# Hydrogeology Study

# Future Solid Waste Disposal Needs Environmental Assessment

## Town of St. Marys

R.J. Burnside & Associates Limited
292 Speedvale Avenue West Unit 20
Guelph ON   N1H 1C4 CANADA

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**R.J. Burnside & Associates Limited**

**Report Prepared By:**


Joy Rutherford, P.Geo.
Senior Hydrogeologist
JR/KH:tp

**Report Reviewed By:**


Kim Hawkes, P.Eng.
Project Engineer

## Executive Summary

The Town of St. Marys (Town) is conducting an Individual Environmental Assessment to review alternative means to manage solid waste for a forty year period. The existing St. Marys landfill Site (the Site) is nearing its approved fill capacity. The approved Terms of Reference eliminate a number of Alternatives to the Undertaking based on technical, financial and environmental criteria. The information presented in this report follows the *Hydrogeological Work Plan* developed after *Expansion of the Existing Landfill* was identified as the preferable Alternative to the Undertaking.

The property that the landfill occupies was originally owned by St. Marys Cement Co. (SMC) and was included in its quarry licence. Prior to the landfill development surficial clay was mined from portions of the Site and the north corner of the Site used to stockpile materials associated with cement production.

The Site was approved as the Town of St. Marys landfill in 1983. Phase I operated from 1984 to 1993 and Phase II/III is the current fill area. The Site is a 37 ha waste disposal Site with an 8 ha landfill area that includes the collection and diversion of recyclable waste, acceptance and transfer of Municipal Hazardous or Special Waste (MHSW) and the composting of leaf and yard waste. The Site has a perimeter leachate collection system (Phase I) and a perimeter system with lateral collector lines below the waste (Phase II/III). The leachate collection system gravity drains to the Town's sanitary sewer.

The study considered the geology and hydrogeology of the On-Site Study Area (the Site) and Study Area Vicinity (1,000 m radius). The study included collection of background data, analysis of operating and monitoring data, and collection of new field data.

The surface of the Site was impacted by industrial activity (quarry) prior to the landfill. By 1978, no part of the Site was in a natural state. The groundwater was also impacted by quarry dewatering. The topography of the Site is a result of the overburden mining, stripping and filling, cement kiln dust stockpiling, realignment of the internal watercourse and landfill construction. The highest elevation is the cement kiln dust stockpile (CKD) and the lowest elevations occur along the watercourse.

On a regional scale, the overburden consists of layers of glacial till separated by inter-till meltwater deposits. The bedrock is limestone and dolostone consisting of the Dundee Formation, underlain by the Lucas Formation of the Detroit River Group. The top 8 to 10 m of bedrock is unsaturated. This is partially attributed to regionally low water levels and partially to quarry dewatering.

The bedrock is a regional water supply aquifer with the Town of St. Marys obtaining its water supply from three bedrock wells northeast of the Site. The Site is not within the municipal Well Head Protection Areas. There are no Significant Groundwater Recharge

Areas on the landfill Site. The SMC quarry north of the landfill and the northeast corner of the landfill Site are mapped as Highly Vulnerable Aquifer. This is due to the removal of the soil by the quarry which exposed the bedrock. The rural residential homes along the west side of Perth Road 123 are supplied by private wells. Most of these are drilled into the bedrock.

The groundwater flow direction in the bedrock is toward the west and northwest. This is the direction of the regional groundwater flow, as well as the location of the North Thames River and the SMC Thomas Street Quarry. The elevation of the River is above the bedrock water level; therefore, there is no groundwater discharge to the river from the bedrock.

The overburden consists primarily of silt and clay glacial till. The thickness varies from 10 m to 20 m due to an upward slope on the bedrock surface from southwest to northeast, as well as removal of soil by SMC. There are no regional overburden aquifers in the vicinity. There are shallow alluvial deposits associated with the river, as well as localized sand seems that may be used by shallow wells. The shallow groundwater flow on the Landfill Site is inward from high points along Perth Road 123 and the cement kiln dust stockpile toward the internal watercourse.

Monitoring wells on the Site have been tested since 1984 and are currently tested twice a year. There is no indication of landfill impact to the bedrock aquifer. This is due to the effectiveness of the leachate collection systems and the Site hydrogeology. Three shallow wells located on the west side of Phase II/III have elevated chloride concentrations. These wells are screened in a sand seam in the till that extends below part of Phase II/III. The wells are downgradient of Perth Road 123 and upgradient of the landfill, therefore road salt is a possible source. However, in 2015, elevated concentrations of boron and iron were noted in a monitoring well. The wells were investigated as part of on-going operations and monitoring of the Site.

Water samples collected from the internal watercourse show similar water quality between upstream and downstream sampling stations. This indicates no landfill impact on the watercourse.

Five preliminary landfill concepts were developed in order to assess the Alternative Methods. These included vertical expansion, horizontal expansion, a new waste footprint and combinations thereof. Each alternative was evaluated according to how Site alterations would impact the groundwater and surface water. Mitigation measures were identified for each potential impact. The impact and associated mitigation measures were ranked according to the magnitude. The rankings were:

- Minor potential impact - requires monitoring with potential for future mitigation;
- Low potential impact - requires site feature alterations with continued monitoring;
- Medium potential impact - requires enhanced engineering with monitoring; or
- Major potential impact - requires substantial engineering measures.

The purpose of outlining the mitigation measures was not to provide all the possible outcomes, but to evaluate the magnitude of the impact by the scale of the mitigation measures that may be needed. The Alternative Methods were then ranked from least impact (fewest major mitigation measures required) to most impact (major mitigation measures required).

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# 1.0 Introduction

## 1.1 Background

The Town of St. Marys (Town) is conducting an Individual Environmental Assessment under the *Environmental Assessment Act* to review alternative means to manage solid waste over a forty year planning period. The existing St. Marys landfill Site (the Site), Environmental Compliance Approval (ECA) Number A150203, is located at 1221 Water St. South, St. Marys, Ontario. The 37 ha Site was part of a former clay borrow pit that was used by St. Marys Cement in cement manufacturing and contains an approved fill area of 8 ha. The landfill is nearing its approved fill capacity and a new means to manage post-diversion solid waste is required. The location of the existing landfill is shown on Figure 1 Site Location and Figure 2 Regional Location.

Terms of Reference (TOR) were approved by the Minister of the Environment and Climate Change on December 29, 2014. The TOR laid out a strategy for completing the EA. The TOR also included a summary of pre-planning work which had been done to eliminate a number of *Alternatives to the Undertaking*. Those *Alternatives* which were eliminated due to a variety of technical, financial and environmental criteria included:

- Do Nothing;
- Energy From Waste;
- Enhance Waste Diversion; and
- Construct a new landfill site at a new location in the Town.

Further assessment was conducted to evaluate transporting waste to a landfill in another jurisdiction or expanding the current landfill Site. This assessment completed in 2015 eliminated waste *Export to Another Jurisdiction* from further consideration.

Work Plans, a requirement of the TOR following identification of Expansion of the Existing Landfill as the preferable *Alternative to the Undertaking*, were prepared in July 2015. The Work Plans provide methodologies for completing the evaluation of *Alternative Methods for Carrying out the Undertaking*. Work Plans were prepared for the following disciplines:

- Terrestrial and Aquatic Ecology;
- Geology and Hydrogeology;
- Socio-Economic Environment;
- Air Quality; and
- Archaeological and Cultural Heritage.

The information presented in this report follows the framework provided by the *Hydrogeological Work Plan*.

## 1.2 Study Purpose

If it is decided to expand the existing landfill, the Undertaking will be defined as:

> *The expansion of the St. Marys landfill in order to provide the necessary capacity to fulfill the Town's post-diversion solid waste disposal needs for the next 40 years.*

The purpose of this study is, therefore:

> *To evaluate a variety of Alternative Methods for expanding the St. Marys landfill in order to fulfill the Town's post-diversion solid waste disposal needs for the next 40 years.*

## 1.3 Alternatives to Be Assessed

Several design options or *Alternative Methods* were considered with respect to landfill expansion. *Alternative Methods* are technically, economically and environmentally feasible ways of *Carrying out the Undertaking*. For this Study, the *Alternative Methods* included various design options associated with the expansion. Increased waste diversion will be considered for the preferred *Alternative Method* but will not constitute part of the undertaking. The *Alternative Methods* to be reviewed are identified in Table 1-1.

**Table 1-1: Alternative Methods for Carrying Out the Undertaking**

| Alternative Methods | | Description |
|---|---|---|
| 1 | Vertical expansion of the existing landfill | This *Method* involves an expansion in the vertical direction within the existing footprint of the landfill. |
| 2 | Horizontal expansion of the existing landfill | This *Method* involves an expansion outside of the existing landfill footprint. |
| 3 | A combination of vertical and horizontal expansion | This *Method* would involve partial vertical expansion along with some horizontal expansion of the landfill footprint, basically a mixture of *Methods* 1 and 2. |
| 4 | Development of a new landfill footprint | This *Method* involves closure of the existing 8 ha footprint and development of a new landfill footprint elsewhere on the 37 ha Site. |
| 5 | Vertical expansion plus a new footprint | This *Method* is a combination of *Methods* 1 and 4. |

## 1.4 Study Area

Two specific study areas were identified for study and are shown on Figure 3 Study Areas. These were:

- On-Site Study Area - includes all lands associated with the existing St. Marys landfill, the 37 ha site located as 1221 Water St. South, St. Marys; and
- Study Area Vicinity - all lands within a 1,000 m radius of the On-Site Study Area.

## 1.5 Study Scope

The scope of this study involved setting out the known characteristics of the On-Site Study Area and the Study Area Vicinity, then assessing the Alternative Methods in light of the following considerations.

What would be the potential negative effects on:

- groundwater quality, quantity and movement?
- surface water quality, quantity and movement?
- surface or ground water from accidental spills or releases to the environment (e.g., leachate)?
- soil erosion or sedimentation on or off site?

## 1.6 Study Timeframe

The EA considered the potential effects over two time periods:

- Construction and operation of the expanded landfill:
  - Construction is currently anticipated to commence in 2018; and,
  - Operations would then occur over a 40 year period, ending around 2058.
- Closure and post-closure of the landfill, including possible impacts due to climate change.

# 2.0 Site History

## 2.1 Site Development

The property that the landfill occupies was originally owned by St. Marys Cement Co. (SMC) now a wholly-owned subsidiary of Votorantim Cimentos based in Sao Paulo, Brazil. Founded in 1912, SMC offices and the cement plant are still located north of the landfill in an area that was formerly a quarry (see Figure 4 Regional Aerial Photograph).

Prior to the development of the landfill, the property was licenced by the Ministry of Natural Resources as part of the SMC quarry. Historical aerial photographs show that soil was stripped from the north end of the Site and possibly some rock quarried. The surficial clay was also mined on portions of the Site for use in the cement production. More recently, the north end of the Site was used to stockpile soils and materials associated with cement production.

Appendix A contains photographs that show the Site from 1955 to 2013. The table below describes the main activities or changes to the main features.

**Table 2-1: History of the Site through Aerial Photographs**

| Year | Description |
|---|---|
| 1955 | - agricultural fields<br>- water course enters Site in the current location but bends north (not northwest as it does now) and appears to outlet at the southwest corner of the quarry<br>- swale in the field west of the watercourse appears to drain east into the watercourse<br>- area north of landfill boundary stripped of overburden, possibly rock quarried<br>- several elevations (lifts) and rock faces visible on quarry property |
| 1963 | - still primarily agricultural field<br>- a shallow lift of quarrying has moved into northeast corner, deeper lifts are still north of landfill boundary<br>- watercourse in same location<br>- stockpile between quarry face and watercourse appears to be overburden stripped from the quarry north of the stockpile |
| 1978 | - excavations and earth moving visible over entire Site (clay mining)<br>- no agricultural fields remain<br>- a large stockpile is present in northeast corner (assumed to be cement kiln dust), partially on the previous stockpile (overburden) and partially on the shallow edge of the quarry<br>- watercourse has been re-routed<br>- water in quarry ponds north of landfill |

| | |
|---|---|
| 1980 | - appears to show extent of clay mining on landfill Site<br>- poor photo quality |
| 1989 | - clay pit face visible along full south boundary of Site<br>- landfilling is occurring on Site, Phase I is visible<br>- cement kiln dust pile is visible |
| 2000 | - Phase I completed<br>- Phase II/III landfilling in east half of footprint<br>- minimal change east of watercourse since 1989<br>- landfill stormwater management ponds visible |
| 2006 | - Phase II/III continues landfilling in east half of footprint<br>- vegetation starting to develop on kiln dust stockpile |
| 2013 | - Phase II/III east half covered, landfilling in west half of footprint<br>- increasing vegetation cover along watercourse and on kiln dust stockpile |

## 2.2 Landfill Construction

In 1979, the Town began investigating the feasibility of using a portion of a former clay pit owned by SMC as a municipal landfill site (CRA, 1982). The 16.2 ha property was smaller than the current Site. The property was leased from SMC. At the time, the long-term end use planned for the Site was to become part of a greenbelt buffer zone surrounding the SMC plant (CRA, 2011).

A Hydrogeologic Investigation was completed with a report issued in November 1982. The Site was approved in 1983, landfilling began in December 1984 in the area known as Phase I. The proposed bottom elevation was 315 m above mean sea level (amsl) (CRA, 1982 Plan 2). Phase I was completed and finished with final cover in the summer of 1993 (CRA, 2012).

A second Hydrogeologic Investigation was completed in November 1992 for Phase II/III. Phase II/III was divided into 8 stages, which corresponded with the development of the leachate collection system from east to west. Stage 7 was constructed in the fall of 2010 and began receiving waste in December 2010. A weigh scale was installed in 2012 to assist in operations and filling control. Stage 8 was constructed in late summer 2013 and began receiving waste in September 2013 (Burnside, 2013). This is the current cell.

The Town purchased the property from SMC in 2009. ECA No. A150203 dated June 24, 2010 (amended 2013 and 2015), reflects Site ownership by the Town and incorporated additional land from SMC to bring the Site to its current size. The Site is now a 37 ha waste disposal Site with an 8 ha landfill area. The ECA also approved the Site for the collection and diversion of recyclable waste (including WEEE), acceptance and transfer of Municipal Hazardous or Special Waste (MHSW), and the composting of leaf and yard waste.

Phase I had a volume of 104,000 $m^3$ and Phase II/III had a maximum volume of 276,000 $m^3$. The maximum waste volume that can be landfill per year is 20,000 $m^3$. ECA Notice No. 2 dated November 16, 2015 increased the approved volume of Phase II/III to a maximum of 291,850 $m^3$ for an interim period ending September 30, 2016. ECA Notice No. 3 dated September 6, 2016 approved a Phase II/III volume of 307,950 $m^3$ for a period ending September 30, 2017.

The EA Terms of Reference (December 2013) determined that the disposals capacity required for the Town for a 40 year planning period would be 708,000 $m^3$. As discussed in the EA Document, this has been confirmed in accordance with the TOR.

## 2.3 Leachate Collection System

The Phase I leachate collection system is a perimeter system consisting of perforated collector pipes connected between manholes. It was installed as a contingency system to control mounding within the waste.

The Phase II/III collection system incorporates perimeter collectors as well as lateral collectors passing beneath the waste. The system was extended as each new Phase was constructed. Both the perimeter system of Phase I and the underdrain system of Phase II/III restrict the movement of leachate beyond the landfilling footprint and control the leachate mound within the waste. The location of the leachate collection systems in Phase I and Phase II/III are shown Figure 5 Site Plan.

Initially, leachate from Phase I was collected in a holding tank near MH1 (PH1). Leachate from Phase II/III was collected in a holding tank near MH3. In 1997, a sewer was installed to gravity drain the leachate directly from the leachate collection systems to the Town's sanitary sewer system. The Phase I leachate holding tank was decommissioned in 2008. The Phase II/III leachate holding tank was used to connect the Phase II/III leachate collection system to the gravity sewer. It contains a valve to shut off leachate flow for maintenance of the sewer line. There is no leachate storage on site.

## 3.0 Study Methods

The study considered the geology and hydrogeology of the On-Site Study Area and Study Area Vicinity. Preliminary landfill concepts were developed in order to assess the Alternative Methods. Alternative methods included vertical expansion, horizontal expansion, a new waste footprint, and combinations thereof.

The Hydrogeological Work Plan was based on potential impacts from these alternatives. For example, a vertical expansion could add to the contaminant loading of the existing footprint. A leachate collection system that controls the mounding within the waste could be used to reduce leachate migration from the waste and minimize impact on groundwater flow direction. A horizontal expansion that increases the waste footprint could shift the contaminant load to a different part of the Site. This could create impacts downgradient and downstream of the new footprint and alter the location of the downgradient monitoring boundaries.

The EA Terms of Reference (December 2013) determined that landfilling capacity required for the Town for a 40 year planning period would be 708,000 $m^3$. To achieve this volume, preliminary concepts indicate that a combination of vertical and horizontal expansion may be required; vertical expansion alone may not provide the necessary capacity.

Components that were considered in assessing the expansion concepts included:

- Regional geology and hydrogeology - aquifers and water use;
- Site geology - soil depth, texture and stratification, bedrock depth and characterization; and
- Site hydrology - occurrence and movement of water across the Site including groundwater & surface water interaction.

### 3.1 Background Data Collection

A substantial amount of data already existed for the landfill Site, although not all of it was readily accessible. The Site is not a green field and has been used for resource extraction, production, and landfilling for over 50 years. In addition, adjacent properties have also been used for resource extraction and monitoring, and for individual homes. Data from various sources was located and incorporated into an updated Site conceptual model. Data sources are listed below, and individual references are provided at the end of this report.

Background data sources included:

- Published geology and hydrogeology maps and reports;
- Landfill hydrogeological investigations and design documents (1982 and 1992);

- Landfill monitoring reports (2010 to 2015);
- Aerial photography and satellite imagery;
- Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA);
- Ontario Ministry of Natural Resources and Forestry (MNRF);
- Ontario Ministry of the Environment and Climate Change (MOECC);
- Thames-Sydenham and Region Source Protection;
- Upper Thames River Conservation Authority;
- Environment Canada;
- Town of St. Marys; and
- St. Marys Cement Co. (SMC).

## 3.2 Field Data Collection

The need to collect additional field data to fill in data gaps was acknowledged. This data collection began in the late fall of 2015 following the approval of the TOR and the first public information centre that allow input from the community. However, due to the nature of groundwater investigations and the freezing of surface water during the winter of 2015/2016, the collection of field data is ongoing and will continue for some time (approximately 6 to 15 months depending on the type of data). The new data will be added to the knowledge data base for the Site and used for potential landfill design, EPA application, and for the ongoing monitoring of the existing Site.

**Test Pits**

Test pits were excavated east of the existing Phase I and Phase II/III landfill areas, east of the watercourse and around the cement kiln dust pile. The purpose of the test pits was to determine the surficial soils beyond the current landfill footprint. The pits were excavated using a tire-mounted backhoe. Observations on soils and water occurrence were recorded. Soil samples were collected and retained. The locations of the test pits are shown on Figure 5 Site Plan.

**Drive Point Piezometers**

Three drive point piezometers were installed along the watercourse. The locations are shown on Figure 5. The purpose was to provide water level data below the watercourse. The drive points were installed beside the existing surface water sampling stations, with the exception of the upstream station (SP1-10). The channel is wider at SP1-10 and the water tends to pond. The drive point (DP1) was installed further west where there is measurable flow in the channel.

The drive point piezometers consisted of a 20 mm diameter, stainless-steel screen with a drive tip at the bottom. The screen is 0.3 m long and is coupled to a length of 20 mm diameter steel pipe. The piezometers were driven into the bottom of the watercourse channel until the bottom of the screen was approximately 0.7 m below the base of the channel. A fourth piezometer was to be driven deeper into channel at the location of SP2-93 and DP2. However, the drive tip met refusal at 0.9 m, assumed to be dense native silt/clay till. Continuing to drive the tip into the dense till bent the steel pipe and screen without obtaining any more depth. The piezometer was removed.

### Existing Non-Monitoring Wells

Existing wells were identified that are not part of the monitoring program (non-monitoring wells). These wells, on the landfill and on adjacent properties, provide additional geology and water level data relevant to this assessment. Three wells were found in the cement kiln dust stockpile (MW04-1, MW04-2 and MW04-3) and a fourth well (a bedrock well) was located east of Phase II/III (MW04-4). The locations are shown on Figure 5. The wells were originally installed for SMC; however, SMC was unable to provide well logs. Burnside measured the depths, elevations and water levels in December 2015.

Another well has been located at the north property boundary. This is a 42 m deep, 150 mm diameter steel cased well. It was likely installed by SMC when they owned the property; however, they have not been able to provide a borehole log for this well. Likewise, the well is not in the MOECC Well Record database. The depth and elevation were measured by Burnside. The depth of the well suggests that it is completed in bedrock. Water levels are also being measured.

### Water Levels

The Work Plan stipulates monthly water levels be measured on Site for a minimum of six months. These water level events are in addition to the water levels measured as part of the current monitoring program. Water levels are measured in the monitoring wells, in the non-monitoring wells, in the drive points and at the surface water stations. Water levels were measured on December 14, 2015, March 8, March 29, April 27, May 31, June 29, July 27, and October 4 of 2016. Levels were not measured in January or February 2016 as surface water and shallow groundwater installations would have been frozen. Water levels at all measuring points (monitoring and non-monitoring) continued to be measured during the spring and fall monitoring events.

### Automatic Water Level Data Loggers

Automatic loggers were installed in three wells to collect continuous water level measurements. The purpose is to collect data on seasonal variations and well response to rainfall events and external pumping.

The wells instrumented were MW04-4 (bedrock), OW5-84 (deep overburden) and OW8B-10 (shallow overburden near bedrock well). The Work Plan stipulates that this data continue to be collected for up to 15 months. The initial frequency is hourly but may be reduced depending on variability of water levels. The data was downloaded monthly coinciding with the manual monthly water level measurements and continues semi-annually to coincide with monitoring events. This data collection is on-going.

**Surface Water Flows**

Surface water flow rates are measured at the downstream surface water station (SP3) for the Site's annual monitoring program. The Work Plan required additional measurements upstream (near DP1). The first measurements that included both stations were made on March 29, 2016. The flow rates upstream and downstream were measured monthly through the spring into summer (March to July) in conjunction with the monthly water level measurements.

**Geomorphic Study of Watercourse**

A detailed assessment of the existing watercourse was completed by Parish Geomorphic[1] during the summer of 2015. The study was completed as part of the Ecological Work Plan.

**Elevation Survey**

All test pits, drive points and non-monitoring wells were surveyed to establish locations, ground elevations and measuring point elevations.

**Installation of New Groundwater Wells**

The Work Plan included a program of drilling and new well installation. The reason for including drilling at this early stage was the lack of data available for the Site. When the Work Plan was prepared, borehole logs and well details were not available for most of the monitoring wells in the current monitoring program. There were no records for the previous landfill investigations and no wells on the east side of the watercourse.

Additional efforts by the Town in the fall of 2015, resulted in all of the logs from previous Site work and monitoring installations to be made available. In addition, SMC was able to provide information on their wells, excavations and dewatering. Wells were located in the cement kiln dust stockpile and accessed. This information allowed for the creation of Site cross-sections and a better understanding of the Site conceptual model.

Depending on the Alternative Method of expansion for the landfill, construction could occur over a substantial part of the Site. There was a possibility that the watercourse

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[1] As of 2016, Parish Geomorphic is now referred to as Matrix Solutions Inc.

would have to be relocated. In addition, Site operational areas may have to be relocated, as could the stormwater control features. Several existing monitoring wells may need to be decommissioned and replaced. Therefore, new wells located to provide useful data would likely be endangered by Site construction in the near future.

In December 2015, a decision was made to defer the drilling program until later in the approval stage. A call was made to the MOECC to discuss this alteration to the Work Plan. Burnside suggested that delaying installation until the configuration of Site facilities had been determined would result in a better monitoring network. However, one new well was added in November 2016 following additional discussions with the MOECC. This well, OW36, was installed downgradient of the Phase II/III fill area.

## 3.3 Data Analysis and Existing Conditions Review

All of the data collected to this point has been analyzed. In addition, the geologic data was used to develop cross-sections of the Study Area Vicinity and the On-Site Study Area, and update geology and groundwater mapping.

At this point, the data has been analyzed to identify knowledge gaps and to determine if the new data significantly changes the conceptual model. Significant knowledge gaps or changes to the conceptual model may impact the selection of alternatives or the design of the alternatives.

The analysis considered the following:

- Occurrence of surficial shallow sand or gravel in the potential footprint;
- Depth and character of till above the bedrock;
- Depth to water (perched conditions);
- Shallow groundwater movement across a potential landfill area;
- Influence of the watercourse on shallow groundwater movement;
- Potential for landfill contaminants to reach the watercourse;
- Potential for landfill contaminants to reach the bedrock;
- Leachate production and collection;
- Potential for mutual interference with licenced aggregate operations; and
- Characteristics of the existing cement kiln dust stockpile.

# 4.0 Existing Conditions

## 4.1 Regional Setting

As shown on Figure 2, the St. Marys Landfill Site is located in the southwest corner of the Town of St. Marys. The Site is approximately 2.4 km south of the downtown area on Water Street South (which becomes Perth Road 123). Between the Site and the Town's residential/commercial core is the SMC Plant, several former quarries and a recreational area (tennis courts and supervised swimming in one of the abandoned quarries).

The SMC owns the land surrounding the north, east and south sides of the Site (see Figure 4). The mined out rock quarry and ponds within which the cement plant is located, is directly north of the Site.

Mined-out clay pits east of the Site are currently used for stockpiling raw materials and waste materials produced in the cement-making process. Beyond this disturbed area is a small agricultural field and industrial land.

The area south of the Site is licenced for aggregate resource extraction but is currently under agricultural use. The area west of the Site (between Perth Road 123 and the North Thames River, has been developed into a strip of low density, rural residential properties. There is also a residence on a small block of land between Water Street South and the Site’s western property boundary (see Figures 4 and 5).

## 4.2 Regional Geology

### 4.2.1 Topography and Drainage

Regionally, the ground surface slopes downward from east to west. In the Study Vicinity Area (within 1,000 m of the Site), ground surface elevations range from less than 295 metres above mean sea level (m amsl) adjacent to the Thames River to approximately 325 m amsl adjacent to the landfill Site. Elevations rise to 330 m amsl east and south of the landfill.

The North Thames River lies approximately 300 m northwest of the Site limits. The North Thames River is a major watercourse formed as a spillway by glacial meltwaters from the ice lobe that created the Mitchell Moraine northwest of the river. The Site is within the Upper (North) Thames River Drainage Basin. The North Thames flows south to London and then southwest where it discharges to Lake St. Clair. Locally, the river flows in a southwesterly direction from St. Marys.

There is an unnamed watercourse that flows through the landfill Site. It has a relatively small drainage area of approximately 600 ha. This small watershed is bounded to the north and east by Trout Creek which flows westward through the Town and joins the North Thames River north of Queen Street (see Figure 2). To the south is Gregory

Creek that flows south and west. To the west are a number of small creeks that flow northward directly to the North Thames River.

### 4.2.2 Overburden

The surficial geology of the area is shown on Figure 6 Surficial Geology. The regional overburden consists of successive glacial till deposits. Glacial till is unsorted material deposited in direct contact with the ice sheets that covered large areas of the continent. This type of soil contains varying amounts of clay, silt, sand, and gravel, as well as cobbles and occasional boulders. Where there is more than one layer of till, each layer marks the advance of progressively younger ice sheets (therefore deeper layers are older).

The oldest till, which rests on the bedrock surface over a large part of Southern Ontario, is the Catfish Creek Till. There are no outcrops of this till mapped in the vicinity of the landfill because it has been buried by younger tills. Catfish Creek Till is an olive to buff stony sandy to silty till. It is characteristically hard and often referred to as hardpan in drill logs (Karrow, 1977). Karrow reported a silt till between the bedrock and the Catfish Creek Till in an exposure at the St. Marys Cement old quarry south of St. Marys. This till may be older than the Catfish Creek.

The surficial geology map (Figure 6) shows small outcrops of a clayey silt till south of St. Marys. It is thought to be younger than the Catfish Creek Till but may be quite local and not present at the landfill.

The dominant surficial till east of the North Thames River is a sand-silt till (Sado and Vagners, 1975). It may correlate to the Tavistock Till north of St. Marys. The Tavistock Till is a gritty clayey silt till. Near Wildwood Lake it is approximately 14% clay, 58% silt and 28% sand.

The dominant surficial till west of the North Thames River is a clayey silt till that correlates to the Rannoch Till. It is not found in the vicinity of the landfill.

The large continental ice sheets alternated between advances and retreats. Advances were usually marked by the deposition of till and the retreats by water sorted deposits carried from the ice by the meltwater. Therefore, the various layers of till may be separated by lenses or seams of gravel and sand, silt and clay. This type of soil can be highly sorted and may consist of only sand or only clay. These inter-till deposits can be small and isolated or significant and regional. One such significant deposit is the Wildwood Silts located near Wildwood Lake approximately four kilometers east of the Site. These are a thick lacustrine sequence of stratified silts (several tens of feet) often overlain by sand and minor gravel.

The most recent deposits lie on top of the till southwest of the Site. Meltwater from the last ice advance left gravel deposits along the Thames River channel and a large area of sand south of the River and west of Perth Road 123. There is a small area between the sand deposit and the Site mapped as lacustrine (sand, silt and clay). This extends onto the western part of the Site and was likely the source of the mined clay. Most of the Site is mapped as "Man-made" as the Site had already been disturbed by human activity before 1973-1974 when the mapping took place.

The various deposits that may make up the overburden within the vicinity of the Site are summarized below. The order is from oldest (lowermost) to youngest (uppermost).

1. Possibly a local clay or silt till directly overlying bedrock that may be the oldest local till.
2. Catfish Creek Till, a regionally extensive stony sandy silt till that is very hard (hardpan) generally considered to be the oldest regional till.
3. Clayey Silt Till, local, probably younger than the Catfish Creek till (outcrops south of the Site and may or may not be present at the Site).
4. Inter-till deposits associated with meltwater, possibly related to the Wildwood Silts.
5. Tavistock Till, regional, a gritty clayey to sandy silt till that occurs extensively at the surface south and east of the North Thames River.
6. Surficial glacio-lacustrine and glacial outwash deposits associated with last meltwater event.

Drift thickness mapping (Sado and Jones, 1980) indicates that the overburden in vicinity of the Site ranges from 10 to 15 m thick (north of the Site) to 30 m thick (south of the Site). This mapping was based not only on MOECC water well records, but on the numerous geotechnical boreholes drilled on SMC properties.

Three cross-sections were constructed through the Study Area Vicinity using geologic data from the MOECC water well records, from deeper boreholes on the landfill Site and from information provided by SMC. The locations of the wells and cross-sections are shown on Figure 7, Regional Topography and Cross-Sections. The MOECC well records are summarized in Appendix B. The monitoring well and borehole logs for the landfill Site and SMC properties are contained in Appendix C. The MOECC wells were not field checked, however the UTM coordinates were checked against the location sketch provided on the original well record. Table B1, Summary Table of Wells on Figure 7, notes four wells that are believed to have incorrect UTMs and have been removed from Figure 7. Three records appeared to be on the wrong side of Water Street (i.e., UTM indicated east side on landfill or SMC properties and sketch indicated west side of Water Street). The fourth record was from Lambton County.

The Regional Cross-Sections (Figures 8, 9 and 10) show that the overburden is primarily glacial till (or hardpan) overlying the bedrock. Isolated seams of silt, sand and gravel do occur within the till and may mark the division between till sheets. Most of these seams occur in monitoring wells or boreholes on the Site. This may be the result of the detail of logging that was conducted on cores taken at the Site. Such small seams may have also occurred in the water wells beyond the Site, but where not considered significant enough to log.

The sections show that the overburden thickness is approximately 10 to 15 m north and east of the Site (B-B' and C'C') and 30 m south and west of the Site (A-A' and C-C') as observed on the drift thickness mapping.

### 4.2.3 Bedrock

The bedrock geology of the area is shown on Figure 11 Bedrock Geology. The study area is underlain by two bedrock formations. The youngest is the Dundee Formation. It is a grey to tan medium to thickly-bedded, fossiliferous limestone and minor dolostone. Bituminous partings are common and oil staining occurs in more porous fossiliferous beds and along fractures. Chert nodules are locally abundant.

The Dundee Formation is underlain by the Lucas Formation of the Detroit River Group. The Lucas Formation consists of thin to medium-bedded, light-brown to grey-brown, fine crystalline, poorly fossiliferous, limestone and dolostone. At the St. Marys quarry exposed Lucas Formation is characterized by laminated limestone (Armstrong and Carter, 2010). The bedrock mapping (Figure 11) indicates that in the south part of the landfill Site, the Dundee Formation is absent, and the overburden lies on the Lucas Formation.

Regionally, the surface of the bedrock slopes downward from east to west. This can be seen in the mapping completed for the 2003 Perth County Groundwater Study (Waterloo Hydrogeologic 2003, Figure 2.17). Selected mapping from this report are included in Appendix D. The bedrock surface in the St. Marys area is approximately 300 m amsl.

The Cross-Sections (Figures 8, 9 and 10) show more local variation in the surface of the bedrock. On Sections A-A' and B-B' the bedrock elevation rises to the north and east. Figure 12 shows the topography of the bedrock around the Site constructed from well records, landfill Site logs and SMC logs. It shows the downward slope on the bedrock surface from east to west. This is consistent with more regional mapping that shows a general east to west slope with local variations. Figure 12 also shows a small valley in the bedrock surface south of the Site.

## 4.3 Regional Hydrogeology

Previous Site investigations reported that there were no regional overburden aquifers in the vicinity of the Site, citing the Thames River Basin Study (MOE, 1981). The MOE study did map localized occurrences of a deep overburden aquifer north of St. Marys and an intermediate aquifer south of Highway 7 (Elginfield Road). Overburden aquifers were mapped mainly along the major water courses and as isolated areas.

Mapping of the water table for the Perth County Groundwater Study (Appendix D, Figure 2.21) shows a regional water table sloping downward from east to west; however, flow along major rivers is toward those rivers. Therefore, in the St. Marys area, flow in the overburden is toward Trout Creek and the North Thames River. The general water table elevation in the St. Marys area is in the 310 m to 320 m range.

The same study mapped the bedrock water levels to show the regional flow in the bedrock is also from east to west (Appendix D, Figure 2.22). The bedrock water level in the St. Marys area is about 300 m amsl. When this water level is compared to the elevation of the top of the bedrock it appears the water level is below the bedrock surface around St. Marys and over the western side of Perth County (Appendix D Figure 2.23). This is also evident on the Regional Cross-Sections where the well records report static water levels below the top of the bedrock surface.

The higher water level in the overburden compared to the bedrock means that regionally, water movement is downward with groundwater in the bedrock being recharged from the overburden.

The limestone and dolomite bedrock of the Dundee and Lucas Formations form the regional water supply aquifer(s). The Town of St. Marys obtains its water supply from three bedrock wells located northeast of the Site. Map E-1 and Map E-2 in Appendix E are maps created by the Thames-Sydenham Source Protection Region for Upper Thames Source Water Protection Planning. The maps show the locations of the municipal wells and the associated Well Head Protection Areas (WHPA) A to C. Each well has Protection Areas associated with travel time of groundwater to each well. These areas are also north and east of the Site and outside of the Study Area Vicinity (1,000 m offset from Site property limits).

An additional WHPA-E was delineated for Wells 1 and 3 as these wells were assessed as GUDI wells (Groundwater Under Direct Influence of surface water). Map E-2 shows the extent to the WHPA-E which includes surface water features upstream of the wells. The landfill Site is located downstream of St. Marys and is not within the WHPA-E.

The Planning Policy for *New Prescribed Instruments Related to Moderate and Low Threats* including waste management are as follows:

*3.03 To reduce the risk to municipal drinking water sources from new activities that would be subject to one or more Prescribed Instruments and located in areas where the activity would be a moderate or low drinking water threat, the province should consider incorporating terms and conditions. These terms and conditions, when implemented, should manage the activity such that it does not become a Significant Drinking Water Threat. Where appropriate these terms and conditions should reduce the risk.*

In other words, in issuing an ECA for an expanded landfill the policy states that the MOECC should consider the type of the threat and include appropriate approval conditions to reduce the risk that may be presented by the proposed land use.

Map E-3 shows areas of Significant Groundwater Recharge (SGWR). In the St. Marys area, the SGWR areas are generally the same as those mapped as surficial sand or gravel on Figure 6. Within the Study Area Vicinity, this includes surficial lacustrine sand above the till and the gravel along the Thames River. The sand deposits south of the Site are likely separated from the bedrock by the underlying till, and therefore, the recharge is local and shallow. There is no significant recharge on the landfill Site as the surface soils are primarily clay and glacial till.

Map E-4 shows areas of highly vulnerable aquifers (HVA). These are areas where an aquifer is close to or exposed at the ground surface. Human activities in these areas could impact the aquifer, potentially impacting wells that rely on the aquifer. The quarry sites both north of the landfill (SMC plant) and the Thomas Street Quarry west of the landfill are mapped as HVA. This is because the surficial soil has been removed and the bedrock has been exposed. Because of the quarry activity and dewatering, groundwater is discharging into the quarries, containing human impact to the quarries. This will reverse if dewatering ceases and the water level in the quarries is allowed to return to the natural water table.

The Town of St. Marys supplies water to town residents; however, there is a strip of rural residential along the west side of Perth Road 123. These homes are supplied by private wells. A private well survey for the 1982 Hydrogeology Investigation identified four dug wells on the west side of Perth Road 123. These wells were north and west of the landfill and varied from 5 m to 13 m deep. The remainder of the local private wells were completed in the bedrock. As a result of this survey, five wells (the 4 dug wells and one drilled well) located west of the landfill were added to the monitoring program. The wells are shown in Table 4-1.

**Table 4-1: Shallow Private Wells**

| 1982 Hydrogeology Investigation | | Current (2016) Status | | |
|---|---|---|---|---|
| **Well Reference** | **Type** | **Drilled Replacement** | **MOECC Well No.** | **Well Reference** |
| #25 C Hall | Dug | 2011 | 7175685 | PW1 |
| #26 D Riordan | Dug | | | PW2 |
| #3 A Riordan | Drilled (1973) | | 5002038 | PW3 |
| #27 W Heard | Dug | 1996 | 5004319 | PW4 |
| #24 M Cubberly/McCurdy | Dug | 1988 | 5003434 | PW5 |

A follow up survey for the 1992 Hydrogeology Investigation reported that one of the dug wells had been replaced by a drilled bedrock well (5003434). Since that time, two more of the dug wells have been replace by drilled bedrock wells (5004319 and 7175685). The one remaining dug well (PW2) and the four drilled wells are used for the current monitoring program to provide background data on the water quality.

The dug well, PW2, supplies a house on the east side of Perth Road 123 north of the landfill. According to the 2012 Monitoring Report, this well has a ground elevation of 321.54 m amsl, a bottom elevation of 309.14, and is 12.4 m deep. As there is no well record, it is not known if or at what depth PW2 intersects a water bearing zone. The closest well to PW2 is OW33-96. OW33-96 was continuously cored and reports till from ground surface to the bottom of well (elevation 307.1 m). However, it does note small seams (less than 3 cm) of sand, silt, gravel and clay. According to the 2012 Annual Monitoring Report, PW2 is reportedly susceptible to seasonal water level fluctuations and has occasionally been dry. In the past, a licensed water hauler reportedly fills the well with imported water.

Several residences have been constructed on the west side of Perth Road 123 since the 1992 survey. Water well records show additional drilled wells along the road. At this point, the well survey has not been repeated as it is expected new homes are on drilled bedrock wells.

## 4.4 Local Geology

### 4.4.1 Topography and Drainage

It has already been noted that the surface of the Site has been impacted by industrial activity since around 1960. It was around that time that the quarry operation to the north progressed onto what is now the landfill Site. It is likely that there were impacts to the groundwater prior to that time with earlier dewatering of the quarry. By 1978, none of the Site was in a natural state. The topography of the Site today is a result of the overburden stripping/filling east of the watercourse, kiln dust stockpiling, the realignment of the watercourse, clay mining over most of the Site west of the watercourse, and finally the construction of the landfill.

The highest elevation on the Site today is the cement kiln dust stockpile (CKD), its peak being around 334 m amsl. The elevations of the fill areas are approximately 327 m (Phase I) and 326 m amsl (Phase II/III). The lowest elevations on the Site occur along the watercourse. This channel enters the east side of the Site at an elevation of approximately 310.0 m amsl and exits at the north end under Water Street South at 306.8 m amsl (see Figure 5). This is an elevation change of 3.2 m over a distance of approximately 840 m, resulting in a grade of 0.4%. However, the elevation changes between SP1-10, the surface water station at the east side of the Site and SP3-93 near the north end is approximately 0.2% (1.5 m elevation over 660 m distance). The grade on the watercourse increases between SP3-93 and Water Street South to 1% (1.7 m over 150 m).

Perth County Road 123 is a topographic ridge on the west side of the Site and acts as a drainage divide. West of the ridge, runoff flows to the Thames River. East of the road, runoff is eastward toward the stormwater retention basins and the watercourse (see Figure 5).

Surface water from the completed landfill areas is directed through a series of perimeter ditches and swales around the landfill footprints and along the interior roadways. The ditches and swales convey runoff generated to two stormwater retention basins (see Figure 5). These stormwater basins attenuate the peak flows during storm events and allow sedimentation. The 2012 Annual Report noted that riser pipes were replaced, and sediment was removed from both stormwater basins during the landfill earthworks in October and November 2007.

The stormwater basins outlet to the watercourse via control features. The watercourse leaves the Site by a culvert under Perth Road 123 and eventually discharges into the Thames River approximately 500 m downstream of the Site.

Upstream of the Site, this watercourse divides into two branches (see Figure 2). The north branch skirts the south edge of the SMC quarry and drains industrial properties and agricultural fields east of the Site. The south branch occupies a vegetated channel between the agricultural fields and the excavated/filled areas on the SMC property. It drains industrial and agricultural land further south and east before crossing James Street and Elginfield Road (Highway 7). According to the 1982 Hydrogeological Report, it drains an area of approximately 607 ha.

Site reconnaissance in 2015 indicated that Site drainage is less defined east of the watercourse. Surface water runoff from the relatively steep slopes of the kiln dust stockpile flows radially in all directions, including west toward the watercourse and north toward the quarry. There are relatively flat areas between the stockpile and the watercourse with isolated water-filled depressions, some of which contain cattails.

#### 4.4.2 Site Overburden

Three cross-sections were constructed using the logs from the on-site monitoring wells, boreholes, test pits, and the bedrock elevations from the regional cross-sections and bedrock contour mapping (Figure 12). The locations of the cross-sections are shown on Figure 13. The cross-sections (D-D’, E-E’, and F-F’) are Figures 14, 15 and 16.

The regional geology (Section 4.2) noted that the overburden consists of layers of glacial till possibly separated by inter-till meltwater deposits. The Site cross-sections also show primarily silt till above the bedrock. All three sections show the main stratigraphic sequence of the Site from top to bottom to be:

1. Lacustrine (clay and/or silt removed by mining);
2. Upper till (possibly Tavistock);
3. Localized inter-till meltwater deposits;
4. Lower till (possibly Catfish Creek); and
5. Bedrock.

East of the watercourse, there is also fill at ground surface. The fill is likely local resulting from overburden stripped during quarrying or from the realignment of the watercourse. The thickness of the overburden varies from 20 m on the south and west parts of the Site to about 10 m on the north edge of the site. This is due partly to soil removal from mining and from an upward slope on the bedrock surface from southwest to northeast.

##### 4.4.2.1 Lacustrine

There is very little of this soil remaining on the Site. As noted, the original ground surface has been substantially altered. The ground surface south of the Site (along the southern property boundary) is approximately 324 m amsl. The base of the Phase II/III footprint was 314 m at the east end and 317 m at the west end. Therefore 7 to 10 m of material was removed along the south edge of the Site. The ground surface on the lot adjoining the northwest side of the Site is 318 m to 320 m. The base of Phase I was approximately 315 m, therefore 3 to 5 m of material was removed during borrow pit operations.

Most of the soil logs record till at surface. There are exceptions (monitoring wells and test pits along the watercourse) but these are thought to be related to the inter-till meltwater deposits (discussed below). One test pit (TP9) in the northwest corner of the Site encountered 0.75 m of sand and gravel over 0.65 m of varved silty fine sand. This could be a remnant of the original deposit.

It is not known if any of this deposit remains below the cement kiln dust stockpile. The historical airphotos (Appendix A) show a possible soil stockpile in 1963 that may have been placed over the native soil. The kiln dust stockpile was built partially over this soil stockpile and partially over the shallow quarry edge. Therefore, the lacustrine material may have been removed from the northeast part of the kiln dust stockpile.

#### 4.4.2.2 Upper and Lower Till

The glacial till is discussed as one unit as it is not possible to reliable differentiate between the till sheets on the Site. Till was reported at all of the drilling locations on the Site. The cross-section shows that it is 18 to 20 m thick below Phase II/III and 15 to 19 m thick below Phase I. East of the watercourse, the rising bedrock surface reduces the depth to about 14 m. At the north property boundary, coinciding with the quarry edge, the till depth may be reduced to 9 to 10 m. This is based on extrapolation of bedrock contours in that area, it has not been confirmed by drilling.

The till is primarily silt and clay. The table below summarizes the grain size analyses completed during the 1982 and 1992 investigations. The analysis from the new well OW36 was added although the analysis was based on the Unified Soils Classification System (USCS). The USCS has a slightly different grain-size distribution than those provided in the older reports.

**Table 4-2: Grain-Size Distribution in Till**

| Location | Sample Interval (m) | Analysis Results (%) | | | | Geologic Material |
|---|---|---|---|---|---|---|
| | | Gravel > 2 mm | Sand 2 - 0.06 mm | Silt 0.06-0.002 mm | Clay <0.002 mm | |
| OW1-80 | 6.1 | 14 | 21 | 37 | 28 | silt till |
| OW4-80 | 0.8 | 7 | 12 | 48 | 33 | silt till |
| OW4-80 | 5.3 | 11 | 22 | 41 | 26 | silt till |
| BH10-91 | 1.22 – 2.13 | 3.77 | 28.68 | 46.66 | 20.88 | silt till |
| BH10-91 | 7.32 – 8.53 | 9.06 | 29.34 | 39.94 | 21.66 | silt till |
| BH11-91 | 1.83 – 3.05 | 0 | 12.22 | 55.93 | 31.85 | silt till |
| BH12-91 | 4.27 – 5.79 | 16.45 | 21.57 | 38.33 | 23.64 | silt till |
| BH13-91 | 4.57 – 5.64 | 2.93 | 26.71 | 42.27 | 28.09 | silt till |
| OW17-91 | 0.61 – 1.22 | 11.70 | 10.20 | 53.50 | 25.00 | silt till |
| BH13-91 | 13.26 – 14.78 | 15.20 | 40.05 | 36.62 | 8.13 | silt and sand till |
| USCS | | >4.75 mm | 4.75-0.075 mm | < 0.075 mm | | |
| OW36 | 4.57 – 5.18 | 0 | 33 | 67 | | silt clay till |

The samples are predominantly silt (36 to 55%) with a clay content of 21 to 32% and sand content of 10 to 29%. The deeper sample from BH13-91 (13.26 m) had a clay content of only 8% and a sand content of 40%. This sample, taken just above the bedrock, may be more representative of the deeper Catfish Creek Till. While higher in sand content, it is generally considered to be of greater density.

#### 4.4.2.3 Localized Inter-Till Deposits

This unit is the meltwater material between the upper and lower till. This local unit, which may consist of sand, gravel or silt, was first noted during drilling for the 1992 Hydrogeological Investigation. Additional drilling and a geophysical ground survey were completed to better define the extent.

This unit is most evident on Cross-Section D-D’ (Figure 14) below Phase II/III. The cross-section runs through the centre of a group of boreholes that reported sand and gravel below a surface till. To the north, east and south, seams of silt or silt and clay were reported that are likely the same deposit but formed in a lower energy depositional environment.

The thickness and elevation of the seam varies but it generally lies between elevations of 310 to 315 m amsl. It is thickest in the vicinity of boreholes BH16-91 (2.90 m) and BH19-91 (3.35 m) below Phase II/III. BH19-91 is also where it is at its highest elevation (315.56 m). The seam is evident as silt on Cross-Section E-E’ (Figure 15) below Phase I and may exist along Cross-Section F-F’ (Figure 16). The locations where this unit has been reported are shown on Figure 13. Locations reporting sand and gravel are circled in yellow, while locations reporting silt or clay are circled in green.

Boreholes and test pits along both sides of the watercourse report silt at ground surface. This is interpreted to be the same unit given that the elevations are consistent (310 to 315 m). The unit appears to be missing east of Phase II/III, but may extend under the western side of the soil and kiln dust stockpile.

The 1992 Phase II/III hydrogeologic investigation included an isopach of the central sand portion of this unit. This figure has been included in Appendix C. The isopach lines indicated that the main axis of the sand deposit runs northwest to southeast below Phase II/III. Laterally, the unit grades into silt with little to some fine sand and trace to some clay. The sand may also be overlain or underlain by silt and clay (see Figure 14 Cross-Section D-D’).

The 1992 report noted that the seam appeared continuous to the west and northwest as three shallow private wells to the west were completed at approximately the same elevation. Those three wells are no longer available for measurement as they have been replaced with bedrock wells (PW1, PW4 and PW5).

The table below summarizes the grain size analyses completed during the 1982 and 1992 investigations. The analysis from the new well OW36 was been added. The deeper sample from OW15-91 is primarily sand and gravel while the shallower sample is the overlying silt and clay. The samples from OW4-80, BH12-91, and OW36 are more representative of the unit beyond the sand core.

**Table 4-3: Grain-Size Distribution in Inter-Till Deposits**

| Location | Sample Interval (m) | Analysis Results (%) | | | | Geologic Material |
|---|---|---|---|---|---|---|
| | | Gravel > 2 mm | Sand 2-0.06 mm | Silt 0.06-0.002 mm | Clay <0.002 mm | |
| OW4-80 | 1.5 | - | 5 | 80 | 15 | silt some clay |
| BH16-91 | 2.74 – 3.35 | 0 | 10.32 | 46.18 | 43.50 | silt and clay |
| BH12-91 | 2.90 – 4.11 | 2.90 | 25.51 | 68.32 | 3.36 | sandy silt |
| OW15-91 | 3.51 – 4.57 | 2.58 | 13.64 | 42.07 | 41.72 | silt and clay |
| OW15-91 | 4.57 – 5.79 | 43.79 | 50.85 | 5.36 | | sand and gravel |
| USCS | | >4.75 mm | 4.75-0.75 mm | <0.075 mm | | |
| OW36 | 2.30 – 2.90 | 3 | 15.5 | 81.5 | | silt and clay |

The 2012 Annual Monitoring Report stated that "*A portion of this sub-unit was removed in 1993, 1997, and 2003 as part of base preparation activities in the active Phase II/III landfilling area. This sub-unit was not encountered during the base preparation of Stage 6 in 2007 or Stage 7 in 2010, of Phase II/III*". The details of the excavation and construction are not currently known. Burnside observed construction of Stage 8 in 2013 and noted that the sub-unit was not encountered.

#### 4.4.2.4 Till - Bedrock Interface

Sand was reported between the till and the bedrock at BH12-91 (below Phase II/III near the south Site boundary, at the OW3-84/OW7-91 nest and in OW5-84 (mid Site along the watercourse). The seam was not reported at the six other on-site boreholes that reached the bedrock (OW8A-91, OW9A-91, OW32A-02, BH10-91, BH11-91, and BH13-91). It is expected to be a very local deposit.

**Table 4-4: Characteristics of Above Bedrock Granular Seam**

| Location | Soil | Thickness | Groundwater |
|---|---|---|---|
| OW3-84/<br>OW7-91 | Fine to med sand | 0.76<br>1.3 | Dry<br>moist |
| OW5-84 | Med to coarse sand with gravel | 1.98 | Saturated |
| BH12-91 | Fine Sand | 0.76 | dry |

### 4.4.3 Site Bedrock

The Site and the Study Area Vicinity are underlain grey to tan brown fossiliferous limestone and minor dolostone of the Dundee Formation. This formation is underlain by a light-brown to grey-brown, poorly fossiliferous, laminated limestone and dolostone of the Lucas Formation (Detroit River Group).

According the 1992 Hydrogeologic Report, a clay seam marks the disconformable contact between the two formations on the quarry wall immediately north of the Site. Erosion occurred on the surface of the older lower rock before the younger rock was formed above it. A geophysical borehole log from OW8A-91 indicated a seam emitting high gamma particle radiation at a depth of 24.5 m. This may correlate with the clay seam separating the Dundee and Lucas Formations. Although less prominent, this geographical marker may correlate to depths of 22 m at OW7-91 and 28.5 m at OW9-91. As such, the bedrock core (observation well screened interval) which was obtained from the lower section of the three bedrock boreholes on Site was interpreted to be the Lucas Formation (CRA, 1992).

An unsaturated interval of bedrock of approximately 12 to 14 m in thickness was noted at each of the bedrock drilling locations. At OW7-91, OW8A-91 and OW9A-91, the bedrock core was taken just below the first indication of the bedrock water table and was found to be moderately fractured (RQD 30 to 45 percent), relatively competent (core recovery 100 percent) and contained numerous stylolites (pressure solution structures).

## 4.5 Site Hydrogeology

### 4.5.1 Bedrock Hydrogeology

The primary aquifer in the area is the limestone bedrock. The Town's municipal wells and the majority of private wells use this bedrock aquifer. Regionally, the groundwater flow within the bedrock is from east to west.

The water levels are measured in the on-site monitoring wells, in the leachate collection system and at surface water stations twice a year (spring and fall). Water levels have also been measured in non-monitoring wells for the EA. The data are contained in tables in Appendix F1 and maps and hydrographs constructed from the data in Appendix F2.

Maps F2.1 and F2.2 show the bedrock flow contours for March and October 2016. The flow direction is toward the west and northwest. This is in the direction of the North Thames River and the regional groundwater flow. However, the North Thames River (at an elevation of approximately 296 m) is above the surface of the bedrock and above the water level in the bedrock (see Figure 9 Cross-Section B-B' and Hydrograph F2.5). At OW32A-02 at the west side of the Site, the water level is 7.7 to 10.4 m (286.6 to 283.7 m amsl) below the top of the bedrock. Therefore, there is no groundwater discharge to the river at this point in the river. The groundwater flow direction is controlled by the regional flow to the west.

The SMC plant is located northeast of the Site within the former limestone quarry. This quarry and the active Thomas Street Quarry located to the northwest of the Site, across the Thames River, are currently dewatered by pumping systems which discharge to the Thames River. This is discussed in more detail in Section 4.6.

According to information provided by SMC, the surface elevation at the plant (east side of Water Street) is approximately 282 m amsl. This is also the bottom of the ponds west of the plant. The water level of the ponds is approximately 285 m. As of Dec. 16, 2015, the deepest part of the Thomas Street Quarry was 273 m. The Thomas Street Quarry sump sits at 276 to 277 m; resulting in a water level in the Thomas Street Quarry no lower than 277 m.

Dewatering of the quarry below the water level in the bedrock will affect the water levels in the bedrock at the landfill. However, the regional water levels are already within the bedrock in this area and throughout western Perth County. There are no pre-quarry water levels at the landfill site, therefore the total quarry impact is not known. The dewatering at the Thomas Street quarry to levels below 280 m will be depressing the bedrock water levels in that area, but natural flow is from the landfill toward the quarry. The dewatering may be steepening the gradient, thereby increasing the flow rate, but not affecting flow direction.

Hydraulic conductivity testing was completed in three bedrock wells in 1992. The results are in Table 4-5.

**Table 4-5: Single Well Response Tests – Bedrock Wells**

| Well | Test Type | Hydraulic Conductivity (m/sec) | Screened Unit |
|---|---|---|---|
| OW7-91 (run 1) | Falling | $2.0x10^{-4}$ | limestone bedrock |
| OW7-91 (run 2) | Falling | $2.1x10^{-4}$ | limestone bedrock |
| OW7-91 (run 3) | Falling | $2.5x10^{-4}$ | limestone bedrock |
| OW7-91 (average) | - | $2.2x10^{-4}$ | |
| | | | |
| OW8A-91 | Falling | $3.8x10^{-5}$ | limestone bedrock |
| | | | |
| OW9A-91 (run 1) | Falling | $2.0x10^{-4}$ | limestone bedrock |
| OW9A-91 (run 2) | Falling | $2.3x10^{-4}$ | limestone bedrock |
| OW9A-91 (average) | - | $2.2x10^{-4}$ | |
| Geometric Mean | | $2.2x10^{-4}$ | |

Source: CRA 1992

### 4.5.2 Overburden Hydrogeology

There are no regional overburden aquifers in the vicinity of the Site. There are some shallow alluvial deposits associated with the river and localized sand, either overlying or within the upper till that may be used by shallow dug wells.

As noted above, the water table in the bedrock is 8 to 10 m below the bedrock surface. The top of the bedrock is dry. Therefore, water found above the bedrock is perched in localized and possibly isolated permeable seams. For example, water is found in the surficial lacustrine deposit (OW4-84), the upper till (OW8B-10), the inter-till deposits (OW9B-91, OW21-91, OW32-96), and the interface between the till and the bedrock (OW5-84).

However, these units can also be dry. For example, OW6-84 in the surficial lacustrine deposit and OW3-84 at the interface between the till and bedrock are both dry and have been since installation. These wells are important to understanding the conceptual model of the Site.

The new well, OW36, was installed November 29, 2016 as a shallow well downgradient of the Phase II/III fill area. The installation plan was to drill the well through the surficial lacustrine deposit and into the top of the underlying till. OW4-84 and the test pits showed that there could be water perched at the bottom of the lacustrine deposit. OW8B-10 showed that if the surficial deposit was dry, there could be water in factures in the top of the till. The final well depth was 6.93 m below ground at an elevation of 306.85 m amsl. This was deeper than OW8B-10 (completed at 307.99 m amsl) and the nearby watercourse (309 to 310 m). The well screen was 3.1 m long and the annular sand pack was extended up into the bottom of the surficial lacustrine deposit. The purpose of this well construction was to capture any water that was in the shallow zone.

Water levels in OW36 were checked through January, February and March of 2017. The well remained dry. If the surficial deposit was dry but there was water in the till, it would take some time for the water to migrate out of the low permeable till. However, after four months the well remained dry.

On January 13, water levels were measured in surrounding shallow wells to evaluate the effect of the low rainfall in the summer of 2016 on the water table. The water levels in those wells indicated that at least 2 m of water was expected in OW36. By September 2017, there was sufficient water in the well for the collection of a water sample.

The possible cause of the slow movement of water into the well is that the sidewalls were smeared with clay cuttings during drilling. However, the till is approximately 30% sand and 30% silt, and the screen is 3 m long making this less likely. Other causes include an absence of shallow water at this location due to perched conditions of the site, capture of shallow upgradient groundwater by the leachate control system in Phase II/III, or very low permeability of the till soil.

OW4-84 water level data (Appendix F, Table F1.1) shows that the well contained water at every monitoring event from 1984 to 1993. However, since 1993 this well has been sporadically dry. The Phase I fill area was covered and closed in 1993. The leachate control system may be capturing upgradient infiltration. It may also be intercepting shallow groundwater on the west side of the fill area during seasonal high water levels. The lowest elevation in the system is at the west side at MH1 (314.2 m amsl) where the shallow groundwater levels are the highest. Both of these scenarios would impact the water level at OW4-84 and support the effectiveness of the LCS.

OW36 will continue to be monitored but the findings to date point to the fact that there is little movement of water in the shallow soils.

Map F2.3 in Appendix F shows shallow water levels for March 29, 2016. Map F2.4 shows water levels for October 4, 2016. The water levels were measured at all possible locations on the Site. These include the wells in the monitoring program, wells not in the program, drive points, and surface water stations.

Earlier groundwater investigations described a shallow groundwater divide along Perth Road 123 with water flowing west and east from the road. The 2016 levels show that the water levels are higher along the road (approximately 317 m amsl) and fall across the landfill to the watercourse (309 to 310 m).

What is not known is the amount of mounding within the landfill cells. Mounding above 317 m could create a small area of westward movement between the landfill and the property boundary. The leachate control systems were installed to minimize mounding. The invert elevations in Phase I are in the range of 314.2 (MH1) to 316.8 m amsl (MH4). Recent water levels in the manholes show that the system is either dry (MH4 and MH5) or the levels are too low to measure (wet to very slow flow). Therefore, the leachate control system is maintaining levels at or below 316.8 m at the perimeter of the footprint.

The 1982 investigation reported water level elevations in the dug wells west of Phase I as 320.62 m (PW1) and 320.12 m (PW2). The water level at OW3-80 (an on-site monitoring well that has since been decommissioned) was 312.32 m at that time. Current water levels at OW34-96 are 315.8 to 317.8 m and at OW2-84 are 317.2 to 319.1 m. These wells are west of OW3-80 (see Figure 5). A water level above 319 m along Perth Road 123 would prevent the westward movement of water from the landfill.

The highest leachate elevation measured in Phase II/III is 316.7 m at MW14 on the south side. The new manholes at the west end of the fill area (highest part of the leachate collection system) are dry or have insufficient water to measure. Inverts at these manholes are at 316.13 m (MH10) to 317.60 m (MH11). With water levels at OW9B-91 around 315.4 m there is some potential for westward flow between the landfill and this well. Water level elevations above 315.4 m west of OW9B-91 would prevent further westward flow and could create stagnant water within the inter-till deposit below Phase II/III.

On the east side of the fill areas, groundwater in the shallow soils moves east toward the watercourse. At DP1, the water in the watercourse is slightly higher than in the DP indicating water moving from surface water to groundwater. At DP2, the gradient is neutral. At DP3 (downstream), the movement is slightly upward indicating groundwater discharge to the watercourse.

On the east side of the watercourse, groundwater is mounded below the cement kiln dust stockpile, driving flow toward the watercourse from the east part of the Site. While there are no wells on the northeast side of the stockpile, approximate water levels in TP6 and TP10 in November 2015 show contours wrapping around the stockpile creating radial flow out from the stockpile, toward the watercourse and the exposed edge of the quarry. Both watercourse and quarry would be discharge points for the shallow flow.

The hydraulic conductivity of the overburden was tested at several wells in previous studies. The values are contained in Table 4-6. The CRA 1982 report noted that after installation of wells in the till in 1980, the water levels took approximately one year to reach static.

**Table 4-6: Single Well Response Tests – Overburden**

| Well | Test Type | Hydraulic Conductivity (m/sec) | Screened Unit |
|---|---|---|---|
| OW1-80 | - | $2.0 \times 10^{-11}$ | clayey silt till |
| OW2-80 | - | $2.0 \times 10^{-9}$ | clayey silt till |
| OW3-80 | - | $4.0 \times 10^{-10}$ | clayey silt till |
| OW4-80 | - | $6.0 \times 10^{-12}$ | clayey silt till |
| Geometric Mean | | $9.9 \times 10^{-11}$ | |
| OW1-84 | Rising | $6.0 \times 10^{-7}$ | gravel seams |
| OW2-84 | Rising | $3.0 \times 10^{-6}$ | gravel seams |
| OW15-91 (run 1) | Falling | $6.7 \times 10^{-6}$ | sand and gravel |
| OW15-91 (run 2) | Rising | $8.7 \times 10^{-6}$ | sand and gravel |
| OW15-91 (average) | - | $7.7 \times 10^{-6}$ | |
| OW25-91 | Rising | $4.7 \times 10^{-6}$ | sand |
| Geometric Mean | | $3.0 \times 10^{-6}$ | |
| OW7-91 (run 1) | Falling | $2.0 \times 10^{-4}$ | limestone bedrock |
| OW7-91 (run 2) | Falling | $2.1 \times 10^{-4}$ | limestone bedrock |
| OW7-91 (run 3) | Falling | $2.5 \times 10^{-4}$ | limestone bedrock |
| OW7-91 (average) | - | $2.2 \times 10^{-4}$ | |
| OW8A-91 | Falling | $3.8 \times 10^{-5}$ | limestone bedrock |
| OW9A-91 (run 1) | Falling | $2.0 \times 10^{-4}$ | limestone bedrock |
| OW9A-91 (run 2) | Falling | $2.3 \times 10^{-4}$ | limestone bedrock |
| OW9A-91 (average) | - | $2.2 \times 10^{-4}$ | |
| Geometric Mean | | $2.2 \times 10^{-4}$ | |

Source: CRA 1992

The velocity of water movement depends on the soil type and gradient. Most of the shallow lacustrine soils have been removed; therefore, flow is either through the shallow till or the inter-till deposits. Table 4-6 contains geometric means for the hydraulic conductivity of wells tested. The hydraulic conductivity for the till is $1 \times 10^{-10}$ m/s and for the inter-till sand is $3 \times 10^{-6}$ m/s.

Estimating velocity using the Darcy relationship of:

V = Ki/n where V = average linear velocity
K = hydraulic conductivity
i = hydraulic gradient
n = porosity

The horizontal hydraulic gradient west of the watercourse was approximately 0.04, calculated from the December 2015 flow map. This is slightly steeper than the gradients of 0.01 to 0.03 noted in the 2013 and 2014 Monitoring Reports.

The horizontal hydraulic gradient east of the watercourse ranged from 0.04 to 0.09 in December 2015, with the steepest gradients occurring on the south side of the CKD stockpile.

Using the horizontal gradient upgradient of DP2 (0.03 in December 2015) and porosities of 0.34 for the silt till and 0.39 for the medium to coarse sand, the velocity would be less than 0.001 m/year through the till and 3 m/year through the sand.

### 4.5.3 Inter-Till Sand Below Phase II/III

The Hydrogeology Investigation for Phase II/III documented the shallow buried sand and gravel seam under the central part of that fill area. The 2012 Monitoring Report also stated that "*During the construction of cell 5 of Phase II/III a seam of sandy soil was excavated. As a contingency measure, a drainpipe was installed to facilitate the removal of leachate contaminated groundwater in the event the clay base of the landfill failed to provide adequate leachate attenuation in that area. The drainpipe is accessible through MH-A and MH-B located, respectively, on the south and north sides of Phase II/III*". This drainpipe was reported to run along the eastern limit of the inter-till unit. The drainpipe has no outlet.

The inverts of manholes A and B are 311.76 m and 310.79 m respectively. The pipe is shown on Site Cross-Section D-D' (Figure 14) at an average elevation of 311.3 m. The base of the landfill in this area is approximately 315 m. The invert of the leachate collection manhole MH6, near MHB, is 314.79 m.

Water levels are measured in all of the manholes as part of the monitoring program. In September 2015, the water level in MHA was 315.13 m and in MHB 315.36. This is approximately the same level as the landfill base. The leachate level in MH6 was too low to measure (near invert of 314.79 m). This indicates an upward gradient from the sand seam to the leachate collection system near this perforated pipe. However, leachate levels in the MH14 to the west have been measured at 316.57 m indicating that there could be sufficient mounding in some parts of the landfill to create a downward gradient.

Occasionally, water is noted flowing from the top of MHB, resulting from a hydraulic head above the top of the manhole (elevation 315.72 m). When this happens, the water flows by roadside swale into Stormwater Basin B. The water overflow from MHB was sampled in 2015 and was added to the annual monitoring program in 2016. If there is overflow from MHB during spring and fall monitoring events, a sample is collected.

#### 4.5.4 Vertical Movement

It is expected that the primary direction of groundwater movement on the Site is downward. While there is some horizontal movement within the inter-till silt/sand seams and the till-bedrock interface sand, the perched conditions and deep bedrock water levels create a dominant downward movement.

There are seven pairs of nested wells on Site. Table F1.2 in Appendix F contains vertical gradients calculated at five of these well nests. The other two nests are not included, as each have a well that is always dry (OW3-84 and OW6-84). OW3-84 is reported to be screened in a deep sand and gravel unit below the till aquitard and above the bedrock. In the same nest, OW4-84 (shallow sand and gravel) and OW7-91 (bedrock) contain water. This indicates a perched condition in the shallow sand and gravel with the deeper water table occurring in the bedrock. OW6-84 is completed in the till while OW5-84 in the same nest is completed in the deep sand and gravel below the till and produces water.

Four of the five nests in Table F1.2 compare an overburden well and a bedrock well. The water level elevations are higher in all of the overburden wells than in the bedrock wells. The groundwater hydrograph in Figure F2.5 also illustrates that the water level elevations in the shallow overburden wells are consistently higher than the water level elevations in the bedrock wells. This shows downward movement of water from overburden to bedrock.

The gradients in Table F1.2 are in the range of 0.7 to 1.0. These are significant gradients and reflect the pronounced difference in water levels between the overburden and the bedrock. The vertical difference in water levels at the four nests ranges from 22 m to 30 m. The actual magnitude of the calculated gradients is not always meaningful because of dry soils between shallow and deep wells.

The fifth nest in Table F1.2 compares two wells in the overburden; OW33-96 and OW34-96. Both wells are reported to be completed in the aquitard but at different depths. The downward gradient of 1.20 to 1.65 indicates perched conditions in the shallow well attributed to the low-permeability till between the shallow and deeper well screens. The low permeability soil impedes the downward movement of water.

## 4.6 St. Marys Cement Activity

SMC is a wholly-owned subsidiary of Votorantim Cimentos, one of the largest cement producers in the world with 25 operating cement plants in the Americas resulting in a combined capacity of 28 million metric tonnes per year. SMC manufactures a variety of cement for different purposes. Their plant is located at 585 Water Street South, St. Marys, Ontario.

The Site boundary for the SMC Quarry and Pit (Site ID 4494), as shown in the online pits and quarries database, is provided on Figure 17. The quarry has a Class A License covering a licensed area of 448.79 ha with a maximum annual extraction rate of 3,250,000 tonnes.

The proximity of the quarries to the landfill Site and the potential for mutual interference in the future makes the quarry activity important to the landfill assessment. Below is a summary of historical and current operations at the two SMC quarries; the Thomas Street Quarry and the South Quarry.

### 4.6.1 1982 Hydrogeologic Investigation for the St. Marys Landfill

The 1982 report indicates that SMC operated two bedrock water supply wells to provide processing water to the cement plant. The Thomas Street Quarry was dewatered by draining the quarry to a pond and pumping from the pond at 3,400 to 4,500 L/min. The report suggested that the combined effect of these pumping activities would create a depression in the groundwater contour around the quarry causing the local bedrock groundwater to flow toward the quarry. Dewatering of the quarry was expected to continue for the life of the landfill since the cement plant is located on the quarry floor.

### 4.6.2 1992 Hydrogeologic Investigation, Phase II/III for the St. Marys Landfill

The 1992 report indicates SMC was quarrying rock from the area north of the Thames River (Thomas Street Quarry) and transporting the limestone to the Plant Site via an overhead conveyor system that crossed the Thames River and Water Street South at a point north of the landfill. Dewatering was largely maintained by one pump at the Cement Plant Site and by three dewatering pumps along the north side of the Thames River in the active Thomas Street Quarry.

The operational plan for the Thomas Street Quarry involved the limestone being removed in two lifts (1 and 2) over three phased areas: A, B and C. The first lift in an area would be removed while the overburden was being removed from the next area. Quarrying would proceed in the following order of area and lifts: A1, B1, A2, C1, B2 and C2. The three phased areas are outlined on Figure 17. The first lift was to be approximately 18 m in thickness while the second 12 m; resulting in a final, completed extraction depth in the order of 267 m amsl. Rehabilitation plans in 1992 indicated the Thomas Street Quarry would be allowed to equilibrate with the water level, forming a

136.4 ha lake with a bottom of elevation of 267 m and a water surface elevation of 281 m. Overburden material would be used to form 2:1 slopes against the quarry walls.

