December 2022 / Rev February 2023

Volume 2

Environmental Assessment of the Township of North Dundas Waste Management Plan

GOLDER
MEMBER OF WSP

TOWNSHIP OF
North Dundas

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Volume 2 – Appendices

APPENDIX A

Approved ToR

August 2019

TOWNSHIP OF
North Dundas

Proposed Terms of Reference Environmental Assessment of the Township of North Dundas Waste Management Plan

Volume 1

Executive Summary

Phase 1: Terms of Reference

An Individual Environmental Assessment (EA) for the waste management plan (EA Study) is being undertaken by the Township of North Dundas and requires approval under the provincial Environmental Assessment Act (EAA). The first phase in the EA process is preparation of a Terms of Reference (ToR). Work on the ToR, which is the framework for carrying out the EA, started in February 2017.

This is an Executive Summary of the content of the proposed ToR, which has been prepared by the Township and will be circulated to government review agencies, Indigenous communities and the public for comment. The comments received on the draft ToR have been considered by the Township in making revisions and preparing the proposed ToR, which will then be submitted to the Minister of Environment, Conservation and Parks (Minister) for a decision. Once approved by the Minister, the ToR provides the framework or work plan that must be subsequently completed to prepare the EA, and the basis for its review and approval.

Current Waste Management System

The Township has implemented a number of waste diversion programs within the municipality over the past 20 years that are practical and affordable for this type of municipality with a small, spread out total population of about 12,000 in 2016, and recognizing the reality that the Township is largely rural in nature with a limited number of small villages. The Township provides curbside pickup of waste, blue box recyclables and leaf and yard materials to all residences and some institutional, commercial and industrial businesses. The Township also operates diversion facilities at the Boyne Road Landfill site consisting of a municipal material recycling facility, tire recycling, brush and wood, a Waste Electrical and Electronic Equipment (WEEE) facility, and a Household Hazardous Waste (HHW) facility that also serves the neighbouring Township of South Dundas. The Township's diversion rate, as reported in 2016 and 2017 to Waste Diversion Ontario or Resource Productivity and Recovery Authority is approximately 25 and 23 percent, respectively.

The Township has and continues to look for opportunities to further increase waste diversion in this sparsely populated rural municipality. In comparison to larger urban centres where the addition of municipal-scale composting/processing of household and IC&I organics is often evaluated to progress towards achieving the province's interim diversion target of 30% by 2020, 50% by 2030 and 80% by 2050 (Strategy for a Waste-Free Ontario: Building the Circular Economy, February 2017), it is noted that the majority of the Township's residents live on larger rural properties where individual composting of leaf and yard materials and food wastes is already a fairly common practice. This composting is not accounted for in the Township's reported diversion rate.

The Boyne Road Landfill operations are located in the former Township of Winchester, along the south side of Boyne Road about 1.5 km east of the Village of Winchester. The site has been operating as a licenced landfill for the disposal of solid, non-hazardous waste since 1965. The Boyne Road Landfill is the only operational waste disposal site in the Township and receives all the residential and some of the industrial, commercial and institutional (IC&I) waste from the entire Township.

The Boyne Road Landfill currently has an approved disposal area of 8.1 hectares (ha). The land area that comprises the landfill property consists of the original disposal area and the addition of a number of parcels of adjoining land between 1992 and 2018 located around the original disposal area on both the south and north sides of Boyne Road, corresponding to a total land area of approximately 97.13 ha. In addition to the landfill property, the Township has acquired groundwater easements on adjacent lands, referred to as Contamination Attenuation Zones. The site operates under Environmental Compliance Approval (ECA) No. A482101.

Based on the original application for licensing of the landfill in 1971, the approved site capacity was approximately 395,000 cubic metres (m^3). When it was first determined in late 2014 that the site was in an overfill situation, the volume of waste in place was approximately 462,000 m^3. As of December 24, 2018, the volume of waste in place was about 533,780 m^3, corresponding to an overfill of approximately 139,000 m^3.

The existing landfill site is a natural attenuation landfill, without an engineered bottom liner and leachate collection system. Compliance of the site with the applicable requirements for protection of off-site groundwater quality relies on natural processes in the subsurface. An annual monitoring program, consisting of groundwater and surface water monitoring, is part of the current site operations. The results of the 2017 monitoring program indicate that with respect to protection of off-site groundwater quality, the landfill is operating in compliance with the MECP Reasonable Use Guideline. Surface water quality in the often-stagnant water within the drainage ditch along the north side of Boyne Road that receives surface water runoff from the landfill site is interpreted to experience discontinuous marginal impacts by landfill leachate but is generally in compliance with provincial surface water management policies. The results of the site monitoring programs show the landfill is performing acceptably and the impacts on the natural environment are deemed acceptable as described in the most recent extension of approval for continued landfilling at the Boyne Road Landfill.

Rationale for the EA Study

As part of a previous 2013 application procedure intended to update a number of items related to site operations and amend the Boyne Road Landfill’s ECA, the Ministry of the Environment, Conservation and Parks (MECP) determined in late 2014 that the site had exceeded its approved capacity and is in an overfill situation. Due to the elements governing the originally approved site capacity, the Township was unexpectedly required to evaluate waste management alternatives to deal with this overfill situation at the site. It is this overfill situation that triggered the need for the EA process.

To continue using the Boyne Road Landfill site in the short-term, an extension of approval for continued landfilling (emergency ECA) was received from the MECP and required the Township to evaluate long term waste management alternatives. Using a planning period of 25 years, the evaluation considered: site closure and waste export, Boyne Road Landfill site expansion, a new landfill site and alternative waste technologies. In this assessment, only the first two alternatives were considered in detail; the last two were not expected to be financially viable alternatives for a small rural municipality. The evaluation of these waste management alternatives considered a combination of technical, social and economic factors. The result of the comparative evaluation was that expansion of the Boyne Road Landfill, together with current and future waste diversion activities, was identified as the Township's preferred long-term waste management alternative. Based on the findings of this evaluation, a Council resolution was passed in November 2015 to pursue approval to expand the site via an EA pursuant to the Ontario EAA. Extensions of the ECA will continue to be required to allow continued site operations until the EA process is completed and the preferred alternative can be implemented, including obtaining the other required regulatory approvals.

The Environmental Assessment commenced in late February 2017 and open houses on preparation of this ToR were held in March and October 2017, followed by preparation and circulation of the Draft ToR in late April 2018. Based on comments received on the Draft ToR from the MECP, it was determined that the 2015 assessment of alternative waste management alternatives was not completed with the necessary detail to support the identified preferred alternative - expansion of the Boyne Road Landfill - at an EA level of detail. As such, key changes have been made to the Draft ToR (and are presented in this Proposed ToR) to review and re-assess the waste management alternatives that are reasonable for the Township to consider within the EA process and identify the preferred alternative. To reflect this revised approach, the title of the project has been changed to Environmental Assessment of the Township of North Dundas Waste Management Plan.

Description of the EA Study

The proposed EA Study is the EA of the Township's waste management plan for disposal of post-diversion waste for a 25-year planning period. The Township is seeking to accommodate waste disposal corresponding to the consumption of approximately 400,000 m^3 of waste disposal (excluding final cover and to be confirmed during the EA Study) from 2022 to 2047 as the Boyne Road Landfill is currently at capacity; the EA Study will be investigating long-term solid waste management options to achieve this objective. The results of a diversion study can influence the amount of waste for disposal requiring management over the planning period and diversion is proposed as an 'Alternative To' including completion of a diversion study concurrently with the EA.

The description and rationale will evolve during the preparation of the Environmental Assessment. Therefore, the final description of the proposed project and the rationale for it will be included in the Environmental Assessment once alternatives have been considered and evaluated.

Phase 2: Environmental Assessment

The two main components of the EA will be the assessment of 'Alternatives To' to identify the preferred approach for the long-term waste management plan and the assessment of 'Alternative Methods" for the preferred alternative.

In terms of ‘Alternatives To’, the Township has considered the range of alternatives that are reasonably available to it as a small rural municipality and has determined that the four alternatives considered in the previously completed preliminary study represent the range of the ‘Alternatives To’ that will be considered in the EA, along with the Do Nothing alternative and a waste diversion alternative.

As such, the six ‘Alternatives To’ that will be considered are:

- Alternative 1 – Landfill Site Closure and Export of Waste for Disposal
- Alternative 2 – Landfill Site Expansion
- Alternative 3 – Establish New Landfill Site in the Township
- Alternative 4 – Alternative Waste Management Technologies (thermal treatment)
- Alternative 5 – Enhanced At-Source Waste Diversion
- Alternative 6 – Do-Nothing. In EAs, the Do-Nothing alternative is considered in the evaluation of ‘Alternatives To’ as a benchmark against which the potential environmental impacts and the advantages and disadvantages of the alternatives being considered can be measured and compared.

A broad set of environmental criteria is proposed to be used for comparative evaluation of the ‘Alternatives To’. These environmental criteria will cover the components that comprise the natural environment, social, economic / financial and technical. The potential effects and/or implications of each of the Alternatives will be generally identified and described for each of the environmental criteria. It is proposed to then complete a comparative assessment of the Alternatives. The outcome of this ranking exercise will be the identification of the preferred ‘Alternative To’ for waste management for the Township of North Dundas.

In terms of ‘Alternative Methods’, following the identification of the preferred ‘Alternative To’, a reasonable range of ‘Alternative Methods’ to implement the EA Study will be developed. The assessment and evaluation of ‘Alternative Methods’ will involve the following steps:

- Identification of the appropriate Study Areas and time frames where potential effects from the preferred ‘Alternative To’ will be studied.
- Characterize the existing environmental conditions relevant to the preferred ‘Alternative To’.
- Develop the ‘Alternative Methods’.
- For the purpose of comparative evaluation of ‘Alternative Methods’, develop a set of environmental components, the rationale for their inclusion, indicators that will be used to assess potential effects and data sources.
- Develop detailed work plans for each of the environmental components.

- Quantitatively or qualitatively (as appropriate for the environmental component) assess the potential effects of the 'Alternative Methods' relative to baseline environmental conditions.
- Compare the 'Alternative Methods' and identify the overall preferred 'Alternative Method'.
- Complete a predictive assessment of environmental effects of the preferred 'Alternative Method' and determine the net effects, including comparison to the Do-Nothing alternative.
- Complete a cumulative effects assessment of the net effects of the preferred alternative with the predicted effects of other existing and identified and probable projects in the area of the preferred alternative, where there are overlapping effects. Consider effects associated with climate change.
- Prepare the EA Study report, technical supporting documents as appropriate and a Consultation Record.

Consultation Program

The ToR describes the Consultation Program prepared and undertaken by the Township for the development of this ToR, as well as the program proposed for the subsequent EA process.

Engagement and consultation with the public and other stakeholders are a key component of the EA process. It enables stakeholders to participate in the planning process and enhance the quality of the EA Study. The key instruments in the program that were used to engage the public and the other stakeholders and seek feedback during the ToR preparation were open houses, letter/email correspondence, the Township of North Dundas' EA website and newspaper advertisements. Input received from this program was considered by the Township in preparing the proposed ToR.

A list of potentially affected Indigenous communities was developed in consultation with the MECP during the development of this ToR. Initially a list of thirteen Indigenous communities was identified as possibly having an interest in this EA Study. All these communities received the Notice of Commencement of the EA Study and invitation to Open House #1. Subsequently the MECP advised that three Indigenous communities have or may have constitutional or Indigenous treaty rights that could be affected by the outcome of the EA study via letter. The MECP has delegated the procedural aspects of the Crown's duty to consult with Indigenous communities through this letter. The Township will be consulting with the three communities in the letter as these are the communities identified that have or may have constitutionally protected Aboriginal or treaty rights that could be adversely affected by the EA Study based on preliminary information.

As a result, a letter was prepared explaining that the consultation on this EA would continue with three of the communities, indicating that the other Indigenous communities could still participate in the EA if they had an interest to continue to receive information and/or engage in the EA Study. None of the communities that were removed from the consultation list indicated that they still wished to be engaged in this EA process. The Indigenous communities were consulted on how they would like to be involved in the EA process. Township staff were available to meet with interested Indigenous communities and discuss the proposed EA Study at any time during the development of the ToR.

During the ToR the Huron-Wendat Nation identified an interest in archaeological studies at the Boyne Road Landfill site. It was communicated to the Huron-Wendat Nation that no studies have yet occurred, but as they advance the Township will communicate with the Huron-Wendat Nation the planned schedule, studies and results.

In addition, pre-consultation regarding the Chesterville municipal water supply well, existing Boyne Road Landfill and possible expansion of the landfill were conducted with the MECP Source Protection Programs Branch and the Raisin-South Nation Protection Region (RSNPR).

Following approval of this ToR and during preparation of the EA, a consultation program will be continued to engage the public, businesses, the Government review team and Indigenous communities. Input will be obtained through a number of engagement activities, which will be generally similar to the activities completed during preparation of the ToR.

The draft ToR was circulated for a five-week public comment period prior to finalization and submission to the MECP of this proposed ToR for approval.

Other Regulatory Approvals

In addition to EA approval, the proposed undertaking is expected to require other regulatory approvals. The other regulatory approvals specific to the proposed EA Study will be determined during the EA process. The Township proposes to seek EA approval prior to proceeding with the other approval processes.

Overview of EA Schedule

Following circulation of the draft ToR for comments, the proposed ToR is subject to a 30-day comment period that will be followed by the Minister's decision. With submission of the proposed ToR in July 2019, the Minister's decision is anticipated in the fourth quarter of 2019. The EA studies will be carried out following ToR approval and then the draft and final EA will be submitted for the Minister's approval. Processes to obtain the other approvals required to implement the EA Study will proceed after EA approval.

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Acronyms, Units of Measure and Glossary of Terms

Acronyms

Acronym	Definition
CAZ	Contaminant Attenuation Zone
CEAA	*Canadian Environmental Assessment Act*
EA	Environmental Assessment
EAA	*Environmental Assessment Act*
ECA	Environmental Compliance Approval
EOWHF	Eastern Ontario Waste Handling Facility
EPA	*Environmental Protection Act*
GHG	Greenhouse Gas
GRT	Government Review Team
HHW	Household Hazardous Waste
IC&I	Industrial, Commercial and Institutional
MMA	Ministry of Municipal Affairs
MNRF	Ministry of Natural Resources and Forestry
MECP	Ministry of the Environment, Conservation and Parks
MRF	Material Recycling Facility
MTCS	Ministry of Tourism, Culture and Sport
NoC	Notice of Commencement
O.Reg.	Ontario Regulation
OWRA	*Ontario Water Resources Act*
RSNPR	Raisin-South Nation Protection Region
SNC	South Nation Conservation
SPPB	Source Protection Programs Branch
SWM	Stormwater Management
ToR	Terms of Reference
WEEE	Waste Electrical and Electronic Equipment

Units of Measure

Acronym	Definition of Units
%	percent
ha	hectare
km	kilometre
km^2	square kilometre
m	metre
m^3	cubic metre

Glossary of Terms

Term	Definition
‘Alternative Methods’	Alternative methods of carrying out the proposed undertaking are different ways of doing the same activity associated with an undertaking. ‘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 To’	‘Alternatives To’ the proposed undertaking are functionally different ways of approaching and dealing with a problem or opportunity.
Contaminant Attenuation Zone	An area of land outside the landfill site property within which the use of groundwater is controlled by the landfill site owner, and within which landfill leachate impacts on groundwater are attenuated (reduced) to achieve landfill site compliance with the Reasonable Use Guideline.
Criteria	A description of each environmental component to be considered in the environmental assessment, consisting of the rationale for including the component and the indicator(s) to be used in the assessment.
Cumulative Effects	The net effects of the proposed undertaking combined with the predicted effects of other existing and identified certain and probable projects in the area of the proposed undertaking, where the effects would overlap.
Disposal Area	The area within the landfill property approved for the disposal of post-diversion waste; also referred to as the waste footprint.

Term	Definition
Environment	As defined by the *Environmental Assessment Act*, environment means: • Air, land or water, • Plant and animal life, including human life, • The social, economic and cultural conditions that influence the life of humans or a community, • Any building, structure, machine or other device or thing made by humans, • Any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities, or • Any part or combination of the foregoing and the interrelationships between any two or more of them (ecosystem approach).
Environmental Assessment	An environmental assessment, commonly known as an individual EA, is a study that is completed by the proponent to assess the potential environmental effects (positive or negative) of an individual project. 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 Compliance Approval	An approval issued by the Ministry of the Environment, Conservation and Parks for the establishment and operation of a waste management site/facility. Previously referred to as a Certificate of Approval (C of A).
Environmental Components	Environmental components are different aspects of the physical, biological and human environments.
Greenfield Site	A parcel of land that has not been previously developed for urban use, i.e., rural or agricultural land or green space.
Groundwater	Water below the ground surface contained in the pore spaces in soil or in openings within the bedrock.
Hazardous Waste	Waste generated from any source that is defined as hazardous by the regulations of Ontario.
Indicators	Specific characteristics of the environmental components that can be measured, qualified, quantified or determined in some way.
IC&I Waste	Waste generated by the Industrial, Commercial & Institutional sector of the economy.
Landfill	An approved site used for the long-term disposal of post-diversion waste.

Term	Definition
Landfill Capacity	The volume approved for disposal of post-diversion wastes and cover materials, described in cubic metres. Also referred to as the approved airspace.
Landfill Expansion	An increase in the approved landfill capacity.
Landfill Gas	Gases generated from the anaerobic decomposition of organic waste materials; mainly consisting of methane and carbon dioxide and traces of other gases
Leachate	The liquid produced when water (typically rainwater or snowmelt) passes through a landfill and contains contaminants as a result of coming in contact with the waste.
Leachate Collection System	The system used to collect leachate generated by a landfill, usually consisting of a network of piping and drainage stone beneath or around the perimeter of the disposal area.
Liner	An engineered constructed barrier layer that minimizes/controls leachate from entering the environment; at landfills, typically constructed on the base and below grade sideslopes to contain leachate from entering the groundwater or surface water systems.
Mitigation Measures	Design features and/or operational approaches used to control the potential effects of the landfill on the environment.
Non-hazardous Solid Waste	Waste generated from any source that is defined as non-hazardous and solid by the regulations of Ontario.
Ontario Regulation 232/98	The regulation that governs the design, operation, closure and post-closure of new or expanding waste disposal sites in the province of Ontario.
Proponent	A person, agency, group or organization that who: a) Carries out or proposes to carry out an undertaking, or b) Is the owner or person having charge, management or control of an undertaking. For this undertaking (EA Study), the proponent is the Township of North Dundas.
Reasonable Use Guideline (or Concept)	The Ministry of Environment, Conservation and Parks guideline used to determine the acceptable level of impact from landfill leachate on off-site groundwater quality and used to assess compliance of landfill sites in terms of effects on groundwater resources.
Receptor	A specific location where the effect(s) from a waste management facility may be received. Also referred to as Points of Reception (PORs).
Residential Waste	Waste generated by residences (ranging from singe to multi-residential units).

Term	Definition
Service Area	The geographic area from which generated waste can be received at a recycling or disposal site, in accordance with the approval for the recycling or disposal site.
Stormwater Management System	An engineered system to manage/control the quantity and/or quality of stormwater runoff from the site, typically consisting of ditches and ponds that discharge to the natural environment.
Surface Water	Water on top of or flowing across the ground surface, i.e., lakes, rivers, ditches.
Terms of Reference	A document prepared by the proponent and submitted to the Ministry of the Environment, Conservation and Parks for approval. The Terms of Reference (ToR) document sets out the framework for the planning and decision-making process to be followed by the proponent during the preparation of an EA. In other words, it is the Township of North Dundas's (the proponent's) work plan for what is going to be studied. If approved, the EA must be prepared according to this ToR. The ToR also provides the framework for evaluating the EA.
(the) Undertaking	The enterprise, activity or a proposal, plan, or program that the Township of North Dundas initiates or proposes to initiate. Also referred to herein as the 'EA Study'.
Waste Generation Rate	The quantity of waste generated by an individual(s) on a daily or annual basis, typically described in tonnes (or kilograms) per person per year.

1.0 INTRODUCTION

This is the Terms of Reference (ToR) document for the Environmental Assessment (EA) of the Township of North Dundas (Township) long-term waste management plan (EA Study). The following subsections provide an introduction to the current waste management system within the municipality and the purpose of the EA Study. An overall map of the Township, which comprises the EA Study Area, is provided on Figure 1.0-1.

1.1 Identification of the Proponent

The Township of North Dundas is the proponent for the proposed EA Study. The Township is located in eastern Ontario about 40 kilometres (km) south of Ottawa within the United Counties of Stormont, Dundas and Glengarry, has a total area of 503 square kilometres (km^2) and a 2016 population of 11,278. The contacts for this EA Study are as follows:

Doug Froats
Director of Waste Management
Township of North Dundas
636 St. Lawrence Street
P.O. Box 489
Winchester, ON K0C 2K0
Telephone: 613-774-2105 ext. 228
Fax: 613-774-5699
E-mail: dfroats@northdundas.com

Trish Edmond, P.Eng.
EA Project Manager
Golder Associates Ltd.
1931 Robertson Road
Ottawa, ON K2H 5B7

Telephone: 613-592-9600
Fax: 613-592-9601
E-mail: trish_edmond@golder.com

1.2 Current Waste Management System

The Township, through its Waste Management department and its waste hauling contractors, currently provides curbside waste collection and disposal services to its ratepayers for residential and some institutional, commercial and industrial waste. It also provides waste diversion services, including recyclable materials and leaf and yard waste curbside collection, tire recycling, as well as the collection of household hazardous waste (HHW) and Waste Electrical and Electronic Equipment (WEEE) for export to authorized processing facilities. The HHW facility also serves the Township of South Dundas. The Township's diversion rate, as reported in 2016 and 2017 to Waste Diversion Ontario and Resource Productivity and Recovery Authority, is approximately 25 and 23 percent (%) (WDO, 2016 and RPRA, 2017).

The material recycling facility, the HHW and WEEE transfer station as well as the waste disposal facility are located at the Township's Boyne Road Landfill site. All recyclables (metal, plastic, paper, cardboard) collected within the Township are taken to the recycling transfer station at the Boyne Road Landfill site, from where they are transferred out of the Township by a recycling contractor. In 2016 and 2017, approximately 650 tonnes and 760 tonnes, respectively, of recyclable materials were collected. The Boyne Road Landfill is located on Lot 8, Concession VI in the former Township of Winchester, along the south side of Boyne Road about 1.5 km east of the Village of Winchester, which is approximately mid-way between the two main population centres within the Township – the Villages of Winchester and

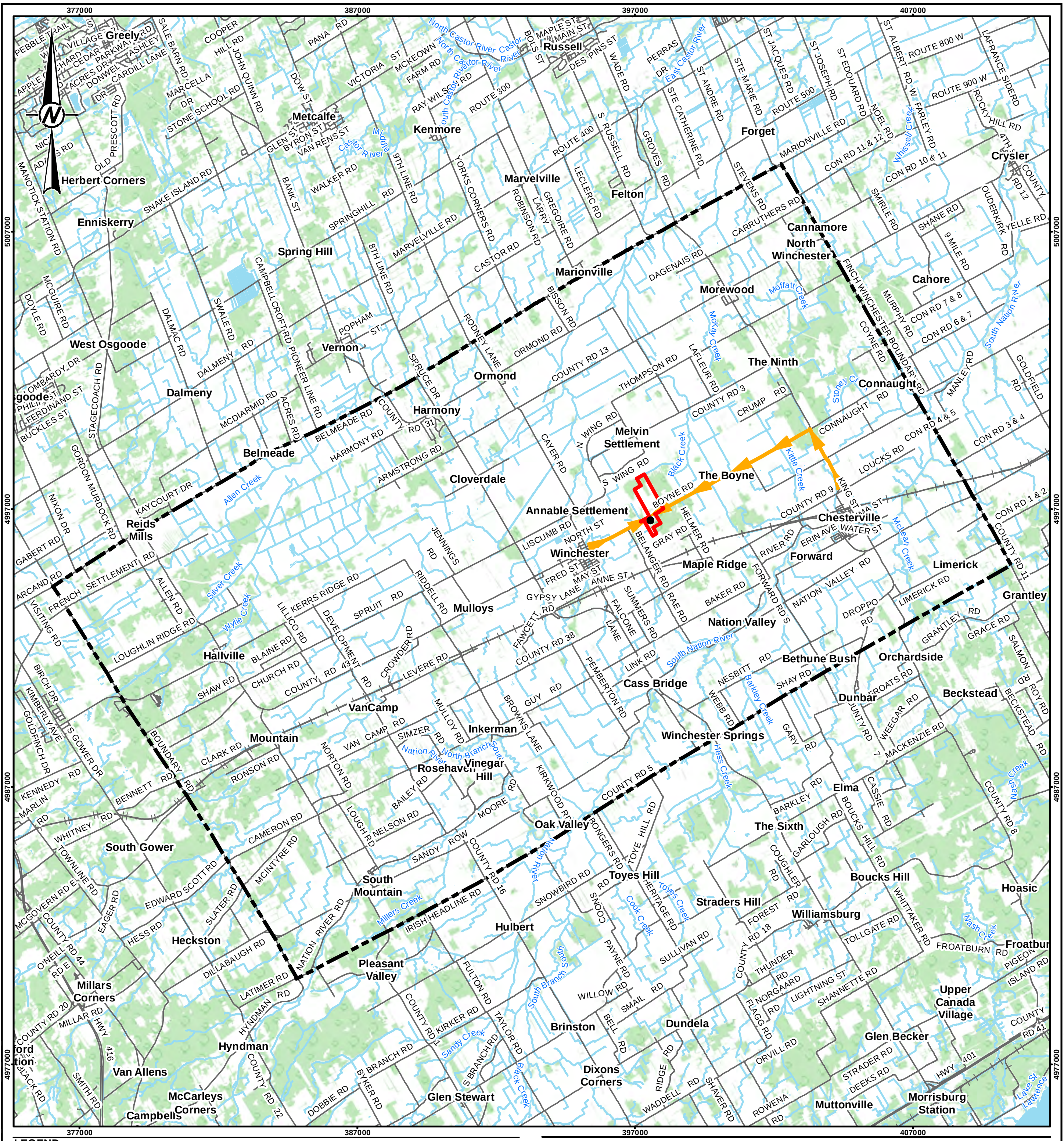
Chesterville. The service area for the landfill is the Township of North Dundas. The current extent of the landfill site property is shown on Figure 1.0-1. The site has been operating as a licenced landfill for the disposal of solid, non-hazardous waste since 1965. The Boyne Road Landfill is the only operational waste disposal site in the Township and receives all the residential and some of the industrial, commercial and institutional (IC&I) waste from the entire Township. The waste collection vehicles haul along the municipal road network directly to disposal at the landfill site; there is no transfer station facility. The Township is mainly rural with several small villages, with Winchester and Chesterville being the two largest villages. The main haul routes to the Boyne Road Landfill are indicated on Figure 1.0-1. The site operates under Environmental Compliance Approval (ECA) No. A482101.

The Boyne Road Landfill currently has an approved disposal area of 8.1 hectares (ha). The land area that comprises the landfill property consists of the original disposal area and the addition of a number of parcels of adjoining land between 1992 and 2018 located around the original disposal area, corresponding to a total land area of approximately 97.13 ha. This includes a 20 metre wide strip of Boyne Road across the northern edge of the landfill footprint and a 73.48 ha parcel of land located north of Boyne Road, both added to the landfill in 2018 as per Notice No. 9 of the ECA dated January 31, 2018. For purposes of this EA, which proposes to consider the alternative of expanding the Boyne Road Landfill, the Township acquired an additional 16.21 ha (40.05 acres) of property to the east and southeast to possibly be added to the site pending the outcome of the EA, eventually bringing the total site area to approximately 113.34 ha. In addition to the landfill property, the Township has acquired groundwater easements (referred to as Contamination Attenuation Zones 1 and 2 in the ECA). These parcels are shown on Figure 1.0-1: Township of North Dundas (EA Study Area)

Figure 1.2-1a groundwater easement to the south for contaminant attenuation may also likely be required for an expansion of the landfill if selected as the preferred alternative during the EA; negotiations to secure an option on this parcel have commenced although they are not complete as of the time of this proposed ToR.

Based on the original application for licensing of the landfill in 1971, the approved site capacity was approximately 395,000 cubic metres (m^3). When it was first determined in late 2014 that the site was in an overfill situation, the volume of waste in place was approximately 462,000 m^3. As of December 24, 2018, the volume of waste in place was about 533,780 m^3, corresponding to an overfill of approximately 139,000 m^3. Additional details regarding the overfill situation are provided in Section 3.1 of this ToR.

Operation of the landfill site, including its diversion facilities, is carried out by the Township in accordance with the requirements of its ECA conditions. The existing landfill site is a natural attenuation landfill, without an engineered bottom liner and leachate collection system. Compliance of the landfill with the applicable requirements for protection of off-site groundwater quality relies on natural processes in the subsurface. An annual monitoring program, consisting of groundwater and surface water monitoring, is part of the current site operations. The results of the 2017 monitoring program (Golder 2018) indicate that with respect to protection of off-site groundwater quality, the landfill is operating in compliance with the Ministry of Environment, Conservation and Parks (MECP) Reasonable Use Guideline (MECP, 1994). Surface water quality in the often-stagnant water within the drainage ditch along the north side of Boyne Road that receives surface water runoff from the landfill site is interpreted to experience discontinuous marginal impacts by landfill leachate but is generally in compliance with provincial surface water management policies. The results of the landfill monitoring programs show that the Boyne Road Landfill is performing acceptably and the impacts on the natural environment are deemed acceptable as described in the most recent extension of approval for continued landfilling (dated January 30, 2019).



LEGEND

🟩 TOWNSHIP OF NORTH DUNDAS

🟥 CURRENT ACTIVE BOYNE ROAD LANDFILL SITE PROPERTY

● DISPOSAL AREA

← HAUL ROUTES

0 2,000 4,000 8,000

1:200,000 METRES

NOTE(S)
1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT

REFERENCE(S)
1. SERVICE LAYER CREDITS:
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: MTM ZONE 9 VERTICAL DATUM: CGVD28

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
TERMS OF REFERENCE FOR THE ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS RESIDUAL WASTE MANAGEMENT PLAN

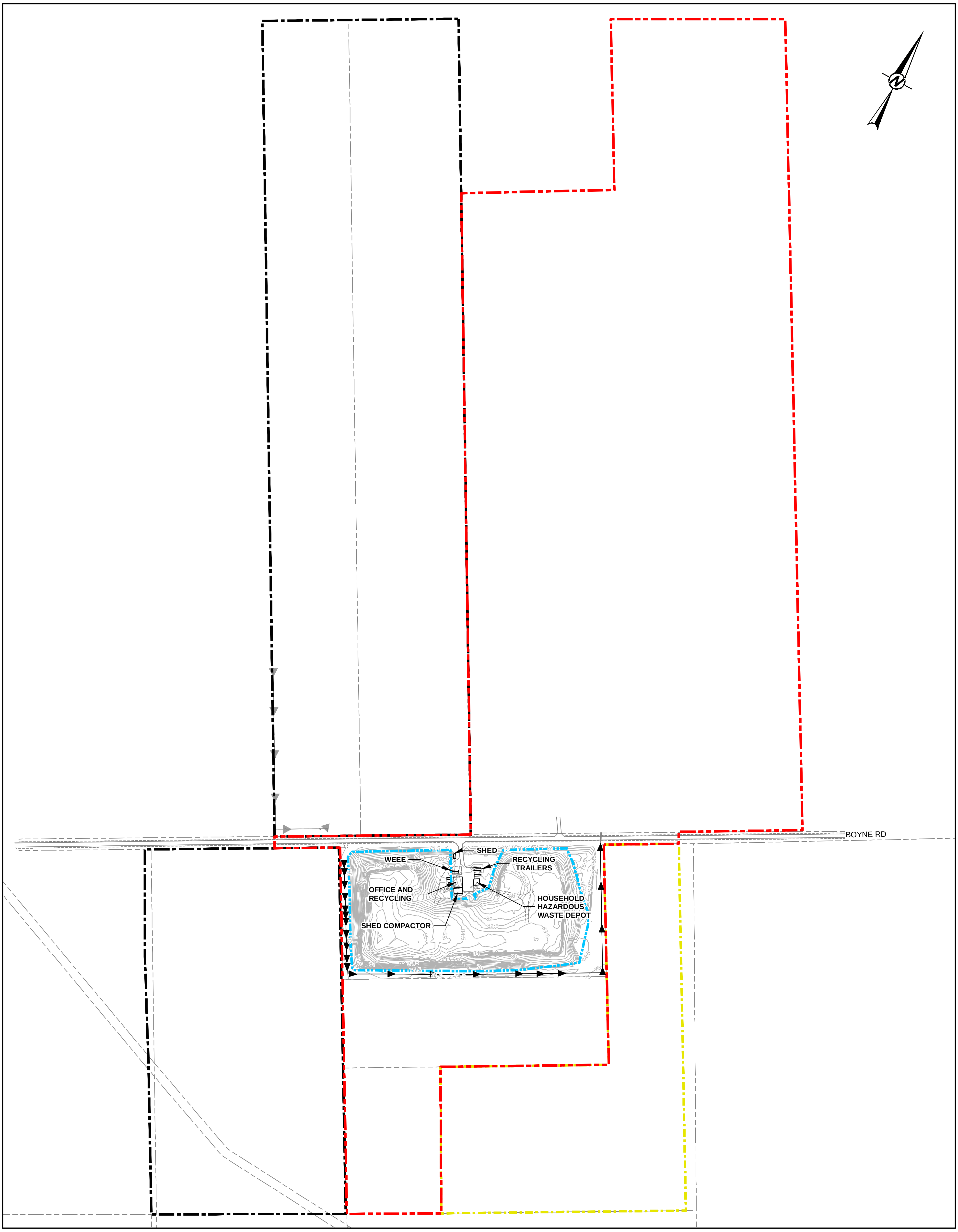
TITLE
TOWNSHIP OF NORTH DUNDAS (EA STUDY AREA)

CONSULTANT

GOLDER

YYYY-MM-DD	2019-02-25
DESIGNED	PLE
PREPARED	JEM
REVIEWED	YJM
APPROVED	PLE

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	1.0/1.2.4	0	1.0-1



LEGEND

- 🟦 EXISTING LANDFILL FILL AREA
- ⬛ APPROXIMATE BOUNDARY OF CONTAMINATION ATTENUATION ZONE
- 🟨 TOWNSHIP OWNED PROPERTY
- 🟥 APPROXIMATE LANDFILL SITE PROPERTY BOUNDARY
- ➤ APPROXIMATE LOCATION OF PERIMETER DITCH AND FLOW DIRECTION
- — GROUND SURFACE CONTOURS (m), BASED ON RESULTS OF THE SURVEYS CONDUCTED IN 2008, 2010, AND 2012 THROUGH 2017

REFERENCES

1. BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY STANTEC CONSULTING LTD.
2. 2008 AND 2010 SURVEYS COMPLETED BY STANTEC CONSULTING LTD.
3. MAY 2012, JULY 2013, NOVEMBER 2014, DECEMBER 2015, NOVEMBER 2016, AND DECEMBER 2017 SURVEYS COMPLETED BY GOLDER ASSOCIATES LTD.

NOTES

1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT

0 60 120 180 240 300
1:6,500 METRES

CLIENT
TOWNSHIP OF NORTH DUNDAS

CONSULTANT
GOLDER

YYYY-MM-DD	2017-03-15
PREPARED	JEM
DESIGN	PLE
REVIEW	YJM
APPROVED	PLE

PROJECT
TERMS OF REFERENCE FOR THE ENVIRONMENTAL
ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS
RESIDUAL WASTE MANAGEMENT PLAN

TITLE
BOYNE ROAD LANDFILL SITE PLAN

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	1.0/1.2.4	0	**1.2-1**

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

25mm

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1.3 Purpose of the EA Study or Undertaking

As part of a 2013 application procedure intended to update a number of items related to the Boyne Road Landfill operations and amend the Boyne Road Landfill ECA, the MECP determined in late 2014 that the landfill had exceeded its originally approved capacity and is in an overfill situation. At that time, it had been estimated that the landfill had approved disposal capacity through 2022. Due to the elements governing the originally approved site capacity, the Township was unexpectedly required to evaluate waste management alternatives to deal with this overfill situation at the landfill.

To continue using the landfill in the short-term, an amendment to the ECA for extension of approval for continued landfilling (emergency ECA) was received from the MECP and required the Township to evaluate long-term waste management alternatives (Golder, 2015). Using an assumed planning period of 25 years, the evaluation considered four alternatives: site closure and waste export, site expansion, a new landfill site and alternative waste technologies. The result of the comparative evaluation was that expansion of the existing Boyne Road Landfill was identified as the preferred long-term waste management alternative. Based on the findings of this evaluation, a Council resolution was passed in November 2015 to pursue approval to expand the site via an Environmental Assessment pursuant to the Ontario *Environmental Assessment Act* (EAA).

The Environmental Assessment commenced in late February 2017 and open houses on preparation of this ToR were held in March and October 2017, followed by preparation and circulation of the Draft ToR in late April 2018. Based on comments received on the Draft ToR from the MECP in December 2018, it was determined that the 2015 assessment of alternative waste management alternatives was not completed with the necessary detail to support the identified preferred alternative - expansion of the Boyne Road Landfill - at an EA level of detail. As such, key changes have been made to the Draft ToR (and are presented in this Proposed ToR) to review and re-assess the waste management alternatives that are reasonable for the Township to consider within the EA process and identify the preferred alternative. To reflect this revised approach, the title of the EA Study has been changed to Environmental Assessment of the Township of North Dundas Waste Management Plan.

Extensions to the emergency ECA have been obtained, with the current permitted operations to the end of January 2020; it is noted that annual applications for and approval of emergency ECA amendments will continue to be required to allow continued site operations until the EA of the long-term waste management plan, associated diversion opportunities and any other associated approvals are completed and the plan can be implemented. An EA Study location map is provided on **Figure 1.0-1** showing the Township of North Dundas and the location of the current active Boyne Road Landfill.

The purpose of the proposed EA Study is:

To provide environmentally safe and cost-effective long-term waste management for the Township of North Dundas for a 25 year planning period.

The purpose statement will be influenced by diversion studies proposed by the Township and made as a commitment in this ToR. It is proposed that the diversion studies be conducted during the EA, early in the process to provide input into post-diversion waste management requirements. Diversion is also an ‘Alternative To’ in this EA. The purpose statement will be refined as the EA proceeds through the planning process and the final purpose statement will be provided in the EA.

The first step in the EA process is the preparation of the ToR. Once approved, the ToR becomes the framework for conducting the EA. This document is the proposed ToR for the EA of the Township of North Dundas long-term waste management plan. This ToR has been prepared considering the Ontario MECP Code of Practice for “Preparing and Reviewing Terms of Reference for Environmental Assessments in Ontario” (MECP, 2014).

This proposed ToR is being submitted to the MECP, GRT members, Indigenous communities and the public for review and comments. The comments received by the MECP will be considered in their review of the proposed ToR and in the decision regarding approval to carry out an individual EA under the EAA.

2.0 EA PROCESS

This section describes the EA process that applies to the EA Study. Note that 'Alternatives To' for this waste management plan are described in Section 4.0 of this report. Technically an EA does not apply to all of the 'Alternatives To'; for example, exporting waste to an alternate disposal location. However, if the preferred 'Alternative To' identified during the EA is similar to the conclusion of the waste management study already completed (Golder, 2015) in that the preferred alternative is expansion of the Boyne Road landfill site, then the EA process applies.

2.1 Environmental Assessment Act (Ontario)

The EAA is a provincial statute that sets out a planning and decision-making process to evaluate the potential environmental effects of a proposed project (Ontario, 2010). *Ontario Regulation (O.Reg.) 101/07 for Waste Management Projects*, which was made under the EAA, states (in part) that some waste management projects, regardless of whether the proponent is public or private, are designated under the Act. Various projects are then exempted. According to *O.Reg. 101/07*, the EAA applies to a proposed change to a landfill site if the total waste disposal capacity exceeds that authorized under the EPA by more than 100,000 m^3 or to incineration without energy from waste (EFW) if the rate of incineration is greater than 10 tonnes of waste per day. The North Dundas Waste Management Plan is subject to the EAA because additional disposal capacity of more than 100,000 m^3 is expected to be required for a landfill alternative and greater than 10 tonnes of waste per day is expected for an incineration facility alternative. Accordingly, the Township's EA Study may be subject to an individual EA process, depending on the preferred alternative identified.

An EA under the EAA is a planning study that assesses environmental effects and advantages and disadvantages of a proposed project. The environment is considered in broad terms that include the environmental (natural) and social (including cultural and economic) aspects of the environment. In an individual EA, the first phase in the process is to develop a ToR for the EA studies (this document). Two public open houses were hosted by the Township as part of the consultation process for the development of the ToR. A draft ToR was then prepared and submitted to the MECP, Government Review Team (GRT), Indigenous groups and the public for review. After giving consideration to the comments received on the draft ToR, a proposed ToR (this document) was then prepared and submitted to the MECP for consideration by the Minister who will decide whether to approve, approve with conditions, or not approve the proposed ToR. If approved, the final ToR will become the framework for preparation and review of the EA. An overview of the entire approval process was presented to the public as part of open house #1 and is available in Volume 3 - Appendix D4.

On February 23, 2017, the Township initiated the EA process by publishing a Notice of Commencement (NoC) of the ToR in local newspapers, on the Township's website, and by mail to the GRT, Indigenous groups and other identified community stakeholders. A copy of the NoC is contained in Volume 3 - Appendix D1.

2.2 Canadian Environmental Assessment Act 2012

In July 2012, the *Canadian Environmental Assessment Act* (CEAA) was repealed and replaced with the CEAA 2012. CEAA 2012 is a federal statute that requires federal agencies to conduct an EA for designated projects and activities and projects on federal lands. The waste management plan is not a designated project and it is not expected that the preferred alternative identified will involve any federal lands; therefore, no federal EA is expected to be required.

2.3 Organization of this ToR

This submission consists of three volumes: Volume 1 – ToR; Volume 2 - Supporting Documents; and Volume 3 - Record of Consultation.

Volume 1 is organized into the following sections:

- Section 1.0 provides an introduction to this ToR, identifies the proponent, presents the purpose of the EA Study and describes, in general, existing waste management system in the Township;
- Section 2.0 describes the EA process, presents the purpose and organization of this ToR, includes the submission statement (i.e., how this ToR is being submitted for approval), and discusses flexibility in this ToR;
- Section 3.0 provides the rationale and description of the EA Study;
- Section 4.0 presents a description of and rationale for the ‘Alternatives To’ that will be evaluated in the EA Study;
- Section 5.0 provides a description of and the rationale for the ‘Alternative Methods’ of carrying out the preferred ‘Alternative To’ including the assessment and evaluation methodology;
- Section 6.0 provides an overview of the existing environmental conditions in the Township of North Dundas that may be affected by the EA Study;
- Section 7.0 presents the consultation plan for developing this ToR and for preparing the EA;
- Section 8.0 provides an overview of other regulatory approvals that may be required;
- Section 9.0 discusses the proposed schedule for preparing the EA;
- Section 10.0 provides statements of commitments and monitoring strategies by the proponent to be completed during the EA; and
- Section 11.0 lists the documents referenced in this ToR.

Volume 2 – Supporting Documents contains Supporting Document #1 – Waste Management Alternatives Evaluation (Golder, 2015).

Volume 3 – Record of Consultation presents the record of the consultation process for the development of this ToR. This includes a summary of events, stakeholder feedback received, and how stakeholder feedback was incorporated into the development of this ToR or a rationale for why it was not considered appropriate for inclusion.

2.4 ToR Submission Statement

This ToR is submitted to the MECP for approval in accordance with *O.Reg. 101/07*, and specifically pursuant to subsections 6(2)(a) and 6.1(2) of the EAA.

The Township of North Dundas will prepare and submit an EA to the MECP for review and approval in accordance with the approved ToR as required by subsection 6.1(1) of the EAA, and in accordance with the requirements of subsection 6.1(2) of the EAA. The subsections that will be addressed by the EA are listed in Table 2.4-1.

Table 2.4-1: Requirements for the EA

Subsection of EAA (Ontario, 2010)	EA Requirements
6.1(2*)(*a)	A description of the purpose of the undertaking.
6.1(2)(b)(i)	A description of and statement of the rationale for the undertaking.
6.1(2)(b)(ii)	A description of and statement of the rationale for the ’Alternative Methods’ of carrying out the undertaking.
6.1(2)(b)(iii)	A description of and a statement of the rationale for the ‘Alternative To’ the undertaking.
6.1(2)(c)(i)	A description of the environment that will be affected or that might reasonably be expected to be affected, directly or indirectly by the undertaking.
6.1(2)(c)(ii)	A description of the effects that will be caused or that might reasonably be expected to be caused to the environment.
6.1(2)(c)(iii)	The actions or mitigation measures that are necessary or that may reasonably be expected to be necessary to prevent, change, mitigate or remedy the effects upon or the effects that might reasonably be expected upon the environment.
6.1(2)(d)	An evaluation of the advantages and disadvantages to the environment of the undertaking, the ‘Alternative Methods’ of carrying out the undertaking and the ‘Alternatives To’ the undertaking.
6.1(2)(e)	A description of any consultation about the undertaking by the Township and the results of the consultation.

2.5 Flexibility of the ToR to Accommodate New Circumstances

The MECP Code of Practice (MECP, 2014) and subsection 6.1(1) of the EAA states that the EA must be prepared as set out in the approved ToR. While these ToR are intended to set out in detail the requirements for preparing the EA, this document cannot present every detail of every aspect of the EA; as such, circumstances could arise under which minor modifications are necessary or desirable. Accordingly, the Code of Practice (MECP, 2014) recognizes that it is important to incorporate flexibility into the ToR to accommodate such circumstances.

Examples of such circumstances may include:

- Situations that arise during the EA that do not allow commitments made in the ToR to be fulfilled. In such a scenario, it may be necessary to modify the commitment during the EA.
- Modifications to the proposed public consultation program.

The information provided in the ToR sets out the minimum requirements for the EA, and hence is preliminary. The information will be confirmed during the preparation of the EA in consultation with the public, Indigenous communities and government agencies. Any proposed minor modifications to this ToR would be documented and discussed in advance with the MECP. The modifications described above and other similar modifications would be considered minor changes that could be included within the overall scope of this ToR without need for seeking approval for a new ToR.

The justification for any proposed minor modifications will be provided to and discussed with the MECP when and if they occur during the EA process, in advance of submitting the EA. Any modifications will be documented, together with justification, in the EA Study report.

3.0 RATIONALE AND DESCRIPTION OF THE EA STUDY

This section of the ToR describes the Township's rationale for the EA Study, a rationale for the proposed 25 year planning period for the waste management plan and a description of the proposed EA Study, including the analysis to estimate the Township's waste management requirements for the 25 year planning period.

3.1 Overview of the Rationale

In May 2013, the Township applied for an amendment to the Boyne Road Landfill site's ECA to recognize an updated Design and Operations plan for the landfill and to add some diversion activities for the site. At that time, it was anticipated that the site operations would continue for approximately 10 years after 2012 (i.e., until 2022), and possibly more. In the fall of 2014, the MECP advised the Township that the approved site capacity based on the original 1971 registration of the site as a landfill had been exceeded and the site was in an overfill situation. The 1971 registration site capacity was determined to be lower than the basis of the site design and was not recognized by MECP, the Township and consultants until 2014. This overfill was confirmed by a survey of the landfill in the late fall of 2014. In view of this unexpected situation, the Township applied for and the MECP issued an amendment to the ECA for extension of approval for continued landfilling (emergency ECA) to allow the Township to continue using the Boyne Road Landfill site for both waste diversion activities and waste disposal until January 2016. One of the conditions of the Emergency ECA was that the Township undertake an evaluation of waste management alternatives and identify the preferred course of action to provide long term waste management services to the Township.

In 2015 the Township undertook an evaluation of waste management alternatives (Golder, 2015), which is provided as Supporting Document #1 to this ToR. The Township Council decided that their preferred alternative to provide long term waste management services for disposal of post-diversion waste (referred to as residual waste) was to expand the Boyne Road Landfill site and passed a resolution on November 10, 2015 to direct staff to commence the EA process required to obtain approval for the expansion. It was acknowledged that annual application to the MECP and their approval to extend the Emergency ECA would be required to continue to operate the landfill during the approvals period. As a result of consultation with MECP regarding the draft ToR, it was concluded that the previous evaluation would not be sufficient to satisfy the requirements of the EAA to define landfill expansion as the preferred alternative for the long-term waste management plan and, as such, an evaluation of 'Alternatives To' will be required in the EA.

Recognizing that the approvals process and then construction associated with implementation of the preferred waste management plan could extend over a 5 or 6 year period commencing in 2016, it is proposed that the planning period commence in 2022.

As an Ontario municipality responsible for providing waste services for its ratepayers, the Township's objective in undertaking this EA is to obtain approval for a long-term solution for waste disposal while concurrently evaluating diversion opportunities to reduce the amount of waste generated for disposal over the planning period.

The Township proposes a 25 year planning period, i.e., 2022 through 2047 for the following reasons:

- As it relates to building strong and healthy communities, the Provincial Policy Statement (2014) states under policies in section 1.1.1 that "…necessary infrastructure, electricity generation facilities and transmission and distribution systems and public service facilities are or will be available to meet current and projected needs. Section 1.1.2 states that "Nothing in policy 1.1.2 limits the planning for infrastructure and public service facilities beyond a 20-year time horizon." The provision of waste management and waste disposal services is a major component of municipal infrastructure; as such, a waste management planning period of 25 years is consistent with the Provincial Policy Statement
- A planning period of 25 years is the same as has been approved in many waste management EAs in Ontario in recent years, for both public and private sector proponents
- It is expected that the initiatives made by the province towards achieving zero-waste are likely to take time regarding planning and policy development followed by implementation. The Township needs to have secure waste management available during this time period. It is expected that some waste policy will be first implemented in urban centres, and therefore will only come later to rural municipalities like North Dundas. This is supported by comments regarding food and organic waste being applicable to larger cities found in "A-Made-in Ontario Environment Plan", November 2018. The plan also says that the MECP recognizes while we work to reduce the amount of waste we produce, it is also recognized that there will be a need for landfills in the future. It is acknowledged that Section 6.8 of the "Policy Statement on Ontario's Food and Organic Waste", April 2018 states that proponents of new or expanded waste management systems for disposal should consider resource recovery opportunities for food and organic waste. The Policy goes on to note that for municipalities the size of the Township the appropriate mechanism for organic waste management would be through home composting, community composting and local event days; the Township currently encourages home composting. The Township will consider waste diversion initiatives in alignment with Provincial policies and will study diversion opportunities as a commitment of this EA. The Township welcomes further information, requirements, regulation and funding on how this will work across the province. Despite a diversion study and Provincial policy, the Township of North Dundas is likely to be reliant on having secure post-diversion waste management available for an extended period of time, which is reasonably proposed by the Township as a 25 year planning period

During this ToR development, the Township updated its required existing post-diversion waste management projections through 2047, as presented in Section 3.2.

3.2 Problem and Opportunity Assessment

As described previously, the Boyne Road Landfill is the only active waste disposal site in the Township and currently serves all the Township of North Dundas. The landfill is currently in an overfill situation (the volume of waste in place exceeds that allowed under the original approval for the site by approximately 139,000 m^3). The landfill site is currently permitted to continue waste disposal through annual extensions of ECA A482101 while the Township explores alternatives for long-term waste management. It is this overfill situation that triggered the need for the EA process. The landfill provides disposal for residential waste as well as a portion of the Township industrial, commercial and institutional (IC&I) waste. The landfill also operates as the location for the Township's diversion activities as described below.

The Township has implemented a number of waste diversion programs within the municipality over the past 20 years that are practical and affordable for this type of municipality with a small, spread out total population of about 12,000 in 2016 with a small growth rate, and recognizing the reality that the Township is largely rural in nature with a limited number of small villages. The Township provides:

- Curbside pickup of residential and small commercial waste throughout the municipality
- Curbside pickup of recyclables throughout the municipality
- Curbside pickup of leaf and yard waste materials
- Drop off for recyclables at the Boyne Road Landfill site
- Operation of a municipal material recycling facility (MRF) at the Boyne Road Landfill site, where collected materials are sorted and then transferred out of the Township by a recycling contractor
- Tire recycling program at the Boyne Road Landfill site
- Receipt of brush and wood at the Boyne Road Landfill site for subsequent chipping
- Operation of a Waste Electrical and Electronic Equipment (WEEE) facility for receipt, storage and transfer of WEEE at the Boyne Road Landfill site
- Operation of a Household Hazardous Waste (HHW) facility at the Boyne Road Landfill site to serve the Townships of North Dundas and South Dundas

The following recyclable materials were collected and diverted from landfill in 2016 and 2017, respectively: 28/175 tonnes of steel; 68/62 tonnes of plastic; 8.7/9.5 tonnes of aluminum; 211/175 tonnes of (news) paper; and 324/336 tonnes of cardboard. The Township's estimated municipal waste diversion rate, as reported in 2016 and 2017 to Waste Diversion Ontario and Resource Productivity and Recovery Authority, is approximately 25 and 23 percent (%), respectively (WDO, 2016 and RPRA, 2017).

The *Waste-Free Ontario Act* is the short-form reference for two pieces of legislation: *Resource Recovery and Circular Economy Act* and the *Waste Diversion Transition Act*, 2016. While the province recognizes that additional waste disposal is needed to meet demands over the next several years, the goal of the *Waste-Free Ontario Act* and subsequent *Strategy for a Waste-Free Ontario* is to shift from waste disposal to waste diversion and make waste management a carbon neutral industry. The Township supports these goals and is taking proactive steps, as practical and affordable for a small rural municipality, toward these goals. The Township commits to evaluating waste diversion initiatives in alignment with current Provincial policies during this EA.

The Township has and continues to look for opportunities to further increase waste diversion in this sparsely populated rural municipality. In comparison to larger urban centres where the addition of municipal-scale composting/processing of household and IC&I organics is often evaluated to progress towards achieving the province’s overall interim diversion target of 30% by 2020, 50% by 2030 and 80% by 2050 (Strategy for a Waste-Free Ontario: Building the Circular Economy, February 2017), it is noted that the majority of the Township’s residents live on larger rural properties where individual composting of leaf and yard materials and food wastes is already a fairly common practice and not documented nor counted in the Township’s reported diversion rate.

Residual solid waste is the waste remaining for disposal (by means of a number of possible alternatives) after diversion/recycling activities. For purposes of estimating the residual waste management requirements for the 25 year planning period, projections were initially based on the latest population growth statistics available for the Township as shown in Table 3.2-1.

Table 3.2-1: Total Population – Township of North Dundas

	Census Year				
	1996	**2001**	**2006**	**2011**	**2016**
Total Population	11,064	11,014	11,095	11,225	11,278

Source: Statistics Canada http://www.statcan.gc.ca

The Statistics Canada data indicates the Township will increase by 0.09% per year in the next 20 to 30 years based on a percentage change of 0.4% in the Township’s population from 2011 to 2016. The United Counties of Stormont, Dundas and Glengarry Official Plan consolidated in 2018 suggests that the population compounded annual growth rate between 2016 and 2036 is expected to be 0.6%. As such, the more conservative compounded annual growth rate was used to determine the post-diversion waste management requirements for the 25 year planning period.

The results of previous surveys of the active portion of the landfill completed since 2008 indicate that the annual fill rate ranges from approximately 10,400 to 18,900 cubic metres per year (with one higher fill rate in 2017), with an average of 14,100 cubic metres per year. Prior to 2008 these parameters were estimated based on car counts, which were later found to be inaccurate. It is also noted that there is not a weigh scale at the current landfill by which to determine tonnage received, diverted and disposed. The landfill does not differentiate between municipal and industrial, commercial and institutional (IC&I) waste and hence detailed information on the volume of waste from each of these sectors is not available.

Based on the range indicated above, the annual landfill airspace consumed varies considerably from year to year, depending on specific events that occur within the Township, i.e., construction and demolition projects, structure fires, etc., and the corresponding need for disposal capacity. For purposes of estimating the initial post-diversion waste management requirements for the 2022-2047 (25 year) planning period to be provided, the current waste diversion rate of 23 to 25% and an allowance for 14,100 cubic metres (m^3) per year of post-diversion waste starting in 2017 have been assumed. The Township intends to promote composting through an education program and possible composter bin rebate to try and increase diversion of organics from the landfill in the near future. But in view of the rural agricultural nature of the Township it is known that there is already residential organics diversion taking place and so it is difficult to estimate what percentage increase in the overall diversion rate will result and over what time period. So, for initial planning purposes, it is proposed to continue to use a 23 to 25 % diversion rate. The proposed post-diversion waste amount is equivalent to approximately 1.15 cubic metres of waste per capita per year. The projected initial future post-diversion waste management requirements are provided in Table 3.2-2 below.

Table 3.2-2: Projected Post-Diversion Waste Management Requirements, Township of North Dundas

Year	Estimated Annual Waste Disposal (m^3)
2017	14,115
2018	14,200
2019	14,285
2020	14,370
2021	14,455
2022	14,545
2023	14,630
2024	14,720
2025	14,805
2026	14,895
2027	14,985
2028	15,075
2029	15,165
2030	15,255
2031	15,350
2032	15,440
2033	15,335
2034	15,625
2035	15,720
2036	15,815
2037	15,910
2038	16,005
2039	16,100
2040	16,195
2041	16,295
2042	16,390
2043	16,490
2044	16,590
2045	16,690
2046	16,790
2047	16,890
TOTAL for 2022 to 2047	**407,900 m^3**

Based on the above assumptions and projection, the waste management plan for 25 years beyond 2022 will have to accommodate waste corresponding to the consumption of approximately 400,000 m^3 (to be confirmed during the EA) of landfill airspace (excluding final cover) that would be required if landfilling is selected as the preferred 'Alternative To' through the EA process. The results of the proposed diversion study can influence and reduce the amount of post-diversion waste requiring management.

3.3 Need for the EA Study

It has previously been determined that the Boyne Road Landfill is currently in an overfill situation in terms of approved site capacity. It is this overfill situation that triggered the need for the EA process. Based on a 25 year planning period commencing in 2022 (which allows time for all approvals for a waste management plan to be in place and for construction associated with the plan), it is estimated that there will be a need to accommodate post-diversion waste corresponding to the consumption of approximately 400,000 m^3 of additional landfill airspace.

3.4 Description of the Proposed EA Study

The proposed EA Study is the EA of the Township's waste management plan for a 25-year planning period. The description and rationale will evolve during the preparation of the Environmental Assessment. Therefore, the final description of the proposed project and the rationale for it will be included in the Environmental Assessment once alternatives have been considered and evaluated.

4.0 RANGE OF ALTERNATIVES TO BE EVALUATED IN THE EA

After a determination that the Boyne Road Landfill site had exceeded its approved disposal capacity and is in an overfill situation and concluding that there was a need for additional waste disposal capacity to continue to provide waste disposal service for the Township of North Dundas, the Township looked at different ways of meeting this need. In EA terminology, this is referred to as assessment of ‘Alternatives To’, which are the functionally different ways of addressing the need.

