Brooks Road Environmental

Geology and Hydrogeology Assessment Report for the Brooks Road Landfill Site Vertical Capacity Expansion Environmental Assessment

Brooks Road Landfill Site
160 Brooks Road
Haldimand County, Ontario

JULY 2016 (UPDATED OCTOBER 2016)
REF. NO. 018235 (64)

Table of Contents

List of Figures

List of Drawings
(Following Text)

List of Tables

List of Appendices

Section 1.0 Introduction

In July 2015 the Minister of the Environment and Climate Change approved the Terms of Reference (ToR) for the Brooks Road Landfill Site Vertical Capacity Expansion Environmental Assessment (EA). This report provides an overview of the alternative conceptual vertical capacity expansion designs (i.e., 'Alternative Methods') for the Brooks Road Landfill Site Vertical Capacity Expansion EA (**Section 2.0**) and documents the following with respect to Geology and Hydrogeology:

- Describes the Geology and Hydrogeology Existing Conditions associated with the EA Study Areas (**Section 3.0**)
- Details the mitigation measures to be incorporated into the Alternative Method designs in order to prevent or minimize effects on Geology and Hydrogeology (**Section 4.0**)
- Documents the net effects analysis for each Alternative Method with respect to Geology and Hydrogeology (**Section 5.0**)
- Identifies the Preferred Alternative Method from a Geology and Hydrogeology perspective through a comparative evaluation process (**Section 6.0**)

Section 2.0 Alternative Methods for Vertical Expansion

Three vertical expansion alternatives have been developed for comparative analysis. The alternatives were identified in consideration of the criteria and assumptions outlined in the Conceptual Design Report (CDR) and based on public input received during the ToR.

The following aspects will be identical across all three vertical expansion alternatives, including:

- An expansion capacity of 421,000 m^3, including waste, daily cover, and interim cover
- The limit of waste (i.e., landfill footprint)
- Traffic associated with importing waste, daily cover, and interim cover
- The location of the site entrance, scale house, and other ancillary supporting features
- The size and location of all buffer areas
- The final cover design (0.6 m of compacted fine-grained soil overlain by a 0.15 m thick vegetative layer)
- The leachate treatment (i.e., batch leachate treatment system)

The three vertical expansion alternatives are illustrated on **Drawings C-02** through **C-07** (following text) and their unique attributes are outlined in **Table 2.1**, below. Further information on the vertical expansion alternatives is found in the CDR.

Table 2.1 Comparison of Vertical Expansion Options			
Attribute	**Alternative 1**	**Alternative 2**	**Alternative 3**
General Description	Expansion capacity with 3H to 1V (33%) side slopes to a crest height of 218.075 m	Expansion capacity with 4H to 1V (25%) side slopes to a crest height of 221.0 m	Expansion capacity with 3H to 1V (33%) side slopes to a crest height of 221.25 m and bench at approx. 210.0 m
Approximate Elevation of Top of Landfill (including final cover)	219.65 m	221.50 m	222.13 m
Approximate Height of Landfill Above Existing Grade of 198.96	20.69 m	22.54 m	23.17 m
Post-Closure Leachate Generation Rate	36 m^3/day	36 m^3/day	36 m^3/day
Number of Vehicles Per Day Associated with Waste and Construction Materials	16	16	16

Section 3.0 Geology and Hydrogeology Environment Potentially Affected

The July 2015 Minister-approved ToR includes a preliminary description of the existing environmental conditions within the Study Areas and commits to providing an expanded description of the existing environmental conditions within the Study Areas in the EA. The following section provides a more detailed description and understanding of the Geology and Hydrogeology Existing Conditions within the Study Areas for use in the assessment and evaluation of Alternative Methods.

3.1 Study Areas

The following two generic study areas were established for preparation of the EA:

- **Site Study Area**, including all lands (i.e., 14.3 hectares [ha]) within the existing, approved boundaries of the Brooks Road Landfill Site (Site), as defined by Environmental Compliance Approval (ECA) No. A110302, dated July 21, 2014, as amended
- **Local Study Area**, including all lands and waters within a 1 kilometre (km) radius of the Site Study Area boundaries

As provided for in the approved ToR, each technical discipline may modify the Local Study Area, as required, during the EA. For Geology and Hydrogeology both the Site and Local Study Areas are applicable (see **Figure 3.1**).

Source: MNRF NRVIS, 2014. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2016;
Aerial: 2006 Grand River Conservation Authority
Coordinate System: NAD 1983 UTM Zone 17N

figure 3.1

STUDY AREAS
GEOLOGY AND HYDROGEOLOGY ASSESSMENT REPORT
BROOKS ROAD LANDFILL
160 Brooks Road, Cayuga, Ontario

Legend

Site Study Area

Local Study Area (1km Radius)

018235-20(INT004)GIS-WA002 Jul 08/2016

3.2 Methodology

Information on the Geology and Hydrogeology Existing Conditions within the Study Areas was gathered from a combination of secondary source research and Site-specific reports.

3.2.1 Available Secondary Source Information Collection and Review

The following information was reviewed:

Site-Specific Reports

- Conestoga-Rovers and Associates. (May 2015). *2014 Annual Operations and Monitoring Report, Edwards Landfill Site, Haldimand County, Ontario.*
- Conestoga-Rovers and Associates. (October 2002, Amended November 2003). *Design and Operations Report, Edwards Landfill Site, Haldimand County, Ontario.*
- Conestoga-Rovers and Associates. (October 2002). *Hydrogeologic Performance Assessment - Updated Design, Edwards Landfill Site, Haldimand County, Ontario.*
- Conestoga-Rovers and Associates. (July 2010). *Updated Site Decommissioning Plan, Edwards Landfill Site, Haldimand County, Ontario.*
- Conestoga-Rovers and Associates. (July 2004). *Well Survey and Limited Hydrogeological Assessment, Edwards Landfill Site, Haldimand County, Ontario.*
- Conestoga-Rovers and Associates. (January 2014). *Site Decommissioning Report, Brooks Road Landfill Site, Haldimand County, Ontario.*
- GHD Ltd. (May 2016). *Gypsum Mine Investigation Report, Haldimand County, Ontario.*

Government Information Available in the Public Domain

- **Physiography mapping (classified as the Haldimand Clay Plain)**
  - Chapman, L.S. and Putnam, D.F, 1984: The Physiography of Southern Ontario; Ontario Geological Survey, Special Volume 2, Ontario Ministry of Natural Resources., Third addition.
- **Topography Mapping (regional topography and slope, and approximate site topography of 200 m above mean sea level [AMSL]).**
  - National Topographic System, 1983: Dunnville, Ontario; Canada Centre for Mapping, Department of Energy, Mines & Resources, Information Current as of 1980, Map Sheet 30 L/13, Edition 6, scale 1:50,000.
- **Soils mapping (classified as lacustrine silty clay)**
  - Ontario Institute of Pedology, 1983: Soils of Haldimand-Norfolk Regional Municipality; Cartography Section, Land Resource Research Institute, Research Branch, Agriculture Canada, Soil Survey Report No. 57, Sheet 6, scale 1:25,000.
- **Quaternary geology mapping (classified as glaciolacustrine clay and silt)**
  - Feenstra, B.H., 1974: Quaternary Geology of the Dunnvile Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P.981, Geological Series, scale 1:50,000. Geology 1973.

- **Bedrock topography mapping (bedrock topography approx. 182.5 m AMSL)**
  - Feenstra, B.H., 1981: Bedrock Topography of the Dunnvile Area, Southern Ontario; Ontario Geological Survey, Preliminary Map P.2412, scale 1:50,000.
- **Bedrock geology mapping (bedrock geology is comprised of argillaceous dolostone and evaporites of the Salina Formation)**
  - Telford, P.G., and Tarrant, G.A., 1975: Paleozoic Geology of the Dunnvile Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P.988, Geological Series, scale 1:50,000. Geology 1974.
- **Karst geology report/mapping**
  - Brunton, F.R. and Dodge, J.E.P. 2008: Karst of Southern Ontario and Manitoulin Island; Ontario Geological Survey, Groundwater Resources Study 5. ISBN 978-1-4249-8376-6 (ZIP FILE).

Active and abandoned gas wells in proximity to the Site were also reviewed (source: Oil, Gas & Salt Resources Library, London, ON).

3.3 Existing Geology and Hydrogeology Conditions

The Site is situated on the Haldimand Clay Plain[1] approximately 2 km east of the Town of Cayuga. The Site is relatively flat. The regional topography is generally flat with a gentle slope to the south towards Lake Erie. The elevation of the Site is approximately 200 m AMSL[2]. A Site location map, which includes regional elevations, is included as **Figure 3.2**.

A review of soil surveys indicates that the surficial soils on-Site are classified as mainly lacustrine silty clay[3]. A review of the quaternary geology in the Local Study Area indicates that the area is generally underlain by glaciolacustrine clay and silt[4]. Published bedrock topography mapping indicates a bedrock elevation of approximately 182.5 m AMSL in the vicinity of the Site[5]. The bedrock geology in the vicinity and underlying the Site is comprised of argillaceous dolostone, shale, and evaporites of the Salina Formation[6]. The Site geology is depicted in geological cross sections across the Site in **Figures 3.3, 3.4, and 3.5**.

---

1 Chapman, L.S. and Putnam, D.F, 1984: The Physiography of Southern Ontario; Ontario Geological Survey, Special Volume 2, Ontario Ministry of Natural Resources., Third addition.

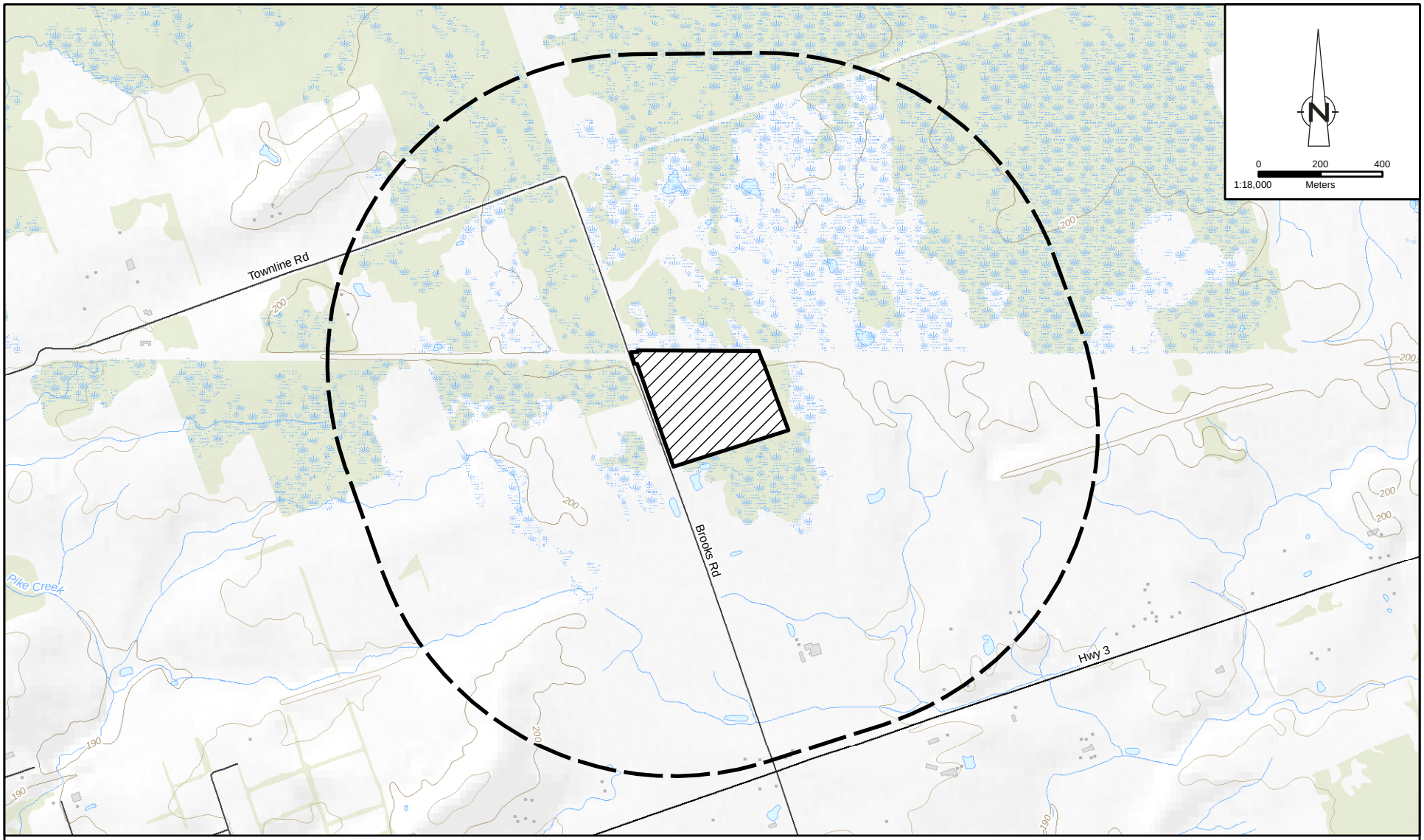
2 National Topographic System, 1983: Dunnville, Ontario; Canada Centre for Mapping, Department of Energy, Mines & Resources, Information Current as of 1980, Map Sheet 30 L/13, Edition 6, scale 1:50,000.

3 Ontario Institute of Pedology, 1983: Soils of Haldimand-Norfolk Regional Municipality; Cartography Section, Land Resource Research Institute, Research Branch, Agriculture Canada, Soil Survey Report No. 57, Sheet 6, scale 1:25,000.

4 Feenstra, B.H., 1974: Quaternary Geology of the Dunnville Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P.981, Geological Series, scale 1:50,000. Geology 1973.

5 Feenstra, B.H., 1981: Bedrock Topography of the Dunnville Area, Southern Ontario; Ontario Geological Survey, Preliminary Map P.2412, scale 1:50,000.

6 Telford, P.G., and Tarrant, G.A., 1975: Paleozoic Geology of the Dunnville Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P.988, Geological Series, scale 1:50,000. Geology 1974.



Source: MNRF NRVIS, 2016. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2016; Haldimand County Official Plan
Aerial: 2006 Grand River Conservation Authority
Coordinate System: NAD 1983 UTM Zone 17N

figure 3.2

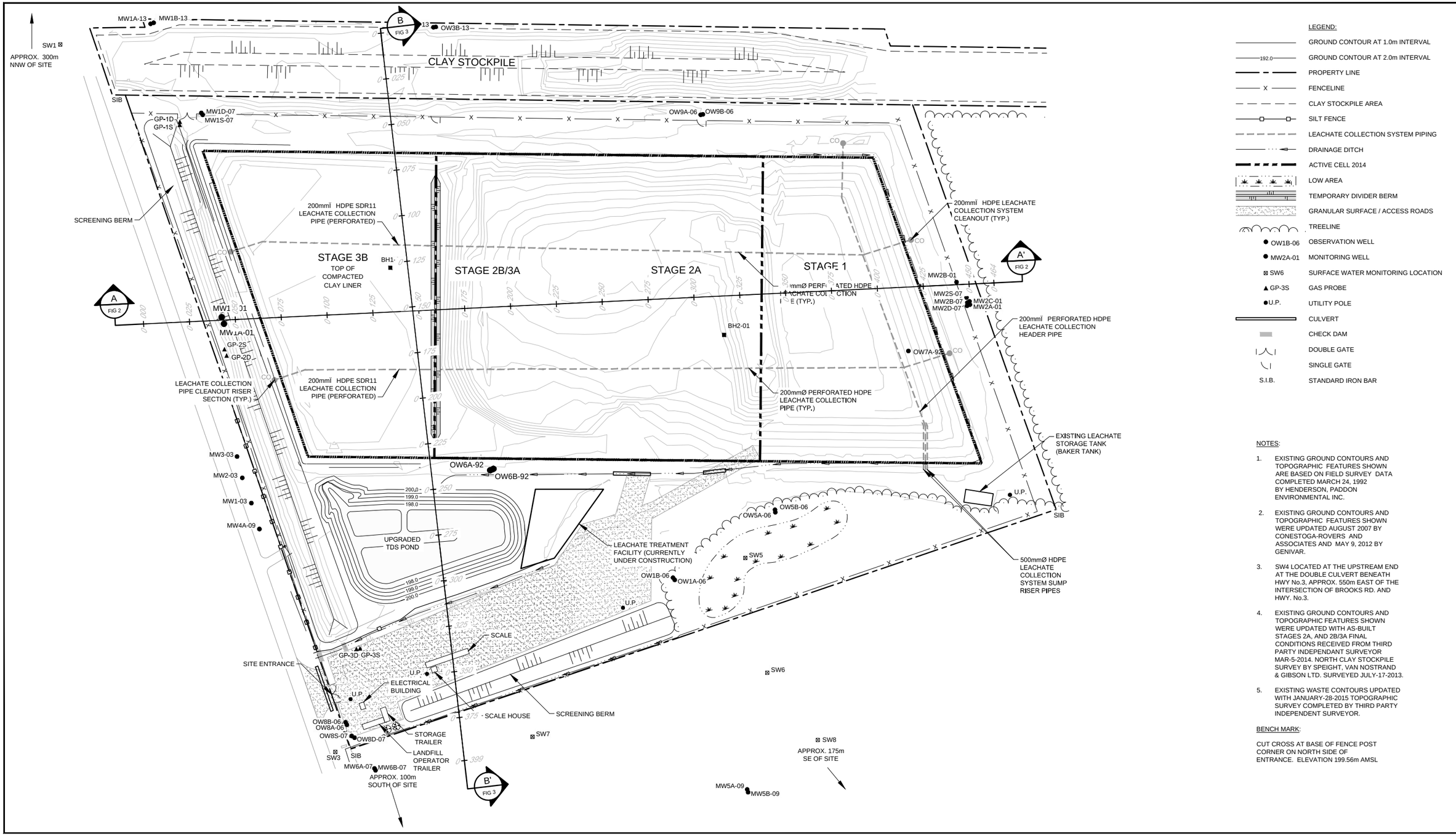
SITE LOCATION MAP
GEOLOGY & HYDROGEOLOGY ASSESSMENT REPORT
BROOKS ROAD LANDFILL
160 Brooks Road, Cayuga, Ontario

Legend

Site Location

Local Study Area (1km Radius)

018235-20(064)GIS-WA002 Apr 25/2016



LEGEND:

- GROUND CONTOUR AT 1.0m INTERVAL
- 192.0 GROUND CONTOUR AT 2.0m INTERVAL
- PROPERTY LINE
- FENCELINE
- CLAY STOCKPILE AREA
- SILT FENCE
- LEACHATE COLLECTION SYSTEM PIPING
- DRAINAGE DITCH
- ACTIVE CELL 2014
- LOW AREA
- TEMPORARY DIVIDER BERM
- GRANULAR SURFACE / ACCESS ROADS
- TREELINE
- OW1B-06 OBSERVATION WELL
- MW2A-01 MONITORING WELL
- SW6 SURFACE WATER MONITORING LOCATION
- GP-3S GAS PROBE
- U.P. UTILITY POLE
- CULVERT
- CHECK DAM
- DOUBLE GATE
- SINGLE GATE
- S.I.B. STANDARD IRON BAR

NOTES:

1. EXISTING GROUND CONTOURS AND TOPOGRAPHIC FEATURES SHOWN ARE BASED ON FIELD SURVEY DATA COMPLETED MARCH 24, 1992 BY HENDERSON, PADDON ENVIRONMENTAL INC.
2. EXISTING GROUND CONTOURS AND TOPOGRAPHIC FEATURES SHOWN WERE UPDATED AUGUST 2007 BY CONESTOGA-ROVERS AND ASSOCIATES AND MAY 9, 2012 BY GENIVAR.
3. SW4 LOCATED AT THE UPSTREAM END AT THE DOUBLE CULVERT BENEATH HWY No.3, APPROX. 550m EAST OF THE INTERSECTION OF BROOKS RD. AND HWY. No.3.
4. EXISTING GROUND CONTOURS AND TOPOGRAPHIC FEATURES SHOWN WERE UPDATED WITH AS-BUILT STAGES 2A, AND 2B/3A FINAL CONDITIONS RECEIVED FROM THIRD PARTY INDEPENDANT SURVEYOR MAR-5-2014. NORTH CLAY STOCKPILE SURVEY BY SPEIGHT, VAN NOSTRAND & GIBSON LTD. SURVEYED JULY-17-2013.
5. EXISTING WASTE CONTOURS UPDATED WITH JANUARY-28-2015 TOPOGRAPHIC SURVEY COMPLETED BY THIRD PARTY INDEPENDENT SURVEYOR.

BENCH MARK:

CUT CROSS AT BASE OF FENCE POST CORNER ON NORTH SIDE OF ENTRANCE. ELEVATION 199.56m AMSL

0 20 40 60m

GHD

BROOKS ROAD LANDFILL SITE
Halimand County, Ontario
GEOLOGY AND HYDROGEOLOGY ASSESSMENT REPORT
VERTICAL CAPACITY EXPANSION ENVIRONMENTAL ASSESSMENT
CROSS SECTION PLAN

18235-20
Oct 12, 2016

Figure 3.3

CAD File: P:\drawings\18000s\18235\18235-reports\18235-20(064)\18235-20(064)GN\18235-20(064)GN-WA001.dwg

A

WEST

A'

EAST

SCREENING BERM

BROOKS ROAD

FENCE

MW1B-01*
MW1A-01*

LIMIT OF REDESIGNED LANDFILL

BH1-01 (O/S 24.09m N)

OW6A-92 (O/S 88.67m S)*

LANDFILL

BH2-01 (O/S 21.19m S)

OW7A-92 (O/S 34.75m S)*

LIMIT OF REDESIGNED LANDFILL

MW2D-07 (O/S 11.75m S)
MW2S-07 (O/S 7.22m S)
MW2B-01*
MW2C-01 (O/S 9.38m S)
MW2A-01 (O/S 11.21m S)

FENCE

TOPSOIL

GROUND SURFACE

SILTY CLAY AND CLAY (WEATHERED)

SILTY CLAY (TILL)

BASE OF WASTE
LEACHATE COLLECTION SYSTEM
COMPACTED CLAY LAYER

HDPE LINER

CLAY (VARVED)

SILTY SAND (TILL)

BEDROCK

BEDROCK

BEDROCK

GYPSUM

216 214 212 210 208 206 204 202 200 198 196 194 192 190 188 186 184 182 180 178 176 174 172

STA

0+025 0+050 0+075 0+100 0+125 0+150 0+175 0+200 0+225 0+250 0+275 0+300 0+325 0+350 0+375 0+400 0+425 0+450

LEGEND

MW1A-01 — WELL DESIGNATION

GROUND SURFACE

WELL

WELL SCREEN

BEDROCK — STRATIGRAPHIC UNIT

INTERPRETED STRATIGRAPHY

- CLAY (VARVED)
- SILTY CLAY AND CLAY (WEATHERED)
- SILTY CLAY (TILL)
- SILTY SAND (TILL)
- BEDROCK

NOTES:

* ABANDONED WELL - HISTORICAL DATA

0 15 30 45m

SCALE:

HORZ.: 1:1500
VERT. : 1:300

GHD

BROOKS ROAD LANDFILL SITE
Halimand County, Ontario
GEOLOGY AND HYDROGEOLOGY ASSESSMENT REPORT
VERTICAL CAPACITY EXPANSION ENVIRONMENTAL ASSESSMENT

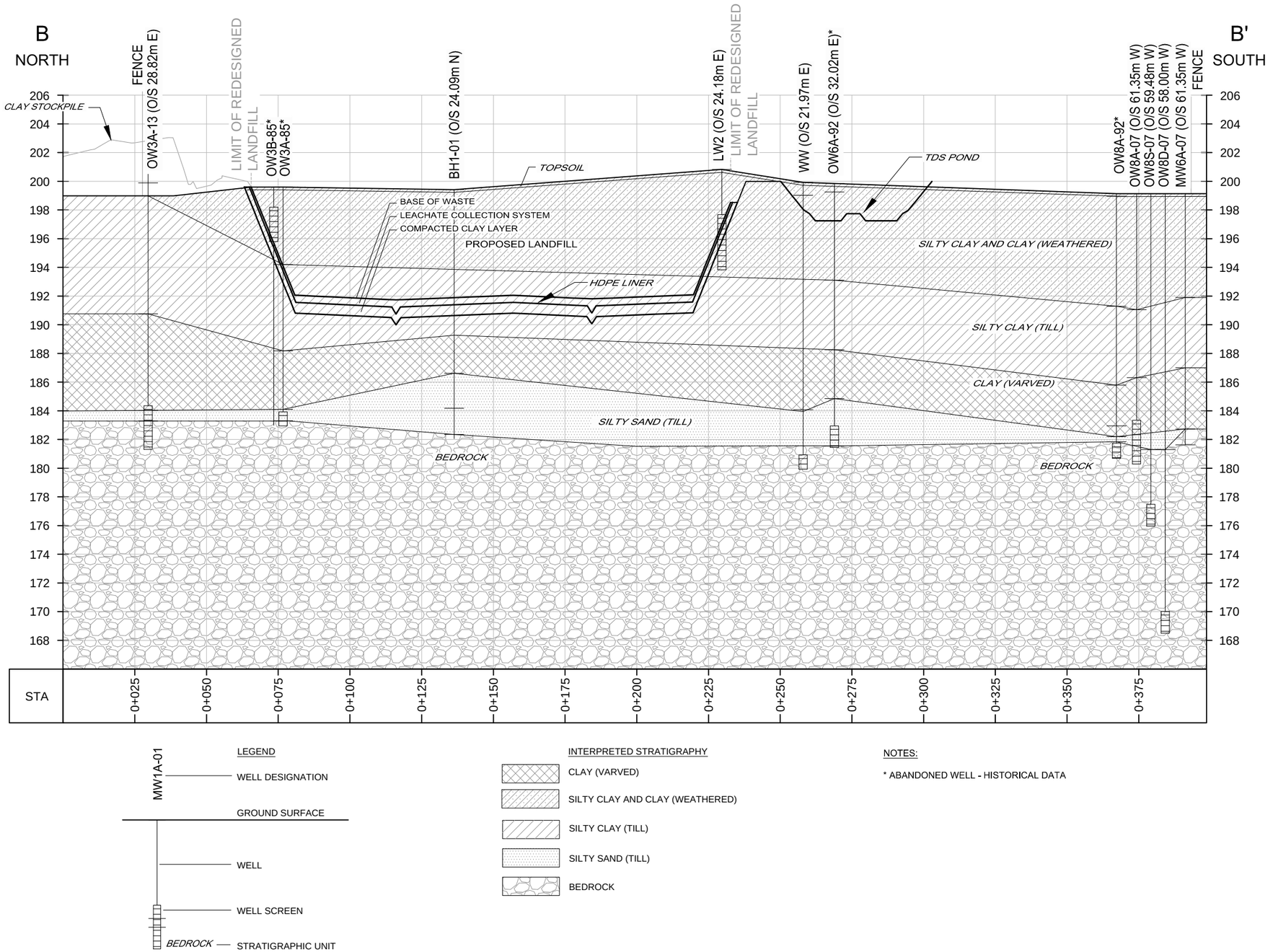
GEOLOGICAL CROSS-SECTION A-A'

18235-20

Oct 12, 2016

Figure 3.4

CAD File: P:\drawings\18000s\18235\18235-reports\18235-20(064)\18235-20(064)GN\18235-20(064)GN-WA001.dwg



LEGEND

MW1A-01 — WELL DESIGNATION

GROUND SURFACE

WELL

WELL SCREEN

BEDROCK — STRATIGRAPHIC UNIT

INTERPRETED STRATIGRAPHY

- CLAY (VARVED)
- SILTY CLAY AND CLAY (WEATHERED)
- SILTY CLAY (TILL)
- SILTY SAND (TILL)
- BEDROCK

NOTES:

* ABANDONED WELL - HISTORICAL DATA

0 15 30 45m

SCALE:

HORZ.: 1:1500
VERT. : 1:300

BROOKS ROAD LANDFILL SITE
Halimand County, Ontario
GEOLOGY AND HYDROGEOLOGY ASSESSMENT REPORT
VERTICAL CAPACITY EXPANSION ENVIRONMENTAL ASSESSMENT

GEOLOGICAL CROSS-SECTION B-B'

18235-20

Oct 12, 2016

Figure 3.5

CAD File: P:\drawings\18000s\18235\18235-reports\18235-20(064)\18235-20(064)GN\18235-20(064)GN-WA001.dwg

Site Geology

The overburden geology is relatively uniform beneath the Site. In general the Site is characterized by a thick (14 to 18 m) glaciolacustrine layer of stratified silty clay, silty clay till and varved clays, underlain by a thin (1 to 3 m) discontinuous layer of silty sand till with varying proportions of gravel and clay. The bedrock has been encountered at depths varying from 15.2 to 20.2 m below ground surface (BGS). A thin surficial deposit of topsoil is generally observed at the surface of the Site, with the exception of the southwestern portion.