The report also made reference to a "Clay Pit/Rock Quarry" southeast of the Thames River; which is known today as the South Quarry (see Figure 17). This pit/quarry was also divided into three phased areas (I, II and III). Within each area, two lifts would occur: A) extraction of the clay resource, and; B) extraction of the limestone resource. Operations would proceed as follows: IA, IB, IIA, IIB, IIIA and IIIB. The three phased areas are also outlined on Figure 17. Extraction in the Clay Pit/Rock Quarry area would be terminated at an elevation of 278 m amsl. The quarry was expected to remain dry at this elevation. The rehabilitation plan for this area was to leave the excavation open. Unused overburden material would be used to create 2:1 slopes against the quarry walls with 3:1 slopes above in the overburden (CRA, 1992).

### 4.6.3 2012 Hydrogeological Assessment for Proposed Quarry Deepening at the St. Marys Cement Thomas Street Quarry

This report was submitted due to a condition in the quarry's PTTW that limited the mining to an elevation of 277 m amsl. The quarry floor elevation was at 277 m amsl in 2012. Drilling investigations demonstrated that the base of the limestone at the Site occurs at elevations between approximately 271 m amsl and 276 m amsl, approximately 1 to 6 m below the elevation restriction.

The stratigraphic sequence in the Thomas Street Quarry consists of limestone of the Dundee Formation and the directly underlying Upper Lucas Formation; both suitable for Portland cement production. The limestone strata overlie dolostone of the Lower Lucas Formation. Investigations indicated that there is approximately 7 m to 10 m of comparatively low permeability dolostone strata separating the limestone base from the first major, highly permeable water bearing horizon beneath the quarry.

Modelling in the report suggested dewatering could lower static groundwater levels at the surrounding municipal/industrial wells by approximately 1 m to 2 m. This lateral expansion and deepening of the quarry would occur within the current area of the southern half of the quarry property, taking place over approximately 10 years. Once the limestone is extracted, the mined out area will be progressively backfilled to the original grade (300-305 m amsl) using the extensive quantities of overburden to be stripped from the northern half of the site; limiting the groundwater inflow.

### 4.6.4 St. Marys Cement Permits to Take Water

Based on the MOECC online Permits to Take Water (PTTW) database, the main PTTW under the permit holder "St. Marys Cement Inc. (Canada)" is Permit No. 5440-8YFHPP. This Permit corresponds to an Environmental Registry of May 2012. The Permit includes the following locations:

**Table 4-7: St Marys Cement Permits to Take Water**

| St. Marys Cement Identification | Purpose | Specific Purpose | Max L/day | Source Type |
|---|---|---|---|---|
| Source #1 (Deep Well 3) | Industrial | Cooling Water | 4,354,560 | Ground Water |
| Source #2 (Deep Well 4) | Industrial | Cooling Water | 3,892,320 | Ground Water |
| Source #3 (Deep Well 5) | Industrial | Other - Industrial | 4,091,000 | Ground Water |
| Source #4 (Garage Well) | Water Supply | Communal | 10,000 | Ground Water |
| Source #5 (Crusher Well) | Water Supply | Communal | 2,000 | Ground Water |
| Source #6 (North Quarry Sump) | Dewatering | Pits and Quarries | 30,240,000 | Ground Water |
| Source #7 (South Quarry Pond) | Dewatering | Pits and Quarries | 10,000,000 | Ground Water |

The source locations are shown on Figure 17 and are based on Figure 1 (Site Location and Site Features) from the 2014 Annual Groundwater Monitoring Report for the St. Marys Cement Facility completed by AMEC Foster Wheeler.

The MOECC PTTW database also lists two other Permits held by SMC. The first is Permit No. 5758-8TANYB for an industrial aggregate washing source with a maximum water taking of 6,813,900 L/day. The second, Permit No. 77-P-1009 issued in 1977 for two dewatering locations and renewed in 1997 as Permit No. 97-P-1059. These two permits were likely replaced by the more recent consolidated permit.

### 4.6.5 Direct Communications with St. Marys Cement Plant

Email communication occurred with the SMC Environmental Coordinator throughout November and December 2015 in order to obtain information on current operations and future plans of the SMC Plant and quarries. The majority of the information provided was for the active Thomas Street Quarry. The Thomas Street Quarry site plan provided to Burnside is dated November 2011.

SMC confirmed that there are no plans for future dewatering locations. They also indicated that the southernmost dewatering location (Source #7) is used only as a fire suppression source; it is tested monthly to ensure it works and it uses a negligible amount of water. They noted that on the Plant Site, Source #3 (Deep Well 5) is not currently in use. This is the SMC well closest to the landfill.

As of December 16, 2015, the lowest elevation at the Thomas Street Quarry was 273 m amsl and the highest elevation was 279 m amsl. The quarry sump maintains the water level at no lower than 277 m amsl. The surface elevation at the plant is approximately 282 m amsl; which is also the bottom of the surface ponds located west of the plant. The surface level of the ponds is approximately 285 m amsl.

SMC only has a mining plan for the Thomas Street Quarry. Based on current resources and production assets, the estimated lifespan of the two quarries is approximately 60 years. SMC indicated that they may be reviewing their licence and Site Plans in 2016.

# 5.0 Monitoring Data and Analysis

Annual monitoring at the Site is conducted in accordance with the ECA. Monitoring of groundwater and surface water on the Site began in 1984. The monitoring is conducted twice each year, in the spring and in the fall. Monitoring locations are shown on Figure 18.

The programs and the data presented here is a summary of the information contained in the monitoring reports. If additional detail is required, it can be found in the most recent Annual Monitoring and Operations Report.

## 5.1 Leachate

The purpose of the leachate monitoring is to:

- Identify the compounds that are present in the leachate generated at the Site;
- Assist in the identification of landfill-derived impacts on the surface water and groundwater; and
- Assess the strength of the leachate going to the sewage treatment plant.

Leachate samples are collected and analyzed for general chemistry parameters, metals and volatile organic compounds (VOC). The monitoring program includes the following parameters:

**Table 5-1: Leachate Monitoring Parameters**

| **Samples from MH1 (Phase I) and MH3 (Phase II/III)** | | | |
|---|---|---|---|
| chloride | BOD | aluminum | lead |
| sulphate | COD | barium | manganese |
| alkalinity | TSS | beryllium | molybdenum |
| calcium | ammonia | bismuth | nickel |
| magnesium | nitrate | cadmium | silver |
| potassium | TKN | chromium | strontium |
| sodium | phosphorous | cobalt | tungsten |
| field pH | phenols | copper | vanadium |
| field temp | VOCs | iron | zinc |
| field conductivity | | | |
| **All Manholes in Phase I and Phase II/III** | | | |
| Measure leachate levels | | | |

The following is the range of typical leachate parameters reported from 1991 to 2015.

**Table 5-2: Leachate Concentrations 1991 to 2015**

| Parameter | Units | MH-1 (Phase I) | | MH-3 (Phase II/III) | |
|---|---|---|---|---|---|
| | | Range | Current | Range | Current |
| Chloride | mg/L | <40 – 760 | 423 | 13 – 3,050 | 1,760 |
| Conductivity (field) | µS/cm | 485 – 7,800 | 3312 | 1,320 – 15,700 | 5,923 |
| BOD | mg/L | 4.3 – 250 | 51 | 21 – 4,695 | 232 |
| COD | mg/L | 23 – 1,110 | 131 | 80 – 7,348 | 692 |
| Ammonia | mg/L | 0.8 – 248 | 142 | 32 – 1,132 | 414 |
| Nitrate | mg/L | <0.1 – 3.84 | <2.5 | <0.1 – 1.79 | <5 |
| Total Phosphorous | mg/L | 0.04 – 79.4 | 0.28 | 0.45 – 39.9 | 10.4 |
| Iron | mg/L | 0.51 - 694 | 46.2 | 1 - 290 | 1.06 |
| Phenols | mg/L | <0.001 - 0.065 | 0.025 | <0.001 – 1.9 | 0.072 |

Both Phases show large variations and there is considerable variation during both the active and closed stages. Current concentrations in both Phases are mid-range values.

The results show concentrations are higher in Phase II/III. This is expected as the Phase II/III is active, and the leachate is younger. Sampling of the Phase I perimeter LCS did not start until 1991, approximately two years before the Phase was completed. Phase I was only active for 9 years, while Phase II/III has been active for 23 years and has a greater mass of waste.

Chloride was identified during the 1992 investigation as the critical contaminant for evaluation of groundwater impact. The chloride concentration in Phase I has declined from the highest recorded concentration of 760 mg/L in 1991 but is still above background. The current chloride concentration in Phase II/III (1,760 mg/L) is typical for landfill leachate and is lower than previous highs of 2,480 to 3,050 mg/L (2003 to 2004).

As expected, ammonia is high, and nitrate is low. Nitrate is expected to increase away from the reducing environment of the landfill. Iron is also high, particularly in Phase I.

VOC testing has reported sporadic occurrences of selected parameters since testing began in 1991 and 1993 (for Phase I and Phase II/III respectively). In the last two years, the parameters detected are primarily BTEX. These are found in both Phases with concentrations being higher in Phase II/III. In addition, low levels of chlorobenzene and chloroethane have been detected in Phase I. The concentration detected in 2014 and 2015 are contained in the tables below.

**Table 5-3: VOC Concentrations in MH1 (Phase I) 2014-2015**

| | Sewer Use By-Law | Jun-14 | Nov-14 | May-15 | Sep-15 |
|---|---|---|---|---|---|
| Chlorobenzene (µg/L) | | <0.40 | 1.30 | 2.80 | <1.00 |
| Chloroethane (µg/L) | | 2.7 | <0.40 | 2.10 | <2.00 |
| Benzene (µg/L) | 10 | 1.5 | 1.4 | 2.4 | 3.5 |
| Ethylbenzene (µg/L) | 60 | 1.6 | 1.5 | 3.0 | <1.00 |
| Toluene (µg/L) | 20 | <0.80 | 0.85 | 0.89 | 5.6 |
| m,p- Xylenes (µg/L) | | <0.80 | <0.40 | 0.78 | <2.00 |
| o-Xylene (µg/L) | | <0.40 | <0.20 | <0.20 | <1.00 |
| Xylenes (Total) (µg/L) | 300 | <0.80 | <0.40 | 0.78 | <2.00 |

**Table 5-4: VOC Concentrations in MH3 (Phase II/III) 2014-2015**

| | Sewer Use By-Law | Jun-14 | Nov-14 | May-15 | Sep-15 |
|---|---|---|---|---|---|
| Chlorobenzene (µg/L) | | <1.00 | <0.40 | <10.0 | <1.00 |
| Chloroethane (µg/L) | | <2.00 | <0.80 | <20.0 | <2.00 |
| Benzene (µg/L) | 10 | <2.00 | 1.2 | <20.0 | <2.00 |
| Ethylbenzene (µg/L) | 60 | 8.5 | 14 | <10.0 | 12 |
| Toluene (µg/L) | 20 | 5.7 | 12 | <20.0 | 11 |
| m,p- Xylenes (µg/L) | | 17 | 28 | <20.0 | 22 |
| o-Xylene (µg/L) | | 4.7 | 8.2 | <10.0 | 7.1 |
| Xylenes (Total) (µg/L) | 300 | 22 | 36 | <20.0 | 29 |

The results are compared to the Town's sewer use bylaws, currently *By-Law Number 46 of 2014, Schedule E - Limits for Sanitary and Combined Sewer Discharge*. All concentrations are below the sewer use criteria.

The measurement of leachate levels in the manholes reports low flow to stagnant conditions in the manholes. The samples collected under these conditions may not be representative of leachate characteristics in the waste mound.

## 5.2 Groundwater

The groundwater monitoring locations and parameters are listed below. Monitoring well logs are included in Appendix C and well details are summarized on Table C-1 Appendix C. Well records available for the private wells are in Appendix B.

**Table 5-5: Landfill Groundwater Monitoring Locations**

| Overburden | | | Bedrock |
|---|---|---|---|
| OW2-84 | OW8B-10 | OW32-96 | OW7-91 |
| OW3-84 | OW9B-91 | OW33-96 | OW8A-91 |
| OW4-84 | OW15-91 | OW34-96 | OW9A-91 |
| OW5-84 | OW21-91 | OW36 | OW32A-02 |
| OW6-84 | OW25-91 | | |

**Table 5-6: Private Groundwater Monitoring Locations**

| Current No. | Well Location | MOECC No. | ECA Designation |
|---|---|---|---|
| PW1 | 1760 Perth Road 123 | 7175685 | Hall (#25) |
| PW2 | 1025 Water Street South | NA | Riordan Farm (#26) |
| PW3 | 1774 Perth Road 123 | 5002038 | Riordan (#3) |
| PW4 | 1736 Perth Road 123 | 5004319 | Heard (#27) |
| PW5 | 1764 Perth Road 123 | 5003434 | McCurdy (#24) |

**Table 5-7: Groundwater Program Parameters**

| Parameters | | Wells |
|---|---|---|
| Field pH<br>Field conductivity<br>Field temperature<br>Chloride<br>Hardness<br>DOC<br>Calcium<br>Magnesium<br>Phenols | Alkalinity<br>Sodium<br>Sulphate<br>Boron<br>Iron<br>Manganese<br>BTEX<br><br>Water levels | OW2-84<br>OW4-84<br>OW5-84<br>OW8B-10<br>OW9B-91<br>OW15-91<br>OW21-91<br>OW25-91<br>OW32-96<br>OW32A-02<br>OW33-96<br>OW34-96<br>OW36 |
| Field pH<br>Field conductivity<br>Field temperature<br>Chloride<br>Hardness | DOC<br>Calcium<br>Magnesium<br>Phenols<br><br>Water levels | OW7-91<br>OW8A-91<br>OW9A-91 |
| Field pH<br>Field conductivity<br>Field temperature<br>Chloride<br>Hardness | DOC<br>Calcium<br>Magnesium<br>Phenols | PW1<br>PW2<br>PW3<br>PW4<br>PW5 |
| Historically dry wells | Water levels | OW3-84<br>OW6-84 |

### 5.2.1 Overburden Groundwater Results

OW2-84 and OW25-91 (overburden) are upgradient of the fill areas and have been considered the background wells for the Site (see Figures F2.3 Appendix F). OW2-84 is the most northwesterly overburden well. Located along the west property boundary it is upgradient of the Phase I fill area. OW25-91 is the most southerly overburden well. Located along the southern property boundary, it is upgradient of the Phase II/III fill area.

The range of concentrations for typical leachate indicators reported at these two wells over the last 10 years is summarized below.

**Table 5-8: Overburden Background Concentrations 2006 to 2015**

| Parameter | Units | OW2-84 | OW25-91 |
|---|---|---|---|
| Chloride | mg/L | 3.6 – 9.0 | 5.0 – 12.0 |
| Conductivity | µS/cm | 260 – 380 | 500 – 750 |
| Hardness | mg/L | 120 – 180 | 300 – 700 |
| DOC | mg/L | 0.8 – 3.0 | <1.0 – 2.5 |

Overburden wells OW32-96, OW33-96 and OW34-96 are located upgradient or cross-gradient relative to the Phase I fill area. The 2015 groundwater chemistry at these wells is summarized below.

**Table 5-9: Upgradient/Cross-Gradient Groundwater Concentrations Phase I - 2015**

| Indicator | Unit | OW32-96 | | OW33-96 | | OW34-96 | |
|---|---|---|---|---|---|---|---|
| | | May | Sept | May | Sept | May | Sept |
| Chloride | mg/L | 49.7 | 56.9 | 32.8 | 37.1 | 18.6 | 23.7 |
| Conductivity | µS/cm | 563 | 446 | 533 | 506 | 609 | 626 |
| Hardness | mg/L | 245 | 258 | 159 | 168 | 276 | 295 |
| DOC | mg/L | 0.9 | 0.8 | 2.0 | 1.2 | 1.2 | 0.8 |

The chloride concentrations are all elevated above background. The levels at OW32-96 and OW34-96 are within their historical ranges, although both are at the top end of those ranges. OW33-96 has been rising slowly since 2002. Conductivity, hardness and DOC are either within or close to the background levels.

Wells OW9B-91, OW15-91 and OW21-91 are located upgradient of Phase II/III. The 2015 groundwater chemistry at these wells is summarized below.

**Table 5-10: Upgradient Groundwater Concentrations Phase II/III - 2015**

| Indicator | Unit | OW9B-91 | | OW15-91 | | OW21-91 | |
|---|---|---|---|---|---|---|---|
| | | May | Sept | May | Sept | May | Sept |
| Chloride | mg/L | 311 | 402 | 67.3 | 99.0 | 344 | 578 |
| Conductivity | µS/cm | 1,628 | 1,763 | 743 | 808 | 1,232 | 1,525 |
| Hardness | mg/L | 586 | 674 | 243 | 296 | 551 | 798 |
| DOC | mg/L | 3.9 | 4.5 | 1.9 | 2.1 | 2.7 | 2.8 |

Prior to 1999, OW21-91 exhibited elevated chloride concentrations up to 50 mg/L. After 1999, the concentrations increased, peaking at 556 mg/L in November 2007. Since that time, the concentration has fluctuated, being as low of 70 mg/L in 2011 and as high as 578 mg/L in September 2015. Conductivity, calcium and magnesium all increased over this same time period (1999 to present). Phenols are also typically elevated at OW21 - 91; the concentration was 28 µg/L in May and 23 µg/L in September.

Chloride concentrations at OW9B-91 began increasing in April 2012 reaching 402 mg/L in September of 2015. The following chloride ranges have been observed at OW9B-91 since installation.

**Table 5-11: Chloride Range at OW9B-91**

| Time Period | Chloride Range |
|---|---|
| 1991 – 2005 | 1 to 6 mg/L |
| 2005 – 2011 | 10 to 40 mg/L |
| 2012 – 2013 | 161 to 194 mg/L |
| 2014 – 2015 | 257 to 402 mg/L |

DOC, iron and manganese concentrations are also elevated at OW9B-91. In 2015 the DOC levels ranged from 3.9 to 4.5 mg/L, which is within the historical range and just below the Ontario Drinking Water Quality Standards (ODWQS). Iron and manganese were measured for the first time at OW9B-91 in 2015. Iron had a concentration of 2.54 mg/L in May and 3.11 mg/L in September; manganese concentrations ranged from 0.101 to 0.126 mg/L.

Elevated chloride levels have been observed at OW15-91 since 2013. Prior to 2013, chloride concentrations ranged from 1 to 15 mg/L at OW15-91. Since 2013, the range has increased to 50 to 99 mg/L. Conductivity and DOC are also elevated above background levels in OW9B-91.

All three of these wells are located along the base of the access road. OW21-91 is located between the access road and the scales. The discussion on topography and local geology noted that Perth Road 123 is along a ridge forming a surface water and shallow groundwater divide. Water levels measured in these wells have always indicated that the wells are upgradient of the landfill. Therefore, it was thought that the elevated chlorides in this area were due to road salt or application of dust suppression brine on the access road.

The concentrations of boron and iron at OW15-91 and OW21-91 remain within historic ranges (2003 to 2015), also suggesting a non-landfill source of chloride. However, these additional parameters were added at OW9B-91 in 2015 and the 2015 results showed elevated concentrations of boron and iron. The source of the elevated chloride, boron and iron is being investigated as part of the on-going operations and monitoring of the site. Work completed on the three wells in 2016 indicated that there may be an issue with the integrity of the well casings at OW 15-91 and OW21-91. This could be allowing surface water seepage into the wells. Investigations are continuing.

According to the water levels and shallow flow mapping, the downgradient wells are located east of the fill area. Groundwater flow in the shallow overburden is toward the east - northeast.

Monitoring wells OW4-84 and OW6-84 are screened in the shallow overburden. OW3-84 and OW5-84 are screened in the deeper sand and gravel between the till and the bedrock. All are downgradient of Phase I. Due to the deep water table in the bedrock and the perched conditions in the overburden, OW3-84 (deep overburden) and OW6-84 (shallow overburden) have always been dry, therefore not sampled.

**Table 5-12: Downgradient Groundwater Concentrations Phase I**

| Indicator | Unit | OW4-84 Shallow | | OW5-84 Deep | |
|---|---|---|---|---|---|
| | | May 2013 | Oct 2013 | May 2015 | Sept 2015 |
| Chloride | mg/L | 0.88 | 0.58 | 46.7 | 36.2 |
| Conductivity | µS/cm | 453 | 524 | 877 | 686 |
| Hardness | mg/L | 2450* | 279 | 354 | 299 |
| DOC | mg/L | 6.5 | 8.6 | 1.2 | 1.0 |

* lab reporting error suspected

OW4-84 (shallow) was installed in 1984. Continuous water samples were collected until 1993, when the well became sporadically dry. Samples were collected in 2013 but not in 2014 and 2015. Original chloride concentrations in 1984 and 1985 are low (less than 10 mg/L). Filling in Phase I began in 1984 and the chloride concentrations in OW4-84 rose from 1988 to 1992 reaching a high of 354 mg/L. After 1992, the concentrations gradually declined and from 2002 to present have been below 10 mg/L. Phase I was closed and capped in 1993. The exact date the full LCS was brought online is not known but is assumed to have been around closure. The decline in chloride concentrations began around 1993, indicating effectiveness of the LCS.

Chloride levels at OW5-84 have been in the range of 15 to 60 mg/L since 2006. Prior to 2006, chloride concentrations were at background. There is no increasing trend. October 2013 was the first time the additional parameters were sampled at OW5-84. Results indicate that sulphate and iron are also elevated at this location. This well is screened in sand and gravel just above the bedrock. There are no background wells in this formation as the formation is sporadic.

OW8B-10 is screened in the shallow overburden, in the till aquitard, downgradient direction from Phase II/III.

**Table 5-13: Downgradient Groundwater Concentrations Phase II/III – 2015**

| Indicator | Unit | OW8B-10 | | MHB |
|---|---|---|---|---|
| | | **May** | **Sept** | **May** |
| Chloride | mg/L | 10.5 | 12.5 | 96.9 |
| Conductivity | µS/cm | 1,052 | 1,025 | 812 |
| Hardness | mg/L | 487 | 498 | 448 |
| DOC | mg/L | 2.2 | 1.9 | 5.2 |

Chloride concentrations at OW8B-10 are close to background levels. Conductivity and DOC levels are slightly elevated above the concentrations at the upgradient wells. Additional parameters were also analyzed at OW8B-10 for the first time in October 2013. The results continue to show sulphate to be higher at this location (350 mg/L) than at the background well OW2-84 (23.2 mg/L). This well is screened in the till rather than the sand or silt.

OW36 was added as a downgradient well on November 29, 2016. As discussed in Section 4.5, this well remained dry for several months. A sample was finally collected in September 2017 and the well was added to the monitoring program. New data from this well has been included in Appendix I. This Appendix contains new data that became available after the draft report was released for review. Testing of OW36 in 2017 and 2018 showed levels slightly elevated above background with chloride between 18 and 21 mg/L.

MHB is the overflow from the perforated pipe under Stage 5 of Phase II/III. Previous monitoring reports stated that a water sample from the overflow of MHB was tested in November 2007 and the results indicated that “MH-B is not impacted by the landfill” (CRA, 2011). Burnside sampled the overflow in May 2015. Leachate indicator results are included in Table 5-13. The chloride concentration was 96.9 mg/L and the remaining leachate indicator parameters were also slightly elevated. MHB was added to the monitoring program in 2016 and regular samples are being collected. The annual monitoring reports contain an evaluation of the water quality and the potential for landfill impacts. ECA design plans will evaluate existing landfill manholes and stormwater movement and required changes.

Overall, the current Site monitoring shows little landfill impact in the shallow overburden. This is due the effectiveness of the leachate collection systems and the Site hydrogeology. This conclusion was discussed further with the MECP Technical Support after their review of the draft report. A summary of that discussion is included in Appendix I.

### 5.2.2 Bedrock Results

OW8A-91 is upgradient of the fill areas and is considered the background bedrock well for the Site. OW8A-91 located east of the Phase II/III filling area, 90 m from the southern property boundary and 280 m from the eastern property boundary.

OW7-91, located east of stormwater management Basin A, is upgradient to Phase I and cross-gradient to Phase II/III.

The range of concentrations reported for typical leachate indicator parameters over the last 10 years for the background wells are summarized below.

**Table 5-14: Bedrock Background Concentrations 2006 to 2015**

| Parameter | Units | OW8A-91 | OW7-91 |
|---|---|---|---|
| Chloride | mg/L | 2.0 – 17 | <3.0 – 42.2 |
| Conductivity | µS/cm | 570 – 1,140 | 402 - 1,800 |
| Hardness | mg/L | 279 – 1,230 | 300 – 1,270 |
| DOC | mg/L | <1.0 – 14.5 | <0.5 – 10.8 |

The water quality in the two wells is similar. Comparison of the overburden and bedrock chemistry indicates all of the parameters above are higher in the bedrock.

There are two downgradient bedrock wells. OW9A-91 is located at the western side of the property at the bottom of the slope of the entrance lane to the Site, downgradient of Phase II/III. OW32A-02 is located near the northwest corner of the Site beside Perth Rd. 123 and is downgradient of Phase I.

**Table 5-15: Downgradient Bedrock Concentrations – 2015**

| Indicator | Unit | OW9A-91 | | OW32A-02 | |
|---|---|---|---|---|---|
| | | May | Sept | May | Sept |
| Chloride | mg/L | 3.64 | 5.92 | 5.34 | 7.23 |
| Conductivity | µS/cm | 764 | 728 | 612 | 488 |
| Hardness | mg/L | 268 | 273 | 240 | 253 |
| DOC | mg/L | 3.6 | 2.9 | 1.4 | 1.2 |

The parameters analyzed at OW9A-91 and OW32A-02 exhibit the same characteristics as the background bedrock wells. Chloride concentrations at these wells range from 1.5 to 11 mg/L. Historically, iron concentrations at OW32A-02 have been elevated above the ODWQS and were 0.769 mg/L and 0.726 mg/L in 2015. Iron is not analyzed in the background bedrock well. There is no indication of landfill impact to the bedrock aquifer.

### 5.2.3 Private Well Results

Five private water supply wells are sampled as part of the monitoring program. The approximate locations of the private wells are shown on Figure 18. The well owners are provided with the laboratory reports for their wells annually.

The wells are only sampled if the owners are present as the sampling points are inside the residences. For that reason, PW2 and PW3 are sampled periodically. The table below contains the results of the last two samples at each well.

**Table 5-16: Groundwater Concentrations – Private Wells**

| Well | Date | Chloride (mg/L) | Hardness (mg/L) | Conductivity (µS/cm) | DOC (mg/L) |
|---|---|---|---|---|---|
| Overburden | | | | | |
| PW2 | Oct 2013 | 131 | 285 | 891 | 2.0 |
| | May 2015 | 137 | 317 | 988 | 1.8 |
| Bedrock | | | | | |
| PW1 | May 2015 | 3.52 | 258 | 664 | 1.2 |
| | Sep 2015 | 4.36 | 286 | 573 | 0.9 |
| PW3 | Nov 2012 | 557 | 318 | 574 | 1.1 |
| | May 2013 | 62.8 | 269 | 726 | 1.2 |
| PW4 | May 2015 | 3.09 | 299 | 761 | 1.2 |
| | Sep 2015 | 3.50 | 321 | 605 | 1.1 |
| PW5 | May 2015 | 29.4 | 291 | 732 | 1.1 |
| | Sep 2015 | 16.3 | 319 | 619 | 1.0 |

**Overburden Private Wells**

PW2 is located on high ground relative to the Site and is considered to be in an upgradient position as indicated by the shallow groundwater flow patterns. The reported depth suggests it is completed at the same elevation as the inter-till unit identified on site.

PW2 has displayed historically fluctuating levels of chloride. Chloride has ranged from 22 mg/L (May 1985) to 326 mg/L (September 2003). Phenols are generally less than 1 µg/L and the other indicator parameters are generally consistent with background conditions. PW2 is reportedly susceptible to seasonal water level fluctuations and has occasionally become dry during summer months. In the past, a licensed water hauler has reportedly filled the well with imported water in such instances. For these reasons, the meaningfulness of the monitoring results is questionable. Only three samples have been obtained in the last five years due to a resident not being present. Access to the sampling point is from inside the residence.

### Bedrock Private Wells

The dug well at PW1 was replaced by a drilled bedrock well in 2011. Two samples were obtained during 2015. The concentrations of calcium, chloride, hardness and DOC in the new bedrock well are significantly lower than the historical concentrations in the old overburden well.

PW3 has not been sampled since May 2013 as there has not been a resident available to provide access permission. Historically, the chloride concentration has been relatively stable and consistent within a range of 30 to 100 mg/L. The first sample in 1985 was 82.5 mg/L. The waste placement in Phase I began in December 1984, therefore the chloride may be naturally occurring in the bedrock aquifer. The well did have two isolated spikes, one in March 2011 at 1,130 mg/L and one in November 2012 at 557 mg/L. Both times the next sample returned to normal levels.

The groundwater quality at PW4 has been stable and is consistent with background concentrations.

PW5 displayed parameter concentrations similar to background groundwater quality for the current reporting period with the exception of chloride. Chloride concentrations in the range of 24 to 38 mg/L are higher than PW1 and PW4 but lower than PW3. Other parameters analyzed at this location are consistent with historical data and the background bedrock aquifer concentrations.

## 5.3 Surface Water

Surface water monitoring conducted at the Site consists of semi-annual samples from the watercourse and from the two stormwater management basins (Basin A and Basin B). The purpose of this monitoring is to identify impacts on the surface water passing through the Site but not in direct contact with the waste.

The watercourse flows across the Site from the southeast corner to the northwest corner. This watercourse provides drainage of the SMC lands located upgradient of the landfill, as well as industrial land and agricultural land further upstream.

Surface water monitoring location SP1-10 is the upstream surface water station and SP3-93 is the downstream station. SP2-93 is located mid-site between the outlets of the two stormwater management basins.

The stormwater management basins collect runoff from the Site and provide sediment control before releasing stormwater to the onsite watercourse. Basin A is located east of Phase I and Basin B is located northeast of Phase II/III. Samples are collected from the inlets and outlets of these ponds to assess the surface water quality on the Site and to provide a basis for the evaluation of the effectiveness of the stormwater basins.

Water levels are also measured at surface water stations during each monitoring event and stream flows are measured at the downstream station SP3-93. The purpose of the data is to provide a general indication of the flow conditions at the monitoring locations at the time of sampling.

**Table 5-17: Surface Water Monitoring Stations**

| Location | Description |
|---|---|
| **Watercourse** | |
| SP1-10[1] | Upstream (background conditions) |
| SP2-93 | Midstream (between Pond A & B outlets) |
| SP3-93 | Downstream (Site discharge ) |
| **Stormwater Pond A (Phase I)** | |
| SP3A-94 | Pond A south inlet |
| SP5A-94 | Pond A north inlet |
| SP4A-94 | Pond A outlet |
| **Stormwater Pond B (Phase II/III)** | |
| SP1B-94 | Pond B inlet |
| SP2B-94 | Pond B outlet |

[1] SP1-93 at the former property boundary was moved upstream to SP1-10 at the new property boundary as a result of the property transfer in 2009.

**Table 5-18: Surface Water Program Parameters**

| Parameters | | Surface Water Station |
|---|---|---|
| Field pH<br>Field conductivity<br>Field temperature<br>Chloride<br>Hardness<br>Calcium<br>Magnesium<br>Iron<br>Manganese | Ammonia<br>Un-ionized ammonia<br>BOD5<br>Total phosphorus<br>Turbidity<br>TSS<br>TDS<br>Phenols<br><br>Water levels | SP1-10<br>SP2-93<br>SP3-93<br>SP1B-94<br>SP2B-94<br>SP3A-94<br>SP5A-94<br>SP4A-94 |
| Flow Measurement | | SP3-93 |

Benthic surveys of the ditch running through the Site were also conducted in 1993, 1994, 1995, 1996, 1998, 2000, 2002, 2004 and 2006. The surveys compared qualitative and quantitative samples taken from SP1-93 (upstream) and SP3-93 (downstream). The results of these surveys indicated no landfill impact on the benthic communities in the watercourse.

Based on the leachate testing and the background water quality, chloride, total phosphorus, iron and TSS were selected as leachate indicator parameters.

**Basin A**

Surface water collected from the cover of Phase I is directed from the perimeter ditches to channels that enter stormwater Basin A at the south (SP3A-94) and north (SP5A-94). The Basin outlets to the watercourse via a corrugated steel pipe (CSP). The outlet sampling location (SP4A-94) is at the downstream end of the pipe.

Historically, chloride concentrations tended to be the highest at the inlet (SP5A-95) which receives water from the north end of Phase I. The concentrations for 2004 to 2012 were in the 60 to 160 mg/L range. This sampling point has been dry since 2013. The concentrations are generally lowest at the south inlet (SP3A-94) which is typically below 100 mg/L and has also been sporadically dry.

The chloride concentrations at the outlet (SP4A-94) are ranging from 30 to 130 mg/L. Iron and total phosphorus concentrations at the outlet are sporadically above the PWQO. TSS levels at the outlet spiked during 2008 monitoring but returned to the historical range of less than 10 mg/L.

**Basin B**

Surface water collected from the cover and perimeter of Phase II/III is directed to stormwater Basin B by a corrugated steel pipe (CSP) beneath the access roadway. The inlet sample location SP1B-94 is at the discharge of the CSP to Basin B. The Basin also outlets to the watercourse via a CSP. The outlet sampling station (SP2B-94) is at the downstream end of the pipe. These sampling stations are sporadically dry and, for this reason, were only sampled once (November 2014) in the last two years.

Chloride concentrations at the inlet (SP1B-94) are typically higher than the outlet (SP2B-94). In the last ten years, chloride at the outlet has exceeded the Aquatic Protection Value (APV) of 180 mg/L on two occasions (August 2012 and November 2014).

Historical results indicate that the surface water generated from the Phase II/III disposal area and Site operations has elevated levels of iron and phosphorous. Iron levels typically exceed the PWQO at both sampling stations. Levels were at the lower end of the historical range when last sampled in November 2014. Total phosphorus has typically exceeded the PWQO at both stations. It was below the detection limit in November 2014. In the last ten years, TSS at the outlet has generally been below 50 mg//L with occasional spikes to 60 to 80 mg/L.

The quality at the Basin A outlet is better than the quality from Basin B. Both Basins A and B were inspected for sediment buildup in 2015; no significant sediment accumulation was noted in Basin A. The sediment depth was measured near the T-bar in Basin B with approximately 43 cm noted in 2015 which represents a 5 cm increase from 2014. The Basin outlets should be inspected on a regular basis and the structures cleaned of roots/vegetation.

**On-Site Watercourse**

Flow rates have been measured and volumes calculated at the downstream surface water station (SP3-93) since 1994. These flow rates are included in Table F1.3 in Appendix F. Flow rates vary from highs ranging from 200 to 600 L/s to lows of less than 5 L/s. In September of 2015, there was no flow and the channel was dry. This was the first time the watercourse was reported to be dry.

As part of the EA work, flows were measured monthly at SP3-93, as well as an upstream location. The upstream location is approximately 30 m east of DP1 (between DP1 and SP1-10). The water at SP1-10 is ponded during low flow conditions and would not have been a reliable measuring location. The channel at DP1 is wide and was also not a suitable location for good flow measurements.

Data was not collected in January or February 2016 due to winter conditions. Measurements were made on March 29 when water levels were high due to snow melt and rainfall. Measurements were continued monthly through to July and then again in October 2016. The comparison of flows between the upstream station and downstream stations shows a gaining stream in the spring and fall and a losing stream in the summer.

There are three water quality sampling stations along the watercourse. The mid-site location, SP2-93 has only been sampled since 2013. Typically, the water quality is similar between upstream (SP1-10) and downstream (SP3-93). This indicates no landfill impact on the watercourse. Chlorides at the upstream station have varied from 13 to 887 mg/L, phosphorus from less than detection limit to 0.69 mg/L and iron from 0.05 to 127 mg/L. Iron and phosphorous typically exceed PWQO at all three locations.

## 5.4 Cement Kiln Dust Stockpile

In 2005, a report on the CKD stockpile was compiled by Golder Associates for St. Marys Cement. The work included drilling three boreholes through the CKD, collecting and testing samples of the material, installing three monitoring wells and collecting a round of water samples for testing. This report was made available to the Town of St. Marys when the Town acquired that part of the site. However, the report contents were confidential and were not available for inclusion in the 2017 *Draft Hydrogeology Study*. That stipulation was lifted in 2019. The report was submitted to the MECP for review on April 4, 2019.

As a follow up to the MECP review, Burnside collected water samples from the three monitoring wells in the CKD stockpile in June 2019. The laboratory data and additional information are contained in Appendix I. This Appendix contains new data that became available after the draft report was released for review. Conclusions from the testing were:

- The water quality is not homogeneous throughout the stockpile. The water quality at the southeast corner of the stockpile is considerably better than the quality in the centre.
- The water quality, while still exceeding some Reg 153 Table 2 criteria, has improved overall from the 2005 testing.

The cement kiln dust stockpile (CKD) has been in place for approximately 30 years. The cap and side slopes are well vegetated, and no erosion has been noted during recent field work in the area. The current watercourse wraps around the south and west sides of the stockpile. Water quality samples from the watercourse since 1985 (as part of the landfill monitoring) have not detected an impact from the landfill or the CKD stockpile. The water quality upstream is typically similar to the water quality downstream.

The potential for future impact remains low if the stockpile is undisturbed. Geotechnical work would be needed if significant work takes place on the stockpile. The relocation of the watercourse may necessitate relocating some of the CKD material along the north side of the stockpile. The work would need to be completed prior to relocation of the watercourse and a cap re-established on the material.

# 6.0 Assessment of Alternative Methods

## 6.1 Alternative Methods to Expand the Existing Landfill

As stated in Section 1.0, the preferred *Alternative to the Undertaking* is to expand the existing landfill. Therefore, the *Alternative Methods* are design options for an expansion. The purpose of this study, as stated in the Hydrogeology Work Plan is:

> *To evaluate a variety of Alternative Methods for expanding the St. Marys landfill in order to fulfill the Town's post-diversion solid waste disposal needs for the next 40 years.*

Five *Alternative Methods* were proposed and are summarized in Table 6-1. A conceptual drawing has been created for each method. These are included in Appendix G. These are not landfill designs, but rather general footprint areas taking into account required buffers, setbacks and maximum slopes.

**Table 6-1: Alternative Methods for Carrying Out the Undertaking**

| Alternative Methods | | Description |
|---|---|---|
| 1 | Vertical expansion of the existing landfill | This *Method* involves an expansion in the vertical direction within the existing footprint of the landfill. |
| 2 | Horizontal expansion of the existing landfill | This involves an expansion outside of the existing landfill footprint. |
| 3 | A combination of vertical and horizontal expansion | This *Method* would involve partial vertical expansion along with some horizontal expansion of the landfill footprint, basically a mixture of *Methods* 1 and 2. |
| 4 | Development of a new landfill footprint | This *Method* involves closure of the existing 8 ha footprint and development of a new landfill footprint elsewhere on the 37 ha Site. |
| 5 | Vertical expansion plus a new footprint | This *Method* is a combination of Methods 1 and 4. |

To assist in assessing how each method will alter the Site, schematic outlines of the Alternative Methods have been added to the cross-sections (see Figures 19, 20 and 21).

The potential volume available with each Alternative Method has been calculated based on the footprint area and proposed height-of-fill contours. The contours will be adjusted during the EPA design stage. The estimated volume required by the Town for 40 years of waste and cover capacity is approximately 708,000 $m^3$.

## 6.2 Impact and Mitigation Evaluation

Each alternative was evaluated according the how it would alter the Site. The alterations included, for example, increasing the height of the waste mound, increasing the waste footprint area, changing topography and slopes, creating new areas of the Site covered by a waste footprint, or altering current stormwater and leachate controls. The impact of each alteration was then considered on:

- Leachate generation
- Groundwater quantity
- Groundwater quality
- Surface water quantity
- Surface water quality

The geological and hydrogeological data contained in Section 4.0 and 5.0 was used in the evaluation of alternative methods. The advantages and disadvantages of the alternatives were determined based on their potential for impact on the hydrology of the Site. Potential impacts could include:

- Construction Phase(s):
  - Encountering silt, sand or gravel seams during construction of cells and stormwater control features;
  - Encountering shallow saturated soil during construction of cells and stormwater control features, and,
  - Encountering contaminated soil during construction.
- Active Filling Phase:
  - Leachate production, mounding and outbreaks;
  - Surface water control;
  - Alteration of shallow groundwater flow;
  - Contaminant migration away from the landfill in shallow groundwater toward surface water features and the property boundary; and,
  - Downward contaminant movement into till.
- Closure and Post-Closure Phase:
  - Leachate production, mounding and outbreaks;
  - Contaminating life span; and,
  - Aggregate resource nearby.

The potential for impacts was based on the expectation that the landfill features required for proper operations would be of sound design and construction. As a minimum, they will be equal to the current design. For example, if the current stormwater control basins need to be relocated, it is assumed that the replacement basins will be properly designed and will meet the same or higher levels of quantity and quality control now in place.

Tables H-1 in Appendix H evaluate the expected Site alterations for each Alternative Method and the related potential impacts. The Site alterations use the existing conditions and the current landfill design and operations as the baseline. Therefore, if a Site alteration is judged to have No Net Impact to groundwater and surface water that does not mean no impact at all, but rather no new impact beyond current Site conditions.

The potential impacts outlined in Table H-1 could be either positive or negative. Some impacts apply to more than one Alternative Method. Each negative impact was given a sequential number (N1, N2, N3, etc.). The negative impacts were then listed in Table H-2 Groundwater or H-3 Surface Water in Appendix H. The tables outline possible mitigation measures for each impact. Each impact and the associated mitigation measures were ranked according to the perceived magnitude. The magnitude was based on both the severity of the impact and the scale of the mitigation measures needed to address it. The rankings were:

- Minor potential impact - requires monitoring with potential for future mitigation (e.g. monitoring around CKD stockpile);
- Low potential impact - requires Site feature alterations with continued monitoring (e.g. stormwater controls);
- Medium potential impact - requires enhanced engineering with monitoring (e.g. extension of current leachate collection system); or
- Major potential impact - requires substantial engineering measures (e.g. redesigned or enhanced leachate collection system).

The following sections summarize the impacts and outline some of the possible mitigation measures. The purpose of outlining the mitigation measures is not to provide all the possible outcomes, but to evaluate the magnitude of the impact by the scale of the mitigation measures that may be needed. Alternative methods that have many minor impacts would be more acceptable than methods that have one or two major impacts.

The impacts and mitigation measures are focused on the On-site Study Area and not the Study Area Vicinity. The impacts in this study are all water related and the goal is to minimize the on-site impacts with mitigation measures to eliminate the off-site impacts in the Study Area Vicinity.

### 6.2.1 Leachate Generation

While this report is focused on groundwater and surface water quantity and quality, the alternative methods could affect the amount and the strength of the leachate produced. This in turn could impact the water resources. Therefore, impacts that affect leachate generation are included in the impact assessment. Leachate related impacts fall into three categories:

**1) Increased leachate generation:**

Impact – This includes an increase in the volume of leachate produced by increasing the footprint area and exposing a larger surface area of waste. It also includes changes to topography within the footprint that could induce more infiltration of precipitation.

Mitigation – Design and Operations to reduce work area (keep working area small), good use of interim, final cover and grading to promote runoff, vegetation to promote evapotranspiration, and stormwater collection and controls. An extension of the current leachate collection system to cover additional footprint areas will require an assessment of the sewage treatment capacity and measuring of the volume produced by the Site. Reducing infiltration into the waste will lower the annual production of leachate but could increase leachate strength or increase the contaminating life expectancy.

**2) Increased mounding of leachate in the waste:**

Impact – Increasing the height of the waste mound could also increase the height of the leachate mounding within the waste. The current leachate collection system was put in place to control the mounding in the existing phases. It was recognized in the design of the phases that infiltration of leachate into the till would be low due to the low permeability of the till. To reduce the potential for leachate breakouts on the side slopes, the current systems were constructed. Controlling the leachate head was also a consideration to controlling the downward movement of leachate into the sand seam underlying Phase II/III. The 1992 design noted higher hydraulic heads in the groundwater in the sand seam than in the leachate collection system.

Mitigation – The design of the leachate collection system would need to be modified or enhanced to maintain the current leachate levels within the waste.

**3) Change in leachate chemistry or strength**

Impact – Placing new waste over existing waste or over the existing cement kiln dust stockpile (CKD) could change the chemistry of the leachate.

Mitigation – Monitoring chemistry in the leachate collection system and/or the CKD and evaluating the ability of the STP to treat it. The municipality has a sewer use by-law in place, but it was meant for commercial and industrial sewage generators.

### 6.2.2 Groundwater Quantity

Changes to groundwater quantity fall into two categories:

**1) Infiltration**

The most significant impact to groundwater quantity would be reducing infiltration or increasing discharge. Extensions of the Leachate Control System (LCS) would increase the removal of water from the Site through the STP. Steeper side slopes or additional slope area would increase rainfall runoff to stormwater features for release into the surface water system, rather than infiltration into groundwater.

While these were noted as impacts, the change to infiltration on the Site has not been considered to be significant. The amount of groundwater recharge at the Site is already low. The current groundwater conditions include a low permeable till that is partially dry with perched water near the surface or in the inter-till sand/silt seams. The top of the bedrock is dry as there is little downward movement of groundwater from till to bedrock.

**2) Flow Direction**

Impact - The shallow groundwater flow pattern below the existing footprint is from west to east toward the watercourse with some discharge of groundwater into the watercourse. East of the watercourse, there is a groundwater mound below the CKD stockpile. The shallow groundwater moves from the CKD stockpile westward toward the watercourse. Moving the watercourse or altering the topography of the Site without controlling groundwater mounding could alter the shallow flow path. Re-aligning the watercourse and using the current channel as part of a future footprint would remove a shallow groundwater discharge point. With no outlet, water levels in that area would rise until the flow direction reversed. There could also be potential for groundwater contaminated by the CKD to migrate west and influence water quality near an expanded landfill footprint.

Mitigation – A conceptual model of current flow and potential flow taking into account the mounding in the waste, in the CKD mound, the location of the new watercourse may be needed to design new footprint areas. An extended leachate collection system would control mounding in the waste but additional works may be required to maintain shallow groundwater flow from the CKD mound toward the current watercourse location. The groundwater flow would have to be either cut off before reaching the waste or picked up in the LCS. The water level monitoring program will need to be revised to track changes to the shallow groundwater movement as expansion development occurs.

### 6.2.3 Groundwater Quality

**1) Leachate or stormwater runoff moving downward to sand/silt seam.**

Impact – An inter-till sand seam has been identified below Phase II/III. This is the seam through which a drainpipe runs between MHA and MHB. The seam is not present or is present as silt over the remainder of the Site. Adding more waste above Phase II/III could result in higher leachate heads moving water downward into this seam. There is also potential for additional footprint areas or new Site features such as excavated stormwater basins or a re-aligned watercourse to open pathways for water to reach the seam (if present).

Mitigation – The presence of the seam would be determined in proposed construction locations. If present and shallow, it may need to be excavated and replace with more impermeable soil if necessary. The leachate head in waste will need to be controlled by an extension of the current LCS or by modifying and enhancing the existing LCS. If necessary, water from MHB could be diverted and treated.

**2) Leachate moving laterally into sand/silt seam from excavation of new footprint or filling of existing watercourse channel.**

Impact – Excavating 5 m of soil from new footprint areas would result in the bottom of the new landfill being at approximately the depth of the current watercourse channel (the channel is approximately 5 m deep from top of bank). Therefore, silt and sand noted in OW4-84, OW6-84, TP5 and TP6 (see Figures15 and 16, Site Cross-Sections) would be exposed in sidewalls of excavation. If the seam is not saturated, leachate could migrate into the sidewalls. If the seam is saturated, shallow groundwater would seep into the excavation or into the waste once in place.

Mitigation – The presence of the seam would be determined in proposed construction locations. If present and shallow, it may need to be excavated and replace with more impermeable soil. The depth of excavation may need to be reduced to maintain the bottom of landfill above the seams, increasing the above ground contours. Another alternative would be a liner designed to separate groundwater in the seam from the waste. Where the seam is not present, construction inspection of floor and side walls for permeable seams would be required.

**3) Reduced separation between bottom of waste and bedrock.**

Impact – The elevation of the top of the bedrock appears to rise toward the north and east sides of the Site. Placing waste in those areas, in conjunction with excavation below current ground level, places the waste closer to the top of the bedrock (the regional aquifer). This reduces till thickness separating the waste from the bedrock.

Mitigation – The depth to bedrock and characteristics of soil between surface and bedrock would need to be confirmed. Current groundwater flow in the bedrock is toward the west (toward private wells and the Thomas Street Quarry) and toward the north (the SMC plant and quarry wall). Major enhancement of the LCS (such as adding a liner) may need to be considered to provide additional separation between waste and bedrock.

### 6.2.4 Surface Water Quantity

#### 1) Increased Runoff

Impact – Adding height to the current fill areas (increasing slope length), adding more waste footprint area (creating more sloped areas), creating slopes on areas that are currently flat, and creating slopes closer to the top of watercourse bank will increase runoff. Runoff could be more rapid with slightly less infiltration; however, infiltration is low in existing conditions due to low permeable surface soil. There could be less retention of water if existing flat areas or surface depressions are reduced and less potential for evaporation or evapotranspiration.

Mitigation – New stormwater and erosion controls measures will have to be incorporated into the design of all Alternative Methods. This could include berms, retention ponds, grassed waterways and vegetated buffer strips to handle clean water on the Site. Some Alternative Methods will require the decommissioning of the current stormwater Basins A and B and new stormwater pond construction.

#### 2) Altered surface water movement across the Site

Impact – Altering the location of the watercourse and stormwater basins or altering Site topography by adding new footprint areas will redirect surface water movement across the Site. Currently, surface water is channeled to the stormwater basins and from there into the watercourse in the centre of the Site. Similarly, runoff from the west side of the CKD stockpile moves toward the centre of the Site. Realigning the watercourse to a position along the eastern and northern property boundary will require moving water from the west and south part of the Site across the Site.

Mitigation – Landfill design will need to incorporate proper grading and stormwater controls to direct, slow and retain water.

### 6.2.5 Surface Water Quality

#### 1) Potential for contaminated runoff

Impact – The risk of precipitation and clean runoff coming in contact with waste may be increased by adding waste above the current Phase I and Phase II/III footprints, adding new footprint areas, and moving the footprint closer to the stormwater basins and watercourse.

Mitigation – The Design and Operations of an expanded landfill will need to incorporate proper stormwater design and best management practices. These could include:

- Control of the size of active working areas.
- Timely grading and covering of completed or dormant areas.
- Diverting clean water away from the waste (including drop-off, recycling, MHSW, and compost areas).
- Retaining water that contacts waste within the footprint and LCS.
- Slowing release of runoff to the watercourse and controlling erosion and sedimentation.
- Berms or vegetated buffer strips to separate footprint areas and watercourse/stormwater retention areas.
- Final cover and erosion control vegetation to maintain cover.
- Contain waste to waste handling areas (including drop-off, recycling, MHSW, compost areas, and wood wastes).
- Encouraging growth of native vegetation in stormwater retention areas.

**2) Leachate break out on side slopes**

Impact – Mounding of leachate within the waste could lead to leachate seeps along slide slopes. There is a potential for seeps to mix with clean runoff and move into the stormwater system.

Mitigation – Leachate mounding must be controlled by reducing infiltration into the top of the waste, facilitating seepage of leachate out the bottom of the waste (LCS) or adding a leachate drainage layer on the above-grade side slope to direct leachate seeps to the LCS. Operations, final cover and proper grading are important in reducing infiltration. Depressions that hold water on the landfill surface must be eliminated. Due to the low permeability soils at this Site, removing leachate from the mound requires the installation and maintenance of a leachate control system.

**3) Re-alignment of watercourse closer to CKD stockpile**

Impact – Re-aligning the watercourse from the centre of the Site to the eastern and northern boundary could put the watercourse closer to the CKD stockpile. Water levels within the stockpile indicate mounding and radial flow outwards from the pile. Cutting a new channel near the toe of the stockpile could induce shallow flow from the stockpile into the channel.

Mitigation – The water quality within the stockpile should be monitored.

## 7.0 Permits and Authorizations

Other permits or authorizations may be required prior to construction. Permits and authorizations often associated with hydrogeology include:

- Environmental Compliance Approval (monitoring, trigger mechanisms and contingency planning);
- Conservation Authority Regulations; and
- Ontario Water Resources Act, approvals for storm water control and leachate collection systems.

A Source Water Protection Risk Management Plan is not required as the Site is not within a Municipal Wellhead Protection Area or Intake Protection Zone.

# 8.0 Preferred Method

This report assessed the current Site conditions including previous man-made terrain and contaminant sources. It used that base to outline the potential impacts to groundwater and surface water from each alternative method and provided mitigation measures for each impact. These mitigation measures, such as a leachate collection system for leachate management, will need to be incorporated in the final design of the preferred alternative.

Based on the Site characteristics as described in this report and the impacts outlined in Section 6.0 and Appendix H, the alternative methods have been ranked from most impact to least impact. The magnitude of the impacts were ranked based on the magnitude of Site alterations required to mitigate each potential impact.

**Leachate Generation and Groundwater**

*Most Impact*

- Method 5
- Method 2
- Method 3 and Method 4
- Method 1

Least Impact

**Surface Water**

*Most Impact*

- Method 1 and Method 5
- Method 4
- Method 2 and Method 3

Least Impact

The method with the lowest combined impact on both groundwater and surface water is Method 3 – Combination of Vertical and Horizontal Expansion.

The preferred method is selected in the Environmental Assessment report based on the method rankings submitted by all of the disciplines involved (terrestrial, aquatic ecology, air quality, etc.). This hydrogeology assessment report should be read in conjunction with the Environmental Assessment report.

The overall Preferred Method is selected in the Main Environmental Assessment Report. Therefore, mitigation, monitoring and conceptual contingency plans are outlined in the final EA Report.

Technical groundwater and surface water comments provided by reviewing agencies (primarily the MECP) on drafts of this report, along with responses to those comments are contained in Appendix I and Appendix J of this Hydrogeology Study Report.

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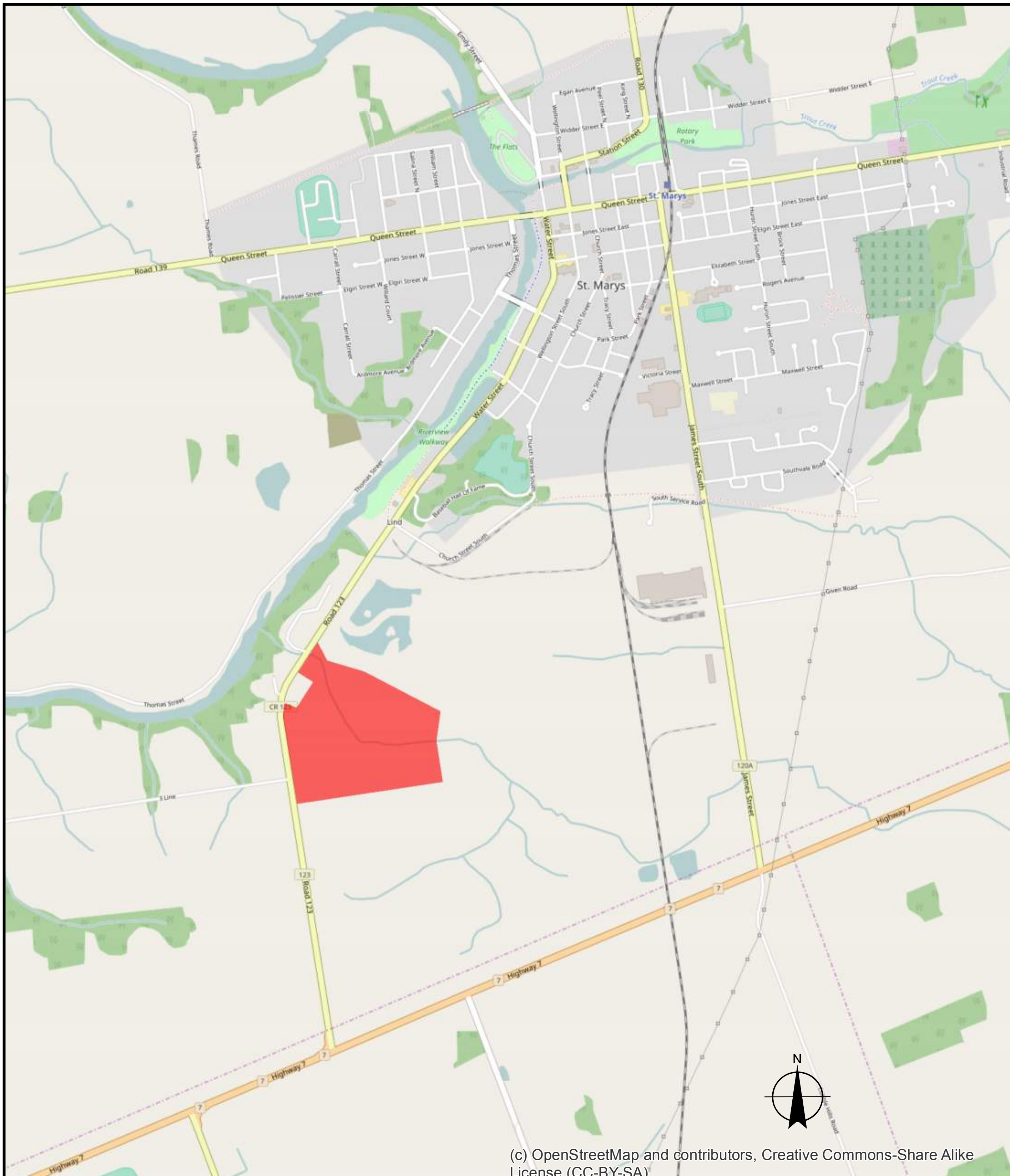
BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

# Figures



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Map Title

**SITE LOCATION**

Client / Report

THE TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

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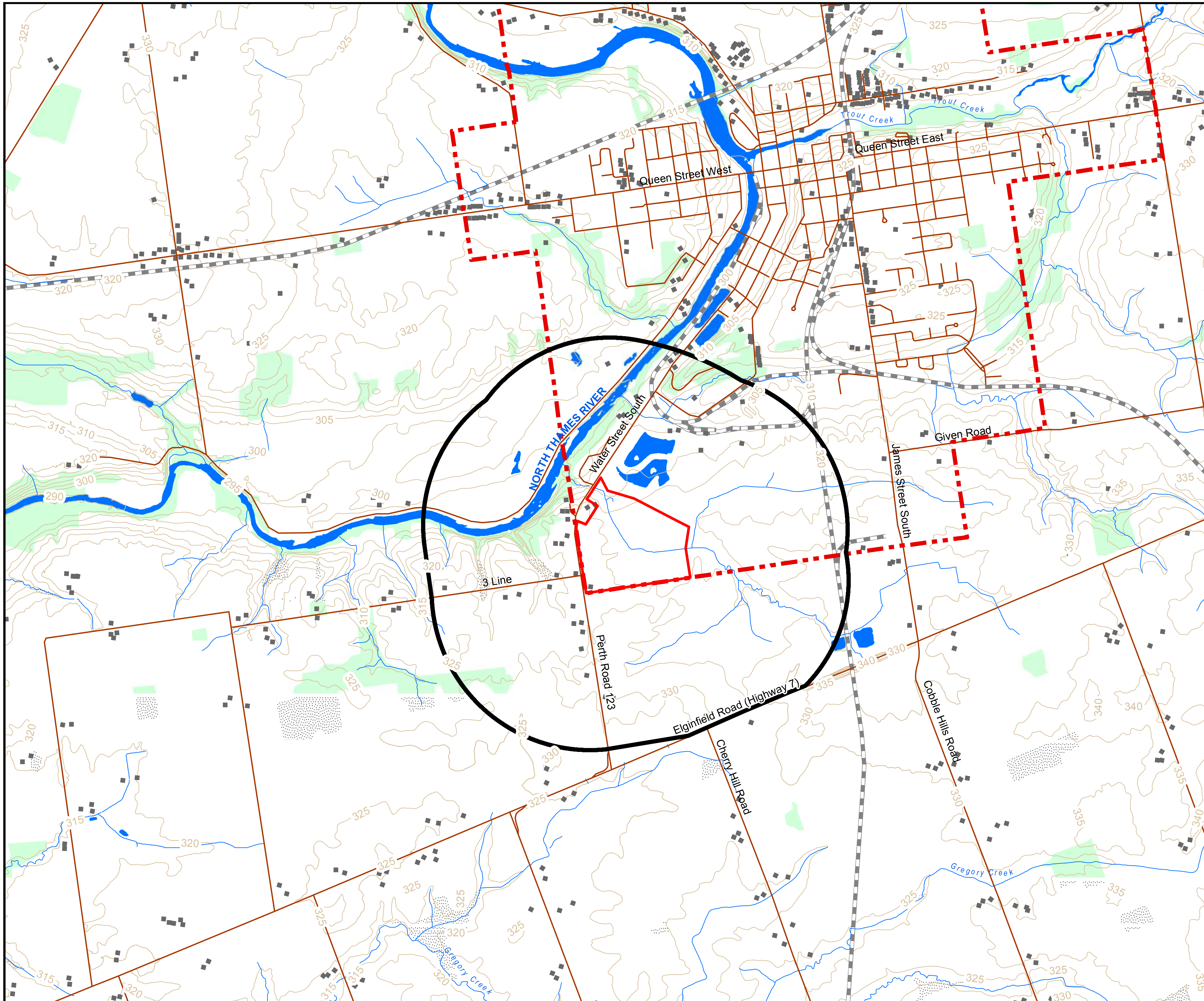


LEGEND

- ON-SITE STUDY
- STUDY AREA
- ST. MARYS TOWN LIMIT
- ROADWAY
- BUILDING
- WATERCOURSE
- RAILWAY
- CONTOUR (5m intervals - masl)
- WETLAND
- WATERBODY
- WOODED

**Sources:**

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TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**REGIONAL LOCATION**

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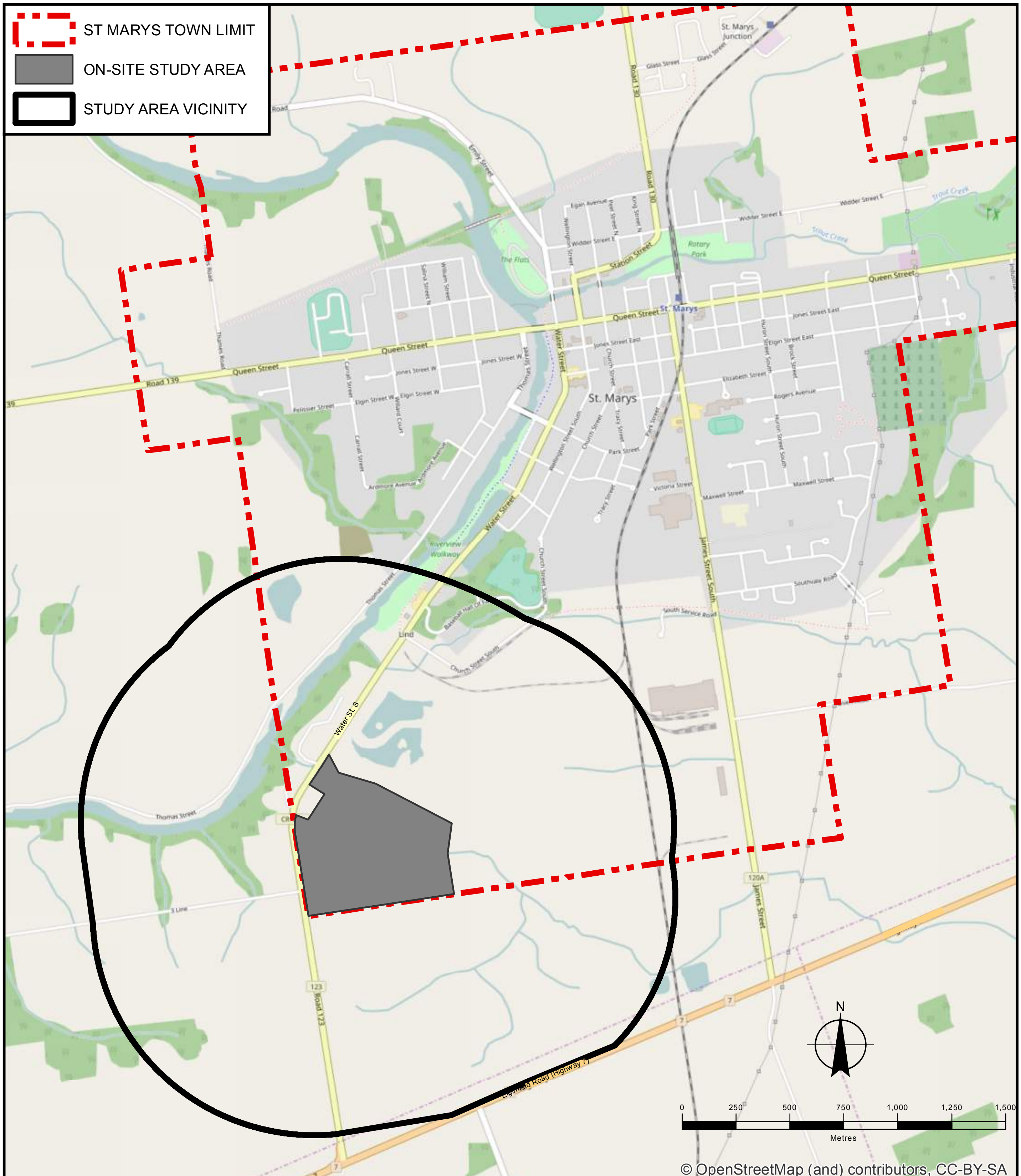


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LEGEND

- ON-SITE STUDY AREA
- STUDY AREA VICINITY

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THE TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**REGIONAL AERIAL PHOTOGRAPH**

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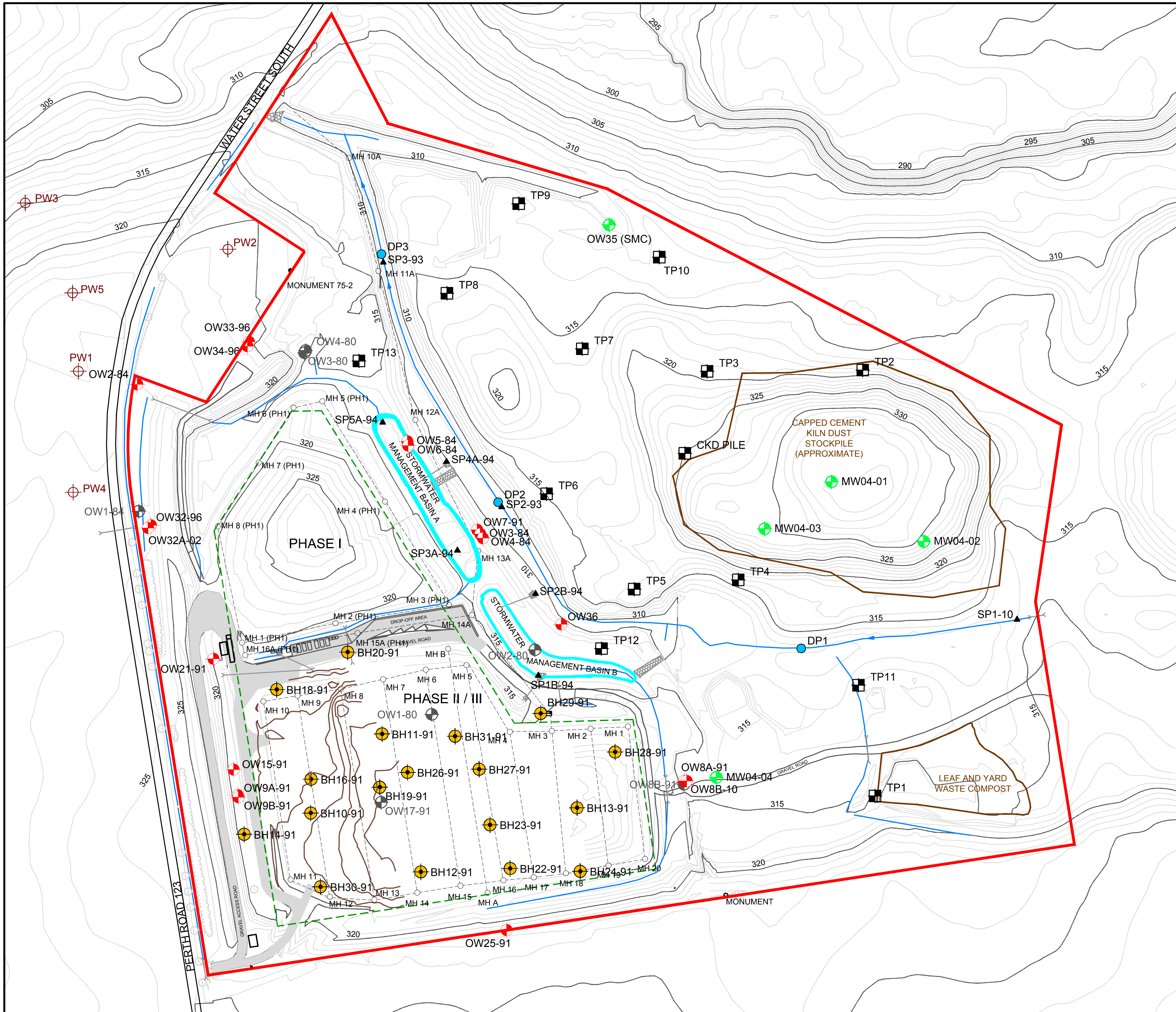


## LEGEND

- ON-SITE STUDY AREA
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- CONTOUR (5m intervals - masl) (MNR - SWOOP2010 - digital elevation data)
- CONTOUR (1m intervals - masl) (MNR - SWOOP2010 - digital elevation data)
- CONTOUR (1m intervals - masl) (RJB 2015 Survey)
- STORM WATER MANAGEMENT BASIN
- LEACHATE COLLECTION SYSTEM
- LEACHATE MANHOLE
- OBSERVATION WELL (ANNUAL MONITORING REPORT)
- OBSERVATION WELL (ABANDONED AND SEALED)
- OBSERVATION WELL
- DRIVE POINT PIEZOMETER
- BOREHOLE
- PRIVATE DOMESTIC WELL (APPROXIMATE LOCATION)
- SURFACE WATER MONITORING LOCATION
- TEST PIT

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TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**SITE PLAN**

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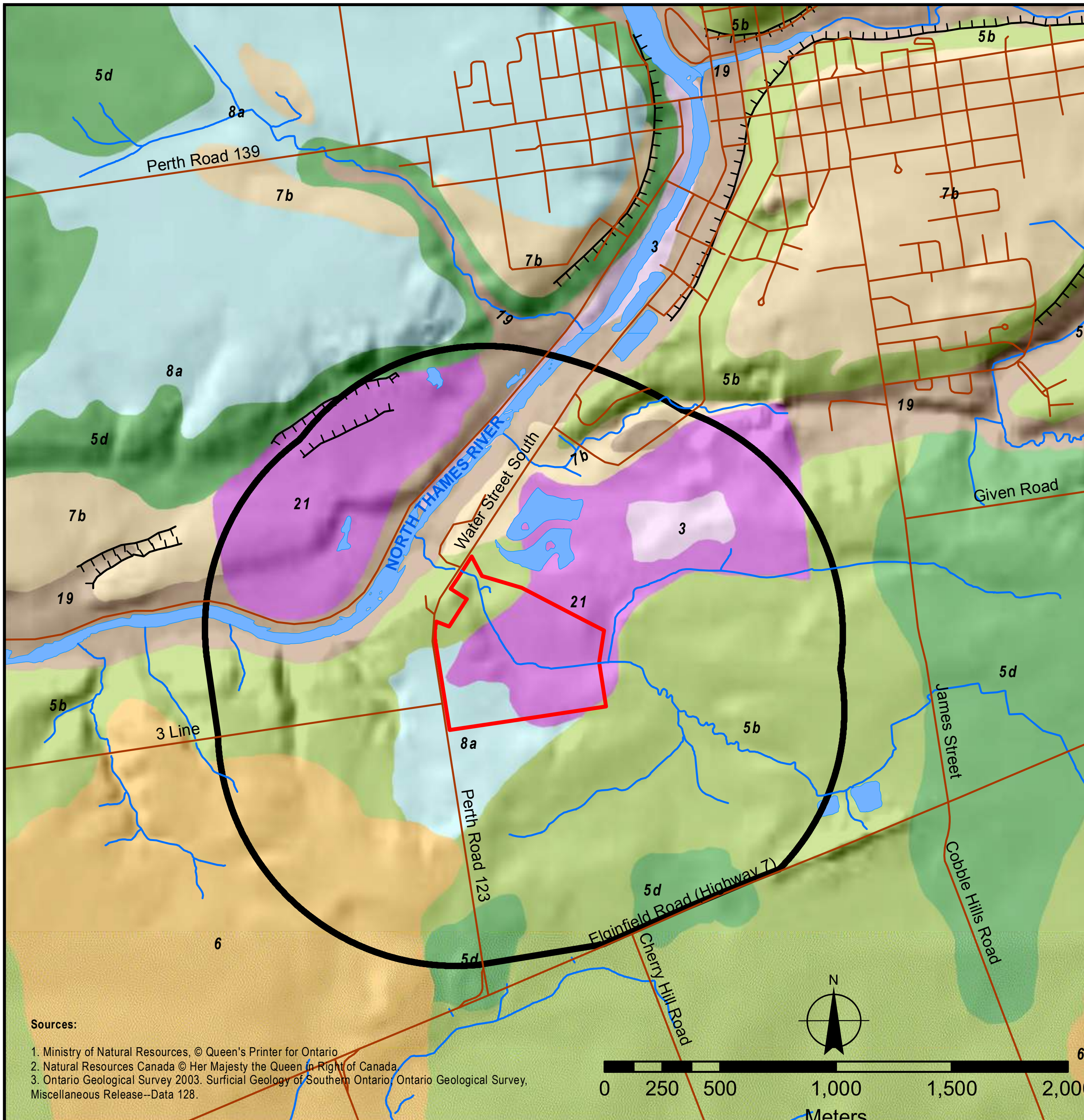


**Sources:**

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada
3. Ontario Geological Survey 2003. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.

