# 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 <sub>2</sub> conversion will be used.	No – NO <sub>2</sub> 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 t₁ output from the model (MECP assumes AERMOD predicts true 60 minute averages) to the desired averaging period t₀ (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<sub>2</sub> 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  $90^{th}$  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<sub>2</sub>, and the remaining 90% in the form of NO. Some or all of the NO will be converted to NO<sub>2</sub> by reaction with ozone (O<sub>3</sub>). If the NO<sub>X</sub> concentration in ppm is multiplied by 0.9 and this value is less than the ozone concentration in ppm, then the NO<sub>2</sub> concentration is equal to the NO<sub>X</sub> concentration. However, if the NO<sub>X</sub> 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<sub>2</sub> 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 $_{\rm X}$  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<sub>2</sub> (M) at ambient temperature, the equation for the NO<sub>X</sub> 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  $NO_2$  concentration.

This method is widely accepted as being a reasonable approach that recognizes the most important mechanism for NO<sub>X</sub> conversion, namely reactions with ozone.



## 3.0 REFERENCES

Cole, H.S. and J.E. Summerhays. 1979. A review of techniques available for estimating short-term NO2 concentrations. Journal of Air Pollution Control Association. pp. 812-817.

- MECP (Ministry of the Environment, Conservation and Parks). 2017. *Air Dispersion Modelling Guideline for Ontario, Version 3.0.* PIBS: 5165e03, Toronto, Ontario
- MECP (Ministry of the Environment, Conservation and Parks). 2016. *Methodology for Modelling Assessments of Contaminants with 10-Minute Average Standards and Guidelines under O.Reg. 419/05*. Technical Bulletin.
- United States Environmental Protection Agency (U.S. EPA). 2004. *Users Guide for the AERMOD Terrain Preprocessor (AERMAP)*. EPA-454/B-03-003. Office of Air Quality Planning and Standards. Emissions, Monitoring, and Analysis Division. Research Triangle Park, North Carolina.
- United States Environmental Protection Agency (U.S. EPA). 2012. *Haul Road Workgroup Final Report*. Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.





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



# May 2022

Volume 2 Appendix B-4

**Estimation of Landfill Gas Generation** (LandGEM)





# **Table of Contents**

1.0	EST	MATION OF LANDFILL GAS PRODUCTION	1
	1.1	Methodology	1
	1.2	Ultimate Methane Yield and Methane Generation Rate Constant	1
	1.3	Waste Tonnage and Waste Composition	1
	1.4	Landfill Gas Generation Estimates	2
2.0	REF	ERENCES	4
TAI	BLES		
Figu		-1: Estimated Landfill Gas and Methane Generation Rates from LandGEM	3
Tab		1: Summary of Total Estimated Landfill Gas and Methane Generation for the oyne Landfill Expansion	3
Tab	le B4-	2: LandGEM Waste Inputs	5
FIG	URES		
Fig		-1: Estimated Landfill Gas and Methane Generation Rates from LandGEM	3



### 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<sup>-1</sup>. 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<sup>-1</sup>, 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<sub>4</sub>) 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<sup>3</sup>.
- 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 m³.
- 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 m³ 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<sup>3</sup>/year for 1966 to 1985, 6,500 m<sup>3</sup>/year for 1976 to 1985 and 9,500 m<sup>3</sup>/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/m³.

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.



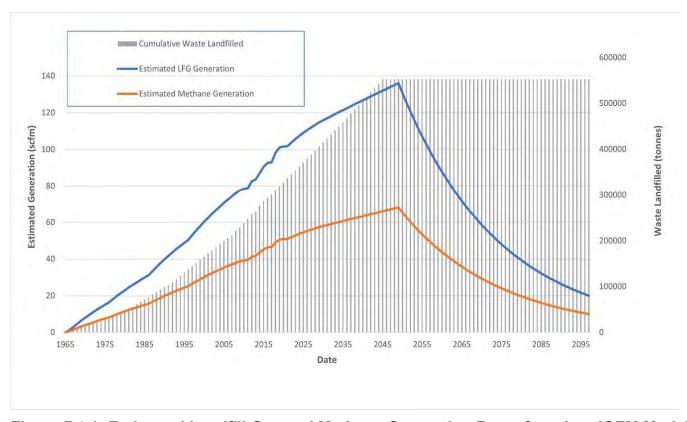


Figure B4-1: Estimated Landfill Gas and Methane Generation Rates from LandGEM Model

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

Year	Landfill Gas Generation Estimate scfm	Landfill Gas Generation Estimate m³/hr	Methane Generation Estimate* scfm	Methane Generation Estimate* m³/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:

scfm = standard cubic feet per minute

<sup>\*</sup> Assumes LFG is comprised of 50% methane

 $m^3$  = cubic metres

# 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 (m³) 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 (m³) 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 (m³) 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





# ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

**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:

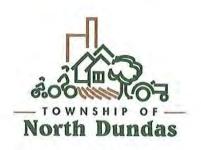
- "Noise" or "noise levels" refers to the levels that can be heard or measured at a Point of Reception (POR).
- A noise "receptor" or "POR" is any location on a noise sensitive land use where noise is received.
- The "level" of a noise is expressed on a logarithmic scale, in units called decibels (dB). 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" (Leq, 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 Leq, 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<sub>90</sub>, 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.



# ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

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





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 KOC 2KO (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





# ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

**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	III.	SOIL DESCRIPTION	
AS	Auger sample	(a)	<b>Cohesionless Soils</b>	
BS	Block sample			
CS	Chunk sample	Density In	ıdex	N
DO or DP	Seamless open-ended, driven or pushed tube samplers	(Relative I	Density)	Blows/300 mm
DS	Denison type sample			Or Blows/ft.
FS	Foil sample	Very loose	;	0 to 4
RC	Rock core	Loose		4 to 10
SC	Soil core	Compact		10 to 30
SS	Split spoon sampler	Dense		30 to 50
ST	Slotted tube	Very dense	e	over 50
TO	Thin-walled, open	•		
TP	Thin-walled, piston	(b)	Cohesive Soils	
WS	Wash sample	( )	$C_u$ or $S_u$	
DT	Dual tube sample	Consistenc		
DD	Diamond drilling		<u>kPa</u>	<u>Psf</u>
	5	Very soft	0 to 12	0 to 250
II.	PENETRATION RESISTANCE	Soft	12 to 25	250 to 500
		Firm	25 to 50	500 to 1,000
Standard	Penetration Resistance (SPT), N:	Stiff	50 to 100	1,000 to 2,000
	(~),	Very stiff	100 to 200	2,000 to 4,000
The number	er of blows by a 63.5 kg. (140 lb.) hammer dropped	Hard	Over 200	Over 4,000
760 mm (3	30 in.) required to drive a 50 mm (2 in.) split spoon r a distance of 300 mm (12 in.).	IV.	SOIL TESTS	7
Dynamic (	Cone Penetration Resistance (DCPT); N <sub>d</sub> :	w	Water content	
•		w <sub>p</sub> or PL	Plastic limited	
The number	er of blows by a 63.5 kg (140 lb.) hammer dropped	w <sub>1</sub> or LL	Liquid limit	
760 mm (3	60 in.) to drive an uncased 50 mm (2 in.) diameter,	C	Consolidaiton (oedometer) tes	t
	ttached to "A" size drill rods for a distance of	CHEM	Chemical analysis (refer to tex	
300 mm (1	2 in.).	CID	Consolidated isotropically dra	
		CIU	Consolidated isotropically und	
PH:	Sampler advanced by hydraulic pressure		with porewater pressure measure	
PM:	Sampler advanced by manual pressure	$D_R$	Relative density	
WH:	Sampler advanced by static weight of hammer	DS	Direct shear test	
WR:	Sampler advanced by weight of sampler and rod	Gs	Specific gravity	
	1	M	Sieve analysis for particle size	
Cone Pene	etration Test (CPT):	MH	Combined sieve and hydrome	
		MPC	Modified Proctor compaction	· · ·
An electro	nic cone penetrometer with a 60° conical tip and a	SPC	Standard Proctor compaction	
	end area of 10 cm <sup>2</sup> pushed through ground at a	OC	Organic content test	
	n rate of 2 cm/s. Measurements of tip resistance $(q_t)$ ,	$SO_4$	Concentration of water-solubl	e sulphates
	pressure (u) and friction along a sleeve are recorded	UC	Unconfined compression test	1
electronica	ally at 25 mm penetration intervals.	UU	Unconsolidated undrained tria	xial test
		V	Field vane test (LV-laboratory	
		γ	Unit weight	,
		ı	·- ·· <b>o</b>	
		Note:	<sup>1</sup> Tests which are anisotropical shear are shown as CAD, C.	

# **LIST OF SYMBOLS**

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

I.	GENERAL	(a) Index Properties (continued)	
π	3.1416	W	water content
ln x	natural logarithm of x	w <sub>1</sub> or LL	liquid limit
log <sub>10</sub> x or log x	logarithm of x to base 10	w <sub>p</sub> or PL	plastic limit
g	acceleration due to gravity	I <sub>p</sub> or PI	plasticity Index = $(w_1 - w_p)$
t	time	W <sub>s</sub>	shrinkage limit
FOS	factor of safety	$I_L$	liquidity index = $(w - w_p) / I_p$
V	volume	I <sub>c</sub>	consistency index = $(w_1 - w) / I_p$
W	weight	e <sub>max</sub>	void ratio in loosest state
		e <sub>min</sub>	void ratio in densest state
II.	STRESS AND STRAIN	$I_D$	density index = $(e_{max} - e) / (e_{max} - e_{min})$
		_	(formerly relative density)
γ	shear strain		
$\Delta$	change in, e.g. in stress: $\Delta \sigma'$	(b) Hydrau	lic Properties
ε	linear strain		
$\epsilon_{ m v}$	volumetric strain	h	hydraulic head or potential
η	coefficient of viscosity	q	rate of flow
v	Poisson's ratio	v	velocity of flow
σ	total stress	i	hydraulic gradient
σ'	effective stress ( $\sigma' = \sigma - u$ )	k	hydraulic conductivity (coefficient of permeability)
$\sigma'_{vo}$	initial vertical effective overburden stress	j	seepage force per unit volume
$\sigma_1 \sigma_2 \sigma_3$	principal stresses (major, intermediate, minor)	3	
$\sigma_{\rm oct}$	mean stress or octahedral stress	(c) Consolio	dation (one-dimensional)
- 601	$= (\sigma_1 + \sigma_2 + \sigma_3) / 3$	(1)	(
τ	shear stress	$C_c$	compression index (normally consolidated range)
u	porewater pressure	$C_r$	recompression index (overconsolidated range)
E	modulus of deformation	$C_s$	swelling index
G	shear modulus of deformation	$C_{\alpha}$	coefficient of secondary consolidation
K	bulk modulus of compressibility	ω <sub>α</sub> m <sub>v</sub>	coefficient of volume change
	ount incoming of compressioning	$c_{v}$	coefficient of consolidation (vertical direction)
III.	SOIL PROPERTIES	$T_{\rm v}$	time factor (vertical direction)
		U	degree of consolidation
(a) Index Proj	perties	$\sigma'_p$	pre-consolidation stress
		OCR	overconsolidation ratio = $\sigma'_p / \sigma'_{vo}$
ρ(γ)	bulk density (bulk unit weight)*		υ γο
$\rho_{\rm d}(\gamma_{\rm d})$	dry density (dry unit weight)	(d) Shear S	trength
$\rho_{\rm w}(\gamma_{\rm w})$	density (unit weight) of water	(4) 211041 2	v. vg
$\rho_{\rm s}(\gamma_{\rm s})$	density (unit weight) of solid particles	TOTT	peak and residual shear strength
Ps(1s) γ'	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )	$ au_{ m p}$ or $ au_{ m r}$	effective angle of internal friction
${ m D_R}$	relative density (specific gravity) of	δ	angle of interface friction
$D_{R}$	solid particles ( $D_R = \rho_s / \rho_w$ ) formerly ( $G_s$ )		coefficient of friction = $\tan \delta$
e	void ratio	μ c'	effective cohesion
e n	porosity	$c_u$ or $s_u$	undrained shear strength ( $\phi = 0$ analysis)
S	degree of saturation		mean total stress $(\sigma_1 + \sigma_3) / 2$
5	degree of saturation	p n'	
*	Density armshal is a Heiterstickt south 12	p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
	Density symbol is $\rho$ . Unit weight symbol is $\gamma$ where $\gamma = \rho g$ (i.e. mass density multiplied by	q	$(\sigma_1 - \sigma_3) / 2$ or $(\sigma'_1 - \sigma'_3) / 2$
	acceleration due to gravity)	q <sub>u</sub>	compressive strength $(\sigma_1 - \sigma_3)$
	·- B//	$S_t$	sensitivity
		Notes:	$\tau = c' + \sigma' \tan \phi'$
		110105.	shear strength = (compressive strength) / 2
			shoul shought (compressive shought) / 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

<b>Description</b>	<b>Bedding Plane Spacing</b>
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

<u>Description</u>	<b>Spacing</b>
Very Wide	> 3 m
Wide	1 - 3  m
Moderately Close	0.3 - 1  m
Close	50 - 300  mm
Very Close	< 50 mm

#### **GRAIN SIZE**

<u>Term</u>	<u>Size*</u>
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 diame	ter 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  $90^{\circ}$  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
II -	Parallel To	STR -	Stress Induced
OR -	Orthogonal		

PROJECT: 14-1125-0007/Boyne Road Landfill

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

### RECORD OF BOREHOLE: MW06-22R

BORING DATE: May 1, 2014

SHEET 1 OF 1

DATUM: Geodetic

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m HYDRAULIC CONDUCTIVITY, k, cm/s SOIL PROFILE SAMPLES BORING METHOD DEPTH SCALE METRES ADDITIONAL LAB. TESTING PIEZOMETER BLOWS/0.30m OR STANDPIPE INSTALLATION STRATA PLOT 80 10<sup>-5</sup> 10⁴ NUMBER ELEV. TYPE SHEAR STRENGTH nat V. + Q - ● rem V. ⊕ U - ○ WATER CONTENT PERCENT DESCRIPTION DEPTH −OW Wp **I**− - w (m) GROUND SURFACE 82.96 0.00 Waste (FILL) Bentonite Seal 10 Silica Sand Grey brown SILTY CLAY 32 mm Diam. PVC #10 Slot Screen 12 Cave in End of Borehole 14 1411250007.GPJ GAL-MIS.GDT 11/07/14 JM 16 18 20 MIS-BHS 001 DEPTH SCALE LOGGED: MIB Golder 1:100 CHECKED: YJM

PROJECT: 06-1122-127-3 LOCATION: See Site Plan RECORD OF BOREHOLE: MW07-23

BORING DATE: September 4, 2007

SHEET 1 OF 1

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

9	НОР	SOIL PROFILE	1		SA	MPL	ES	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	k, cm/s	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/03m	20 40 60 80 SHEAR STRENGTH nal V. + Q. ■ Cu, KPa rem V ⊕ U - Q	WATER CONTENT PERCENT  WP   OW   W	OR STANDPIPE INSTALLATION
i.	BOR		STR	(m)	Z		BO	20 40 60 80	Wp   → W   WI 4 4 5	
0		GROUND SURFACE		74.97						
-		TOPSOIL	WVP	74.76						
		Very stiff grey brown SILTY CLAY (Weathered Crust)		0.21						Bentorule Seal
t	(w	Brown SILTY CLAY, trace gravel		73.90	1	50 DO	20			Silica Sand
2	Power Auger 200mm dam. (Hollow Stem)	Dense brown to grey sandy SILT, some grey clay, occasional sand seam (GLACIAL TILL)		73.35 1.02	1 1	50 DO	35			
	Primo						П			
	200				3	50 00	39			32mm Diam. PVC #10 Slot Screen
3			27							
1					4	50 DO	32			Ž.
	+	End of Borhole	1000	3,72						EF
4	М	(Auger Refusal)								WL in screen at Elev. 72.56m on Sept. 25, 2007
6										
n										
7										
8										
0										
10										
DE	PTH S	SCALE		-				Golder		OGGED: D.J.S.

PROJECT: 06-1122-127-3 LOCATION: See Site Plan

# RECORD OF BOREHOLE: MW07-24

BORING DATE: September 4, 2007

SHEET 1 OF 1

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

4	НОВ	SOIL PROFILE	112		SA	MPL		DYNAMIC PENET RESISTANCE, BL	WS/0.3m	1	777.0.5	ULIC CO k, cm/s				NGA	PIEZOMETER
METRES	MET		PLOT	ELEV.	ER	ш	10.3m	20 40		80 '	10	-		_	O <sup>ck</sup>	ADDITIONAL LAB TESTING	OR STANDPIPE
ME	BORING METHOD	DESCRIPTION	STRATA PLOT	DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGT Cu, kPa		ŭ-0	Wp	TER CO	-oW	-1		CAB	INSTALLATION
-	a	GROUND SURFACE	S	75,32	-		m	20 40	GO	80	20	40	- 60	) {	30		
0	Т	Dark brown PEAT	11/2	0.00													
			4 1														Bentonite Seal
		Grey brown SILTY CLAY (Weathered Crush)	H	0.55													Native Backfill
Y		Citaly		74.25		50										П	S S S S S S S S S S S S S S S S S S S
1	Stem)	Compact grey brown CLAYEY SILT, trace gravel	m	1.07	1	50 DO	13									М	Bentonite Seal
	uger tollow s			1													
	Power Auger 200mm Diam (Hollow Stem)			73.49	2	50	m									П	Salica Sand
2	P Christin C	Brown grey SANDY SILT, some gravel, occasional cobbles		1,83		DO											
	20		1		F												
			30		.3	50 DO	40										38mm Diam PVC #10 Slot Screen
			200														
3			89	72.03	4	50 DO	44										
		End of Borehole (Auger Refusal)	1023	3 20												Ш	
	1		W														WL in screen at Elov. 73.49m on Sept. 25, 2007
			Ш													У	Sept. 25, 2007
																М	
																Ш	
5											- 1						
8																	
	18						П										
							M										
1																	
							Н										
n																	
-																	
Ü																	
10																	2
		CCALE	1		-		-	M.	ler ciates						-		OGGED: D.J.S.
																1.7	ACCED- DIE

### 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

1	HO	SOIL PROFILE	Th		SA	MPL		DYNAMIC RESISTAN			1	k, cm/s		MAL	PIEZOMETER
METRES	BORING METHOD	ps/16229/10	STRATA PLOT	ELEV.	SER	w	BLOWS/0.3m	SHEAR ST	40 PENGTH		80	10° 1	ONTENT PERCEN	Em	OR STANDPIPE
3	RINC	DESCRIPTION	RATA	DEPTH	NUMBER	TYPE	OWS	SHEAR ST Cu, kPa	RENGIN	rem V. d	ŭ-0		OW IN	A 88	INSTALLATION
	8		ST	(m)			m	20	40	60	80		0 60 B		
0	-	GROUND SURFACE	34	74.13					-	+	-				
	1	Dark brown PEAT	0.5	1.											
	Ш		17.3	73.58							1 1				Bentonite Seal
		Grey brown SILTY CLAY (Weathered	à	0.55		Ш					1 1				
	11	Crush)												10	□
- 1					ш	Ы	М	9.1 H			1 1				
	11					П					1 1				₩
					Ш		Ш								Native Backfill
						50					1 4				
2					2	50 DO	8				1 4				Native Backhil
*					-										
- 1															Ž
	F			71.45	2	50 DO	17								Dentonite Seal
	w Ster	Compact to dense brown grey SANDY SILT, some gravel & clay, trace cobbles (GLACIAL TILL)	1/2	2.68											
3	Auger	(GLACIAL TILL)													Silico Sand
	Diam (Hollo					50									1
- 1	200mm Dam (Hollow Stern)		32		3	50 DO	22								
	200		100		-										[8
	Ш				Г			1	- 1						
1	Ш				4	50 DO	14								1 8
			1				W	ľ							
- 1			1				М								
- 1					5	50 DO	96			l.					38mm Diam, PVC #10 Slot Screen
5			332												
			300												
			1												
			100												
ū				07.88	6	50	4								
1	-	End of Borehole	- AZX	0.25		DK1									
		(Auger Relusal)													(All in reman at
			10												WL in screen at Elev. 72.71m on Sept. 25, 2007
7					П	П									Copt 23, 2001
В															5
0															
10															
$\perp$	نيد		_					A .		1					
DE	РТН	SCALE					1	M						1	OGGED: D.J.S.
-							- (	7	COL	er iates					HECKED: HLRF

