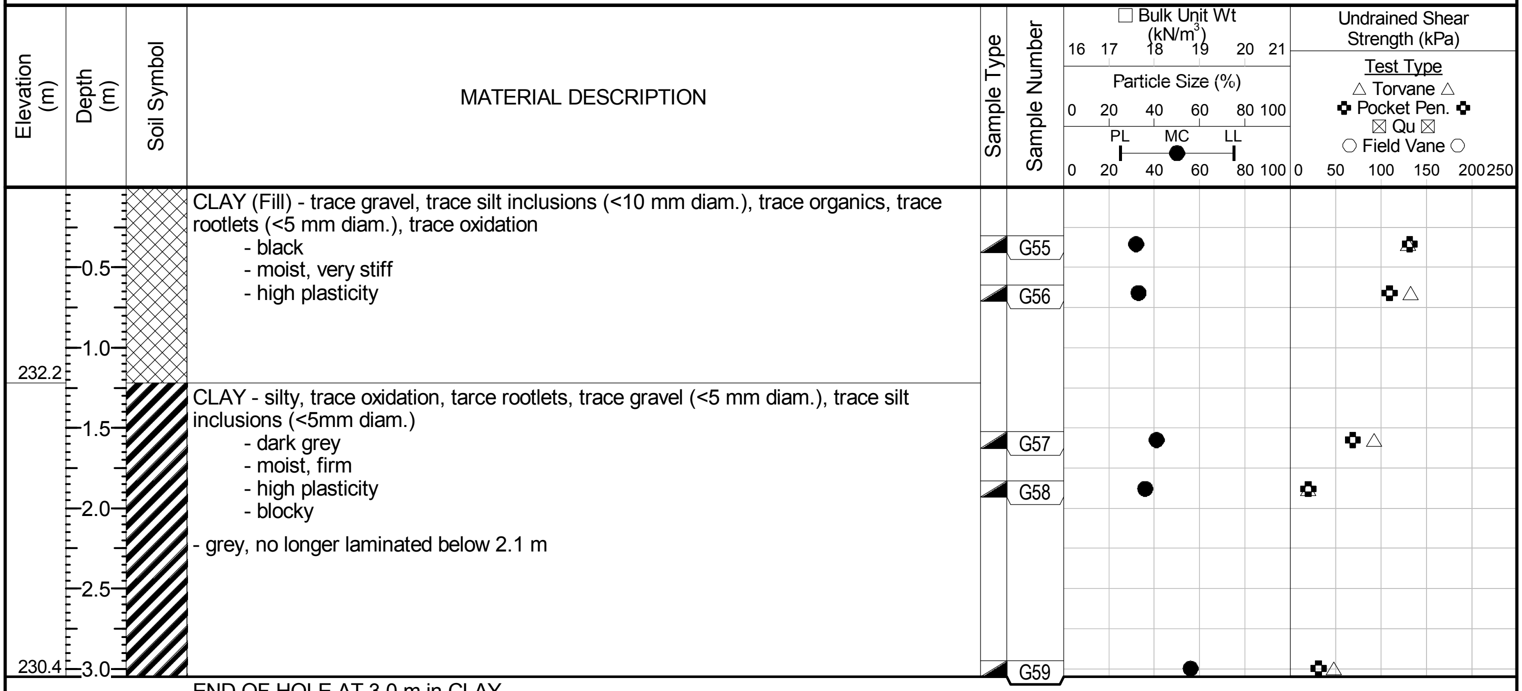
Ground Elevation: 233.40 m

Method: 508 mm Auger, Soilmec STM-20 Truck Mount

Date Drilled: 23 October 2013

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▥ Fines ▨ Clay ▥ Silt ░ Sand ● Gravel ◌ Cobbles ● Boulders



CLAY (Fill) - trace gravel, trace silt inclusions (<10 mm diam.), trace organics, trace rootlets (<5 mm diam.), trace oxidation
- black
- moist, very stiff
- high plasticity

CLAY - silty, trace oxidation, tarce rootlets, trace gravel (<5 mm diam.), trace silt inclusions (<5mm diam.)
- dark grey
- moist, firm
- high plasticity
- blocky

- grey, no longer laminated below 2.1 m

END OF HOLE AT 3.0 m in CLAY

Notes:

1) No sloughing or seepage observed.

2) Test hole backfilled with auger cuttings to surface.

Logged By: Beta Taryana

Reviewed By: Michael Van Helden

Project Engineer: Michael Van Helden

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH13-04

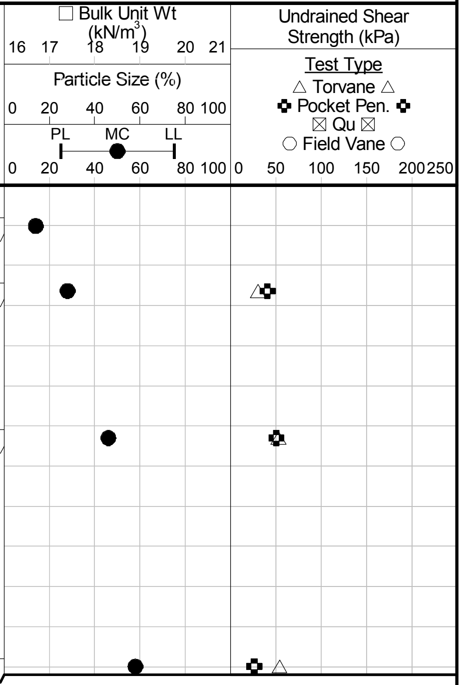
1 of 1

Client:	Dillon Consulting Ltd.	**Project Number:**	0022 010 00
Project Name:	City of Winnipeg Resource Recovery Centres	**Location:**	UTM N-5512914, E628783 (Brady Site)
Contractor:	Subterranean Ltd.	**Ground Elevation:**	233.10 m Existing Ground
Method:	508 mm Auger, Soilmec STM-20 Truck Mount	**Date Drilled:**	23 October 2013

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▨ Fines ▨ Clay ▥ Silt ⁘ Sand ● Gravel ○ Cobbles ⬛ Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
		SILT and CLAY - trace rootlets - brown, dry to moist, firm, low plasticity		
232.8		CLAY - silty, trace rootlets, trace silt inclusions (<5 mm diam.), trace organics, trace oxidation - black - moist, firm to stiff - high plasticity	◩	G46
	0.5		◩	G47
	1.0			
	1.5	- grey, no organics below 1.4 m	◩	G48
	2.0			
	2.5			
230.1	3.0		◩	G49



END OF HOLE AT 3.0 m in CLAY

Notes:

1) No sloughing or seepage observed.

2) Test hole backfilled with auger cuttings to surface.

Logged By: Beta Taryana **Reviewed By:** Michael Van Helden **Project Engineer:** Michael Van Helden

Sub-Surface Log

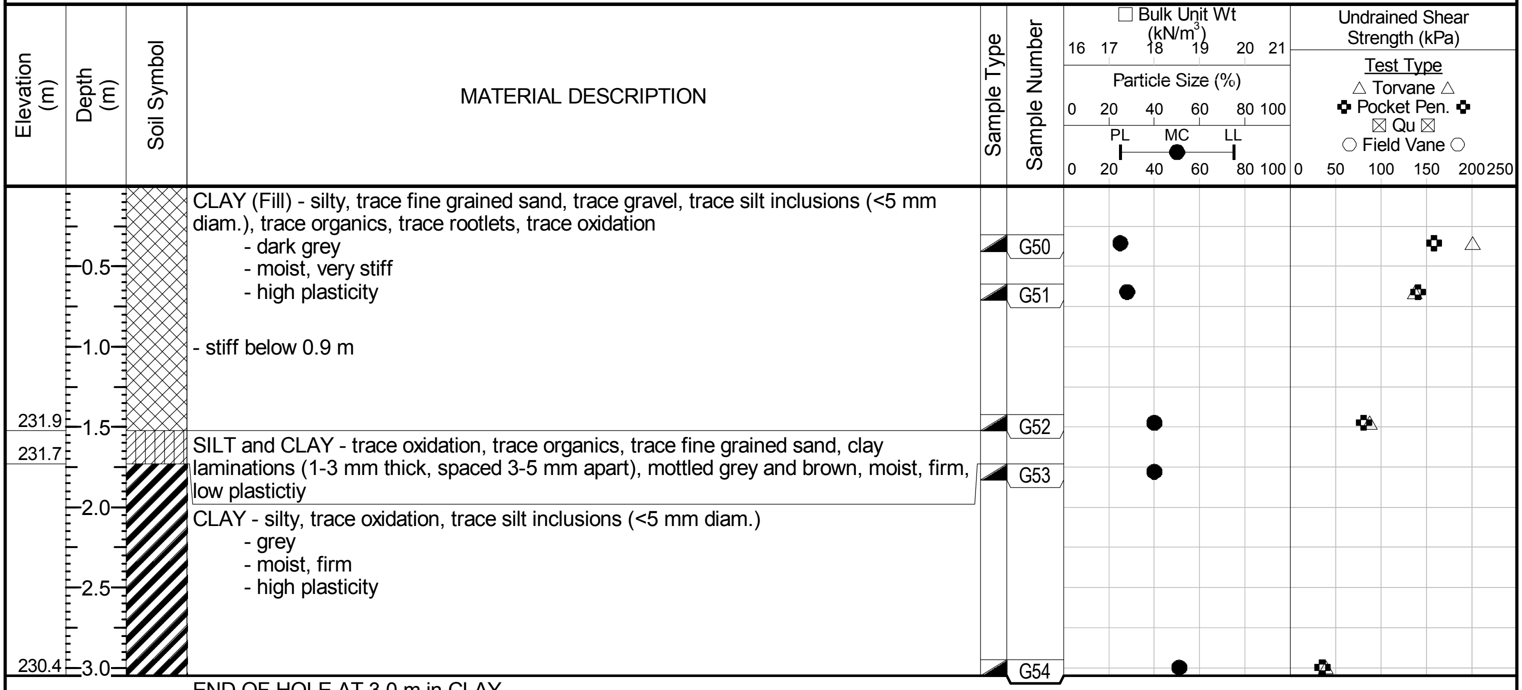
Test Hole TH13-05

1 of 1

Client: Dillon Consulting Ltd.
Project Number: 0022 010 00
Project Name: City of Winnipeg Resource Recovery Centres
Location: UTM N-5512917, E628830 (Brady Site)
Contractor: Subterranean Ltd.
Ground Elevation: 233.40 m
Method: 508 mm Auger, Soilmec STM-20 Truck Mount
Date Drilled: 23 October 2013

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▥ Fines ▨ Clay ▥ Silt ▒ Sand ▓ Gravel ▢ Cobbles ■ Boulders



CLAY (Fill) - silty, trace fine grained sand, trace gravel, trace silt inclusions (<5 mm diam.), trace organics, trace rootlets, trace oxidation
- dark grey
- moist, very stiff
- high plasticity

- stiff below 0.9 m

SILT and CLAY - trace oxidation, trace organics, trace fine grained sand, clay laminations (1-3 mm thick, spaced 3-5 mm apart), mottled grey and brown, moist, firm, low plastictiy

CLAY - silty, trace oxidation, trace silt inclusions (<5 mm diam.)
- grey
- moist, firm
- high plasticity

END OF HOLE AT 3.0 m in CLAY
Notes:
1) No sloughing or seepage observed.
2) Test hole backfilled with auger cuttings to surface.