**LEGEND**

- ROADWAY
- WATERCOURSE
- WATERBODY
- ON-SITE STUDY AREA
- STUDY AREA VICINITY
- Terrace
- 3: Paleozoic bedrock
- 5b: Stone-poor, carbonate-derived silty to sandy till
- 5d: Glaciolacustrine-derived silty to clayey till
- 6: Ice-contact stratified deposits
- 7b: Glaciofluvial deposits: Gravelly deposits
- 8a: Fine-textured glaciolacustrine deposits: Massive-well laminated
- 19: Modern alluvial deposits
- 21: Man-made deposits

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Map Title

**SURFICIAL GEOLOGY**

Client / Report

THE TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

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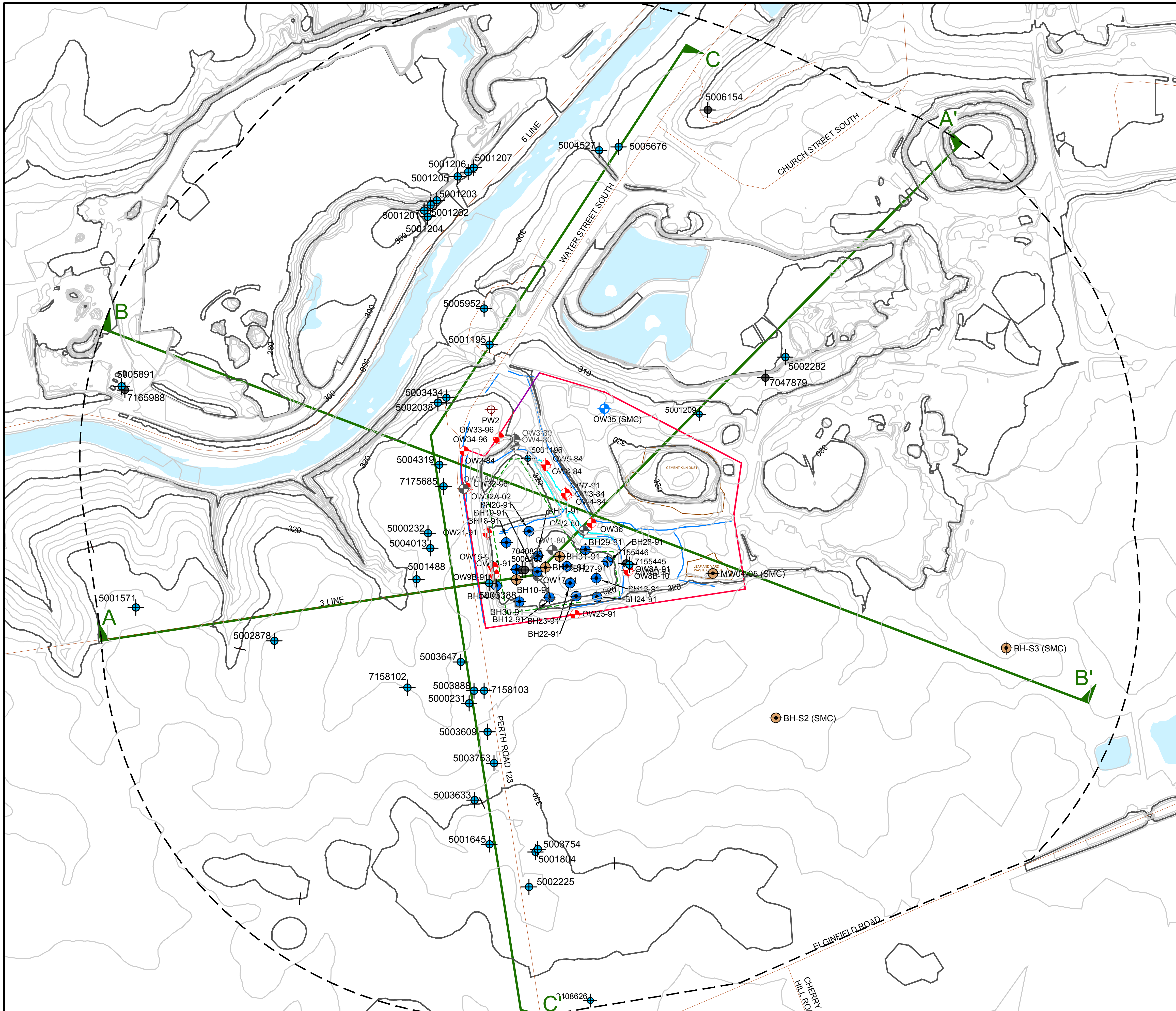


## LEGEND

- ON-SITE STUDY AREA
- STUDY AREA VICINITY
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- CONTOUR (10m intervals - masl)
- CONTOUR (2m intervals - masl)
- ROADWAY
- OBSERVATION WELL
- OBSERVATION WELL (ABANDONED AND SEALED)
- OBSERVATION WELL (SOURCE UNKNOWN)
- PRIVATE DOMESTIC WELL (APPROXIMATE LOCATION)
- MOECC WELL RECORD LOCATION
- MOECC WELL RECORD LOCATION (ABANDONED)
- BOREHOLE
- A A' CROSS SECTION LOCATION KEY

Note: Well locations were not field checked

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TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**REGIONAL TOPOGRAPHY AND CROSS SECTIONS**

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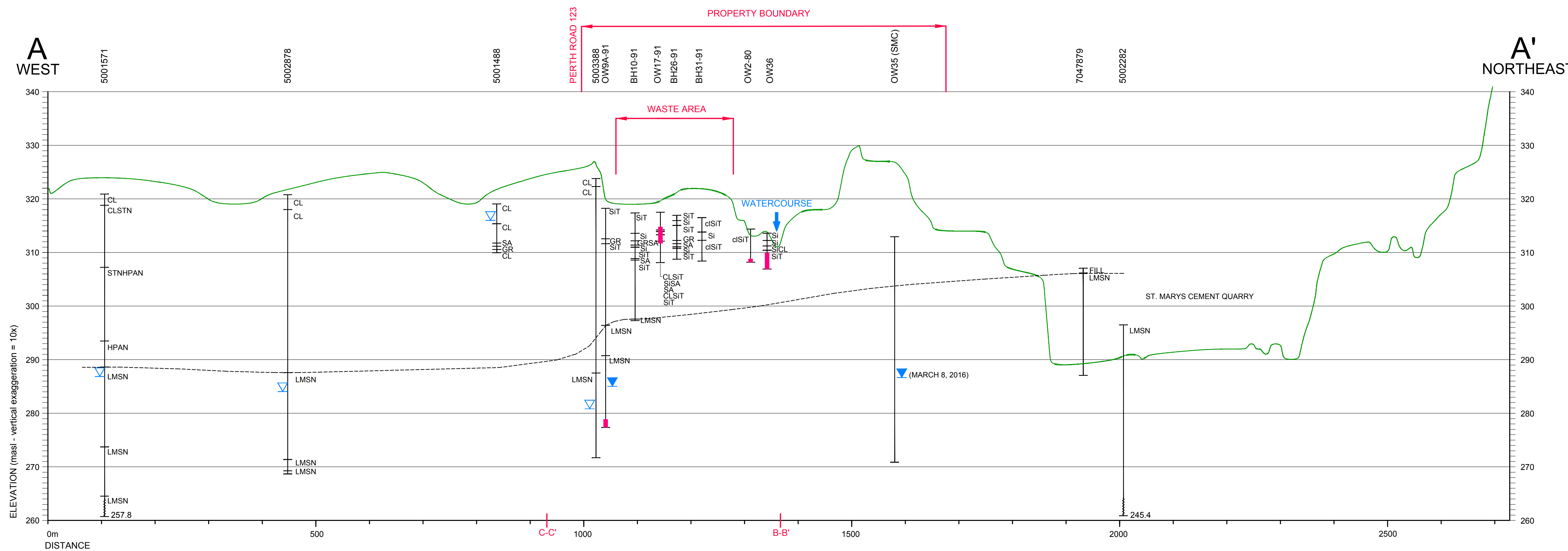


## LEGEND

4901807 MW10 —— WELL / BOREHOLE ID

—— MOECC WELL RECORD NUMBER

—— GROUND LEVEL

—— WELL

CLGR —— GEOLOGICAL STRATIGRAPHY

—— STATIC WATER LEVEL (REPORTED ON MOECC WELL RECORD)

—— MEASURED WATER LEVEL (DECEMBER 14, 2015)

—— WELL SCREEN

- - - - INTERPRETED GEOLOGICAL CONTACT

WATERCOURSE CROSSING

| | | | | | |
|---|---|---|---|---|---|
| cl | CLAYEY | CL | CLAY | TS | TOPSOIL |
| si | SILTY | Si | SILT | T | TILL |
| sa | SANDY | SA | SAND | F | FILL |
| gr | GRAVELLY | GR | GRAVEL | MRL | MARL |
| | | STN | STONES | HPAN | HARDPAN |
| | | BLD | BOULDER | RCK | ROCK |
| | | LMSN | LIMESTONE | PRDG | PREDUG |

BURNSIDE

Client / Report
TOWN OF ST. MARYS
*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title
**REGIONAL CROSS SECTION A-A'**

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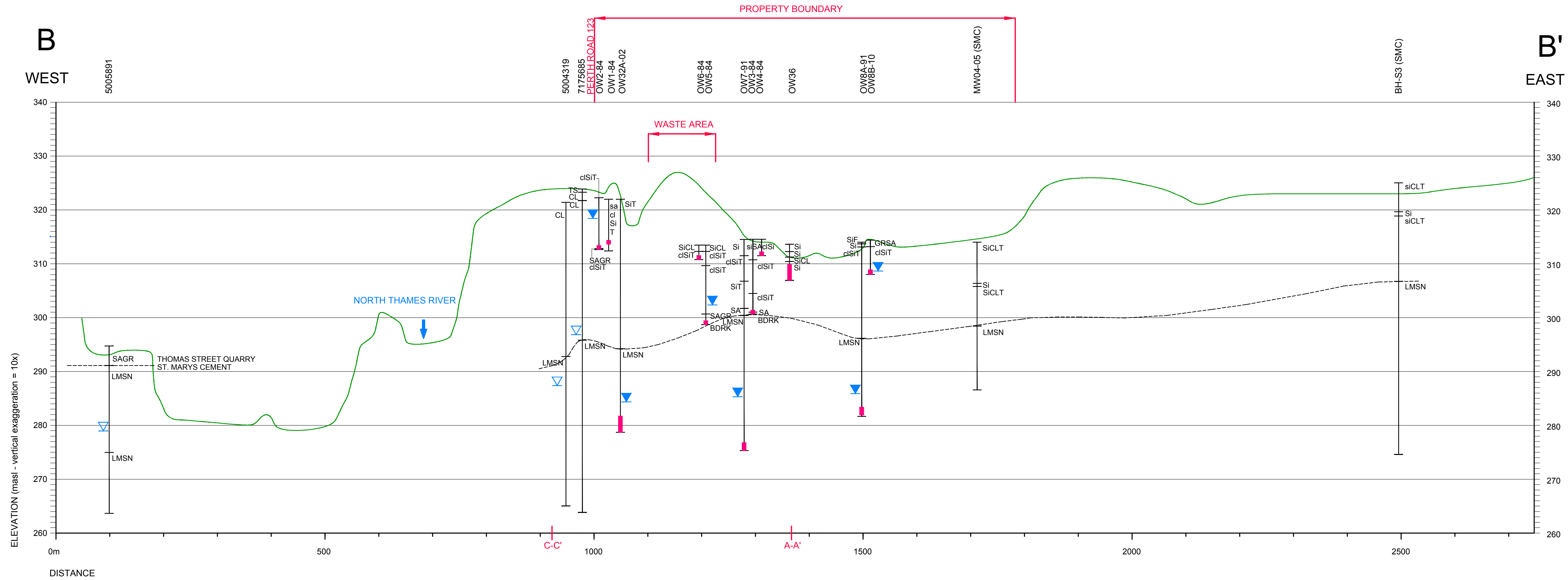



## LEGEND

- 4901807 — MOECC WELL RECORD NUMBER
- MW10 — WELL / BOREHOLE ID
- GROUND LEVEL
- WELL
- CLGR — GEOLOGICAL STRATIGRAPHY
- STATIC WATER LEVEL (REPORTED ON MOECC WELL RECORD)
- MEASURED WATER LEVEL (DECEMBER 14, 2015)
- WELL SCREEN
- INTERPRETED GEOLOGICAL CONTACT
- WATERCOURSE CROSSING

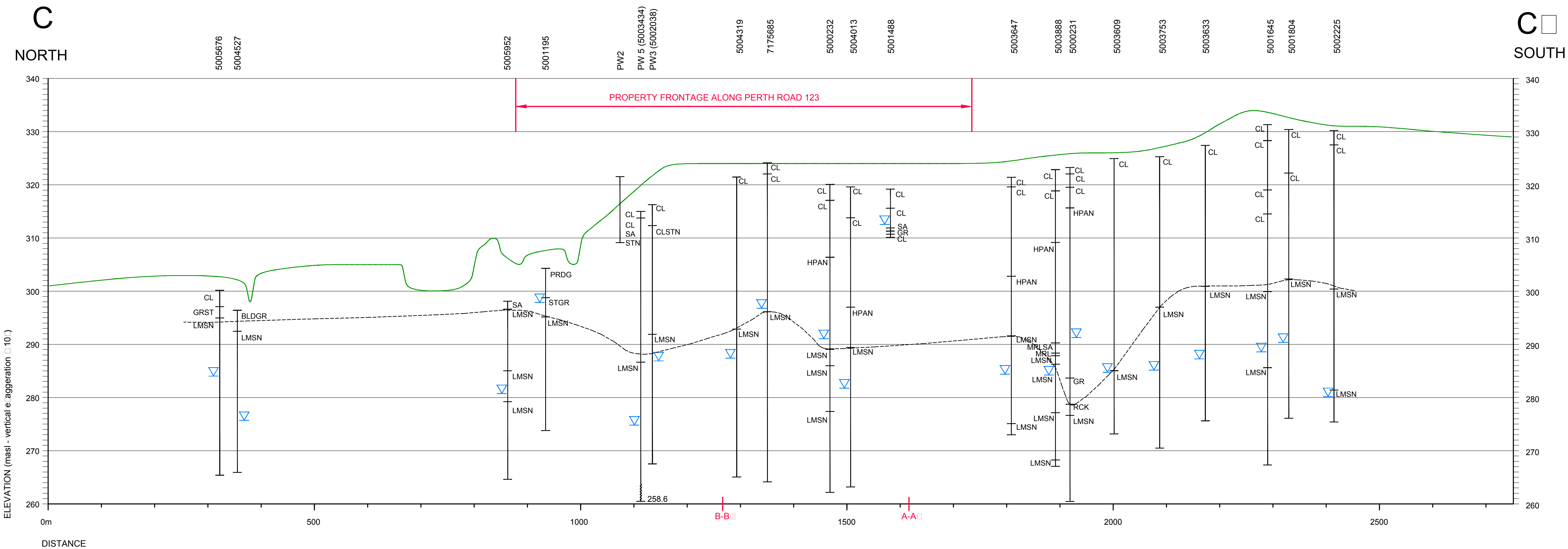
| | | | | | |
|---|---|---|---|---|---|
| cl | CLAYEY | CL | CLAY | TS | TOPSOIL |
| si | SILTY | Si | SILT | T | TILL |
| sa | SANDY | SA | SAND | F | FILL |
| gr | GRAVELLY | GR | GRAVEL | MRL | MARL |
| | | STN | STONES | HPAN | HARDPAN |
| | | BLD | BOULDER | RCK | ROCK |
| | | LMSN | LIMESTONE | PRDG | PREDUG |

BURNSIDE

Client / Report
TOWN OF ST. MARYS
*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title
**REGIONAL CROSS SECTION B-B'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | MARCH 2017 | 9 |
| Scale | | Project No. | |
| H-1:7,500 V-1:750 | | 300032339 | |




## LEGEND

| | |
|---|---|
| 4901807 / MW10 | WELL / BOREHOLE ID |
| | MOECC WELL RECORD NUMBER |
| | GROUND LEVEL |
| | WELL |
| CLGR | GEOLOGICAL STRATIGRAPHY |
| | STATIC WATER LEVEL (REPORTED ON MOECC WELL RECORD) |
| | MEASURED WATER LEVEL (DECEMBER 14, 2015) |
| | WELL SCREEN |

---- INTERPRETED GEOLOGICAL CONTACT

WATERCOURSE CROSSING

| | | | | | |
|---|---|---|---|---|---|
| cl | CLAYEY | CL | CLAY | TS | TOPSOIL |
| si | SILTY | Si | SILT | T | TILL |
| sa | SANDY | SA | SAND | F | FILL |
| gr | GRAVELLY | GR | GRAVEL | MRL | MARL |
| | | STN | STONES | HPAN | HARDPAN |
| | | BLD | BOULDER | RCK | ROCK |
| | | LMSN | LIMESTONE | PRDG | PREDUG |

BURNSIDE

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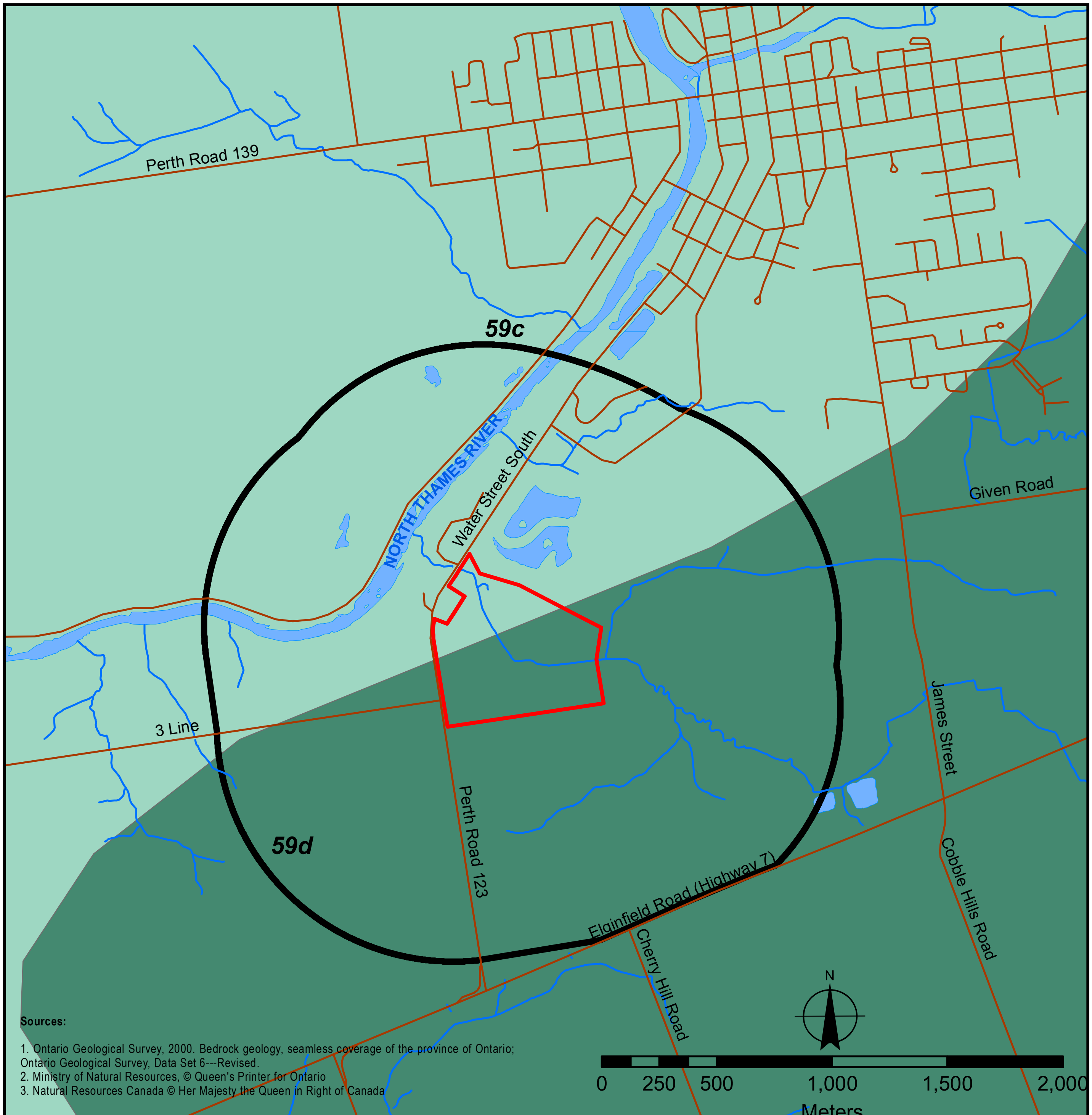
TOWN OF ST. MARYS
*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title
**REGIONAL CROSS SECTION C-C'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | MARCH 2017 | 10 |
| Scale | | Project No. | |
| H-1:7,500 V-1:750 | | 300032339 | |

File Name:gis//(ELMO)/PROJECTS/033110 (HEWITT)/ 032339 2016 EA HG STUDY REGIONAL AND SITE CROSS SECTIONS.dwg Date Plotted: April 26, 2017 - 2:00 PM




Sources:

1. Ontario Geological Survey, 2000. Bedrock geology, seamless coverage of the province of Ontario; Ontario Geological Survey, Data Set 6---Revised.
2. Ministry of Natural Resources, © Queen's Printer for Ontario
3. Natural Resources Canada © Her Majesty the Queen in Right of Canada

**LEGEND**

- ON-SITE STUDY AREA
- STUDY AREA VICINITY
- ROADWAY
- WATERCOURSE
- WATERBODY

Bedrock Geology

- 59c: Dundee Fm:;limestone, dolostone, shale
- 59d: Detroit River Gp:; Onondaga Fm; limestone, dolostone, shale

Map Title

**BEDROCK GEOLOGY**

| Client / Report | Drawn | Checked | Date | Figure No. |
|---|---|---|---|---|
| THE TOWN OF ST. MARYS<br>*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY* | SK | CM | MARCH 2017 | 11 |
| | Scale: 1:25,000 | | Project No.: 300032339 | |

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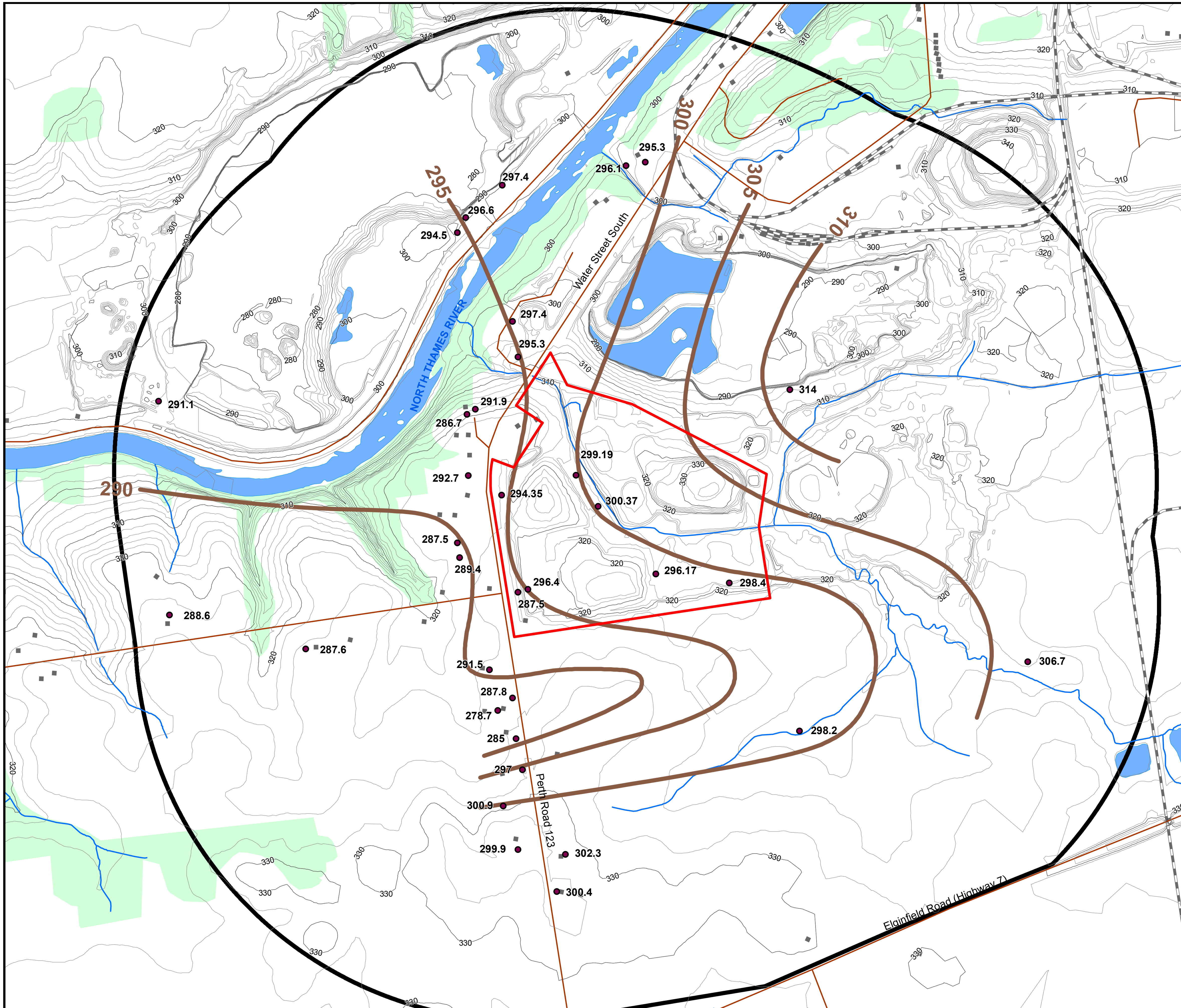


LEGEND

- ON-SITE STUDY
- STUDY AREA
- ROADWAY
- CONTOUR (10m intervals)
- CONTOUR (2m intervals - masl)
- BUILDING
- WATERCOURSE
- RAILWAY
- WATERBODY
- WOODED
- moecc_locations
- BEDROCK SURFACE CONTOUR (5m intervals)

**306.7** BEDROCK ELEVATION (masl)

**Sources:**

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

N

0 200 400 600 800

Metres

BURNSIDE

Client / Report

THE TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**BEDROCK SURFACE TOPOGRAPHY**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | MARCH 2017 | 12 |
| Scale | | Project No. | |
| 1:10,000 | | 300032339 | |

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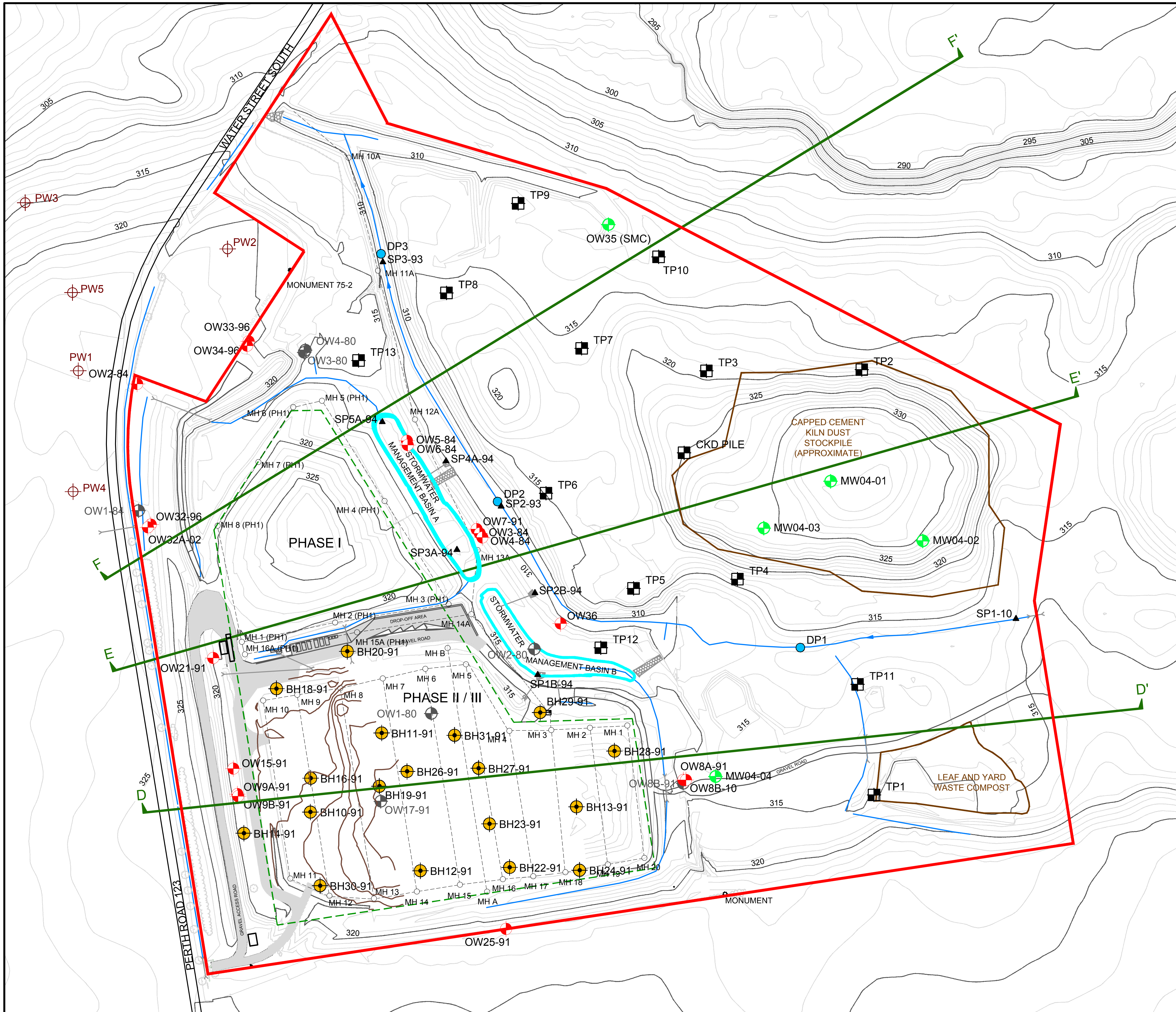



## LEGEND

- ON-SITE STUDY AREA
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- CONTOUR (5m intervals - masl) (MNR - SWOOP2010 - digital elevation data)
- CONTOUR (1m intervals - masl) (MNR - SWOOP2010 - digital elevation data)
- CONTOUR (1m intervals - masl) (RJB 2015 Survey)
- STORM WATER MANAGEMENT BASIN
- LEACHATE COLLECTION SYSTEM
- LEACHATE MANHOLE
- OBSERVATION WELL (ANNUAL MONITORING REPORT)
- OBSERVATION WELL (ABANDONED AND SEALED)
- OBSERVATION WELL
- DRIVE POINT PIEZOMETER
- BOREHOLE
- PRIVATE DOMESTIC WELL (APPROXIMATE LOCATION)
- SURFACE WATER MONITORING LOCATION
- TEST PIT
- A A' CROSS SECTION LOCATION KEY

N

0 60 120 180 240

Metres

BURNSIDE

Client / Report

TOWN OF ST. MARYS

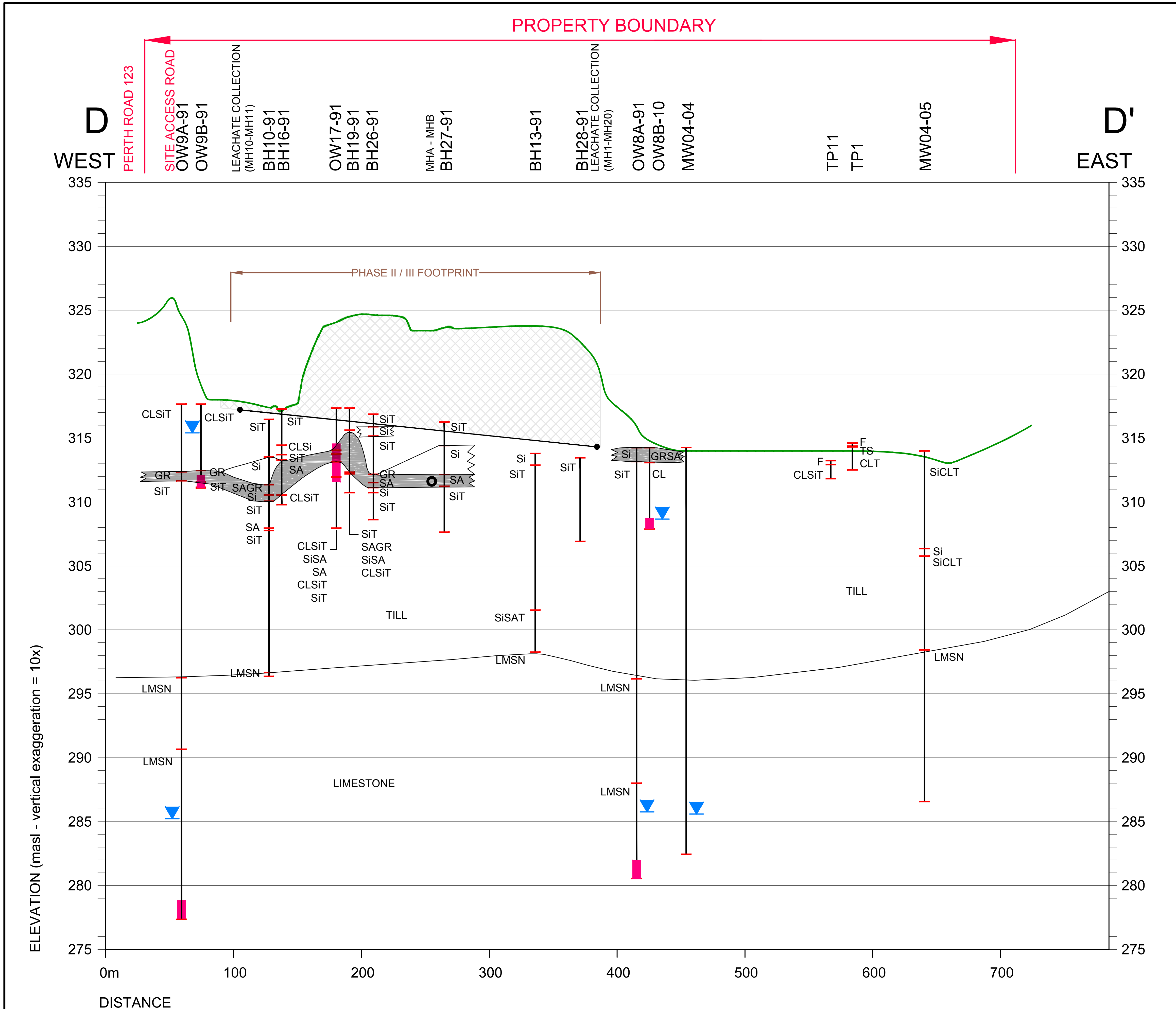
*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**SITE TOPOGRAPHY AND CROSS SECTIONS**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | APRIL 2017 | 13 |
| Scale | | Project No. | |
| 1:3,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY FIGURES 5, 13 & 18.dwg Date Plotted: April 26, 2017 - 12:38 PM




LEGEND

- WELL NUMBER (MW9)
- GEOLOGICAL STRATIGRAPHY
- MEASURED WATER LEVEL (DEC.14, 2015)
- WELL SCREEN

| | | | | | |
|---|---|---|---|---|---|
| cl | clayey | CL | Clay | TS | Topsoil |
| si | silty | Si | Silt | T | Till |
| sa | sandy | SA | Sand | F | Fill |
| gr | gravelly | GR | Gravel | HPAN | Hardpan |
| | | STN | Stones | RCK | Rock |
| | | BLD | Boulder | | |
| | | LMSN | Limestone | | |

- INTERPRETED GEOLOGICAL CONTACT
- WATERCOURSE CROSSING
- LEACHATE COLLECTION SYSTEM
- DRAIN PIPE BETWEEN MHA AND MHB

BURNSIDE

Client / Report

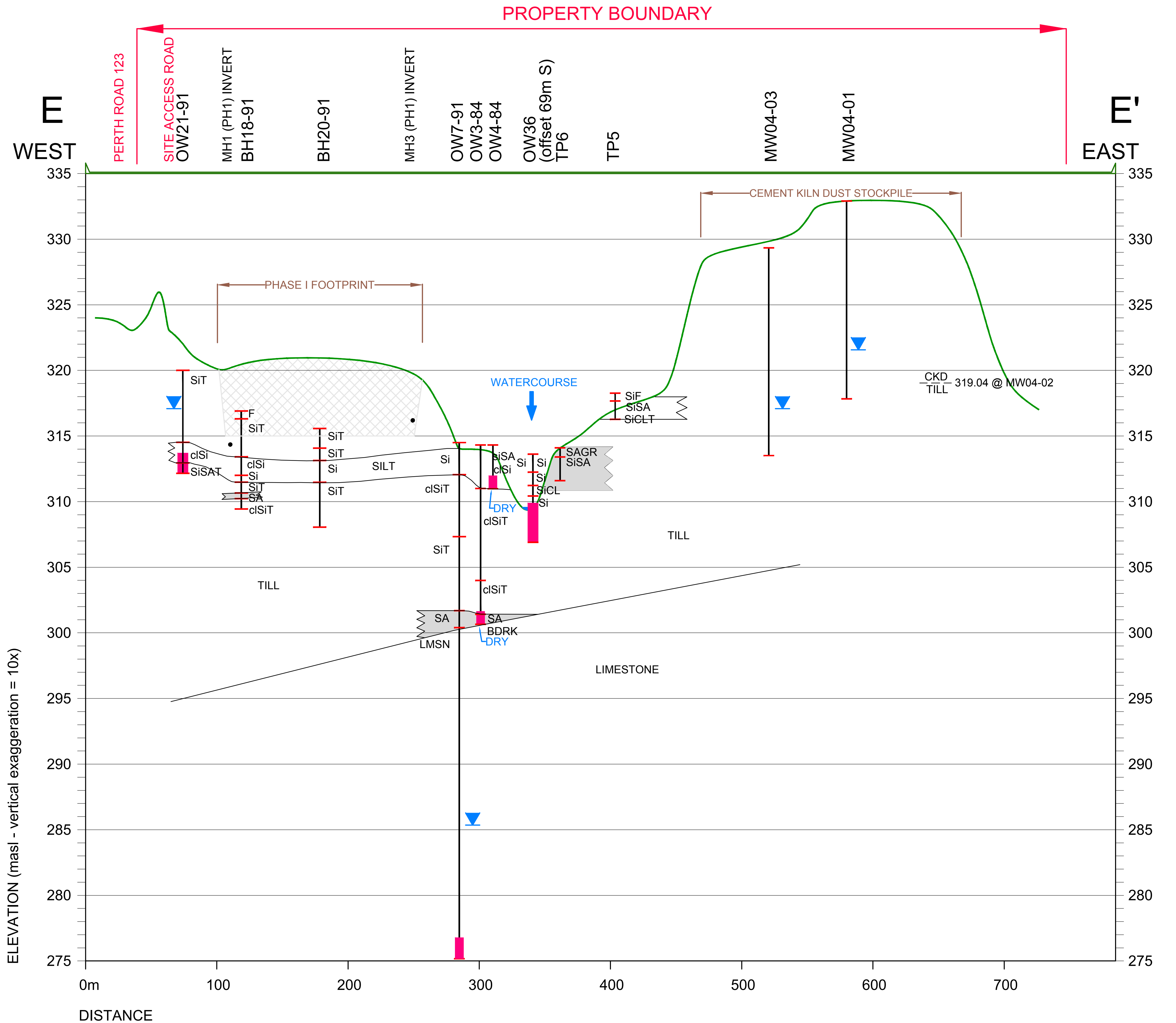
TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**SITE CROSS SECTION D-D'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2017 | 14 |
| Scale | | Project No. | |
| H - 1:3,000 V - 1:300 | | 300032339 | |




LEGEND

MW9 WELL NUMBER

GEOLOGICAL STRATIGRAPHY

MEASURED WATER LEVEL (DEC.14, 2015)

WELL SCREEN

| | | | | | |
|---|---|---|---|---|---|
| cl | clayey | CL | Clay | TS | Topsoil |
| si | silty | Si | Silt | T | Till |
| sa | sandy | SA | Sand | F | Fill |
| gr | gravelly | GR | Gravel | HPAN | Hardpan |
| | | STN | Stones | RCK | Rock |
| | | BLD | Boulder | | |
| | | LMSN | Limestone | | |

INTERPRETED GEOLOGICAL CONTACT

WATERCOURSE CROSSING

LEACHATE COLLECTION SYSTEM

BURNSIDE

Client / Report

TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**SITE CROSS SECTION E-E'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
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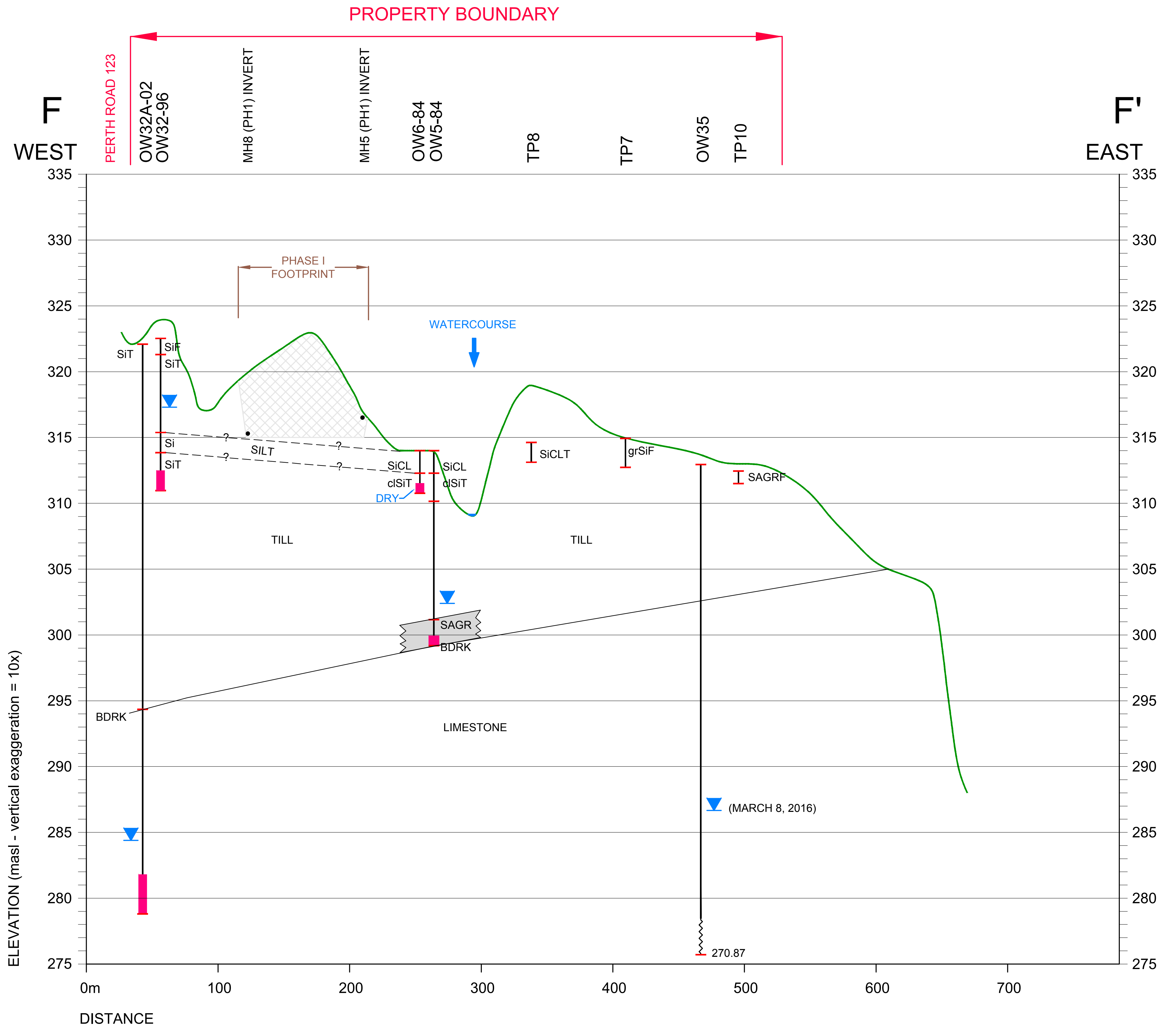
| Scale | | Project No. | |
| H - 1:3,000 V - 1:300 | | 300032339 | |




LEGEND

MW9 WELL NUMBER

GEOLOGICAL STRATIGRAPHY

MEASURED WATER LEVEL (DEC.14, 2015)

WELL SCREEN

| | | | | | |
|---|---|---|---|---|---|
| cl | clayey | CL | Clay | TS | Topsoil |
| si | silty | Si | Silt | T | Till |
| sa | sandy | SA | Sand | F | Fill |
| gr | gravelly | GR | Gravel | HPAN | Hardpan |
| | | STN | Stones | RCK | Rock |
| | | BLD | Boulder | | |
| | | LMSN | Limestone | | |

INTERPRETED GEOLOGICAL CONTACT

WATERCOURSE CROSSING

LEACHATE COLLECTION SYSTEM

BURNSIDE

Client / Report

TOWN OF ST. MARYS

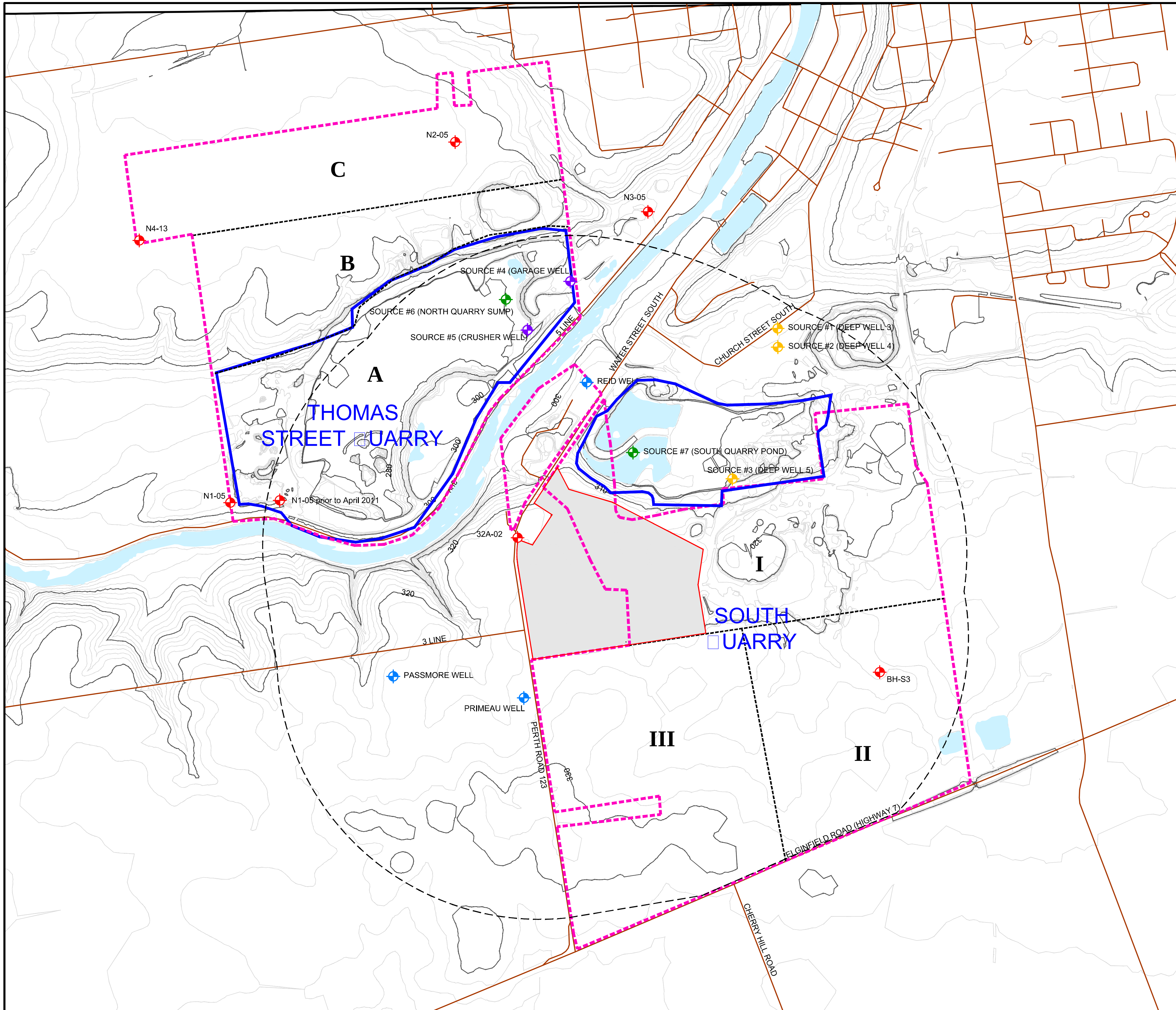
*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**SITE CROSS SECTION F-F'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2017 | 16 |
| Scale | | Project No. | |
| H - 1:3,000 V - 1:300 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY REGIONAL AND SITE CROSS SECTIONS.dwg Date Plotted: April 26, 2017 - 1:15 PM




## LEGEND

- QUARRY BOUNDARIES (From the Pits and Quarries Online Database)
- APPROXIMATE QUARRY EXTENTS (EXISTING)
- ON-SITE STUDY AREA
- STUDY AREA VICINITY
- A PHASED EXTRACTION AREA
- APPROXIMATE LIMIT OF PHASED EXTRACTION AREAS
- DRAINAGE SWALE
- CONTOUR (10m intervals - masl)
- CONTOUR (2m intervals)
- MONITORING WELL
- INDUSTRIAL WATER SUPPLY WELL
- WATER SUPPLY WELL
- DOMESTIC WELL MONITORING WELL
- DEWATERING (APPROXIMATE)

Note: The information provided in this drawing is based on Figure 1 from the 2014 Annual Groundwater Monitoring Report for St. Marys Cement and Figure 2.2 from the 1992 Phase II/III Hydrogeologic Investigation for the St. Marys Landfill Site.

N

0 300 600 900 1,200

Metres

BURNSIDE

Client / Report

TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**ST. MARYS CEMENT SITE FEATURES**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2017 | 17 |
| Scale | | Project No. | |
| 1:15,000 | | 300032339 | |


LEGEND

- ON-SITE STUDY AREA
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- LEACHATE COLLECTION SYSTEM
- LEACHATE MANHOLE
- OBSERVATION WELL
- OBSERVATION WELL (ABANDONED AND SEALED)
- PRIVATE DOMESTIC WELL (APPROXIMATE LOCATION)
- SURFACE WATER MONITORING LOCATION

AIR PHOTO SOURCE:
GOOGLE EARTH PRO 2013 SATELLITE IMAGE

N

0 60 120 180 240
Metres

BURNSIDE

Client / Report

TOWN OF ST. MARYS

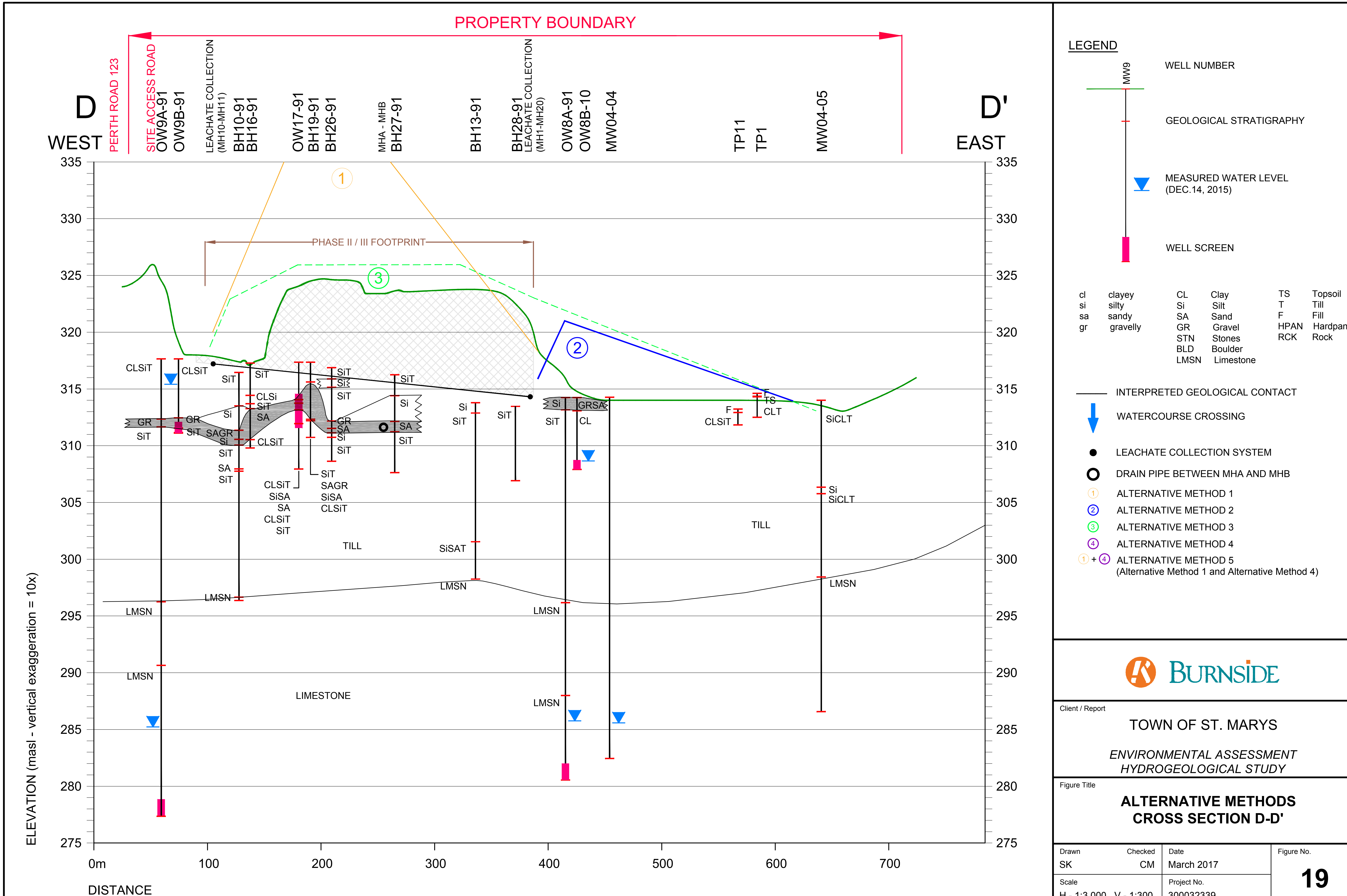
*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**MONITORING LOCATIONS**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | APRIL 2017 | 18 |
| Scale | | Project No. | |
| 1:3,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY FIGURES 5, 13 & 18.dwg Date Plotted: April 26, 2017 - 12:33 PM




BURNSIDE

Client / Report

TOWN OF ST. MARYS

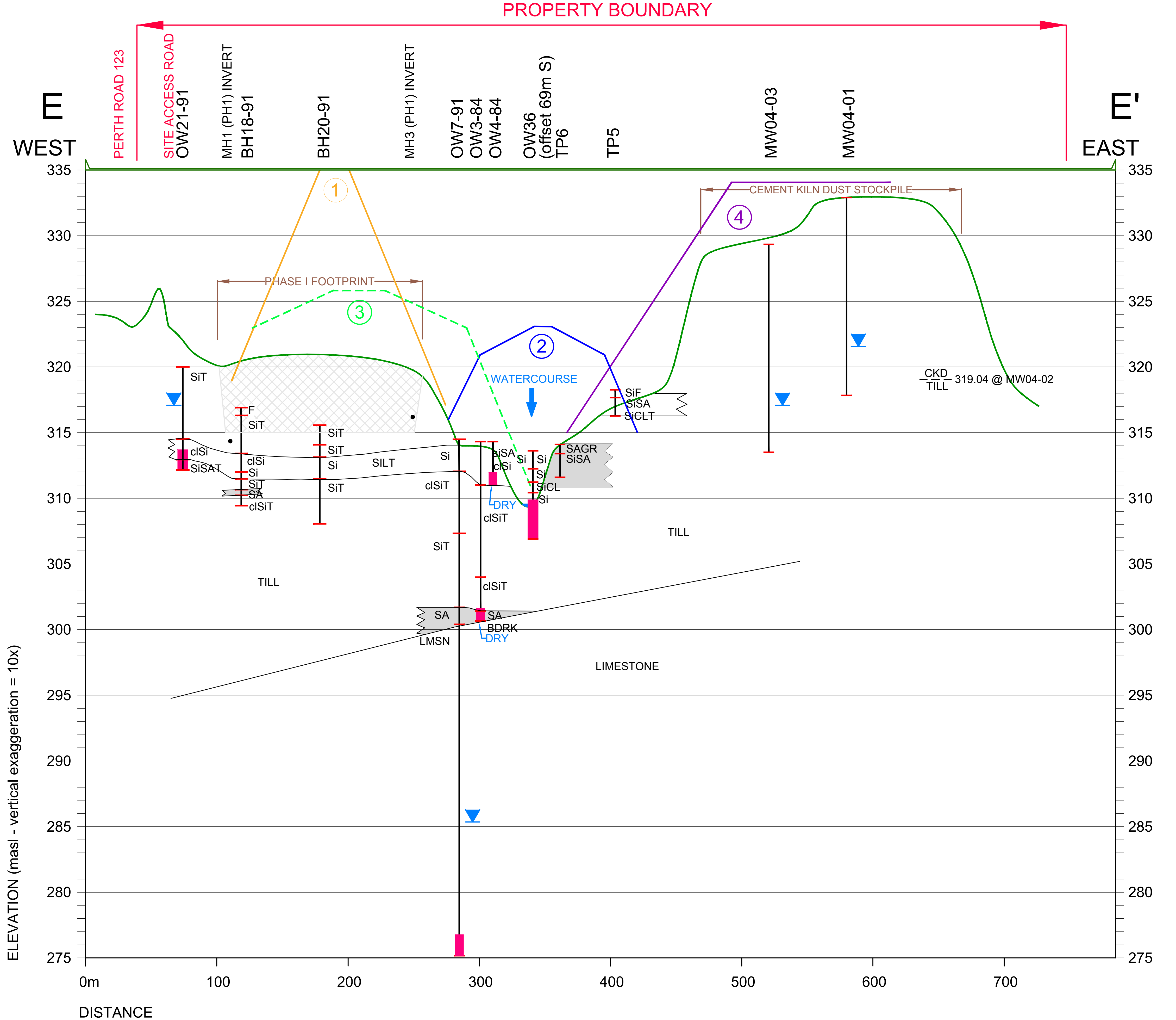
*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**ALTERNATIVE METHODS**
**CROSS SECTION D-D'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2017 | 19 |
| Scale: H - 1:3,000 V - 1:300 | | Project No. 300032339 | |

File Name: 032339 2016 EA HG STUDY REGIONAL AND SITE CROSS SECTIONS.dwg Date Plotted: April 26, 2017 - 1:13 PM




LEGEND

MW9 — WELL NUMBER

GEOLOGICAL STRATIGRAPHY

MEASURED WATER LEVEL (DEC.14, 2015)

WELL SCREEN

| | | | | | |
|---|---|---|---|---|---|
| cl | clayey | CL | Clay | TS | Topsoil |
| si | silty | Si | Silt | T | Till |
| sa | sandy | SA | Sand | F | Fill |
| gr | gravelly | GR | Gravel | HPAN | Hardpan |
| | | STN | Stones | RCK | Rock |
| | | BLD | Boulder | | |
| | | LMSN | Limestone | | |

INTERPRETED GEOLOGICAL CONTACT

WATERCOURSE CROSSING

LEACHATE COLLECTION SYSTEM

1 ALTERNATIVE METHOD 1

2 ALTERNATIVE METHOD 2

3 ALTERNATIVE METHOD 3

4 ALTERNATIVE METHOD 4

1 + 4 ALTERNATIVE METHOD 5 (Alternative Method 1 and Alternative Method 4)

BURNSIDE

Client / Report

TOWN OF ST. MARYS

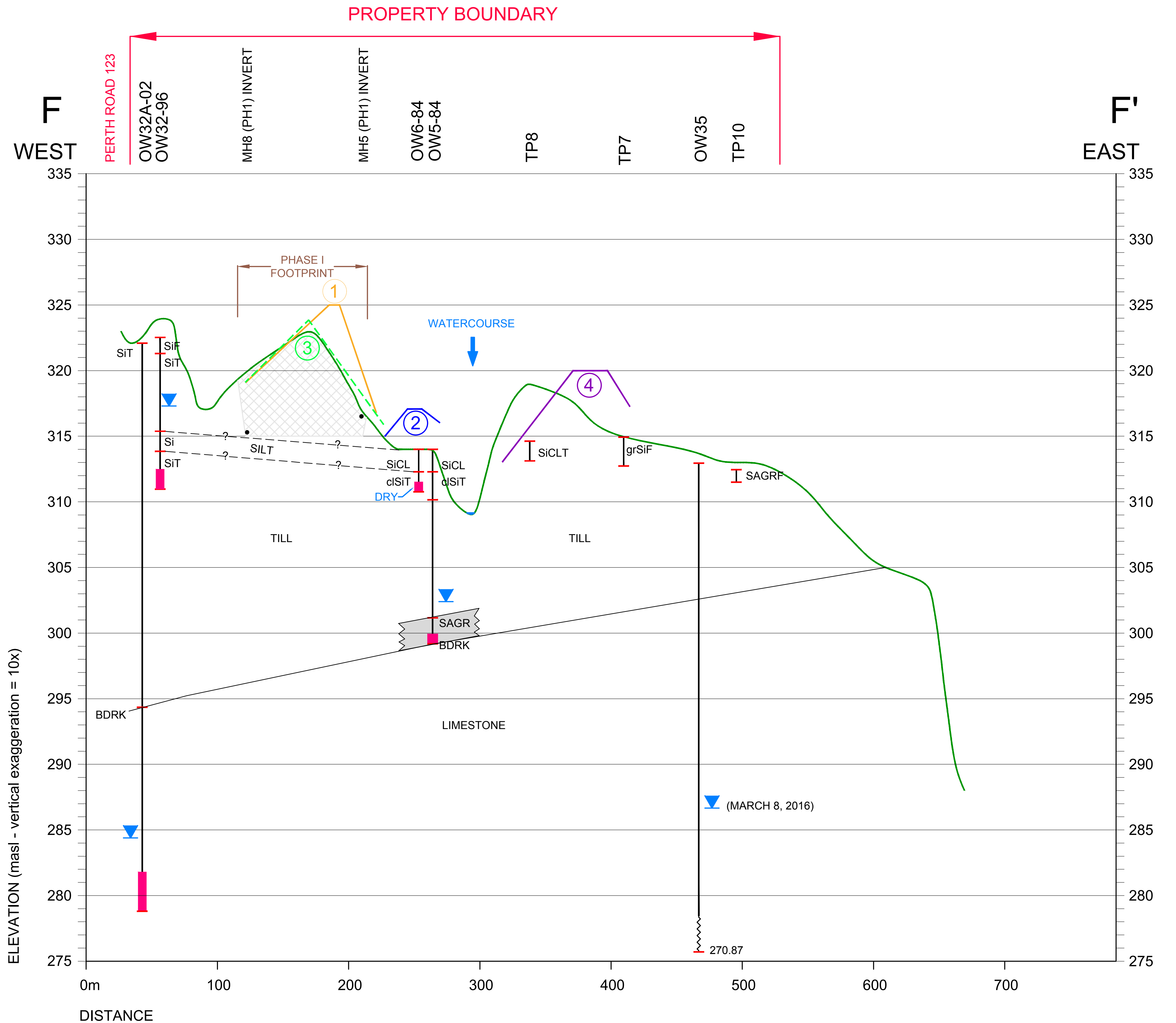
*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**ALTERNATIVE METHODS CROSS SECTION E-E'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2017 | 20 |
| Scale | | Project No. | |
| H - 1:3,000 V - 1:300 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY REGIONAL AND SITE CROSS SECTIONS.dwg Date Plotted: April 26, 2017 - 1:13 PM




LEGEND

WELL NUMBER (MW9)

GEOLOGICAL STRATIGRAPHY

MEASURED WATER LEVEL (DEC.14, 2015)

WELL SCREEN

| | | | | | |
|---|---|---|---|---|---|
| cl | clayey | CL | Clay | TS | Topsoil |
| si | silty | Si | Silt | T | Till |
| sa | sandy | SA | Sand | F | Fill |
| gr | gravelly | GR | Gravel | HPAN | Hardpan |
| | | STN | Stones | RCK | Rock |
| | | BLD | Boulder | | |
| | | LMSN | Limestone | | |

INTERPRETED GEOLOGICAL CONTACT

WATERCOURSE CROSSING

LEACHATE COLLECTION SYSTEM

1 ALTERNATIVE METHOD 1

2 ALTERNATIVE METHOD 2

3 ALTERNATIVE METHOD 3

4 ALTERNATIVE METHOD 4

1 + 4 ALTERNATIVE METHOD 5 (Alternative Method 1 and Alternative Method 4)

BURNSIDE

Client / Report

TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**ALTERNATIVE METHODS CROSS SECTION F-F'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2017 | 21 |
| Scale | | Project No. | |
| H - 1:3,000 V - 1:300 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY REGIONAL AND SITE CROSS SECTIONS.dwg Date Plotted: April 26, 2017 - 1:13 PM

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

# Appendix A

## Historical Aerial Photographs


LEGEND

CURRENT PROPERTY BOUNDARY
SOUTHERN E□TENT OF □UARRYING
WATERCOURSE

Sources:
1. 1955 airphoto o□tained □rom National Airphoto Li□rary

N

0 50 100 200 300 400
Metres

BURNSIDE

Client / Report

TOWN OF ST MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**1□□□ AIR □HOTO**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2016 | **A-1** |
| Scale | | Project No. | |
| 1:5,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY APPENDI□ A.dwg Date Plotted: □une 1, 2016 - 12:33 PM


LEGEND

- CURRENT PROPERTY BOUNDARY
- SOUTHERN E□TENT OF □UARRYING
- WATERCOURSE

Sources:
1. 1963 airphoto o□tained □rom National Airphoto Li□rary

N

0 50 100 200 300 400
Metres

BURNSIDE

Client / Report

TOWN OF ST MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**1□□□ AIR □HOTO**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2016 | **A-2** |
| Scale | | Project No. | |
| 1:5,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY APPENDI□ A.dwg Date Plotted: □une 1, 2016 - 12:34 PM


LEGEND

CURRENT PROPERTY BOUNDARY
FORMER WATERCOURSE
NEW WATERCOURSE

Sources:
1. 1978 airphoto obtained from National Airphoto Library

N

0 50 100 200 300 400
Metres

BURNSIDE

Client / Report

TOWN OF ST MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**1978 AIR PHOTO**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2016 | A- |
| Scale | | Project No. | |
| 1:5,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY APPENDIX A.dwg Date Plotted: June 1, 2016 - 12:35 PM


LEGEND

CURRENT PROPERTY BOUNDARY

WATERCOURSE

Sources:
1. 1980 airphoto obtained from National Airphoto Library

N

0 50 100 200 300 400

Metres

BURNSIDE

Client / Report

TOWN OF ST MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**1980 AIR PHOTO**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2016 | A-4 |
| Scale | | Project No. | |
| 1:5,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY APPENDIX A.dwg Date Plotted: June 1, 2016 - 2:47 PM


LEGEND

- CURRENT PROPERTY BOUNDARY
- WATERCOURSE
- FILLING

Sources:
1. 1989 airphoto o□tained □rom National Airphoto Li□rary

N

0 50 100 200 300 400
Metres

BURNSIDE

Client / Report

TOWN OF ST MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**1□□□ AIR □HOTO**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2016 | A-□ |
| Scale | | Project No. | |
| 1:5,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY APPENDI□ A.dwg Date Plotted: □une 1, 2016 - 12:40 PM


LEGEND

CURRENT PROPERTY BOUNDARY

WATERCOURSE

Sources:
1. 2000 airphoto obtained from National Airphoto Library

N

0 50 100 200 300 400

Metres

BURNSIDE

Client / Report

TOWN OF ST MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**2000 AIR PHOTO**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2016 | A-□ |
| Scale | | Project No. | |
| 1:5,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY APPENDIX A.dwg Date Plotted: June 1, 2016 - 12:27 PM


LEGEND

CURRENT PROPERTY BOUNDARY

WATERCOURSE

Sources:
1. 2006 airphoto obtained from Upper Thames River Conservation Authority.