# 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

8		SOIL PROFILE			SA	MPL	ES	RESI	AMIC STAN	PENE	ETRA	VS/0.	3m	1	HY	DRAULIC k, c	CONDL m/s	CTIVIT	Υ	To	PIEZOMETER
BORING METHOD		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0 3m	SHE/ Cu, k	AR ST	TREN	GTH	nat ren	V. + 1 V €	Q - 0 U - C		10* WATER	10°	NT PER	-1 WI	ADDITIONAL LAB TESTING	OR STANDPIPE INSTALLATION
, B		Ground Surface Dark brown PEAT	1/2 E	74.67			۵		20	a(	0	60		30		20	40	60	80		
Power Auger 200mm Dam (Hollow Stem)	1	Very stiff grey brown SILTY CLAY (Weathered Crush)	3 2 3	73.03 1.04		50 DO	5														Bentonite Seal
Po 200mm Di		Stiff grey SILTY CLAY		71.62 3.05		50 DO	4														文 Native Backfill
	00	Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)		70,71																	
5	i i	Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam		00.82		50 DO	DO	10	0	90		00									Bentonite Seal
Rotary Drill HQ Core					۰	NO RG		TCR (%)	(%)	03	ROD (%)	00									Silica Sand
8:	F	Fresh grey LIMESTONE BEDROCK, with shale interbed	<b>高田田</b>	67 14 7.53	7	NQ RC		10	SCR	60	$\exists$	71									32mm Diam. PVC #10 Slot Screnn
					8	NO RC		10	0	97		75									32mm Diam. PVC #10 Slot Screnn
	E	End of Borehole		65.53 9.14																	WL in screen at Elev. 73.29m on Sept. 25, 2007

## 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

Y CO	HOD	SOIL PROFILE	T+	1	SA	MPL		DYNAMIC PE RESISTANC	E, BLOW	S/0.3m	1		cm/s			NAL	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	TA PLOT	ELEV. DEPTH (m)	MBER	TYPE	BLOWS/0.3m	SHEAR STR Cu, kPa	40 ENGTH	nat V. H		WATE	10 <sup>6</sup> R CONTE	IT PERC	ENT	ADDITIONAL LAB TESTING	OR STANDPIPE INSTALLATION
	BOR		STRATA	(m)	ž		810	4.7.5	40		80		40		80 80	44	
0		GROUND SURFACE	300	75.5													1417
		(Note: Stratigaphy from BRW-1, June 1992) SILTY CLAY		0.0													Concrete
2		Glacial Till		73.5 2.0	4 (1)												
3																	₹
4																	
5																	Bootonite Seal
6																	
7		Linestone Bedrock		68.1 7.4	4												
8																	
Ħ																	Silica Sand 32mm Diam. PVC 5.810 Slot Screen C
10	_L	CONTINUED NEXT PAGE		<u>-</u> . – –	+	-	-			+	-		-44-	-	4		#10 Slot Screen C
	-	CONTINUEDIVEXT PAGE						A .		1							

PROJECT: 06-1122-127-3 LOCATION: See Site Plan

# RECORD OF BOREHOLE: BRW1

BORING DATE: September 7, 2007

SHEET 2 OF 3

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

N C	HOD	SOIL PROFILE			SA	MPLI		RESIS	TANCE,	BLOW	S/0.3m	1		, cm/s			NG A	PIEZOMETER
TRES	3 ME	Constitution	PLO	ELEV.	SER	Ä.	3/0,3m	SHEAR		10 NGTH	_	- 0 - 0	10°			10 <sup>-3</sup> ERCENT	ADDITIONAL LAB. TESTING	OR STANDPIPE
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	DEPTH (m)	NUMBER	TYPE	BLOWS/0,3m	Cu, kPa	a	NIOIN	nat V. + rem V. €	ŭ-0					APD	INSTALLATION
-	m	CONTINUED FROM DESIGNAD BASE	_	Ž.,i	-		an	2	0	40	60	80	20	40	50	80		
10		CONTINUED FROM PREVIOUS PAGE Linestone Bedrock	- -											1				[8]
	Ш		垚										( 1)	- 1			10	
	Ш		芸											- 1				143
	Ш		17											- 1				
11			莊											- 1				1
			辛											- 1				1
			莊			Ш								- 1		- 1	118	32mm Diam, PVC
			莊							1								
12	Ш		豆															掛
			臣															
			끞															
			끞															Silver Cond
			芸															Silica Sand
13			11															
			171															
	Ш		莊															
	Ш		끞												- 1			Bentonite Seal
14			芸															
			荘															
			丑															
			11															
15	Ш		끂														117	Silica Sand
	Ш		莊												- 1		10	3
	Ш		王															3
	Ш		芸															3
16	П		臣								1						1111	1 8
			豆									1 1						13
			莊															
			莊															32mm Diam. PVC #10 Slot Screen B
17			臣															
			立															3
			宁															3
			臣															3
18			莊															3
			豆															3
			莊															8
			茔															Silica Sand
19			莊															25
			긒															
			4															Bentonite Seal
			芸															
20 -			- 57		- 7		-				+		عبيد	-+				
		CONTINUED NEXT PAGE			_	Ц											1_	
DEF	PTH S	CALE					-										L	OGGED: D.J.S.
	50	- 100 g / 1					- (	E	C	OIG	ates						7.5	ECKED: HLRF

## 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

T	00	SOIL PROFILE	1		SA	MPLE	S	DYNAMIC PENE RESISTANCE, B	TRAT	ION S/0,3m	1	HYD	RAULIC k, cm	CONDU	CTIVITY,	7	00.	PIEZOMETER
METRES	BORING METHOD		101		ox.		30	20 40			10	-	106	10'5	-	-	ADDITIONAL LAB. TESTING	OR STANDPIPE
MET	SING	DESCRIPTION	A I	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENG Cu, kPa	TH	nat V. + rem V. ⊕	Q- 0 U- 0			CONTEN			ADDIT	INSTALLATION
	BO		STR	(m)	Z		BLC	20 40		60 8	0			40		80	7.3	
20		CONTINUED FROM PREVIOUS PAGE Linestone Bedrock	1.6			4							-	-	-	+	-	
	1	Linestone Beurock	异															
			异			М									1			
-			莊											1				Bentonite Seal
21			11										18					
1			莊															
П			盅														17	Silica Sand
4			莊															(8)
22	П		臣															6.
			뫂															
-			茔													1		
			臣			П												(S)
23			国															32mm Diam. PVC
			퍞															#10 Stot Screen A
			丑															
			岛															
24			辛															2
	h		茔															2
	ı		莊															1
25	L	F-4-fills	豆	50.54	L													
		End of Hole		25.00		П										1		
1			Ш														1	WL in screen A at Elev. 72.99m on Sept. 25, 2007
																		Selfer and selfer
26																		
			11															WL in screen B at
																		Elev. 72.99m on Sept. 25, 2007
-			11															/
27		( )	11											1		1		
1		ľ								1								WL in screen C at
																		Wt. in screen C at Elev. 73.02m on Sept. 25, 2007
28																		
29																		
												1						
		h l																
30																		
			1-1	-		Ш	H	A A					_		1	4	_	
DEF	TH	SCALE					1	Asset	lde	T								OGGED: D.J.S.
125	50							ASS	oci	ates							CH	ECKED: HLRF

## 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

u,	CO	3	SOIL PROFILE			SA	MPL	ES	DYNAMIC PENE RESISTANCE, B	TRATIOI LOWS/0	,3m	1	HYDRA	ULIC CO k, cm/s	ONDUCT	IVITY,		10	PIEZOMETER	
DEPTH SCALE METRES	BORING METHOD		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	20 40 SHEAR STRENG Cu, kPa	TH na	_			TER CO	ONTENT	PERC		ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION	
5	80	3		STR	(m)	Z		BLC	20 40	60	80	)	20		0 6		80			
0		- 1	GROUND SURFACE TOPSOIL	222	75.6								-4	_			-			
1			Very stiff grey brown SILTY CLAY (Weathered Crust)		75.4 0.2	0													Protective casing set in Bentonite Seal	
. 2	Power Auger	D:am (Hollow Stem)	Compact grey SANDY SILT, some gravel, trace clay, occasional silty sand and silt seam or layer (GLACIAL TILL)		74.11		50 DO	21												
3		200mm				2	50 DO	28											38mm Diam PVC #10 Slot Screen	
- 4					71.3															
Ì		T	End of Borehole Auger Refusal	722	4.2															_
- 5																				
6																				
7																				
8																				
. 0																				
DEF		H S0	CALE						Go	lder								Lo	OGGED: D.J.S. DECKED: #LRF	

# 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

0	RORING METHOD	3	SOIL PROFILE	b		SA	MPL	_	DYNAMIC RESISTAN				1		k, cm/s			400)	NAL	PIEZOMET	ER
MEINES	S ME	1	DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0 3m	SHEAR ST Cu, kPa	40 RENGTH	60 I nat		Q - •	_		CONTEN	1	10 <sup>-3</sup> ENT	ADDITIONAL LAB. TESTING	OR STANDPIE INSTALLAT	
8	N N		DESCRIPTION	TRAT	DEPTH (m)	NON	7	LOW	Cu, kPa							O <sup>W</sup>		WI	AB LAB	INSTALLATI	ION
+	α	3	GROUND SURFACE	S	-	-		an I	20	40	60	8	0	2	0	40	60	80			_
0	Н	-	TOPSOIL	EEE	74.93			$\dashv$		+	-					+	-	+			
-	П	ł	Grey brown SILTY CLAY (Weathered	W	74.72															Protective casing	
			Crust)		74.32															set in Bentonite Seal	п
-		ı	Grey brown SANDY SILT, some gravel,	<b>***</b>	0.61															Sea	п
			trace clay, occasional cobble (GLACIAL TILL)															1			
1				28												1					1
1																					涯
-		(H)				-															1
-	J.O	ow St			1	1	50 DO	62													I.E
2	Power Auger	(Hot				7.37	00	Starts													1
	Powe	200mm Diam (Hollow Stem)		<i>?</i> ?		Г												1			E
		00mm	Compact prev SILTY SAND some		72.49											1				38mm Diam PVC #10 Slot Screen	1
-	П	2	Compact grey SILTY SAND, some gravel, occasional fine to coarse sand layer (GLACIAL TILL)																	III TO CHOL CUITOCH	
			layer (GLACIAL TILL)															1			1
3																					NE.
-						2	50 DO	26													1
				<i>1</i> 22	71.27																
			Grey SANDY SILT, some gravel and clay (GLACIAL TILL)		3.66																
4	_	+	End of Borehole Auger Refusal	8/1/	70.88 4.05		П	$\exists$													L
-		- 1	Auger Refusal															1			
1		-1																			
-1		-																			
5		-																			
		-																	1		
١		-																1			
-		1																			
6		- 1																	1		
1		- 1																			
		-															1				
-		- 1								-1									1		
7		- 1																	1		
-																					
		-																	1		
		-															'				
8		-																			
9																					
10																					
			CALE					100	A										17	OGGED: D.J.S.	

1:50

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

9, E	HOD	SOIL PROFILE	1 -	_	SAI	MPLE	-	DYNAMIC PENETRATION RESISTANCE, BLOWS/0,3m	1	k, cm/s		A N	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD		STRATA PLOT	ELEV.	SER	m	/0.3m	20 40 60	80	-1	ONTENT PERCE	ADDITIONAL	OR STANDPIPE
MEPT	RING	DESCRIPTION	ATA	DEPTH	NUMBER	TYPE	BLOWS/0	SHEAR STRENGTH nat V. Cu, kPa rem V.	# U-O		ONTENT PERCE	APD DAR	INSTALLATION
r)	80		STR	(m)	2		B	20 40 60	80			80	
. 0		GROUND SURFACE		82.10									
. 2		GARBAGE (FILL)		0.00									Protective casing set in Bentonite Seal
	Power Auger	Annual An											Caved Material Silica Sand
- 6					1	50 DO	19						38mm Diam PVC #10 Slot Screen
. 7.		PEAT		74.48 7.62	2	50 DO	5						
- 8		Grey brown SILTY CLAY  Grey brown SANDY SILT  End of Borehole		7.77 74.02 8.08 8.23	3	50 DO	10						Bentonite Seal
- 0													
- 10													
DEI		SCALE					(	Golder				ı	LOGGED: D.J.S. HECKED: JELRE

PROJECT: 1416664-6000

### RECORD OF BOREHOLE: 15-1

SHEET 1 OF 1

BORING DATE: July 23, 2015 LOCATION: See Site Plan

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DESCRIPTION  GENERAL COMPLETE				THAININER, 04KG, DROP, 700HIII								PENETRATION TEST HAIV	.,	ong, bron, roomin
ORIGINAL SURFFICE  ORIGINAL SURF	ĘĘ.			SOIL PROFILE	1.		SA	MPL		DYNAMIC PENETRA RESISTANCE, BLO		HYDRAULIC CONDUCTIVITY, k, cm/s	일등	PIEZOMETER
ORIGINAL SURFFICE  ORIGINAL SURF	1SC/ IRES		_   		PLOT	  ,	ER	111	.30m		60 80		TION	OR
ORIGINAL SURFFICE  ORIGINAL SURF	EPTF ME			DESCRIPTION	ATA		UMBI	TYPE	WS/C	SHEAR STRENGTH Cu, kPa	nat V. + Q - ● rem V. ⊕ U - ○	WATER CONTENT PERCENT	AB. T	
GROUND SUPPORT  TOPOSIL  TOPOS					STR	(m)	Z		BLO			WP WI	٠,	
Construction of the constr						74.40								
CLUMA CLUMPER SET, two to medium by the company of	_			TOPSOIL		0.00								1
501 of South-to Auger Refusals  7.27  - 3  - 5  - 5  - 5  - 7  - 7	_		(em)	(CL/ML) CLAYEY SILT. low to medium		74.05 0.35								Bentonite Seal
501 of South-to Auger Refusals  7.27  - 3  - 5  - 5  - 5  - 7  - 7	-	je j	low S	plasticity; brown; cohesive, w>PL, very		1		,,						
501 of South-to Auger Refusals  7.27  - 3  - 5  - 5  - 5  - 7  - 7		er Aug	유)			73.49		AS	-					Silica Sand
501 of South-to Auger Refusals  7.27  - 3  - 5  - 5  - 5  - 7  - 7	_ 1	Powe	Dian	(ML) sandy SILT, some low plasticity										
501 of South-to Auger Refusals  7.27  - 3  - 5  - 5  - 5  - 7  - 7	_		00 ml	brown (GLACIAL TILL); wet, compact										50 mm Diam. PVC
End of Screeched Agent Voltated  1.88  Agent Voltated  7  7  7  7  7	-		آ				_							
Auger Refusal  Agent Refusal  1  1  1  1  1  1  1  1  1  1  1  1  1	-		Н	End of Borehole			2	SS	>50					
	_ ,													
	_ ^													-
	ļ.													
	Ē													-
	Ļ													]
	— 3 -													=
	Ē													-
	ļ.													]
	_													-
- 8 - 9 - 10	- - 4													4
- 8 - 9 - 10														]
- 8 - 9 - 10	-													_
- 8 - 9 - 10	_													-
- 8 - 9 - 10														=
	٥													3
	_													-
	-													=
														]
	<del>-</del> 6													-
	-													-
	-													1
														]
	- - 7													<u> </u>
	ļ '													=
	Ė													-
	E													]
	ŀ													
	- 8 -													=
	E													]
	ļ.													]
	ļ.													
	_ 9													-
	Ĺ													]
	ŀ													
	F													
	L													
	T 10													
DEPTH SCALE  1:50  CHECKED: MIB						<u> </u>	<u> </u>		1					
1:50 Associates CHECKED: MIB	DE	ΕPΤ	H S	CALE					(		er		LC	OGGED: PAH
	1:	50							,	VASSOC	iates		СН	ECKED: MIB

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

PROJECT: 1416664-6000 LOCATION: See Site Plan

### RECORD OF BOREHOLE: 15-2

BORING DATE: July 23, 2015

SHEET 1 OF 1 DATUM: Geodetic

4   5	e l	SOIL PROFILE	1		SA	MPL		DYNAMIC PENETR RESISTANCE, BLC		HYDRAULIC CONDUCTIV k, cm/s	ITY,	PIEZOMETER
METRES MODING METHOD	BORING METH	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m		60 80 H nat V. + Q - • rem V. ⊕ U - C	Wp F	ERCENT DILIG	OR OR STANDPIPE INSTALLATION
o 1 Power Auger	200 mm Diam. (Hollow Stem)	GROUND SURFACE TOPSOIL (CL/ML) CLAYEY SILT, trace gravel and low plasticity fines; grey brown; cohesive, w~PL, very stiff		74.68 0.00 74.47 0.21	1	AS	-	20 40	60 80	20 40 60	80	Bentonite Seal  Silica Sand  50 mm Diam. PVC #10 Slot Screen
4 4 5		End of Borehole Auger Refusal		. 73.28 1.40								
8												
9												

PROJECT: 1416664-6000

### **RECORD OF BOREHOLE: 15-3**

SHEET 1 OF 2

LOCATION: See Site Plan	BORING DATE: July 21, 2015	DATUM: Geodetic
-------------------------	----------------------------	-----------------

삨	9	SOIL PROFILE			SA	MPL		DYNAMIC PEI RESISTANCE	NETRATIO , BLOWS/0	N \ ).3m \		HYDRAUL k,	.IC CONDU cm/s	CTIVITY,	څُد ا	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRE Cu, kPa		at V. + Q m V. ⊕ U	) - O	Wp 📙	ER CONTER		ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
_		GROUND SURFACE	ν.	75.41			- B	20	40 60	80		20	40	60 80		
0		TOPSOIL		0.00												
. 1		(CI/CH) SILTY CLAY, trace sand; grey brown, fissured (WEATHERED CRUST); cohesive, w~PL, very stiff		75.16 0.25												Bentonite Seal
	ger illow Stem)	GLACIAL TILL		73.89 1.52												Silica Sand
3	Power Auger 200 mm Diam. (Hollow Stem)															Bentonite Seal
				71.45												Native Backfill
4		Fresh, grey LIMESTONE  Borehole continued on RECORD OF DRILLHOLE 15-3	+	3.96 4.09												-
		BINEERIOLE 13-3														
5																
6																
v																
7																
8																
9																
10																
DE	PTH S	SCALE					4	<b>B</b> AS	- 112						L	OGGED: PAH
DE	PTH S	SCALE						<b>FAG</b>	older	,						OGGED: PAH IECKED: MIB

PROJECT: 1416664-6000 DRILLING DATE: July 21, 2015 LOCATION: See Site Plan

RECORD OF DRILLHOLE: 15-3

DRILL RIG: CME 55

INCLINATION: -90° AZIMUTH: ---DRILLING CONTRACTOR: Downing Drilling PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate 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 DEPTH SCALE METRES SYMBOLIC LOG ELEV. DESCRIPTION FRACT. INDEX PER 0.25 m HYDRAULIC D CONDUCTIVITY PO K, cm/sec RUN DEPTH RECOVERY DISCONTINUITY DATA DIP w.r.t CORE AXIS oint Loa Index (MPa) (m) TOTAL SOLID CORE % TYPE AND SURFACE DESCRIPTION 2,000 0000 8848 BEDROCK SURFACE Fresh, grey LIMESTONE Bentonite Seal Silica Sand - Lost core from 4.87 m to 5.03 m - Lost core from 5.49 m to 5.53 m - Lost core from 5.69 m to 5.74 m 9 Rotary Drill NQ Core 32 mm Diam. PVC #10 Slot Screen - Lost core from 6.96 m to 7.01 m 67.33 End of Drillhole 10 11 12 13 14 DEPTH SCALE LOGGED: PAH

Golder

MIS-RCK 004 1416664-6000.GPJ GAL-MISS.GDT 12/14/15

1:50

SHEET 2 OF 2

DATUM: Geodetic

### RECORD OF BOREHOLE: 16-1

SHEET 1 OF 2

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

LOCATION: See Site Plan

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: December 8, 2016

DATUM: Geodetic

»LE	HOD	SOIL PROFILE	1_	_	SA	MPLE		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	A P	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	20 40 60 80 SHEAR STRENGTH nat V. + Q - ● Cu, kPa rem V. ⊕ U - ○	Wp <del>                                    </del>	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
	ш	GROUND SURFACE	S.	74.71			ā	20 40 60 80	20 40 60 80		
0		(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		73.41 1.30							Bentonite Seal
2		CRUST); cohesive, very stiff  (CL/MC) CLAYEY SILT to SILTY CLAY;		72.60 2.11	2	ss	5				
	(u	trace gravel; grey; cohesive, very stiff									Silica Sand
3	Power Auger 200 mm Diam. (Hollow Stem)				3	ss	4				Silica Santu
4	200 mm [										
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				32 mm Diam. PVC #10 Slot Screen 'B'
6					5	ss	>50				
7		Borehole continued on RECORD OF DRILLHOLE 16-1		67.93 6.78							Bentonite Seal
8											
9											
10											
DE	PTH S	] SCALE	1					Golder Associates		LC	OGGED: JD