The silty clay deposits are described as being locally fractured (weathered) from the surface down to depths varying from 3 to 5 m BGS, and are characterized as a very stiff to hard with low plasticity. At depths in excess of 5 m, the silty clay deposits have little to no fracturing and the consistency of the units increase from stiff to very stiff.

Underlying the silty clay deposits, a thin discontinuous silty sand till with varying proportions of clay and gravel is encountered across the Site. The silty sand till ranges in thickness from 1 to 3 m and often contains cobbles and/or broken angular bedrock fragments. This deposit is usually well graded with fine to medium grained sand, minor silt and trace clay, and is described as dense to compact, grey, and saturated. The silty sand till rests directly over the bedrock.

Bedrock underlying the Site has been described as a fractured shale, dolostone and gypsum of the Salina Formation. The top of bedrock elevation ranges from 180.80 to 185.73 m above mean sea level (AMSL), and forms a small bedrock valley from northwest to southeast across the Site. The valley is characterized by a thicker silty sand till deposit. Regionally, the bedrock topography dips to the south.

The base elevation of the landfill's compacted clay liner is at approximately 191 m AMSL at the west end of the Site and slopes at 5 percent grade towards the east to an elevation of approximately 189 m AMSL. The base of the landfill liner resides in the silty clay till stratigraphy, with varved clay, silty sand till, and bedrock underneath the silty clay till respectively. The thickness between the base of the landfill and bedrock ranges from 5 to 9 m.

Site Hydrogeology

In general, the geologic units identified at the Site may be grouped into two main hydrogeologic units, as follows:

i) An unconfined water table (shallow overburden) unit within the shallow fractured silty clay unit

ii) A confined basal overburden/shallow bedrock aquifer

These two hydrogeological units are separated by a thick (between 9 and 12 m) layer of stratified silty clay, silty clay till, and varved clays which form a continuous aquitard of very low hydraulic conductivity.

Groundwater level data historically gathered from the shallow overburden unit and basal overburden/shallow bedrock aquifer indicate that the clay aquitard provides hydraulic separation between the two units. Differences in hydraulic head between the two units have varied between 9.5 to 15 m as historically measured at the location of nested wells. The vertical hydraulic gradient between the two hydrogeologic units is downward.

Based on historical groundwater level data, the shallow overburden unit is generally encountered at depths varying from 0.5 to 4 m BGS across the Site. The shallow overburden unit is an unconfined water table unit, which overlies the impermeable un-weathered silty clay unit. Based on the shallow overburden monitoring wells monitored in 2014, groundwater flow in this unit is generally towards the southeast.

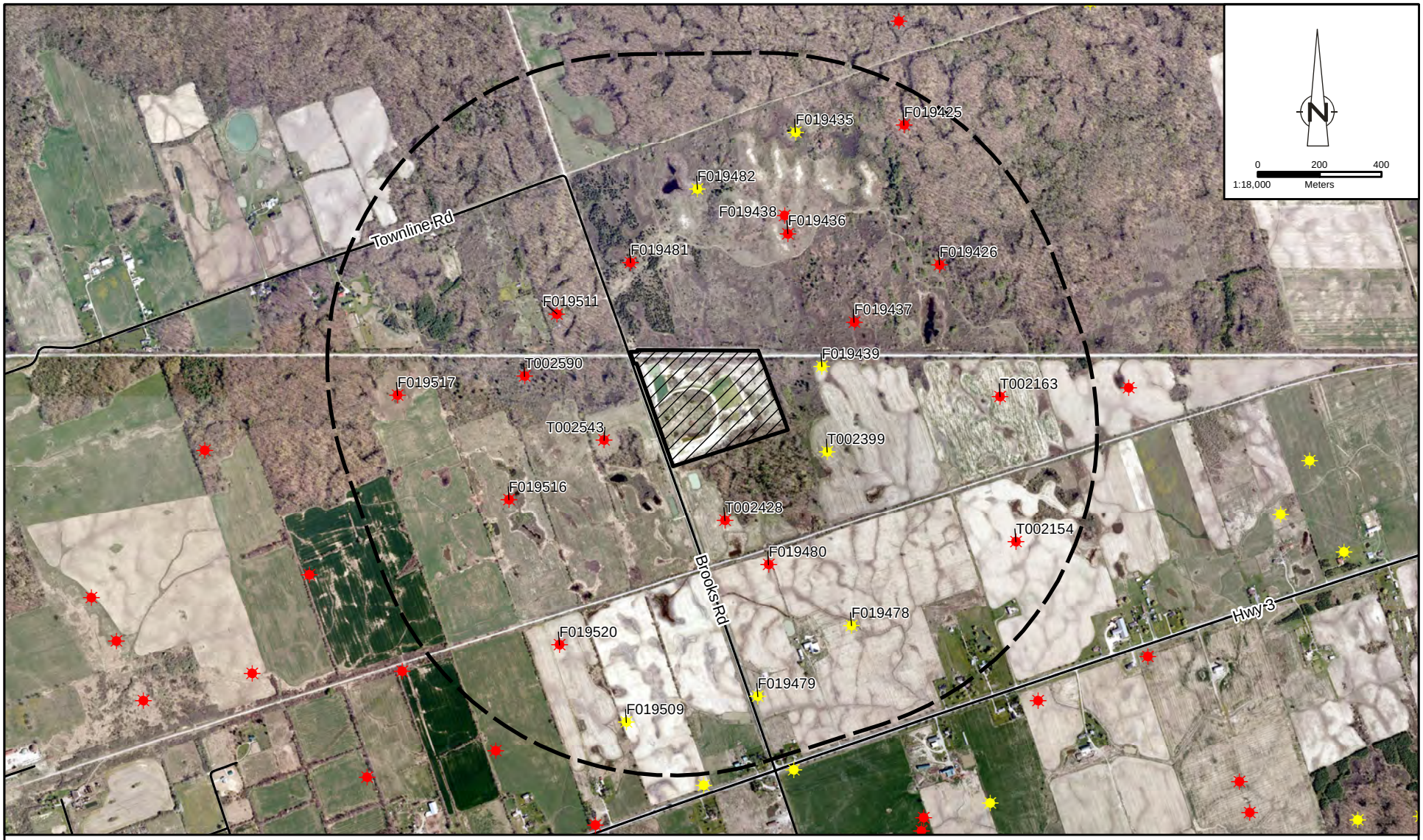
Underlying the silty clay aquitard, a confined basal overburden/shallow bedrock aquifer has been observed within the lower portion of the silty sand till unit and the shallow fractured bedrock. Groundwater quality and water level data indicate that the lower silty sand till unit and the shallow fractured portion of the bedrock are hydraulically connected and geochemically similar. Therefore, these two geological units have been considered to form one aquifer.

Based on the groundwater data obtained to date, the basal overburden/shallow bedrock aquifer is generally encountered at depths varying from 14 to 17 m BGS. The groundwater flow pattern in this aquifer is in a southerly direction with a relatively flat horizontal hydraulic gradient.

Natural Gas Deposits and Natural Gas Wells

A review of oil, gas and salt resource mapping in Ontario indicates that several active and plugged gas wells are located within the Local Study Area. No active/plugged gas wells were identified on the Site, however research indicates that 23 current and former gas wells are located within the Local Study Area. A total of 16 gas wells have been identified as abandoned, of which 15 have been identified as plugged, and a total of seven gas wells that may be active, suspended, or abandoned are found within the Local Study Area. The gas wells all targeted the Haldimand Pool within the Clinton Group and were drilled to a total depth (true vertical depth) ranging from 207.6 to 229.5 m BGS at approximately the top of the Queenston Formation. A natural gas pipeline is also located approximately 400 m south of the Site. A list of the Ontario Oil and Gas Wells located within the Local Study Area is itemized in **Table 3.1** and a reference Figure is attached as **Figure 3.6**.

Due to the depths of the natural gas wells, it is not anticipated that there would be any influence from the landfill on the natural gas wells.



Source: MNRF NRVIS, 2014. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2016; Haldimand County Official Plan
Aerial: 2006 Grand River Conservation Authority
Coordinate System: NAD 1983 UTM Zone 17N

Legend

- Site Location
- Local Study Area (1km Radius)
- Abandoned Gas Well
- Status Unknown

figure 3.6

OIL AND GAS WELL LOCATIONS
GEOLOGY & HYDROGEOLOGY ASSESSMENT REPORT
BROOKS ROAD LANDFILL
160 Brooks Road, Cayuga, Ontario

018235-20(064)GIS-WA001 Jul 08/2016

Mining Claims and Abandoned Mines

A review of the Ministry of Northern Development and Mines (MNDM) information for abandoned mines and mining claims was completed. No mining claims were identified within the Site Study Area, however one abandoned mine was identified within the Local Study Area to the northwest of the Site (AMIS File # 04888 / MDI # MDI30L13NW00003). The mine was reviewed in a CRA report entitled Well Survey and Limited Hydrogeological Assessment, dated July 2004 (2004 Report). The 2004 Report indicates two documents were reviewed: Gypsum in Ontario, C.R. Guillet, dated 1964, and Abandoned Mines Hazard Abatement Program, London District Site Examinations, prepared by Patrick Chance & Associates Consulting Geologists, dated 1994 (1994 Inspection). The information presented below was gathered from the above-referenced reports and has been revised with the most current information available including information from the Gypsum Mine Investigation Report prepared by GHD that provides an assessment of potential influences of the former Cayuga Gypsum Mine on groundwater at the landfill Site (see **Appendix A**).

The former gypsum mine was operated by the Cayuga Gypsum Company Limited between 1942 and 1949. Gypsum was mined from a 0.9 m thick bed at a depth of 25.9 m BGS.

Mining operations were accomplished via two mine shafts. The first shaft was located approximately 112 m south of Townline Road and 350 m west of Brooks Road. The former shaft can reportedly be located by a 2.4 m deep depression, with a footprint of 3 by 4.6 m. The shaft was a vertical prospect shaft of unknown support, and was back-filled with unknown materials. The 1994 Inspection did not document any evidence of subsidence; however the report recommended that a 50 m radius area of caution be observed in the vicinity of this shaft.

Based on the available historical documentation, approximately 10,300 tonnes of gypsum was reportedly removed from this prospect shaft during the operation of the mine. With a density of 2.3 ft./m^3 and a thickness of 1 m, this would correspond to lateral workings with an aerial footprint of approximately 4,356 square metres (m^2). In order to access the gypsum in the 1 m seam, it is likely that approximately 1-2 m of the overlying shale bedrock would also have been removed.

The second shaft was located approximately 305 m south of the first shaft. The 1994 inspection was reportedly unable to locate the second shaft. The second shaft was also a vertical prospect shaft of unknown support and it is unknown if the shaft has been back-filled. It is not known how much gypsum was removed from this shaft.

Due to property access restrictions, an inspection of the former Cayuga Gypsum Mine could not be conducted.

During the operation of the mine from 1942 to 1949, dewatering operations would likely have been conducted to keep the mine shafts and associated galleries dry. As such, during the operation of the

mine the local groundwater flow would have been influenced by mine dewatering activities. Active removal of large quantities of groundwater from the bedrock would have resulted in inward hydraulic gradients. As such, the bedrock groundwater flow in the vicinity of the former mine would have been directed towards the active galleries during operation of the mine.

Upon closure of the mine in 1949, the dewatering activities at the mine would have ceased and the associated mine shafts and galleries would have flooded within the first year of closure. The mine has now been abandoned for 67 years. Since the former galleries and shafts are flooded, no water deficit should be present between these former underground structures and the surrounding bedrock. Thus essentially steady state conditions should exist and the former underground structures will no longer have a hydraulic influence on the local bedrock aquifer.

In the unlikely event that the former mine shafts would not have been properly sealed following closure of the mine, there could exist the potential for surface water and groundwater in the shallow overburden to enter the mine shafts and migrate to the underlying bedrock aquifer. If infiltration were occurring, the shafts would be acting as a sink to the overburden groundwater and a source of recharge to the local bedrock groundwater. This would result in a cone of depression in the overburden groundwater towards the former mine shafts and radial flow from the galleries in the bedrock groundwater. Under this scenario there could be a potential for bedrock groundwater flow being diverted away from the former galleries. However, based on the relatively small dimension of the former galleries (areal extent of approximately 4,356 m^2) it is expected that any influence of these galleries on the bedrock aquifer would be localized to the immediate vicinity of the former galleries. Bedrock aquifer influence beyond the limits of the former Cayuga Gypsum Mine property is anticipated to be negligible.

The Gypsum Mine Investigation Report reviewed information related to historical mining operations including location and extent of mining activities, review of physical site conditions for evidence of historical mining operations, and an evaluation of hydraulic gradients within the available monitoring network to identify potential evidence of a hydraulic influence on horizontal or vertical gradients in the vicinity of the Site. The report concluded that there is no evidence of an influence related to the former Cayuga Gypsum Mine on the bedrock aquifer at the Landfill Site.

Other Data Sources

A review of the Ontario Geological Survey Karst of Southern Ontario and Manitoulin Island report indicates that no potentially karst, inferred karst, or known karst bedrock has been identified within the study area[7]. Furthermore the groundwater conditions are unfavourable for the dissolution of the bedrock and the Upper Silurian bedrock consists of generally argillaceous dolostone, shale, and

[7] Brunton, F.R. and Dodge, J.E.P. 2008: Karst of Southern Ontario and Manitoulin Island; Ontario Geological Survey, Groundwater Resources Study 5. ISBN 978-1-4249-8376-6 (ZIP FILE).

evaporites (primarily gypsum), the latter of which precludes the formation of large-scale karst features. Furthermore, no sink holes or caving features have been identified in the study area.

Section 4.0 Mitigation Measures to be Incorporated into the Alternative Method Designs

Based on the description of the Alternative Methods provided in **Section 2.0** and the characterization of Geology and Hydrogeology Existing Conditions within the Study Areas described in **Section 3.0**, there are no mitigation measures recommended to be incorporated into the Alternative Methods designs in order to avoid or minimize impacts on Geology and Hydrogeology.

Section 5.0 Net Effects Assessment

This section documents the net effects assessment for the Alternative Methods for the Brooks Road Landfill Site Vertical Capacity Expansion EA from a Geology and Hydrogeology perspective.

5.1 Net Effects Assessment Methodology

The assessment of the Alternative Methods was conducted in two steps:

- **Step 1: Confirm Evaluation Criteria and Indicators/Measures**
  Prior to undertaking the net effects assessment, the Geology and Hydrogeology evaluation criteria, indicators, and measures developed in the Minister approved ToR were reviewed and confirmed for application to each of the Alternative Methods.

- **Step 2: Undertake the Net Effects Analysis**
  With the evaluation criteria, indicators and measures confirmed through the preceding step, a net effects analysis of the Alternative Methods was carried out consisting of the following activities:
  - Identify potential effects (based on measures) on the Geology and Hydrogeology
  - Develop and apply avoidance/mitigation/compensation/enhancement measures
  - Determine net effects on the environment

5.2 General Assumptions

The principal assumption with respect to the net effects analysis is that leachate generation would not change from existing conditions. The landfill footprint would not change and the leachate collection system would maintain leachate levels as per the current design criteria.

5.3 Criteria/Indicators

	Environmental Component	Evaluation Criteria	Study Area	Indicators	Rationale	Data Sources
NATURAL	Geology & Hydrogeology	Groundwater quality	Site & Local Study Areas	• Predicted effects to groundwater quality at property boundaries and off-Site	Contaminants associated with waste disposal sites have the potential to enter the groundwater and impact off-Site groundwater.	• Hydrogeological and geotechnical studies • Water well records • Determination of water well users in the area • Annual Site Monitoring Reports • Proposed leachate control concept designs • Environment Canada Canadian Climate Normals • Leachate generation assessment • Provincial Water Quality Monitoring Network (PWQMN)
		Groundwater flow	Site & Local Study Areas	• Predicted groundwater flow characteristics	Physical works may disrupt natural groundwater flows.	• Hydrogeological and geotechnical studies • Water well records • Determination of water well users in the area • Annual Site Monitoring Reports

5.4 Potential Environmental Effects

5.4.1 Alternative Method 1

As Alternative Method 1 is a vertical expansion of the existing Brooks Road Landfill there would be no change to the landfill footprint. Leachate generation would not change from existing conditions and the leachate collection system would continue to maintain leachate levels as per the current design criteria. Consequently, there is no potential for effects on groundwater quality or flow characteristics.

5.4.2 Alternative Method 2

As Alternative Method 2 is a vertical expansion of the existing Brooks Road Landfill there would be no change to the landfill footprint. Leachate generation would not change from existing conditions and the leachate collection system would continue to maintain leachate levels as per the current design criteria. Consequently, there is no potential for effects on groundwater quality or flow characteristics.

5.4.3 Alternative Method 3

As Alternative Method 3 is a vertical expansion of the existing Brooks Road Landfill there would be no change to the landfill footprint. Leachate generation would not change from existing conditions and the leachate collection system would continue to maintain leachate levels as per the current design criteria. Consequently, there is no potential for effects on groundwater quality or flow characteristics.

5.5 Mitigation Measures Beyond Those Incorporated into the Design

5.5.1 Alternative Method 1

As there are no potential effects on groundwater quality or flow characteristics, no specific mitigation measures are required with respect to these indicators.

5.5.2 Alternative Method 2

As there are no potential effects on groundwater quality or flow characteristics, no specific mitigation measures are required with respect to these indicators.

5.5.3 Alternative Method 3

As there are no potential effects on groundwater quality or flow characteristics, no specific mitigation measures are required with respect to these indicators.

5.6 Net Environmental Effects

5.6.1 Alternative Method 1

There are no net effects on groundwater quality or flow characteristics associated with Alternative Method 1.

5.6.2 Alternative Method 2

There are no net effects on groundwater quality or flow characteristics associated with Alternative Method 2.

5.6.3 Alternative Method 3

There are no net effects on groundwater quality or flow characteristics associated with Alternative Method 3.

Table 5.1 Alternative Method 1 Geology & Hydrogeology Potential Environmental Effects, Mitigation Measures & Net Effects						
	Environmental Component	**Evaluation Criteria**	**Indicator**	**Potential Effects**	**Mitigation Measures**	**Net Effects**
NATURAL	Geology & Hydrogeology	Groundwater Quality	Predicted effects to groundwater quality at property boundaries and off-Site	No potential effects to groundwater quality at property boundaries and off-Site.	No mitigation measures required.	No effects to groundwater quality at property boundaries and off-Site.
		Groundwater Flow	Predicted groundwater flow characteristics	No potential effects to groundwater flow characteristics.	No mitigation measures required.	No effects to groundwater flow characteristics.

Table 5.2 Alternative Method 2 Geology & Hydrogeology Potential Environmental Effects, Mitigation Measures & Net Effects						
	Environmental Component	**Evaluation Criteria**	**Indicator**	**Potential Effects**	**Mitigation Measures**	**Net Effects**
NATURAL	Geology & Hydrogeology	Groundwater Quality	Predicted effects to groundwater quality at property boundaries and off-Site	No potential effects to groundwater quality at property boundaries and off-Site.	No mitigation measures required.	No effects to groundwater quality at property boundaries and off-Site.
		Groundwater Flow	Predicted groundwater flow characteristics	No potential effects to groundwater flow characteristics.	No mitigation measures required.	No effects to groundwater flow characteristics.

Table 5.3 Alternative Method 3 Geology & Hydrogeology Potential Environmental Effects, Mitigation Measures & Net Effects						
	Environmental Component	**Evaluation Criteria**	**Indicator**	**Potential Effects**	**Mitigation Measures**	**Net Effects**
NATURAL	Geology & Hydrogeology	Groundwater Quality	Predicted effects to groundwater quality at property boundaries and off-Site	No potential effects to groundwater quality at property boundaries and off-Site.	No mitigation measures required.	No effects to groundwater quality at property boundaries and off-Site.
		Groundwater Flow	Predicted groundwater flow characteristics	No potential effects to groundwater flow characteristics.	No mitigation measures required.	No effects to groundwater flow characteristics.

Section 6.0 Comparative Evaluation

This section documents the comparative evaluation of the Alternative Methods from a Geology and Hydrogeology perspective based on the net environmental effects identified in **Section 5.0**.

6.1 Comparative Evaluation Methodology

The Minister approved ToR states that the comparative evaluation of the Alternative Methods will be carried out using a Reasoned Argument (or Trade-off) method, with evaluation criteria as the basis for comparison. Under the Reasoned Argument approach, the differences in the net effects associated with each Alternative Method are highlighted. Based on these differences, the advantages and disadvantages of each alternative can be identified according to the evaluation of trade-offs between the various evaluation criteria and indicators. The relative significance of potential impacts is then examined to provide a clear rationale for the selection of a preferred alternative from a Geology and Hydrogeology perspective. The term *trade-offs* is defined as "*things of value given up in order to gain different things of value*". Each Alternative Method will be compared against the others to distinguish relative differences in impacts to the environment, taking into account possible mitigation measures.

6.2 Comparative Evaluation Results

Based on the comparative evaluation completed for the three alternative designs, all alternatives rank equally in terms of their net environmental effects on geology and hydrogeology. The results of the comparative evaluation ranking are summarized in **Table 6.1**.

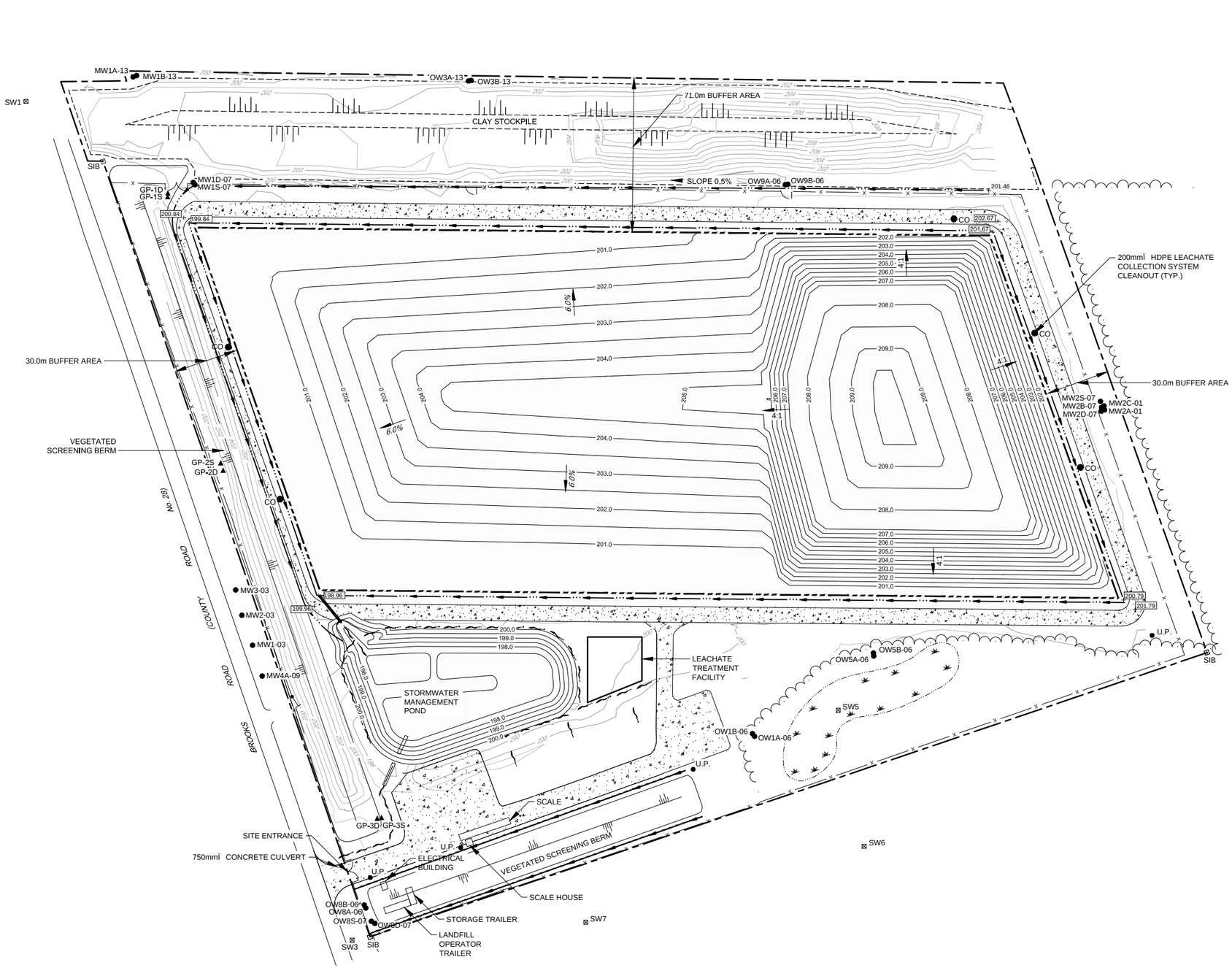
Table 6.1 Geology & Hydrogeology Comparative Evaluation

	Environmental Component	Evaluation Criteria	Indicator	Alternative Method 1 Net Effects	Alternative Method 2 Net Effects	Alternative Method 3 Net Effects
NATURAL	Geology & Hydrogeology	Groundwater Quality	Predicted effects to groundwater quality at property boundaries and off-Site	No effects to groundwater quality at property boundaries and off-Site. **NO NET EFFECTS**	No effects to groundwater quality at property boundaries and off-Site. **NO NET EFFECTS**	No effects to groundwater quality at property boundaries and off-Site. **NO NET EFFECTS**
			Criteria Ranking:	**Tied for 1st**	**Tied for 1st**	**Tied for 1st**
			Criteria Rationale:	All three alternatives are preferred as they would all results in no effects to groundwater quality at property boundaries and off-Site...		
		Groundwater Flow	Predicted groundwater flow characteristics	No effects to groundwater flow characteristics. **NO NET EFFECTS**	No effects to groundwater flow characteristics. **NO NET EFFECTS**	No effects to groundwater flow characteristics. **NO NET EFFECTS**
			Criteria Ranking:	**Tied for 1st**	**Tied for 1st**	**Tied for 1st**
			Criteria Rationale:	All three alternatives are preferred as they would all results in no effects to groundwater flow characteristics.		
		Environmental Component Ranking:		**Tied for 1st**	**Tied for 1st**	**Tied for 1st**
	RATIONALE			**There is no distinction between the alternatives in relation to their effects on groundwater quality and flow characteristics.**		

Section 7.0 Conclusion

The present physical and hydrogeological conditions were reviewed at the Site and within a 1 km radius. The alternative expansion options were presented and reviewed in terms of their net effects on the surrounding environment. Based on this review, there are no anticipated net effects in terms of the Site geology or hydrogeology resulting from the three vertical expansion alternatives reviewed.