N

0 50 100 200 300 400

Metres

BURNSIDE

Client / Report

TOWN OF ST MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**2006 AIR PHOTO**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2016 | A-□ |
| Scale | | Project No. | |
| 1:5,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY APPENDIX A.dwg Date Plotted: June 1, 2016 - 12:30 PM


LEGEND

CURRENT PROPERTY BOUNDARY

WATERCOURSE

Sources:
1. 2013 airphoto obtained from Google Earth Pro.

N

0 50 100 200 300 400

Metres

BURNSIDE

Client / Report

TOWN OF ST MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**2013 AIR PHOTO**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2016 | A- |
| Scale | | Project No. | |
| 1:5,000 | | 300032339 | |

File Name: 032339 2016 EA HG STUDY APPENDIX A.dwg Date Plotted: June 1, 2016 - 12:31 PM

# Appendix B

# Water Well Records



Appendix B

**Appendix B-1**
**Summary Table for Wells on Figure 7**
**Water Well Records - Ministry of the Environment and Climate Change**
**St. Marys Landfill**

| Well Number | Date Drilled | Well Type | Elev. (m) | Borehole Depth (m) | Depth to Bedrock (m) | Bedrock Elevation (m) | Water Found (m) | Static Level (m) | Pumping Level (m) | Pumping Rate (Lpm) | Test Hours | Test Min |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3408626* | | | | | | | | | | | | |
| 5000230* | Jun-59 | Well: Supply | 296.32 | 55.80 | 30.50 | 265.80 | 49 | 24 | 25 | 45.5 | 3 | 0 |
| 5000231 | Aug-60 | Well: Supply | 323.19 | 62.80 | 44.50 | 278.70 | 58 | 32 | 34 | 45.5 | 3 | 0 |
| 5000232 | Jul-62 | Well: Supply | 319.99 | 57.90 | 31.10 | 288.90 | 49 | 29 | 30 | 40.9 | 3 | 0 |
| 5001195 | Jun-47 | Well: Supply | 304.39 | 30.50 | 9.10 | 295.30 | 6 | 6 | 0 | 45.5 | 1 | 0 |
| 5001196* | Aug-47 | Well: Supply | 319.93 | 32.30 | 7.30 | 312.60 | 10 | 10 | 0 | 45.5 | 1 | 0 |
| 5001201 | Feb-65 | Borehole: Test | 296.40 | 28.00 | | | | | | | | |
| 5001202 | Mar-65 | Borehole: Test | 296.50 | 46.30 | | | | | | | | |
| 5001203 | May-65 | Borehole: Test | 296.56 | 34.40 | | | | | | | | |
| 5001204 | Jun-65 | Borehole: Test | 296.07 | 41.10 | 1.50 | 294.50 | 25 | 7 | 20 | 309.1 | 8 | 0 |
| 5001205 | Nov-66 | Borehole: Test | 297.45 | 22.90 | | | 2 | | | | | |
| 5001206 | Dec-66 | Borehole: Test | 297.36 | 21.00 | | | 2 | | | | | |
| 5001207 | Nov-66 | Borehole: Test | 297.40 | 22.90 | | | 2 | | | | | |
| 5001209* | Dec-67 | Well: Supply | 318.21 | 22.90 | 1.20 | 317.00 | 23 | 7 | 11 | 54.6 | 2 | 30 |
| 5001488 | Jun-68 | Well: Supply | 319.35 | 9.10 | | | 7 | 7 | | | | |
| 5001571 | Feb-69 | Well: Supply | 320.87 | 63.10 | 32.30 | 288.60 | 56 | 34 | 35 | 54.6 | 1 | 30 |
| 5001645 | Apr-70 | Well: Supply | 331.31 | 64.00 | 31.40 | 299.90 | 55 | 43 | 43 | 36.4 | 2 | 0 |
| 5001804 | Dec-71 | Well: Supply | 330.30 | 54.30 | 28.00 | 302.30 | 50 | 40 | 43 | 40.9 | 5 | 0 |
| 5002038 | Nov-73 | Well: Supply | 316.29 | 48.80 | 24.40 | 291.90 | 31 | 29 | 34 | 22.7 | 1 | 0 |
| 5002225 | Oct-74 | Well: Supply | 330.22 | 54.90 | 29.90 | 300.40 | 55 | 50 | 52 | 45.5 | 1 | 0 |
| 5002282 | Oct-75 | Well: Supply | 315.11 | 50.30 | | | 10 | 2 | 10 | 3568.6 | 8 | 0 |
| 5002878 | Oct-80 | Well: Supply | 320.81 | 52.10 | 33.20 | 287.60 | 52 | 37 | 46 | 36.4 | 1 | 0 |
| 5003388 | Oct-87 | Well: Supply | 323.75 | 52.10 | 36.30 | 287.50 | 52 | 43 | 45 | 31.8 | 1 | 0 |
| 5003434 | Jun-88 | Well: Supply | 315.03 | 56.40 | 28.30 | 286.70 | 56 | 40 | 48 | 31.8 | 1 | 0 |
| 5003609 | Aug-89 | Well: Supply | 324.94 | 51.80 | 39.90 | 285.00 | 52 | 40 | 44 | 36.4 | 1 | 0 |
| 5003633 | Sep-89 | Well: Supply | 327.42 | 51.80 | 26.50 | 300.90 | 52 | 40 | 46 | 36.4 | 1 | 0 |
| 5003647 | Sep-89 | Well: Supply | 321.40 | 48.50 | 29.90 | 291.50 | 47 | 37 | 39 | 45.5 | 1 | 30 |
| 5003753 | Jul-90 | Well: Supply | 325.30 | 54.90 | 28.30 | 297.00 | 55 | 40 | 44 | 54.6 | 1 | 0 |
| 5003754** | Aug-90 | Well: Supply | 330.19 | | | | 66 | 45 | 57 | 27.3 | 2 | 0 |
| 5003888 | Jul-91 | Well: Supply | 322.86 | 55.80 | 35.10 | 287.80 | 47 | 39 | 41 | 77.3 | 3 | 0 |
| 5004013 | Sep-92 | Well: Supply | 319.85 | 56.40 | 30.50 | 289.40 | 43 | 38 | | 54.6 | 1 | 30 |
| 5004319 | Aug-96 | Well: Supply | 321.38 | 56.40 | 28.70 | 292.70 | 56 | 34 | 47 | 36.4 | 1 | 0 |
| 5004527 | Nov-97 | Well: Supply | 296.39 | 30.50 | 0.30 | 296.10 | 24 | 21 | | 45.5 | 1 | 30 |
| 5005676 | May-04 | Well: Supply | 300.43 | 34.80 | 5.20 | 295.30 | 35 | 16.2 | 24.4 | 46.0 | 2 | 0 |
| 5005891 | May-05 | Well: Observation | 294.75 | 31.10 | 3.70 | 291.10 | 28 | 16 | | 136.4 | | |
| 5005952 | Aug-05 | Well: Supply | 298.90 | 33.50 | 1.50 | 297.40 | 32 | 17 | 22 | 227.3 | 1 | 0 |
| 5006154 | Jul-06 | Well: Abandoned | 311.38 | 40.80 | | | | | | | | |
| 5006163 | Sep-06 | Well: Abandoned | 321.14 | 6.10 | | | | | | | | |
| 7040835 | Sep-06 | Well: Abandoned | 321.14 | | | | | | | | | |
| 7047879 | Jun-07 | Well: Abandoned | 314.87 | 20.70 | 0.90 | 314.00 | 16 | 16 | | | | |
| 7155445 | Oct-10 | Well: Observation | | 6.40 | | | | | | | | |
| 7155446 | Oct-10 | Well: Abandoned | | 0.40 | | | | | | | | |
| 7158102 | Jun-10 | Well: Supply | | 60.00 | 31.40 | | 55 | 36 | 40 | 113.7 | 1 | 30 |
| 7158103 | Jun-10 | Well: Supply | | 60.00 | 31.40 | | 54 | 37 | 39 | 113.7 | 1 | 30 |
| 7165988 | Apr-11 | Well: Abandoned | | | | | | | | | | |
| 7175685 | Aug-11 | Well: Supply | | 60.00 | 28.00 | | 58 | 27 | 30 | 136.4 | 1 | 30 |

Notes:
WWR - water well record
* Well location was not included on mapping due to expected wrong location based on information in the MOECC WWR
** 11m extension of existing MOECC WWR No. 5001804

40P/38

UTM 1 7 Z 4 8 7 1 4 7 E

~~THAMES RIVER CON~~ 5 R 4 7 8 6 4 5 7 N

Elev. 6 R 4 0 6 3

Lot 37

Basin 2 3

The Ontario Water Resources Commission Act, 1957

# WATER WELL RECORD

50 № 231

GROUND WATER BRANCH
NOV 21 1960
ONTARIO WATER RESOURCES COMMISSION

County or District PERTH Township, Village, Town or City BLANSHARD

[redacted]te completed 6 (day) AUG. (month) 60 (year)

[redacted]dress R. R. 3 St. Marys

## Casing and Screen Record

Inside diameter of casing 4"

Total length of casing 153'

Type of screen

Length of screen

Depth to top of screen

Diameter of finished hole 4"

## Pumping Test

Static level 105'

Test-pumping rate 10 G.P.M.

Pumping level 110'

Duration of test pumping 3 hrs.

Water clear or cloudy at end of test clear

Recommended pumping rate 10 G.P.M.

with pumping level of 110

## Well Log / Water Record

| Overburden and Bedrock Record | From ft. | To ft. | Depth(s) at which water(s) found | No. of feet water rises | Kind of water (fresh, salty, sulphur) |
|---|---|---|---|---|---|
| top soil | 0 | 1 | | | |
| yellow clay | 1 | 4 | | | |
| sandy clay | 4 | 12 | | | |
| blue clay | 12 | 25 | | | |
| stoney hardpan | 25 | 130 | | | |
| Cemented gravel | 130 | 146 | | | |
| Caving rock | 146 | 153 | | | |
| brown limestone | 153 | 206 | 190 - 206 | 101 | FRESH |

For what purpose(s) is the water to be used? farm

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

Drilling Firm W. D. HOPPER & SONS

Address SEAFORTH

Licence Number 672

Name of Driller NEIL HOPPER

Address SEAFORTH

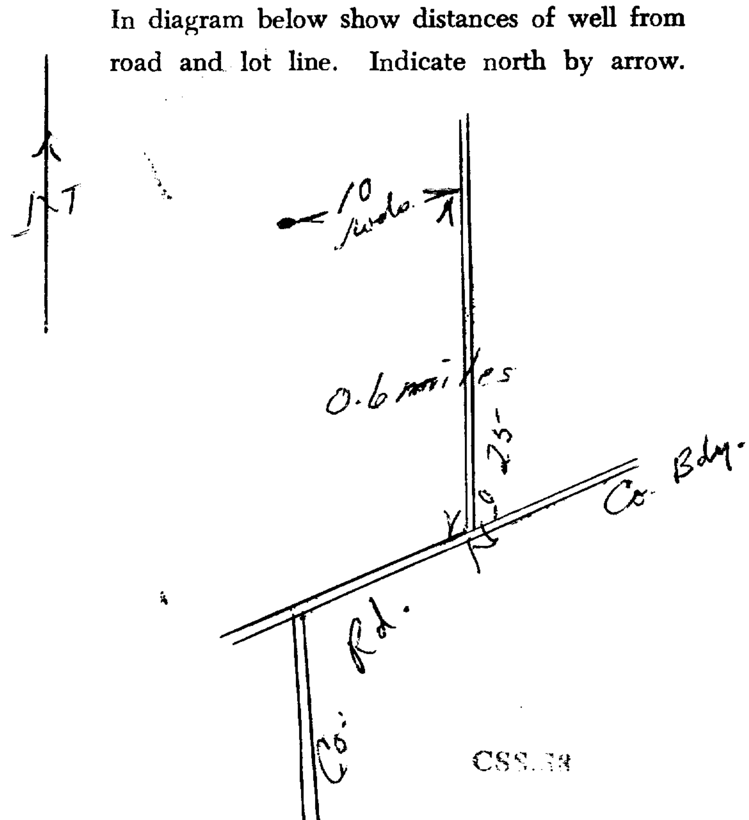
Date Nov. 16/60

Neil Hopper
(Signature of Licensed Drilling Contractor)

## Location of Well

117

In diagram below show distances of well from road and lot line. Indicate north by arrow.




Form 5

CSS.38

40 P/38

UTM 1 7 z 4 8 7 0 4 0 E

Lot - 37

5 R 4 7 8 6 9 6 0 N

Elev. 5 R 1 0 5 5



No 50 232

The Ontario Water Resources Commission Act

# WATER WELL RECORD

Basin 2 3

County or District Perth

Township, Village, Town or City Blanshard.

Con. Thames Rd. Lot ~~10~~ 37

Date completed 6 (day) June (month) 62 (year)

[redacted]ress RR # 3 St Marys

| Casing and Screen Record | |
|---|---|
| Inside diameter of casing | 4" |
| Total length of casing | 112' |
| Type of screen | — |
| Length of screen | — |
| Depth to top of screen | — |
| Diameter of finished hole | 4" |

| Pumping Test | |
|---|---|
| Static level | 95' |
| Test-pumping rate | 9 G.P.M. |
| Pumping level | 98' |
| Duration of test pumping | 3 hrs. |
| Water clear or cloudy at end of test | Clear. |
| Recommended pumping rate | 9 G.P.M. |
| with pump setting of | 125' feet below ground surface |

| Well Log: Overburden and Bedrock Record | From ft. | To ft. | Water Record: Depth(s) at which water(s) found | Kind of water (fresh, salty, sulphur) |
|---|---|---|---|---|
| Topsoil & Yellow Clay | 0 | 10 | 166-190 | Fresh. |
| Blue Clay | 10 | 45 | | |
| Hardpan | 45 | 102 | | |
| Start of Limestone | 102 | 112 | | |
| Grey limestone | 112 | 140 | | |
| Brown Limestone | 140 | 190 | | |

For what purpose(s) is the water to be used? Domestic

Is well on upland, in valley, or on hillside? Upland.

Drilling or Boring Firm W. P. Hopper & Son.

Address Seaforth

Licence Number 741

Name of Driller or Borer Neil Hopper

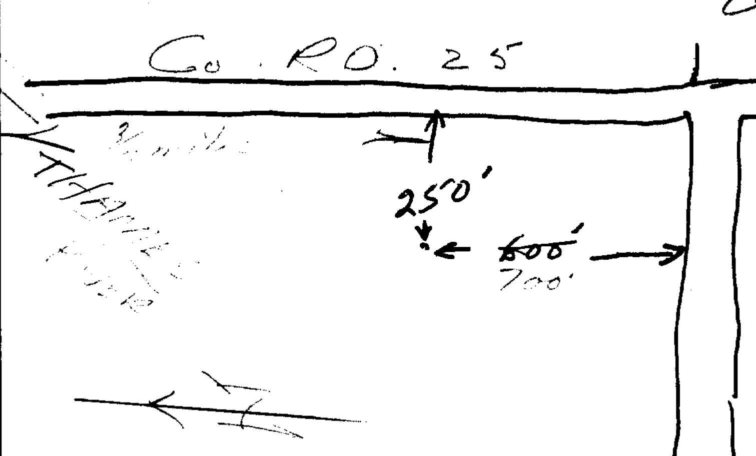
Address RR # 2 Seaforth

Date June 6, 62

Neil Hopper
(Signature of Licensed Drilling or Boring Contractor)

## Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.




Form 7 5M-61-3852

OWRC COPY

CSS.38

40P/39

1

UTM 17 Z 487200 E

9 R 4787391 N

Elev. 9 R 8100

Basin 23

ONTARIO

The Well Drillers Act

Department of Mines, Province of Ontario

RECEIVED No. 1195
DEC 3 19[illegible]
GEOLOGICAL BRANCH
DEPARTMENT OF MINES

# Water Well Record

County or District Perth Twp. St Marys ~~Township/Concession~~ Con. .... Lot ~~36~~ .... Pt. Lot ....

[redacted] ...ter St. St Marys. Ont.

[redacted] cluding pump) ....

| Pipe and Casing Record | | Pumping Test | |
|---|---|---|---|
| Casing diameter(s) | 4" | Date | |
| Length(s) of casing(s) | 30 ft. | Developed Capacity | 600 gal. per hr. |
| Length of screen | | Duration of Test | 1 hr |
| Type of screen | | Pumping Rate | 600 gal per hr. |
| Type of pump | | Drawdown | |
| Capacity of pump | | Static level of completed well | 100 ft. 21' |
| Depth of pump setting | | Is well a gravel-wall type? | no |

## Water Record

Kind (fresh or mineral) fresh

Quality (hard, soft, contains iron, sulphur etc.) hard

Appearance (clear, cloudy, coloured)

For what purpose(s) is the water to be used? domestic

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

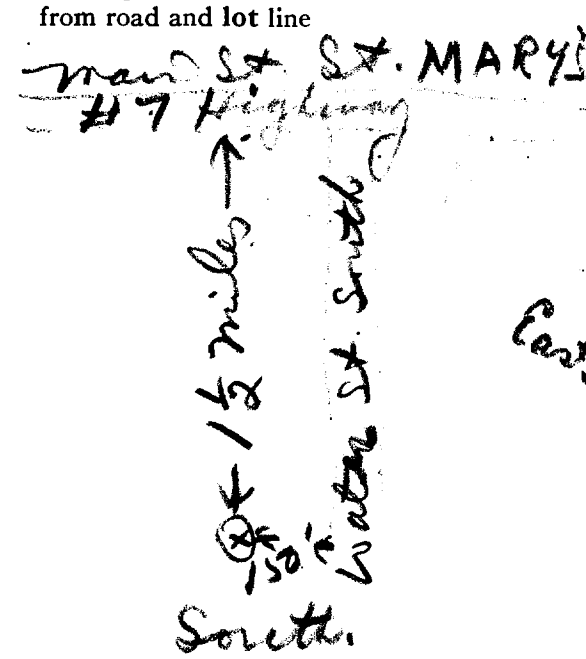
| Depth(s) to Water Horizon(s) | Kind of Water | No. of Feet Water Rises |
|---|---|---|
| 21' | | |

## Well Log

| Drift and Bedrock Record | From | To |
|---|---|---|
| dug well. started drilling in bottom. | 0 ft. | 18 ft. |
| stones & gravel. | 18 | 30 |
| grey limestone rock | 30 | 100 |

## 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? hillside

Drilling Firm McCauley & Hayden

Address

Recorded by Lorne Hayden Address RR4 Denfield Ont.

Date .... Licence Number ....

CSS.S8

UTM 1|7|z 4|8|7|0|1|1|0
(45)
5|R 4|7|8|6|7|8|0

Elev. ~~6~~ R 1|0|5|2

Basin 2|3

Con TR
L 37

CODED

5001488
3 9

7

**The Ontario Water Resources Commission Act**

# WATER WELL RECORD

County or District PERTH Township, Village, Town or City Blanchard

Con. T. R. ~~Thames S. B. C.~~ Lot ~~44~~ 37 Date completed 18 June 1968 (day month year)

[redacted] Address ~~262 Wellington St.~~ St Marys Ont. R.R. # 3

| Casing and Screen Record | |
|---|---|
| Inside diameter of casing | 30" |
| Total length of casing | 30' |
| Type of screen | gravel packed |
| Length of screen | |
| Depth to top of screen | |
| Diameter of finished hole | 30" |

| Pumping Test | |
|---|---|
| Static level | 22 feet |
| Recovery ~~Test pumping~~ rate | 3 G.P.M. |
| ~~Pumping level~~ | ~~28~~ |
| Duration of test pumping | Timed recovery |
| Water clear or cloudy at end of test | cloudy |
| Recommended pumping rate | 2-3 G.P.M. |
| with pump setting of | 27 feet below ground surface |

| Well Log: Overburden and Bedrock Record | From ft. | To ft. | Water Record: Depth(s) at which water(s) found | Kind of water (fresh, salty, sulphur) |
|---|---|---|---|---|
| Top soil | 0 | 6" | | |
| Dark Brown Clay | 6" | 12' | | |
| Grey Clay | 12 | 24 | | |
| Sand | 24 | 26 | 24 | fresh |
| Gravel | 26 | 28 | | |
| Grey clay | 28 | 30 | | |

For what purpose(s) is the water to be used? Domestic

Is well on upland, in valley, or on hillside? level

Drilling or Boring Firm Hades Well Logging & Drilling

Address Elmira Ontario.

Licence Number 2862

Name of Driller or Borer R. L. Franklin

Address c/o Hades

Date June 30/68

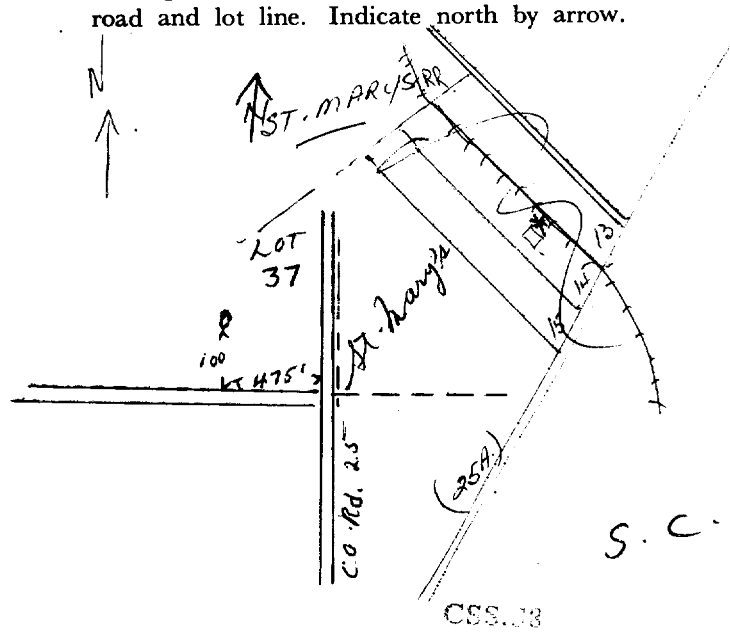
(Signature of Licensed Drilling or Boring Contractor)

Form 7 5M 60-20912

OWRC COPY

**Location of Well**

In diagram below show distances of well from road and lot line. Indicate north by arrow.




S. C.

CSS. 33

UTM 17 Z 4862810 TR. Lot 39

4 R 4786710 CODED

Elev. 5 R 1060

Basin 23

7

5001571

3 9

The Ontario Water Resources Commission Act

# WATER WELL RECORD

County or District Perth Township, Village, Town or City Blanshard

Con. Thames River Con. Lot North Pt Lot 39 Date completed 25 (day) Feb. (month) 1964 (year)

[redacted] Address St Mary's RR#3

DIVISION OF WATER RESOURCES ... 1969 ... WATER RESOURCES COMMISSION

SB

| Casing and Screen Record | |
|---|---|
| Inside diameter of casing | 4" |
| Total length of casing | 107 |
| Type of screen | none used |
| Length of screen | |
| Depth to top of screen | |
| Diameter of finished hole | 4" |

| Pumping Test | |
|---|---|
| Static level | 112' |
| Test-pumping rate | 12 G.P.M. |
| Pumping level | 114' |
| Duration of test pumping | 1½ hrs. |
| Water clear or cloudy at end of test | Clear |
| Recommended pumping rate | 10-12 G.P.M. |
| with pump setting of | 135 feet below ground surface |

| Well Log: Overburden and Bedrock Record | From ft. | To ft. | Water Record: Depth(s) at which water(s) found | Kind of water (fresh, salty, sulphur) |
|---|---|---|---|---|
| top clay | 0 | 7 | | |
| clay + stones | 7 | 45 | | |
| stones + hardpan | 45 | 90 | | |
| hardpan | 90 | 106 | | |
| brown limestone | 106 | 155 | | |
| light brown limestone | 155 | 185 | | |
| white limestone | 185 | 207 | 185-207 | fresh |

For what purpose(s) is the water to be used? F + D + S.

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

Drilling or Boring Firm D. Hopper Well Drilling

Address R R #2 Seaforth

Licence Number ~~3211~~ 3178

Name of Driller or Borer Durl Hopper

Address R R #2 Seaforth, Ontario

Date April 13, 1969

Durl Hopper

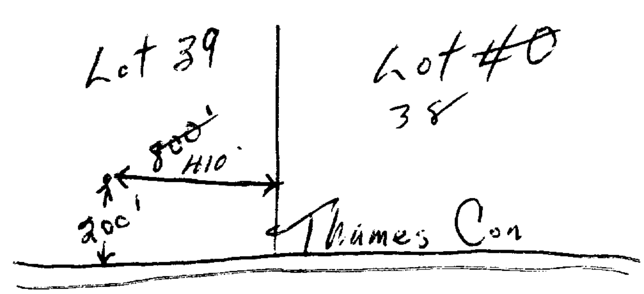
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

**OWRC COPY**

## Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.




S.C.

40P/39

The Ontario Water Resources Commission Act

# WATER WELL RECORD

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5001645

MUNICIP. 50001 | CON. SB

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT |
|---|---|---|---|
| PERTH | BLANCHARD | SOUTH BOUNDARY | 018 |

DATE COMPLETED: DAY 06 MO. ~~APRIL~~ 04 YR. 70

[redacted] R. #3 ST. MARY'S

[redacted] 86090 | RC. 4 | ELEVATION 1090 | RC. 5 | BASIN CODE 23

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH – FEET FROM | TO |
|---|---|---|---|---|---|
| yellow | clay | sandy | packed | 0 | 10 |
| grey | clay | stones | hard | 10 | 40 |
| blue | clay | | soft | 40 | 55 |
| grey | clay | stones | hard | 55 | 103 |
| grey | limestone | | hard | 103 | 114 |
| grey | limstone | brown streaks | hard | 114 | 150 |
| brown | limestone | | medium | 150 | 210 |

31 | 0010505509 | 0040205512 | 0055305 | 0103205512 | 0150215 | 0210615

## 41 WATER RECORD

| WATER FOUND AT – FEET | KIND OF WATER |
|---|---|
| 0180 ~~180-210~~ | 1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM. INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH – FEET FROM | TO |
|---|---|---|---|---|
| ~~4~~ 04 | 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE | .205 | 0 | ~~114~~ 0114 |
| ~~4~~ 04 | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE | | 114 | ~~210~~ 0210 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE | | | |

## SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT – FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER | PUMPING RATE 0008 GPM. | DURATION OF PUMPING 02 HOURS 00 MINS.

| STATIC LEVEL | WATER LEVEL END OF PUMPING | 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 140 FEET | 142 FEET | FEET | FEET | FEET | FEET |

WATER LEVELS DURING: 1 ☐ PUMPING 2 ☐ RECOVERY

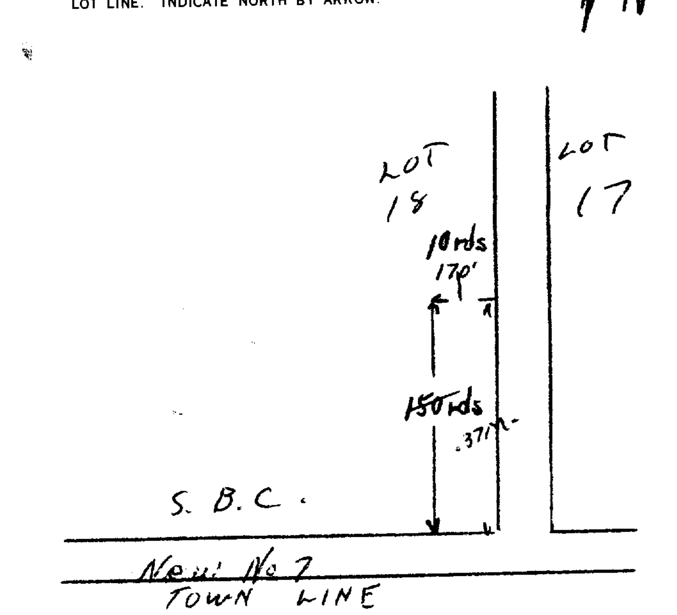
IF FLOWING, GIVE RATE GPM. | PUMP INTAKE SET AT FEET | WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING 170 FEET | RECOMMENDED PUMPING RATE 0010 GPM.

004.0 GPM./FT. SPECIFIC CAPACITY

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




DRILLERS REMARKS:

**FINAL STATUS OF WELL**: 1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

**WATER USE** 12: 1 ☒ DOMESTIC 2 ☒ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

**METHOD OF DRILLING**: 1 ☐ CABLE TOOL 2 ☒ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

## CONTRACTOR

NAME OF WELL CONTRACTOR: W. D. HOPPER & SONS | LICENCE NUMBER: 2604 ~~3495~~

ADDRESS: R.R. # 2 SEAFORTH, ONT.

NAME OF DRILLER OR BORER: NEIL HOPPER | LICENCE NUMBER:

SIGNATURE OF CONTRACTOR: Neil Hopper | SUBMISSION DATE: DAY 6 MO. MAY YR. 70

## OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 2604 | DATE RECEIVED 080571 ~~8 057~~

DATE OF INSPECTION 6, 11, 70 | INSPECTOR 71P S.C.

REMARKS: 7

OWRC COPY

40P39

The Ontario Water Resources Commission Act

# WATER WELL RECORD

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5001804 | MUNICIP. 50001 | CON. SB

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT |
|---|---|---|---|
| [redacted] | Blanchard | south bounty of ~~Blanchard~~ | 017 |

[redacted] #3 St. Marys, Ontario

DATE COMPLETED: DAY 23 MO. 12 YR. 71

[redacted] 86070 | RC. 4 | ELEVATION 1072 | RC. 4 | BASIN CODE 23

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH – FEET FROM | TO |
|---|---|---|---|---|---|
| brown | clay | stones | | 0 | 27 |
| blue | clay | stones | | 27 | 92 |
| grey | limestone | | hard | 92 | 178 |

31 | 00270051? | 0092305112 | 0178215

32

## 41 WATER RECORD

| WATER FOUND AT – FEET | KIND OF WATER |
|---|---|
| 0165 ~~165 to 178~~ | ☒ FRESH |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM. INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH – FEET FROM | TO |
|---|---|---|---|---|
| 05 | ☒ STEEL | 244 | 0 | 0093 |
| 05 | ☒ OPEN HOLE | | 93 | 0178 |

## SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

## 61 PLUGGING & SEALING RECORD

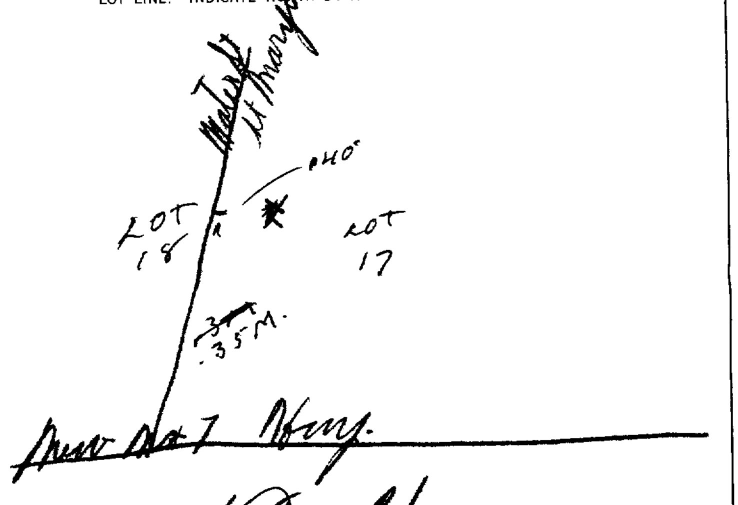
| DEPTH SET AT – FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |

## 71 PUMPING TEST

| | |
|---|---|
| PUMPING TEST METHOD | ☒ PUMP ☐ BAILER |
| PUMPING RATE | 0009 GPM. |
| DURATION OF PUMPING | 05 HOURS 00 MINS. |
| STATIC LEVEL | 132 FEET |
| WATER LEVEL END OF PUMPING | 140 FEET |
| WATER LEVELS DURING | ☒ PUMPING ☐ RECOVERY |
| 15 MINUTES | 140 FEET |
| 30 MINUTES | FEET |
| 45 MINUTES | FEET |
| 60 MINUTES | FEET |
| IF FLOWING, GIVE RATE | GPM. |
| PUMP INTAKE SET AT | 160 FEET |
| WATER AT END OF TEST | ☒ CLEAR ☐ CLOUDY |
| RECOMMENDED PUMP TYPE | ☐ SHALLOW ☒ DEEP |
| RECOMMENDED PUMP SETTING | 165 FEET |
| RECOMMENDED PUMPING RATE | 0008 GPM. |
| SPECIFIC CAPACITY | 001.1 GPM./FT. |

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




150 ft From Rd
100 ft From South Lot Line

DRILLERS REMARKS:

| | |
|---|---|
| FINAL STATUS OF WELL | ☒ WATER SUPPLY |
| WATER USE | ☒ DOMESTIC ☒ STOCK — 12 |
| METHOD OF DRILLING | ☒ CABLE TOOL |

## CONTRACTOR

NAME OF WELL CONTRACTOR: Mervin Jones — LICENCE NUMBER 3009
ADDRESS: RR#3 Thorndale, Ontario
NAME OF DRILLER OR BORER: Murray Jones — LICENCE NUMBER
SIGNATURE OF CONTRACTOR: Mervin Jones
SUBMISSION DATE: DAY 28 MO. 12 YR. 71

## OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 3009 | DATE RECEIVED 060172
DATE OF INSPECTION 28 2 72 | INSPECTOR
REMARKS: CSS.38 | P | WI

OWRC COPY

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

# WATER WELL RECORD

Ontario

40 P/36

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 5002038 | MUNICIP. 50001 | CON. TR

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT 25-27 |
|---|---|---|---|
| [redacted] | Blanshard | Thames R. | 037 |

[redacted] .R.#3 St. Marys Onyario. | DATE COMPLETED DAY 14 MO. 11 Nov YR. 73

5002038 17 [redacted] 4787240 4 1042 4 23 MAR 20, 1975 51

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | TO |
|---|---|---|---|---|---|
| Brown | Clay | | | 0 | 13 |
| Grey | Clay & Stones | | | 13 | 80 |
| Grey | Limestone | | | 80 | 160 |

31 0013605 | 0080295 12 | 0160215
32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 0103 | ☒ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL |
| | ☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL |
| | ☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL |
| | ☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL |
| | ☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | TO |
|---|---|---|---|---|
| 05 | ☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE | 188 | 0 | 0068 |
| 05 ~~3/4~~ | ☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☒ OPEN HOLE | | 68 | 0160 |
| | ☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE | | | |

## SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

PUMPING TEST METHOD: ☒ PUMP ☐ BAILER | PUMPING RATE 0005 GPM | DURATION OF PUMPING 01 HOURS 00 MINS

| STATIC LEVEL | WATER LEVEL END OF PUMPING | WATER LEVELS DURING ☒ PUMPING ☐ RECOVERY: 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 096 FEET | 110 FEET | FEET | FEET | FEET | 110 FEET |

IF FLOWING, GIVE RATE GPM | PUMP INTAKE SET AT 130 FEET | WATER AT END OF TEST ☒ CLEAR ☐ CLOUDY

RECOMMENDED PUMP TYPE ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING 130 FEET | RECOMMENDED PUMPING RATE 0005 GPM

000.4 GPM./FT. SPECIFIC CAPACITY

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.

Follow rd. out of St. Marys past past St. Marys Cement plant to top of hill turn right 2nd place on left side.

N

OWRC P.8

DRILLERS REMARKS:

## FINAL STATUS OF WELL

☒ WATER SUPPLY ☐ OBSERVATION WELL ☐ TEST HOLE ☐ RECHARGE WELL ☐ ABANDONED, INSUFFICIENT SUPPLY ☐ ABANDONED, POOR QUALITY ☐ UNFINISHED

## WATER USE 01

☒ DOMESTIC ☐ STOCK ☐ IRRIGATION ☐ INDUSTRIAL ☐ OTHER ☐ COMMERCIAL ☐ MUNICIPAL ☐ PUBLIC SUPPLY ☐ COOLING OR AIR CONDITIONING ☐ NOT USED

## METHOD OF DRILLING

☐ CABLE TOOL ☒ ROTARY (CONVENTIONAL) ☐ ROTARY (REVERSE) ☐ ROTARY (AIR) ☐ AIR PERCUSSION ☐ BORING ☐ DIAMOND ☐ JETTING ☐ DRIVING

## CONTRACTOR

NAME OF WELL CONTRACTOR: Hadco Well Drilling & Digging Ltd. | LICENCE NUMBER 2519
ADDRESS: P.O.Box 730 Elmira Ontario.
NAME OF DRILLER OR BORER: R.L.Franklin | LICENCE NUMBER
SIGNATURE OF CONTRACTOR | SUBMISSION DATE DAY 6 MO. Dec YR. 73

## OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 2519 | DATE RECEIVED 17 12 73
DATE OF INSPECTION 26 7 74 | INSPECTOR 7
REMARKS: CSS.S8 | P 2 | WI

MINISTRY OF THE ENVIRONMENT COPY

FORM 7 07-091

40 P/36

MINISTRY OF THE ENVIRONMENT

The Ontario Water Resources Act

# WATER WELL RECORD

Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5002225 | MUNICIP. 50001 | CON. SB

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT |
|---|---|---|---|
| [illegible] Perth | Blanchard | South Boundary | 017 |

| OWNER (SURNAME FIRST) | ADDRESS | DATE COMPLETED |
|---|---|---|
| ST. MARYS, CEMENT CO. | St. Marys, Ontario | DAY 23 MO. 10 YR. 74 |

21 | UTM ZONE 17 | EASTING 487303 | NORTHING 4785979 | RC. 4 | ELEVATION 1082 | RC. 4 | BASIN CODE 23

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|---|
| black | topsoil | | | 0 | 1 |
| brown | clay | | | 1 | 9 |
| grey | clay | sand and stones | | 9 | 98 |
| grey | limestone | | | 98 | 160 |
| b rown | limestone | | | 160 | 180 |

31 | 0001802 | 0009605 | 0098205 2813 | 0160215 | 0180615

32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 180 | 1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM. INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|
| 05 | 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE | 188 | 0 | 0100 |
| 05 | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE | | 100 | 0180 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE | | | |

## SCREEN

| SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET |
|---|---|---|
| | | |

| MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET |
|---|---|
| | |

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

| PUMPING TEST METHOD | PUMPING RATE | DURATION OF PUMPING |
|---|---|---|
| 1 ☐ PUMP 2 ☒ BAILER | 0010 GPM. | 01 HOURS 00 MINS |

| STATIC LEVEL | WATER LEVEL END OF PUMPING | WATER LEVELS DURING (1 ☒ PUMPING 2 ☐ RECOVERY) 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 165 FEET | 170 FEET | FEET | 110 FEET | FEET | FEET |

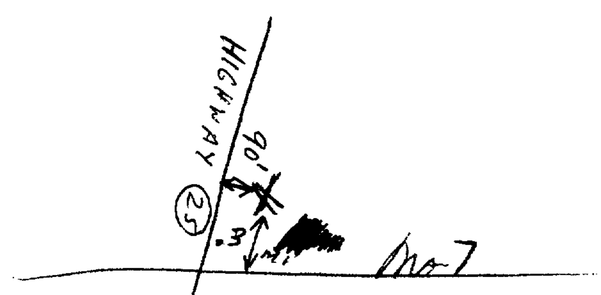
| IF FLOWING, GIVE RATE | PUMP INTAKE SET AT | WATER AT END OF TEST |
|---|---|---|
| GPM. | FEET | 1 ☒ CLEAR 2 ☐ CLOUDY |

| RECOMMENDED PUMP TYPE | RECOMMENDED PUMP SETTING | RECOMMENDED PUMPING RATE |
|---|---|---|
| ☐ SHALLOW ☒ DEEP | 175 FEET | 0008 GPM |

002.0 GPM./FT. SPECIFIC CAPACITY

## LOCATION OF WELL 8185

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




DRILLERS REMARKS:

## FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

## WATER USE 01

1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

## METHOD OF DRILLING

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

## CONTRACTOR

NAME OF WELL CONTRACTOR: Mervin Jones — LICENCE NUMBER 3009

ADDRESS: R. R. #3, Thorndale, Ont.

NAME OF DRILLER OR BORER: Murray Jones — LICENCE NUMBER 3034

SIGNATURE OF CONTRACTOR: Mervin Jones — SUBMISSION DATE DAY 24 MO. 10 YR. 74

## OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 3009 | DATE RECEIVED 240175

DATE OF INSPECTION May 2/75 | INSPECTOR

REMARKS: COVERED

P B.S.

WI

CSS. 58

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FORM 7 07-091

MINISTRY OF THE ENVIRONMENT

The Ontario Water Resources Act

# WATER WELL RECORD

Ontario

407/3g

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 15002282 | MUNICIP. 50601 | CON.

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT 25-27 |
|---|---|---|---|
| Perth | ~~Blanchard~~ ST MARY'S TOWN | South Boundary Conc | [redacted] |

| OWNER (SURNAME FIRST) 28-47 | ADDRESS | DATE COMPLETED 48-53 |
|---|---|---|
| [redacted] | St. Marys, Ontario. | DAY 01 MO. 10 YR. 75 |

21 | ZONE 17 | EASTING 488020 | NORTHING 4787380 | RC. 4 | ELEVATION 0970 | RC. 3 | BASIN CODE 23

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | TO |
|---|---|---|---|---|---|
| Grey | Limestone | | | 0' | 33' |
| Brown | Limestone | | | 33' | 40' |
| Brown | Limestone | | Hard | 40' | 82' |
| | Limestone | | Broken | 82' | 85' |
| Brown | Limestone | | Hard | 85' | 95' |
| Brown&Grey | Limestone | | | 95' | 163' |
| Brown | Limestone | | Hard | 163' | 165' |

31 | 0033215 | 0040615 | 008261573 | 00851571 | 009561573 | 0163615 | 1

32 | 016561573

### 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 0033 | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☒ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |

### 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | TO |
|---|---|---|---|---|
| 6" | 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE | .330 | 0' | 0015' |
| 12 | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE | | 15 | 0165 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE | | | |

### SCREEN

| SIZE(S) OF OPENING (SLOT NO.) | DIAMETER | LENGTH |
|---|---|---|
| None | INCHES | FEET |
| MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN | FEET |

### 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

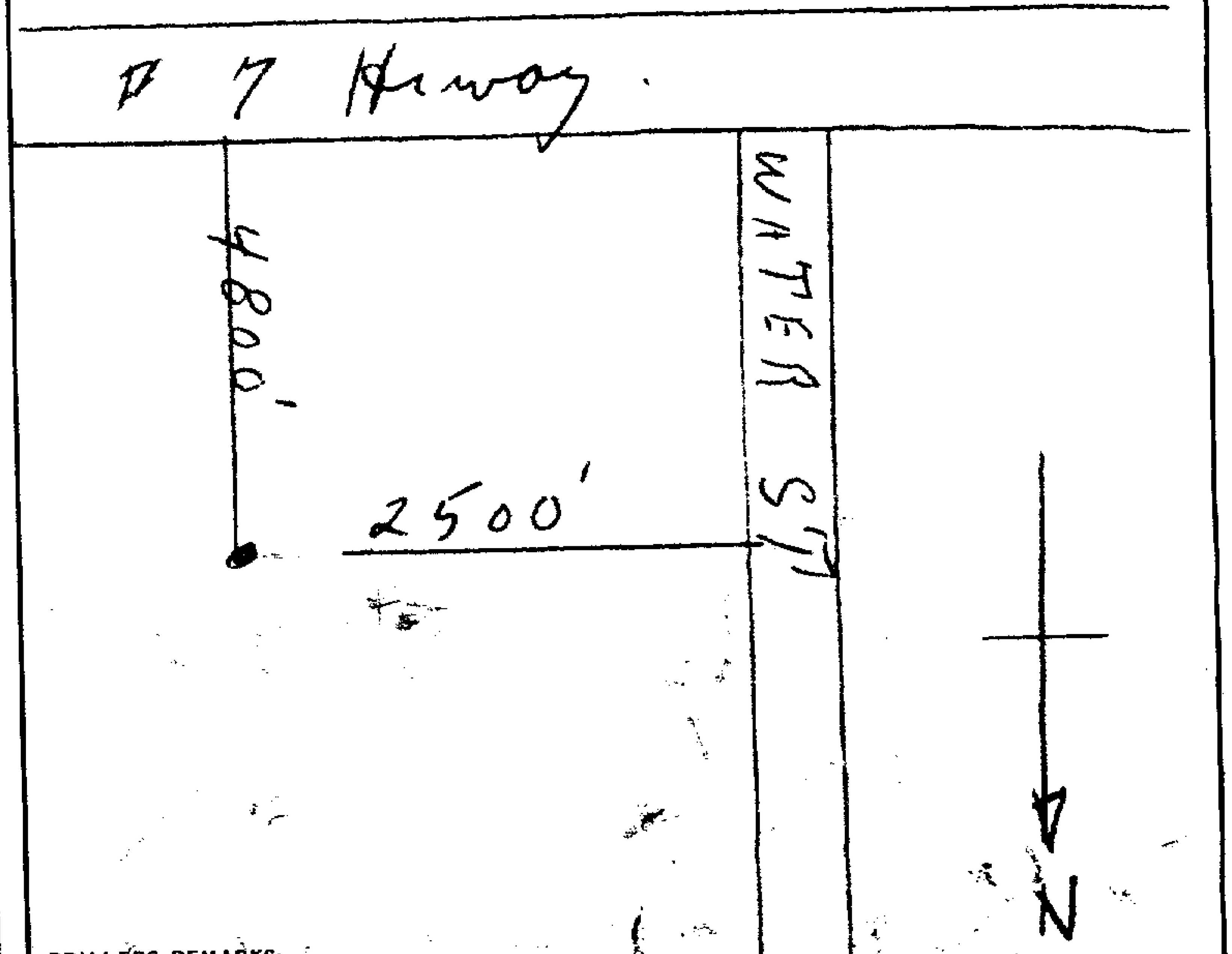
### 71 PUMPING TEST

| | | | | |
|---|---|---|---|---|
| PUMPING TEST METHOD 1 ☒ PUMP 2 ☐ BAILER | PUMPING RATE 0785 GPM | DURATION OF PUMPING 08 HOURS 00 MINS | | |
| STATIC LEVEL 006 (5'78) | WATER LEVEL END OF PUMPING 033 (33.0) FEET | WATER LEVELS DURING: 15 MINUTES 008 (8.42) FEET | 30 MINUTES 008 (7.52) FEET | 1 ☐ PUMPING 2 ☒ RECOVERY; 45 MINUTES FEET; 60 MINUTES 007 (7.30) FEET |
| IF FLOWING, GIVE RATE GPM | PUMP INTAKE SET AT FEET | WATER AT END OF TEST 1 ☒ CLEAR 2 ☐ CLOUDY | | |
| RECOMMENDED PUMP TYPE ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING 060 (60) FEET | RECOMMENDED PUMPING RATE 600 GPM | | |
| 50-53 GPM./FT. SPECIFIC CAPACITY | | | | |

| | |
|---|---|
| FINAL STATUS OF WELL 1 | 1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED |
| WATER USE 04 | 1 ☒ ~~DOMESTIC~~ 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☒ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED |
| METHOD OF DRILLING 2 | 1 ☐ CABLE TOOL 2 ☒ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING |

### LOCATION OF WELL 8887

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




DRILLERS REMARKS:

### CONTRACTOR

| | |
|---|---|
| NAME OF WELL CONTRACTOR: International Water Supply Ltd. | LICENCE NUMBER 2801 |
| ADDRESS: Barrie, Ontario. | |
| NAME OF DRILLER OR BORER: Tom Kyle | LICENCE NUMBER 2801 |
| SIGNATURE OF CONTRACTOR: Bl. Hodg | SUBMISSION DATE DAY 3 MO. OCT YR. 75 |

### OFFICE USE ONLY

| | | |
|---|---|---|
| DATA SOURCE 1 | CONTRACTOR 2801 | DATE RECEIVED 071075 |
| DATE OF INSPECTION 14/9/76 | INSPECTOR | |
| REMARKS: CSS.S8 | | P B.J. / WI B.J. |

MINISTRY OF THE ENVIRONMENT COPY

FORM 7 07-091

Ministry of the Environment
Ontario

(27)

The Ontario Water Resources Act
# WATER WELL RECORD

1 OP '39

5002878

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | MUNICIP. 50001 | CON. TR

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT |
|---|---|---|---|
| PERTH | BLANSHARD | THAMES R. | 038 |

[redacted] R. #3 ST. MARYS

DATE COMPLETED: DAY 28 MO 10 YR 80

[redacted] 786620 | RC. 4 | ELEVATION 1060 | RC. 4 | BASIN CODE 23

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | TO |
|---|---|---|---|---|---|
| | topsoil | | | 0 | 2 |
| brown | clay | with sand and gravel | | 2 | 9 |
| grey | clay | sand and stones | | 9 | 109 |
| brown | limestone | | | 109 | 162 |
| grey | limestone | | | 162 | 169 |
| brown | limestone | | | 169 | 171 |

31 | 0002 02 | 0009605281 1 | 0109205281 2 | 0162615 | 0169215 | 0171615
32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 0171 | 1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |
| | 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM. INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | TO |
|---|---|---|---|---|
| 05 | 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE | 188 | 0 | 0110 |
| 05 | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE | | 110 | 0171 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE | | | |

## SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER | PUMPING RATE 0008 GPM | DURATION OF PUMPING 01 HOURS 00 MINS

| STATIC LEVEL | WATER LEVEL END OF PUMPING | 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 120 FEET | 150 FEET | 150 FEET | 150 FEET | 150 FEET | 150 FEET |

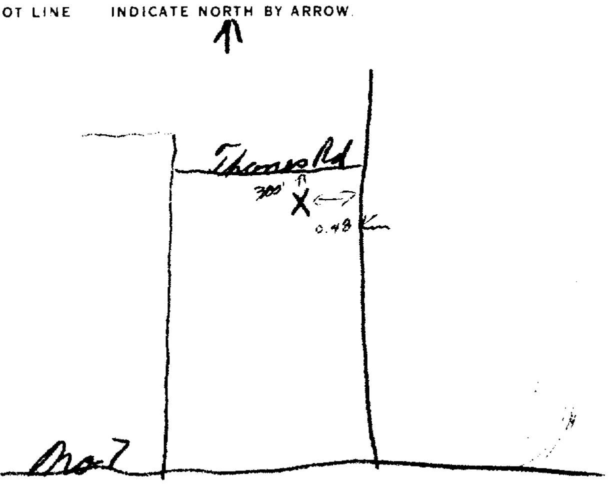
WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE: GPM | PUMP INTAKE SET AT: FEET | WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING 160 FEET | RECOMMENDED PUMPING RATE 0007 GPM

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




DRILLERS REMARKS:

**FINAL STATUS OF WELL** 1
1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

**WATER USE** 12
1 ☒ DOMESTIC 2 ☒ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

**METHOD OF DRILLING** 2
1 ☐ CABLE TOOL 2 ☒ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

## CONTRACTOR

NAME OF WELL CONTRACTOR: MERVIN JONES | LICENCE NUMBER: 3009
ADDRESS: R. R. #3 THORNDALE, ONTARIO
NAME OF DRILLER OR BORER: MURRAY S. JONES | LICENCE NUMBER: 3034
SIGNATURE OF CONTRACTOR: Mervin Jones | SUBMISSION DATE: DAY ___ MO ___ YR ___

## OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 3009 | DATE RECEIVED 101180
DATE OF INSPECTION 17/7/81 | INSPECTOR 7
REMARKS: Villeas P/P CSS.SS CWP

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506-4-77

Ministry of the Environment
Ontario

(51)

The Ontario Water Resources Act 40P/29

# WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5003388 | MUNICIP 50601 | CON

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT |
|---|---|---|---|
| [redacted] | Blanchard ST. MARYS | South Boundry | ~~36~~ 17 |

[redacted] Marys, Ont. VILLIAGE.

DATE COMPLETED: DAY ~~26~~ MO 10 YR 87

21 | [redacted] 86770 | ELEVATION 1063 | RC | BASIN CODE

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|---|
| | | | | 0 | 1 |
| black | topsoil | | | 1 | 5 |
| brown | clay | sand | | | |
| | | | | 5 | 119 |
| grey | clay | sand and stones | | 119 | 171 |
| grey | limestone | | | | |

31

32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 171 | 1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|
| 5 | 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | 188 | 0 | 121 |
| 5 | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE 5 ☐ PLASTIC | | 121 | 171 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | | | |

## SCREEN

| SIZE(S) OF OPENING (SLOT NO.) | DIAMETER | LENGTH |
|---|---|---|
| | INCHES | FEET |
| MATERIAL AND TYPE | | DEPTH TO TOP OF SCREEN FEET |

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

| | |
|---|---|
| PUMPING TEST METHOD | 1 ☐ PUMP 2 ☒ BAILER |
| PUMPING RATE | 7 GPM |
| DURATION OF PUMPING | 1 HOURS MINS |
| STATIC LEVEL | 141 FEET |
| WATER LEVEL END OF PUMPING | 147 FEET |
| WATER LEVELS DURING | 1 ☒ PUMPING 2 ☐ RECOVERY |
| 15 MINUTES | 147 FEET |
| 30 MINUTES | 147 FEET |
| 45 MINUTES | 147 FEET |
| 60 MINUTES | 147 FEET |
| IF FLOWING, GIVE RATE | GPM |
| PUMP INTAKE SET AT | FEET |
| WATER AT END OF TEST | 1 ☒ CLEAR 2 ☐ CLOUDY |
| RECOMMENDED PUMP TYPE | ☐ SHALLOW ☒ DEEP |
| RECOMMENDED PUMP SETTING | 165 FEET |
| RECOMMENDED PUMPING RATE | 7 GPM |

## FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED
9 ☐ DEWATERING

## WATER USE

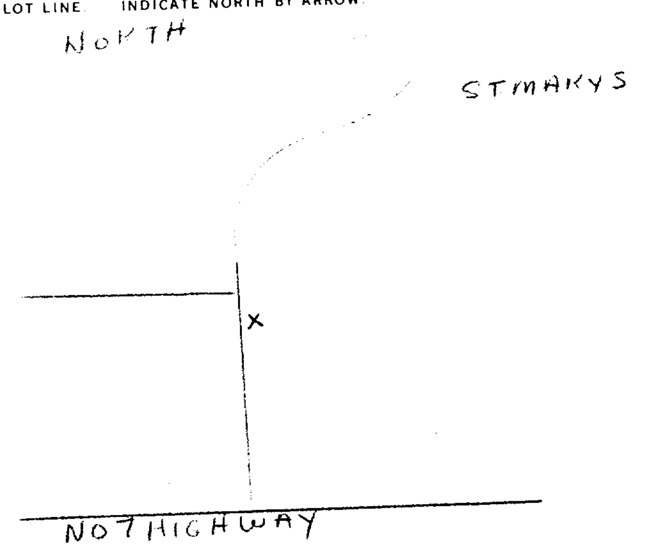
1 ☒ DOMESTIC
2 ☒ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

## METHOD OF CONSTRUCTION

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING
☐ DIGGING
☐ OTHER

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




14419

DRILLERS REMARKS

## CONTRACTOR

| | |
|---|---|
| NAME OF WELL CONTRACTOR | Mervin Jones |
| WELL CONTRACTOR'S LICENCE NUMBER | 3009 |
| ADDRESS | R.r. 3, Thorndale, Ont. |
| NAME OF WELL TECHNICIAN | Murray S. Jones |
| WELL TECHNICIAN'S LICENCE NUMBER | T0068 |
| SIGNATURE OF TECHNICIAN/CONTRACTOR | Mervin Jones |
| SUBMISSION DATE | DAY 26 MO 10 YR 87 |

## OFFICE USE ONLY

| | |
|---|---|
| DATA SOURCE | |
| CONTRACTOR | |
| DATE RECEIVED | NOV 04 1987 |
| DATE OF INSPECTION | 2/9/88 |
| INSPECTOR | |
| REMARKS | CSS.S8 |

FORM NO. 0506 (11/86) FORM 9

MINISTRY OF THE ENVIRONMENT COPY

Ministry of the Environment

Ontario

(30)

The Ontario Water Resources Act

# WATER WELL RECORD

5003434 SB

MUNICIP 50001

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11

PLAN 295

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC | LOT |
|---|---|---|---|
| [redacted] | ARD | THAMES | 295 |

[redacted] R. #3 St. Marys, Ontario NOM 2V0

DATE COMPLETED: DAY 15 MO 6 YR 88

[redacted]87253 RC ELEVATION 1060 RC BASIN CODE

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|---|
| Black | Topsoil | | | 0 | 1 |
| Brown | Clay | Stones | | 1 | 4 |
| Grey | Clay | Sand and Stones | | 4 | 93 |
| Grey | Limestone | | | 93 | 185 |

31

32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 185 | 1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|
| 5 | 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | 188 | 0 | 94 |
| 5 | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE 5 ☐ PLASTIC | | 94 | 185 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | | | |

## SCREEN

| SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET |
|---|---|---|
| | | |

| MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET |
|---|---|
| | |

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

| PUMPING TEST METHOD | PUMPING RATE | DURATION OF PUMPING |
|---|---|---|
| 1 ☐ PUMP 2 ☒ BAILER | 7 GPM | 1 HOURS MINS |

| STATIC LEVEL | WATER LEVEL END OF PUMPING | 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 132 FEET | 156 FEET | 156 FEET | 156 FEET | 156 FEET | 156 FEET |

WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE: GPM

PUMP INTAKE SET AT: FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 180 FEET

RECOMMENDED PUMPING RATE: 7 GPM

## FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED
9 ☐ DEWATERING

## WATER USE

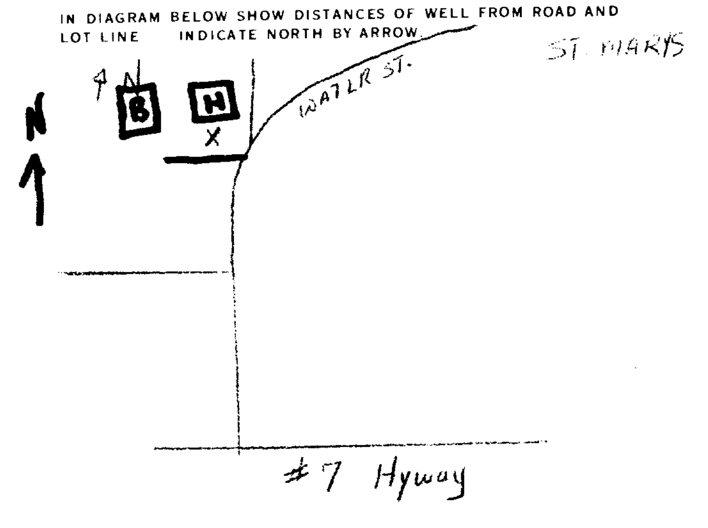
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

## METHOD OF CONSTRUCTION

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING
☐ DIGGING
☐ OTHER

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




27648

DRILLERS REMARKS

## CONTRACTOR

NAME OF WELL CONTRACTOR: Mervin Jones

WELL CONTRACTOR'S LICENCE NUMBER: 3009

ADDRESS: R. R. #3 Thorndale, Ontario NOM 2P0

NAME OF WELL TECHNICIAN: Murray S. Jones

WELL TECHNICIAN'S LICENCE NUMBER: T 0068

SIGNATURE OF TECHNICIAN/CONTRACTOR: Mervin Jones

SUBMISSION DATE: DAY 16 MO. 6 YR 88

## OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 3009 | DATE RECEIVED JUN 22 1988

DATE OF INSPECTION | INSPECTOR

REMARKS

CSS.S8

Ministry of the Environment
Ontario

(H9)

The Ontario Water Resources Act
# WATER WELL RECORD
SB

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5003609 | MUNICIP 50001 | CON. 18

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY ETC. | LOT |
|---|---|---|---|
| [redacted] | [redacted] | Thames Concession | Reg. P |

[redacted]. #3 St. Marys, Ontario NOM 2V0

DATE COMPLETED: DAY 03 MO 08 YR 89

21 [redacted] ELEVATION 1080 RC. BASIN CODE

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | TO |
|---|---|---|---|---|---|
| Grey | Clay | Sand and Stones | | 0 | 131 |
| Grey | Limestone | | | 131 | 170 |

31
32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 170 | 1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | TO |
|---|---|---|---|---|
| 5 | 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | 188 | 0 | 131 |
| 5 | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE 5 ☐ PLASTIC | | 131 | 170 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | | | |

## SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER
PUMPING RATE: 8 GPM
DURATION OF PUMPING: 1 HOURS MINS

| STATIC LEVEL | WATER LEVEL END OF PUMPING | WATER LEVELS DURING 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 132 FEET | 145 FEET | 145 FEET | 145 FEET | 145 FEET | 145 FEET |

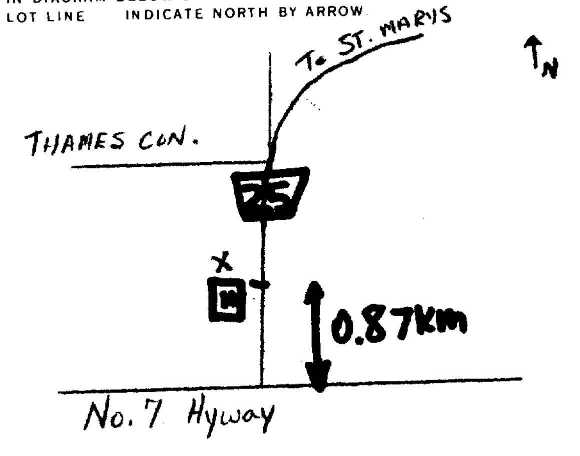
WATER LEVELS DURING: 1 ☐ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING: 150 FEET
RECOMMENDED PUMPING RATE: 8 GPM

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




46764

DRILLERS REMARKS

## FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED
☐ DEWATERING

## WATER USE

1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

## METHOD OF CONSTRUCTION

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING
☐ DIGGING
☐ OTHER

## CONTRACTOR

NAME OF WELL CONTRACTOR: MERVIN JONES DRILLING LTD.
WELL CONTRACTOR'S LICENCE NUMBER: 3009
ADDRESS: R. R. #3 Thorndale, Ontario NOM 2PO
NAME OF WELL TECHNICIAN: MURRAY S. JONES
WELL TECHNICIAN'S LICENCE NUMBER: T-0068
SIGNATURE OF TECHNICIAN/CONTRACTOR: Mervin Jones
SUBMISSION DATE: DAY 03 MO 08 YR 89

## OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 3009 | DATE RECEIVED AUG 14 1989
DATE OF INSPECTION | INSPECTOR
REMARKS
CSS.S8

(65)

Ministry of the Environment
Ontario

The Ontario Water Resources Act

# WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5003633 | MUNICIP 50001 | CON. SB

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT |
|---|---|---|---|
| [redacted] | Blanshard | Thames | 18 |

[redacted], St.Marys, Ontario, — DATE COMPLETED: DAY 18 MO 9 YR 89

21 | [redacted] 86205 | RC. | ELEVATION 1080 | RC. | BASIN CODE

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | TO |
|---|---|---|---|---|---|
| brown | clay | sand | | 0 | 12 |
| grey | clay | sand and stones | | 12 | 87 |
| grey | limestone | | | 87 | 170 |

31

32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 170 | 1 ☒ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 3 ☐ SULPHUR; 2 ☐ SALTY 4 ☐ MINERALS 6 ☐ GAS |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | TO |
|---|---|---|---|---|
| 5 | 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | 188 | 0 | 88 |
| 5 | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | | 88 | 170 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | | | |

## SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER
PUMPING RATE: 8 GPM
DURATION OF PUMPING: 1 HOURS MINS

| STATIC LEVEL | WATER LEVEL END OF PUMPING | 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 132 FEET | 150 FEET | 150 FEET | 150 FEET | 150 FEET | 150 FEET |

WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING: 160 FEET
RECOMMENDED PUMPING RATE: 8 GPM

## FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED
☐ DEWATERING

## WATER USE

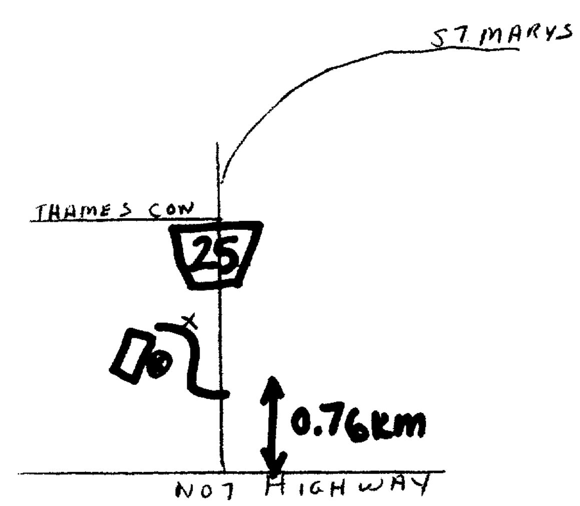
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

## METHOD OF CONSTRUCTION

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING
☐ DIGGING
☐ OTHER

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




46786

DRILLERS REMARKS

## CONTRACTOR

NAME OF WELL CONTRACTOR: MErvin Jones Drilling LTD
WELL CONTRACTOR'S LICENCE NUMBER: 3009
ADDRESS: R.R.3 Thorndale, Ontario,
NAME OF WELL TECHNICIAN: Murray S. Jones
WELL TECHNICIAN'S LICENCE NUMBER: T0068
SIGNATURE OF TECHNICIAN/CONTRACTOR: Mervin Jones
SUBMISSION DATE: DAY 18 MO 9 YR 89

## OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 3009 | DATE RECEIVED SEP 27 1989
DATE OF INSPECTION | INSPECTOR
REMARKS
CSS.S8

FORM NO. 0506 (11/86) FORM 9

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Ontario

The Ontario Water Resources Act

# WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5003647 | MUNICIP 50001 | CON. SB

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC | LOT |
|---|---|---|---|
| [redacted] | [redacted]rd Twp. | Con. S.B. | Pt.18 |

[redacted] c/o F. Weitzel
[redacted] R.R. 2, Tavistock, ON N0B 2R0

DATE COMPLETED: DAY 13 MO Sept. YR 89

[redacted] 86565 | RC | ELEVATION 1080 | RC | BASIN CODE

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | TO |
|---|---|---|---|---|---|
| Brown | Clay | | Hard | 0 | 6 |
| Grey | Clay | STones | Hard | 6 | 61 |
| Grey | Hardpan | Stones | Hard | 61 | 98 |
| Grey-Brn. | Limestone | | Hard | 98 | 152 |
| Brown | Limestone | | Medium | 152 | 159 |

31

32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 138, 153, 159 | 1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | TO |
|---|---|---|---|---|
| 6 | 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | .188 | 0 | 100-8 |
| 6 | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE 5 ☐ PLASTIC | | 100-8 | 159 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | | | |

## SCREEN

| SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET |
|---|---|---|
| | | |

| MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET |
|---|---|
| | |

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

| PUMPING TEST METHOD | PUMPING RATE | DURATION OF PUMPING |
|---|---|---|
| air — 1 ☒ PUMP 2 ☒ BAILER | 10 GPM | 1 HOURS 30 MINS |

| STATIC LEVEL | WATER LEVEL END OF PUMPING | 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 121 FEET | 129 FEET | 125 FEET | 127 FEET | 129 FEET | 129 FEET |

WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE: GPM

PUMP INTAKE SET AT: 150 FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 150 FEET

RECOMMENDED PUMPING RATE: 10 GPM

## FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED
9 ☐ DEWATERING

## WATER USE

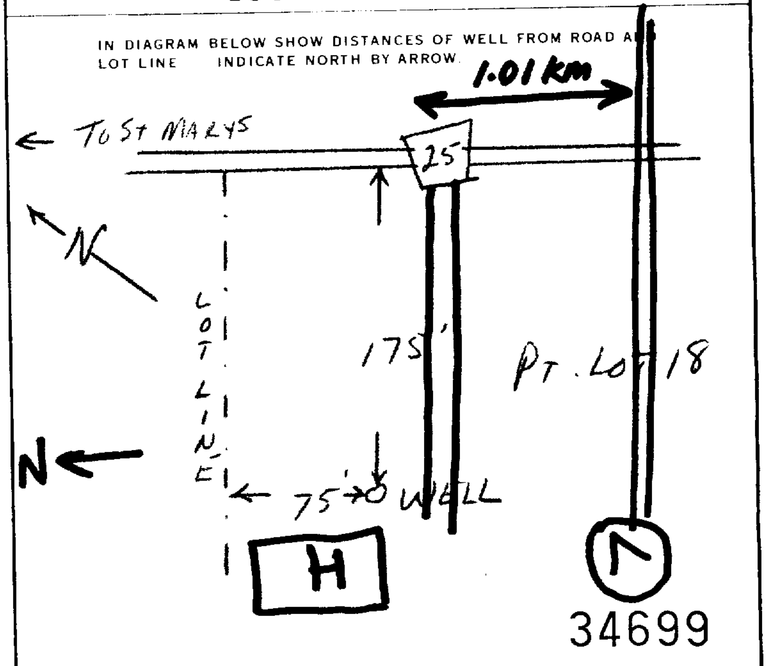
1 ☒ DOMESTIC
2 ☒ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

## METHOD OF CONSTRUCTION

1 ☐ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☒ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING
☐ DIGGING
☐ OTHER

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




DRILLERS REMARKS

## CONTRACTOR

| NAME OF WELL CONTRACTOR | WELL CONTRACTOR'S LICENCE NUMBER |
|---|---|
| Davidson Well Drilling Limited | 1737 |

ADDRESS: Box 486, Wingham, Ontario. N0G 2W0

| NAME OF WELL TECHNICIAN | WELL TECHNICIAN'S LICENCE NUMBER |
|---|---|
| D. Casemore | T0154 |

SIGNATURE OF TECHNICIAN/CONTRACTOR | SUBMISSION DATE: DAY 20 MO Sept. YR 89

## OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 1737 | DATE RECEIVED OCT 18 1989

DATE OF INSPECTION | INSPECTOR

REMARKS

CSS.S8

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

(40)

Ministry of the Environment
Ontario

The Ontario Water Resources Act
# WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5003753 | MUNICIP 50001 | CON. SB

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT |
|---|---|---|---|
| [redacted] | | THAMES | 18 |

[redacted] #3 St. Marys, Ontario NOM 2V0 — DATE COMPLETED: DAY 23 MO 07 YR 90

21 | ELEVATION 1080 | BASIN CODE

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|---|
| Grey | Clay | Sand and Stones | | 0 | 93 |
| Brown | Limestone | | | 93 | 180 |

31

32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 175 to 180 | ☒ FRESH |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|
| 5 | ☒ STEEL | 188 | 0 | 94 |
| 5 | ☒ OPEN HOLE | | 94 | 180 |

## SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET | MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |

## 71 PUMPING TEST

| Field | Value |
|---|---|
| PUMPING TEST METHOD | ☒ BAILER |
| PUMPING RATE | 12 GPM |
| DURATION OF PUMPING | 1 HOURS |
| STATIC LEVEL | 132 FEET |
| WATER LEVEL END OF PUMPING | 145 FEET |
| WATER LEVELS DURING | ☒ PUMPING |
| 15 MINUTES | 145 FEET |
| 30 MINUTES | 145 FEET |
| 45 MINUTES | 145 FEET |
| 60 MINUTES | 145 FEET |
| IF FLOWING, GIVE RATE | |
| PUMP INTAKE SET AT | |
| WATER AT END OF TEST | ☒ CLEAR |
| RECOMMENDED PUMP TYPE | ☒ DEEP |
| RECOMMENDED PUMP SETTING | 170 FEET |
| RECOMMENDED PUMPING RATE | 10 GPM |

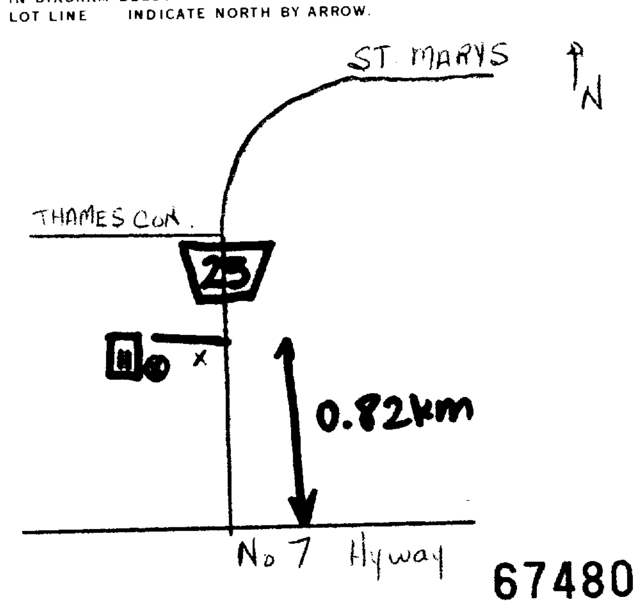
**FINAL STATUS OF WELL:** ☒ WATER SUPPLY

**WATER USE:** ☒ DOMESTIC

**METHOD OF CONSTRUCTION:** ☒ ROTARY (CONVENTIONAL)

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




67480

DRILLERS REMARKS

## CONTRACTOR

| Field | Value |
|---|---|
| NAME OF WELL CONTRACTOR | MERVIN JONES DRILLING LTD. |
| WELL CONTRACTOR'S LICENCE NUMBER | 3009 |
| ADDRESS | R. R. #3 Thorndale, Ontario NOM 2P0 |
| NAME OF WELL TECHNICIAN | STEPHEN BLIGHT |
| WELL TECHNICIAN'S LICENCE NUMBER | T-1626 |
| SIGNATURE OF TECHNICIAN/CONTRACTOR | Mervin Jones |
| SUBMISSION DATE | DAY 24 MO. 07 YR. 90 |

## OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 3009 | DATE RECEIVED SEP 06 1990
DATE OF INSPECTION | INSPECTOR
REMARKS

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FORM NO. 0506 (11/86) FORM 9

Ministry of the Environment
Ontario

The Ontario Water Resources Act

# WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5003888 | MUNICIP. 50091 | CON. SB | 18

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT |
|---|---|---|---|
| [redacted] | [redacted] | TRC | |

DATE COMPLETED: DAY 18/ 7/1991 YR.

