REPORT

Geotechnical Investigation – Technical Study Report

DURHAM YORK
RESIDUAL WASTE EA STUDY

PROJECT NO. 1009497

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GLOSSARY AND ABBREVIATIONS

** An asterisk (*) beside a defined term indicates that the term is defined in the Environmental Assessment Act.*

Alternative Methods:	Alternative methods of carrying out the proposed undertaking are different ways of doing the same activity. Alternative methods could include consideration of one or more of the following: alternative technologies; alternative methods of applying specific technologies; alternative sites for a proposed undertaking; alternative design methods; and, alternative methods of operating any facilities associated with a proposed undertaking.
Alternatives:	Both alternative methods and alternatives to a proposed undertaking.
Alternatives To:	Alternatives to the proposed undertaking are functionally different ways of approaching and dealing with a problem or opportunity.
Caisson:	Caissons are cylindrical tubes, typically filled with concrete, that are used to transfer building foundation loads to underlying soil or bedrock layers.
Durham:	The Regional Municipality of Durham or its geographic area, as the context requires.
Durham/York Residual Waste EA Study:	The Durham/York Residual Waste Study is a joint initiative between the Region of Durham and York Region to work together to find a way to manage solid waste remaining after at-source diversion.
Energy-from-Waste (EFW):	The recovery of energy in the form of heat and/or power from the thermal treatment of waste. Generally applied to incineration, pyrolysis, gasification but can also include the combustion of landfill gas and gas produced from anaerobic digestion of organic materials.

Environment*:	The environment is broadly defined under the Environmental Assessment Act as follows: (a) Air, land or water; (b) Plant and animal life, including human life; (c) The social, economic and cultural conditions that influence the life of humans or a community; (d) Any building, structure, machine or other device or thing made by humans; (e) Any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities; or, (f) Any part or combination of the foregoing and the interrelationships between any two or more of them.
Environmental Assessment:	Environmental assessment is a study, which assesses the potential environmental effects (positive or negative) of a proposal. Key components of an environmental assessment include consultation with government agencies and the public; consideration and evaluation of alternatives; and, the management of potential environmental effects. Conducting an environmental assessment promotes good environmental planning before decisions are made about proceeding with a proposal.
Environmental Assessment Act:	The *Environmental Assessment Act* (and amendments and regulations thereto) is a provincial statute that sets out a planning and decision-making process to evaluate the potential environmental effects of a proposed undertaking. Proponents wishing to proceed with an undertaking must document their planning and decision-making process and submit the results from their environmental assessment to the Minister for approval.
Impact Management Measures:	Measures which can lessen potential negative environmental effects or enhance positive environmental effects. These measures could include mitigation, compensation, or community enhancement.
Impact Studies:	Studies that predict negative consequences (if any) of a proposed undertaking. Air, visual, natural environmental, traffic, hydrogeological, Noise, Health Risk, Land Use and Hydrological Impact Studies are required under the Environmental Protection Act.

Individual Environmental Assessment:	An Individual Environmental Assessment requires the following steps to fully address the requirements of the EAA: Preparation of the Proposed EA Terms of Reference; Submission of the EA Terms of Reference to the Minister of the Environment for Approval; Completion of the EA Study in accordance with approved EA Terms of Reference, and; Submission of the EA Study to the Minister of the Environment for Approval.
Ministry of the Environment (MOE) Ontario:	The MOE monitors pollution and restoration trends in Ontario and uses that information to develop environmental laws, regulations, standards, policies, programs, and guidelines. The MOE works to provide cleaner air, land, and water for Ontarians.
Mitigation:	Measures taken to reduce adverse impacts on the environment.
Modulus:	Modulus of subgrade reaction is a parameter used to determine the thickness of concrete slabs-on-grade and is a function of pressure on the soil and the resulting deformation.
Municipal Solid Waste (MSW):	Common garbage or trash generated by industries, businesses, institutions, and homes.
Proctor dry density:	A standardized method of determining the density of soil that has been subjected to a defined compactive energy. It is used for specifying the the level of compaction of soils.
Project:	Encompasses the design, construction (including construction financing) and operation of the EFW Facility, and includes, the EA Study, the supply of municipal waste, and the sale of energy.
Proponent*:	A person, agency, group or organization that carries out or proposes to carry out an undertaking or is the owner or person having charge, management or control of an undertaking.
Regions:	Durham and York collectively.

Terms of Reference:	A document prepared by the proponent and submitted to the Ministry of the Environment for approval. The terms of reference sets out the framework for the planning and decision-making process to be followed by the proponent during the preparation of an environmental assessment. In other words, it is the proponent's work plan for what is going to be studied. If approved, the environmental assessment must be prepared according to the terms of reference.
Thermal Treatment:	Use of elevated temperatures to treat wastes (e.g., combustion or gasification).
Till:	Till refers to sediments that have been deposited by glaciers. The sediments may consist of clay, silt. sand, gravel or boulders.
Waste-to-Energy (WTE) Facility/Municipal-Waste Combustor:	Facility where recovered municipal solid waste is converted into a usable form of energy, usually via combustion.
York:	The Regional Municipality of York or its geographic area, as context requires.

List of Abbreviations

ASTM	American Society for Testing Materials
EA	Environmental assessment
EAA	Environmental Assessment Act
ha	Hectares
Min	Minimum
MOE	Ontario Ministry of the Environment
OD	Outside Diameter
OPSS	Ontario Provincial Standard Specification
USC	Unified Soil Classification

UNITS OF MEASUREMENT

Area

m^3	cubic metre

Mass/Weight

Re. Orders of Magnitude: x 10^2 = x 100, x10^3 = x 1000, etc.

g	gram	
ng	nanogram	1 x 10^{-9} grams
kg	kilogram	1 x 10^3 g
t	metric tonne	1 x 10^3 kg
lb	pound	1 lb = 453.592 grams

Pressure

kPa	kilopascals
MPa/m	megaPascals per metre

Volume

L	litre	
mL	millilitre	1 L = 1 x 10^3 mL
m^3	cubic metre	1 m3 = 1 x 10^3 L

Time

s	second
min	minute
hr	hour
wk	week
y	year

Miscellaneous

°C	temperature in degrees Celsius
N/A	not available
%	percent

REPORT

1.0 INTRODUCTION

Durham and York Regions (the Regions) have partnered to undertake a joint Residual Waste Planning Study. Both municipalities are in need of a solution to manage the residual solid waste that remains after diversion. The Regions are working together to address the social, economic, and environmental concerns through an Environmental Assessment (EA) Study process to examine potential long-term residual waste management alternatives.