Logged By: Beta Taryana
Reviewed By: Michael Van Helden
Project Engineer: Michael Van Helden

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH13-06

1 of 1

Client: Dillon Consulting Ltd.

Project Number: 0022 010 00

Project Name: City of Winnipeg Resource Recovery Centres

Location: UTM N-5512886, E628759 (Brady Site)

Contractor: Subterranean Ltd.

Ground Elevation: 233.40 m

Method: 508 mm Auger, Soilmec STM-20 Truck Mount

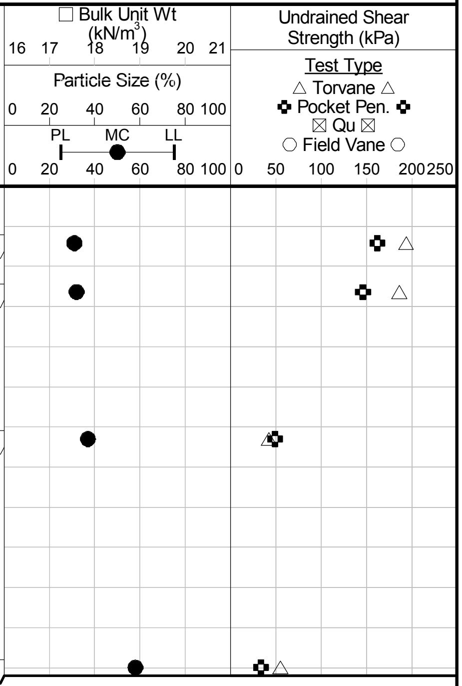
Date Drilled: 23 October 2013

Sample Type: ◢ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ◨ Core (C)

Particle Size Legend: ▥ Fines ▨ Clay ▥ Silt ░ Sand ▚ Gravel ▱ Cobbles ▚ Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		☒	CLAY (Fill) - silty, trace silt inclusions (<5 mm diam.), trace rootlets - grey - moist, very stiff - high plasticity	◢ ◢	G42 G43
232.0		▨	CLAY - silty, trace silt inclusions (<5mm diam.), trace rootlets, silt laminations (1-3 mm thick, spaced 3-5 mm apart), trace oxidation - mottled grey and brown - moist, firm to stiff, high plasticity - grey, no longer laminated below 1.7 m	◢	G44
230.4	3.0			◢	G45

Depth scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0



END OF HOLE AT 3.0 m in CLAY

Notes:

1) No sloughing or seepage observed.

2) Test hole backfilled with auger cuttings to surface.

Logged By: Beta Taryana **Reviewed By:** Michael Van Helden **Project Engineer:** Michael Van Helden

TREK GEOTECHNICAL

Sub-Surface Log

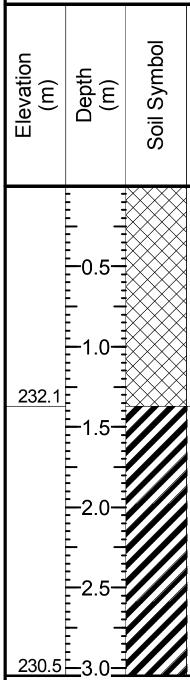
Test Hole TH13-07

1 of 1

Client: Dillon Consulting Ltd.
Project Number: 0022 010 00
Project Name: City of Winnipeg Resource Recovery Centres
Location: UTM N-5512862, E628693 (Brady Site)
Contractor: Subterranean Ltd.
Ground Elevation: 233.50 m
Method: 508 mm Auger, Soilmec STM-20 Truck Mount
Date Drilled: 23 October 2013

Sample Type: ◩ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ░ Sand ▣ Gravel ▢ Cobbles ■ Boulders



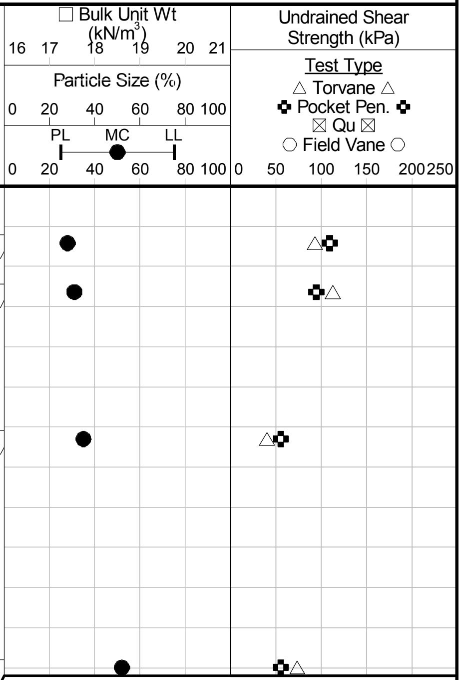
MATERIAL DESCRIPTION

CLAY (Fill) - silty, trace silt inclusions (<5 mm diam.), trace rootlets, trace organics, trace oxidation
- grey
- moist, stiff
- high plasticity

CLAY - silty, trace oxidation, trace silt inclusions (<10 mm diam.), trace rootlets, silt laminations (1-3 mm thick, spaced 2-5 mm apart)
- mottled grey and brown
- moist, firm, high plasticity

- grey, no longer laminated below 1.7 m

Sample Type	Sample Number
◩	G60
◩	G61
◩	G62
◩	G63



END OF HOLE AT 3.0 m in CLAY
Notes:
1) No sloughing or seepage observed.
2) Test hole backfilled with auger cuttings to surface.

Logged By: Beta Taryana
Reviewed By: Michael Van Helden
Project Engineer: Michael Van Helden

Sub-Surface Log

Test Hole TH13-08

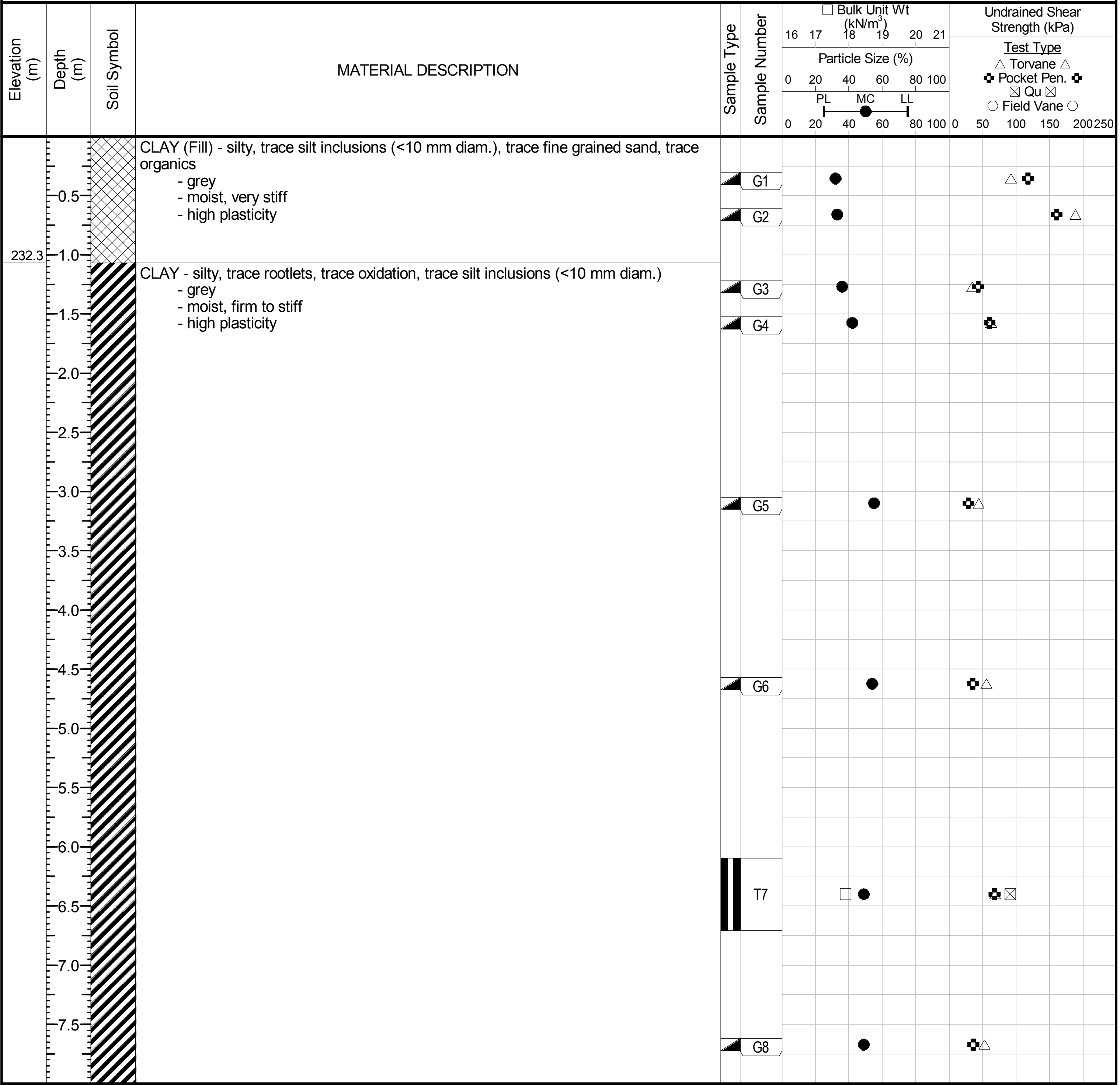
1 of 2

Client: Dillon Consulting Ltd.
Project Name: City of Winnipeg Resource Recovery Centres
Contractor: Subterranean Ltd.
Method: 508 mm Auger, Soilmec STM-20 Truck Mount

Project Number: 0022 010 00
Location: UTM N-5512927, E628712 (Brady Site)
Ground Elevation: 233.40 m
Date Drilled: 22 October 2013