[redacted] ST.MARYS ONT.

21 | [redacted] 86490 | RC | ELEVATION 1080 | RC | BASIN CODE

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | TO |
|---|---|---|---|---|---|
| YELLOW | CLAY | | | 0 | 13 |
| GREY | CLAY | | | 13 | 45 |
| GREY | HARDPAN | STONES | | 45 | 107 |
| WHITE | MARL | SAND | | 107 | 113 |
| WHITE | MARL | | | 113 | 115 |
| GREY | LIMESTONE | | | 115 | 120 |
| BROWN | LIMESTONE | | FRACTURED | 120 | 150 |
| BROWN | LIMESTONE | GREY LIMESTONE | LAYERED | 150 | 179 |
| BROWN | LIMESTONE | | LOOSE | 179 | 183 |

31

32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 153 | FR — 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| 160 | FR — 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| 179 | FR — 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| 183 | FR — 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | TO |
|---|---|---|---|---|
| 5" | ST (1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC) | .188 | +1 | 118 |
| 5" | OP (1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC) | | 118 | 183 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | | | |

## SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

| PUMPING TEST METHOD | PUMPING RATE | DURATION OF PUMPING |
|---|---|---|
| 1 ☒ PUMP 2 ☐ BAILER | 17 GPM | 3 HOURS MINS |

| STATIC LEVEL | WATER LEVEL END OF PUMPING | WATER LEVELS DURING (1 ☐ PUMPING 2 ☐ RECOVERY) RC — 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 127 FEET | 134 FEET | 127 FEET | FEET | FEET | FEET |

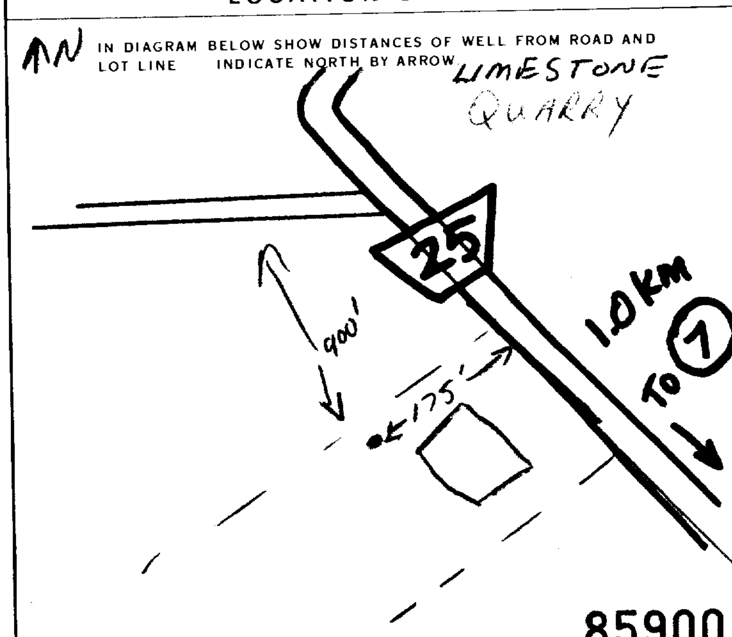
IF FLOWING, GIVE RATE: GPM | PUMP INTAKE SET AT: 175 FEET | WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING: 165 FEET | RECOMMENDED PUMPING RATE: 15 GPM

| | |
|---|---|
| FINAL STATUS OF WELL | WATR — 1 ☐ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED ☐ DEWATERING |
| WATER USE | DOMS, COOL — 1 ☐ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED |
| METHOD OF CONSTRUCTION | CONV, AIR — 1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING ☐ DIGGING ☐ OTHER |

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW




85900

DRILLERS REMARKS: PUMP BY W.D.HOPPER &SONS

## CONTRACTOR

NAME OF WELL CONTRACTOR: W.D.HOPPER & SONS LTD. | WELL CONTRACTOR'S LICENCE NUMBER: 2604

ADDRESS: RR# 2 SEAFORTH ONT.

NAME OF WELL TECHNICIAN: RON HOPPER | WELL TECHNICIAN'S LICENCE NUMBER: T-0135

SIGNATURE OF TECHNICIAN/CONTRACTOR: [signature] | SUBMISSION DATE: DAY 30/ MO 9/1991 YR.

## OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 2604 | DATE RECEIVED NOV 12 1991

DATE OF INSPECTION | INSPECTOR

REMARKS: APL

CSS.S8

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FORM NO. 0506 (11/86) FORM 9

Ministry of the Environment
Ontario

The Ontario Water Resources Act
# WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5004013 | MUNICIP 50001 | CON. T.R

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC. | LOT |
|---|---|---|---|
| [redacted] | BLANSHARD | T. RD. | 37 |

[redacted] MARYS, ONT.

DATE COMPLETED: DAY 29/ MO 9/ YR 1992

ELEVATION | RC | BASIN CODE

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|---|
| BRN | CLAY | STONES | | 0 | 19 |
| GREY | CLAY | STONES | | 19 | 74 |
| GREY | HARDPAN | STONES | | 74 | 100 |
| BRN | LIMESTONE | | | 100 | 185 |

31
32

## 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 140-185 | FR (1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS) |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |
| | 1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS |

## 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | DEPTH - FEET TO |
|---|---|---|---|---|
| 5" | ST (1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC) | .188 | + 2 | 105 |
| 5" | OP (1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC) | | 105 | 185 |
| | 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC | | | |

## SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

## 61 PLUGGING & SEALING RECORD

| DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.) |
|---|---|---|
| | | |
| | | |
| | | |

## 71 PUMPING TEST

PUMPING TEST METHOD: 1 X PUMP 2 ☐ BAILER
PUMPING RATE: 12 GPM
DURATION OF PUMPING: 1 HOURS 30 MINS

| STATIC LEVEL | WATER LEVEL END OF PUMPING | 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 124 FEET | FEET | FEET | FEET | FEET | FEET |

WATER LEVELS DURING: 1 ☐ PUMPING 2 ☐ RECOVERY

IF FLOWING GIVE RATE: GPM
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: CL (1 ☐ CLEAR 2 ☐ CLOUDY)
RECOMMENDED PUMP TYPE: ☐ SHALLOW X DEEP
RECOMMENDED PUMP SETTING: 150 FEET
RECOMMENDED PUMPING RATE: 12 GPM

## FINAL STATUS OF WELL

WATR — 1 WATER SUPPLY; 2 ☐ OBSERVATION WELL; 3 ☐ TEST HOLE; 4 ☐ RECHARGE WELL; 5 ☐ ABANDONED, INSUFFICIENT SUPPLY; 6 ☐ ABANDONED, POOR QUALITY; 7 ☐ UNFINISHED; ☐ DEWATERING

## WATER USE

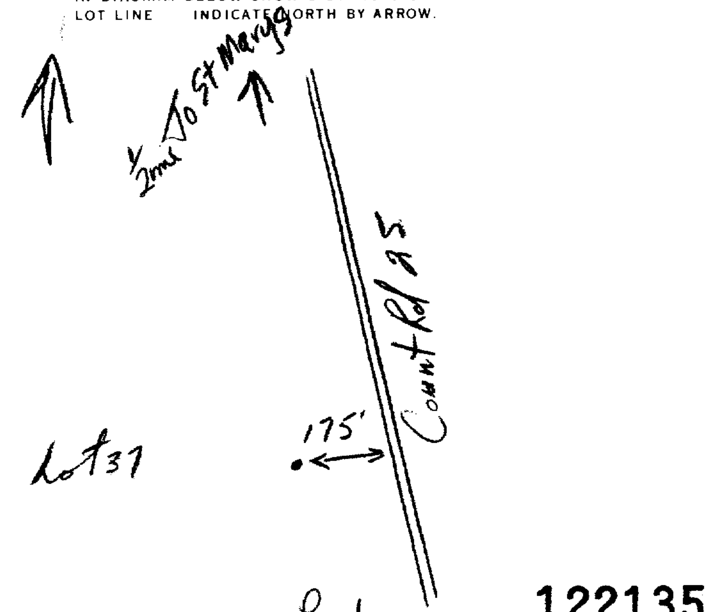
DOMS — 1 ☐ DOMESTIC; 2 ☐ STOCK; 3 ☐ IRRIGATION; 4 ☐ INDUSTRIAL; ☐ OTHER; 5 ☐ COMMERCIAL; 6 ☐ MUNICIPAL; ☐ PUBLIC SUPPLY; 8 ☐ COOLING OR AIR CONDITIONING; 9 ☐ NOT USED

## METHOD OF CONSTRUCTION

ROTY AIR — 1 ☐ CABLE TOOL; 2 ☐ ROTARY (CONVENTIONAL); 3 ☐ ROTARY (REVERSE); 4 ☐ ROTARY (AIR); 5 ☐ AIR PERCUSSION; 6 ☐ BORING; 7 ☐ DIAMOND; 8 ☐ JETTING; 9 ☐ DRIVING; ☐ DIGGING; ☐ OTHER

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.




122135

DRILLERS REMARKS: approx footages

## CONTRACTOR

NAME OF WELL CONTRACTOR: DURL HOPPER LIMITED
WELL CONTRACTOR'S LICENCE NUMBER: 2644
ADDRESS: R.R.# 7, ST.MARYS, ONT. N4X 1C9
NAME OF WELL TECHNICIAN: SHAWN HOPPER
WELL TECHNICIAN'S LICENCE NUMBER: 92-149
SIGNATURE OF TECHNICIAN/CONTRACTOR: [signature]
SUBMISSION DATE: DAY 10/14/1992 MO. YR.

## OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 2644 | DATE RECEIVED JUL 19 1993
DATE OF INSPECTION | INSPECTOR
REMARKS: CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

Ministry of the Environment
Ontario

The Ontario Water Resources Act
# WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 5004319 | MUNICIP 50091 | CON. TR

| COUNTY OR DISTRICT | TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE | CON., BLOCK, TRACT, SURVEY, ETC | LOT |
|---|---|---|---|
| Perth | Blanshard | Thames River | 37 6-7 |

[redacted] R.3, St.Marys, Ontario, N4x 1c6 — 1740 Perth Rd. 23

DATE COMPLETED: DAY 15 MO 8 YR 96

[redacted]HING | RC | ELEVATION | RC | BASIN CODE

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

| GENERAL COLOUR | MOST COMMON MATERIAL | OTHER MATERIALS | GENERAL DESCRIPTION | DEPTH - FEET FROM | TO |
|---|---|---|---|---|---|
| grey | clay | sand and stones | | 0 | 94 |
| grey | limestone | | | 94 | 185 |

31
32

### 41 WATER RECORD

| WATER FOUND AT - FEET | KIND OF WATER |
|---|---|
| 185 | ☒ FRESH |

### 51 CASING & OPEN HOLE RECORD

| INSIDE DIAM INCHES | MATERIAL | WALL THICKNESS INCHES | DEPTH - FEET FROM | TO |
|---|---|---|---|---|
| 5 | ☒ STEEL | 188 | 0 | 95 |
| 5 | ☒ OPEN HOLE | | 95 | 185 |

### SCREEN
SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET | MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

### 61 PLUGGING & SEALING RECORD
DEPTH SET AT - FEET FROM | TO | MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

### 71 PUMPING TEST

| PUMPING TEST METHOD | PUMPING RATE | DURATION OF PUMPING |
|---|---|---|
| ☒ BAILER | 8 GPM | 1 HOURS |

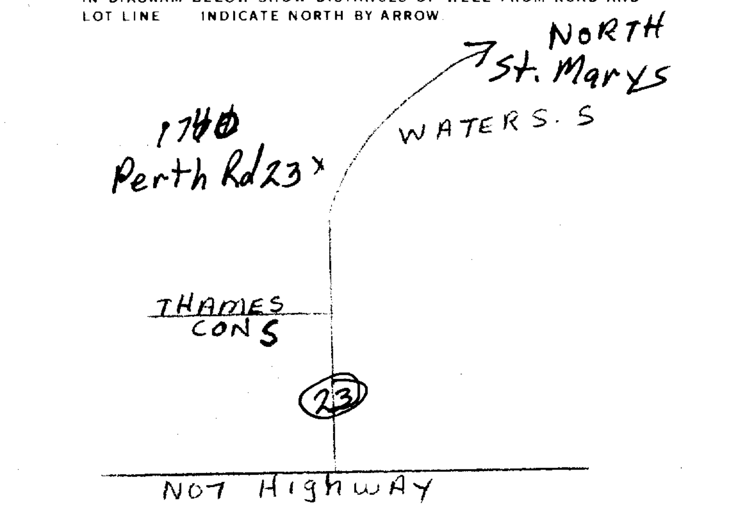
| STATIC LEVEL | WATER LEVEL END OF PUMPING | 15 MINUTES | 30 MINUTES | 45 MINUTES | 60 MINUTES |
|---|---|---|---|---|---|
| 112 FEET | 155 FEET | 155 FEET | 155 FEET | 155 FEET | 155 FEET |

WATER LEVELS DURING: ☒ PUMPING
IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: ☒ CLEAR
RECOMMENDED PUMP TYPE: ☒ DEEP
RECOMMENDED PUMP SETTING: 170 FEET
RECOMMENDED PUMPING RATE: 8 GPM

FINAL STATUS OF WELL: ☒ WATER SUPPLY
WATER USE: ☒ DOMESTIC
METHOD OF CONSTRUCTION: ☒ ROTARY (CONVENTIONAL)

## LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW




146532

DRILLERS REMARKS

### CONTRACTOR

| NAME OF WELL CONTRACTOR | WELL CONTRACTOR'S LICENCE NUMBER |
|---|---|
| Mervin Jones Drilling LTD | 3009 |

ADDRESS: R.R.3, Thorndale, Ontario, NOM 2po

| NAME OF WELL TECHNICIAN | WELL TECHNICIAN'S LICENCE NUMBER |
|---|---|
| Murray S. Jones | T0068 |

SIGNATURE OF TECHNICIAN/CONTRACTOR: Murray S Jones
SUBMISSION DATE: DAY 16 MO 8 YR 96

### OFFICE USE ONLY
DATA SOURCE | CONTRACTOR 3009 | DATE RECEIVED AUG 27 1996
DATE OF INSPECTION | INSPECTOR
REMARKS: CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

Ministry of Environment and Energy
Ontario

# The Ontario Water Resources Act
# WATER WELL RECORD

Print only in spaces provided.
Mark correct box with a checkmark, where applicable.

11

5004527

Municipality: 50601
Con.

| County or District | Township/Borough/City/Town/Village | Con block tract survey, etc. | Lot |
|---|---|---|---|
| [redacted] | BLANSHARD | TOWN OF ST.MARYS Front Street | 1 |
| | Address: WATER ST. S, ST.MARYS, ONTARIO | Date completed: 18 /11 /1997 (day month year) | |

Northing | RC | Elevation | RC | Basin Code | ii | iii | iv

## LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

| General colour | Most common material | Other materials | General description | Depth – feet From | To |
|---|---|---|---|---|---|
| BRN | TOP SOIL | | | 0 | 1 |
| GREY | GRANITE | BOULDERS & GRAVEL | | 1 | 13 |
| GREY | LIMESTONE | | | 13 | 100 |

31
32

## WATER RECORD

| Water found at – feet | Kind of water |
|---|---|
| 80-100 | Fresh |

## CASING & OPEN HOLE RECORD

| Inside diam inches | Material | Wall thickness inches | Depth – feet From | To |
|---|---|---|---|---|
| 6" | Galvanized | .188 | 0 | 20 |
| 6" | Open hole | | 20 | 100 |

## SCREEN

Sizes of opening (Slot No.) | Diameter inches | Length feet
Material and type | Depth at top of screen feet

## PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

| Depth set at – feet From | To | Material and type (Cement grout, bentonite, etc.) |
|---|---|---|
| 0 | 18 | BEN.CLA.SLUR |

## PUMPING TEST

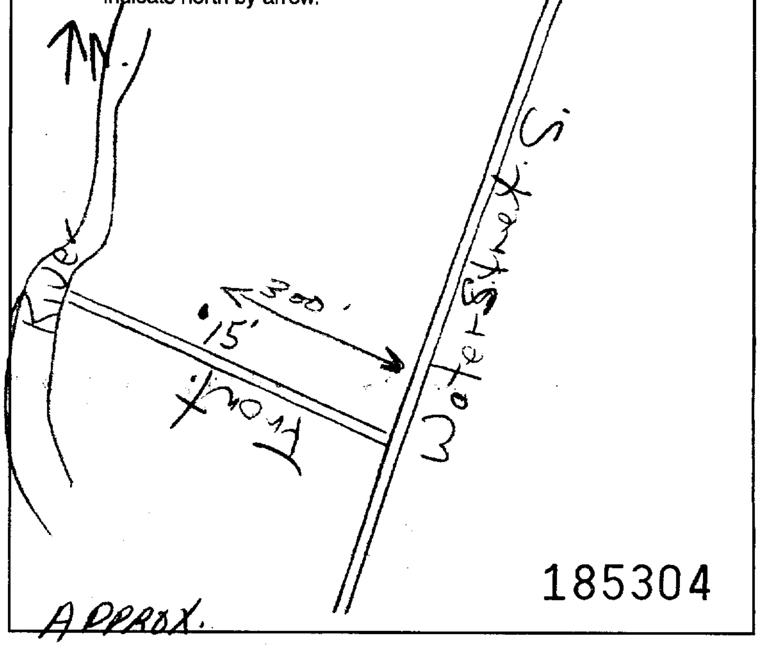
Pumping test method: Pump
Pumping rate: 10 GPM
Duration of pumping: 1 Hours 30 Mins

| Static level | Water level end of pumping | 15 minutes | 30 minutes | 45 minutes | 60 minutes |
|---|---|---|---|---|---|
| 60 feet | feet | 68 feet | feet | feet | feet |

Water levels during: ☐ Pumping ☐ Recovery
If flowing give rate: GPM
Pump intake set at: feet
Water at end of test: Clear ☐ Cloudy
Recommended pump type: ☐ Shallow Deep
Recommended pump setting: 75 feet
Recommended pump rate: 10 GPM

## LOCATION OF WELL

In diagram below show distances of well from road and lot line. Indicate north by arrow.




185304

## FINAL STATUS OF WELL

- ☑ Water supply
- ☐ Observation well
- ☐ Test hole
- ☐ Recharge well
- ☐ Abandoned, insufficient supply
- ☐ Abandoned, poor quality
- ☐ Abandoned (Other)
- ☐ Dewatering
- ☐ Unfinished
- ☐ Replacement well

## WATER USE

- ☑ Domestic
- ☐ Stock
- ☐ Irrigation
- ☐ Industrial
- ☐ Commercial
- ☐ Municipal
- ☐ Public supply
- ☐ Cooling & air conditioning
- ☐ Not used
- ☐ Other

## METHOD OF CONSTRUCTION

- ☐ Cable tool
- ☑ Rotary (conventional)
- ☐ Rotary (reverse)
- ☐ Rotary (air)
- ☐ Air percussion
- ☐ Boring
- ☐ Diamond
- ☐ Jetting
- ☐ Driving
- ☐ Digging
- ☐ Other

Name of Well Contractor: DURL HOPPER LIMITED
Well Contractor's Licence No.: 2644
Address: RR # 7, ST.MARYS, ONTARIO N4X 1C9
Name of Well Technician: DOUGLAS HOPPER
Well Technician's Licence No.: T-2023
Signature of Technician/Contractor: [signature]
Submission date: 15 /12 /1997 (day mo yr)

MINISTRY USE ONLY
Data source | Contractor: 2644 | Date received: MAY 22 1998
Date of inspection | Inspector
Remarks: CSS.S8

0506 (07/94) Front Form 9

2 - MINISTER OF ENVIRONMENT & ENERGY COPY

Ontario Ministry of the Environment

Well Tag N A 009296 (below)

A 009296

# Well Record

*Regulation 903 Ontario Water Resources Act*

page ___ of ___

## Instructions for Completing Form

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- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Management Coordinator at 416-235-6203.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

**Ministry Use Only**

[redacted]

| Address of Well Location (County/District/Municipality) | Township | Lot | Concession |
|---|---|---|---|
| Perth | Town of St. Marys | - | - |

| RR#/Street Number/Name | City/Town/Village | Site/Compartment/Block/Tract etc. |
|---|---|---|
| Box 1646, Water Street | St. Marys | |

| GPS Reading | NAD | Zone | Easting | Northing | Unit Make/Model | Mode of Operation |
|---|---|---|---|---|---|---|
| 305 Elev | 8 3 | 17 | 0487550 | 4788129 | Garmin/etrex | X Undifferentiated ☐ Averaged ☐ Differentiated, specify |

## Log of Overburden and Bedrock Materials (see instructions)

| General Colour | Most common material | Other Materials | General Description | Depth From | Metres To |
|---|---|---|---|---|---|
| Brown | Clay | | | 0 | 3.05 |
| Brown | Gravel | Stones | | 3.05 | 5.18 |
| Brown | Limestone | | | 5.18 | 34.76 |

### Hole Diameter

| Depth From | Metres To | Diameter Centimetres |
|---|---|---|
| 0 | 6.40 | 24.13 |

### Water Record

| Water found at Metres | Kind of Water |
|---|---|
| 34.76 | X Fresh ☐ Sulphur ☐ Gas ☐ Salty X Minerals ☐ Other: |
| ___ m | ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: |
| ___ m | ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: |

After test of well yield, water was
X Clear and sediment free
☐ Other, specify

Chlorinated X Yes ☐ No

### Construction Record

| Inside diam centimetres | Material | Wall thickness centimetres | Depth From | Metres To |
|---|---|---|---|---|
| **Casing** | | | | |
| 15.558 | X Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | 0.48 | +0.61 | 0 |
| " | X Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | " | 0 | 6.40 |
| | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | | | |
| **Screen** | | | | |
| Outside diam | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | Slot No. | | |
| **No Casing or Screen** | | | | |
| | X Open hole | | 6.40 | 34.76 |

### Test of Well Yield

| Pumping test method | Draw Down Time min | Draw Down Water Level Metres | Recovery Time min | Recovery Water Level Metres |
|---|---|---|---|---|
| Pump | | | | |
| Pump intake set at - (metres) 25.91 | Static Level | 16.16 | | |
| Pumping rate - (litres/min) 45.46 | 1 | 18.29 | 1 | 21.34 |
| Duration of pumping 2 hrs + 00 min | 2 | 19.82 | 2 | 19.82 |
| Final water level end of pumping 24.39 metres | 3 | 21.34 | 3 | 16.77 |
| Recommended pump type. ☐ Shallow X Deep | 4 | 22.87 | 4 | 16.16 |
| Recommended pump depth 25.91 metres | 5 | 24.39 | 5 | |
| Recommended pump rate. 45.46 (litres/min) | 10 | | 10 | |
| If flowing give rate - (litres/min) | 15 | | 15 | |
| | 20 | | 20 | |
| | 25 | | 25 | |
| If pumping discontinued, give reason. | 30 | | 30 | |
| Clear | 40 | | 40 | |
| | 50 | | 50 | |
| | 60 | 24.39 | 60 | 16.16 |

### Plugging and Sealing Record

X Annular space ☐ Abandonment

| Depth set at - Metres From | To | Material and type (bentonite slurry, neat cement slurry) etc. | Volume Placed (cubic metres) |
|---|---|---|---|
| 0 | 6.40 | Bentonite Slurry | 0.14 |

### Method of Construction

☐ Cable Tool X Rotary (air) ☐ Diamond ☐ Digging
X Rotary (conventional) ☐ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

### Water Use

X Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☐ Commercial ☐ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

### Final Status of Well

X Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☐ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

### Well Contractor/Technician Information

| Name of Well Contractor | Well Contractor's Licence No. |
|---|---|
| Mc Leod Well Drilling Ltd | 3563 |

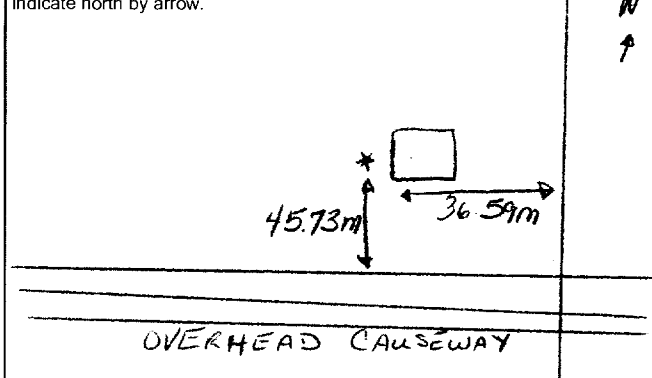
Business Address (street name, number, city etc.)
R.R. 4, 293810 Culloden Line, Ingersoll, Ont N5C 3J7

| Name of Well Technician (last name, first name) | Well Technician's Licence No. |
|---|---|
| Ralph H. Mc Leod | T-0073 |

Signature of Technician/Contractor: x [signature] | Date Submitted YYYY MM DD

### Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.




Audit No. Z 09299 | Date Well Completed 2004 05 27

Was the well owner's information package delivered? X Yes ☐ No | Date Delivered 2004 06 07

### Ministry Use Only

Data Source | Contractor 3563

Date Received JUN 28 2004 | Date of Inspection YYYY MM DD

Remarks | Well Record Number 5005676

Ontario Ministry of the Environment

**Well Tag Number** (Place sticker and print number below)
A010930

# Well Record
*Regulation 903 Ontario Water Resources Act*

page 1 of 1

## Instructions for Completing Form

- For use in the **Province of Ontario** only. This document is a permanent **legal** document. Please retain for future reference.
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- Questions regarding completing this application can be directed to the Water Well Management Coordinator at 416-235-6203.
- **All metre measurements shall be reported ~~to 1/10th of a metre~~.** FEET
- Please print clearly in blue or black ink only.

**Ministry Use Only** MUN | CON | LOT

[redacted]

| Address of Well Location (County/District/Municipality) | Township | Lot | Concession |
|---|---|---|---|
| PERTH | BLANSHARD | 29 | TRN |

| RR#/Street Number/Name | City/Town/Village | Site/Compartment/Block/Tract etc. |
|---|---|---|
| PERTH LINE 5 | ST. MARYS | |

GPS Reading NAD 8 3 Zone 17 Easting 486260 Northing 4787504 Unit Make/Model MAG/M~~XX~~ Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

## Log of Overburden and Bedrock Materials (see instructions)

| General Colour | Most common material | Other Materials | General Description | Depth Metres From | To |
|---|---|---|---|---|---|
| BROWN | SAND/GRAVEL | COBBLES | | 0 | 12 |
| GREY | LIMESTONE | | | 12 | 65 |
| BROWN | LIMESTONE | | | 65 | 102 |

N1-05

### Hole Diameter

| Depth Metres From | To | Diameter Centimetres |
|---|---|---|
| 0 | 18 | 8 3/4 |
| 18 | 102 | 5 7/8 |

### Construction Record

| Inside diam centimetres | Material | Wall thickness centimetres | Depth Metres From | To |
|---|---|---|---|---|
| **Casing** | | | | |
| 6" | ☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | .188 | +2 | 18 |
| | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | | | |
| | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | | | |
| **Screen** | | | | |
| Outside diam | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | Slot No. | | |
| **No Casing or Screen** | | | | |
| | ☒ Open hole | | 18 | 102 |

### Test of Well Yield

Pumping test method: AIR
Pump intake set at - (metres)
Pumping rate - (litres/min) 30gpm
Duration of pumping ____hrs + ____ min
Final water level end of pumping ____ metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ____ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

| Draw Down Time min | Water Level Metres | Recovery Time min | Water Level Metres |
|---|---|---|---|
| Static Level | 52 | | |
| 1 | | 1 | |
| 2 | | 2 | |
| 3 | | 3 | |
| 4 | | 4 | |
| 5 | | 5 | |
| 10 | | 10 | |
| 15 | | 15 | |
| 20 | | 20 | |
| 25 | | 25 | |
| 30 | | 30 | |
| 40 | | 40 | |
| 50 | | 50 | |
| 60 | | 60 | |

### Water Record

Water found at Metres / Kind of Water
92 m ☒ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☒ Clear and sediment free
☐ Other, specify

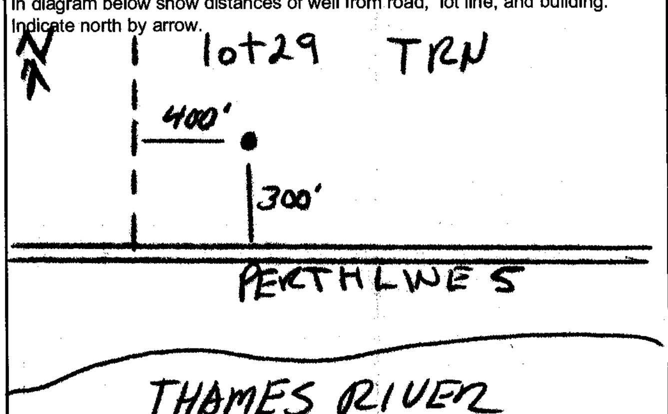
Chlorinated ☐ Yes ☒ No

### Plugging and Sealing Record ☒ Annular space ☐ Abandonment

| Depth set at - Metres From | To | Material and type (bentonite slurry, neat cement slurry) etc. | Volume Placed (cubic metres) |
|---|---|---|---|
| 0 | 18 | BENTONITE SLURRY | 0.2cu/m |

### Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.




### Method of Construction

☐ Cable Tool ☐ Rotary (air) ☐ Diamond ☐ Digging
☒ Rotary (conventional) ☒ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

### Water Use

☐ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☒ Commercial ☐ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

### Final Status of Well

☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☒ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

### Well Contractor/Technician Information

Name of Well Contractor: DURL HOPPER LIMITED
Well Contractor's Licence No.: 2644
Business Address (street name, number, city etc.): R.R.#7, ST.MARYS, ON N4X 1C9
Name of Well Technician (last name, first name): HOPPER, DOUGLAS
Well Technician's Licence No.: T-2323
Signature of Technician/Contractor: X
Date Submitted: 2005 06 02

Audit No. Z 29730
Date Well Completed: 2005 05 06
Was the well owner's information package delivered? ☐ Yes ☒ No
Date Delivered: YYYY MM DD

### Ministry Use Only

Data Source
Contractor 2644
Date Received AUG 0 8 2005
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (09/03) Contractor's Copy ☐ Ministry's Copy ☒ Well Owner's Copy ☐ *Cette formule est disponible en français*

Ontario Ministry of the Environment

**Well Tag Number** (Place sticker and print number below) A029210

# Well Record
***Regulation 903 Ontario Water Resources Act***

page 1 of 1

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- **All metre measurements shall be reported to ~~1/10th of a metre.~~** Feet
- Please print clearly in blue or black ink only.

| Ministry Use Only | | |
|---|---|---|
| MUN | CON | LOT |

**Well Owner's Information and Location of Well Information**

[redacted]

| Address of Well Location (County/District/Municipality) | Township | Lot / Concession |
|---|---|---|
| PERTH | Blanshard | PT 37 TRS |

| RR#/Street Number/Name | City/Town/Village | Site/Compartment/Block/Tract etc. |
|---|---|---|
| Rd 123 - 750 WATER ST | ST MARYS | |

GPS Reading NAD 83 Zone 17 Easting 482200 Northing 4787708 Unit Make/Model GARMIN Mode of Operation: ☐ Undifferentiated ☑ Averaged ☐ Differentiated, specify

## Log of Overburden and Bedrock Materials (see instructions)

| General Colour | Most common material | Other Materials | General Description | Depth From | Metres To |
|---|---|---|---|---|---|
| Brown | Sand | Cobbles | | 0 | 5 |
| Grey | Limestone | Brown layers | | 5 | 43 |
| Grey | Limestone | | | 43 | 62 |
| Brown | Limestone | | | 62 | 110 |

### Hole Diameter

| Depth From | Metres To | Diameter Centimetres |
|---|---|---|
| 0 | 20' | 8 3/4" |
| 20 | 110 | 6 1/4" |

### Water Record

| Water found at ___ Metres | Kind of Water |
|---|---|
| 95' m ☐ Gas ☐ Other: | ☑ Fresh ☐ Sulphur ☐ Salty ☐ Minerals |
| 105' m ☐ Gas ☐ Other: | ☑ Fresh ☐ Sulphur ☐ Salty ☐ Minerals |
| 110' m ☐ Gas ☐ Other: | ☑ Fresh ☐ Sulphur ☐ Salty ☐ Minerals |

After test of well yield, water was ☑ Clear and sediment free ☐ Other, specify

Chlorinated ☑ Yes ☐ No

### Construction Record

| Inside diam centimetres | Material | Wall thickness centimetres | Depth From | Metres To |
|---|---|---|---|---|
| **Casing** | | | | |
| 6 1/4 | ☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | .188 | +2 | 20 |
| | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | | | |
| | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | | | |
| **Screen** | | | | |
| Outside diam | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | Slot No. | | |
| **No Casing or Screen** | | | | |
| | ☑ Open hole | | 20 | 110 |

### Test of Well Yield

| Pumping test method | Draw Down Time min | Draw Down Water Level Metres | Recovery Time min | Recovery Water Level Metres |
|---|---|---|---|---|
| Pump | Static Level | 57' | | |
| Pump intake set at - (metres) 80' | 1 | 63 | 1 | 59 |
| Pumping rate - (litres/min) 50gpm | 2 | 65 | 2 | 58 |
| Duration of pumping 1 hrs + 0 min | 3 | 67 | 3 | 58 |
| Final water level end of pumping 71' metres | 4 | 69 | 4 | 57 |
| Recommended pump type. ☐ Shallow ☑ Deep | 5 | 70 | 5 | |
| Recommended pump depth. 85' metres | 10 | 71 | 10 | 57 |
| Recommended pump rate. (litres/min) 50gpm | 15 | | 15 | |
| If flowing give rate - (litres/min) | 20 | | 20 | |
| | 25 | | 25 | |
| If pumping discontinued, give reason. | 30 | | 30 | |
| | 40 | | 40 | |
| | 50 | | 50 | |
| | 60 | 71 | 60 | 57 |

### Plugging and Sealing Record ☑ Annular space ☐ Abandonment

| Depth set at - Metres From | To | Material and type (bentonite slurry, neat cement slurry) etc. | Volume Placed (cubic metres) |
|---|---|---|---|
| 0 | 22 | Bentonite chips | |

### Method of Construction

☐ Cable Tool ☑ Rotary (air) ☐ Diamond ☐ Digging
☑ Rotary (conventional) ☐ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

### Water Use

☐ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☑ Commercial ☐ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

### Final Status of Well

☑ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☐ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

### Well Contractor/Technician Information

| Name of Well Contractor | Well Contractor's Licence No. |
|---|---|
| DURL HOPPER LTD | 2644 |

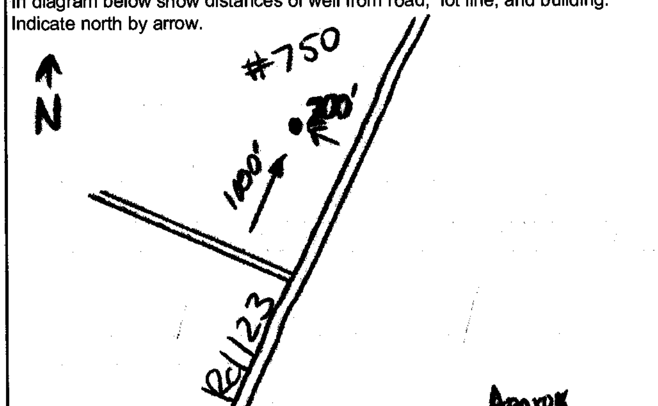
Business Address (street name, number, city etc.) RR#7 ST MARYS ONT N4X 1C9

| Name of Well Technician (last name, first name) | Well Technician's Licence No. |
|---|---|
| HOPPER SIMON | 05-1029 |

Signature of Technician/Contractor X [signature] Date Submitted YYYY 2005 MM 08 DD 30

### Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.




Audit No. Z 29760

Date Well Completed Approx YYYY 2005 MM 08 DD 11

Was the well owner's information package delivered? ☑ Yes ☐ No

Date Delivered YYYY 2005 MM 08 DD 11

### Ministry Use Only

| Data Source | Contractor 2644 |
|---|---|
| Date Received OCT 25 2005 | Date of Inspection YYYY MM DD |
| Remarks | Well Record Number |

0506E (09/03) Contractor's Copy ☐ Ministry's Copy ☑ Well Owner's Copy ☐ *Cette formule est disponible en français*

Ontario Ministry of the Environment

**Well Tag Number** (Place sticker and print number below)

NA.

# Well Record

*Regulation 903 Ontario Water Resources Act*

page 1 of 1

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- **All metre measurements shall be reported to ~~1/10th of a metre~~.** Feet.
- Please print clearly in blue or black ink only.

| Ministry Use Only | | |
|---|---|---|
| MUN | CON | LOT |

## Well Owner's Information and Location of Well Information

| Field | Entry |
|---|---|
| First Name | ST MARY'S |
| Last Name | CEMENT INC. |
| Mailing Address (Street Number/Name, RR,Lot,Concession) | PO BOX 1000 ST MARYS |
| County/District/Municipality | PERTH |
| Township/City/Town/Village | BLANSHARD |
| Province | Ontario |
| Postal Code | N4X 1B6 |
| Telephone Number (include area code) | 519-284-1020 |
| Address of Well Location (County/District/Municipality) | PERTH / ST MARYS TOWN |
| Township | BLANSHARD |
| Lot | |
| Concession | TR. |
| RR#/Street Number/Name | WATER ST |
| City/Town/Village | ST MARYS |
| Site/Compartment/Block/Tract etc. | THAMES RIVER. |
| GPS Reading NAD | 83 |
| Zone | 17 |
| Easting | 487932 |
| Northing | 4787528 |
| Unit Make/Model | Magellan |
| Mode of Operation | ☐ Undifferentiated ☑ Averaged ☐ Differentiated, specify |

## Log of Overburden and Bedrock Materials (see instructions)

| General Colour | Most common material | Other Materials | General Description | Depth From | Metres To |
|---|---|---|---|---|---|
| Brown | Fill | | Hard. | 0 | 3 |
| Grey | Limestone. | | | 3 | 68 |

### Hole Diameter

| Depth From | Metres To | Diameter Centimetres |
|---|---|---|
| 0 | 6' | 6 5/8 |
| 6' | 68' | 6" |

### Water Record

| Water found at Metres | Kind of Water |
|---|---|
| 52 m | ☑ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: |
| m | ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: |
| m | ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: |

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify

Chlorinated ☑ Yes ☐ No

### Construction Record

| Inside diam centimetres | Material | Wall thickness centimetres | Depth From | Metres To |
|---|---|---|---|---|
| **Casing** | | | | |
| 6 1/4 | ☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | .188 | 0 | 6 |
| | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | | | |
| | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | | | |
| **Screen** | | | | |
| Outside diam | ☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized | Slot No. | | |
| **No Casing or Screen** | | | | |
| | ☑ Open hole | | 6 | 68 |

### Test of Well Yield

| Pumping test method | Draw Down Time min | Water Level Metres | Recovery Time min | Water Level Metres |
|---|---|---|---|---|
| NA. | | | | |
| Pump intake set at - (metres) | Static Level | 52 | | |
| Pumping rate - (litres/min) | 1 | | 1 | |
| Duration of pumping ___hrs + ___ min | 2 | | 2 | |
| Final water level end of pumping ___ metres | 3 | | 3 | |
| Recommended pump type. ☐ Shallow ☐ Deep | 4 | | 4 | |
| Recommended pump depth. ___ metres | 5 | | 5 | |
| Recommended pump rate. (litres/min) | 10 | | 10 | |
| If flowing give rate - (litres/min) | 15 | | 15 | |
| | 20 | | 20 | |
| | 25 | | 25 | |
| If pumping discontinued, give reason. | 30 | | 30 | |
| | 40 | | 40 | |
| | 50 | | 50 | |
| | 60 | | 60 | |

### Plugging and Sealing Record

☐ Annular space ☑ Abandonment

| Depth set at - Metres From | To | Material and type (bentonite slurry, neat cement slurry) etc. | Volume Placed (cubic metres) |
|---|---|---|---|
| 3 | 68 | Chip + Granular Bentonite | |
| 0 | 3 | Backfill Casing removed. | |

### Method of Construction

☐ Cable Tool ☐ Rotary (conventional) ☐ Rotary (reverse) ☐ Rotary (air) ☐ Air percussion ☐ Boring ☐ Diamond ☐ Jetting ☐ Driving ☐ Digging ☐ Other

NA.

### Water Use

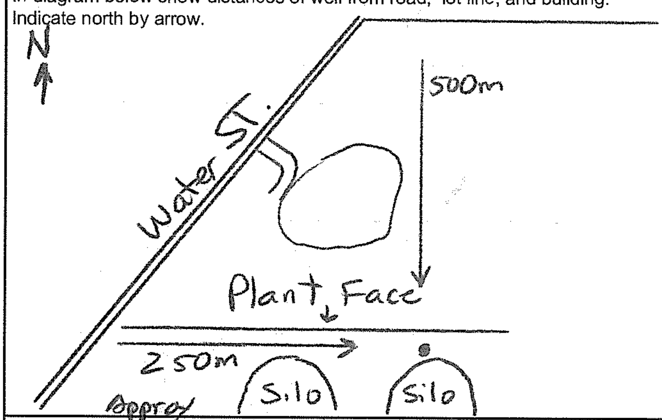
☐ Domestic ☐ Stock ☐ Irrigation ☐ Industrial ☐ Commercial ☐ Municipal ☐ Public Supply ☑ Not used ☐ Cooling & air conditioning ☐ Other

### Final Status of Well

☐ Water Supply ☐ Observation well ☐ Test Hole ☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality ☐ Unfinished ☐ Dewatering ☐ Replacement well ☑ Abandoned, (Other) Location

### Location of Well

In diagram below show distances of well from road, lot line, and building. Indicate north by arrow.




Audit No. Z 31269

Date Well Completed YYYY MM DD: 2007 06 27

Was the well owner's information package delivered? ☐ Yes ☑ No

Date Delivered YYYY MM DD

### Well Contractor/Technician Information

| Field | Entry |
|---|---|
| Name of Well Contractor | DURL HOPPER LTD |
| Well Contractor's Licence No. | 2644 |
| Business Address (street name, number, city etc.) | RR# 7 ST MARYS ONT N4X 1C9. |
| Name of Well Technician (last name, first name) | HOPPER, SHAWN |
| Well Technician's Licence No. | T2315 |
| Signature of Technician/Contractor | X [signature] |
| Date Submitted YYYY MM DD | 2007 07 17 |

### Ministry Use Only

| Field | Entry |
|---|---|
| Data Source | |
| Contractor | 2644 |
| Date Received YYYY MM DD | AUG 10 2007 |
| Date of Inspection YYYY MM DD | |
| Remarks | |
| Well Record Number | |

Ontario | Ministry of the Environment

**Well Tag No.** *(Place Sticker and/or Print Below)* A109023

# Well Record

*Regulation 903 Ontario Water Resources Act*

[redacted]

## Well Location

| Address of Well Location (Street Number/Name) | Township | Lot | Concession |
|---|---|---|---|
| 1760 Road 123 | Blanshard Township | 37 | 1R |

| County/District/Municipality | City/Town/Village | Province | Postal Code |
|---|---|---|---|
| Perth | Kirkton | Ontario | N0K 1K0 |

| UTM Coordinates | Zone | Easting | Northing | Municipal Plan and Sublot Number | Other |
|---|---|---|---|---|---|
| NAD 83 | 17 | 487094 | 4787245 | | |

## Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

| General Colour | Most Common Material | Other Materials | General Description | Depth (m/ft) From | Depth (m/ft) To |
|---|---|---|---|---|---|
| Black | Top Soil | | | 0 | 2 |
| Brown | Clay | Stones | | 2 | 7 |
| Grey | Clay | | | 7 | 92 |
| Grey | Limestone | | | 92 | 197 |

## Annular Space

| Depth Set at (m/ft) From | To | Type of Sealant Used (Material and Type) | Volume Placed ($m^3/ft^3$) |
|---|---|---|---|
| 0 | 24 | Benseal Slurry | 400 lbs |
| 24 | 98 | Quickgel Slurry | |

## Method of Construction

- ☐ Cable Tool
- ☒ Rotary (Conventional)
- ☐ Rotary (Reverse)
- ☐ Boring
- ☐ Air percussion
- ☐ Other, specify
- ☐ Diamond
- ☐ Jetting
- ☐ Driving
- ☐ Digging

## Well Use

- ☐ Public
- ☒ Domestic
- ☐ Livestock
- ☐ Irrigation
- ☐ Industrial
- ☐ Other, specify
- ☐ Commercial
- ☐ Municipal
- ☐ Test Hole
- ☐ Cooling & Air Conditioning
- ☐ Not used
- ☐ Dewatering
- ☐ Monitoring

## Construction Record - Casing

| Inside Diameter (cm/in) | Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel) | Wall Thickness (cm/in) | Depth (m/ft) From | To |
|---|---|---|---|---|
| 6 5/8" | Steel | 0.188 Wall | +2 | 98 |
| Open hole | | | 98 | 197 |

## Construction Record - Screen

| Outside Diameter (cm/in) | Material (Plastic, Galvanized, Steel) | Slot No. | Depth (m/ft) From | To |
|---|---|---|---|---|
| | | | | |

## Status of Well

- ☒ Water Supply
- ☐ Replacement Well
- ☐ Test Hole
- ☐ Recharge Well
- ☐ Dewatering Well
- ☐ Observation and/or Monitoring Hole
- ☐ Alteration (Construction)
- ☐ Abandoned, Insufficient Supply
- ☐ Abandoned, Poor Water Quality
- ☐ Abandoned, other, specify
- ☐ Other, specify

## Water Details

| Water found at Depth (m/ft) | Kind of Water |
|---|---|
| 189 | ☒ Fresh ☐ Untested ☐ Gas ☐ Other, specify |
| 195 | ☒ Fresh ☐ Untested ☐ Gas ☐ Other, specify |
| | ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify |

## Hole Diameter

| Depth (m/ft) From | To | Diameter (cm/in) |
|---|---|---|
| 0 | 197 | 9 |

## Results of Well Yield Testing

After test of well yield, water was: ☒ Clear and sand free ☐ Other, specify

If pumping discontinued, give reason: CLEAR

Pump intake set at (m/ft): 175

Pumping rate (l/min / GPM): 30

Duration of pumping: 1 hrs + 30 min

Final water level end of pumping (m/ft): 99

If flowing give rate (l/min / GPM): NOT FLOWING

Recommended pump depth (m/ft): 175

Recommended pump rate (l/min / GPM): 20

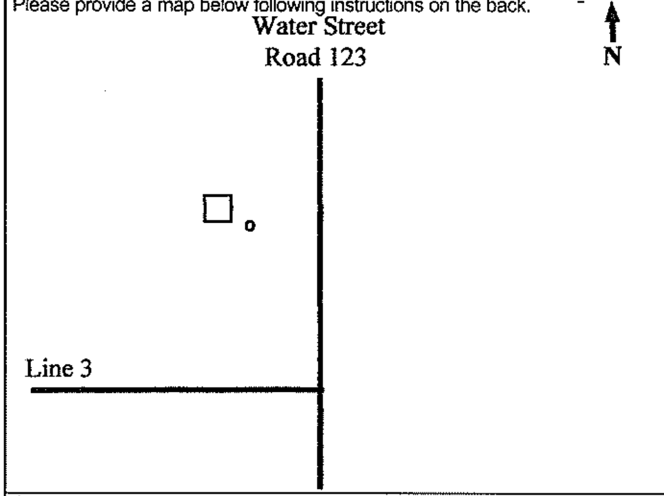
Well production (l/min / GPM): 30

Disinfected? ☒ Yes ☐ No

| Draw Down Time (min) | Water Level (m/ft) | Recovery Time (min) | Water Level (m/ft) |
|---|---|---|---|
| Static Level | 90 | | 99 |
| 1 | 91.3 | 1 | 98.5 |
| 2 | 92.6 | 2 | 98.1 |
| 3 | 93.9 | 3 | 97.7 |
| 4 | 94.11 | 4 | 97.1 |
| 5 | 96.3 | 5 | 96.5 |
| 10 | 98.4 | 10 | 94.5 |
| 15 | 99 | 15 | 92.3 |
| 20 | 99 | 20 | 91.1 |
| 25 | 99 | 25 | 90 |
| 30 | 99 | 30 | 90 |
| 40 | 99 | 40 | 90 |
| 50 | 99 | 50 | 90 |
| 60 | 99 | 60 | 90 |

## Map of Well Location

Please provide a map below following instructions on the back.




## Well Contractor and Well Technician Information

| Business Name of Well Contractor | Well Contractor's Licence No. |
|---|---|
| HAYDEN WATER WELLS CO.,INC. | 7090 |

| Business Address (Street Number/Name) | Municipality |
|---|---|
| 35339 Saintsbury Line RR # 1 | Lucan |

| Province | Postal Code | Business E-mail Address |
|---|---|---|
| Ontario | N0M2J0 | haydenwaterwells@on.aibn.com |

| Bus. Telephone No. (inc. area code) | Name of Well Technician (Last Name, First Name) |
|---|---|
| 5192270057 | Hayden, Jay |

Well Technician's Licence No.: 1094 | Signature of Technician and/or Contractor | Date Submitted: YYYYMMDD

Comments: Well is 70 feet off road

Well owner's information package delivered: ☒ Yes ☐ No

Date Package Delivered: 20110823

Date Work Completed: 20110823

**Ministry Use Only**

Audit No. Z136378

Received JAN 27 2012

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

# Appendix C

## Monitoring Well and Soil Logs



Appendix C

**Appendix C1.1**
**Summary of Landfill Monitoring Wells & Boreholes**
**St. Marys Landfill**

| Monitoring Well | Date of Installation | Screened Stratigraphy | Top of Casing (m ags) | Depth Below Ground Surface: Borehole Depth | Well Screen | | Sand Pack | | Bentonite Seal | | Well Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Bottom | Top | Bottom | Top | Bottom | Top | |
| OW1-80 | 27-May-80 | Clayey Silt Till | 0.93 | 7.60 | 6.90 | 6.30 | 7.60 | 6.00 | 6.00 | 5.80 | Decom |
| OW2-80 | 27-May-80 | Clayey Silt Till | | 6.40 | 5.80 | 5.20 | 6.40 | 4.80 | 4.80 | 4.60 | Decom |
| OW3-80 | 27-May-80 | Clayey Silt Till | 1.13 | 4.60 | 4.20 | 3.60 | 4.60 | 3.00 | 3.00 | 2.80 | Decom |
| OW4-80 | 27-May-80 | Clayey Silt Till | 1.03 | 10.50 | 9.80 | 9.20 | 10.50 | 9.00 | 9.00 | 8.80 | Decom |
| OW1-84 | 25-Sep-84 | Sandy Clayey Silt Till w Gravel | 0.61 | 9.60 | 8.38 | 7.62 | 9.60 | 6.50 | 6.50 | 5.87 | Decom |
| OW2-84 | 25-Sep-84 | Sand and Gravel | 0.65 | 9.60 | 9.53 | 8.77 | 9.60 | 8.08 | 8.08 | 7.10 | WL / S |
| OW3-84 | 24-Sep-84 | Sand with Gravel | 0.46 | 13.87 | 13.87 | 13.11 | 13.87 | 11.05 | 11.05 | 10.36 | WL |
| OW4-84 | 24-Sep-84 | Silty Sand / Clayey Silt | 0.84 | 13.87 | 3.05 | 2.29 | 3.05 | 1.83 | 1.83 | 1.45 | WL / S |
| OW5-84 | 25-Sep-84 | Sand with Gravel | 0.49 | 14.78 | 14.78 | 14.02 | 14.78 | 11.73 | 11.73 | 11.28 | WL / S |
| OW6-84 | 25-Sep-84 | Silt / Clayey Silt Till | 0.86 | 14.78 | 3.20 | 2.44 | 3.20 | 2.18 | 2.18 | 1.98 | WL |
| OW7-91 | 4-Oct-91 | Limestone | 0.77 | 39.22 | 39.01 | 37.49 | 39.22 | 33.83 | 33.83 | 0.50 | WL / S |
| OW8A-91 | 3-Oct-91 | Limestone | 0.86 | 32.36 | 32.11 | 30.58 | 32.11 | 26.36 | 26.36 | 0.60 | WL / S |
| OW8B-10 | 25-Oct-10 | Clay | 0.96 | 6.40 | 6.40 | 5.49 | 6.40 | 4.57 | 4.57 | 0.00 | WL / S |
| OW9A-91 | 1-Oct-91 | Limestone | 0.74 | 40.39 | 40.39 | 38.86 | 40.39 | 37.19 | 37.19 | 0.55 | WL / S |
| OW9B-91 | 1-Oct-91 | Gravel | 0.84 | 6.55 | 6.10 | 5.18 | 6.55 | 4.57 | 4.57 | 0.60 | WL / S |
| OW15-91 | 21-Oct-91 | Sand and Gravel | 0.85 | 6.20 | 5.49 | 4.57 | 5.49 | 3.91 | 3.91 | 0.60 | WL / S |
| OW17-91 | 16-Nov-91 | Silt Till / Sand / Silt and Sand | 1.00 | 9.45 | 5.79 | 2.74 | 6.05 | 2.34 | 2.34 | 0.60 | Decom |
| OW21-91 | 9-Dec-91 | Silt and Sand Till / Silt and Clay | 0.77 | 7.70 | 7.70 | 6.17 | 7.70 | 5.33 | 5.33 | 0.60 | WL / S |
| OW25-91 | 11-Dec-91 | Silt some Sand / Gravel | 0.56 | 10.36 | 9.75 | 8.84 | 10.36 | 7.01 | 7.01 | 0.61 | WL / S |
| OW32-96 | 7-Aug-96 | Silt Till | 0.89 | 11.58 | 11.43 | 9.91 | 11.58 | 6.10 | 6.10 | 1.22 | WL / S |
| OW32A-02 | 17-Sep-02 | Limestone | 0.45 | 43.28 | 43.28 | 40.24 | 43.28 | 36.58 | 36.58 | 0.00 | WL / S |
| OW33-96 | 8-Aug-96 | Till | 0.91 | 13.56 | 13.41 | 11.89 | 13.56 | 9.85 | 9.85 | 1.20 | WL / S |
| OW34-96 | 9-Aug-96 | Silt Till | 0.82 | 9.14 | 8.99 | 5.94 | 9.14 | 4.42 | 4.42 | 1.25 | WL / S |
| OW35 | | | 0.57 | | 42.08 | | | | | | Inactive |
| OW36 | 29-Nov-16 | Silty Clayey Sand Till | 0.76 | 6.93 | 6.93 | 3.88 | 6.93 | 2.74 | 2.74 | 0.30 | WL / S |
| MW04-01 | | | 0.65 | | 15.07 | | | | | | Inactive |
| MW04-02 | | | 0.71 | | 11.97 | | | | | | Inactive |
| MW04-03 | | | 0.74 | | 15.82 | | | | | | Inactive |
| MW04-04 | | | 0.77 | | 31.57 | | | | | | Inactive |
| DP1 | 24-Nov-15 | - | 1.12 | 0.71 | 0.71 | 0.41 | - | - | - | - | WL |
| DP2 | 24-Nov-15 | - | 1.16 | 0.67 | 0.67 | 0.37 | - | - | - | - | WL |
| DP3 | 24-Nov-15 | - | 1.15 | 0.68 | 0.68 | 0.38 | - | - | - | - | WL |

| Monitoring Well | Well Location | Screened Flow System | Elevation (above mean sea level): Ground Elevation | Top of Casing | Bottom of Borehole | Well Screen | | Sand Pack | | Bentonite Seal | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Bottom | Top | Bottom | Top | Bottom | Top |
| OW1-80 | Phase II/III | Shallow Overburden | 316.02 | 316.95 | 308.42 | 309.12 | 309.72 | 308.42 | 310.02 | 310.02 | 310.22 |
| OW2-80 | Phase II/III | Shallow Overburden | NA | 315.39 | NA | NA | NA | NA | NA | NA | NA |
| OW3-80 | Phase I | Shallow Overburden | 315.07 | 316.20 | 310.47 | 310.87 | 311.47 | 310.47 | 312.07 | 312.07 | 312.27 |
| OW4-80 | Phase I | Deep Overburden | 315.10 | 316.13 | 304.60 | 305.30 | 305.90 | 304.60 | 306.10 | 306.10 | 306.30 |
| OW1-84 | Phase I | Shallow Overburden | 321.87 | 322.48 | 312.27 | 313.49 | 314.25 | 312.27 | 315.37 | 315.37 | 316.00 |
| OW2-84 | Phase I | Shallow Overburden | 322.19 | 322.84 | 312.59 | 312.66 | 313.42 | 312.59 | 314.11 | 314.11 | 315.09 |
| OW3-84 | Phase I | Deep Overburden | 314.58 | 315.04 | 300.71 | 300.71 | 301.47 | 300.71 | 303.53 | 303.53 | 304.22 |
| OW4-84 | Phase I | Shallow Overburden | 314.52 | 315.36 | 300.65 | 311.47 | 312.23 | 311.47 | 312.69 | 312.69 | 313.07 |
| OW5-84 | Phase I | Deep Overburden | 313.93 | 314.42 | 299.15 | 299.15 | 299.91 | 299.15 | 302.20 | 302.20 | 302.65 |
| OW6-84 | Phase I | Shallow Overburden | 313.93 | 314.79 | 299.15 | 310.73 | 311.49 | 310.73 | 311.75 | 311.75 | 311.95 |
| OW7-91 | Phase I | Bedrock | 314.50 | 315.27 | 275.28 | 275.49 | 277.01 | 275.28 | 280.67 | 280.67 | 314.00 |
| OW8A-91 | Phase II/III | Bedrock | 314.00 | 314.86 | 281.64 | 281.89 | 283.42 | 281.89 | 287.64 | 287.64 | 313.40 |
| OW8B-10 | Phase II/III | Shallow Overburden | 314.39 | 315.35 | 307.99 | 307.99 | 308.90 | 307.99 | 309.82 | 309.82 | 314.39 |
| OW9A-91 | Phase II/III | Bedrock | 317.75 | 318.49 | 277.36 | 277.36 | 278.89 | 277.36 | 280.56 | 280.56 | 317.20 |
| OW9B-91 | Phase II/III | Shallow Overburden | 317.74 | 318.58 | 311.19 | 311.64 | 312.56 | 311.19 | 313.17 | 313.17 | 317.14 |
| OW15-91 | Phase II/III | Shallow Overburden | 317.82 | 318.67 | 311.62 | 312.33 | 313.25 | 312.33 | 313.91 | 313.91 | 317.22 |
| OW17-91 | Phase II/III | Shallow Overburden | 317.39 | 318.39 | 307.94 | 311.60 | 314.65 | 311.34 | 315.05 | 315.05 | 316.79 |
| OW21-91 | Phase I | Shallow Overburden | 319.99 | 320.76 | 312.29 | 312.29 | 313.82 | 312.29 | 314.66 | 314.66 | 319.39 |
| OW25-91 | Phase II/III | Shallow Overburden | 322.86 | 323.42 | 312.50 | 313.11 | 314.02 | 312.50 | 315.85 | 315.85 | 322.25 |
| OW32-96 | Phase I | Shallow Overburden | 322.54 | 323.43 | 310.96 | 311.11 | 312.63 | 310.96 | 316.44 | 316.44 | 321.32 |
| OW32A-02 | Phase I | Bedrock | 322.09 | 322.54 | 278.81 | 278.81 | 281.85 | 278.81 | 285.51 | 285.51 | 322.09 |
| OW33-96 | Phase I | Shallow Overburden | 320.66 | 321.57 | 307.10 | 307.25 | 308.77 | 307.10 | 310.81 | 310.81 | 319.46 |
| OW34-96 | Phase I | Shallow Overburden | 320.77 | 321.59 | 311.63 | 311.78 | 314.83 | 311.63 | 316.35 | 316.35 | 319.52 |
| OW35 | | | 312.95 | 313.52 | | 270.87 | | | | | |
| OW36 | Phase II/III | Shallow Overburden | 313.78 | 314.54 | 306.85 | 306.85 | 309.90 | 306.85 | 311.04 | 311.04 | 313.48 |
| MW04-01 | CKD Pile | | 332.90 | 333.55 | | 317.83 | | | | | |
| MW04-02 | CKD Pile | | 329.41 | 330.12 | | 317.44 | | | | | |
| MW04-03 | CKD Pile | | 329.33 | 330.07 | | 313.51 | | | | | |
| MW04-04 | Phase II/III | Bedrock | 314.21 | 314.98 | | 282.64 | | | | | |
| DP1 | Phase II/III | | 310.06 | 311.18 | 309.35 | 309.35 | 309.65 | - | - | - | - |
| DP2 | Phase I | | 309.57 | 310.73 | 308.90 | 308.90 | 309.20 | - | - | - | - |
| DP3 | Phase I | | 308.86 | 310.01 | 308.18 | 308.18 | 308.48 | - | - | - | - |

Notes:
All measurmetns are in metres
ags - above ground surface
MW - monitoring well - 51 mm diameter PVC
OW - observatio well - 51 mm diameter PVC; except OW7-91, OW8A-91 and OW9A-91 - 102 mm diameter PVC
DP - drive point - 19 mm diameter stainless-steel screen and galvanized steel standpipe
All measurements are based on conditions at time of construction
WL - water levels measured as part of monitoring program
S - water samples collected as part of monitoring program
NA - not available
Decom - decommissioned
CKD - cement kiln dust
Inactive - not currently monitored

## Appendix C1.2
### Summary of Landfill Monitoring Wells & Boreholes
### St. Marys Landfill

| *Borehole* | *Date* | *Ground Elevation (amsl)* | *Borehole Depth (bgs)* | *Borehole Depth (amsl)* | *Location* |
|---|---|---|---|---|---|
| BH10-91 | 15-Oct-91 | 317.37 | 20.12 | 297.25 | Phase II/III |
| BH11-91 | 10-Oct-91 | 316.25 | 17.68 | 298.57 | Phase II/III |
| BH12-91 | 16-Oct-91 | 317.07 | 19.96 | 297.11 | Phase II/III |
| BH13-91 | 18-Oct-91 | 313.79 | 15.54 | 298.25 | Phase II/III |
| BH14-91 | 21-Oct-91 | 317.60 | 7.57 | 310.03 | Phase II/III |
| BH16-91 | 21-Oct-91 | 317.24 | 7.32 | 309.92 | Phase II/III |
| BH18-91 | 16-Nov-91 | 317.00 | 7.47 | 309.53 | Phase II/III |
| BH19-91 | 16-Nov-91 | 317.39 | 6.71 | 310.68 | Phase II/III |
| BH20-91 | 9-Dec-91 | 315.62 | 6.71 | 308.91 | Phase II/III |
| BH22-91 | 10-Dec-91 | 314.22 | 4.27 | 309.95 | Phase II/III |
| BH23-91 | 11-Dec-91 | 313.97 | 5.18 | 308.79 | Phase II/III |
| BH24-91 | 11-Dec-91 | 313.97 | 4.57 | 309.40 | Phase II/III |
| BH26-91 | 12-Dec-91 | 316.96 | 8.23 | 308.73 | Phase II/III |
| BH27-91 | 12-Dec-91 | 316.01 | 8.23 | 307.78 | Phase II/III |
| BH28-91 | 12-Dec-91 | 313.50 | 6.55 | 306.95 | Phase II/III |
| BH29-91 | 13-Dec-91 | 314.24 | 6.71 | 307.53 | Phase II/III |
| BH30-91 | 13-Dec-91 | 317.61 | 8.23 | 309.38 | Phase II/III |
| BH31-91 | 13-Dec-91 | 316.52 | 8.08 | 308.44 | Phase II/III |

Notes:
All measurmetns are in metres
amsl - above mean sea level
bgs - below ground surface

Project Name: ST. MARYS LANDFILL SITE
Job No. 979-645
Client: TOWN OF ST. MARYS
Borehole Type: Hollow Stem Auger
Location: On Site

Borehole No. OW1-80
Date Completed May 27, 1980
Geologist/Engineer ESR
Elevation Top of Casing, 316.946m AMS

| Depth (Elev.) | Stratigraphy | Description & Remarks | Sample Number | Sample Type | Sample Blows/Foot | Penetration Test Blows/Foot 20 40 60 80 |
|---|---|---|---|---|---|---|
| | | Grey clayey-silt till | | | | |
| 3m | | | 13 | AS | | |
| 6.1m | | | 14 | AS | | |
| 7.6m | | | 15 | SS | 100 | |

Piezometer or Standpipe Installation

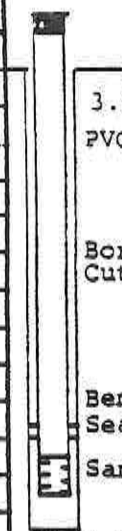


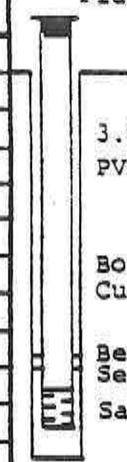

FIGURE 2.1

Conestoga - Rovers & Associates

Project Name: ST. MARYS LANDFILL SITE
Job No. 979-645
Client: TOWN OF ST. MARYS
Borehole Type: Hollow Stem Auger
Location: On Site

Borehole No. OW2-80
Date Completed May 27, 1980
Geologist/Engineer ESR
Elevation Top of Casing, 315.386m AMS

| Profile | | | Sample | | | Penetration Test Blows/Foot | Piezometer or Standpipe Installation |
|---|---|---|---|---|---|---|---|
| Depth (Elev.) | Stratigraphy | Description & Remarks | Number | Type | Blows/Foot | 20 40 60 80 | |
| | | Grey clayey-silt till | | | | | |
| 3m | | | | | | | |
| 6.1m | | | | | | | |
| 6.4m | | | | | | | |



Threaded Plug
3.8cm Ø PVC pipe
Borehole Cuttings
Bentonite Seal
Sand
Well Screen 3.8cm x .6m slotted PVC pipe wrapped with fiberglass cloth

FIGURE 2.2

Conestoga - Rovers & Associates

Project Name: ST. MARYS LANDFILL SITE
Job No. 979-645
Client: TOWN OF ST. MARYS
Borehole Type: Hollow Stem Auger
Location:

Borehole No. OW3-80
Date Completed May 27, 1980
Geologist/Engineer ESR
Elevation Top of casing, 316.197m AMSL

| Depth (Elev.) | Stratigraphy | Description & Remarks | Sample Number | Sample Type | Sample Blows/Foot | Penetration Test Blows/Foot (20 40 60 80) |
|---|---|---|---|---|---|---|
| | | Grey clayey silt till | | | | |
| 1.8m | | Grey, clayey silt | | | | |
| 2.4m | | | | | | |
| 3m | | Grey clayey silt till | ~~11~~ | ~~AS~~ | | |
| 4.6m | | | 12 | SS | 40 | |

Piezometer or Standpipe Installation

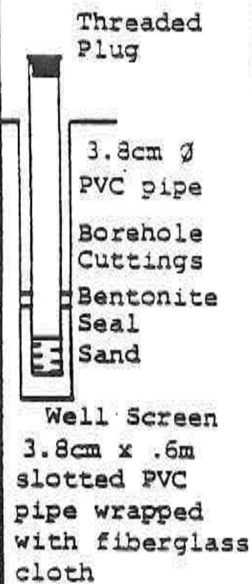



FIGURE 2.3
Conestoga - Rovers & Associates

Project Name: ST. MARYS LANDFILL SITE
Job No. 979-645
Client: TOWN OF ST. MARYS
Borehole Type: Hollow Stem Auger
Location:

Borehole No. OW4-80
Date Completed May 27, 1980
Geologist/Engineer ESR
Elevation Top of Casing, 316.126m AMSL

| Depth (Elev.) | Stratigraphy | Profile: Description & Remarks | Sample Number | Sample Type | Blows/Foot | Penetration Test Blows/Foot (20 40 60 80) |
|---|---|---|---|---|---|---|
| | | Grey clayey silt till | 1 | SS | 37 | |
| 1.2m | | | | | | |
| 1.8m | | Grey clayey silt | 2 | SS | 53 | |
| | | | 3 | SS | 56 | |
| 3m | | Grey clayey silt till | 4 | SS | | |
| | | | 5 | SS | 28 | |
| | | | 6 | SS | 31 | |
| | | | 7 | SS | 31 | |
| 6.1m | | | 8 | SS | | |
| | | | 9 | SS | 62 | |
| 9.1m | | | 10 | SS | 100 | |
| 10.2m | | Rock | | | | |