RECORD OF DRILLHOLE: 16-1 PROJECT: 1650505 SHEET 2 OF 2 DRILLING DATE: December 8, 2016 DATUM: Geodetic LOCATION: See Site Plan DRILL RIG: CME INCLINATION: -90° AZIMUTH: ---DRILLING CONTRACTOR: Downing Drilling BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate 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 DEPTH SCALE METRES SYMBOLIC LOG ELEV. HYDRAULIC Diametral CONDUCTIVITY Point Load Index (MPa) DESCRIPTION R.Q.D. FRACT. INDEX PER 0.25 m RUN DEPTH RECOVERY DISCONTINUITY DATA DIP w.r.t. CORE AXIS (m) TOTAL SOLID CORE % TYPE AND SURFACE DESCRIPTION 2,000 9000 8848 BEDROCK SURFACE 67.93 Slightly weathered to weathered, highly fractured, grey LIMESTONE, with shale interbedded Bentonite Seal Rotary Drill 32 mm Diam. PVC #10 Slot Screen 'A' 2 End of Drillhole 10 11 12 13 14 15 16 DEPTH SCALE LOGGED: JD Golder

CHECKED: MIB

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

1:50

LOCATION: See Site Plan

### RECORD OF BOREHOLE: 16-2

SHEET 1 OF 1 BORING DATE: December 8, 2016 DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

» LE	HOD	SOIL PROFILE	1 -		SA	MPLES	RESISTANC	ENETRAT	TON S/0.3m	1	HYDRAULIC CONDUCTIVITY, k, cm/s	NG PE	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE BLOWS/0.30m	20 SHEAR STR Cu, kPa	40 ENGTH	1	U-O	10 <sup>-6</sup> 10 <sup>-5</sup> 10 <sup>-4</sup> 10 <sup>-3</sup> WATER CONTENT PERCENT  WP   WI  20 40 60 80	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
. 0		GROUND SURFACE		74.72				Ĭ					
		(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							Native Backfill
	em)				4	SS 5							Bentonite Seal
3	Power Auger 200 mm Diam. (Hollow Stem)				5	SS 2							Silica Sand
4	200 mm				6	SS 3							
5					7	SS 1							32 mm Diam. PVC #10 Slot Screen
6				68.62	8	SS 2							
		(ML) sandy SILT, some gravel; grey (GLACIAL TILL); non-cohesive, wet, compact		6.10 68.01 6.71	9	SS 2							
7		Auger Refusal											
8													
9													
10													
DE	PTH S	CALE	1	1	I				er ates			L	OGGED: JD

### **RECORD OF BOREHOLE: 16-3**

SHEET 1 OF 3

LOCATION: See Site Plan

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: December 8, 2016

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

, F		SOIL PROFILE	<b>I</b> ⊢		SA	MPLES	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	₽ <sub>N</sub>	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE BLOWS/0.30m	20 40 60 80 SHEAR STRENGTH nat V. + Q - ● CU, kPa rem V. ⊕ U - ○  20 40 60 80	10 <sup>-6</sup> 10 <sup>-5</sup> 10 <sup>-4</sup> 10 <sup>-3</sup> WATER CONTENT PERCENT  Wp	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
0		GROUND SURFACE		75.05						
		(PT) sandy SILT, some organics; dark brown (PEAT); non-cohesive, moist, very loose		0.00	1	SS 1				
1					2	ss wh				Bentonite Seal
2		(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
					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				Sillica Sand
4					6	ss wh				
5	Power Auger 200 mm Diam. (Hollow Stem)				7	ss wh				
6	P. 200 mm D				8	ss wh				Bentonite Seal
0					9	SS 1				
7		(SP) gravelly SAND, some silt; reddish grey; non-cohesive, wet, loose		67.73	10	SS 9				Sillica Sand
8			A A A A A		11	SS 3				32 mm Diam. PVC
9			4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4		12	SS 9				#10 Slot Screen 'B'
		(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very dense		9.17	13	SS 22				Silica Sand
10	_L	CONTINUED NEXT PAGE			_14 _	S <u>S</u> 28				Bentonite Seal

LOCATION: See Site Plan

### **RECORD OF BOREHOLE: 16-3**

BORING DATE: December 8, 2016 DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

SHEET 2 OF 3

SAI	VIPLE	R HAMMER, 64kg; DROP, 760mm											PENETRA	IION IE	ST HAI	MMER,	64kg; DROP, 760mm
	00	SOIL PROFILE			SA	MPL	.ES	DYNAMIC PEN	ETRATI BLOWS	ON /0.3m	)	HYDRAULI k, c	C CONDUC m/s	TIVITY,		ص ا	
METRES	BORING METHOD		LOT		ĸ		30m				0 ``	10 <sup>-6</sup>			0 <sup>-3</sup>	ADDITIONAL LAB. TESTING	PIEZOMETER OR
MET	SING	DESCRIPTION	STRATA PLOT	ELEV. DEPTH	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRE Cu, kPa	NGTH I	nat V. + em V. ⊕	Q - • U - O		R CONTEN	T PERCE		B. E.	STANDPIPE INSTALLATION
	BOR		STR/	(m)	ž	ľ	BLO\				0	Wp <b>I</b> — 20			W <b>I</b> 80	⋖	
10		CONTINUED FROM PREVIOUS PAGE	414.4														
	nger	(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very				SS	28										
	Power Auger	non-cohesive, wet, compact to very dense			14	55	28										
	8																
	ور 9																Bentonite Seal
1	Wash Boring NW Casing				15	SS	64										
	Was																
ŀ		Borehole continued on RECORD OF		63.47 11.58	16	SS	>50										
		DRILLHOLE 16-3															
2																	
3																	
5																	
,																	
9																	
0																	
- [			l	1	l	1	1		1	1	l	1	1	1	1	1	I

DEPTH SC 1 : 50

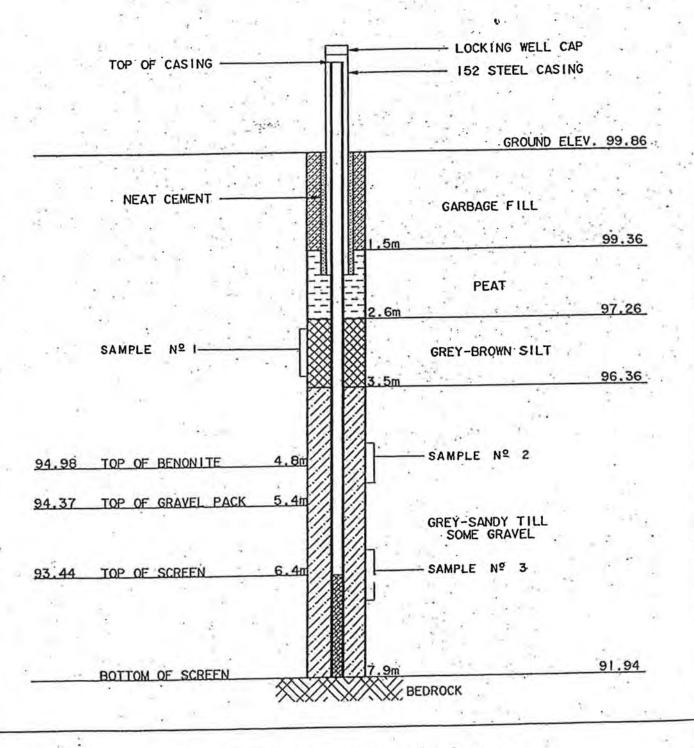
MIS-BHS 001 1650505-8000.GPJ GAL-MIS.GDT 03/23/17 JM

CHECKED: MIB

RECORD OF DRILLHOLE: 16-3 PROJECT: 1650505 SHEET 3 OF 3 DRILLING DATE: December 8, 2016 DATUM: Geodetic LOCATION: See Site Plan DRILL RIG: CME INCLINATION: -90° AZIMUTH: ---DRILLING CONTRACTOR: Downing Drilling BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate 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 DEPTH SCALE METRES SYMBOLIC LOG ELEV. HYDRAULIC Diametral CONDUCTIVITY Point Load Index (MPa) DESCRIPTION FRACT. INDEX PER 0.25 m RUN DEPTH RECOVERY DISCONTINUITY DATA DIP w.r.t. CORE AXIS (m) TOTAL SOLID CORE % TYPE AND SURFACE DESCRIPTION 180 270 0000 8848 BEDROCK SURFACE Slightly weathered to weathered, highly fractured, grey LIMESTONE, with shale interbedded 11.58 8 Bentonite Seal Silica Sand 12 32 mm Diam. PVC #10 Slot Screen 'A' ğ 13 3 Silica Sand 61.05 14 End of Drillhole 15 16 17 18 19 MIS-RCK 004 1650505-8000.GPJ GAL-MISS.GDT 03/23/17 JM 20 21 DEPTH SCALE LOGGED: JD Golder 1:50 CHECKED: MIB

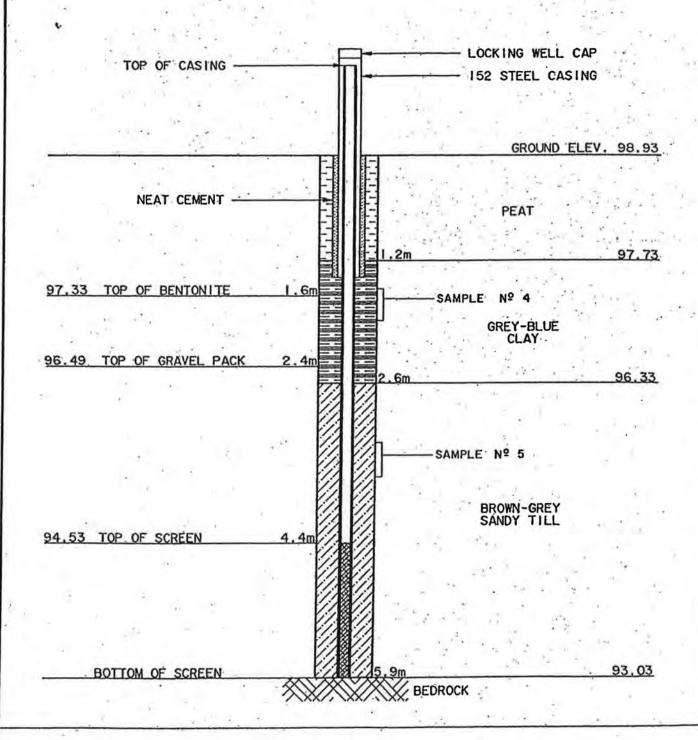
# MONITORING WELL #1 BOREHOLE LOG





DATE: MARCH, 1991	TOWNSHIP OF WINCHESTER LANDFILL	90-7848
SCALE: N.T.S.	MONITORING WELL INSTALLATION	

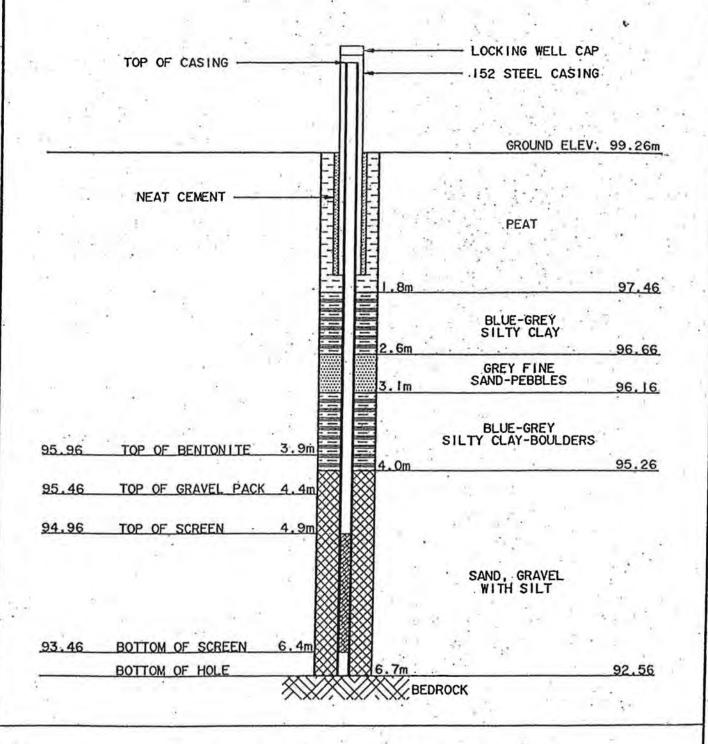
### MONITORING WELL #2 BOREHOLE LOG





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

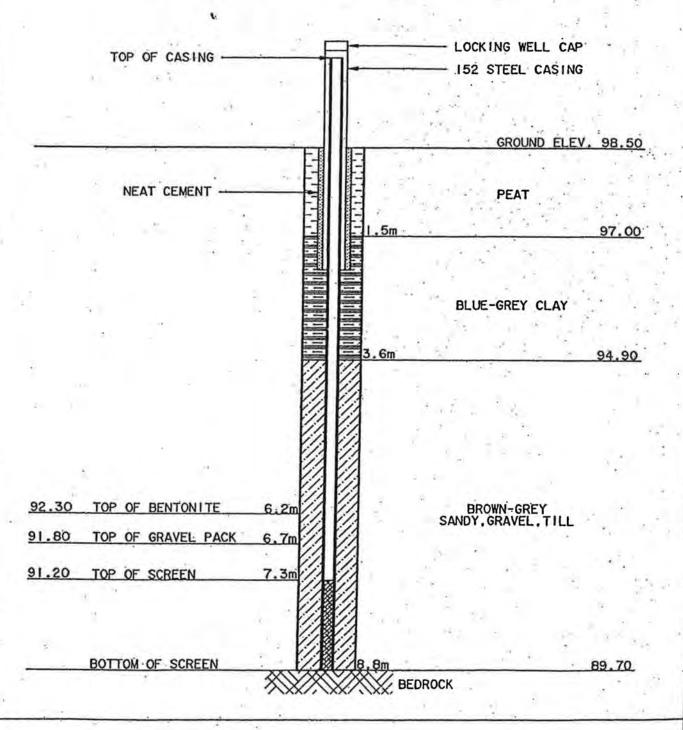
### MONITORING WELL #3 BOREHOLE LOG





MARCH, 1991	TOWNSHIP OF WINCHESTER LANDFILL	DRAWING NO. 90-7848
SCALE:	MONITORING WELL INSTALLATION	

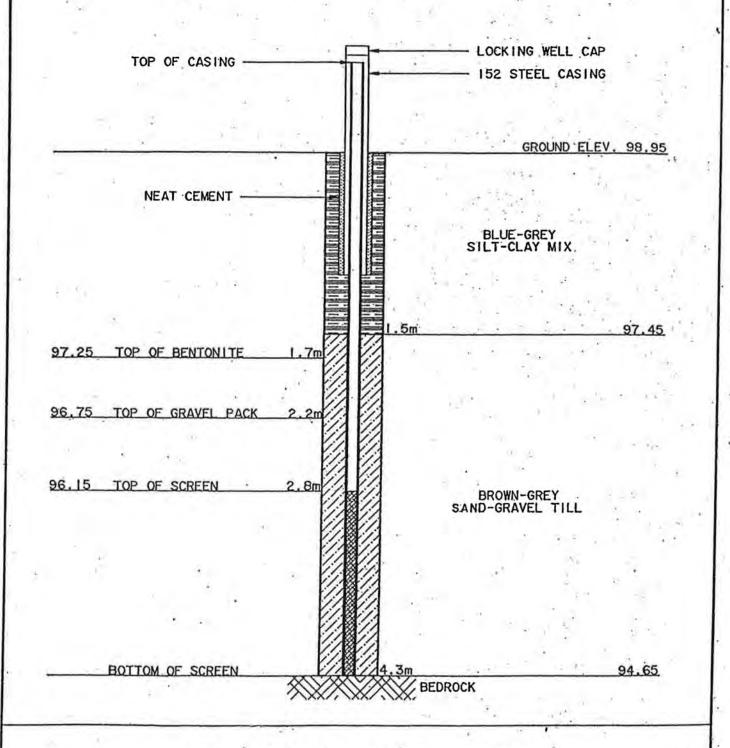
### MONITORING WELL #4 BOREHOLE LOG



# OLIVER MANGIONE MCCALLA & ASSOCIATES LIMITED Consulting Engineers Nepean, Ontario

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

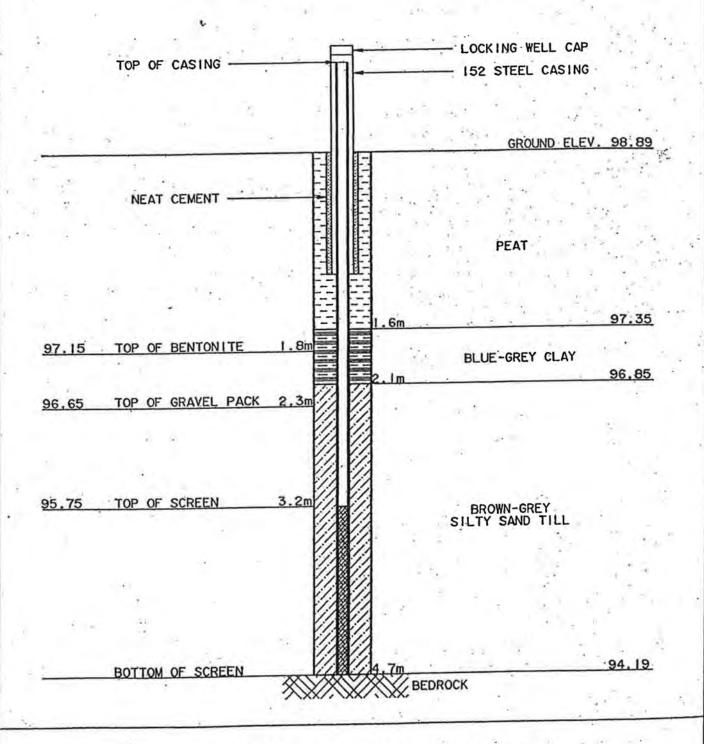
## MONITORING WELL #5 BOREHOLE LOG





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

## MONITORING WELL #6 BOREHOLE LOG





DATE: MARCH, 1991	TOWNSHIP OF WINCHESTER LANDFILL	90-7848
SCALE: N.T.S.	MONITORING WELL INSTALLATION	

ONITORING WELL NUMBER: MW 7

DRILL TYPE: CME 55 HOLLOW STEM AUGER

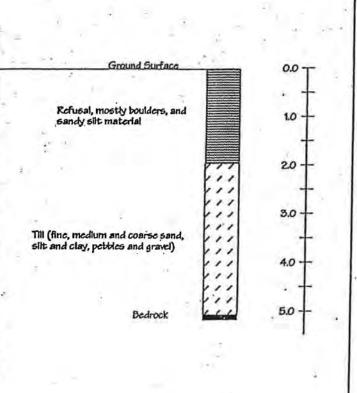
PRILLER: MARATHON

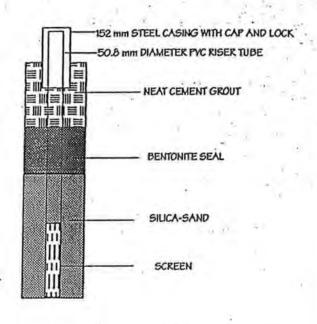
LOCATION: CONCESSION VII, LOT 8

DATE: JUNE 9, 1992

SOIL DESCRIPTION DEPTH ELEV.

PIEZOMETER INSTALLATION





Π.	S.	THOMPSON	&
S	SO	THOMPSON CLATES LTD.	