Drawings



No.	Revision	Date	Initial

LEGEND

- 202.0 — FINAL CONTOURS BEFORE VERTICAL EXPANSION (1.0m INTERVAL (m AMSL))
- FINAL CONTOURS BEFORE VERTICAL EXPANSION (0.5m INTERVAL (m AMSL))
- 202 — GROUND CONTOUR (2.0m INTERVAL)
- GROUND CONTOUR (1.0m INTERVAL)
- PROPERTY LINE
- APPROVED LIMIT OF WASTE
- x — EXISTING FENCELINE
- CLAY STOCKPILE AREA
- PERIMETER DITCH
- TREELINE
- GRANULAR SURFACE ACCESS ROAD
- SWAMPY AREA
- 201.67 — SPOT ELEVATION (m AMSL)
- CO — LEACHATE COLLECTION SYSTEM CLEAN OUT
- SIB — STANDARD IRON BAR
- OW1B-06 — OBSERVATION WELL
- MW2A-01 — MONITORING WELL
- SW6 — SURFACE WATER MONITORING
- GP-3S — GAS PROBE
- U.P. — UTILITY POLE
- DOUBLE GATE
- SINGLE GATE

SCALE VERIFICATION

THIS BAR MEASURES 50mm ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

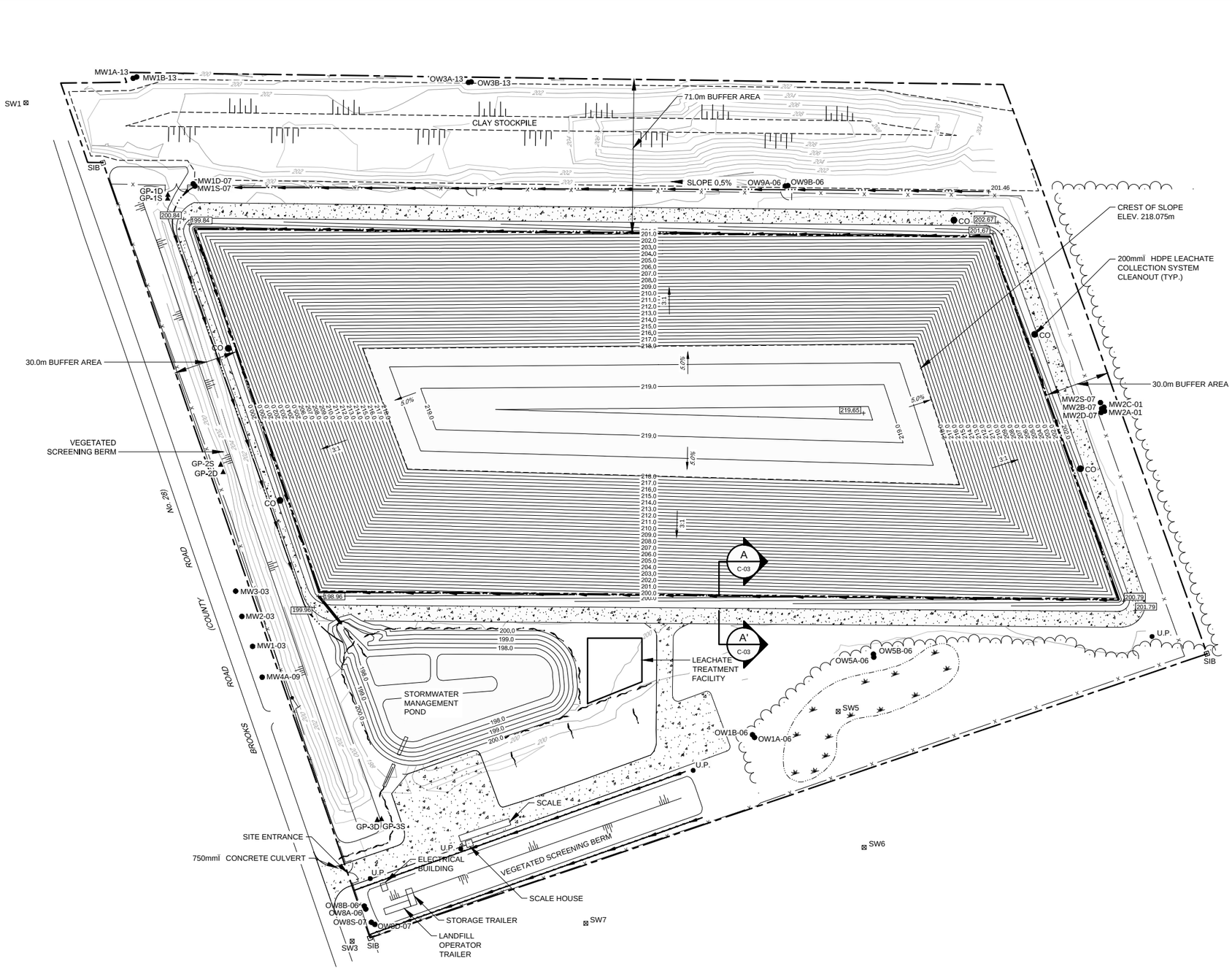
BROOKS ROAD LANDFILL SITE
HALDIMAND COUNTRY, ONTARIO

CONCEPTUAL DESIGN REPORT

EXISTING CONDITIONS INTERIM CLOSURE

Source Reference:
EXISTING GROUND CONTOURS AND TOPOGRAPHIC FEATURES SHOWN ARE BASED ON TERVITA AS-BUILT FOR FINAL CONDITIONS FOR STAGE 2A, 2B AND STAGE 3A, AND NORTH CLAY STOCKPILE SURVEY BY VAN NOSTRAND AND GIBSON SURVEYED JULY-17-2013

Project Manager:	Reviewed By:	Date:	
G.FERRARO	P.KEMP	DECEMBER 2015	
Scale: 1:1000	Project N°: 18235-20	Report N°: 051	Drawing N°: C-01



No.	Revision	Date	Initial

LEGEND

- 202.0 — TOP OF FINAL CONTOUR (1.0m INTERVAL (m AMSL))
- TOP OF FINAL COVER CONTOUR (0.5m INTERVAL (m AMSL))
- 202 — GROUND CONTOUR (2.0m INTERVAL)
- GROUND CONTOUR (1.0m INTERVAL)
- PROPERTY LINE
- APPROVED LIMIT OF WASTE
- x — EXISTING FENCELINE
- CLAY STOCKPILE AREA
- PERIMETER DITCH
- TREELINE
- GRANULAR SURFACE ACCESS ROAD
- SWAMPY AREA
- 201.67 — SPOT ELEVATION (m AMSL)
- CO — LEACHATE COLLECTION SYSTEM CLEAN OUT
- SIB — STANDARD IRON BAR
- OW1B-06 — OBSERVATION WELL
- MW2A-01 — MONITORING WELL
- SW6 — SURFACE WATER MONITORING
- GP-3S — GAS PROBE
- U.P. — UTILITY POLE
- DOUBLE GATE
- SINGLE GATE

SCALE VERIFICATION

THIS BAR MEASURES 50mm ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

BROOKS ROAD LANDFILL SITE
HALDIMAND COUNTRY, ONTARIO

CONCEPTUAL DESIGN REPORT

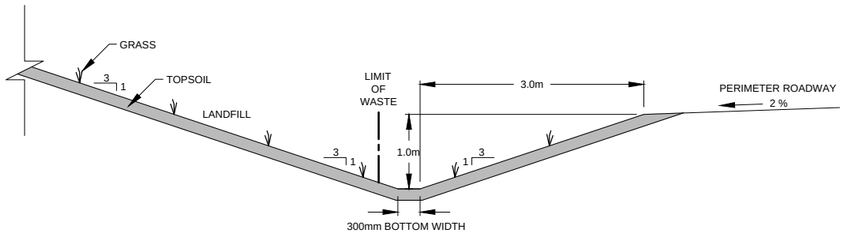
VERTICAL EXPANSION ALTERNATIVE 1

GHD

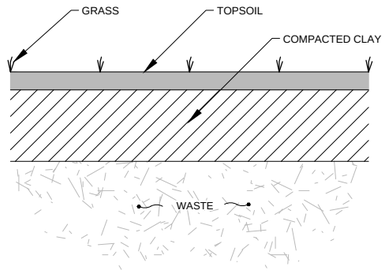
Source Reference:
EXISTING GROUND CONTOURS AND TOPOGRAPHIC FEATURES SHOWN ARE BASED ON TERVITA AS-BUILT FOR FINAL CONDITIONS FOR STAGE 2A, 2B AND STAGE 3A, AND NORTH CLAY STOCKPILE SURVEY BY VAN NOSTRAND AND GIBSON SURVEYED JULY-17-2013

Project Manager:	Reviewed By:	Date:	
G.FERRARO	P.KEMP	DECEMBER 2015	
Scale: 1:1000	Project N°: 18235-20	Report N°: 051	Drawing N°: C-02

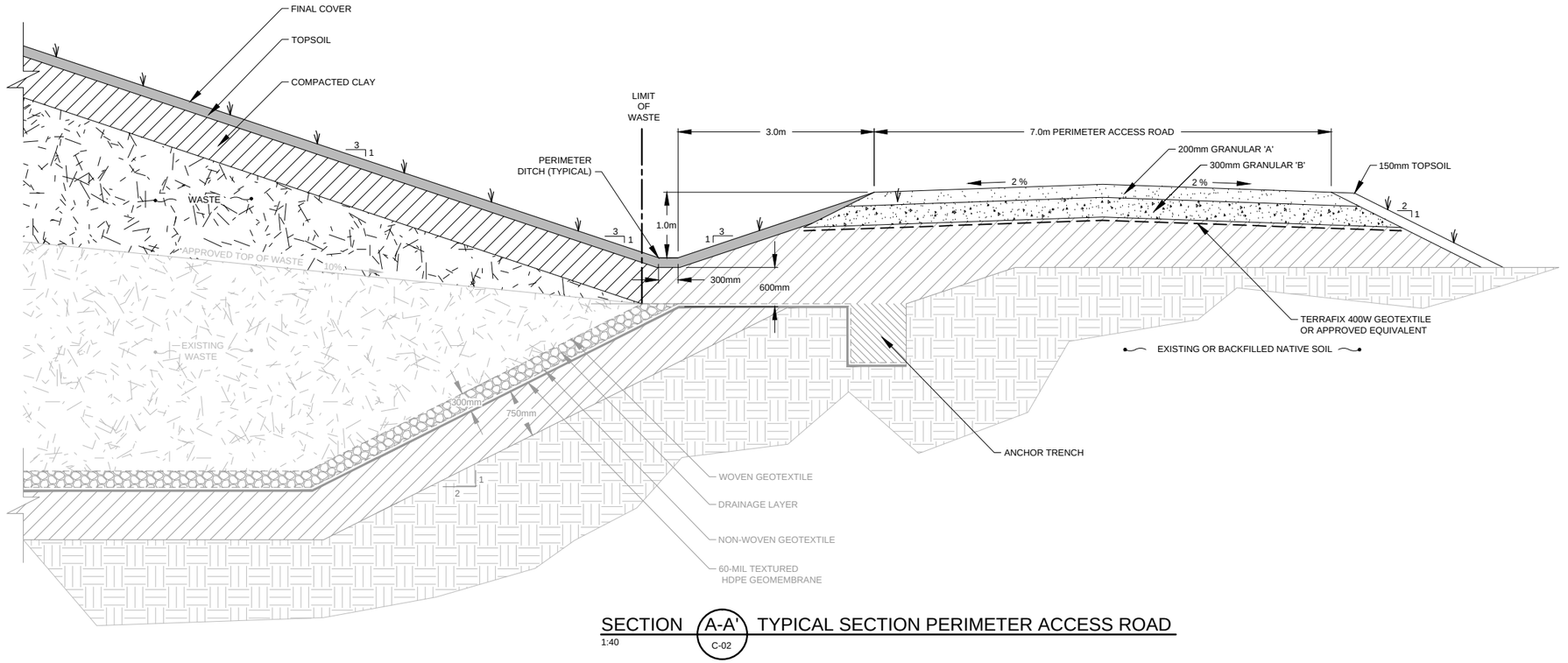
18235-20(051)CI-WA002 JAN 19/2016



DETAIL 1 PERIMETER DITCH (TYPICAL)
1:40 C-03



DETAIL 2 FINAL COVER
1:40 C-03



SECTION A-A' TYPICAL SECTION PERIMETER ACCESS ROAD
1:40 C-02

No.	Revision	Date	Initial

SCALE VERIFICATION

THIS BAR MEASURES 50mm ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

BROOKS ROAD LANDFILL SITE
HALDIMAND COUNTRY, ONTARIO

CONCEPTUAL DESIGN REPORT

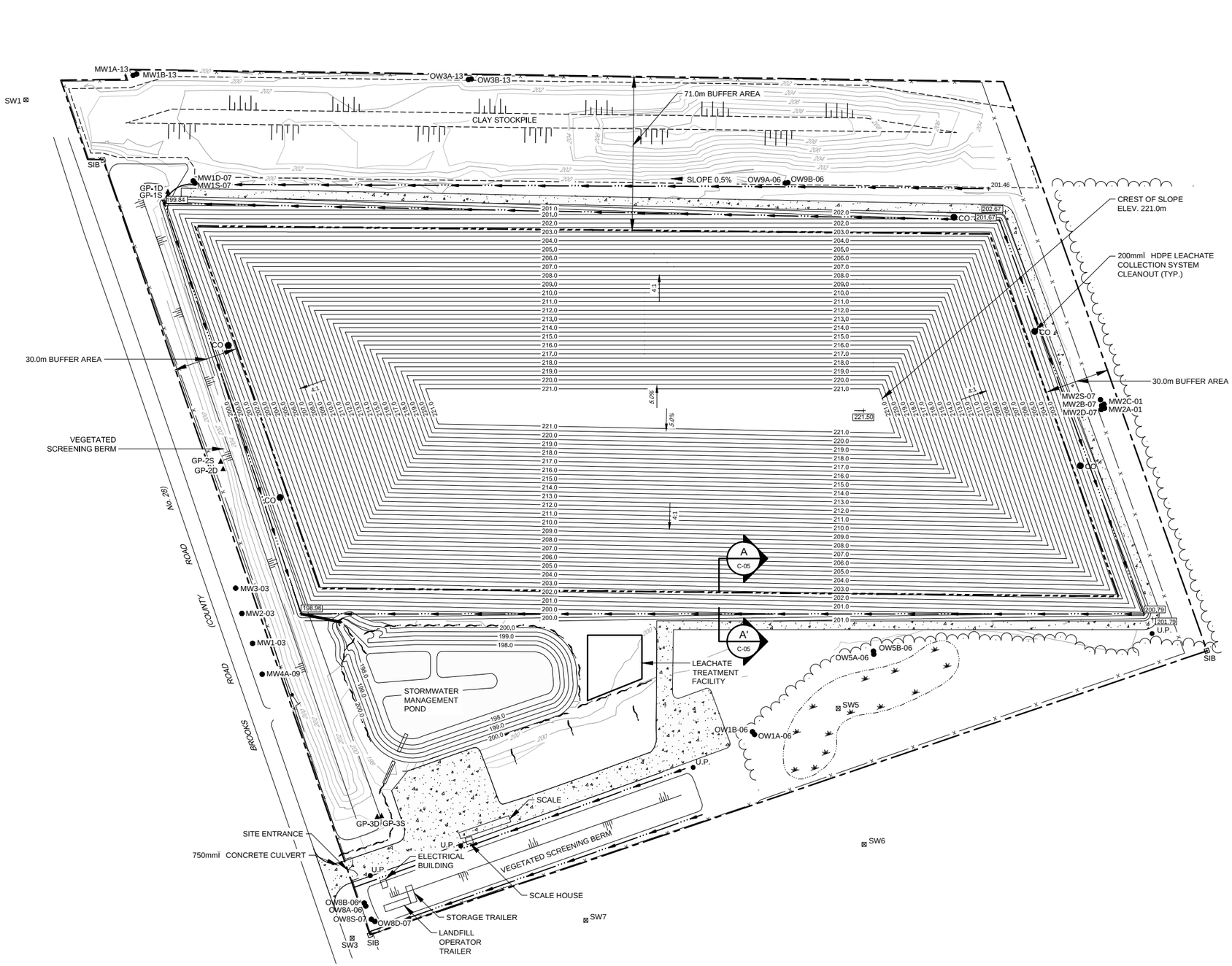
VERTICAL EXPANSION
ALTERNATIVE 1 DETAILS

GHD

Source Reference:

Project Manager:	Reviewed By:	Date:	
G.FERRARO	P.KEMP	DECEMBER 2015	
Scale: 1:1000	Project No: 18235-20	Report No: 051	Drawing No: C-03

18235-20(051)CI-WA003 DEC 4/2015



No.	Revision	Date	Initial

LEGEND

- 202.0 — TOP OF FINAL COVER CONTOUR (1.0m INTERVAL (m AMSL))
- TOP OF FINAL COVER CONTOUR (0.5m INTERVAL (m AMSL))
- 202 — GROUND CONTOUR (2.0m INTERVAL)
- GROUND CONTOUR (1.0m INTERVAL)
- PROPERTY LINE
- APPROVED LIMIT OF WASTE
- x — EXISTING FENCELINE
- CLAY STOCKPILE AREA
- PERIMETER DITCH
- TREELINE
- GRANULAR SURFACE ACCESS ROAD
- SWAMPY AREA
- 201.67 — SPOT ELEVATION (m AMSL)
- CO — LEACHATE COLLECTION SYSTEM CLEAN OUT
- SIB — STANDARD IRON BAR
- OW1B-06 — OBSERVATION WELL
- MW2A-01 — MONITORING WELL
- SW6 — SURFACE WATER MONITORING
- GP-3S — GAS PROBE
- U.P. — UTILITY POLE
- DOUBLE GATE
- SINGLE GATE

SCALE VERIFICATION

THIS BAR MEASURES 50mm ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

BROOKS ROAD LANDFILL SITE
HALDIMAND COUNTRY, ONTARIO

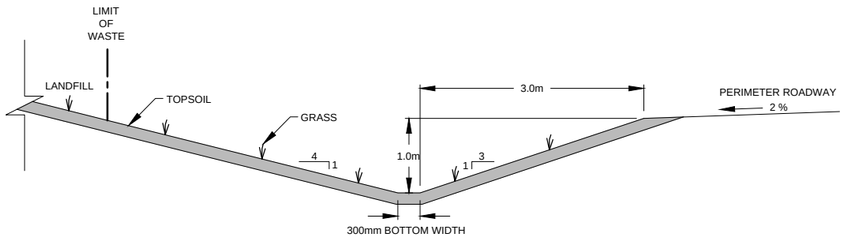
CONCEPTUAL DESIGN REPORT

VERTICAL EXPANSION ALTERNATIVE 2

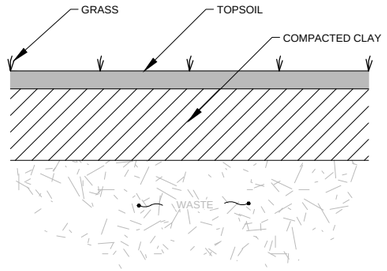
GHD

Source Reference:
EXISTING GROUND CONTOURS AND TOPOGRAPHIC FEATURES SHOWN ARE BASED ON TERVITA AS-BUILT FOR FINAL CONDITIONS FOR STAGE 2A, 2B AND STAGE 3A, AND NORTH CLAY STOCKPILE SURVEY BY VAN NOSTRAND AND GIBSON SURVEYED JULY-17-2013

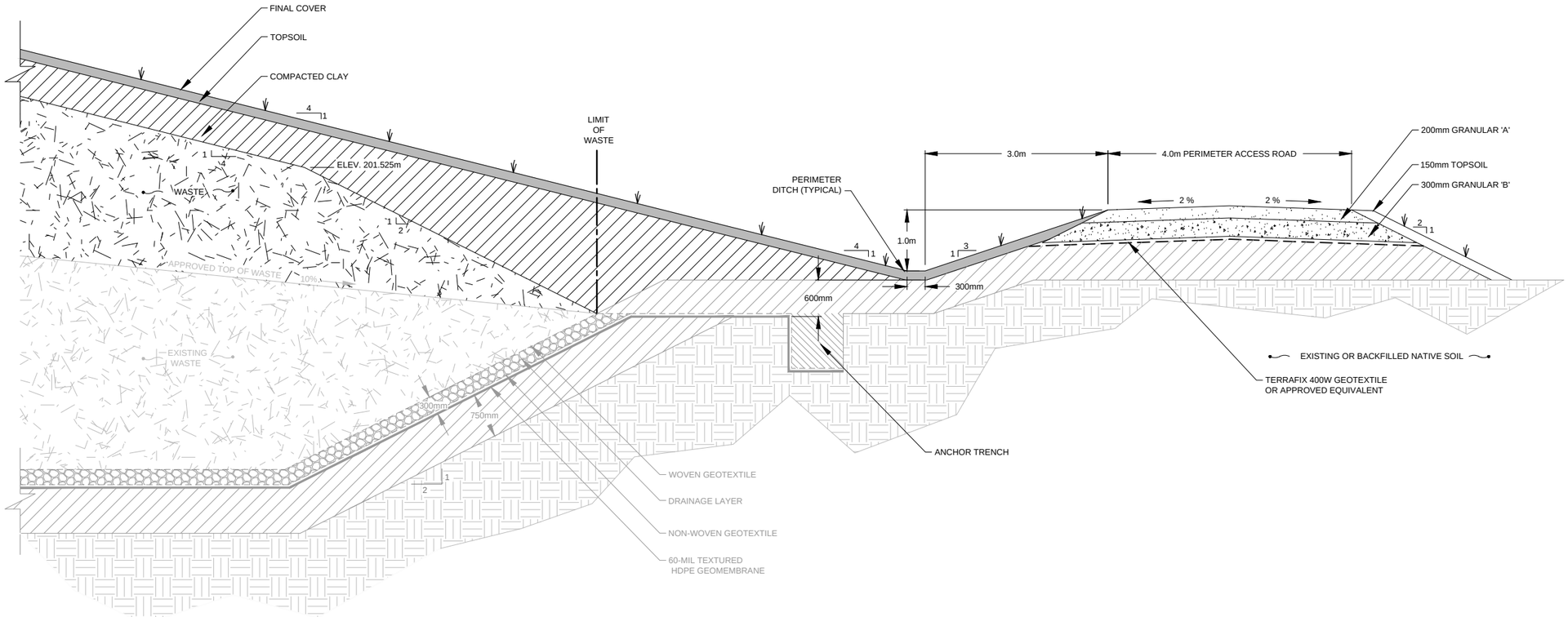
Project Manager:	Reviewed By:	Date:	
G.FERRARO	P.KEMP	DECEMBER 2015	
Scale: 1:1000	Project N°: 18235-20	Report N°: 051	Drawing N°: C-04



DETAIL 1 PERIMETER DITCH (TYPICAL)
1:40 C-05



DETAIL 2 FINAL COVER
1:40 C-05



SECTION A-A' TYPICAL SECTION PERIMETER ACCESS ROAD
1:40 C-04

No.	Revision	Date	Initial

SCALE VERIFICATION

THIS BAR MEASURES 50mm ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

BROOKS ROAD LANDFILL SITE
HALDIMAND COUNTRY, ONTARIO

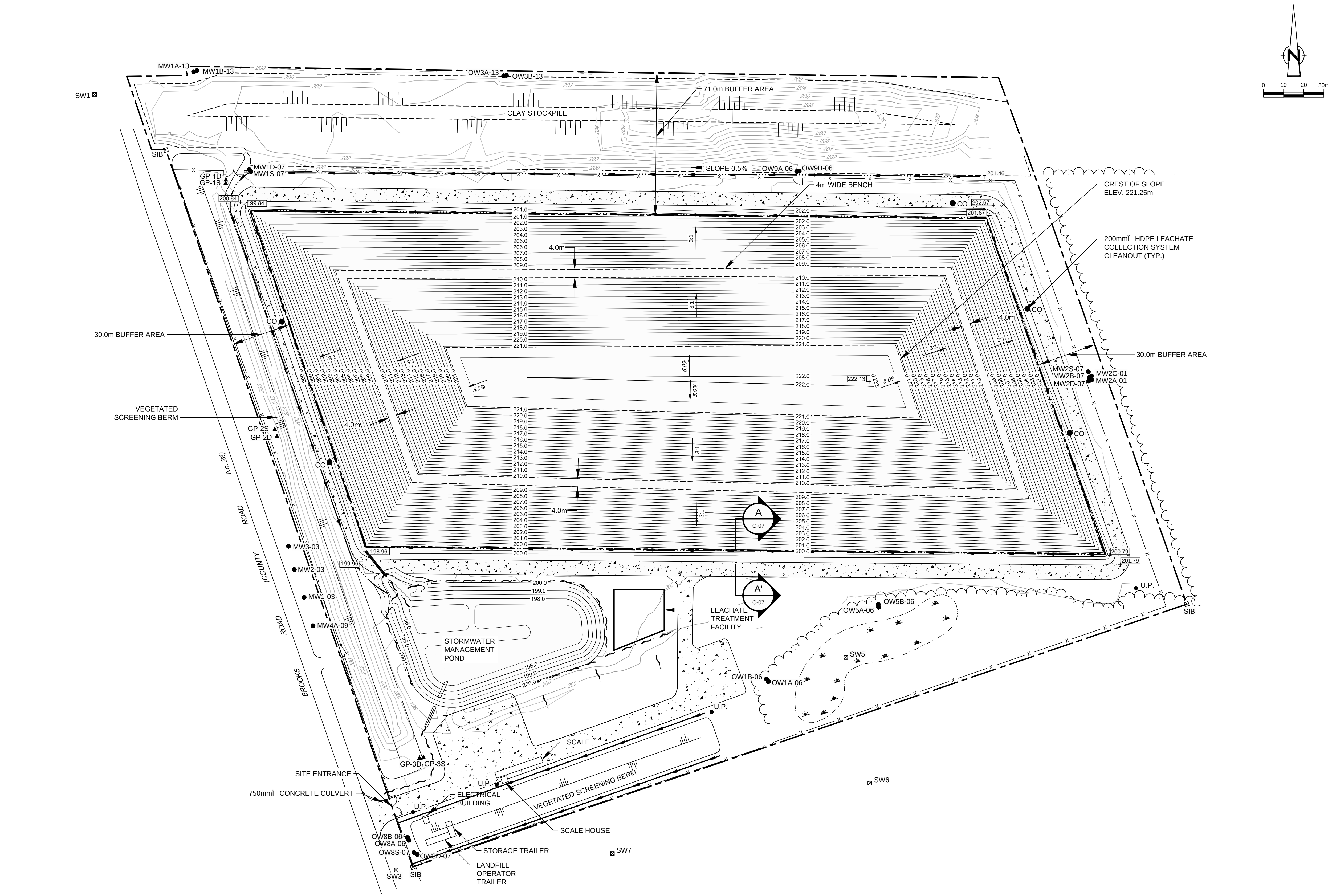
CONCEPTUAL DESIGN REPORT

VERTICAL EXPANSION
ALTERNATIVE 2 DETAILS

.