The assessment previously conducted by the Township that led to the identification of expansion of the Boyne Road Landfill as the preferred waste management alternative considered both landfilling and non-landfilling options. The previously completed Waste Management Alternatives Evaluation (Golder, 2015) is provided as Supporting Document #1 to this ToR and is described in Section 4.1.

4.1 Waste Management Study Conducted Prior to the EA

This section of the ToR summarizes the findings of the previously completed preliminary assessment study and is included to provide the reader with an overview of the work that has already been done.

The previously completed study provided an evaluation of waste management options to address the overfill situation at the Boyne Road Landfill using a combination of technical, approvability and financial factors to assist the Township in identifying a preferred course of action to provide both short-term and long-term waste management services for the municipality.

The alternatives considered by the Township consisted of the following:

Alternative 1 – Landfill Site Closure and Export of Waste for Disposal

Alternative 2 – Landfill Site Expansion

Alternative 3 – Establish New Landfill Site in the Township

Alternative 4 – Alternative Waste Management Technologies (thermal treatment, e.g., Energy from-Waste).

Alternatives 3 and 4 were not expected to be financially viable alternatives for a small rural municipality considering the small population and relatively small volume of waste generated within the Township; as well, these alternatives would involve a lengthier and likely more contentious approvals process, and/or the need to collaborate with other municipalities. Alternatives 3 and 4 were therefore screened out early in the evaluation, and in the assessment only Alternatives 1 and 2 were considered in detail.

Alternative 1 would involve the following steps: 1) preparation of a closure plan for the landfill site; 2) application to establish a waste transfer facility at the site; 3) negotiation of a disposal contract at a privately owned landfill facility and commence hauling for disposal; and 4) completion of the landfill closure works. Post-closure monitoring and maintenance of the landfill would be ongoing. For Alternative 1, two scenarios were considered: Alternative 1a where services would be provided to export both the residential and non-residential waste that is currently disposed at the Boyne Road Landfill (estimated 8,000 tonnes/year), and Alternative 1b where service would be provided for only the residential waste component (estimated 2,900 tonnes/year). For Alternative 1b, the owners of all non-residential generated waste would have to make their own arrangements for disposal at facilities other than those provided by the Township.

Alternative 2 would involve a landfill expansion of more than 100,000 m^3 of capacity and require an individual EA according to the *Waste Management Projects Regulation* (*Ontario Regulation 101/07*) and the following steps would be followed: 1) obtain MECP approval to continue landfilling operations on the existing approved footprint at the Boyne Road Landfill site during the expansion approvals process; 2) identify the property and easements that may be required for the expansion and if possible secure options to acquire them during the ToR or EA; 3) commence EA process; 4) assuming landfill expansion was selected during the EA, after EA approval, apply for an amended ECA for expanded site operations (expected 5 to 6 year combined EA and ECA approvals process); and 5) construct initial phase and associated works for the expansion area and commence landfilling within the expansion.

For Alternative 2, preliminary studies were undertaken to assess potential impacts associated with a conceptual expanded Boyne Road Landfill layout on specific aspects of the environment: groundwater, surface water, atmospheric (air, odour, noise) and natural environment (biology). For purposes of this preliminary assessment, a conceptual design configuration of the expansion was located on the south side of the existing landfill to provide an assumed additional airspace of 550,000 m^3. Details on each of these studies and the key findings and implications on the landfill expansion are provided in the report. Of the technical considerations associated with the expansion, in terms of both operating considerations and costs, it was identified that the only economically viable approach for the Township is to continue operating an expanded Boyne Road Landfill as a natural attenuation site (one without a bottom liner, a leachate collection system and a requirement for treatment of the collected leachate), recognizing that it may be necessary for the Township to acquire additional property and/or groundwater easement agreements for contaminant attenuation. As such, the groundwater and surface water technical feasibility studies only considered proceeding with a landfill expansion based on a continued natural attenuation landfill design approach.

Using the considerable amount of information available from subsurface investigations and ongoing site monitoring programs, a preliminary assessment of the potential effects of landfill leachate on groundwater quality and the likelihood that the expanded site will satisfy the requirements of the MECP Reasonable Use Guideline (MECP, 1994) in the long term was carried out using predictive contaminant modelling. The assessment concluded that an expansion of the landfill as contemplated in the 2015 preliminary assessment could be expected to satisfy the Reasonable Use Guideline with specific enlargements of the Contamination Attenuation Zones. Because this is the primary technical factor in determining whether expansion of the Boyne Road Landfill as a natural attenuation site is feasible, and because of the importance of this in the Township's decision-making, a technical consultation meeting was held in October 2015 between the Township and MECP hydrogeologists and surface water staff who are familiar with the Boyne Road Landfill. The purposes of this technical meeting were: 1) to present the results of recent additional site investigations, the predictive calculation approach, and the results of the assessment; and 2) to obtain MECP feedback on the approach taken and whether or not they would likely be supportive of this approach if the expansion of the Boyne Road landfill was decided as the preferred approach and the findings were presented in the context of EA studies undertaken for a natural attenuation expansion design of the Boyne Road Landfill. The MECP technical staff considered that the approach taken in the assessment was appropriate. The assessment of potential impacts of an expanded Boyne Road Landfill on off-site groundwater resources will be further assessed in the EA, if expansion of the landfill is identified as the preferred alternative.

Pre-consultation was also carried out with the MECP Source Protection Programs Branch (MECP SPPB) and the Raisin-South Nation Protection Region (RSNPR) because the Chesterville Water Supply is obtained from a high capacity overburden well located some 3 km southeast from the Boyne Road Landfill. Both the current and possible expanded fill areas are located within a well head protection area with a vulnerability score of 4. The pre-consultation conducted with the MECP SPPB was regarding the water supply well, existing landfill and the alternative to expand the landfill. Correspondence related to this pre-consultation is documented in Volume 3 - Appendix F including a summary memo of the issues and outcomes. The issue of source water protection will be further assessed in the EA, as appropriate.

To compare Alternatives 1 and 2, the following evaluation factors were considered:

- Technical feasibility
- Likelihood to obtain MECP Approval
- Opinion of Probable Costs (capital expenditures and long-term annual operating costs over 30 years)

Alternative 1 – Closure of the Boyne Road Landfill and waste export for disposal – was considered to be technically feasible. The only landfill licensed to accept waste from the Township in eastern Ontario and in operation at the time of the 2015 study was the privately-owned Eastern Ontario Waste Handling Facility (EOWHF). The only uncertainty for the Township under Alternative 1 would be the Conditions imposed by the MECP for approval of the landfill site closure and the establishment of a waste transfer station at the location of the existing landfill, but these requirements are common to many landfill sites and the Conditions were not expected to be onerous. Beyond the 30-year planning period considered in the study, there is uncertainty that the Township may face related to the remaining capacity at the selected private waste disposal facility (the EOWHF landfill), although it was assumed that the continuing demand for waste disposal in eastern Ontario would result in the availability of an alternative to this facility in the longer-term, in the event the EOWHF site is not able to provide continuing services to the Township.

Alternative 2 – Expand the Boyne Road Landfill site – was considered to have a reasonable likelihood of obtaining EA approval as a natural attenuation landfill, with the understanding that the Township can secure the required additional lands for the expansion and negotiate the required CAZ easements with adjacent landowners. If these cannot be secured, then an expansion application is unlikely to be successful since there is insufficient land area available on the currently owned landfill property and (based on the preliminary predictive modelling for the conceptual expansion configuration) the CAZ does not extend far enough beyond the property in the required directions. It was considered that if EA approval is received, there is little risk that the ECA amendment would not be subsequently approved. The technical feasibility of Alternative 2 appeared favourable, although in view of changing EA requirements, Ministerial approvals, and waste management practices, as well as potential stakeholder concerns, there is always a degree of uncertainty inherent in the outcome of an EA process.

The comparison of the Financial Implications of each Alternative is provided in Table 4.1-1 below.

Table 4.1-1: Comparison of Financial Implications of Waste Management Alternatives

Alternatives	Quantities Considered (in 2015)	Capital Expenditures (in 2015 dollars)	Estimated Annual Operating Costs [1] (in 2015 dollars)	Estimated Overall Probable Costs over 30 years [2] (in 2015 dollars)
Alternative 1a: Closure of Boyne Road Landfill and Waste Export (Residential and Non-Residential Waste)	8,000 tonnes	$1,130,000	$550,000	$17,630,000
Alternative 1b: Closure of Boyne Road Landfill and Waste Export (Residential Waste Only)	2,900 tonnes	$1,115,000	$200,000	$7,115,000
Alternative 2: Boyne Road Landfill Expansion	18,900 m^3 *	$5,500,000	$55,000	$7,150,000

Notes:

[1] Curbside collection costs are not taken into consideration in this evaluation and only the incremental costs to haul waste to the EOWHF site for disposal are included in Alternative 1.

[2] For this calculation, annual operating costs were not adjusted for inflation or for an increase in waste disposal requirements, as they are not meant to reflect future values. Instead, it is intended to evaluate the general financial implications of each Alternative.

* The quantity considered in the 2015 study was larger than is anticipated for the expansion planning period based on more recent data.

The comparison of the Financial Implications of each Alternative indicated that Alternative 2 would yield an overall probable cost over 30 years approximately three times lower than Alternative 1a, and similar overall probable costs to Alternative 1b over 30 years. The costs associated with operating a landfill site do not cease once the landfill has reached capacity and is closed. Post-closure care (PCC) costs are expected to be required for many years after closure (over the remainder of the contaminating lifespan of the landfill site), mainly continued monitoring and reporting activities as well as site maintenance. Based on current MECP requirements, PCC costs for the landfill are expected to be generally similar between the two Alternatives.

Although the capital costs for Alternative 2 are greater than those of Alternative 1, the difference in operating costs over the course of the expected expansion life time favours Alternative 2 over Alternative 1a and results in Alternative 2 being similar to Alternative 1b in terms of overall financial implications. It is noted that the capital costs for Alternatives 1a and 1b were expected to all occur in 2016 (assumed closure date) whereas much of the capital costs for Alternative 2 were expected to occur over the course of the lengthy approval process and the initial phase of construction of the expansion (assumed from 2016 to 2022). Moreover, the difference in operating costs between the three Alternatives is due to waste hauling costs and tipping fees associated with Alternatives 1a and 1b. Although the Township would be able to tender the hauling contract regularly (often on a 3 to 5 year basis), the waste disposal service provider was the only viable option available for the Township. The Township would consider negotiation of a long-term contract for the tipping fees to avoid unforeseen future cost increases. Based on this assessment, it was determined that expanding the existing landfill was considered feasible from a technical and economic standpoint.

The summary of the previously completed waste management alternatives evaluation, including the main advantages and disadvantages, is presented in Table 4.1-2 below.

Table 4.1-2: Summary of Waste Management Alternatives Evaluation

Alternatives	Considerations			Main Advantages	Main Disadvantages
	Technical Feasibility	MECP Approvals	Capital and Operating Costs		
Alternative 1: Closure of Boyne Road Landfill and Waste Export	High degree of certainty	High degree of certainty	Less favourable	1) High certainty 2) Fast transition from current waste management service 3) Lower capital expenditures	1) Higher operating costs 2) Dependency on a single waste disposal service provider
Alternative 2: Boyne Road Landfill Expansion	Likely	Reasonable likelihood to obtain approvals for a natural attenuation landfill	More favourable	1) Lower operating costs 2) Lower overall financial implications 3) Continued operations at the site under Township control	1) Higher capital expenditures 2) Relative uncertainty of EA approval 3) Lengthy approval process

The findings of this study were provided to the Township and discussed at a meeting of Council on November 10, 2014. Township Council decided that Alternative 2- Expand the Boyne Road Landfill - was the preferred option and by Council resolution directed staff to pursue the EA process required to obtain approval for the landfill expansion.

Information on consultation related to the Golder 2015 study is provided in Section 7.0 of the ToR.

4.2 Development and Evaluation of ‘Alternatives To’

The evaluation of ‘Alternatives To’ for the purpose of providing waste management for the Township of North Dundas for a 25-year planning period will be carried out as an initial step of the EA.

In preparing this ToR, the Township has considered the range of alternatives that are possibly available to it as a small rural municipality and has determined that the four options considered in the previously completed preliminary study (Golder, 2015) represent the range of the ‘Alternatives To’ that will be considered in the EA, along with the Do Nothing alternative and enhanced waste diversion programs.

As such, the six ‘Alternatives To’ that will be considered are:

- Alternative 1 – Landfill Site Closure and Export of Waste for Disposal: This alternative would involve closure of the Boyne Road landfill site and export of post-diversion waste to a waste disposal facility outside the municipality that is licensed to accept the waste. It is noted that the only landfill whose service area includes the Township of North Dundas and is currently in operation is the EOWHS, as was assessed in the preliminary assessment.
- Alternative 2 – Landfill Site Expansion: This alternative would involve the expansion of the Boyne Road landfill site and its continued use.
- Alternative 3 – Establish New Landfill Site in the Township: This alternative would involve the closure of the Boyne Road landfill and the establishment of a new landfill facility, a greenfield site, at a new location to be determined within the geographic boundaries of the Township.
- Alternative 4 – Alternative Waste Management Technologies (thermal treatment): This alternative would consider the potential to use an alternative waste management technology for waste management. Although there are various thermal processes on the market, most have not been demonstrated successful at a commercial scale operation in Ontario. As such, and in view of thermal facilities currently licensed and operating in Ontario (albeit for municipalities far larger than North Dundas, the only thermal treatment technology that will be considered in this assessment is incineration (energy-from-waste or EFW). The use of this technology would require the service to be provided by a private sector operator of this type of facility, since it is beyond the capability of the Township both financially and operationally. It is expected that a new site within the Township would have to be established for this process. It is also noted that with this technology there remains a need for a landfill for the disposal of ash, which could be a limited expansion of the Boyne Road landfill site, a new small landfill at the same site of the incinerator or export of the ash outside the Township for disposal at a licensed landfill.
- Alternative 5 – Enhanced At-Source Waste Diversion: This alternative will require the Township to consider and look for opportunities to increase diversion from disposal by considering public feedback, evaluating current legislation and funding mechanisms and assessing diversion opportunities in alignment with the small, rural nature of the Township. With the exception of a zero waste solution, this alternative does not have the ability to fully address the stated problem being assessed but can reduce the amount of post-diversion waste requiring management. A zero waste solution is not presently considered possible or available to the Township given its small size and tax base to pay for this system and no control over IC&I waste generators (which are provincially legislated).

- Alternative 6 – Do-Nothing: In EAs, the Do-Nothing alternative is considered in the evaluation of 'Alternatives To' as a benchmark against which the potential environmental impacts and the advantages and disadvantages of the alternatives being considered can be measured and compared. For the Township of North Dundas, the Do-Nothing alternative would be to close the Boyne Road Landfill (since it has already exceeded its originally approved capacity) and not pursue any other solution for waste management for the Township. It is noted that one of the Township's basic requirements as a municipality is to provide municipal services and infrastructure for its ratepayers. As such, the Do-Nothing alternative is not an 'Alternative To' that could be considered to resolve the long-term waste management problem; rather, as stated above, it provides a basis of comparison as part of the EA process.

To provide a basis for comparative evaluation, each of Alternatives 1 to 5 will be developed at a conceptual level so that their feasibility of implementation, potential effects on the environment and relative advantages and disadvantages can be identified. This will involve the following:

- For Alternative 1, the concept as described in the preliminary assessment will be updated, including soliciting an updated tipping fee cost from the EOWHF.
- For Alternative 2, an envelope that could be used to accommodate 400,000 m^3 of additional landfill airspace will be developed and considered.
- For Alternative 3, a set of general exclusionary criteria that are typically used for landfill siting will be decided for the purpose of screening out areas of the Township that are not suitable and could not be considered for a new landfill site. Published mapping sources would provide the information used in this screening exercise. Areas surviving this screening will represent potential locations for siting a new landfill. A preliminary total land area required for development of a landfill having a new airspace of 400,000 m^3 and following the requirements of O.Reg. 232/98 will be determined, and the size of the potential locations assessed to determine whether they are large enough. If there are no potential areas large enough remaining, Alternative 3 will be eliminated from the comparative evaluation.
- For Alternative 4, published information sources would be used to describe the general characteristics of an incineration facility for the Township of North Dundas. The screening exercise for siting a new landfill site would also provide relevant information for a possible incineration site.
- For Alternative 5, the existing diversion program including how estimates of diversion are made without a weigh scale will be considered with assistance from the Township. Potential waste diversion options will be developed with the Township, considering the small, rural nature of the municipality as well as MECP policy and any programming or funding. Waste diversion options will be presented to the public for comment as well as to discuss the mechanism for their comparison and evaluation. A solid waste diversion report will be prepared that summarizes the work completed and provides recommendations and an implementation plan.

- For Alternative 6, the general characteristics of Do Nothing would be as described above.

Given the fundamentally different characteristics of each of the ‘Alternatives To’, a broad set of environmental criteria is proposed to be used for comparative evaluation of the ‘Alternatives To’. The proposed preliminary evaluation criteria, which will be finalized during the EA in consultation with the MECP, Indigenous communities and the public, are provided in Table 4.2-1.

Table 4.2-1: Preliminary Criteria for Evaluation of ‘Alternatives To’ the Undertaking

Environmental Category	Preliminary Evaluation Criteria
Natural Environment	• Potential effects on groundwater resources • Potential effects on surface water resources • Potential effects on natural environment features (aquatic and terrestrial biology) • Potential effects on air quality, including consideration of transportation effects
Social	• Potential effects on cultural environment (archaeology and built heritage) • Potential impacts on existing land use • Potential site operational effects on sensitive receptors (i.e., noise, air quality)
Economic/Financial	• Relative costs and timing of approvals • Relative cost of implementation (capital and operational costs)
Technical Considerations	• Potential effect on road network and airports • Ability of the Township to operate • Technical risks associated with the operation of the alternative

The potential effects and/or implications of each of Alternatives 1 to 5 will be generally identified and described for each of the environmental criteria. It is proposed to then use a qualitative assessment methodology to complete a comparative assessment of Alternatives 1 to 5. The methodology would consist of assigning an overall relative ranking from most preferred to least preferred for each alternative, first for each of the criteria and then for the environmental category.

As part of the comparative assessment, the advantages and disadvantages of each ‘Alternative To’ would then be described. The Do-Nothing alternative would be included in this comparison.

The outcome of this ranking exercise will be the identification of the preferred ‘Alternative To’ for waste management for the Township of North Dundas.

5.0 DEVELOPMENT AND EVALUATION OF ‘ALTERNATIVE METHODS’

Following the identification of the preferred ‘Alternative To’, a reasonable range of ‘Alternative Methods’ will be developed.

In EA terminology, ‘Alternative Methods’ are the different ways that the preferred ‘Alternative To’ can be implemented. The MECP Code of Practice (MECP, 2014) states that a reasonable range of alternative methods should be considered that address the need and are within the proponent’s ability to implement. The alternative methods should be determined by the significance of potential environmental effects of the preferred ‘Alternative To’ and the circumstances specific to the preferred ‘Alternative To’, such as the proponent’s situation, timing and financing. For example, should expansion of the Boyne Road Landfill site be identified as the preferred ‘Alternative To’, the ‘Alternative Methods’ would consist of alternative expanded landfill site designs and configurations to satisfy the requirements of O.Reg. 232/98, such as location of the expansion on the existing site, landfill expansion geometry and various approaches of managing leachate and landfill gas.

The individual ‘Alternative Methods’ will be identified, refined and confirmed during the EA.

5.1 Assessment and Evaluation of ‘Alternative Methods’

In general, the assessment and evaluation of ‘Alternative Methods’ will form the EA methodology and is expected to involve the following steps:

- Identification of the appropriate Study Areas and time frames where potential effects from the preferred ‘Alternative To’ will be studied.
- Characterize the existing environmental conditions relevant to the preferred ‘Alternative To’.
- Develop the ‘Alternative Methods’.
- For the purpose of comparative evaluation of ‘Alternative Methods’, develop a set of environmental criteria, the rationale for their inclusion, indicators that will be used to assess potential effects and data sources. These will be established during the EA in consultation with the MECP, Indigenous groups, GRT and the public. In general, the environmental criteria cover the components of the environment and typically include some or all of atmosphere, geology and hydrogeology, surface water, biology, land use, archaeology and cultural heritage, socio-economic, transportation and site design & operational considerations.
- Develop detailed work plans for each of the environmental components and include input from the agencies, Indigenous communities and the public; where relevant, pre-consult with the appropriate regulatory agency prior to undertaking the work plans.

- Quantitatively or qualitatively (as appropriate for the environmental component) assess the potential effects of the ‘Alternative Methods’,

- Compare the ‘Alternative Methods’ and identify the overall preferred ‘Alternative Method’.

- Complete a predictive assessment of environmental effects of the preferred ‘Alternative Method’ and determine the net effects, including comparison to the Do-Nothing alternative.

- Complete a cumulative effects assessment of the net effects of the preferred alternative with the predicted effects of other existing and identified and probable projects in the area of the preferred alternative, where there are overlapping effects. Consider effects associated with climate change.

- Prepare the EA Study report, technical supporting documents as appropriate and a Consultation Record.

6.0 DESCRIPTION OF EXISTING ENVIRONMENTAL CONDITIONS

The environment is defined as those components of the natural and human environment that may be affected by the undertaking and for this EA are separated broadly into environmental and social components.

This section presents an overview of existing environmental conditions for the environmental and social components within the overall Regional Study Area, which is the Township of North Dundas. As described in the MECP Code of Practice (MECP, 2014), the Municipality of North Dundas commits to present in the EA report a more detailed description of the existing environmental conditions in study areas relevant to the preferred ‘Alternative To’ and in study areas relevant to the comparative evaluation of ‘Alternative Methods’.

The following is an overview of existing environmental conditions in the Township of North Dundas.

The Township was formed in 1998 by the amalgamation of the former Townships of Winchester and Mountain, as well as the Villages of Winchester and Chesterville. The Township is located south of the City of Ottawa, within the Counties of Stormont, Dundas & Glengarry. The total land area comprising the Township is 503.2 square km. Based on the Canadian census, the 2016 population was 11,278, only slightly larger than the 2011 population of 11,225. Approximately one-third of the population is within Winchester and Chesterville, with the remainder located in several smaller communities and spread across this largely rural municipality.

6.1 Atmosphere

Within the Township, air quality is expected to be typical of rural eastern Ontario with transportation and agricultural activities contributing to baseline air quality/odour and noise levels. The closest air monitoring stations to the Township are located in Ottawa and Cornwall.

6.2 Geology and Hydrogeology

The uppermost bedrock unit underlying the majority of the Township is limestone of the Gull River Formation, which is indicated to be overlain by Rockcliffe Formation shale in the south-central part of the Township.

Overburden soils generally consist of a mixture of marine silty clay and glacial till plain, with some specific areas underlain by organic soils. In the eastern part of the Township, an elongated northeast to south west trending ridge consisting of glacial outwash sand and gravel is present; this is locally known as the Morewood Esker, and more regionally as the Vars-Winchester esker. There is also a northeast-southwest trending area of granular soils in the western part of the Township (Hallville area) known as Hyndmans Ridge. There are several licenced aggregate operations that extract sand and gravel from these ridge features.

The thickness of overburden soil overlying the bedrock is shown to generally range from about 5 to 10 metres, with some areas of both thicker and thinner soil cover. It is known from previous subsurface studies within the Township for specific purposes, i.e., water supply studies, Boyne Road Landfill site, wastewater lagoons, that the thickness of overburden can be quite variable over relatively short horizontal distances and that there can be significant departures from the general drift thickness shown on published mapping.

The Township relies on groundwater from drilled wells for potable water supply. The Villages of Winchester and Chesterville each have communal water supplies from high capacity drilled overburden wells located within portions of the Morewood Esker. The remainder of the Township relies on individual wells that generally obtain their water from zones within the bedrock.

6.3 Surface Water

In regard to surface water, the Township is located within the South Nation River watershed and overlaps the Upper South Nation, Middle South Nation, and Castor River subwatersheds (SNC, 2018), all within the regulatory jurisdiction of South Nation Conservation. The overall regional drainage is towards the northeast, with the majority of the Township surface water runoff towards branches of the South Nation River and the northern portion towards the South and East Castor Rivers, which in turn discharge to the South Nation River further to the northeast. Drainage of this largely rural agricultural area is via a network of constructed municipal drains, which have a low Department of Fisheries and Oceans (DFO) drain classification as related to aquatic habitat.

6.4 Biology

The Township is located in Ecoregion 6E (Lake Simcoe - Rideau), which covers approximately 6.4% of Ontario, extending from Lake Huron east to the Rideau River (Crins et al. 2009). The majority of this ecoregion exists as cropland (44.4%) and pasture or abandoned fields (12.8%), while water covers 4% of the ecoregion (Crins et al. 2009). Forest cover within the Township of North Dundas is 13.3% (SNC, 2016).

The Township is located in the Upper St. Lawrence section of the Great Lakes – St. Lawrence Forest Region, which contains a wide variety of both coniferous and deciduous species (Rowe 1972). The region is dominated by sugar maple (Acer saccharum) and American beech (Fagus grandifolia) forests, with associates of red maple (Acer rubrum), yellow birch (Betula alleghaniensis), white ash (Fraxinus americana), basswood (Tilia americana), largetooth aspen (Populus grandidentata), red oak (Quercus rubra) and bur oak (Quercus macrocarpa). Hemlock (Tsuga canadensis), white pine (Pinus strobus), white spruce (Picea glauca) and balsam fir (Abies balsamea) occur on acidic soils, while white cedar (Thuja occidentalis), silver maple (Acer saccharinum), green ash (Fraxinus pennsylvanica) and black ash (Fraxinus nigra), and elms (Ulmus spp) occur in poorly drained areas (Rowe 1972).

The Township includes the Winchester Swamp Provincially Significant Wetland (PSW) to the northwest, the Morewood Bog PSW to the northeast, and a small portion of the South Gower PSW at the western edge of the Township. The Township contains one county forest, namely the Alvin Runnalls Forest. South Nation Conservation also operates several small conservation areas in the Township, including Cass Bridge and Oak Valley Pioneer Park that also functions as a nut tree research site.

6.5 Agricultural

Much of the land area within the Township has been cleared for farming purposes. Most of the Township is classified as being underlain by Class 1 to 3 farmland, indicating its high potential for agricultural uses. Areas of Class 4 farmland are present in the western portion of the Township, and an area of Class 5 in the far east central portion. Within the Township there are a range of active farm activities, mainly various types of crops and raising of animals.

6.6 Archaeology

The Township is situated within the South Nation River drainage basin, which is known to have been occupied by Indigenous populations since at least the Woodland Period (950 BCE – 1550 CE). A number of archaeological sites have been registered within the Township, providing evidence of previous historic land use and occupation.

6.7 Cultural Heritage

The Euro-Canadian cultural heritage of the Township of North Dundas began around 1800. Settlers cleared land in the area for farming and the Township has remained primarily an agricultural area for the last two centuries. Villages including Chesterville, Winchester, and Winchester Springs developed and over time small family farms were combined into large specialized farms as agricultural practices changed.

6.8 Socio-economic

The Township is largely engaged in diversified rural economy, either directly as agricultural businesses or in the form of support services to those businesses. There is also local retail and institutional employers to support the residents and businesses. Major employers in the Township are Parmalat (the largest milk and dairy products facility in Canada) and the Winchester District Hospital, both located in Winchester.

6.9 Transportation

County Road (formerly Highway) 31 provides a main north-south link through the central part of the Township, connecting the City of Ottawa to the north with Highway 401 to the south. County Road (formerly Highway) 43 provides a main east-west link through the central part of the Township, connecting with Highway 416 further to the west. The Township is serviced by a network of County and Township roads. The CPR main line passes through the Township.

The nearest airport to the Township is the Ottawa International Airport and the Rideau Valley Air Park, an aerodrome, could also be reasonably nearby.

7.0 CONSULTATION

This section of the ToR presents an overview of the results of consultation and engagement carried out during the development of this ToR, in consideration of the MECP's Code of Practice: Consultation in Ontario's Environmental Assessment Process (Consultation Code of Practice; MECP, 2014b). The Township has developed a Consultation (Engagement) Plan for the development of this ToR as well as the subsequent EA process. A copy of this Engagement Plan is provided in Volume 3 - Appendix A. A summary of the proposed Engagement Plan for conducting the EA is presented in Section 7.3.

A summary of the engagement activities conducted during the development of the ToR is provided in Section 7.2. For ease of reference, the engagement activities are presented sequentially from the beginning of this ToR process. The first and second open houses were held during the development of this ToR. The third and fourth open houses are proposed to be held during the EA.

7.1 Consultation Activities Completed Prior to ToR

In terms of consultation related to the previously completed Waste Management Alternatives Evaluation and the Council decision, the Golder 2015 report was an item on the Council meeting agenda and was presented to Council at the regular Council meeting that was open to the public and the media; Council debated the report in a public forum and passed the Council decision by resolution that was part of the meeting minutes. Local media present at the meeting prepared and published an article on this item and the Council decision in the local paper. The Council decision to proceed with an EA to expand the Boyne Road landfill was part of the materials at Open Houses #1 and #2 as part of the ToR consultation process. No concerns were expressed by the public about Council's decision, and the few comments received by the Township were in support of the decision and the proposed course of action.

7.2 Record of Consultation Activities during the ToR Phase

Consultation with the public and other stakeholders is a key component of the EA process. It enables stakeholders to participate in the planning process and enhance the quality of the undertaking. The key vehicles in the Engagement Plan that were used to engage the public and the other stakeholders and elicit feedback were open houses, letter/email correspondence, the Township of North Dundas' EA website and newspaper advertisements.

The objectives of the Consultation Plan for preparation of this ToR were to:

- Engage stakeholders from the beginning of the process using a variety of consultation events and activities including open houses and to ensure that there are adequate opportunities to learn about the undertaking and to provide input, feedback and comments concerning the undertaking and EA process, and that these comments are considered by the EA Study team

- Engage local elected officials to ensure that they are provided with regular and timely information concerning this ToR development process
- Engage Indigenous communities as early as possible in the development of this ToR for the EA and to facilitate their involvement in the process in ways that meet their needs
- Ensure the consultation process is open, transparent and inclusive
- Document all issues and concerns identified by the public, agencies and other stakeholders and to demonstrate how these concerns and issues have been incorporated into the final ToR (this document)
- Fulfill the EA process public consultation requirements

Consultation related to the development of this ToR is documented in detail within the Consultation Record, Volume 3 of this ToR submission. Sections 7.2.1 to 7.2.4 summarize the primary consultation activities that have occurred throughout the development of this ToR.

7.2.1 Notice of Commencement and Open House #1

The EA process was announced by publishing a Notice of Commencement (NoC) and notice of open house #1 in the Winchester Press and Chesterville Record newspapers on February 22, 2017 and March 1, 2017 (Volume 3 - Appendix D1), as required under the EAA. The NoC provided a brief overview of the proposed undertaking, the location of the undertaking, the EA process, information about the proponent, how to contact the Township with comments and questions and the date, time and location of open house #1.

The NoC was also posted on the EA Study website and can be found at:
northdundas.com/town-hall/landfill-recycling/environmental-assessments/landfillea/.

Additionally, introduction letters accompanied by the NoC were emailed and/or mailed to the following stakeholders between February 22, 2017 and February 23, 2017 (see Volume 3 - Appendices C2 and D2):

- 30 GRT members (Volume 3 – Appendix B contains the original and evolving list of GRT. At NoC it included: South Nation Conservation, Ministry of Agriculture, Food and Rural Affairs (2), Ministry of Tourism, Culture and Sport, Ministry of Citizenship and Immigration, Ministry of Community Safety and Correctional Services, Ministry of Health and Long Term Care, Eastern Ontario Health Unit, Ministry of Municipal Affairs and Housing (2), Ministry of Natural Resources, Ministry of Northern Development and Mines (4), Fire Department, Canadian Environmental Assessment Agency, Environment and Climate Change Canada, Transport Canada, Ottawa International Airport, Rideau Valley Air Park, Counties of Stormont, Dundas and Glengarry, Township of North Dundas, the four local school boards with schools in the Township and Ministry of the Environment, Conservation and Parks (3))
- 13 Indigenous Communities (see Section 7.2.4 for a listing)

The NoC was also mailed to 23 property owners located within a one km radius of the site on February 22, 2017 (see Volume 3 - Appendix D2).

Table 7.2-1 summarizes all the GRT responses received following the NoC and open house #1 invitation. Copies of the correspondence are provided in Volume 3 – Appendix D3.

Table 7.2-1: Stakeholder Responses

Stakeholder	Stakeholder Comment	Township of North Dundas' Response
Transport Canada, Environmental Assessment Program	Transport Canada does not require receipt of all individual or Class EA related notifications. Request that project proponents self-assess the need to consult with Transport Canada.	No response required. Transport Canada was removed from the EA Study contact list as the EA Study will not interact with federal property nor will it require approval or authorization under any Acts administered by Transport Canada. The Township will continue to consult with the Ottawa Airport and Rideau Valley Air Park.
Charles O'Hara Ministry of Municipal Affairs	We have no comment	Followed up to see if this meant to remove MMA from the distribution list. No response received.
Anjala Puvananathan Canadian Environmental Assessment Agency	The *Canadian Environmental Assessment Act* focuses federal environmental reviews on projects that have the potential to cause significant adverse environmental effects in areas of federal jurisdiction and applies to physical activities described in the *Regulations Designating Physical Activities*. Based on the information provided, your project does not appear to be described in the Regulations. Review the Regulations to confirm applicability to the proposed project and if you agree, removed the Canadian Environmental Assessment Agency from your distribution list.	Regulations were reviewed and EA Study does not appear to be described; therefore, the Canadian Environmental Assessment Agency was removed from distribution. No response required.

Stakeholder	Stakeholder Comment	Township of North Dundas' Response
Katherine Kirzati Ministry of Tourism, Culture and Sport	MTCS's interest in this EA project relates to its mandate of conserving Ontario's cultural heritage, which includes: archaeological resources, including land and marine; built heritage resources, including bridges and monuments; and, cultural heritage landscapes. While some cultural heritage resources may have already been formally identified, others may be identified through screening and evaluation. Aboriginal communities may have knowledge that can contribute to the identification of cultural heritage resources, and we suggest that any engagement with Aboriginal communities includes a discussion about known or potential cultural heritage resources that are of value to these communities. Municipal Heritage Committees, historical societies and other local heritage organizations may also have knowledge that contributes to the identification of cultural heritage resources. Your EA project may impact archaeological resources and you should screen the project with the MTCS Criteria for Evaluating Archaeological Potential to determine if an archaeological assessment is needed. MTCS archaeological sites data are available at archaeology@ontario.ca. If your EA project area exhibits archaeological potential, then an archaeological assessment (AA) should be undertaken by an archaeologist licenced under the OHA, who is responsible for submitting the report directly to MTCS for review. The MTCS Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes should be completed to help determine whether your EA project may impact cultural heritage resources. The Township's clerk can provide information on property registered or designated under the Ontario Heritage Act. Municipal Heritage Planners can also provide information that will assist you in completing the checklist.	Acknowledged. No further action.

Stakeholder	Stakeholder Comment	Township of North Dundas' Response
	If potential or known heritage resources exist, MTCS recommends that a Heritage Impact Assessment (HIA), prepared by a qualified consultant, should be completed to assess potential project impacts. Our Ministry's Info Sheet #5: Heritage Impact Assessments and Conservation Plans outlines the scope of HIAs. Please send the HIA to MTCS for review, and make it available to local organizations or individuals who have expressed interest in heritage. All technical heritage studies and their recommendations are to be addressed and incorporated into EA projects. Please advise MTCS whether any technical heritage studies will be completed for your EA project, and provide them to MTCS before issuing a Notice of Completion or commencing any work on site. If your screening has identified no known or potential cultural heritage resources, or no impacts to these resources, please include the completed checklists and supporting documentation in the EA report or file.	

The first open house occurred on March 7, 2017 at Council Chambers at the Township Office, 636 St. Laurence Street, Winchester ON from 5 to 8 p.m.

This open house provided a general overview of the current Boyne Road Landfill site, the EA process, the previous assessment of the proposed ‘Alternatives To’, a description of the preferred ‘Alternative To’ resulting from the previous assessment, proposed criteria for comparison of ‘Alternative Methods’ of expansion of the Boyne Road Landfill site and how stakeholders can be involved in the EA process.

The purpose of the open house was to inform the public of the EA Study and seek input on the EA Process, the proposed community engagement program, the proposed criteria for comparison of ‘Alternative Methods’ of expansion of the Boyne Road Landfill site, and next steps for the EA Study. A total of 10 display boards were featured at open house #1. Copies of the display boards available at the open house, the feedback sheets and blank sign in sheets are provided in Volume 3 - Appendix D4 and were posted on the EA Study website at the time of the event.

This event was designed to provide opportunities for attendees to speak directly with the Township and the EA consulting team. Attendees were asked to sign in and were encouraged to fill out a comment sheet to provide feedback and recommendations.

Two representatives from the Township and two of their EA consultants were in attendance at open house #1.

A total of 13 people attended open house #1 on March 7, 2017 including one member of the GRT, two Township staff, three Township councillors and seven members of the public (one of whom was a reporter for the local media covering the open house). The overall atmosphere of the open house was professional, courteous and respectful.

No comments were received through completion of the formal feedback sheet. One individual completed feedback on the display board regarding ranking of the criteria. A copy of this feedback is provided in Volume 3 - Appendix D5.

7.2.2 Open House #2

The second open house occurred on October 26, 2017 at Council Chambers at the Township Office, 636 St. Laurence Street, Winchester ON from 5 to 8 p.m.

Open house #2 was advertised in the Winchester Press and Chesterville Record newspapers on October 12, 2017 (Volume 3 - Appendix E1), and on the EA Study website

Letters or emails were sent between October 10 and 12 to the GRT, Indigenous communities, neighbours within one km of the site and individuals who signed up at open house #1 (Volume 3 - Appendices E2 and C3).

At this open house the public learned about the proposed content of the Draft Terms of Reference (overall work plan for the EA Study) including existing site conditions, preliminary Boyne Road Landfill expansion concepts (known as ‘Alternative Methods’), the proposed methodology and technical studies for evaluating and comparing the ‘Alternative Methods’ of expanding the Boyne Road Landfill site, and how to be involved in the EA process.

A main focus of the open house was to inform the public and seek input on the proposed work plans for technical studies associated with the Boyne Road Landfill expansion. A total of 22 display boards were featured at open house #2. Copies of the information available at the open house, the feedback sheets, and blank sign in sheets are included in Volume 3 - Appendix E4.

This event was designed to provide opportunities for attendees to speak directly with the Township and the EA consulting team. Attendees were asked to sign in and were encouraged to fill out a comment sheet to provide feedback and recommendations.

One representative from the Township and two of their EA consultants were in attendance at open house #2.

A total of 4 people attended open house #2 on October 26, 2017 including one member of the GRT and three members of the public. Two members of the public were reporters for local media covering the open house. The overall atmosphere of the open house was professional, courteous and respectful.

MTCS requested a change in whom to send information to for this ToR and EA (Volume 3 - Appendix E3). No formal feedback forms were completed or received from the public. No comments were received from the Indigenous communities or GRT on the Open House #2 content. Overall, meeting attendees were satisfied with the information presented and provided positive verbal feedback on the quality of the information materials and answers provided.

7.2.3 Draft Proposed Terms of Reference

An initial draft of the Proposed ToR was shared with the MECP for a high-level review in March 2018.

The availability of the Draft Proposed ToR was advertised in the Winchester Press and Chesterville Record newspapers on April 25, 2018 as provided in Volume 3 - Appendix G1. Notice of the availability of the Draft Proposed ToR was distributed to the GRT, Indigenous Communities, neighbours within 1 km of the site, and the public who signed up for the information list between April 25 and 27, 2018 for a four-week comment period. Examples of the distribution emails and letters are provided in Volume 3 Appendices G2 and C4. The GRT and Indigenous Communities received hard or electronic copies of the Draft Proposed ToR, whereas the public were directed to the EA Study website and publicly accessible areas where documents were available for review.

Comments and questions on the Draft Proposed ToR were provided by the Environmental Assessment and Permissions Branch (noise and waste) of the MECP. Comments and questions were also provided by the Programs and Services Branch of the Ministry of Tourism, Culture and Sport (archaeology and built heritage), the Ministry of Natural Resources and Forestry, and the Ministry of Northern Development and Mines. In addition to the provincial government, comments and questions were provided by the Raisin Region Conservation Authority and South Nation Conservation. These comments and questions are provided in disposition tables in Volume 3 - Appendix G3 along with responses from the Township and how the comments were included in the proposed ToR. In general, the comments received from the above GRT and agencies were related to various aspects of the proposed EA methodology associated with expansion of the Boyne Road Landfill including the scope and requirements for the noise, archaeology, natural environment, cultural heritage landscapes and built heritage resources studies. Only one comment was received from the public or Indigenous communities, that being a request from the Huron-Wendat Nation who wish to be advised when an archaeological assessment commences at the Boyne Road Landfill site.

Comments and questions were also provided by the Environmental Assessment and Permissions (EA) Branch of the MECP in December 2018, April 2019 and July 2019. These comments and questions are provided in three separate disposition tables in Volume 3 - Appendix G3 along with responses from the Township and how the comments were included in the proposed ToR. In general, these comments were related to: the appropriateness of relying on the previously completed Waste Management Alternatives Evaluation study and associated consultation as the justification for an EA focussed only on the expansion of the Boyne Road Landfill site as the identified ‘Alternative To’; arriving at some specific determinations at the ToR stage and not proposing additional assessment and refinement during the EA; the basis used for projecting post-diversion waste management requirements over the 25 year planning period; aspects of the proposed EA methodology and proposed EA consultation plan; and the need for additional commitments made by the Township during the ToR process to be included in the ToR. It was requested that the draft ToR be revised and submitted to the MECP for review prior to circulation of the proposed ToR for comment; three iterations of revisions were completed. Conference calls occurred with EA Branch representatives on November 22, 2018, January14, 2019, May 8, 2019 and May 29, 2019 to discuss their comments and questions.

7.2.4 Consultation with Indigenous Communities

A list of potentially affected Indigenous communities was developed in consultation with the MECP during the development of this ToR (see Volume 3 - Appendix C1). Initially a larger list was developed that included:

- Algonquin Anishinabag Nation Tribal Council
- Algonquins of Pikwakanagan First Nation
- Algonquins of Ontario, Consultation Office
- Communauté anicinape de Kitcisakik

- Conseil de la Première Nation Abitibiwinni
- Eagle Village First Nation-Kipawa
- Kitigan Zibi Anishinabeg
- Long Point First Nation
- Huron-Wendat Nation
- Métis Nation of Ontario
- Mohawks of Akwesasne
- Nation Anishnabe du Lac Simon
- Wahgoshig First Nation

All of these communities did receive the NoC and invitation to open house #1 (Volume 3 - Appendix C2) via both email and mail. The written correspondence was followed up with phone calls to each community. Subsequently the MECP advised that three Indigenous communities have or may have constitutional or Indigenous treaty rights that could be affected by the outcome of EA study (Volume 3 - Appendix C1) via letter. The MECP has delegated the procedural aspects of the Crown's duty to consult with Indigenous communities through this letter. The Township will be consulting with the three communities in the letter as these are the communities identified that have or may have constitutionally protected Aboriginal or treaty rights that could be adversely affected by the EA Study based on preliminary information.

As a result, a letter was prepared explaining that the consultation on this EA would continue with three of the communities: the Algonquins of Ontario Consultation Office, the Mohawks of Akwesasne and the Huron-Wendat Nation. The letter indicated that the other Indigenous communities could still participate in the EA if they had an interest to continue to receive information and/or engage in the EA Study (Volume 3 - Appendix C1). None of the communities that were removed from the consultation list indicated that they still wished to be engaged in this EA process. The smaller list of communities identified were sent an email invitation to participate in open house #2 and in the EA and discussions about potential benefits and effects of the EA Study on Indigenous community interests (see Volume 3 - Appendix C3). The written correspondence was followed up with phone calls to each community.

A program to engage and consult with Indigenous communities was carried out considering their specific needs and specific issues. The Indigenous communities were consulted on how they would like to be involved in the EA process. Communication tools available to Indigenous communities include meetings or presentations for individual Indigenous communities, smaller discussion groups with interested persons/groups by phone and/or in-person on specific topics, site tours, copies of information and email correspondence.

Township staff were available to meet with interested Indigenous communities and discuss the proposed EA Study at any time during the development of the ToR.

During the ToR the Huron-Wendat Nation identified an interest in archaeological studies at the Boyne Road Landfill site. It was communicated to the Huron-Wendat Nation that no studies have yet occurred, but as they advance the Township will communicate with the Huron-Wendat Nation the planned schedule, studies and results (Volume 3 - Appendix C2 and C3).

7.3 Proposed Consultation Plan for the EA

Following approval of this ToR and during preparation of the EA, a consultation program will be continued to engage the public, businesses, the GRT and Indigenous communities interested during the EA process. The Township will update the Community Engagement Plan outlined in Volume 3-Appendix B to align with the Code of Practice: Consultation in Ontario's Environmental Assessment Process (2014). The Community Engagement Plan will be followed, in particular as it relates to key stakeholders, methods for engagement, roles and responsibilities and principles of engagement. Input will be obtained through a number of engagement activities, as proposed below and in accordance with the methods of engagement outlined in the Community Engagement Plan. In addition to the engagement activities described below, consultation specific to individual Indigenous communities will also be carried out. These additional activities are described in Section 7.4. The results of the engagement program conducted by the Township during preparation of the EA will be presented in the EA Report.

The proposed consultation activities for the EA studies are as follows:

- A NoC of the commencement of the EA will be prepared and published in the local media and distributed to the EA Study stakeholders via email or letter.
- As enhanced at-source waste diversion is an 'Alternative To' in the EA Study, the assessment of diversion opportunities will require public input on possible diversion options, comparison criteria and recommendations for the Township that are in alignment with Provincial policy as well as the small, rural nature of the Township. A **Technical Bulletin** will be sent to stakeholders via email or letter. Stakeholders will be invited to provide their comments by contacting the EA Study team via telephone or to return an attached feedback form. The technical bulletin and feedback form will also be posted on the EA Study website.
- **Open House #3** will present the approved ToR, describe the EA process, the results of the diversion study, the criteria and methodology used to identify the preferred 'Alternative To', the results of the 'Alternatives To' assessment, and proposed next steps. Stakeholders will be invited to Open House #3 via email or letter and a notice will be placed in the newspaper. The content will be posted on the EA Study website and feedback will be gathered at the event verbally, via feedback forms handed out at the open house and via posting the feedback form on the EA Study website along with the open house content.

- A **Technical Bulletin** will be prepared and emailed or mailed to stakeholders to present the preferred ‘Alternative To’, inform the public about each of the ‘Alternative Methods’ to be considered, the criteria for the comparative evaluation of those ’Alternative Methods’ and the results of the comparison, and invite participation and comment regarding the ‘Alternative Methods’ and comparison. Stakeholders will be invited to provide their comments by contacting the EA Study team via telephone or to return an attached feedback form. The technical bulletin and feedback form will also be posted on the EA Study website.
- **Open House #4** will present the proposed EA and inform the public about the identification of the preferred Alternative Method, as well as inform them of the results of the existing conditions studies and the predicted effects on the environment, and the commitments the Township is making to mitigate any adverse effects. Stakeholders will be invited to Open House #4 via email or letter and a notice will be placed in the newspaper. The content will be posted on the EA Study website and feedback will be gathered at the event verbally, via feedback forms handed out at the open house and via posting the feedback form on the EA Study website along with the open house content.
- **EA Study Website** to inform the public on the EA process, public engagement activities and to solicit comments from the public, as mentioned above.
- **Letters and emails** to the GRT members, Indigenous communities and interested parties to provide information and invite feedback, as mentioned above.
- **Circulation of Draft EA** for GRT, Indigenous communities and public comment prior to finalization and submission to the MECP. The public will be notified of the draft via email or letter and invited to review the draft electronically on the EA Study website or at the locations where hard copies will be made available. The GRT and Indigenous communities will be circulated an electronic and/or hard copy of the draft as per their preference. The Township will call them in advance of the draft circulation to understand their preference.

There are a number of key decision-making milestone points when consultation will occur during preparation of the EA. The main milestones are: 1) results of the diversion study and identification of the preferred ‘Alternative To’ at proposed open house #3 and 2) reviewing the developed ‘Alternative Methods’, the evaluation criteria and indicators applied to ‘Alternative Methods’ and the recommended ‘Alternative Method’ identified through the comparative evaluation process via the Newsletter and at Open House #4.

During the EA there may be issues raised or disputes during preparation of the EA that may be difficult to resolve. The Township will attempt to resolve all issues or disputes to reach a resolution that is amenable, recognizing that interests of multiple stakeholders and/or regulations may sometimes dictate a resolution that may not be desirable to all parties. If a mutually agreeable resolution is not achieved, the matter will be referred to the MECP for guidance.

If a stakeholder identifies a need for accommodation with regards to attaining their feedback, for example, a need for more time to review a document, this can be reviewed on a case by case basis.

7.4 Proposed Indigenous Engagement Plan for the EA

It is recognized that Indigenous communities have specific interests and rights with regard to consultation on projects that might potentially affect them. The consultation with Indigenous communities will provide insight into the potential effects on Indigenous communities, including the potential effects on use of lands for traditional purposes. It is also recognized that Indigenous communities may have specific and differing needs with regard to how they would like to be consulted and some Indigenous communities have developed guidelines and protocols for consultation. Based on feedback obtained from the Indigenous communities, specific approaches for engaging with Indigenous communities will be reflected in the consultation plan updated for the EA, as applicable. To address these interests, the Township will continue to inform Indigenous communities about the proposed EA Study and invite their participation in the EA process, always in a manner that the community is comfortable with. For example, in a different language or by means of personal event or meeting.

The Township will meet with interested Indigenous communities and discuss the proposed EA Study at any time during the EA Study process.

8.0 OTHER REGULATORY APPROVALS

In addition to EA approval for the Township's waste management plan, there are other regulatory approvals that may be required. The specific approvals will depend on the preferred 'Alternative To' and 'Alternative Method' identified during the EA process. The types of provincial or municipal approvals could include some or all of the following.

- Planning Act – if the site location selected for the preferred alternative requires changes to the Official Plan and/or zoning.
- Environmental Protection Act (EPA) – for certain types of projects, i.e., a landfill expansion, transfer station, new landfill site, incinerator, an application for an Environmental Compliance Approval (ECA) under the EPA is required to proceed with construction and operation of the facility/project.
- Ontario Water Resources Act (OWRA) – under Section 53 of the OWRA, an application for approval is required for components of the project defined as "sewage works" under the Act, i.e., stormwater management systems.
- Drainage Act – approvals under the Drainage Act may be required to assess if changes to land use to implement the preferred alternative will require alterations to a municipal drain.
- Conservation Authorities Act - The Township is located within the jurisdiction of South Nation Conservation (SNC), which is responsible under The Conservation Authorities Act O.Reg. 170/06 for issuing permits for construction within or alterations to water courses. An application for a work permit from SNC may be needed to construct the project.

The approvals required specifically for the preferred alternative will be determined in consultation with regulatory agencies and described in the EA Report. The Township is proposing to submit applications for other approvals and supporting documents required to proceed to implement the project following receipt of EA approval.

9.0 EA SCHEDULE

A draft ToR was made available to the MECP, Indigenous communities, GRT, stakeholder committees and the public in late April 2018. An open house about the draft ToR was conducted on October 26, 2017.

Following circulation of the draft ToR for comments, the proposed ToR is subject to a 30-day comment period that will be followed by the Minister's decision.

EA timelines are dependent on the Minister's decision about this ToR and the EA cannot proceed without an approved ToR. With submission of the proposed ToR in July 2019, the Minister's decision is anticipated in the fourth quarter of 2019. On approval of the proposed ToR, the EA Study will then proceed.

The EA application documents will be circulated in draft and then in final form to be reviewed by the GRT members, Indigenous communities, stakeholder committees and the public. It is proposed that any supplementary evaluations, responses and/or clarifications required by this review process will be documented by addendum to the EA (which can be done under special circumstances before a Minister’s decision) or other appropriate method.

10.0 COMMITMENTS AND MONITORING

The EA Report will include a comprehensive list of commitments made by the Township of North Dundas during the development of this ToR.

10.1 Commitments

A list of commitments made during the development of this ToR and during consultation is contained in Table 10.1-1.

Table 10.1-1: List of ToR Commitments

ID	ToR Commitment
1	The EA will be prepared in accordance with subsections 6(2)(a) and 6.1(2) of the EA Act.
2	The Township will contact Indigenous groups to discuss their consultation needs and their involvement in the EA.
3	The Township will consider the stated purpose of the EA during the EA process and will refine the purpose statement, if required. The final purpose statement will be provided in the EA Study report.
4	Additional information on waste disposal and diversion projections will be provided during the EA to further support the need for the equivalent of 400,000 m^3 of additional waste disposal capacity (excluding final cover).
5	The Township commits to completing a Waste Diversion Study to assess further opportunities for at-source residential diversion in the Township.
6	The Township commits to updating the consultation plan to align with the Code of Practice: Consultation in Ontario’s Environmental Assessment Process (2014).
7	During the EA, the Township will develop evaluation criteria and indicators to be used to compare ‘Alternative Methods’, in consultation with the MECP, GRT, Indigenous communities and the public.
8	During the EA, the appropriate Study Areas for assessment of impacts from ‘Alternatives To’ and ‘Alternative Methods’ will be determined and described in the EA Study report.
9	During the EA, detailed technical work plans for each of the environmental components will be developed in consultation with the agencies, Indigenous communities and the public. Where relevant, the Township will provide the detailed work plans to the appropriate regulatory agency for review and concurrence prior to undertaking the work.

ID	ToR Commitment
10	During the EA, a more detailed description of the existing conditions relevant to the preferred ‘Alternative To’ and ‘Alternative Methods’ will be prepared using a combination of sources of existing information and site-specific studies and will be provided in the EA Study report.
11	The Township will provide in the EA Study report a final detailed description of the proposed project once the preferred ‘Alternative Method’ has been identified.
12	The preferred alternative will be assessed from the perspective of climate change.
13	A cumulative impact assessment of the preferred alternative will be completed and provided in the EA Study report.
14	The Township commits to developing a monitoring framework during the preparation of the EA.
15	The Township commits to circulating a draft EA Study report prior to submission of the final EA Study report.
16	The Township commits to determining and describing the other regulatory approvals required to proceed with the preferred alternative and including this in the EA Study report.
17	The list of ToR commitments will be provided in the EA Study report together with the way in which these commitments were addressed during the EA and the location of the information within the EA documents. The EA Study report will also include a list of commitments made by the Township during the preparation of the EA studies and during consultation throughout the EA process.

10.2 Compliance and Effects Monitoring

Mitigation measures are designed to avoid or reduce potential adverse effects from the undertaking.

The Township of North Dundas commits to developing a monitoring framework during the preparation of the EA. The monitoring framework will consider all phases of the proposed undertaking. The monitoring will include:

- Compliance monitoring
- Effects monitoring

A description of the proposed effects monitoring programs for the preferred ‘Alternative Method’ will be prepared and included in the EA. It is anticipated that the detailed effects monitoring requirements for the preferred ‘Alternative Method’ will ultimately be determined through the conditions of EPA/OWRA approval. Compliance monitoring is an assessment of whether an undertaking has been constructed, implemented and/or operated in accordance with the commitments made during the preparation of the EA and the conditions of the EAA. Compliance monitoring and contingency measures will be designed to detect and immediately respond to potential problems and unanticipated effects. Effects monitoring will involve activities designed to determine and verify the anticipated effects of the undertaking.

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APPENDIX B

Air Quality and Odour

Appendix B-1 Background Air Quality
Appendix B-2 Emission Calculations
Appendix B-3 Dispersion Modeling
Appendix B-4 Estimation of Landfill Gas Generation (LandGEM)

Appendix B-1 Background Air Quality

May 2022

Volume 2
Appendix B-1

Background Air Quality

GOLDER
MEMBER OF WSP

TOWNSHIP OF
North Dundas

Table of Contents

TABLES

FIGURES

1.0 INTRODUCTION

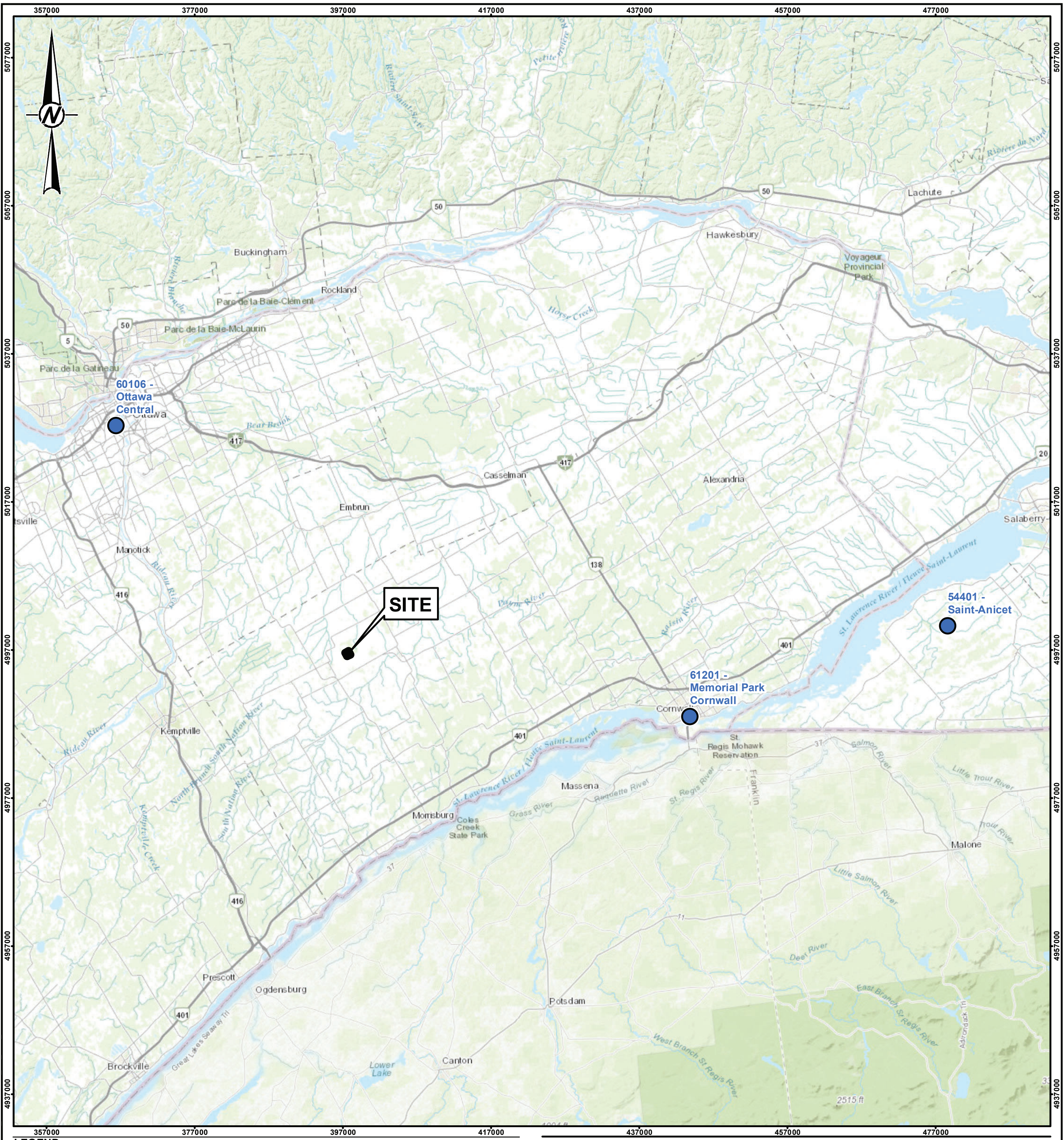
This appendix is part of the Air Quality assessment for the proposed expansion of the Boyne Road Landfill site in the Township of North Dundas. This work has been conducted in accordance with the requirements set out in the approved Terms of Reference (ToR), dated February 2019 and the work plan in Section 8 of Volume 1 of this Environmental Assessment Study Report which was circulated to the Ministry of the Environment, Conservation and Parks (MECP).