**NSULTING ENGINEERS** 

ROSEMOUNT AVE. CORNWALL KGJ 3ES

	According to	
FIGURE	TILE	

SOIL PROFILE AND PIEZOMETER CONSTRUCTION

JOB

WINCHESTER TOWNSHIP LANDFILL SITE

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

MONITORING WELL NUMBER: MW 8

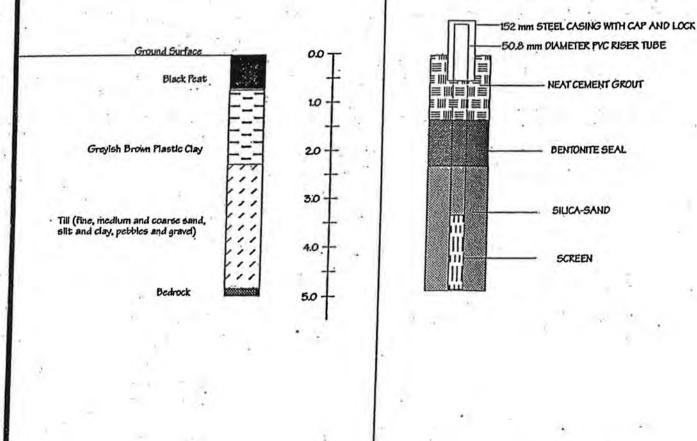
DRILL TYPE: CME 55 HOLLOW STEM AUGER

DRILLER: MARATHON

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

SOIL DESCRIPTION ELEV. (m) (m)

PIEZOMETER INSTALLATION



M.	S.	THÒM	PSON	&
AS	SO	CIATES	LTD.	

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE CORNWALL K6J 3ES

JOB

SOIL PROFILE AND PIEZOMETER CONSTRUCTION

DATE JUNE 1992

SCALE AS SHOWN

DRAWN MHM

JOB No. 92094

FIGURE:

WINCHESTER TOWNSHIP LANDFILL SITE

MONITORING WELL NUMBER: MW 9

LOCATION: CONCESSION VII, LOT 8

DRILL TYPE: CME 55 HOLLOW STEM AUGER

DRILLER: MARATHON

DATE: JUNE 9, 1992

SOIL DESCRIPTION	STRAT.	DEPTH ELEV. (m) (m)	PIEZOMETER INSTALLATION
Ground Surface Black Peat		20-	152 mm STEEL CASING WITH CAP AND LOCK  -50.8 mm DIAMETER PVC RISER TUBE
Greyish Brown Plastic Clay		5.0	BENTONITE SEAL
Till (fine, medium and coarse sand, silt and clay, pebbles and grave)		7.0 -	SILICA-SAND  SCREEN
Bedrock		9.0 +	

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

MONITORING BEDROCK WELL: BRW-1

LOCATION: CONCESSION VII, LOT 8

DATE: JUNE 10, 1992

DRILL TYPE: CME 55 HOLLOW STEM AUGER

DRILLER: MARATHON

STRAT. DEPTH ELEV. PIEZOMETER INSTALLATION SOIL DESCRIPTION (m) (m) (LD. = 158.8 mm) 0.0 Greyish Brown Plastic Clay NEAT CEMENT GROUT (LD. = 228 mm) 4.0 Till (fine, medium and coarse sand, silt and clay, pebbles and gravel) 8.0 Fractured Umestone 120 OPEN HOLE ( LD. = 152 mm) 16.0 Light grey Limestone, Compact 20.0 24.0 28.0

M. S.	<b>THOMPSON</b>	&
	CIATES LTD.	

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE. CORNWALL K6J 3E5

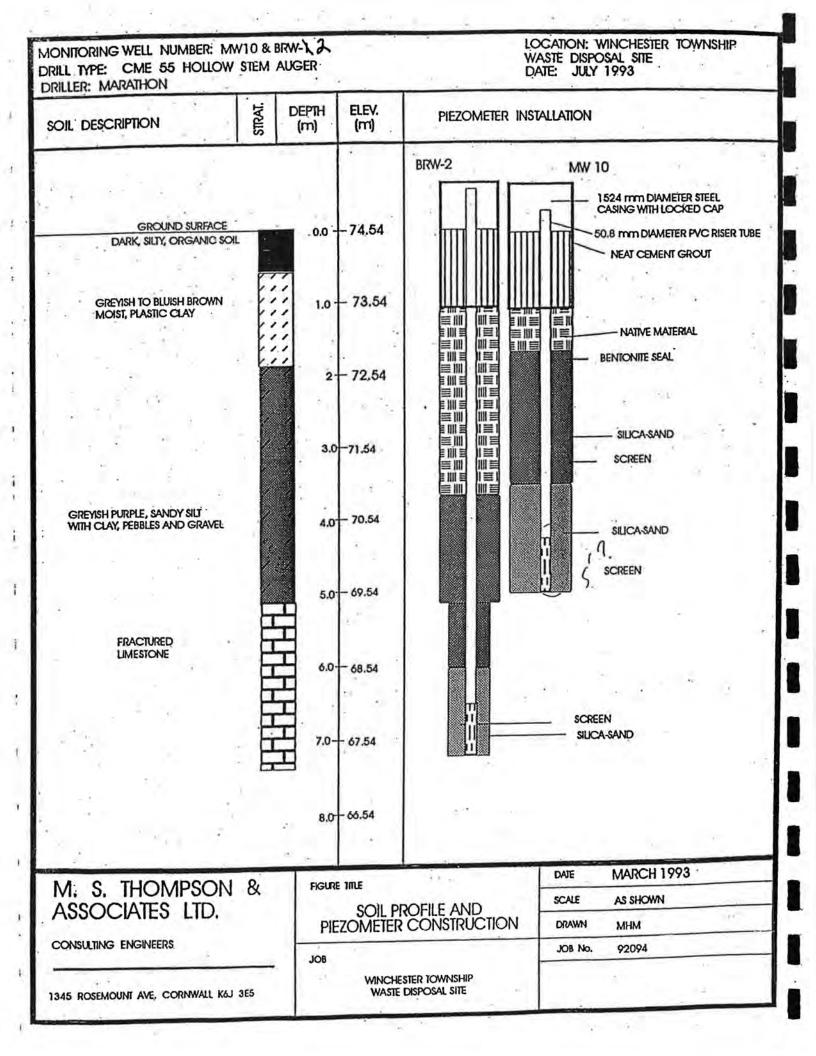
FIGURE TITLE	
SOIL PROFILE AND F	EZOMETER CONSTRUCTION

\_\_\_\_\_

WINCHESTER TOWNSHIP LANDFILL SITE

JOB

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



## Log of MW 16

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince



	S	UBSURFACE PROFILE		. 8	SAMPLE		Malatia		
Depth	Symbol	- Description	Elev.	Number	Type	Recovery	Volatile Organic Compounds ppmv 25 75 125175	Well Data	Lab Analysis
0 m 0		Ground Surface	0						
1-1	الالالالا	TOPSOIL Topsoil.	-0.76	AU 1	1				
3-1-1-		CLAYEY SILT		SS 2					
5=		Medium grey, moist, soft, fractured clayey silt with			H				,
5-1 6-1 7-2	$\mathbb{I}$	traces of sand till.		SS 3	Ш				*
1 7	1		-2.3		-	NAME OF			
9-1-3				SS 4					D B
11-1-1		SILTY SAND  Medium brown to grey, moist to saturated, silty sand with some coarse gravel till.		SS 5					
13 - 4		, ,	-4.6	SS 6	$\Pi$				
16-1-5 17-1- 18-1- 19-1-		End of Borehole							
20=6			1				1111111		

Drill Method: Hollow Stem Auger

Trow Consulting Engineers Ltd.

Drill Date: September 26, 2002

154 Colonnade Road South Nepean, Ontario K2E 7J5

Hole Size: 0.15 metres

Checked by: B.Coons

Sheet: 1 of 1

Datum:

## Log of MW 17

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince



SUBSURFACE PROFILE			5	SAMPLE		14-1-17-			
Depth	Symbol	Description	Elev.	Number	Туре	Recovery	Volatile Organic Compounds ppmv 25 75 125175	Well Data	Lab Analysis
m		Ground Surface	0			lien.			
	727	TOPSOIL . Topsoil.	-0.3						
+	,			AU 1					
-1 -1				SS 2			Management of the control of the con		
-2		SILTY GRAVELLY SAND Medium brown, dry, hard, silty gravelly sand till.	-3	AU 3	}				
		, n		SS 4					
4		SILTY GRAVELLY SAND Medium grey, wet, hard, silty gravelly sand till.  End of Borehole	-4.6	AU 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

## Log of MW 18

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince



	S	UBSURFACE PROFILE			SAMPLE		Volatile		
S 50	Symbol	Description	Elev.	Number	Туре	Recovery	Organic Compounds ppmv 25 75 125175	Well Data	Lab Analysis
0		Ground Surface	0		100				
0	2/2	TOPSOIL Topsoil.	-0.3		1				
	#	SILTYCLAY		AU 1		47.00			Ŷı
1	#	Medium brown, moist, silty fractured clay.	-1.2	- SS 2					
2		SILTY SAND		SS 3					
		Medium brown, dry, silty sand with some gravel till.	-3	SS 4	$\prod$				
3		SILTY SANDY GRAVEL  Medium grey, wet, silty sandy gravel till.  Refusal at 11 feet.	-3.4	SS 5	П	***************************************			
		End of Borehole						0.0	
4			ż						
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

# Log of MW 19

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

· Logged by: Matt Prince



	S	UBSURFACE PROFILE		SAMPLE			Volatile		
Depth	Symbol	Description	Elev.	Number	Туре	Recovery	Organic Compounds ppmv 25 75 125175	Well Data	Lab Analysis
ft m		Ground Surface	0		7 4	-			
antitude of	7~	Topsoil.	-0.3	AU 1	1				
1	H	SILTY CLAY		SS 2	Ĭ				ī
-2	###	Medium brown, dry, har, silty day with some gravel till.		AU 3	1		Account to the control of the contro		
Thinks to	#			AŲ 4	1				
4		SILTY SAND Medium grey, dry, hard, silty sand with some gravel till. Refusal at 11'2". End of Borehole	-3.4	SS 5	П				
5									

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

ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN
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 m³. 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:

- 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<sub>s</sub>, is calculated as:

$$F_s = k_s \times M$$

Where:  $k_s = \text{horizontal seismic coefficient}$ ; 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:

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

 $\tau$  = Strength of the soil;

c' = Effective cohesion of the soil;

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

and,

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<sup>3</sup>.

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.



Project No. 1648253 Golder Associates Ltd. January 28, 2022

Matarial	Bulk Unit	Drained	Undrained Parameters	
Material	Weight (kN/m³)	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.

Castian	Global Factor of Safety							
Section	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.



Trish Edmond, P.Eng. Project No. 1648253
Golder Associates Ltd. January 28, 2022

#### 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.** 

Bridgit Bocage, P.Eng. Geotechnical Engineer

Anft Br

Sarah MacDonald P.Eng. Senior Geotechnical Engineer

Saral MacDonald

### 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:

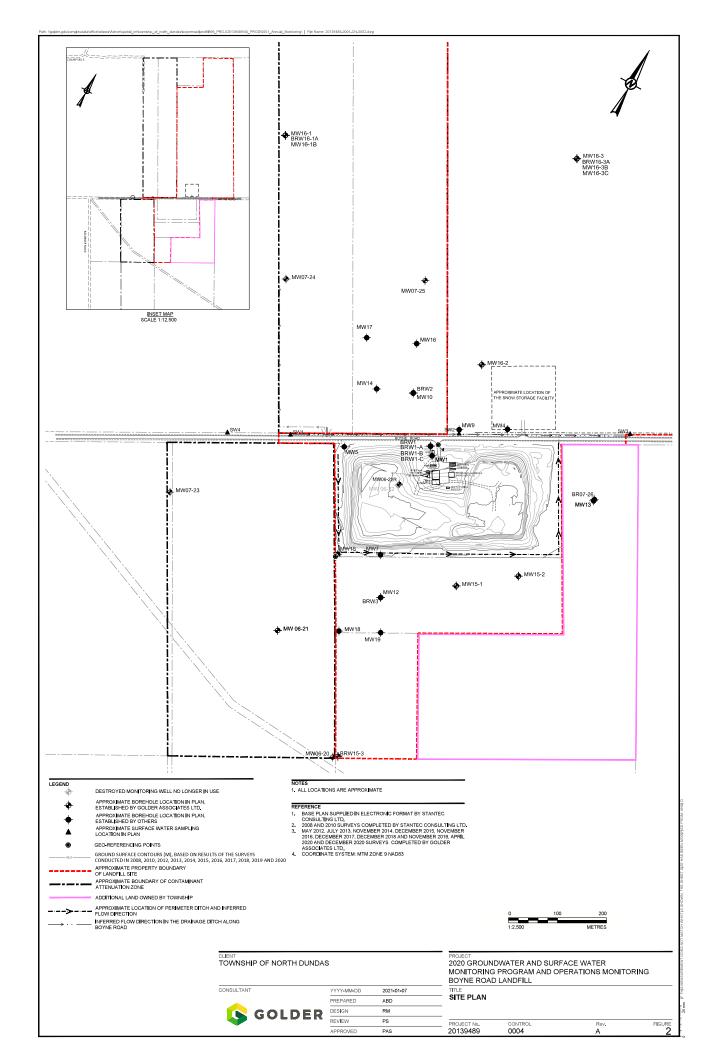
Bray, J.D., Zekkos, D., Kavazanjian Jr., E., Athanasopoulos, G.A., Riemer, M.F. (2009). "Shear Strength of Municipal Solid Waste." *Journal of Geotechnical and Geoenvironmental Engineering*, 135(6), 709-722.

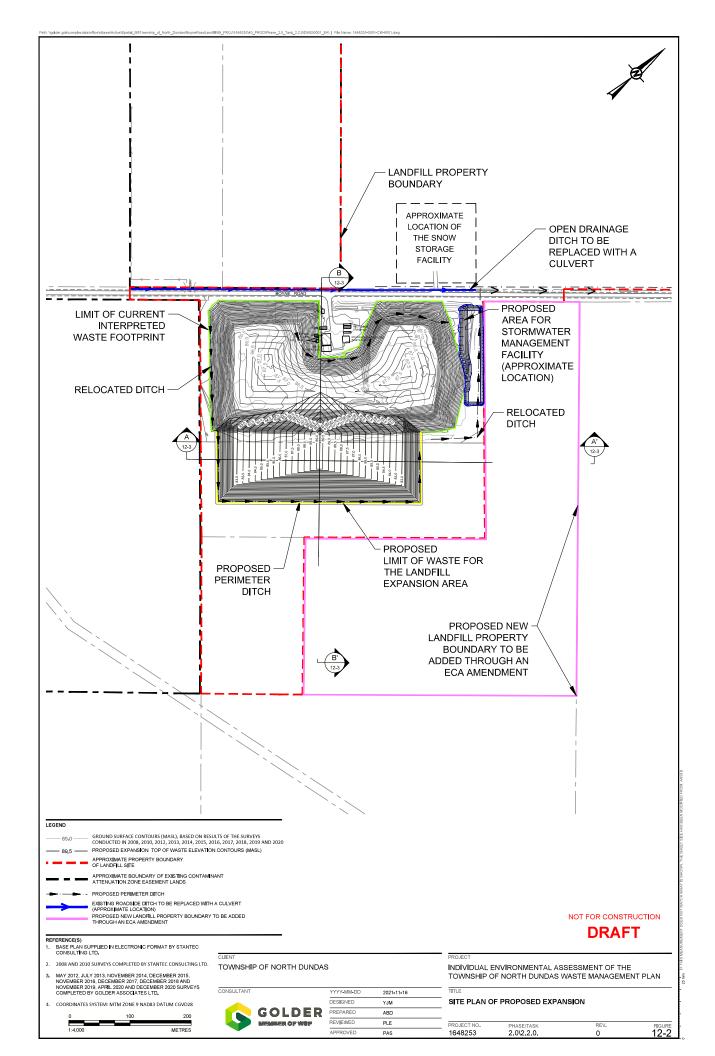
Lefebvre, G. (1981). "Fourth Canadian Geotechnical Colloquium: Strength and slope stability in Canadian soft clay deposits." *Canadian Geotechnical Journal*, 18(3), 420-442.

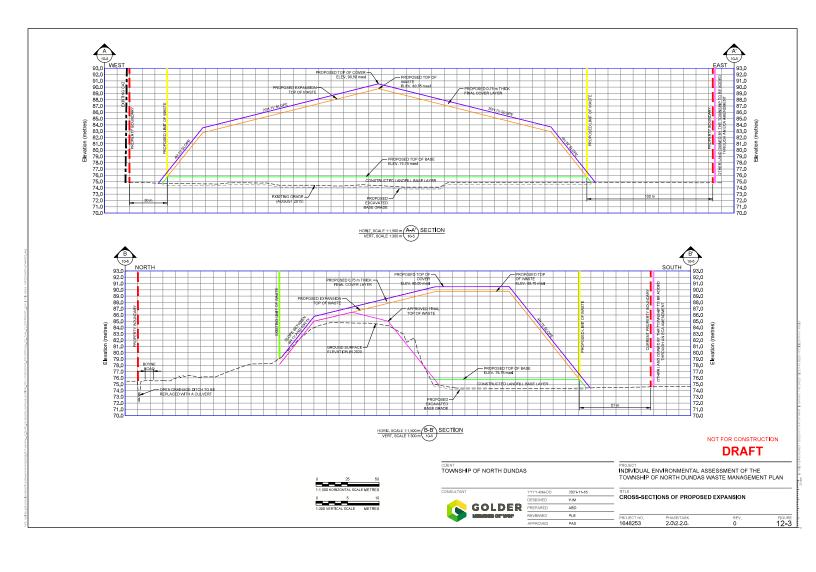


### **ATTACHMENTS - FIGURES**

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







# **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	III.	SOIL DESCRIPTION	
AS	Auger sample	(a)	<b>Cohesionless Soils</b>	
BS	Block sample	,		
CS	Chunk sample	Density In	dex	N
DO or DP	Seamless open-ended, driven or pushed tube samplers	(Relative I	Density)	Blows/300 mm
DS	Denison type sample	•		Or Blows/ft.
FS	Foil sample	Very loose	}	0 to 4
RC	Rock core	Loose		4 to 10
SC	Soil core	Compact		10 to 30
SS	Split spoon sampler	Dense		30 to 50
ST	Slotted tube	Very dense	2	over 50
TO	Thin-walled, open			
TP	Thin-walled, piston	(b)	Cohesive Soils	
WS	Wash sample	,	$C_u$ or $S_u$	
DT	Dual tube sample	Consistenc		
DD	Diamond drilling		<u>kPa</u>	<u>Psf</u>
	<u> </u>	Very soft	0 to 12	0 to 250
II.	PENETRATION RESISTANCE	Soft	12 to 25	250 to 500
		Firm	25 to 50	500 to 1,000
Standard	Penetration Resistance (SPT), N:	Stiff	50 to 100	1,000 to 2,000
	<i>\'</i>	Very stiff	100 to 200	2,000 to 4,000
The number	er of blows by a 63.5 kg. (140 lb.) hammer dropped	Hard	Over 200	Over 4,000
760 mm (3	0 in.) required to drive a 50 mm (2 in.) split spoon			,
sampler fo	r a distance of 300 mm (12 in.).	IV.	SOIL TESTS	
Dynamic (	Cone Penetration Resistance (DCPT); N <sub>d</sub> :	w	Water content	
·	, ,, <u>-</u>	w <sub>p</sub> or PL	Plastic limited	
The number	er of blows by a 63.5 kg (140 lb.) hammer dropped	w <sub>1</sub> or LL	Liquid limit	
	0 in.) to drive an uncased 50 mm (2 in.) diameter,	C	Consolidation (oedometer) tes	t
	ttached to "A" size drill rods for a distance of	CHEM	Chemical analysis (refer to tex	t)
300 mm (1	2 in.).	CID	Consolidated isotropically dra	ined triaxial test <sup>1</sup>
		CIU	Consolidated isotropically und	
PH:	Sampler advanced by hydraulic pressure		with porewater pressure measure	
PM:	Sampler advanced by manual pressure	$D_R$	Relative density	
WH:	Sampler advanced by static weight of hammer	DS	Direct shear test	
WR:	Sampler advanced by weight of sampler and rod	Gs	Specific gravity	
		M	Sieve analysis for particle size	
Cone Pene	etration Test (CPT):	MH	Combined sieve and hydromet	
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	MPC	Modified Proctor compaction	•
An electro	nic cone penetrometer with a 60° conical tip and a	SPC	Standard Proctor compaction	
	end area of 10 cm <sup>2</sup> pushed through ground at a	OC	Organic content test	
	rate of 2 cm/s. Measurements of tip resistance $(q_t)$ ,	$SO_4$	Concentration of water-soluble	e sulphates
	pressure (u) and friction along a sleeve are recorded	UC	Unconfined compression test	r
electronica	ally at 25 mm penetration intervals.	UU	Unconsolidated undrained tria	xial test
		V	Field vane test (LV-laboratory	
		γ	Unit weight	
		1	om wight	
		Note:	Tests which are anisotropical shear are shown as CAD, CA	