Source Reference:

Project Manager:	Reviewed By:	Date:	
G.FERRARO	P.KEMP	DECEMBER 2015	
Scale: 1:1000	Project No: 18235-20	Report No: 051	Drawing No: C-05



Nº	Revision	Date	Initial

LEGEND

- 202.0 — TOP OF FINAL COVER CONTOUR (1.0m INTERVAL (m AMSL))
- TOP OF FINAL COVER CONTOUR (0.5m INTERVAL (m AMSL))
- 202 — GROUND CONTOUR (2.0m INTERVAL)
- GROUND CONTOUR (1.0m INTERVAL)
- PROPERTY LINE
- APPROVED LIMIT OF WASTE
- x — EXISTING FENCELINE
- CLAY STOCKPILE AREA
- PERIMETER DITCH
- TREELINE
- GRANULAR SURFACE ACCESS ROAD
- SWAMPY AREA
- 201.67 — SPOT ELEVATION (m AMSL)
- ● CO — LEACHATE COLLECTION SYSTEM CLEAN OUT
- □ SIB — STANDARD IRON BAR
- ● OW1B-06 — OBSERVATION WELL
- ● MW2A-01 — MONITORING WELL
- ⊠ SW6 — SURFACE WATER MONITORING
- ▲ GP-3S — GAS PROBE
- ● U.P. — UTILITY POLE
- DOUBLE GATE
- SINGLE GATE

SCALE VERIFICATION

THIS BAR MEASURES 50mm ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

BROOKS ROAD LANDFILL SITE
HALDIMAND COUNTRY, ONTARIO

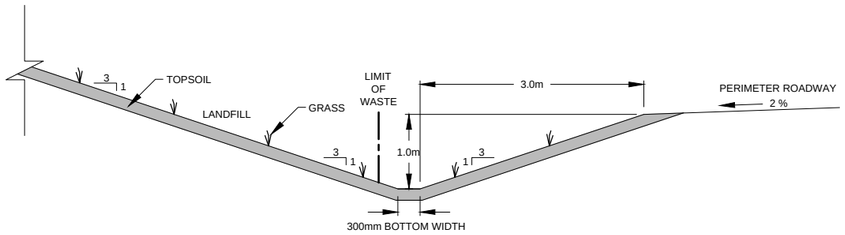
CONCEPTUAL DESIGN REPORT

VERTICAL EXPANSION ALTERNATIVE 3

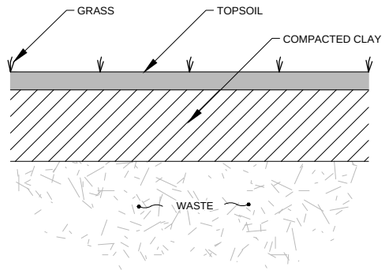
Source Reference:
EXISTING GROUND CONTOURS AND TOPOGRAPHIC FEATURES SHOWN ARE BASED ON TERVITA AS-BUILT FOR FINAL CONDITIONS FOR STAGE 2A, 2B AND STAGE 3A, AND NORTH CLAY STOCKPILE SURVEY BY VAN NOSTRAND AND GIBSON SURVEYED JULY-17-2013

Project Manager: G.FERRARO	Reviewed By: P.KEMP	Date: DECEMBER 2015	
Scale: 1:1000	Project Nº: 18235-20	Report Nº: 051	Drawing Nº: C-06

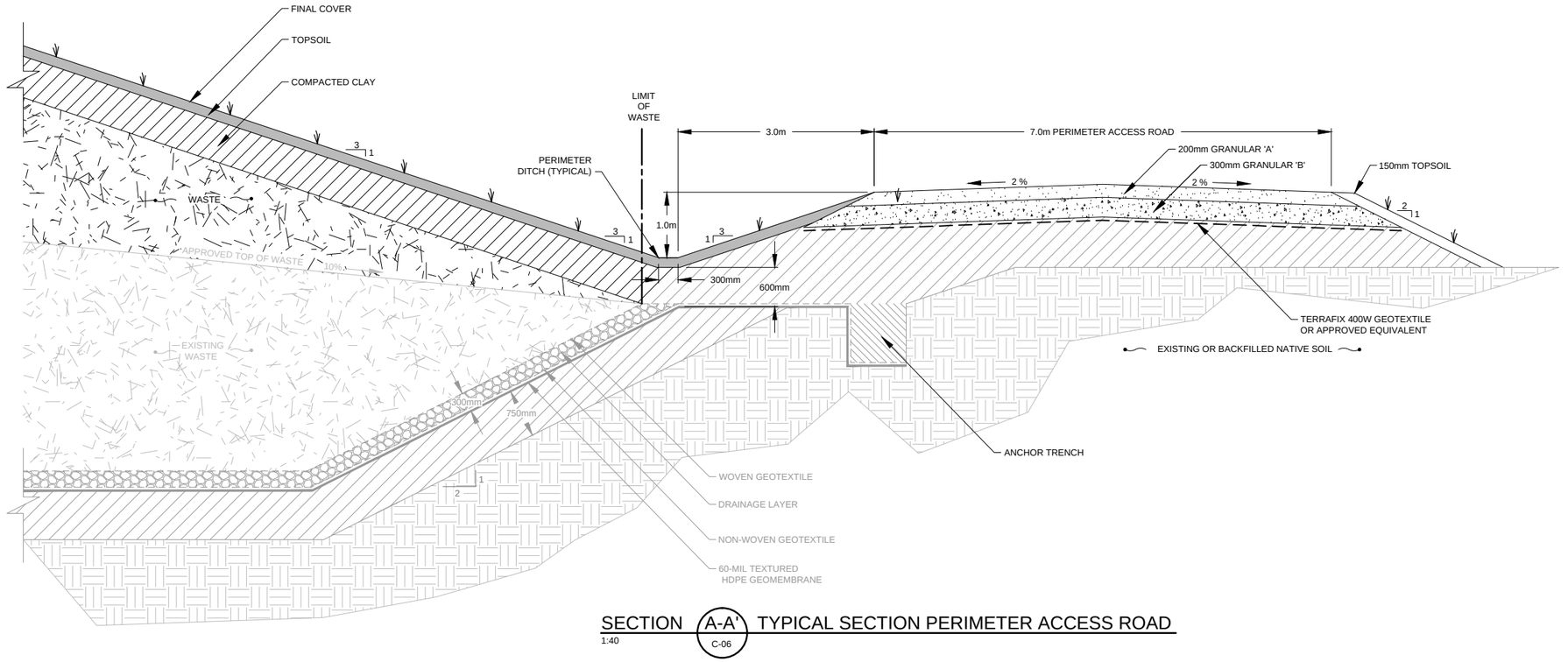
18235-20(051)CI-WA006 JAN 19/2016



DETAIL 1 C-07 PERIMETER DITCH (TYPICAL)
1:40



DETAIL 2 C-07 FINAL COVER
1:40



SECTION A-A' C-06 TYPICAL SECTION PERIMETER ACCESS ROAD
1:40

No.	Revision	Date	Initial

SCALE VERIFICATION

THIS BAR MEASURES 50mm ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

BROOKS ROAD LANDFILL SITE
HALDIMAND COUNTRY, ONTARIO

CONCEPTUAL DESIGN REPORT

VERTICAL EXPANSION
ALTERNATIVE 3 DETAILS

.

Source Reference:

Project Manager:	Reviewed By:	Date:	
G.FERRARO	P.KEMP	DECEMBER 2015	
Scale: 1:1000	Project No: 18235-20	Report No: 051	Drawing No: C-07

Tables Following Text

TABLE 3.1

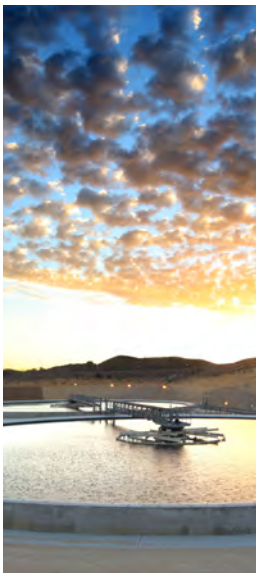
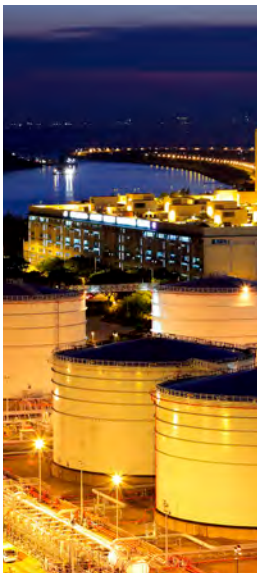
LIST OF ONTARIO OIL GAS RECORDS WITHIN IN STUDY AREA
GEOLOGY AND HYDROGEOLOGY ASSESSMENT REPORT
BROOKS ROAD LANDFILL
CAYUGA, ONTARIO

LICENCE NUMBER	WELL NAME	OPERATOR	WELL TYPE	WELL MODE	TVD	TD DATE	PLUG DATE
F019425	Pt. Colborne-Welland Gas Co. - J. Kozak #1, North Cayuga - 22 - INTR	Port Colborne - Welland Natural Gas & Oil Co. Ltd.	Gas Show	Abandoned Well	210.62	21-Nov-1947	21-Nov-1947
F019426	W.C. Patterson - Miss Doyle, North Cayuga - 22 - INTR	W. C. Patterson Gas Co. Ltd.	Dry Hole	Abandoned Well	214.58	26-Nov-1927	
F019435	P.C. Welland Gas Co - C. Bunn #1, North Cayuga - 23 - INTR	Port Colborne - Welland Natural Gas & Oil Co. Ltd.	Natural Gas Well	Unknown	207.57	30-Apr-1943	
F019436	Pt. Col-Welland Gas Co - C. Bunn #2, North Cayuga 1 - 23 - INTR	Port Colborne - Welland Natural Gas & Oil Co. Ltd.	Natural Gas Well	Abandoned Well	210.31	17-Jun-1943	3-Feb-1960
F019437	Pt. C. -Welland Gas Co - C. Bunn #3, North Cayuga - 23 - INTR	Port Colborne - Welland Natural Gas & Oil Co. Ltd.	Natural Gas Well	Abandoned Well	229.51	28-Aug-1943	23-Jul-1954
F019438	Dom Nat Gas Co - Wm Bunn #1, North Cayuga - 23 - INTR	Dominion Natural Gas Co., Ltd.	Dry Hole	Abandoned Well	213.97	5-Apr-1928	9-Apr-1928
F019439	Haldimand Gas Synd - W.R. Slack #2, North Cayuga - 23 - INTR	Haldimand Natural Gas Syndicate	Natural Gas Well	Unknown	211.84	21-Dec-1957	
F019478	W.C. Patterson - W.A. Oster #1, North Cayuga - 24 - INTR	W. C. Patterson Gas Co. Ltd.	Natural Gas Well	Unknown	219.76		
F019479	W.C. Patterson - W.A. Oster #2, North Cayuga - 24 - INTR	W. C. Patterson Gas Co. Ltd.	Natural Gas Well	Unknown	224.33	31-Jan-1929	
F019480	Union Gas Co of Canada - W.A. Oster #3, North Cayuga - 24 - INTR	Union Gas Limited	Gas Show	Abandoned Well	217.93	28-Nov-1938	8-Nov-1938
F019481	Pt Col.-Welland Gas Co - C. Bunn #4, North Cayuga - 24 - INTR	Port Colborne - Welland Natural Gas & Oil Co. Ltd.	Natural Gas Well	Abandoned Well	211.53	9-Oct-1943	30-Jun-1964
F019482	Pt. Col - Welland Gas Co Ltd. - C. Bunn #5, North Cayuga - 24 - INTR	Port Colborne - Welland Natural Gas & Oil Co. Ltd.	Natural Gas Well	Unknown	207.87	24-Nov-1943	
F019509	W.C. Patterson - J. Badger, North Cayuga - 25 - INTR	W. C. Patterson Gas Co. Ltd.	Natural Gas Well	Unknown	219.15	19-Mar-1929	
F019511	Pt. Col-Welland Gas & Oil Co - J. Ferguson #1, North Cayuga - 25 - INTR	Port Colborne - Welland Natural Gas & Oil Co. Ltd.	Gas Show	Abandoned Well	213.66	20-Jan-1948	20-Jan-1948
F019516	Dom Nat Gas Co - A.& W. Geddes #2, North Cayuga - 26 - INTR	Dominion Natural Gas Co., Ltd.	Natural Gas Well	Abandoned Well	213.66	4-Oct-1929	25-Aug-1964
F019517	Dom Nat Gas Co - A.&W. Geddes #3, North Cayuga - 26 - INTR	Dominion Natural Gas Co., Ltd.	Dry Hole	Abandoned Well	210.01	24-Oct-1929	25-Oct-1929
F019520	Dom Nat Gas Co - W.B. Hamilton #2, North Cayuga - 26 - INTR	Dominion Natural Gas Co., Ltd.	Natural Gas Well	Abandoned Well	215.80	20-May-1929	12-Mar-1935
T002154	Haldimand Gas No. 477, North Cayuga - 22 - INTR	Haldimand Gas & Oil Wells Ltd.	Natural Gas Well	Abandoned Well	214.58	13-Dec-1965	24-Jul-1974
T002163	Haldimand Gas No. 481, North Cayuga - 22 - INTR	Haldimand Gas & Oil Wells Ltd.	Natural Gas Well	Abandoned Well	214.27	1-Aug-1966	4-Aug-1971
T002399	Haldimand Gas No. 489, North Cayuga - 23 - INTR	Haldimand Gas & Oil Wells Ltd.	Natural Gas Well	Unknown	213.66	13-Oct-1967	
T002428	Haldimand Gas No. 491, North Cayuga - 24 - INTR	Haldimand Gas & Oil Wells Ltd.	Gas Show	Abandoned Well	215.80	7-May-1968	16-Jul-1968
T002543	Haldimand Gas No. 494, North Cayuga - 25 - INTR	Haldimand Gas & Oil Wells Ltd.	Natural Gas Well	Abandoned Well	213.66	30-Aug-1968	10-Jun-1975
T002590	Haldiamnd Gas No. 496, North Cayuga - 25 - INTR	Haldimand Gas & Oil Wells Ltd.	Natural Gas Well	Abandoned Well	210.62	24-Oct-1968	9-Jun-1975

Notes:
TVD Total Vertical Depth
TD Date Date total depth reached

Appendix A

Gypsum Mine Investigation Report


Gypsum Mine Investigation Report

Brooks Road Landfill Site
160 Brooks Road
Haldimand County, Ontario

Brooks Road Environmental c/o 2270386 Ontario Limited

651 Colby Drive Waterloo Ontario N2V 1C2
018235 | Report No 69 | June 1 2016

Table of Contents

Figure Index

Table Index

Appendices

1. Introduction

1.1 General

GHD has prepared the following Gypsum Mine Investigation report on behalf of Brooks Road Environmental c/o 2270386 Ontario Limited (BRE), the owner of the Brooks Road Landfill Site (Landfill Site). The Site operates under Environmental Compliance Approval No. A110302 (ECA) and this report has been prepared to satisfy Condition 48 of the ECA.

Condition 48 of the ECA states:

"…the owner/operator shall, with the consent of the Gypsum Mine owner, enter the mine property and conduct a survey to identify any nearby Gypsum Mine and its associated underground structures. Any influence of these underground structures on the bedrock aquifer, shall be assessed by the landfill Owner/Operator and a written report of the findings shall be submitted to the District Manager."

Condition 48 was incorporated into the ECA for the Site based on evidence that a gypsum mine once operated on a property located northwest of the Landfill Site. The gypsum mine was owned and operated by the Cayuga Gypsum Company Limited, and was known as the Cayuga Gypsum Mine.

In response to several conditions in the ECA, including Condition 48, GHD Limited formerly Conestoga-Rovers & Associates[1] (CRA) prepared a report in July 2004 entitled Well Survey and Limited Hydrogeology Assessment report (2004 Report). The 2004 Report provided a literature review of the former gypsum mine and concluded that the following:

"*…influence on the bedrock aquifer would be negligible and limited to the immediate vicinity of the former galleries and would not extend beyond the limits of the former mine property*".

This report utilizes the information provided in the 2004 Report on local gypsum mining as well as data and interpretations from the Site environmental monitoring program to evaluate the potential for influences on groundwater conditions at the Site, specifically the bedrock aquifer, from former gypsum mining operations.

1.2 Site Setting

The Landfill Site is located at 160 Brooks Road in Cayuga, Ontario approximately one kilometre north of Kings Highway No. 3 (Talbot Road). The Landfill Site is legally described as Part of Lot 24, Concession I-N.T.R., of the former North Cayuga Township, former Regional Municipality of Haldimand-Norfolk, and now Haldimand County. The Cayuga Gypsum Mine is documented as being located on the west-half of Lot 25, Concession I-N.T.R, and northwest of the Landfill Site.

The local Site setting is shown on Figure 1.1 along with the landfill and gypsum mine properties identified.

[1] CRA formally changed its corporate name to GHD on July 1, 2015.

1.3 Approach

Assessment of potential influence of the former Cayuga Gypsum Mine on groundwater at the Landfill Site, in particular the influence on the bedrock aquifer, has been undertaken through evaluating the following information:

- A review of information related to historical mining operations including location and extent of mining activities.
- Review of physical site conditions for evidence of historical mining operations.
- Evaluation of hydraulic gradients within the available monitoring network to identify potential evidence of a hydraulic influence on horizontal or vertical gradients in the vicinity of the Site.

1.4 Background

The 2004 Report included a thorough review of the available information on the history of gypsum mining in the area. As indicated in the 2004 Report, two principal documents provided relevant information on the subject: Gypsum in Ontario, C.R. Guillet, dated 1964, and Abandoned Mines Hazard Abatement Program, London District Site Examinations, prepared by Patrick Chance & Associates Consulting Geologists, dated 1994 (1994 Inspection). More recently, the former gypsum mine is documented in the Ministry of Northern Development & Mines (MNDM) Abandoned Mines Information System (AMIS) and Mineral Deposit Inventory (MDI) as AMIS # 04888 and MDI # MDI30L13NW00003. A summary of Ontario Department of Mines (ODM) reports is provided in Table 1. A summary of the details related to mining operations and their potential influence on the bedrock aquifer is provided in the following paragraphs.

The mine was operated by the Cayuga Gypsum Company Limited between 1942 and 1949. Gypsum was mined from a 0.9 metre (m) thick bed at a depth of 25.9 m below ground surface (BGS).

Mining operations were accomplished via two mine shafts. As shown on Figure 1.1, the first shaft was located approximately 112 m south of Townline Road and 350 m west of Brooks Road. The former shaft can reportedly be located by a 2.4 m deep depression, with a footprint of 3 by 4.6 m. The shaft was a vertical prospect shaft of unknown support, and was back-filled with unknown materials. The 1994 Inspection did not document any evidence of subsidence, however the report recommended that a 50 m radius area of caution be observed in the vicinity of this shaft.

Based on the available historical documentation, approximately 10,300 tonnes of gypsum was reportedly removed from this prospect shaft during the operation of the mine. With a density of 2.3 t/m^3 and a thickness of 1 m, this would correspond to lateral workings with an aerial footprint of approximately 4,356 square metres (m^2). In order to access the gypsum in the 1 m seam, it is likely that approximately 1-2 m of the overlying shale bedrock would also have been removed.

The second shaft (also shown on Figure 1.1) was located approximately 305 m south of the first shaft. The 1994 inspection was reportedly unable to locate the second shaft. The second shaft was also a vertical prospect shaft of unknown support and it is unknown if the shaft has been back-filled. It is not known how much gypsum was removed from this shaft.

Dewatering Activities

There is no direct information available regarding dewatering activities that took place while the mine was in operation. However, during operation of the mine from 1942 to 1949, dewatering operations would likely have been conducted to keep the mine shafts and associated galleries dry. As such, during the operation of the mine the local groundwater flow within the bedrock aquifer would have been influenced by mine dewatering activities. It is likely that flow within the bedrock aquifer in the vicinity of the former mine would have been directed towards the active galleries during operation of the mine.

The 2004 Report discussed that upon closure of the mine in 1949, the dewatering activities at the mine would have ceased and the associated mine shafts and galleries would have flooded within the first year of closure. The mine has now been abandoned for 67 years. Since the former galleries and shafts are flooded, no water deficit should be present between these former underground structures and the surrounding bedrock. Thus steady state conditions should exist and the former underground structures will no longer have a hydraulic influence on the local bedrock aquifer.

The 2004 Report concluded that, in the unlikely event that the former mine shafts would not have been properly sealed following closure of the mine, there could exist the potential for surface water and groundwater in the shallow overburden to enter the mine shafts and migrate to the underlying bedrock aquifer. If infiltration were occurring, the shafts would be acting as a sink to the overburden groundwater and a source of recharge to the local bedrock groundwater. This would result in a cone of depression in the overburden groundwater towards the former mine shafts and radial flow from the galleries in the bedrock groundwater. Under this scenario there could be a potential for bedrock groundwater flow being diverted away from the former galleries. However, based on the relatively small dimension of the former galleries (areal extent of approximately 4,356 m^2) it is expected that any influence of these galleries on the bedrock aquifer would be localized to the immediate vicinity of the former galleries.

2. Hydrogeology

The following subsections provide a summary of the hydrogeological Site setting, summary of bedrock monitoring well installations, summary of groundwater flow patterns and gradients, and an assessment of potential influence of the former gypsum mine on the groundwater flow patterns/gradients at the Site. A site map with groundwater monitoring locations can be referenced on Figure 2.0.

2.1 Hydrogeologic Setting

In general, the pertinent hydrostatigraphic units identified at the Landfill Site that comprise the hydrogeologic setting of the landfill have been divided into two main flow zones, as follows:

i) An unconfined water table (shallow overburden) unit within shallow fractured silty clay (weathered) unit.

ii) A confined basal overburden/shallow bedrock aquifer.

The shallow overburden unit is encountered at depths varying from 0.5 to 4.0 m BGS across the Site. The shallow overburden unit is a water table (unconfined) unit which occurs within the fractured portion of the weathered clay till and overlies the low permeability un-weathered clay till.

Based on the static groundwater elevations monitored in shallow overburden monitoring wells, groundwater flow in this unit is towards the south.

The second principal groundwater flow zone occurs within a confined basal overburden/shallow bedrock aquifer that has been observed within the lower portion of a basal silty sand till unit and the shallow fractured bedrock. Groundwater quality and water level data from monitoring wells screened within the lower silty sand till unit exhibited geochemical and hydraulic characteristics which are not substantially different from samples obtained from well nests screened solely within the shallow fractured bedrock. Therefore, the basal till and shallow fractured bedrock have been generally considered to form a single aquifer.

Based on the groundwater data obtained to date, the basal overburden/shallow bedrock aquifer is generally encountered at depths varying from 14 to 17 m BGS. The groundwater flow pattern of this unit is characterized by a weak gradient and a southerly flow direction.

These two principal flow zones are separated by a thick (between 9 and 12 m) layer of stratified silty clay, silty clay till, and varved clays which form an aquitard of very low hydraulic conductivity. Groundwater level data gathered from the shallow overburden unit and basal overburden/shallow bedrock aquifer confirm that the clay aquitard creates hydraulic separation between the two units. Historical differences in vertical hydraulic head have varied from 9.5 to 15 m at nested wells screened within these two units.

The bedrock formation underlying the Landfill Site has been described as fractured shale, dolostone, and evaporites (gypsum) of the Salina Formation. The top of bedrock elevation ranges from 180.80 to 185.73 m above mean sea level (AMSL), and forms a small bedrock valley from northwest to southeast across the Site. The bedrock valley is infilled with a thicker silty sand till deposit. Regionally, the bedrock topography dips to the south.

No significant flow zones within the deeper bedrock have been identified on-Site. Several monitoring well installations have been completed within bedrock below the basal overburden/shallow bedrock aquifer, as discussed in the following Section.

2.2 Bedrock Well Installations

In 2007, three monitoring well nests were constructed at the Site in the northwest corner (MW1S-07, MW1D-07), southwest corner (OW8S-07, OW8D-07), and centre East-side (MW2S-07, MW2D-07), as shown on Figure 2.0. At each well nest two bedrock monitoring wells (intermediate and deep) were installed next to nested pairs of shallow overburden and basal overburden/shallow bedrock monitoring wells. The following lists the typical monitoring well nest installations at these three locations:

- Shallow overburden monitoring well installed in the upper 5 m of overburden.
- Basal overburden/shallow bedrock monitoring well installed at the base of the overburden unit and top of the bedrock unit.
- Intermediate bedrock monitoring well constructed to target the highest hydraulic conductivity between the basal overburden and the deep bedrock monitoring wells.
- Deep bedrock monitoring well installed in the gypsum seam or, if not encountered, installed at a depth of 30 m bgs.

The deepest corehole at each of the nested wells was permeability tested using a pressure-injection (Lugeon packer) test methodology. The Lugeon packer based pressure-injection test methodology consists of determining a maximum injection pressure (P_{max}) per foot of depth to the top packer below ground surface. Typical maximum recommended pressure is approximately 1 pound per square inch (psi) per foot of depth. The value for maximum pressure used during testing was based on an assumption of crystalline bedrock materials. The maximum pressure is designed to not cause hydrofracturing of the bedrock material, while still providing sufficient injection pressure to accurately measure formation response to water injection.