1.1 Purpose

This appendix documents the methods, inputs and assumptions that were used to calculate background air quality concentrations for the Site-vicinity Study Area.

2.0 AIR QUALITY MONITORING DATA

Background air quality was characterised using observations from the Environment and Climate Change Canada (ECCC) National Air Pollution Surveillance Network (NAPS) air quality monitoring stations (ECCC, 2021). The closest air quality monitoring station is located at 960 Carling Avenue in Ottawa, Ontario (Ottawa Central Station). Two other NAPS air quality monitoring stations were selected for inclusion in the determination of background air quality: Bedford and Third Street in Cornwall, Ontario (Memorial Park Cornwall Station); and 1128 de la Guerre in Saint-Anicet, Quebec (Saint-Anicet Station). These monitoring stations are indicated on Figure B1-1.



LEGEND

● AIR MONITORING STATION

0 7,000 14,000 28,000

1:750,000 METRES

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: MTM ZONE 9 VERTICAL DATUM: CGVD28

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE
AIR MONITORING STATIONS

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-05-27
DESIGNED	----
PREPARED	JEM
REVIEWED	JPM
APPROVED	PLE

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0/2.2.0	0	**B1-1**

Path: N:\Active\Spatial IM\Township of North Dundas\BoyneRoadLandfill\99 PROJ\1648253\40 PROD\Phase 2.0 Task 2.1.1 Air\1648253-2211-RA-5-1.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
25mm
0

The Boyne Road Landfill and surrounding Site-vicinity Study Area are located in a rural location. A wind-rose for the area is provided in Figure B1-2 and indicates that the predominant wind direction is from the southwest.

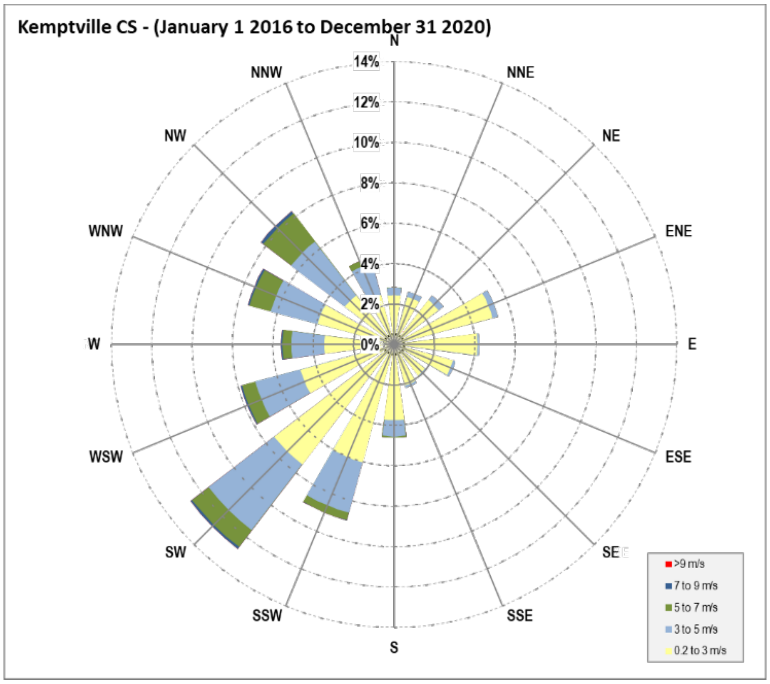


Figure B1-2: Five-year Wind Rose for Kemptville, Ontario

The Ottawa Central station (NAPS ID 60106) is one of the closest NAPS station to the Project (approximately 45 km north-northwest), so it is expected that the area of the Boyne Road Landfill would experience similar impacts from regional transport of compounds as this station. This station is located in Central Ottawa; as such, it is more likely to be influenced by local sources of emissions from commercial and residential land uses, in addition to local traffic emissions. Comparatively, the landfill site is located in an agricultural area. All air quality indicator compounds with the exception of carbon monoxide (CO), sulphur dioxide (SO_2), and vinyl chloride are monitored at this station.

The Memorial Park Cornwall station (61201) located approximately 47 km away to the east-southeast was selected as it is also one of the closest stations to the Site but is less urban than the Ottawa Central station. All air quality indicator compounds with the exception of CO and SO_2 are monitored at this station.

The Saint-Anicet station (54401) station located approximately 76 km away was selected due to the similar rural land use and proximity to the Great Lakes/Highway 401 corridor. This station is located a little further away from the site than the Ottawa Central station and Memorial Park Cornwall station, but it is located in a much more similar environment to the site. All air quality indicator compounds are monitored at this station.

The relative locations of the air quality monitoring stations selected to describe the background air quality are summarized in Table B1-1 and presented on Figure B1-1.

Table B1-1: Location of Air Monitoring Stations

Station	Address	NAPS Station ID	Latitude and Longitude	Distance to the Site (km)	Direction
Ottawa Central	960 Carling Ave	60106	45.38287, -75.71387	45	North-Northwest
Memorial Park Cornwall	Bedford & Third St	61201	45.017981, -74.735314	47	East-Southeast
Sainte-Anicet	1128 de la Guerre	54401	45.120624, -74.2896	76	East

Table B1-2 provides a summary of the complete years of monitoring data available for assessment for each station, for each of the indicator compounds.

There is no monitoring data available for suspended particulate matter less than 44 microns (SPM) and particulate matter less than 10 microns (PM_{10}); however, the background SPM and PM_{10} concentrations can be estimated from the available $PM_{2.5}$ monitoring results. $PM_{2.5}$ is a subset of PM_{10}, and PM_{10} is a subset of SPM. Therefore, it is reasonable to assume that the ambient concentrations of SPM will be greater than corresponding PM_{10} levels, and PM_{10} concentrations will be greater than the corresponding levels of $PM_{2.5}$. The mean levels of $PM_{2.5}$ in Canadian locations have been found to be about 54% of the PM_{10} concentrations and about 30% of the TSP concentrations (Lall et al. 2004). By applying this ratio, it is possible to estimate the background SPM and PM_{10} concentrations for the Site-vicinity Study Area. Hydrogen sulphide (H_2S) is not measured at any of the above three stations; therefore, the 1-hour background concentration was taken from the ECCC's draft screening Assessment for H_2S (ECCC, 2017) and converted to the relevant averaging periods using MECP recommended methodologies in the *Air Dispersion Modelling Guideline for Ontario* (MECP, 2017).

Table B1-2: Availability of Ambient Air Quality Data

Compound	Saint-Anicet Station	Ottawa Central Station	Memorial Park Cornwall Station
SPM	—	—	—
PM_{10}	—	—	—
$PM_{2.5}$	2000-2007, 2017-2018	**2007-2017**	2003-2018
NO	**2000-2013**	2007-2017	2000-2001, 2006-2018
NO_2	**2007-2018**	2007-2017	2000-2001, 2006-2018
SO_2	**2014-2018**	—	—
CO	**2006-2008, 2010-2015**	2007-2008	—
O_3	**2000-2008, 2010-2018**	2007-2017	2000-2018
H_2S	—	—	—
C_2H_3Cl	**2009-2013**	—	—

Notes:
”—” indicates that data for the parameter were not available.
Bolded years indicate the years that were carried forward into the assessment for the respective compound and station.

2.1 Assessment of Background Air Quality

The continuous monitoring stations listed in Table B1-1 were used to reflect the existing conditions in the Site-vicinity Study Area. The existing air quality levels, based on background air concentrations from available monitoring stations, are summarized in the following sections. The available air monitoring data represents the combined effect of emissions from sources near to each of the monitoring stations, as well as the effect of the emissions transported into the region. The emissions transported into the region could be considered to be the ‘background air quality’, which would be added to dispersion modelling results as part of the impact assessment for the landfill site (Section 13.1 of the EA study report).

Although gaseous monitoring equipment records concentrations in units of parts per million parts (ppm) or parts per billion parts (ppb), regulatory criteria are established on the basis of micrograms per cubic metre (µg/m³). In this section, monitoring results for gaseous compounds are presented in the units of µg/m³, to facilitate the comparison of monitoring records to regulatory criteria. The conversion from ppm to µg/m³ is unique to each compound, based on the molecular weight of the compound and standard atmospheric conditions (1 atmosphere of pressure and 25°C). In contrast, particulate and metals monitoring equipment records concentrations in units of µg/m³, allowing for direct comparison to the regulatory criteria.

2.2 Comparison of Monitored Data by Indicator Compound

The 90th percentile of the 1-hour, 8-hour, and 24-hour measurements are typically used to represent the background air quality value when conducting an impact assessment, as this value is exceeded only 10% of the time. The annual average concentration is used for annual background levels (Alberta Environment, 2013) based on the limited measurement data. The average concentration for the shorter time periods provides an indication of what air quality would typically be at the location. The 75th percentile provides an indication of the concentration below which the vast majority of the existing air quality readings occurred. Significant differences between the average and 75th percentile readings provide an indication that the background air quality is dominated by infrequent, but extreme events.

2.2.1 Fine Particulate Matter ($PM_{2.5}$)

Particulate emissions occur due to anthropogenic activities (such as industrial, transportation, and residential sources) and natural sources. Particulate matter is classified based on its aerodynamic particle size, primarily due to the different health effects that can be associated with particles of different diameters. In Ontario, $PM_{2.5}$ emissions have been demonstrating a steady decline over time, decreasing by approximately 11% from 2009 to 2018 (MECP, 2021).

The 24-hour standard for $PM_{2.5}$, the Canadian Ambient Air Quality Standard (CAAQS), is calculated as the three year average of the annual 98th percentile of the daily 24-hour average concentrations. The annual CAAQS is based on the annual average concentration averaged over three years of measurements. Table B1-3 lists the 24-Hour and Annual $PM_{2.5}$ ambient monitoring results calculated according to these methodologies. Saint-Anicet is not listed in Table B1-3 as $PM_{2.5}$ data is not available for three consecutive years within the past 10 years.

Table B1-3: Summary of 24-Hour and Annual $PM_{2.5}$ Monitoring Results for Comparison to the Canadian Ambient Air Quality Standard

Years	Ottawa Central 24-Hour (CAAQS = 27 µg/m³)	Ottawa Central Annual (CAAQS = 8.8 µg/m³)	Memorial Park Cornwall 24-Hour (CAAQS = 27 µg/m³)	Memorial Park Cornwall Annual (CAAQS = 8.8 µg/m³)
2013–2015	19.56	6.92	—	—
2014–2016	17.57	6.44	16.90	6.75
2015–2017	16.47	6.12	15.98	6.40
2016–2018	N/A	N/A	15.80	6.21

Notes:

”N/A” indicates that data was not available for the parameter for one or more years in the time period selected

”—” indicates that data for the parameter was not pulled because of more recent data available

The 24-hour and annual CAAQS has not been exceeded at either station over the assessment periods.

2.2.2 Nitrogen Dioxide (NO_2)

NO_x is emitted in two primary forms: nitric oxide (NO) and nitrogen dioxide (NO_2). NO reacts with ozone in the atmosphere to create NO_2. The primary source of oxides of nitrogen (NO_x) in the region is the combustion of fossil fuels. Emissions of NO_X result from the operation of stationary sources such as incinerators, boilers, and generators, as well as the operation of mobile sources such as vehicles, haul trucks, and other equipment.

The annual mean concentrations of NO_2 in Ontario have decreased by 21% from 2009 to 2018 (MECP, 2021). None of the monitored values for NO_2 were above the 1-hour or 24-hour Ontario AAQC for NO_2 during the monitoring periods assessed.

Tables B1-4 and B1-5 below present the 90th percentile and maximum monitored concentrations compared to the 1-hour and 24-hour AAQC.

Table B1-4: Summary of the 90th Percentile and Maximum 1-Hour NO_2 Monitoring Results for Comparison to the Ontario AAQC

Station	**NO_2 1-hour Criteria [µg/m³]**	**90th percentile concentration [µg/m³]**	**90th percentile as a % of the Criteria**	**Maximum concentration [µg/m³]**	**Maximum as a % of the Criteria**
Saint-Anicet	400	9.40	2%	84.64	21%
Ottawa Central	400	24.45	6%	103.45	26%
Memorial Park Cornwall	400	22.57	6%	127.91	32%

Table B1-5: Summary of the 90th Percentile and Maximum 24-Hour NO_2 Monitoring Results for Comparison to the Ontario AAQC

Station	**NO_2 24-hour Criteria [µg/m³]**	**90th percentile concentration [µg/m³]**	**90th percentile as a % of the Criteria**	**Maximum concentration [µg/m³]**	**Maximum as a % of the Criteria**
Saint-Anicet	200	8.91	2%	44.41	22%
Ottawa Central	200	21.62	11%	62.70	31%
Memorial Park Cornwall	200	21.00	11%	70.69	35%

The 1-hour CAAQS standards for NO_2 are calculated as the 98th percentile of the daily maximum 1-hour concentrations, averaged over three years of measurements. Table B1-6 lists the 1-Hour ambient monitoring results calculated according to this methodology.

Table B1-6: Summary of 1-Hour NO_2 Monitoring Results for Comparison to the Canadian Ambient Air Quality Standard

Years	**Saint-Anicet 1-Hour NO_2 [µg/m³]** (CAAQS 1-Hour = 79 µg/m³)	**Ottawa Central 1-Hour NO_2 [µg/m³]** (CAAQS 1-Hour = 79 µg/m³)	**Memorial Park Cornwall 1-Hour NO_2 [µg/m³]** (CAAQS 1-Hour = 79 µg/m³)
2013–2015	—	83.22	—
2014–2016	44.15	79.00	81.61
2015–2017	40.39	75.69	79.10
2016–2018	42.72	N/A	78.02

Notes:

”N/A” indicates that data was not available for the parameter for one or more year in the time period selected

”—” indicates that data for the parameter was not pulled because of more recent data available

The 1-hour CAAQS was exceeded at the Ottawa Central station over 2013-2015 but the measurements for the subsequent three-year periods have decreased to below the corresponding CAAQS. The 1-hour CAAQS was also exceeded at the Memorial Park Cornwall station over 2014-2016 and 2015-2017, but the measurement for the last three-year period from 2016 to 2018 has decreased to below the corresponding CAAQS.

2.2.3 Sulphur Dioxide (SO_2)

The primary source of SO_2 in Ontario is the combustion of fossil fuels in the electricity and smelter sectors. Emissions have decreased significantly due to the phase out of coal-fired generating stations in the province.

The annual mean concentrations of SO_2 in Ontario have decreased by 59% from 2009 to 2018 (MECP, 2021).

Tables B1-7 through B1-9 below present the 90th percentile and maximum monitored concentrations compared to the 10-Minute, 1-hour and Annual AAQC. Out of the chosen stations, SO_2 data is only available at the Saint-Anicet station. SO_2 data for the Saint-Anicet Station is collected on a 1-hour basis; therefore, the 1-hour data was converted to a 10-minute basis using MECP conversion factors (MECP 2017).

Table B1-7: Summary of the 90th Percentile and Maximum 10-minute SO_2 Monitoring Results for Comparison to the Ontario AAQC

Station	SO_2 10-minute Criteria [µg/m³]	90th percentile concentration [µg/m³]	90th percentile as a % of the Criteria	Maximum concentration [µg/m³]	Maximum as a % of the Criteria
Saint-Anicet	180	4.32(a)	2%	203.56(a)	113%

Notes:

(a) 10-minute SO_2 concentrations were converted from the corresponding 1-hour SO_2 monitoring results using MECP conversion factors (MECP 2017)

Table B1-8: Summary of the 90th Percentile and Maximum 1-Hour SO_2 Monitoring Results for Comparison to the Ontario AAQC

Station	SO_2 1-hour Criteria [µg/m³]	90th percentile concentration [µg/m³]	90th percentile as a % of the Criteria	Maximum concentration [µg/m³]	Maximum as a % of the Criteria
Saint-Anicet	100	2.62	3%	123.37	123%

Table B1-9: Summary of the 90th Percentile and Maximum 24-hour SO_2 Monitoring Results for Comparison to the AAQC

Station	SO_2 24-hour Criteria [µg/m³]	90th percentile concentration [µg/m³]	90th percentile as a % of the Criteria	Maximum concentration [µg/m³]	Maximum as a % of the Criteria
Saint-Anicet	150	3.06	2%	26.88	18%

The monitored 1 hour and 10-minute measured SO_2 concentrations have been periodically above the Ontario AAQC at the Saint-Anicet Station over the 5-year monitoring period but the 90th percentile of all monitoring data is below the corresponding Ontario AAQCs.

2.2.4 Carbon Monoxide (CO)

Carbon Monoxide is a colourless, odourless, tasteless, and, at high concentrations, toxic gas. It is produced primarily from the incomplete combustion of fossil fuels, as well as natural sources, with approximately 71% of emissions arising from the transportation sector in Ontario (MECP 2019).

Tables B1-10 and B1-11 below present the 90th percentile and maximum monitored concentrations compared to the 1-hour and 8-hour National Ambient Air Quality Standards and Objectives. Out of the chosen stations, CO data is only available at the Saint-Anicet station. No exceedances of the 1-hour or 8-hour National Ambient Air Quality Standards and Objectives criteria for CO were recorded at the station from 2011 to 2015. CO monitoring ceased at this station in 2015.

Table B1-10: Summary of the 90th Percentile and Maximum 1-Hour CO Monitoring Results for Comparison to the National Ambient Air Quality Standards and Objectives

Station	CO 1-hour Criteria [µg/m³]	90th percentile concentration [µg/m³]	90th percentile as a % of the Criteria	Maximum concentration [µg/m³]	Maximum as a % of the Criteria
Saint-Anicet	15,000	343.57	2.29%	1145.24	7.63%

Table B1-11: Summary of the 90th Percentile and Maximum 8-Hour CO Monitoring Results for Comparison to the National Ambient Air Quality Standards and Objectives

Station	CO 8-hour Criteria [µg/m³]	90th percentile concentration [µg/m³]	90th percentile as a % of the Criteria	Maximum concentration [µg/m³]	Maximum as a % of the Criteria
Saint-Anicet	6,000	343.57	5.73%	638.06	10.63%

2.2.5 Ozone (O_3)

Ground-level ozone is formed when nitrogen oxides (NO_x) and volatile organic carbon (VOCs) react in the presence of sunlight. Monitored ground-level ozone records were below the Ontario 1-hour AAQC at both the Saint-Anicet station and the Memorial Park Cornwall station in 2018 as well as the Ottawa Central station in 2017. At all three stations, between their respective span of 5 years considered, the maximum 1-hour concentration of O_3 and 90th percentile was also below the Ontario AAQC.

Currently there is no 8-hour Ontario AAQC for O_3, but there is a Canadian Ambient Air Quality Standard that has been used for comparison to the data. While the maximum 8-hour concentration of O_3 exceeds the standard at all three stations, compliance with the Canadian Ambient Air Quality Standard is based on the fourth highest 8-hour value annually, averaged over a 3-year period. Table B1-12 presents a summary of the three-year averaging methodology using 8-hour O_3 ambient monitoring results. The Canadian Ambient Air Quality Standard has not been exceeded for all three stations.

Table B1-12: Summary of 3-year average for 4th Highest 8-Hour O_3 Value Monitoring Results for Comparison to the CAAQS

Years	**Saint-Anicet 8-Hour Ozone [µg/m³]** (CAAQS = 123.6 µg/m³)	**Ottawa Central 8-Hour Ozone [µg/m³]** (CAAQS = 123.6 µg/m³)	**Memorial Park Cornwall 8-Hour Ozone [µg/m³]** (CAAQS = 123.6 µg/m³)
2013–2015	—	114.72	—
2014–2016	113.22	115.21	116.93
2015–2017	116.73	117.75	119.87
2016–2018	114.64	N/A	117.75

Notes:

”N/A” indicates that data was not available for the parameter for one or more year in the time period selected

”—” indicates that data for the parameter was not pulled because of more recent data available.

2.2.6 Vinyl Chloride (C_2H_3Cl)

Vinyl Chloride is a volatile organic compound (VOC) and one of the common constituents in landfill gas (LFG). It is formed in the environment when soil organisms break down chlorinated solvents.

Table B1-13 below presents the 90th percentile and maximum monitored concentrations compared to the 24-hour and Vinyl Chloride AAQC. No exceedances of the 24-hour or annual AAQC for Vinyl Chloride were recorded at the Saint-Anicet station from 2009 to 2013. VOC monitoring ceased at this station after 2013, therefore no further data is available.

Table B1-13: Summary of the 90th Percentile and Maximum 24-Hour Vinyl Chloride Monitoring Results for Comparison to the Ontario AAQC

Station	**Vinyl Chloride 24-hour Criteria [µg/m³]**	**90th percentile concentration [µg/m³]**	**90th percentile as a % of the Criteria**	**Maximum concentration [µg/m³]**	**Maximum as a % of the Criteria**
Saint-Anicet	1	0.0038	<1%	0.013	1.3%

2.2.7 Hydrogen Sulphide (H_2S)

H_2S is a major odorous component in landfill gas (LFG). LFG and Hydrogen Sulphide are formed from the biodegradation of the municipal solid waste material within the landfill.

H_2S is not measured at any of the three NAPS stations used for background air quality. Therefore, the 1-hour background concentration was taken from the ECCC’s Draft Screening Assessment for H_2S (ECCC, 2017) and converted to the relevant averaging periods using

MECP recommended methodologies (MECP, 2017). Table B1-14 below summarizes the 10-minute and 24-hour average background concentrations used in the assessment.

Table B1-14: Summary of Hydrogen Sulphide Concentrations for Comparison to the Ontario AAQC

Indicator Compound	Averaging Period	AAQC Criteria [µg/m³]	Background Concentration [µg/m³]	Percentage of Air Quality Criteria
Hydrogen Sulphide	10-minute	13	0.84	6.5%
Hydrogen Sulphide	24-Hour	7	0.21	3.0%

2.2.8 Summary of Monitored Data by Station

For the Saint-Anicet and Memorial Park Cornwall stations, monitoring data for the years 2014 through 2018 (where available) were summarized by indicator compound for the averaging period relevant to the AAQC. CO and SO_2 data were summarized for the years 2011 through 2015 and 2014 through 2018, respectively, from the Saint-Anicet station. To provide an understanding of the variability of the monitoring data, the average, 75th percentile, 90th percentile, and maximum values are summarized in Tables B1-15 to B1-17. As discussed in the previous sections, the 90th percentile of the 1-hour, 8-hour, and 24-hour measurements is typically used to represent the background air quality value when conducting an impact assessment, while the annual average concentration is used for annual background levels (Alberta Environment, 2013). The average concentration for the shorter time periods provides an indication of what air quality would typically be at the location. The 75th percentile provides an indication of the concentration below which the vast majority of the existing air quality readings occurred.

Table B1-15: Summary of Background Air Quality at Saint-Anicet Station (2014 – 2018)(a) in µg/m³

Indicator	Averaging Period	Average	75th	90th	Max
SPM(b)	24-Hour	22.48	26.94	38.31	83.61
	Annual	22.39	—	—	24.52
PM_{10}(b)	24-Hour	12.49	14.97	21.28	46.45
$PM_{2.5}$(a)	24-Hour	6.74	8.08	11.49	25.08
	Annual	6.72	—	—	7.36
CO(a)	1-Hour	163.74	229.05	343.57	1145.24
	8-Hour	179.17	286.31	343.57	638.06
	Annual	255.44	—	—	262.94
SO_2(a)	1-Hour	1.12	0.52	2.62	123.37
	24-Hour	1.12	1.25	3.06	26.88
	Annual	1.12	—	—	1.12
NO_2(a)	1-Hour	4.94	5.64	9.40	84.64
	24-Hour	4.93	5.80	8.91	44.41
	Annual	4.93	—	—	5.42
O_3(a)	1-Hour	54.95	70.65	84.39	139.34
	8-Hour	68.08	79.73	91.25	130.26
C_2H_3Cl(c)	24-Hour	0.001502	0.00235	0.00380	0.01260
	Annual	0.001520	—	—	0.00179

Notes:

”—” indicates that data for the parameter were not available at that station.

(a) Data measured in parts per billion (ppb) or parts per million (ppm) were converted to µg/m³ assuming standard temperature and pressure (25°C and one atmosphere of pressure).

(b) Data converted from $PM_{2.5}$.

(c) Data from years 2009-2013

Table B1-16: Summary of Background Air Quality at Ottawa Central Station (2013 – 2017)$^{(a)}$ in µg/m³

Indicator	Averaging Period	Average	75th	90th	Max
SPM$^{(b)}$	24-Hour	21.46	26.67	38.58	161.67
	Annual	21.50	—	—	23.62
$PM_{10}$$^{(b)}$	24-Hour	11.92	14.81	21.44	89.81
$PM_{2.5}$$^{(a)}$	24-Hour	6.44	8.00	11.58	48.50
	Annual	6.45	—	—	7.09
NO$^{(a)}$	1-Hour	2.15	1.23	3.68	170.53
	24-Hour	2.15	1.69	4.80	46.93
	Annual	2.15	—	—	3.44
$NO_2$$^{(a)}$	1-Hour	11.03	13.17	24.45	103.45
	24-Hour	11.03	13.72	21.62	62.70
	Annual	11.03	—	—	12.41
$O_3$$^{(a)}$	1-Hour	51.93	66.72	80.46	149.15
	8-Hour	65.49	77.52	90.27	133.94

Notes:

”—” indicates that data for the parameter were not available at that station.

(a) Data measured in parts per billion (ppb) or parts per million (ppm) were converted to µg/m³ assuming standard temperature and pressure (25°C and one atmosphere of pressure).

(b) Data converted from $PM_{2.5}$.

Table B1-17: Summary of Background Air Quality at the Memorial Park Cornwall Station (2014-2018)(a) in µg/m³

Indicator	Averaging Period	Average	75th	90th	Max
SPM(b)	24-Hour	21.72	27.36	38.47	108.06
	Annual	21.69	—	—	23.33
PM_{10}(b)	24-Hour	12.07	15.20	21.37	60.03
$PM_{2.5}$(a)	24-Hour	6.52	8.21	11.54	32.42
	Annual	6.51	—	—	7.00
NO(a)	1-Hour	1.90	1.23	2.45	262.54
	24-Hour	1.90	1.64	3.94	60.12
	Annual	1.90	—	—	2.58
NO_2(a)	1-Hour	10.04	11.29	22.57	127.91
	24-Hour	10.04	11.99	21.00	70.69
	Annual	9.91	—	—	10.68
O_3(a)	1-Hour	53.84	68.69	82.42	145.22
	8-Hour	67.09	78.99	91.50	132.71

Notes:

”—” indicates that data for the parameter were not available at that station.

(a) Data measured in parts per billion (ppb) or parts per million (ppm), were converted to µg/m³ assuming standard temperature and pressure (25°C and one atmosphere of pressure).

(b) Data converted from 1-hour average concentrations using MECP methodologies (MECP, 2017)

2.3 Summary of Background Air Quality

This section presents the existing air quality for the Site-vicinity Study Area, which will be added as background to the dispersion modelling results as part of the impact assessment for the proposed expansion of the Boyne Landfill site.

Due to proximity to the Site-vicinity Study Area, and the fact the Site-vicinity Study Area is similarly located in a rural location, the Saint Anicet station is considered to be the most representative station of the Site-vicinity Study Area, and therefore represents the background for indicator compounds as monitored at that station. As Saint-Anicet station only has two recent years of data available for $PM_{2.5}$ (2017 and 2018), the Ottawa Central station was selected for SPM, PM_{10} and $PM_{2.5}$. Table B1-18 provides the background air quality values, which are based on the values from the stations as described above and shown in **Bold** font.

Table B1-18: Background Air Quality Values (90th Percentile, Average for Annual Only)

Indicator	Averaging Period	Background (µg/m³)	Saint-Anicet (µg/m³)	Ottawa Central (µg/m³)	Memorial Park Cornwall (µg/m³)
SPM	24-hour	38.58	—	**38.58**	38.47
	Annual	21.50	—	**21.50**	21.69
PM_{10}	24-hour	21.44	—	**21.44**	21.37
$PM_{2.5}$	24-hour	11.58	—	**11.58**	11.54
	Annual	6.45	—	**6.45**	6.51
NO_2	1-Hour	9.40	**9.40**	24.45	22.57
	24-Hour	8.91	**8.91**	21.62	21.00
	Annual	4.93	**4.93**	11.03	9.91
SO_2	10-minute	4.32	**4.32**	—	—
	1-Hour	2.62	**2.62**	—	—
	24-hour	3.06	**3.06**	—	—
	Annual	1.12	**1.12**	—	—
CO	1-Hour	343.57	**343.57**	—	—
	8-Hour	343.57	**343.57**	—	—
O_3	1-Hour	84.39	**84.39**	80.46	82.42
	8-Hour	91.25	**91.25**	90.27	91.50
H2S	10-minute	0.84	—	—	—
H2S	24-Hour	0.21	—	—	—
C_2H_3Cl	24-Hour	0.0038	**0.0038**	—	—
	Annual	0.0015	**0.0015**	—	—

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Appendix B-2 Emission Calculations

May 2022

Volume 2
Appendix B-2

Emission Calculations

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North Dundas

Table of Contents

TABLES

1.0 INTRODUCTION

This appendix is part of the Air Quality assessment for the proposed expansion of the Boyne Road Landfill site in the Township of North Dundas. This work has been conducted in accordance with the requirements set out in the approved Terms of Reference (ToR), dated February 2019 and the work plan dated May 27, 2021 prepared following commencement of the EA and circulated to the Ministry of the Environment, Conservation and Parks (MECP).

1.1 Purpose

This appendix documents the methods, input parameters and assumptions that were used to estimate the air emission rates for Boyne Road Landfill site.

The calculated emission rates were used as inputs for dispersion modelling to predict the indicator compound concentrations resulting from the existing and proposed expanded landfill. The emission estimation methods described within this appendix follow generally accepted practices for conducting Environmental Assessments (EAs) and, where appropriate, guidance in the Ministry of the Environment, Conversation and Parks ESDM Procedure Document (MECP 2018).

2.0 ASSESSMENT OF COMPOUNDS AND ACTIVITIES

Emissions were assessed for activities, process descriptions and equipment/vehicle specifications provided by the Township of North Dundas and the Golder design team. Scientifically accepted and well documented emission factors, most notably U.S. AP-42 (U.S. EPA 1995), were also used.

Compounds that will be discharged from the landfill in negligible amounts and/or activities that discharge a compound in a negligible amount were excluded from further analysis.

All potential sources of emissions for the proposed expansion were identified; however, only significant sources (e.g., emissions from the landfill cap) were carried through to the dispersion modelling assessment. Sources with emissions rates that are expected to be either negligible or infrequent were not considered (e.g., household hazardous waste drop off). Details of the specific emissions calculation methods and resulting emissions are provided in the following sections.

Table B2-1 below provides a summary of the activities for which emissions were calculated in the air quality assessment, as well as a summary of the compounds expected to be released.

Table B2-1: Significant Activities at the Proposed Landfill Expansion

General Location	Source	Significant (Yes or No)?	Modelled (Yes or No)?	Rationale
Landfill Cap	Landfill gas emissions released passively through the landfill cap	Yes	Yes	—
Landfill Working Area	Fugitive dust and vehicle exhaust emissions from material handling activities at the working face	Yes	Yes	—
Paved & unpaved roads	Vehicle exhaust and fugitive road dust from travel on on-site roads	Yes	Yes	—
Storage piles	Wind erosion from on-site storage piles	Yes	Yes	—
Office and Recycling Building	Combustion emissions from comfort heating equipment at the office and recycling buildings	Yes	Yes	—

2.1 Activities Not Included in Assessment

There are activities associated with the landfill that produce emissions; however, not all activities produce emissions for any or all compounds that are relevant to the overall emissions assessment. All activities that potentially produce emissions were evaluated to determine their relevance; however, only activities that were assessed as relevant were included in the assessment. The following rationale describes why certain activities and/or emissions of certain compounds can be excluded from the assessment, as per the MECP ESDM Procedure Document (MECP 2018):

- The emission rates of certain compounds are very small relative to the overall emissions at the proposed landfill expansion; and
- The emissions of certain sources are known to not be relevant due to the type of operations in the assessment (i.e., activities that are carried out by subcontractors).

Table B2-2 lists the activities that were not assessed and the accompanying rationale.

Table B2-2: Emissions Not Included in the Assessment

Activity/Compound	Rationale for Excluding from the Assessment
Vehicles on-site used by subcontractors (excluding landfill/earth moving equipment)	This activity is known to not be relevant to the type of operations in this assessment.
Construction and post closure phases for landfill expansion	These activities are considered to be insignificant in comparison to the operational phase of the landfill.
Public Drop Off Area/HHW	These activities are considered to be insignificant in comparison to the other activities occurring on-site.

3.0 DATA SOURCES AND ASSUMPTIONS

Table B2-3 and B2-4, below, document the assumptions made as part of the estimation of emission rates for the existing landfill (Table B2-3) and proposed landfill expansion (Table B2-4)

Table B2-3: Data Sources and Assumptions – Existing Landfill

Activity	Parameter	Value	Unit	Notes
Landfill Operations	Landfill area	80,645	m^2	Data from site plans
Landfill Operations	LFG Emissions	1,526,524	m^3/yr	Calculated using the LandGEM model
Landfill Operations	LFG Emissions	174 (103)	m^3/hr (CFM)	

Activity	**Parameter**	**Value**	**Unit**	**Notes**
Landfill Operations	Odour concentration	10,000	OU/m^3	Upper range estimate of odour concentration from the MECP's Interim Guide to Estimate and Assess Landfill Air Impacts
Landfill Operations	Surface area of daily tipping face	200	m^2	Estimate provided by the Township of North Dundas
Landfill Operations	Average daily waste receipt	26	Mg/day	No scales on site; based on 40 m^3 of waste received per day
Landfill Operations	Average daily cover throughput	16	Mg/day	Estimated based on provided historical fill rate volume of 13470 m^3 per year and 286 operating days
Landfill Operations	Working face odour emissions	0.898	g/m^2	WMCC 2012
Landfill Operations	Density of daily cover	1.75	Mg/m^3	Estimated based on similar landfills in Ontario and confirmed by Township of North Dundas
Landfill Operations	Moisture content of waste	11	%	Misc. fill materials, US EPA AP-42 Section 13.2.4
Landfill Operations	Moisture content of daily cover	12	%	Cover, US EPA AP-42 Section 13.2.4
Unpaved Roads	Average vehicle height	3	m	Estimated based on typical waste trucks
Unpaved Roads	Average lane width	7.3 (24 ft for two lane)	m (ft)	Estimate provided by Township of North Dundas
Unpaved Roads	Vehicle weights	Various	tonnes	Estimated based on similar landfills in Ontario and confirmed by Township of North Dundas
Unpaved Roads	Silt Content	6.4	%	US EPA AP-42 Section 13.2.2, mean silt loading for MSW landfills
Unpaved Roads	Dust suppressant control efficiency	40	%	Assumed 40% dust control based on a maximum vehicle speed of 40 km/hr (25 mph) – WRAP Fugitive Dust Handbook (Sept 2006)
Comfort Heating	Maximum Thermal Input	80,000	BTU/hr	Combustion emission factors from US EPA AP-42 Chapter 1.5 for Propane

Table B2-4: Data Sources and Assumptions – Landfill Expansion

Activity	Parameter	Value	Unit	Notes
Landfill Operations	Landfill area	119,000	m^2	Data from site plans
Landfill Operations	LFG Emissions	2,025,457	m^3/yr	Maximum future landfill gas generation estimated using the LandGEM model
Landfill Operations	Odour concentration	10,000	OU/m^3	Upper range estimate of odour concentration from the MECP's Interim Guide to Estimate and Assess Landfill Air Impacts
Landfill Operations	Surface area of daily tipping face	200	m^2	Estimate provided by the Township of North Dundas
Landfill Operations	Working face odour emissions	0.898	g/m^2	WMCC 2012
Landfill Operations	Average daily waste receipt	33	Mg/day	Estimate based on maximum forecasted waste volume of 9,576 tonnes per year and 286 operating days
Landfill Operations	Average daily cover throughput	21	Mg/day	Estimate based on maximum forecasted Fill volume of 17100 m^3 per year and 286 operating days
Landfill Operations	Density of daily cover	1.75	Mg/m^3	Estimated based on similar landfills in Ontario and confirmed by Township of North Dundas
Landfill Operations	Moisture content of waste	11	%	Misc. fill materials, US EPA AP-42 Section 13.2.4
Landfill Operations	Moisture content of daily cover	12	%	Cover, US EPA AP-42 Section 13.2.4
Unpaved Roads	Vehicle weights	Various	tonnes	Estimated based on similar landfills in Ontario and confirmed by Township of North Dundas
Unpaved Roads	Silt Content	6.4	%	US EPA AP-42 Section 13.2.2, mean silt loading for MSW landfills

Activity	Parameter	Value	Unit	Notes
Unpaved Roads	Dust suppressant control efficiency	40	%	Assumed 40% dust control based on a maximum vehicle speed of 40 km/hr (25 mph) – WRAP Fugitive Dust Handbook (Sept 2006)
Unpaved Roads	Average lane width	7.3 (24 ft for two lane)	m (ft)	Estimate provided by Township of North Dundas

4.0 EMISSION CALCULATION METHODOLOGIES

The following sections detail the emission calculation methodology for each source included in the assessment. The emission rates are all in units of grams (g) per second (g/s), with the exception of odour that is in odour units (OU) per second (OU/s), which is required for the dispersion models. The dispersion model assumes the emission rate is constant over an hourly period, which is the smallest time-step within the models used for predictions.

4.1 Landfill Cap

Fugitive LFG emissions will be released through the landfill cap. LFG constituents and their estimated respective concentrations in the LFG were obtained from published emission factors for landfill gas generation (US. EPA, 2008). Average fugitive LFG emissions per year were estimated using results from the LandGEM model.

The following is a sample calculation for the emission rate of vinyl chloride from the landfill cap for the proposed expansion conditions:

$$\mathrm{ER} = \mathrm{conc.}\frac{\mu\mathrm{g}}{\mathrm{m}^3} \times \mathrm{LGF}\ \frac{\mathrm{m}^3}{\mathrm{yr}} \times \frac{1\ \mathrm{yr}}{365\ \mathrm{days}} \times \frac{1\ \mathrm{day}}{24\ \mathrm{hrs}} \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}} \times \frac{1\ \mathrm{g}}{1{,}000{,}000\ \mu\mathrm{g}}$$

Where:

ER = emission rate (m^3/s)

conc. = concentration of the contaminant in the landfill gas (g/m^3) obtained from US EPA AP 42 Chapter 2.4 (US EPA, 2008)

LFG = average landfill gas emissions per yr. (m^3/yr.) (obtained from LandGEM)

$$\mathrm{ER} = 18{,}647\ \frac{\mu\mathrm{g}}{\mathrm{m}^3} \times 2{,}025{,}247\frac{\mathrm{m}^3}{\mathrm{yr}} \times \frac{1\ \mathrm{yr}}{365\ \mathrm{days}} \times \frac{1\ \mathrm{day}}{24\ \mathrm{hrs}} \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}} \times \frac{1\ \mathrm{g}}{1{,}000{,}000\ \mu\mathrm{g}}$$

$$\mathrm{ER} = 0.0012\ \mathrm{g/s}$$

Emissions of the remaining indicator compounds were calculated in the same manner presented above.

The odour emissions from the landfill cap were also calculated in the same manner but using an odour emission concentration of 10,000 OU/m^3 (MECP, 1992).

The following is a sample calculation for the emission rate of odour from the landfill cap for the proposed expansion conditions:

$$\mathrm{ER} = \mathrm{conc.}\frac{\mathrm{OU}}{m^3} \times \mathrm{LGF}\ \frac{\mathrm{m}^3}{\mathrm{yr}} \times \frac{1\ \mathrm{year}}{365\ \mathrm{days}} \times \frac{1\ \mathrm{day}}{24\ \mathrm{hrs}} \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}}$$

Where:
ER = emission rate (m^3/s)
OU = Odour Units
conc. = concentration of the odour in the landfill gas (OU/m^3) (MECP, 1992)
LFG = average landfill gas emissions per yr. ($m^3/yr.$) (obtained from LandGEM)

$$\mathrm{ER} = 10000\ \frac{\mathrm{OU}}{\mathrm{m}^3} \times 2{,}025{,}247\frac{\mathrm{m}^3}{\mathrm{yr}} \times \frac{1\ \mathrm{yr}}{365\ \mathrm{days}} \times \frac{1\ \mathrm{day}}{24\ \mathrm{hrs}} \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}}$$

$$\mathrm{ER} = 642\frac{\mathrm{OU}}{\mathrm{s}}$$

4.2 Landfill Working Area

Fugitive dust will be generated at the Landfill Working Area from material transfer activities, including depositing of waste, bulldozing of deposited waste and application of daily cover. In addition, odours may occur from the deposited waste, before the application of daily cover.

Published emission factors were used to calculate the fugitive dust emissions associated with material transfer activities that will occur at the landfill active area (US EPA 2006 and 1998).

Fugitive dust from depositing of waste:

The following predictive emissions equation was used in determining the emission factors for material handling:

$$\mathrm{EF} = \mathrm{k} \times 0.0016\ \times \frac{\left(\frac{\mathrm{U}}{2.2}\right)^{1.3}}{\left(\frac{\mathrm{M}}{2}\right)^{1.4}}$$

Where:
EF = particulate emission factor (kg/Mg)
k = particle size multiplier for particle size range (see Table B2-5)
U = mean wind speed (m/s)
M = moisture content of material (percent) (%)

Table B2-5: Particle Size Assumptions Material Transfer (US EPA, 2006)

Size Range	k
$PM_{2.5}$	0.053
PM_{10}	0.35
SPM	0.8*

Notes: *scaled from 0.74 to 0.8 to represent particulate <44 microns versus <30 microns

The following is a sample calculation for the SPM emission factor for the depositing of waste in the active area. A daily maximum wind speed of 9.07 m/s was obtained from the pre-processed meteorological data (2016-2020) used in the modelling assessment, along with a moisture content of 12% for municipal solid waste landfill cover soil

$$\mathrm{EF} = 0.8 \times 0.0016 \times \frac{\left(\frac{9.07\ \mathrm{m/s}}{2.2}\right)^{1.3}}{\left(\frac{12}{2}\right)^{1.4}}$$

$$\mathrm{EF} = 0.000657\ \mathrm{kg/Mg}$$

The following is a sample calculation for the SPM emission rate per drop for a handling rate of 16.5 Mg/day of daily cover. This represents an hourly emission rate during operating hours.

$$\mathrm{ER} = \mathrm{EF}\frac{\mathrm{kg}}{\mathrm{Mg}} \times \mathrm{Operation\ Max\ Capacity}\frac{\mathrm{Mg}}{\mathrm{day}} \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}} \times \frac{1{,}000\ \mathrm{g}}{1\ \mathrm{kg}} \times \frac{1\ \mathrm{day}}{\mathrm{hours\ of\ operations}}$$

$$\mathrm{ER} = \frac{0.000657\ \mathrm{kg}}{\mathrm{Mg}} \times \frac{16.5\ \mathrm{Mg}}{\mathrm{day}} \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}} \times \frac{1{,}000\ \mathrm{g}}{1\ \mathrm{kg}} \times \frac{1\ \mathrm{day}}{8\ \mathrm{hr}}$$

$$\mathrm{ER} = 0.000376\ \mathrm{g/s}$$

The emission rates of PM_{10} and $PM_{2.5}$ were calculated in the same manner as above.

Fugitive Dust from Material Movement (Bulldozing):

Deposited waste may be compacted/redistributed using a bulldozer. The following predictive emissions equations were used in determining the emission factors for bulldozing activities at the active area:

SPM SPM ≤ 10 µm SPM ≤ 2.5 µm

$$\mathrm{EF} = \frac{2.6(\mathrm{s})^{1.2}}{(\mathrm{M})^{1.3}} \qquad \mathrm{EF} = \frac{0.45(\mathrm{s})^{1.5}}{(\mathrm{M})^{1.4}} \times 0.75 \qquad \mathrm{EF} = \frac{2.6(\mathrm{s})^{1.2}}{(\mathrm{M})^{1.3}} \times 0.105$$

Where:
EF = particulate emission factor (kg/hr)
s = material silt content (%)
M = moisture content of material (%)

Table B2-6: Assumptions Material Movement (Bulldozing)

Parameter	Value	Reference
Moisture Content (M)	12	US EPA, 2006 – municipal solid waste landfill cover
Silt Content (s)	9	US EPA, 2006– municipal solid waste landfill cover

The following is a sample calculation for the SPM emission factor:

$$\mathrm{EF(SPM)} = \frac{2.6\ (9)^{1.2}}{(12)^{1.3}}$$

$$\mathrm{EF} = 1.44\ \mathrm{kg/hr}$$

The following is a sample calculation for the SPM hourly emission rate for material movement (Bulldozing).

$$\mathrm{ER} = \mathrm{EF}\frac{\mathrm{kg}}{\mathrm{hr}} \times \frac{1{,}000\ g}{1\ \mathrm{kg}} \times \frac{1\ \mathrm{hr}}{3600\ \mathrm{s}}$$

$$\mathrm{ER} = 1.44\frac{\mathrm{kg}}{\mathrm{hr}} \times \frac{1{,}000\ g}{1\ \mathrm{kg}} \times \frac{1\ \mathrm{hr}}{3600\ \mathrm{s}}$$

$$\mathrm{ER} = 0.399\ \mathrm{g/s}$$

The emission rates of PM_{10} and $PM_{2.5}$ were calculated in the same manner as above with the exception of using the specific particle size emission factor equation.

Odour from Landfill Working Area:

The odour from the Landfill Working Area was determined based on an odour emission rate of 0.898 OU/m^2/s calculated from emission factors for other representative landfills in Ontario (WMCC, 2012). This emission factor was multiplied by the size of the active area, which was estimated to be 200 $m^{2.}$ The resulting emission rate for odour is 179.6 OU/s.

The following is a sample calculation for the emission rate of odour from the working face for the proposed expansion conditions:

$$\mathrm{ER} = \mathrm{conc.}\frac{\mathrm{OU}}{m^2/s} \times \mathrm{Area}\; m^2$$

Where:
ER = Emission rate (m^3/s)
OU = Odour Units
conc. = Concentration of the odour in the landfill gas (OU/m^2/s) working face of other representative landfills in Ontario
Area = Surface area of daily working face (m^2)

$$\mathrm{ER} = 0.898\frac{\mathrm{OU}}{m^2/s} \times 200\; m^2$$

$$\mathrm{ER} = 179.6\ \mathrm{OU}/s$$

4.3 Non-Road Vehicles – Exhaust Emissions

Combustion emissions are released from tailpipes of vehicles travelling on-site. Emission rates for tailpipe emissions from non-road equipment (i.e., compactor and loader) were calculated using emission factors (US EPA, 2018). Load factors for the non-road equipment were estimated for each piece of equipment based on assumptions for similar equipment. (US EPA, 2002)

Table B2-7: Non-Road Equipment

Equipment	Horsepower	# of units
Compactor - Caterpillar 816K	284	1
Front End Loader - Case 80	80	1

The following predictive emissions equation was used to determine the combustion emission rates for SPM, CO, and NOx for the on-site vehicles:

$$\mathrm{ER} = \mathrm{EF}\ \times \text{engine horsepower rating}\ \times \text{load factor}\ \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}}$$

Where:
ER = emission rate (g/s), and
EF = emission factor (g/hp-hr)
Load factor = utilization factor for the equipment

The following is a sample calculation for the NO_x emissions for the Caterpillar 816K Compactor located at the active area:

$$\mathrm{ER} = \frac{0.30\ \mathrm{g}}{\mathrm{hp-hr}} \times 284\ \mathrm{hp}\ \times 0.59\ \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}}$$

$$\mathrm{ER} = 0.014\ \frac{\mathrm{g}}{\mathrm{s}}$$

The emission rates for PM_{10} and $PM_{2.5}$ were calculated by multiplying SPM emission rate by estimated particle size fraction (US EPA, 1996). The following is a sample calculation for PM_{10} emissions for Caterpillar 816K Compactor:

$$\text{ER for SPM} = 0.000465\ \frac{\mathrm{g}}{\mathrm{s}}$$

$$\text{ER for PM10} = 0.000465 \frac{\mathrm{g}}{\mathrm{s}} \times 0.96$$

$$\text{ER for PM10} = 0.000447\ \frac{\mathrm{g}}{\mathrm{s}}$$

The following emissions equation was used to determine the combustion emission factor for SO_2 in grams per horsepower hour (US EPA, 2018):

$$SO_2 = (\mathrm{BSFC}\ \times 453.6 \times (1 - \mathrm{SOxcnv}) - \mathrm{HC}) \times 0.01 \times \mathrm{SOxdsl}\ \times 2$$

Where:
SO_2 is in g/hp-hr
BSFC = is the in-use adjusted fuel consumption in the lb/hp-hr
453.6 = conversion factor from weight percent to weight fraction
SOxcnv = fraction of fuel sulfur converted to direct PM
HC = the in-use adjusted hydrocarbon emissions in g/hp-hr
0.01 = the conversion factor from weight percent to weight fraction
SOxdsl = the episodic weight percent to weight fraction
2 = the grams of SO_2 formed from a gram of sulfur

The following is a sample calculation for the SO_2 emissions factor for the Caterpillar 816K Compactor located at the active area:

$$SO_2 = \left(0.367\ \frac{lb}{hp-hr} \times 453.6 \times (1-0.02247) - 0.01\right) \times 0.01 \times 0.0015\% \ \times 2$$

$$\text{Emission Factor for } SO_2 = 0.0000488\ \frac{\text{g}}{\text{hp}-\text{hr}}$$

Emission rate sample calculation for SO_2:

$$\text{ER} = \frac{0.0000488\ \text{g}}{\text{hp}-\text{hr}} \times 284\ \text{hp}\ \times 0.59\ \times \frac{1\ \text{hr}}{3{,}600\ \text{s}}$$

$$\text{ER} = 0.00000227\ \frac{\text{g}}{\text{s}}$$

4.4 On-Road Vehicles – Exhaust Emissions

The Site has one access road, which is unpaved. For the access roads (one considered for existing and one considered for expansion) located on the landfill property, the location and length of the road segments was conservatively estimated such that it would represent the longest distance that a truck could reasonably travel on-site.

The on-road vehicles travelling on the Landfill road segments was provided by the Township of North Dundas and is based on the Traffic Study completed as part of the EA. Vehicle weights were estimated for each class of vehicle entering the landfill. This data is summarized in Table B2-8:

Table B2-8: Boyne Road Landfill On-road Vehicles – Type and Volume of Vehicles

Vehicle Type Description	Average Vehicle Weight (tonnes)	Peak Trips per hour - Existing	Peak Trips per hour - Expansion
Municipal Waste/ Recycling Truck	10.00	2.40	4.2
Cars/ Pickup Trucks	2.50	7.80	13.65
Large Trucks	5.00	1.80	3.15

Emission factors for the on-site vehicle exhaust for on-road vehicles (i.e., cars, trucks and waste vehicles) were obtained using the U.S. EPA MOVES3 emission model.

The emission factors developed for the on-road vehicles operated at the facility are provided in the Tables below:

Table B2-9: Emission Factors for Waste Trucks Calculated Using MOVES Model

Compound	Emission Factor (g/VKT)(a)
SPM	0.53
PM_{10}	0.53
$PM_{2.5}$	0.49
NO_X	11.56
SO_2	0.01
CO	4.05

Notes: a) VKT =vehicle kilometres travelled

Table B2-10: Emission Factors for Five Tonne Diesel Trucks Calculated Using MOVES Model

Compound	Emission Factor (g/VKT)(a
SPM	0.29
PM_{10}	0.29
$PM_{2.5}$	0.27
NO_X	3.49
SO_2	0.00
CO	3.44

Table B2-11: Emission Factors for Passenger Vehicles (Gasoline) Calculated Using MOVES Model

Compound	Emission Factor (g/VKT)
SPM	0.0032
PM_{10}	0.0032
$PM_{2.5}$	0.0028
NO_X	0.38
SO_2	0.0029
CO	5.19

The following equation was used to determine the vehicle kilometres travelled per hour (VKT/hr):

$$\frac{\text{VKT}}{\text{hr}} = \frac{\text{\# of Trucks}}{\text{Hour}} \text{ x Road Length Travelled (km)}$$

The following is a sample calculation for VKT/hr on the existing road for the waste trucks for the current operations:

$$\frac{\text{VKT}}{\text{hr}} = \frac{2.4\ \text{Waste Trucks}}{\text{Hour}} * 0.601\ \text{km} * 2\ \text{trips}$$

VKT/hr = 2.9

The VKT for each of the road segments was calculated using the equation above. The maximum number of vehicle trips per hour for current existing and proposed phases for each road segment was used in the calculation. Tables B2-12 list the road segments and VKT/hr for each of the three vehicle types travelling on the roads.

Table B2-12: Waste Truck – Road Segment Maximum VKT/hr

Description	Vehicles on Segment	Maximum Trips per hour	Segment Length [one way, m]	Maximum VKT/hr
Current Unpaved	Waste Truck	2.4	601	2.9
Current Unpaved	Five Tonne Diesel Trucks	1.8	601	2.2
Current Unpaved	Passenger Vehicles	7.8	601	9.4
Expansion Unpaved	Waste Truck	4.2	864	7.3
Expansion Unpaved	Five Tonne Diesel Trucks	3.2	864	5.4
Expansion Unpaved	Passenger Vehicles	13.7	864	23.6

The following predictive emissions equation was used to determine the exhaust emission rates for on-site vehicles travelling on the unpaved roads:

$$\text{ER} = \text{EF} \times \frac{\text{VKT}}{\text{hr}} \times \frac{1\ \text{hr}}{3{,}600\ \text{s}}$$

Where:

ER = emission rate (g/s)

EF = emission factor (g/VKT)

The following is a sample calculation for the total NO_x emissions for Waste Truck exhaust emissions on the existing unpaved road segment for the existing phase.

$$E\text{R} = \frac{11.6\ \text{g}}{\text{VKT}} \times \frac{2.9\ \text{VKT}}{\text{hr}} \times \frac{1\ \text{hr}}{3{,}600\ \text{s}}$$

$$\text{ER} = 0.00926\ \text{g/s}$$

Additionally, SPM, PM_{10} and $PM_{2.5}$, SO_2, and CO were calculated using the same equation.

4.5 Unpaved Road Dust

The movement of vehicles on the on-site roads will generate fugitive road dust. The predictive equation referenced in AP42 emission methodologies for unpaved roads (US EPA, 2006b) was used to calculate the fugitive dust emissions from unpaved roadways. The equation accounts for the application of dust suppressant control efficiency. The equation is as follows:

$$\mathrm{EF} = \left(\mathrm{k}\left(\frac{\mathrm{s}}{12}\right)^{\mathrm{a}} \times \left(\frac{\mathrm{W}}{3}\right)^{\mathrm{b}} \times 281.9\right)(1 - \text{control efficiency})$$

Where:

EF = particulate emission factor (g/VKT)

k = empirical constant for particle size range (pounds (lbs) per vehicle mile travelled (VMT)) (see Table B2-13)

s = road surface silt content (%) assumed to be 6.4% (as per US EPA AP-42 Section 13.2.2 for MSW landfills)

W = average weight (tons) of the vehicles traveling the road

a = empirical constant for particle size range (dimensionless) (see Table B2-13)

b = empirical constant for particle size range (dimensionless) (see Table B2-13)

281.9 = conversion from pounds per vehicle miles travelled to grams per vehicle kilometres travelled

control efficiency = reduction of fugitive dust emissions due to natural mitigation or dust suppression activities.

Table B2-13: Particle Size Assumptions for Unpaved Road Dust

Size Range	k (lb/VMT)	a	b
SPM	4.9	0.7	0.45
PM_{10}	1.5	0.9	0.45
$PM_{2.5}$	0.15	0.9	0.45

The following is a sample calculation for SPM emission factor for a Waste Truck that will travel on the existing road in the current phase (unpaved road to active area of landfill). A Waste Truck travelling on this segment will have an average weight of 9.84 tons; vehicle weights were estimated based on similar landfills and are presented in Table B2-14.

Table B2-14: Road Vehicle Weights

Vehicle Type Description	Average Vehicle Weight (tonnes)	Average Vehicle Weight (tons)
Municipal Waste/ Recycling Truck	10.00	9.84
Cars/ Pickup Trucks	2.50	2.46
Large Trucks	5.00	4.92

This calculation is prior to mitigation controls.

$$\mathrm{EF} = \left(4.9\left(\frac{6.4}{12}\right)^{0.7} \times \left(\frac{9.84}{3}\right)^{0.45} \times 281.9\right)$$

$$\mathrm{EF} = 1520\ \mathrm{g/VKT}$$

A control efficiency of 40% was applied, based on the on-site vehicle speed limit of 40 km/hr (25 mph) determined from discussions with the Township and observations on site.

$$\mathrm{EF} = 1520\frac{\mathrm{g}}{\mathrm{VKT}} * \ (-40\%)$$

$$\mathrm{EF} = 911\frac{\mathrm{g}}{\mathrm{VKT}}$$

The following is a sample calculation for the SPM emission rate for waste trucks travelling along the existing road in the existing phase:

$$\mathrm{ER} = \frac{911\ \mathrm{g}}{\mathrm{VKT}} \times \frac{2.9\ \mathrm{VKT}}{\mathrm{hr}} \times \frac{1\ \mathrm{hr}}{3600\ \mathrm{s}}$$

$$\mathrm{ER} = 0.73\ \mathrm{g/s}$$

The emission rates of PM_{10} and $PM_{2.5}$ were calculated as presented above.