Piezometer or Standpipe Installation

Threaded Plug

3.8cm Ø PVC pipe

Borehole Cuttings

Bentonite Seal

Sand

Well Screen 3.8cm x .6m slotted PVC pipe wrapped with fiberglass cloth

FIGURE 2.4

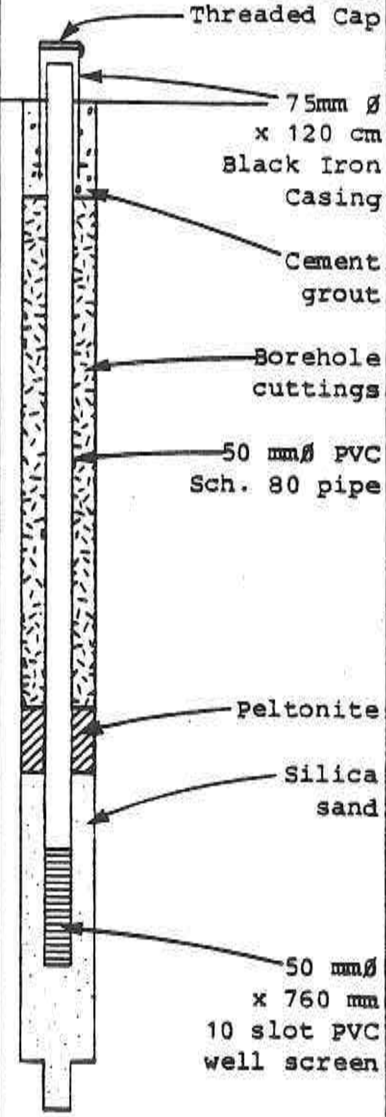
Conestoga - Rovers & Associates

# STRATIGRAPHIC AND INSTRUMENTATION LOG

PROJECT NAME: ST. MARYS LANDFILL SITE
HOLE Nº: OW1-84
JOB Nº: 9-645
DATE COMPLETED: SEPTEMBER 25, 1984
CLIENT: TOWN OF ST. MARYS
GEOLOGIST/ENGINEER: PSB
HOLE TYPE: HOLLOW STEM AUGER
GROUND ELEVATION:* 321.87 m AMSL
LOCATION:
TOP OF PIPE ELEVATION:* 322.484 M AMSL

| PROFILE: DEPTH (ELEVATION) | PROFILE: STRATIGRAPHY DESCRIPTION & REMARKS | SAMPLE: NUMBER | SAMPLE: TYPE | SAMPLE: BLOWS/FT. |
|---|---|---|---|---|
| 0.0 / 321.87 | | | | |
| 0.91 / 320.96 | Sandy clayey silt till with gravel | | | |
| 5.87 / 316.00 | | | | |
| 6.50 / 315.37 | | | | |
| 8.38 / 313.49 | | | | |
| 9.14 / 312.73 | Sandy clayey silt till with wet gravel seams | 1 | SS | 89 |
| 9.60 / 312.27 | | | | |

MONITOR INSTALLATION




* REFER TO "WATER ELEVATIONS" TABLE FOR CURRENT REFERENCE ELEVATIONS
▼ WATER FOUND ▽ STATIC WATER LEVEL ◯ GRAIN SIZE ANALYSIS SS — SPLIT SPOON SAMPLE

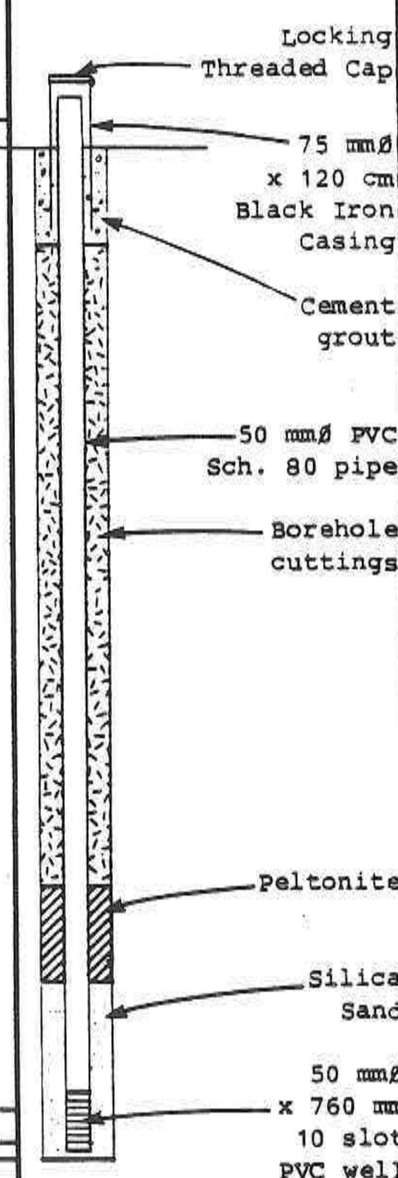
# STRATIGRAPHIC AND INSTRUMENTATION LOG

PROJECT NAME : ST. MARYS LANDFILL SITE
HOLE Nº : OW2-84
JOB Nº : 9-645
DATE COMPLETED: SEPTEMBER 25, 1984
CLIENT : TOWN OF ST. MARYS
GEOLOGIST/ENGINEER : PSB
HOLE TYPE : HOLLOW STEM AUGER
GROUND ELEVATION:* 322.25 m AMSL
LOCATION :
TOP OF PIPE ELEVATION:* 322.841 m AMSL

**PROFILE**

| DEPTH (ELEVATION) | STRATIGRAPHY DESCRIPTION & REMARKS |
|---|---|
| 0.0 / 322.25 – 0.91 / 321.34 | Brown clayey silt till with minor gravel |
| 7.10 / 315.15 | |
| 8.08 / 314.17 | |
| 9.45 / 312.80 | Brown sand and gravel |
| 9.60 / 312.65 | Brown clayey silt till |

**MONITOR INSTALLATION**




**SAMPLE**

| NUMBER | TYPE | BLOWS/FT. |
|---|---|---|
| 1 | SS | 21 |
| 2 | SS | 27 |
| 3 | SS | 72 |
| 4 | SS | 61 |

* REFER TO "WATER ELEVATIONS" TABLE FOR CURRENT REFERENCE ELEVATIONS

▼ WATER FOUND ▽ STATIC WATER LEVEL ◯ GRAIN SIZE ANALYSIS SS — SPLIT SPOON SAMPLE

# STRATIGRAPHIC AND INSTRUMENTATION LOG

PROJECT NAME : ST. MARYS LANDFILL SITE
HOLE Nº : OW3-84, OW4-84 - page 1 of

JOB Nº : 9-645
DATE COMPLETED : SEPTEMBER 24, 1984

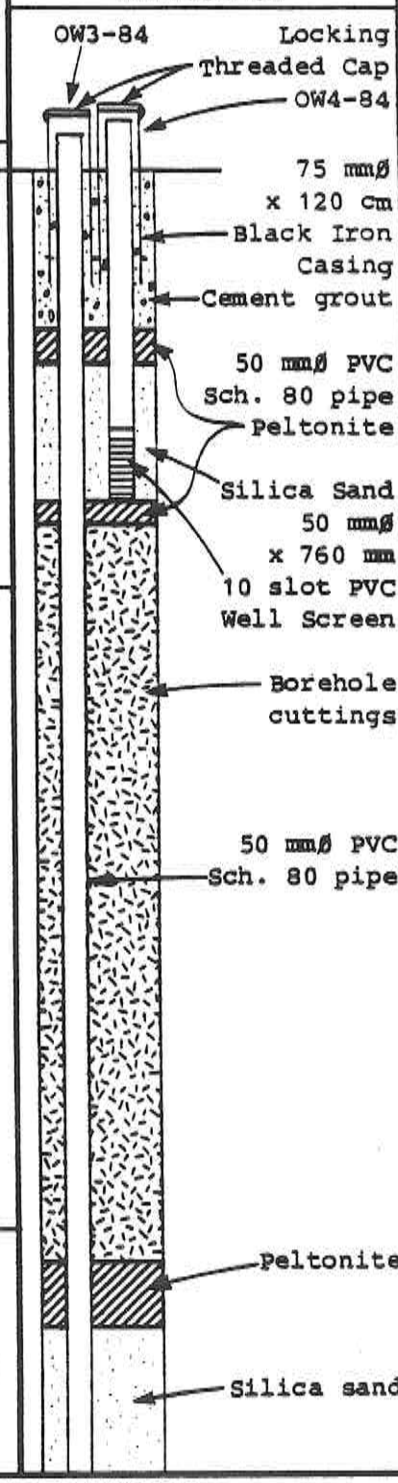
CLIENT : TOWN OF ST. MARYS
GEOLOGIST/ENGINEER : PSB

HOLE TYPE : HOLLOW STEM AUGER
GROUND ELEVATION:* 314.52 m AMSL

LOCATION :
TOP OF PIPE ELEVATION:* 315.035, 315.364 m AM

| DEPTH (ELEVATION) | PROFILE: STRATIGRAPHY DESCRIPTION & REMARKS | SAMPLE NUMBER | TYPE | BLOWS/FT. |
|---|---|---|---|---|
| 0.0 / 314.52 | Interbedded moist to wet brown silty sand and clayey silt with minor gravel | | | |
| 1.45 / 313.07 | | 1 | SS | 48 |
| 1.83 / 312.69 | | | | |
| 3.05 / 311.47 | | 2 | SS | 88 |
| 3.66 / 310.86 | Dry brown clayey silt till with minor gravel | | | |
| | | 3 | SS | 54 |
| | | 4 | SS | 64 |
| | | 5 | SS | 180 |
| | | 6 | SS | 183 |
| 10.06 / 304.46 | Moist brown clayey silt till with sand and minor gravel | | | |
| 10.36 / 304.16 | | 7 | SS | 150 |
| 11.05 / 303.47 | | | | |
| 12.19 / 302.33 | | 8 | SS | 102 |

MONITOR INSTALLATION




* REFER TO "WATER ELEVATIONS" TABLE FOR CURRENT REFERENCE ELEVATIONS

▼ WATER FOUND ▽ STATIC WATER LEVEL ○ GRAIN SIZE ANALYSIS SS — SPLIT SPOON SAMPLE

# STRATIGRAPHIC AND INSTRUMENTATION LOG

PROJECT NAME : ST. MARYS LANDFILL SITE

HOLE Nº: OW3-84, OW4-84 - page 2 of

JOB Nº : 9-645

DATE COMPLETED: SEPTEMBER 24, 1984

CLIENT : TOWN OF ST. MARYS

GEOLOGIST/ENGINEER : PSB

HOLE TYPE : HOLLOW STEM AUGER

GROUND ELEVATION:* 314.52 m AMSL

LOCATION :

TOP OF PIPE ELEVATION:* 315.035, 315.364 m AMSL

| PROFILE | | MONITOR INSTALLATION | SAMPLE | | |
|---|---|---|---|---|---|
| DEPTH (ELEVATION) | STRATIGRAPHY DESCRIPTION & REMARKS | | NUMBER | TYPE | BLOWS/FT. |
| 12.19<br>302.33 | Moist brown clayey silt till with sand and minor gravel | 50 mmø PVC Sch. 80 pipe | | | |
| 13.11<br>301.41 | Moist brown medium sand with fine sand and fine gravel | Silica sand | 9 | SS | 60 |
| 13.87<br>300.65 | Bedrock | 50 mmø x 760 mm 10 slot PVC Well screen | | | |

* REFER TO "WATER ELEVATIONS" TABLE FOR CURRENT REFERENCE ELEVATIONS

▼ WATER FOUND ▽ STATIC WATER LEVEL ◯ GRAIN SIZE ANALYSIS SS — SPLIT SPOON SAMPLE

# STRATIGRAPHIC AND INSTRUMENTATION LOG

PROJECT NAME: ST. MARYS LANDFILL SITE
HOLE Nº: OW5-84, OW6-84 - page 1 o

JOB Nº: 9-645
DATE COMPLETED: SEPTEMBER 25, 1984

CLIENT: TOWN OF ST. MARYS
GEOLOGIST/ENGINEER: PSB

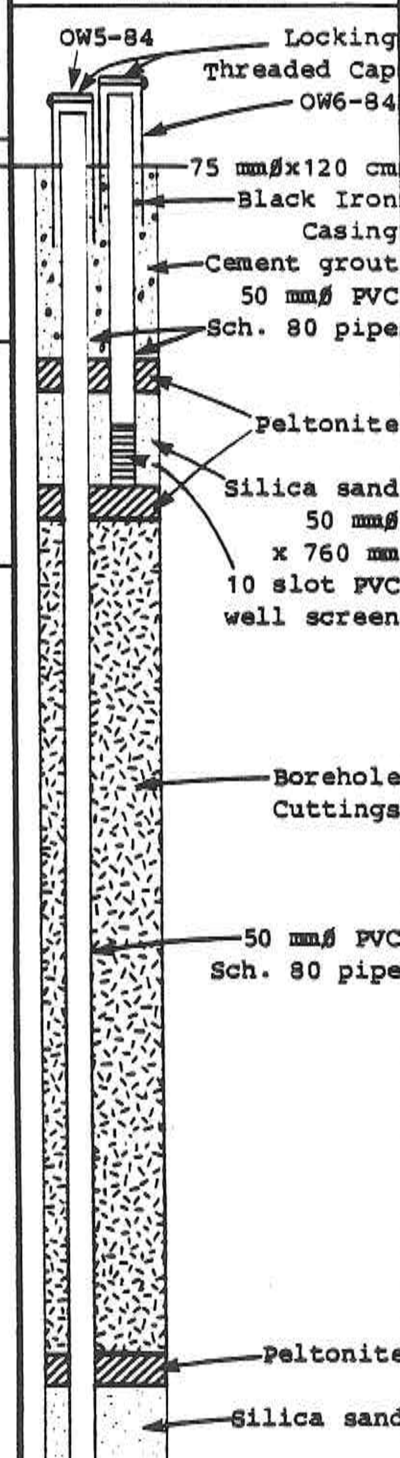
HOLE TYPE: HOLLOW STEM AUGER
GROUND ELEVATION:* 313.97 m AMSL

LOCATION:
TOP OF PIPE ELEVATION:* 314.423, 314.794

A

| DEPTH (ELEVATION) | PROFILE: STRATIGRAPHY DESCRIPTION & REMARKS | SAMPLE NUMBER | TYPE | BLOWS/FT. |
|---|---|---|---|---|
| 0.0 / 313.97 | | | | |
| | Dry gray silt with clay and minor fine sand | 1 | SS | 98 |
| 1.68 / 312.29 | | | | |
| 1.98 / 311.99 | | | | |
| | Interbedded dry gray brown silt and clayey silt till with minor gravel | 2 | SS | 38 |
| 3.20 / 310.77 | | | | |
| 3.81 / 310.16 | | | | |
| | Dry brown clayey silt till with cobbles | 3 | SS | 48 |
| | | 4 | SS | 55 |
| | | 5 | SS | 90 |
| | | 6 | SS | 144 |
| | | 7 | SS | 260 |
| 11.28 / 302.69 | | | | |
| 11.73 / 302.24 | | | | |
| 12.19 / 301.78 | | | | |

MONITOR INSTALLATION




* REFER TO "WATER ELEVATIONS" TABLE FOR CURRENT REFERENCE ELEVATIONS

▼ WATER FOUND ▽ STATIC WATER LEVEL ○ GRAIN SIZE ANALYSIS SS — SPLIT SPOON SAMPLE

# STRATIGRAPHIC AND INSTRUMENTATION LOG

PROJECT NAME: ST. MARYS LANDFILL SITE
HOLE Nº: OW5-84, OW6-84 - page 2 of

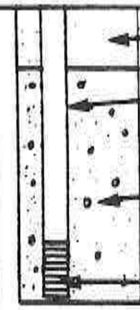
JOB Nº: 9-645
DATE COMPLETED: SEPTEMBER 25, 1984

CLIENT: TOWN OF ST. MARYS
GEOLOGIST/ENGINEER: PSB

HOLE TYPE: HOLLOW STEM AUGER
GROUND ELEVATION:* 313.97 m AMSL

LOCATION:
TOP OF PIPE ELEVATION:* 314.423, 314.794 m AM

| PROFILE | | MONITOR INSTALLATION | SAMPLE | | |
|---|---|---|---|---|---|
| DEPTH (ELEVATION) | STRATIGRAPHY DESCRIPTION & REMARKS | | NUMBER | TYPE | BLOWS/FT. |
| 12.19-<br>301.78- | Dry brown clayey silt till with cobbles | Silica sand | 8 | SS | 165 |
| 12.80-<br>301.17- | Wet brown coarse sand with gravel and medium sand | 50 mmØ PVC Sch. 80 pipe<br>Collapsed Sand & gravel<br>50 mmØ x 760 mm 10 slot PVC Well screen | 9 | SS | 108 |
| 14.33-<br>299.64- | | | | | |
| 14.78-<br>299.19- | Bedrock | | | | |



* REFER TO "WATER ELEVATIONS" TABLE FOR CURRENT REFERENCE ELEVATIONS

▼ WATER FOUND ▽ STATIC WATER LEVEL ○ GRAIN SIZE ANALYSIS SS — SPLIT SPOON SAMPLE

## STRATIGRAPHIC AND INSTRUMENTATION LOG
## (OVERBURDEN)

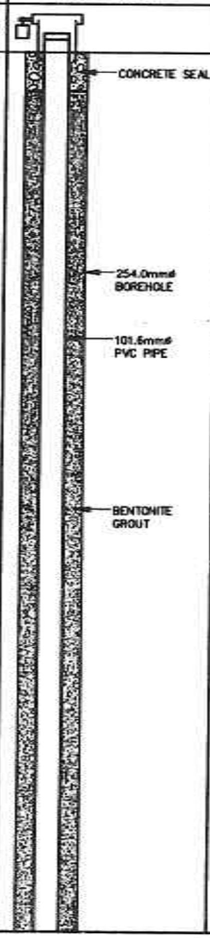
(L-01)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 1 of 5)
DATE COMPLETED: OCTOBER 4, 1991
DRILLING METHOD: 159mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | SAMPLE NUMBER | STATE | 'N' VALUE |
|---|---|---|---|---|---|
| | REFERENCE POINT (Top of Riser). GROUND SURFACE | 315.270 / 314.50 | | | |
| 1.0 – 3.0 | ML-SILT(GLACIOLACUSTINE), trace to little clay, sandy partings (up to 3mm thick) between varved laminations (3 to 20mm thick), non-cohesive, fractured (0.0 to 0.61m BGS), light brown and moist (0.0 and 0.91m BGS), grey and wet (0.91 to 1.52m BGS) – trace clay, non-cohesive, thin varves (2 to 5mm thick) with frequent sandy partings, light grey and brown, wet, dilatant | | 1CS, 2CS | | |
| 3.0 – 8.0 | ML-SILT(TILL), some clay, little sand, frequent pebbles, very hard, cohesive, light to medium gray-brown, damp, one oblique fracture with silty face – frequent cobbles, occasional horizontal fractures, 4.6 to 5.2m BGS, very hard, and less damp below 5.2M – trace to little sand, no apparent fractures – augering refusal at 6.4m change to 6 1/8" air rotary | 311.35 | 3CS, 4CS, 5CS | | |
| 8.0 – 13.0 | ML-SILT(TILL), some fine sand, some gravel, trace to little clay, extremely dense, non-cohesive light brown, moist | 306.77 | 6SS | | >100 |
| 13.0 | SP-SAND, fine to medium grained, poorly graded, brown, damp to moist | 301.70 | | | |

MONITOR INSTALLATION



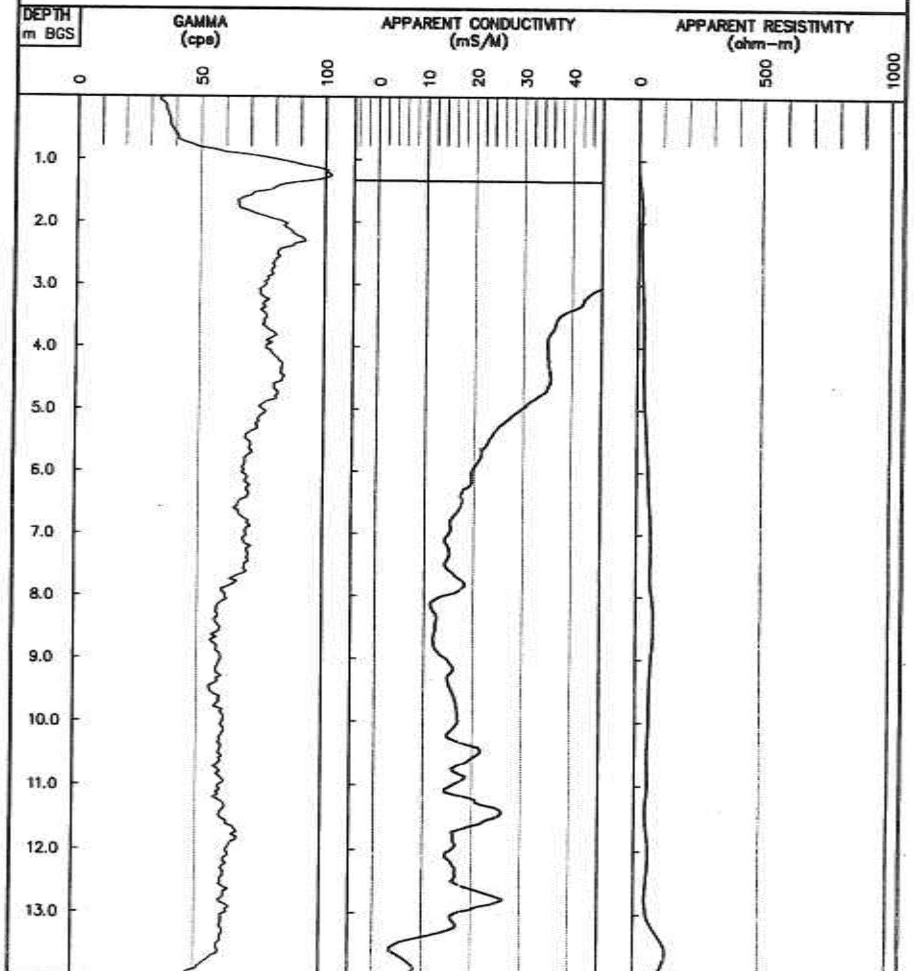

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

## STRATIGRAPHIC AND INSTRUMENTATION LOG
## (GEOPHYSICS)

(L-01)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 1 of 5)
DATE LOGGED: OCTOBER 11, 1991
DRILLING METHOD: 159mm ID HSA
SURVEY BY HYD-ENG GEOPHYSICS INC.



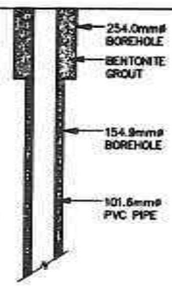
## STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-01)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 2 of 5)
DATE COMPLETED: OCTOBER 4, 1991
DRILLING METHOD: 159mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | - fine to medium gravel | | | | | |
| 14.0 | END OF OVERBURDEN HOLE @ 14.12 m BGS. | 300.40 | | | | |
| 15.0 | | | | | | |
| 16.0 | | | | | | |
| 17.0 | | | | | | |
| 18.0 | | | | | | |
| 19.0 | | | | | | |
| 20.0 | | | | | | |
| 21.0 | | | | | | |
| 22.0 | | | | | | |
| 23.0 | | | | | | |
| 24.0 | | | | | | |
| 25.0 | | | | | | |
| 26.0 | | | | | | |



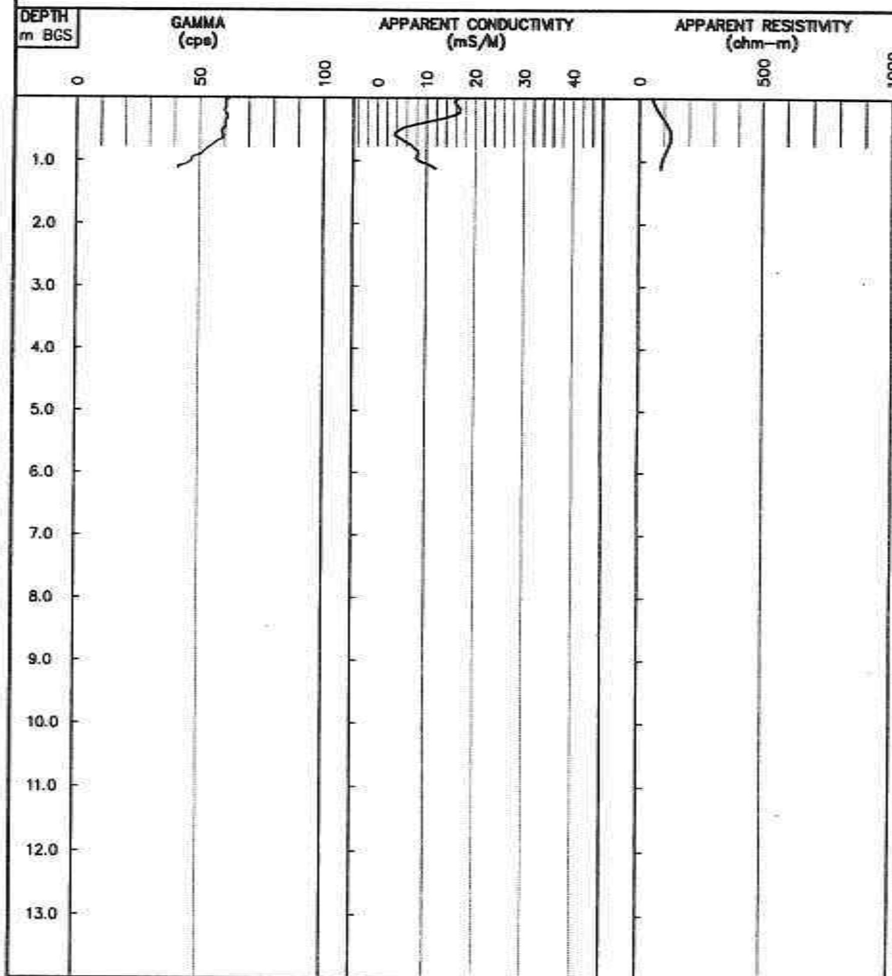

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-01)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 2 of 5)
DATE LOGGED: OCTOBER 11, 1991
DRILLING METHOD: 159mm ID HSA
SURVEY BY HYD-ENG GEOPHYSICS INC.



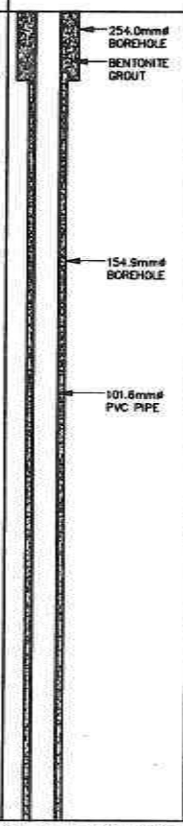
## STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

(L-02)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 3 of 5)
DATE COMPLETED: OCTOBER 4, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ 6.4cm CORE
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | DESCRIPTION OF STRATA | ELEVATION m AMSL | MONITOR INSTALLATION | BEDROCK INTERVAL | RUN NUMBER | CORE RECOVERY % | RQD % | WATER RETURN % |
|---|---|---|---|---|---|---|---|---|
| | See Overburden log | | | | | | | |
| 14.0 | LIMESTONE(Dundee Formation): grey, hard, interbeds of brown argillaceous limestone (as described from drilling returns) | 300.37 | | | | | | |
| 15.0 | | | | | | | | |
| 16.0 | | | | | | | | |
| 17.0 | | | | | | | | |
| 18.0 | – argillaceous limestone, soft, brown, interbeds of hard grey limestone | | | | | | | |
| 19.0 | | | | | | | | |
| 20.0 | | | | | | | | |
| 21.0 | | | | | | | | |
| 22.0 | LIMESTONE(Lucas Formation): | 292.50 | | | | | | |
| 23.0 | | | | | | | | |
| 24.0 | | | | | | | | |
| 25.0 | | | | | | | | |




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

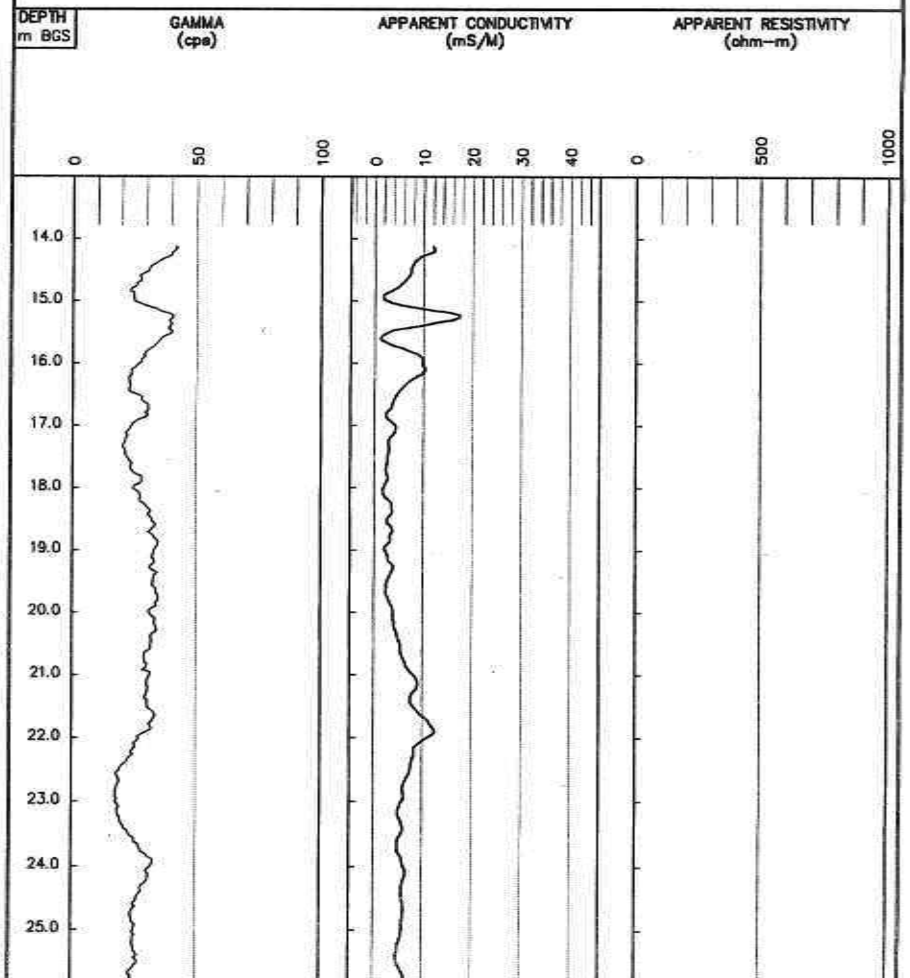
WATER FOUND    STATIC WATER LEVEL    NM – NOT MEASURED

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-02)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 3 of 5)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ 6.4cm CORE
SURVEY BY HYD-ENG GEOPHYSICS INC.



## STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

(L-02)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 4 of 5)
DATE COMPLETED: OCTOBER 4, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ 6.4cm CORE
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | DESCRIPTION OF STRATA | ELEVATION m AMSL | MONITOR INSTALLATION | BEDROCK INTERVAL | RUN NUMBER | CORE RECOVERY % | RQD % | WATER RETURN % |
|---|---|---|---|---|---|---|---|---|
| 26.0 | – damp | | BENTONITE GROUT | | | | | |
| 27.0 | | | 154.9mmø BOREHOLE | | | | | |
| 28.0 | | 285.99 | 101.6mmø PVC PIPE | | | | | |
| 29.0 | | | | | | | | |
| 30.0 | – few thin shale interbeds | | | | | | | |
| 31.0 | | | | | | | | |
| 32.0 | | | | | | | | |
| 33.0 | | | | | | | | |
| 34.0 | | | | | | | | |
| 35.0 | – light to dark brown, sugary to porous/ granular texture, layered | | | | | | | |
| | – grey (35.66 to 35.81m BGS) | | | | | | | |
| 36.0 | | | SAND PACK | | 1 | 100 | 30 | |
| 37.0 | – grey with occasional brown layers, brown rock is medium to high porosity, grey rock is low porosity, well fractured, some small vugs and solution cavities, stylolites | | | | | | | |

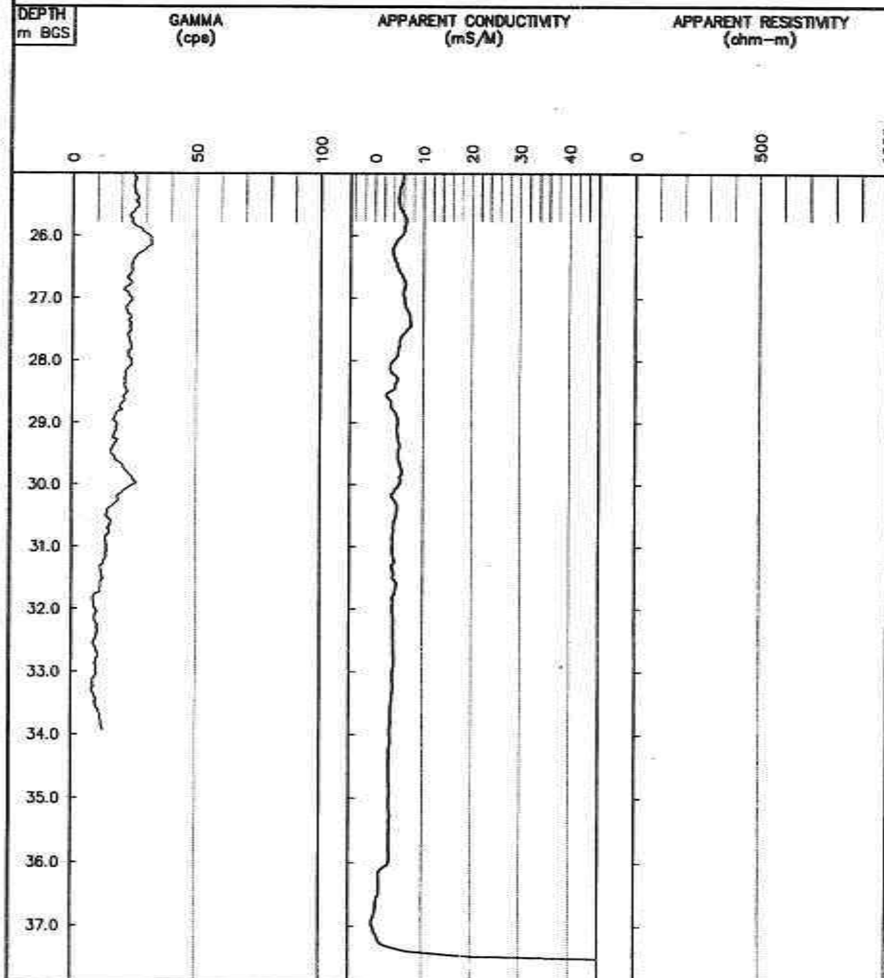
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
▽ WATER FOUND ▼ STATIC WATER LEVEL (OCT 26, 1991) NM – NOT MEASURED

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-02)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 4 of 5)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ 6.4cm CORE
SURVEY BY HYD-ENG GEOPHYSICS INC.



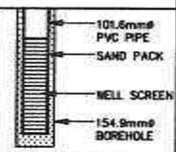
## STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

(L-02)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 5 of 5)
DATE COMPLETED: OCTOBER 4, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ 6.4cm CORE
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | DESCRIPTION OF STRATA | ELEVATION m AMSL | MONITOR INSTALLATION | BEDROCK INTERVAL | RUN NUMBER | CORE RECOVERY % | RQD % | WATER RETURN % |
|---|---|---|---|---|---|---|---|---|
| 38.0 | – fractured (@ 37.95m BGS) | | | | | | | |
| | – fractured (@ 38.40m BGS)<br>– fractured (@ 38.71m BGS) | | | | | | | |
| 39.0 | – (as indicated by drilling rate) | | | | | | | |
| | END OF HOLE @ 39.22 m BGS. | 275.28 | | | | | | |
| 40.0 | | | | | | | | |
| 41.0 | | | | | | | | |
| 42.0 | | | | | | | | |
| 43.0 | | | | | | | | |
| 44.0 | | | | | | | | |
| 45.0 | | | | | | | | |
| 46.0 | | | | | | | | |
| 47.0 | | | | | | | | |
| 48.0 | | | | | | | | |
| 49.0 | | | | | | | | |




SCREEN DETAILS:
Screened Interval:
37.49 to 39.01m BGS
Length –1.5m
Diameter –101.6mm
Slot # 10
Material –Stainless Steel
Sand pack interval:
33.83 to 39.22m BGS
Material –# 3 Silica Sand

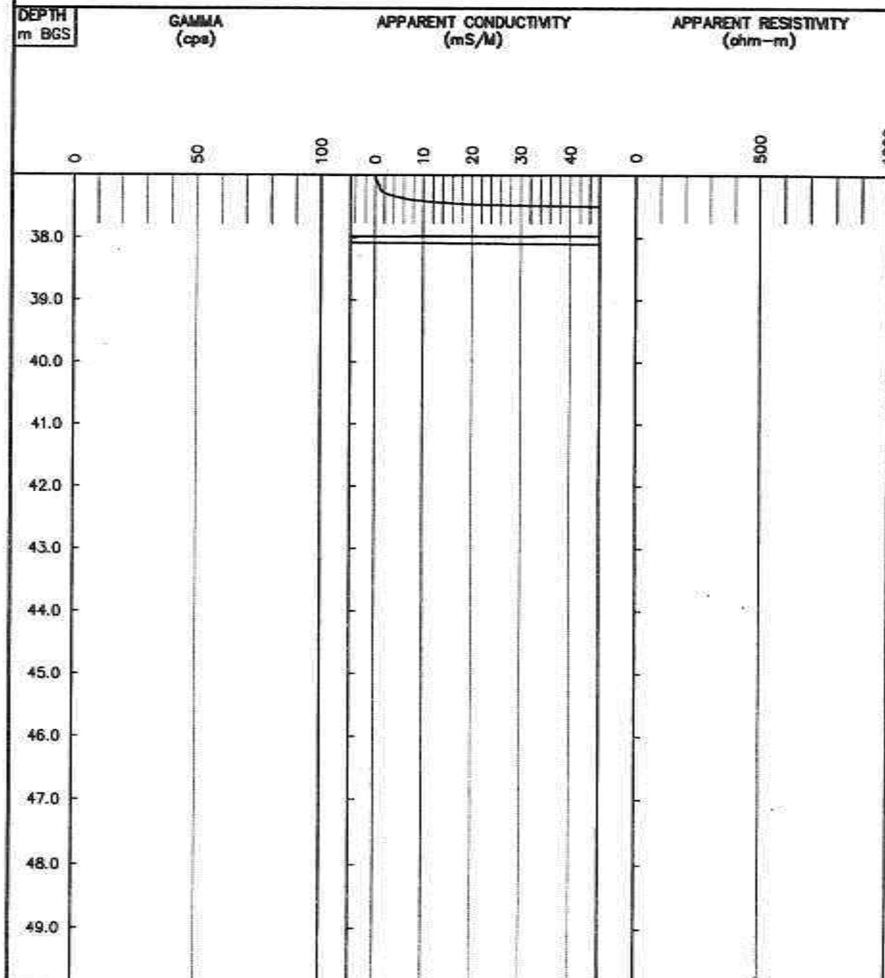
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
∇ WATER FOUND   ▼ STATIC WATER LEVEL   NM – NOT MEASURED

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-02)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW7-91 (Page 5 of 5)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ 6.4cm CORE
SURVEY BY HYD-ENG GEOPHYSICS INC.



## STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

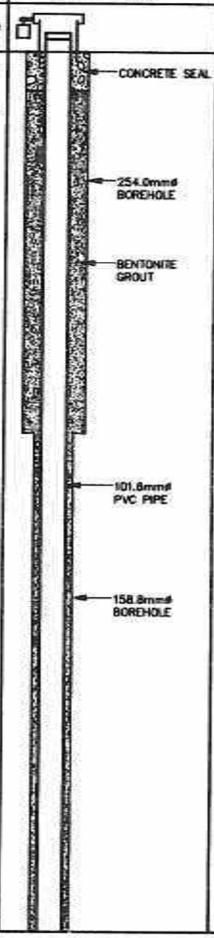
(L-03)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW8A-91 (Page 1 of 4)
DATE COMPLETED: OCTOBER 3, 1991
DRILLING METHOD: 6 1/4" ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|
| | REFERENCE POINT (Top of Riser) | 314.860 | | | |
| | GROUND SURFACE | 314.00 | | | |
| | ML-SILT(FILL), some clay, some cobbles, hard, brown, damp | 313.70 | | | |
| | ML-SILT(GLACIOLACUSTRINE), little to some fine grained sand, trace clay, tan, damp | 313.09 | | | |
| 1.0 | ML/CL-SILT(TILL), some clay, some sand, some pebbles and cobbles, extremely hard, massive, no fracturing, brown, damp | | 1CS | X | |
| 2.0 | – becomes light brown to grey, lots of cobbles | | 2CS | X | |
| 3.0 | | | | | |
| 4.0 | – preferential parting in horizontal plane, fewer cobbles and gravel, damp to moist | | 3CS | X | |
| | – some pebbles and small cobbles | | | | |
| 5.0 | – more fractured | | 4CS | X | |
| 6.0 | – fewer pebbles, some horizontal fracturing, minor vertical fracturing, less damp | | | | |
| 7.0 | | | 5CS | X | |
| 8.0 | | | | | |
| 9.0 | – little fine sand, little gravel, very hard, damp to moist | | | | |
| 10.0 | – boulder | | | | |
| 11.0 | | | 6SS | X | >100 |
| 12.0 | | | | | |
| 13.0 | | | | | |

MONITOR INSTALLATION




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

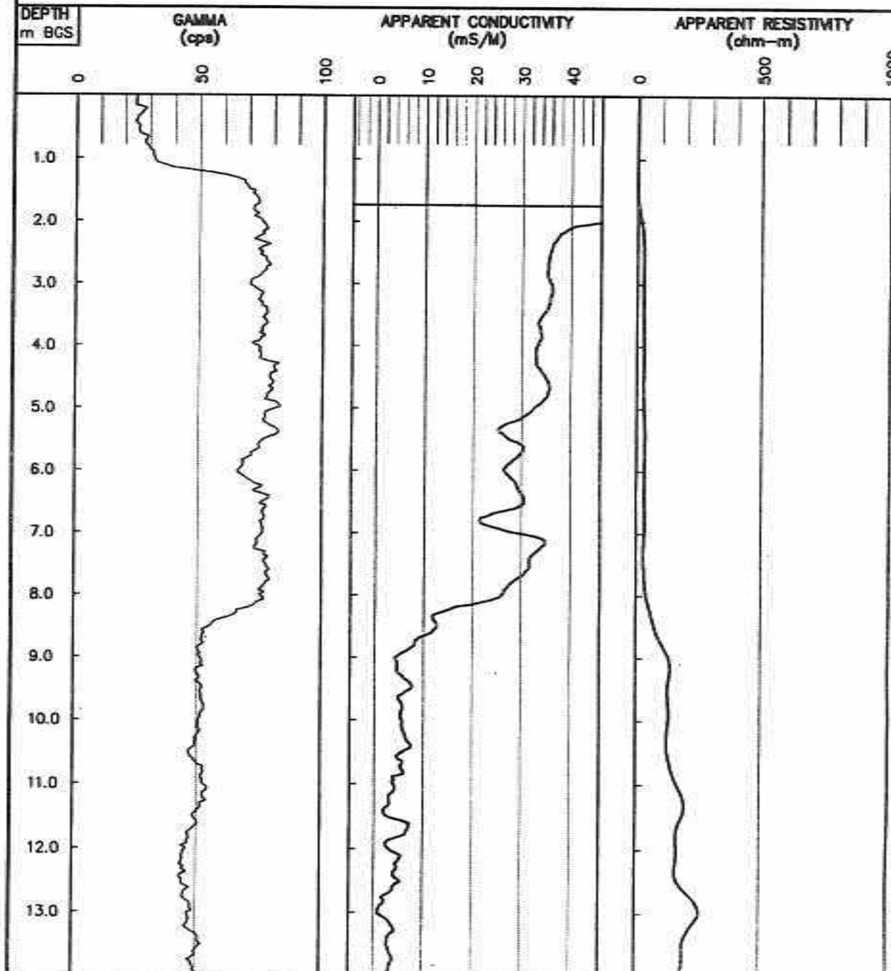
GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-03)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW8A-91 (Page 1 of 4)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 6 1/4" ID HSA
SURVEY BY HYD-ENG GEOPHYSICS INC.



## STRATIGRAPHIC AND INSTRUMENTATION LOG
## (OVERBURDEN)

(L-03)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW8A-91 (Page 2 of 4)
DATE COMPLETED: OCTOBER 3, 1991
DRILLING METHOD: 6 1/4" ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| 14.0 | – boulder, moist | | 158.8mmø BOREHOLE | | | |
| 15.0 | | | | | | |
| | – firm, moist to wet, dilatant | | | | | |
| 16.0 | | | | 7SS | ⊠ | 75 |
| 17.0 | | | 101.6mmø PVC PIPE | | | |
| 18.0 | END OF OVERBURDEN HOLE @ 17.83 m BGS. CONTINUED ON BEDROCK LOG | *296.17* | | | | |
| 19.0 | | | | | | |
| 20.0 | | | | | | |
| 21.0 | | | | | | |
| 22.0 | | | | | | |
| 23.0 | | | | | | |
| 24.0 | | | | | | |
| 25.0 | | | | | | |
| 26.0 | | | | | | |

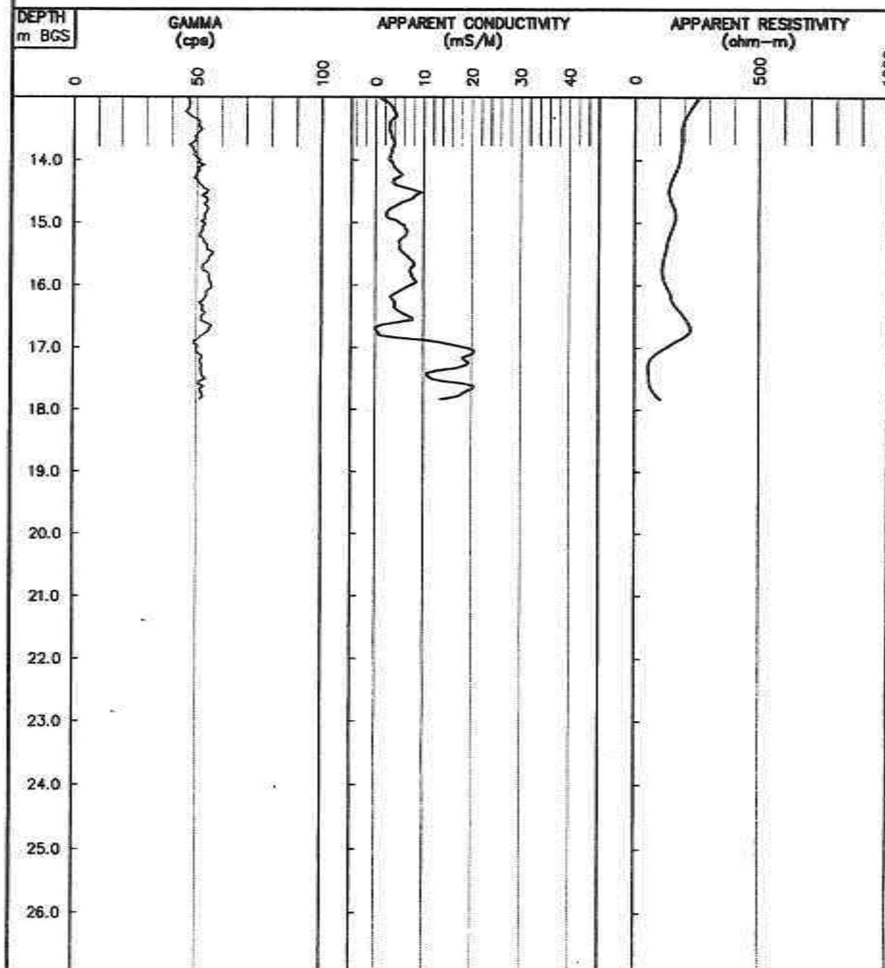
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

## STRATIGRAPHIC AND INSTRUMENTATION LOG
## (GEOPHYSICS)

(L-03)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW8A-91 (Page 2 of 4)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 6 1/4" ID HSA
SURVEY BY HYD-ENG GEOPHYSICS INC.



## STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

(L-04)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OWBA-91 (Page 3 of 4)
DATE COMPLETED: OCTOBER 3, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ CORE
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | DESCRIPTION OF STRATA | ELEVATION m AMSL | MONITOR INSTALLATION | BIT DEPTH / RECORD | RUN NUMBER | CORE RECOVERY % | RQD % | WATER RETURN % |
|---|---|---|---|---|---|---|---|---|
| | See Overburden log | | | | | | | |
| 17.0 | | | | | | | | |
| 18.0 | LIMESTONE(Dundee Formation): light brown to brown and light to dark grey, fine grained, sugary texture argillaceous, soft, dry (as described from drilling returns) | 296.17 | | | | | | |
| 19.0 | | | | | | | | |
| 20.0 | | | 158.8mmø BOREHOLE | | | | | |
| 21.0 | | | | | | | | |
| 22.0 | | | BENTONITE GROUT | | | | | |
| 23.0 | | | | | | | | |
| 24.0 | | | | | | | | |
| 25.0 | | | 101.6mmø PVC PIPE | | | | | |
| 26.0 | LIMESTONE(Lucas Formation): | 288.00 | BENTONITE PELLET SEAL | | | | | |
| 27.0 | | | SAND PACK | | | | | |
| 28.0 | – water bearing fracture (28.19 to 28.35m BGS) | 286.22 | | | | | | |

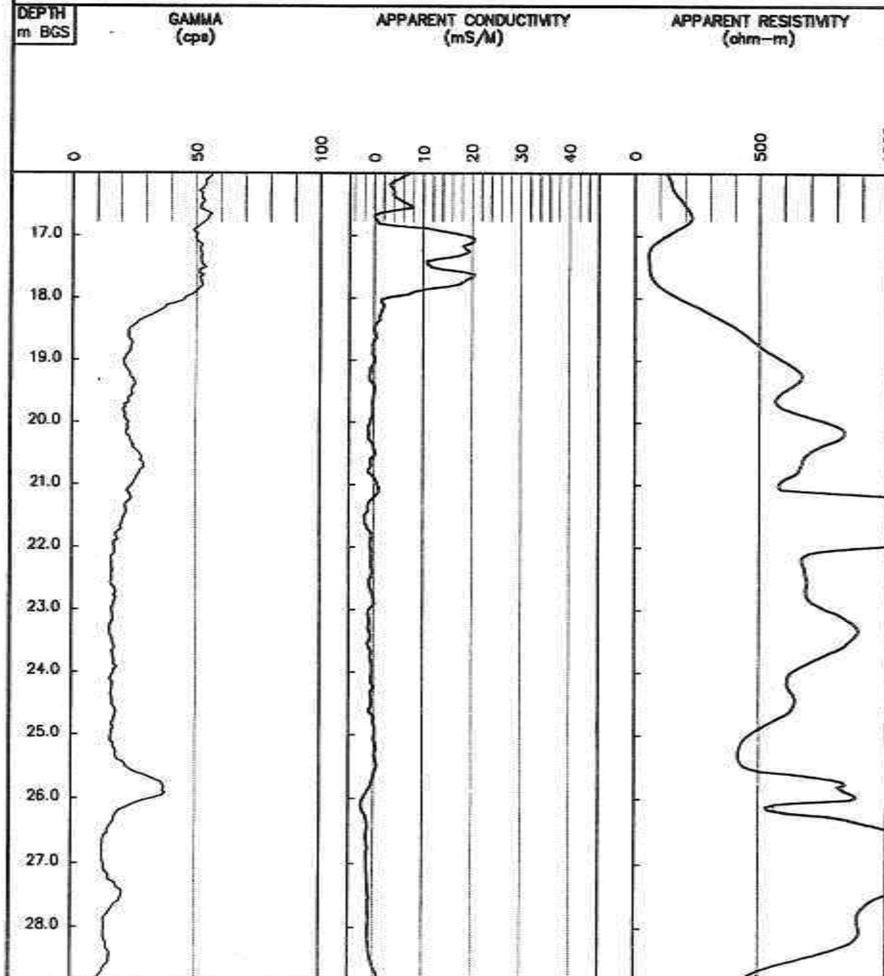
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
▽ WATER FOUND ▼ STATIC WATER LEVEL (OCT 26/91) NM – NOT MEASURED

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-04)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OWBA-91 (Page 3 of 4)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ CORE
SURVEY BY HYD-ENG GEOPHYSICS INC.

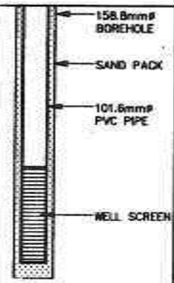


# STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

(L-04)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW8A-91 (Page 4 of 4)
DATE COMPLETED: OCTOBER 3, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ CORE
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | DESCRIPTION OF STRATA | ELEVATION m AMSL | MONITOR INSTALLATION | BEDROCK INTERVAL | RUN NUMBER | CORE RECOVERY % | RQD % | WATER RETURN % |
|---|---|---|---|---|---|---|---|---|
| 29.0<br>30.0<br>31.0<br>32.0<br>33.0 | - light grey to brown, solution cavities and vugs (up to 2cm thick) with calcite infilling, stylolites<br>- iron staining (28.35 to 28.65m BGS)<br>- brown (28.65m to 29.11m BGS)<br>- water bearing fracture (@ 28.80m BGS)<br>- grey (29.11 to 29.72m BGS)<br>- water bearing fracture (@ 29.11m BGS)<br>- brown (29.72 to 32.00m BGS)<br>- water bearing fracture (29.72m BGS)<br>- porous (29.72 to 29.87m BGS)<br>- water bearing fracture (@ 30.02m BGS)<br>- water bearing fracture (@ 30.33m BGS)<br>- rough and open water bearing fracture (@ 30.94m BGS)<br>- porous (31.89 to 31.55m BGS)<br>- water bearing fracture (@ 31.69m BGS)<br>- water bearing fracture (@ 32.00m BGS)<br>- grey (32.00 to 32.36m BGS)<br>END OF HOLE @ 32.36 m BGS. | 281.64 |  | | 1 | 100 | 40 | |
| 34.0<br>35.0<br>36.0<br>37.0<br>38.0<br>39.0<br>40.0 | | | SCREEN DETAILS:<br>Screened Interval:<br>30.58 to 32.11m BGS<br>Length -1.5m<br>Diameter -101.6mm<br>Slot # 10<br>Material -Stainless Steel<br>Sand pack interval:<br>26.36 to 32.10m BGS<br>Material -# 3 Silica Sand | | | | | |



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

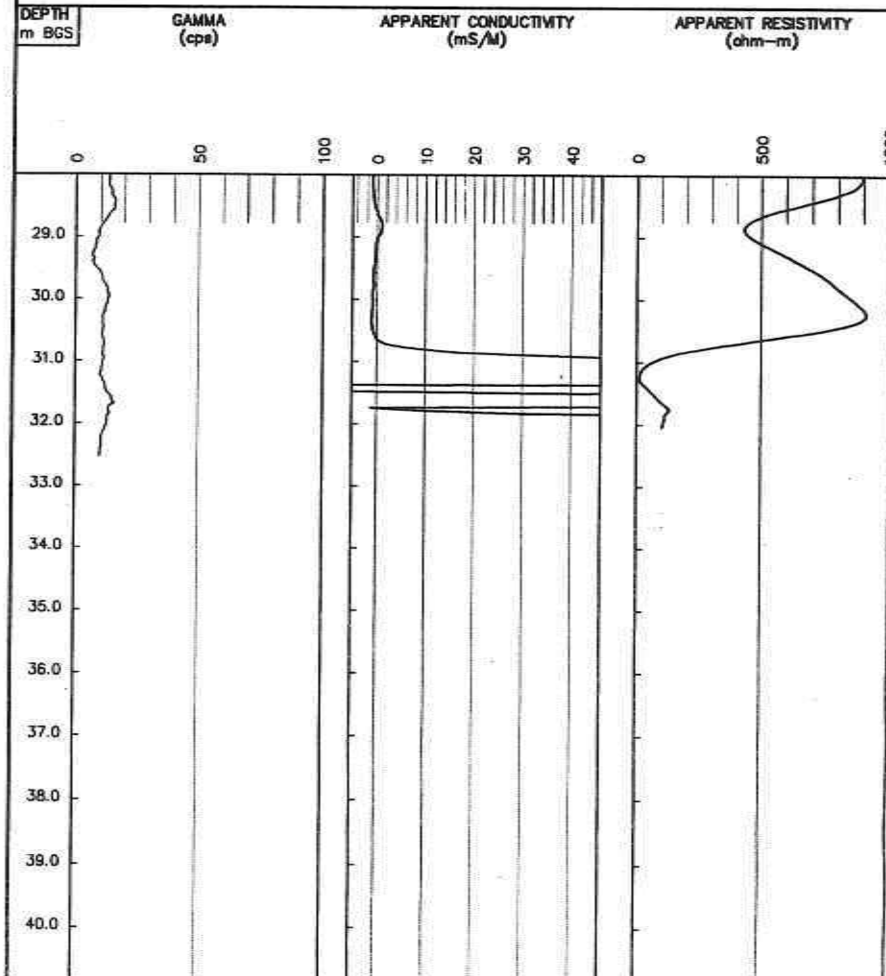
WATER FOUND    STATIC WATER LEVEL    NM - NOT MEASURED

# STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-04)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW8A-91 (Page 4 of 4)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ CORE
SURVEY BY HYD-ENG GEOPHYSICS INC.



# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

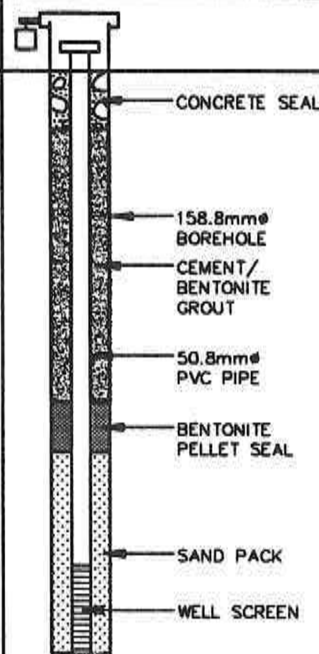
(L-05)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW8B-91
DATE COMPLETED: OCTOBER 4, 1991
DRILLING METHOD: 15cm AIR ROTARY
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|
| | REFERENCE POINT (Top of Riser) | 314.690 | | | |
| | GROUND SURFACE | 313.72 | | | |
| | For stratigraphy from 0.0 to 5.49m BGS see log OW8A-91 | | | | |
| 1.0 | | | | | |
| 2.0 | | | | | |
| 3.0 | | | | | |
| 4.0 | | | | | |
| 5.0 | | | | | |
| | ML/CL-SILT(TILL), some clay, some sand, some stone, very hard, medium grey to brown, very damp | 308.23 | | | |
| 6.0 | | 307.67 | 1SS | | >100 |
| | END OF HOLE @ 6.05 m BGS. | | | | |
| | NOTES: | | | | |
| 7.0 | 1. At completion borehole remained dry. | | | | |
| 8.0 | | | | | |
| 9.0 | | | | | |
| 10.0 | | | | | |
| 11.0 | | | | | |
| 12.0 | | | | | |
| 13.0 | | | | | |

MONITOR INSTALLATION




SCREEN DETAILS:
Screened Interval:
5.13 to 6.05m BGS
Length -0.9m
Diameter -50.8mm
Slot # 10
Material -Stainless Steel
Sand pack interval:
3.96 to 6.05m BGS
Material -# 3 Silica Sand

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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

OW8B-91

Decommissioned

Ontario Ministry of the Environment

# Well Record

*Regulation 903 Ontario Water Resources Act*

Page 1 of

Measurements recorded in: ☐ Metric ☐ Imperial

**Well Tag No.** *(Place Sticker and/or Print Below)*: A-[illegible] - 0[illegible]

## Well Owner's Information

| First Name | Last Name / Organization | E-mail Address | ☐ Well Constructed by Well Owner |
|---|---|---|---|
| | [illegible] & the Town of St. Marys | [illegible]@townofstmarys.com | |

| Mailing Address (Street Number/Name) | Municipality | Province | Postal Code | Telephone No. *(inc. area code)* |
|---|---|---|---|---|
| 415 Jones Street South | St. Marys | ON | N4X1B6 | 519 [illegible] |

## Well Location

| Address of Well Location (Street Number/Name) | Township | Lot | Concession |
|---|---|---|---|
| 1221 Water St. South | Town of St. Marys | 35 | Thames Concession |

| County/District/Municipality | City/Town/Village | Province | Postal Code |
|---|---|---|---|
| Perth County | St. Marys | **Ontario** | |

| UTM Coordinates | Zone | Easting | Northing | Municipal Plan and Sublot Number | Other |
|---|---|---|---|---|---|
| NAD 83 | 17 | 48[illegible]578 | 4787041 | | |

## Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

| General Colour | Most Common Material | Other Materials | General Description | Depth *(m/ft)* From | To |
|---|---|---|---|---|---|
| | | | Bentonite Chip | 0.0 | 6.4 |

## Annular Space

| Depth Set at *(m/ft)* From | To | Type of Sealant Used *(Material and Type)* | Volume Placed *(m³/ft³)* |
|---|---|---|---|
| | | | |

## Method of Construction

☐ Cable Tool ☐ Diamond ☐ Rotary (Conventional) ☐ Jetting ☐ Rotary (Reverse) ☐ Driving ☐ Boring ☐ Digging ☐ Air percussion ☐ Other, *specify*

## Well Use

☐ Public ☐ Commercial ☐ Not used ☐ Domestic ☐ Municipal ☐ Dewatering ☐ Livestock ☐ Test Hole ☐ Monitoring ☐ Irrigation ☐ Cooling & Air Conditioning ☐ Industrial ☐ Other, *specify*

## Construction Record - Casing

| Inside Diameter *(cm/in)* | Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel) | Wall Thickness *(cm/in)* | Depth *(m/ft)* From | To |
|---|---|---|---|---|
| | | | | |

## Construction Record - Screen

| Outside Diameter *(cm/in)* | Material (Plastic, Galvanized, Steel) | Slot No. | Depth *(m/ft)* From | To |
|---|---|---|---|---|
| | | | | |

## Status of Well

☐ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☒ Abandoned, other, *specify* Damaged ☐ Other, *specify*

## Water Details

| Water found at Depth | Kind of Water |
|---|---|
| *(m/ft)* ☐ Gas | ☐ Fresh ☐ Untested ☐ Other, *specify* |
| *(m/ft)* ☐ Gas | ☐ Fresh ☐ Untested ☐ Other, *specify* |
| *(m/ft)* ☐ Gas | ☐ Fresh ☐ Untested ☐ Other, *specify* |

## Hole Diameter

| Depth *(m/ft)* From | To | Diameter *(cm/in)* |
|---|---|---|
| 0.0 | 6.4 | 20.9 |

## Results of Well Yield Testing

After test of well yield, water was: ☐ Clear and sand free ☐ Other, *specify*

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping ___ hrs + ___ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

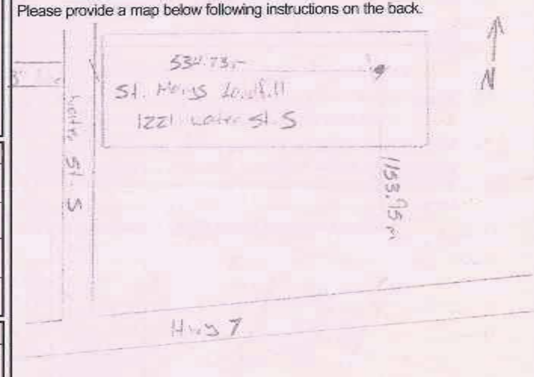
Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

| Draw Down Time *(min)* | Water Level *(m/ft)* | Recovery Time *(min)* | Water Level *(m/ft)* |
|---|---|---|---|
| Static Level | | | |
| 1 | | 1 | |
| 2 | | 2 | |
| 3 | | 3 | |
| 4 | | 4 | |
| 5 | | 5 | |
| 10 | | 10 | |
| 15 | | 15 | |
| 20 | | 20 | |
| 25 | | 25 | |
| 30 | | 30 | |
| 40 | | 40 | |
| 50 | | 50 | |
| 60 | | 60 | |

## Map of Well Location

Please provide a map below following instructions on the back.




Comments:

## Well Contractor and Well Technician Information

| Business Name of Well Contractor | Well Contractor's Licence No. |
|---|---|
| Alliance Drilling + Investigative Services Ltd | 7282 |

| Business Address (Street Number/Name) | Municipality |
|---|---|
| 3217 Hemlock Hill Drive | Elmira |

| Province | Postal Code | Business E-mail Address |
|---|---|---|
| ON | N3B2Z3 | [illegible]@alliancedrilling.com |

| Bus. Telephone No. *(inc. area code)* | Name of Well Technician (Last Name, First Name) |
|---|---|
| 519 [illegible]3331 | [illegible] |

| Well Technician's Licence No. | Signature of Technician and/or Contractor | Date Submitted |
|---|---|---|
| 3518 | | 2010 02 20 |

| Well owner's information package delivered | Date Package Delivered | Date Work Completed |
|---|---|---|
| ☐ Yes ☐ No | YYYYMMDD | 2010 02 25 |

**Ministry Use Only**

Audit No. Z 102053

Received

0506E (12/2007)

Well Owner's Copy

OW8B-10

Ontario Ministry of the Environment

# Well Record

**Regulation 903 Ontario Water Resources Act**

Page 1 of 1

**Well Tag No.** *(Place Sticker and/or Print Below)* A108429

**Measurements recorded in:** ☑ Metric ☐ Imperial

## Well Owner's Information

| First Name | Last Name / Organization | E-mail Address | ☐ Well Constructed by Well Owner |
|---|---|---|---|
| | Corporation of the Town of St. Marys | tsmythe@town.stmarys.on.ca | |

| Mailing Address (Street Number/Name) | Municipality | Province | Postal Code | Telephone No. *(inc. area code)* |
|---|---|---|---|---|
| 408 James Street South | St. Marys | ON | N4X1B6 | 519 284 2340 |

## Well Location

| Address of Well Location (Street Number/Name) | Township | Lot | Concession |
|---|---|---|---|
| 221 Water St. South | Town of St Marys | 35 | Thames Concession |

| County/District/Municipality | City/Town/Village | Province | Postal Code |
|---|---|---|---|
| Perth County | St. Marys | Ontario | |

| UTM Coordinates | Zone | Easting | Northing | Municipal Plan and Sublot Number | Other |
|---|---|---|---|---|---|
| NAD 83 | 17 | 485758 | 4787041 | | |

## Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

| General Colour | Most Common Material | Other Materials | General Description | Depth (m/ft) From | To |
|---|---|---|---|---|---|
| Brown | Gravel | Sand | Packed | 0.0 | 1.22 |
| Grey | Clay | | Dense | 1.22 | 6.4 |

## Annular Space

| Depth Set at (m/ft) From | To | Type of Sealant Used (Material and Type) | Volume Placed (m³/ft³) |
|---|---|---|---|
| 0.0 | 4.57 | Bentonite chip | 0.59 |

## Method of Construction

☐ Cable Tool ☐ Diamond ☐ Rotary (Conventional) ☐ Jetting ☐ Rotary (Reverse) ☐ Driving ☑ Boring ☐ Digging ☐ Air percussion ☐ Other, specify

## Well Use

☐ Public ☐ Commercial ☐ Not used ☐ Domestic ☐ Municipal ☐ Dewatering ☐ Livestock ☐ Test Hole ☑ Monitoring ☐ Irrigation ☐ Cooling & Air Conditioning ☐ Industrial ☐ Other, specify

## Construction Record - Casing

| Inside Diameter (cm/in) | Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel) | Wall Thickness (cm/in) | Depth (m/ft) From | To |
|---|---|---|---|---|
| 5.39 | Plastic | 0.47 | 0.0 | 5.49 |

## Construction Record - Screen

| Outside Diameter (cm/in) | Material (Plastic, Galvanized, Steel) | Slot No. | Depth (m/ft) From | To |
|---|---|---|---|---|
| 6.03 | Plastic | 10 | 5.49 | 6.4 |

## Status of Well

☐ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☒ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, specify ☐ Other, specify

## Water Details

Water found at Depth (m/ft) Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify

Water found at Depth (m/ft) Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify

Water found at Depth (m/ft) Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify

## Hole Diameter

| Depth (m/ft) From | To | Diameter (cm/in) |
|---|---|---|
| 0 | 6.4 | 20.4 |

## Results of Well Yield Testing

After test of well yield, water was: ☐ Clear and sand free ☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ___ hrs + ___ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min / GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min / GPM)

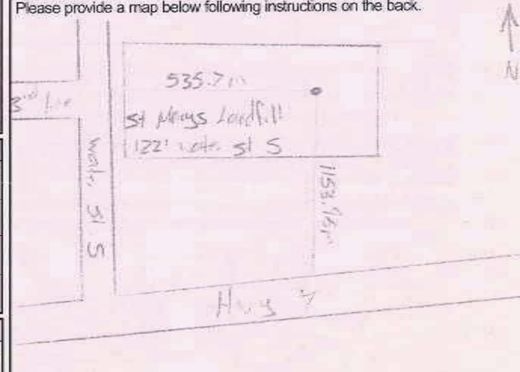
Well production (l/min / GPM)

Disinfected? ☐ Yes ☐ No

| Draw Down Time (min) | Water Level (m/ft) | Recovery Time (min) | Water Level (m/ft) |
|---|---|---|---|
| Static Level | | | |
| 1 | | 1 | |
| 2 | | 2 | |
| 3 | | 3 | |
| 4 | | 4 | |
| 5 | | 5 | |
| 10 | | 10 | |
| 15 | | 15 | |
| 20 | | 20 | |
| 25 | | 25 | |
| 30 | | 30 | |
| 40 | | 40 | |
| 50 | | 50 | |
| 60 | | 60 | |

## Map of Well Location

Please provide a map below following instructions on the back.