The standard Lugeon pressure-injection test typically consists of five constant head pressure steps for each test interval, as follows:

Step	Duration	Pressure
1	10 minutes	1/3 P_{max}
2	10 minutes	2/3 P_{max}
3	10 minutes	P_{max}
4	10 minutes	2/3 P_{max}
5	10 minutes	1/3 P_{max}

During each pressure step, the test pressure and water flow rate are recorded at 1 minute intervals. Average values of pressure and flow rate recorded during each pressure step are used to determine the Lugeon value for the individual pressure step. Houlsby (1976) determined five pressure-flow regimes, each with distinctive patterns: laminar flow, turbulent flow, dilation of rock fractures, washout of rock fractures, and void filling. Lugeon pressure testing is used to identify zones of contrasting hydraulic conductivity within fractured bedrock. The results can also be used to estimate the hydraulic conductivity. The results of the Lugeon pressure testing at bedrock coreholes advanced on-Site are summarized in Table 2.2.

The results of Lugeon testing performed within bedrock coreholes at the Site indicated no significant flow zones were apparent within the rock below the upper weathered portion of the shallow bedrock flow zone. This finding is significant for the purposes of this evaluation as it supports the interpretation that there is little evidence of a significant hydraulic connection between the former mine shafts and bedrock flow zones on-Site.

The basal overburden/shallow bedrock, intermediate bedrock and deep bedrock monitoring wells installed for the purposes of this evaluation are screened at the elevations included in the following table:

Well Location	Unit	Screened Interval (m AMSL)	Total Gypsum (cm)
MW1A-07	Basal Overburden	181.99 – 185.04	no record
MW1A-13	Basal Overburden	183.03 – 184.55	no record
MW2A-01	Basal Overburden	181.24 – 184.29	no record
OW08-06	Basal Overburden	180.60 – 183.64	no record
MW1S-07	Intermediate Bedrock	178.11 – 179.63	21.5
MW2S-07	Intermediate Bedrock	177.63 – 179.15	24.4
OW8S-07	Intermediate Bedrock	175.97 – 177.49	45.7
MW1D-07	Deep Bedrock	173.51 – 175.95	37.0
MW2D-07	Deep Bedrock	171.67 – 173.20	114.5
OW8D-07	Deep Bedrock	168.50 – 170.02	88.9

2.3 Groundwater Flow and Hydraulic Gradients

As there is no evidence of mine shafts on-Site, groundwater flow patterns and hydraulic gradients are the most useful interpretive tools available for evaluating the potential presence of an effect related to nearby historic mine shafts on the bedrock aquifer on-Site. Although it is not possible to accurately quantify the effects that nearby mine shafts may have, the differences in flow patterns and gradients between the different units monitored on-Site may provide some evidence of a hydraulic influence from these features.

Static Groundwater Elevations

The following table provides a summary of static groundwater elevation ranges for each of the three bedrock hydrostratigraphic intervals for data collected from well pairs between 2007 and 2015:

Hydrostatigraphic Interval	Groundwater Range (m AMSL)
Basal Overburden/Shallow Bedrock	183.11 – 184.34
Intermediate Bedrock	183.88 – 184.46
Deep Bedrock	183.82 – 184.37

As indicated by the above summary, the following two principal observations are made:

1. Static groundwater elevations within all three flow zones experience only minor fluctuations (<1 m in total variation within each hydrostratigraphic interval).
2. Static groundwater elevations are very similar within all three flow zones.

The maximum difference in groundwater elevations for nested monitoring well pairs historically observed is 40 cm (OW8A, OW8S) and 35 cm (OW8A, OW8D). The data for MW1A-07 and MW1A-13 has been unreliable and was not included in the above summary table. Monitoring well MW1A-07 was abandoned and replaced in 2013 due to well construction integrity issues apparent as result of consistently elevated water levels. A hydrograph of groundwater elevations in the basal overburden/shallow bedrock, intermediate bedrock, and deep bedrock units is presented on Figure 2.1. A summary of groundwater elevations for individual monitoring wells and dates from 2007 to 2015 is provided in Table 2.

The principal observation taken from the hydrograph presented on Figure 2.1 is that the patterns of fluctuations in static groundwater elevations are very similar at all wells presented, regardless of the hydrostratigraphic interval monitored. The implication of this observation is that the sources of recharge to these intervals are most likely common or related. If there was a significant effect on the deeper bedrock hydrostratigraphic interval from the presence of a mine shaft, it would be expected that the static groundwater fluctuations within the deeper bedrock monitoring wells would be different than those observed in the wells monitoring the shallower intervals and monitoring wells located horizontally further away from the shaft(s).

Vertical Hydraulic Gradients

Vertical hydraulic gradients were calculated between nested monitoring wells in the basal overburden/shallow bedrock unit, intermediate bedrock unit, and the deep bedrock unit. Vertical hydraulic gradients are tabulated in Table 2.1. There are two principal observations taken from the vertical hydraulic gradients presented in Table 2.1. The first observation is that the vertical gradients

are generally very low. This pattern is expected based on the similarities in static groundwater elevations previously presented for the different hydrostratigraphic intervals monitored.

The second observation is that the vertical gradients are not consistently upward or downward between any of the hydrostratigraphic intervals monitored. In other words, both upward and downward gradients have historically been observed between each of the intervals.

The presence of relatively low and fluctuating vertical hydraulic gradients between all intervals monitored suggests that there is not a separate hydraulic influence that is significantly influencing groundwater within the deeper bedrock interval. If the abandoned mine shafts located to the northwest of the Site were affecting the hydraulics within the bedrock aquifer it would be expected that a consistent vertical hydraulic relationship between the deeper bedrock and other intervals would be observed.

Horizontal Hydraulic Gradients and Groundwater Flow Patterns

A comparison of groundwater flow patterns for the basal overburden/shallow bedrock, intermediate bedrock, and deep bedrock hydrostratigraphic intervals is presented on Figures 2.2 to 2.8 for July monitoring events in 2007, 2009, and 2011 to 2015.

Groundwater flow patterns presented on Figures 2.2 through 2.8 for the basal overburden/shallow bedrock aquifer indicate groundwater flow directions are in a southerly direction with relatively flat horizontal gradients in the range of 0.0008 to 0.0012 m/m. This flow pattern is consistent with historical flow directions presented as part of the annual environmental monitoring program completed at the Site.

The following observations are made considering the groundwater flow directions presented on Figures 2.2 through 2.8 for the intermediate and deep bedrock intervals:

1. The static groundwater elevations between the two intervals are generally very similar, but not identical. This suggests that the intervals may be connected to the same sources of recharge, but are not completed within productive flow zones.
2. The horizontal gradients are usually extremely flat.
3. The implied directions fluctuate. It is unusual for a natural flow zone with consistent sources of recharge and downgradient points of discharge to exhibit completely different flow directions from one year to the next.
4. Monitoring wells completed in both intervals experience very slow recharge. This observation suggests that water levels may be near static, but slow to respond to changes in hydrostatic pressure within the interval.

Based on the above observations, it is interpreted that the groundwater contours depicted on Figures 2.2 through 2.8 for the intermediate and deep bedrock intervals are not necessarily accurate representations of the direction of flow within these units. It is more likely that the monitoring wells are completed within non-productive zones within the bedrock and horizontal flow within these intervals is minimal. The results of Lugeon testing completed in the bedrock coreholes support this interpretation.

For the purposes of this evaluation, the implication of these observations is that the deep and intermediate bedrock intervals do not appear to be affected by the historic mine shafts located to

the northwest of the Site. If there was a consistent, meaningful hydraulic influence on these intervals from the mine shaft, it would be expected that a consistent pattern in horizontal flow directions would result.

3. Conclusions

Based on a review of historical documentation related to the former gypsum mine, review of the Site conditions and groundwater elevations/gradients the following conclusions are presented:

1. The gypsum mining activities of the former Cayuga Gypsum Mine are documented to be small in scale and limited to a maximum area of approximately 4,356 m^2.
2. There is no physical evidence identified in the field investigations completed by GHD or others that historic mine shafts or sink holes exist in the immediate vicinity of the Site.
3. The deep bedrock monitoring wells on the Landfill Site are screened to intersect the gypsum unit and/or respective depth that was being mined by the Cayuga Gypsum Mine.
4. The results of the interpretations provided herein support the previous conclusion that the bedrock aquifer at the Landfill Site does not appear to be affected by the historic mine shafts located to the northwest of the Site.

All of Which is Respectfully Submitted,

GHD

Jeffrey P. Leader, C.Tech.

Benjamin O. Kempel, B.E.S.

Gregory D. Ferraro, P. Eng.

References

GHD. April 2016. 2015 Operations and Monitoring Report, Brooks Road Landfill Site, Haldimand County, Ontario.

Armstrong, D.K. and Carter, T.R. 2010. The subsurface Paleozoic stratigraphy of southern Ontario; Ontario Geological Survey, Special Volume 7, 301p.

Conestoga-Rovers and Associates. April 30, 2007. Letter: Response to MOE Letter Dated March 27, 2007, Edwards Landfill Site, Haldimand County, Ontario.

Ministry of Northern Development and Mines. Revised June 13, 2005. Mineral Deposit Inventory # MDI30L13NW00003, [ONLINE] Available at: http://www.geologyontario.mndmf.gov.on.ca/gosportal/gos?command=mndmsearchdetails:mdi&uuid=MDI30L13NW00003. [Accessed March 31, 2016].

Conestoga-Rovers and Associates. April 5, 2005. Letter: Response to MOE Letter Dated March 30, 2005, Edwards Landfill Site, Haldimand County, Ontario.

Conestoga-Rovers and Associates. March 14, 2005. Letter: Response to MOE Letter Dated February 11, 2005, Edwards Landfill Site, Haldimand County, Ontario.

Conestoga-Rovers and Associates. November 29, 2004. Memorandum: Proposed Work Program and Timeline, Influence of the Former Cayuga Gypsum Mine on the Hydrogeology of Bedrock Aquifer, Edwards Landfill Site, Haldimand County, Ontario.

Conestoga-Rovers and Associates. July 2004. Report: Well Survey and Limited Hydrogeological Assessment, Edwards Landfill Site, Haldimand County, Ontario.

Patrick Chance & Associates. 1994. Gypsum Mines and Prospects in Brant & Haldimand-Norfolk; Abandon Mines Hazard Abatement Program.

Haynes, S.J. and Hughes-Pearl, J., 1990. Gypsum Deposits of Southern Ontario; Department of Geological Sciences, Brock University, St. Catharines, Grant 319, 10p., MP 150

Haynes, S.J. and Hughes-Pearl, J., 1989. Gypsum Deposits of Southern Ontario; Department of Geological Sciences, Brock University, St. Catharines, Grant 319, 15p., MP 143

Haynes, S.J., Boland, R., and Hughes-Pearl, J., 1988. Gypsum Deposits of Southern Ontario; Department of Geological Sciences, Brock University, St. Catharines, Grant 319, 14p., MP140

Miles, M.C. et al., 1986. Geochemical Study of the Salina Group of Southern Ontario Isotopes and Major and Minor Elements; Ontario Geological Survey, Ontario Geoscience Research Grant Program, Grant No. 148, 93p, OFR 5619

Guillet, G.R., 1983. Mineral Resources of South-Central Ontario; Ontario Geological Survey, Open File Report 5431, page 63, OFR5431

Guillet, G.R., 1964. Gypsum in Ontario; Ontario Department of Mines, Industrial Mineral Report No. 18, 147p., IMR018

Fifty-Ninth Annual Report of the Ontario Department of Mines, Vol. LVIV, Part I, 1950 (printed 1951), Ontario Department of Mines, page 83, ARV59

Fifty-Eighth Annual Report of the Ontario Department of Mines, Vol. LVIII, Part I, 1949 (printed 1950), Ontario Department of Mines, page 85, ARV58

Fifty-Seventh Annual Report of the Ontario Department of Mines, Vol. LVII, Part I, 1948 (printed 1949), Ontario Department of Mines, pages 37-38, ARV57

Oil & Gas Research Library. Plug Date January 20, 1948. Well Name: Pt. Col-Welland Gas & Oil Co - J. Ferguson #1, Licence # F019511 [Accessed March 31, 2016].

Fifty-Sixth Annual Report of the Ontario Department of Mines, Vol. LVI, Part I, 1947 (printed 1948), Ontario Department of Mines, pages 215-216., ARV56

Department of Mines, Provice of Ontario. November 29, 1947. Water Well Record No.284 (2600284), Ministry of the Environment & Climate Change

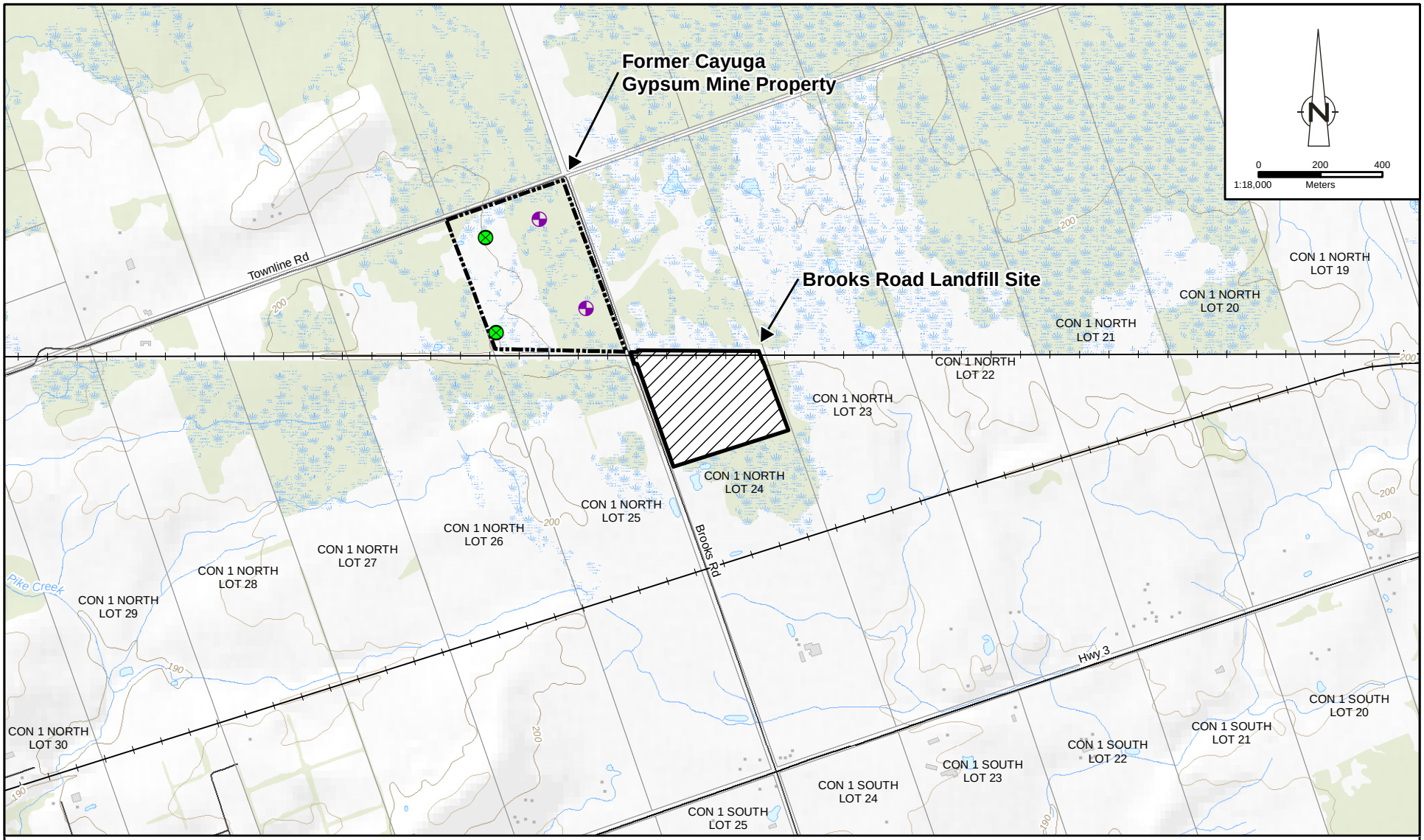
Department of Mines, Provice of Ontario. December 11, 1947. Water Well Record No.285 (2600285), Ministry of the Environment & Climate Change

Fifty-Fifth Annual Report of the Ontario Department of Mines, Vol. LV, Part I, 1946 (printed 1948), Ontario Department of Mines, 555p., ARV55

Fifty-Fourth Annual Report of the Ontario Department of Mines, Vol. LIV, Part I, 1945 (printed 1947), Ontario Department of Mines, pg 100., ARV54

Fifty-Third Annual Report of the Ontario Department of Mines, Vol. LIII, Part I, 1944 (printed 1946), Ontario Department of Mines, 626p., ARV53

Fifty-Second Annual Report of the Ontario Department of Mines, Vol. LII, Part I, 1943 (printed 1946), Ontario Department of Mines, page 206., ARV52



Source: MNRF NRVIS, 2016. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2016; Haldimand County Official Plan
Coordinate System: NAD 1983 UTM Zone 17N

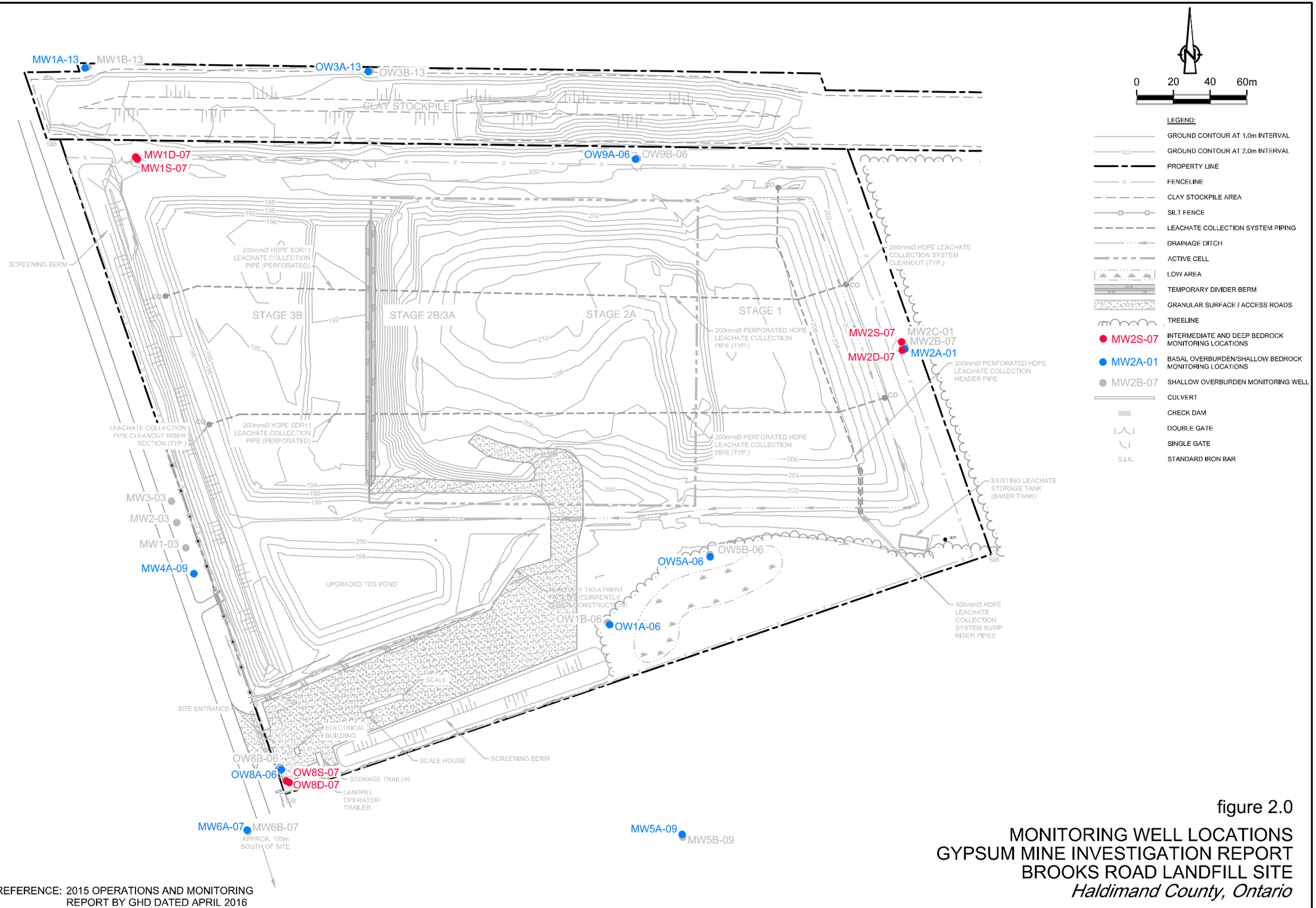
Legend

- Approximated Locations of Mine Shafts
- Historical Water Wells
- Site Location
- Lot Fabric
- Former Cayuga Gypsum Mine Property

figure 1.1

SITE LOCATION MAP
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL
160 Brooks Road, Cayuga, Ontario

018235-00(069)GIS-WA001 May 23/2016



REFERENCE: 2015 OPERATIONS AND MONITORING REPORT BY GHD DATED APRIL 2016

figure 2.0

MONITORING WELL LOCATIONS
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL SITE
Haldimand County, Ontario

18235-00(069)GN-WA008 MAY 4/2016

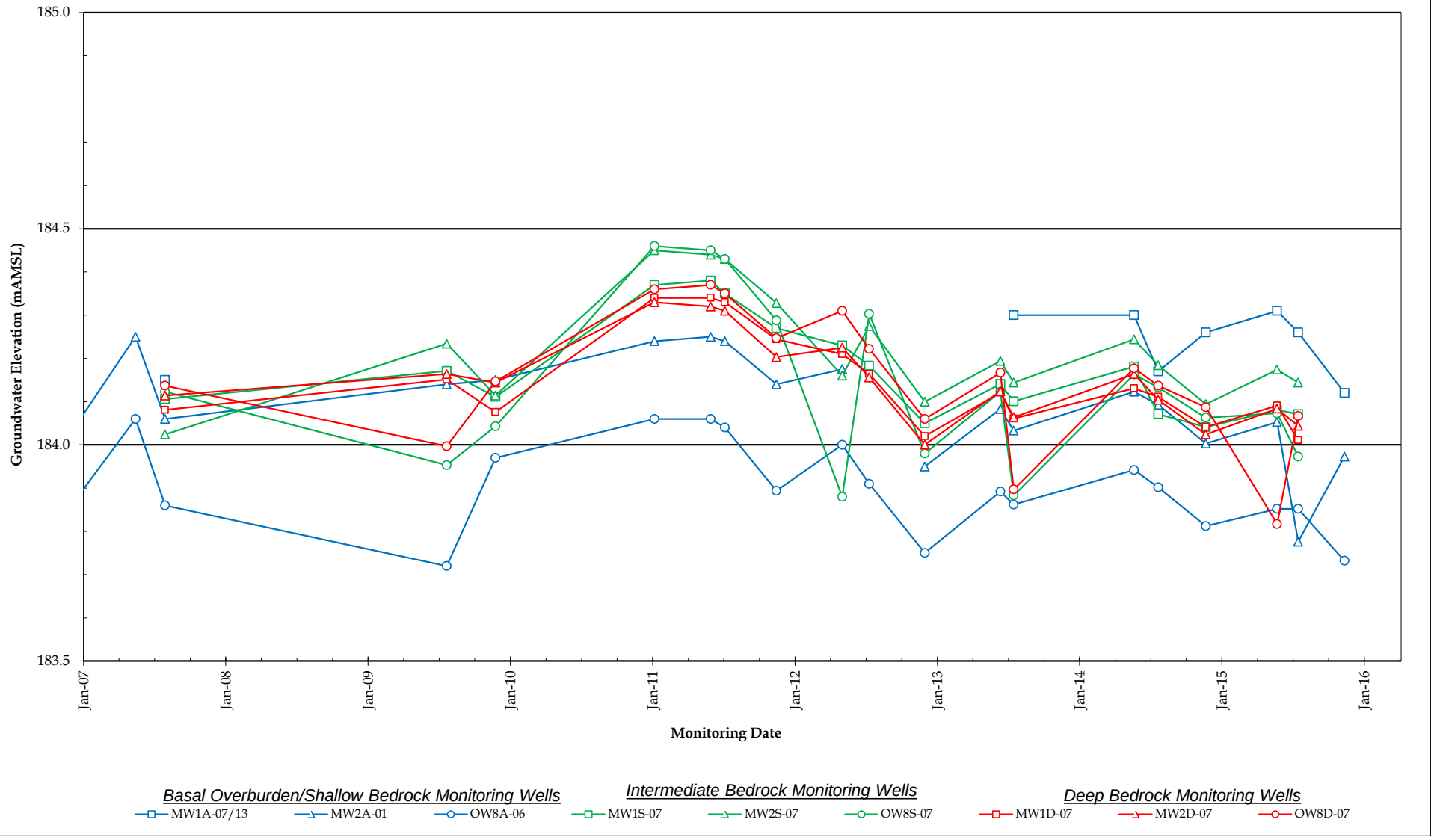
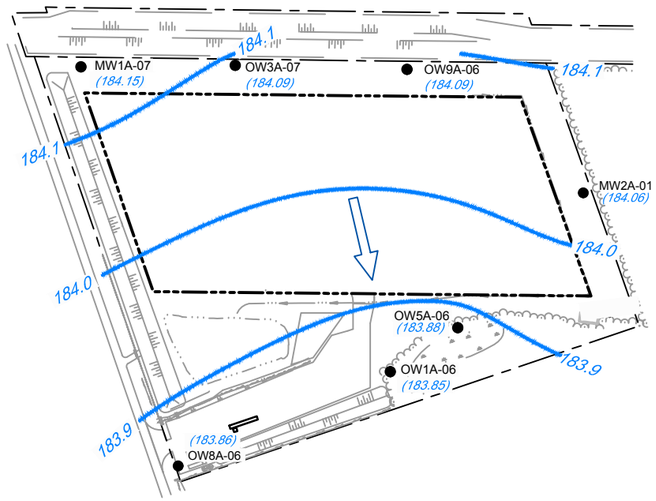
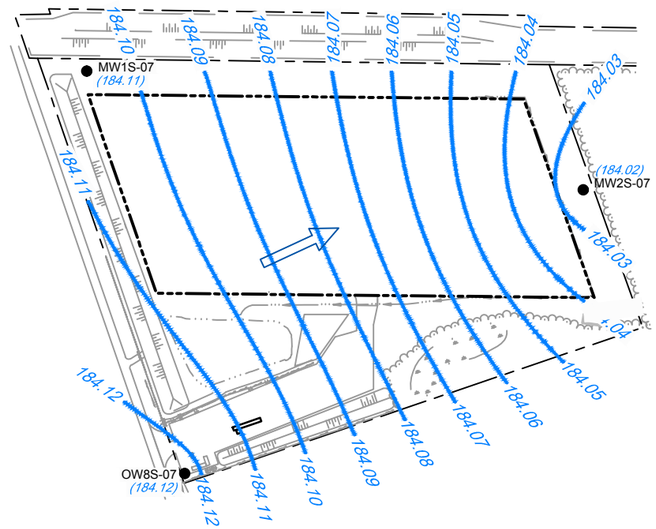