1.1 The Environmental Assessment Process

The purpose of the undertaking (i.e., what the outcome of this EA Study is intended to do) as described in the Approved EA Terms of Reference is:

> *"To process - physically, biologically and/or thermally - the waste that remains after the application of both Regions' at-source waste diversion programs in order to recover resources - both material and energy - and to minimize the amount of material requiring landfill disposal. In proceeding with this undertaking only those approaches that will meet or exceed all regulatory requirements will be considered."*

The EA Study follows a planning approach where environmental constraints or opportunities are considered in the context of the broadly defined environment under the *Environmental Assessment Act* (EAA) (i.e., the natural environment as well as the social, economic and heritage and other "environments" relevant to the undertaking) and potential effects are understood and addressed before development occurs. In accordance with the approved EA Terms of Reference and EAA, the EA process evaluates: alternatives considering potential effects on the environment; the availability of mitigation measures that address, in whole or in part, the potential effects; and, the comparison of the advantages and disadvantages of the remaining or "net" effects. The result of this process provides the planning rationale and support for a preferred approach and method to implement the undertaking.

The EA document has been prepared and conducted in accordance with the EAA, and in accordance with the Terms of Reference approved by Ontario's Minister of the Environment on March 31, 2006. There are currently no federal environmental assessment process triggers identified and, therefore, this Project does not require approval under the *Canadian Environmental Assessment Act* (CEAA).

It is understood and contemplated that environmental management measures recommended as part of the EA process and this Technical Study Report will in many cases be refined, updated, modified and/or superceded as a result of subsequent approval processes.

This EA process essentially consists of three parts taking place in stages including:

- the Development and Approval of an EA Terms of Reference,
- the evaluation of "Alternatives to" the undertaking, and;

- the evaluation of "Alternative methods" of implementing the undertaking.

Refer to the EA for a detailed description of the EA process undertaken as part of the EA Study.

1.2 Purpose of this Report

This Report titled *Geotechnical Investigation – Technical Study Report* was carried out as part of the Durham/York Residual Waste Study at the Proposed Thermal Treatment Facility Site (the Site) on Osborne Road, Clarington, Ontario. The geotechnical investigation was carried out to determine the general subsurface conditions at the Site and to provide geotechnical parameters and recommendations to assist with the design for the development of the Site. The Technical Study Report presents all findings of the field and laboratory work undertaken for the investigation. Recommendations on the geotechnical aspects to assist with the design are also reported.

The geotechnical investigation was undertaken to provide information in regards to the general Site subsurface conditions. It was not intended to provide the geotechnical information required for specific designs nor should it be used for this purpose.

2.0 STUDY METHODOLOGY

The scope of work for the investigation was in general accordance with the JWSL proposal dated December 3, 2007. A potential disturbed area "footprint" equal to the projected maximum design capacity of 400,000 tonnes per year was assumed to carry out the investigation. The scope of work included the drilling of seventeen boreholes distributed on a grid throughout the Site and classification of soils samples. Fourteen boreholes were put down to an approximate depth of six metres and three were put down to at least twelve metres.

2.1 Site Description and Geology

The Site is located in Clarington, Ontario, south of Highway 401 and the South Service Road, east of Courtice Road and west of and adjacent to Osborne Road. The Site is about 12.1 hectares (ha), and is currently vacant land covered with grass, shrubs and trees. A communications tower is located to the southwest portion of the Site between BH9 and BH10.

The Site is generally trapezoidal in shape. The width (east–west) is approximately 320 m and the length (north-south) varies from 300 to 460 m. The ground surface is generally level but slopes gradually towards the south. The south end of the property slopes more steeply towards the rail road tracks. The Site was snow covered at the time of the investigation.

Based on the Ontario Geological Survey Preliminary Map P2204 – Quaternary Geology, published by the Ontario Ministry of Natural Resources, the overburden consists of glaciolacustrine deposits of silt and clay with sand tills.

2.2 Investigative Procedure

The geotechnical investigation consisted of drilling a series of boreholes to assess the subsurface soil and groundwater conditions within the area of the Site. During the investigation, Standard Penetration Tests (N values) were conducted within the overburden and samples of the soil were recovered and classified. Detailed logs of the soils encountered and the sampling carried out are found in **Appendix B** Borehole Records.

2.2.1 Boreholes

Prior to commencing the field investigation, the borehole locations were cleared of underground public services and utilities by private and public utility locators in the presence of a JWSL representative.

Seventeen boreholes were put down to depths ranging from 5.1 m to 12.2 m within the proposed development area using a track-mounted drill rig equipped for geotechnical testing. The borehole locations are shown on Drawing No. 1 in **Appendix B**.

Each of the boreholes was advanced through the soil using 55 mm, continuous flight hollow-stem augers. Soil samples were taken using conventional 50 mm split-spoon samplers while performing Standard Penetration Tests. The Standard Penetration Test (N-value) is used to determine the number of blows required to drive a 50 mm OD, split-spoon sampler 300 mm into the soil using a standard fall height and weight. N-values can be used as an indication of relative density, and can also be used to estimate other soil parameters.

Experienced JWSL geotechnical personnel logged all field drilling and sampling operations.

2.2.2 Surveying

The borehole locations and elevations were determined by JWSL representatives. The locations of the boreholes were determined by measuring the distances from the Site boundaries. The boreholes elevations were surveyed by JWSL personnel relative to a Temporary Benchmark established on Osborne Road approximately 30 m north of the southeast corner of the Site. This temporary elevation was assumed to be 100 metres.

2.2.3 Soil Sampling and Classification

Soil samples were recovered using the split-spoon sampling procedure in general accordance with ASTM Standard D1586, Standard Method for Penetration Tests and Split Barrel Sampling of Soils. In general, the samples were obtained at a regular interval of 750 mm from the surface to a depth of 3 metres, and subsequently at an interval of 1500 mm. The split-spoon samples were sealed in glass jars and/or plastic bags in the field to protect the soil and maintain the soil's natural moisture content. All soil samples were taken to our laboratory for final visual assessment, classification, and testing.