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

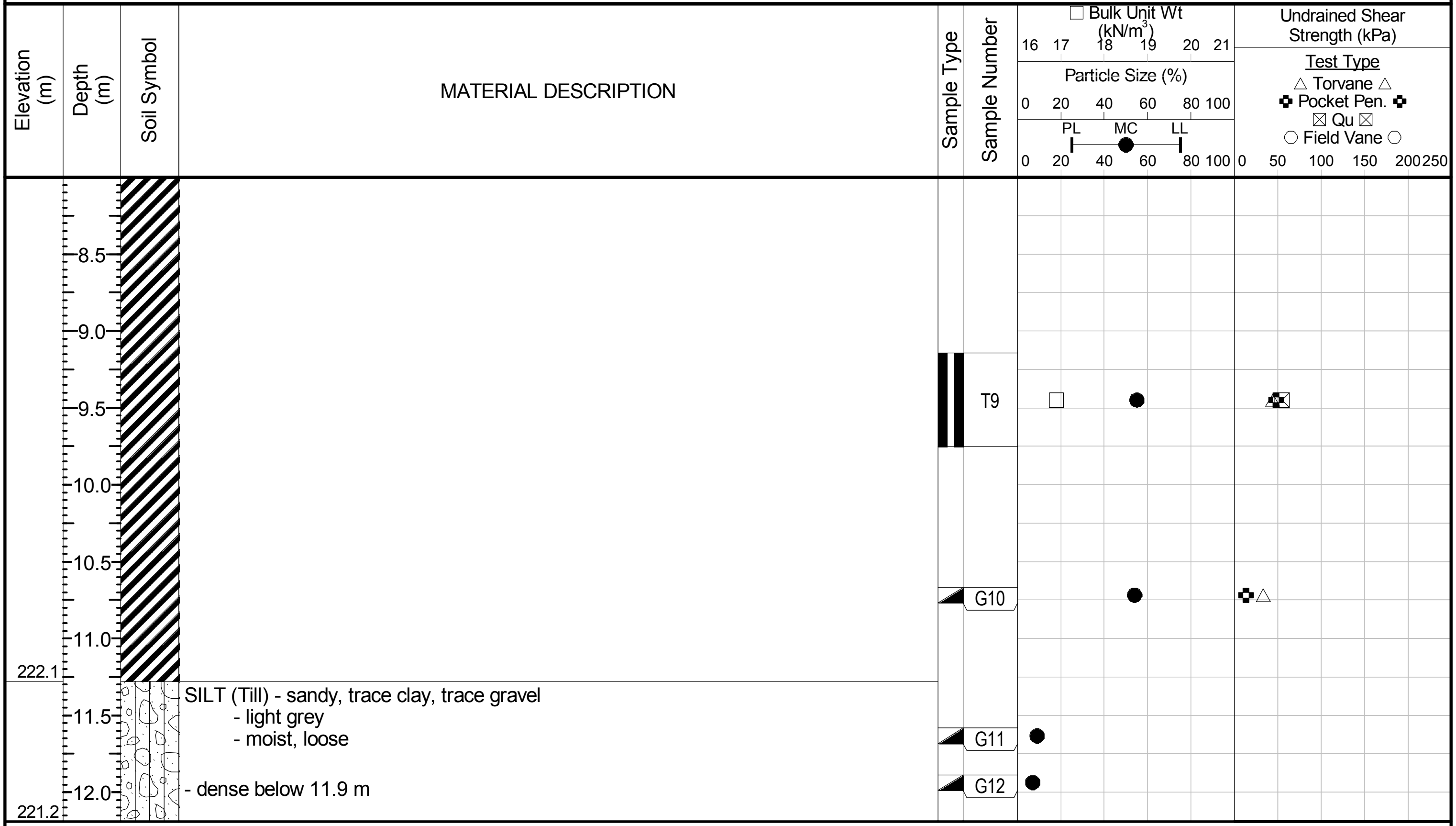


CLAY (Fill) - silty, trace silt inclusions (<10 mm diam.), trace fine grained sand, trace organics
- grey
- moist, very stiff
- high plasticity

CLAY - silty, trace rootlets, trace oxidation, trace silt inclusions (<10 mm diam.)
- grey
- moist, firm to stiff
- high plasticity

Logged By: Beta Taryana
Reviewed By: Michael Van Helden
Project Engineer: Michael Van Helden

Sub-Surface Log



SILT (Till) - sandy, trace clay, trace gravel
- light grey
- moist, loose

- dense below 11.9 m

POWER AUGER REFUSAL AT 12.1 m in CLAY (Till)
Notes:
1) No sloughing or seepage observed.
2) Test hole backfilled with auger cuttings to surface.

Logged By: Beta Taryana **Reviewed By:** Michael Van Helden **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH13-09

1 of 1

Client: Dillon Consulting Ltd.

Project Number: 0022 010 00

Project Name: City of Winnipeg Resource Recovery Centres

Location: UTM N-5512994, E628678 (Brady Site)

Contractor: Subterranean Ltd.

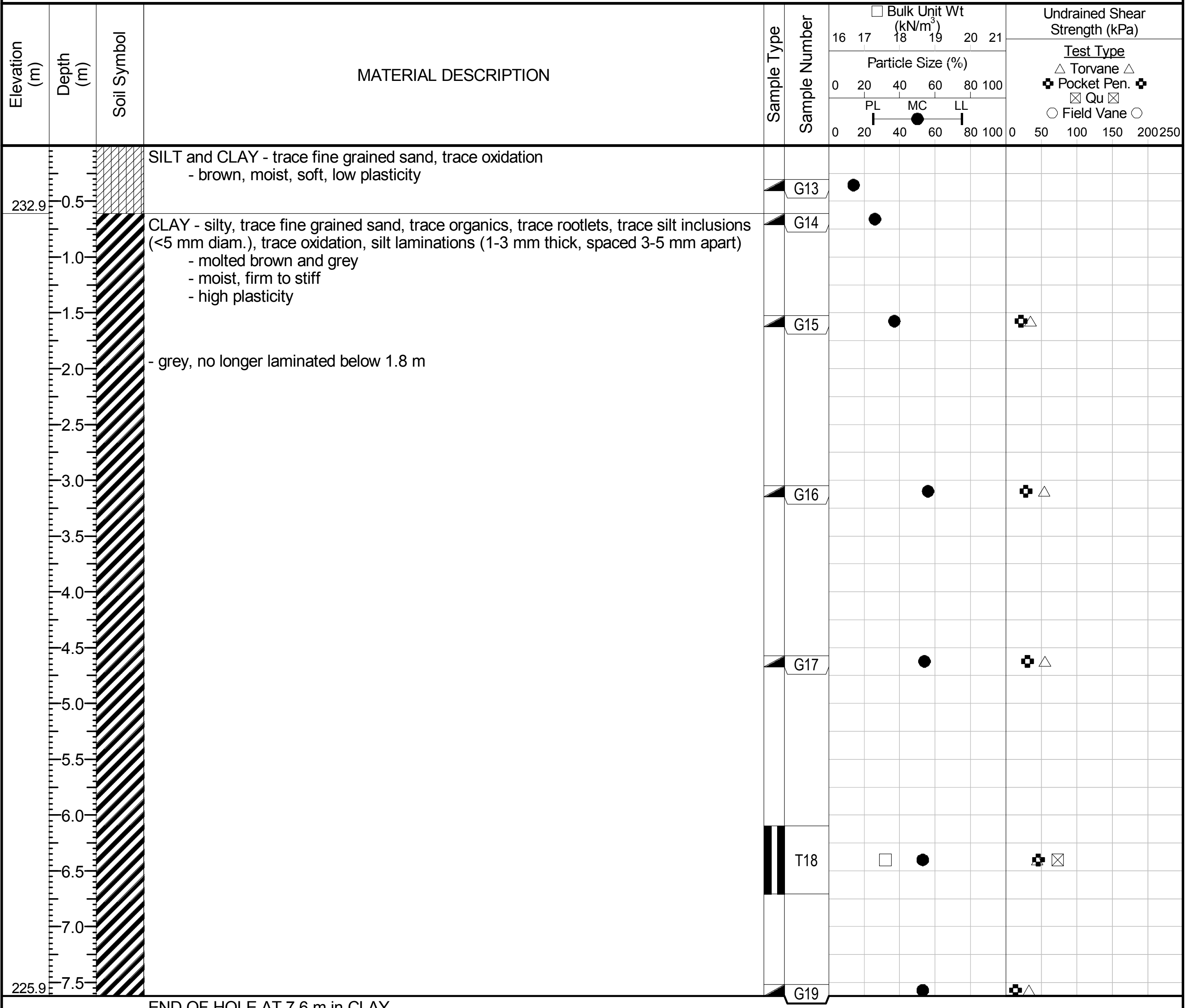
Ground Elevation: 233.50 m

Method: 508 mm Auger, Soilmec STM-20 Truck Mount

Date Drilled: 22 October 2013

Sample Type: ◪ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ◧ Core (C)

Particle Size Legend: ▨ Fines ▨ Clay ▥ Silt ░ Sand ▦ Gravel ▦ Cobbles ■ Boulders



SILT and CLAY - trace fine grained sand, trace oxidation
- brown, moist, soft, low plasticity

CLAY - silty, trace fine grained sand, trace organics, trace rootlets, trace silt inclusions (<5 mm diam.), trace oxidation, silt laminations (1-3 mm thick, spaced 3-5 mm apart)
- molted brown and grey
- moist, firm to stiff
- high plasticity

- grey, no longer laminated below 1.8 m

END OF HOLE AT 7.6 m in CLAY

Notes:

1) No sloughing or seepage observed.

2) Test hole backfilled with auger cuttings to surface.

Logged By: Beta Taryana

Reviewed By: Michael Van Helden

Project Engineer: Michael Van Helden

TREK GEOTECHNICAL

Sub-Surface Log

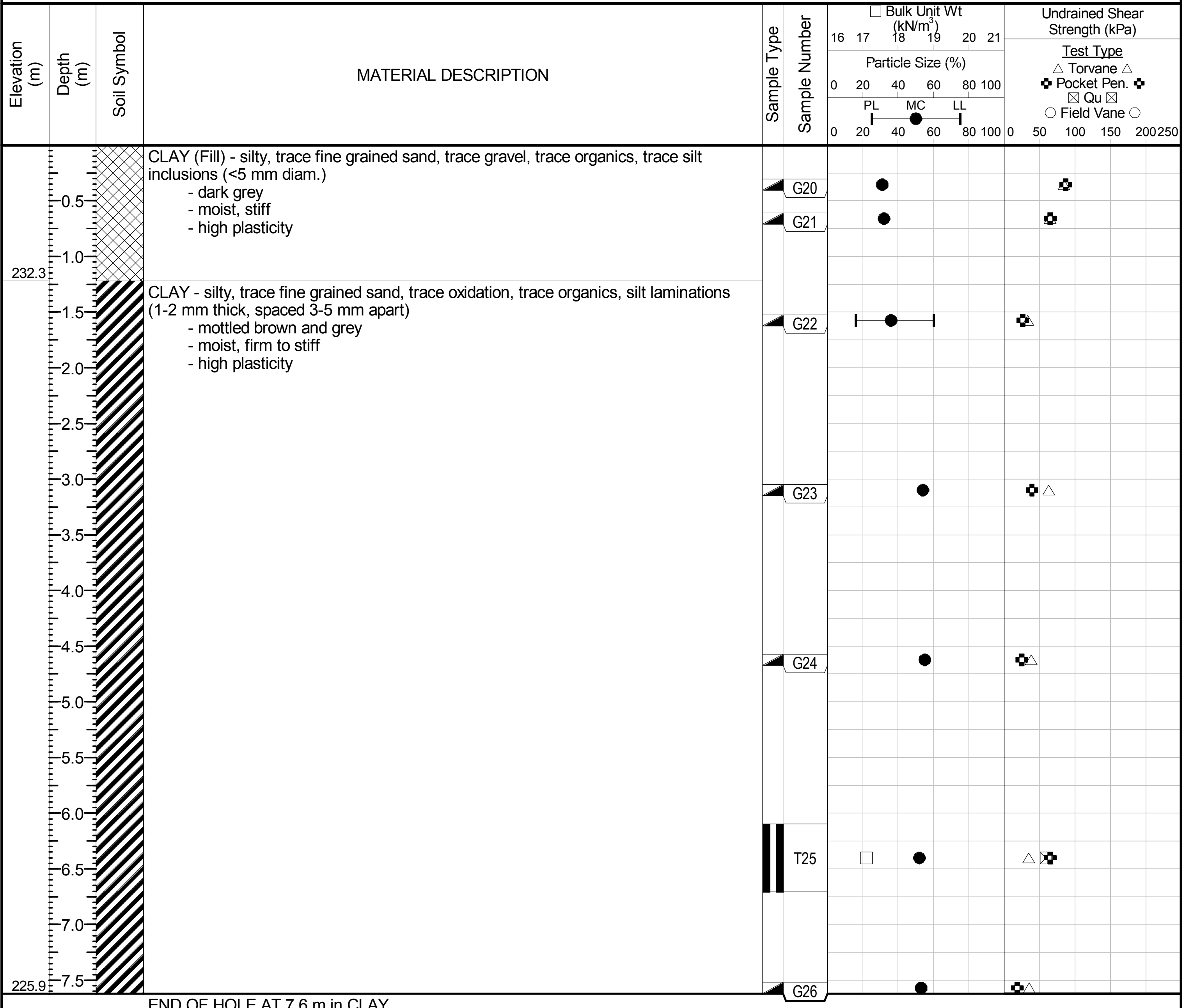
Test Hole TH13-10

1 of 1

Client: Dillon Consulting Ltd.
Project Number: 0022 010 00
Project Name: City of Winnipeg Resource Recovery Centres
Location: UTM N-5513056, E628688 (Brady Site)
Contractor: Subterranean Ltd.
Ground Elevation: 233.50 m Existing Ground
Method: 508 mm Auger, Soilmec STM-20 Truck Mount
Date Drilled: 22 October 2013