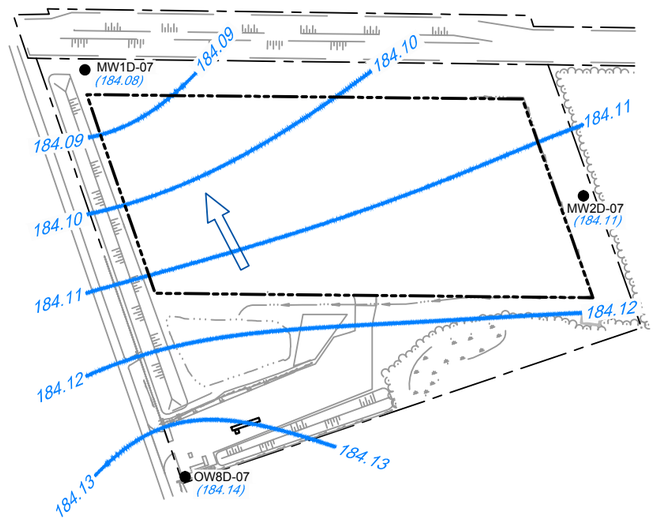
figure 2.1
BEDROCK UNIT HYDROGRAPH (2007-2015)
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL SITE
Haldimand County, Ontario



BASAL OVERBURDEN/SHALLOW BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE JULY 2007



INTERMEDIATE BEDROCK UNIT POTENTIOMETRIC SURFACE JULY 2007



DEEP BEDROCK UNIT POTENTIOMETRIC SURFACE JULY 2007

LEGEND:

- PROPERTY LINE
- LANDFILL FOOTPRINT
- MW2A-01 — MONITORING WELL
- 198.0 — GROUNDWATER CONTOURS
- (182.35) — GROUNDWATER ELEVATION
- INTERPRETED GROUNDWATER FLOW DIRECTION

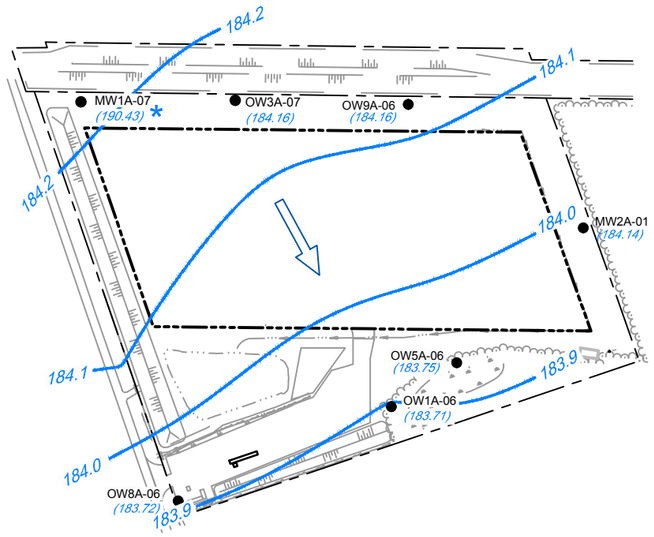
N

0 50 100 150m

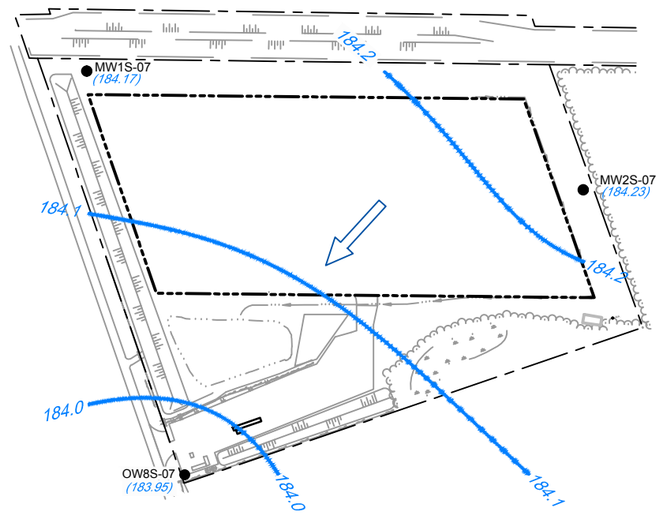
figure 2.2

BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE - JULY 2007
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL SITE
Haldimand County, Ontario

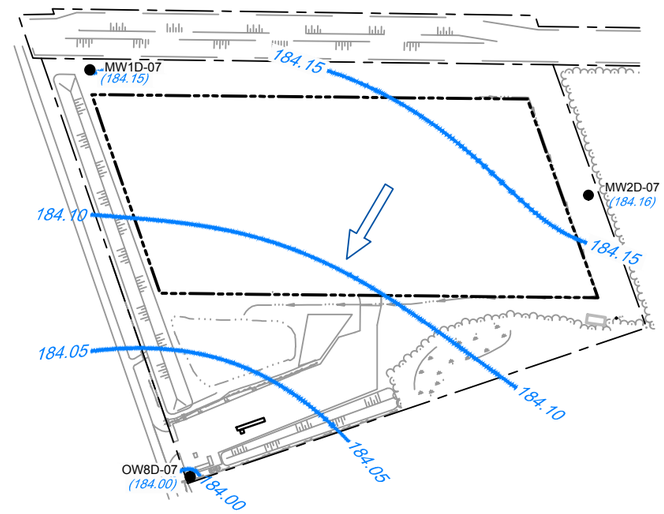
18235-00(069)GN-WA001 JUN 1/2016



BASAL OVERBURDEN/SHALLOW
BEDROCK AQUIFER UNIT
POTENTIOMETRIC SURFACE
JULY 2009



INTERMEDIATE BEDROCK UNIT
POTENTIOMETRIC SURFACE
JULY 2009



DEEP BEDROCK UNIT
POTENTIOMETRIC SURFACE
JULY 2009

LEGEND:

- PROPERTY LINE
- LANDFILL FOOTPRINT
- MW2A-01 — MONITORING WELL
- 198.0 — GROUNDWATER CONTOURS
- (184.16) — GROUNDWATER ELEVATION
- (190.43) * — NOT USED TO GENERATE CONTOURS
- INTERPRETED GROUNDWATER FLOW DIRECTION

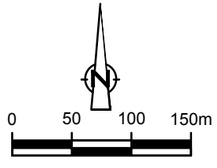
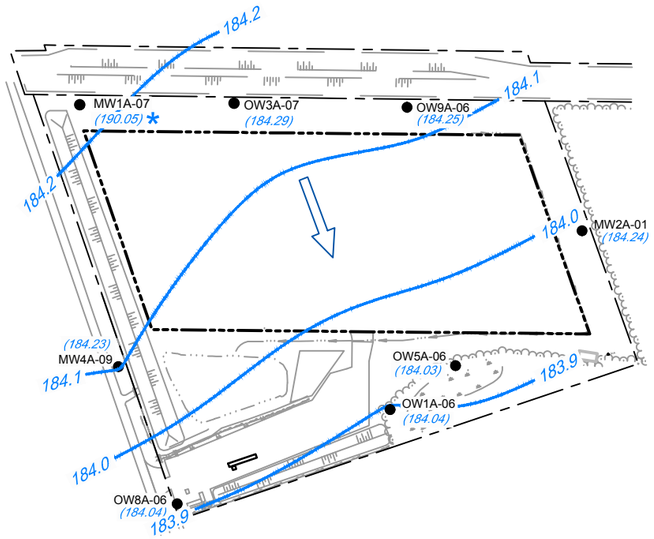
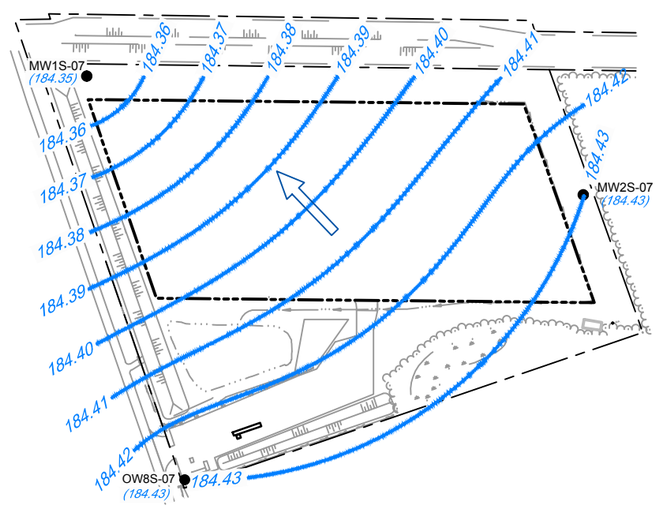


figure 2.3

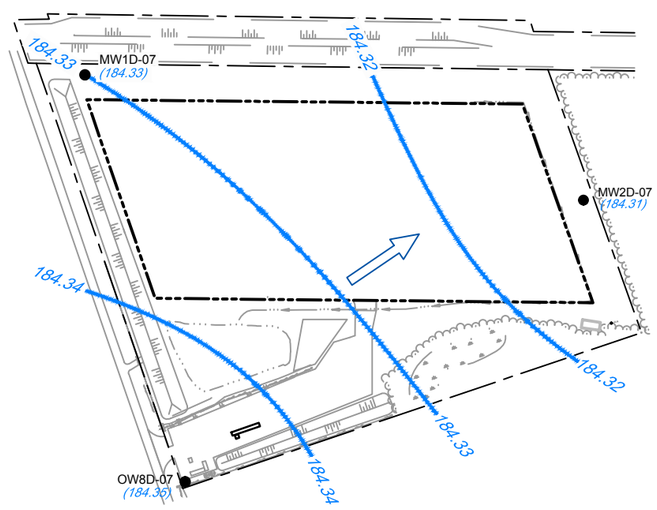
BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE - JULY 2009
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL SITE
Haldimand County, Ontario



BASAL OVERBURDEN/SHALLOW BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE JULY 2011



INTERMEDIATE BEDROCK UNIT POTENTIOMETRIC SURFACE JULY 2011



DEEP BEDROCK UNIT POTENTIOMETRIC SURFACE JULY 2011

LEGEND:

- PROPERTY LINE
- LANDFILL FOOTPRINT
- MW2A-01 — MONITORING WELL
- 184.0 — GROUNDWATER CONTOURS
- (182.35) — GROUNDWATER ELEVATION
- (190.05)* — NOT USED TO GENERATE CONTOURS
- INTERPRETED GROUNDWATER FLOW DIRECTION

N

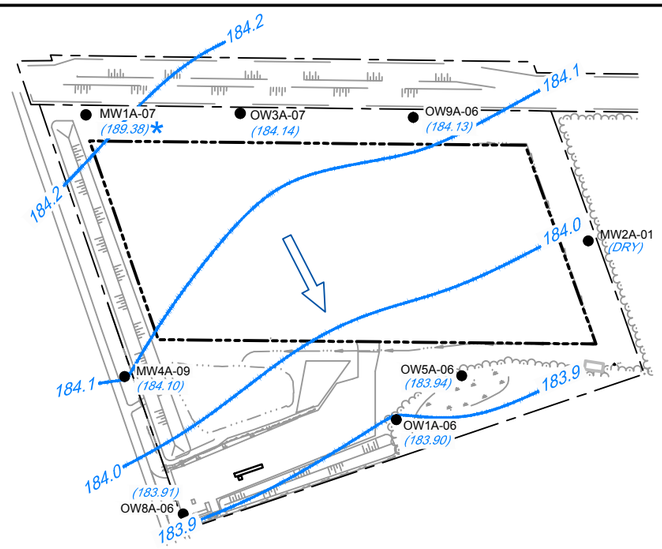
0 50 100 150m

figure 2.4

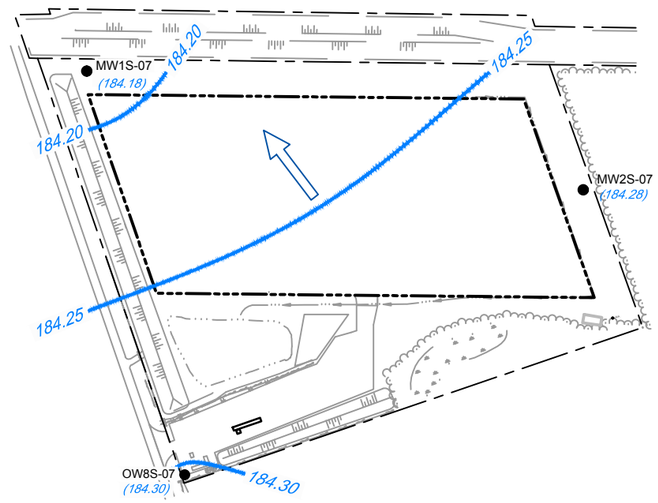
BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE - JULY 2011
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL SITE
Haldimand County, Ontario

GHD

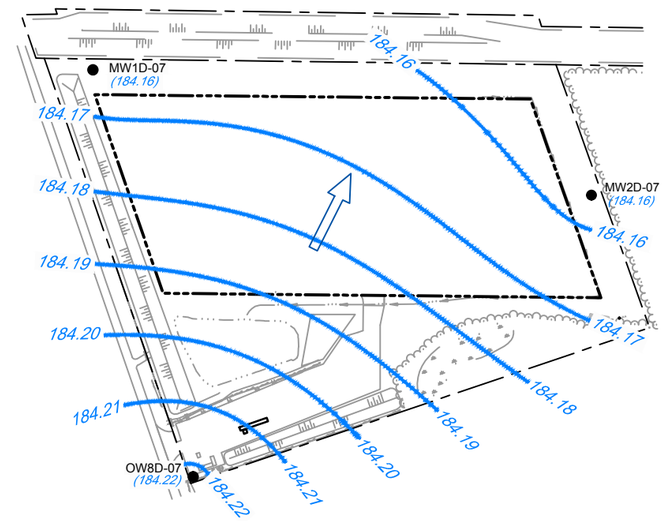
18235-00(069)GN-WA003 JUN 1/2016



BASAL OVERBURDEN/SHALLOW BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE JULY 2012



INTERMEDIATE BEDROCK UNIT POTENTIOMETRIC SURFACE JULY 2012



DEEP BEDROCK UNIT POTENTIOMETRIC SURFACE JULY 2012

LEGEND:

- PROPERTY LINE
- LANDFILL FOOTPRINT
- MW2A-01 — MONITORING WELL
- 198.0 — GROUNDWATER CONTOURS
- (184.13) — GROUNDWATER ELEVATION
- (189.38)* — NOT USED TO GENERATE CONTOURS
- INTERPRETED GROUNDWATER FLOW DIRECTION

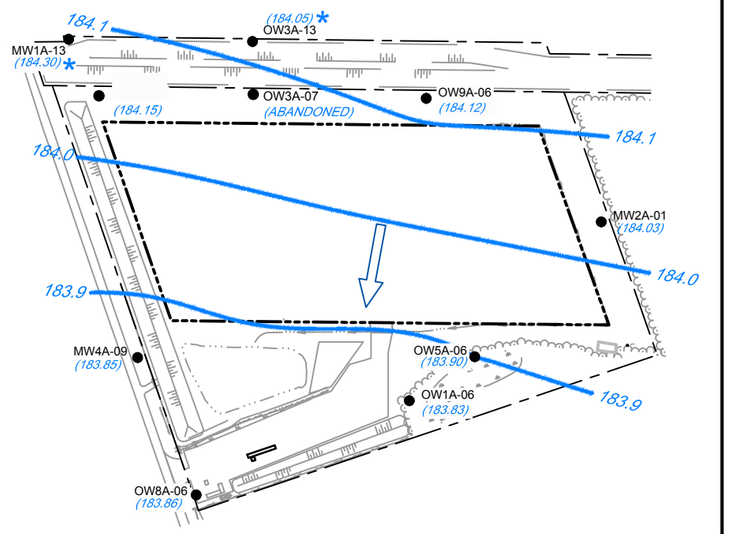
N

0 50 100 150m

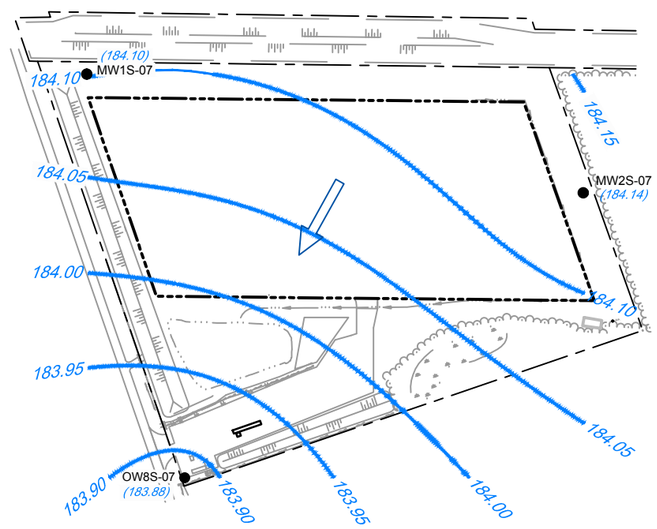
figure 2.5

BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE - JULY 2012
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL SITE
Haldimand County, Ontario

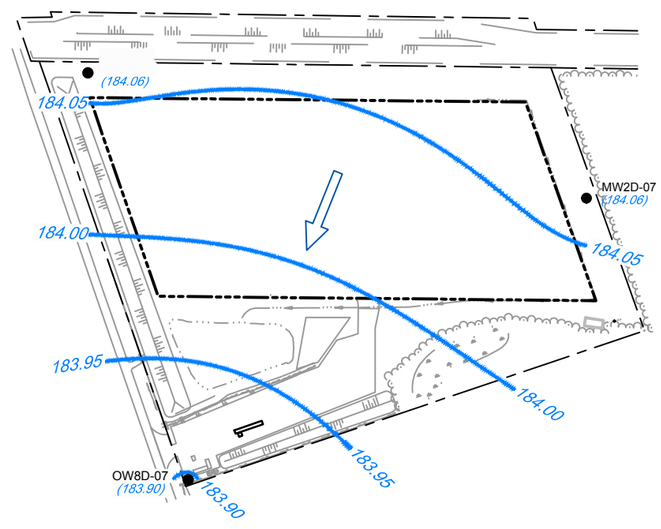
18235-00(069)GN-WA004 JUN 1/2016



BASAL OVERBURDEN/SHALLOW
BEDROCK AQUIFER UNIT
POTENTIOMETRIC SURFACE
JULY 2013



INTERMEDIATE BEDROCK UNIT
POTENTIOMETRIC SURFACE
JULY 2013



DEEP BEDROCK UNIT
POTENTIOMETRIC SURFACE
JULY 2013

LEGEND:

- PROPERTY LINE
- LANDFILL FOOTPRINT
- MW2A-01 — MONITORING WELL
- 198.0 — GROUNDWATER CONTOURS
- (182.35) — GROUNDWATER ELEVATION
- (184.30) * — NOT USED TO GENERATE CONTOURS
- INTERPRETED GROUNDWATER FLOW DIRECTION

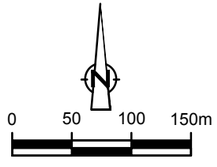
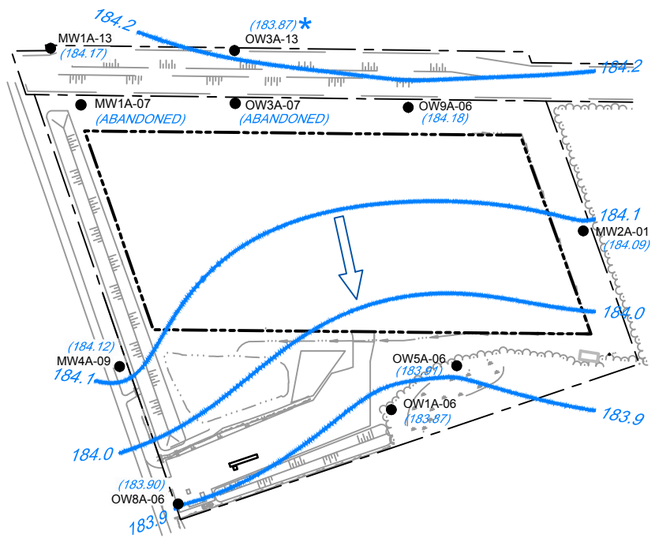
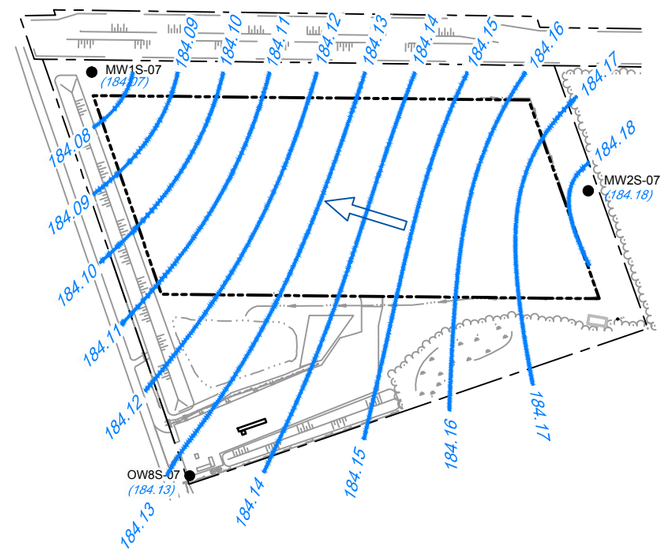


figure 2.6

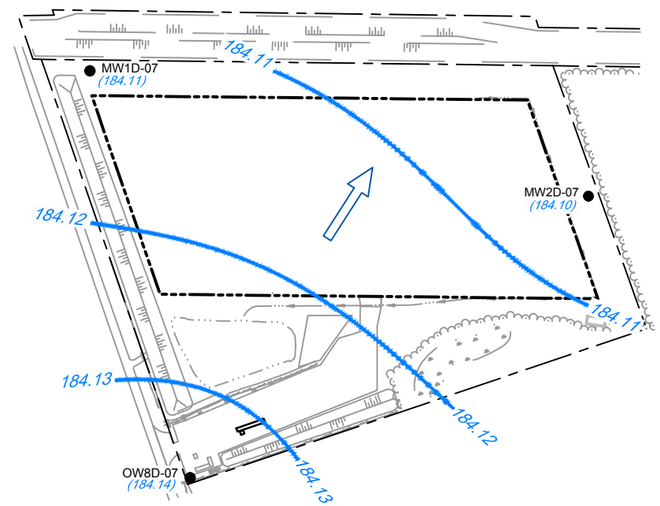
BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE - JULY 2013
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL SITE
Haldimand County, Ontario



BASAL OVERBURDEN/SHALLOW
BEDROCK AQUIFER UNIT
POTENTIOMETRIC SURFACE
JULY 2014



INTERMEDIATE BEDROCK UNIT
POTENTIOMETRIC SURFACE
JULY 2014



DEEP BEDROCK UNIT
POTENTIOMETRIC SURFACE
JULY 2014

LEGEND:

- PROPERTY LINE
- LANDFILL FOOTPRINT
- MW2A-01 — MONITORING WELL
- 198.0 — GROUNDWATER CONTOURS
- (184.09) — GROUNDWATER ELEVATION
- (183.87) * — NOT USED TO GENERATE CONTOURS
- INTERPRETED GROUNDWATER FLOW DIRECTION

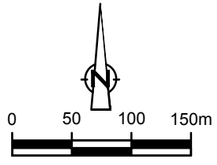
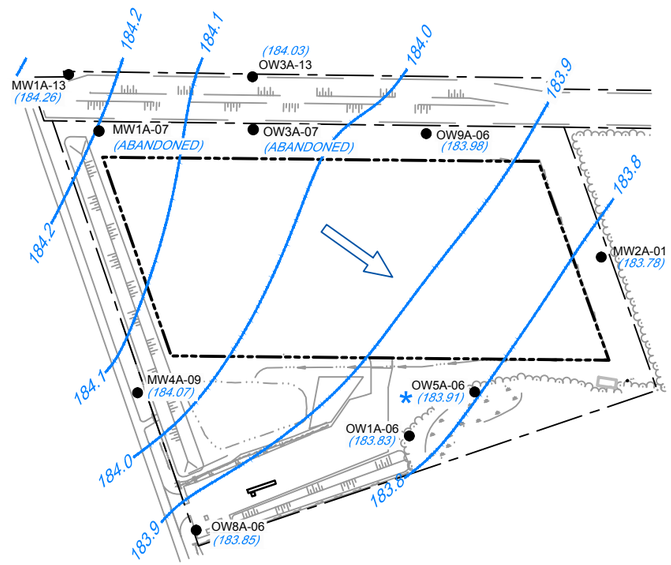
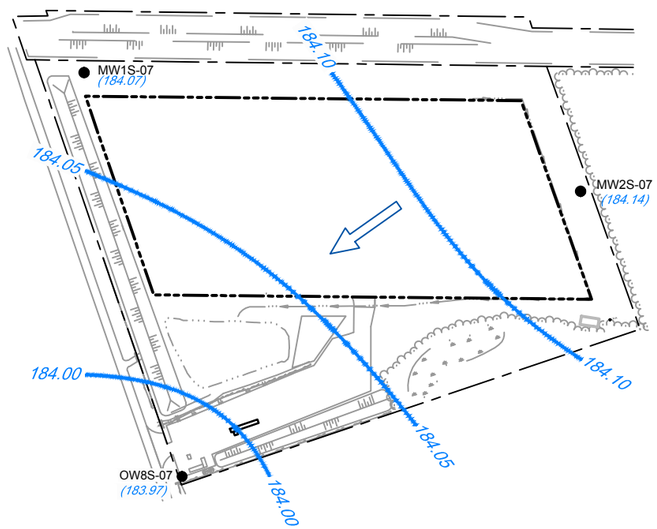


figure 2.7

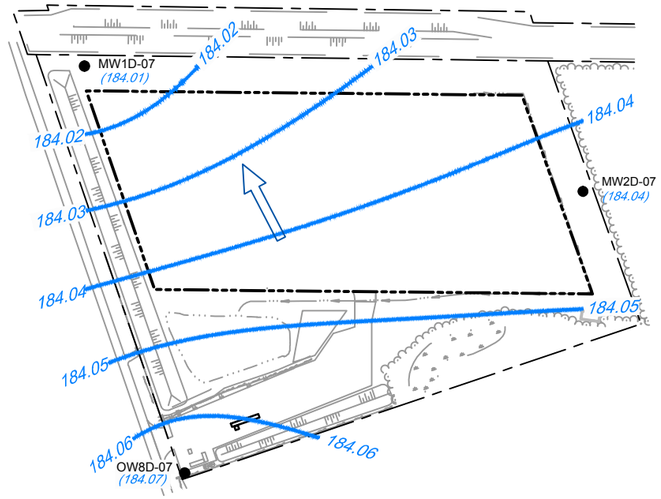
BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE - JULY 2014
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL SITE
Haldimand County, Ontario