All samples were returned to the laboratory and were classified in general accordance with the Unified Soil Classification (USC) system, ASTM D 2487, Standard Practice for Classification of Soils for Engineering Purposes. Soil descriptions are given in the appended Borehole Records.

The soil samples collected for this investigation will be retained for a period of 90 days after which they will be discarded unless we are notified otherwise.

3.0 SUBSURFACE CONDITIONS

3.1 General

The subsurface conditions encountered are described on the Borehole Records in **Appendix B.**

In general, the subsurface conditions encountered at the test locations consisted of a surficial layer of sod/topsoil underlain with native glacial till. The Boreholes Records include soil stratification at the actual borehole locations with detailed soil descriptions for each stratum encountered in the boreholes. Variations in the soil stratification may occur and should be expected between borehole locations and elsewhere on the Site.

Summaries of the various soil strata and groundwater conditions at the borehole locations are provided in the following subsections.

3.1.1 Sod/Topsoil

A layer of sod and black to dark brown sandy silt and/or silty sand (topsoil) trace clay was encountered in all borehole locations on the ground surface. The thickness of the sod/topsoil layer ranged from 300 to 620 mm and averaged 395 mm over the Site.

3.1.2 Glacial Till

Glacial till consisting of mainly brown silty sand with traces of gravel and clay, was encountered in all borehole locations. At four locations (BH2, BH3, BH4 and BH11) a 700 to 900 mm thick layer of brown sandy silt till was encountered directly under the sod/topsoil. At three locations (BH6, BH7 and BH8) a 900 to 2400 mm thick layer of clayey silt was encountered directly under the sod/topsoil. In BH9 a stratum of sand and gravel was encountered underlying the silty sand till and the borehole was terminated in this layer.

3.1.3 Groundwater

Groundwater was encountered in ten of the boreholes during drilling and/or upon completion of drilling at depths ranging from 0.9 to 7.2 m below the existing ground surface. The groundwater level presented in this Report is the level that was encountered at the time of our activities and may not have become fully static at the time of measurement. It should be noted that groundwater levels are subject to fluctuations due to particular precipitation events and on a seasonal basis.

3.1.4 Summary

The following Table 1 summarizes the thickness of each of the layers found in boreholes BH1 to BH17. For a more detailed record of the subsurface conditions encountered, refer to the Borehole Records in **Appendix B**.

Table 3-1 Summary of Soil and Groundwater Conditions

Borehole No.	Sod/Topsoil Thickness (mm)	Surface Elevation (m)					
		Ground Surface	Sandy Silt Till	Clayey Silt Till	Silty Sand Till	Sand and Gravel Till	Groundwater[1]
BH1	450	99.2	-	-	98.7	-	98.3
BH2	450	99.1	98.6	-	97.7	-	96.1
BH3	620	99.3	98.7	-	97.9	-	-
BH4	460	99.7	99.2	-	98.5	-	98.8
BH5	460	98.8	-	-	99.3	-	-
BH6	320	99.2	-	98.9	96.5	-	96.6
BH7	320	99.4	-	99.1	98.0	-	93.7
BH8	450	99.5	-	99.0	98.1	-	-
BH9	450	97.7	-	-	97.2	96.2	96.8
BH10	450	99.1	-	-	98.6	-	-
BH11	450	99.8	99.3	-	98.4	-	-
BH12	340	99.6	-	-	99.3	-	94.2
BH13	320	96.5	-	-	97.2	-	-
BH14	300	97.5	-	-	97.2	-	92.4
BH15	300	99.4	-	-	99.1	-	94.0
BH16	300	99.3	-	-	99.0	-	92.1
BH17	300	97.1	-	-	96.8	-	-

Note (1) Groundwater elevations were observed during drilling; piezometers were not installed.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

The geotechnical investigation of the Site was undertaken to provide general subsurface information for site development. It was understood that a further geotechnical investigation would be undertaken to satisfy the specific requirements of the Facility.

4.2 Sod/Topsoil Removal

The surficial layer of sod and topsoil should be removed in all building and pavement areas. These materials can be stockpiled for use in Site landscaping or can be removed from the Site.

4.3 Foundations

The following sections describe the requirements for Facility foundations.

4.3.1 Engineered Fill

Fill materials placed under footings or slabs-on-grade is considered to be engineered fill. Site till excavated from above the groundwater table can be used as engineered fill as long as it is maintained at a suitable moisture content to permit the specified compaction. Site till excavated from below the groundwater table can also be used as engineered fill but provision for drying will likely be necessary. All Site till materials are considered susceptible to softening with increased moisture contents and this should be considered when planning the development of the Site.

Engineered fill imported to the Site should meet the Ontario Provincial Standard Specification (OPSS) requirements for Select Subgrade Material.

Prior to placing engineered fill, the exposed till surface should compacted to at least 100 percent of the standard Proctor dry density. All engineered fills should be compacted in lifts that are compatible with the compaction equipment used to a minimum of 100 percent of standard Proctor dry density.

Where engineered fill is used under spread/strip footings and slab-on-ground construction, the engineered fill must be placed within the stress zone of influence of the proposed footings. The placement of the engineered fill should extend horizontally to include the conventional 1H:1V downward splay from the perimeter of the footings.

It is recommended that inspection by experienced geotechnical personnel be carried out during excavation and engineered fill placement to ensure that all unsuitable soils are removed, that approved fill materials are used, and that the required compaction is carried out.

4.3.2 Conventional Footings and Slabs-on Grade

Based on the conditions encountered at the borehole locations, use of spread/strip footing foundations and slab on ground construction is practical for the Site.

Spread/strip footings constructed on the native soils or on engineered fill, comprised and placed in accordance with the above recommendations may be designed using a net allowable bearing pressure of 250 kPa. If the base of any footing excavations becomes disturbed, the disturbed material should be excavated and replaced with a clean granular material compacted to the requirements for engineered fill. Associated total and differential settlements should be less than 25 mm and 20 mm, respectively. All footings founded on soil which will be subjected to freezing conditions should have a soil cover of at least 1.2 metres for frost protection.