Sample Type: ◣ Grab (G) ▮ Shelby Tube (T) ☒ Split Spoon (SS) ⧗ Split Barrel (SB) ▯ Core (C)

Particle Size Legend: ▦ Fines ▨ Clay ▥ Silt ⁘ Sand Gravel Cobbles Boulders



CLAY (Fill) - silty, trace fine grained sand, trace gravel, trace organics, trace silt inclusions (<5 mm diam.)
- dark grey
- moist, stiff
- high plasticity

CLAY - silty, trace fine grained sand, trace oxidation, trace organics, silt laminations (1-2 mm thick, spaced 3-5 mm apart)
- mottled brown and grey
- moist, firm to stiff
- high plasticity

END OF HOLE AT 7.6 m in CLAY
Notes:
1) No sloughing or seepage observed.
2) Test hole backfilled with auger cuttings to surface.

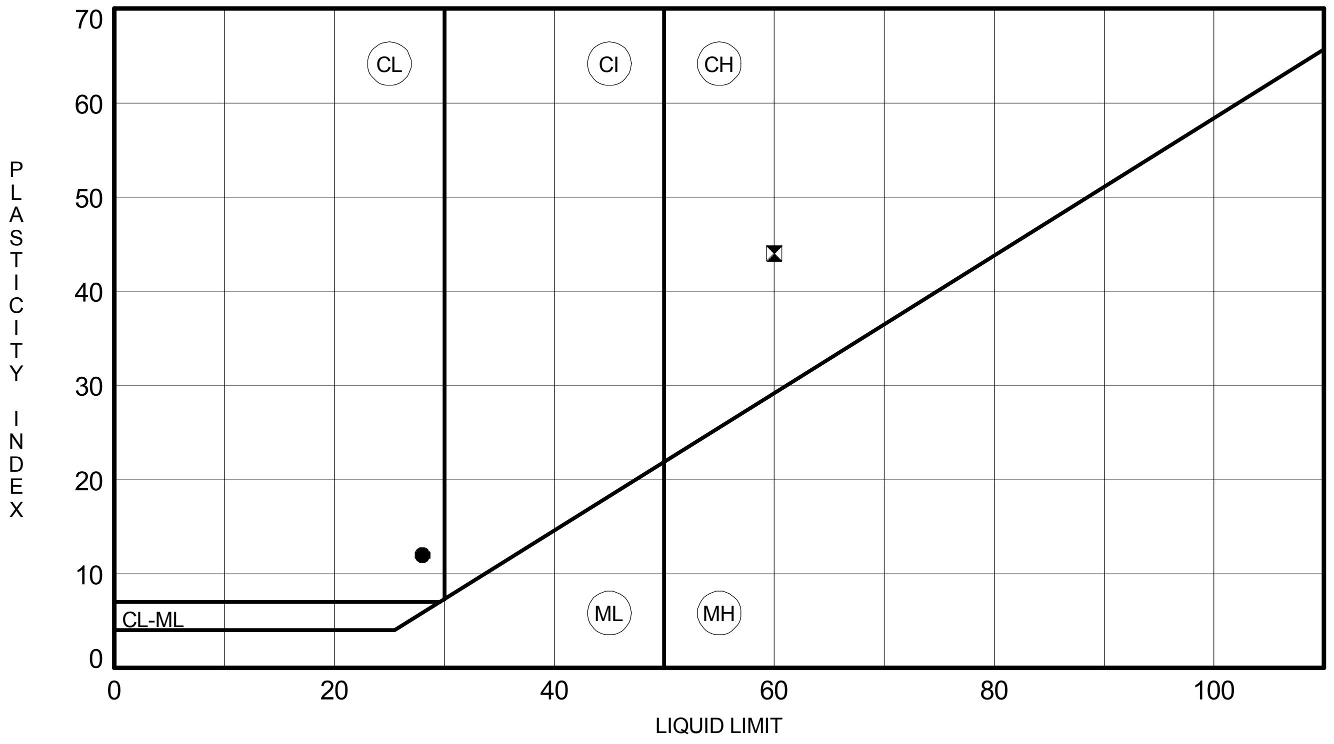
Logged By: Beta Taryana
Reviewed By: Michael Van Helden
Project Engineer: Michael Van Helden

Appendix C

Laboratory Testing Results

A-LINE PLASTICITY CHART

CLIENT Dillon Consulting Ltd.
PROJECT NAME City of Winnipeg Resource Recovery Centres
PROJECT NUMBER 0022 010 00
PROJECT LOCATION Brady Road



TEST HOLE No.	Sample	Depth (m)	LL	PL	PI	Fines	Classification
● **TH13-01**	**G29**	**1.5 - 1.6**	**28**	**16**	**12**		
⧗ **TH13-10**	**G22**	**1.5 - 1.6**	**60**	**16**	**44**		

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Shelby Tube Visual

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole	TH13-01
Sample #	T31
Depth (m)	4.6 - 5.2
Sample Date	23-Oct-13
Test Date	28-Oct-13
Technician	Hachem Ahmed

Tube Extraction

Recovery (mm) 585

Bottom - 4.6 m **5.2 m - Top**

PP Tv	Moisture Visual		Qu γ_{Bulk}
105 mm	105 mm	180mm	195 mm

Visual Classification

Material	Silty clay
Composition	trace silt inclusions <10mm dia.
trace oxidation	
Color	dark grey
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.13
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	12.3

Pocket Penetrometer

Reading	**1**	1.15
	2	1.20
	3	1.00
	Average	1.12
Undrained Shear Strength (kPa)		54.8

Moisture Content

Tare ID	H80
Mass tare (g)	8.4
Mass wet + tare (g)	346
Mass dry + tare (g)	224
Moisture %	56.6%

Unit Weight

Bulk Weight (g)		969.30
Length (mm)	**1**	140.66
	2	140.60
	3	140.62
	4	140.41
Average Length (m)		0.141
Diam. (mm)	**1**	71.64
	2	71.95
	3	72.09
	4	71.57
Average Diameter (m)		0.072
Volume (m^3)		5.69E-04
Bulk Unit Weight (kN/m^3)		16.7
Bulk Unit Weight (pcf)		106.3
Dry Unit Weight (kN/m^3)		10.7
Dry Unit Weight (pcf)		67.9

Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole TH13-01
Sample # T31
Depth (m) 4.6 - 5.2
Sample Date 23-Oct-13
Test Date 28-Oct-13
Technician Hachem Ahmed

Unconfined Strength

	kPa	ksf
Max q_u	68.2	1.4
Max S_u	34.1	0.7

Specimen Data

Description Silty clay - trace silt inclusions <10mm dia., trace oxidation, dark grey, moist, firm to stiff, high plasticity

Length	140.6	(mm)
Diameter	71.8	(mm)
L/D Ratio	2.0	
Initial Area	0.00405	(m^2)
Load Rate	1.00	(%/min)

Moisture %	57%	
Bulk Unit Wt.	16.7	(kN/m^3)
Dry Unit Wt.	10.7	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.13	12.3	0.26
Vane Size		
m		

Pocket Penetrometer

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
1.15	56.4	1.18
1.20	58.9	1.23
1.00	49.1	1.02
1.12	**54.8**	**1.14**

Failure Geometry

Sketch:

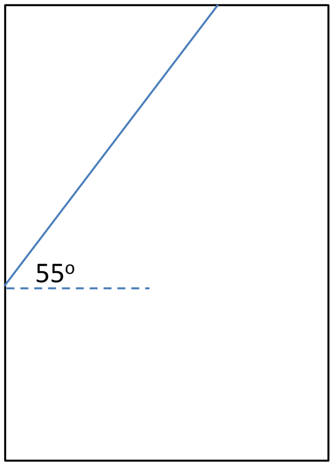


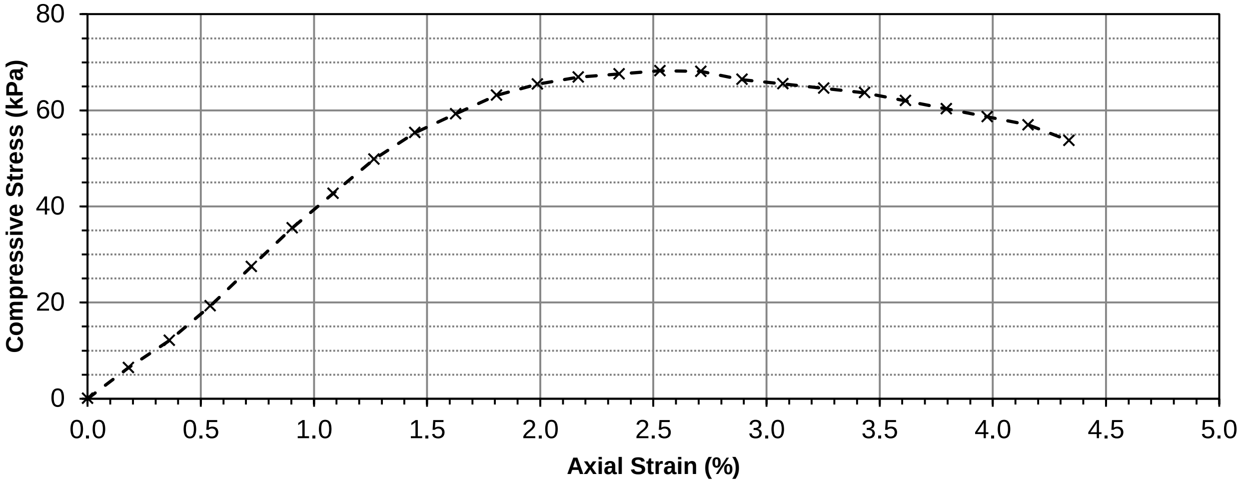
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004050	0.0	0.00	0.00
10	8	0.2540	0.18	0.004058	26.2	6.45	3.22
20	15	0.5080	0.36	0.004065	49.1	12.08	6.04
30	24	0.7620	0.54	0.004072	78.6	19.31	9.65
40	34	1.0160	0.72	0.004080	112.1	27.48	13.74
50	44	1.2700	0.90	0.004087	145.1	35.49	17.74
60	53	1.5240	1.08	0.004095	174.7	42.67	21.34
70	62	1.7780	1.26	0.004102	204.4	49.83	24.91
80	69	2.0320	1.45	0.004110	227.5	55.35	27.68
90	74	2.2860	1.63	0.004117	244.0	59.26	29.63
100	79	2.5400	1.81	0.004125	260.4	63.14	31.57
110	82	2.7940	1.99	0.004132	270.4	65.42	32.71
120	84	3.0480	2.17	0.004140	276.9	66.89	33.45
130	85	3.3020	2.35	0.004148	280.2	67.56	33.78
140	86	3.5560	2.53	0.004155	283.5	68.23	34.12
150	86	3.8100	2.71	0.004163	283.5	68.10	34.05
160	84	4.0640	2.89	0.004171	276.9	66.40	33.20
170	83	4.3180	3.07	0.004179	273.7	65.49	32.74
180	82	4.5720	3.25	0.004186	270.4	64.58	32.29
190	81	4.8260	3.43	0.004194	267.1	63.67	31.84
200	79	5.0800	3.61	0.004202	260.4	61.98	30.99
210	77	5.3340	3.79	0.004210	253.9	60.30	30.15
220	75	5.5880	3.98	0.004218	247.3	58.62	29.31
230	73	5.8420	4.16	0.004226	240.7	56.96	28.48