BASAL OVERBURDEN/SHALLOW BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE JULY 2015



INTERMEDIATE BEDROCK UNIT POTENTIOMETRIC SURFACE JULY 2015



DEEP BEDROCK UNIT POTENTIOMETRIC SURFACE JULY 2015

LEGEND:

- PROPERTY LINE
- LANDFILL FOOTPRINT
- MW2A-01 — MONITORING WELL
- 198.0 — GROUNDWATER CONTOURS
- (183.78) — GROUNDWATER ELEVATION
- (183.91)* — NOT USED TO GENERATE CONTOURS
- INTERPRETED GROUNDWATER FLOW DIRECTION

N

0 50 100 150m

GHD

18235-00(069)GN-WA007 JUN 1/2016

figure 2.8

BEDROCK AQUIFER UNIT POTENTIOMETRIC SURFACE - JULY 2015
GYPSUM MINE INVESTIGATION REPORT
BROOKS ROAD LANDFILL SITE
Haldimand County, Ontario

Historical Timeline of Annual Reports Prepared by the Ontario Department of Mines
Gypsum Mine Investigation Report
Brooks Road Landfill
Haldimand County, Ontario

Dates	Summary
1942	In the 1942 report published by the ODM in 1946 (52nd Annual Report), James Rose was listed as the President and Manager, and J.F. O'Leary as the Vice-President, and the property was identified as consisting of 1,500 acres in Concession I, North Cayuga Township, Haldimand County. The following excerpt was taken from the same report: *"Operations began on April 1, 1942, and continued to September 1. On the Badger farm, lot 25, a vertical shaft was sunk through 52 feet of clay, 30 feet of shale, and 3 feet of gypsum to a total depth of 85 feet. A level was established from the bottom of the shaft and a crosscut was begun. Through the clay section the shaft is cribbed with 2- by 10-inch elm planks on edge and divided into four compartments: two bucketways, a manway, and a ventilation compartment. Three diamond-drill holes, each 100 feet deep, were drilled from surface."*
1943	No record of the Cayuga Gypsum Company in the 1943 report published by the ODM in 1945 (53rd Annual Report).
1944	The 1944 report published by the ODM in 1947 (54th Annual Report) indicates that *"underground operations in 1944 consisted of pumping out the shaft and driving a heading some 12 feet on the 85-foot level. A headframe 35 feet high was erected."* Gypsum production values were reported in the same annual report by the other Ontario producers, however there were no quantities of gypsum produced or sales recorded in 1944 for the Cayuga Gypsum Mine.
1945	No record of the Cayuga Gypsum Company in the 1945 report published by the ODM in 1948 (55th Annual Report).
1946	As recorded in the 1946 report published by the ODM in 1948 (56th Annual Report), the authorized capitalization is now 1,000,000 shares, while James Rose continues as President and J.F. O'Leary is listed as a director, with the head office now being situated in Cayuga. The following excerpt is taken from the same report: *"The company holds 100 acres of ground known as the Badger property on the west half of lot 25, in the first concession north of Talbot road, North Cayuga Township, Haldimand County. Operations were resumed at this property on August 12, 1946, and carried on continuously throughout the rest of the year. From the bottom of the 85-foot shaft, a 3-foot bed of gypsum was mined by room-and-pillar method, extending in all directions from the shaft. The maximum distance the work was carried from the shaft was 175 feet. A total of 3,222 tons of crude gypsum was hoisted and shipped."*
1947	The 1947 report published by the ODM in 1949 (57th Annual Report) indicates that the Cayuga Gypsum Company operated on a small scale in 1947 and its production of raw gypsum was destined for export. The Annual Report further notes: *"operations were carried on intermittently during the year. A second shaft was collared near the railway track, approximately 1,000 feet south of the No. 1 shaft. A total of 5,244 tons of gypsum was hoisted and crushed."* (1)November and December of 1947, two water wells were drilled on the former Cayuga Gypsum Mine property for drinking water and fire protection use (MOECC Well # 2600284, 2600285).

Historical Timeline of Annual Reports Prepared by the Ontario Department of Mines
Gypsum Mine Investigation Report
Brooks Road Landfill
Haldimand County, Ontario

Dates	Summary
1948	The 1948 report published by the ODM in 1950 (58th Annual Report) indicates that Roy W. Horsely is the president and acting manager of the Cayuga Gypsum Company, while James Rose and J.F. O'Leary no longer appear to be associated with the company. The report notes: *"mining operations were carried on intermittently during the year by a small crew. Stoping is by the room-and-pillar method. The plant consists of a shaft headframe and a small crushing-plant and storage bin. Crude gypsum is only produced. A total of 1,025 tons of crude gypsum was hoisted during the year."* (2)January 20, 1948, gas well known as Pt.Col-Welland Gas & Oil Co - J. Ferguson #1 (MNRF Well Licence # F019511) was plugged on the property.
1949	The 1949 report published by the ODM in 1951 (59th Annual Report) indicates that the *"Cayuga Gypsum Company, which closed down during the year, shipped its raw material directly to the manufacturers."* The report also indicates *"during the year operations were carried on from February to August. A total of approximately 800 tons of ore was hoisted. No processing of the ore was done other than crushing, and it was then shipped as mine run."*

Notes:

The timeline detailed above is consistent with ODM report entitled Gypsum in Ontario, authored by G.R. Guillet, and dated 1964, whereas it was indicated that the mine opened in 1942 and closed in 1949.

ODM	Ontario Department of Mines (now known as the Ministry of Northern Development & Mines).
MOECC	Ministry of the Environment & Climate Change.
MNRF	Ministry of Natural Resources & Forestry.
OGSR	Oil, Gas & Salt Resources.
(1)	Water well records retrieve from the MOECC Water Well Records.
(2)	Gas well record sourced from the OGSR Library Well Records.

Table 2

Summary of Groundwater Elevations
Gypsum Mine Investigation Report
Brooks Road Landfill Site
Haldimand County, Ontario

Well No.	Ground Elevation	Top of Riser Elevation	30-Jul-07	22-Jul-09	24-Nov-09	6-Jan-11	30 to 31-May-11	5 to 7-July-11	14 to 16-Nov-11	1 to 3-May-12	10 to 12-Jul-12	30-Nov-12	12 to 13-Jun-13	16-Jul-13	21-May-14	22-Jul-14	20-Nov-14	23-May-15	16-Jul-15	12-Nov-15
Basal Overburden / Shallow Bedrock																				
MW1A-07	199.72 (4)	200.72	184.15	190.43(8)	190.18(8)	190.05(8)	189.83(8)	189.72(8)	189.67(8)	188.62(8)	189.38(8)	189.33(8)	189.22(8)	Abandoned	--	--	--	--	--	--
MW1A-13	199.64 (7)	200.42	--	--	--	--	--	--	--	--	--	--	--	184.30	184.30	184.17	184.26	184.31	184.26	184.12
MW2A-01	200.35 (2)	201.19	184.06	184.14	184.15	184.24	184.25	184.24	184.14	184.18	DRY	183.95	184.08	184.03	184.12	184.09	184.00	184.05	183.78	183.97
MW4A-09	199.25 (6)	200.15	--	184.16	184.16	184.29	184.26	184.23	184.13	184.22	184.10	183.97	184.10	183.85	184.16	184.12	184.03	184.08	184.07	183.98
MW5A-09	198.53 (6)	199.39	--	184.20	184.20	187.46(9)	187.43(9)	187.40(9)	187.30(9)	187.37(9)	187.27(9)	187.15(9)	184.15	184.12	184.20	184.17	183.48	184.12	184.10	184.06
MW6A-07	198.57 (6)	199.39	--	184.15	184.15	184.34	184.31	184.28	184.15	NM	NM	NM	184.10	184.07	184.14	183.11(10)	184.03	184.08	184.04	183.99
OW1A-06	199.47 (3)	200.24	183.85	183.71	183.97	184.15	184.05	184.04	183.89	184.03	183.90	183.74	183.89	183.83	183.94	183.87	183.79	183.85	183.83	183.77
OW3A-07	199.23 (4)	200.14	184.09	184.16	184.19	184.30	184.30	184.29	184.18	184.23	184.14	Blockage at 1.53	Abandoned	--	--	--	--	--	--	--
OW3A-13	200.51 (7)	201.23	--	--	--	--	--	--	--	--	--	--	184.07	184.05	184.11	184.07	184.00	184.04	184.03	183.97
OW5A-06	198.72 (3)	199.72	183.88	183.75	183.97	184.09	184.07	184.03	183.93	184.02	183.94	183.79	183.94	183.90	Blockage at 14.42	183.91	183.84	183.88	183.67	183.82
OW8A-06	198.29 (3)	199.33	183.86	183.72	183.97	184.06	184.06	184.04	183.89	184.00	183.91	183.75	183.89	183.86	183.94	183.90	183.81	183.85	183.85	183.73
OW9A-06	199.88 (4)	201.08	184.09	184.16	184.16	184.30	184.29	184.25	184.17	184.24	184.13	183.96	184.12	184.12	184.17	184.18	184.04	184.10	183.98	184.01
Intermediate Bedrock Wells																				
MW1S-07	199.65 (4)	200.14 (5)	184.11	184.17	184.11	184.37	184.38	184.35	184.27	184.23	184.18	184.05	184.14	184.10	184.18	184.07	184.04	184.08	184.07	NM
MW2S-07	200.49 (4)	201.13 (5)	184.02	184.23	184.11	184.45	184.44	184.43	184.33	184.16	184.28	184.10	184.19	184.14	184.24	184.18	184.09	184.17	184.14	NM
OW8S-07	198.98 (5)	199.67 (5)	184.12	183.95	184.04	184.46	184.45	184.43	184.29	183.88	184.30	183.98	184.12	183.88	184.16	184.13	184.06	184.07	183.97	NM
Deep Bedrock Wells																				
MW1D-07	199.72 (4)	200.15 (5)	184.08	184.15	184.08	184.34	184.34	184.33	184.24	184.21	184.16	184.02	184.12	184.06	184.13	184.11	184.04	184.09	184.01	NM
MW2D-07	200.63 (4)	201.16 (5)	184.11	184.16	184.14	184.33	184.32	184.31	184.20	184.23	184.16	184.00	184.12	184.06	184.16	184.10	184.02	184.08	184.04	NM
OW8D-07	198.98 (5)	199.32 (5)	184.14	184.00	184.15	184.36	184.37	184.35	184.25	184.31	184.22	184.06	184.17	183.90	184.18	184.14	184.09	183.82	184.07	NM

Notes:
All units in meters above mean sea level (m AMSL)
(1) Surveyed on June 8, 2004
(2) Surveyed on February 18, 2005
(3) Surveyed on January 9, 2007
(4) Surveyed on June 13, 2007
(5) Surveyed on July 26, 2007
(6) Surveyed on March 31, 2010
(7) Surveyed on July 17, 2013
(8) Water level not considered reliable, monitoring well replaced
(9) Water level elevation obtained from others and considered unreliable
(10) Water level not considered reliable
NM Not Measured

Table 2.1

Summary of Vertical Hydraulic Gradients
Gypsum Mine Investigation Report
Brooks Road Landfill Site
Haldimand County, Ontario

	Jul. 2007	Jul. 2009	Nov. 2009	Jan. 2011	May 2011	Jul. 2011	Nov. 2011	May 2012	Jul. 2012	Nov. 2012	Jun. 2013	Jul. 2013	May 2014	Jul. 2014	Nov. 2014	May 2015	Jul. 2015	Nov. 2015
Basal Overburden/Shallow Bedrock - Deep Bedrock																		
MW1A-07 - MW1D-07	0.008	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW1A-13 - MW1D-07	--	--	--	--	--	--	--	--	--	--	--	0.029	0.020	0.007	0.014	0.014	0.051	--
MW2A-07 - MW2D-07	0.003	-0.002	0.001	-0.007	-0.007	-0.006	-0.005	-0.008	0.000	-0.008	-0.004	-0.003	-0.004	-0.001	-0.002	-0.003	-0.025	--
OW8A-07 - OW8D-07	-0.020	-0.021	-0.014	-0.023	-0.023	-0.027	-0.023	-0.023	-0.024	-0.023	-0.021	-0.003	-0.018	-0.018	-0.021	0.003	-0.016	--
Average Vertical Gradient:	**-0.003**	**-0.011**	**-0.006**	**-0.015**	**-0.015**	**-0.016**	**-0.014**	**-0.016**	**-0.012**	**-0.016**	**-0.012**	**0.008**	**-0.0005**	**-0.004**	**-0.003**	**0.005**	**0.003**	--
																	Minimum:	**-0.016**
																	Maximum:	**0.008**
Basal Overburden/Shallow Bedrock - Intermediate Bedrock																		
MW1A-07 - MW1S-07	0.010	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW1A-13 - MW1S-07	--	--	--	--	--	--	--	--	--	--	--	0.040	0.024	0.020	0.014	0.015	0.038	--
MW2A-07 - MW2S-07	0.008	-0.021	0.009	-0.043	-0.043	-0.042	0.003	0.002	0.000	-0.025	-0.025	-0.025	-0.027	-0.021	-0.021	-0.027	-0.083	--
OW8A-07 - OW8S-07	-0.045	-0.040	-0.013	-0.067	-0.067	-0.068	0.021	0.021	-0.068	-0.040	-0.040	-0.004	-0.038	-0.040	-0.043	-0.038	-0.021	--
Average Vertical Gradient:	**-0.009**	**-0.030**	**-0.002**	**-0.055**	**-0.055**	**-0.055**	**0.012**	**0.012**	**-0.034**	**-0.032**	**-0.032**	**0.004**	**-0.014**	**-0.013**	**-0.017**	**-0.017**	**-0.022**	--
																	Minimum:	**-0.055**
																	Maximum:	**0.012**
Intermediate Bedrock - Deep Bedrock																		
MW1S-07 - MW1D-07	0.006	0.005	0.008	0.007	0.010	0.005	0.006	0.005	0.005	0.007	0.005	0.010	0.012	-0.010	0.000	-0.002	0.014	--
MW2S-07 - MW2D-07	-0.015	0.011	-0.005	0.020	0.020	0.020	0.021	-0.011	0.020	0.016	0.011	0.013	0.013	0.013	0.011	0.015	0.016	--
OW8S-07 - OW8D-07	-0.002	-0.006	-0.014	0.013	0.011	0.011	0.005	-0.058	0.011	-0.011	-0.006	-0.002	-0.002	-0.001	-0.003	0.034	-0.013	--
Average Vertical Gradient:	**-0.004**	**0.003**	**-0.004**	**0.013**	**0.013**	**0.012**	**0.011**	**-0.021**	**0.012**	**0.004**	**0.003**	**0.007**	**0.008**	**0.001**	**0.003**	**0.016**	**0.006**	--
																	Minimum:	**-0.021**
																	Maximum:	**0.016**

Table 2.2

Summary of Horizontal Hydraulic Gradients
Gypsum Mine Investigation Report
Brooks Road Landfill Site
Haldimand County, Ontario

Date	Basal Overburden/ Shallow Bedrock Wells		Intermediate Bedrock Wells		Deep Bedrock Wells	
	Gradient	Orientation	Gradient	Orientation	Gradient	Orientation
Jul. 2007	0.0009	SSE	0.0002	ENE	0.0002	NW
Jul. 2009	0.0009	SE	0.0007	SW	0.0004	SW
Nov. 2009	0.0008	SSE	0.0002	SW	0.0002	NW
Jan. 2011	0.0008	SSE	0.0003	NW	0.0001	NE
May 2011	0.0009	SSE	0.0002	NW	0.0001	NE
Jul. 2011	0.0009	SSE	0.0002	NW	0.0001	NE
Nov. 2011	0.0010	SSE	0.0001	W	0.0001	ENE
May 2012	0.0011	SSE	0.0010	S	0.0003	N
Jul. 2012	0.0009	SSE	0.0003	NW	0.0002	NNE
Nov. 2012	0.0011	SE	0.0003	SW	0.0001	NE
Jun. 2013	0.0011	SE	0.0002	WSW	0.0001	NNE
Jul. 2013	0.0010	SSW	0.0006	SW	0.0005	SSW
May 2014	0.0009	SE	0.0002	WSW	0.0001	NNW
Jul. 2014	0.0012	S	0.0003	WNW	0.0001	NE
Nov. 2014	0.0011	SSE	0.0001	W	0.0002	NE
May 2015	0.0011	SSE	0.0002	WSW	0.0008	SSW
Jul. 2015	0.0010	SE	0.0004	SW	0.0002	NNW
Nov. 2015	0.0010	SSE	--	--	--	--
Minimum:	**0.0008**		**0.0001**		**0.0001**	
Maximum:	**0.0012**		**0.0010**		**0.0008**	
Geometric Mean:	**0.0010**		**0.0003**		**0.0002**	

Table 2.3

Summary of Groundwater Velocities
Gypsum Mine Investigation Report
Brooks Road Landfill Site
Haldimand County, Ontario

Intermediate Bedrock Unit	***MW1S-07***	***MW2S-07***	***OW8S-07***
Hydraulic Conductivity (cm/s):	2.59E-04	4.88E-04	5.92E-04
Horizontal Hydraulic Gradient (m/m):	0.0003	0.0003	0.0003
Effective Porosity Fractured Flow (%)	5%	5%	5%
Groundwater velocity (m/year):	*0.49*	*0.92*	*1.12*
Deep Bedrock Unit	***MW1D-07***	***MW2D-07***	***OW8D-07***
Hydraulic Conductivity (cm/s):	<1.22E-06	<1.31E-06	<1.31E-06
Horizontal Hydraulic Gradient (m/m):	0.0002	0.0002	0.0002
Effective Porosity Fractured Flow (%)	5%	5%	5%
Groundwater velocity (m/year):	*0.002*	*0.002*	*0.002*

Appendices

Appendix A
Stratigraphic and Instrumentation Logs

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW1A-07
DATE COMPLETED: May 7, 2007
DRILLING METHOD: 108mm ID HSA
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m ASD
	TOP OF CASING TOP OF RISER GROUND SURFACE	200.80 200.67 199.67
0	FILL - CLAY, trace SILT (Disturbed), soft to firm, high plasticity, brown, damp	
1	OL/PT - SILT LOAM, trace CLAY, trace SAND, trace GRAVEL (NATIVE), soft, moderate plasticity, black, moist	198.76
		198.15
2	CL - SILTY CLAY, firm to stiff, low plasticity, brown with grey streaking/mottling, damp: suspect mechanical fracture due to drilling - silt, with clay, stiff - no apparent streaking/mottling	
3	- stiff to very stiff, damp	
4		
		195.10
5	CH - CLAY, trace SILT (Varved), firm, high plasticity, slow dilatency, reddish brown/grey, damp; silty varves consisting of alternating coloured bands of grey and reddish brown - 0.25cm piece of fine grained, subangular gravel, vertical deposition	
6	- 33cm layer/zone of clay with silt, moderate plasticity, rapid dilatency	
		192.75
7	CH - CLAY, trace SILT, trace GRAVEL (Till), stiff to very stiff, moderate plasticity, grey, damp; fine grained gravel - 10cm layer of fine grained gravel, moist	
8	- greyish brown in colour	
9		
10	- soft	
11	- 5cm layer of clay and gravel, trace silt	
		188.24
12	CH - CLAY, trace SILT (Varved), soft, high plasticity, moderate dilatency, reddish brown/grey, wet; silty varves consisting of alternating coloured bands of grey and reddish brown - piece of gravel/cobble >5cm, broken by spilt spoon	
13	- 2.5cm piece of subangular gravel	
14		

Monitoring Well: Concrete; CONCRETE; 108mm Ø Borehole; BENTONITE AND CONCRETE GROUT; 51mm Ø SCH 40 PVC RISER PIPE; BENTONITE GRAVEL

SAMPLE NUMBER	INTERVAL	REC (%)	'N' VALUE	P.I.D.
01		29.2	4	0
02		39.6	2	0
03		45.8	8	0
04		85.4	8	0
05		106.3	25	0
06		47.9	26	0
07		108.3	16	0
08		110.4	8	0
09		120.8	11	0
10		70.8	17	0
11		97.9	14	0
12		110.4	12	0
13		25	9	0
14		87.5	6	0
15		112.5	10	0
16		125	8	0
17		100	8	0
18		104.2	9	0
19		108.3	5	0
20		108.3	8	0

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW1A-07
DATE COMPLETED: May 7, 2007
DRILLING METHOD: 108mm ID HSA
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m ASD	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE	SAMPLE P.I.D.
16	- stiff, brown, damp	183.97	#2 Silica Sand	21		108.3	6	0
	CH - SILT, trace CLAY, trace SAND, trace GRAVEL, firm, low plasticity, rapid dilatency, grey, moist		51mm Ø SCH 40 PVC WELL SCREEN	22		83.3	23	0
17	- firm, grey, moist	183.15						
	- silt and gravel, with sand, trace clay, stiff/compact, brown, moist; occasional 5cm piece of gravel	182.91		23		56.3	>50	0
	- firm, grey							
18	- stiff, brown	181.96						
	GM/GC - SAND and GRAVEL, trace FINES, compact, brown, wet; shale fragments throughout							
	Bedrock inferred							
19	END OF BOREHOLE @ 17.68m BGS							
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								

WELL DETAILS
Screened interval:
185.04 to 181.99m ASD
14.63 to 17.68m BGS
Length: 3.05m
Diameter: 51mm
Slot Size: 10
Material: Sch 40 PVC
Seal:
199.06 to 186.41m ASD
0.61 to 13.26m BGS
Material: Bentonite and Concrete
Sand Pack:
185.65 to 181.99m ASD
14.02 to 17.68m BGS
Material: No.2 SILICA SAND

Seal:
186.41 to 185.65m ASD
13.26 to 14.02m BGS
Material: Bentonite Gravel

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: BROOKS ROAD LANDFILL SITE
PROJECT NUMBER: 018235
CLIENT: C/O 2270386 ONTARIO LIMITED
LOCATION: CAYUGA, HALDIMAND COUNTY, ON

HOLE DESIGNATION: MW1A-13
DATE COMPLETED: June 27, 2013
DRILLING METHOD: 4-1/4" HSA
FIELD PERSONNEL: D. TURNER

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	TOP OF RISER GROUND SURFACE	200.42 199.64					
0.5	GP-GRAVEL (FILL), with clay, loose, medium to well graded	199.18	CONCRETE	1		20	5
	CL-CLAY (FILL), with silt, soft, low plasticity, brown, moist	199.03					
1.0	CL-SILTY CLAY, trace gravel, trace sand, firm, low plasticity, brown, dry, grey bands		2" PVC RISER				
1.5			BENTONITE				
2.0				2		100	21
2.5							
3.0	- moist at 3.05m BGS						
3.5				3		75	18
4.0							
4.5	CI-SILTY CLAY, firm, medium to high plasticity, brown, with grey, moist	195.07					
5.0				4		80	12
5.5							
6.0							
6.5				5		80	14

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: BROOKS ROAD LANDFILL SITE
PROJECT NUMBER: 018235
CLIENT: C/O 2270386 ONTARIO LIMITED
LOCATION: CAYUGA, HALDIMAND COUNTY, ON

HOLE DESIGNATION: MW1A-13
DATE COMPLETED: June 27, 2013
DRILLING METHOD: 4-1/4" HSA
FIELD PERSONNEL: D. TURNER

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
7.5	- trace gravel 3cm Ø at 7.62m BGS			6		100	19
8.0							
8.5							
9.0				7		75	17
9.5							
10.0							
10.5							
11.0	CI-GRAVELLY CLAY, with silt, soft, medium plasticity, brown, wet	188.67		8		70	33
11.5							
12.0	CH-CLAY, trace silt, soft, high plasticity, grey, moist	187.45					
12.5				9		80	11
13.0							
13.5							

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: BROOKS ROAD LANDFILL SITE
PROJECT NUMBER: 018235
CLIENT: C/O 2270386 ONTARIO LIMITED
LOCATION: CAYUGA, HALDIMAND COUNTY, ON

HOLE DESIGNATION: MW1A-13
DATE COMPLETED: June 27, 2013
DRILLING METHOD: 4-1/4" HSA
FIELD PERSONNEL: D. TURNER

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	ML-SILT, with sand, with clay, some gravel, soft, low plasticity, grey, moist	185.62	BENTONITE CHIPS	10		60	39
14.5							
15.0							
15.5			2" PVC SCREEN	11		50	25
16.0			SAND PACK				
16.5							
17.0	- bedrock inferred at 17.07m BGS			12		50	16
17.5							
18.0	END OF BOREHOLE @ 18.14m BGS	181.50					
18.5							
19.0							
19.5							
20.0							
20.5							

WELL DETAILS
Screened interval:
184.55 to 183.03m
15.09 to 16.61m BGS
Length: 1.52m
Diameter: 51mm
Slot Size: 0.010
Material: PVC
Seal:
185.77 to 185.16m
13.87 to 14.48m BGS
Material: BENTONITE CHIPS
Sand Pack:
185.16 to 181.50m
14.48 to 18.14m BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HALDIMAND-NORFOLK
LOCATION: CAYUGA, ONTARIO

HOLE DESIGNATION: MW2A-01
DATE COMPLETED: October 16, 2001
DRILLING METHOD: 108mm ID HSA, and AIR ROTARY
FIELD PERSONNEL: P. SMART

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m ASD	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	TOP OF RISER GROUND SURFACE	201.13 200.44					
	See MW2B-01 log description		CONCRETE HOLEPLUG 203.2mm Ø Borehole BENTONITE GROUT				
12	CL-SILTY CLAY, very stiff, brown silty laminations, grey, moist	188.25		1		100	11
14	SILT AND SAND (TILL), trace clay, fine to medium sand, trace coarse sand with gravel	185.96		2		100	40

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STATIC WATER LEVEL ▼ October 19/01

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HALDIMAND-NORFOLK
LOCATION: CAYUGA, ONTARIO

HOLE DESIGNATION: MW2A-01
DATE COMPLETED: October 16, 2001
DRILLING METHOD: 108mm ID HSA, and AIR ROTARY
FIELD PERSONNEL: P. SMART

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m ASD	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
16	BEDROCK, auger ground into bedrock 0.6 m, air rotary drilling, no drill returns below 15.24m BGS	185.51	HOLEPLUG 101.6mm Ø COREHOLE SAND PACK WELL SCREEN				
19	END OF BOREHOLE @ 19.20m BGS	181.24					
20	(pp) - Pocket Penetrometer Value (70) - Field Shear Vane Value s - Field Vane Sensitivity		WELL DETAILS Screened interval: 184.29 to 181.24m ASD 15.15 to 19.20m BGS Length: 3.05m Diameter: 51mm Slot Size: #10 Sand Pack: 184.59 to 181.24m ASD 15.85 to 19.20m BGS Material: SILICA SAND #2				
21							
22							
23							
24							
25							
26							
27							
28							
29							