Excavation to the anticipated required depth at some locations may require excavation below the groundwater table. A sump and pump arrangement is recommended to temporarily control the groundwater during excavation and fill placement.

For slab areas, all surficial sod/topsoil or any other deleterious materials encountered should be removed followed by cuts to design subgrades. Any organic materials and/or soft deformable area detected shall be excavated and replaced with compacted suitable site till or OPSS Select Subgrade Material.

Slabs-on-ground should be constructed on a compacted bedding layer with a minimum thickness of 150 mm of free-draining gravel such as OPSS Granular A. A modulus of subgrade reaction of 30 MPa/m can be used for design of slabs on ground. Perimeter foundation drains, with a positive outlet, should be provided at locations where slabs are below exterior finished grade.

4.3.3 Caisson Foundations

The Site is also suitable for the of caisson foundations Caissons should be founded to a depth of at least 3.0 m below existing surface and a net allowable bearing pressure of 450 kPa can be used.

4.3.4 Earthquake Criteria

For the purpose of earthquake design the term relevant to the geotechnical conditions is the Site Classification for Seismic Site Response. Based on the conditions encountered in the boreholes, and in accordance with Table 4.1.8.4A of the 2006 Ontario Building Code, Site Class “D” soil profile should be applied to this Site.

4.4 Excavations

Tills encountered onsite are considered to be Type 3 and excavations should be sloped at a 1H:1V from the bottom of the excavation. If sufficient room is not available to slope the excavated walls, shoring will be required to maintain the stability of the excavation.

Based on the information obtained from the investigation, it is considered unlikely that the presence of groundwater will be a factor with respect the planned scope of development. Should excavations remain open for extended periods, water seepage and infiltration from perched pockets or zones in the fill materials or native soils can be expected. However, the quantity of seepage and accumulation should be manageable using conventional sump pits and contractors pumps.

The site slopes of any excavations should be protected from exposure to precipitation and associated ground surface runoff to prevent further softening and loss of strength and could lead to additional sloughing and caving.

4.5 Site Grading Considerations

The fine grained nature of the silty and clayey Site soils make them conductive to deterioration from trafficking, particularly during wet weather. Therefore, construction should be well planned to minimize rendering material which is initially suitable to a deteriorated unsuitable condition.

Surface water drainage should be provided at the up gradient side of the Site to prevent water from flowing onto active working areas. Suitable erosion protection and sediment control measures (e.g. silt fences, check dams) should be provided as required.

4.6 Pavements

The pavement designs for the Site should be carried out when the Site traffic loadings have been determined. It is expected that the pavement structures will generally be as follows:

Table 4-1 Summary of Soil and Groundwater Conditions

Material	Pavement Type		
	Light Duty Asphalt	Heavy Duty Asphalt	Heavy Duty Concrete
Asphalt Surface Course	40 mm	40 mm	-
Asphalt Base Course	50 mm	75 mm	-
Portland Cement Concrete	-	-	250 mm
Granular A Base	300 mm	500 mm	200 mm
Granular B subbase	-	300 mm	-

All of the materials used in the construction of Site pavements should be produced and placed in accordance with the respective OPSS requirements.

5.0 CLOSURE

This Report presents the geotechnical soil, bedrock and groundwater conditions encountered at the time of the field program and provides general geotechnical interpretation for the development of the Site. A further geotechnical investigation will be required as more information on the Site development is determined.

APPENDIX A

Symbols and Terms Used on Borehole and Test Pit Records

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting good vegetative growth
Peat	-	fibrous fragments of visible and invisible decayed organic matter
Till	-	unstratified and unsorted glacial deposit which may include particle sizes from clay to boulders
Fill	-	materials not identified as deposited by natural geological processes

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	material breaks along plane of fracture
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	alternating layers or beds greater than 6mm (1/4") thick
Laminated	-	alternating layers or beds less than 6mm (1/4") thick
Blocky	-	material can be broken into small and hard angular lumps
Lensed	-	irregular shaped pockets of soil with differing textures
Seam	-	a thin, confined layer of soil having different particle size, texture, or color from materials above and below
Well Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particles sizes
Uniformly Graded	-	predominantly one grain size

Soil descriptions and classification are based on the Unified Soil Classification System (USCS) (ASTM D-2488), which classifies soils on the basis of engineering properties. The system divides soils into three major categories: (1) coarse grained, (2) fine-grained, and (3) highly organic. The soil is then subdivided based on either gradation or plasticity characteristics. This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification. The classification excludes particles larger than 76 mm.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present and as described below in accordance with the standard of the Ministry of Transportation of Ontario:

Trace or occasional	Less than 10%
Some	10-20%
With	20-30%

The standard terminology to describe cohesionless soils includes the compactness as determined by the Standard Penetration Test 'N'-value*.

Compactness	'N'-value
Very loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

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SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

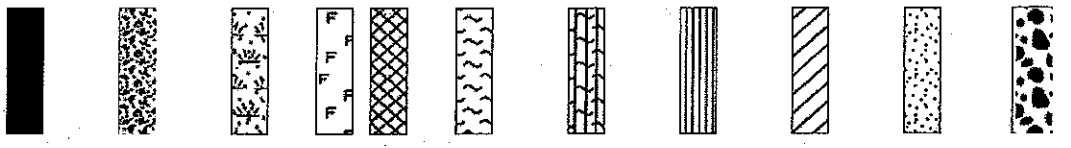
The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis. Standard Penetration Test 'N'-values* can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils.

Consistency	Undrained Shear Strength (kPa)	'N'-Value
Very Soft	<12.5	<2
Soft	12.5-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

Note: *'N'-VALUE- The Standard Penetration Test records the number of blows of a 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sampler 1 foot (305mm). For split spoon samples where full penetration is not achieved, the number of blows is reported over the sampler penetration in millimeters (e.g. 50/75).

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



Asphalt *Concrete* *Topsoil* *Fill* *Peat* *Organic Silt* *Silt* *Clay* *Sand* *Gravel*

Sedimentary Rock *Metamorphic Rock* *Igneous Rock*

WATER LEVEL MEASUREMENT

Open Borehole or Test Pit

Monitoring Well, Piezometer or Standpipe

SAMPLE TYPE

SS	Split spoon sample (obtained from the Standard Penetration Test)
TW	Thin Wall Sample or Shelby Tube
PS	Piston sample
GS	Grab sample
AS	Auger sample
VT	Vane Test
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ,etc.	Rock core samples obtained with the use of standard size diamond drilling bits.

