

REPORT

Geotechnical Investigation –
Technical Study Report

DURHAM YORK
RESIDUAL WASTE EA STUDY

PROJECT NO. 1009497

Table of Contents

GLOSSARY AND ABBREVIATIONS	iv
GEOTECHNICAL INVESTIGATION-TECHNICAL STUDY REPORT	10
1.0 INTRODUCTION.....	10
1.1 The Environmental Assessment Process	10
1.2 Purpose of this Report	11
2.0 STUDY METHODOLOGY	11
2.1 Site Description and Geology.....	11
2.2 Investigative Procedure.....	11
2.2.1 Boreholes	12
2.2.2 Surveying	12
2.2.3 Soil Sampling and Classification	12
3.0 SUBSURFACE CONDITIONS.....	13
3.1 General	13
3.1.1 Sod/Topsoil	13
3.1.2 Glacial Till.....	13
3.1.3 Groundwater	13
3.1.4 Summary.....	13
4.0 DISCUSSION AND RECOMMENDATIONS	14
4.1 General	14
4.2 Sod/Topsoil Removal.....	14
4.3 Foundations	14
4.3.1 Engineered Fill	15
4.3.2 Conventional Footings and Slabs-on Grade	15
4.3.3 Caisson Foundations	16
4.3.4 Earthquake Criteria	16
4.4 Excavations.....	16
4.5 Site Grading Considerations	16
4.6 Pavements	17
5.0 CLOSURE.....	18

List of Tables

Table 1	Summary of Soil and Groundwater Conditions	14
Table 2	Summary of Soil and Groundwater Conditions	17

List of Appendices

APPENDIX A	Symbols and Terms Used on Borehole and Test Pit Records
APPENDIX B	Borehole Records BH1 to BH22
APPENDIX C	Drawing No. 1, Borehole Locations

DRAFT

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:	<p>An Individual Environmental Assessment requires the following steps to fully address the requirements of the EAA:</p> <ul style="list-style-type: none">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:	<p>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.</p>
Mitigation:	<p>Measures taken to reduce adverse impacts on the environment.</p>
Modulus:	<p>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.</p>
Municipal Solid Waste (MSW):	<p>Common garbage or trash generated by industries, businesses, institutions, and homes.</p>
Proctor dry density:	<p>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.</p>
Project:	<p>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.</p>
Proponent*:	<p>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.</p>
Regions:	<p>Durham and York collectively.</p>

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

m³ cubic metre

Mass/Weight

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

g gram

ng nanogram 1×10^{-9} grams

kg kilogram 1×10^3 g

t metric tonne 1×10^3 kg

lb pound $1 \text{ lb} = 453.592 \text{ grams}$

Pressure

kPa kilopascals

MPa/m megaPascals per metre

Volume

L litre

mL millilitre $1 \text{ L} = 1 \times 10^3 \text{ mL}$

m³ cubic metre $1 \text{ m}^3 = 1 \times 10^3 \text{ L}$

Time

s second

min minute

hr hour

wk week

y year

Miscellaneous

°C temperature in degrees Celsius

N/A not available

% percent

DRAFT

GEOTECHNICAL INVESTIGATION-TECHNICAL STUDY 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 (ToR) 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).

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 draft 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 Osbourne 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 Osbourne 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 Osbourne 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 1 Summary of Soil and Groundwater Conditions

Borehole No.	Sod/Topsoil Thickness (mm)	Surface Elevation (m)					Groundwater ¹
		Ground Surface	Sandy Silt Till	Clayey Silt Till	Silty Sand Till	Sand and Gravel Till	
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 be 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 conducive 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 2 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.

DRAFT

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.

This Report was prepared by Janan Sulaiman, Ph.D. and Eric Theriault, P.Eng. We trust that this information is adequate for your present purposes. If you have any questions with respect to the above, please contact us at your convenience.

Yours very truly,

JACQUES WHITFORD STANTEC LIMITED

Prepared By:

DRAFT

Eric Theriault, P.Eng.
Principal

P:\1000xxx\1005XXX\1009497\EA - Documentation\DRAFT EA Document\Durham York EA\Technical Reports\Geotech\Final Geotechnical Report - June 9 2009 FINAL.doc