4.6 Comfort Heating

The office building located on site at the landfill used electric comfort heating, producing no emissions. The vehicle and equipment storage buildings used a propane heating unit during night time hours to ensure vehicles and equipment started up the next day. Emission estimates from propane combustion products were obtained from published emission factors for liquified petroleum gas combustion (US. EPA, 2008).

Table B2-15: Emission Factors for LPG Combustion

Compound	Emission Factor (lb/1000 gal)
SPM	0.2
PM_{10}	0.2
$PM_{2.5}$	0.2
NO_X	13
SO_2 (multiplied by S)*	0.10S
CO	7.5

*S equals the sulfur content expressed in gr/100 ft³ gas vapor

Fuel Sulfur Content = 15 gr/100ft^3

Propane Heat Content = 91500000 BTU/1000 gal

Emission factor for SO_2:

$$\mathrm{EF} = 15\,\frac{\mathrm{gr}}{100\mathrm{ft3}} * \ (0.10)$$

$$\text{Emission Factor for } SO_2 = 0.015\ \frac{\mathrm{lb}}{1000\ \mathrm{gal}}$$

The following predictive emissions equation was used to determine the combustion emission rates for SPM, PM_{10}, $PM_{2.5}$, CO, SO_2 and NOx for the propane heating unit:

$$\mathrm{ER} = \mathrm{EF}\ \times \text{maximum thermal heat input}\ \times \frac{1000\ \mathrm{gal}}{91500000\ \mathrm{BTU}} \times \frac{454\ \mathrm{g}}{1\ \mathrm{lb}} \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}}$$

Where:
ER = emission rate (g/s), and
EF = emission factor (lb/1000 gal).

The following is a sample calculation for the NO_x emissions for the propane heating unit:

$$\mathrm{ER} = \frac{13\ \mathrm{lb}}{1000\ \mathrm{gal}} \times 80{,}000\,\frac{\mathrm{BTU}}{\mathrm{hr}} \times \frac{1000\ \mathrm{gal}}{91500000\ \mathrm{BTU}} \times \frac{454\ \mathrm{g}}{1\ \mathrm{lb}} \times \frac{1\ \mathrm{hr}}{3{,}600\ \mathrm{s}}$$

$$\mathrm{ER} = 0.00143\ \frac{\mathrm{g}}{\mathrm{s}}$$

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Appendix B-3 Dispersion Modeling

May 2022

Volume 2
Appendix B-3

Dispersion Modeling

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TABLES

1.0 INTRODUCTION

This appendix is part of the Air Quality assessment for the proposed expansion of the Boyne Road Landfill site in the Township of North Dundas. This work has been conducted in accordance with the requirements set out in the approved Amended Terms of Reference (ToR), dated February 2019 and the work plan dated May 27, 2021 prepared following commencement of the EA and circulated to the Ministry of the Environment, Conservation and Parks (MECP).

1.1 Purpose

This appendix documents the methods, inputs and assumptions that were used to carry out the dispersion modelling to predict ground-level concentrations of indicator contaminants resulting from the operations of the existing landfill and the proposed landfill expansion.

The modelling approach described within this appendix follows generally accepted practices for conducting EAs and, where appropriate, follows MECP guidance (MECP, 2017).

2.0 AIR DISPERSION MODEL

Potential effects to air quality were evaluated with the aid of the latest version of the AERMOD dispersion model (Version 19191). AERMOD was selected for the assessment of the existing landfill and the proposed landfill expansion since:

- it is recognized by provincial regulators as one that is suitable for this application
- it can evaluate various source configurations and compounds
- it has a technical basis that is scientifically sound, and is in keeping with the current understanding of dispersion in the atmosphere
- it makes predictions that are consistent with observations

AERMOD was developed by the U.S. EPA and consists of the model and two pre-processors: the AERMET meteorological pre-processor and the AERMAP terrain pre-processor. The following approved dispersion model and pre-processors were used in the assessment:

- AERMOD dispersion model (v. 19191)
- AERMAP surface pre-processor (v. 18081)

A 5-year pre-processed meteorological dataset (2016-2020) was provided by the MECP, pre-processed in version 19191 of AERMET.

2.1 Model Inputs

To predict ambient air concentrations with the aid of AERMOD, a series of inputs are required. These inputs can be grouped into categories:

- dispersion meteorological data
- terrain and receptors
- emissions and source configurations

Each of these input categories are discussed separately in the following sections.

2.1.1 Meteorological Data

The MECP, as well as other agencies, recommends that five years of hourly data be used in the model to cover a wide range of potential meteorological conditions. A site-specific MECP pre-processed meteorological dataset for the site was obtained directly from MECP on August 7th, 2021. The dataset covers the period of January 1, 2016 to December 31, 2020.

The AERMET pre-processor produced two meteorological data files. The first file contains boundary layer scaling parameters (e.g., surface friction velocity, mixing height, and Monin-Obukhov length) as well as wind speeds, wind directions and temperature at a reference-height (i.e., 10 m). The second file contains one or more levels (a profile) of winds, temperature, and the standard deviation of the fluctuating components of the wind. These files were used directly as inputs to AERMOD.

2.1.2 Terrain

Terrain elevations have the potential to influence air quality concentrations at individual receptors, therefore surrounding terrain data is required when using regulatory dispersion models in both simple and complex terrain situations. Digital terrain data is used in the AERMAP pre-processor to determine the base elevations of receptors, sources and buildings. AERMAP then searches the terrain height and location that has the greatest influence on dispersion for each receptor (U.S. EPA, 2004). This is referred to as the hill height scale. The base elevation and hill height scale produced by AERMAP are directly inserted into the AERMOD input file.

Digital terrain data for the site was obtained from the MECP (GeoTIFF Format) (MECP, 2019). The digital elevation model (CDEM) file used in the modelling was CDEM_DEM_040I.

2.1.3 Receptors

Discrete receptors located off-site at nearby residences (referred to as sensitive receptors) were used for the indicator compounds, these are illustrated on Figure 9-1 as part of the main EASR in Section 9.1.1.

For the assessment of compliance with O. Reg. 419/05, a nested grid of receptors was used for the assessment based on the MECP Dispersion Modelling Guideline (MECP, 2017). Receptors were centered on the sources and placed as follows:

- 20 m spacing within 200 m of all sources of emissions
- 50 m spacing within 300 m of all sources of emissions
- 100 m spacing within 800 m of all sources of emissions
- 200 m spacing within 1,800 m of all sources of emissions
- 500 m spacing within 5,000 m of all sources of emissions

2.1.4 Emission Rates

Hourly emission rates were estimated for the indicator compounds emitted from the Boyne Landfill expansion activities (including existing activities) and used as inputs for the dispersion model. A detailed description of the methodology and sample calculations for determining the emission rates is provided in Volume 2 Appendix B-2.

2.2 Model Source Configurations

Emission sources that were parameterized in the modelling include the landfill cap, the active area, fugitive road dust, exhaust emissions from road and non-road vehicles, storage pile material handling and wind erosion emissions from daily cover material.

The model source types that were used in this assessment include area and volume sources, as described below. Site layout and emission source location figures showing the location of the emission sources for the existing landfill are presented on Figure 13-1 and for the proposed expansion on Figure 13-2 of the main EASR in Section 13.1.1.

2.2.1 Area Sources

Area sources are used to model low elevation or ground releases. The landfill cap and operations at the active area were modelled as area sources.

The input parameters for the area sources are provided in Table B3-1. The release heights were estimated to be the difference between the Base Elevation (as provided by AERMAP) and the final (target) elevations. The final target elevations for the Existing Landfill were estimated using the 2020 Boyne Landfill Surface Contours figure. An average Active Fill Waste Height was estimated using six cross sections of the landfill contours (3 east-west and 3 north-south). For the Expansion Landfill scenario, the same methodology (average of six cross-sections) was used to estimate the final target heights of the Fill Waste. Cross-sections of Proposed Expansion Landfill Contours figure were used.

Table B3-1: Area Source Summary

Source Description (and ID #)	Release Height Above Grade [m]*	Area (m^2)	UTM Northing (m)	UTM Easting (m)	Indicator Compound	Emission Rate During Operation (g/s-m^2)
Existing Landfill Cap (CAP_E)	9.13	80,645	474662	4994580	H_2S	3.0E-08
					C_2H_3Cl	1.1E-08
					CO	9.6E-08
					Odour (OU/s-m^2)	6.0E-03
Existing Landfill Operations (FILL)	10.88	200	474788	4994546	SPM	2.0E-03
					PM_{10}	4.1E-04
					$PM_{2.5}$	2.3E-04
					CO	8.5E-04
					NOx	8.8E-04
					SO_2	4.3E-07
					Odour (OU/s-m^2)	9.0E-01
Expansion Landfill Cap (CAP_EXP)	11.14	118,269	474625	4994305	H_2S	2.7E-08
					C_2H_3Cl	1.0E-08
					CO	8.7E-08
					Odour (OU/s-m^2)	5.4E-03
Expansion Landfill Operations (FILL)	12.89	200	474788	4994546	SPM	2.0E-03
					PM_{10}	4.1E-04
					$PM_{2.5}$	2.3E-04
					CO	8.5E-04
					NOx	8.8E-04
					SO_2	4.3E-07
					Odour (OU/s-m^2)	9.0E-01

Notes: *Please note the grade has been assumed to be the land outside of the waste extents (~ elevation 75 to 76 m above sea level).

2.2.2 Volume Sources

Volume sources are used to model releases from a variety of industrial sources that cannot be classified as a point or area source. The roads at Boyne Road Landfill have been modelled following the line volume source approach (MECP, 2017). This includes modelling the roads as a series of individual volume sources creating a line that follows the road (US EPA, 2012).

The roads were divided into separated contiguous volume sources with a release height of 2.53 m, which was calculated by multiplying the assumed height of the vehicles (2.98 m) by 1.7 and dividing by 2 as per the MECP and USEPA Guidance (MECP, 2017, USEPA, 2012). The roads are assumed to be 7.3 m wide (for 2 lanes). The emission rate for each entire road segment was divided between the volume sources.

For the current operations, the access road location was assumed to run between the site entrance and the existing working face location. For the proposed expansion, the access road was assumed to run between the site entrance and the furthest working face location. The roads were modelled using this approach for both the existing and proposed expansion scenarios and the road pathways are presented on Figure 13-1 and 13-2 found in Section 13.1.1 of the main EASR.

Table B3-2: Volume Source Summary

Source Description (and ID #)	Release Height Above Grade [m]	Initial Lateral Dimension of Volume [m]	Initial Vertical Dimension of Volume [m]	X Coordinate [m]	Y Coordinate [m]	Indicator Compound	Emission Rate (g/s)
Storage Piles – existing (SP1)	3	14.53	0.7	474626	4994388	SPM	2.4E-02
						PM_{10}	1.2E-02
						$PM_{2.5}$	1.8E-03
Storage Piles – expansion (SP1)	3	14.53	0.7	474626	4994388	SPM	2.4E-02
						PM_{10}	1.2E-02
						$PM_{2.5}$	1.8E-03
Propane Heating – existing and expansion (HEAT)	5	2.56	1.16	474696	4994536	SPM	2.2E-05
						PM_{10}	2.2E-05
						$PM_{2.5}$	2.2E-05
						NOx	8.3E-04
						CO	1.4E-03
						SO_2	1.7E-06

Table B3-3: Volume Source Summary – Roads

Source Description (and ID #)	Release Height Above Grade [m]	Plume Height [m]	Plume Width [m]	Indicator Compound	Emission Rate per Road Segment (g/s)	# of AERMOD Sources in Road Segment	Emission Rate Per Model Source (g/s)
Unpaved road – existing (EXISTROAD)	2.53	5.06	13.3	SPM	2.4E+00	24	1.0E-01
				PM_{10}	6.5E-01		2.7E-02
				$PM_{2.5}$	6.5E-02		2.7E-03
				CO	1.9E-02		7.9E-04
				NOx	1.2E-02		5.2E-04
				SO_2	1.3E-05		5.5E-07
Unpaved road – expansion (EXPANROAD)	2.53	5.06	13.3	SPM	6.0E+00	33	1.8E-01
				PM_{10}	1.6E+00		5.0E-02
				$PM_{2.5}$	1.7E-01		5.0E-03
				NOx	4.7E-02		1.4E-03
				CO	3.1E-02		9.4E-04
				SO_2	3.3E-05		1.0E-06

2.3 Options to be used in the AERMOD Model

The options that were used in the AERMOD model are summarized in Table B3-4 below.

Table B3-4: Options Used in the AERMOD Model

Modelling Parameter	Description	Used in the Assessment?
DFAULT	Specifies that regulatory default options will be used.	Yes
CONC	Specifies that concentration values will be calculated.	Yes
EMISFACT HROFDY	Specifies that variable emissions are in use for variable emissions type “Hour-of-day”	Yes (see table B3-5)
OLM	Specifies that the non-default Ozone Limiting Method (OLM) for NO_2 conversion will be used.	No – NO_2 is converted during post processing as described in section 2.5 below.
DDPLETE	Specifies that dry deposition will be calculated.	No
WDPLETE	Specifies that wet deposition will be calculated.	No
FLAT	Specifies that the non-default option of assuming flat terrain will be used.	No, the model will use elevated terrain as detailed in the AERMAP output.
NOSTD	Specifies that the non-default option of no stack-tip downwash will be used.	No
AVERTIME	Time averaging periods calculated.	1-hr, 8-hr, 24-hr, Annual
URBANOPT	Allows the model to incorporate the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions.	No
URBANROUGHNESS	Specifies the urban roughness length (m).	No, site specific roughness values were incorporated into the AERMET processing.

The variable emissions by hour of day option in AERMOD was applied for road segments where the volume of vehicle traffic on road segments varies significantly over the course of the day. Table B3-5 lists the road segments and scaling factor applied to emissions.

Table B3-5: Variable Emissions Scaling Factors

Sources	Hour of Day	Scaling Factor
EXISTROAD, FILL, EXPANROAD, FILL_EXP	0:00-8:00	0
	8:00-9:00	1
	9:00-10:00	1
	10:00-11:00	1
	11:00-12:00	1
	12:00-13:00	1
	13:00-14:00	1
	14:00-15:00	1
	15:00-16:00	1
	16:00-17:00	1
	17:00-0:00	0

2.4 Time Average Conversions

The smallest time scale that AERMOD predicts is a 1-hour average value. There are instances when criteria are based on shorter averaging times, and in these cases a conversion factor, recommended by the MECP, for conversion from a 1-hour averaging period to the applicable averaging period less than 1-hour was used (MECP, 2017).

An example is given below for converting from a 1-hour averaging period to a 10-minute averaging period, which is required for odour modelling:

$$F = \left(\frac{t_1}{t_0} \right)^n$$

$$= \left(\frac{60}{10} \right)^{0.28}$$

$$= 1.65$$

Where:

F = the factor to convert from the averaging period t_1 output from the model (MECP assumes AERMOD predicts true 60 minute averages) to the desired averaging period t_0 (assumed to be 10-minutes in the example above).

n = the exponent variable; in this case the MECP value of n = 0.28 is used for conversion.

For averaging periods greater than 1-hour, the AERMOD output was used directly.

2.5 NOx to NO_2 Conversion

Emissions of oxides of nitrogen (NO_X) were used as inputs to the AERMOD model. The modelled predictions of NO_X were then used to calculate the nitrogen dioxide (NO_2) concentration, one of the indicator compounds, using the Ozone Limiting Method (OLM) suggested by Cole and Summerhays (Cole et al. 1979). The 1-hour and 24-hour NO_2 concentrations were calculated using the background ozone conservatively determined as the 90th percentile of the 1-hour measured ground-level ozone concentration (see Appendix A for baseline).

The OLM (Cole et al. 1979) assumes that 10% of the NOx emissions are in the form of NO_2, and the remaining 90% in the form of NO. Some or all of the NO will be converted to NO_2 by reaction with ozone (O_3). If the NO_X concentration in ppm is multiplied by 0.9 and this value is less than the ozone concentration in ppm, then the NO_2 concentration is equal to the NO_X concentration. However, if the NO_X concentration in ppm is multiplied by 0.9 and the value is equal to or greater than the ozone concentration in ppm, then the NO_2 concentration is given by the following equations:

$$NO_2(ppm) = O_3(ppm) + 0.1 * NO_X(ppm)$$

For example, the maximum 24-hr modelled concentration of NO_X was 41.79 µg/m³. This can be translated into a concentration in ppm using the equation below at standard temperature and pressure.

$$1ppm = \frac{V_m}{M} \frac{1\mu g}{1Lair}$$

Using a molar volume of 22.414 L (V_m) at standard temperature and pressure and the molecular weight of NO_2 (M) at ambient temperature, the equation for the NO_X concentration becomes

$$NO_X(ppm) = 41.79\,\frac{\mu g}{m^3}\left(\frac{1m^3}{1000L}\right)\left(\frac{22.414L}{(14.0067 + 2 * 15.9994)}\right)\left(\frac{273.15 + 25}{273.15}\right)$$

$$NO_X = 0.022\,ppm$$

Since this value multiplied by 0.9 is 0.022 ppm which is less than the ozone concentration of 0.043 ppm, the NO_2 concentration is equal to the NOx concentration.

This method is widely accepted as being a reasonable approach that recognizes the most important mechanism for NO_X conversion, namely reactions with ozone.

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Appendix B-4 Estimation of Landfill Gas Generation (LandGEM)

May 2022

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Estimation of Landfill Gas Generation (LandGEM)

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TABLES

FIGURES

1.0 ESTIMATION OF LANDFILL GAS PRODUCTION

1.1 Methodology

For purposes of the EA, a model was prepared to estimate the potential landfill gas (LFG) generation rates at the Boyne Road Landfill site in the Township of North Dundas using LandGEM v.3.03 (June 2020) developed by the United States Environmental Protection Agency (US EPA, 1991). The LandGEM model is based on a first-order decay model of landfill gas generation. The key input parameters for the model are the historical and projected annual tonnages of waste disposed of in the landfill footprint, the LFG production potential and the LFG generation rate factor. The waste inputs for the LandGEM model have been provided in Table B4-2, located at the end of this Appendix. The model incorporated available or assumed historical, current and projected waste quantities disposed at the landfill over the operational lifespan of the landfill.

1.2 Ultimate Methane Yield and Methane Generation Rate Constant

The LFG production potential (L_o) is a measure of the ultimate methane yield in cubic metres of methane per tonne of waste (m^3/tonne), and LFG generation rate factor (k) is the methane generation rate constant in year^{-1}. Both L_o and k are highly influenced by moisture content, as well as waste composition, temperature, pH, particle size and availability of nutrients. The inputs for L_o and k were the standard Ministry accepted values of 125 cubic metres of methane per tonne of waste and 0.040 years^{-1}, respectively (MECP, 1992).

1.3 Waste Tonnage and Waste Composition

LFG generation rates were estimated for the Boyne Road Landfill based on the estimated historical and projected waste tonnages landfilled, assuming an operational lifespan of 84 years (i.e., 1964 to 2048). The assumptions used to estimate the historical waste tonnages are provided below. Daily cover and soil fill materials were excluded from the waste tonnages.

The compiled estimated historical and projected waste tonnages were input directly to the model. In the absence of site-specific data, LFG generated at the landfill site was assumed to be comprised of approximately 50% methane (CH_4) by volume, based on the published data on typical LFG composition.

The LandGEM model assumes a waste composition similar to typical historical MSW in estimating LFG generation rates.

The Boyne Road landfill does not have a weigh scale; as such, there is no annual waste tonnage information available. There have been annual surveys of airspace consumed for a number of years; using a compacted waste density of 0.7 tonnes/cubic metre and a 4:1 waste: cover ratio, these volumes were converted to tonnage to estimate the projected tonnage of waste during the expansion period from 2023 through 2048.

To estimate the landfilled tonnage from 1965 to 2023, the following describes the methodology used to derive the annual waste tonnage estimates, which are presented in the attachment:

- The calculated total volume of landfilled airspace used for waste and daily cover between 1965 and 2020 is 555,700 m^3.
- The volume of airspace used in each of 2009 to 2020 was calculated based on annual topographic surveys, with the calculated airspace consumed at the end of 2008 of 375,077 m^3.
- Prior to 2009, there are only vehicle counts available to indicate waste received at the site. The estimation of annual fill rate from 1996 to 2008 was based on the average annual fill rate for 2009 – 2011 and corrected for population growth in five year increments. During this period, approximately 12,500 m^3 of airspace was consumed annually.
- For 1966 to 1995, it was assumed that there were progressive step changes to the annual fill rate, starting at 5000 m^3 /year for 1966 to 1985, 6,500 m^3/year for 1976 to 1985 and 9,500 m^3/year for 1986 to 1995.
- The volumes were then converted to waste tonnage using a 4:1 waste: cover ratio and a waste density of 0.7 Mg/m^3.

This approach is considered both reasonable and conservative in terms of estimating LFG generation since it results in more waste being placed in more recent years and over the years since the site has been operational (reflecting a gradually increasing larger population and an increase in waste generation per capita).

1.4 Landfill Gas Generation Estimates

The resulting theoretical maximum total LFG and methane generation rate estimates obtained from the LandGEM model are illustrated in Figure B4-1. Table B4-1 presents a summary of the estimated LFG and methane theoretical maximum generation. Estimated annual waste input tonnages are presented in the attachment.

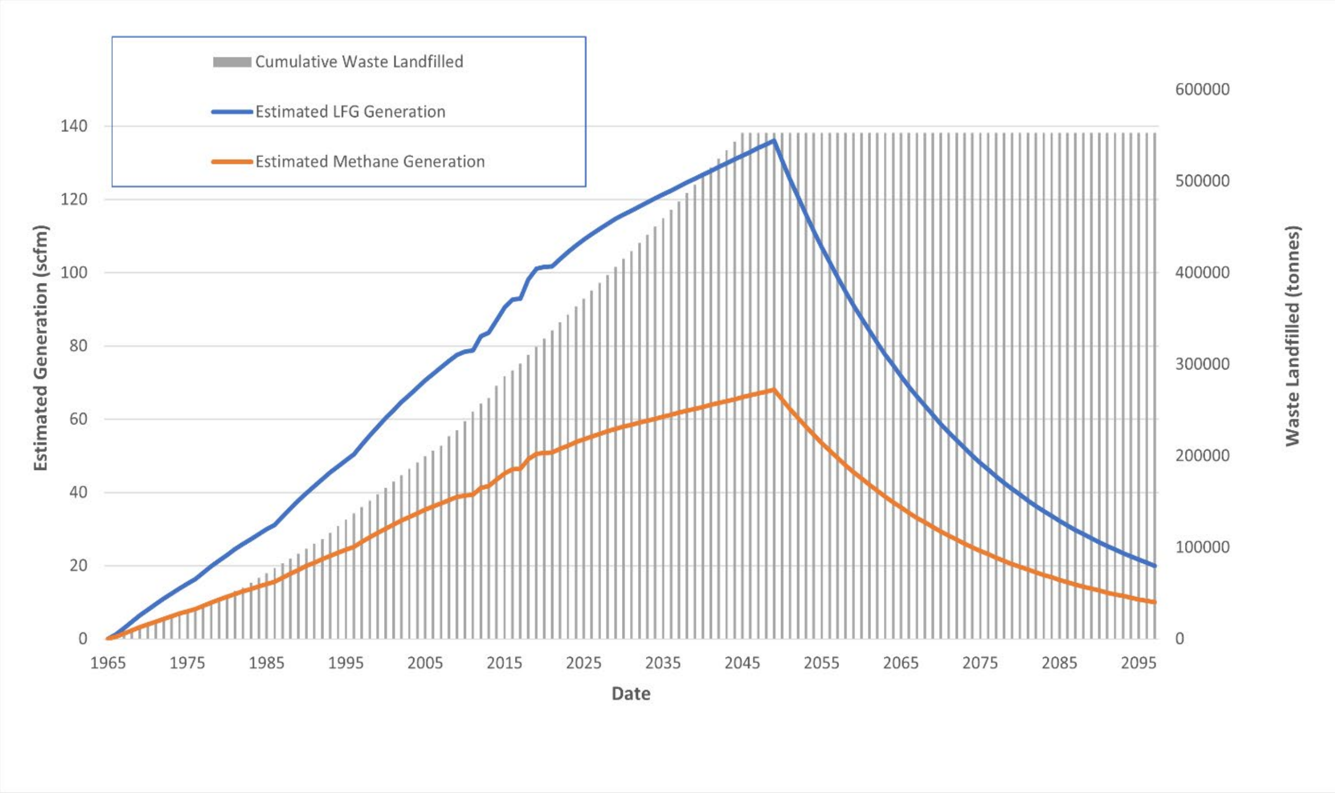


Figure B4-1: Estimated Landfill Gas and Methane Generation Rates from LandGEM Model

Table B4-1: Summary of Total Estimated Landfill Gas and Methane Generation for the Boyne Landfill Expansion

Year	Landfill Gas Generation Estimate	Landfill Gas Generation Estimate	Methane Generation Estimate*	Methane Generation Estimate*
	scfm	m^3/hr	scfm	m^3/hr
2021	101.8	172.9	50.8	86.4
2035	121.4	206.2	60.7	103.1
2048 (landfill closure)	135.0	229.4	67.5	114.7
2049 (peak LFG generation)	136.0	231.2	68.0	115.6
2065	71.8	122.0	35.9	61.0
2080	39.4	67.0	19.7	33.5

Notes:

* Assumes LFG is comprised of 50% methane
m^3 = cubic metres
scfm = standard cubic feet per minute

2.0 REFERENCES

MOE, Air Resources Branch. *Interim Guide to Estimate and Assess Landfill Air Impacts.* October 1992. United State Environmental Protection Agency. *Landfill Gas Emissions Model (LandGEM) Version 3.03 (June 2020) User's Guide*. May 2005.

Table B4-2: LandGEM Waste Inputs

Year	Est. Fill Rate (m^3) Waste+ Cover	Waste Fill Rate (m3/year)	Waste Input (Mg/year)
1965	3188	2550	1785
1966	5000	4000	2800
1967	5000	4000	2800
1968	5000	4000	2800
1969	5000	4000	2800
1970	5000	4000	2800
1971	5000	4000	2800
1972	5000	4000	2800
1973	5000	4000	2800
1974	5000	4000	2800
1975	5000	4000	2800
1976	6500	5200	3640
1977	6500	5200	3640
1978	6500	5200	3640
1979	6500	5200	3640
1980	6500	5200	3640
1981	6500	5200	3640
1982	6500	5200	3640
1983	6500	5200	3640
1984	6500	5200	3640
1985	6500	5200	3640
1986	9500	7600	5320
1987	9500	7600	5320
1988	9500	7600	5320
1989	9500	7600	5320
1990	9500	7600	5320
1991	9500	7600	5320
1992	9500	7600	5320
1993	9500	7600	5320
1994	9500	7600	5320
1995	9500	7600	5320
1996	12454	9963	6974
1997	12443	9954	6968
1998	12432	9946	6962
1999	12421	9937	6956

Year	Est. Fill Rate (m^3) Waste+ Cover	Waste Fill Rate (m3/year)	Waste Input (Mg/year)
2000	12410	9928	6950
2001	12399	9919	6943
2002	12417	9934	6954
2003	12435	9948	6964
2004	12453	9962	6974
2005	12471	9977	6984
2006	12489	9991	6994
2007	12518	10014	7010
2008	12547	10038	7026
2009	10400	8320	5824
2010	9500	7600	5320
2011	18600	14880	10416
2012	11500	9200	6440
2013	18000	14400	10080
2014	18900	15120	10584
2015	15500	12400	8680
2016	10360	8288	5802
2017	23909	19127	13389
2018	18587	14870	10409
2019	11897	9518	6662
2020	13470	10776	7543
2021	16200	12960	9072
2022	16100	12880	9016
2023	16000	12800	8960
2024	15800	12640	8848
2025	15700	12560	8792
2026	15700	12560	8792
2027	15600	12480	8736
2028	15500	12400	8680
2029	15400	12320	8624
2030	15300	12240	8568
2031	15400	12320	8624
2032	15500	12400	8680
2033	15600	12480	8736
2034	15700	12560	8792
2035	15800	12640	8848

Year	Est. Fill Rate (m^3) Waste+ Cover	Waste Fill Rate (m3/year)	Waste Input (Mg/year)
2036	15900	12720	8904
2037	16000	12800	8960
2038	16100	12880	9016
2039	16200	12960	9072
2040	16300	13040	9128
2041	16400	13120	9184
2042	16500	13200	9240
2043	16600	13280	9296
2044	16700	13360	9352
2045	16800	13440	9408
2046	16900	13520	9464
2047	17000	13600	9520
2048	17100	13680	9576

APPENDIX C

Noise

Appendix C-1 Key Concepts
Appendix C-2 Letter to MECP re Boyne Road Landfill Expansion January 5, 2021

Appendix C-1 Key Concepts

Acoustic values can be described in terms of noise or sound. While noise is defined as unwanted sound, the terms noise and sound are often used interchangeably. An introduction to key concepts used in the assessment of outdoor acoustics is provided below:

- “Noise” or “noise levels” refers to the levels that can be heard or measured at a Point of Reception (POR).
- A noise “receptor” or “POR” is any location on a noise sensitive land use where noise is received.
- The “level” of a noise is expressed on a logarithmic scale, in units called decibels (dB). Since the scale is logarithmic, a noise that is twice the noise level as another will be three decibels (3 dB) higher. “Sound pressure level” is the physical quantity that is measured in the environment that describes sound waves quantitatively. It is a ratio of the absolute pressure relative to a reference (i.e., 20 micropascals [μPa]). This ratio of pressures is converted to a decibel scale (dB).
- Noise emissions and noise levels have an associated frequency. The human ear does not respond to all frequencies in the same way. Mid-range frequencies are most readily detected by the human ear, while the human ear is generally less sensitive to low and high frequencies. Environmental noise levels used in this assessment are presented as “A-weighted decibels” (or dBA), which incorporates the frequency response of the human ear.
- Outdoor noise is usually expressed as an “equivalent noise level” ($L_{eq,\,T}$), which is a logarithmic average (i.e., energy average) of the measured or predicted noise levels over a given period of time (T). An equivalent noise level measured or predicted over the nighttime period would be referred to as $L_{eq,\,night}$.
- The “percentile noise level”, designated Ln, is the noise level exceeded “n” percent of a specified time period and is measured in dBA. The L_{90}, for instance, is the noise level exceeded 90% of the time. It is a noise level index that commonly refers to the baseline noise level and is most often referenced in a rural setting.
- Environmental noise levels vary throughout the day and it is therefore important to distinguish between the time of day (i.e., daytime / evening / nighttime). For the purposes of this assessment, in general the day is divided into two periods for which noise is evaluated: daytime from 07:00 to 23:00 and nighttime from 23:00 to 07:00. However, applicable guidance documents for this assessment provide other definitions of daytime and nighttime, or define three periods (i.e., daytime, evening, and nighttime), which were also considered depending on the assessment criteria being evaluated.

Appendix C-2 Letter to MECP re Boyne Road Landfill Expansion January 5, 2021

TOWNSHIP OF
North Dundas

Ministry of Environment, Conservation and Parks
Environmental Assessment and Permissions Division
Environmental Permissions Branch
Noise Approvals
135 St Clair Avenue West,
Toronto, ON
M4V 1P5
Attention: Header Merza, Senior Noise Engineer

Dear Mr. Header Merza,

The Township of North Dundas (the Township) is currently undertaking an Individual Environmental Assessment (EA) for the waste management plan (EA Study) that requires approval under the provincial Environmental Assessment Act (EAA). This EA has been completed and will be submitted to the Ministry of Environment, Conservation and Parks (MECP) following the approved Terms of Reference (ToR) as required by subsection 6.1(1) of the EAA, and in accordance with the requirements of subsection 6.1(2) of the EAA.

The rationale for the EA Study is that as part of a previous application procedure intended to update a number of items related to site operations and amend the Township's Boyne Road Landfill's Environmental Compliance Approval (ECA) located at 12620 Boyne Rd, Winchester, ON K0C 2K0 (the Landfill), the MECP determined that the Landfill had exceeded its approved capacity and is in an overfill situation. It is this overfill situation that triggered the need for the EA process. The Township evaluated long term waste management alternatives, with the EA Study . The result of the comparative evaluation was that expansion of the existing Landfill, together with current and future waste diversion activities, was identified as the Township's preferred long-term waste management alternative.

One of the several technical studies being prepared for the EA Study is the noise impact assessment. On Monday December 13, 2021, there was a conference call between yourself, the assigned MECP reviewer for the EA Study, the Environmental Assessment Services MECP Project Officer and Golder Associates regarding the identification of Points of Reception (PORs) for the purposes of the noise impact assessment, and specifically the Townships current land use planning policy. The following is a summary of key items discussed during the conference call:

- The Township currently follows the United Counties of Stormont, Dundas, and Glengarry Official Plan (the Official Plan). According to the Official Plan, most lands in the vicinity of the Landfill are zoned as "Rural District". This land use designation allows for noise sensitive land uses.

- Noise sensitive PORs were identified through a desktop review in accordance with "Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning Publication NPC-300" (NPC-300). As per NPC-300, a noise impact assessment is carried out at both existing and vacant lot noise sensitive PORs.
- The Official Plan states *"Development within 500 metres of an existing waste management system shall generally be discouraged unless supported by an appropriate study or studies which confirm that there will be no negative impacts on the proposed development related to current uses/activities associated with the normal operation of the waste management system."*. The Township will be revisiting their zoning bylaws in 2022, requiring the minimum separation distance of 500 m between the Landfill and noise sensitive land uses as defined in NPC-300, be applied to any proposed development in the vicinity of the Landfill. In the interim, the Township has adopted this requirement.
- The land directly adjacent to the east of the Landfill is owned by the Township and vacant. The Township will not permit noise sensitive land uses on these lands even though zoned as "Rural District" since they are within 500 m of the Landfill.
- The lands located to the northwest, west and southwest are identified as 'Contamination Attenuation Zone' (CAZ) and vacant. These lands are not owned by the Township, but the Township has control over the groundwater rights through easement agreements; as such, a water supply well cannot be drilled on these lands, thereby eliminating potential development on these vacant lands by a noise sensitive use. Therefore, the Township will not permit noise sensitive land uses on these CAZ lands since potable water supply is not permitted and also the CAZ lands are within 500 m of the Landfill.

As requested by you during the conference call, please accept this letter as confirmation the Township will not permit a noise sensitive land use within 500 m of the Landfill or within the existing or any future CAZ. Therefore as agreed upon during the conference call, the EA Study noise impact assessment will not require an assessment be carried out at noise sensitive PORs within 500 m of the Landfill or within the existing or any future CAZ.

We believe this letter summaries our recent discussion but please let us know otherwise and if you require any further clarification or additional information.

Thank You,

Doug Froats
Director of Waste Management

cc. Trish Edmond, Golder Associates Ltd.
Jordan Hughes, MECP Project Officer

APPENDIX D

Geology, Hydrogeology, and Geotechnical

Appendix D-1 Borehole Logs
Appendix D-2 Boyne Road Landfill Slope Stability Technical Memorandum
Appendix D-3 POLLUTE Output

Appendix D-1 Borehole Logs

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures, and in the text of the report are as follows:

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive an uncased 50 mm (2 in.) diameter, 60^0 cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

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

Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60^0 conical tip and a projected end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	**N** Blows/300 mm Or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

C_u or S_u

Consistency	kPa	Psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	Over 200	Over 4,000

IV. SOIL TESTS

w	Water content
w_p or PL	Plastic limited
w_1 or LL	Liquid limit
C	Consolidaiton (oedometer) test
CHEM	Chemical analysis (refer to text)
CID	Consolidated isotropically drained triaxial test[1]
CIU	Consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	Relative density
DS	Direct shear test
Gs	Specific gravity
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	Organic content test
SO_4	Concentration of water-soluble sulphates
UC	Unconfined compression test
UU	Unconsolidated undrained triaxial test
V	Field vane test (LV-laboratory vane test)
γ	Unit weight

Note: [1] Tests which are anisotropically consolidated prior shear are shown as CAD, CAU.

LIST OF SYMBOLS

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

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$ x or log x	logarithm of x to base 10
g	acceleration due to gravity
t	time
FOS	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

w	water content
w_1 or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity Index = ($w_1 - w_p$)
w_s	shrinkage limit
I_L	liquidity index = ($w - w_p$) / I_p
I_c	consistency index = ($w_1 - w$) / I_p
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = ($e_{max} - e$) / ($e_{max} - e_{min}$) (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

[2] shear strength = (compressive strength) / 2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of rock material weathering
Faintly Weathered: weathering limited to the surface of major discontinuities.
Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.
Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable
Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.
Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very Thickly Bedded	> 2 m
Thickly Bedded	0.6 m to 2m
Medium Bedded	0.2 m to 0.6 m
Thinly Bedded	60 mm to 0.2 m
Very Thinly Bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly Laminated	< 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very Wide	> 3 m
Wide	1 – 3 m
Moderately Close	0.3 – 1 m
Close	50 – 300 mm
Very Close	< 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 – 60 mm
Medium Grained	60 microns – 2mm
Fine Grained	2 – 60 microns
Very Fine Grained	< 2 microns

Note: *Grains > 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery

The percentage of solid 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 varies from 0% for completely broken core 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including naturally occurring fractures but not including mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^0 angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

BD -	Bedding	PY -	Pyrite
FO -	Foliation/Schistosity	Ca -	Calcite
CL -	Clean	PO -	Polished
SH -	Shear Plane/Zone	K -	Slickensided
VN -	Vein	SM -	Smooth
FLT -	Fault	RO -	Ridged/Rough
CO -	Contact	ST -	Stepped
JN -	Joint	PL -	Planar
FR -	Fracture	IR -	Irregular
MB -	Mechanical Break	UN -	Undulating
BR -	Broken Rock	CU -	Curved
BL -	Blast Induced	TCA -	To Core Axis
‖ -	Parallel To	STR -	Stress Induced
OR -	Orthogonal		

PROJECT: 14-1125-0007/Boyne Road Landfill

RECORD OF BOREHOLE: MW06-22R

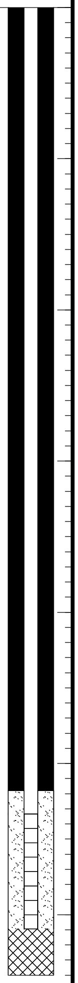
SHEET 1 OF 1

LOCATION: N 4994479.6; E 474643.5 (UTM NAD83 Zone 18T)

BORING DATE: May 1, 2014

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		82.96							
0	Power Auger 200 mm Diam. (Hollow Stem)	Waste (FILL)	▨	0.00							
11		Grey brown SILTY CLAY	▥	71.99 10.97							
12.8		End of Borehole		70.16 12.80							



DEPTH SCALE

1 : 100

Golder Associates

LOGGED: MIB

CHECKED: YJM

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: MW07-23

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 4, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	74.97				
0	Power Auger 200mm diam. (Hollow Stem)	TOPSOIL	0.00				
		Very stiff grey brown SILTY CLAY (Weathered Crust)	74.76 0.21				Bentonite Seal
1		Brown SILTY CLAY, trace gravel	73.90 1.07	1	50 DO	20	Silica Sand
		Dense brown to grey sandy SILT, some grey clay, occasional sand seam (GLACIAL TILL)	73.35 1.62	2	50 DO	35	
2				3	50 DO	39	32mm Diam. PVC #10 Slot Screen
3				4	50 DO	32	∇
		End of Borhole (Auger Refusal)	71.25 3.72				WL in screen at Elev. 72.56m on Sept. 25, 2007
4							
5							
6							
7							
8							
9							
10							

MIS-BHS 001 061122127-3.GPJ GAL-MISS.GDT 3/25/08 MLF

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: MW07-24

SHEET 1 OF 1

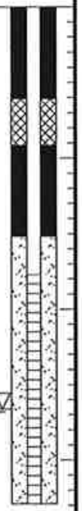
LOCATION: See Site Plan

BORING DATE: September 4, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		75.32							
0	Power Auger 200mm Diam. (Hollow Stem)	Dark brown PEAT		0.00							Bentonite Seal
1		Grey brown SILTY CLAY (Weathered Crush)		74.77 0.55							Native Backfill
		Compact grey brown CLAYEY SILT, trace gravel		74.25 1.07	1	50 DO	13				Bentonite Seal Salica Sand
2 3		Brown grey SANDY SILT, some gravel, occasional cobbles		73.49 1.83	2 3 4	50 DO 50 DO 50 DO	13 40 44				38mm Diam. PVC #10 Slot Screen
4 5 6 7 8 9 10		End of Borehole (Auger Refusal)		72.03 3.29							WL in screen at Elev. 73.49m on Sept. 25, 2007

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: MW07-25

SHEET 1 OF 1

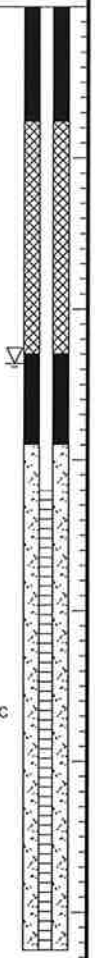
LOCATION: See Site Plan

BORING DATE: September 5, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.13							
0		Dark brown PEAT		0.00							Bentonite Seal
		Grey brown SILTY CLAY (Weathered Crush)		73.58 0.55							
1											Native Backfill
					1	50 DO	8				
2											
					2	50 DO	17				Bentonite Seal
		Compact to dense brown grey SANDY SILT, some gravel & clay, trace cobbles (GLACIAL TILL)		71.45 2.68							
3	Power Auger 200mm Diam. (Hollow Stem)										Silica Sand
					3	50 DO	22				
4											
					4	50 DO	14				
					5	50 DO	96				38mm Diam. PVC #10 Slot Screen
5											
6											
					6	50 DO					
		End of Borehole (Auger Refusal)		67.88 6.25							
7											WL in screen at Elev. 72.71m on Sept. 25, 2007
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: JLRF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: BR07-26

SHEET 1 OF 1

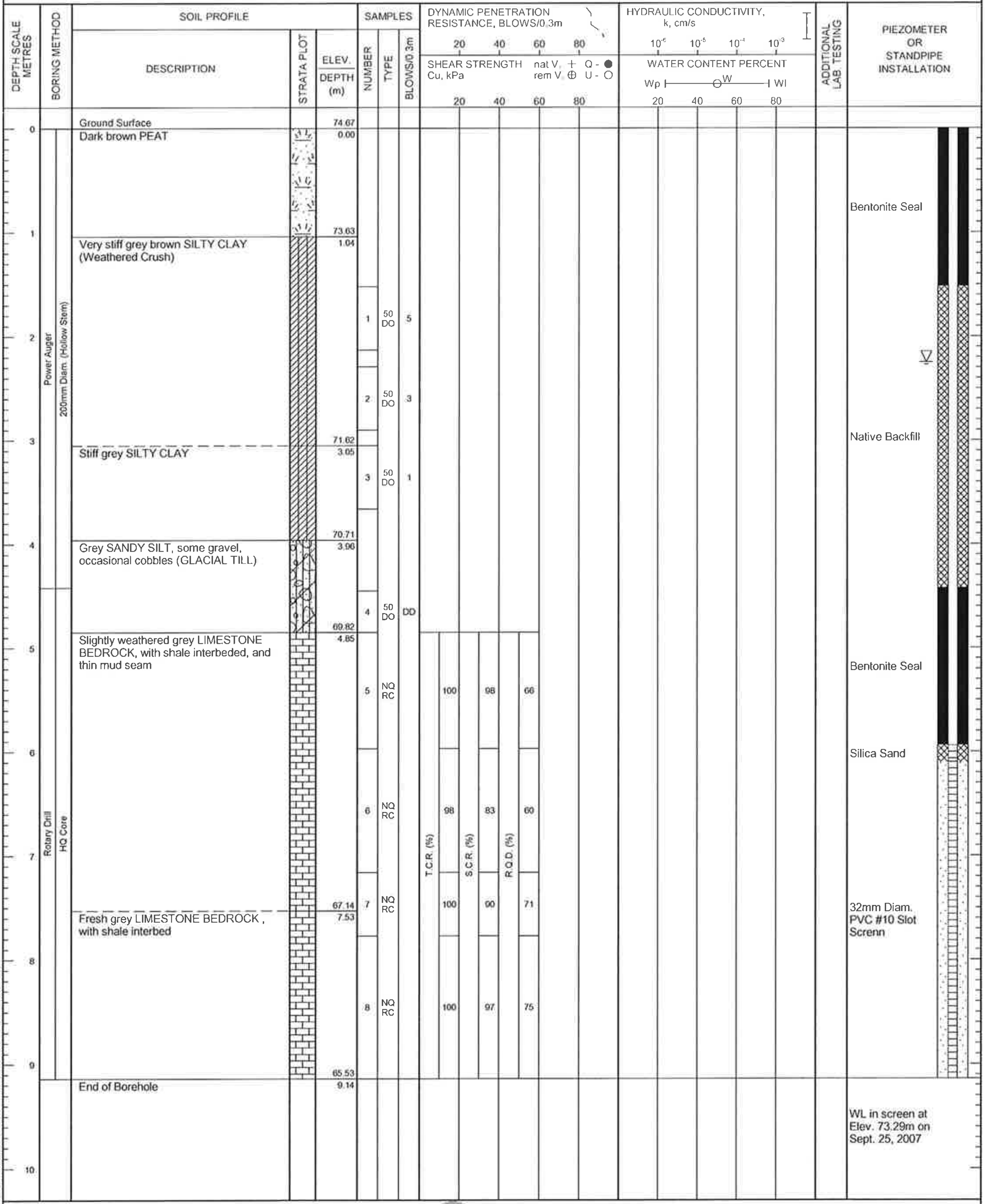
LOCATION:

BORING DATE: September 7, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	T.C.R. (%)	S.C.R. (%)	R.Q.D. (%)
Ground Surface	74.67						
Dark brown PEAT	0.00						
Very stiff grey brown SILTY CLAY (Weathered Crush)	73.63 1.04	1	50 DO	5			
		2	50 DO	3			
Stiff grey SILTY CLAY	71.62 3.05	3	50 DO	1			
Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)	70.71 3.96	4	50 DO	DD			
Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam	69.82 4.85	5	NQ RC		100	98	66
		6	NQ RC		98	83	60
Fresh grey LIMESTONE BEDROCK, with shale interbed	67.14 7.53	7	NQ RC		100	90	71
		8	NQ RC		100	97	75
End of Borehole	65.53 9.14						

DEPTH SCALE

1 : 50

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: BRW1

SHEET 1 OF 3

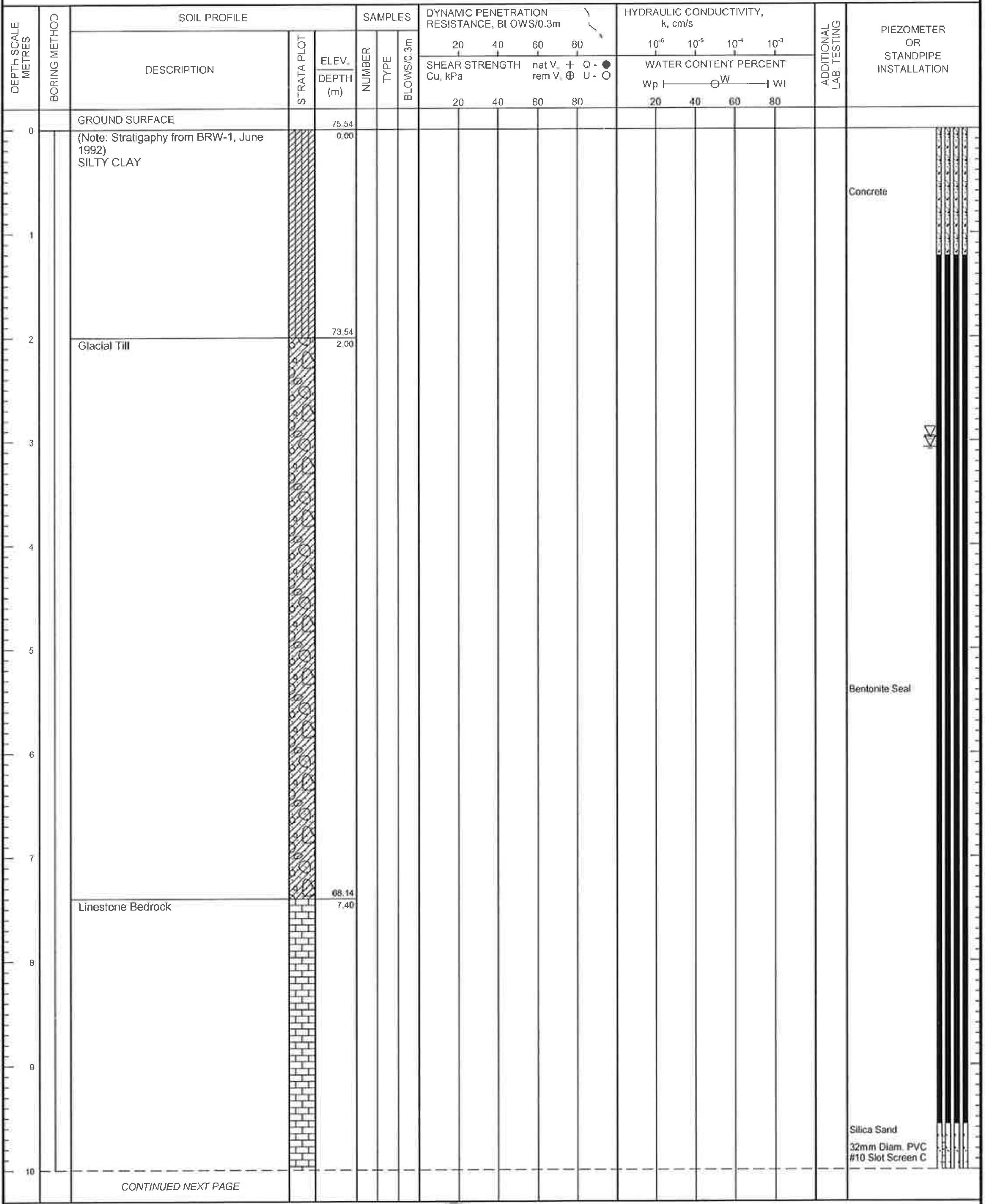
LOCATION: See Site Plan

BORING DATE: September 7, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	75.54
(Note: Stratigaphy from BRW-1, June 1992) SILTY CLAY	0.00
Glacial Till	73.54 2.00
Linestone Bedrock	68.14 7.40

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLCF

MIS-BHS 001 061122127-3.GPJ GAL-MISS.GDT 3/25/08 MLF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: BRW1

SHEET 2 OF 3

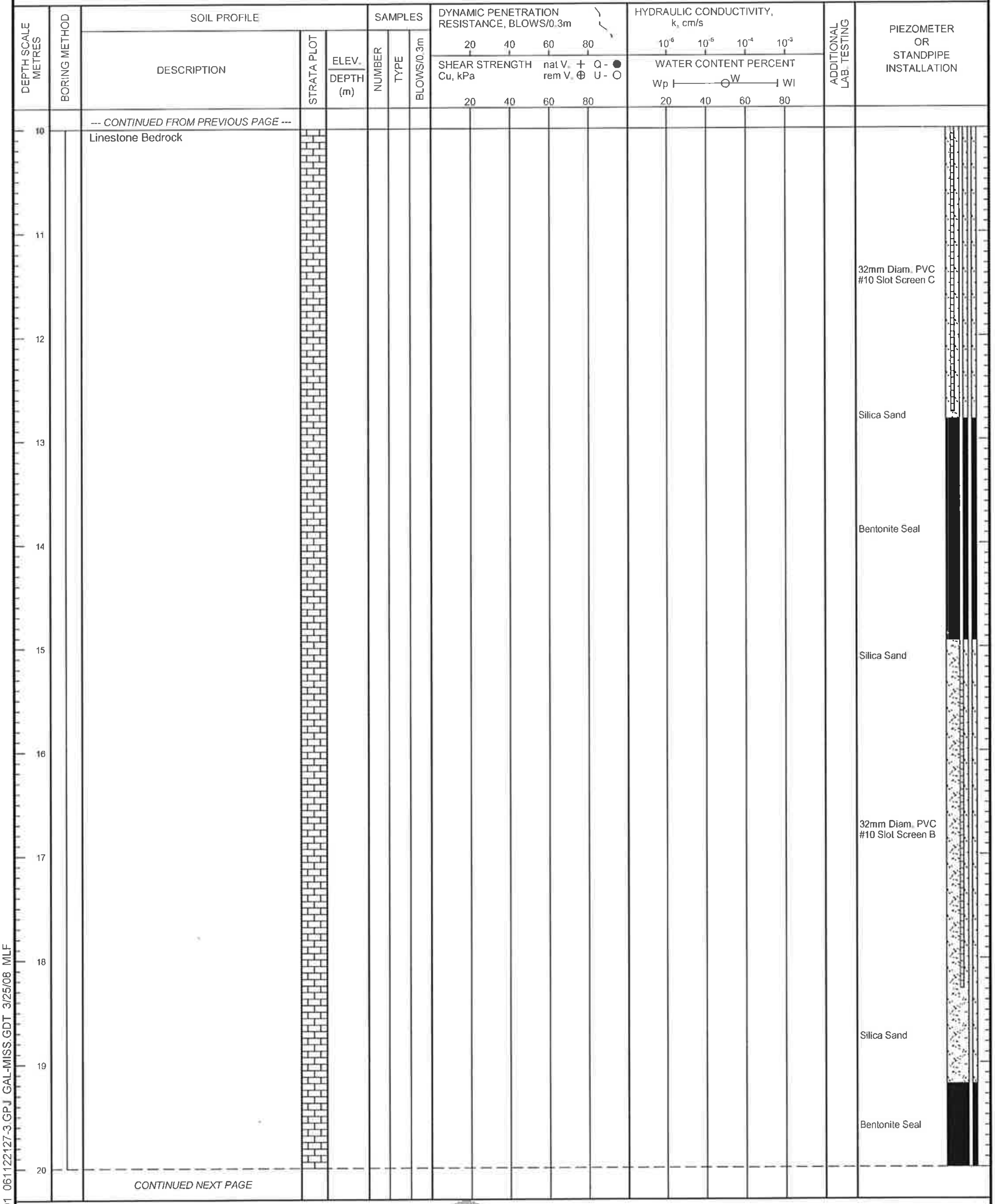
LOCATION: See Site Plan

BORING DATE: September 7, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



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Linestone Bedrock

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: BRW1

SHEET 3 OF 3

LOCATION: See Site Plan

BORING DATE: September 7, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0,3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
20		Linestone Bedrock									Bentonite Seal
21											Silica Sand
23											32mm Diam. PVC #10 Slot Screen A
25		End of Hole		50.54 25.00							WL in screen A at Elev. 72.99m on Sept. 25, 2007
26											WL in screen B at Elev. 72.99m on Sept. 25, 2007
27											WL in screen C at Elev. 73.02m on Sept. 25, 2007

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-6200

RECORD OF MONITORING WELL: MW 06-20

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: Nov. 23, 2006

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE		75.64			
0	Power Auger 200mm Diam (Hollow Stem)	TOPSOIL		0.00			
		Very stiff grey brown SILTY CLAY (Weathered Crust)		75.40 0.24			
		Compact grey SANDY SILT, some gravel, trace clay, occasional silty sand and silt seam or layer (GLACIAL TILL)		74.18 1.46	1	50 DO	21
					2	50 DO	28
		End of Borehole Auger Refusal		71.37 4.27			

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

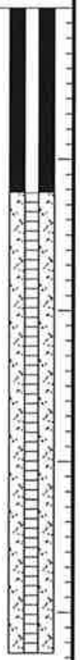
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



Protective casing set in Bentonite Seal

38mm Diam PVC #10 Slot Screen

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

MIS-BHS 001 061122127-6200.GPJ GAL-MISS.GDT 3/25/08

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-6200

RECORD OF MONITORING WELL: MW 06-21

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: Nov. 23, 2006

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

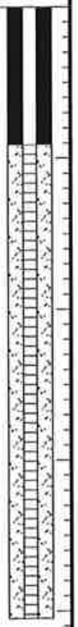
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.93				
0	Power Auger 200mm Diam (Hollow Stem)	TOPSOIL		0.00				
		Grey brown SILTY CLAY (Weathered Crust)		74.72 0.21				Protective casing set in Bentonite Seal
1		Grey brown SANDY SILT, some gravel, trace clay, occasional cobble (GLACIAL TILL)		74.32 0.61				
2					1	50 DO	62	
		Compact grey SILTY SAND, some gravel, occasional fine to coarse sand layer (GLACIAL TILL)		72.49 2.44				38mm Diam PVC #10 Slot Screen
3					2	50 DO	26	
		Grey SANDY SILT, some gravel and clay (GLACIAL TILL)		71.27 3.66				
4		End of Borehole Auger Refusal		70.88 4.05				
5								
6								
7								
8								
9								
10								



MIS-BHS 001 061122127-6200.GPJ GAL-MISS.GDT 3/25/08

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-6200

RECORD OF MONITORING WELL: MW 06-22

SHEET 1 OF 1

LOCATION: See Site Plan

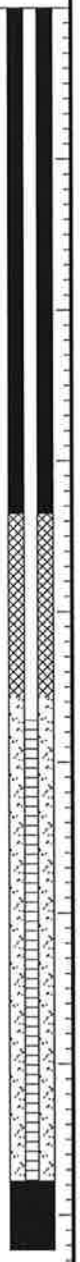
BORING DATE: Nov. 23, 2006

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		82.10							
0	Power Auger 200mm Diam (Hollow Stem)	GARBAGE (FILL)		0.00							
					1	50 DO	19				
					2	50 DO	5				
		PEAT		74.48 7.62							
		Grey brown SILTY CLAY		7.77	3	50 DO	10				
		Grey brown SANDY SILT		74.02 8.08							
		End of Borehole		8.23							



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.J.S.
CHECKED: WLRF

PROJECT: 1416664-6000

RECORD OF BOREHOLE: 15-1

SHEET 1 OF 1

LOCATION: See Site Plan

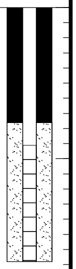
BORING DATE: July 23, 2015

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.40							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							Bentonite Seal
		(CL/ML) CLAYEY SILT, low to medium plasticity; brown; cohesive, w>PL, very stiff		74.05 0.35	1	AS	-				Silica Sand
1		(ML) sandy SILT, some low plasticity fines, some gravel, subrounded; grey brown (GLACIAL TILL); wet, compact		73.49 0.91	2	SS	>50				50 mm Diam. PVC #10 Slot Screen
		End of Borehole Auger Refusal		72.72 1.68							
2											
3											
4											
5											
6											
7											
8											
9											
10											



MIS-BHS 001 1416664-6000.GPJ GAL-MIS.GDT 12/14/15 JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: MIB

PROJECT: 1416664-6000

RECORD OF BOREHOLE: 15-2

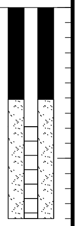
SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 23, 2015

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.68							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		(CL/ML) CLAYEY SILT, trace gravel and low plasticity fines; grey brown; cohesive, w~PL, very stiff		74.47 0.21							Bentonite Seal Silica Sand
1					1	AS	-				50 mm Diam. PVC #10 Slot Screen
		End of Borehole Auger Refusal		73.28 1.40							
2											
3											
4											
5											
6											
7											
8											
9											
10											



DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: MIB

PROJECT: 1416664-6000

RECORD OF BOREHOLE: 15-3

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: July 21, 2015

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	75.41							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00							
		(CI/CH) SILTY CLAY, trace sand; grey brown, fissured (WEATHERED CRUST); cohesive, w~PL, very stiff	75.16 0.25							Bentonite Seal
1										Silica Sand
		GLACIAL TILL	73.89 1.52							
2										Bentonite Seal
3										Native Backfill
4		Fresh, grey LIMESTONE	71.45 3.96							
		Borehole continued on RECORD OF DRILLHOLE 15-3	4.09							
5										
6										
7										
8										
9										
10										

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: MIB

PROJECT: 1416664-6000

RECORD OF DRILLHOLE: 15-3

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: July 21, 2015

DATUM: Geodetic

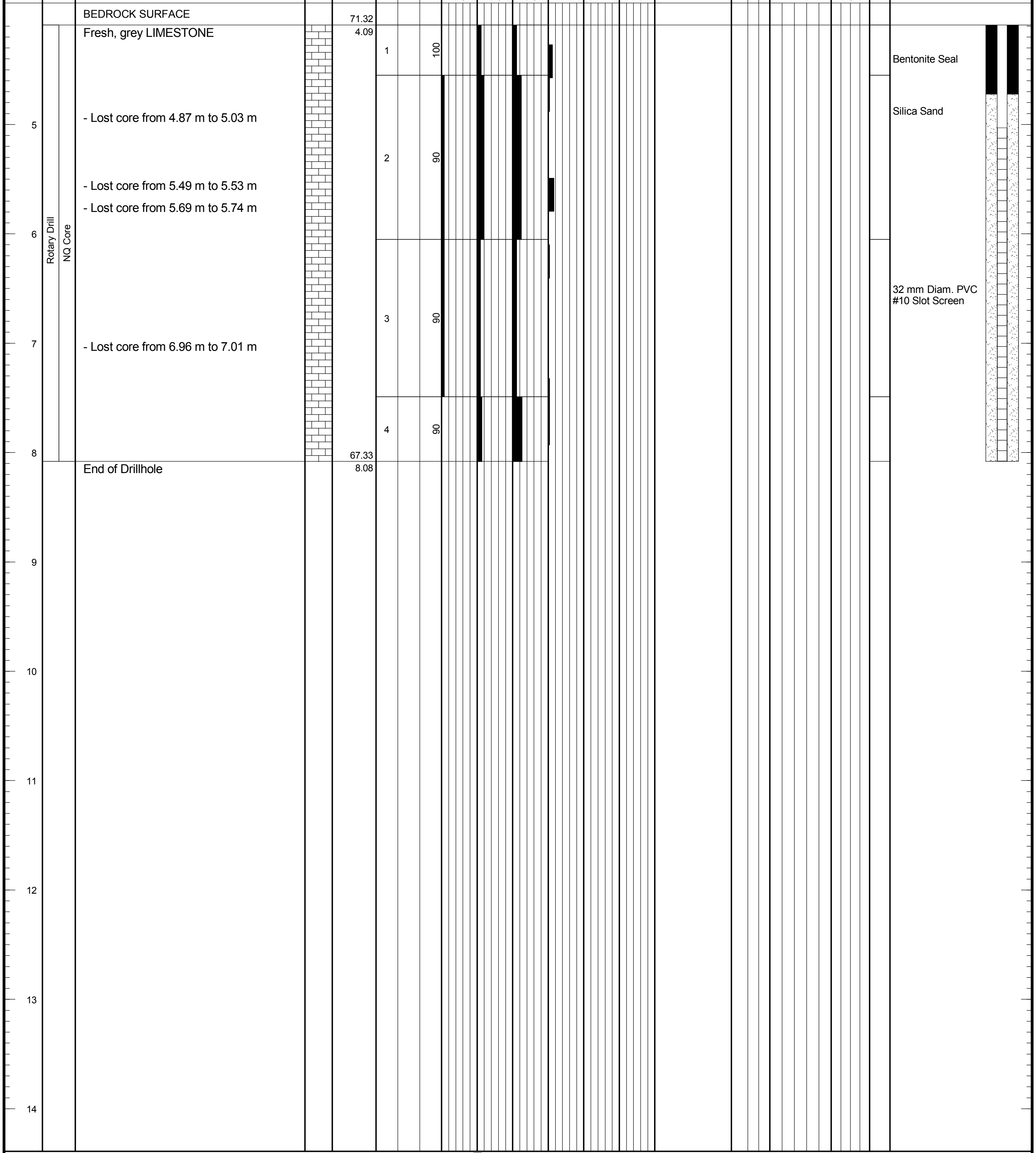
INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Downing Drilling

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate
BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular
PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.



DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	FLUSH % RETURN	
	BEDROCK SURFACE	71.32			
Rotary Drill NQ Core	Fresh, grey LIMESTONE	4.09	1	100	Bentonite Seal
	- Lost core from 4.87 m to 5.03 m		2	90	Silica Sand
	- Lost core from 5.49 m to 5.53 m				
	- Lost core from 5.69 m to 5.74 m				
			3	90	32 mm Diam. PVC #10 Slot Screen
	- Lost core from 6.96 m to 7.01 m				
			4	90	
		67.33			
	End of Drillhole	8.08			

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: MIB

PROJECT: 1650505

RECORD OF BOREHOLE: 16-1

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: December 8, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

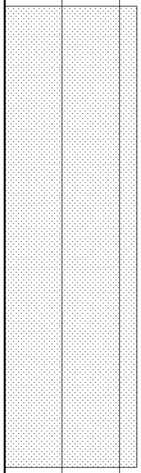
BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
	GROUND SURFACE	74.71			
Power Auger 200 mm Diam. (Hollow Stem)	(PT) sandy SILT, some organics; dark brown (PEAT); non-cohesive, moist, very loose	0.00	1	SS	1
	(CL/MC) CLAYEY SILT to SILTY CLAY, trace gravel; grey brown (WEATHERED CRUST); cohesive, very stiff	73.41 1.30	2	SS	5
	(CL/MC) CLAYEY SILT to SILTY CLAY; trace gravel; grey; cohesive, very stiff	72.60 2.11	3	SS	4
	(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very dense	69.99 4.72	4 5	SS SS	2 >50
	Borehole continued on RECORD OF DRILLHOLE 16-1	67.93 6.78			

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

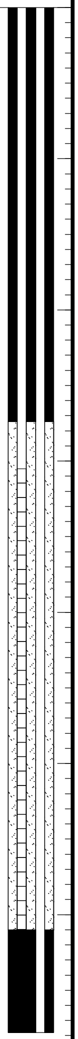
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢ ○W ⊣ Wl 20 40 60 80



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: JD

CHECKED: MIB

PROJECT: 1650505

RECORD OF DRILLHOLE: 16-1

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: December 8, 2016

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME

DRILLING CONTRACTOR: Downing Drilling

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

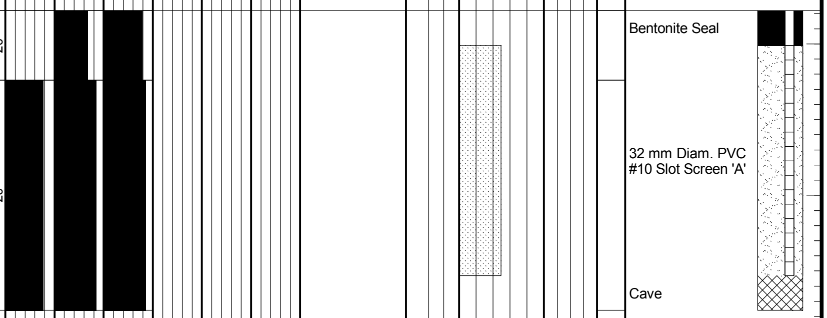
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25 m 5 10 15 20	DISCONTINUITY DATA B Angle 0 90 180 270	DIP w.r.t. CORE AXIS 0 30 60 90	TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Diametral Point Load Index (MPa) 2 4 6	RMC -Q' AVG.	
		BEDROCK SURFACE		67.93																
7	Rotary Drill NQ Core	Slightly weathered to weathered, highly fractured, grey LIMESTONE, with shale interbedded		6.78	1	20														Bentonite Seal
8				65.95 8.76	2	20														32 mm Diam. PVC #10 Slot Screen 'A' Cave
9		End of Drillhole																		
10																				
11																				
12																				
13																				
14																				
15																				
16																				



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: JD
CHECKED: MIB

PROJECT: 1650505

RECORD OF BOREHOLE: 16-2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 8, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE: DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m) | SAMPLES: NUMBER, TYPE, BLOWS/0.30m | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 | SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80 | HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} | WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80 | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

BORING METHOD: Power Auger 200 mm Diam. (Hollow Stem)

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	74.72
(PT) sandy SILT, trace organics; dark brown (PEAT); non-cohesive, moist, very loose	0.00
(CL/MC) CLAYEY SILT to SILTY CLAY, trace gravel; grey brown; cohesive, very stiff	72.89 1.83
(ML) sandy SILT, some gravel; grey (GLACIAL TILL); non-cohesive, wet, compact	68.62 6.10
End of Borehole Auger Refusal	68.01 6.71

NUMBER	TYPE	BLOWS/0.30m
1	SS	1
2	SS	1
3	SS	1
4	SS	5
5	SS	2
6	SS	3
7	SS	1
8	SS	2
9	SS	22

Native Backfill

Bentonite Seal

Silica Sand

32 mm Diam. PVC
#10 Slot Screen

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: JD
CHECKED: MIB

MIS-BHS 001 1650505-8000.GPJ GAL-MIS.GDT 03/23/17 JM

PROJECT: 1650505

RECORD OF BOREHOLE: 16-3

SHEET 1 OF 3

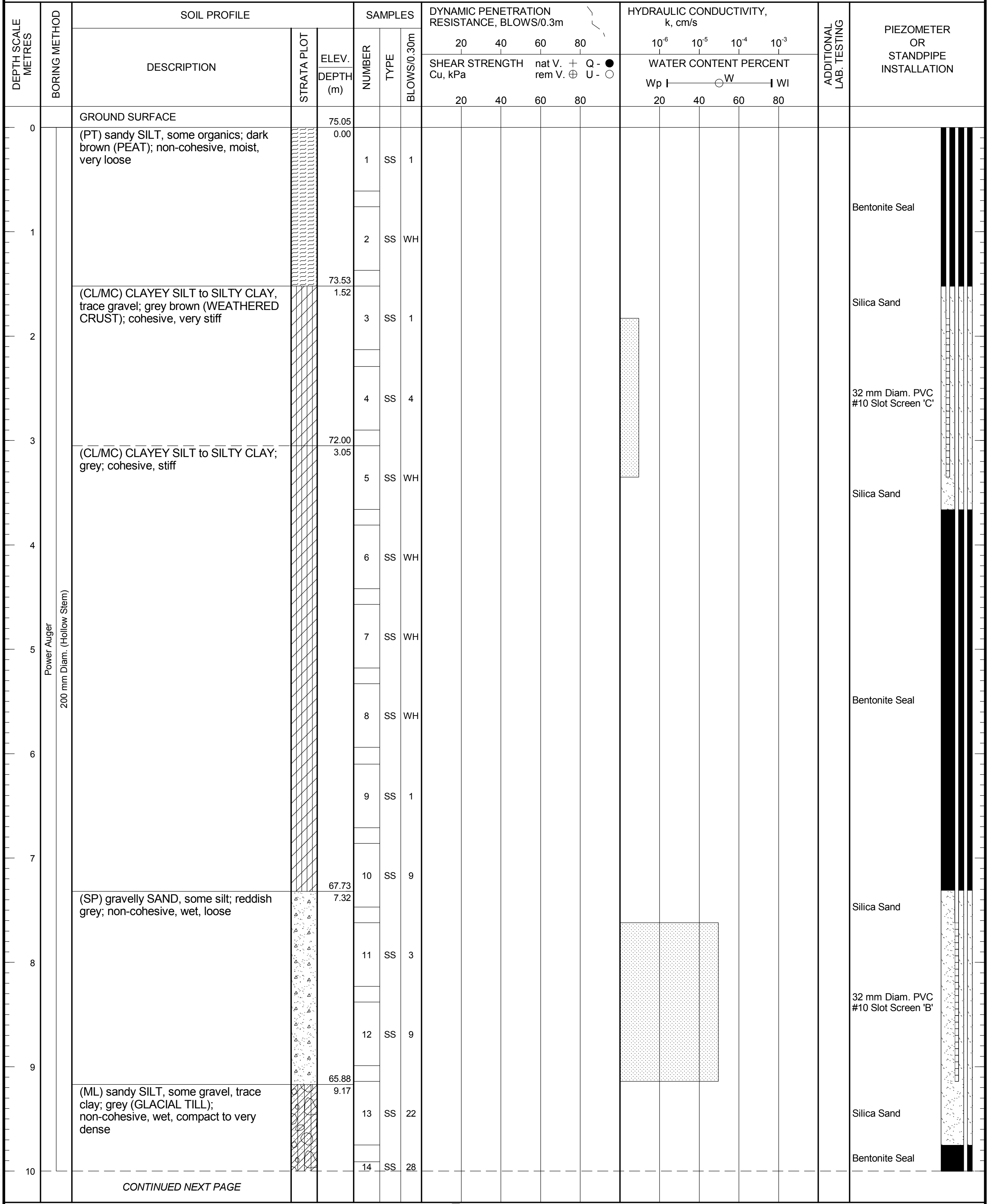
LOCATION: See Site Plan

BORING DATE: December 8, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



GROUND SURFACE 75.05

ELEV. DEPTH (m)	DESCRIPTION
0.00	(PT) sandy SILT, some organics; dark brown (PEAT); non-cohesive, moist, very loose
73.53 1.52	(CL/MC) CLAYEY SILT to SILTY CLAY, trace gravel; grey brown (WEATHERED CRUST); cohesive, very stiff
72.00 3.05	(CL/MC) CLAYEY SILT to SILTY CLAY; grey; cohesive, stiff
67.73 7.32	(SP) gravelly SAND, some silt; reddish grey; non-cohesive, wet, loose
65.88 9.17	(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very dense

NUMBER	TYPE	BLOWS/0.30m
1	SS	1
2	SS	WH
3	SS	1
4	SS	4
5	SS	WH
6	SS	WH
7	SS	WH
8	SS	WH
9	SS	1
10	SS	9
11	SS	3
12	SS	9
13	SS	22
14	SS	28

Bentonite Seal

Silica Sand

32 mm Diam. PVC
#10 Slot Screen 'C'

Silica Sand

Bentonite Seal

Silica Sand

32 mm Diam. PVC
#10 Slot Screen 'B'

Silica Sand

Bentonite Seal

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: JD
CHECKED: MIB

PROJECT: 1650505

RECORD OF BOREHOLE: 16-3

SHEET 2 OF 3

LOCATION: See Site Plan

BORING DATE: December 8, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Power Auger	(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very dense			14	SS	28				
11	Wash Boring NW Casing				15	SS	64				Bentonite Seal
				63.47 11.58	16	SS	>50				
		Borehole continued on RECORD OF DRILLHOLE 16-3									
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: JD

CHECKED: MIB

PROJECT: 1650505

RECORD OF DRILLHOLE: 16-3

SHEET 3 OF 3

LOCATION: See Site Plan

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: December 8, 2016

DRILL RIG: CME

DRILLING CONTRACTOR: Downing Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

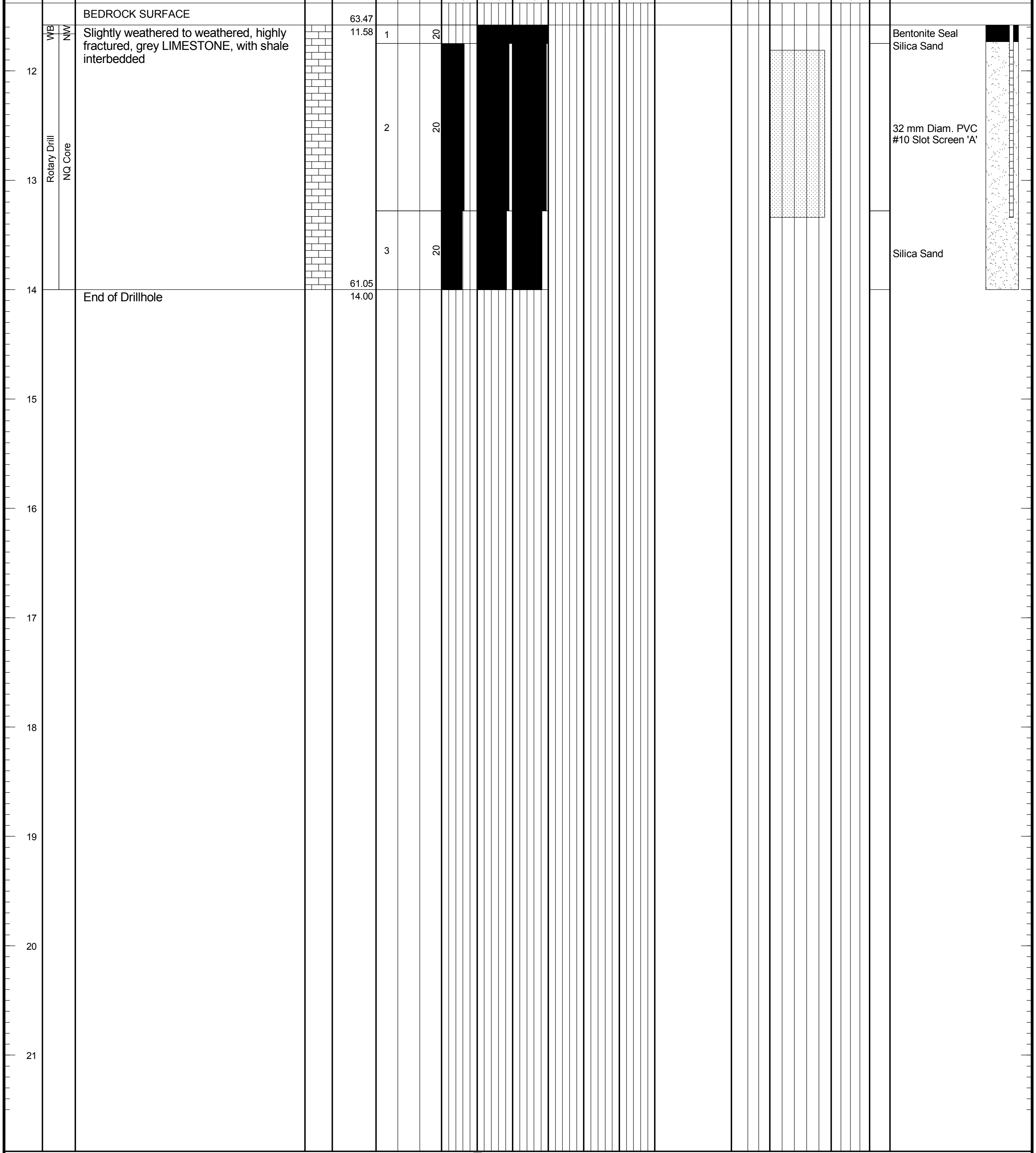
BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK SURFACE	63.47																
12	WB NW Rotary Drill NQ Core	Slightly weathered to weathered, highly fractured, grey LIMESTONE, with shale interbedded	11.58	1	20														Bentonite Seal Silica Sand
13				2	20														32 mm Diam. PVC #10 Slot Screen 'A'
			61.05	3	20														Silica Sand
14		End of Drillhole	14.00																
15																			
16																			
17																			
18																			
19																			
20																			
21																			

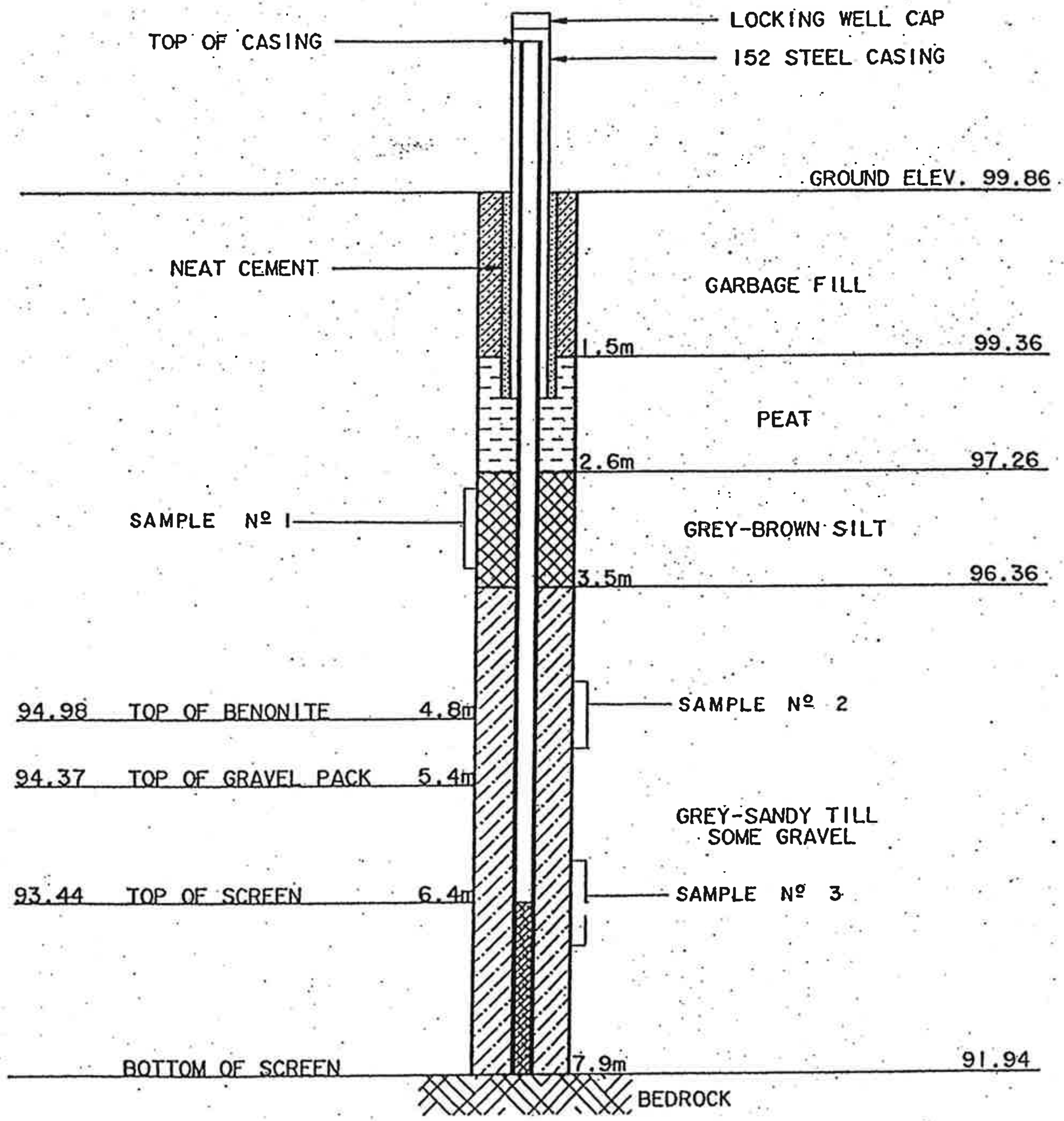
MIS-RCK 004 1650505-8000.GPJ GAL-MISS.GDT 03/23/17 JM

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: JD
CHECKED: MIB

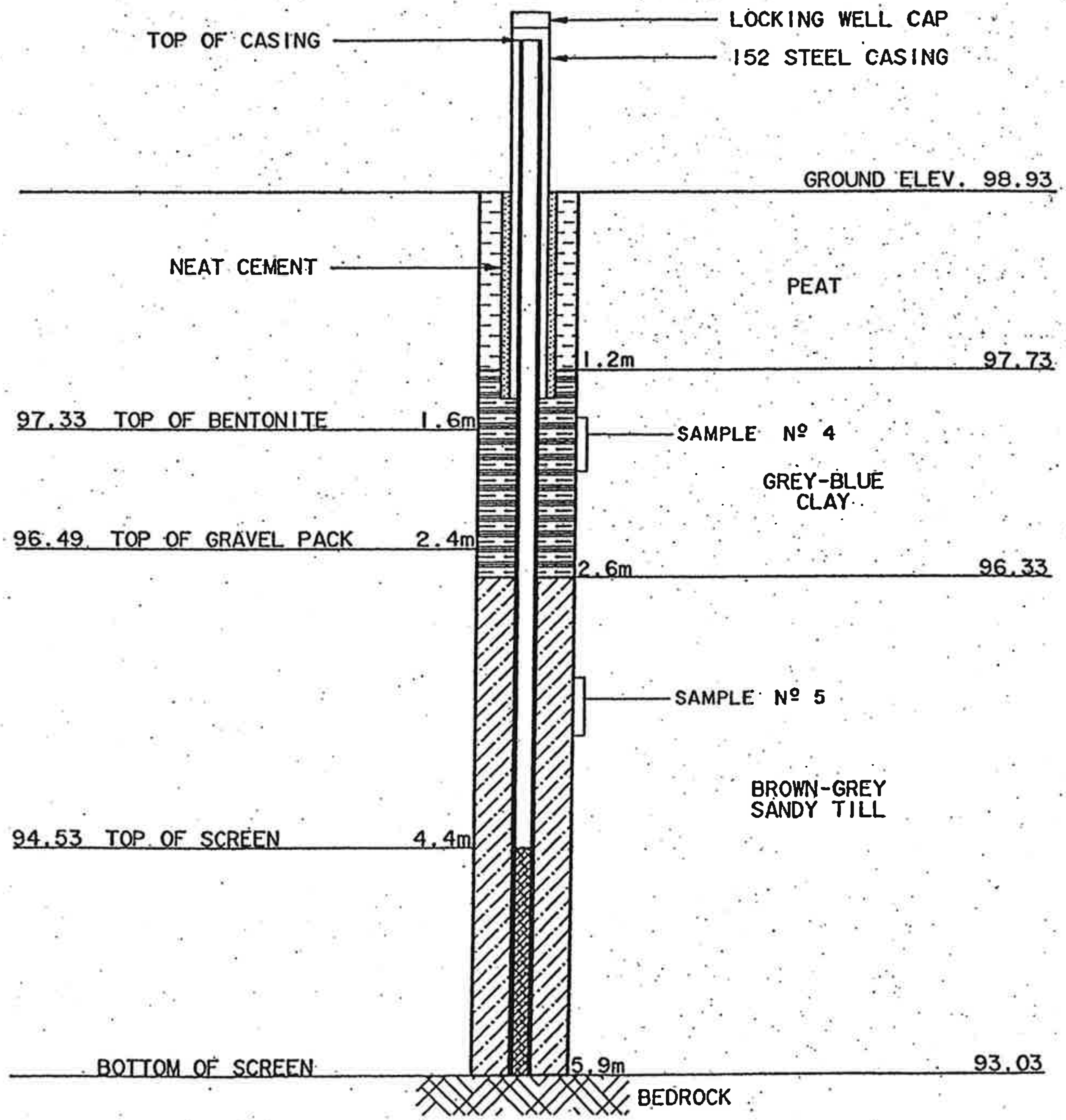
MONITORING WELL #1 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE: MARCH, 1991	CLIENT: TOWNSHIP OF WINCHESTER LANDFILL	DRAWING NO. 90-7848
SCALE: N.T.S.	TITLE: MONITORING WELL INSTALLATION	

MONITORING WELL #2 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE: MARCH, 1991

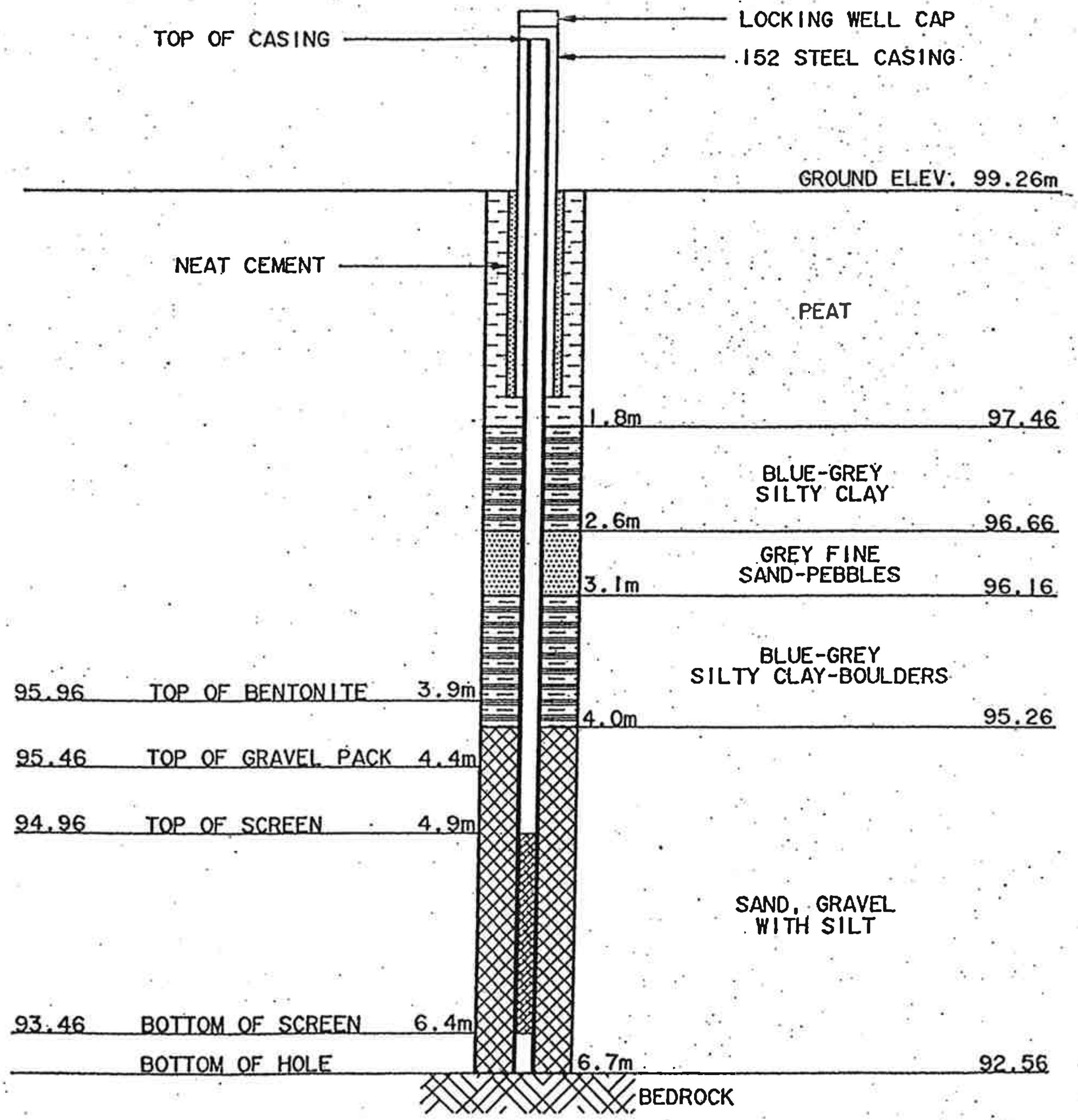
CLIENT: TOWNSHIP OF WINCHESTER LANDFILL

DRAWING NO. 90-7848

SCALE: N.T.S.

TITLE: MONITORING WELL INSTALLATION

MONITORING WELL #3 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE:
MARCH, 1991

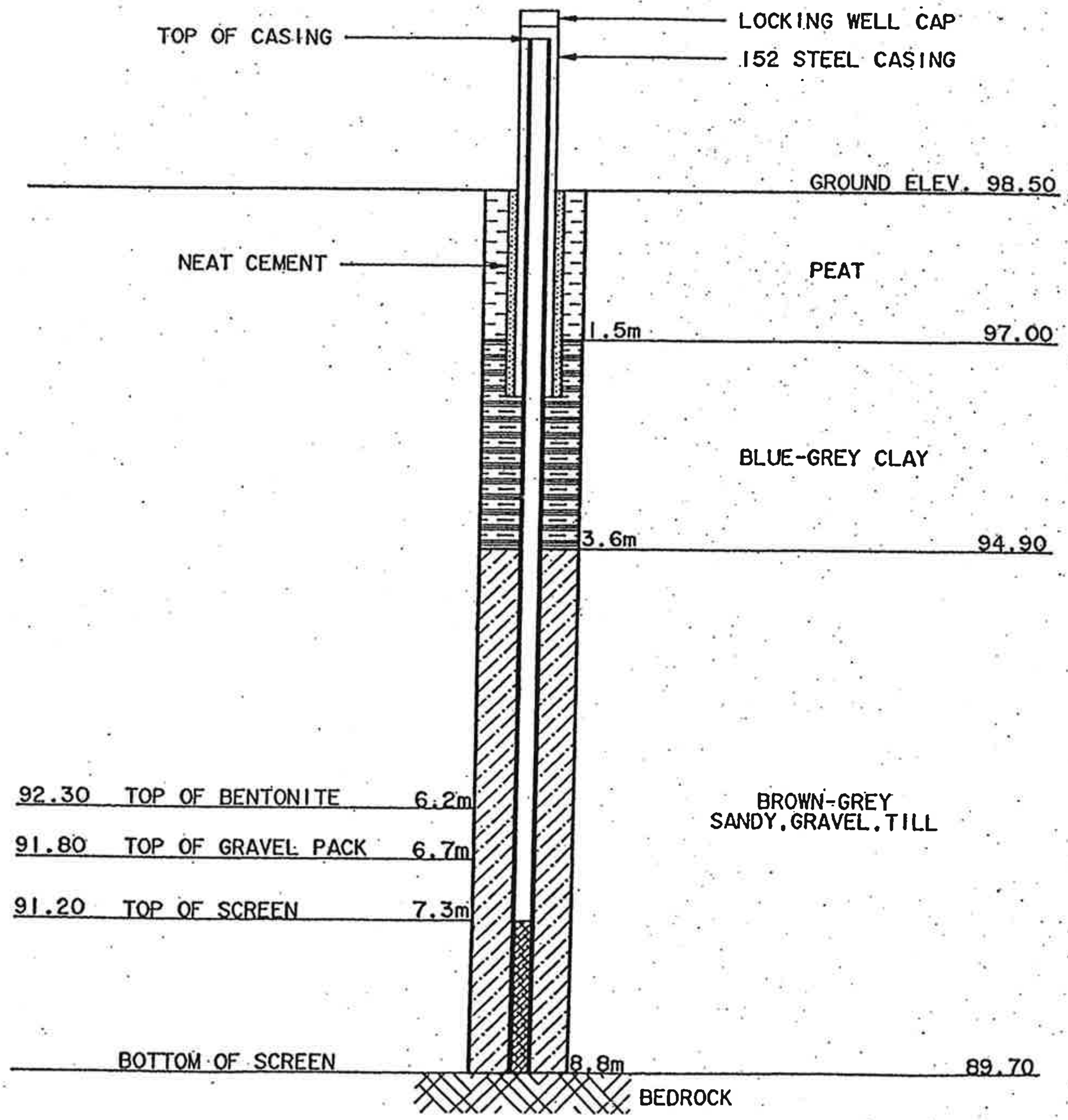
CLIENT:
TOWNSHIP OF WINCHESTER LANDFILL

DRAWING NO.
90-7848

SCALE:
N.T.S.

TITLE:
MONITORING WELL INSTALLATION

MONITORING WELL #4 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE: MARCH, 1991

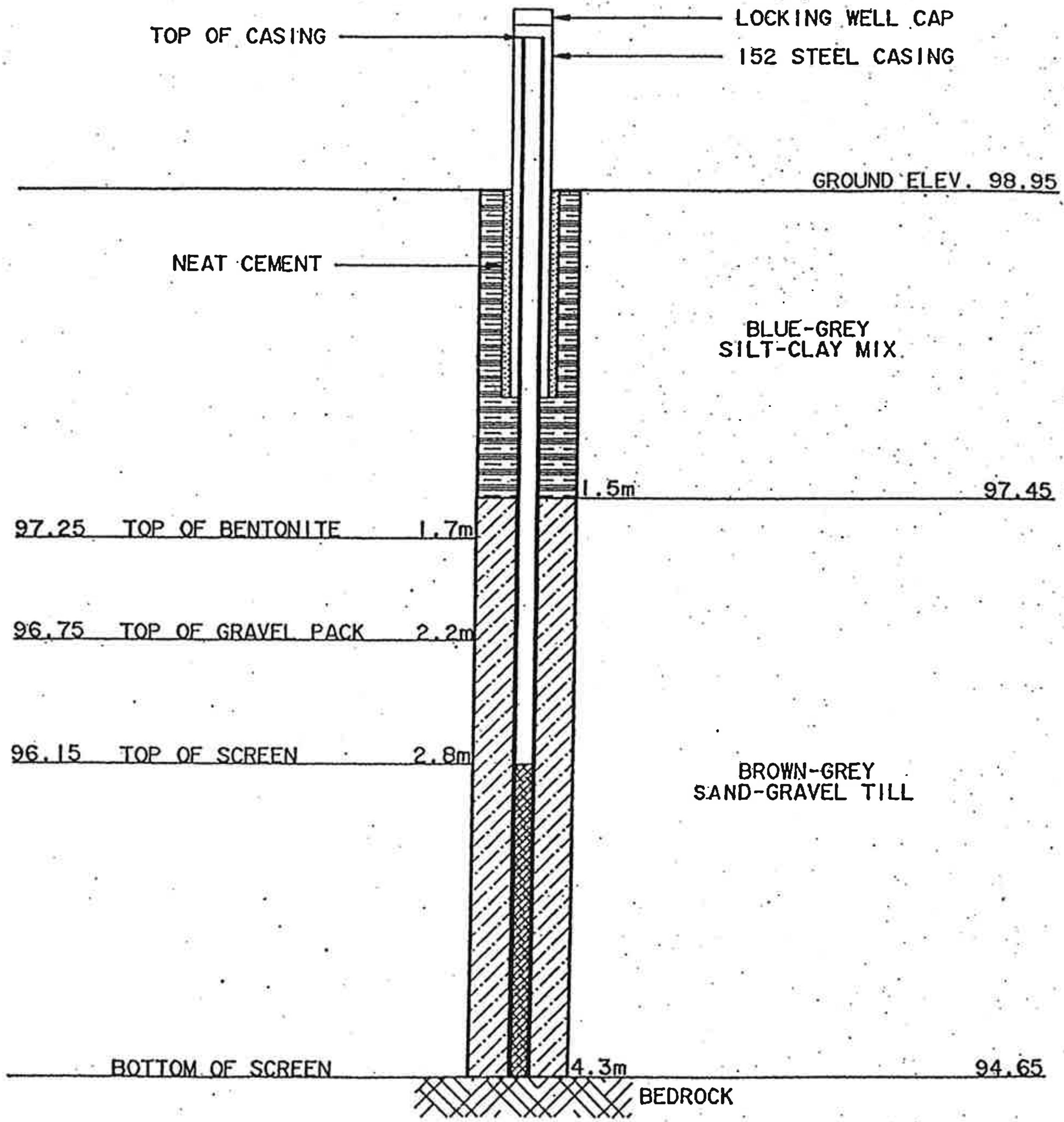
CLIENT: TOWNSHIP OF WINCHESTER LANDFILL

DRAWING NO. 90-7848

SCALE: N.T.S.

TITLE: MONITORING WELL INSTALLATION

MONITORING WELL #5 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE:
MARCH, 1991

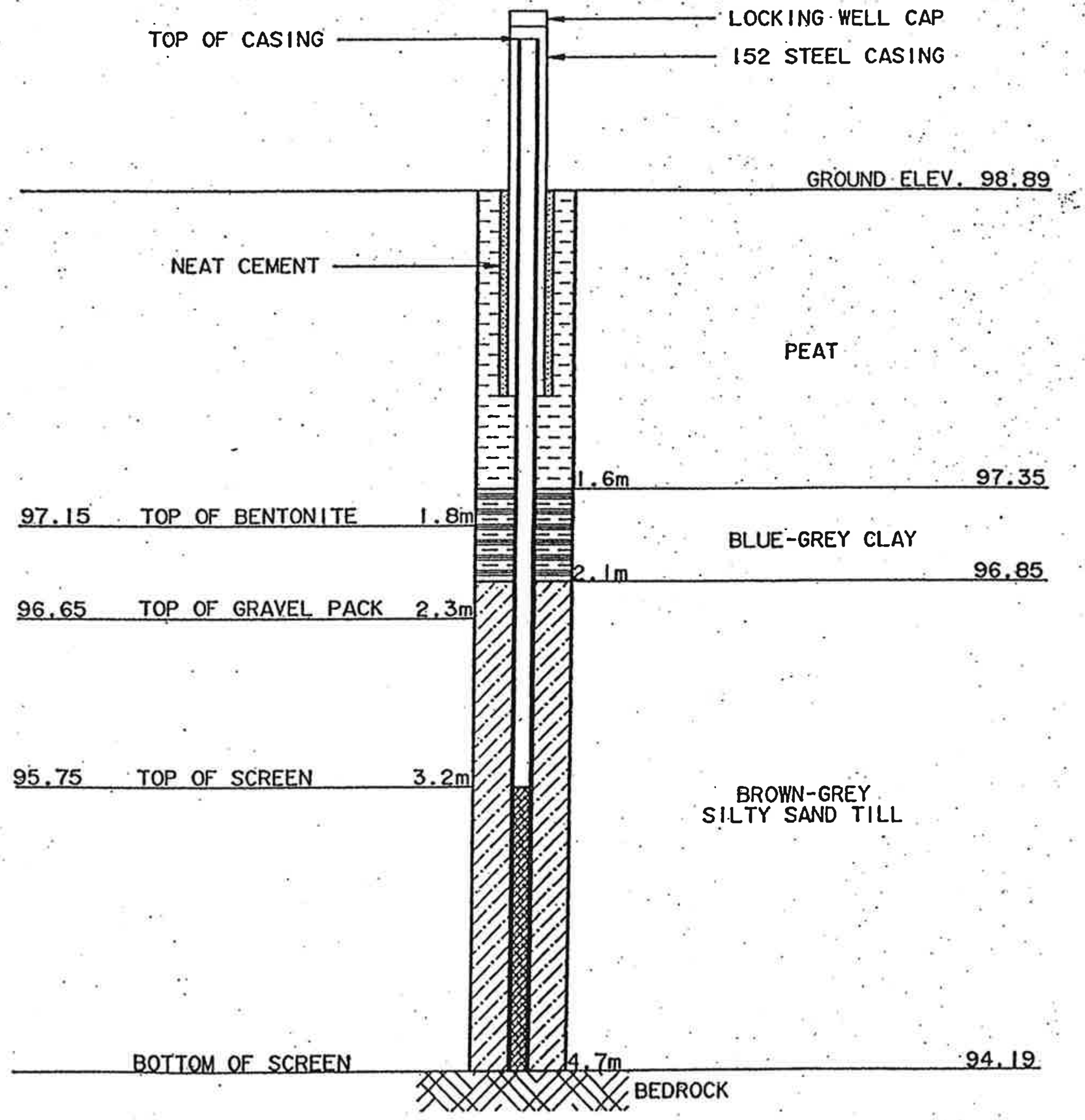
CLIENT:
TOWNSHIP OF WINCHESTER LANDFILL

DRAWING NO.
90-7848

SCALE:
N.T.S.

TITLE:
MONITORING WELL INSTALLATION

MONITORING WELL #6 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

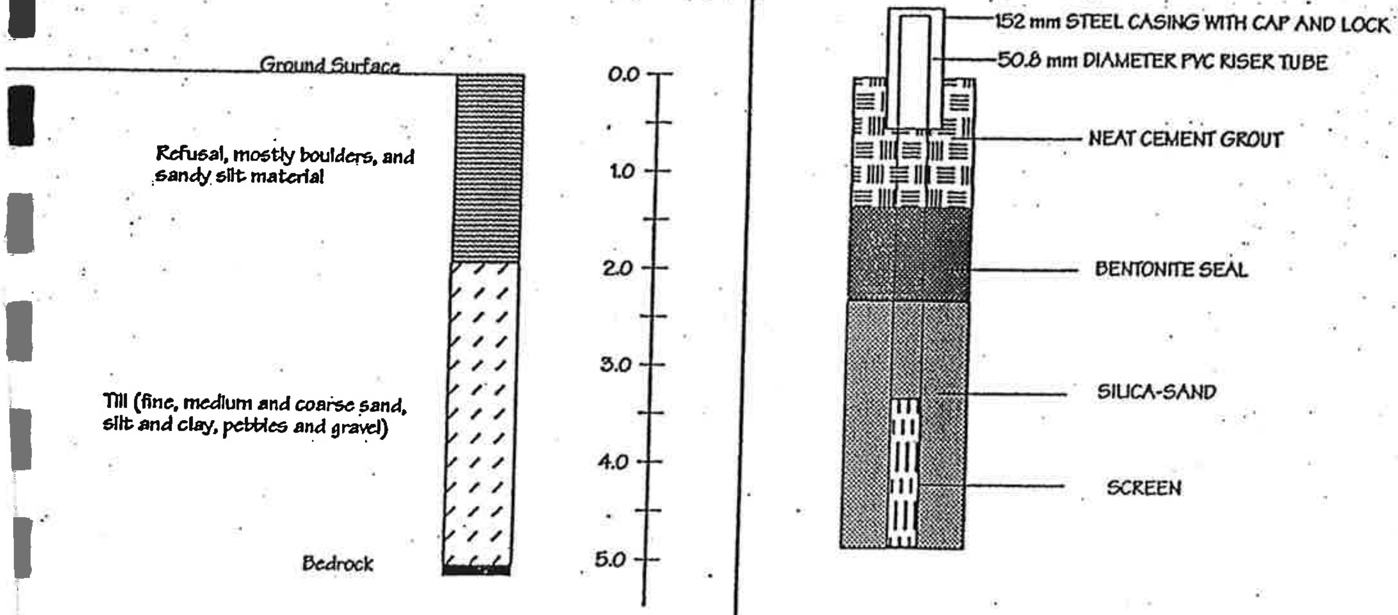
DATE: MARCH, 1991	CLIENT: TOWNSHIP OF WINCHESTER LANDFILL	DRAWING NO. 90-7848
SCALE: N.T.S.	TITLE: MONITORING WELL INSTALLATION	

STRATIGRAPHIC DESCRIPTION AND OVER-BURDEN MONITORING WELL INSTALLATION
WINCHESTER TOWNSHIP LANDFILL SITE

ONITORING WELL NUMBER: MW 7
RILL TYPE: CME 55 HOLLOW STEM AUGER
RILLER: MARATHON

LOCATION: CONCESSION VII, LOT 8
DATE: JUNE 9, 1992

SOIL DESCRIPTION	STRAT.	DEPTH (m)	ELEV. (m)	PIEZOMETER INSTALLATION



I. S. THOMPSON & SSOCIATES LTD. NSULTING ENGINEERS	FIGURE TITLE SOIL PROFILE AND PIEZOMETER CONSTRUCTION	DATE	JUNE 1992
		SCALE	AS SHOWN
		DRAWN	MHM
ROSEMOUNT AVE. CORNWALL K6J 3E5	JOB WINCHESTER TOWNSHIP LANDFILL SITE	JOB No.	92094
		FIGURE:	

STRATIGRAPHIC DESCRIPTION AND OVER-BURDEN MONITORING WELL INSTALLATION

WINCHESTER TOWNSHIP LANDFILL SITE

MONITORING WELL NUMBER: MW 8

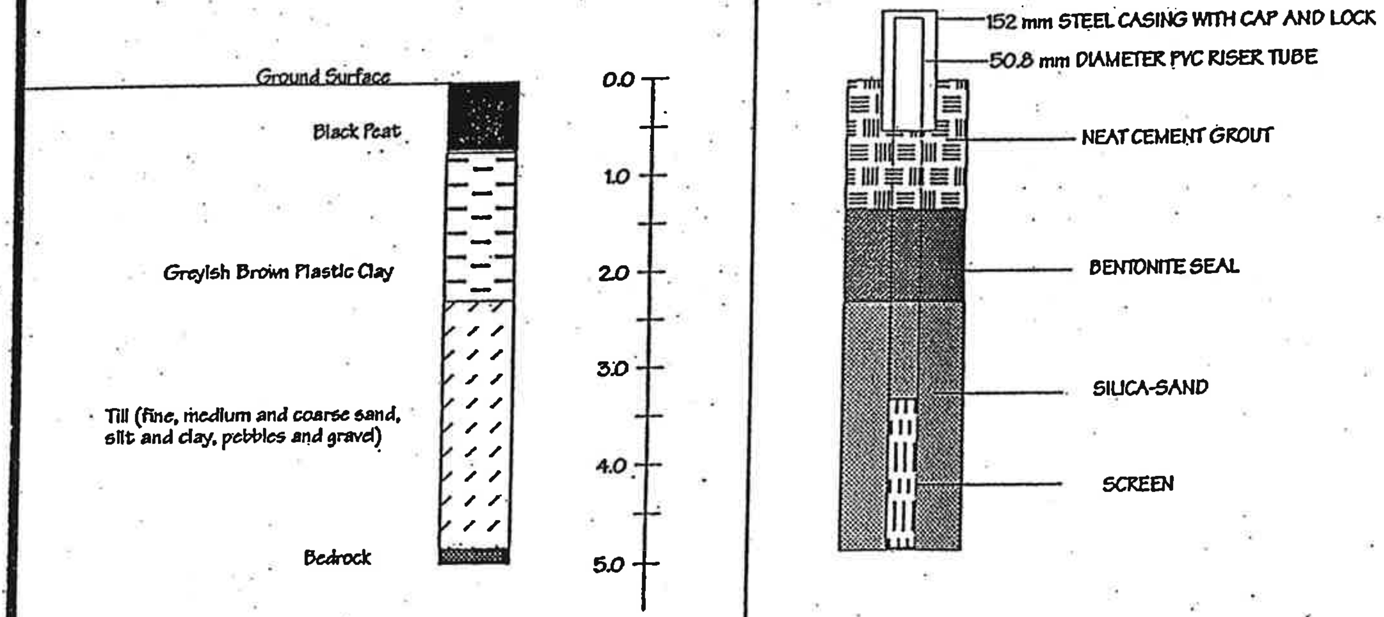
DRILL TYPE: CME 55 HOLLOW STEM AUGER

DRILLER: MARATHON

LOCATION: CONCESSION VII, LOT 8

DATE: JUNE 9, 1992

SOIL DESCRIPTION	STRAT.	DEPTH (m)	ELEV. (m)	PIEZOMETER INSTALLATION



M. S. THOMPSON & ASSOCIATES LTD.

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE. CORNWALL K6J 3E5

FIGURE TITLE

SOIL PROFILE AND PIEZOMETER CONSTRUCTION

JOB

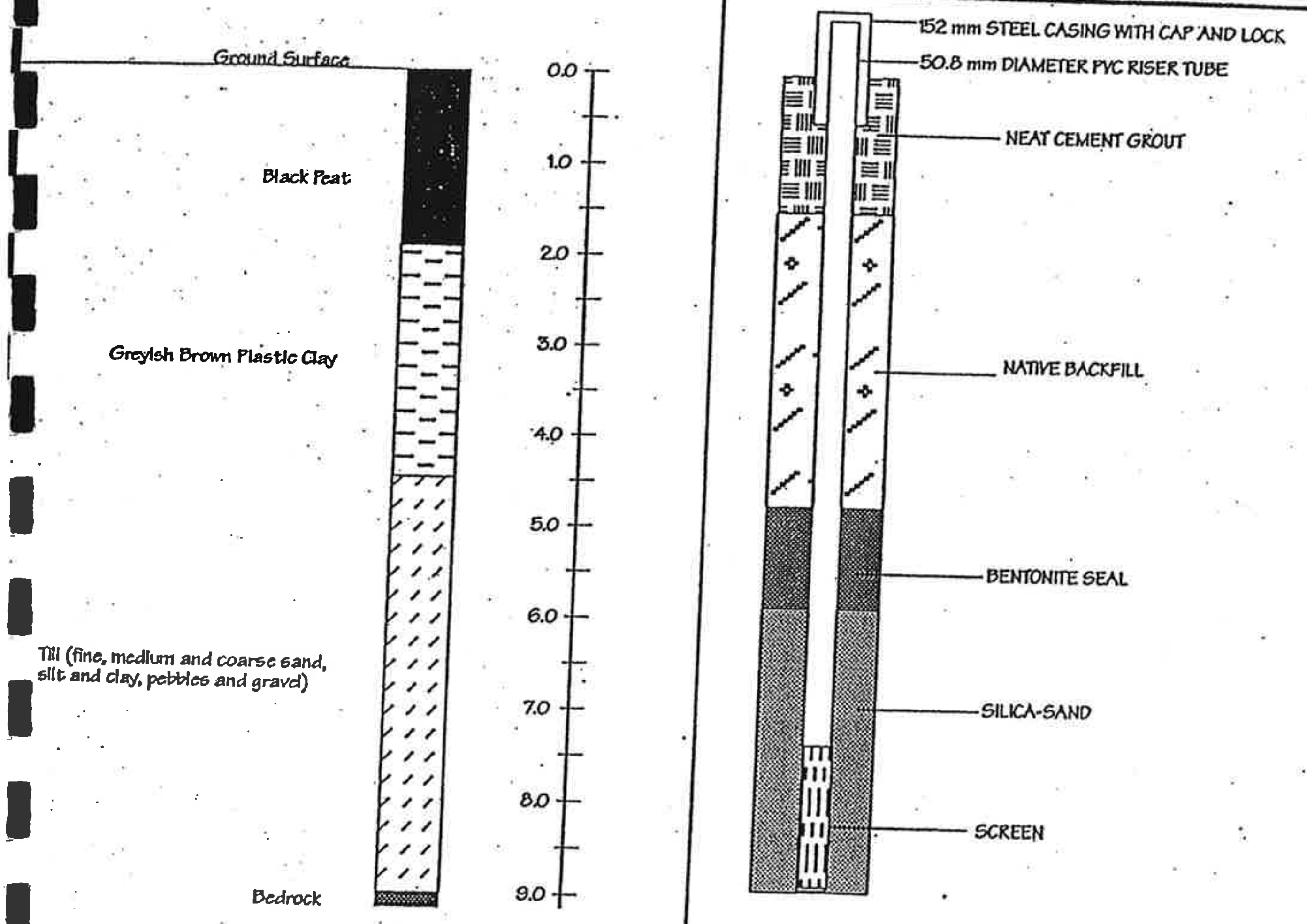
WINCHESTER TOWNSHIP LANDFILL SITE

DATE	JUNE 1992
SCALE	AS SHOWN
DRAWN	MHM
JOB No.	92094
FIGURE:	

STRATIGRAPHIC DESCRIPTION AND OVER-BURDEN MONITORING WELL INSTALLATION
WINCHESTER TOWNSHIP LANDFILL SITE

MONITORING WELL NUMBER: MW 9
LOCATION: CONCESSION VII, LOT 8
DRILL TYPE: CME 55 HOLLOW STEM AUGER
DATE: JUNE 9, 1992
DRILLER: MARATHON

SOIL DESCRIPTION	STRAT.	DEPTH (m)	ELEV. (m)	PIEZOMETER INSTALLATION



M. S. THOMPSON &
SSOCIATES LTD.
NSULTING ENGINEERS

ROSEMOUNT AVE. CORNWALL K6J 3E5

FIGURE TITLE
SOIL PROFILE AND PIEZOMETER CONSTRUCTION

JOB
WINCHESTER TOWNSHIP LANDFILL SITE

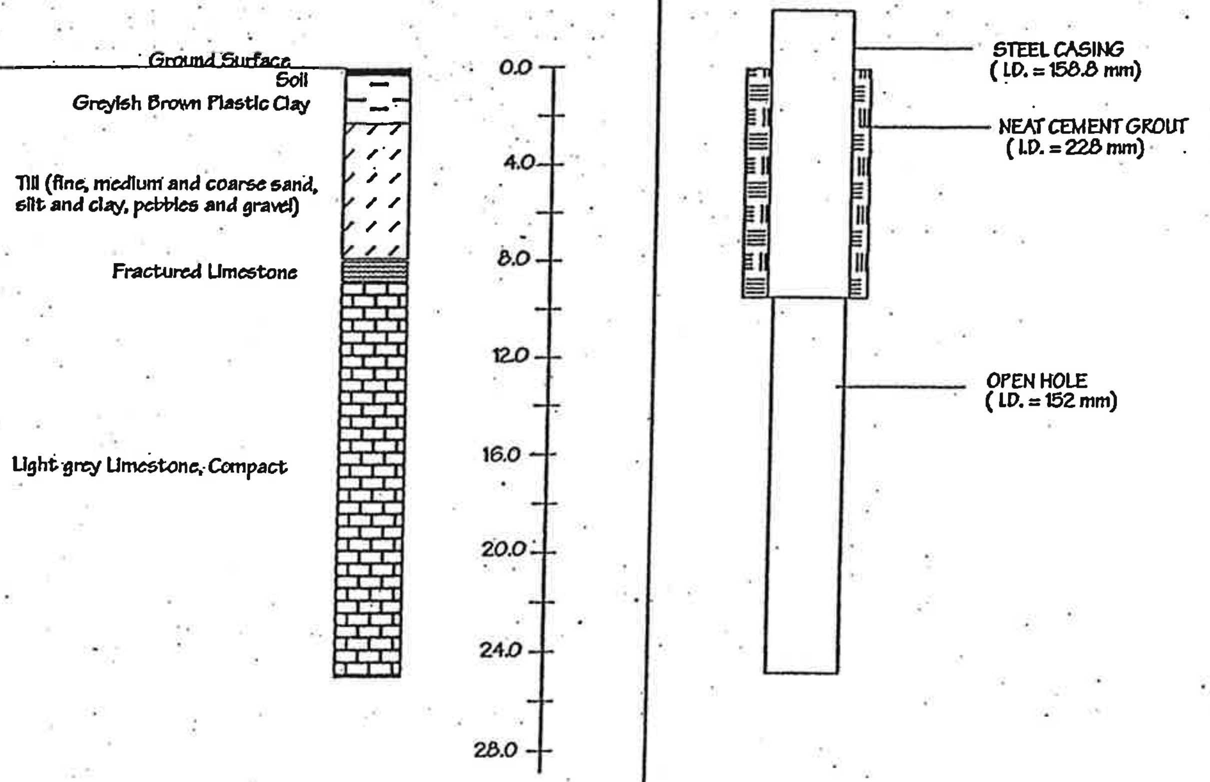
DATE JUNE 1992
SCALE AS SHOWN
DRAWN MHM
JOB No. 92094
FIGURE:

STRATIGRAPHIC DESCRIPTION AND OVER-BURDEN MONITORING WELL INSTALLATION

WINCHESTER TOWNSHIP LANDFILL SITE

MONITORING BEDROCK WELL: BRW-1
LOCATION: CONCESSION VII, LOT 8
DRILL TYPE: CME 55 HOLLOW STEM AUGER
DATE: JUNE 10, 1992
DRILLER: MARATHON

SOIL DESCRIPTION	STRAT.	DEPTH (m)	ELEV. (m)	PIEZOMETER INSTALLATION



M. S. THOMPSON & ASSOCIATES LTD.

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE. CORNWALL K6J 3E5

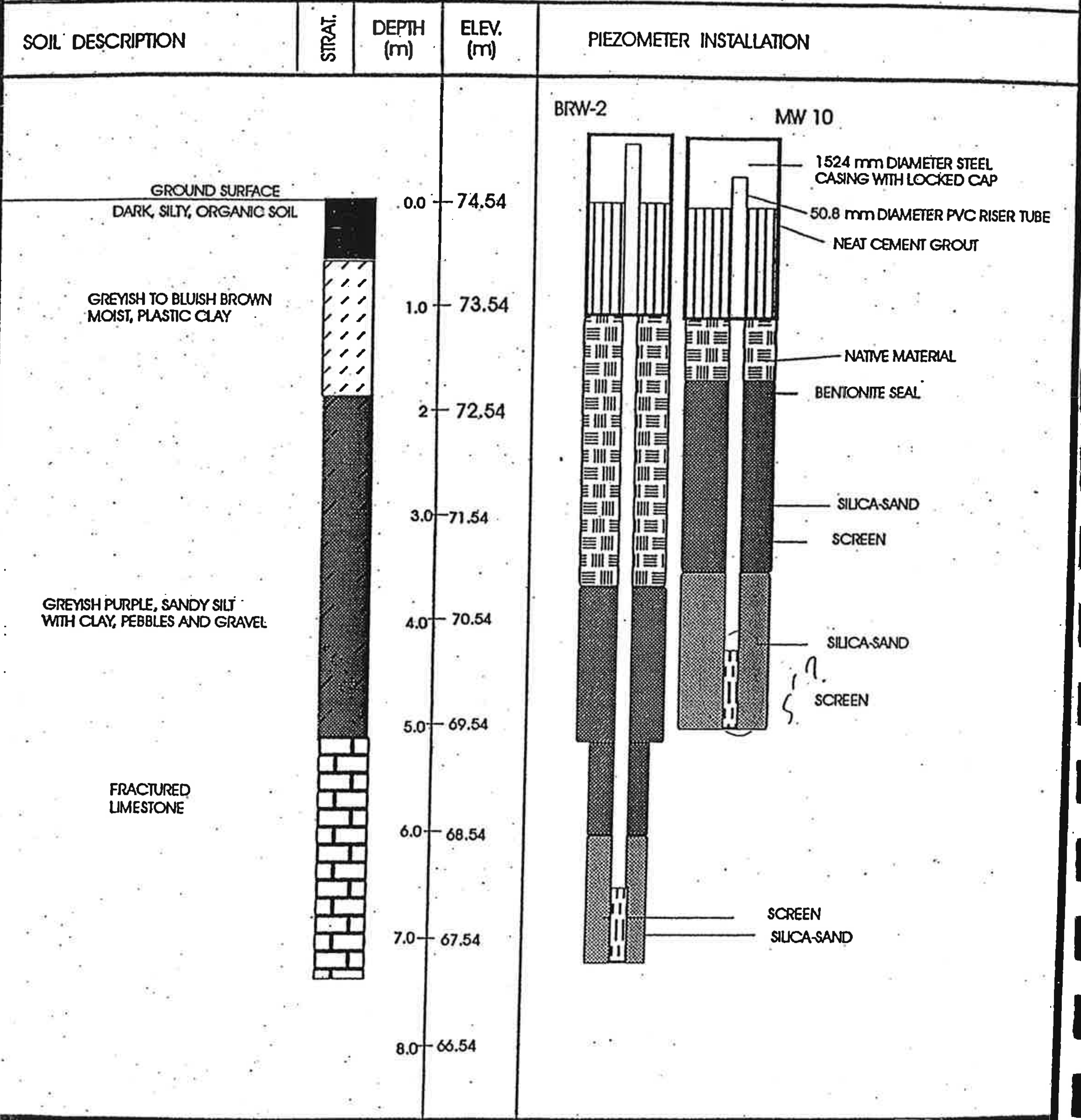
FIGURE TITLE
SOIL PROFILE AND PIEZOMETER CONSTRUCTION

JOB
WINCHESTER TOWNSHIP LANDFILL SITE

DATE JUNE 1992
SCALE AS SHOWN
DRAWN MHM
JOB No. 92094
FIGURE:

MONITORING WELL NUMBER: MW10 & BRW-12
DRILL TYPE: CME 55 HOLLOW STEM AUGER
DRILLER: MARATHON

LOCATION: WINCHESTER TOWNSHIP
WASTE DISPOSAL SITE
DATE: JULY 1993



M. S. THOMPSON & ASSOCIATES LTD.

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE, CORNWALL K6J 3E5

FIGURE TITLE

SOIL PROFILE AND
PIEZOMETER CONSTRUCTION

JOB

WINCHESTER TOWNSHIP
WASTE DISPOSAL SITE

DATE	MARCH 1993
SCALE	AS SHOWN
DRAWN	MHM
JOB No.	92094

Project No: MC12684A

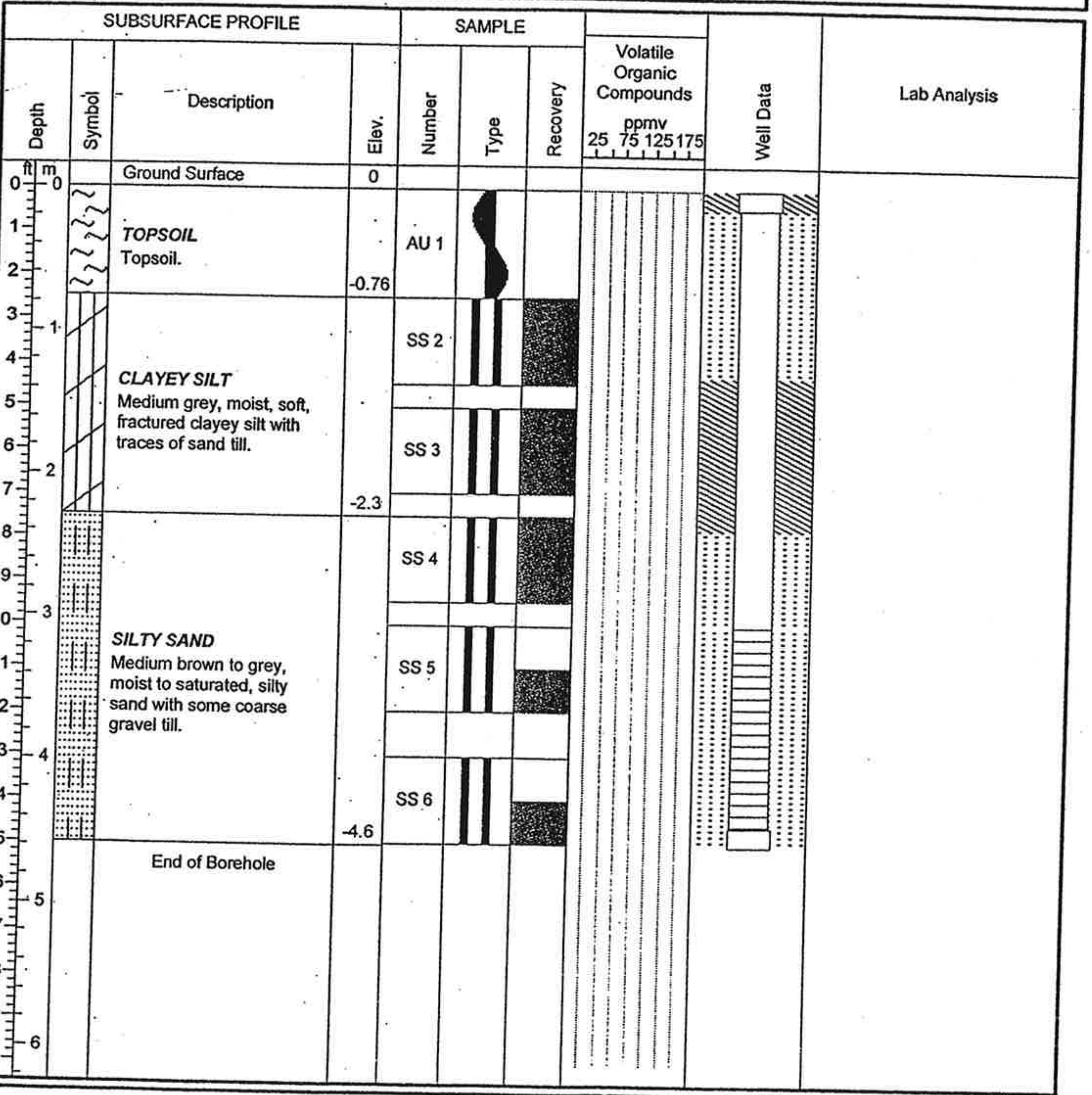
Log of MW 16

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince



SUBSURFACE PROFILE				SAMPLE					
Depth	Symbol	Description	Elev.	Number	Type	Recovery	Volatile Organic Compounds ppmv 25 75 125 175	Well Data	Lab Analysis
		Ground Surface	0						
		TOPSOIL Topsoil.	-0.76	AU 1					
		CLAYEY SILT Medium grey, moist, soft, fractured clayey silt with traces of sand till.	-2.3	SS 2 SS 3					
		SILTY SAND Medium brown to grey, moist to saturated, silty sand with some coarse gravel till.	-4.6	SS 4 SS 5 SS 6					
		End of Borehole							

Drill Method: Hollow Stem Auger

Drill Date: September 26, 2002

Hole Size: 0.15 metres

Trow Consulting Engineers Ltd.

154 Colonnade Road South
Nepean, Ontario K2E 7J5

Datum:

Checked by: B.Coons

Sheet: 1 of 1

Project No: MC12684A

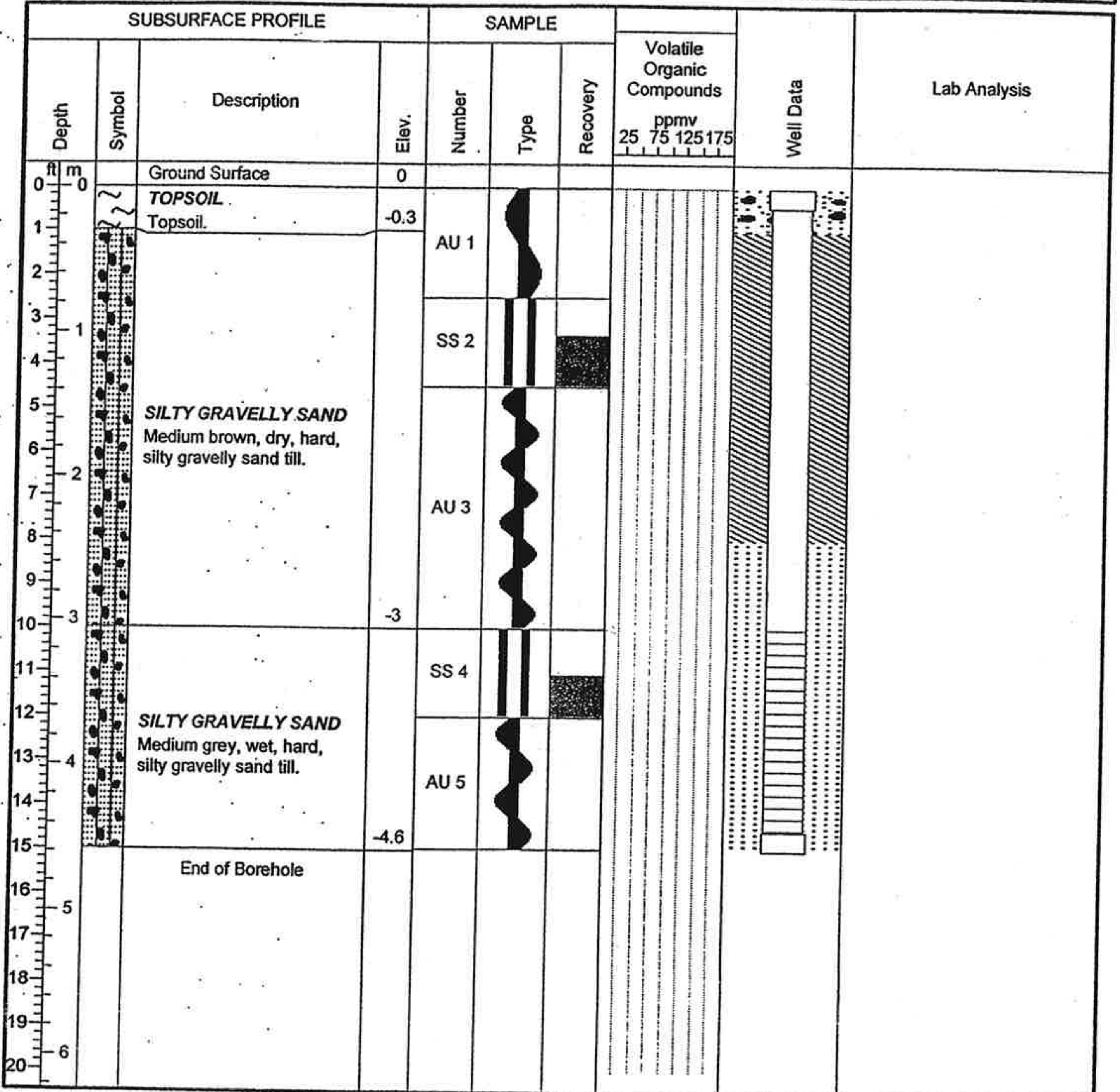
Log of MW 17

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince



Description	Elev.	Number
Ground Surface	0	
TOPSOIL Topsoil.	-0.3	AU 1
SILTY GRAVELLY SAND Medium brown, dry, hard, silty gravelly sand till.	-3	SS 2 AU 3
SILTY GRAVELLY SAND Medium grey, wet, hard, silty gravelly sand till.	-4.6	SS 4 AU 5
End of Borehole		

Drill Method: Hollow Stem Auger

Drill Date: September 26, 2002

Hole Size: 0.15 metres

Trow Consulting Engineers Ltd.
154 Colonnade Road South
Nepean, Ontario K2E 7J5

Datum:

Checked by: B.Coons

Sheet: 1 of 1

Project No: MC12684A

Log of MW 18

Project: North Dundas Landfill - Boyne Rd.

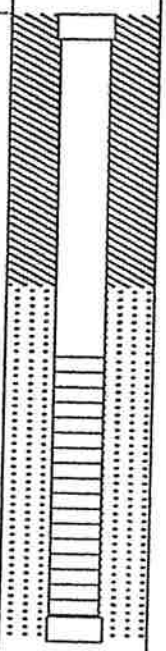
Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince

SUBSURFACE PROFILE				SAMPLE			Volatile Organic Compounds ppmv 25 75 125 175	Well Data	Lab Analysis
Depth ft / m	Symbol	Description	Elev.	Number	Type	Recovery			
0 / 0		Ground Surface	0						
		TOPSOIL Topsoil.	-0.3	AU 1					
		SILTY CLAY Medium brown, moist, silty fractured clay.	-1.2	SS 2					
		SILTY SAND Medium brown, dry, silty sand with some gravel till.	-3	SS 3 SS 4					
		SILTY SANDY GRAVEL Medium grey, wet, silty sandy gravel till. Refusal at 11 feet.	-3.4	SS 5					
		End of Borehole							

Depth scale: ft 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20; m 0 1 2 3 4 5 6



Drill Method: Hollow Stem Auger

Drill Date: September 26, 2002

Hole Size: 0.15 metres

Trow Consulting Engineers Ltd.
154 Colonnade Road South
Nepean, Ontario K2E 7J5

Datum:

Checked by: B.Coons

Sheet: 1 of 1

Project No: MC12684A

Log of MW 19

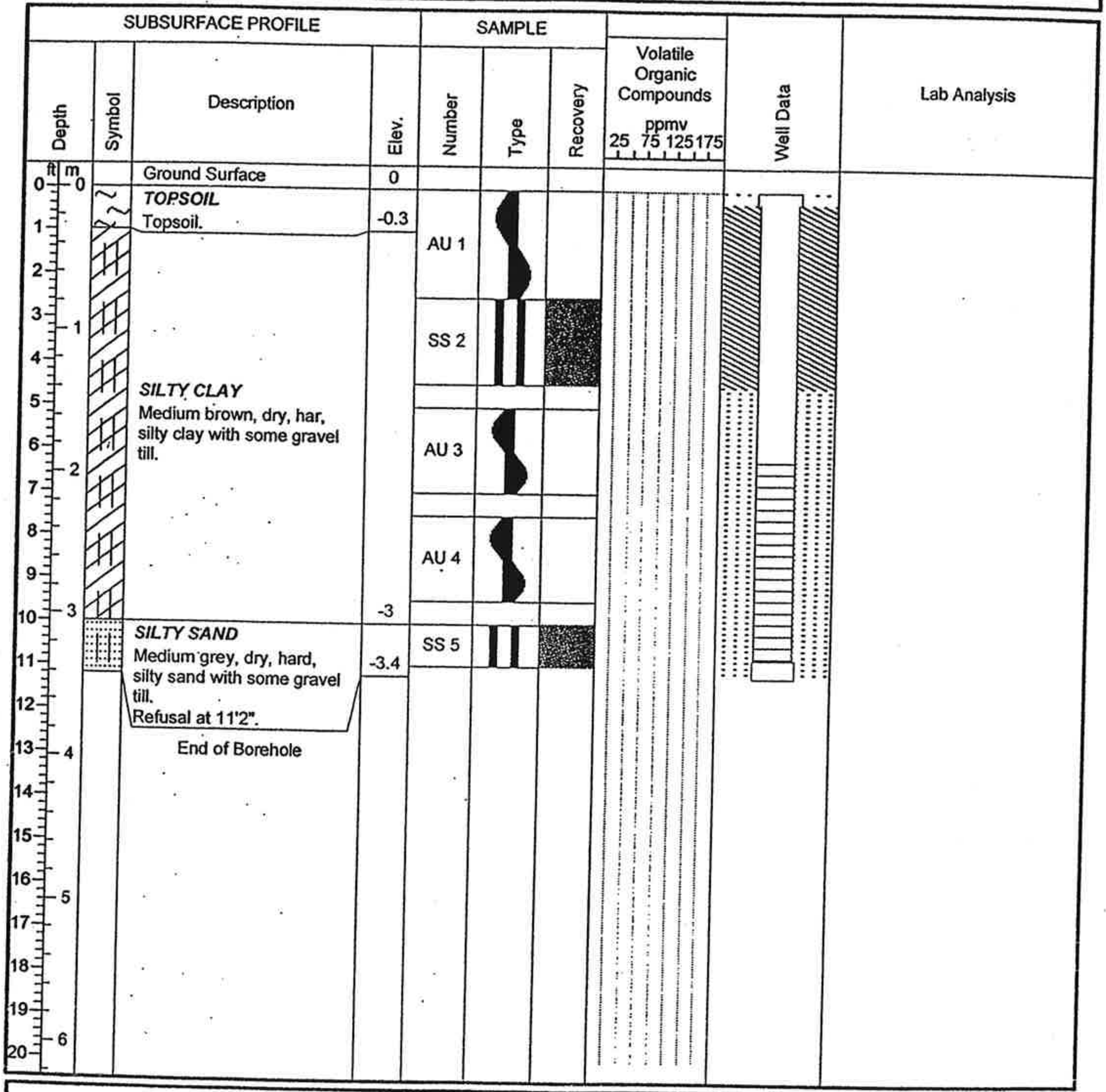
Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince

Trow



Description	Elev.	Number
Ground Surface	0	
TOPSOIL Topsoil.	-0.3	AU 1
SILTY CLAY Medium brown, dry, har, silty clay with some gravel till.	-3	SS 2 AU 3 AU 4
SILTY SAND Medium grey, dry, hard, silty sand with some gravel till. Refusal at 11'2".	-3.4	SS 5
End of Borehole		

Drill Method: Hollow Stem Auger

Drill Date: September 26, 2002

Hole Size: 0.15 metres

Trow Consulting Engineers Ltd.

154 Colonnade Road South
Nepean, Ontario K2E 7J5

Datum:

Checked by: B.Coons

Sheet: 1 of 1

Appendix D-2 Boyne Road Landfill Slope Stability Technical Memorandum

TECHNICAL MEMORANDUM

DATE January 28, 2022 **Project No.1648253**

TO Trish Edmond, P.Eng.
Golder Associates Ltd.

FROM Bridgit Bocage, P.Eng.
William Cavers, P.Eng.

EMAIL **Bridgit_Bocage@golder.com**
William_Cavers@golder.com

INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN, BOYNE ROAD LANDFILL EXPANSION - GEOTECHNICAL ASSESSMENT

This memorandum provides the results of the geotechnical assessment carried out considering the updated landfilling configuration for the proposed expansion of the Boyne Road Landfill site.

1.0 PROJECT DETAILS

The Boyne Road Landfill site is located on Boyne Road just east of Belanger Road in the Township of North Dundas, Ontario.

It is understood that the proposed expansion consists primarily of horizontal expansion on the south side of the existing footprint. The horizontal expansion adds an additional 3.8 hectares of footprint for a total landfill footprint of 11.9 hectares. The total expanded landfill capacity for waste, including the daily cover, will be about 1,060,750 m^3. The maximum elevation of the top of waste will be at about elevation 90.5 masl; a 0.75 thick final soil cover will be placed above the waste. This is approximately 15 m above the average ground surface elevation in the vicinity of the landfill expansion and approximately 2.5 m higher than the existing approved landfill.

The geometry of the proposed landfill side slopes are proposed to be 4H:1V or flatter and landfill top area slopes no steeper than 20H:1V.

An approximately 1 m thick pad of imported permeable fill material will be placed above the existing ground surface as a base layer for the waste disposal.

2.0 BOREHOLE INVESTIGATIONS

Several borehole investigations have been carried out at the site. Previous work included investigations carried out by Golder in 2006, 2007, 2014 to 2016, and geotechnical investigations carried out in 1991 by Olivier Mangione McCalla and Associates Ltd., in 1992 and 1993 by M.S. Thompson Associates Ltd., and in 2002 by Trow Associates Inc. The relevant boreholes within the footprint of the expansion are shown on the attached Site Plan

(Figure 2 - Site Plan from Golder Report titled, "2020 Groundwater and Subsurface Water Monitoring Program and Operations Monitoring, Boyce Road Landfill, Project No. 20139489"). The relevant borehole logs are appended following the text of this memorandum.

3.0 SLOPE STABILITY ASSESSMENT

In general, six main components are typically involved in assessing the stability of a slope:

1) The geometry of the slope;
2) The geology of the slope (i.e., the composition of the various soil layers within the slope and their depth, thickness, and orientation);
3) The groundwater conditions (the groundwater levels and the hydraulic gradient/flow conditions);
4) The strength parameters for the soils and waste;
5) The unit weights (i.e., densities) of the soils and waste within the slope; and,
6) External loading (i.e., surcharge, seismic forces).

Two overall cross-sections (denoted as A-A' and B-B') were used for analysis. The critical side of each cross section was modelled, resulting in consideration of a total of two analysis sections. The sections were developed based on the proposed new fill placement plans and considered the existing ground surface profile along with the overlying proposed fill surface.

The stability of the waste pile and side slopes was evaluated using the SLOPE/W computer program. The Morgernstern Price method, which satisfies both moment and force equilibrium, was used to compute a factor of safety. The factor of safety is defined as the ratio of the magnitude of the forces tending to resist failure to the magnitude of the forces tending to cause failure.

Theoretically, a slope with a factor of safety of less than 1.0 will undergo movement and one with a factor of safety of 1.0 or greater will not undergo movement. For analyses of the stability of slopes under static loading conditions, a factor of safety of greater than about 1.3 can be considered acceptable for this project and reflects inherent uncertainties related to waste material and subsurface variabilities, geometric imprecision, strain incompatibilities, and other risk factors.

The seismic loads imposed on a slope are modelled in a simplified manner by applying a horizontal "pseudo static" force to the soil mass. The "pseudo-static" force, F_s, is calculated as:

$$F_s = k_s \text{ x } M$$

Where: k_s = horizontal seismic coefficient; and,

M = mass of soil contained within the failure surface.

A minimum factor of safety of 1.1 is recommended under seismic loading conditions.

The seismic slope stability evaluations were carried out assuming that the design earthquake would correspond to an event with a 2% probability of occurrence in 50 years (i.e., the 2,475-year design earthquake). Based on the methodology outlined in CHBDC (2014) and NBCC (2015), the Site Class was determined using representative average values of N_{60}. The average shear wave velocity in the upper 30 m at the site was calculated to be about 600 m/s, which corresponds to a Site Class C. The ground surface PGA is about 0.36 g. Therefore, a k_h value of 0.18 g, equal to one-half the ground surface PGA, was used in the slope stability analyses.

3.1 Material Properties

The subsurface stratigraphy was inferred from subsurface information obtained previously by Golder and others.

The key material properties required to complete a stability analysis are the unit weight and shear strength of the materials. The shear strength of soil or waste is conventionally described using a Mohr-Coulomb criterion. This criterion describes the shear strength of a soil in terms of cohesive and frictional components. The magnitude of the frictional component depends on the stress acting perpendicular to the potential failure plane. From this criterion, the strength of a soil to resist shear stress (i.e., to resist sliding) is described by:

$$\tau = c' + \sigma' \tan \phi'$$

τ = Strength of the soil;

c' = Effective cohesion of the soil;

σ' = Effective normal stress (i.e., stress acting perpendicular to the shear plane);

and,

ϕ' = Effective internal friction angle.

The groundwater level was set at the bottom of the landfill base layer in the slope stability analyses.

The material parameters adopted for the analysis are summarized in the table below. The unit weights of the soils and waste were estimated from our experience with similar materials. The value of the unit weight of the waste fill was 13 kN/m^3.

The strength parameters assigned to the soils were based on the results of the in-situ testing. The undrained shear strength of the clay soils, where encountered, was estimated based on the N-values shown on the borehole records since shear strength values were not obtained in any of the boreholes within the landfill footprint. The ranges provided below represent a summary of the values used in the analyses. The drained parameters for the clay were based on the work carried out by Lefebvre (1981) studying the strength characteristics of the clay in this region and their influence on slope stability.

Material	Bulk Unit Weight (kN/m^3)	Drained Parameters		Undrained Parameters
		Effective Cohesion (kPa)	Effective Internal Friction Angle (°)	Cohesion (kPa)
Cover Layer	19	0	32	N/A
Waste Fill	13	0	32	N/A
Topsoil or Peat	11.5	0	10	N/A
Silty Clay (firm to stiff)	16	7.4	28.7	50
Glacial Till	21	0	35	N/A
Landfill Base Layer	20.5	0	35	N/A

3.2 Slope Stability Analysis Results

Two overall cross sections (identified as A-A’ and B-B’) were analyzed. The locations of the cross-sections are shown on attached Figure 12-2 (Site Plan of Proposed Expansion taken from Section 12.0 of the EASR). The stability results are graphically shown on the attached Figures 1 to 6.

The following table indicates the global factors of safety obtained for both static and dynamic analyses for the proposed expanded landfill configuration as shown in Figure 12-3 dated November 2021.

Section	Global Factor of Safety		
	Static Drained	Static Undrained	Seismic
A-A’ West	1.9	1.8	1.1
B-B’ South	2.7	2.6	1.5

The results of the stability assessment carried out based on the November 2021 fill plan, indicate that the factor of safety against deep-seated static instability of the analyzed sections is greater than 1.5; the proposed expansion configuration is therefore considered acceptable for static conditions.

The results of the seismic slope stability analyses carried out using a simple “pseudo-static” model where a horizontal force is applied to the failure mass to represent the seismic loading, indicate that the factor of safety against deep-seated instability would be 1.1, or greater, for all sections.

3.3 Settlement

Based on the existing subsurface conditions within the footprint of the landfill expansion, it is anticipated that settlements due to waste fill placement will be minimal. It should also be noted that there is no landfill infrastructure beneath the existing landfill that could be adversely affected by compression of subgrade soils under the weight of the waste.

4.0 CLOSURE

We trust this memorandum contains sufficient information for your present requirements.

Yours truly,

GOLDER ASSOCIATES LTD.

Sarah MacDonald

Bridgit Bocage, P.Eng.
Geotechnical Engineer

Sarah MacDonald P.Eng.
Senior Geotechnical Engineer

BB/WC/PAS/hdw
https://golderassociates.sharepoint.com/sites/117046/project files/6 deliverables/3 geotechnical/slope stability memo/1648253-tm-rev0-boyne rd landfill slope stability-2022 01 20.docx

Attachments:

- Figure 2 – Site Plan from Golder Report titled, “2020 Groundwater and Subsurface Water Monitoring Program and Operations Monitoring, Boyce Road Landfill, Project No. 20139489”
- Figure 12-2 – Site Plan of Proposed Expansion taken from Section 12.0 of the EASR
- Figure 12-3 – Cross-Sections of Proposed Expansion taken from Section 12.0 of the EASR
- Record of Borehole Sheets
- Figures 1 to 6 – SLOPE/W Output Sections

References:

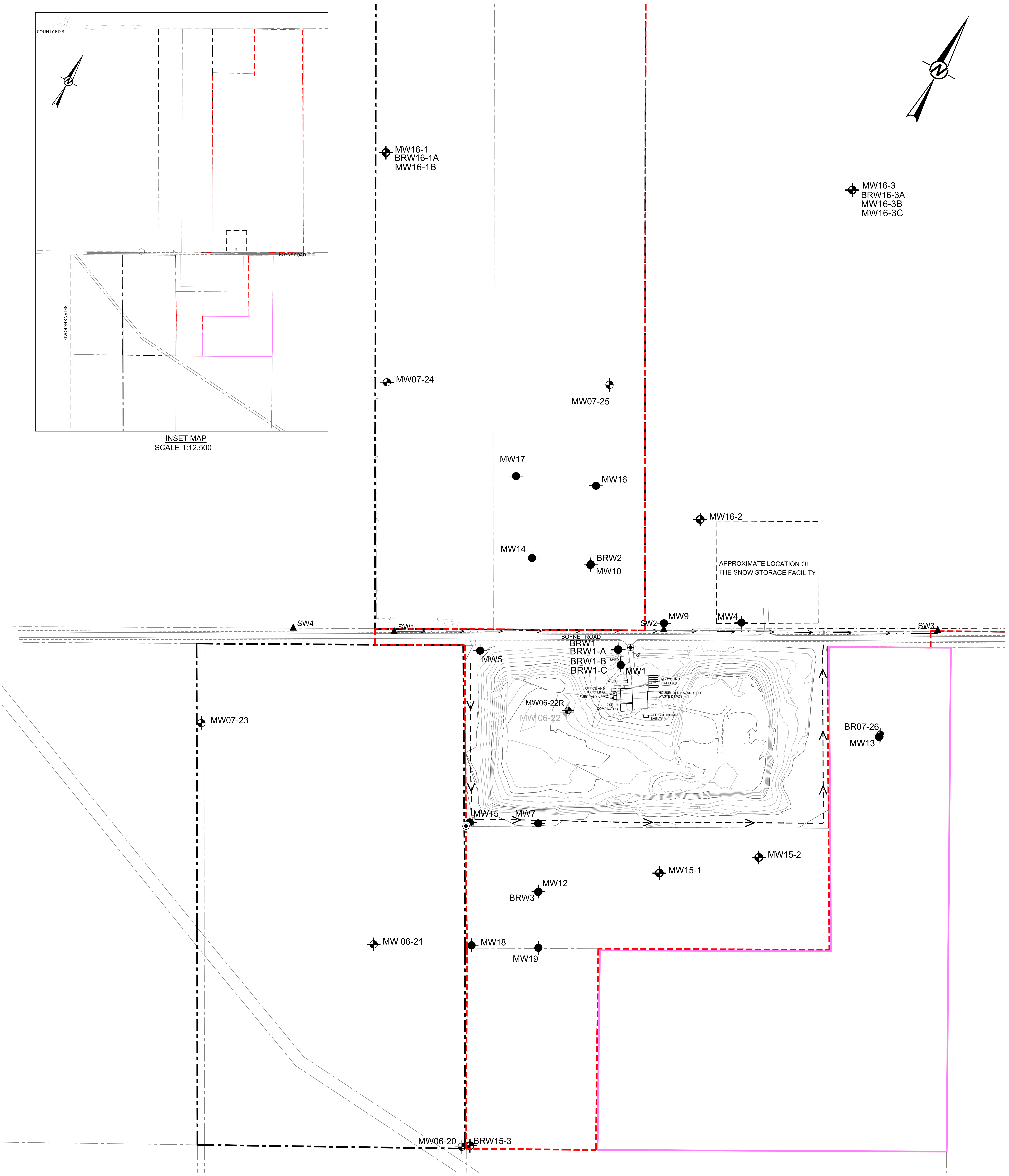
Bray, J.D., Zekkos, D., Kavazanjian Jr., E., Athanasopoulos, G.A., Riemer, M.F. (2009). “Shear Strength of Municipal Solid Waste.” *Journal of Geotechnical and Geoenvironmental Engineering*, 135(6), 709-722.

Lefebvre, G. (1981). “Fourth Canadian Geotechnical Colloquium: Strength and slope stability in Canadian soft clay deposits.” *Canadian Geotechnical Journal*, 18(3), 420-442.

ATTACHMENTS - FIGURES

- Figure 2 – Site Plan
- Figure 12-2 – Site Plan of Proposed Expansion
- Figure 12-3 – Cross-Sections of Proposed Expansion

Path: \\golder.gds\complexdata\office\ottawa\Active\spatial_im\township_of_north_dundas\boyneroadlandfill\99_PROJ\20139489\40_PROD\0001_Annual_Monitoring\ | File Name: 20139489-0001-CH-0002.dwg



LEGEND

- DESTROYED MONITORING WELL NO LONGER IN USE
- APPROXIMATE BOREHOLE LOCATION IN PLAN, ESTABLISHED BY GOLDER ASSOCIATES LTD.
- ● APPROXIMATE BOREHOLE LOCATION IN PLAN, ESTABLISHED BY OTHERS
- ▲ APPROXIMATE SURFACE WATER SAMPLING LOCATION IN PLAN
- ⊙ GEO-REFERENCING POINTS
- 85.0 GROUND SURFACE CONTOURS (M), BASED ON RESULTS OF THE SURVEYS CONDUCTED IN 2008, 2010, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 AND 2020
- APPROXIMATE PROPERTY BOUNDARY OF LANDFILL SITE
- APPROXIMATE BOUNDARY OF CONTAMINANT ATTENUATION ZONE
- ADDITIONAL LAND OWNED BY TOWNSHIP
- APPROXIMATE LOCATION OF PERIMETER DITCH AND INFERRED FLOW DIRECTION
- INFERRED FLOW DIRECTION IN THE DRAINAGE DITCH ALONG BOYNE ROAD

NOTES

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE

1. BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY STANTEC CONSULTING LTD.
2. 2008 AND 2010 SURVEYS COMPLETED BY STANTEC CONSULTING LTD.
3. MAY 2012, JULY 2013, NOVEMBER 2014, DECEMBER 2015, NOVEMBER 2016, DECEMBER 2017, DECEMBER 2018 AND NOVEMBER 2019, APRIL 2020 AND DECEMBER 2020 SURVEYS COMPLETED BY GOLDER ASSOCIATES LTD.
4. COORDINATE SYSTEM: MTM ZONE 9 NAD83

0 100 200
1:2,500 METRES

CLIENT
TOWNSHIP OF NORTH DUNDAS

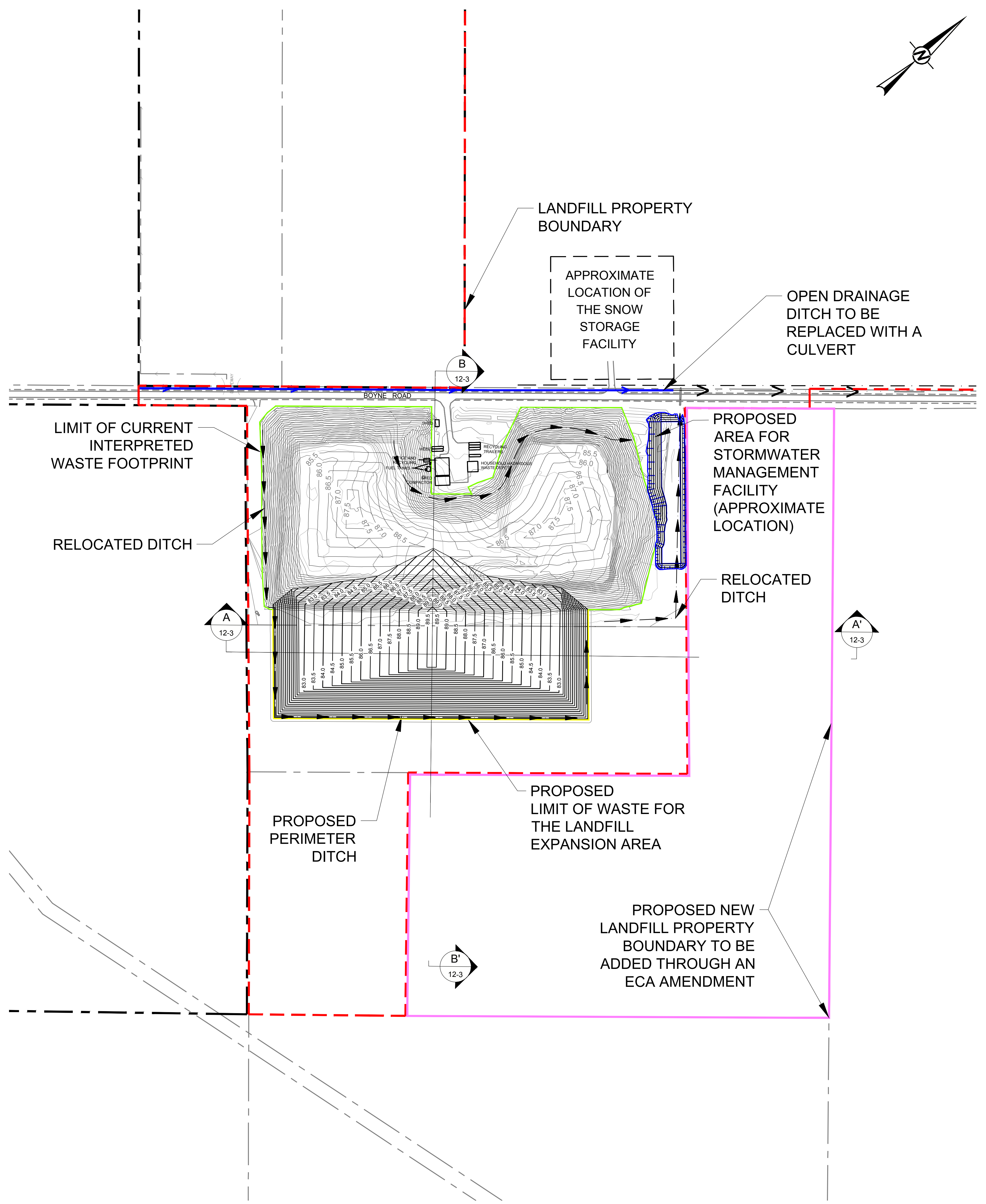
PROJECT
2020 GROUNDWATER AND SURFACE WATER
MONITORING PROGRAM AND OPERATIONS MONITORING
BOYNE ROAD LANDFILL

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-07
PREPARED	ABD
DESIGN	RM
REVIEW	PS
APPROVED	PAS

TITLE
SITE PLAN

PROJECT No.	CONTROL	Rev.	FIGURE
20139489	0004	A	2



LEGEND

85.0	GROUND SURFACE CONTOURS (MASL), BASED ON RESULTS OF THE SURVEYS CONDUCTED IN 2008, 2010, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 AND 2020
89.5	PROPOSED EXPANSION TOP OF WASTE ELEVATION CONTOURS (MASL)
🟥	APPROXIMATE PROPERTY BOUNDARY OF LANDFILL SITE
▬	APPROXIMATE BOUNDARY OF EXISTING CONTAMINANT ATTENUATION ZONE EASEMENT LANDS
➝	PROPOSED PERIMETER DITCH
➝	EXISTING ROADSIDE DITCH TO BE REPLACED WITH A CULVERT (APPROXIMATE LOCATION)
▬	PROPOSED NEW LANDFILL PROPERTY BOUNDARY TO BE ADDED THROUGH AN ECA AMENDMENT

REFERENCE(S)

1. BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY STANTEC CONSULTING LTD.
2. 2008 AND 2010 SURVEYS COMPLETED BY STANTEC CONSULTING LTD.
3. MAY 2012, JULY 2013, NOVEMBER 2014, DECEMBER 2015, NOVEMBER 2016, DECEMBER 2017, DECEMBER 2018 AND NOVEMBER 2019, APRIL 2020 AND DECEMBER 2020 SURVEYS COMPLETED BY GOLDER ASSOCIATES LTD.
4. COORDINATES SYSTEM: MTM ZONE 9 NAD83 DATUM CGVD28

0 100 200
1:4,000 METRES

NOT FOR CONSTRUCTION

DRAFT

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

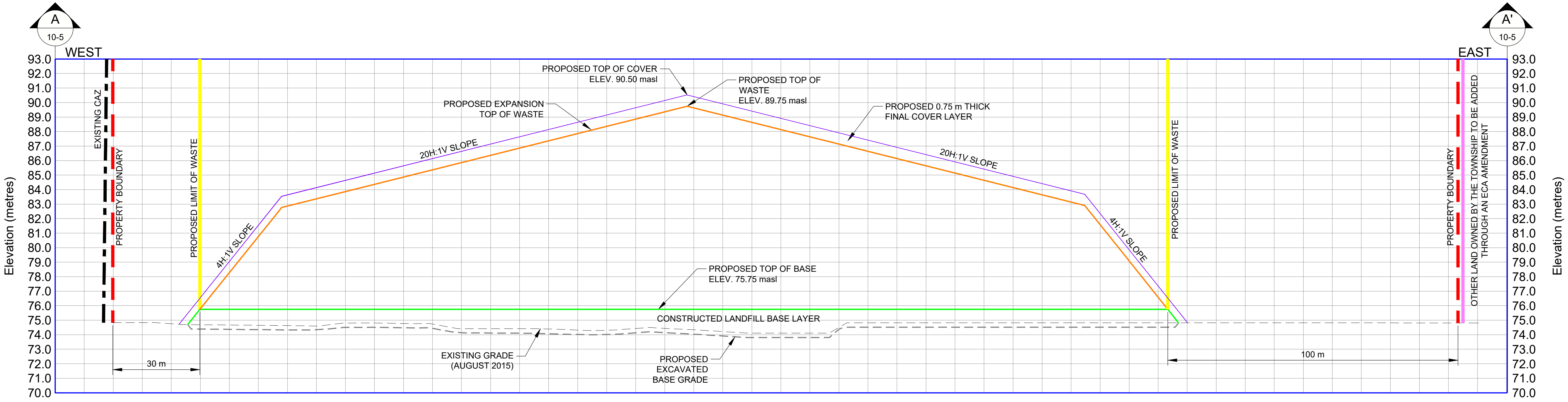
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-11-16
DESIGNED	YJM
PREPARED	ABD
REVIEWED	PLE
APPROVED	PAS

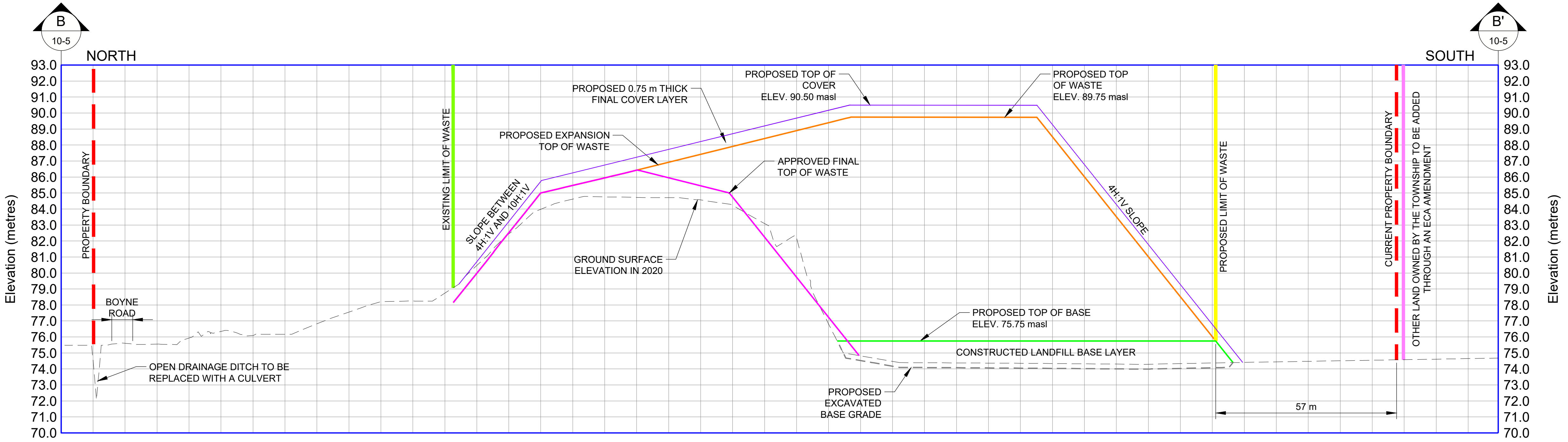
TITLE
SITE PLAN OF PROPOSED EXPANSION

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0\2.2.0.	0	12-2

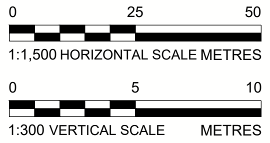
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25 mm
0



HORIZ. SCALE 1:1,500 m A-A' 10-5 SECTION
VERT. SCALE 1:300 m



HORIZ. SCALE 1:1,500 m B-B' 10-5 SECTION
VERT. SCALE 1:300 m



NOT FOR CONSTRUCTION

DRAFT

CLIENT
TOWNSHIP OF NORTH DUNDAS

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-11-16
DESIGNED	YJM
PREPARED	ABD
REVIEWED	PLE
APPROVED	PAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE
CROSS-SECTIONS OF PROPOSED EXPANSION

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0\2.2.0.	0	12-3

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25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

ATTACHMENTS

- Record of Borehole Sheets

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures, and in the text of the report are as follows:

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive an uncased 50 mm (2 in.) diameter, 60^0 cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

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

Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60^0 conical tip and a projected end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm Or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	C_u or S_u kPa	Psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	Over 200	Over 4,000

IV. SOIL TESTS

w	Water content
w_p or PL	Plastic limited
w_l or LL	Liquid limit
C	Consolidaiton (oedometer) test
CHEM	Chemical analysis (refer to text)
CID	Consolidated isotropically drained triaxial test[1]
CIU	Consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	Relative density
DS	Direct shear test
Gs	Specific gravity
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	Organic content test
SO_4	Concentration of water-soluble sulphates
UC	Unconfined compression test
UU	Unconsolidated undrained triaxial test
V	Field vane test (LV-laboratory vane test)
γ	Unit weight

Note: [1] Tests which are anisotropically consolidated prior shear are shown as CAD, CAU.

LIST OF SYMBOLS

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

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$ x or log x	logarithm of x to base 10
g	acceleration due to gravity
t	time
FOS	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes:

[1] $\tau = c' + \sigma' \tan \phi'$

[2] shear strength = (compressive strength) / 2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of rock material weathering
Faintly Weathered: weathering limited to the surface of major discontinuities.
Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.
Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable
Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.
Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very Thickly Bedded	> 2 m
Thickly Bedded	0.6 m to 2m
Medium Bedded	0.2 m to 0.6 m
Thinly Bedded	60 mm to 0.2 m
Very Thinly Bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly Laminated	< 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very Wide	> 3 m
Wide	1 – 3 m
Moderately Close	0.3 – 1 m
Close	50 – 300 mm
Very Close	< 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 – 60 mm
Medium Grained	60 microns – 2mm
Fine Grained	2 – 60 microns
Very Fine Grained	< 2 microns

Note: *Grains > 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery

The percentage of solid 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 varies from 0% for completely broken core 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including naturally occurring fractures but not including mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^0 angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

BD -	Bedding	PY -	Pyrite
FO -	Foliation/Schistosity	Ca -	Calcite
CL -	Clean	PO -	Polished
SH -	Shear Plane/Zone	K -	Slickensided
VN -	Vein	SM -	Smooth
FLT -	Fault	RO -	Ridged/Rough
CO -	Contact	ST -	Stepped
JN -	Joint	PL -	Planar
FR -	Fracture	IR -	Irregular
MB -	Mechanical Break	UN -	Undulating
BR -	Broken Rock	CU -	Curved
BL -	Blast Induced	TCA -	To Core Axis
∥ -	Parallel To	STR -	Stress Induced
OR -	Orthogonal		

PROJECT: 14-1125-0007/Boyne Road Landfill

RECORD OF BOREHOLE: MW06-22R

SHEET 1 OF 1

LOCATION: N 4994479.6; E 474643.5 (UTM NAD83 Zone 18T)

BORING DATE: May 1, 2014

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		82.96							
0	Power Auger 200 mm Diam. (Hollow Stem)	Waste (FILL)	▨	0.00							Bentonite Seal
				71.99							Silica Sand
		Grey brown SILTY CLAY		10.97							32 mm Diam. PVC #10 Slot Screen
				70.16							Cave in
		End of Borehole		12.80							

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

DEPTH SCALE

1 : 100

Golder Associates

LOGGED: MIB

CHECKED: YJM

MIS-BHS 001 1411250007.GPJ GAL-MIS.GDT 11/07/14 JM

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: MW07-23

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 4, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V ⊕ U - ○ : 20 40 60 80

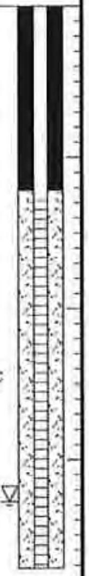
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE	74.97			
0	Power Auger 200mm diam. (Hollow Stem)	TOPSOIL	0.00			
		Very stiff grey brown SILTY CLAY (Weathered Crust)	74.76 0.21			
1		Brown SILTY CLAY, trace gravel	73.90 1.07	1	50 DO	20
		Dense brown to grey sandy SILT, some grey clay, occasional sand seam (GLACIAL TILL)	73.35 1.62	2	50 DO	35
2						
				3	50 DO	39
3				4	50 DO	32
		End of Borhole (Auger Refusal)	71.25 3.72			
4						
5						
6						
7						
8						
9						
10						

PIEZOMETER OR STANDPIPE INSTALLATION



WL in screen at Elev 72 56m on Sept 25, 2007

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

MIS-BHS 001 061122127-3.GPJ GAL-MISS.GDT 3/25/08 MLF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: MW07-24

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: September 4, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE		75.32			
0	Power Auger 200mm Diam. (Hollow Stem)	Dark brown PEAT		0.00			
		Grey brown SILTY CLAY (Weathered Crush)		74.77 0.55			
1		Compact grey brown CLAYEY SILT, trace gravel		74.25 1.07	1	50 DO	13
2		Brown grey SANDY SILT, some gravel, occasional cobbles		73.40 1.83	2	50 DO	13
					3	50 DO	40
3					4	50 DO	44
		End of Borehole (Auger Refusal)		72.03 3.20			

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

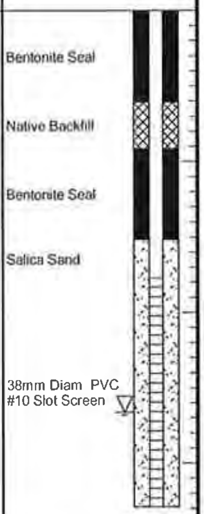
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—O W—⊣ Wl 20 40 60 80

ADDITIONAL LAB TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



WL in screen at Elev. 73.49m on Sept. 25, 2007

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: MW07-25

SHEET 1 OF 1

LOCATION: See Site Plan

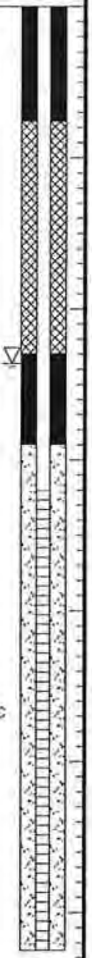
BORING DATE: September 5, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V + Q - ● rem V ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.13							
0	Power Auger 200mm Diam. (Hollow Stem)	Dark brown PEAT		0.00							Bentonite Seal
		Grey brown SILTY CLAY (Weathered Crush)		73.58 0.55							
1											Native Backfill
2					1	50 DO	8				
					2	50 DO	17				Bentonite Seal
		Compact to dense brown grey SANDY SILT, some gravel & clay, trace cobbles (GLACIAL TILL)		71.45 2.68							
3											Silica Sand
					3	50 DO	22				
4					4	50 DO	14				
					5	50 DO	96				38mm Diam. PVC #10 Slot Screen
5											
6					6	50 DO					
		End of Borehole (Auger Refusal)		67.88 6.25							WL in screen at Elev. 72.71m on Sept. 25, 2007
7											
8											
9											
10											



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: ILRF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: BR07-26

SHEET 1 OF 1

LOCATION:

BORING DATE: September 7, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V + Q - ● rem V ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT Wp ├──○W──┤ Wl 20 40 60 80

ADDITIONAL LAB TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0		Ground Surface	74.67
0	Power Auger 200mm Diam. (Hollow Stem)	Dark brown PEAT	0.00
1		Very stiff grey brown SILTY CLAY (Weathered Crush)	73.63 1.04
3		Stiff grey SILTY CLAY	71.62 3.05
4		Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)	70.71 3.96
5	Rotary Drill HQ Core	Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam	69.82 4.85
7.5		Fresh grey LIMESTONE BEDROCK , with shale interbed	67.14 7.53
9		End of Borehole	65.53 9.14

SAMPLES NUMBER	TYPE	BLOWS/0.3m	T.C.R. (%)	S.C.R. (%)	R.Q.D. (%)
1	50 DO	5			
2	50 DO	3			
3	50 DO	1			
4	50 DO	DD			
5	NQ RC		100	98	66
6	NQ RC		98	83	60
7	NQ RC		100	90	71
8	NQ RC		100	97	75

PIEZOMETER OR STANDPIPE INSTALLATION

- Bentonite Seal
- ∇
- Native Backfill
- Bentonite Seal
- Silica Sand
- 32mm Diam. PVC #10 Slot Screnn

WL in screen at Elev. 73.29m on Sept. 25, 2007

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D J S

CHECKED: HLRF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: BRW1

SHEET 1 OF 3

LOCATION: See Site Plan

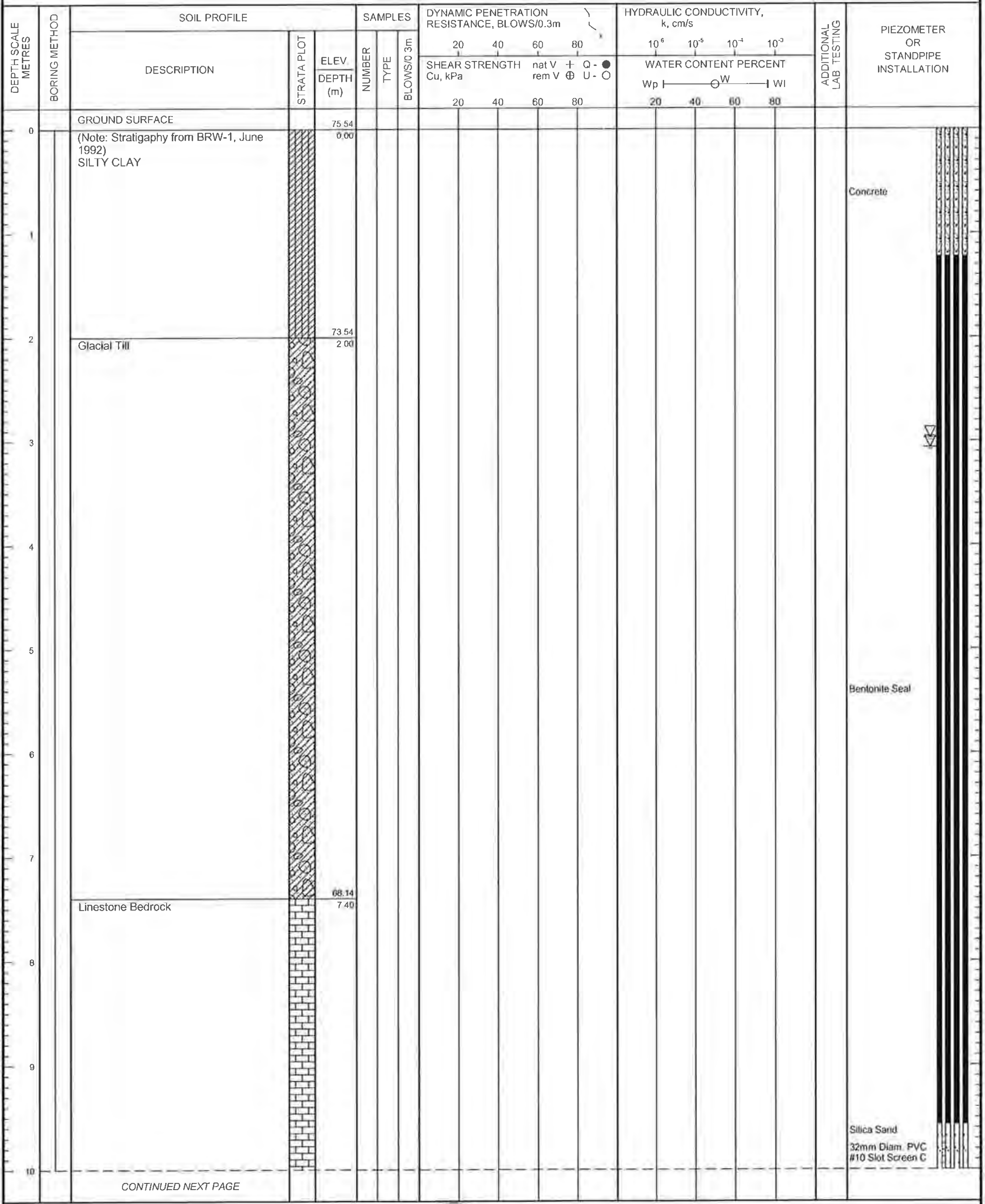
BORING DATE: September 7, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
	GROUND SURFACE	75.54
0	(Note: Stratigaphy from BRW-1, June 1992) SILTY CLAY	0.00
2	Glacial Till	73.54 2.00
7	Linestone Bedrock	68.14 7.40
10	*CONTINUED NEXT PAGE*	