# **LIST OF SYMBOLS**

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

I.	GENERAL	(a) Index Pr	roperties (continued)
π	3.1416	W	water content
ln x	natural logarithm of x	$w_1$ or LL	liquid limit
$\log_{10} x$ or $\log x$	logarithm of x to base 10	w <sub>p</sub> or PL	plastic limit
g	acceleration due to gravity	I <sub>p</sub> or PI	plasticity Index = $(w_1 - w_p)$
t	time	$\mathbf{W}_{\mathbf{S}}$	shrinkage limit
FOS	factor of safety	$I_L$	liquidity index = $(w - w_p) / I_p$
V	volume	I <sub>c</sub>	consistency index = $(w_1 - w) / I_p$
W	weight	e <sub>max</sub>	void ratio in loosest state
		e <sub>min</sub>	void ratio in densest state
II.	STRESS AND STRAIN	$I_D$	density index = $(e_{max} - e) / (e_{max} - e_{min})$
			(formerly relative density)
γ	shear strain		
$\Delta$	change in, e.g. in stress: $\Delta \sigma'$	(b) Hydraul	lic Properties
ε	linear strain		
$\epsilon_{ m v}$	volumetric strain	h	hydraulic head or potential
η	coefficient of viscosity	q	rate of flow
ν	Poisson's ratio	v	velocity of flow
σ	total stress	i	hydraulic gradient
σ'	effective stress ( $\sigma' = \sigma - u$ )	k	hydraulic conductivity (coefficient of permeability)
$\sigma'_{vo}$	initial vertical effective overburden stress	j	seepage force per unit volume
$\sigma_1 \sigma_2 \sigma_3$	principal stresses (major, intermediate, minor)	_	
$\sigma_{ m oct}$	mean stress or octahedral stress	(c) Consolid	lation (one-dimensional)
	$= (\sigma_1 + \sigma_2 + \sigma_3) / 3$	,	,
τ	shear stress	$C_c$	compression index (normally consolidated range)
u	porewater pressure	$C_r$	recompression index (overconsolidated range)
Е	modulus of deformation	$C_s$	swelling index
G	shear modulus of deformation	$C_{\alpha}$	coefficient of secondary consolidation
K	bulk modulus of compressibility	m <sub>v</sub>	coefficient of volume change
		$c_{ m v}$	coefficient of consolidation (vertical direction)
III.	SOIL PROPERTIES	$T_{\mathbf{v}}$	time factor (vertical direction)
		U	degree of consolidation
(a) Index Proj	perties	$\sigma'_{p}$	pre-consolidation stress
		OCR	overconsolidation ratio = $\sigma'_p / \sigma'_{vo}$
ρ(γ)	bulk density (bulk unit weight)*		r
$\rho_d(\gamma_d)$	dry density (dry unit weight)	(d) Shear St	trength
$\rho_{\rm w}(\gamma_{\rm w})$	density (unit weight) of water		_
$\rho_{\rm s}(\gamma_{\rm s})$	density (unit weight) of solid particles	$\tau_p$ or $\tau_r$	peak and residual shear strength
γ'	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )	φ'	effective angle of internal friction
${\rm D_R}$	relative density (specific gravity) of	δ	angle of interface friction
- K	solid particles ( $D_R = \rho_s / \rho_w$ ) formerly ( $G_s$ )	μ	coefficient of friction = $\tan \delta$
e	void ratio	c'	effective cohesion
n	porosity	$c_u$ or $s_u$	undrained shear strength ( $\phi = 0$ analysis)
S	degree of saturation	р	mean total stress $(\sigma_1 + \sigma_3) / 2$
~		p'	mean effective stress $(\sigma'_1 + \sigma'_3) / 2$
*	Density symbol is $\rho$ . Unit weight symbol is $\gamma$	q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
	where $\gamma = \rho g$ (i.e. mass density multiplied by		compressive strength $(\sigma_1 - \sigma_3)$
	acceleration due to gravity)	$egin{array}{l} q_u \ S_t \end{array}$	sensitivity $(o_1 - o_3)$
		יֻ t	Sensitivity
		Notes:	$\tau = c' + \sigma' \tan \phi'$
			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

<b>Description</b>	<b>Bedding Plane Spacing</b>
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

<b>Description</b>	<b>Spacing</b>
Very Wide	> 3 m
Wide	1 - 3  m
Moderately Close	0.3 - 1  m
Close	50 - 300  mm
Very Close	< 50 mm

## **GRAIN SIZE**

<u>Term</u>	<u>Size*</u>
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 diamet	ter 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  $90^{\circ}$  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
II -	Parallel To	STR -	Stress Induced
OR -	Orthogonal		

PROJECT: 14-1125-0007/Boyne Road Landfill

# RECORD OF BOREHOLE: MW06-22R

LOCATION: N 4994479.6; E 474643.5 (UTM NAD83 Zone 18T) BORING DATE: May 1, 2014

SHEET 1 OF 1

DATUM: Geodetic

\_\_\_\_

HOD	SOIL PROFILE		SA	AMPLES		PENETRATIONS	ON /0.3m	k, cm		A S	PIEZOMETER
DEPTH SCALE METRES BORING METHOD	DESCRIPTION	STRATA PLOT (w) 14dan		TYPE BLOWS/0.30m	SHEAR S Cu, kPa	STRENGTH I	80 80 nat V. + Q - ● em V. ⊕ U - C	WATER Wp	10 <sup>-5</sup> 10 <sup>-4</sup> 10 <sup>-3</sup> CONTENT PERCENT	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
	GROUND SURFACE	82 <u>.</u> 96			20	40 6	80 80	20	40 60 80		
2 4 6 9 10 12 12 14 14 14 16 10 16 16 16 16 16 16 16 16 16 16 16 16 16	Grey brown SILTY CLAY  End of Borehole	71.96 70.16 12.80									Silica Sand 32 mm Diam. PVC #10 Slot Screen Cave in
16											
18											
DEPTH:	SCALE		<u> </u>			Golder Ssocia	<u> </u>				OGGED: MIB

PROJECT: 06-1122-127-3 LOCATION: See Site Plan

# RECORD OF BOREHOLE: MW07-23

BORING DATE: September 4, 2007

SHEET 1 OF 1

DATUM: Local

SAMPLER HAMMER, 64kg, DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

	90	SOIL PROFILE	35.		SA	MPL	ES	DYNAMIC PENETRATION RESISTANCE, BLOWS/0 3m	HYDRAULIC CONDUCTIVITY, k, cm/s	Q PIEZ	METER
	BORING METHOD		107		œ		34	20 40 60 80	10° 10° 10° 10°	E	OR STANDPIPE
	NGN	DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH nal V. + Q - ● Cu, kPa rem V ⊕ U - O	WATER CONTENT PERCENT	m INSTA	LLATION
	30RI	100000000000000000000000000000000000000	TRA	DEPTH (m)	5	-	SLOV			3	
-		GROUND SURFACE	(O)		-	-	-	20 40 60 80	20 40 60 80	-	
-	T	TOPSOIL	13.14	74.97 0.00 74.76							
			133	921							
		Very stiff grey brown SILTY CLAY (Weathered Crust)								Land or	
ı	П									Bentonite Sei	N.
	П					L					
l		Brown SILTY CLAY, trace gravel	-	73,90	1	50 DO	20			500 550 40	
ı	2		M							Silica Sand	15
	200mm dram (Hollow Stem)		333	73.35	-						3
Aurer	Hallo	Dense brown to grey sandy SILT, some grey clay, occasional sand seam (GLACIAL TILL)	1	1.62	2	50 DO	35				1
OWEL	iam (	(GLACIAL TILL)				00					13
a	mmd		<i>***</i>	1							13
ı	200		300							32mm Diam. #10 Stot Scre	PVC
ı			26		3	50 DO	39			#10 Slot Scre	en 3
			60								3
1			1		-						1
					1	50 DO	32				Ā
			1		4	DO	92				18
L		End of Borhole	100	71.25 3.72		-					1
		(Auger Refusal)		3.72							
ı										WL in screen	al on
ı										WL in screen Elev 72 56m Sept 25, 200	on 7
ı										3.00	
l	ы		170								
l											
ı			₩.,								
l											
l	Ш										
l	П										
l	М										
ı			118								
1											
l											
					1	1					
							'				



CHECKED: HLRF

# 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

4	HOD	SOIL PROFILE	16		SAMPLES			DYNAMIC PENET RESISTANCE, BL		1	k,	cm/s			NG NG	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	20 40 SHEAR STRENG Cu, kPa	60 80 FH nat V + rem V ⊕		Wp H	10° ER CONTE	NT PERC	WI H	ADDITIONAL LAB TESTING	OR STANDPIPE INSTALLATION
		GROUND SURFACE	in in	75,32			ш	20 40	60 80	9	20	40	60	80		0 32
0	T	Dark brown PEAT	11/2			m										
			7 3	1												Bentonite Seal
		Grey brown SILTY CLAY (Weathered	H	74,77												
	П.	Crush)														Native Backfill
1	Stem)	Compact grey brown CLAYEY SILT,	撊	1.07	1	50. DO	13									Bentonite Seal
	.   3	trace gravel	M		H											101000
	Power Augor Diam. (Hollo		M													Salica Sand
2	Power rm Diam.	Brown grey SANDY SILT, some gravel, occasional cobbles	<b>***</b>	73.40 1 83	2	50 DO	13									
	200r	occasional codoles	22		-								1			
	П															38mm Diam PVC #10 Slot Screen ₩
					3	50 DO	40									#10 Slot Screen
3						60				- 1						
			300	72.03	4	50 DO	44									
		End of Borehole (Auger Refusal)		3.20											1 8	
																Wt. in screen at Elev. 73.49m on Sept. 25, 2007
A																Sept. 25, 2007
			11 8				П									
5														1		
									1							
									1 1							
											- 1			1		
.6			1											1		
7																
			1.													
			Ш													
9																
10																
										5						
DE	PTH.	SCALE						A CONTRACTOR	4						L	OGGED: D.J.S.
	50						1	GO	der ciates						CH	ECKED: HLRF

# RECORD OF BOREHOLE: MW07-25

SHEET I OF I

LOCATION: See Site Plan

BORING DATE: September 5, 2007

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

- 1	Q	SOIL PROFILE			24	MPL	69	DYNAMIC PENETRATION RESISTANCE, BLOWS/0 3m	1	k, cm/s		78	PIEZOMETER
METAES	BORING METHOD		LOT	20-	œ		3m	20 40 60	30	104 105 10	10°	ADDITIONAL LAB. TESTING	OR STANDPIPE
1	NG	DESCRIPTION	TA P	ELEV.	NUMBER	TYPE	WSV	SHEAR STRENGTH nat V + Cu, kPa rem V €	Q- 0	WATER CONTENT	PERCENT	DOIT B. TE	INSTALLATION
	BOR		STRATA PLOT	(m)	2	-	BLOWS/03m			We Haw		44	
+	-	GROUND SURFACE	US.	1 200	-		-	20 40 60	30	20 40 6	0 80		
0	1	Dark brown PEAT	34	74.13									
1		7	11 8										
1			S.F.	73.58		h							Bentonite Seal
1		Grey brown SILTY CLAY (Weathered	à	0.55									
		Crush)					Ш						
Ť			1333										■
1													₩
1				8 1									Native Backfill
-	1		1333	9. 1								110	Native Backfill
1					1	50' DO	8						₩
2													⊗
1			1333		-				1 1				✓
1						50	3						
	Stern)	Compact to dense brown grey SANDY	1	71,45 2.60	2	50 DO	17						Bentonite Seal
	(Hollow Stern)	SILT, some gravel & clay, trace cobbles (GLACIAL TILL)			-								
3	Diam (Hollo	(GLACIAL TILL)	6/2		-								Silica Sand
	200mm Diam		1		3	50. DO	22						
1	Omm					20							
1	22		333										<b> </b>
			300	V.									
			200	M	4	50 DO	14						1
1					1	7							
1			87		-								20 mm Diam Chief
-					5	50 DO	96						38mm Diam, PVC #10 Slot Screen
5			332									Mil	13
1	Ш		28		1								
1													l like
1													<b>注</b>
-													l Mi
0			322			RD.							
1	1	End of Borehole	960	67.88 6.25	6	50							
-	П	(Auger Refusal)	10										
-			1/ /								1 II 1		WL in screen at Elev 72 71m on Sept 25, 2007
													Sept 25, 2007
7													
	Ų ľ								5				
0													
*													
											711		
0												1	
				1									
0													
- 1			1 1									M M	

CHECKED: ILRF

# 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

Ground Surface Dark brown PEAT  Very sliff grey brown SI (Weathered Crush)	A ST	74 6	Z	TYPE	BLOWS/0.3m	SHEA Cu, kl	R ST Pa	40	ЗТН	rem V	B0 1 0 - 0	10° WA'	ter con	TENT PE		ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
Ground Surface Dark brown PEAT	34 2.2 34 2.2 35 34 3.2 36 34 3.2 37 3.2 38 38 3.2 38 38 38 38 38 38 38 38 38 38 38 38 38 3	74 6	,	TYPE	BLOWSA	Cu, kl	Pa			rem V	D U- C	Wpl				ADDIT		
Ground Surface Dark brown PEAT	34 2.2 34 2.2 35 34 3.2 36 34 3.2 37 3.2 38 38 3.2 38 38 38 38 38 38 38 38 38 38 38 38 38 3	74 6	,		96		20	40		vers.				-		100	INSTALLATION	
Dark brown PEAT	3	0.00					1			60	80	20	40	60	80	-		
Very stiff grey brown Si (Weathered Crush)	8	2000					t			1			$\forall$	+		F		
Very stiff grey brown Si (Weathered Crush)	100	1										1 1						
Very stiff grey brown SI (Weathered Crush)	100											1 1					Bentonite Seal	
X13 45 10 10 10 10 10 10 10 10 10 10 10 10 10	TY CLAY	73.6																
			1														8	
W Stern			τ	50 DO	5												8	
Ploto																	立	
Spren Die			2	50 DO	ā						1	1 1						
		71.65	2														Native Backfill	
Stiff grey SILTY CLAY		3.0	5	50														
				50														
Grey SANDY SILT, son	e gravel,															7	∑ Native Backfill	
occasional cobbles (GL	ACIAL TILL)																8	
		100.00	4	50 DO	00													
BEDROCK, with shale i	LIMESTONE Transferbeded, and	1 4.85 I	S							1							Bentonite Seal	
min mad scam	芸	표	5	NQ RC		10	0	96	64					- U			Dentante Gear	
		H																
		<u> </u>								1							Silica Sand	
		H	0	NQ RC		98		83	00									
HOCON	喜	H				(E)	(%) 3		(%)								D.3	
		H H	-			10.	SCF	H	202									
Fresh grey LIMESTONS	BEDROCK .	7.50	3	NQ RC		104	0	90	7								32mm Diam. PVC #10 Slot	
with Shale Interced		II.															Screnn	
		T I		NQ				64									32mm Diam, PVC #10 Slot Screnn	
	臣	T I		RC		100			1									
	芸	I 65.57	3															
End of Borehole		9.14	1														WL in screen at	
																	Elev. 73.29m on Sept. 25, 2007	
HQ Core Z00mm Dism (Hollow Stern)	Grey SANDY SILT, som occasional cobbles (GL/ Slightly weathered grey BEDROCK, with shale in thin mud seam  Fresh grey LIMESTONE with shale interbed	Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)  Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam  Fresh grey LIMESTONE BEDROCK, with shale interbed	Stiff grey SiLTY CLAY  Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)  Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam  Fresh grey LIMESTONE BEDROCK	Stiff grey SiLTY CLAY  Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)  Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam  Fresh grey LIMESTONE BEDROCK .  With shale interbed  Fresh grey LIMESTONE BEDROCK .  Fresh grey LIMESTONE BEDROCK .  BY 14  Fresh grey LIMESTONE BEDROCK .  BY 14  Fresh grey LIMESTONE BEDROCK .  BY 14  BY 14  BY 14  BY 14  BY 14  BY 15  BY 16  BY 17  BY 17  BY 18  BY 18	Stiff grey SILTY CLAY  3.05  3 50  70.71  Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)  Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam  5 NG RC  Fresh grey LIMESTONE BEDROCK 753  NO RC  87.14  NO RC  11 NO RC  11 NO RC  12 NO RC  14 NO RC  15 NO RC  16 NO RC  17 NO RC  17 NO RC  18 NO RC  19 NO RC  10 NO RC  11 NO RC  11 NO RC	Stiff grey SILTY CLAY  3.05 3.05 3.06 3.06 3.06 3.06 3.06 3.06 3.06 3.06	Stiff grey SiLTY CLAY  3.05 3.05 3.00 1  Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)  Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam  5. NQ RC  Fresh grey LIMESTONE BEDROCK.  Fresh grey LIMESTONE BEDROCK.  Fresh grey LIMESTONE BEDROCK.  6. NQ RC  10.  10.  11.  12.  13.  14.  15.  10.  10.  10.  11.  13.  14.  15.  16.  16.  17.  16.  16.  16.  16.  16	Stiff grey SILTY CLAY  3.05 3.50 3.50 4.50 DD  Silghtly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam  5. NQ RC 100 RC 1	Stiff grey SILTY CLAY  3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.	Slift grey SILTY CLAY  70.71  Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)  80.82  Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam  5 NO RC  60.82  60.83  60.82  60.82  60.82  60.83  60	Stiff grey SiLTY CLAY  3 50 3 50 3 50 79.71 Grey SANDY SILT, some gravel, occasional cobbles (GLACIAL TILL)  Slightly weathered grey LIMESTONE BEDROCK, with shale interbeded, and thin mud seam  5 NO RC  60.82 6 NO RC  60.82 6 NO RC  60.82 6 NO RC 6 RC 6 RC 75.51 7 NO RC 75.51 8 NO RC 75.52 8 RC 8 RC 8 RC 8 RC 8 RC 8 RC 9 NO	Silft grey Silt Y CLAY  The state of the sta	Shift grey SiLTY CLAY  3.00 3.00 3.00 3.00 4.50 DD  Slightly weathered grey LiMESTONE BEDROCK, with shale interbeded, and thin mud seam  5. NO 6. NO 7. Sightly weathered grey LiMESTONE BEDROCK, with shale interbeded, and thin mud seam  6. NO 7. Sightly weathered grey LiMESTONE BEDROCK, with shale interbeded, and thin mud seam  7. So 8. NO 8. NO 9. NO 9	Stiff grey SiLTY CLAY  3.00 3.50 3.50 1  70.71  Grey SANDY SiLT, some gravel, occasional cobbles (GLACIAL Till.)  60.80 4.50 00 00 81.86  Slightly weathered grey LiMESTONE BEDROCK, with shale interbeded, and thin mad seam  5. NG RC  60.80 6	Stiff grey SiLTY CLAY  3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.	Slift grey SiLTY CLAY  3.00 3.50 1  Grey SANDY SiLT, some gravet, occasional cobbles (GLACIAL TILL) 3.00 3.50 4.50 0.00 0.00 0.00 0.00 0.00 0.00 0	Slightly weathered gray LIMESTONE BEDROCK, with shale interbed and thin mud seam  Freeth gray LIMESTONE BEDROCK, with shale interbed inter	

# 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

4	HOL	SOIL PROFILE	TE	1	-	SAM	-	-	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3		HYDRAULIC CONDUCT k, cm/s		NAL SAL	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	DEF (n	V TH	NOWBER	TYPE	BLOWS/03m	20 40 60 SHEAR STRENGTH nat Cu, kPa rem	80 V + Q - 0 V ⊕ U - O	vvp I	PERCENT WI	ADDITIONAL LAB TESTING	OR STANDPIPE INSTALLATION
_	m	GROUND SURFACE	(n		-	-	1	00	20 40 60	80	20 40 6	0 80	+	
0	-	(Note: Stratigaphy from BRW-1, June	- lees		0.00	+	+	-		_			-	HH
t		1992) SILTY CLAY												Concrete
2		Glacial Till		7	3 54									
3														₹
4														
5														Bentonite Seal
6														
7					8.14 7.40									
8		Linestone Bedrock		пинанини	, 30									
9				100000000000000000000000000000000000000										Sitica Sand
			弄											32mm Diam PVC #10 Slot Screen C
10		CONTINUED NEXT PAGE		1		1		_			1			
DE	оты с	CONTINUED NEXT PAGE  SCALE			_	1	1		Golder				1	OGGED: DJS