Comments:

## Well Contractor and Well Technician Information

| Business Name of Well Contractor | Well Contractor's Licence No. |
|---|---|
| Aardvark Drilling + Investigative Services Ltd | 7312 |

| Business Address (Street Number/Name) | Municipality |
|---|---|
| 3217 Harlock Hill Drive | Elmira |

| Province | Postal Code | Business E-mail Address |
|---|---|---|
| ON | N3B2Z5 | [illegible] |

| Bus. Telephone No. (inc. area code) | Name of Well Technician (Last Name, First Name) |
|---|---|
| 519 664 3331 | [illegible] |

| Well Technician's Licence No. | Signature of Technician and/or Contractor | Date Submitted |
|---|---|---|
| 5568 | | 20100216 |

Well owner's information package delivered: ☐ Yes ☒ No

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 20100625

**Ministry Use Only**

Audit No. Z102059

Received

0506E (12/2007)

Well Owner's Copy

## STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

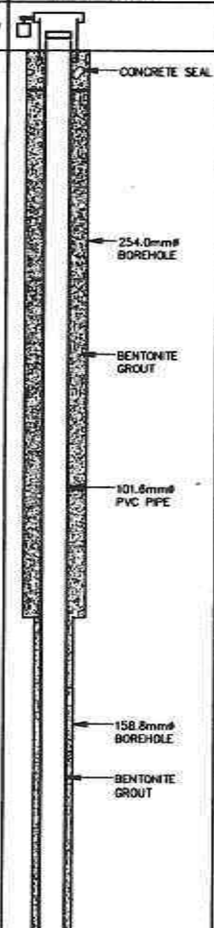
(L-06)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW9A-91 (Page 1 of 4)
DATE COMPLETED: OCTOBER 1, 1991
DRILLING METHOD: 159mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL |
|---|---|---|
| | REFERENCE POINT (Top of Riser) | 318.490 |
| | GROUND SURFACE | 317.75 |
| | For stratigraphy from 0.0 to 6.55m BGS see log OW9B-91 | |
| 1.0 | | |
| 2.0 | | |
| 3.0 | | |
| 4.0 | | |
| 5.0 | | |
| 6.0 | | |
| | ML-SILT(TILL), little to some fine sand and gravel, little to some clay, very compacted, damp | 311.20 |
| 7.0 | | |
| 8.0 | | |
| 9.0 | | |
| 10.0 | | |
| 11.0 | | |
| | - boulder | |
| 12.0 | - sand content increasing | |
| 13.0 | | |

MONITOR INSTALLATION




SAMPLE: NUMBER | STATE | 'N' VALUE

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

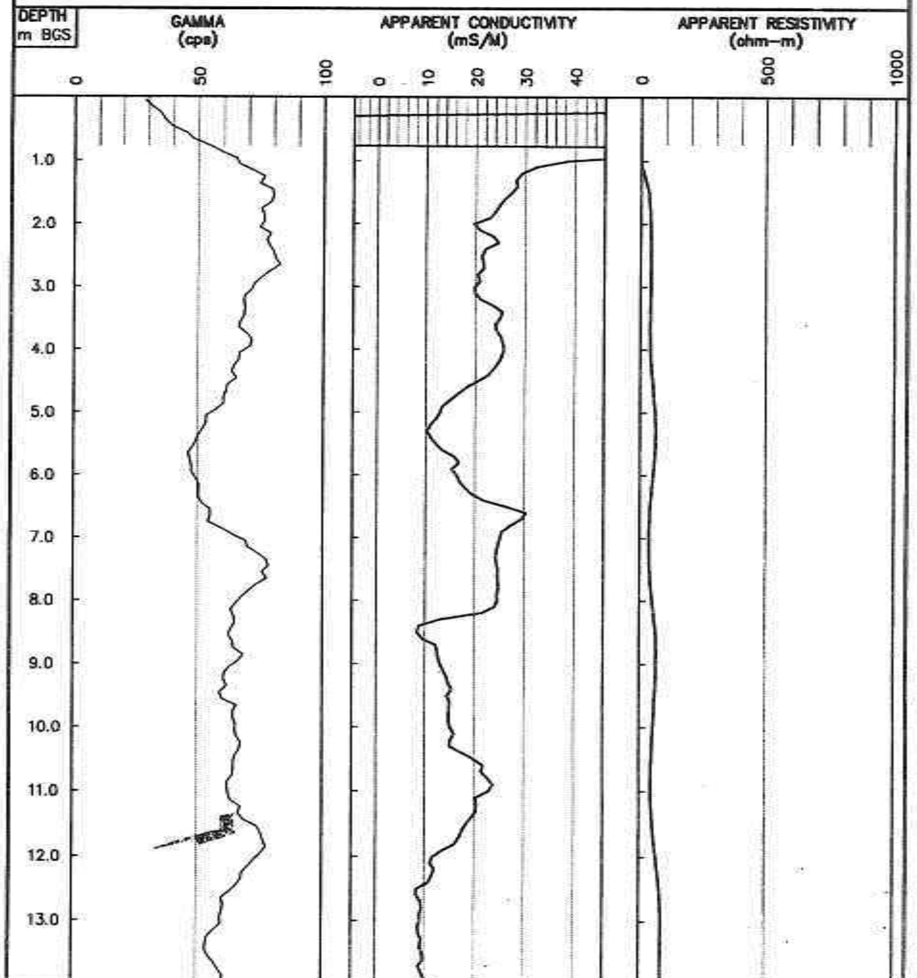
GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-06)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW9A-91 (Page 1 of 4)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 159mm ID HSA
SURVEY BY HYD-ENG GEOPHYSICS INC.



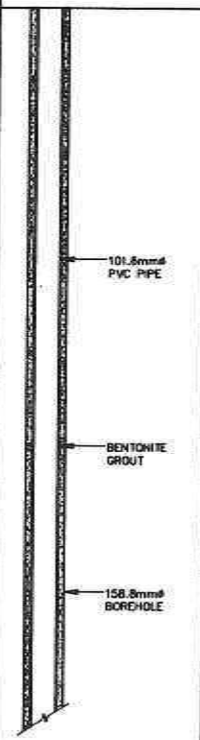
## STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-06)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW9A-91 (Page 2 of 4)
DATE COMPLETED: OCTOBER 1, 1991
DRILLING METHOD: 159mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| 14.0 | | | | | | |
| 15.0 | | | | | | |
| 16.0 | - few pebbles, very dense | | | | | |
| 17.0 | | | | | | |
| 18.0 | | | | | | |
| 19.0 | - becoming clayey silt | | | | | |
| 20.0 | | | | | | |
| 21.0 | BEDROCK | 296.41 | | | | |
| 22.0 | END OF OVERBURDEN HOLE @ 21.34 m BGS. | | | | | |
| 23.0 | | | | | | |
| 24.0 | | | | | | |
| 25.0 | | | | | | |
| 26.0 | | | | | | |



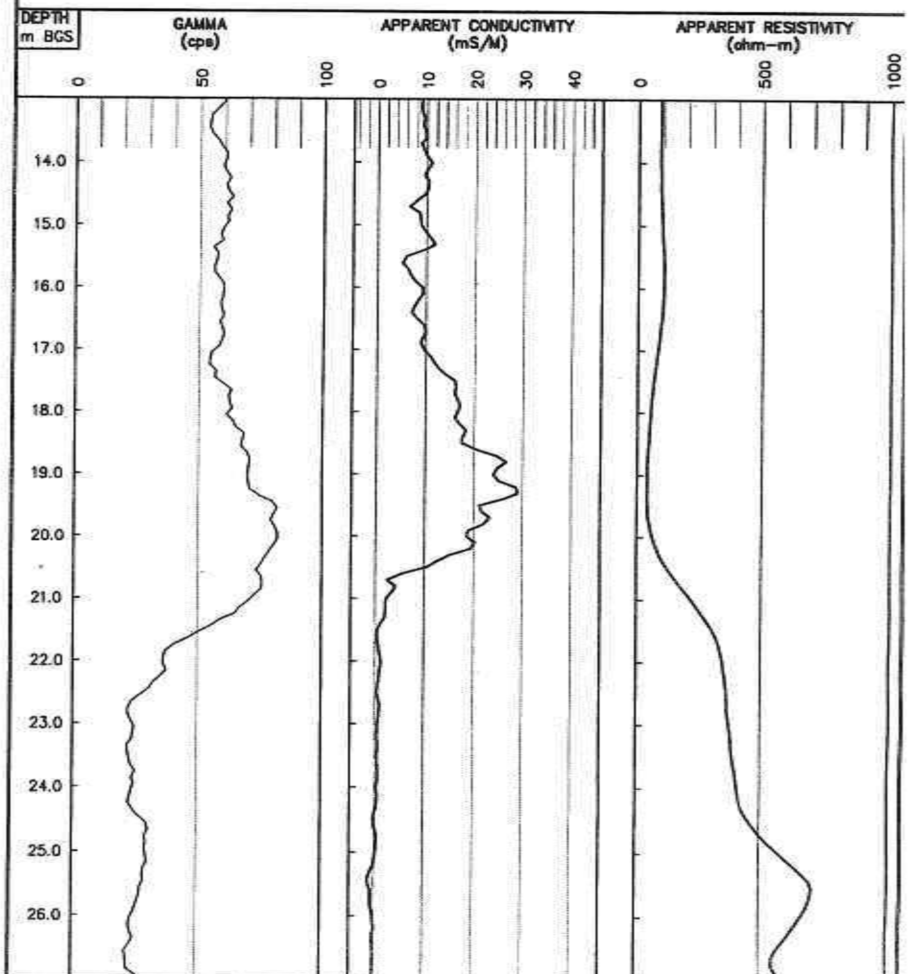

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-06)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW9A-91 (Page 2 of 4)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 159mm ID HSA
SURVEY BY HYD-ENG GEOPHYSICS INC.



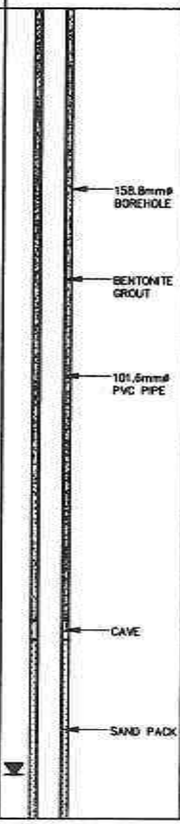
## STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

(L-07)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW9A-91 (Page 3 of 4)
DATE COMPLETED: OCTOBER 4, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ CORE
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | DESCRIPTION OF STRATA | ELEVATION m AMSL | MONITOR INSTALLATION | BIEDDRERORCVKAL | RUNUMBER | CORE RECOVERY % | RQD % | WATER RETURN % |
|---|---|---|---|---|---|---|---|---|
| | Overburden | | | | | | | |
| 21.0 | LIMESTONE(Dundee Formation): cream/beige, rock flour | 296.41 | | | | | | |
| 22.0 | | | | | | | | |
| 23.0 | | | 158.8mmø BOREHOLE | | | | | |
| 24.0 | – light brown, softer | | BENTONITE GROUT | | | | | |
| 25.0 | | | | | | | | |
| 26.0 | | | 101.6mmø PVC PIPE | | | | | |
| 27.0 | LIMESTONE(Lucas Formation): | 290.75 | | | | | | |
| 28.0 | | | | | | | | |
| 29.0 | | | | | | | | |
| 30.0 | – light brown argillaceous limestone, soft, damp | | CAVE | | | | | |
| 31.0 | | | SAND PACK | | | | | |
| 32.0 | | 285.54 | | | | | | |



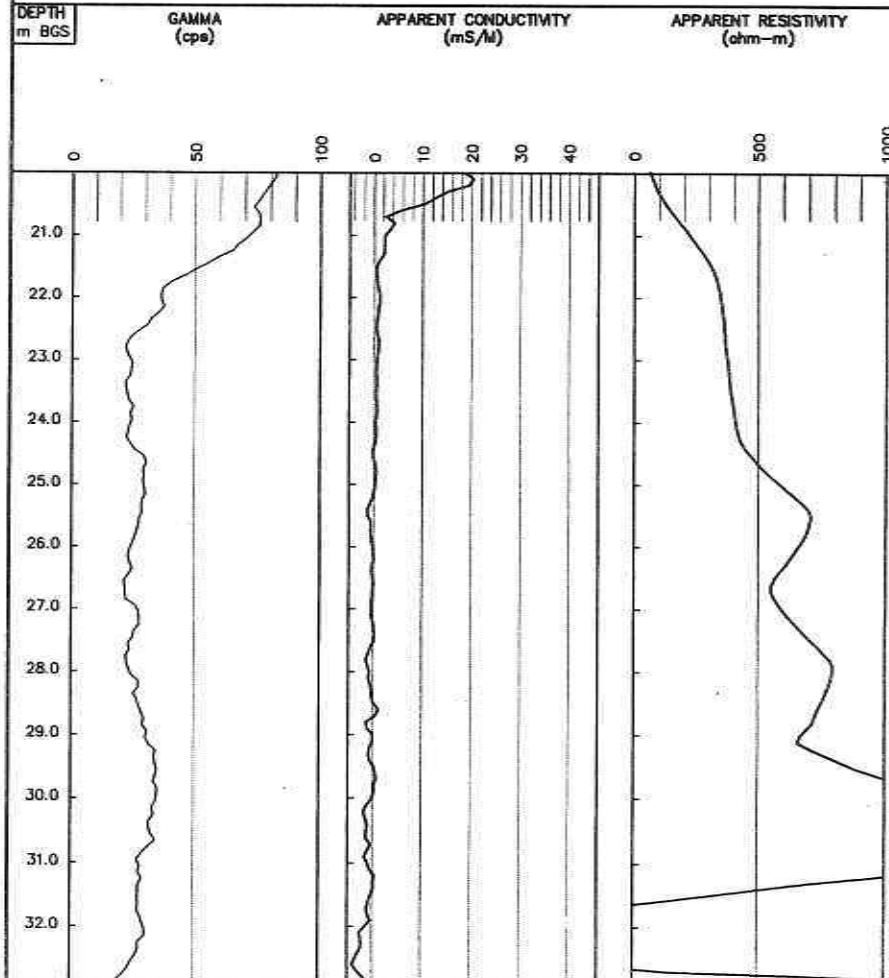
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND — STATIC WATER LEVEL (OCT 26/91) NM – NOT MEASURED

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-07)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW9A-91 (Page 3 of 4)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ CORE
SURVEY BY HYD-ENG GEOPHYSICS INC.



## STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)

(L-07)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW9A-91 (Page 4 of 4)
DATE COMPLETED: OCTOBER 4, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ CORE
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | DESCRIPTION OF STRATA | ELEVATION m AMSL | MONITOR INSTALLATION | BEDROCK INTERVAL | RUN NUMBER | CORE RECOVERY % | RQD % | WATER RETURN % |
|---|---|---|---|---|---|---|---|---|
| 33.0–36.0 | | | 158.8mmø BOREHOLE; SAND PACK | | | | | |
| 36.0–38.0 | – light brown to buff argillaceous limestone, medium to high porosity<br>– lighter colored with slight color laminations<br>– water bearing fracture (@ 36.58m BGS) | | | | | | | |
| 38.0–40.39 | – darker colored with high concentrations of stylolites<br>– water bearing fracture (@ 38.25m BGS)<br>– water bearing fracture (@ 38.40m BGS)<br>– water bearing fracture (@ 38.86m BGS)<br>– water bearing fracture (@ 39.17m BGS)<br>– water bearing fracture (@ 39.47m BGS) | | WELL SCREEN | | 1 | 100 | 45 | |
| 40.39 | END OF HOLE @ 40.39 m BGS. | 277.36 | | | | | | |

Depth scale: 33.0, 34.0, 35.0, 36.0, 37.0, 38.0, 39.0, 40.0, 41.0, 42.0, 43.0, 44.0

SCREEN DETAILS:
Screened Interval:
38.86 to 40.39m BGS
Length –1.5m
Diameter –50.8mm
Slot # 10
Material –Stainless Steel
Sand pack interval:
37.19 to 40.39m BGS
Material –# 3 Silica Sand

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

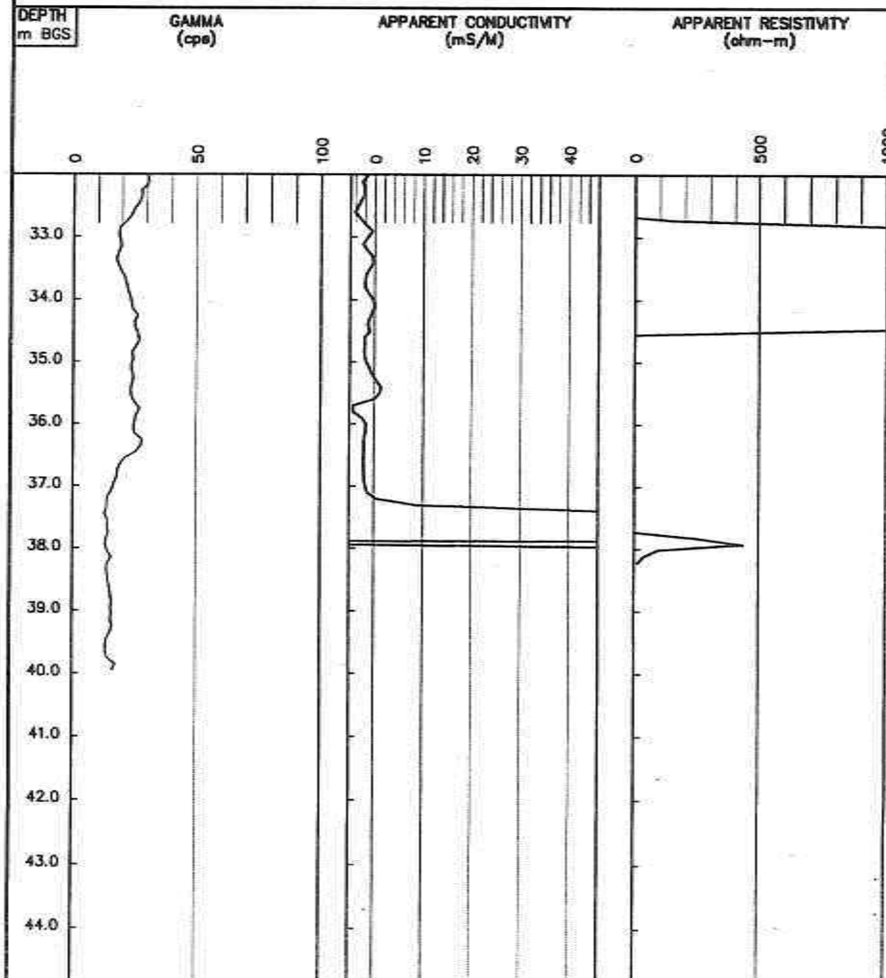
WATER FOUND   STATIC WATER LEVEL   NM – NOT MEASURED

## STRATIGRAPHIC AND INSTRUMENTATION LOG (GEOPHYSICS)

(L-07)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW9A-91 (Page 4 of 4)
DATE COMPLETED: OCTOBER 11, 1991
DRILLING METHOD: 15cm AIR ROTARY / HQ CORE
SURVEY BY HYD-ENG GEOPHYSICS INC.



# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

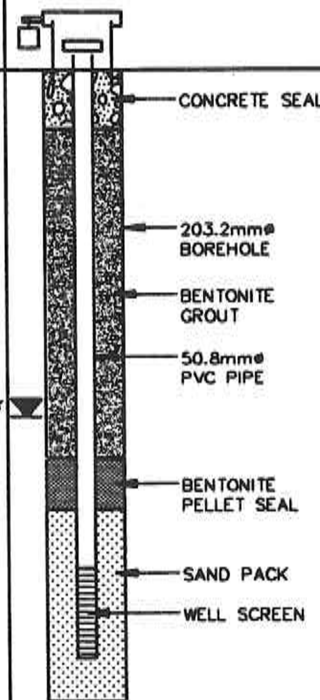
(L-08)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW9B-91
DATE COMPLETED: OCTOBER 1, 1991
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL |
|---|---|---|
| | REFERENCE POINT (Top of Riser) | 318.580 |
| | GROUND SURFACE | 317.74 |
| | ML/CL-SILT(TILL), some clay, some sand and small pebbles, rootlets, stiff to hard, well fractured, grey to brown, damp to moist<br>- well developed sub-vertical fracture (0.3 to 0.45m BGS)<br>- hard, some pebbles (small to large), no obvious fracturing | |
| 1.0 | | |
| 2.0 | | |
| 3.0 | | |
| | | 314.13 |
| 4.0 | | |
| 5.0 | | |
| | GM-GRAVEL, fine to medium grained, some sand, silt and stones, few cobbles, saturated | 312.56 |
| 6.0 | | |
| | ML-SILT(TILL), little to some fine grained sand and fine gravel, little clay, very compacted, damp to moist | 311.64 |
| | - trace fine grained sand, trace clay, extremely dense, non-plastic, laminated, light grey and brown, damp | 311.19 |
| 7.0 | | |
| | END OF HOLE @ 6.55 m BGS. | |
| 8.0 | | |
| 9.0 | | |
| 10.0 | | |
| 11.0 | | |
| 12.0 | | |
| 13.0 | | |

MONITOR INSTALLATION




SCREEN DETAILS:
Screened Interval:
5.18 to 6.10m BGS
Length -0.9m
Diameter -50.8mm
Slot # 10
Material -Stainless Steel
Sand pack interval:
4.57 to 6.55m BGS
Material -# 3 Silica Sand

SAMPLE

| NUMBER | STATE | 'N' VALUE |
|---|---|---|
| 1CS | | |
| 2CS | | |
| 3CS | | |
| 4CS | | |
| 5CS | | |
| 6SS | | >100 |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼ (OCT 26, 1991)

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

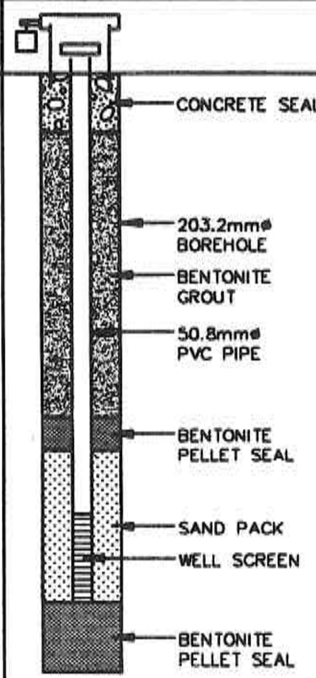
(L-14)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW15-91
DATE COMPLETED: OCTOBER 21, 1991
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | SAMPLE NUMBER | SAMPLE STATE | 'N' VALUE |
|---|---|---|---|---|---|
| | REFERENCE POINT (Top of Riser) | 318.670 | | | |
| | GROUND SURFACE | 317.82 | | | |
| | ML/CL-SILT(TILL), some clay and sand, damp to moist | | | | |
| 1.0 | | | | | |
| 2.0 | | | | | |
| 3.0 | | 314.77 | | | |
| | ML-SILT(TILL), some clay and sand, trace gravel, slightly layered, firm, light brown, damp to moist | 314.13 | 1CS (3.5 - 4.6m) | | |
| 4.0 | ML/CL-SILT and CLAY(GLACIOLACUSTRINE), trace gravel, little very fine sand, layered, tan, moist | 313.25 | | | |
| 5.0 | SW/GW-SAND and GRAVEL, medium to coarse, some cobbles, salt and pepper color, saturated | | 2CS (4.6 - 5.8m) | | |
| | | 312.03 | 3CS | | |
| 6.0 | ML-SILT(TILL), some clay and sand, cobbles, dense, light brown, moist | 311.62 | 4CS | | |
| | END OF HOLE @ 6.20 m BGS. | | | | |
| 7.0 | | | | | |
| 8.0 | | | | | |
| 9.0 | | | | | |
| 10.0 | | | | | |
| 11.0 | | | | | |
| 12.0 | | | | | |
| 13.0 | | | | | |

MONITOR INSTALLATION




SCREEN DETAILS:
Screened Interval:
4.57 to 5.49m BGS
Length -0.9m
Diameter -50.8mm
Slot # 10
Material -Stainless Steel
Sand pack interval:
3.91 to 5.49m BGS
Material -# 3 Silica Sand

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

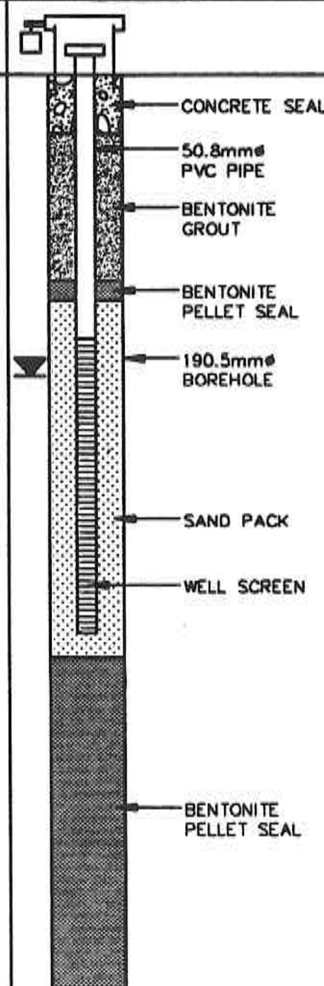
(L-16)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW17-91
DATE COMPLETED: NOVEMBER 16, 1991
DRILLING METHOD: 95mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL |
|---|---|---|
| | REFERENCE ELEVATION (Top of Riser) | 318.39 |
| | GROUND SURFACE | 317.39 |
| | ML/CL-SILT(TILL), some clay, little sand, little gravel, few cobbles, very stiff, grey, damp | |
| 1.0 | - very cobbly | |
| 2.0 | | |
| 3.0 | | 314.26 |
| | ML/SM-SILT and SAND, very fine grained, compact, brown, saturated | 314.04 |
| 4.0 | SW-SAND, little fine gravel, coarse grained, well graded, compact, brown, saturated | 313.73 |
| | ML/CL-SILT(TILL), some clay, little sand and gravel, stiff, grey, moist<br>- sand and gravel seams, wet (4.88 to 4.98m BGS and 5.08 to 5.13m BGS) | 313.07 |
| 5.0 | | |
| 6.0 | ML-SILT(TILL), some sand, little to some clay, little gravel, very hard, light brown, damp<br>- sand seam, wet (5.49 to 5.59m BGS) | 311.90 |
| 7.0 | | |
| 8.0 | | |
| 9.0 | | |
| | END OF HOLE @ 9.45 m BGS. | 307.94 |
| 10.0 | | |
| 11.0 | | |
| 12.0 | | |
| 13.0 | | |

MONITOR INSTALLATION




SCREEN DETAILS:
Screened Interval:
2.74 to 5.79m BGS
Length -3.0m
Diameter -50.8mm
Slot # 10
Material -PVC
Sand pack interval:
2.34 to 6.05m BGS
Material -# 2 Filter

| SAMPLE NUMBER | STATE | 'N' VALUE |
|---|---|---|
| 1CS | | |
| 2CS | | |
| 3SS | | 26 |
| 4SS | | 20 |
| 5SS | | 41 |
| 6SS | | >60 |
| 7SS | | 53 |
| 8SS | | 53 |
| 9SS | | 58 |
| 10SS | | >50 |
| 11SS | | >70 |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼ (NOV 22, 1991)

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

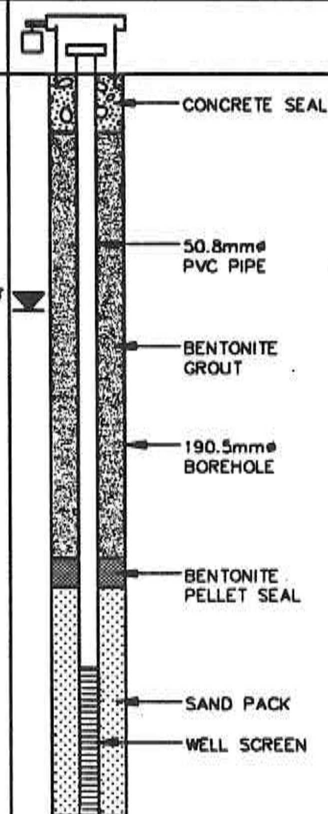
(L-20)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW21-91
DATE COMPLETED: DECEMBER 9, 1991
DRILLING METHOD: 95mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | SAMPLE NUMBER | STATE | 'N' VALUE |
|---|---|---|---|---|---|
| | REFERENCE POINT (Top of Riser) | 320.760 | | | |
| | GROUND SURFACE | 319.99 | | | |
| | ML-SILT(TILL), little to some clay and sand, trace gravel, damp | | | | |
| 1.0 | | | | | |
| | - hard, moist to wet | | | | |
| 2.0 | | | | | |
| | - damp | 317.53 | | | |
| 3.0 | | | | | |
| 4.0 | | | | | |
| | - very hard, damp | | | | |
| 5.0 | | | 1SS | X | 68 |
| | ML/CL-SILT and CLAY (GLACIOLACUSTRINE), little sand and fine gravel, damp | 314.61 | 2SS | X | 71 |
| 6.0 | - little to some clay and fine sand, extremely dense, non-cohesive, tan, damp, layered | | 3SS | X | >100 |
| | - moist | | 4SS | X | 93 |
| 7.0 | - some sand and clay, little fine gravel, very hard, brown, damp | 312.92 | | | |
| | ML-SILT and SAND(TILL), little clay, little gravel, extremely hard, light brown to grey, damp to moist | 312.29 | 5SS | X | >100 |
| 8.0 | END OF HOLE @ 7.70 m BGS. | | | | |
| 9.0 | | | | | |
| 10.0 | | | | | |
| 11.0 | | | | | |
| 12.0 | | | | | |
| 13.0 | | | | | |

MONITOR INSTALLATION




SCREEN DETAILS:
Screened Interval:
6.17 to 7.70m BGS
Length -1.5m
Diameter -50.8mm
Slot # 10
Material -Stainless Steel
Sand pack interval:
5.33 to 7.70m BGS
Material -# 2 Filter

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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼ (DEC 12, 1991)

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

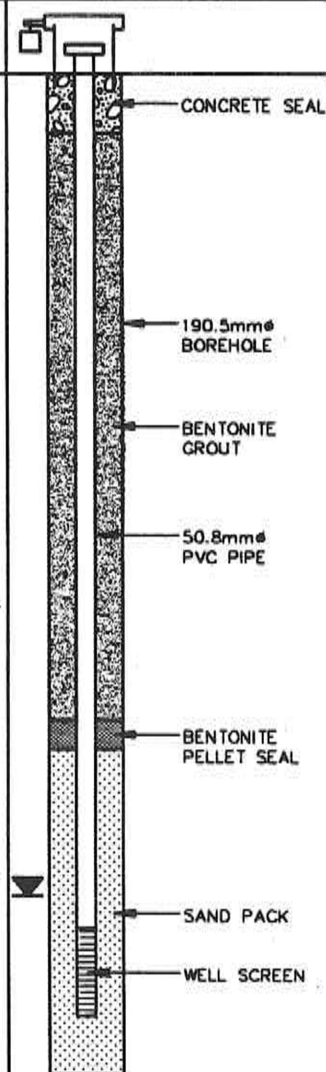
(L-24)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW25-91
DATE COMPLETED: DECEMBER 11, 1991
DRILLING METHOD: 95mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL |
|---|---|---|
| | REFERENCE POINT (Top of Riser) | 323.420 |
| | GROUND SURFACE | 322.86 |
| | OL-SILT(TOPSOIL), little sand and clay, organics, black, moist | |
| 1.0 | ML/CL-SILT, some clay, little to some sand, stiff, light brown, moist, cohesive | 322.25 |
| 2.0 | | |
| 3.0 | - hard, grey-brown | |
| 4.0 | | |
| 5.0 | - stone | |
| 6.0 | | |
| 7.0 | | |
| 8.0 | SP-SAND, trace silt and fine gravel, fine to medium grained fining upwards, very dense, salt and pepper colour, dry<br>- silt and clay layer (2cm thick)<br>- medium grained, wet | 315.54<br>314.35 |
| 9.0 | GW-GRAVEL, some sand and silt, fine, wet | 313.93 |
| 10.0 | ML-SILT, some sand, little to some clay, few large pebbles, very stiff, light grey-brown, moist to wet<br>- gravel seam (5cm thick) | 313.50 |
| | END OF HOLE @ 10.36 m BGS. | 312.50 |
| 11.0 | | |
| 12.0 | | |
| 13.0 | | |

MONITOR INSTALLATION




SCREEN DETAILS:
Screened Interval:
8.84 to 9.75m BGS
Length -0.9m
Diameter -50.8mm
Slot # 10
Material -Stainless Steel
Sand pack interval:
7.01 to 10.36m BGS
Material -# 2 Filter

SAMPLE

| NUMBER | STATE | 'N' VALUE |
|---|---|---|
| 1AR | | |
| 2AR | | |
| 3AR | | |
| 4SS | | 41 |
| 5SS | | 50 |
| 6SS | | 37 |
| 7SS | | 28 |
| 8SS | | 49 |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼ (DEC 13, 1991)

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

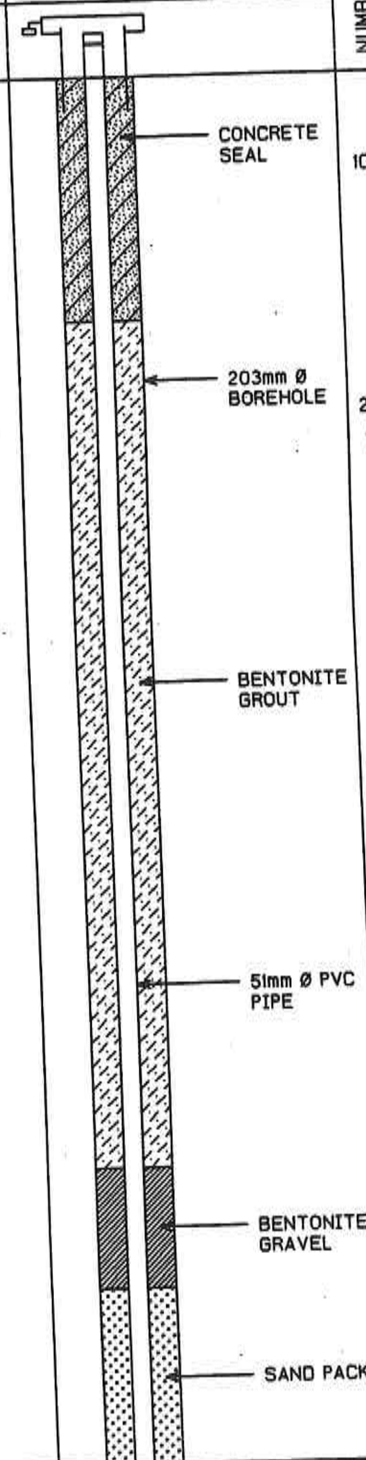


PROJECT NAME: ST. MARYS LANDFILL
PROJECT NUMBER: 0645
CLIENT: TOWN OF ST. MARYS
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW32-96
DATE COMPLETED: AUGUST 7, 1996
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m AMSL | SAMPLE NUMBER | STATE | 'N' VALUE | PID (ppm) |
|---|---|---|---|---|---|---|
| | REFERENCE POINT (Top of Riser) | 323.43 | | | | |
| | GROUND SURFACE | 322.54 | | | | |
| | ML-SILT (FILL), little sand and clay, trace gravel, brown, damp | | 1CS | | | |
| 0.5 | - light and dark grey | | | | | |
| 1.0 | | 321.47 | | | | |
| | ML-SILT (BURIED TOPSOIL), little sand and clay, little vegetal matter, dark brown, moist | 321.32 | | | | |
| 1.5 | ML-SILT (TILL), little sand and clay, firm, some fine fracturing, highly mottled light grey and brown | | 2CS | | | |
| 2.0 | - some fine sand, wet (2.0 to 2.3m BGS) | | | | | |
| | - little coarse sand and fine gravel, stiff, slightly mottled, moist to wet | | | | | |
| 2.5 | - little gravel, hard augering, light brown, moist | | | | | |
| 3.0 | | | 3CS | | | |
| 3.5 | - becoming grey, moist | | | | | |
| 4.0 | - grey, damp to moist | | | | | |
| 4.5 | | | 4CS | | | |
| 5.0 | - massive | | | | | |
| 5.5 | | | | | | |
| | - boulder | | | | | |
| 6.0 | | | 5CS | | | |
| 6.5 | | | | | | |

MONITOR INSTALLATION




NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ▽ STATIC WATER LEVEL ▼

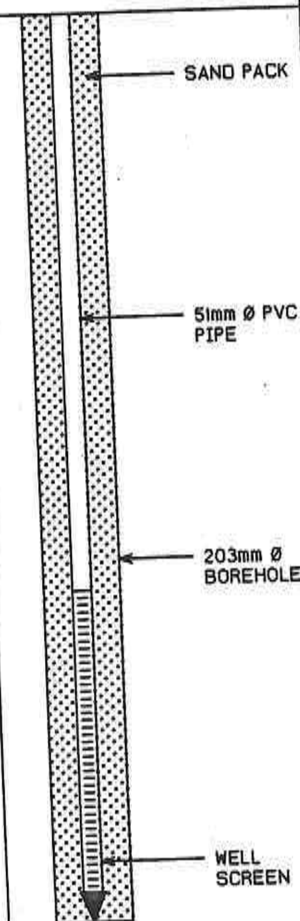
# (OVERBURDEN)

PROJECT NAME: ST. MARYS LANDFILL
PROJECT NUMBER: 0645
CLIENT: TOWN OF ST. MARYS
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW32-96
DATE COMPLETED: AUGUST 7, 1996
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m AMSL | SAMPLE NUMBER | STATE | 'N' VALUE | PID (ppm) |
|---|---|---|---|---|---|---|
| | | 315.38 | | | | |
| | ML-SILT (WATER LAID TILL), trace to little fine sand, trace clay, slightly stratified, light grey, damp to moist | | | | | |
| 7.5 | | | 6CS | | | |
| 8.0 | | | | | | |
| 8.5 | | 313.85 | | | | |
| | ML-SILT (TILL), little sand, gravel and clay, massive, grey-brown, moist | | | | | |
| 9.0 | | | 7CS | | | |
| 9.5 | | | | | | |
| 10.0 | | | 8CS | | | |
| 10.5 | - seams of wet sand and silt @ 10.36 to 10.59 and 10.92 to 10.97m BGS | | | | | |
| 11.0 | - massive till | | 9CS | | | |
| 11.5 | | 310.96 | | | | |
| | END OF HOLE @ 11.58m BGS | | | | | |
| 12.0 | | | | | | |
| 12.5 | | | | | | |
| 13.0 | | | | | | |
| 13.5 | | | | | | |

MONITOR INSTALLATION




SCREEN DETAILS
Screened Interval:
9.91 to 11.43m BGS
Length: 1.52m
Diameter: 51mm
Slot Size: #10
Material: PVC
Sand Pack:
6.10 to 11.58m BGS
Material: #1 Silica Sand

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

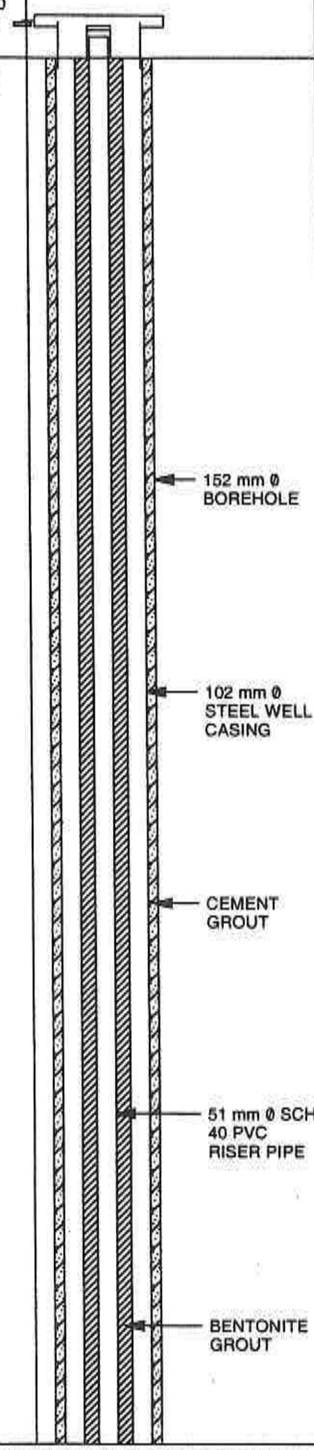


PROJECT NAME: St. Marys Landfill
PROJECT NUMBER: 645
CLIENT: Town of St. Marys
LOCATION: Town of St. Marys

HOLE DESIGNATION: MW32A-02
DATE COMPLETED: September 17, 2002
DRILLING METHOD: MUD ROTARY
FIELD PERSONNEL: B. KEMPEL

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE INTERVAL | SAMPLE REC (%) | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|---|
| | TOP OF RISER | 322.640 | | | | | |
| | GROUND SURFACE | 322.09 | | | | | |
| | TOPSOIL | 321.93 | | | | | |
| | ML - SILT (TILL), trace to with sand, trace to with clay, mottled grey and brown | | | | | | |
| 3.66 | - grey at 3.66m BGS | | | | | | |

Depth scale (m BGS): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5




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

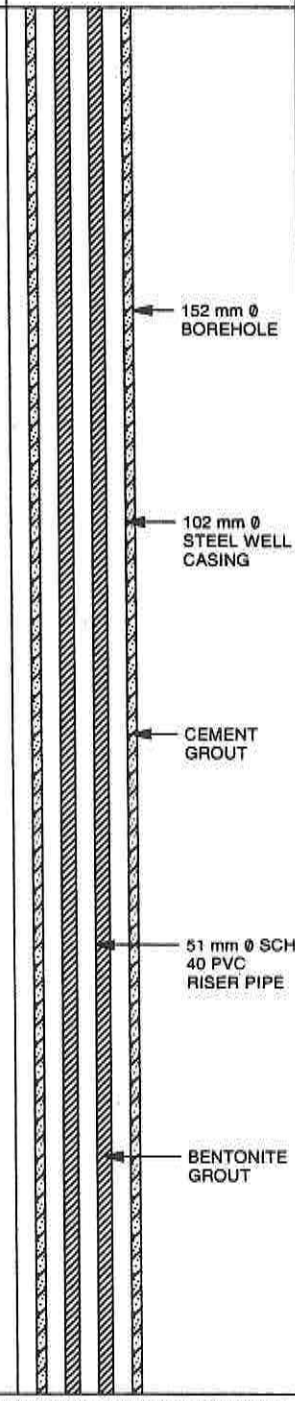
# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)



PROJECT NAME: St. Marys Landfill
PROJECT NUMBER: 645
CLIENT: Town of St. Marys
LOCATION: Town of St. Marys

HOLE DESIGNATION: MW32A-02
DATE COMPLETED: September 17, 2002
DRILLING METHOD: MUD ROTARY
FIELD PERSONNEL: B. KEMPEL

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m | MONITOR INSTALLATION | 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 | | | | | | | |
| 14.5 | | | | | | | |
| 15.0 | | | | | | | |
| 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

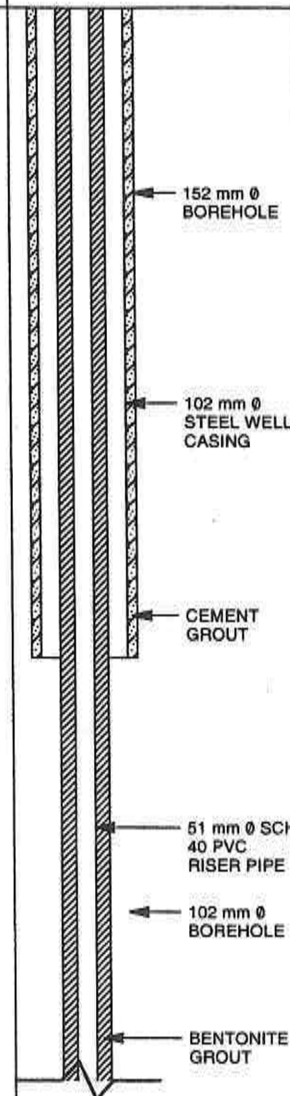
# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)



PROJECT NAME: St. Marys Landfill
PROJECT NUMBER: 645
CLIENT: Town of St. Marys
LOCATION: Town of St. Marys

HOLE DESIGNATION: MW32A-02
DATE COMPLETED: September 17, 2002
DRILLING METHOD: MUD ROTARY
FIELD PERSONNEL: B. KEMPEL

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE INTERVAL | SAMPLE REC (%) | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|---|
| 20.5 | | | | | | | |
| 21.0 | | | | | | | |
| 21.5 | | | | | | | |
| 22.0 | | | | | | | |
| 22.5 | | | | | | | |
| 23.0 | | | | | | | |
| 23.5 | | | | | | | |
| 24.0 | - with cobbles at 23.77m BGS | | | | | | |
| 24.5 | | | | | | | |
| 25.0 | - 2' thick quartz boulder at 24.69m BGS | | | | | | |
| 25.5 | | | | | | | |
| 26.0 | | | | | | | |
| 26.5 | | | | | | | |
| 27.0 | | | | | | | |
| 27.5 | | | | | | | |
| 28.0 | END OF OVERBURDEN HOLE @ 27.74m BGS | | | | | | |
| 28.5 | | | | | | | |
| 29.0 | | | | | | | |
| 29.5 | | | | | | | |




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

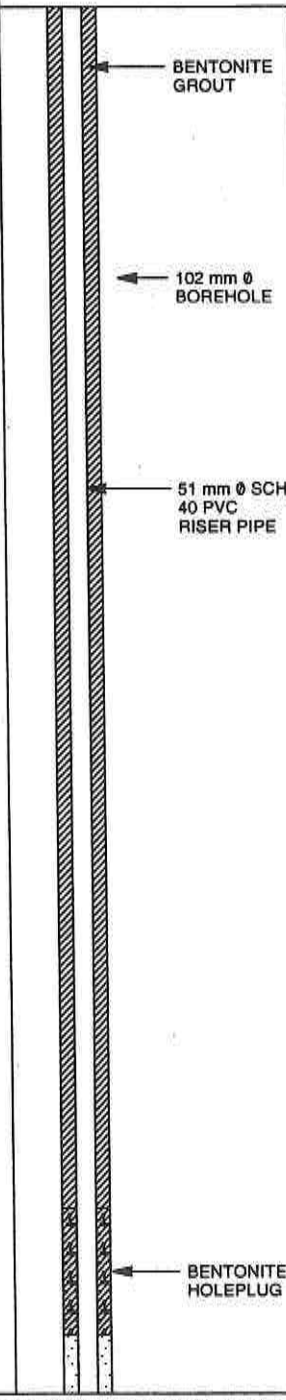
# STRATIGRAPHIC AND INSTRUMENTATION LOG (BEDROCK)



PROJECT NAME: St. Marys Landfill
PROJECT NUMBER: 645
CLIENT: Town of St. Marys
LOCATION: Town of St. Marys

HOLE DESIGNATION: MW32A-02
DATE COMPLETED: September 17, 2002
DRILLING METHOD: MUD ROTARY
FIELD PERSONNEL: B. KEMPEL

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m | MONITOR INSTALLATION | RUN NUMBER | CORE RECOVERY % | RQD % |
|---|---|---|---|---|---|---|
| 27.5 | | | BENTONITE GROUT | | | |
| 28.0 | BEDROCK - LIMESTONE (Dundee Formation), light brown, competent | 294.35 | | | | |
| 29.0 | | | 102 mm Ø BOREHOLE | 1 | | |
| 30.5 | | | 51 mm Ø SCH 40 PVC RISER PIPE | | | |
| 32.5 | | | | 2 | | |
| 35.5 | | | | 3 | | |
| 36.0 | | | BENTONITE HOLEPLUG | | | |




Depth scale: 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, 34.5, 35.0, 35.5, 36.0, 36.5

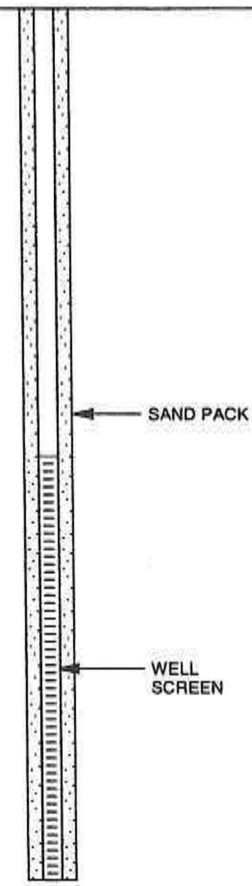
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (BEDROCK)



| | |
|---|---|
| PROJECT NAME: St. Marys Landfill | HOLE DESIGNATION: MW32A-02 |
| PROJECT NUMBER: 645 | DATE COMPLETED: September 17, 2002 |
| CLIENT: Town of St. Marys | DRILLING METHOD: MUD ROTARY |
| LOCATION: Town of St. Marys | FIELD PERSONNEL: B. KEMPEL |

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m | MONITOR INSTALLATION | RUN NUMBER | CORE RECOVERY % | RQD % |
|---|---|---|---|---|---|---|
| 37.5 | | | | | | |
| 38.0 | | | | | | |
| 38.5 | | | | 4 | | |
| 39.0 | | | | | | |
| 39.5 | | | | | | |
| 40.0 | | | SAND PACK | | | |
| 40.5 | - begin to lose drilling fluid to formation at 40.23m BGS | | | | | |
| 41.0 | | | | | | |
| 41.5 | | | | | | |
| 42.0 | | | WELL SCREEN | 5 | | |
| 42.5 | | | | | | |
| 43.0 | | | | | | |
| 43.5 | END OF BOREHOLE @ 43.28m BGS | 278.80 | | | | |
| 44.0 | | | | | | |
| 44.5 | | | | | | |
| 45.0 | | | | | | |
| 45.5 | | | | | | |
| 46.0 | | | | | | |
| 46.5 | | | | | | |




WELL DETAILS
Screened interval:
281.85 to 278.80m
Length: 3.05m
Diameter: 51mm
Slot Size: 10
Sand Pack:
285.51 to 278.80m
Material: #2 SILCA SAND

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

BEDROCK LOG MW32A.GPJ CRA_CORP.GDT 6/13/03

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)

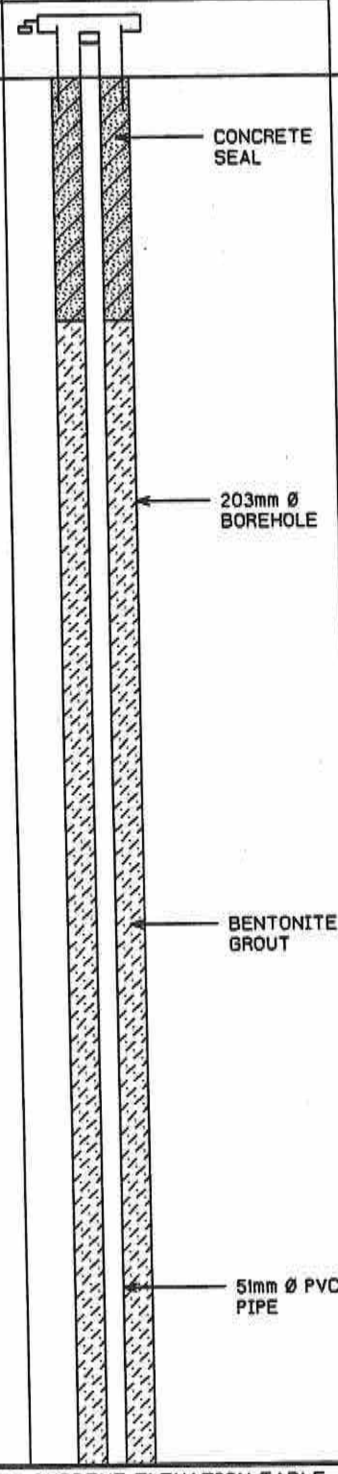


PROJECT NAME: ST. MARYS LANDFILL
PROJECT NUMBER: 0645
CLIENT: TOWN OF ST. MARYS
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW33-96
DATE COMPLETED: AUGUST 8, 1996
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m AMSL | SAMPLE NUMBER | STATE | 'N' VALUE | PID (ppm) |
|---|---|---|---|---|---|---|
| | REFERENCE POINT (Top of Riser) | 321.57 | | | | |
| | GROUND SURFACE | 320.66 | | | | |
| | ML-SILT (TOPSOIL), little sand, little vegetal matter, dark brown, moist | | | | | |
| | ML-SILT (TILL), little sand, trace gravel and clay, firm, light brown, damp to moist | 320.36 | | | | |
| 0.5 | | | 1CS | | | |
| 1.0 | - massive | | | | | |
| 1.5 | | | | | | |
| | - stone | | 2CS | | | |
| 2.0 | | | | | | |
| 2.5 | - moist | | | | | |
| 3.0 | - hard, damp | | | | | |
| | | | 3CS | | | |
| 3.5 | | | | | | |
| 4.0 | - massive, grey, damp to moist | | | | | |
| 4.5 | | | | | | |
| | | | 4CS | | | |
| 5.0 | - 25mm seam of wet sand, silt and gravel @ 5.03m BGS<br>- slightly stratified below 5.03m BGS | | | | | |
| 5.5 | - highly stratified | | | | | |
| 6.0 | - wet (dilatant) outwash silts | | | | | |
| | - massive, very hard, grey, damp to moist | | 5CS | | | |
| 6.5 | | | | | | |

MONITOR INSTALLATION




NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ⊻ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)

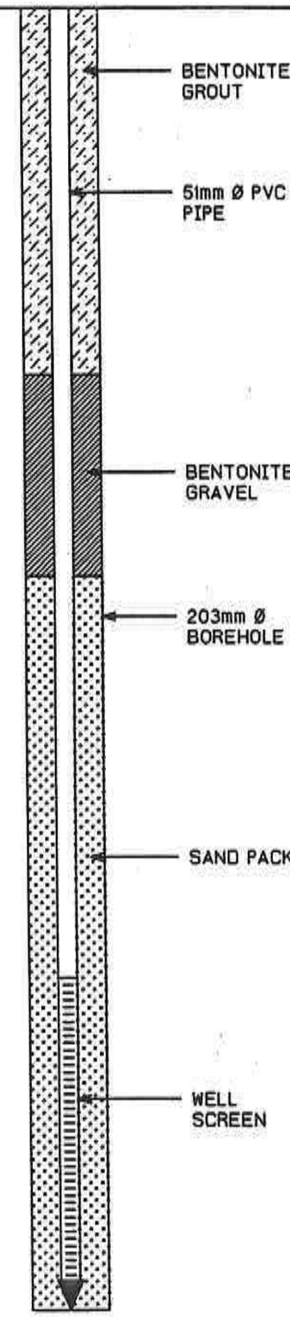


PROJECT NAME: ST. MARYS LANDFILL
PROJECT NUMBER: 0645
CLIENT: TOWN OF ST. MARYS
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW33-96
DATE COMPLETED: AUGUST 8, 1996
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m AMSL | SAMPLE NUMBER | STATE | 'N' VALUE | PID (ppm) |
|---|---|---|---|---|---|---|
| | | | 5CS | | | |
| 7.5 | | | | | | |
| 8.0 | | | 6CS | | | |
| 8.5 | - sand and gravel, some silt, wet 8.61 to 8.71m BGS<br>- till with little gravel, damp to moist | | | | | |
| 9.0 | - cobbles @ 8.84, 9.14, 9.45 and 9.75m BGS | | | | | |
| 9.5 | | | 7CS | | | |
| 10.0 | - very moist<br>- hard, dry | | | | | |
| 10.5 | | | | | | |
| 11.0 | | | 8CS | | | |
| 11.5 | - damp to moist | | | | | |
| 12.0 | | | | | | |
| 12.5 | - layers of silt, sand and clay<br>- very moist to wet (12.70 to 12.75m BGS)<br>- dry | | 9CS | | | |
| 13.0 | | | | | | |
| 13.5 | - some sand, hard, brown, damp to moist<br>Refusal<br>END OF HOLE @ 13.56m BGS | 307.10 | 10CS | | | |

MONITOR INSTALLATION




NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)



PROJECT NAME: ST. MARYS LANDFILL
PROJECT NUMBER: 0645
CLIENT: TOWN OF ST. MARYS
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW33-96
DATE COMPLETED: AUGUST 8, 1996
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE | SAMPLE PID (ppm) |
|---|---|---|---|---|---|---|---|
| 14.5 | | | **SCREEN DETAILS**<br>Screened Interval:<br>11.89 to 13.41m BGS<br>Length: 1.52m<br>Diameter: 51mm<br>Slot Size: #10<br>Material: PVC<br>Sand Pack:<br>9.85 to 13.56m BGS<br>Material: #1 Silica Sand | | | | |
| 15.0 | | | | | | | |
| 15.5 | | | | | | | |
| 16.0 | | | | | | | |
| 16.5 | | | | | | | |
| 17.0 | | | | | | | |
| 17.5 | | | | | | | |
| 18.0 | | | | | | | |
| 18.5 | | | | | | | |
| 19.0 | | | | | | | |
| 19.5 | | | | | | | |
| 20.0 | | | | | | | |
| 20.5 | | | | | | | |

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ▽ STATIC WATER LEVEL ▼

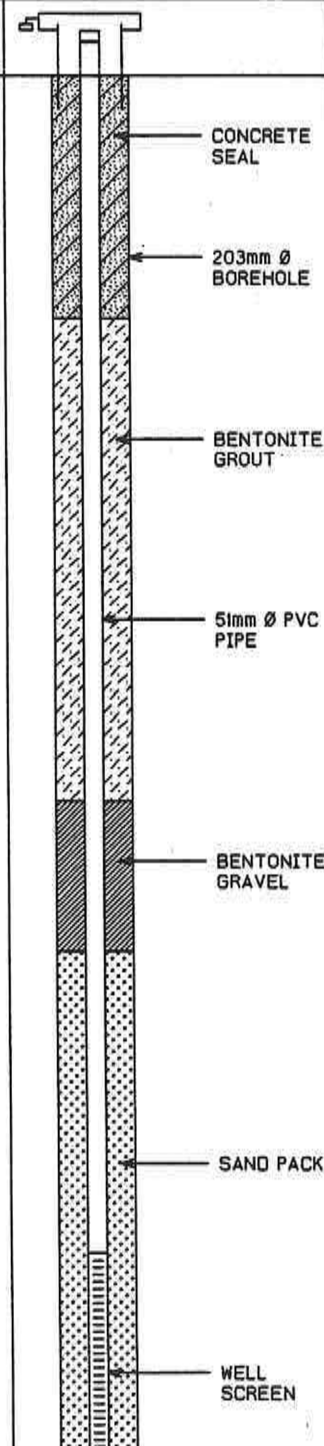
# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)



PROJECT NAME: ST. MARYS LANDFILL
PROJECT NUMBER: 0645
CLIENT: TOWN OF ST. MARYS
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW34-96
DATE COMPLETED: AUGUST 9, 1996
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE | SAMPLE PID (ppm) |
|---|---|---|---|---|---|---|---|
| | REFERENCE POINT (Top of Riser) | 321.59 | | | | | |
| | GROUND SURFACE | 320.77 | | | | | |
| | Refer to OW33-96 for stratigraphic details. | | | | | | |
| -0.5 | | | | | | | |
| -1.0 | | | | | | | |
| -1.5 | | | | | | | |
| -2.0 | | | | | | | |
| -2.5 | | | | | | | |
| -3.0 | | | | | | | |
| -3.5 | | | | | | | |
| -4.0 | | | | | | | |
| -4.5 | | | | | | | |
| -5.0 | | | | | | | |
| -5.5 | | | | | | | |
| -6.0 | | | | | | | |
| -6.5 | | | | | | | |




NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

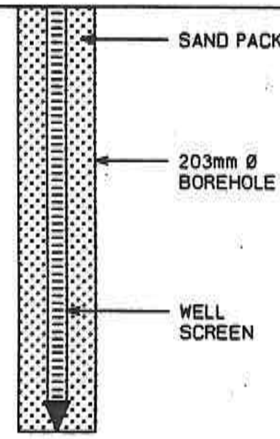


PROJECT NAME: ST. MARYS LANDFILL
PROJECT NUMBER: 0645
CLIENT: TOWN OF ST. MARYS
LOCATION: AS PER PLAN

HOLE DESIGNATION: OW34-96
DATE COMPLETED: AUGUST 9, 1996
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEV. m AMSL | SAMPLE NUMBER | STATE | 'N' VALUE | PID (ppm) |
|---|---|---|---|---|---|---|
| -7.5 | | | | | | |
| | ML-SILT (TILL), little sand, clay and gravel, trace cobbles, very hard, massive, brown, damp to moist | 313.15 | | | | |
| -8.0 | | | 1CS | | | |
| -8.5 | - dry to damp | | | | | |
| | - wet | | | | | |
| -9.0 | | | 2CS | | | |
| | END OF HOLE @ 9.14m BGS | 311.63 | | | | |
| -9.5 | | | | | | |
| -10.0 | | | | | | |
| -10.5 | | | | | | |
| -11.0 | | | | | | |
| -11.5 | | | | | | |
| -12.0 | | | | | | |
| -12.5 | | | | | | |
| -13.0 | | | | | | |
| -13.5 | | | | | | |

MONITOR INSTALLATION




<u>SCREEN DETAILS</u>
Screened Interval:
5.94 to 8.99m BGS
Length: 3.05m
Diameter: 51mm
Slot Size: #10
Material: PVC
Sand Pack:
4.42 to 9.14m BGS
Material: #1 Silica Sand

<u>NOTES:</u> MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
WATER FOUND ▽ STATIC WATER LEVEL ▼

# LOG OF DRILLING OPERATIONS

**OW36**



BURNSIDE
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Guelph, Ontario N1H 1C4
telephone (519) 823-4995 fax (519) 836-5477

| | | |
|---|---|---|
| Client: **Town of St. Marys** | Project Name: **St. Marys Landfill** | Logged by: **C. Martin** |
| Project No.: **300032339.2016** | Location: **St. Marys** | Ground (m amsl): **313.78** |
| Drilling Co.: | Date Started: **11/29/2016** | Static Water Level Depth (m): |
| Drilling Method: **Hollow Stem Auger** | Date Completed: **11/29/2016** | Sand Pack Depth (m) : **2.74 - 6.93** |

Surface Elevation (m): **313.78**

| Depth (m) | Stratigraphic Description | Elev. / Depth (m) |
|---|---|---|
| 0.00 | Light brown SILT (ML); massive; soft; cohesive; low plasticity; dry | 312.41 / 1.37 |
| 1.37 | Grey/brown SILT, some clay, some gravel (subangular to subrounded), trace sand (ML); massive; firm; cohesive; medium plasticity; moist | 311.40 / 2.38 |
| 2.38 | Dark brown SILT and CLAY, some gravel (subangular to subrounded), trace sand (ML-CL); massive; stiff to very stiff; cohesive; medium plasticity; moist to wet | 310.59 / 3.19 |
| 3.19 | Medium brown SILT, some gravel (subangular to subrounded), trace to some sand, trace to some clay (ML); massive; very stiff; cohesive; low plasticity; till; moist | 306.85 / 6.93 |

Well construction: cement; bentonite seal; silica sand pack; screen; bottom 6.93

| SAMPLE Num. | Type |
|---|---|
| 1 | SS |
| 2 | SS |
| 3 | SS |
| 4 | SS |
| 5 | SS |
| 6 | SS |
| 7 | SS |
| 8 | SS |

Prepared By: **C. Martin** Checked By: **J. Rutherford** Date Prepared: **11/29/2016**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

| LEGEND | MONITORING WELL DATA | SAMPLE TYPE | |
|---|---|---|---|
| Water found @ time of drilling | Pipe: **51 mm dia. PVC** | AC Auger Cutting | SS Split Spoon |
| Static Water Level - | Screen: **51 mm dia. PVC #10 slot** | CS Continuous | AR Air Rotary |
| | | RC Rock Core | WC Wash Cuttings |

BHLOG GUELPH P:\GINT\PROJECTS\300 JOBS\300032339 ST. MARYS LANDFILL\032339 ST. MARYS 2016NOV29 OW36.GPJ TEMPLATE.GDT 1/12/17

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)

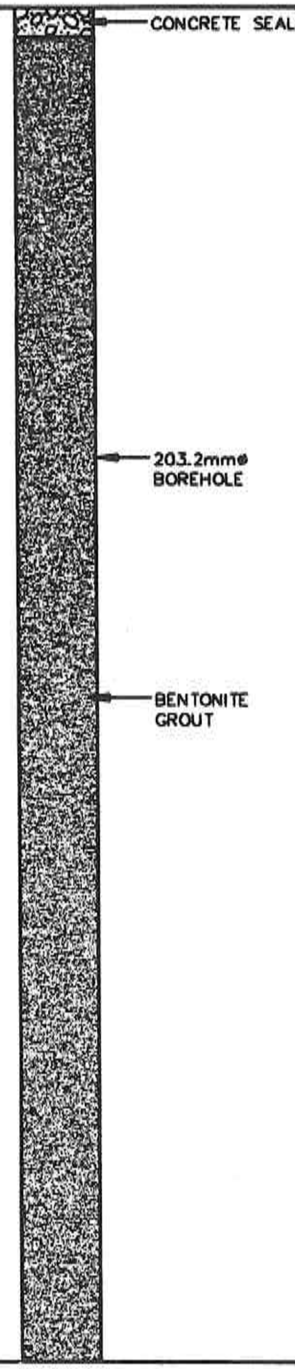
(L-09)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH10-91 (Page 1 of 2)
DATE COMPLETED: OCTOBER 15, 1991
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|
| | GROUND SURFACE | 317.37 | | | |
| 1.0 | ML-SILT(TILL), little fine sand, little to some clay, little gravel, stoney, soft, moist, fractured to 0.30m<br>- very hard, light brown, dry to damp<br>- little to some clay, some sand, very stiff, light to medium grey-brown, damp | | 1CS | | |
| 2.0 | | | 2CS (1.2 - 2.1m) | | |
| 3.0 | - some clay, softer, massive, moist | | 3CS | | |
| 4.0 | ML-SILT(GLACIOLACUSTRINE), some clay, soft, layered, moist to wet, dilatant<br>- some clay, occasional pebble, more massive, less layering | 313.56 | | | |
| 5.0 | GW/SW-GRAVEL and SAND, gravel is fine, sand is fine to coarse grained, little to some silt, brown, saturated | 312.19 | 4CS | | |
| 6.0 | ML-SILT, (GLACIOLACUSTRINE), trace to some clay, few pebbles, slightly layered, light brown and grey, damp | 311.43 | | | |
| 7.0 | ML-SILT(TILL), some clay, some sand, occasional pebbles, stones, very hard, stiff, brown to dark brown, damp<br>- increasing gravel content | 310.97 | 5CS | | |
| 8.0 | | | 6CS (7.3 - 8.5m) | | |
| 9.0 | SW-SAND, fine to coarse grained, some coarse gravel, little to some silt, brown, saturated | 308.84 | | | |
| 10.0 | ML-SILT(TILL), some clay, little to some coarse sand and gravel, few cobbles, very hard, stiff, brown and grey, damp<br>- few cobbles | 308.68 | 7CS | | |
| 11.0 | | | 8CS | | |
| 12.0 | - fine to coarse sand seam wtih some silt and gravel, wet (2cm thick)<br>- horizontal fracturing | | | | |
| 13.0 | | | 9CS | | |

MONITOR INSTALLATION




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

GRAIN SIZE ANALYSIS (circle) WATER FOUND ▽ STATIC WATER LEVEL ▼

## STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-09)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH10-91 (Page 2 of 2)
DATE COMPLETED: OCTOBER 15, 1991
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| 14.0 | | | | 10CS | | |
| 15.0 | | | 203.2mm⌀ BOREHOLE | 11CS | | |
| 16.0 | | | BENTONITE GROUT | | | |
| 17.0 | - fine to medium grained sand seam, little silt, wet, (6cm thick) | | | 12CS | | |
| 18.0 | - trace sand, moist | | | | | |
| 19.0 | | | | 13CS | | |
| | LIMESTONE (BEDROCK) | 297.56 | | 14CS | | |
| 20.0 | END OF HOLE @ 20.12 m BGS. | 297.25 | | | | |
| 21.0 | | | | | | |
| 22.0 | | | | | | |
| 23.0 | | | | | | |
| 24.0 | | | | | | |
| 25.0 | | | | | | |
| 26.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)

(L-10)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH11-91 (Page 1 of 2)
DATE COMPLETED: OCTOBER 10, 1991
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 316.25 | | | | |
| | SM-SAND, some silt, some roots, loose, brown moist | 316.10 | CONCRETE SEAL | | | |
| 1.0 | ML-SILT(TILL), little to some clay and sand, little gravel, hard, very stiff, light brown and grey, damp | 315.34 | | 1CS | | |
| | ML/SM-SILT and SAND(GLACIOLACUSTRINE), fine grained, little clay, trace pebbles | | | | | |
| 2.0 | ML/CL-SILT(TILL), some clay, little sand, trace gravel, hard, very stiff, unfractured, light brown to grey, damp to moist | 314.42 | | 2CS (1.8 - 3.1m) | | |
| 3.0 | | | | | | |
| 4.0 | SM/ML-SILT(GLACIOLACUSTRINE), some fine grained sand, trace clay, poorly graded, well layered (undulating), tan, damp to moist<br>- fine sand seam, little to some silt, saturated (4.45m to 4.50m BGS) | 312.44 | 203.2mmø BOREHOLE | 3CS | | |
| 5.0 | | | | 4CS | | |
| 6.0 | | | | | | |
| 7.0 | ML/CL-SILT(TILL), some clay, some fine to coarse gravel, little sand, few cobbles, very hard, stiff, light brown to grey, damp<br>- oblique fracture with silt infilling<br>- dry to damp | 310.00 | BENTONITE GROUT | 5CS | | |
| 8.0 | | | | 6CS | | |
| 9.0 | | | | | | |
| 10.0 | - 2cm wet pocket (@ 9.9m BGS)<br>- softer (10.0m to10.5m BGS) | | | 7CS | | |
| 11.0 | | | | 8CS | | |
| 12.0 | | | | | | |
| 13.0 | ML-SILT(GLACIOLACUSTRINE), little to some clay, little fine sand, occasional pebble, layered, varved, light grey to light brown, damp to moist | 303.45 | | 9CS | | |

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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)

(L-10)

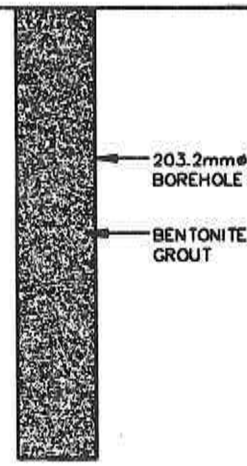
PROJECT NAME: ST. MARY'S LANDFILL
HOLE DESIGNATION: BH11-91
(Page 2 of 2)

PROJECT NO.: 0645
DATE COMPLETED: OCTOBER 10, 1991

CLIENT: TOWN OF ST. MARY'S
DRILLING METHOD: 108mm ID HSA

LOCATION: AS PER PLAN
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| 14.0 | | | | | | |
| | ML–SILT(TILL), little to some fine sand and clay, little gravel, very dense, hard, damp | 301.95 | 203.2mmø BOREHOLE | 10CS | | |
| 15.0 | | | BENTONITE GROUT | | | |
| 16.0 | – becoming silt with some sand and little clay, partially cemented | | | 11CS | | |
| 17.0 | | | | 12CS | | |
| | LIMESTONE(BEDROCK), light grey and brown, layered, massive | 298.88<br>298.57 | | | | |
| 18.0 | END OF HOLE @ 17.68 m BGS. | | | | | |
| 19.0 | | | | | | |
| 20.0 | | | | | | |
| 21.0 | | | | | | |
| 22.0 | | | | | | |
| 23.0 | | | | | | |
| 24.0 | | | | | | |
| 25.0 | | | | | | |
| 26.0 | | | | | | |




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

GRAIN SIZE ANALYSIS   WATER FOUND   STATIC WATER LEVEL

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-11)

PROJECT NAME: ST. MARY'S LANDFILL

PROJECT NO.: 0645

CLIENT: TOWN OF ST. MARY'S

LOCATION: AS PER PLAN

HOLE DESIGNATION: BH12-91 (Page 1 of 2)