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D J S

CHECKED: HLCF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: BRW1

SHEET 2 OF 3

LOCATION: See Site Plan

BORING DATE: September 7, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- *CONTINUED FROM PREVIOUS PAGE* ---									
10		Linestone Bedrock									
11											32mm Diam. PVC #10 Slot Screen C
12											Silica Sand
13											
14											Bentonite Seal
15											Silica Sand
16											32mm Diam. PVC #10 Slot Screen B
17											
18											Silica Sand
19											Bentonite Seal
20											
		CONTINUED NEXT PAGE									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-3

RECORD OF BOREHOLE: BRW1

SHEET 3 OF 3

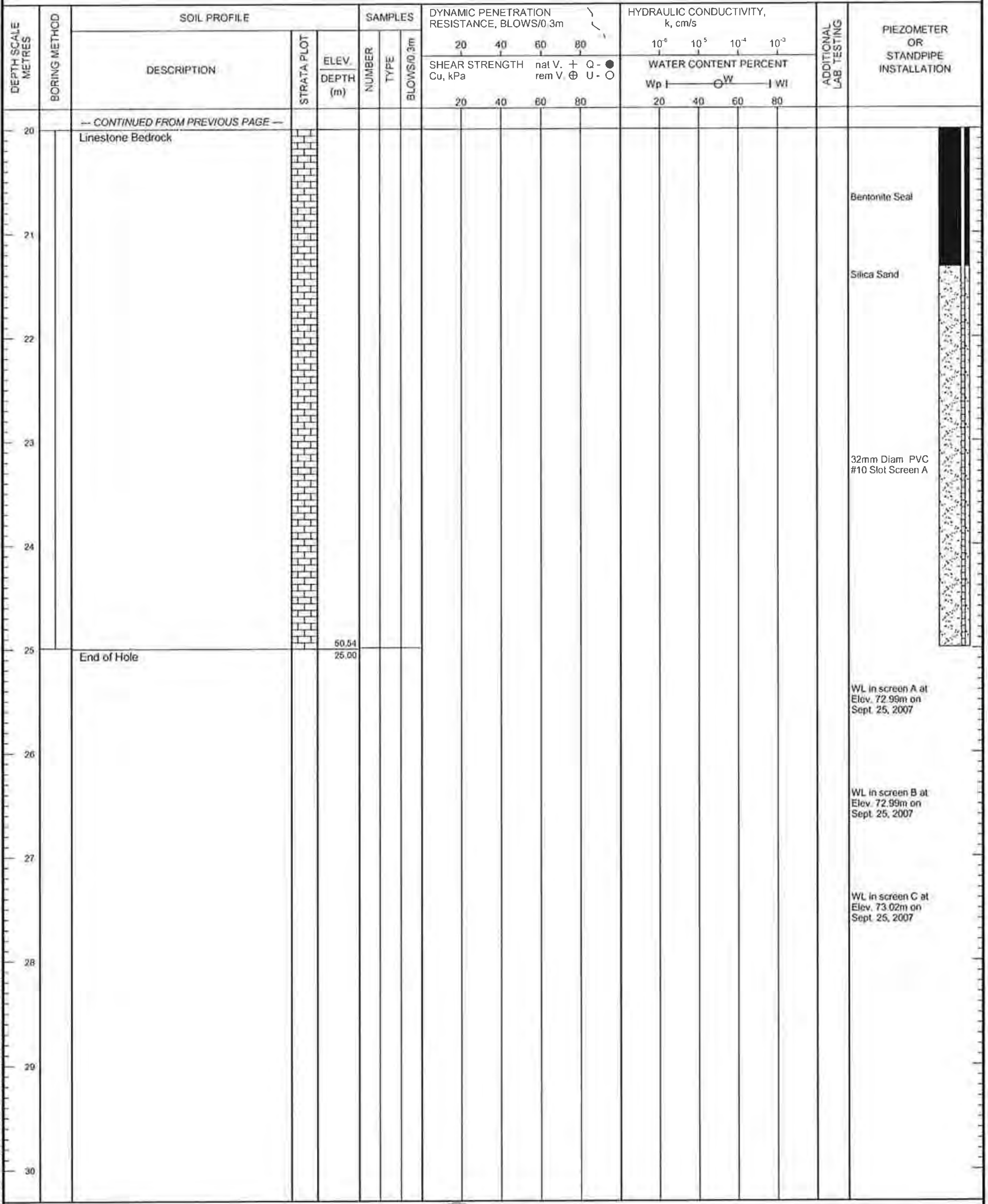
LOCATION: See Site Plan

BORING DATE: September 7, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



— CONTINUED FROM PREVIOUS PAGE —

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)
20	Linestone Bedrock	
25	End of Hole	50.54 25.00

Bentonite Seal

Silica Sand

32mm Diam PVC
#10 Slot Screen A

WL in screen A at
Elev. 72.99m on
Sept. 25, 2007

WL in screen B at
Elev. 72.99m on
Sept. 25, 2007

WL in screen C at
Elev. 73.02m on
Sept. 25, 2007

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.J.S.
CHECKED: HLRF

PROJECT: 06-1122-127-6200

RECORD OF MONITORING WELL: MW 06-20

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: Nov. 23, 2006

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

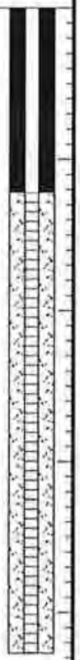
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	75.64				
0	Power Auger 200mm Diam (Hollow Stem)	TOPSOIL	0.00				
		Very stiff grey brown SILTY CLAY (Weathered Crust)	75.40 0.24				Protective casing set in Bentonite Seal
1							
		Compact grey SANDY SILT, some gravel, trace clay, occasional silty sand and silt seam or layer (GLACIAL TILL)	74.18 1.46	1	50 DO	21	
2							
							38mm Diam PVC #10 Slot Screen
3				2	50 DO	28	
4							
		End of Borehole Auger Refusal	71.37 4.27				
5							
6							
7							
8							
9							
10							



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-6200

RECORD OF MONITORING WELL: MW 06-21

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: Nov. 23, 2006

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

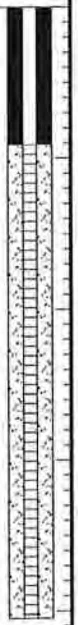
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.93					
0	Power Auger 200mm Diam (Hollow Stem)	TOPSOIL		0.00					
		Grey brown SILTY CLAY (Weathered Crust)		74.72 0.21					Protective casing set in Bentonite Seal
1 2		Grey brown SANDY SILT, some gravel, trace clay, occasional cobble (GLACIAL TILL)		74.32 0.61	1	50 DO	62		
3		Compact grey SILTY SAND, some gravel, occasional fine to coarse sand layer (GLACIAL TILL)		72.49 2.44	2	50 DO	26		38mm Diam PVC #10 Slot Screen
4		Grey SANDY SILT, some gravel and clay (GLACIAL TILL)		71.27 3.66					
5 6 7 8 9 10		End of Borehole Auger Refusal		70.88 4.05					



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 06-1122-127-6200

RECORD OF MONITORING WELL: MW 06-22

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: Nov 23, 2006

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

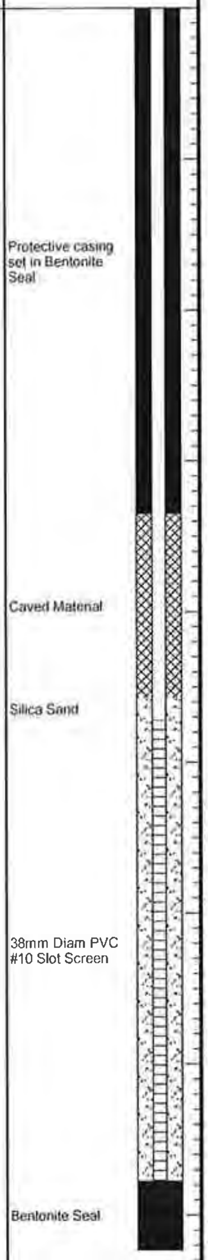
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V + Q - ● rem V ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		82.10					
0	Power Auger 200mm Diam (Hollow Stem)	GARBAGE (FILL)		0.00					
6					1	50 DO	19		
7					2	50 DO	5		
		PEAT		74.48 7.62					
		Grey brown SILTY CLAY		7.77	3	50 DO	10		
8		Grey brown SANDY SILT		74.02 8.08					
		End of Borehole		8.23					



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: HLRF

PROJECT: 1416664-6000

RECORD OF BOREHOLE: 15-1

SHEET 1 OF 1

LOCATION: See Site Plan

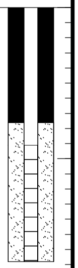
BORING DATE: July 23, 2015

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.40							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							
		(CL/ML) CLAYEY SILT, low to medium plasticity; brown; cohesive, w>PL, very stiff		74.05 0.35	1	AS	-				Bentonite Seal
1		(ML) sandy SILT, some low plasticity fines, some gravel, subrounded; grey brown (GLACIAL TILL); wet, compact		73.49 0.91	2	SS	>50				Silica Sand 50 mm Diam. PVC #10 Slot Screen
		End of Borehole Auger Refusal		72.72 1.68							
2											
3											
4											
5											
6											
7											
8											
9											
10											



DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED: MIB

PROJECT: 1416664-6000

RECORD OF BOREHOLE: 15-2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 23, 2015

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.68							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL		0.00							Bentonite Seal
		(CL/ML) CLAYEY SILT, trace gravel and low plasticity fines; grey brown; cohesive, w~PL, very stiff		74.47 0.21							Silica Sand
1					1	AS	-				50 mm Diam. PVC #10 Slot Screen
		End of Borehole Auger Refusal		73.28 1.40							
2											
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: MIB

PROJECT: 1416664-6000

RECORD OF BOREHOLE: 15-3

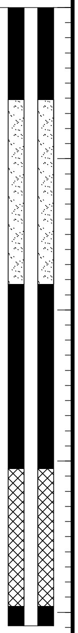
SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: July 21, 2015

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	75.41							
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00							
		(CI/CH) SILTY CLAY, trace sand; grey brown, fissured (WEATHERED CRUST); cohesive, w~PL, very stiff	75.16 0.25							Bentonite Seal
1										Silica Sand
		GLACIAL TILL	73.89 1.52							
2										Bentonite Seal
3										Native Backfill
		Fresh, grey LIMESTONE	71.45 3.96							
4		Borehole continued on RECORD OF DRILLHOLE 15-3	4.09							
5										
6										
7										
8										
9										
10										



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED: MIB

PROJECT: 1416664-6000

RECORD OF DRILLHOLE: 15-3

LOCATION: See Site Plan

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: July 21, 2015

DRILL RIG: CME 55

DRILLING CONTRACTOR: Downing Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

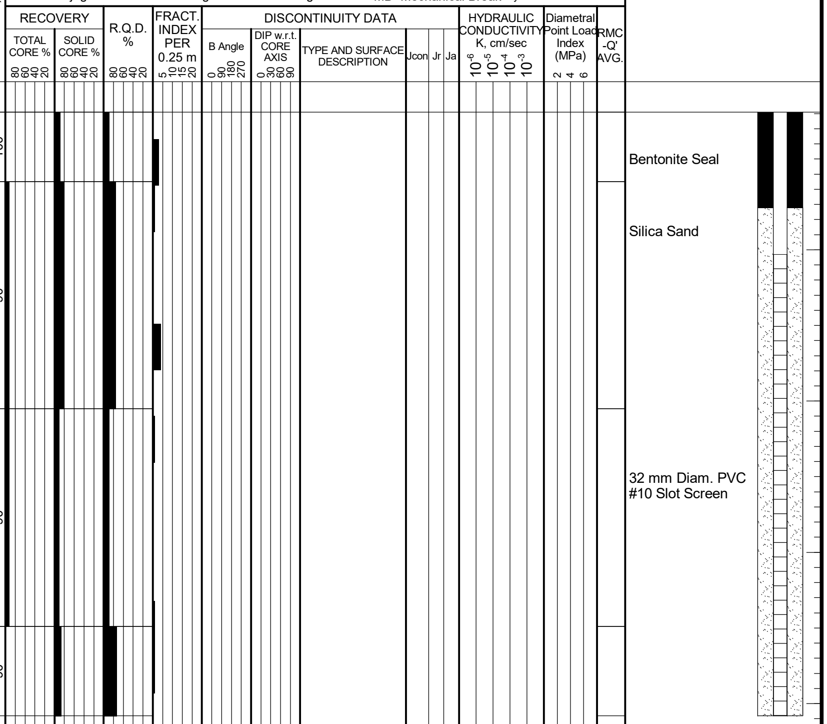
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN FLUSH	
		BEDROCK SURFACE		71.32			
	Rotary Drill NQ Core	Fresh, grey LIMESTONE		4.09	1	100	Bentonite Seal
5		- Lost core from 4.87 m to 5.03 m			2	90	Silica Sand
		- Lost core from 5.49 m to 5.53 m					
		- Lost core from 5.69 m to 5.74 m					
6					3	90	32 mm Diam. PVC #10 Slot Screen
7		- Lost core from 6.96 m to 7.01 m					
					4	90	
8				67.33			
		End of Drillhole		8.08			
9							
10							
11							
12							
13							
14							



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: MIB

PROJECT: 1650505

RECORD OF BOREHOLE: 16-1

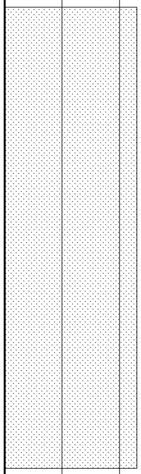
SHEET 1 OF 2

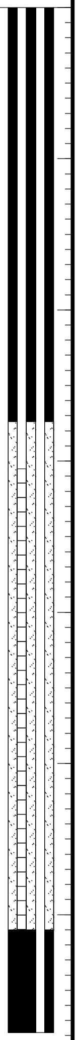
LOCATION: See Site Plan
BORING DATE: December 8, 2016
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80
ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	74.71				
0	Power Auger 200 mm Diam. (Hollow Stem)	(PT) sandy SILT, some organics; dark brown (PEAT); non-cohesive, moist, very loose	0.00	1	SS	1	
1							
		(CL/MC) CLAYEY SILT to SILTY CLAY, trace gravel; grey brown (WEATHERED CRUST); cohesive, very stiff	73.41 1.30	2	SS	5	Bentonite Seal
2		(CL/MC) CLAYEY SILT to SILTY CLAY; trace gravel; grey; cohesive, very stiff	72.60 2.11				
3				3	SS	4	Silica Sand
4							32 mm Diam. PVC #10 Slot Screen 'B'
5		(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very dense	69.99 4.72	4	SS	2	
6				5	SS	>50	Bentonite Seal
7		Borehole continued on RECORD OF DRILLHOLE 16-1	67.93 6.78				
8							
9							
10							





DEPTH SCALE
1 : 50

Golder Associates

LOGGED: JD
CHECKED: MIB

PROJECT: 1650505

RECORD OF DRILLHOLE: 16-1

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: December 8, 2016

DATUM: Geodetic

DRILL RIG: CME

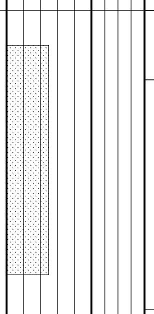
INCLINATION: -90° AZIMUTH: ---

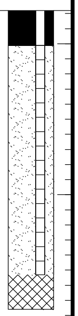
DRILLING CONTRACTOR: Downing Drilling

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate
BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular
PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN FLUSH	
		BEDROCK SURFACE		67.93			
7	Rotary Drill NQ Core	Slightly weathered to weathered, highly fractured, grey LIMESTONE, with shale interbedded		6.78	1	20	Bentonite Seal
8					2	20	32 mm Diam. PVC #10 Slot Screen 'A'
				65.95 8.76			Cave
9		End of Drillhole					
10							
11							
12							
13							
14							
15							
16							





DEPTH SCALE

1 : 50

Golder Associates

LOGGED: JD

CHECKED: MIB

PROJECT: 1650505

RECORD OF BOREHOLE: 16-2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 8, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

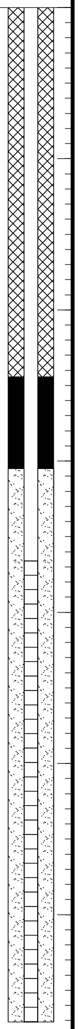
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE	74.72					
0	(PT) sandy SILT, trace organics; dark brown (PEAT); non-cohesive, moist, very loose	0.00	1	SS	1		
1			2	SS	1		Native Backfill
2	(CL/MC) CLAYEY SILT to SILTY CLAY, trace gravel; grey brown; cohesive, very stiff	72.89 1.83	3	SS	1		
			4	SS	5		Bentonite Seal
3			5	SS	2		Silica Sand
4			6	SS	3		
5			7	SS	1		32 mm Diam. PVC #10 Slot Screen
			8	SS	2		
6	(ML) sandy SILT, some gravel; grey (GLACIAL TILL); non-cohesive, wet, compact	68.62 6.10	9	SS	22		
	End of Borehole Auger Refusal	68.01 6.71					
7							
8							
9							
10							



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: JD

CHECKED: MIB

PROJECT: 1650505

RECORD OF BOREHOLE: 16-3

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: December 8, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

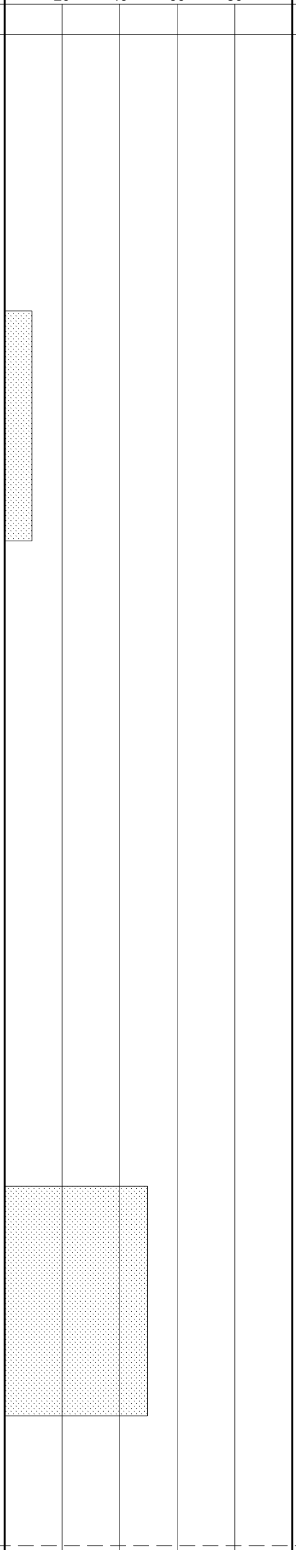
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl: 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE	75.05				
0	(PT) sandy SILT, some organics; dark brown (PEAT); non-cohesive, moist, very loose	0.00	1	SS	1	Bentonite Seal
1			2	SS	WH	
	(CL/MC) CLAYEY SILT to SILTY CLAY, trace gravel; grey brown (WEATHERED CRUST); cohesive, very stiff	73.53 1.52	3	SS	1	Silica Sand
2			4	SS	4	32 mm Diam. PVC #10 Slot Screen 'C'
3	(CL/MC) CLAYEY SILT to SILTY CLAY; grey; cohesive, stiff	72.00 3.05	5	SS	WH	Silica Sand
4			6	SS	WH	
5			7	SS	WH	
			8	SS	WH	Bentonite Seal
6			9	SS	1	
7			10	SS	9	
	(SP) gravelly SAND, some silt; reddish grey; non-cohesive, wet, loose	67.73 7.32				Silica Sand
8			11	SS	3	32 mm Diam. PVC #10 Slot Screen 'B'
			12	SS	9	
9	(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very dense	65.88 9.17	13	SS	22	Silica Sand
10			14	SS	28	Bentonite Seal



CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: JD
CHECKED: MIB

PROJECT: 1650505

RECORD OF BOREHOLE: 16-3

SHEET 2 OF 3

LOCATION: See Site Plan

BORING DATE: December 8, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m				
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Power Auger	(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very dense			14	SS	28				
11	Wash Boring NW Casing				15	SS	64				Bentonite Seal
				63.47	16	SS	>50				
		Borehole continued on RECORD OF DRILLHOLE 16-3		11.58							
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: JD

CHECKED: MIB

PROJECT: 1650505

RECORD OF DRILLHOLE: 16-3

SHEET 3 OF 3

LOCATION: See Site Plan

DRILLING DATE: December 8, 2016

DATUM: Geodetic

DRILL RIG: CME

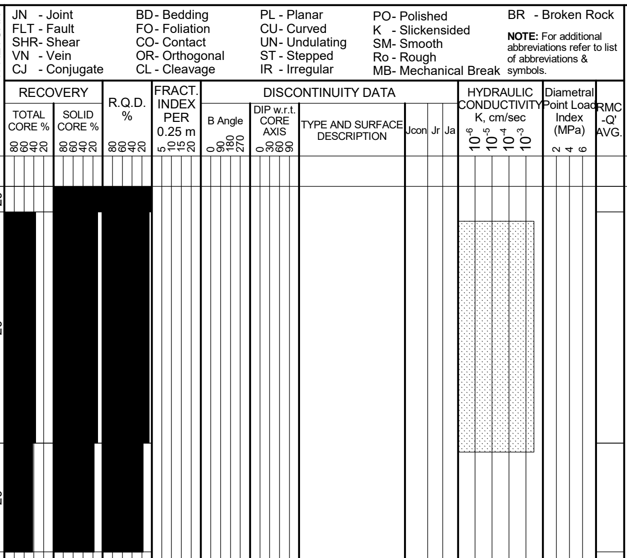
INCLINATION: -90° AZIMUTH: ---

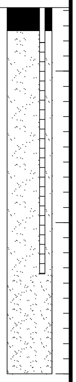
DRILLING CONTRACTOR: Downing Drilling

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate
BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular
PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN FLUSH	
		BEDROCK SURFACE		63.47			
	WB NW	Slightly weathered to weathered, highly fractured, grey LIMESTONE, with shale interbedded		11.58	1	20	Bentonite Seal Silica Sand
12							
	Rotary Drill NQ Core				2	20	32 mm Diam. PVC #10 Slot Screen 'A'
13							
					3	20	Silica Sand
14		End of Drillhole		61.05 14.00			
15							
16							
17							
18							
19							
20							
21							





DEPTH SCALE

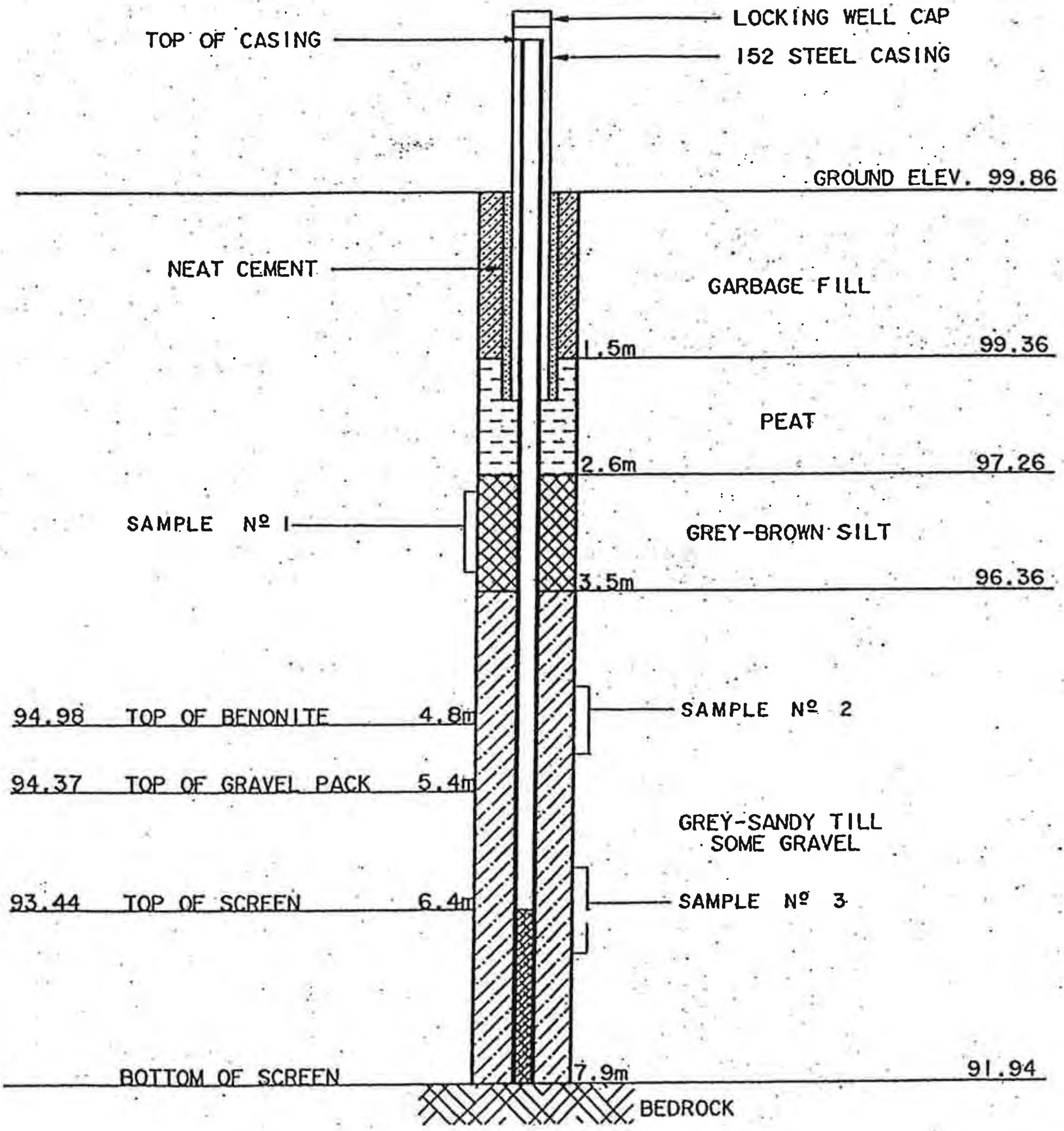
1 : 50

Golder Associates

LOGGED: JD

CHECKED: MIB

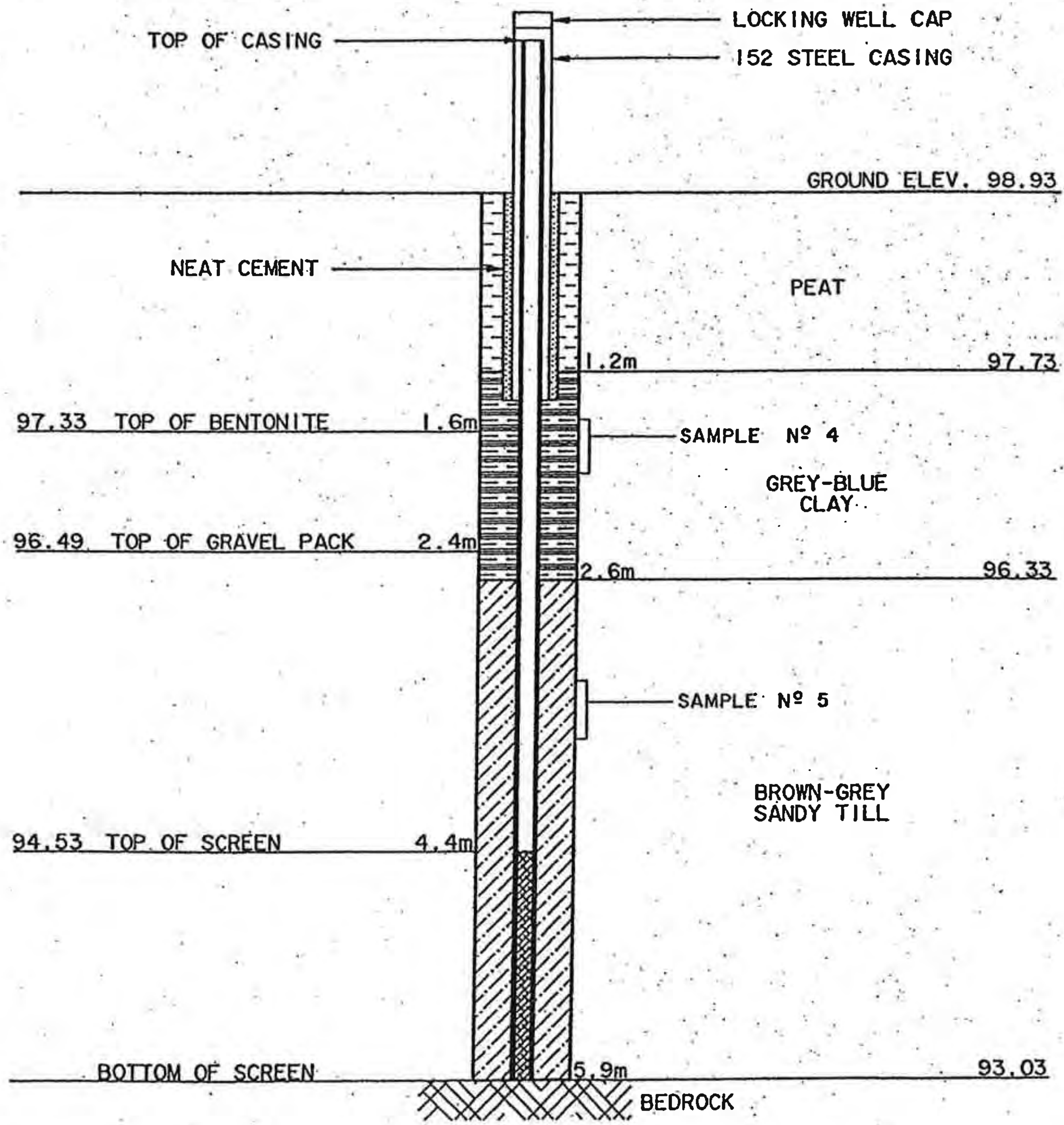
MONITORING WELL #1 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE: MARCH, 1991	CLIENT: TOWNSHIP OF WINCHESTER LANDFILL	DRAWING NO. 90-7848
SCALE: N.T.S.	TITLE: MONITORING WELL INSTALLATION	

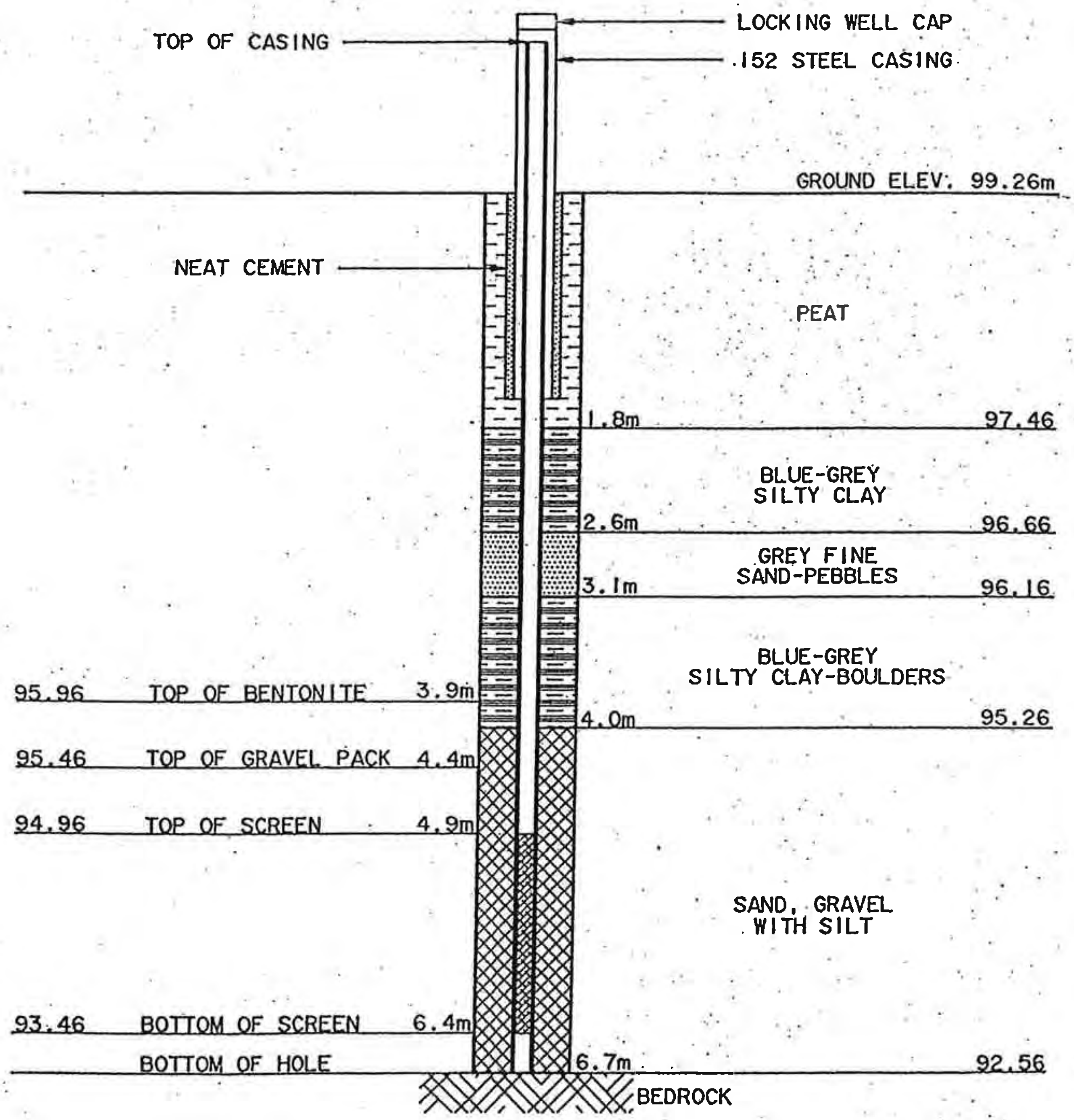
MONITORING WELL #2 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE: MARCH, 1991	CLIENT: TOWNSHIP OF WINCHESTER LANDFILL	DRAWING NO. 90-7848
SCALE: N.T.S.	TITLE: MONITORING WELL INSTALLATION	

MONITORING WELL #3 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE:
MARCH, 1991

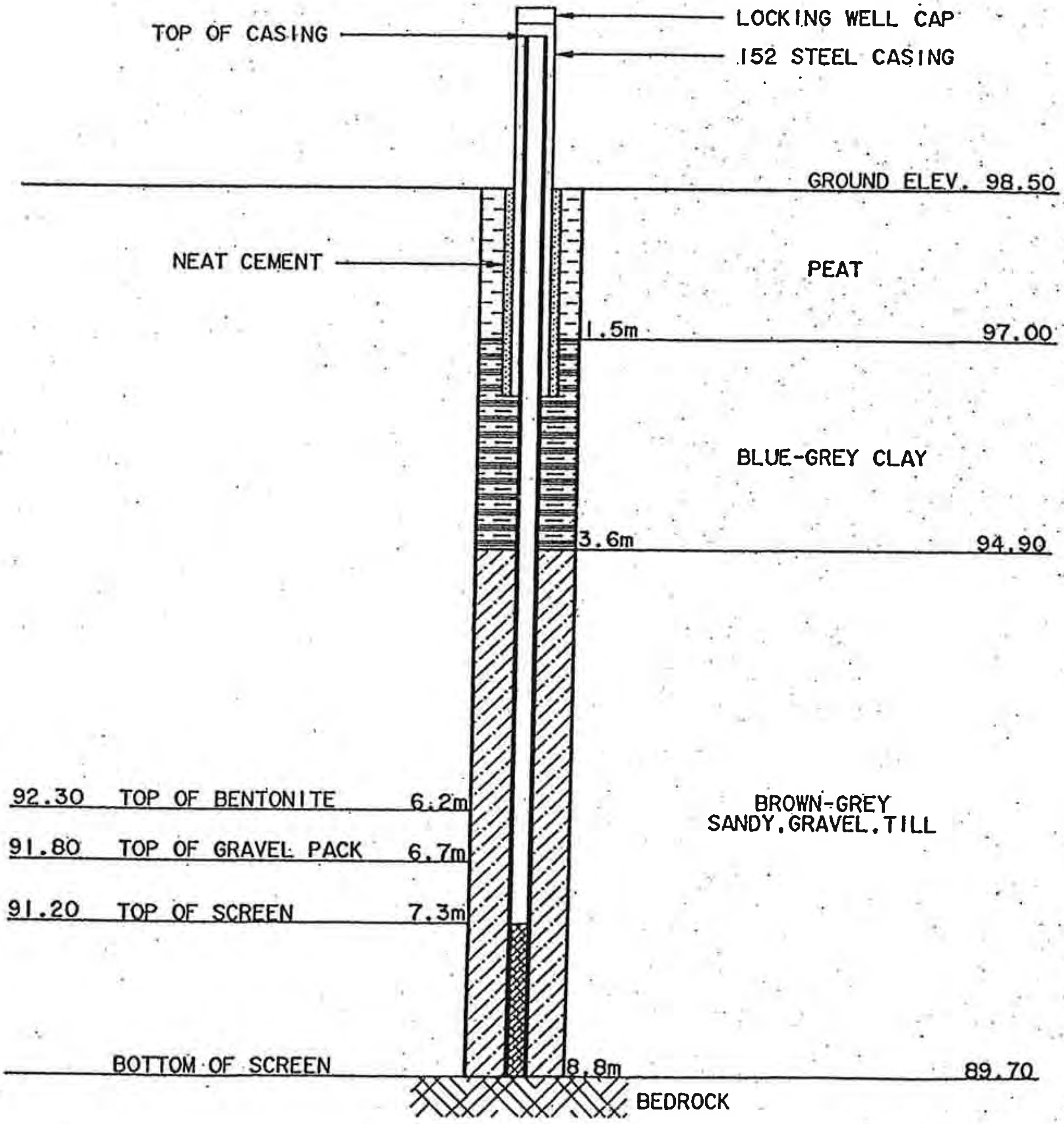
CLIENT:
TOWNSHIP OF WINCHESTER LANDFILL

DRAWING NO.
90-7848

SCALE:
N.T.S.

TITLE:
MONITORING WELL INSTALLATION

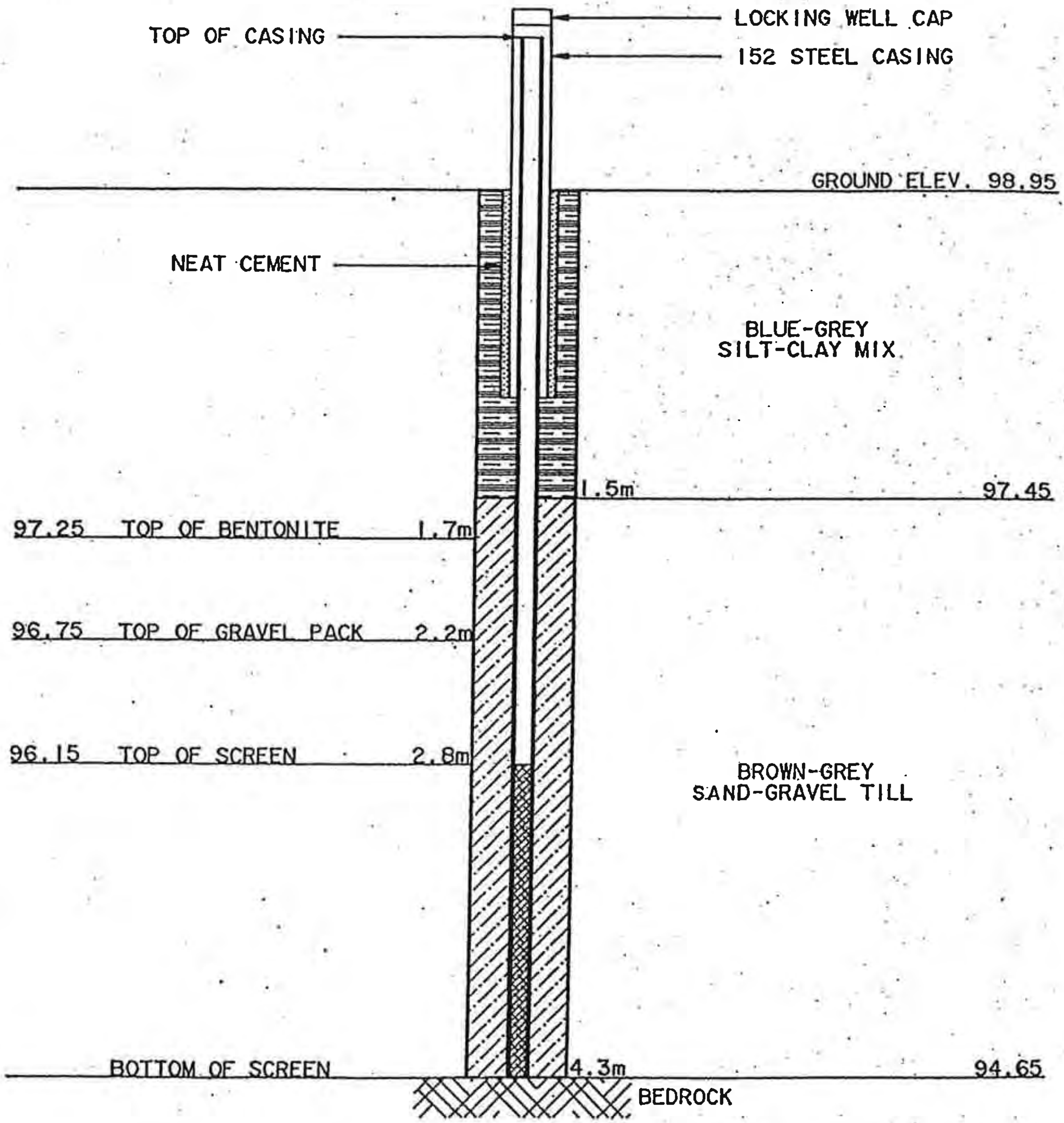
MONITORING WELL #4 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE: MARCH, 1991	CLIENT: TOWNSHIP OF WINCHESTER LANDFILL	DRAWING NO. 90-7848
SCALE: N.T.S.	TITLE: MONITORING WELL INSTALLATION	

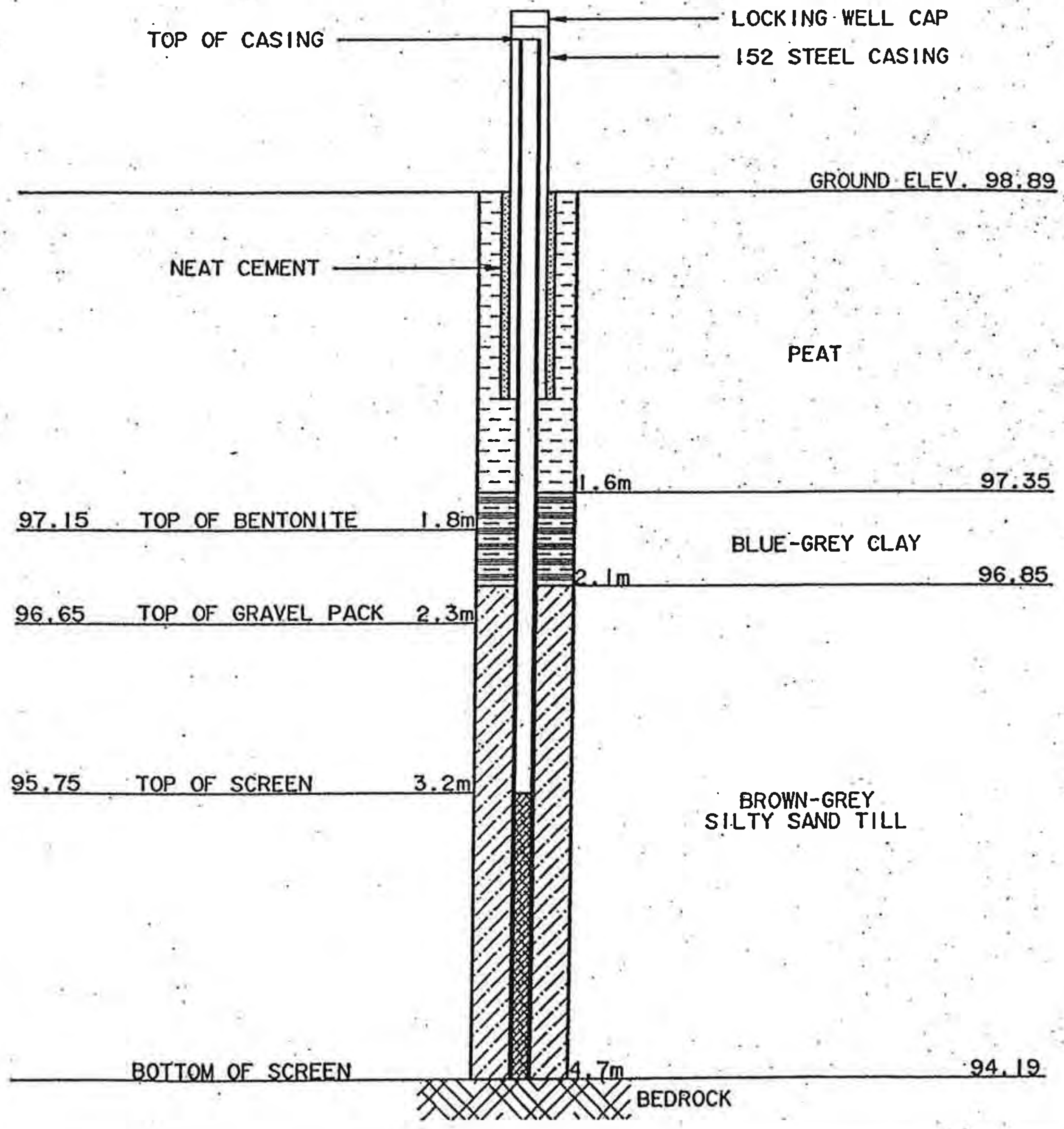
MONITORING WELL #5 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE: MARCH, 1991	CLIENT: TOWNSHIP OF WINCHESTER LANDFILL	DRAWING NO. 90-7848
SCALE: N.T.S.	TITLE: MONITORING WELL INSTALLATION	

MONITORING WELL #6 BOREHOLE LOG



OLIVER MANGIONE McCALLA
& ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DATE: MARCH, 1991
CLIENT: TOWNSHIP OF WINCHESTER LANDFILL
DRAWING NO. 90-7848
SCALE: N.T.S.
TITLE: MONITORING WELL INSTALLATION

STRATIGRAPHIC DESCRIPTION AND OVER-BURDEN MONITORING WELL INSTALLATION

WINCHESTER TOWNSHIP LANDFILL SITE

ONITORING WELL NUMBER: MW 7

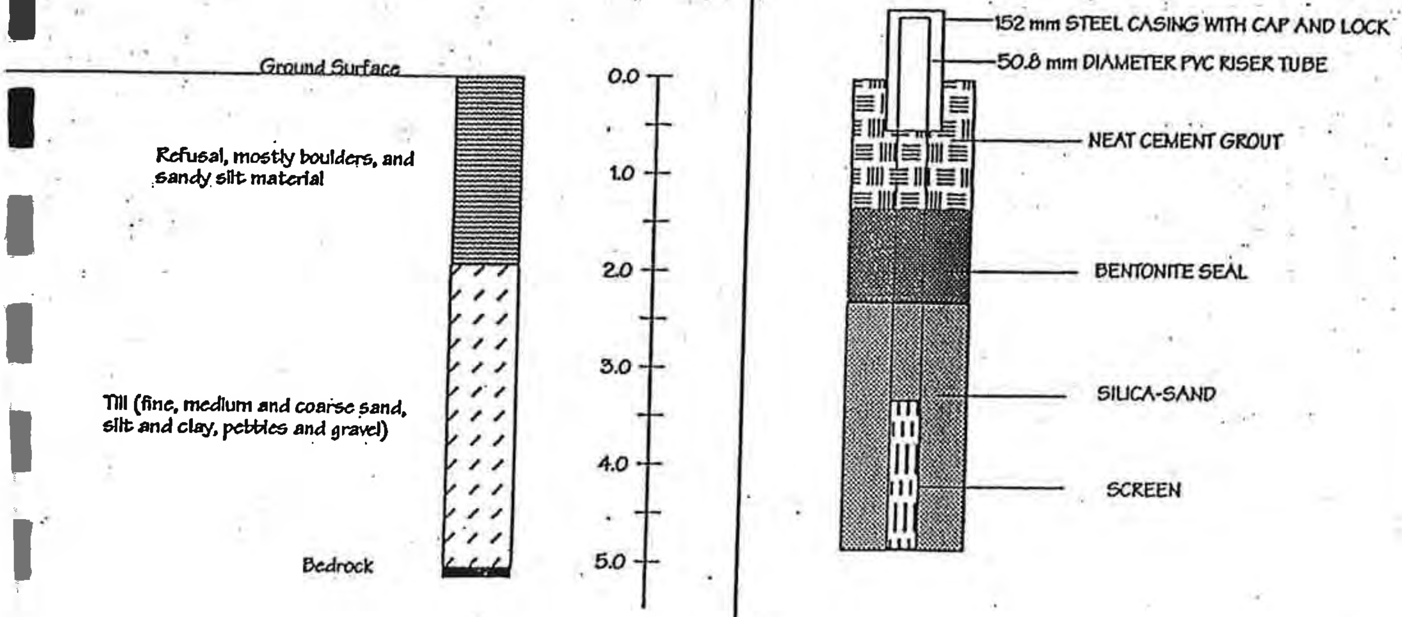
DRILL TYPE: CME 55 HOLLOW STEM AUGER

DRILLER: MARATHON

LOCATION: CONCESSION VII, LOT 8

DATE: JUNE 9, 1992

SOIL DESCRIPTION	STRAT.	DEPTH (m)	ELEV. (m)	PIEZOMETER INSTALLATION



I. S. THOMPSON &
SSOCIATES LTD.
NSULTING ENGINEERS

ROSEMOUNT AVE. CORNWALL K6J 3E5

FIGURE TITLE	SOIL PROFILE AND PIEZOMETER CONSTRUCTION
JOB	WINCHESTER TOWNSHIP LANDFILL SITE
DATE	JUNE 1992
SCALE	AS SHOWN
DRAWN	MHM
JOB No.	92094
FIGURE:	

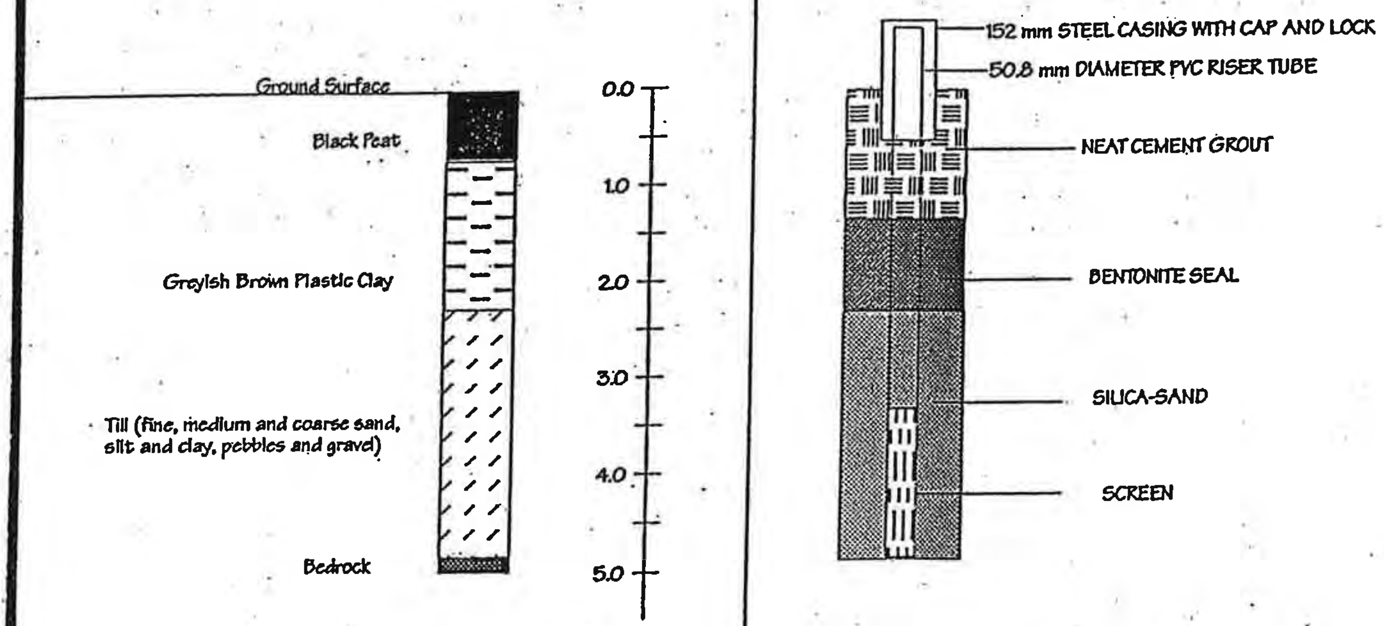
STRATIGRAPHIC DESCRIPTION AND OVER-BURDEN MONITORING WELL INSTALLATION

WINCHESTER TOWNSHIP LANDFILL SITE

MONITORING WELL NUMBER: MW 8
DRILL TYPE: CME 55 HOLLOW STEM AUGER
DRILLER: MARATHON

LOCATION: CONCESSION VII, LOT 8
DATE: JUNE 9, 1992

SOIL DESCRIPTION	STRAT.	DEPTH (m)	ELEV. (m)	PIEZOMETER INSTALLATION



M. S. THOMPSON & ASSOCIATES LTD.

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE. CORNWALL K6J 3E5

FIGURE TITLE	SOIL PROFILE AND PIEZOMETER CONSTRUCTION
JOB	WINCHESTER TOWNSHIP LANDFILL SITE
DATE	JUNE 1992
SCALE	AS SHOWN
DRAWN	MHM
JOB No.	92094
FIGURE:	

STRATIGRAPHIC DESCRIPTION AND OVER-BURDEN MONITORING WELL INSTALLATION
WINCHESTER TOWNSHIP LANDFILL SITE

MONITORING WELL NUMBER: MW 9

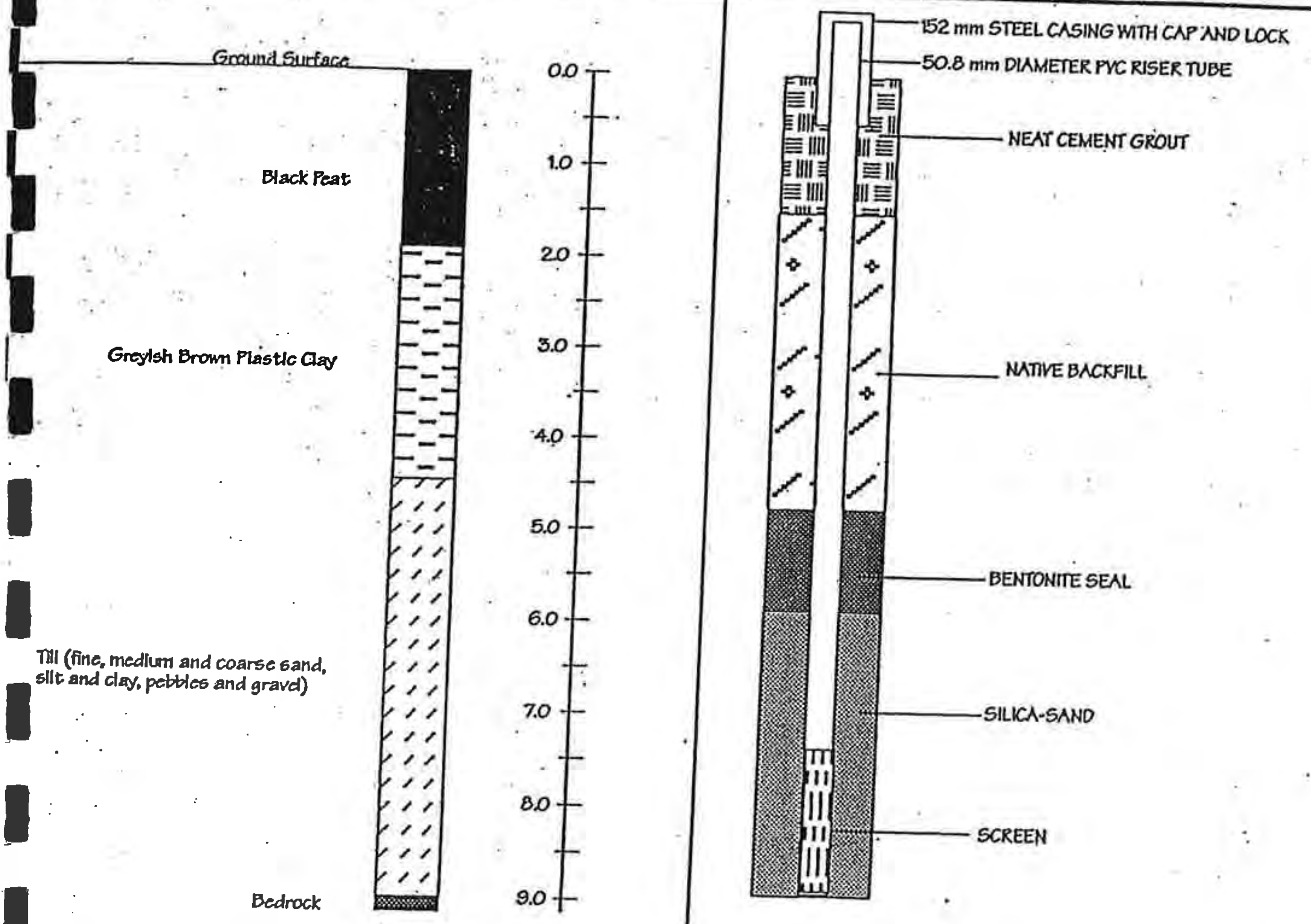
LOCATION: CONCESSION VII, LOT 8

DRILL TYPE: CME 55 HOLLOW STEM AUGER

DATE: JUNE 9, 1992

DRILLER: MARATHON

SOIL DESCRIPTION	STRAT.	DEPTH (m)	ELEV. (m)	PIEZOMETER INSTALLATION



M. S. THOMPSON &
SSOCIATES LTD.
NSULTING ENGINEERS

ROSEMOUNT AVE. CORNWALL K6J 3E5

FIGURE TITLE SOIL PROFILE AND PIEZOMETER CONSTRUCTION	DATE	JUNE 1992
	SCALE	AS SHOWN
	DRAWN	MHM
JOB WINCHESTER TOWNSHIP LANDFILL SITE	JOB No.	92094
	FIGURE:	