PROJECT: 06-1122-127-3 LOCATION: See Site Plan

# RECORD OF BOREHOLE: BRW1

BORING DATE: September 7, 2007

SHEET 2 OF 3 DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

y	B P	SOIL PROFILE			SA	MPL	ES	DYNAMIC PENETRATION RESISTANCE, BLOWS	70.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	78	PIEZOMETER
METRES	BORING METHOD		A PLOT	ELEV	BER	JE .	3/0.3m	20 40 6 SHEAR STRENGTH	0 80 °	10 <sup>6</sup> 10 <sup>6</sup> 10 <sup>4</sup> 10 <sup>3</sup> WATER CONTENT PERCENT	ADDITIONAL LAB TESTING	OR STANDPIPE
2	SORING	DESCRIPTION	STRATA	DEPTH (m)	NUMBER	TYPE	BLOWS/03m	Cu, kPa	em V ⊕ U-O	Wp I WI	ADD	INSTALLATION
-	m	CONTINUED FROM PREVIOUS PAGE -		-	-		ш	20 40 6	0 80	20 40 60 80		
11		Linestone Bedrock	HEHERER									
12												32mm Diam PVC
13			THE PERSON									Silica Sand
14												Bentonite Seal
15												Silica Sand
17												32mm Diam. PVC #10 Slot Screen B
18												Silica Sand
19												Bentonite Seal
		CONTINUED NEXT PAGE										

# 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

	GOH	SOIL PROFILE	1		SA	MPLE	S	YNAMIC P RESISTANC	ENETR E, BLO	WS/0.3	lm	1		RAULIC (	s			40	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT	my 40.	2		E S	50	40	60	B		-	106	105	10-	100	ADDITIONAL LAB TESTING	OR STANDPIPE
MET	SNI	DESCRIPTION	ATA P	DEPTH	NUMBER	TYPE	New C	HEAR STE	RENGTH	nat rem	V. + V. ⊕	Q- • U- O			CONTEN			TIOON TIOON	INSTALLATION
	BOB		STR	(m)	Z	1	275		40				100		40 OV		80 80	42	
1		- CONTINUED FROM PREVIOUS PAGE -	7							1						I	Ĩ		
50	T	Linestone Bedrock	17						11										
	Ш		1													1			
И			莊		П											T			
	Ш		亞		Ш		Ш	- 11	-1										Bentonite Scal
			1,1		Ш		Ш	- 18						10				В	
21	Ш		111		Н		н	- (4)											
П			TIL		Ш		П	- 40	1						1				Silica Sand
1			亞		Ш		Ш	- 10											33
П	Ш		11				П							1				.1	A**
22	Ш		11		Ш		н												1
	Ш		莊		П		ш							1					8
1			11				П	- 11											100
			1,1																3.2
			1,1																(4)
23			177		Ш		Ш	-110							1				25
			莊						1										32mm Diam PVC #10 Stot Screen A
			TT																
			1,1																
-			11		Ш		Ш		1										100
24			111		Ш														
1			莊																(4)
-	И		五																25
			莊																- A
25			节	50.54															135
-		End of Hole		25.00															
1			111		Ш														WL in screen A at Elav. 72.99m on
1			Ш		Ш				- 1										Sept. 25, 2007
			1.1		П														
26			1.1		П														X
-																			
-			11		Ш														WL in screen B at Elev. 72.99m on Sept. 25, 2007
-					П														Sept 25, 2007
					П														
27			11.1																V
																			WL in screen C at
																			WL in screen C at Elev. 73.02m on Sept. 25, 2007
																			100000000000000000000000000000000000000
28																			
	1																18		
20																			
20																			
30																			
				_		_	_	7						_	1	1	1	_	

Associates

CHECKED: IFLEF

#### 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

METRES	WET		0				E	20	10	60	80	10-	10.5	10-1	107	ZE	PIEZOMETER
	BORING METHOD	DESCRIPTION	STRATA PLOT	DEPTH	NUMBER	TYPE	BLOWS/0.3m	SHEAR STREM	IO NGTH		1	WAT	ER CONTE	NT PERC	1	ADDITIONAL LAB TESTING	STANDPIPE INSTALLATION
	8	GROUND SURFACE	ST	(m)	-		10	20	10 I	60	80	20	40	60	80		
0	T	TOPSOIL		75.64 0.00 75.40						1					1		
		Very stiff grey brown SILTY CLAY (Weathered Crust)		0.24													Protective cusing set in Bentonite Seal
Auger	Hollow Stem)	Compact grey SANDY SILT, some gravel, trace clay, occasional silty sand and silt seam or layer (GLACIAL TILL)		74.16	1	50 DO	21										
Power Auger	200mm Diam (Hoklow Stem)		900														36mm Diam PVC #10 Slot Screen
					2	50 DO	28										
4				71,37													
		End of Borehole Auger Refusal	Ī	4.27													
6:																	
7																	
B																	
0																	
ia								Ass.									

#### 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

5	90	SOIL PROFILE			SA	War	ES	DYNAMIC PENETRA RESISTANCE, BLOV	VS/0.3m		HYDRAULIC k, cr	n/s	CIVITY	4	ويد	PIEZOMETER
METRES	BORING METHOD		101	-1	œ		E.C.	20 40	60 80			10'5		10-3	ADDITIONAL LAB TESTING	OR STANDPIPE
ME	DNI	DESCRIPTION		DEPTH	NUMBER	TYPE	BLCMS/0.3m	SHEAR STRENGTH Cu, kPa	nat V. + Q - rem V ⊕ U -	0			NT PER		DDO TIE	INSTALLATION
	BOR		STR	(m)	Z		BLC	20 40	60 80		Wp ← 20			-  WI	47	
1		GROUND SURFACE		74.93					T			T	T	T		
0	1	TOPSOIL		0.00 74.72							11/					
1		Grey brown SILTY CLAY (Weathered Crust)	1	0.21												Protective casing
			1333	74.32												set in Bentonite Seal
	Т	Grey brown SANDY SILT, some gravel, trace clay, occasional cobble (GLACIAL	1	0.61											113	
1		TILL)								П						
						Ш							- 1			
1	-		32				М									
1	Sterr															
	Hotion-				1	50 DO	02			1						
2	200mm Dism (Hollow Stem)		<b>%</b>		-											
	Pertin C		40	72 49		Н									10	38mm Diam PVC
1	200	gravel, occasional fine to coarse sand		2.44						1						38mm Diam PVC #10 Slot Screen
1	П	layer (GLACIAL TILL)												1		
3			1		-											l Mi
1	Т		2		2	50 00	26									
١						00	~	1 1								
1		Grey SANDY SILT, some gravel and clay (GLACIAL TILL)		3.66				1 1								
4		clay (GLACIAL TILE)	32	70.88												
		End of Borehole Auger Refusal		4.05										М		
1		rago rosas			Ш											
1			1													
			1/1							1				1		
5			14					1.1						1		
1										П					1	
					П						1 11					
П			1 1													
Ď.															411	
-			1.1		Ш			1 1								
-																
1			1 1									171				
,			11											1		
1			1 1							1	1 1					
														1		
8																
															1	
u																
10			1 1													
		1.00														
DEF	тн	SCALE						Gold	or	-			_		L	OGGED: DJS

CHECKED: HLRF

#### 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

3	НООН	SOIL PROFILE	- 1.		SA	MPL		DYNAMIC PENETI RESISTANCE, BLO	WS/0.3m	HYDRAULIC CONDUCTIVIT k, cm/s	10	PIEZOMETER
METRES	BORING METHOD		STRATA PLOT	pi eu	a;	m	10 3m	20 40	60 80	10" 10" 10"		OR STANDPIPE
ME	SING	DESCRIPTION	ATA	DEPTH	NUMBER	TYPE	BLOWS/0	SHEAR STRENGT Cu, kPa	H nal V + Q - ● rem V ⊕ U - O	WATER CONTENT PE	RCENT	INSTALLATION
	BOR		TR	(m)	M		BLC	20 40	60 80	20 40 60	80 80	
		GROUND SURFACE	-	82.10				1 1	TT			
0	Т	GARBAGE (FILL)	- 88	0.00			-					
			<b>X</b>	8								
- 1			- 1888	8								
- 1			<b>***</b>	3							1 1	
			<b>***</b>	8						1 1 1 1		
1			- 1888	3							1 1	
			- 1	8							1 1	
			- 1888	3							4 10	
			- 1888	ă .		Ш	П				1 1	Protective casing set in Bentonite
			- 1888	3			М				1 1	Soal
2			- 1888	3			Ш					
			- 1888	3			М					
			88	8								
			<b>**</b>	8								
			***	8								
3		V III		8								
3				8								
				8								88
	12			8								Caved Material
- 1	Stem)		- 1	8							1 1	8
	Jon S			3								Caved Material
4	Power Auger 200mm Diam (Hollow Stetn)			3						12 T IX II		
	Pow		<b>**</b>	3								
- 1	Отти		- 1888	3							1 1	l 🛚
- 1	22		- 1	8		Ш					1 1	Silica Sand
	10		₩	8	П						1 1	1
5				3								
			***	3								3
				3								1 4
				8								
			<b>**</b>	8								
6			- 1888	8	$\vdash$	H	Н		1 1			38mm Diam PVC
- 1			<b>***</b>	8	4	50						#10 Slot Screen
- 1				8	'	50 DO	10					1
				8	-	1						
			<b>***</b>									
2						1						I SE
				3	2	50 DO	5					
				71.00								(注
		PEAT		74.46		1						
		Grey brown SILTY CLAY	33	731	1 3	50 DO	10					Bunkenia Cost
0		Grey brown SANDY SILT		74.02	13	DO	1					Bentonite Seal
1	-	Grey brown SANDY SILT End of Borehole	433	8.23								
												1
0												1
												1
ia.												
									100			
								44				
DE	PTH S	SCALE					-	Gol	der ciates			LOGGED: D.J.S HECKED: #L.R.F
	50						1.0	Acco	ciator		C	HECKED ILLEY

PROJECT: 1416664-6000

# RECORD OF BOREHOLE: 15-1

SHEET 1 OF 1 DATUM: Geodetic

LOCATION: See Site Plan

SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: July 23, 2015

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

, FE	ТНОБ	SOIL PROFILE	<b>⊢</b>		SA	MPLE		DYNAMIC PENETRATION \ RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	NG NG	PIEZOMETER
METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	20 40 60 80 SHEAR STRENGTH nat V. + Q - • rem V. ⊕ U - ○	10 <sup>-5</sup> 10 <sup>-5</sup> 10 <sup>-4</sup> 10 <sup>-3</sup> WATER CONTENT PERCENT  Wp   → W   W	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
_		GROUND SURFACE	S					20 40 60 80	20 40 60 80		
0	$\top$	TOPSOIL	ESS	74.40 0.00		$\vdash$					
	ver Auger m. (Hollow Stem)	(CL/ML) CLAYEY SILT, low to medium plasticity; brown; cohesive, w>PL, very stiff		74.05 0.35 73.49	1	AS	-				Bentonite Seal Silica Sand
1	Power Auger 200 mm Diam (Hollow S			0.91 72.72	2	ss	>50				50 mm Diam. PVC 2 #10 Slot Screen
2		End of Borehole Auger Refusal		1.68							
3											
4											
5											
6											
7											
8											
9											
10											
DE	PTH S	CCALE	•				_	Golder		L	OGGED: PAH

PROJECT: 1416664-6000 LOCATION: See Site Plan

#### RECORD OF BOREHOLE: 15-2

BORING DATE: July 23, 2015

SHEET 1 OF 1 DATUM: Geodetic

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m HYDRAULIC CONDUCTIVITY, k, cm/s SOIL PROFILE SAMPLES BORING METHOD DEPTH SCALE METRES ADDITIONAL LAB. TESTING PIEZOMETER STRATA PLOT BLOWS/0.30m 10<sup>-5</sup> NUMBER STANDPIPE INSTALLATION ELEV. TYPE SHEAR STRENGTH nat V. + Q - ● rem V. ⊕ U - ○ WATER CONTENT PERCENT DESCRIPTION DEPTH -OW - W Wp **⊢** GROUND SURFACE 74.68 TOPSOIL (CL/ML) CLAYEY SILT, trace gravel and low plasticity fines; grey brown; cohesive, w~PL, very stiff Bentonite Seal Silica Sand 50 mm Diam. PVC #10 Slot Screen AS 1 8 End of Borehole Auger Refusal 2 1416664-6000 GPJ GAL-MIS GDT 12/14/15 9 10 DEPTH SCALE LOGGED: PAH Golder

1:50

CHECKED: MIB

PROJECT: 1416664-6000 LOCATION: See Site Plan

## RECORD OF BOREHOLE: 15-3

SHEET 1 OF 2

DATUM: Geodetic

BORING DATE: July 21, 2015

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m HYDRAULIC CONDUCTIVITY, k, cm/s SOIL PROFILE SAMPLES BORING METHOD DEPTH SCALE METRES ADDITIONAL LAB. TESTING PIEZOMETER STRATA PLOT BLOWS/0.30m 10<sup>-5</sup> NUMBER STANDPIPE INSTALLATION ELEV. TYPE SHEAR STRENGTH nat V. + Q - ● rem V. ⊕ U - ○ WATER CONTENT PERCENT DESCRIPTION DEPTH -OW - W Wp **⊢** GROUND SURFACE 75.41 TOPSOIL 0.00 75.16 0.25 (CI/CH) SILTY CLAY, trace sand; grey brown, fissured (WEATHERED CRUST); cohesive, w~PL, very stiff Bentonite Seal Silica Sand GLACIAL TILL Power Auger n Diam. (Hollow 2 200 mm Bentonite Seal Native Backfill Fresh, grey LIMESTONE Borehole continued on RECORD OF DRILLHOLE 15-3 9 10

DEPTH SCALE 1:50

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

Golder

SSOciates

LOGGED: PAH
CHECKED: MIB

RECORD OF DRILLHOLE: 15-3 PROJECT: 1416664-6000 SHEET 2 OF 2 DRILLING DATE: July 21, 2015 DATUM: Geodetic LOCATION: See Site Plan DRILL RIG: CME 55 INCLINATION: -90° AZIMUTH: -DRILLING CONTRACTOR: Downing Drilling PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugat 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 DEPTH SCALE METRES SYMBOLIC LOG ELEV. DESCRIPTION HYDRAULIC Diametra
CONDUCTIVITY Point Loa
K, cm/sec Index
COMPA FRACT. INDEX PER 0.25 m RUN DEPTH RECOVERY DISCONTINUITY DATA DIP w.r.t. CORE AXIS (m) TOTAL SOLID CORE % TYPE AND SURFACE DESCRIPTION 190 180 270 : 0000 8848 BEDROCK SURFACE Fresh, grey LIMESTONE Bentonite Seal Silica Sand - Lost core from 4.87 m to 5.03 m - Lost core from 5.49 m to 5.53 m - Lost core from 5.69 m to 5.74 m 9 Rotary Drill NQ Core 32 mm Diam. PVC #10 Slot Screen - Lost core from 6.96 m to 7.01 m End of Drillhole 10 11 12 13

DEPTH SCALE 1:50

MIS-RCK 004 1416664-6000.GPJ GAL-MISS.GDT 12/14/15

14

Golder

# RECORD OF BOREHOLE: 16-1

SHEET 1 OF 2

BORING DATE: December 8, 2016 LOCATION: See Site Plan

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

<u>.</u>	阜	SOIL PROFILE			S	AMPL		DYNAMIC PENETRATION \ RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	ا وِدِ ا	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.30m	20 40 60 80 SHEAR STRENGTH nat V. + Q - ● Cu, kPa rem V. ⊕ U - ○	10 <sup>-5</sup> 10 <sup>-5</sup> 10 <sup>-4</sup> 10 <sup>-3</sup> WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
ے د	BOR		TRAI	DEPTH (m)	Ń	F	3LOW		Wp <b>I</b> → W   WI	E.B.	
		GROUND SURFACE	1 0,	74.71				20 40 60 80	20 40 60 80		
0		(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	Auger Hollow Stem)									:	Silica Sand
4	Power Auger 200 mm Diam. (Hollow Stem)	(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very		69.99 4.72	4	ss				;	32 mm Diam. PVC #10 Slot Screen 'B'
5		non-cohesive, wet, compact to very dense			5	SS	>50				12 - 14 - 14 - 14 - 14 - 14 - 14 - 14 -
7		Borehole continued on RECORD OF DRILLHOLE 16-1		67.93 6.78							Bentonite Seal
8											
9											
10											
DE	PTH S	SCALE				1		Golder Associates		LO	GGED: JD

RECORD OF DRILLHOLE: 16-1 PROJECT: 1650505 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 PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate 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 DEPTH SCALE METRES SYMBOLIC LOG ELEV. DESCRIPTION HYDRAULIC Diametral CONDUCTIVITYPoint Load Index (MPa) RUN FRACT. INDEX PER 0.25 m 8898 spec DEPTH RECOVERY DISCONTINUITY DATA DIP w.r.t. CORE AXIS (m) TOTAL SOLID CORE % TYPE AND SURFACE DESCRIPTION 190 180 270 : 0000 8848 BEDROCK SURFACE 67.93 Slightly weathered to weathered, highly fractured, grey LIMESTONE, with shale interbedded Bentonite Seal Rotary Drill NQ Core 32 mm Diam. PVC #10 Slot Screen 'A' 2 End of Drillhole 10 11 12 13 14 15 16 DEPTH SCALE LOGGED: JD Golder 1:50 CHECKED: MIB

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

# 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

S	THOD	-	SOIL PROFILE		· ·	SA	MPL	_	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	ING ING	PIEZOMETER
METRES	BORING METHOD	-	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	20 40 60 80  SHEAR STRENGTH nat V. + Q - ( CU, kPa rem V. ⊕ U - ( 20 40 60 80	10° 10° 10° 10° 10° 10° 10° 10° 10° 10°	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
0		- 1	GROUND SURFACE	 ===	74.72							KXI
1		į	(PT) sandy SILT, trace organics; dark brown (PEAT); non-cohesive, moist, very loose			2	SS	1				Native Backfill
2		1	(CL/MC) CLAYEY SILT to SILTY CLAY, trace gravel; grey brown; cohesive, very stiff		72,89 1,83	3	ss	1				
3	1	ow Stem)				4	ss	5				Bentonite Seal
	Power Auger	200 mm Diam. (Hollow Stem)				5	ss	2				Silica Sand
4		70				6	ss	3				
5						7	ss	1				32 mm Diam. PVC #10 Slot Screen
6			(ML) sandy SILT, some gravel; grey (GLACIAL TILL); non-cohesive, wet,		68.62 6.10	l	ss	2				
7		-	End of Borehole Auger Refusal		68.01 6.71	9	ss	22				
8												
9												
10												
DE 1:		I SC	ALE	1	I	1			Golder			DGGED: JD ECKED: MIB