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

ROCK DESCRIPTION

Total Core Recovery (TCR): The percentage of drill core recovered, regardless of quality, or length measured relative to the length of the total core run.
Solid Core Recovery (SCR): The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.
Rock Quality Designation (RQD): The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run.

RQD	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very Poor, crushed, very severely fractured

Terminology describing rock mass:

Discontinuities		Bedding, Lamination, Bands
Spacing (mm)	Description	
2000-6000	Very Wide	Very Thick
600-2000	Wide	Thick
200-600	Moderate	Medium
60-200	Close	Thin
20-60	Very Close	Very Thin
6-20	Extremely Close	Laminated
<6		Thinly Laminated

Strength classification of rock:

Strength Classification	Field Identification Method	Range of Unconfined Compressive Strength (MPa)
Extremely weak	Indented by thumbnail	<1
Very weak	Crumbles under firm blows of geological hammer; can be peeled with a pocket knife	1-5
Weak rock	Can be peeled by a pocket knife with difficulty; shallow indentations made by a firm blow with point of geological hammer	5-25
Medium strong	Cannot be scraped or peeled with a pocket knife; specimen can be fractured with a single firm blow of geological hammer	25-50
Strong	Specimen requires more than one blow of geological hammer to fracture	50-100
Very strong	Specimen requires many blows of geological hammer to fracture	100-250
Extremely strong	Specimen can only be chipped by geological hammer	>250

Weathering:
Unweathered: no signs of discoloration or oxidation of rock material
Slightly Weathered: discontinuities are stained or discolored; rock material partially discolored
Moderately Weathered: total discoloration; generally surface of core is intact and not friable; discontinuities may contain filling of altered material
Highly Weathered: total discoloration; surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water; discontinuities frequently contain filling of altered material
Completely Weathered: total discoloration; appearance of core is that of soil although internally the rock texture is usually partly preserved; discontinuities frequently contain filling of altered material

APPENDIX B

Borehole Records 1 to 17

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 1 SHEET 1 of 2

CLIENT Region of Durham PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario DATUM Local

DATES: BORING January 16, 2008 WATER LEVEL TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.2		0				
	98.7	TOPSOIL	1				
		Compact to very dense brown silty SAND	2	SS	1	360/460	10
1		- with gravel	3				
		- weathered and trace clay at upper layer	4	SS	2	460/460	27
			5				
2			6				
			7	SS	3	430/460	32
			8				
			9	SS	4	150/460	50/150mm
3		- grey below 3m	10				
			11				
			12				
			13				
4			14	SS	5	460/460	24
			15				
			16				
5			17				
			18				
			19	SS	6	430/460	30
6			20				
			21				
			22				
			23				
7			24	SS	7	360/460	44
			25				
			26				
8			27				
			28				
			29	SS	8	380/460	60/100mm
9			30				
			31				
			32				
10							

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 1 SHEET 2 of 2

CLIENT Region of Durham PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario DATUM Local

DATES: BORING January 16, 2008 WATER LEVEL TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) TCR(%) / SCR(%)	SAMPLES N-VALUE OR RQD(%)
10	89.2				33				
					34	SS	9	150/460	50/150mm
11					35				
					36				
					37				
					38				
12	87.0				39	SS	10	130/460	50/30mm
		- Water table at a depth of 0.9m at the end of Boring			40				
					41				
13					42				
					43				
					44				
					45				
14					46				
					47				
					48				
					49				
15					50				
					51				
					52				
16					53				
					54				
					55				
					56				
17					57				
					58				
					59				
18					60				
					61				
					62				
19					63				
					64				
					65				
20									

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 2

CLIENT Region of Durham

PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario

DATUM Local

DATES: BORING January 16, 2008

WATER LEVEL

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION
0	99.1	
	98.6	Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL
1		Compact brown sandy SILT - trace gravel and clay - weathered
	97.7	
2		Dense brown silty SAND - with gravel
3		- trace clay below 3m
4		- grey below 3.6m
5		- Very dense below 5m
6	92.5	
		- Water table at a depth of 3.0m at the end of Boring
7		
8		
9		
10		

STRATA PLOT

WATER LEVEL

DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0				
1				
2				
3	SS	1	460/460	14
4				
5				
6	SS	2		37
7				
8	SS	3	410/460	42
9				
10				
11	SS	4	430/460	36
12				
13				
14				
15				
16	SS	5	460/460	22
17				
18				
19				
20				
21	SS	6	360/460	50/150mm
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 3

CLIENT Region of Durham

LOCATION Osbourne Rd., Clarington, Ontario

DATES: BORING January 16, 2008 WATER LEVEL

PROJECT No. 1009497.01

DATUM Local

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.3		0				
		Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL	1				
	98.7		2				
1		Compact brown sandy SILT - trace gravel	3	SS	1	460/460	19
	97.9		4				
		Compact to dense brown silty SAND - with gravel	5				
2			6	SS	2	460/460	26
			7				
			8	SS	3	430/460	28
3		- trace clay below 3.1m	9				
			10	SS	4	430/460	36
		- grey and compact below 3.6m	11				
4			12				
			13				
			14				
			15				
5			16	SS	5	460/460	22
			17				
			18				
			19				
6			20				
			21	SS	6	460/460	22
	92.7		22				
		- Borehole is dry at the end of Boring	23				
7			24				
			25				
			26				
8			27				
			28				
			29				
9			30				
			31				
			32				
10							

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 4

CLIENT Region of Durham — PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario — DATUM Local

DATES: BORING January 16, 2008 — WATER LEVEL — TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.7		0				
	99.2	Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL	1				
1	98.5	Compact brown sandy SILT - with clay trace gravel	3	SS	1	460/460	23
		Compact to dense brown silty SAND - with gravel - trace clay at upper layer	6	SS	2	460/460	18
2			8	SS	3	460/460	28
3			11	SS	4	410/460	32
		- grey below 3.3m - compact below 4m					
4							
			16	SS	5	430/460	20
5							
6			21	SS	6	460/460	22
	93.1	- Water table at a depth of 1.0m at the end of Boring					
7							
8							
9							
10							