STRATIGRAPHIC DESCRIPTION AND OVER-BURDEN MONITORING WELL INSTALLATION
WINCHESTER TOWNSHIP LANDFILL SITE

MONITORING BEDROCK WELL: BRW-1

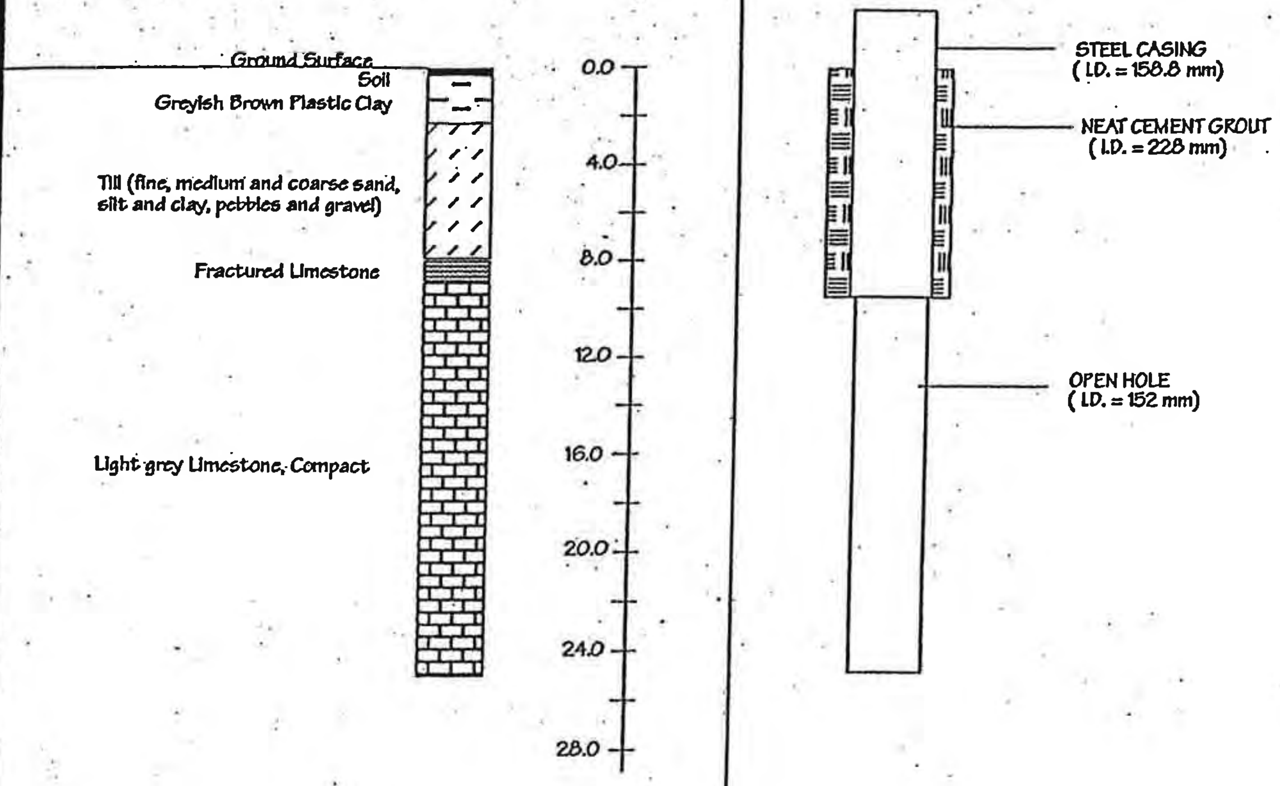
LOCATION: CONCESSION VII, LOT 8

DRILL TYPE: CME 55 HOLLOW STEM AUGER

DATE: JUNE 10, 1992

DRILLER: MARATHON

SOIL DESCRIPTION	STRAT.	DEPTH (m)	ELEV. (m)	PIEZOMETER INSTALLATION



M. S. THOMPSON & ASSOCIATES LTD.

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE. CORNWALL K6J 3E5

FIGURE TITLE

SOIL PROFILE AND PIEZOMETER CONSTRUCTION

JOB

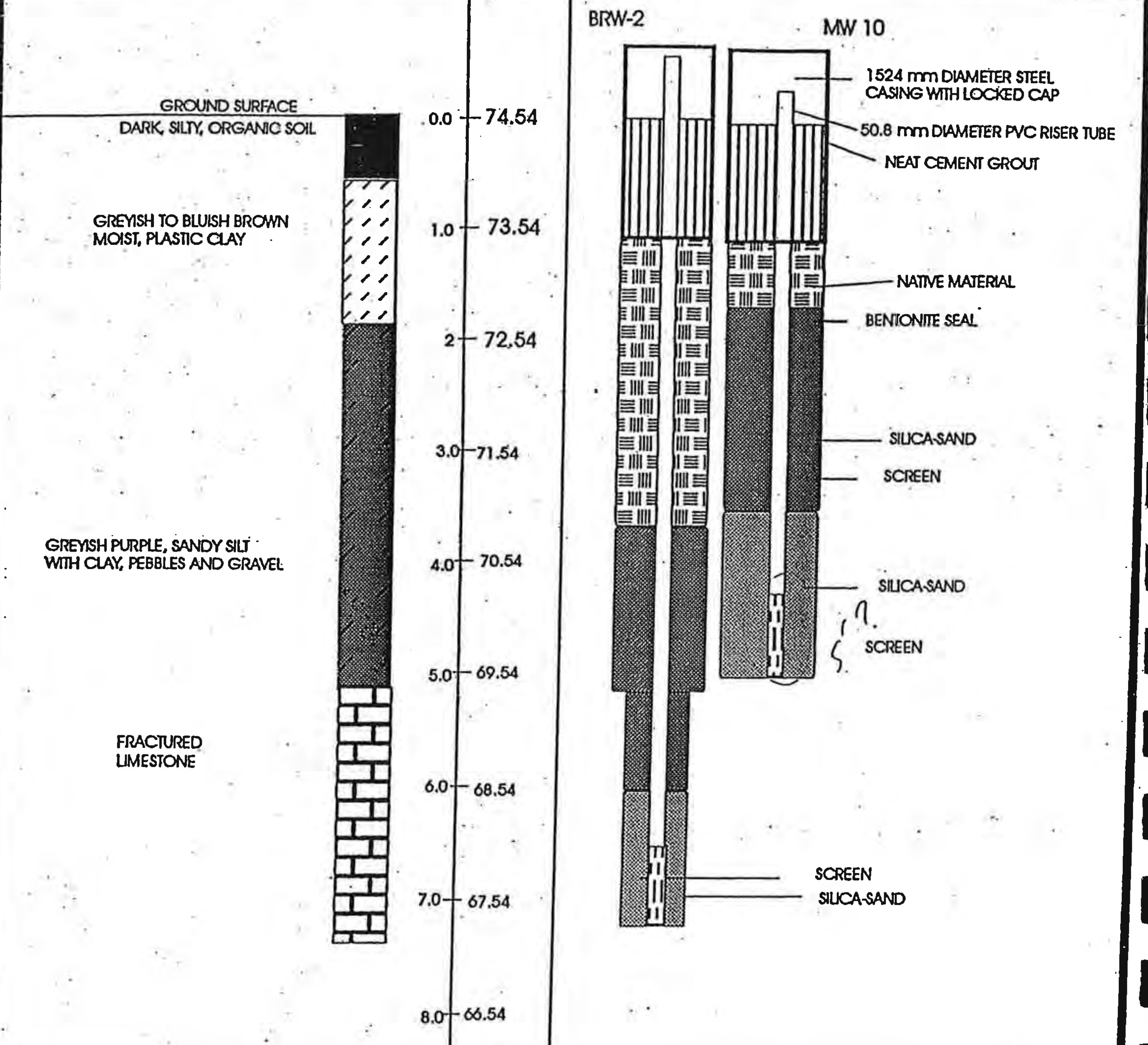
WINCHESTER TOWNSHIP LANDFILL SITE

DATE	JUNE 1992
SCALE	AS SHOWN
DRAWN	MHM
JOB No.	92094
FIGURE:	

MONITORING WELL NUMBER: MW10 & BRW-12
DRILL TYPE: CME 55 HOLLOW STEM AUGER
DRILLER: MARATHON

LOCATION: WINCHESTER TOWNSHIP
WASTE DISPOSAL SITE
DATE: JULY 1993

SOIL DESCRIPTION	STRAT.	DEPTH (m)	ELEV. (m)	PIEZOMETER INSTALLATION



M. S. THOMPSON & ASSOCIATES LTD.

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE, CORNWALL K6J 3E5

FIGURE TITLE

SOIL PROFILE AND PIEZOMETER CONSTRUCTION

JOB

WINCHESTER TOWNSHIP
WASTE DISPOSAL SITE

DATE	MARCH 1993
SCALE	AS SHOWN
DRAWN	MHM
JOB No.	92094

Project No: MC12684A

Log of MW 16

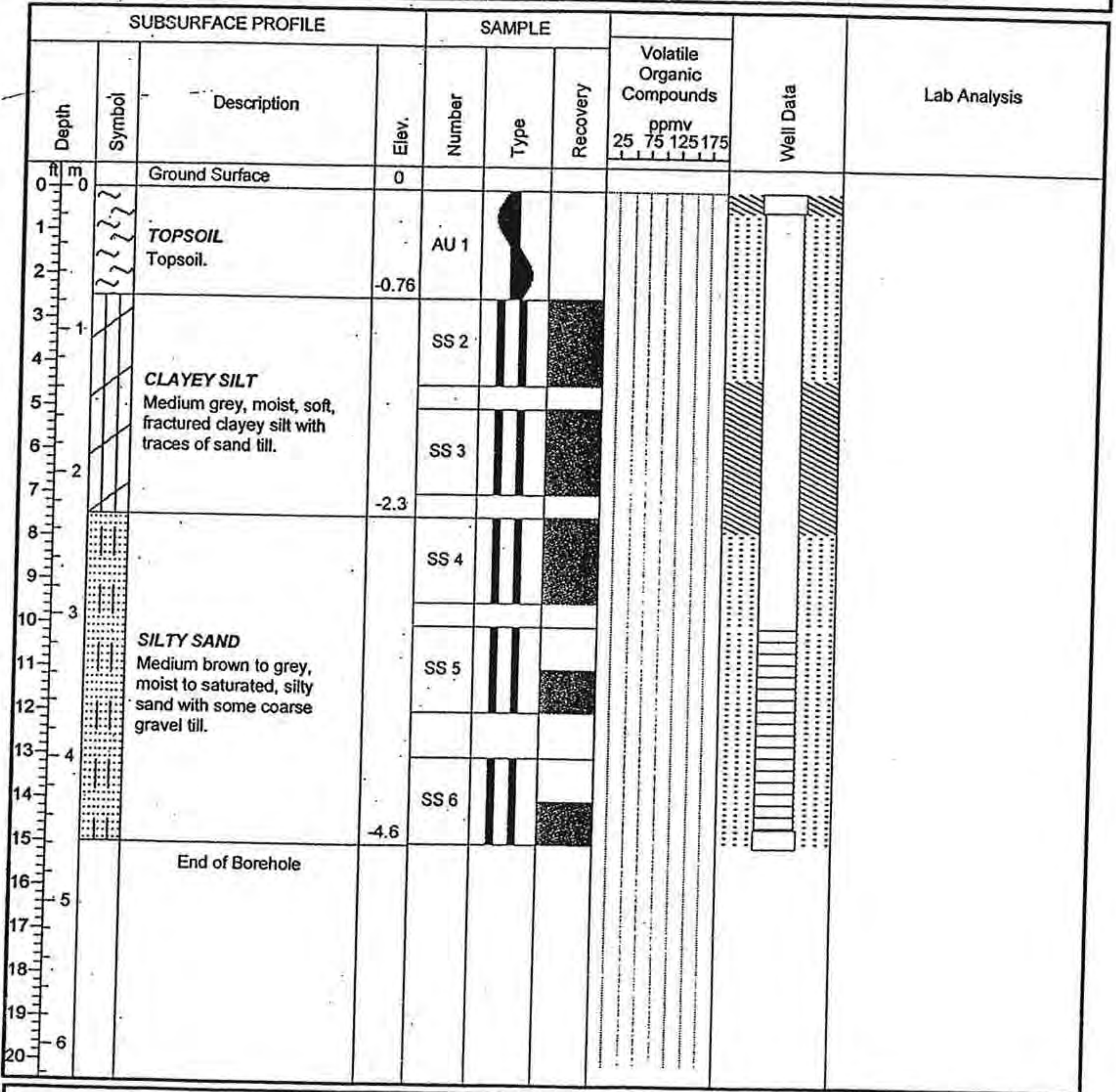
Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince

Trow



Description	Elev.	Number
Ground Surface	0	
TOPSOIL Topsoil.	-0.76	AU 1
CLAYEY SILT Medium grey, moist, soft, fractured clayey silt with traces of sand till.	-2.3	SS 2 SS 3
SILTY SAND Medium brown to grey, moist to saturated, silty sand with some coarse gravel till.	-4.6	SS 4 SS 5 SS 6
End of Borehole		

Drill Method: Hollow Stem Auger

Drill Date: September 26, 2002

Hole Size: 0.15 metres

Trow Consulting Engineers Ltd.
154 Colonnade Road South
Nepean, Ontario K2E 7J5

Datum:

Checked by: B.Coons

Sheet: 1 of 1

Project No: MC12684A

Log of MW 17

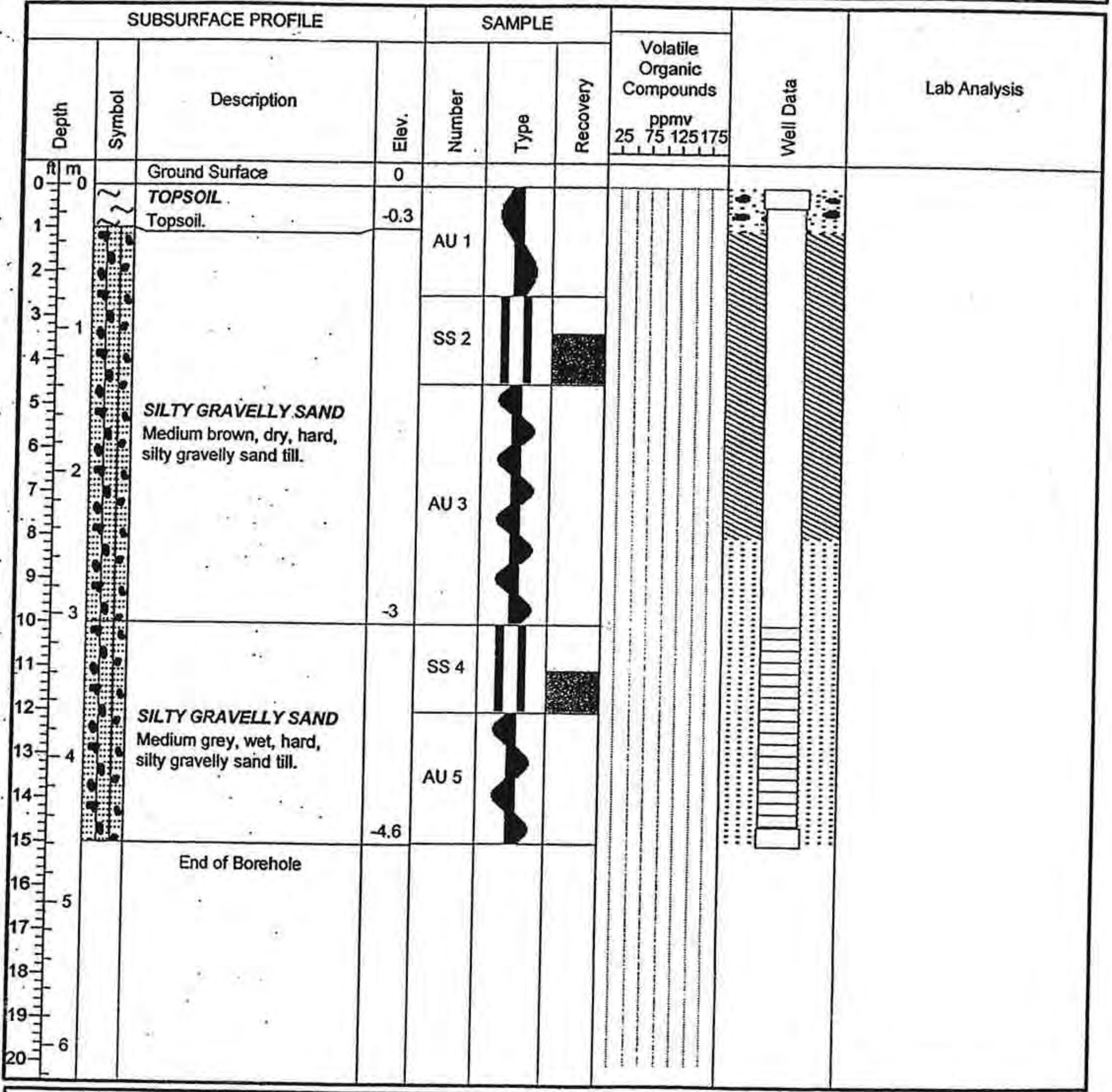
Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince

Trow



Description	Elev.	Number
Ground Surface	0	
TOPSOIL Topsoil.	-0.3	AU 1
SILTY GRAVELLY SAND Medium brown, dry, hard, silty gravelly sand till.	-3	SS 2 AU 3
SILTY GRAVELLY SAND Medium grey, wet, hard, silty gravelly sand till.	-4.6	SS 4 AU 5
End of Borehole		

Drill Method: Hollow Stem Auger

Drill Date: September 26, 2002

Hole Size: 0.15 metres

Trow Consulting Engineers Ltd.
154 Colonnade Road South
Nepean, Ontario K2E 7J5

Datum:

Checked by: B.Coons

Sheet: 1 of 1

Project No: MC12684A

Log of MW 18

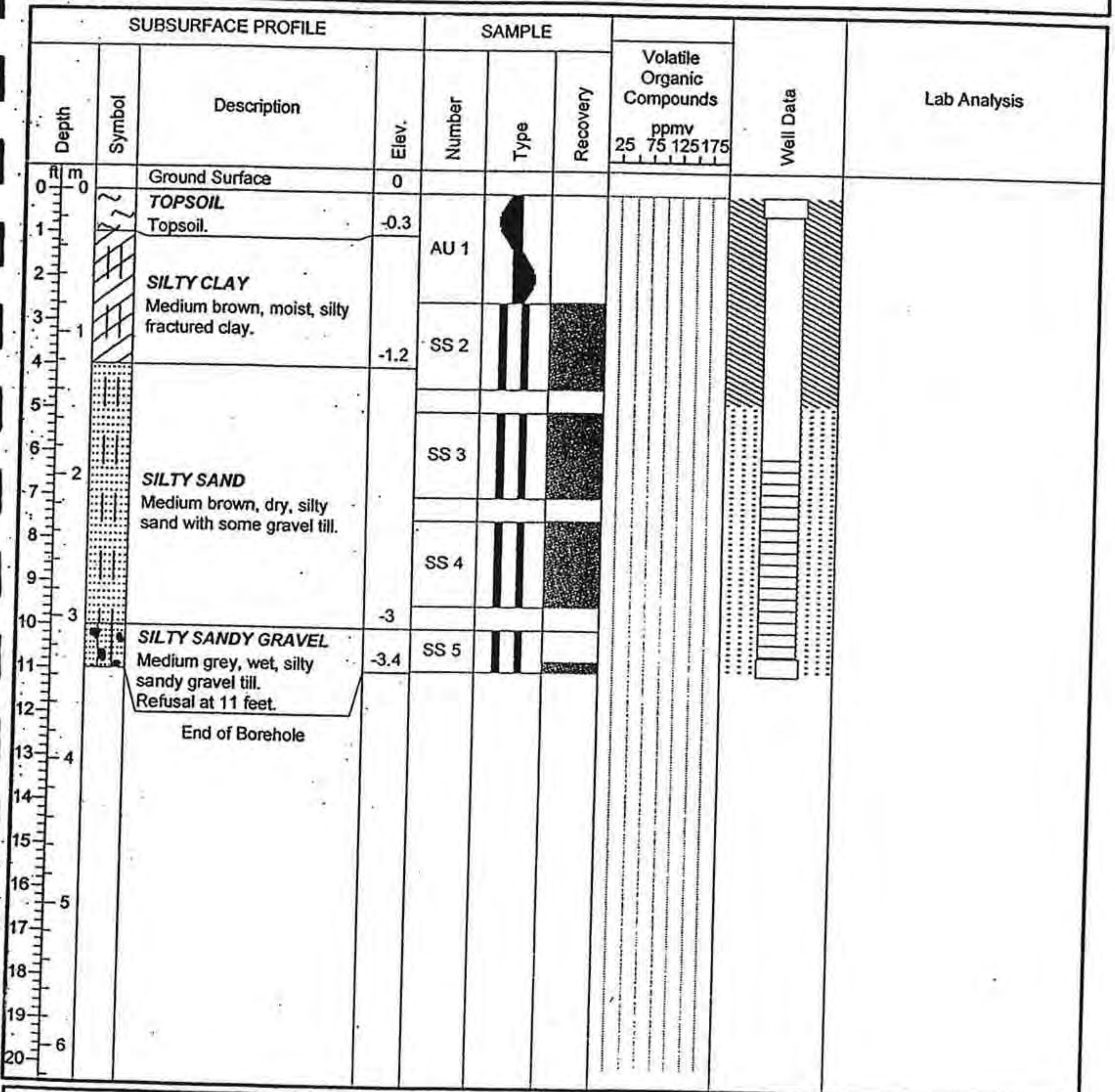
Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince

Trow



Description	Elev.	Number
Ground Surface	0	
TOPSOIL Topsoil.	-0.3	AU 1
SILTY CLAY Medium brown, moist, silty fractured clay.	-1.2	SS 2
SILTY SAND Medium brown, dry, silty sand with some gravel till.	-3	SS 3 SS 4
SILTY SANDY GRAVEL Medium grey, wet, silty sandy gravel till. Refusal at 11 feet.	-3.4	SS 5
End of Borehole		

Drill Method: Hollow Stem Auger

Drill Date: September 26, 2002

Hole Size: 0.15 metres

Trow Consulting Engineers Ltd.
154 Colonnade Road South
Nepean, Ontario K2E 7J5

Datum:

Checked by: B.Coons

Sheet: 1 of 1

Project No: MC12684A

Log of MW 19

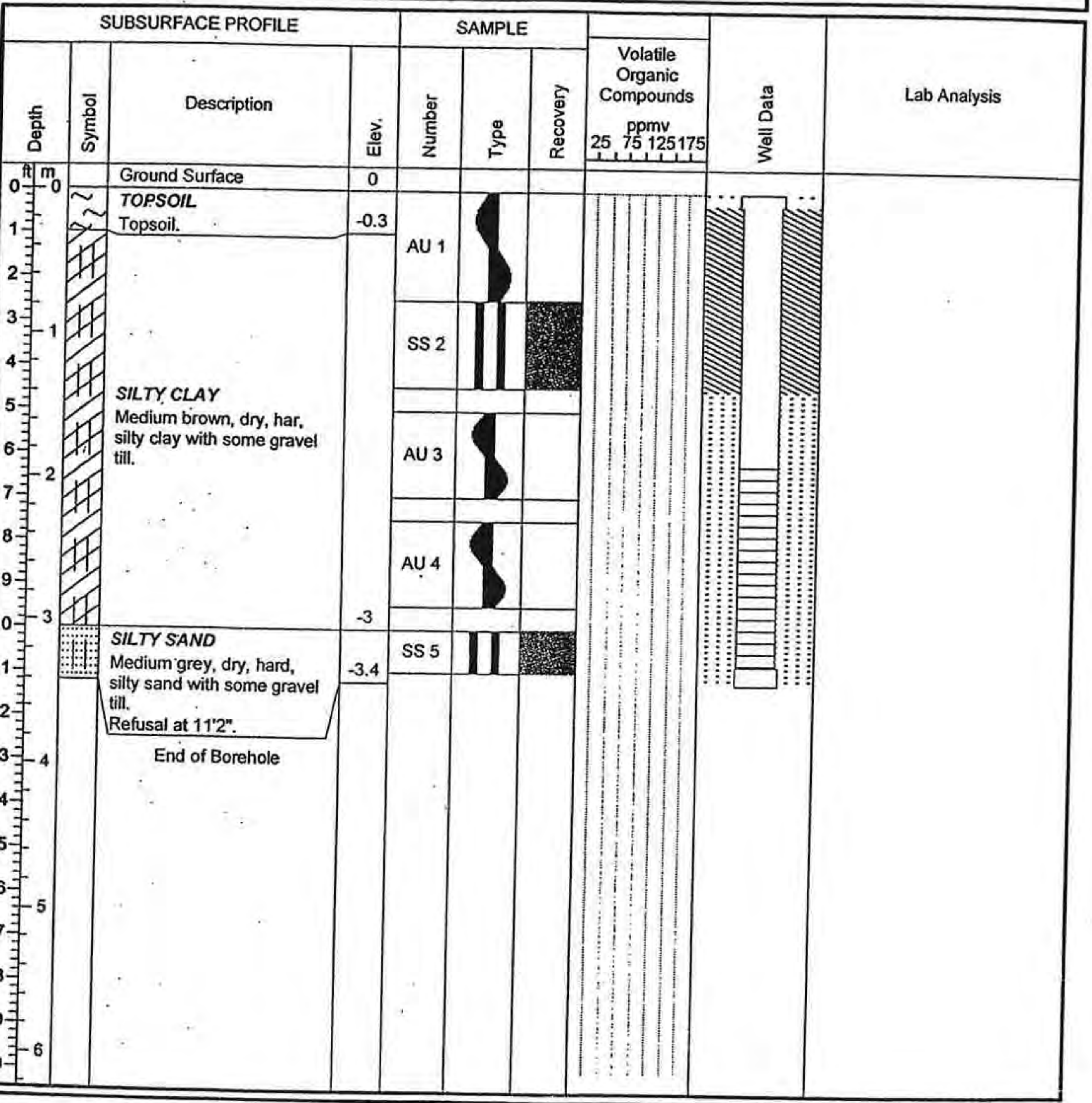
Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince

Trow



Ground Surface

TOPSOIL
Topsoil.

SILTY CLAY
Medium brown, dry, har, silty clay with some gravel till.

SILTY SAND
Medium grey, dry, hard, silty sand with some gravel till.
Refusal at 11'2".

End of Borehole

Drill Method: Hollow Stem Auger

Drill Date: September 26, 2002

Hole Size: 0.15 metres

Trow Consulting Engineers Ltd.

154 Colonnade Road South
Nepean, Ontario K2E 7J5

Datum:

Checked by: B.Coons

Sheet: 1 of 1

ATTACHMENTS – SLOPE/W OUTPUT SECTIONS

- Figures 1 to 6

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟪	Base Layer	Mohr-Coulomb	20.5	0	35
⬛	Bedrock	Bedrock (Impenetrable)			
🟦	Cover Layer	Mohr-Coulomb	19	0	32
🟨	Glacial Till	Mohr-Coulomb	21	0	35
🟩	Silty Clay (stiff to very stiff)	Mohr-Coulomb	16	7.4	28.7
🟧	Topsoil/Peat	Mohr-Coulomb	11.5	0	10
⬜	Waste Fill	Mohr-Coulomb	13	0	32

Title: 1648253 - Boyne Road Landfill
File Name: Section A-A' West Drained.gsz
Description: Section AA' - West Side Slope Drained Analysis
Method: Morgenstern-Price

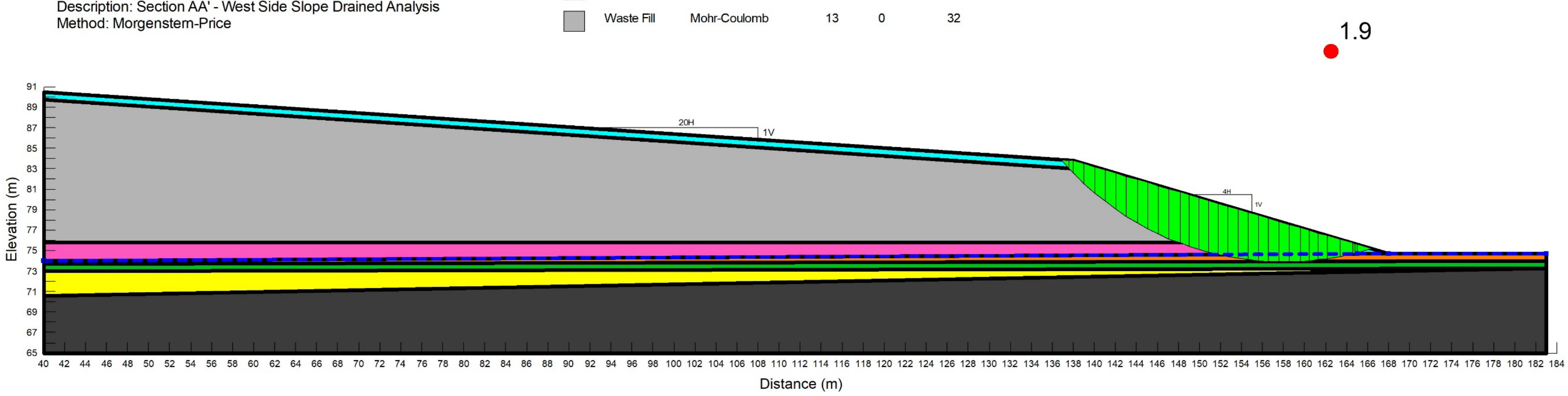


FIGURE 1

REVIEW
CHECK WC 2022-01-28
CADD
DESIGN BB 2022-01-28
REV. 0 SCALE AS SHOWN
FILE No. 1648253
PROJECT No. 1648253

TITLE

SECTION A-A' (WEST)
STABILITY ANALYSES
STATIC DRAINED CONDITION

PROJECT

INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF
NORTH DUNDAS WASTE MANAGEMENT PLAN
SLOPE STABILITY ASSESSMENT

GOLDER
MEMBER OF WSP

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟪	Base Layer	Mohr-Coulomb	20.5		0	35
⬛	Bedrock	Bedrock (Impenetrable)				
🟦	Cover Layer	Mohr-Coulomb	19		0	32
🟨	Glacial Till	Mohr-Coulomb	21		0	35
🟩	Silty Clay (stiff to very stiff)	Undrained (Phi=0)	16	50		
🟧	Topsoil/Peat	Mohr-Coulomb	11.5		0	10
⬜	Waste Fill	Mohr-Coulomb	13		0	32

Title: 1648253 - Boyne Road Landfill
File Name: Section A-A' West Undrained.gsz
Description: Section AA' - West Side Slope Undrained Analysis
Method: Morgenstern-Price

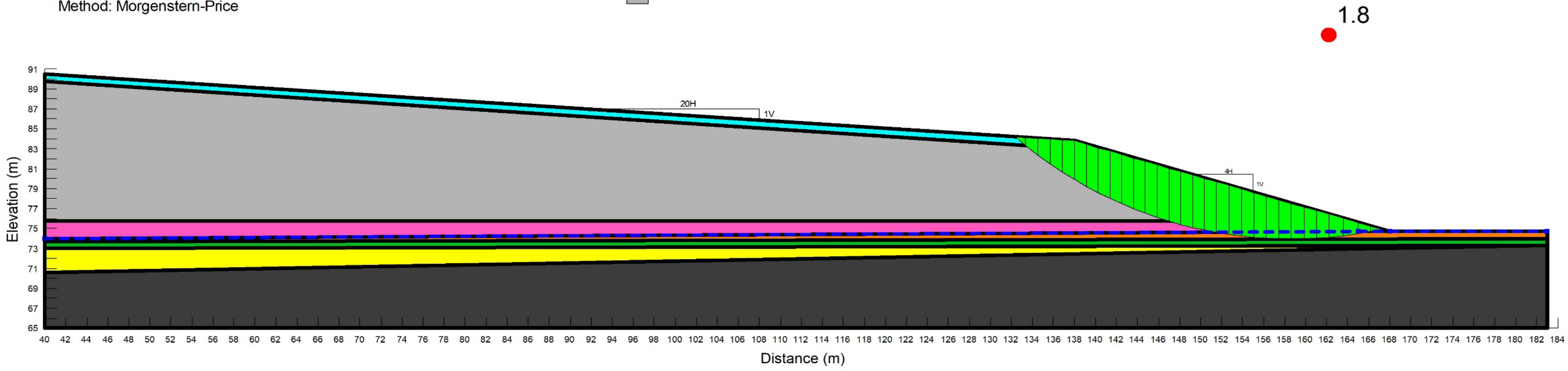


FIGURE 2

REVIEW	CHECK	CADD	DESIGN	REV. 0	FILE No.	PROJECT No.
	WC		BB	SCALE AS SHOWN	1648276	1648276
	2022-01-28		2022-01-28			

TITLE

SECTION A-A' (WEST)
STABILITY ANALYSES
STATIC UNDRAINED CONDITION

PROJECT

INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF
NORTH DUNDAS WASTE MANAGEMENT PLAN
SLOPE STABILITY ASSESSMENT

GOLDER
MEMBER OF WSP

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟪	Base Layer	Mohr-Coulomb	20.5		0	35
⬛	Bedrock	Bedrock (Impenetrable)				
🟦	Cover Layer	Mohr-Coulomb	19		0	32
🟨	Glacial Till	Mohr-Coulomb	21		0	35
🟩	Silty Clay (stiff to very stiff)	Undrained (Phi=0)	16	50		
🟧	Topsoil/Peat	Mohr-Coulomb	11.5		0	10
⬜	Waste Fill	Mohr-Coulomb	13		0	32

Title: 1648253 - Boyne Road Landfill
File Name: Section A-A' West Seismic.gsz
Description: Section AA' - West Side Slope Seismic Analysis
Method: Morgenstern-Price

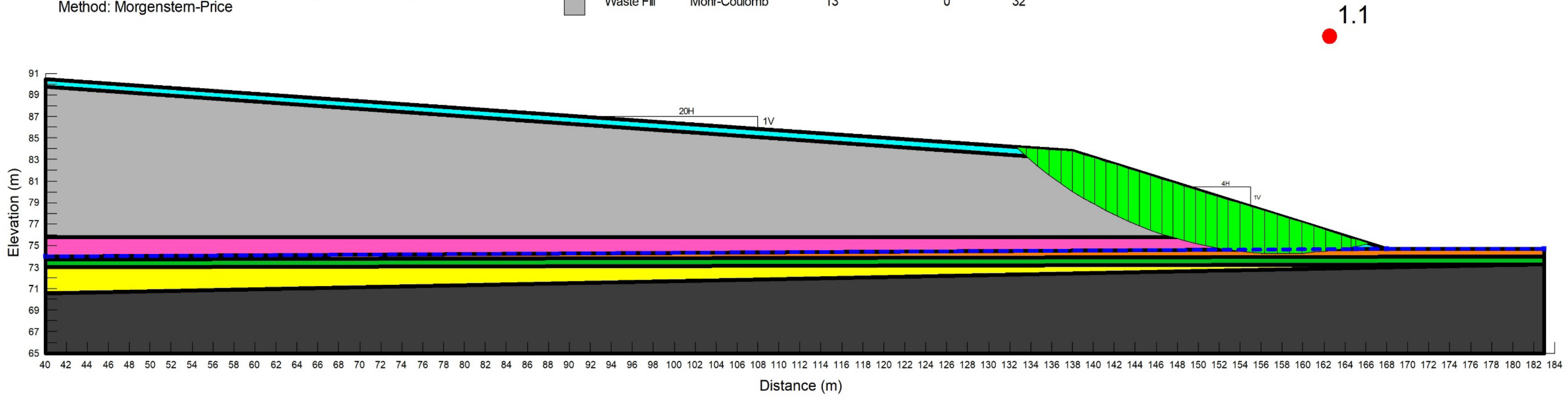


FIGURE 3

REVIEW
CHECK WC 2022-01-28
CADD
DESIGN BB 2022-01-28
REV. 0
SCALE AS SHOWN
FILE No. 1648253
PROJECT No. 1648253

TITLE

SECTION A-A' (WEST)
STABILITY ANALYSES
SEISMIC CONDITION

PROJECT

INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN
SLOPE STABILITY ASSESSMENT

GOLDER
MEMBER OF WSP

Title: 1648253 - Boyne Road Landfill
File Name: Section B-B' South Drained.gsz
Description: Section BB' - South Side Slope Drained Analysis
Method: Morgenstern-Price

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟪	Base Layer	Mohr-Coulomb	20.5	0	35
⬛	Bedrock	Bedrock (Impenetrable)			
🟦	Cover Layer	Mohr-Coulomb	19	0	32
🟨	Glacial Till	Mohr-Coulomb	21	0	35
🟩	Silty Clay (stiff to very stiff)	Mohr-Coulomb	16	7.4	28.7
⬜	Waste Fill	Mohr-Coulomb	13	0	32

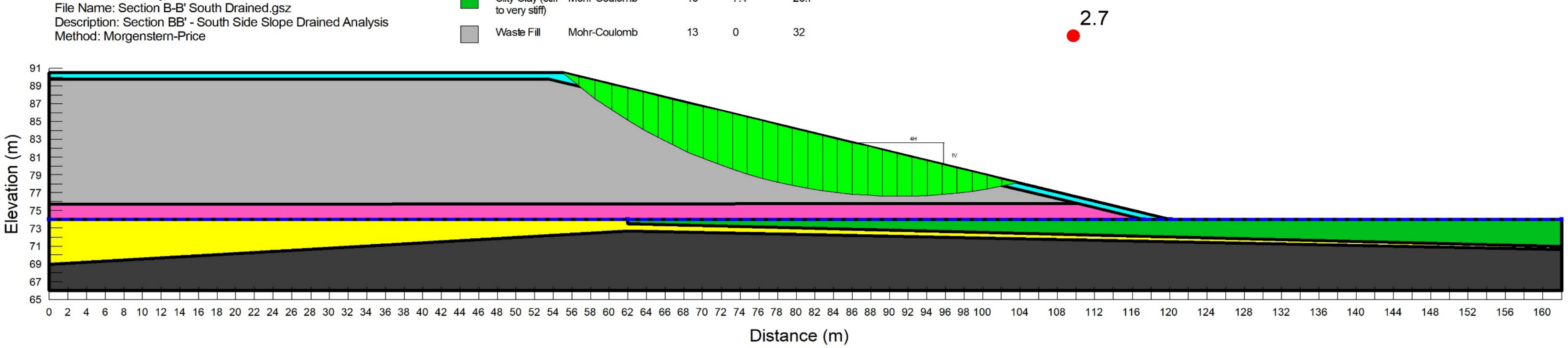


FIGURE 4

REVIEW	CHECK	CADD	DESIGN	REV. 0	FILE No.	PROJECT No.
	WC		BB	SCALE AS SHOWN	1648253	1648253
	2022-01-28		2022-01-28			

TITLE

SECTION B-B' (SOUTH)
STABILITY ANALYSES
STATIC DRAINED CONDITION

PROJECT

INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF
NORTH DUNDAS WASTE MANAGEMENT PLAN
SLOPE STABILITY ASSESSMENT

GOLDER
MEMBER OF WSP

Title: 1648253 - Boyne Road Landfill
File Name: Section B-B' South Undrained.gsz
Description: Section BB' - South Side Slope Undrained Analysis
Method: Morgenstern-Price

Color	Name	Model	Unit Weight (kN/m^3)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟪	Base Layer	Mohr-Coulomb	20.5		0	35
⬛	Bedrock	Bedrock (Impenetrable)				
🟦	Cover Layer	Mohr-Coulomb	19		0	32
🟨	Glacial Till	Mohr-Coulomb	21		0	35
🟩	Silty Clay (stiff to very stiff)	Undrained (Phi=0)	16	50		
⬜	Waste Fill	Mohr-Coulomb	13		0	32

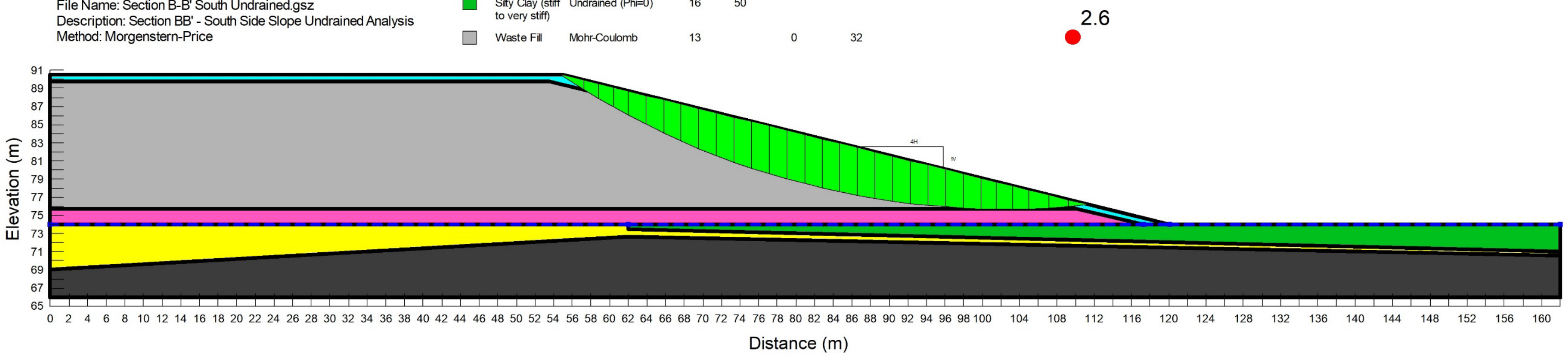


FIGURE 5

REVIEW
CHECK WC 2022-01-28
CADD
DESIGN BB 2022-01-28
REV. 0 SCALE AS SHOWN
FILE No. 1648253
PROJECT No. 1648253

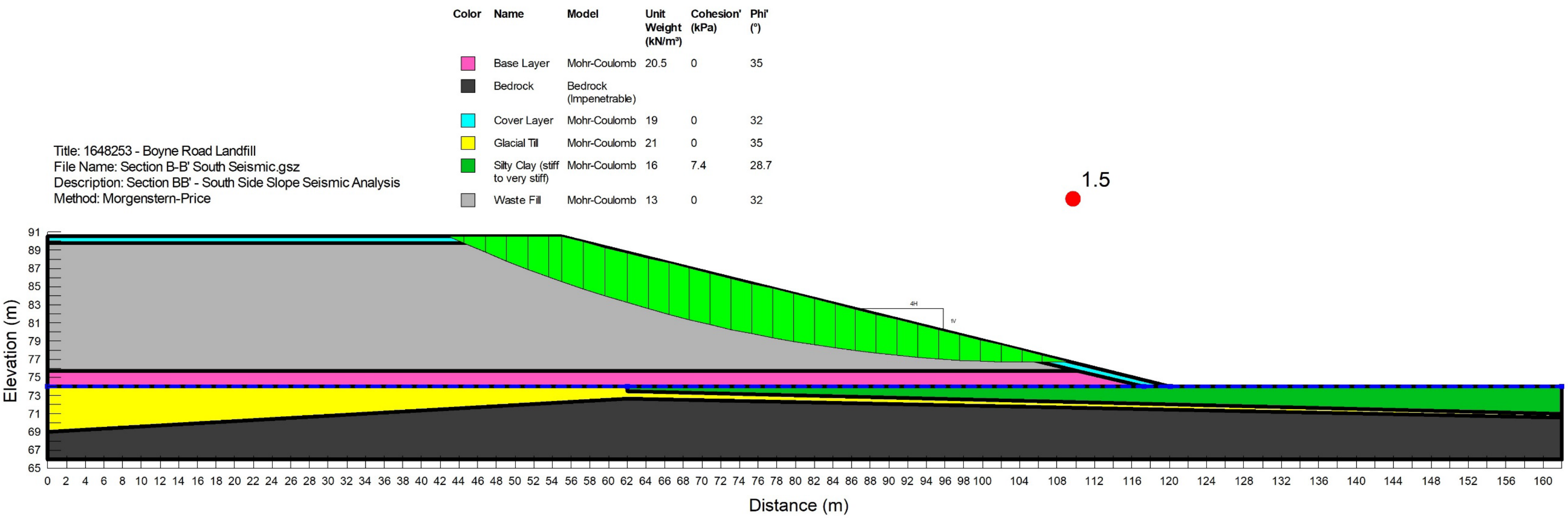
TITLE

SECTION B-B' (SOUTH)
STABILITY ANALYSES
STATIC UNDRAINED CONDITION

PROJECT

INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN
SLOPE STABILITY ASSESSMENT

GOLDER
MEMBER OF WSP



Title: 1648253 - Boyne Road Landfill
File Name: Section B-B' South Seismic.gsz
Description: Section BB' - South Side Slope Seismic Analysis
Method: Morgenstern-Price

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟪	Base Layer	Mohr-Coulomb	20.5	0	35
⬛	Bedrock	Bedrock (Impenetrable)			
🟦	Cover Layer	Mohr-Coulomb	19	0	32
🟨	Glacial Till	Mohr-Coulomb	21	0	35
🟩	Silty Clay (stiff to very stiff)	Mohr-Coulomb	16	7.4	28.7
⬜	Waste Fill	Mohr-Coulomb	13	0	32

FIGURE 6

REVIEW
CHECK WC 2022-01-28
CADD
DESIGN BB 2022-01-28
REV. 0 SCALE AS SHOWN
FILE No. 1648253
PROJECT No. 1648253

TITLE

SECTION B-B' (SOUTH)
STABILITY ANALYSES
SEISMIC CONDITION

PROJECT

INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF
NORTH DUNDAS WASTE MANAGEMENT PLAN
SLOPE STABILITY ASSESSMENT

GOLDER
MEMBER OF WSP

Appendix D-3 POLLUTE Output

POLLUTEv7

Version 7.13

Boyne Source Boron

**THE VARIABLE VELOCITY AND/OR CONCENTRATION OPTION HAS BEEN USED
NOTE THAT THE ACCURACY OF THE CALCULATIONS WITH THIS OPTION WILL DEPEND
ON THE NUMBER OF SUBLAYERS USED**

Layer Properties

Layer	Thickness	Number of Sublayers	Coefficient of Hydrodynamic Dispersion	Matrix Porosity	Distribution Coefficient	Dry Density
Till	4.4 m	200	0.019 m2/a	0.35	0 mL/g	1.9 g/cm3

Boundary Conditions

Finite Mass Top Boundary

Fixed Outflow Bottom Boundary
Landfill Length = 202 m
Landfill Width = 1 m
Base Thickness = 3 m
Base Porosity = 0.35

VARIATION IN PROPERTIES WITH TIME:

TIME PERIODS WITH THE SAME SOURCE AND VELOCITY

Period	Start Time	No. of Steps	Time Step	Source Conc	Rate of Change	Height of Leachate	Volume Collected
1	0 year	15	5 year	5 mg/L	0	10000000 m	0 m/a
2	75 year	100	5 year	5 mg/L	0	2.54 m	0 m/a

Period	Start Time	End Time	Darcy Velocity	Dispersivity	Base Velocity
1	0 year	75 year	0.33 m/a	0.1 m	23.5 m/a
2	75 year	575 year	0.33 m/a	0.1 m	23.5 m/a

Laplace Transform Parameters

TAU = 7 **N =** 20 **SIG =** 0 **RNU =** 2

Calculated Concentrations at Selected Times and Depths

Time year	Depth m	Concentration mg/L
5	0.000E+00	5.000E+00
10	0.000E+00	5.000E+00
15	0.000E+00	5.000E+00
20	0.000E+00	5.000E+00
25	0.000E+00	5.000E+00
30	0.000E+00	5.000E+00
35	0.000E+00	5.000E+00
40	0.000E+00	5.000E+00
45	0.000E+00	5.000E+00
50	0.000E+00	5.000E+00
55	0.000E+00	5.000E+00
60	0.000E+00	5.000E+00
65	0.000E+00	5.000E+00
70	0.000E+00	5.000E+00
75	0.000E+00	5.000E+00

Time year	Depth m	Concentration mg/L
80	0.000E+00	2.639E+00
85	0.000E+00	1.393E+00
90	0.000E+00	7.354E-01
95	0.000E+00	3.882E-01
100	0.000E+00	2.049E-01
105	0.000E+00	1.082E-01
110	0.000E+00	5.711E-02
115	0.000E+00	3.015E-02
120	0.000E+00	1.591E-02
125	0.000E+00	8.401E-03
130	0.000E+00	4.435E-03
135	0.000E+00	2.341E-03
140	0.000E+00	1.236E-03
145	0.000E+00	6.525E-04
150	0.000E+00	3.444E-04
155	0.000E+00	1.818E-04
160	0.000E+00	9.599E-05
165	0.000E+00	5.067E-05
170	0.000E+00	2.675E-05
175	0.000E+00	1.412E-05
180	0.000E+00	7.454E-06
185	0.000E+00	3.935E-06

Time year	Depth m	Concentration mg/L
190	0.000E+00	2.077E-06
195	0.000E+00	1.097E-06
200	0.000E+00	5.790E-07
205	0.000E+00	3.057E-07
210	0.000E+00	1.614E-07
215	0.000E+00	8.524E-08
220	0.000E+00	4.503E-08
225	0.000E+00	2.381E-08
230	0.000E+00	1.260E-08
235	0.000E+00	6.689E-09
240	0.000E+00	3.566E-09
245	0.000E+00	1.918E-09
250	0.000E+00	1.048E-09
255	0.000E+00	5.883E-10
260	0.000E+00	3.457E-10
265	0.000E+00	2.176E-10
270	0.000E+00	1.499E-10
275	0.000E+00	1.141E-10
280	0.000E+00	9.514E-11
285	0.000E+00	8.504E-11
290	0.000E+00	7.965E-11
295	0.000E+00	7.671E-11

Time year	**Depth m**	**Concentration mg/L**
300	0.000E+00	7.508E-11
305	0.000E+00	7.413E-11
310	0.000E+00	7.353E-11
315	0.000E+00	7.311E-11
320	0.000E+00	7.279E-11
325	0.000E+00	7.252E-11
330	0.000E+00	7.225E-11
335	0.000E+00	7.201E-11
340	0.000E+00	7.176E-11
345	0.000E+00	7.152E-11
350	0.000E+00	7.126E-11
355	0.000E+00	7.100E-11
360	0.000E+00	7.074E-11
365	0.000E+00	7.047E-11
370	0.000E+00	7.020E-11
375	0.000E+00	6.992E-11
380	0.000E+00	6.964E-11
385	0.000E+00	6.935E-11
390	0.000E+00	6.906E-11
395	0.000E+00	6.876E-11
400	0.000E+00	6.846E-11
405	0.000E+00	6.816E-11

Time **year**	**Depth** **m**	**Concentration** **mg/L**
410	0.000E+00	6.786E-11
415	0.000E+00	6.755E-11
420	0.000E+00	6.724E-11
425	0.000E+00	6.693E-11
430	0.000E+00	6.662E-11
435	0.000E+00	6.629E-11
440	0.000E+00	6.598E-11
445	0.000E+00	6.566E-11
450	0.000E+00	6.534E-11
455	0.000E+00	6.501E-11
460	0.000E+00	6.469E-11
465	0.000E+00	6.436E-11
470	0.000E+00	6.404E-11
475	0.000E+00	6.371E-11
480	0.000E+00	6.338E-11
485	0.000E+00	6.305E-11
490	0.000E+00	6.273E-11
495	0.000E+00	6.240E-11
500	0.000E+00	6.206E-11
505	0.000E+00	6.174E-11
510	0.000E+00	6.141E-11
515	0.000E+00	6.108E-11

Time year	**Depth m**	**Concentration mg/L**
520	0.000E+00	6.076E-11
525	0.000E+00	6.043E-11
530	0.000E+00	6.010E-11
535	0.000E+00	5.978E-11
540	0.000E+00	5.945E-11
545	0.000E+00	5.913E-11
550	0.000E+00	5.881E-11
555	0.000E+00	5.848E-11
560	0.000E+00	5.816E-11
565	0.000E+00	5.784E-11
570	0.000E+00	5.753E-11
575	0.000E+00	5.720E-11

NOTICE

Although this program has been tested and experience would indicate that it is accurate within the limits given by the assumptions of the theory used, we make no warranty as to workability of this software or any other licensed material. No warranties either expressed or implied (including warranties of fitness) shall apply. No responsibility is assumed for any errors, mistakes or misrepresentations that may occur from the use of this computer program. The user accepts full responsibility for assessing the validity and applicability of the results obtained with this program for any specific case.

POLLUTEv7

Version 7.13

Boyne Source Chloride

**THE VARIABLE VELOCITY AND/OR CONCENTRATION OPTION HAS BEEN USED
NOTE THAT THE ACCURACY OF THE CALCULATIONS WITH THIS OPTION WILL DEPEND
ON THE NUMBER OF SUBLAYERS USED**

Layer Properties

Layer	Thickness	Number of Sublayers	Coefficient of Hydrodynamic Dispersion	Matrix Porosity	Distribution Coefficient	Dry Density
Till	4.4 m	200	0.019 m2/a	0.35	0 mL/g	1.9 g/cm3

Boundary Conditions

Finite Mass Top Boundary

Fixed Outflow Bottom Boundary
Landfill Length = 202 m
Landfill Width = 1 m
Base Thickness = 3 m
Base Porosity = 0.35

VARIATION IN PROPERTIES WITH TIME:

TIME PERIODS WITH THE SAME SOURCE AND VELOCITY

Period	Start Time	No. of Steps	Time Step	Source Conc	Rate of Change	Height of Leachate	Volume Collected
1	0 year	15	5 year	1500 mg/L	0	10000000 m	0 m/a
2	75 year	100	5 year	1500 mg/L	0	2.54 m	0 m/a

Period	Start Time	End Time	Darcy Velocity	Dispersivity	Base Velocity
1	0 year	75 year	0.33 m/a	0.1 m	23.5 m/a
2	75 year	575 year	0.33 m/a	0.1 m	23.5 m/a

Laplace Transform Parameters

TAU = 7 **N =** 20 **SIG =** 0 **RNU =** 2

Calculated Concentrations at Selected Times and Depths

Time year	Depth m	Concentration mg/L
5	0.000E+00	1.500E+03
10	0.000E+00	1.500E+03
15	0.000E+00	1.500E+03
20	0.000E+00	1.500E+03
25	0.000E+00	1.500E+03
30	0.000E+00	1.500E+03
35	0.000E+00	1.500E+03
40	0.000E+00	1.500E+03
45	0.000E+00	1.500E+03
50	0.000E+00	1.500E+03
55	0.000E+00	1.500E+03
60	0.000E+00	1.500E+03
65	0.000E+00	1.500E+03
70	0.000E+00	1.500E+03
75	0.000E+00	1.500E+03

Time year	Depth m	Concentration mg/L
80	0.000E+00	7.916E+02
85	0.000E+00	4.179E+02
90	0.000E+00	2.206E+02
95	0.000E+00	1.165E+02
100	0.000E+00	6.148E+01
105	0.000E+00	3.245E+01
110	0.000E+00	1.713E+01
115	0.000E+00	9.044E+00
120	0.000E+00	4.774E+00
125	0.000E+00	2.520E+00
130	0.000E+00	1.331E+00
135	0.000E+00	7.024E-01
140	0.000E+00	3.708E-01
145	0.000E+00	1.957E-01
150	0.000E+00	1.033E-01
155	0.000E+00	5.455E-02
160	0.000E+00	2.880E-02
165	0.000E+00	1.520E-02
170	0.000E+00	8.025E-03
175	0.000E+00	4.236E-03
180	0.000E+00	2.236E-03

Time **year**	**Depth** **m**	**Concentration** **mg/L**
185	0.000E+00	1.181E-03
190	0.000E+00	6.232E-04
195	0.000E+00	3.290E-04
200	0.000E+00	1.737E-04
205	0.000E+00	9.170E-05
210	0.000E+00	4.842E-05
215	0.000E+00	2.557E-05
220	0.000E+00	1.351E-05
225	0.000E+00	7.142E-06
230	0.000E+00	3.781E-06
235	0.000E+00	2.007E-06
240	0.000E+00	1.070E-06
245	0.000E+00	5.754E-07
250	0.000E+00	3.143E-07
255	0.000E+00	1.765E-07
260	0.000E+00	1.037E-07
265	0.000E+00	6.527E-08
270	0.000E+00	4.497E-08
275	0.000E+00	3.423E-08
280	0.000E+00	2.854E-08
285	0.000E+00	2.552E-08

Time **year**	**Depth** **m**	**Concentration** **mg/L**
290	0.000E+00	2.389E-08
295	0.000E+00	2.302E-08
300	0.000E+00	2.252E-08
305	0.000E+00	2.224E-08
310	0.000E+00	2.206E-08
315	0.000E+00	2.193E-08
320	0.000E+00	2.184E-08
325	0.000E+00	2.175E-08
330	0.000E+00	2.168E-08
335	0.000E+00	2.160E-08
340	0.000E+00	2.153E-08
345	0.000E+00	2.145E-08
350	0.000E+00	2.138E-08
355	0.000E+00	2.130E-08
360	0.000E+00	2.122E-08
365	0.000E+00	2.114E-08
370	0.000E+00	2.106E-08
375	0.000E+00	2.098E-08
380	0.000E+00	2.089E-08
385	0.000E+00	2.080E-08
390	0.000E+00	2.072E-08

Time year	**Depth m**	**Concentration mg/L**
395	0.000E+00	2.063E-08
400	0.000E+00	2.054E-08
405	0.000E+00	2.045E-08
410	0.000E+00	2.036E-08
415	0.000E+00	2.027E-08
420	0.000E+00	2.017E-08
425	0.000E+00	2.008E-08
430	0.000E+00	1.998E-08
435	0.000E+00	1.989E-08
440	0.000E+00	1.979E-08
445	0.000E+00	1.970E-08
450	0.000E+00	1.960E-08
455	0.000E+00	1.950E-08
460	0.000E+00	1.941E-08
465	0.000E+00	1.931E-08
470	0.000E+00	1.921E-08
475	0.000E+00	1.911E-08
480	0.000E+00	1.901E-08
485	0.000E+00	1.892E-08
490	0.000E+00	1.882E-08
495	0.000E+00	1.872E-08

Time year	Depth m	Concentration mg/L
500	0.000E+00	1.862E-08
505	0.000E+00	1.852E-08
510	0.000E+00	1.842E-08
515	0.000E+00	1.832E-08
520	0.000E+00	1.823E-08
525	0.000E+00	1.813E-08
530	0.000E+00	1.803E-08
535	0.000E+00	1.793E-08
540	0.000E+00	1.784E-08
545	0.000E+00	1.774E-08
550	0.000E+00	1.764E-08
555	0.000E+00	1.754E-08
560	0.000E+00	1.745E-08
565	0.000E+00	1.735E-08
570	0.000E+00	1.726E-08
575	0.000E+00	1.716E-08

NOTICE

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