# RECORD OF BOREHOLE: 16-3

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: December 8, 2016

DATUM: Geodetic

CLANC  CLAYEY SILT to SILTY CLAY,   CLAYER SILTY CLAY,   CLAYEY SILT to SILTY CLAY,   CLAYER SILTY CLAYER S		₽┃	SOIL PROFILE			SA	MPLE		DYNAMIC PENETRATION HYDRAULIC RESISTANCE, BLOWS/0.3m HYDRAULIC k, or	CONDUCTIVITY, m/s	PIEZOMETER
PT   Servity SLT to SLT Y CLAY   Total State   Total SLT Y CLAY   Total State   Tota	METRES	BORING METH		STRATA PLOT	DEPTH	NUMBER	TYPE	BLOWS/0.30m	20 40 60 80 10° SHEAR STRENGTH nat V. + Q. ● Cu, kPa WATER Why L = O Why L		OR STANDPIPE INSTALLATION
Denotonic Start Province (PEAT), non-cohesive, moist, very loose 1	0	$\dashv$		<b>E</b> EE:	75.05 0.00						<u> </u>
CLANC) CLAYEY SILT to SILTY CLAY trace gravel, grey brown (MEATHERED CRUST); cohesive, very stiff  3 3 56 4  72.00  4 56 4  72.00  5 56 WH  6 58 WH  6 58 WH  7 55 WH  7 55 WH  7 55 WH  7 55 WH  8 56 WH			brown (PEAT); non-cohesive, moist,				ss	1			Bentonite Seal
2   4   SS   4   32 mm Diam, at OSket Screen   322 mm Diam, at OSket Screen   323 mm Diam, at OSket Screen   324 mm Diam, at OSket Screen   325 mm Diam, at OSket Screen   326 mm Diam, at OSket Screen   326 mm Diam, at OSket Screen   326 mm Diam, at OSket Screen   327 mm Diam, at OSket Screen   328 mm Diam, at	1						ss	WH			
3 (CLAMC) CLAYEY SILT to SILTY CLAY; 5 SS WH  6 SS WH  7 SS WH  8 SS WH  8 SS WH  8 SS WH  9 SS 1  (SP) gravelly SAND, some silt, reddish grey; non-cohesive, wel, loose  8 SS II  8 SS S WH  9 SS 1	2		(CL/MC) CLAYEY SILT to SILTY CLAY, trace gravel; grey brown (WEATHERED CRUST); cohesive, very stiff		1.52		ss	1			Silica Sand
CLIMC) CLAYEY SILT to SILTY CLAY: grey; cohesive, stiff	3				72.00	4	ss	4			32 mm Diam. PVC #10 Slot Screen 'C'
Samp Diam. #10 Slot Screen   Samp Diam. *10			(CL/MC) CLAYEY SILT to SILTY CLAY; grey; cohesive, stiff				ss	WH			Silica Sand
8 SS WH  9 SS 1  9 SS 1  (SP) gravelly SAND, some silt; reddish grey; non-cohesive, wet, loose  11 SS 3  Silica Sand  32 mm Diam. #10 Slot Screen	4	(t				6	ss	wн			
8 SS WH  9 SS 1  9 SS 1  (SP) gravelly SAND, some silt; reddish grey; non-cohesive, wet, loose  11 SS 3  Silica Sand  32 mm Diam. #10 Slot Screen	Power Auger	Diam. (Hollow Sten				7	ss	wн			
(SP) gravelly SAND, some silt; reddish grey; non-cohesive, wet, loose  10 SS 9 Silica Sand  11 SS 3  32 mm Diam. #10 Slot Screen		200 mm				8	ss	wн			Bentonite Seal
(SP) gravelly SAND, some silt; reddish grey; non-cohesive, wet, loose  11 SS 9  Silica Sand  32 mm Diam. #10 Slot Scree						9	ss	1			
8	7	-	(SP) gravelly SAND, some silt; reddish		67.73 7.32	10	ss	9			Silica Sand
#10 Slot Screi	8		3, 1011 3013013 1101 1000	a a		11	ss	3			
						12	ss	9			32 mm Diam. PVC #10 Slot Screen 'B'
(ML) sandy SILT, some gravel, trace clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very dense			non-cohesive, wet, compact to very		65.88 9.17	13	ss	22			Silica Sand
10	10	L	 			_14 .	ss	<u>28</u>		-	Bentonite Seal

#### RECORD OF BOREHOLE: 16-3

SHEET 2 OF 3 DATUM: Geodetic

BORING DATE: December 8, 2016 LOCATION: See Site Plan

SAMPLER HAMMER, 64kg; DROP, 760mm

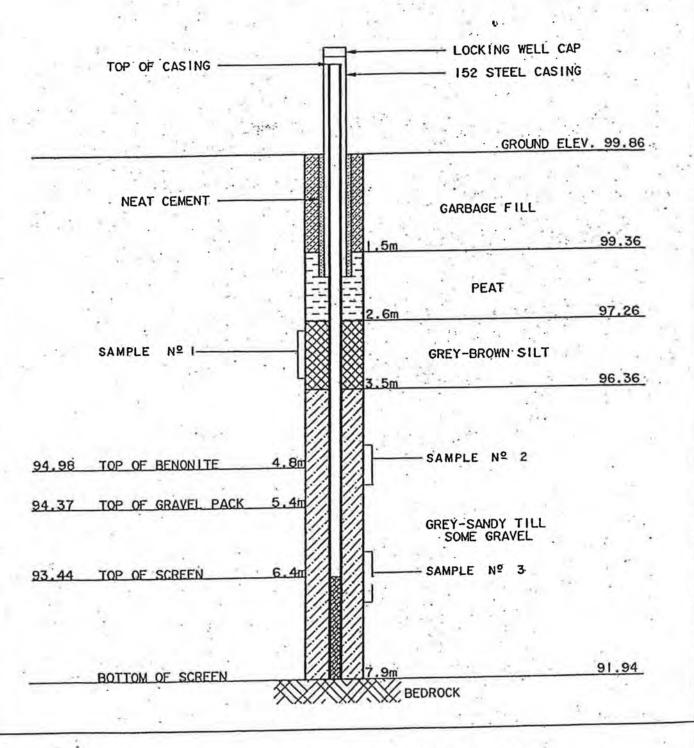
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

<u>"</u>	HOD	SOIL PROFILE	1.	1	SA	MPL	$\blacksquare$	DYNAMIC PENETRA RESISTANCE, BLOV		HYDRAULIC (	/s	무일	PIEZOMETER
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	20 40 SHEAR STRENGTH Cu, kPa	rem V. ⊕ U - O	WATER (	10 <sup>-5</sup> 10 <sup>-4</sup> 10 <sup>-3</sup> CONTENT PERCENT  W   W	ADDITIONAL LAB. TESTING	OR STANDPIPE INSTALLATION
	Δ.	CONTINUED EDOM DECLICATOR DAGE		,			Ш	20 40	60 80	20	40 60 80	+	
10	<u>_</u>	CONTINUED FROM PREVIOUS PAGE (ML) sandy SILT, some gravel, trace	932				$\vdash$						
	Power Auger	(ML) sandy SILT, some gravel, trace clay; grey (CLACIAL TILL); non-cohesive, wet, compact to very dense			14	SS	28						
11	Wash Boring NW Casing				15	SS	64						Bentonite Seal
	^ -			63.47		ss	>50						
12		Borehole continued on RECORD OF DRILLHOLE 16-3		11.58									
13													
14													
15													
16													
17													
18													
19													
20													
DE	PTH S	CALE	•	•				Gold	(A)			L	OGGED: JD

RECORD OF DRILLHOLE: 16-3 PROJECT: 1650505 SHEET 3 OF 3 DRILLING DATE: December 8, 2016 DATUM: Geodetic LOCATION: See Site Plan DRILL RIG: CME INCLINATION: -90° AZIMUTH: -DRILLING CONTRACTOR: Downing Drilling PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate 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 DEPTH SCALE METRES SYMBOLIC LOG ELEV. DESCRIPTION HYDRAULIC Diametral CONDUCTIVITYPoint Load Index (MPa) FRACT. INDEX PER 0.25 m 8898 spec DEPTH RECOVERY DISCONTINUITY DATA DIP w.r.t. CORE AXIS (m) TOTAL SOLID CORE % TYPE AND SURFACE DESCRIPTION 190 180 270 : 0000 8848 BEDROCK SURFACE Slightly weathered to weathered, highly fractured, grey LIMESTONE, with shale interbedded 11.58 8 Bentonite Seal Silica Sand 12 32 mm Diam. PVC #10 Slot Screen 'A' 2 ğ 13 3 Silica Sand 61.05 End of Drillhole 15 16 17 18 19 MIS-RCK 004 1650505-8000.GPJ GAL-MISS.GDT 03/23/17 JM 20 21 DEPTH SCALE LOGGED: JD Golder 1:50 CHECKED: MIB

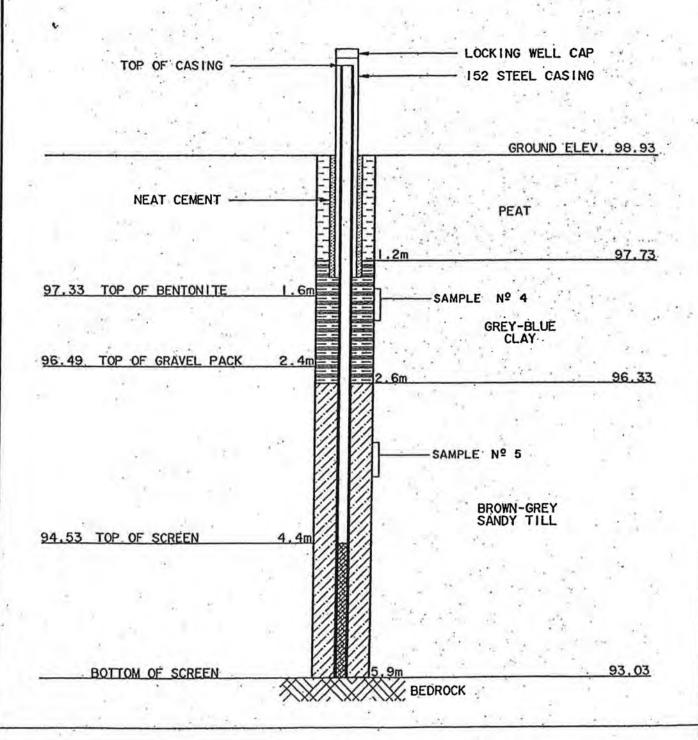
# MONITORING WELL #1 BOREHOLE LOG



# OLIVER MANGIONE MCCALLA & ASSOCIATES LIMITED Nepson, Ontorio

DATE: MARCH, 1991	TOWNSHIP OF WINCHESTER LANDFILL	90-7848
SCALE: N.T.S.	MONITORING WELL INSTALLATION	

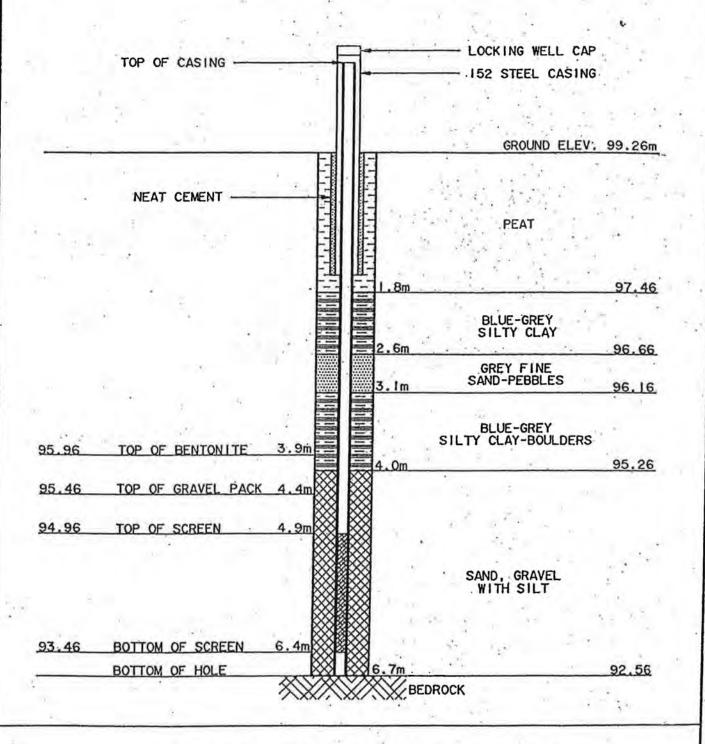
# MONITORING WELL #2 BOREHOLE LOG





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

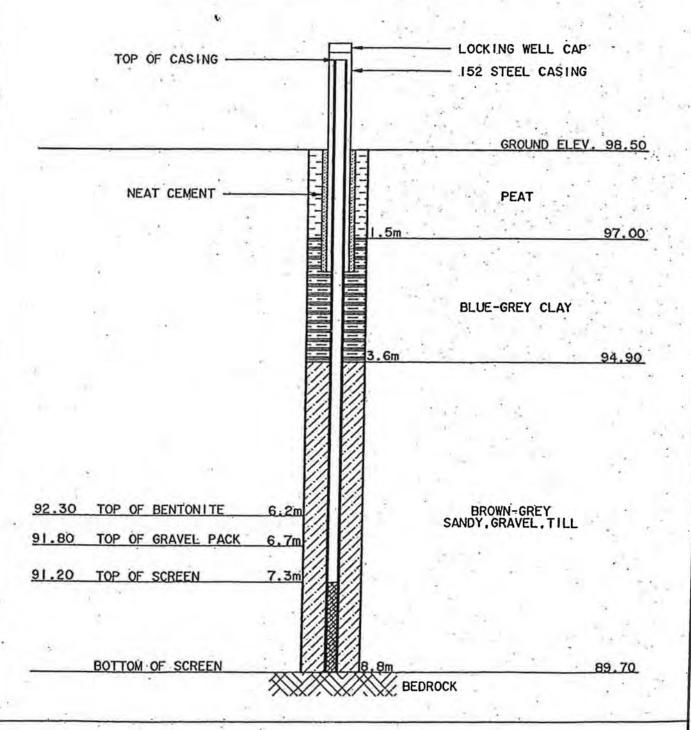
# MONITORING WELL #3 BOREHOLE LOG





MARCH, 1991	TOWNSHIP OF WINCHESTER LANDFILL	90-7848
SCALE: N.T.S.	MONITORING WELL INSTALLATION	

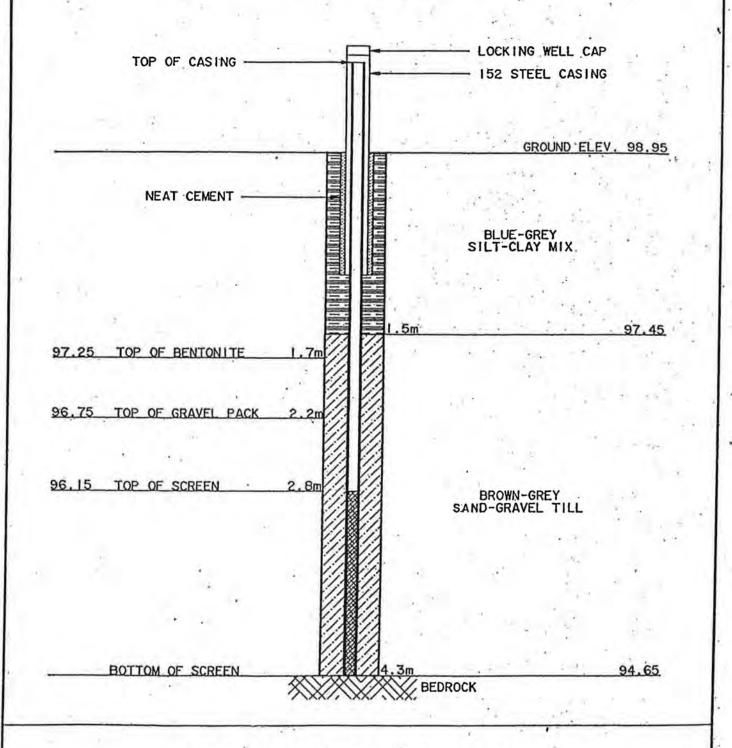
# MONITORING WELL #4 BOREHOLE LOG



# OLIVER MANGIONE MCCALLA & ASSOCIATES LIMITED Nepean, Ontario

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

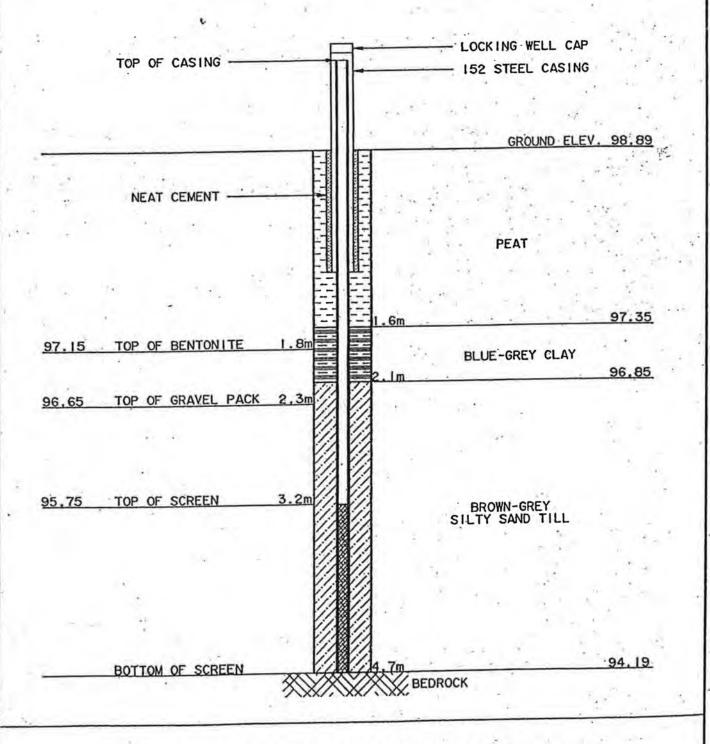
# MONITORING WELL #5 BOREHOLE LOG





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

# MONITORING WELL #6 BOREHOLE LOG





DATE: MARCH, 1991	TOWNSHIP OF WINCHESTER LANDFILL	90-7848
SCALE: N.T.S.	MONITORING WELL INSTALLATION	

ONITORING WELL NUMBER: MW 7

DRILL TYPE: CME 55 HOLLOW STEM AUGER

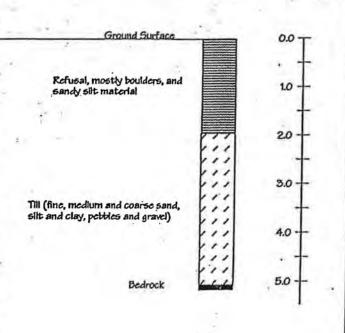
RILLER: MARATHON

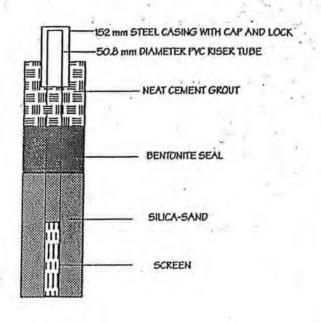
LOCATION: CONCESSION VII, LOT 8

DATE: JUNE 9, 1992

SOIL DESCRIPTION BY DEPTH ELEV.