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

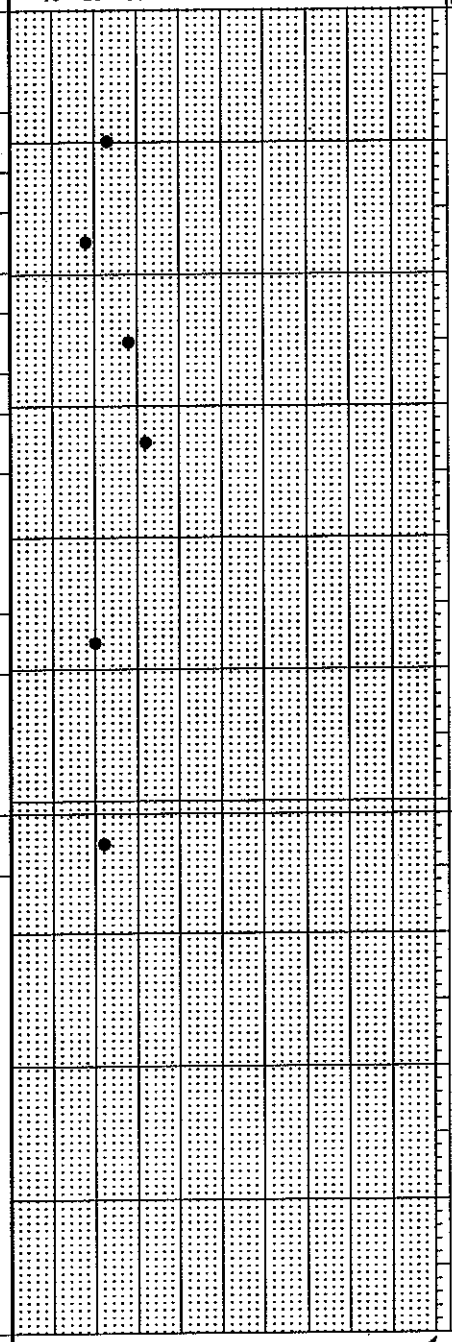
WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL



□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 5

CLIENT Region of Durham — PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario — DATUM Local

DATES: BORING January 17, 2008 — WATER LEVEL — TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.8		0				
	99.3	Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL	1				
1		Compact to very dense brown silty SAND - with gravel	3	SS	1	460/460	30
			6	SS	2	410/460	50/125mm
2			8	SS	3	230/460	50/75mm
3			11	SS	4	100/460	50/100mm
4		- grey below 4m	16	SS	5	430/460	68
5							
6	93.7		20				
		- Borehole is dry at the end of Boring	21	SS	6	100/460	60/75mm
7							
8							
9							
10							

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 6

CLIENT Region of Durham — PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario — DATUM Local

DATES: BORING January 17, 2008 — WATER LEVEL — TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.2		0				
	98.9	Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL	1				
1		Compact to dense brown clayey SILT - trace sand and gravel, weathered	2				
			3	SS	1	430/460	19
			4				
			5				
2			6	SS	2	460/460	43
			7				
			8	SS	3	430/460	27
	96.5		9				
3		Compact to very dense silty SAND - with gravel	10				
			11	SS	4	430/460	28
		- grey below 3.6m	12				
			13				
4			14				
			15				
			16	SS	5	150/460	50/50mm
5			17				
			18				
			19				
6	93.1		20				
		- Water table at a depth of 2.7m at the end of Boring	21	SS	6	150/460	50/50mm
			22				
7			23				
			24				
			25				
8			26				
			27				
			28				
9			29				
			30				
			31				
10			32				

SAMPLES

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 7 SHEET 1 of 2

CLIENT Region of Durham PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario DATUM Local

DATES: BORING January 17, 2008 WATER LEVEL TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.4		0				
	99.1	Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL	1				
1		Compact brown clayey SILT - with sand trace gravel, weathered	3	SS	1	460/460	18
	98.0	Compact to very dense silty SAND - with gravel	6	SS	2	430/460	20
2			8	SS	3	460/460	33
3			11	SS	4	460/460	46
4		- grey below 4.0m - trace clay between depth 3m to 4m	16	SS	5	430/460	60
5							
6			21	SS	6	460/460	95
7							
8			26	SS	7	410/460	50/125mm
9							
			31	SS	8	410/460	89
10			32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100 GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 7 SHEET 2 of 2

CLIENT Region of Durham PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario DATUM Local

DATES: BORING January 17, 2008 WATER LEVEL TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) TCR(%) / SCR(%)	SAMPLES N-VALUE OR RQD(%)
10	89.4				33				
					34				
					35				
11					36	SS	9	100/460	50/50mm
					37				
					38				
12	87.2				39	SS	10	100/460	50/50mm
		- Water table at a depth of 5.7m at the end of Boring			40				
					41				
13					42				
					43				
					44				
14					45				
					46				
					47				
15					48				
					49				
					50				
16					51				
					52				
					53				
17					54				
					55				
					56				
18					57				
					58				
					59				
19					60				
					61				
					62				
20					63				
					64				
					65				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 8

CLIENT Region of Durham — PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario — DATUM Local

DATES: BORING January 17, 2008 — WATER LEVEL — TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.5				0				
	99.0	Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL			1				
1		Compact brown clayey SILT - with sand trace gravel, weathered			3	SS	1	460/460	25
	98.1				4				
		Compact to very dense silty SAND - with gravel - trace clay at upper layer			5				
2					6	SS	2	460/460	25
					7				
					8	SS	3	460/460	21
3					9				
					10				
					11	SS	4	230/460	30
4		- grey below 3.6m			12				
					13				
					14				
					15				
					16	SS	5	460/460	25
5					17				
					18				
					19				
6	93.4				20				
		- Borehole is dry at the end of Boring			21	SS	6	100/460	50/30mm
					22				
7					23				
					24				
					25				
8					26				
					27				
					28				
9					29				
					30				
					31				
10					32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 9