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Data (cont'd)

Elapsed Time (s)	Axial Disp. (mm)	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	69	6.0960	4.3366	0.004234	227.5	53.73	26.86

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Shelby Tube Visual

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole	TH13-01
Sample #	T33
Depth (m)	7.6 - 8.2
Sample Date	23-Oct-13
Test Date	7-Nov-13
Technician	Hachem Ahmed

Tube Extraction

Recovery (mm) 570

Bottom - 8.2 m **7.6 m - Top**

PP Tv Visual Moisture		Qu γ_{Bulk}	
100 mm	220 mm	160 mm	190 mm

Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions <10mm diam.

Color	dark grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.50
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	49.0

Pocket Penetrometer

Reading	**1**	1.00
	2	0.90
	3	1.10
	Average	1.00
Undrained Shear Strength (kPa)		49.0

Moisture Content

Tare ID	C30
Mass tare (g)	8.4
Mass wet + tare (g)	395
Mass dry + tare (g)	250.4
Moisture %	59.8%

Unit Weight

Bulk Weight (g)		1062.50
Length (mm)	**1**	151.58
	2	151.50
	3	151.40
	4	151.24
Average Length (m)		0.151
Diam. (mm)	**1**	72.07
	2	72.63
	3	72.27
	4	72.13
Average Diameter (m)		0.072
Volume (m^3)		6.21E-04
Bulk Unit Weight (kN/m^3)		16.8
Bulk Unit Weight (pcf)		106.8
Dry Unit Weight (kN/m^3)		10.5
Dry Unit Weight (pcf)		66.8

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole	TH13-01
Sample #	T33
Depth (m)	7.6 - 8.2
Sample Date	23-Oct-13
Test Date	7-Nov-13
Technician	Hachem Ahmed

Unconfined Strength

	kPa	ksf
Max q_u	114.4	2.4
Max S_u	57.2	1.2

Specimen Data

Description CLAY - silty, trace silt inclusions <10mm diam., dark grey, moist, stiff, high plasticity

Length	151.4	(mm)	**Moisture %**	60%	
Diameter	72.3	(mm)	**Bulk Unit Wt.**	16.8	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	10.5	(kN/m^3)
Initial Area	0.00410	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.50	49.0	1.02
Vane Size		
m		

Pocket Penetrometer

Reading	Undrained Shear Strength	
tsf	kPa	ksf
1.00	49.1	1.02
0.90	44.1	0.92
1.10	54.0	1.13
1.00	**49.1**	**1.02**

Failure Geometry

Sketch:

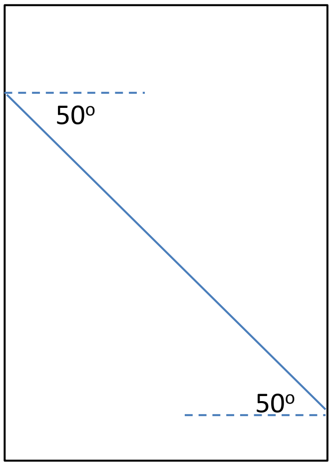


Photo:

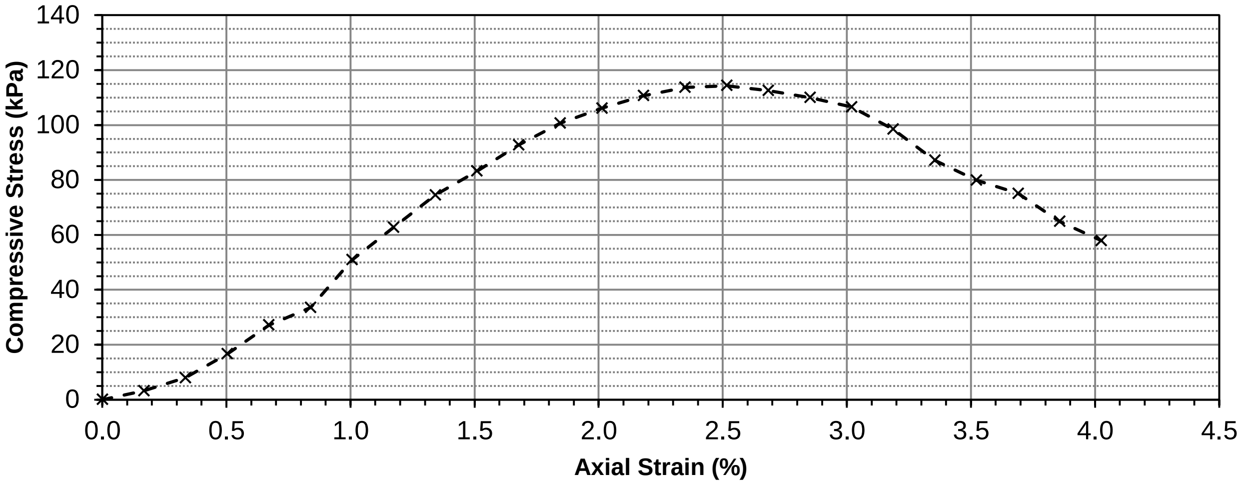

TREK GEOTECHNICAL
Project 0022 010 00
Location C.O.W. Resource Recovery Centres
Hole No. TH13-01 Sample No. T33
Depth 25'-27' Date Oct 23, 2013
Technician HA

Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004103	0.0	0.00	0.00
10	4	0.2540	0.17	0.004110	13.1	3.18	1.59
20	10	0.5080	0.34	0.004116	32.7	7.95	3.97
30	21	0.7620	0.50	0.004123	68.8	16.68	8.34
40	34	1.0160	0.67	0.004130	112.1	27.14	13.57
50	42	1.2700	0.84	0.004137	138.5	33.47	16.73
60	64	1.5240	1.01	0.004144	211.0	50.92	25.46
70	79	1.7780	1.17	0.004151	260.4	62.74	31.37
80	94	2.0320	1.34	0.004158	309.9	74.52	37.26
90	105	2.2860	1.51	0.004166	346.6	83.20	41.60
100	117	2.5400	1.68	0.004173	387.0	92.73	46.37
110	127	2.7940	1.85	0.004180	420.6	100.63	50.32
120	134	3.0480	2.01	0.004187	444.2	106.09	53.05
130	140	3.3020	2.18	0.004194	464.4	110.73	55.36
140	144	3.5560	2.35	0.004201	477.9	113.74	56.87
150	145	3.8100	2.52	0.004209	481.3	114.35	57.18
160	143	4.0640	2.68	0.004216	474.5	112.56	56.28
170	140	4.3180	2.85	0.004223	464.4	109.97	54.98
180	136	4.5720	3.02	0.004230	451.0	106.60	53.30
190	126	4.8260	3.19	0.004238	417.2	98.46	49.23
200	112	5.0800	3.35	0.004245	370.1	87.19	43.60
210	103	5.3340	3.52	0.004252	339.8	79.91	39.95
220	97	5.5880	3.69	0.004260	319.8	75.08	37.54
230	84	5.8420	3.86	0.004267	276.9	64.90	32.45

Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Data (cont'd)

Elapsed Time (s)	Axial Disp. (mm)	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	75	6.0960	4.0256	0.004275	247.3	57.85	28.92

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Shelby Tube Visual

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole	TH13-01
Sample #	T35
Depth (m)	10.7 - 11.3
Sample Date	23-Oct-13
Test Date	28-Oct-13
Technician	Chiran Peiris

Tube Extraction

Recovery (mm) 630

Bottom - 11.3 **10.7 m - Top**

PP Tv		Qu γ_{Bulk}	Moisture Visual
100 mm	185 mm	185 mm	160 mm

Visual Classification

Material	CLAY
Composition	Silty
trace sand	
trace oxidation	
Color	dark grey
Moisture	moist
Consistency	soft to firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.34
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	33.3

Pocket Penetrometer

Reading	**1**	0.25
	2	0.34
	3	0.30
	Average	0.30
Undrained Shear Strength (kPa)		14.5

Moisture Content

Tare ID	A13
Mass tare (g)	8.4
Mass wet + tare (g)	382.3
Mass dry + tare (g)	250.2
Moisture %	54.6%

Unit Weight

Bulk Weight (g)		1059.50
Length (mm)	**1**	152.24
	2	152.14
	3	152.09
	4	152.25
Average Length (m)		0.152
Diam. (mm)	**1**	71.76
	2	71.67
	3	71.86
	4	71.89
Average Diameter (m)		0.072
Volume (m^3)		6.16E-04
Bulk Unit Weight (kN/m^3)		16.9
Bulk Unit Weight (pcf)		107.4
Dry Unit Weight (kN/m^3)		10.9
Dry Unit Weight (pcf)		69.4

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole	TH13-01
Sample #	T35
Depth (m)	10.7 - 11.3
Sample Date	23-Oct-13
Test Date	28-Oct-13
Technician	Chiran Peiris

Unconfined Strength

	kPa	**ksf**
Max q_u	109.0	2.3
Max S_u	54.5	1.1

Specimen Data

Description CLAY - Silty, trace sand, trace oxidation, dark grey, moist, soft to firm, high plasticity

Length	152.2	(mm)	**Moisture %**	55%	
Diameter	71.8	(mm)	**Bulk Unit Wt.**	16.9	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	10.9	(kN/m^3)
Initial Area	0.00405	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.34	33.3	0.70
Vane Size		
m		

Pocket Penetrometer

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.25	12.3	0.26
0.34	16.7	0.35
0.30	14.7	0.31
0.30	**14.6**	**0.30**

Failure Geometry

Sketch:

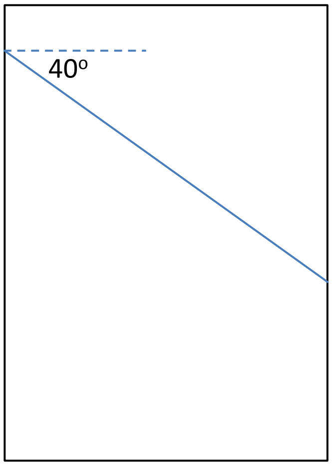

Photo:

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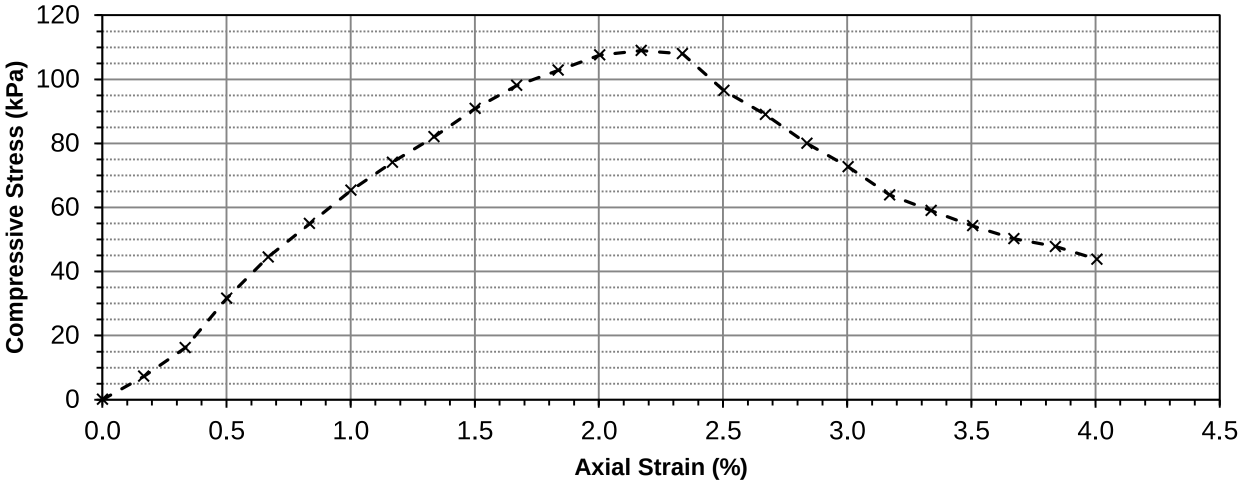
Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004048	0.0	0.00	0.00
10	9	0.2540	0.17	0.004055	29.4	7.26	3.63
20	20	0.5080	0.33	0.004062	65.5	16.12	8.06
30	39	0.7620	0.50	0.004069	128.6	31.61	15.80
40	55	1.0160	0.67	0.004076	181.4	44.50	22.25
50	68	1.2700	0.83	0.004082	224.2	54.92	27.46
60	81	1.5240	1.00	0.004089	267.1	65.31	32.65
70	92	1.7780	1.17	0.004096	303.3	74.05	37.02
80	102	2.0320	1.34	0.004103	336.4	81.99	41.00
90	113	2.2860	1.50	0.004110	373.5	90.87	45.43
100	122	2.5400	1.67	0.004117	403.8	98.08	49.04
110	128	2.7940	1.84	0.004124	424.0	102.81	51.41
120	134	3.0480	2.00	0.004131	444.2	107.53	53.76
130	136	3.3020	2.17	0.004138	451.0	108.98	54.49
140	135	3.5560	2.34	0.004145	447.6	107.98	53.99
150	121	3.8100	2.50	0.004152	400.4	96.44	48.22
160	112	4.0640	2.67	0.004159	370.1	88.99	44.49
170	101	4.3180	2.84	0.004167	333.1	79.94	39.97
180	92	4.5720	3.00	0.004174	303.3	72.67	36.34
190	81	4.8260	3.17	0.004181	267.1	63.88	31.94
200	75	5.0800	3.34	0.004188	247.3	59.04	29.52
210	69	5.3340	3.51	0.004195	227.5	54.22	27.11
220	64	5.5880	3.67	0.004203	211.0	50.21	25.11
230	61	5.8420	3.84	0.004210	201.1	47.77	23.88

Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Data (cont'd)

Elapsed Time (s)	Axial Disp. (mm)	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	56	6.0960	4.0058	0.004217	184.6	43.78	21.89
250	46	6.3500	4.17	0.004225	151.7	35.90	17.95
260	40	6.6040	4.34	0.004232	131.9	31.16	15.58
270	36	6.8580	4.51	0.004239	118.7	27.99	14.00
280	32	7.1120	4.67	0.004247	105.5	24.84	12.42
290	30	7.3660	4.84	0.004254	98.9	23.25	11.63

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Shelby Tube Visual

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole	TH13-08
Sample #	T07
Depth (m)	6.1 - 6.7
Sample Date	23-Oct-13
Test Date	6-Nov-13
Technician	Hachem Ahmed

Tube Extraction

Recovery (mm) 690

Visual Classification

Material	CLAY
Composition	silty
trace silt incluisons < 5mm diam.	
trace oxidation	
Color	brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	blocky
Gradation	-

Torvane

Reading	0.70
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	68.7

Pocket Penetrometer

Reading	**1**	1.40
	2	1.35
	3	1.40
	Average	1.38
Undrained Shear Strength (kPa)		67.8

Moisture Content

Tare ID	E106
Mass tare (g)	8.5
Mass wet + tare (g)	459.5
Mass dry + tare (g)	311.5
Moisture %	48.8%

Unit Weight

Bulk Weight (g)		1098.00
Length (mm)	**1**	147.67
	2	147.58
	3	147.44
	4	147.44
Average Length (m)		0.148
Diam. (mm)	**1**	71.99
	2	72.11
	3	72.14
	4	71.74
Average Diameter (m)		0.072
Volume (m^3)		6.01E-04
Bulk Unit Weight (kN/m^3)		17.9
Bulk Unit Weight (pcf)		114.1
Dry Unit Weight (kN/m^3)		12.0
Dry Unit Weight (pcf)		76.7

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole	TH13-08
Sample #	T07
Depth (m)	6.1 - 6.7
Sample Date	23-Oct-13
Test Date	6-Nov-13
Technician	Hachem Ahmed

Unconfined Strength

	kPa	ksf
Max q_u	182.5	3.8
Max S_u	91.3	1.9

Specimen Data

Description CLAY - silty, trace silt incluisons < 5mm diam., trace oxidation, brown, moist, stiff, high plasticity, blocky

Length	147.5	(mm)
Diameter	72.0	(mm)
L/D Ratio	2.0	
Initial Area	0.00407	(m^2)
Load Rate	1.00	(%/min)

Moisture %	49%	
Bulk Unit Wt.	17.9	(kN/m^3)
Dry Unit Wt.	12.0	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.70	68.7	1.43
Vane Size		
m		

Pocket Penetrometer

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
1.40	68.7	1.43
1.35	66.2	1.38
1.40	68.7	1.43
1.38	**67.9**	**1.42**

Failure Geometry

Sketch:

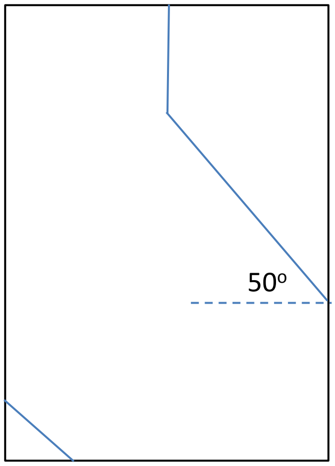


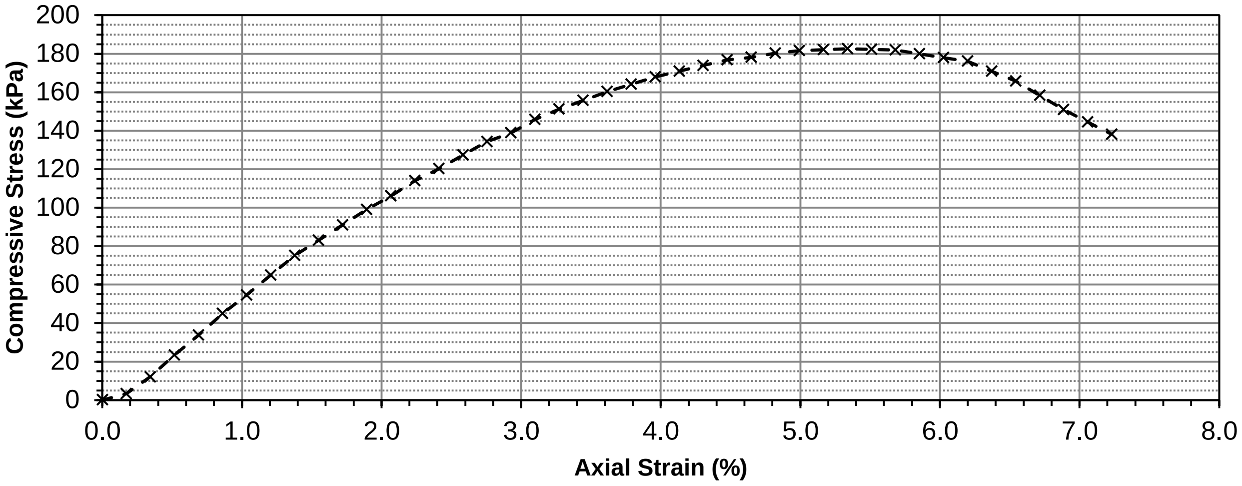
Photo:

Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004071	0.0	0.00	0.00
10	4	0.2540	0.17	0.004078	13.1	3.21	1.60
20	15	0.5080	0.34	0.004085	49.1	12.02	6.01
30	29	0.7620	0.52	0.004092	95.6	23.36	11.68
40	42	1.0160	0.69	0.004099	138.5	33.78	16.89
50	56	1.2700	0.86	0.004106	184.6	44.97	22.48
60	68	1.5240	1.03	0.004113	224.2	54.50	27.25
70	81	1.7780	1.21	0.004121	267.1	64.81	32.41
80	94	2.0320	1.38	0.004128	309.9	75.08	37.54
90	104	2.2860	1.55	0.004135	343.2	82.99	41.50
100	114	2.5400	1.72	0.004142	376.9	90.98	45.49
110	124	2.7940	1.89	0.004150	410.5	98.93	49.47
120	133	3.0480	2.07	0.004157	440.8	106.05	53.02
130	143	3.3020	2.24	0.004164	474.5	113.96	56.98
140	151	3.5560	2.41	0.004171	501.4	120.21	60.10
150	160	3.8100	2.58	0.004179	531.8	127.26	63.63
160	169	4.0640	2.75	0.004186	562.1	134.27	67.13
170	175	4.3180	2.93	0.004194	582.3	138.85	69.42
180	184	4.5720	3.10	0.004201	612.6	145.82	72.91
190	191	4.8260	3.27	0.004209	636.2	151.16	75.58
200	197	5.0800	3.44	0.004216	656.4	155.68	77.84
210	203	5.3340	3.62	0.004224	676.9	160.27	80.14
220	208	5.5880	3.79	0.004231	694.4	164.11	82.05
230	213	5.8420	3.96	0.004239	711.8	167.92	83.96

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Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Data (cont'd)