PIEZOMETER INSTALLATION





I. S. THOMPSON	&
SSOCIATES LTD.	

**NSULTING ENGINEERS** 

ROSEMOUNT AVE. CORNWALL KGJ 3E5

FIGURE TITLE
SOIL PROFILE AND PIEZOMETER CONSTRUCTION

\*

JOB

WINCHESTER TOWNSHIP LANDFILL SITE

DATE	JUNE 1992	
SCALE	AS SHOWN	14.7
DRAWN	мнм	
JOB No.	92094	
FIGURE:	4.8	

MONITORING WELL NUMBER: MW 8

DRILL TYPE: CME 55 HOLLOW STEM AUGER

DRILLER: MARATHON

LOCATION: CONCESSION VII, LOT 8

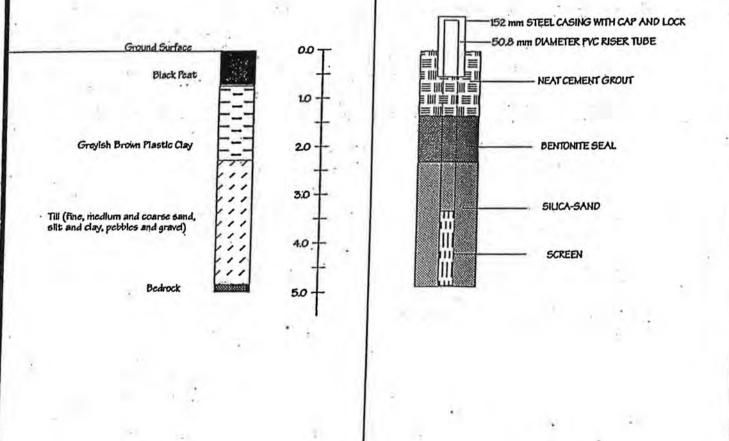
DATE: JUNE 9, 1992

SOIL DESCRIPTION

STRAL DEPTH (m)

ELEV. (m)

PIEZOMETER INSTALLATION



M.	S.	THÒM	PSON	&
ASS	SO	CIATES	LTD.	

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE. CORNWALL K6J 3E5

FIGURE TITLE

SOIL PROFILE AND PIEZOMETER CONSTRUCTION

JUNE 1992 DATE SCALE AS SHOWN МНМ DRAWN

JOB

WINCHESTER TOWNSHIP LANDFILL SITE

92094 JOB No. FIGURE:

MONITORING WELL NUMBER: MW 9

LOCATION: CONCESSION VII, LOT 8

DATE: JUNE 9, 1992

DRILL TYPE: CME 55 HOLLOW STEM AUGER

DRILLER: MARATHON DEPTH' ELEV. PIEZOMETER INSTALLATION SOIL DESCRIPTION (m) (m) 152 mm STEEL CASING WITH CAP AND LOCK 50.8 mm DIAMETER PYC RISER TUBE Ground Surface 00 EIII NEAT CEMENT GROUT 1.0 Black Peat 20 3.0 NATIVE BACKFILL Greyish Brown Plastic Clay 4.0 5.0 BENTONITE SEAL 6.0 Till (fine, medium and coarse sand, silt and clay, publics and gravd) SILICA-SAND 7.0 80 SCREEN

M.	S.	<b>THOMPSON</b>	&
IS:	SO	CIATES LTD.	

NSULTING ENGINEERS

ROSEMOUNT AVE. CORNWALL KGJ 3ES

FIGURE TITLE	ŀ
SOIL PROFILE AND PIEZOMETER CONSTRUCTION	1
	_

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

WINCHESTER TOWNSHIP LANDFILL SITE

JOB

MONITORING BEDROCK WELL: BRW-1

LOCATION: CONCESSION VII, LOT 8

DATE: JUNE 10, 1992

DRILL TYPE: CME 55 HOLLOW STEM AUGER

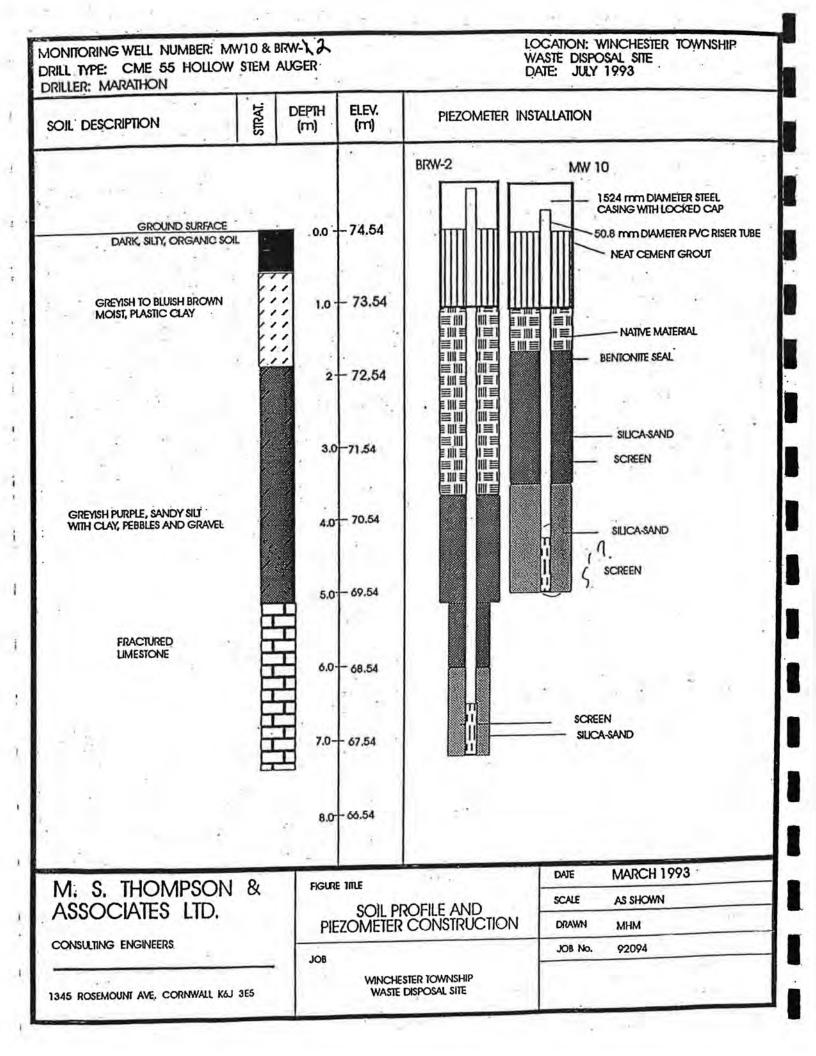
DRILLER: MARATHON			and the state of t
SOIL DESCRIPTION	STRAT.	DEPTH ELEV.	PIEZOMETER INSTALLATION
Ground Surface. Soli Greyish Brown Plastic Clay Till (fine, medium and coarse sand silt and clay, petbles and gravel) Fractured Limestone Light grey Limestone, Compact	777	0.0 — 4.0 — 12.0 — 20.0 — 24.0 —	STEEL CASING (I.D. = 158.8 mm)    III
			The state of the s

M.	S.	THOMPSON	&
		CIATES LTD.	

CONSULTING ENGINEERS

1345 ROSEMOUNT AVE. CORNWALL KGJ 3E5

FIGURE TITLE  50IL PROFILE AND PIEZOMETER CONSTRUCTION	DATE JUNE 1992
	SCALE AS SHOWN
	DRAWN MHM
JOB	JOB No. 92094
WINCHESTER TOWNSHIP LANDFILL SITE	FIGURE:



## Log of MW 16

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince



UBSURFACE PROFILE			SAMPLE		Volatile		
- Description	Elev.	Number	Type	Recovery	Organic Compounds	Well Data	Lab Analysis
Ground Surface	0				TITE COLUMN		
TOPSOIL Topsoil.	-0.76	AU 1	1			-	
		SS 2		N.			
	1.18			2011000			
fractured clayey silt with traces of sand till.		SS 3					
	-2.3			NAME OF THE OWNER, OWNE			
		SS 4					
SILTY SAND  Medium brown to grey, moist to saturated, silly sand with some coarse gravel till.	1	SS 5					
	-4.6	SS 6	II				
End of Borehole							
	Ground Surface  TOPSOIL Topsoil.  CLAYEY SILT Medium grey, moist, soft, fractured clayey silt with traces of sand till.  SILTY SAND Medium brown to grey, moist to saturated, silty sand with some coarse gravel till.	Ground Surface 0  TOPSOIL Topsoil0.76  CLAYEY SILT Medium grey, moist, soft, fractured clayey silt with traces of sand till.  -2.3  SILTY SAND Medium brown to grey, moist to saturated, silty sand with some coarse gravel till.	Ground Surface  TOPSOIL Topsoil.  CLAYEY SILT Medium grey, moist, soft, fractured clayey silt with traces of sand till.  SS 3  -2.3  SS 4  SILTY SAND Medium brown to grey, moist to saturated, silty sand with some coarse gravel till.  SS 6  -4.6	Ground Surface  TOPSOIL Topsoil.  CLAYEY SILT Medium grey, moist, soft, fractured clayey silt with traces of sand till.  SILTY SAND Medium brown to grey, moist to saturated, silty sand with some coarse gravel till.  SS 6  4.6	Ground Surface  O  TOPSOIL Topsoil.  CLAYEY SILT Medium grey, moist, soft, fractured clayey silt with traces of sand till.  SS 3  SS 4  SILTY SAND Medium brown to grey, moist to saturated, silly sand with some coarse gravel till.  SS 6  4.6	Description  AU 1  Description  Des	TOPSOIL Topsoil.  CLAYEY SILT Medium grey, moist, soft, fractured clayey silt with traces of sand till.  SS 4  SILTY SAND Medium brown to grey, moist to saturated, silty sand with some coarse gravel till.  SS 6  4.6

Drill Method: Hollow Stem Auger

Trow Consulting Engineers Ltd.

Drill Date: September 26, 2002

154 Colonnade Road South Nepean, Ontario K2E 7J5

Hole Size: 0.15 metres

Datum:

Checked by: B.Coons

Sheet: 1 of 1

## Log of MW 17

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince



	SUBSURFACE PROFILE		S	SAMPLE		Moletile		
Symbol	Description	Elev.	Number	Туре	Recovery	Volatile Organic Compounds ppmv 25 75 125175		Lab Analysis
m <sub>o</sub> ~	Ground Surface	0			0.76			
2,2	TOPSOIL.	-0.3	AU 1					
			A0 1					
-1			SS 2	$\Pi$	D 1961312			
				Щ				
- 2	SILTY GRAVELLY SAND Medium brown, dry, hard,			}				
-2	silty gravelly sand till.			1				
-			AU 3	1				
				<b>₹</b>				
-3		-3						
	**		SS 4	Ш				
	SILTY GRAVELLY SAND							
-4	Medium grey, wet, hard, silty gravelly sand till.		AU 5	•				
	4 19.			1				
		-4.6	_					
4 1	End of Borehole							
-5	1	1			1			
- 5	(9)				1			
-								
	4				1			
-								
-6						1111111		

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

## Log of MW 18

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince



*	S	UBSURFACE PROFILE			SAMPLE	-	Volatile			
	Symbol	Description	Elev.	Number	Туре	Recovery	Organic Compounds ppmv 25 75 125175	Well Data	Lab Analysis	
m -0		Ground Surface	0	1111						
	422	TOPSOIL Topsoil.	-0.3		1					
	#	SILTY CLAY		AU 1		BOX WINDS CO.				
-1	#	Medium brown, moist, silty fractured clay.	-1.2	- SS 2						
. 2		SILTY SAND		SS 3						
		Medium brown, dry, silty sand with some gravel till.	-3	SS 4	$\prod$					
-3	Ĭ.	SILTY SANDY GRAVEL Medium grey, wet, silty	-3.4	SS 5	П	ACMINIST STREET				
d		sandy gravel till. Refusal at 11 feet.								
4		End of Borehole								
-5									1.	

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

## Log of MW 19

Project: North Dundas Landfill - Boyne Rd.

Client: Township of North Dundas

Location: Winchester, ON

Logged by: Matt Prince



	S	UBSURFACE PROFILE		5	SAMPLE				
Depth	Symbol	Description	Elev.	Number	Туре	Recovery	Volatile Organic Compounds ppmv 25 75 125175		Lab Analysis
m <sub>o</sub>		Ground Surface	0		7.5				
-	41/2	TOPSOIL Topsoil.	-0.3	AU 1	1				
-1	##	SILTY CLAY		SS 2	Í				
-2	##	Medium brown, dry, har, silty clay with some gravel till.		AU 3	1				
	H X	* **	-3	AŲ4	1				
-4	A	SILTY SAND  Medium grey, dry, hard, silty sand with some gravel till.  Refusal at 11'2".  End of Borehole	-3.4	SS 5	11				
-6				4					

Drill Method: Hollow Stem Auger

Drill Date: September 26, 2002

Hole Size: 0.15 metres

Trow Consulting Engineers Ltd.

Nepean, Ontario K2E 7J5

154 Colonnade Road South

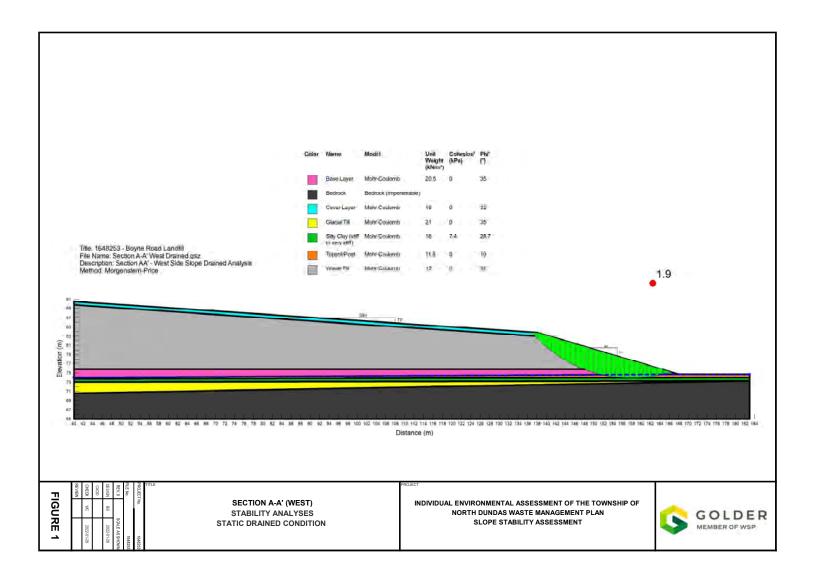
Datum:

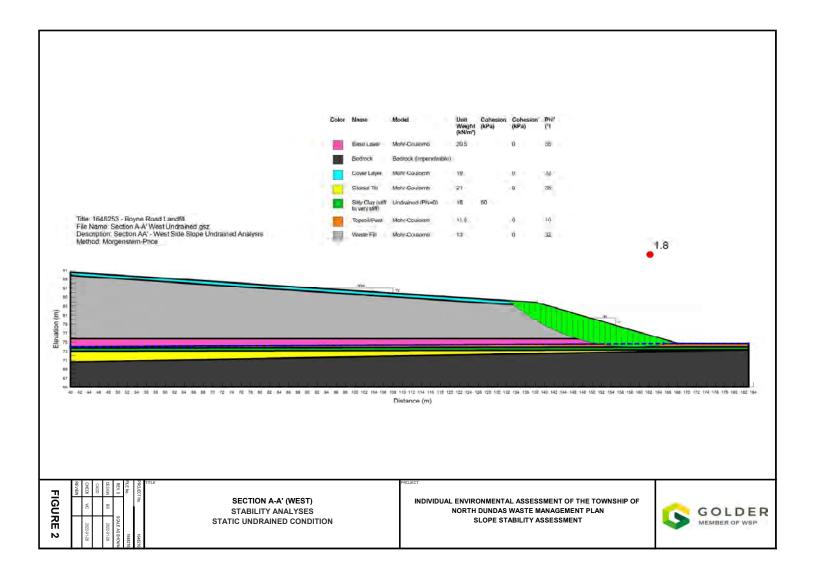
Checked by: B.Coons

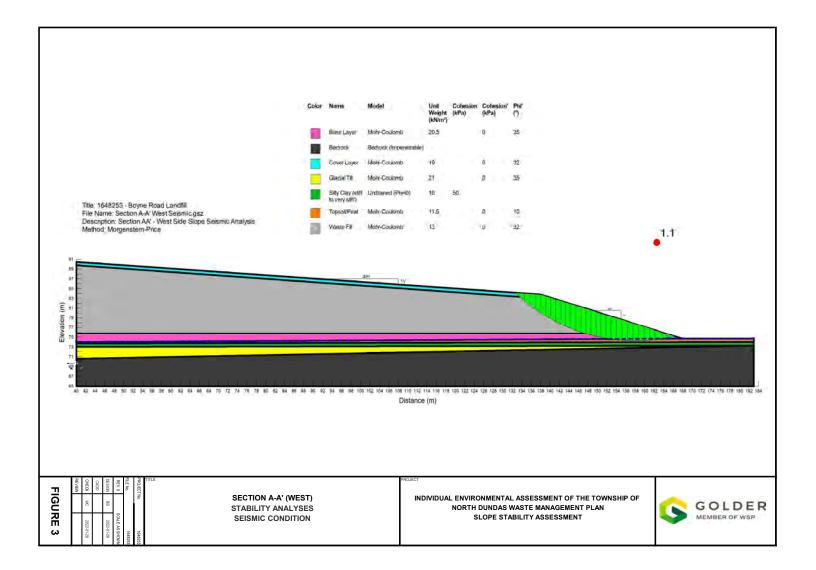
Sheet: 1 of 1

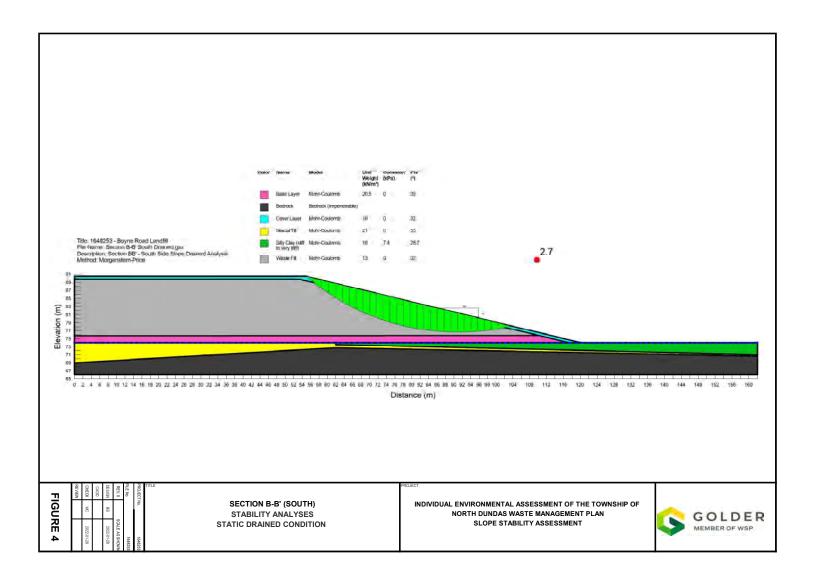
ATTACHMENTS - SLOPE/W OUTPUT SECTIONS

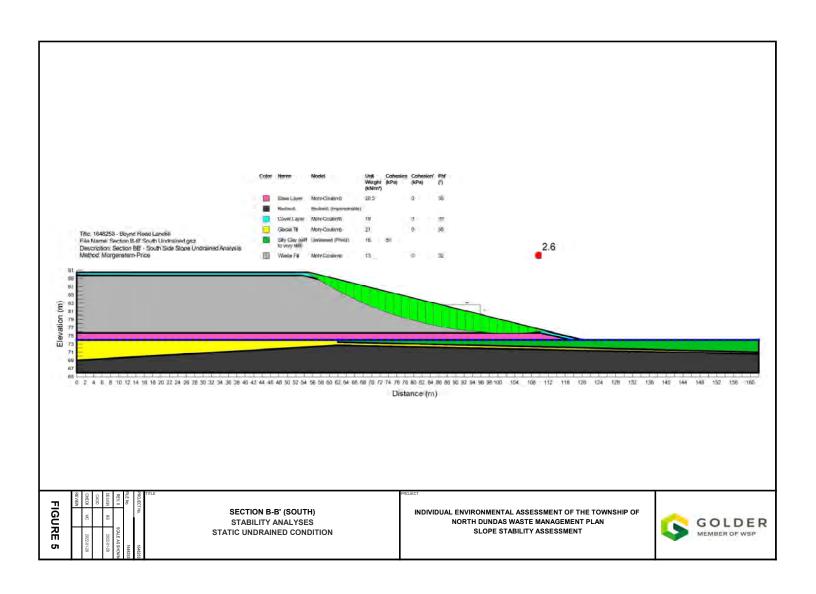
- Figures 1 to 6

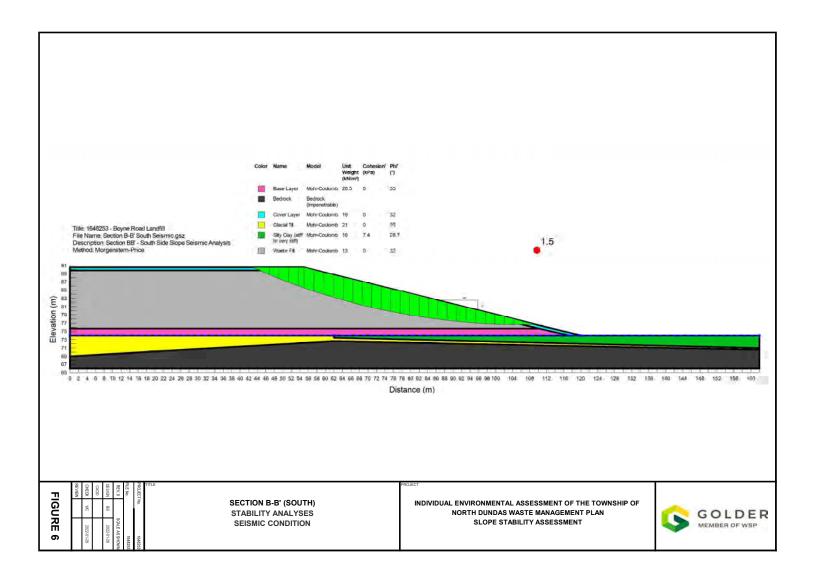












## ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

**Appendix D-3 POLLUTE Output** 



#### **POLLUTEv7**

Version 7.13

Copyright (c) 2007.
GAEA Technologies Ltd., R.K. Rowe and J.R. Booker

#### **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		