CLIENT Region of Durham

PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario

DATUM Local

DATES: BORING January 17, 2008

WATER LEVEL

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	97.7					
	97.2	Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL				
1		Compact to very brown dense silty SAND - with gravel	SS	1	430/460	23
	96.2	- Very dense SAND and GRAVEL	SS	2	230/460	55/75mm
2						
3		- grey below 3m	SS	3	51/460	60/75mm
4						
5			SS	4	150/460	60/125mm
6	91.6	- Water table at a depth of 0.9m at the end of Boring	SS	5	180/460	50/50mm
7						
8						
9						
10						

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 10

CLIENT Region of Durham

PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario

DATUM Local

DATES: BORING January 18, 2008

WATER LEVEL

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) TCR(%) / SCR(%)	SAMPLES N-VALUE OR RQD(%)
0	99.1				0				
	98.6	Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL			1				
		Very dense brown silty SAND - with gravel			2				
1					3	SS	1	410/460	90
					4				
					5				
2					6	SS	2	410/460	95
					7				
					8				
					9				
3					10				
					11	SS	3	100/460	50/75mm
					12				
					13				
4					14				
					15				
					16	SS	4	380/460	88
5		- grey below 4.8m			17				
					18				
					19				
6	93.0				20				
		- Borehole is dry at the end of Boring			21	SS	5	410/460	85
					22				
7					23				
					24				
					25				
8					26				
					27				
					28				
					29				
9					30				
					31				
10					32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 11

CLIENT Region of Durham

PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario

DATUM Local

DATES: BORING January 18, 2008

WATER LEVEL

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) TCR(%) / SCR(%)	SAMPLES N-VALUE OR RQD(%)
0	99.8				0				
	99.3	Dark brown clayey silty sand, organic matter and rootlets: TOPSOIL			1				
1		Compact brown sandy SILT - with gravel trace clay			2				
	98.4				3	SS	1	410/460	19
		Very dense brown silty SAND - with gravel			4				
					5				
2					6	SS	2	410/460	50/100mm
					7				
					8				
					9				
3					10				
					11	SS	3	150/460	60/125mm
					12				
					13				
4					14				
					15				
		- grey below 4.7m			16	SS	4	230/460	50/75mm
					17				
5					18				
					19				
	93.7				20				
6		- Borehole is dry at the end of Boring			21	SS	5	150/460	60/125mm
					22				
					23				
7					24				
					25				
					26				
8					27				
					28				
					29				
9					30				
					31				
10					32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

W_P W W_L

WATER CONTENT & ATTERBERG LIMITS

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 12

CLIENT Region of Durham

PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario

DATUM Local

DATES: BORING January 18, 2008

WATER LEVEL

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.6					
	99.3	TOPSOIL				
		Compact to very dense brown silty SAND				
1		- with gravel	SS	1	430/460	24
			SS	2	230/460	20
2		- trace silt below 2.1m				
3			SS	3	100/460	60/75mm
4						
5		- grey below 5.1m	SS	4	150/460	60/100mm
6	93.5		SS	5	360/460	60/100mm
		- Water table at a depth of 5.4m at the end of Boring				
7						
8						
9						
10						

DEPTH (ft): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 13

CLIENT Region of Durham — PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario — DATUM Local

DATES: BORING January 17, 2008 — WATER LEVEL — TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) TCR(%) / SCR(%)	SAMPLES N-VALUE OR RQD(%)
0	96.5					
	96.2	TOPSOIL				
		Compact to very dense brown silty SAND - with gravel	SS	1	460/460	16
1						
			SS	2	460/460	58
2						
3			SS	3	460/460	87
4		- grey below 4m				
			SS	4	100/460	60/75mm
5						
			SS	5	100/460	57/75mm
6	90.4					
		- Borehole is dry at the end of Boring				
7						
8						
9						
10						

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100 GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 14

CLIENT Region of Durham

PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario

DATUM Local

DATES: BORING January 18, 2008

WATER LEVEL

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) / TCR(%) / SCR(%)	SAMPLES N-VALUE OR RQD(%)
0	97.5				0				
	97.2	TOPSOIL			1				
		Very dense brown silty SAND - with gravel			2				
1					3	SS	1	430/460	56
					4				
		- dense between depth 1.3m to 2.4m			5				
					6	SS	2	410/460	28
2					7				
		- very dense below 2.4m			8				
					9				
3					10				
					11	SS	3	230/460	50/50mm
					12				
		- grey below 4m			13				
4					14				
					15				
					16	SS	4	150/460	60/100mm
5				▼	17				
					18				
					19				
6	91.4				20				
		- Water table at a depth of 5.1m at the end of Boring			21	SS	5	360/460	60/100mm
					22				
7					23				
					24				
					25				
8					26				
					27				
					28				
9					29				
					30				
					31				
10					32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 15

CLIENT Region of Durham

PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario

DATUM Local

DATES: BORING January 18, 2008

WATER LEVEL

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.4					
	99.1	TOPSOIL				
		Dense to very dense brown silty SAND - with gravel	SS	1	430/460	28
1			SS	2	410/460	62
2						
3			SS	3	100/460	50/75mm
4						
			SS	4	100/460	60/75mm
5		- grey below 4.8m				
			SS	5	250/460	60/75mm
6	93.3	- Water table at a depth of 5.4m at the end of Boring				
7						
8						
9						
10						

STRATA PLOT

WATER LEVEL

DEPTH (ft): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 16 SHEET 1 of 2

CLIENT Region of Durham PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario DATUM Local

DATES: BORING January 18, 2008 WATER LEVEL TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	DEPTH (ft)	TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)
0	99.3		0				
	99.0	TOPSOIL					
		Very dense brown silty SAND - with gravel	3	SS	1	430/460	73
1			6	SS	2	430/460	55/75mm
2		- trace silt below 2.1m	10				
			11	SS	3	150/460	55/50mm
3			15				
4			16	SS	4	230/460	74
5		- grey below 4.8m	20				
			21	SS	5	430/460	60
6			25				
7			26	SS	6	460/460	31
		- trace clay below 7.5m	30				
8			31	SS	7	380/460	50/125mm
9			32				
10							

STRATA PLOT

WATER LEVEL

SAMPLES

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

REMARKS & GRAIN SIZE DISTRIBUTION (%)

10 20 30 40 50 60 70 80 90 100

GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 16 SHEET 2 of 2

CLIENT Region of Durham PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario DATUM Local

DATES: BORING January 18, 2008 WATER LEVEL TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) TCR(%) / SCR(%)	SAMPLES N-VALUE OR RQD(%)
10	89.3				33				
					34				
					35				
11					36	SS	8	230/460	50/75mm
					37				
					38				
12	87.1				39	SS	9	280/460	60/75mm
		- Water table at a depth of 7.2m at the end of Boring			40				
					41				
13					42				
					43				
					44				
14					45				
					46				
					47				
15					48				
					49				
					50				
16					51				
					52				
					53				
17					54				
					55				
					56				
18					57				
					58				
					59				
19					60				
					61				
					62				
20					63				
					64				
					65				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

□ Field Vane Test (kPa)

■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

JACQUES WHITFORD LIMITED

BOREHOLE RECORD

BH 17

CLIENT Region of Durham

PROJECT No. 1009497.01

LOCATION Osbourne Rd., Clarington, Ontario

DATUM Local

DATES: BORING January 17, 2008

WATER LEVEL

TPC ELEV.