Elapsed Time (s)	Axial Disp. (mm)	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	217	6.0960	4.1320	0.004246	725.7	170.90	85.45
250	221	6.3500	4.30	0.004254	739.7	173.87	86.94
260	225	6.6040	4.48	0.004262	753.6	176.82	88.41
270	227	6.8580	4.65	0.004269	760.6	178.14	89.07
280	230	7.1120	4.82	0.004277	771.0	180.26	90.13
290	232	7.3660	4.99	0.004285	778.0	181.57	90.78
300	233	7.6200	5.16	0.004293	781.5	182.05	91.02
310	234	7.8740	5.34	0.004300	784.9	182.52	91.26
320	234	8.1280	5.51	0.004308	784.9	182.19	91.10
330	234	8.3820	5.68	0.004316	784.9	181.86	90.93
340	232	8.6360	5.85	0.004324	778.0	179.92	89.96
350	230	8.8900	6.03	0.004332	771.0	177.98	88.99
360	228	9.1440	6.20	0.004340	764.0	176.05	88.02
370	222	9.3980	6.37	0.004348	743.1	170.91	85.46
380	216	9.6520	6.54	0.004356	722.2	165.80	82.90
390	207	9.9060	6.71	0.004364	690.9	158.31	79.15
400	198	10.1600	6.89	0.004372	659.8	150.91	75.45
410	190	10.4140	7.06	0.004380	632.8	144.47	72.24
420	182	10.6680	7.23	0.004388	605.8	138.06	69.03

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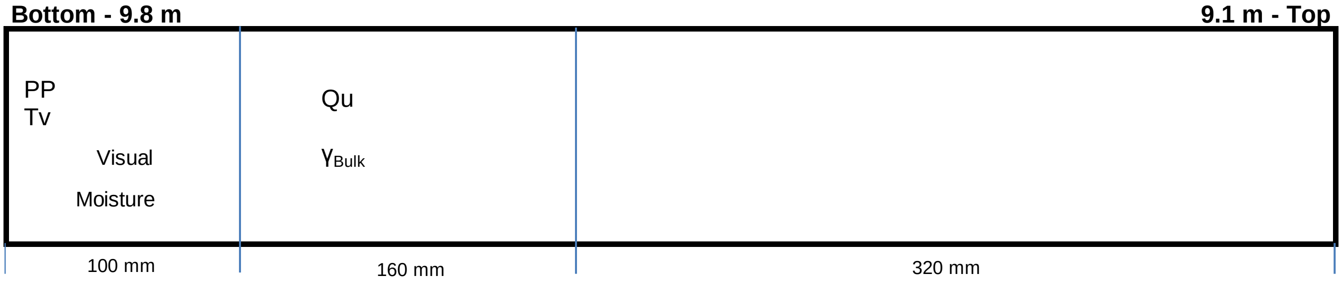
Shelby Tube Visual

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.
Test Hole	TH13-08
Sample #	T09
Depth (m)	9.1 - 9.8
Sample Date	23-Oct-13
Test Date	6-Nov-13
Technician	Hachem Ahmed

Tube Extraction

Recovery (mm) 580



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions <5mm diam.	
trace gravel inclusions <19mm diam.	
Color	dark grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	stratified
Gradation	-

Torvane

Reading	0.45
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	44.1

Pocket Penetrometer

Reading	**1**	1.00
	2	1.00
	3	0.95
	Average	0.98
Undrained Shear Strength (kPa)		48.2

Moisture Content

Tare ID	F52
Mass tare (g)	8.5
Mass wet + tare (g)	417.8
Mass dry + tare (g)	271.8
Moisture %	55.5%

Unit Weight

Bulk Weight (g)		1028.80
Length (mm)	**1**	145.80
	2	145.29
	3	145.45
	4	145.40
Average Length (m)		0.145
Diam. (mm)	**1**	72.12
	2	72.05
	3	72.31
	4	72.25
Average Diameter (m)		0.072
Volume (m^3)		5.95E-04
Bulk Unit Weight (kN/m^3)		16.9
Bulk Unit Weight (pcf)		107.9
Dry Unit Weight (kN/m^3)		10.9
Dry Unit Weight (pcf)		69.4

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Unconfined Compressive Strength
ASTM D2166

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole	TH13-08
Sample #	T09
Depth (m)	9.1 - 9.8
Sample Date	23-Oct-13
Test Date	6-Nov-13
Technician	Hachem Ahmed

Unconfined Strength

	kPa	ksf
Max q_u	109.7	2.3
Max S_u	54.9	1.1

Specimen Data

Description CLAY - silty, trace silt inclusions <5mm diam., trace gravel inclusions <19mm diam., dark grey, moist, stiff, high plasticity, stratified

Length	145.5	(mm)	**Moisture %**	55%	
Diameter	72.2	(mm)	**Bulk Unit Wt.**	16.9	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	10.9	(kN/m^3)
Initial Area	0.00409	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.45	44.1	0.92
Vane Size		
m		

Pocket Penetrometer

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
1.00	49.1	1.02
1.00	49.1	1.02
0.95	46.6	0.97
0.98	**48.2**	**1.01**

Failure Geometry

Sketch:

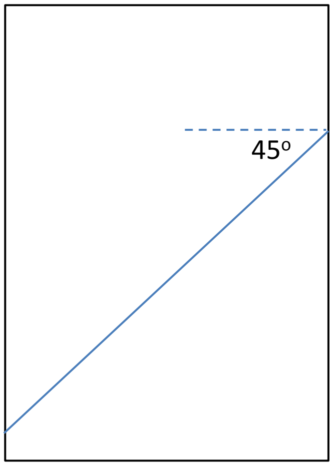

Photo:

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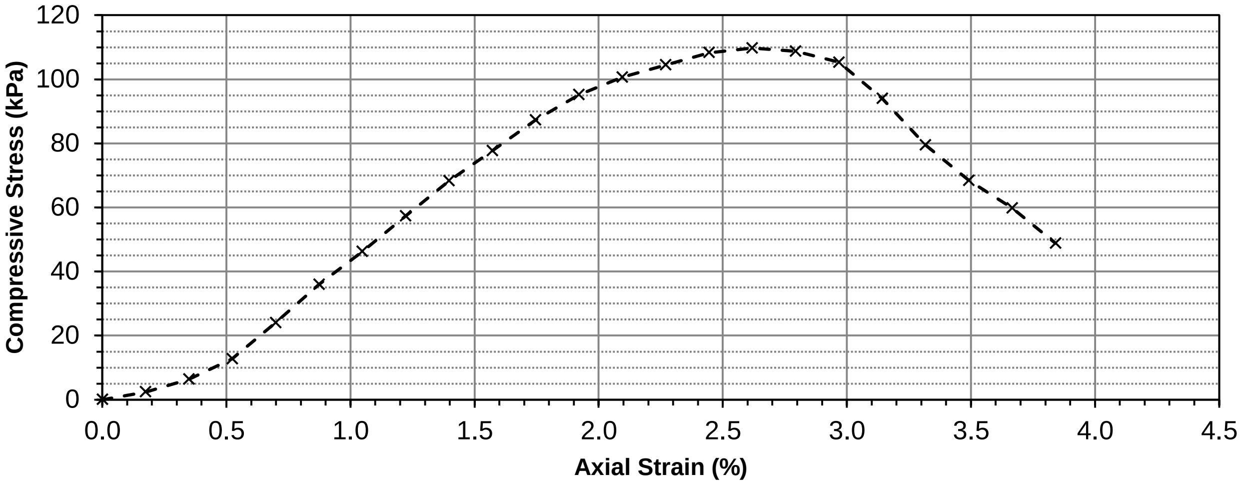
Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004092	0.0	0.00	0.00
10	3	0.2540	0.17	0.004099	9.8	2.39	1.20
20	8	0.5080	0.35	0.004107	26.2	6.37	3.19
30	16	0.7620	0.52	0.004114	52.4	12.73	6.37
40	30	1.0160	0.70	0.004121	98.9	24.01	12.00
50	45	1.2700	0.87	0.004128	148.3	35.94	17.97
60	58	1.5240	1.05	0.004135	191.2	46.24	23.12
70	72	1.7780	1.22	0.004143	237.4	57.30	28.65
80	86	2.0320	1.40	0.004150	283.5	68.32	34.16
90	98	2.2860	1.57	0.004157	323.1	77.72	38.86
100	110	2.5400	1.75	0.004165	363.4	87.25	43.62
110	120	2.7940	1.92	0.004172	397.0	95.16	47.58
120	127	3.0480	2.10	0.004180	420.6	100.63	50.32
130	132	3.3020	2.27	0.004187	437.5	104.48	52.24
140	137	3.5560	2.44	0.004195	454.3	108.30	54.15
150	139	3.8100	2.62	0.004202	461.1	109.72	54.86
160	138	4.0640	2.79	0.004210	457.7	108.72	54.36
170	134	4.3180	2.97	0.004217	444.2	105.33	52.66
180	120	4.5720	3.14	0.004225	397.0	93.98	46.99
190	102	4.8260	3.32	0.004233	336.4	79.48	39.74
200	88	5.0800	3.49	0.004240	290.2	68.43	34.21
210	77	5.3340	3.67	0.004248	253.9	59.76	29.88
220	63	5.5880	3.84	0.004256	207.7	48.81	24.41

Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Data (cont'd)

Elapsed Time (s)	Axial Disp. (mm)	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)

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Shelby Tube Visual

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.
Test Hole	TH13-09
Sample #	T18
Depth (m)	6.1 - 6.7
Sample Date	23-Oct-13
Test Date	6-Nov-13
Technician	Hachem Ahmed

Tube Extraction

Recovery (mm) 550

Bottom - 6.7 m **6.1 m - Top**

PP Tv Visual Moisture	Qu γ_{Bulk}	
140 mm	160 mm	250 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions <10mm diam.	
trace oxidation	
Color	bown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.45
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	44.1

Pocket Penetrometer

Reading	**1**	0.95
	2	0.90
	3	0.95
	Average	0.93
Undrained Shear Strength (kPa)		45.8

Moisture Content

Tare ID	W62
Mass tare (g)	8.3
Mass wet + tare (g)	407.4
Mass dry + tare (g)	268.9
Moisture %	53.1%

Unit Weight

Bulk Weight (g)		1060.00
Length (mm)	**1**	145.11
	2	144.59
	3	144.66
	4	144.77
Average Length (m)		0.145
Diam. (mm)	**1**	71.96
	2	72.45
	3	72.37
	4	71.69
Average Diameter (m)		0.072
Volume (m^3)		5.91E-04
Bulk Unit Weight (kN/m^3)		17.6
Bulk Unit Weight (pcf)		111.9
Dry Unit Weight (kN/m^3)		11.5
Dry Unit Weight (pcf)		73.1

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Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole TH13-09
Sample # T18
Depth (m) 6.1 - 6.7
Sample Date 23-Oct-13
Test Date 6-Nov-13
Technician Hachem Ahmed

Unconfined Strength

	kPa	ksf
Max q_u	146.3	3.1
Max S_u	73.1	1.5

Specimen Data

Description CLAY - silty, trace silt inclusions <10mm diam., trace oxidation, bown, moist, stiff, high plasticity

Length	144.8	(mm)	**Moisture %**	53%	
Diameter	72.1	(mm)	**Bulk Unit Wt.**	17.6	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	11.5	(kN/m^3)
Initial Area	0.00408	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.45	44.1	0.92
Vane Size		
m		

Pocket Penetrometer

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.95	46.6	0.97
0.90	44.1	0.92
0.95	46.6	0.97
0.93	**45.8**	**0.96**