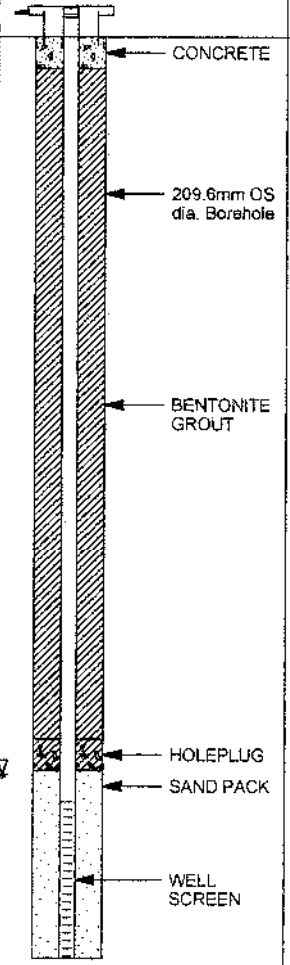
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
STATIC WATER LEVEL ▼ October 19/01

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSL
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: OW8A-06
DATE COMPLETED: November 21, 2006
DRILLING METHOD: 108mm ID HSA
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m ASD
	TOP OF CASING	199.40
	TOP OF RISER	199.33
	GROUND SURFACE	198.29
0	CH - CLAY (Disturbed), firm, high plasticity, brown, damp to moist	
2	CH - CLAY (Native), firm, high plasticity, brown, trace grey colour, damp	196.46
4	- possible 9cm long fracture	
6	CH - CLAY (Varved), trace SILT, firm, brown, damp	192.95
	- 2.5cm layer of trace SAND, fine grained, grey	
	- CLAY, trace GRAVEL	191.06
8	CH - CLAY (Till), trace SILT, trace SAND, trace GRAVEL, firm, fine grained subangular gravel, coarse grained sand, damp	
	- possible 12.5cm long fracture	
10	- 7.6cm layer of trace SAND and GRAVEL, fine grained	
	- 2.5cm layer of GRAVEL, fine grained	
	- piece of GRAVEL, coarse grained, subangular	
12	- 7.6cm layer of trace SAND and GRAVEL, medium grained sand, fine grained gravel, sand is yellow in colour, gravel is subangular	186.32
	- soft, moist	
	- piece of GRAVEL, coarse grained, subangular	
14	CH - CLAY (Varved), soft, moist	
	- very soft, rapid dilatency	
	- possible fractures noted at two of the varves	
16	- piece of GRAVEL (Granite), coarse grained	182.28
	GM/GP - GRAVELLY SAND, trace FINES, compact, poorly graded, brown	182.13
	SHALE (Bedrock), brown	181.13
18	END OF BOREHOLE @ 17.98m BGS	
20		
22		
24		
26		



WELL DETAILS
Screened interval:
183.35 to 180.30m ASD
14.94 to 17.98m BGS
Length: 3.05m
Diameter: 51mm
Slot Size: 10
Material: Sch 40 PVC
Seal:
197.68 to 184.27m ASD
0.61 to 14.02m BGS
Material: Bentonite Gravel
Sand Pack:
183.96 to 180.30m ASD
14.33 to 17.98m BGS
Material: No.2 SILICA SAND

SAMPLE NUMBER	INTERVAL	REC (%)	N' VALUE	P.I.D.
01	P/S	100		0
02	P/S	100		0
03	P/S	100		0
04	P/S	100		0
05	P/S	100		0
06	P/S	95		0
07	P/S	100		0
08	P/S	100		0
09	P/S	100		0
10		75	11	0
11		50	40	0
12		100	>50	0

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ▽ Dec 11, 2006

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW1D-07
DATE COMPLETED: May 14, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	TOP OF CASING TOP OF RISER GROUND SURFACE	200.22 200.15 199.72					
0.5 – 9.5	Please refer to Overburden Stratigraphy Log MW1A-07.		260mm Ø BOREHOLE PORTLAND BENTONITE				

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

OVERBURDEN LOG 18235-2007-BEDROCK.GPJ CRA_CORP.GDT 4/15/16

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW1D-07
DATE COMPLETED: May 14, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
10.5							
11.0							
11.5			BENTONITE PORTLAND				
12.0			51mm Ø SCH 40 PVC RISER				
12.5			102mm Ø STEEL CASING				
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							
16.5							
17.0	END OF OVERBURDEN HOLE @ 16.76m BGS						
17.5							
18.0							
18.5							
19.0							
19.5							

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW1D-07
DATE COMPLETED: May 14, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %
17.0	Weathered Bedrock - Dolomitic Shale, gravel sized fragments, light and dark grey in colour, fine texture, moderately to highly weathered - iron oxidization present	182.96 182.65				
17.5	DOLOSTONE-SHALE BEDROCK (SALINA FORMATION), dolostone shale, light grey/dark grey, thin horizontal laminations to wavy beds, fine grained and micro-crystalline, argillaceous, slightly weathered; occasional to frequent gypsum beds/nodules, occasional selenite crystals - fracture, slightly weathered, suspect open aperture - suspect horizontal fractures with very close aperture; suspect vertical fractures randomly interesecting bedding planes from 17.45 to 17.53 m.bgs - fracture, moderately weathered, iron oxizidization present - gypsum bed (21.5cm), white, micro-crystalline, minor inclusions of dark grey shale		96mm Ø COREHOLE			
18.0						
18.5						
19.0						
19.5						
20.0				4	99	99
20.5						
21.0						
21.5				5	100	100
22.0						
22.5						
23.0			BENTONITE GRAVEL	6	100	100
23.5						
24.0	- gypsum bed (37cm), white, micro-crystalline, <5% dolomitic-shale		NO.2 SILICA SAND			
24.5						
25.0			51mm Ø SCH 40 PVC SCREEN	7	94	94
25.5						
26.0						

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW1D-07
DATE COMPLETED: May 14, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %
27.0				8	98	98
27.5						
28.0				9	78	78
28.5			BENTONITE GRAVEL			
29.0						
29.5						
30.0	- gypsum bed (5.1cm) - gypsum bed (2.5cm)			10	98	98
30.5						
	END OF BOREHOLE @ 30.68m BGS	169.04				
31.0			WELL DETAILS Screened interval: 175.95 to 173.51m AMSL 23.77 to 26.21m BGS Length: 2.44m Diameter: 51mm Slot Size: 10 Material: Sch 40 PVC Seal: 173.51 to 169.04m AMSL 26.21 to 30.68m BGS Material: Bentonite Gravel Sand Pack: 176.25 to 173.51m AMSL 23.47 to 26.21m BGS Material: No.2 SILICA SAND ---------- Seal: 177.17 to 176.25m AMSL 22.56 to 23.47m BGS Material: Bentonite Gravel ---------- Seal: 199.11 to 177.17m AMSL 0.61 to 22.56m BGS Material: Cement-Bentonite Grout			
31.5						
32.0						
32.5						
33.0						
33.5						
34.0						
34.5						
35.0						
35.5						
36.0						

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW1S-07
DATE COMPLETED: May 17, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	TOP OF CASING TOP OF RISER GROUND SURFACE	200.21 200.14 199.65					
0.5	Please refer to Overburden Stratigraphy Log MW1A-07.						
1.0							
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0			260mm Ø BOREHOLE				
6.5							
7.0							
7.5							
8.0			PORTLAND BENTONITE				
8.5							
9.0			102mm Ø STEEL CASING				
9.5			BENTONITE				

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW1S-07
DATE COMPLETED: May 17, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
10.5			PORTLAND				
11.0							
11.5							
12.0			51mm Ø SCH 40 PVC RISER				
12.5							
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							
16.5	END OF OVERBURDEN HOLE @ 16.46m BGS						
17.0							
17.5							
18.0							
18.5							
19.0							
19.5							

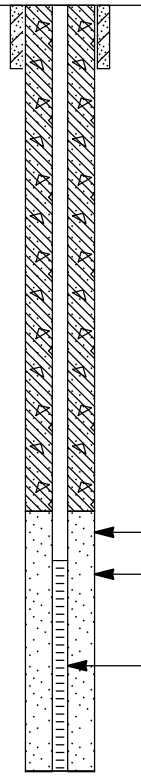
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW1S-07
DATE COMPLETED: May 17, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %
16.5	Please refer to Bedrock Stratigraphy Log MW1D-07.	183.19				
17.0				1	70	51
17.5						
18.0						
18.5				2	100	100
19.0						
19.5						
20.0				3	100	100
20.5						
21.0						
21.5	END OF BOREHOLE @ 21.54m BGS	178.11				
22.0						
22.5						
23.0						
23.5						
24.0						
24.5						
25.0						
25.5						



WELL DETAILS
Screened interval:
179.63 to 178.11m AMSL
20.02 to 21.54m BGS
Length: 1.52m
Diameter: 51mm
Slot Size: 20
Material: Sch 40 PVC
Seal:
199.65 to 179.99m AMSL
0.00 to 19.66m BGS
Material: Cement-Bentonite Grout
Sand Pack:
181.21 to 178.11m AMSL
18.44 to 21.54m BGS
Material: No.2 SILICA SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW2D-07
DATE COMPLETED: May 29, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	TOP OF CASING TOP OF RISER GROUND SURFACE	201.21 201.16 200.63					
0.5 – 9.5	Please refer to Overburden Stratigraphy Log MW2A-07.		260mm Ø BOREHOLE PORTLAND BENTONITE 102mm Ø STEEL CASING				

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW2D-07
DATE COMPLETED: May 29, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
10.5							
11.0							
11.5							
12.0							
12.5			BENTONITE PORTLAND				
13.0							
13.5			51mm Ø SCH 40 PVC RISER				
14.0							
14.5							
15.0	END OF OVERBURDEN HOLE @ 14.94m BGS						
15.5							
16.0							
16.5							
17.0							
17.5							
18.0							
18.5							
19.0							
19.5							

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW2D-07
DATE COMPLETED: May 29, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %
15.0	DOLOSTONE-SHALE BEDROCK (SALINA FORMATION), dolomite shale, light grey/dark grey, thin horizontal laminations to wavy beds, fine grained and microcrystalline, argillaceous, gypsiferous, slightly weathered in upper 3 metres, no gypsum apparent in upper 0.7 metres; occasional to frequent gypsum beds/nodules, occasional selenite crystals	185.70		1	64	50
15.5	- highly fractured					
16.0				2	23	0
16.5						
17.0						
17.5	- fracture, moderately weathered, oxizidization present			3	100	44
18.0	- fracture, moderately weathered, 10 degree angle, apparent oxidization - 5.08cm of conglomerate, mudstone gravel size particles interbedded within dolomitic-shale			4	84	45
18.5	- fractured zone inferred (27cm), weathered sub-angular gravel					
19.0	- fracture inferred					
19.5	- gypsum bed (7.5cm), minor shale inclusions			5	100	89
20.0	- gypsum/selenite bed (2.5cm), micro to fine crystalline structure; fracture inferred, slight weathering		96mm Ø COREHOLE			
20.5	- fracture inferred - gypsum (~75%), intermixed with dolomitic-shale, 11.5cm zone			6	100	86
21.0	- fracture, moderately weathered					
21.5	- gypsum bed (6.4cm), minor shale inclusions			7	100	100
22.0						
22.5	- gypsum bed (19cm), minor shale inclusions					
23.0				8	100	100
23.5						
24.0	- gypsum (60-70%), 7.6cm zone					

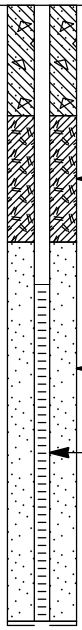
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW2D-07
DATE COMPLETED: May 29, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %
25.0				9	100	100
25.5						
26.0	- fracture - fracture					
26.5				10	100	100
27.0	- gypsum bed (23cm), minor shale inclusions					
27.5	- gypsum (~50%), 8.9cm zone					
28.0	- gypsum bed (91.5cm), minor shale inclusions			11	100	100
28.5						
29.0	END OF BOREHOLE @ 28.96m BGS	171.68				
29.5						
30.0						
30.5						
31.0						
31.5						
32.0						
32.5						
33.0						
33.5						
34.0						



WELL DETAILS
Screened interval:
173.20 to 171.68m AMSL
27.43 to 28.96m BGS
Length: 1.52m
Diameter: 51mm
Slot Size: 10
Material: Sch 40 PVC
Seal:
175.33 to 174.42m AMSL
25.30 to 26.21m BGS
Material: Bentonite Gravel
Sand Pack:
174.42 to 171.68m AMSL
26.21 to 28.96m BGS
Material: No.2 SILICA SAND

Seal:
200.63 to 174.95m AMSL
0.00 to 25.68m BGS
Material: Cement-Bentonite Grout

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW2S-07
DATE COMPLETED: June 1, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	TOP OF CASING TOP OF RISER GROUND SURFACE	201.20 201.13 200.49					
0.5	Please refer to Overburden Stratigraphy Log MW2A-01.						
1.0							
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							
5.5							
6.0			260mm Ø BOREHOLE				
6.5							
7.0							
7.5			PORTLAND BENTONITE				
8.0							
8.5							
9.0			102mm Ø STEEL CASING				
9.5			BENTONITE				

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW2S-07
DATE COMPLETED: June 1, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
10.5			PORTLAND 51mm Ø SCH 40 PVC RISER				
11.0							
11.5							
12.0							
12.5							
13.0							
13.5							
14.0							
14.5							
15.0	END OF OVERBURDEN HOLE @ 14.94m BGS						
15.5							
16.0							
16.5							
17.0							
17.5							
18.0							
18.5							
19.0							
19.5							

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW2S-07
DATE COMPLETED: June 1, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %
15.0	Please refer to Bedrock Stratigraphy Log MW2D-07.	185.55				
15.5						
16.0						
16.5						
17.0						
17.5						
18.0						
18.5						
19.0						
19.5						
20.0			96mm Ø COREHOLE			
20.5						
21.0						
21.5			NO.2 SILICA SAND			
22.0						
22.5			51mm Ø SCH 40 PVC SCREEN			
23.0	END OF BOREHOLE @ 22.86m BGS	177.63				
23.5						
24.0						

WELL DETAILS
Screened interval:
179.15 to 177.63m AMSL
21.34 to 22.86m BGS
Length: 1.52m
Diameter: 51mm
Slot Size: 20
Material: Sch 40 PVC
Seal:

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: MW2S-07
DATE COMPLETED: June 1, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %	
25.0			200.49 to 180.68m AMSL 0.00 to 19.81m BGS Material: Bentonite Gravel Sand Pack: 180.68 to 179.15m AMSL 19.81 to 21.34m BGS Material: No.2 SILICA SAND				
25.5							
26.0							
26.5							
27.0							
27.5							
28.0							
28.5							
29.0							
29.5							
30.0							
30.5							
31.0							
31.5							
32.0							
32.5							
33.0							
33.5							
34.0							

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: OW8D-07
DATE COMPLETED: June 14, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader/B.Iotzov

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	TOP OF CASING TOP OF RISER GROUND SURFACE	199.38 199.32 198.98					
0.5 – 9.5	Please refer to Overburden Stratigraphy Log OW8A-07.		260mm Ø BOREHOLE PORTLAND BENTONITE 102mm Ø STEEL CASING				

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: OW8D-07
DATE COMPLETED: June 14, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader/B.Iotzov

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
10.5							
11.0							
11.5							
12.0							
12.5							
13.0							
13.5							
14.0			BENTONITE PORTLAND				
14.5			51mm Ø SCH 40 PVC RISER				
15.0							
15.5							
16.0							
16.5							
17.0							
17.5	END OF OVERBURDEN HOLE @ 17.68m BGS						
18.0							
18.5							
19.0							
19.5							

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: OW8D-07
DATE COMPLETED: June 14, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader/B.Iotzov

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %
17.5						
18.0	DOLOSTONE-SHALE BEDROCK (SALINA FORMATION), dolostone shale, light grey/dark grey, thin horizontal laminations to wavy beds, fine grained and micro-crystalline, argillaceous, gypsiferous, slightly weathered in upper 3 metres, no gypsum apparent in the first 0.7 metres; occasional to frequent gypsum beds/nodules, occasional selenite crystals; highly fractured to 18.5 m.bgs - mudstone conglomerate bed (40.6cm), gravel size particles interbedded within dolomitic-shale	181.30		1	8	0
18.5						
19.0				2	91	65
19.5						
20.0	- gypsum bed (15.2cm), medium to coarse crystalline, irregular upper and lower contacts		96mm Ø COREHOLE			
20.5	- gypsum bed (14cm) - gypsum (70-80%), fine to medium crystalline structure, shale inclusions, 21.6cm zone			3	83	83
21.0						
21.5	- gypsum (70%), micro to medium crystalline structure, 45.7cm zone					
22.0	- suspect fractured zone (12.8cm), 5 fractures inferred along mudstone beds			4	100	93
22.5						
23.0						
23.5				5	100	95
24.0						
24.5	- fracture					
25.0	- vuggy, partially filled with gypsum, 8.9cm zone			6	100	100
25.5	- vuggy, partially filled with selenite crystals, horizontal, 14cm zone					
26.0	- vuggy					
26.5				7	100	100

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: OW8D-07
DATE COMPLETED: June 14, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader/B.Iotzov

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %
27.5	- gypsum bed (25.5cm), medium to coarse crystalline structure - gypsum bed (8.9cm), medium crystalline structure					
28.0				8	100	100
28.5						
29.0	- gypsum bed (78.7cm), wavy upper contact, occasional mudstone seam, medium crystalline structure		NO.2 SILICA SAND			
29.5						
30.0	- gypsum (90%) interbedded with dolostone, 10.2cm zone		51mm Ø SCH 40 PVC SCREEN	9	100	100
30.5	END OF BOREHOLE @ 30.48m BGS	168.50				
31.0						
31.5						
32.0						
32.5						
33.0						
33.5						
34.0						
34.5						
35.0						
35.5						
36.0						
36.5						

WELL DETAILS
Screened interval:
170.02 to 168.50m AMSL
28.96 to 30.48m BGS
Length: 1.52m
Diameter: 51mm
Slot Size: 20
Material: Sch 40 PVC
Seal:
198.98 to 170.94m AMSL
0.00 to 28.04m BGS
Material: Bentonite Grout Seal
Sand Pack:
170.94 to 168.50m AMSL
28.04 to 30.48m BGS
Material: No.2 SILICA SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: OW8S-07
DATE COMPLETED: June 19, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	TOP OF CASING TOP OF RISER GROUND SURFACE	199.83 199.67 198.98					
0.5 – 9.5	Please refer to Overburden Stratigraphy Log OW8A-06.		260mm Ø BOREHOLE PORTLAND BENTONITE 102mm Ø STEEL CASING				

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: OW8S-07
DATE COMPLETED: June 19, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
10.5			BENTONITE PORTLAND				
11.0							
11.5							
12.0			51mm Ø SCH 40 PVC RISER				
12.5							
13.0							
13.5							
14.0							
14.5							
15.0							
15.5							
16.0							
16.5							
17.0							
17.5	END OF OVERBURDEN HOLE @ 17.68m BGS						
18.0							
18.5							
19.0							
19.5							

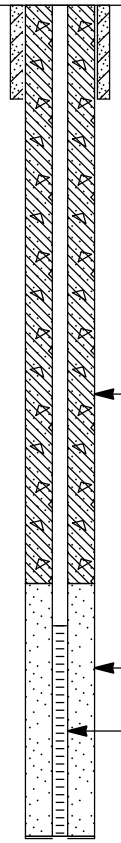
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

PROJECT NAME: EDWARDS LANDFILL
PROJECT NUMBER: 18235
CLIENT: HNSLI
LOCATION: 160 Brooks Rd., Haldimand County, Ontario

HOLE DESIGNATION: OW8S-07
DATE COMPLETED: June 19, 2007
DRILLING METHOD: 6 1/4" HSA/HQ CORING
FIELD PERSONNEL: J.Leader

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. m AMSL	Monitoring Well	RUN NUMBER	CORE RECOVERY %	RQD %
17.5						
	Please refer to Bedrock Stratigraphy Log OW8D-07.	181.30				
18.0						
18.5						
19.0						
19.5						
20.0						
20.5						
21.0						
21.5						
22.0						
22.5						
23.0	END OF BOREHOLE @ 23.01m BGS	175.97				
23.5						
24.0						
24.5						
25.0						
25.5						
26.0						
26.5						



WELL DETAILS
Screened interval:
177.49 to 175.97m AMSL
21.49 to 23.01m BGS
Length: 1.52m
Diameter: 51mm
Slot Size: 20
Material: Sch 40 PVC
Seal:
198.98 to 177.80m AMSL
0.00 to 21.18m BGS
Material: Bentonite Grout Seal
Sand Pack:
177.80 to 175.97m AMSL
21.18 to 23.01m BGS
Material: No.2 SILICA SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

Appendix B
Water Well Records

UTM | 17 Z | 5 9 5 0 5 9 E
| 9 R | 4 7 5 8 0 4 3 N
Elev. | 9 R | 0 6 5 5
Basin | 2 4

4 30L 13W

26 No. 284

ONTARIO

The Well Drillers Act

Department of Mines, Province of Ontario

Water Well Record

County or District Haldimand Tp. N. Cayuga Con IV Lot 25 Pt. Lot

Owner [redacted] Address Cayuga Acres

Date Completed Nov 27, 1947 Cost of Well (not including pump) 2.25 per ft.

Pipe and Casing Record	Pumping Test
Casing diameter(s) 6 1/4	Date
Length(s) of casing(s) 56'	Developed Capacity
Length of screen	Duration of Test
Type of screen	Pumping Rate
Type of pump	Drawdown
Capacity of pump	Static level of completed well 48'
Depth of pump setting	Is well a gravel-wall type?

Water Record

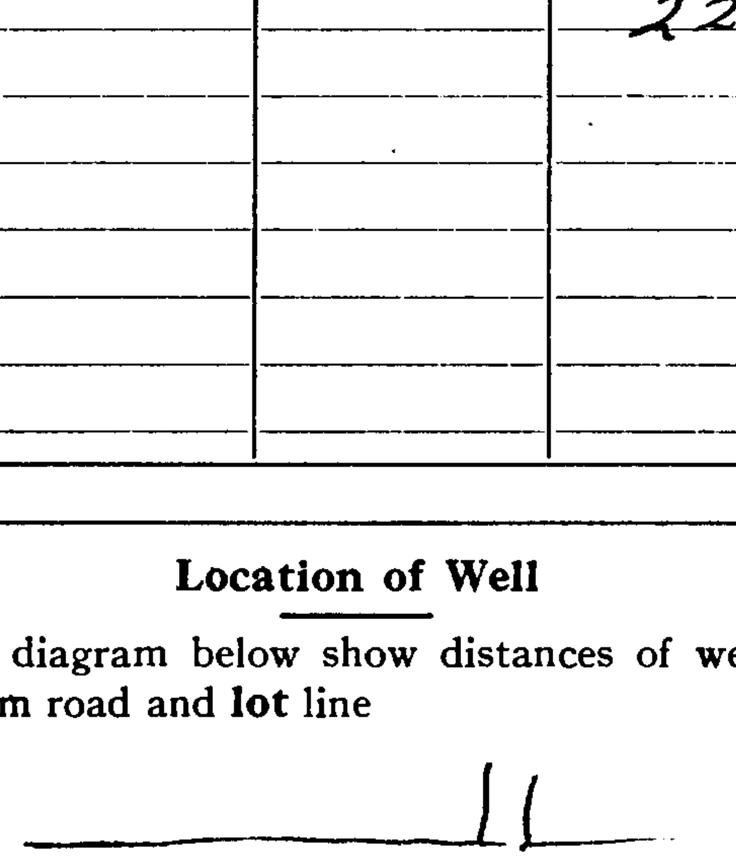
	Depth(s) to Water Horizon(s)	Kind of Water	No. of Feet Water Rises
Kind (fresh or mineral) fresh			
Quality (hard, soft, contains iron, sulphur etc.)			22'
Appearance (clear, cloudy, coloured)			
For what purpose(s) is the water to be used? drinking water and fire protection			
How far is well from possible source of contamination?			
What is source of contamination?			
Enclose a copy of any mineral analysis that has been made of water			

Well Log

Drift and Bedrock Record	From	To
clay	0 ft.	51 ft.
trap rock	51	56
brown lime & shale	56	65'
shale & gypsum	65'	70

Location of Well

In diagram below show distances of well from road and **lot** line



Situation: Is well on upland, in valley, or on hillside?

Drilling Firm C. A. Ricker

Address Canboro

Recorded by Address

Date Licence Number

CSS.58

UTM 17 Z 5 9 4 9 4 9 E
9 R 4 7 5 8 3 6 5 N
Elev. 9 R 0 6 5 0
Basin 2 3

ONTARIO

30L 13W

26 No. 285

The Well Drillers Act

Department of Mines, Province of Ontario

Water Well Record

County or District Haldimand Tp. N. Cayuga Con 11E Lot 25 Pt. Lot

[redacted] Address Cayuga Acres

cluding pump)

Pipe and Casing Record

Casing diameter(s) 6¼"
Length(s) of casing(s) 49'
Length of screen
Type of screen
Type of pump
Capacity of pump
Depth of pump setting

Pumping Test

Date
Developed Capacity
Duration of Test
Pumping Rate
Drawdown
Static level of completed well 49'
Is well a gravel-wall type?

Water Record

Kind (fresh or mineral) fresh
Quality (hard, soft, contains iron, sulphur etc.)
Appearance (clear, cloudy, coloured)
For what purpose(s) is the water to be used? drinking water and fire protection
How far is well from possible source of contamination?
What is source of contamination?
Enclose a copy of any mineral analysis that has been made of water

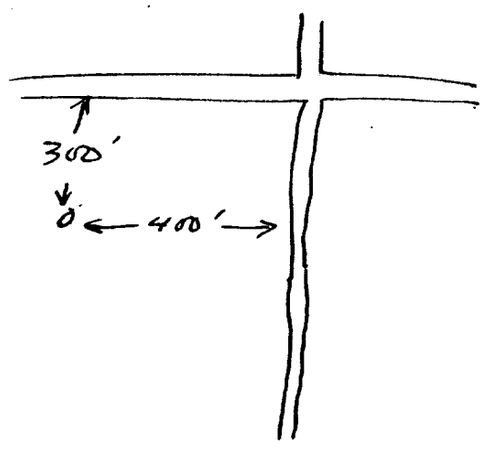
Depth(s) to Water Horizon(s)	Kind of Water	No. of Feet Water Rises
67		18'

Well Log

Drift and Bedrock Record	From	To
clay	0 ft.	28 ft.
gravel	28	32
gravel & hardpan	32	49
brown lime	49	65
shale & gypsum.	65	68
water at 67'		
drilled to 70'		

Location of Well

In diagram below show distances of well from road and **lot** line



1500' North of M.C. tracks.

Situation: Is well on upland, in valley, or on hillside?
Drilling Firm E. A. Ricker
Address Canboro
Recorded by Address
Date Licence Number

CSS.S8

www.ghd.com