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) TCR(%) / SCR(%)	SAMPLES N-VALUE OR RQD(%)
0	97.1				0				
	96.8	TOPSOIL			1				
		Dense to very dense brown silty SAND - with gravel - trace clay at upper layer			2				
1					3	SS	1	460/460	42
					4				
					5				
2					6	SS	2	150/460	50/125mm
					7				
					8	SS	3	100/460	50/75mm
					9				
3					10				
					11	SS	4	230/460	50/75mm
		- grey below 3.3m			12				
4					13				
					14				
					15				
					16	SS	5	100/460	60/50mm
5	92.1				17				
		- Borehole is dry at the end of Boring			18				
					19				
6					20				
					21				
					22				
7					23				
					24				
					25				
8					26				
					27				
					28				
9					29				
					30				
					31				
10					32				

UNDRAINED SHEAR STRENGTH (kPa)

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90 100

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

□ Field Vane Test (kPa)

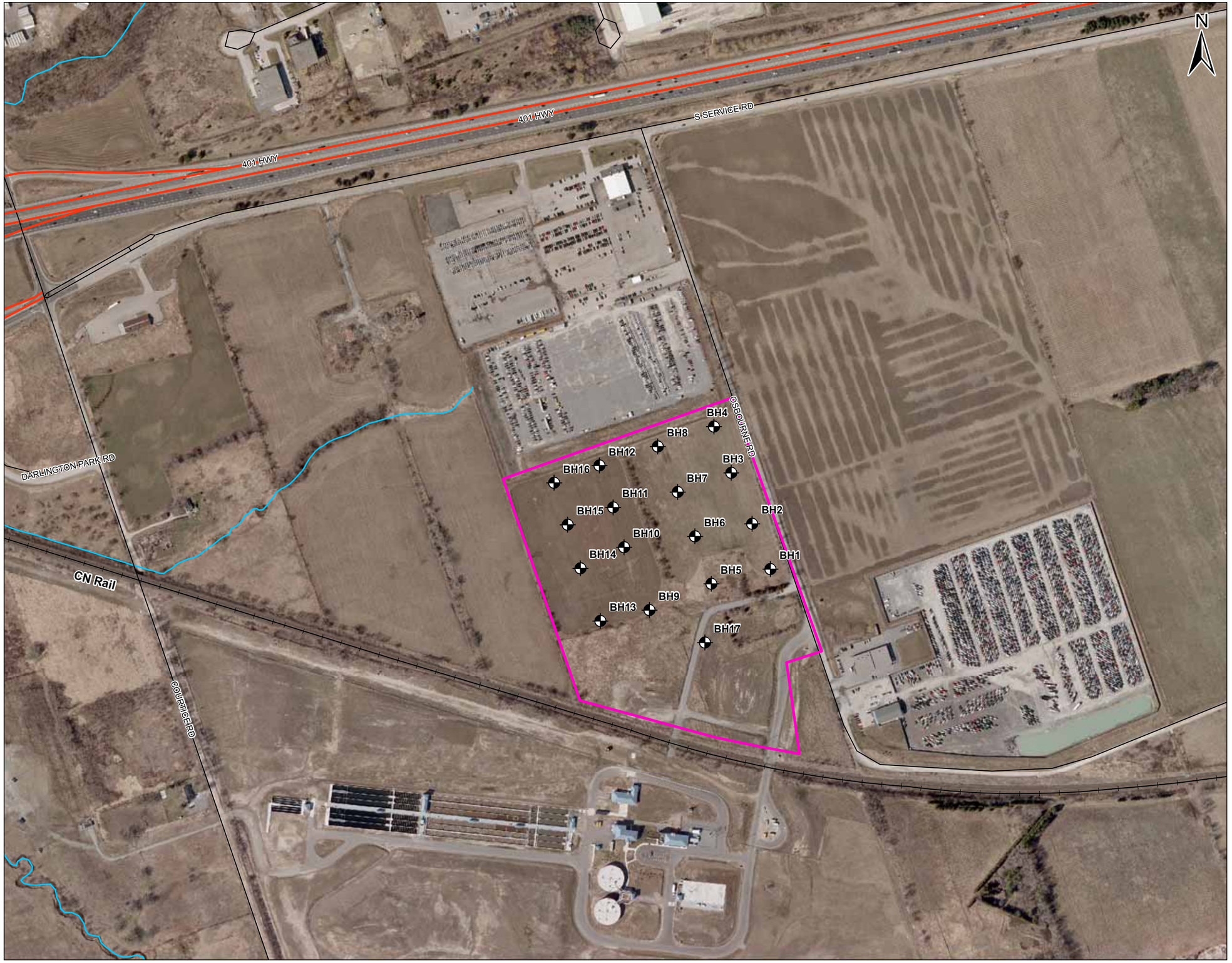
■ Remoulded Vane Test (kPa)

△ Pocket Penetrometer Test (kPa)

Jacques Whitford

APPENDIX C

Drawing No. 1, Borehole Locations



DURHAM/YORK
RESIDUAL WASTE STUDY

Borehole Locations

- Approximate Borehole Location
- Railway
- Road
- Highway
- Watercourse
- Proposed Clarington 01 Site

0 50 100 150

Metres - 1:5,000

1009497-013

Jacques Whitford

DRAWING NO.

1

Last Modified: Feb. 17, 2009 By: S Allen