Failure Geometry

Sketch:

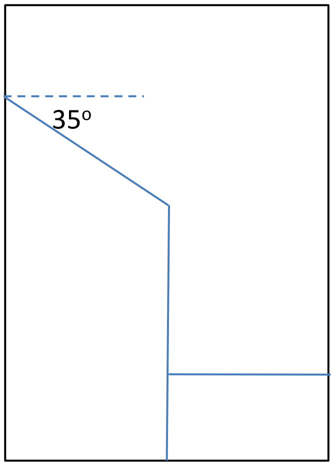

Photo:

Project 0022 010 00
Location C.O.W. Resource Recovery Centres
Hole No. TH13-09 Sample No. T18
Depth 20'-22' Date Oct 23, 2013
Technician HA

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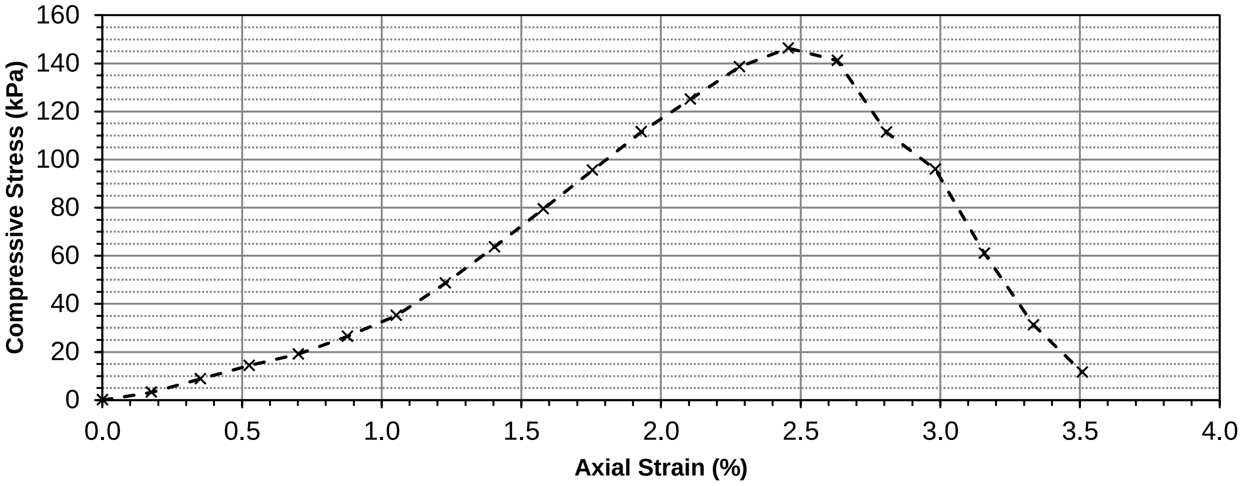
Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004085	0.0	0.00	0.00
10	4	0.2540	0.18	0.004092	13.1	3.19	1.60
20	11	0.5080	0.35	0.004099	36.0	8.78	4.39
30	18	0.7620	0.53	0.004106	58.9	14.35	7.18
40	24	1.0160	0.70	0.004114	78.6	19.12	9.56
50	33	1.2700	0.88	0.004121	108.8	26.40	13.20
60	44	1.5240	1.05	0.004128	145.1	35.14	17.57
70	61	1.7780	1.23	0.004136	201.1	48.63	24.31
80	80	2.0320	1.40	0.004143	263.8	63.67	31.83
90	100	2.2860	1.58	0.004150	329.7	79.44	39.72
100	120	2.5400	1.75	0.004158	397.0	95.50	47.75
110	140	2.7940	1.93	0.004165	464.4	111.49	55.75
120	157	3.0480	2.11	0.004173	521.6	125.01	62.51
130	174	3.3020	2.28	0.004180	578.9	138.50	69.25
140	184	3.5560	2.46	0.004188	612.6	146.29	73.14
150	178	3.8100	2.63	0.004195	592.4	141.20	70.60
160	141	4.0640	2.81	0.004203	467.8	111.30	55.65
170	122	4.3180	2.98	0.004210	403.8	95.91	47.95
180	78	4.5720	3.16	0.004218	257.2	60.97	30.48
190	40	4.8260	3.33	0.004226	131.9	31.21	15.61
200	15	5.0800	3.51	0.004233	49.1	11.60	5.80

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Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Data (cont'd)

Elapsed Time (s)	Axial Disp. (mm)	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)

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Shelby Tube Visual

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.
Test Hole	TH13-10
Sample #	T25
Depth (m)	6.1 - 6.7
Sample Date	23-Oct-13
Test Date	29-Oct-13
Technician	Hachem Ahmed

Tube Extraction

Recovery (mm) 460

Bottom - 6.7 **6.1 m - Top**

PP Tv		Moisture Visual	Qu γ_{Bulk}
50 mm	175 mm	155 mm	80 mm

Visual Classification

Material	Clay
Composition	silty

trace silt inclusion <5mm dia.
trace oxidation

Color	dark grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.35
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	34.3

Pocket Penetrometer

Reading	**1**	1.30
	2	1.25
	3	1.40
	Average	1.32
Undrained Shear Strength (kPa)		64.6

Moisture Content

Tare ID	W72
Mass tare (g)	8.4
Mass wet + tare (g)	378.4
Mass dry + tare (g)	252.6
Moisture %	51.5%

Unit Weight

Bulk Weight (g)		1060.20
Length (mm)	**1**	147.76
	2	147.88
	3	147.93
	4	147.96
Average Length (m)		0.148
Diam. (mm)	**1**	72.61
	2	73.03
	3	71.71
	4	71.80
Average Diameter (m)		0.072
Volume (m^3)		6.07E-04
Bulk Unit Weight (kN/m^3)		17.1
Bulk Unit Weight (pcf)		109.1
Dry Unit Weight (kN/m^3)		11.3
Dry Unit Weight (pcf)		72.0

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022 010 00
Client	Dillon Consulting Ltd.
Project	City of Winnipeg Resource Recovery Centres - Brady Rd.

Test Hole	TH13-10
Sample #	T25
Depth (m)	6.1 - 6.7
Sample Date	23-Oct-13
Test Date	29-Oct-13
Technician	Hachem Ahmed

Unconfined Strength

	kPa	ksf
Max q_u	117.9	2.5
Max S_u	58.9	1.2

Specimen Data

Description Clay - silty, trace silt inclusion <5mm dia., trace oxidation, dark grey, moist, stiff, high plasticity

Length	147.9	(mm)	**Moisture %**	52%	
Diameter	72.3	(mm)	**Bulk Unit Wt.**	17.1	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	11.3	(kN/m^3)
Initial Area	0.00410	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.35	34.3	0.72
Vane Size		
m		

Pocket Penetrometer

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
1.30	63.8	1.33
1.25	61.3	1.28
1.40	68.7	1.43
1.32	**64.6**	**1.35**

Failure Geometry

Sketch:

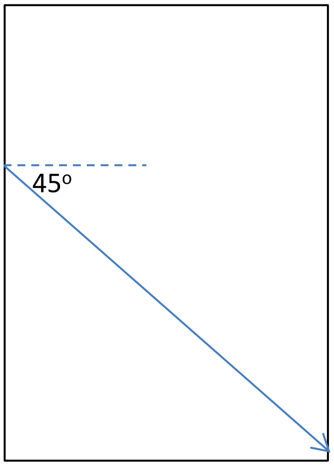


Photo:

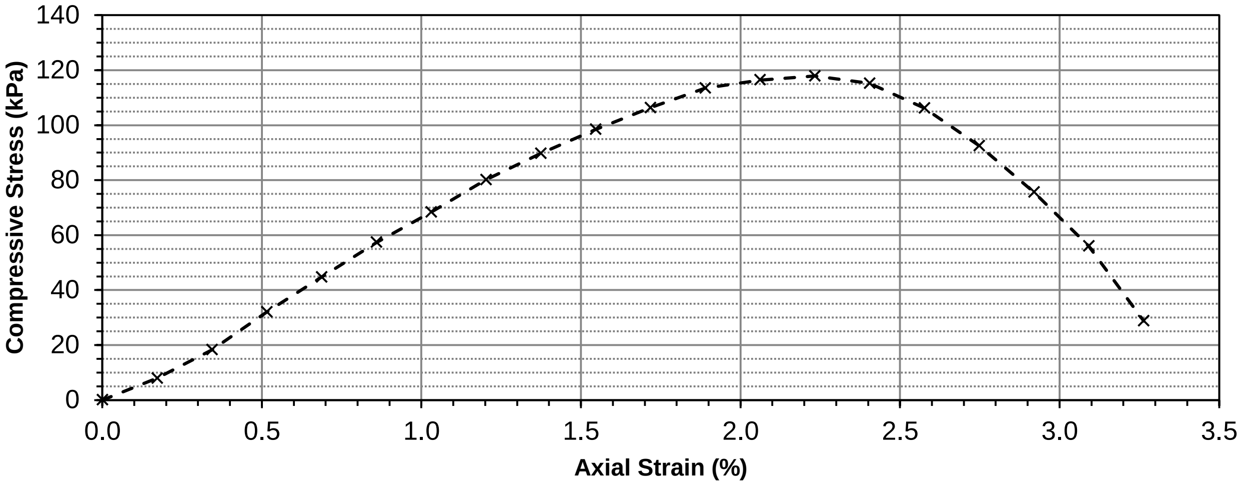
Project 0022 010 00
Location C.O.W Resource Recovery Centres
Hole No. TH13-10 Sample No. T25
Depth 20'-22' Date Oct 23, 2013
Technician HA

Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004104	0.0	0.00	0.00
10	10	0.2540	0.17	0.004111	32.7	7.96	3.98
20	23	0.5080	0.34	0.004118	75.3	18.30	9.15
30	40	0.7620	0.52	0.004125	131.9	31.97	15.99
40	56	1.0160	0.69	0.004132	184.6	44.68	22.34
50	72	1.2700	0.86	0.004140	237.4	57.35	28.67
60	86	1.5240	1.03	0.004147	283.5	68.37	34.19
70	101	1.7780	1.20	0.004154	333.1	80.18	40.09
80	113	2.0320	1.37	0.004161	373.5	89.75	44.87
90	124	2.2860	1.55	0.004169	410.5	98.48	49.24
100	134	2.5400	1.72	0.004176	444.2	106.37	53.19
110	143	2.7940	1.89	0.004183	474.5	113.44	56.72
120	147	3.0480	2.06	0.004190	488.0	116.45	58.22
130	149	3.3020	2.23	0.004198	494.7	117.85	58.93
140	146	3.5560	2.40	0.004205	484.6	115.25	57.62
150	135	3.8100	2.58	0.004213	447.6	106.25	53.12
160	118	4.0640	2.75	0.004220	390.3	92.49	46.25
170	97	4.3180	2.92	0.004228	319.8	75.65	37.83
180	72	4.5720	3.09	0.004235	237.4	56.06	28.03
190	37	4.8260	3.26	0.004243	122.0	28.75	14.37

Unconfined Compressive Strength

ASTM D2166

Project No. 0022 010 00
Client Dillon Consulting Ltd.
Project City of Winnipeg Resource Recovery Centres - Brady Rd.

Unconfined Compression Test Data (cont'd)

Elapsed Time (s)	Axial Disp. (mm)	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)