DATE COMPLETED: OCTOBER 16, 1991

DRILLING METHOD: 108mm ID HSA

CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 317.07 | | | | |
| | ML-SILT(TILL), some clay, little sand, trace gravel, few cobbles, soft, well fractured, light brown to brown, damp | | CONCRETE SEAL | 1CS | | |
| 1.0 | - very hard, occasional fracture | | | | | |
| 2.0 | | | | 2CS | | |
| 3.0 | ML-SILT(OUTWASH), some very fine grained sand, trace clay, occasional pebble, compact, poorly graded, tan, saturated | 314.17 | | 3CS (2.9 - 4.1m) | | |
| 4.0 | ML-SILT(TILL), some clay, some sand, little gravel, hard, very stiff, slight horizontal fracturing and layering, brown, damp | 312.96 | 203.2mmø BOREHOLE | 4CS (4.3 - 5.8m) | | |
| 5.0 | | | | | | |
| 6.0 | | | | 5CS | | |
| 7.0 | - trace to little gravel, frequent pebbles and cobbles, stiff, medium brown, damp | | BENTONITE GROUT | | | |
| 8.0 | - sand, silt and gravel seam (8.23 to 8.38m BGS) | | | 6CS | | |
| 9.0 | - wet seam | | | | | |
| | - wet seam | | | 7CS | | |
| 10.0 | - little clay and sand, trace gravel, crumbly and fissile, light brown-grey, dry to damp | | | | | |
| 11.0 | | | | 8CS | | |
| | - dry sand seam (2cm thick) | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | 9CS | | |
| | - frequent sub-horizontal to oblique fractures, dark brown, moist (13.4 to 14.3m BGS) | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)

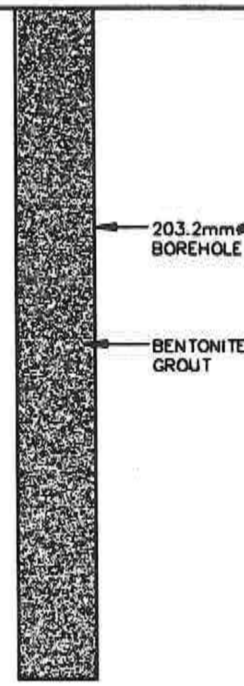
(L-11)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH12-91 (Page 2 of 2)
DATE COMPLETED: OCTOBER 16, 1991
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|
| 14.0 | - occasional thin varved intervals | | 10CS | | |
| 15.0 | - oblique fractures, moist (14.94 to 15.40m BGS)<br>- little clay, trace to little gravel, hard, blocky structure, medium brown-grey, damp | | 11CS | | |
| 16.0 | | | | | |
| 17.0 | - less pebbles | | 12CS | | |
| 18.0 | - layered silts (18.29 to 19.20m BGS) | | | | |
| 19.0 | | | 13CS | | |
| | SP-SAND, fine grained, little to some silt, poorly graded, dry | 297.87 | 14CS | | |
| 20.0 | LIMESTONE(BEDROCK)<br>END OF HOLE @ 19.96 m BGS. | 297.11 | | | |
| 21.0 | | | | | |
| 22.0 | | | | | |
| 23.0 | | | | | |
| 24.0 | | | | | |
| 25.0 | | | | | |
| 26.0 | | | | | |

MONITOR INSTALLATION




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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-12)

| | | | |
|---|---|---|---|
| PROJECT NAME: | ST. MARY'S LANDFILL | HOLE DESIGNATION: | BH13-91 (Page 1 of 2) |
| PROJECT NO.: | 0645 | DATE COMPLETED: | OCTOBER 18, 1991 |
| CLIENT: | TOWN OF ST. MARY'S | DRILLING METHOD: | 108mm ID HSA |
| LOCATION: | AS PER PLAN | CRA SUPERVISOR: | J.C. MUGFORD |

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 313.79 | | | | |
| | ML-SILT(OUTWASH), little sand, little clay, few pebbles, stiff, interlayered, brown and tan, damp | | CONCRETE SEAL | 1CS | | |
| 1.0 | ML/CL-SILT(TILL), some clay, some sand, trace gravel, hard, stiff, damp<br>- fractured | 312.88 | | | | |
| 2.0 | - fine to coarse grained sand seam, trace silt, wet (2cm thick) | | | 2CS | | |
| 3.0 | | | | 3CS | | |
| 4.0 | - horizontal fracture, shiny | | | 4CS | | |
| 5.0 | | | 203.2mmø BOREHOLE | 5CS (4.6 - 5.6m) | | |
| | - no fractures observed | | | | | |
| 6.0 | | | | 6CS | | |
| 7.0 | | | BENTONITE GROUT | | | |
| 8.0 | | | | 7CS | | |
| 9.0 | - frequent horizontal to sub-vertical fractures, shiny, smooth, moist (9.14 to 10.67m BGS) | | | 8CS | | |
| 10.0 | - dry to damp | | | | | |
| 11.0 | - little to some clay, damp | | | 9CS | | |
| 12.0 | ML-SILT and SAND(TILL), little gravel, trace to little clay, compact, non-cohesive, tan to light brown, moist, partially cemented | 301.54 | | 10CS | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)

(L-12)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH13-91 (Page 2 of 2)
DATE COMPLETED: OCTOBER 18, 1991
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| 14.0 | | | 203.2mmø BOREHOLE; BENTONITE GROUT | 11CS (13.3 - 14.8m) | | |
| 15.0 | - very moist | | | 12CS | | |
| | LIMESTONE(BEDROCK) | 298.25 | | | | |
| 16.0 | END OF HOLE @ 15.54 m BGS. | | | | | |
| 17.0 | | | | | | |
| 18.0 | | | | | | |
| 19.0 | | | | | | |
| 20.0 | | | | | | |
| 21.0 | | | | | | |
| 22.0 | | | | | | |
| 23.0 | | | | | | |
| 24.0 | | | | | | |
| 25.0 | | | | | | |
| 26.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-13)

PROJECT NAME: ST. MARY'S LANDFILL | HOLE DESIGNATION: BH14-91

PROJECT NO.: 0645 | DATE COMPLETED: OCTOBER 21, 1991

CLIENT: TOWN OF ST. MARY'S | DRILLING METHOD: 108mm ID HSA

LOCATION: AS PER PLAN | CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 317.60 | | | | |
| | ML/CL-SILT(TILL), some sand and clay, damp | | CONCRETE SEAL | | | |
| 1.0 | | | | | | |
| 2.0 | | | 203.2mmø BOREHOLE | | | |
| 3.0 | ML-SILT(GLACIOLACUSTRINE), some clay, little fine grained sand, few pebbles, soft to firm, layered, light brown to brown, moist | 314.60 | | 1CS | | |
| 4.0 | | | BENTONITE GROUT | | | |
| 5.0 | ML-SILT(TILL), little to some sand, little clay, trace gravel, few cobbles, firm, light brown, moist | 313.13 | | 2CS | | |
| | ML-SILT(OUTWASH), little to some very fine sand, trace clay, occasional pebble, compact, tan, wet – occasional fine to medium grained sand seam, wet (2cm thick) | 312.42 | | 3CS | | |
| 6.0 | | | | | | |
| 7.0 | ML/CL-SILT(TILL), some clay and sand, trace gravel, very stiff, medium to dark brown, moist – damp | 311.20 | | 4CS | | |
| 8.0 | END OF HOLE @ 7.57 m BGS. | 310.03 | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-15)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH16-91
DATE COMPLETED: OCTOBER 21, 1991
DRILLING METHOD: 108mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 317.24 | | | | |
| | ML-SILT(TILL), some clay and sand, damp to moist | | CONCRETE SEAL | | | |
| 1.0 | | | | | | |
| 2.0 | | | 203.2mmø BOREHOLE | | | |
| 3.0 | ML/CL-SILT and CLAY(GLACIOLACUSTRINE), trace to little fine sand, layered, firm, tan to light brown, moist | 314.50 | | 1CS (2.7 - 3.4m) | X | |
| | ML-SILT(TILL), some fine grained sand, little clay, firm, tan, saturated | 313.89 | BENTONITE GROUT | | | |
| 4.0 | SW-SAND, coarse grained, little silt, little gravel, little fine grained sand, saturated | 313.43 | | | | |
| | | | | 2CS | X | |
| 5.0 | | | | 3CS | X | |
| 6.0 | - some gravel | | | 4CS | X | |
| 7.0 | ML/CL-SILT(TILL), some clay, stiff, brown, damp to moist<br>- fine to medium grained sand seam, wet (20cm thick) | 310.53 | | | | |
| | END OF HOLE @ 7.32 m BGS. | 309.92 | | | | |
| 8.0 | | | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-17)

| | | | |
|---|---|---|---|
| PROJECT NAME: | ST. MARY'S LANDFILL | HOLE DESIGNATION: | BH18-91 |
| PROJECT NO.: | 0645 | DATE COMPLETED: | NOVEMBER 16, 1991 |
| CLIENT: | TOWN OF ST. MARY'S | DRILLING METHOD: | 95mm ID HSA |
| LOCATION: | AS PER PLAN | CRA SUPERVISOR: | J.C. MUGFORD |

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 317.00 | | | | |
| | GM-GRAVEL(FILL), some silt, some sand, loose brown, moist | | CONCRETE SEAL | | | |
| 1.0 | ML-SILT(TILL), some sand, little to some clay, little gravel, hard, light brown, damp to moist | 316.39 | | | | |
| 2.0 | | | | 1SS | X | 50 |
| | | | 190.5mmø BOREHOLE | | | |
| 3.0 | - damp | | | | | |
| | | | | 2SS | X | 52 |
| 4.0 | ML/CL-SILT and CLAY(GLACIOLACUSTRINE), occasional pebble, hard, layered, damp | 313.42 | BENTONITE GROUT | 3SS | X | 48 |
| 5.0 | ML-SILT(OUTWASH), little sand and clay, fining upwards, very dense, brown, wet, dilatant | 312.12 | | 4SS | X | 77 |
| | ML-SILT(TILL), some sand, some clay, little gravel, grey-brown, hard, damp to moist | 311.77 | | 5SS | X | 79 |
| 6.0 | SW-SAND, trace silt, well graded, medium dense, salt and pepper colour, saturated | 310.75 | | 6SS | X | 27 |
| 7.0 | ML/CL-SILT(TILL), some clay, some sand, little gravel, hard, grey-brown, damp | 310.29 | | 7SS | X | 43 |
| | END OF HOLE @ 7.47 m BGS. | 309.53 | | | | |
| 8.0 | | | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-18)

PROJECT NAME: ST. MARY'S LANDFILL

PROJECT NO.: 0645

CLIENT: TOWN OF ST. MARY'S

LOCATION: AS PER PLAN

HOLE DESIGNATION: BH19-91

DATE COMPLETED: NOVEMBER 16, 1991

DRILLING METHOD: 95mm ID HSA

CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 317.39 | | | | |
| | ML/CL–SILT(TILL), some clay and sand, moist | | CONCRETE SEAL | | | |
| 1.0 | | | | | | |
| 2.0 | SW/GM–SAND and GRAVEL, little silt, loose, wet, occasional silt layer | 315.56 | 190.5mmø BOREHOLE | | | |
| 3.0 | | | BENTONITE GROUT | 1SS | | 35 |
| 4.0 | – coarse grained sand | | | | | |
| 5.0 | SM–SILT and SAND, very fine grained, very dense, light brown, wet | 312.36 | | 2SS | | 80 |
| | ML/CL–SILT(TILL), some clay, some sand, little gravel, hard, medium brown-grey, damp | 312.21 | | | | |
| 6.0 | | | | 3SS | | 76 |
| 7.0 | END OF HOLE @ 6.71 m BGS. | 310.68 | | | | |
| 8.0 | | | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

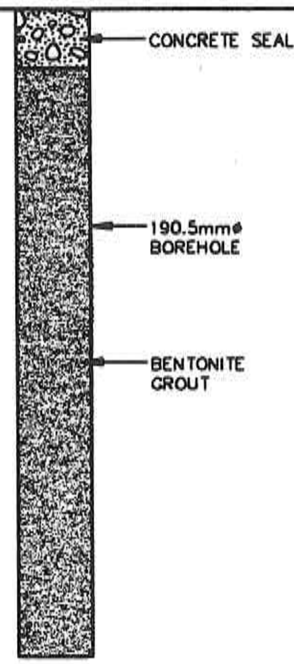
(L-19)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH20-91
DATE COMPLETED: DECEMBER 9, 1991
DRILLING METHOD: 95mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL |
|---|---|---|
| | GROUND SURFACE | 315.62 |
| 1.0 | ML-SILT(TILL), little to some clay and sand, trace gravel, hard, damp | 314.09 |
| 2.0, 3.0 | ML-SILT(TILL, REWORKED LACUSTRINE), some clay, trace to little fine sand, hard, light brown, damp<br>- few dark brown moist clayey seams, few small pebbles, no obvious layering<br>- laminated silt and clay layers, hard, light brown, damp | 313.09 |
| 4.0, 5.0 | ML/SM-SILT(LACUSTRINE), little to some very fine sand, trace clay, tan, dilatant, wet, dense, trace layering, non-cohesive<br>- very dense, slight layering, few dilatant sand pores<br>- undulating silt and sand bedding layers (2 to 4cm thick) | 311.50 |
| 6.0, 7.0 | ML-SILT(TILL), some clay and sand, trace gravel, hard, brown<br>- fine to medium sand and silt layers, wet (0.5 to 1.5cm thick @ 4.27, 4.36, 4.45 and 4.54m BGS)<br>- little to some sand, few large pebbles, extremely hard, damp<br>- little gravel | 308.91 |
| | END OF HOLE @ 6.71 m BGS. | |
| 8.0 | | |
| 9.0 | | |
| 10.0 | | |
| 11.0 | | |
| 12.0 | | |
| 13.0 | | |

MONITOR INSTALLATION




| SAMPLE NUMBER | STATE | 'N' VALUE |
|---|---|---|
| 1SS | ☒ | 69 |
| 2SS | ☒ | 69 |
| 3SS | ☒ | 91 |
| 4SS | ☒ | 86 |
| 5SS | ☒ | 77 |
| 6SS | ☒ | 76 |
| 7SS | ☒ | 67 |
| 8SS | ☒ | 54 |
| 9SS | ☒ | 54 |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
## (OVERBURDEN)

(L-21)

PROJECT NAME: ST. MARY'S LANDFILL

PROJECT NO.: 0645

CLIENT: TOWN OF ST. MARY'S

LOCATION: AS PER PLAN

HOLE DESIGNATION: BH22-91

DATE COMPLETED: DECEMBER 10, 1991

DRILLING METHOD: 95mm ID HSA

CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 314.22 | | | | |
| | SW-SAND, little silt, trace gravel, fine to medium grained, loose, brown, saturated | 313.61 | CONCRETE SEAL | 1SS | | 21 |
| 1.0 | ML-SILT(TILL), some sand, little gravel, trace to little clay, hard, brown, moist | 313.15 | 190.5mmø BOREHOLE | 2SS | | 74 |
| | GW-GRAVEL, some sand, little silt, saturated | 312.70 | | | | |
| 2.0 | ML-SILT(TILL), some sand, little clay and gravel, hard, light brown, moist | | BENTONITE GROUT | 3SS | | 53 |
| | | | | 4SS | | 50 |
| 3.0 | - some clay, grey | | | | | |
| | - very stoney (3.66 to 4.27m BGS) | | | 5SS | | 40 |
| 4.0 | | | | | | |
| | END OF HOLE (REFUSAL) @ 4.27 m BGS. | 309.95 | | | | |
| 5.0 | | | | | | |
| 6.0 | | | | | | |
| 7.0 | | | | | | |
| 8.0 | | | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-22)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH23-91
DATE COMPLETED: DECEMBER 11, 1991
DRILLING METHOD: 95mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 313.97 | | | | |
| | ML-SILT(LACUSTRINE), little to some very fine sand, trace clay, occasional small pebble, non-cohesive, medium dense, tan, moist | 313.51 | CONCRETE SEAL | 1SS | X | 25 |
| 1.0 | ML-SILT(TILL), some sand, little clay, little gravel, stiff, brown, damp | 313.21 | | 2SS | X | 56 |
| | SM-SAND and SILT, some gravel, very dense, brown, moist to wet | 312.45 | 190.5mmø BOREHOLE | 3SS | X | 38 |
| 2.0 | ML-SILT(TILL), some clay and sand, trace gravel, hard, brown, damp to moist<br>- stones and gravel (2.29to 3.05m BGS) | | | | | |
| 3.0 | - damp | | BENTONITE GROUT | 4SS | X | 60 |
| 4.0 | - stoney | | | | | |
| 5.0 | | | | 5SS | X | >100 |
| | END OF HOLE @ 5.18 m BGS. | 308.79 | | | | |
| 6.0 | | | | | | |
| 7.0 | | | | | | |
| 8.0 | | | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
## (OVERBURDEN)

(L-23)

PROJECT NAME: ST. MARY'S LANDFILL

PROJECT NO.: 0645

CLIENT: TOWN OF ST. MARY'S

LOCATION: AS PER PLAN

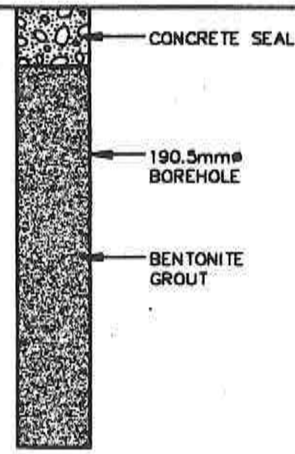
HOLE DESIGNATION: BH24-91

DATE COMPLETED: DECEMBER 11, 1991

DRILLING METHOD: 95mm ID HSA

CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 313.97 | | | | |
| | ML-SILT(TILL), some sand and clay, little gravel, hard, light brown, damp | | CONCRETE SEAL | | | |
| 1.0 | | | | 1AR | X | |
| | - stoney, brown | | 190.5mmø BOREHOLE | | | |
| 2.0 | | | BENTONITE GROUT | 2AR | X | |
| 3.0 | | | | | | |
| 4.0 | | | | 3AR | X | |
| | END OF HOLE @ 4.57 m BGS. | 309.40 | | | | |
| 5.0 | | | | | | |
| 6.0 | | | | | | |
| 7.0 | | | | | | |
| 8.0 | | | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |




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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-25)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH26-91
DATE COMPLETED: DECEMBER 12, 1991
DRILLING METHOD: 95mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 316.96 | | | | |
| | ML-SILT(TILL), some clay and sand, little gravel, hard, grey-brown, moist, cohesive | | CONCRETE SEAL | | | |
| 1.0 | ML/SM-SILT(LACUSTRINE), some fine sand, little clay, very dense, tan, moist to wet, faint layering, non-cohesive | 315.95 | | 1SS | X | 38 |
| 2.0 | ML-SILT(TILL, REWORKED LACUSTRINE), some fine sand, little to some clay, trace gravel light grey-brown, damp to moist, cohesive -occasional clay seam with thin (.5cm thick) silt and fine sand layering, damp to moist, occasional moist oblique fracture | 315.13 | | 2SS | X | 40 |
| 3.0 | | | 190.5mmø BOREHOLE | 3SS | X | 28 |
| | | | | 4SS | X | 38 |
| 4.0 | - trace fine pebbles | | | 5SS | X | 47 |
| | | | BENTONITE GROUT | | | |
| 5.0 | GW-GRAVEL, some sand, trace silt, stoney, very dense, saturated | 312.24 | | 6SS | X | 76 |
| | SW-SAND, some gravel, fine to coarse grained, very dense, salt and pepper colour, saturate | 311.63 | | 7SS | X | 43 |
| 6.0 | ML/SM-SILT, some fine sand, trace clay, tan, saturated | 311.02 | | | | |
| | ML-SILT(TILL), some sand and clay, trace to little gravel, hard, light grey-brown, damp to moist | 310.71 | | 8SS | X | 36 |
| 7.0 | | | | | | |
| 8.0 | | | | 9SS | X | 80 |
| | END OF HOLE @ 8.23 m BGS. | 308.73 | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)

(L-26)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH27-91
DATE COMPLETED: DECEMBER 12, 1991
DRILLING METHOD: 95mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 316.01 | | | | |
| | ML-SILT(TILL), some sand and clay, little gravel, light brown, damp | | CONCRETE SEAL | | | |
| 1.0 | | | | | | |
| | ML-SILT(LACUSTRINE), some clay and fine sand, dense, tan, damp, layered | 314.49 | | | | |
| 2.0 | | | | 1SS | ☒ | 40 |
| 3.0 | | | 190.5mmø BOREHOLE | 2SS | ☒ | 47 |
| 4.0 | SW-SAND, some gravel, fine to coarse grained, well graded, very dense, saturated | 312.20 | BENTONITE GROUT | | | |
| 5.0 | ML-SILT(TILL), some sand and clay, little gravel, very hard, light brown, damp to moist | 311.29 | | 3SS | ☒ | 50 |
| 6.0 | | | | 4SS | ☒ | >50 |
| 7.0 | | | | | | |
| 8.0 | | | | 5SS | ☒ | 94 |
| | END OF HOLE @ 8.23 m BGS. | 307.78 | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG
# (OVERBURDEN)

(L-27)

PROJECT NAME: ST. MARY'S LANDFILL

PROJECT NO.: 0645

CLIENT: TOWN OF ST. MARY'S

LOCATION: AS PER PLAN

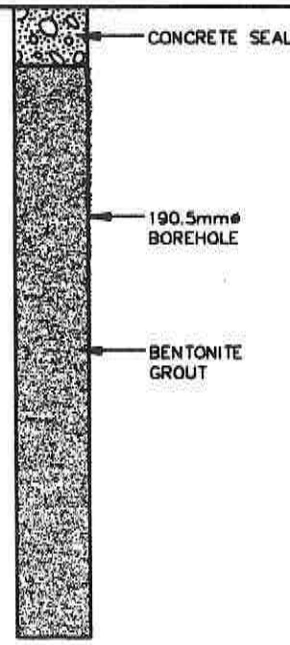
HOLE DESIGNATION: BH28-91

DATE COMPLETED: DECEMBER 12, 1991

DRILLING METHOD: 95mm ID HSA

CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 313.50 | | | | |
| | ML-SILT(TILL), some sand and clay, little gravel, very stoney, hard, brown, damp | | CONCRETE SEAL | | | |
| 1.0 | | | | | | |
| 2.0 | | | | 1SS | X | 32 |
| | | | 190.5mmø BOREHOLE | | | |
| 3.0 | | | | 2SS | X | 44 |
| | - moist | | BENTONITE GROUT | | | |
| 4.0 | | | | | | |
| | - damp | | | 3SS | X | |
| 5.0 | | | | | | |
| 6.0 | | | | 4SS | X | 54 |
| | END OF HOLE @ 6.55 m BGS. | 306.95 | | | | |
| 7.0 | | | | | | |
| 8.0 | | | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |




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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-28)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH29-91
DATE COMPLETED: DECEMBER 13, 1991
DRILLING METHOD: 95mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 314.24 | | | | |
| | GW-GRAVEL(FILL), some silt and sand, dense, moist | | CONCRETE SEAL | | | |
| 1.0 | ML-SILT(TILL), some clay and sand, little gravel, hard, brown, damp | 313.33 | | | | |
| 2.0 | - sand seam (0.5cm thick) | | 190.5mmø BOREHOLE | 1SS | X | 32 |
| 3.0 | - very hard | | | 2SS | X | 43 |
| 4.0 | | | BENTONITE GROUT | | | |
| 5.0 | | | | 3SS | X | 66 |
| 6.0 | | | | 4SS | X | 86 |
| 7.0 | END OF HOLE @ 6.71 m BGS. | 307.53 | | | | |
| 8.0 | | | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-29)

PROJECT NAME: ST. MARY'S LANDFILL

PROJECT NO.: 0645

CLIENT: TOWN OF ST. MARY'S

LOCATION: AS PER PLAN

HOLE DESIGNATION: BH30-91

DATE COMPLETED: DECEMBER 13, 1991

DRILLING METHOD: 95mm ID HSA

CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 317.61 | | | | |
| | ML-SILT(TILL), some sand and clay, little gravel, stoney, hard, brown, damp | | CONCRETE SEAL | 1AR | | |
| 1.0 | | | | | | |
| 2.0 | | 315.32 | | | | |
| | ML-SILT(LACUSTRINE), some clay, little to some fine sand, medium dense, tan, moist | | 190.5mmø BOREHOLE | 2AR | | |
| 3.0 | | 314.56 | | | | |
| | ML/SM-SILT(OUTWASH), some fine sand, trace clay, very dense, tan, wet<br>- fine to medium grained sand and silt seam, wet (3.35 to 3.51m and 3.81 to 4.11m BGS) | | | 3SS | | 72 |
| 4.0 | - occasional pebble, coarsely layered, very dense, wet | | BENTONITE GROUT | 4SS | | >50 |
| 5.0 | - silt with little fine sand and clay | 312.43 | | 5SS | | >100 |
| | ML-SILT(TILL), some clay and sand, little gravel, stoney, very hard, brown, damp | | | 6SS | | 36 |
| 6.0 | - moist | | | 7SS | | 36 |
| 7.0 | | | | | | |
| 8.0 | | 309.38 | | 8SS | | 69 |
| | END OF HOLE @ 8.23 m BGS. | | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

# STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

(L-30)

PROJECT NAME: ST. MARY'S LANDFILL
PROJECT NO.: 0645
CLIENT: TOWN OF ST. MARY'S
LOCATION: AS PER PLAN

HOLE DESIGNATION: BH31-91
DATE COMPLETED: DECEMBER 13, 1991
DRILLING METHOD: 95mm ID HSA
CRA SUPERVISOR: J.C. MUGFORD

| DEPTH m BGS | STRATIGRAPHIC DESCRIPTION & REMARKS | ELEVATION m AMSL | MONITOR INSTALLATION | SAMPLE NUMBER | SAMPLE STATE | SAMPLE 'N' VALUE |
|---|---|---|---|---|---|---|
| | GROUND SURFACE | 316.52 | | | | |
| | ML-SILT(TILL), some sand and clay, trace gravel, hard, brown, damp | | CONCRETE SEAL | | | |
| 1.0 | | | | | | |
| 2.0 | | | | 1SS | X | 49 |
| 3.0 | ML/SM-SILT(LACUSTRINE), little fine sand, little to some clay, hard, tan, moist to wet gradational layering<br>- silt with some fine sand (3.20 to 3.51m BGS) | 313.78 | 190.5mmø BOREHOLE | 2SS | X | 58 |
| 4.0 | ML-SILT(TILL), some sand and clay, little gravel, hard, brown, damp | 312.25 | BENTONITE GROUT | | | |
| 5.0 | | | | 3SS | X | 52 |
| 6.0 | | | | 4SS | X | 46 |
| 7.0 | - very hard, dry to damp | | | 5SS | X | >100 |
| 8.0 | END OF HOLE @ 8.08 m BGS. | 308.44 | | | | |
| 9.0 | | | | | | |
| 10.0 | | | | | | |
| 11.0 | | | | | | |
| 12.0 | | | | | | |
| 13.0 | | | | | | |

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

GRAIN SIZE ANALYSIS ◯ WATER FOUND ▽ STATIC WATER LEVEL ▼

**Appendix C4**
**Landfill Test Pit Logs**
**St. Marys Landfill**

| Test Pit No | Depth Interval | Soil Description | Soil Sample No. | Soil Sample Depth | Groundwater |
|---|---|---|---|---|---|
| TP 1 | | Elevation: 314.61 masl | | | |
| | 0 - 0.25 | Medium grey clayey SILT; friable; contains roots; moist (FILL) | | | |
| | 0.25 - 0.30 | Dark grey SILT, organic matter (TOPSOIL) | | | |
| | 0.30 - 2.10 | Medium grey silty CLAY, some sand, some gravel; bedded to 0.66 then massive; stiff to very stiff; moist (TILL)<br>Becoming gravelly at bottom of pit with sandy seams, trace cobbles; wet | S1<br>S2 | 0.45<br>1.0 | No water seepage observed |
| TP 2 | | Elevation: 316.14 masl | | | |
| | 0 - 1.75 | Light to medium grey gravelly SILT, some clay, some sand, some cobbles; weathered; soft to firm; moist becoming wet around 1.0 m<br>Becoming sandy at bottom of pit<br>Steel pipe in pit bottom (FILL) | S1<br>S2 | 1.05<br>1.75 | No water seepage observed |
| TP 3 | | Elevation: 318.52 masl | | | |
| | 0 - 2.70 | Medium grey gravelly sandy SILT, trace clay, some cobbles (rounded to subrounded); loose to soft; some caving of pit sidewalls; moist (FILL)<br>Wet seams and inclusions of stiff clay and hard till below 2.2 m | S1<br>S2<br>S3 | 1.05<br>2.25<br>2.70 | No water seepage observed |
| TP 4 | | Elevation: 316.34 masl | | | |
| | 0 - 0.20 | Medium brown SILT, some organic matter (TOPSOIL) | | | |
| | 0.20 - 2.30 | Light brown SILT, some gravel, some sand, trace cobbles, trace boulder; seams of stiff clay; stiff; weathered (FILL) | S1 | 1.00 | |
| | 2.30 - 2.60 | Black SILT, some sand; wire fragment; slight odour; moist (FILL) | | | No water seepage observed |
| TP 5 | | Elevation: 318.29 masl | | | |
| | 0 - 0.60 | Light brown cobbly SILT, some sand, some gravel; loose, friable; moist (FILL) | | | |
| | 0.60 - 1.90 | Light grey SILT and fine SAND; low plastic; massive; dense; moist (native waterlaid deposit) | S1 | 1.40 | |
| | 1.90 - 2.00 | Medium grey SILT and CLAY, some sand, some gravel, trace cobbles; hard; moist (TILL) | S2 | 2.00 | No water seepage observed |

**Appendix C4**
**Landfill Test Pit Logs**
**St. Marys Landfill**

| Test Pit No | Depth Interval | Soil Description | Soil Sample No. | Soil Sample Depth | Groundwater |
|---|---|---|---|---|---|
| TP 6 | | Elevation: 314.10 masl | | | No water seepage observed<br>Cattails in water filled depression nearby likely due to poor drainage and not a shallow water table |
| | 0 - 0.70 | Light brown silty SAND and GRAVEL, some cobbles; compact; saturated | S1 | 0.35 | |
| | 0.70 - 2.50 | Light grey SILT and fine SAND; low plastic; massive; dense; moist (native waterlaid deposit)<br>Becoming saturated around 2.3-2.4 m | S2<br>S3 | 1.2<br>2.5 | |
| TP 7 | | Elevation: 314.93 masl | | | No water seepage observed |
| | 0 - 2.20 | Light brown sandy, gravelly SILT, some cobbles (rounded/subrounded), trace small boulders; massive; stiff; moist (FILL)<br>Caving sidewalls<br>Becoming saturated around 1.9 m | S1<br>S2 | 1.4<br>2.2 | |
| TP 8 | | Elevation: 314.62 masl | | | No water seepage observed |
| | 0 - 0.25 | Medium brown SILT and CLAY, some organic matter containing roots; friable; moist to wet (TOPSOIL) | | | |
| | 0.25 - 1.50 | Medium grey-brown SILT and CLAY, trace sand, trace gravel, trace cobbles; fractured to 0.5 m very stiff to hard; moist (TILL) | S1 | 0.90 | |
| TP 9 | | Elevation: 314.14 masl | | | No water seepage observed |
| | 0 - 0.30 | Dark brown SILT, some fine sand, some organic matter; wet (TOPSOIL) | | | |
| | 0.30 - 0.60 | Meduim brown SILT, fine sand; moist | | | |
| | 0.60 - 0.75 | Mediumb rown silty fine to coarse SAND & fine GRAVEL; loose to compact; wet | S1 | 0.65 | |
| | 0.75 - 1.40 | Light grey silty fine SAND; varved; dense; moist | S2 | 1.30 | |
| TP 10 | | Elevation: 312.47 masl | | | Water seepage around 1.0 m |
| | 0 - 0.15 | Medium brown SILT, some sand, some gravel, some organic matter (TOPSOIL) | | | |
| | 0.15 - 1.00 | Meduim brown SILT, SAND, GRAVEL (rounded), ROCK fragments (angular) (FILL)<br>Difficult to dig below 1.0 m due to amount of rock rubble | S1 | 1.00 | |

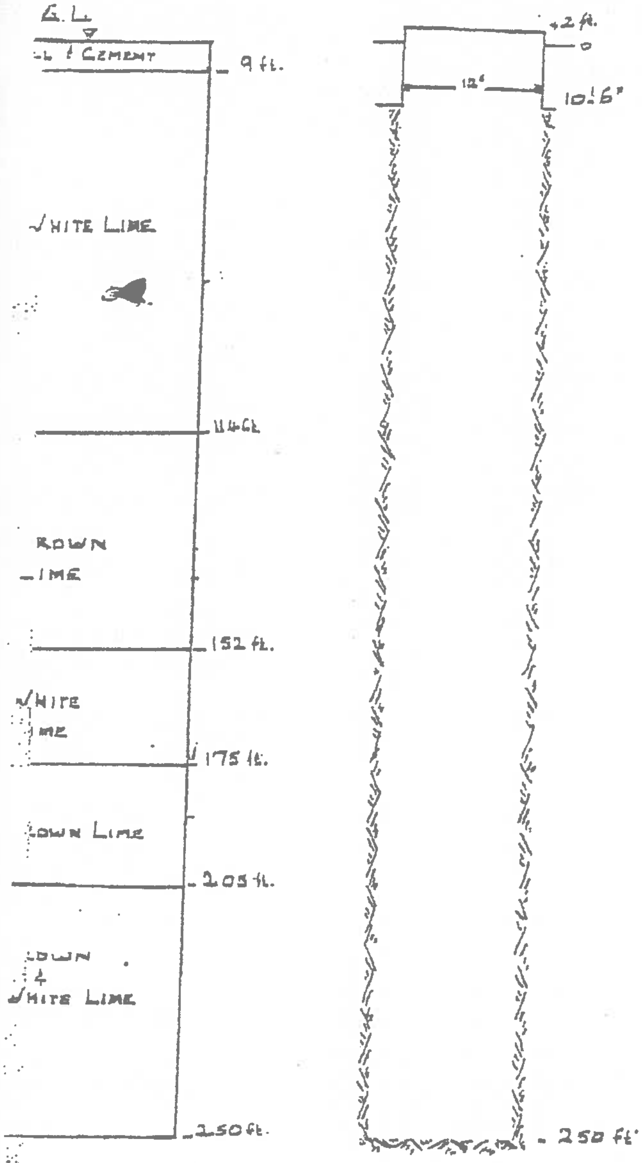
# Appendix C4
# Landfill Test Pit Logs
# St. Marys Landfill

| Test Pit No | Depth Interval | Soil Description | Soil Sample No. | Soil Sample Depth | Groundwater |
|---|---|---|---|---|---|
| TP 11 | | Elevation: 313.23 masl | | | |
| | 0 - 0.30 | Medium grey SILT and CLAY, some sand, trace gravel, some organic matter (FILL) | | | |
| | 0.30 - 1.40 | Medium grey CLAY and SILT, some sand, trace gravel, trace cobbles (rounded); weathered to 1.3 m; very stiff to hard; moist (TILL) | S1 | 1.30 | No water seepage observed |
| TP 12 | | Elevation: 314.14 masl | | | |
| | 0 - 0.10 | Dark brown SILT, organic matter (TOPSOIL) | | | |
| | 0.10 - 1.30 | Light grey-brown SILT, some clay, trace sand, trace gravel; stiff to very stiff; moist | S1 | 1.30 | No water seepage observed |
| TP 13 | | Elevation: 315.86 masl | | | |
| | 0 - 0.15 | Medium grey CLAY and SILT, trace organic matter; loose; moist | | | |
| | 0.15 - 1.30 | Medium grey CLAY and SILT, trace sand, trace gravel, trace cobbles; weathered to 0.7 m; very stiff to hard; moist (TILL) | S1 | 0.80 | No water seepage observed |
| CKD | | Elevation: 323.94 masl | | | |
| | 0 - 0.30 | Dark Brown SILT, some organic matter; moist (TOPSOIL) | | | |
| | 0.30 - 0.50 | Light grey, silt like, loose, dry (cement kiln dust) | S1 | 0.50 | No water seepage observed |

Logged on November 5, 2015 by J. Rutherford

All measurements are in metres unless otherwise indicated.

Soil samples will be retained for three months from date of report.




## Well Material

Outer Casing: 10'6" x 12" T&C

Inner Casing

Screen

Plug

Gravel

## Pump

No. 38414 | Setting BP-MB 100'

No. Stages 6 | Length Bowls 5'-7"

Bowl 10" | Size & Lgth. Suction 10' x 8"

Head TF | Size Column 8"

Materials or setting details other than standard

Impellers: Trim

BOWL ALL BRONZE. LINE SHAFT & COUPLINGS - ST. ST./12

## Motor

| | | | |
|---|---|---|---|
| Make | G.E. | Phase | 3 |
| H. P. | 60 | Cycles | 60 |
| R. P. M. | 1800 | Volts | 550 |
| Type | K | Amps. | 58.5 |
| Frame | 444-P | Serial | YPJ 1105030 |
| Bearing Nos. | | | |

## Special Equipment

Installation: Feb. 20. 1958.

Well No. 4

B. P. referred to original ground level +2'

Clear depth below B. P. 249'-10"

Started June 17. 1957 Final Test Feb. 20. 1958

Preliminary Test Jul. 8. 1957 Static Level 38'9"

Final Test ______ Pumping Level 50'

Guarantee ______ I G P M Capacity 846 (B.P. Prel. Test) I G P M

Contract Pressure ______ # Pressure Pump 75 ______ #

Length Air Line 114' Main ______ #

INTERNATIONAL WATER SUPPLY LTD.

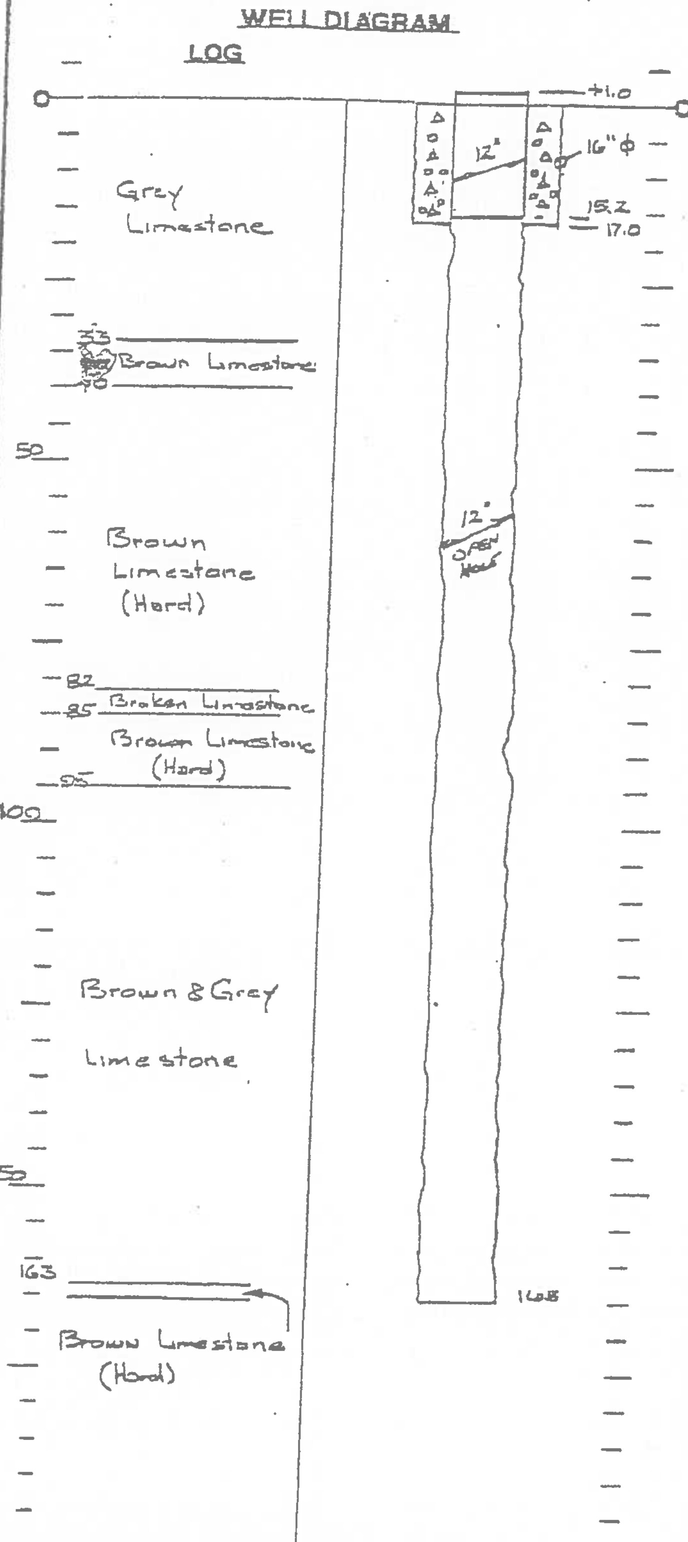
MONTREAL, OAKVILLE | LONDON, CANADA WATER SUPPLY CONTRACTORS | SASKATOON VANCOUVER

ST. MARYS CEMENT CO.
ST. MARYS ONT

DRILLED BY: J. McGEARY
INSTALLED BY: G. KEYES.

DRAWN BY FGB
APPROVED BY

## WELL DIAGRAM




## WELL MATERIAL

Outer Casing: 12 " dia., ______ " Wall Thk. Matl.: ST

Cemented from 0 ' 0 " to 17 ' 0 "

Inner Casing: — " dia., — " Wall Thk. Matl.: —

Screen: Make — " dia., Opening & Matl.: —

Plug: Type — Matl — Other: —

Gravel: Type — Size — Quantity —

## WELL TEST DATA

*Preliminary Test* Date: Sept 29/75 by T. Kyle

Static Level: 5.78 ft ' — " below M.P. +1.70

Pumping Rate IGM: 785

Pumping Duration: 8 hrs. — min

Pumping Level at Test End: 33.0 ft (AIR LINE)

Performance Plots: dd-t Dwg. A-75556

dd-r Dwg. A-75557

*Final Test:* Date ______ by ______

Rated Well Capacity IGM ______

Pumping Rate IGM ______ Static level ______ ' ______ "

Pumping level ______ ' ______ " at ______ hrs. ______ min.

Pump pressure: ______ psi: Main pressure ______ psi

Shut off: AGH ______ psi: W.L. ______ ' ______ "

Clear Well Depth from B.P. ______ ' ______ " Air Line ______ ' ______ "

## PUMP & MOTOR DATA (Cert. Curve)

Pump Make Layne Rating 625 IGM @ 344 ' TH

Head: Type TF 818 S.N. 80911

Column: 70 ' X 8 " X 1½ ": Shaft Mtl: SS

Bowl: 10 THC Stage 8 : Curve: TEST 193-36

Suction: 8 " dia. 10 ' 0 " Long

Special: Zinc Sleeves ______ : Taped Oil Line ______

Other ______

Motor Make: WEST Frame: 404TP SN: L-195 7222

100 HP, 3 ph. 60 hz. 1800 rpm 575

Bearing No. Upper 7222

Lower 6314 ZZC3

*Special Equipment*

① Amercoated Column Pipe In & out

② SS 8" cone Strainer

| WELL REVISIONS AND REHABILITATION | | |
|---|---|---|
| DATE | WORK DONE | BY |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**International Water Supply Limited**

SASKATOON – BARRIE – MONTREAL

CLIENT: ST. MARYS CEMENT CO.

WELL NO: WELL 1/75 (No 6)

| DRILLED BY: T. KYLE | DATE: Sept 75 | DRAWN: BLH |
|---|---|---|
| INSTALLED BY: | DATE: | DATE: OCT 3/75 |

PROJECT: 04-1112-056

# RECORD OF DRILLHOLE: BH-S3

SHEET 1 OF 6

LOCATION: N 4786842.9 ;E 488576.4

DRILLING DATE: Aug. 7, 2003 - Aug. 13, 2003

DATUM: NAD 83

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 75

DRILLING CONTRACTOR: ALL-TERRAIN

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

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

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | NOTES WATER LEVELS INSTRUMENTATION |
|---|---|---|---|---|---|---|
| | | GROUND SURFACE | | 325.03 | | |
| 0 | 159mm I.D. HOLLOW STEM AUGER | UPPER GLACIAL TILL (0.0m to 5.39m) Stiff to hard, medium reddish brown becoming medium dark grey below 3 m, moist, massive textured SILTY CLAY with sand and trace to some matrix supported gravel, occasional cobbles and boulders of limestone, dolostone and igneous composition. | | 0.00 | 1 | Top of Casing elev. 325.757; Top of Pipe elev. 325.655 |
| 1–3 | | | | | 2 | Concrete Seal in Upper 1m; 159mm Borehole |
| 4–5 | August 8, 2003 | | | | 3 | 123mm Borehole |
| | 123mm PQ CORE HOLE | GLACIOLACUSTRINE SILT (5.39m to 6.16m) Firm to compact, light grey, moist to wet, dilatent, bedded SILT and CLAYEY SILT. | | 319.64 / 5.39 | 4 | |
| 6 | | LOWER GLACIAL TILL (6.16m to 18.29m) Hard, medium brownish grey, moist, massive textured SILTY CLAY to CLAYEY SILT with sand and trace to some matrix supported gravel, cobbles and boulders of limestone, dolostone and igneous composition. | | 318.87 / 6.16 | 5 | Bentonite Grout |
| 7–9 | | | | | 6 | Sch 40, 51mm dia. flush threaded pvc riser pipe |
| 10 | | | | | 7 | |

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KJC

CHECKED:

LOCATION: N 4786842.9 ;E 488576.4

INCLINATION: -90° AZIMUTH: —

DRILLING DATE: Aug. 7, 2003 - Aug. 13, 2003

DRILL RIG: CME 75

DRILLING CONTRACTOR: ALL-TERRAIN

DATUM: NAD 83

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

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

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | ELEV. / DEPTH (m) | RUN No. | NOTES WATER LEVELS INSTRUMENTATION |
|---|---|---|---|---|---|
| 10 | | — CONTINUED FROM PREVIOUS PAGE — | | | |
| | 123mm PQ CORE HOLE; August 8, 2003 | LOWER GLACIAL TILL (6.16m to 18.29m) Hard, medium brownish grey, moist, massive textured SILTY CLAY to CLAYEY SILT with sand and trace to some matrix supported gravel, cobbles and boulders of limestone, dolostone and igneous composition. | | 7 | |
| 11 | | | | 8 | |
| 12 | | | | | 123mm Borehole |
| 13 | | | | 9 | |
| 14 | | | | | |
| 15 | | | | 10 | Bentonite Grout |
| 16 | | | | 11 | |
| 17 | August 11, 2003 | | | 12 | |
| 18 | | BEDROCK SURFACE | 306.74 | | |
| | | DUNDEE FORMATION | 18.29 | 1 | |
| 19 | August 12, 2003 | | | 2 | |
| 20 | | | | 3 | PVC |

CONTINUED NEXT PAGE

PROJECT: 04-1112-056

# RECORD OF DRILLHOLE: BH-S3

SHEET 3 OF 6

LOCATION: N 4786842.9 ;E 488576.4

INCLINATION: -90°  AZIMUTH: —

DRILLING DATE: Aug. 7, 2003 - Aug. 13, 2003

DRILL RIG: CME 75

DRILLING CONTRACTOR: ALL-TERRAIN

DATUM: NAD 83

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | COLOUR % RETURN / FLUSH | RECOVERY: TOTAL CORE % / SOLID CORE % | R.Q.D. % | FRACT. INDEX PER .3m | B Angle | DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | HYDRAULIC CONDUCTIVITY K, cm/sec | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | — CONTINUED FROM PREVIOUS PAGE — | | | | | | | | | | | | | | | |
| 20 | 123mm PQ CORE HOLE | DUNDEE FORMATION LIMESTONE (18.29m to 24.32m depth) Fresh, weathered on open bedding partings, light creamy grey to light tan grey, very fine to fine grained, non-porous, thin to medium bedded, partly fossiliferous (rugose corals) LIMESTONE. Limestone tends to separate on open bedding partings. Formation has sharp basal contact. ·□from 18.29 to 23.10 m, predominately very fine to fine grained thin to medium bedded creamy grey limestone ·□from 23.10 to 24.32 bioturbated limestone with numerous burrow casts | | | 3 | | | | | | | | B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, J,(2,1),, B,(2,1),, B,(2,1),, J,(2,1),, B,(2,1),, B,(2,1),, J,(2,1),, B,(2,1),, ... | | | | Monitoring well pipe |
| 21 | | | | | | | | | | | | | | | | | |
| 22 | | | | | 4 | | | | | | | | B,(2,1),, (repeated) | | | | Bentonite Grout |
| 23 | | | | | 5 | | | | | | | | B,(2,1),, (repeated) | | | | Bentonite gravel seal; PVC Washer |
| 24 | | | | 300.71 / 24.32 | 6 | | | | | | | | B,(2,1),, J,(2,1),, B,(2,1),, B,(2,1),, | | | | |
| | August 12, 2003 | UPPER LUCAS FORMATION LIMESTONE (25.91m to 37.19m) Fresh, weathered on open bedding partings, light to medium tan to brownish grey, interbedded very fine to fine grained, non-porous to faintly porous, locally pitted to vuggy, thin to medium bedded, laminar textured (stromatolitic) in part and locally oolitic, weakly stylolitic, partly fossiliferous LIMESTONE with dark tan sections of porous, faintly petroliferous limestone. Basal contact marked by porous horizon. ·□from 24.32 to 25.37 m laminar textured limestone with soft sediment slump structures ·□from 25.37 to 25.65 m Dundee Marker Bed, medium grey, mottled lithoclastic dolostone with rip-up clasts at base. ·□from 30.57 to 30.80 m medium grey, mottled porous to pitted dolostone marker bed, sharp basal contact ·□from 31.73 to 31.94 m dark grey, porous, laminar, faintly petroliferous argillaceous dolostone bed | | | | | | | | | | | B,(2,1),, B,(2,1),, B,(2,1),, | | | | |
| 25 | | | | 299.66 / 25.37 | 7 | | | | | | | | B,(2,1),, B,(2,1),, B,(2,1),, | | | | |
| | | | | 299.38 / 25.65 | | | | | | | | | | | | | |
| 26 | 96mm HQ CORE HOLE | | | 299.12 / 25.91 | | | | | | | | | B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, | | | | Open 96mm Drillhole |
| 27 | | | | | 8 | | | | | | | | B,(2,1),, J,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, | | | | |
| 28 | | | | | 9 | | | | | | | | B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, | | | | |
| 29 | | | | | 10 | | | | | | | | B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, | | | | |
| 30 | | CONTINUED NEXT PAGE | | | | | | | | | | | | | | | |

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KJC

CHECKED:

MISS-ROCK-2 04111205GAARCK.GPJ GAL-CANADA.GDT 4/1/05 JDR

# RECORD OF DRILLHOLE: BH-S3

PROJECT: 04-1112-056
LOCATION: N 4786842.9 ;E 488576.4
INCLINATION: -90° AZIMUTH: —

DRILLING DATE: Aug. 7, 2003 - Aug. 13, 2003
DRILL RIG: CME 75
DRILLING CONTRACTOR: ALL-TERRAIN



DATUM: NAD 83

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

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

— CONTINUED FROM PREVIOUS PAGE —

| Depth (m) | Drilling record | Description | Elev. / Depth (m) | Run No. | Type and surface description | Notes / Water levels / Instrumentation |
|---|---|---|---|---|---|---|
| 30 | | | 294.46 / 30.57; 294.23 / 30.80 | 10 | B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, J,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, J,(2,1),, | |
| 31–32 | August 12, 2003 | | 293.30 / 31.73; 293.09 / 31.94 | 11 | B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, | |
| 32–34 | 96mm HQ CORE HOLE | UPPER LUCAS FORMATION DOLOMITIC LIMESTONE (25.91m to 37.19m) Fresh, weathered on open bedding partings, light to medium tan to brownish grey, interbedded very fine to fine grained, non-porous to faintly porous, locally pitted to vuggy, thin to medium bedded, laminar textured (stromatolitic) in part and locally oolitic, weakly stylolitic, partly fossiliferous dolomitic LIMESTONE with dark tan sections of porous, faintly petroliferous limestone. Basal contact marked by porous horizon. ·from 30.57 to 30.80 m medium grey, mottled porous to pitted dolostone marker bed, sharp basal contact ·from 31.73 to 31.94 m dark grey, porous, laminar, faintly petroliferous argillaceous dolostone bed | | 12 | B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, | Open 96mm Drillhole |
| 35–36 | | UPPER LUCAS FORMATION becomes dolomitic limestone from 30.57 m to 37.19 m | | 13 | B,(2,1),, B,(2,1),, B,(2,1),, J,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, | |
| 37–40 | August 13, 2003 | LOWER LUCAS FORMATION DOLOSTONE (37.19m to 50.44m) Transitional contact with overlying strata. Fresh, faintly weathered in some beds, moderately weathered on open bedding partings, light to medium tan to brownish grey, very fine to fine grained, non-porous to faintly to moderately porous, thin to medium bedded laminar textured DOLOSTONE with faintly petroliferous beds. · from 37.19m to 37.34m dark brownish grey, argillaceous dolostone · from 38.05m to 38.19m angular intraformational dolostone breccia · from 38.79m to 39.03m dark grey argillaceous partings and brown porous, faintly petroliferous dolostone with void at 39.03m where drill water circulation lost | 287.84 / 37.19; 37.34; 286.98 / 38.05; 38.19; 286.24 / 38.79; 286.00 / 39.03; 285.57 / 39.50 | 14, 15, 16 | B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, B,(2,1),, J,(2,1),, | Aug 18/03 |

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KJC
CHECKED:

PROJECT: 04-1112-056

# RECORD OF DRILLHOLE: BH-S3



LOCATION: N 4786842.9 ;E 488576.4

INCLINATION: -90° AZIMUTH: —

DRILLING DATE: Aug. 7, 2003 - Aug. 13, 2003

DRILL RIG: CME 75

DRILLING CONTRACTOR: ALL-TERRAIN

DATUM: NAD 83

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

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

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER .3m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION) | HYDRAULIC CONDUCTIVITY K, cm/sec ($10^{-6}$ $10^{-5}$ $10^{-4}$ $10^{-3}$) | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

— CONTINUED FROM PREVIOUS PAGE —

Drilling record: 96mm HQ CORE HOLE; August 13, 2003

**LOWER LUCAS FORMATION CONTINUED**
- at 39.27m 10 mm thick black argillaceous bed
- from 39.46m to 39.50m medium grey mottled marker bed
- from 40.88m to 40.76 m dark grey argillaceous dolostone
- from 40.78m to 42.52m and 43.37m to 43.75m weathered vuggy dolostone developed from solution of fossils
- from 44.56m to 44.81m yellowish weathered porous dolostone
- from 45.31m to 45.96m thinly bedded dolostone with open weathered bedding partings with additionel open partings at 46.15m, 47.06m, 47.24m, 47.27m and 47.55m, weathered and porous between 47.27m and 47.55m
- from 47.55m to 50.43m fresh limestone and dolomitic limestone

| ELEV. | DEPTH (m) |
|---|---|
| 284.35 | 40.68 |
| | 40.78 |
| 282.51 | 42.52 |
| 281.66 | 43.37 |
| 281.28 | 43.75 |
| 280.47 | 44.56 |
| 280.22 | 44.81 |
| 279.72 | 45.31 |
| 279.07 | 45.96 |
| 278.88 | 46.15 |
| 277.97 | 47.06 |
| 277.79 | 47.27 |
| 277.48 | 47.55 |

| Depth scale (m) | Run No. | Discontinuity type and surface description |
|---|---|---|
| 40 | 16 | B,(2,1),, ; B,(2,1),, |
| 41 | 16–17 | J,(2,1),, ; B,(2,1),, ; B,(2,1),, |
| 42 | 17 | B,(2,1),, ; B,(2,1),, ; B,(2,1),, ; B,(2,1),, ; B,(2,1),, ; B,(2,1),, ; B,(2,1),, |
| 43 | 18 | J,(2,1),, ; B,(2,1),, |
| 44 | 18–19 | B,(2,1),, ; B,(2,1),, ; B,(2,1),, ; B,(2,1),, ; B,(2,1),, |
| 45 | 19 | B,(2,1),, ; B,(2,1),, |
| 46 | 20 | B,(2,1),, ; B,(2,1),, |
| 47 | 20 | B,(2,1),, ; B,(2,1),, ; B,(2,1),, ; B,(2,1),, |
| 48 | 21 | B,(2,1),, ; B,(2,1),, ; J,(2,1),, ; B,(2,1),, ; B,(2,1),, ; B,(2,1),, |
| 49 | 22 | J,(2,1),, ; B,(2,1),, ; B,(2,1),, ; B,(2,1),, ; J,(2,1),, ; B,(2,1),, ; B,(2,1),, |
| 50 | | |

NOTES: Open 96mm Drillhole

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KJC

CHECKED:

PROJECT: 04-1112-056

# RECORD OF DRILLHOLE: BH-S3



LOCATION: N 4786842.9 ;E 488576.4

DRILLING DATE: Aug. 7, 2003 - Aug. 13, 2003

DATUM: NAD 83

DRILL RIG: CME 75

INCLINATION: -90° AZIMUTH: —

DRILLING CONTRACTOR: ALL-TERRAIN

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

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

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE (m/min) | COLOUR % RETURN | FLUSH | RECOVERY TOTAL CORE % | RECOVERY SOLID CORE % | R.Q.D. % | FRACT. INDEX PER .3m | B Angle | DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | HYDRAULIC CONDUCTIVITY K, cm/sec | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | — CONTINUED FROM PREVIOUS PAGE — | | | | | | | | | | | | | | | | | |
| 50 | | LOWER LUCAS FORMATION CONTINUED | | 274.59 | 22 | | | | | | | | | | B,(2,1),, | | | | Open 96mm Drillhole |
| | | END OF BOREHOLE | | 50.44 | | | | | | | | | | | | | | | |
| 51 | | | | | | | | | | | | | | | | | | | |
| 52 | | | | | | | | | | | | | | | | | | | |
| 53 | | | | | | | | | | | | | | | | | | | |
| 54 | | | | | | | | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | | | | | | |
| 56 | | | | | | | | | | | | | | | | | | | |
| 57 | | | | | | | | | | | | | | | | | | | |
| 58 | | | | | | | | | | | | | | | | | | | |
| 59 | | | | | | | | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | | | | | | | | |

DEPTH SCALE

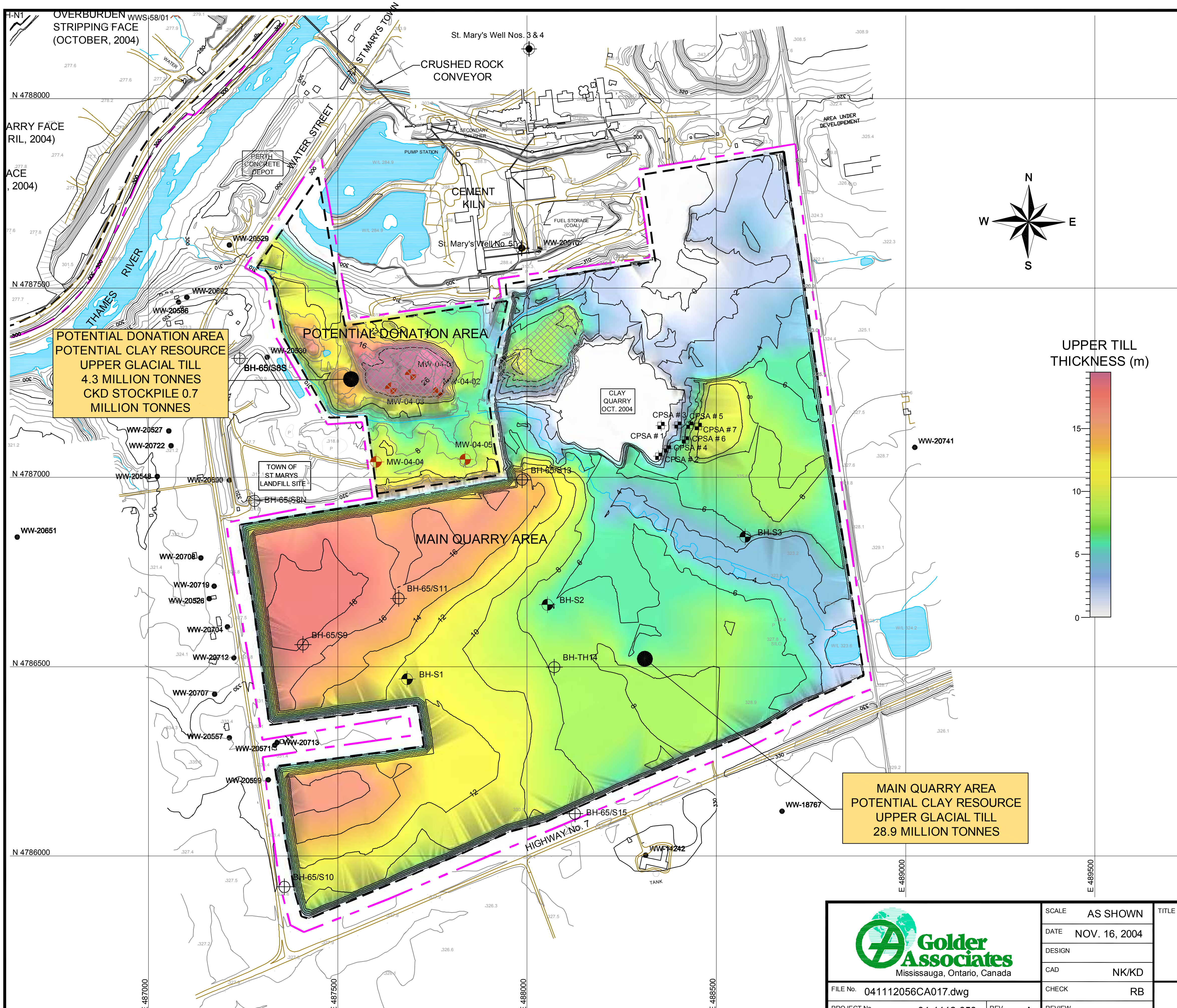
1 : 50

Golder Associates

LOGGED: KJC

CHECKED:

MISS-ROCK-2 041112056AARCK.GPJ GAL-CANADA.GDT 4/1/05 JDR




## LEGEND

QUARRY LICENCE BOUNDARY

QUARRY EXCAVATION SETBACK

MW-04-04 BOREHOLE LOCATION FROM CURRENT INVESTIGATION FOR LANDFILL AREA, REPORT GOLDER NO. 04-1112-047

CPSA # 3 TEST PITS LOCATION FROM CURRENT INVESTIGATION, 2004

BH-S1 BOREHOLE LOCATION DRILLED BY GOLDER, 2000

WW-20618 WATER WELL SUPPLY LOCATION - MINISTRY OF ENVIRONMENT (MOE) WWIS DATABASE

BH-65/S8 BOREHOLE LOCATION - DRILLED BY ST. MARY'S CEMENT, 1965

MUNICIPAL / INDUSTRIAL WATER SUPPLY WELLS

CKD STOCKPILE

## NOTES

1. THIS FIGURE IS TO BE READ IN CONJUCTION WITH THE ATTACHED REPORT.
2. THE CURRENT EXCAVATION FACE AT THE QUARRY WAS SURVEYED BY AGM SURVEYING AND ENGINEERING, DRAWING No. SM 0412T1.dwg (OCTOBER, 2004).
3. THE TEST PITS WERE SURVEYED BY AGM SURVEYING AND ENGINEERING BY REPORT No. SM-CEM-34 (SEPTEMBER, 2004).
4. LOCATIONS OF 1958, 1965 AND 1974 BOREHOLES AND MOE WELLS ARE APPROXIMATE ONLY.
5. TONNAGE ESTIMATES BASED ON VOLUMES WITH BULK DENSITY OF 2.0 T/m$^3$ FOR SOIL.

## REFERENCE

BASE MAP FROM ST. MARYS CEMENT INC. TOPOGRAPHIC SURVEY UPDATED SEPTEMBER 2004, DRAWING No. MP 001 V.01 (3D CONTOURS), UMT NAD83.

OCTOBER 2004 SURVEY OF THOMAS ST. QUARRY FACE AND OVERBURDEN STRIPPING FACE AND SOUTH QUARRY CLAY PIT OBTAINED FROM AGM, FILE NAME SM0412T1.DWG, DATED OCT. 7, 2004, SCALE 1:2000.

200 0 200 400

SCALE 1:10000 METRES

Golder Associates
Mississauga, Ontario, Canada

| | |
|---|---|
| SCALE | AS SHOWN |
| DATE | NOV. 16, 2004 |
| DESIGN | |
| CAD | NK/KD |
| CHECK | RB |
| REVIEW | |
| FILE No. | 041112056CA017.dwg |
| PROJECT No. | 04-1112-056 |
| REV. | A |

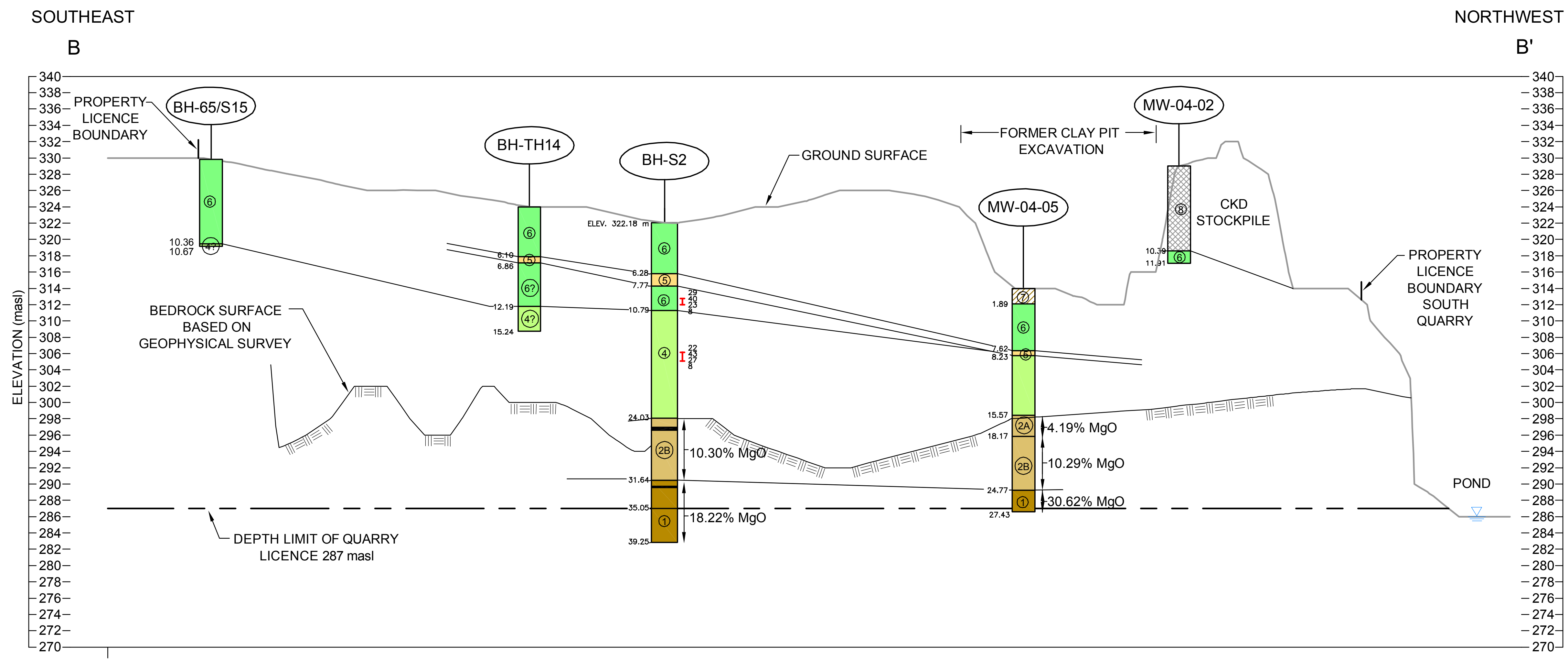
TITLE

# INFERRED THICKNESS OF POTENTIAL CLAY RESOURCE SOUTH QUARRY

ST. MARY'S CEMENT Co.

FIGURE 17

PLOT DATE: November 22, 2004
FILENAME: T:\Projects\2004\04-1112-056 (SCC,Ontario)\-CA- Combined Reports\041112056CA017.dwg




## STRATIGRAPHY

### SURFICIAL DEPOSITS

8 FILL, loose to compact, grey, silt to sand, cement kiln dust

7 FILL, loose to compact, brown, silty sand to sand and gravel

6 UPPER GLACIAL TILL Very stiff to hard, medium dark grey, moist, massive textured, well graded SILTY CLAY with sand and trace to some matrix support gravel and occasional cobbles of limestone, dolostone, igneous composition.

5 MIDDLE GLACIOLACUSTRINE SILT Firm to compact, light grey, moist to wet, dialatent, massive textured, well graded to thinly bedded SILT and CLAYEY SILT.

4 LOWER GLACIAL TILL Hard, medium brownish grey, moist to dry appearing, massive textured SILTY CLAY to CLAYEY SILT with sand and trace to some matrix supported gravel, occasional cobbles and boulders of limestone, dolostone and igneous composition. Cobbles and boulders increase to 10 to 20 percent near base of sequence.

### BEDROCK DEPOSITS

3 DUNDEE FORMATION LIMESTONE Fresh, weathered on open bedding partings, light creamy grey to light tan grey, very fine to fine grained, non-porous, thin to medium bedded, partly fossiliferous (rugose corals) LIMESTONE.(3A) and Dolomitic Limestone(3B) Limestone tends to separate on open bedding partings.

2 UPPER LUCAS FORMATION DOLOMITIC LIMESTONE Fresh, weathered on open bedding partings, light to medium tan to brownish grey, interbedded very fine to fine grained, non-porous to faintly porous, locally pitted to vuggy, thin to medium bedded, laminar textured (stromatolitic) in part and locally oolitic, weakly stylolitic, partly fossiliferous LIMESTONE(2A) and Dolomitic Limestone(2B) with dark tan sections of porous, faintly petroliferous limestone.

1 LOWER LUCAS FORMATION DOLOSTONE Fresh, faintly weathered in some beds, moderately weathered on open bedding partings, light to medium tan to brownish grey, very fine to fine grained, faintly to moderately porous, thin to medium bedded, laminar textured DOLOMITIC LIMESTONE to DOLOSTONE with faintly petroliferous beds.

NOTE
FOR LOCATION OF SECTION B - B' REFER TO FIGURE 10

## LEGEND

GRAIN SIZE CLASSIFICATION TEST INTERVAL
22 → % CLAY SIZE (<0.002mm) % SILT SIZE [0.002mm to
51 → 0.075mm (No. 200 SEIVE)] % SAND SIZE [0.075mm to
19 → 4.75mm (No. 200 to No. 4 SEIVE)] % GRAVEL SIZE [4.75mm
8 → to 26.2mm (No. 4 to 3 SEIVE)]

STATIC GROUNDWATER LEVEL
BH-S1 MEASURED AUGUST 22, 2003
BH-S3 MEASURED AUGUST 18, 2003

12.49% MgO LENGTH AVERAGED MAGNESIUM OXIDE PERCENT CONCENTRATION OF SOIL AND BEDROCK BASED ON WHOLE ROCK ANALYSES

SCALE Horizontal 1:6000 (120 0 120 240) METRES

SCALE Vertical 1:600 (12 0 12 24) METRES

Golder Associates
Mississauga, Ontario, Canada

| | |
|---|---|
| SCALE | AS SHOWN |
| DATE | NOV. 15, 2004 |
| DESIGN | |
| CAD | KD |
| CHECK | RB |
| REVIEW | |
| FILE No. | 041112056CA014.dwg |
| PROJECT No. | 04-1112-056 |
| REV. | A |

TITLE
# SUB-SURFACE CONDITIONS SECTION B-B' SOUTH QUARRY

ST. MARY'S CEMENT Co.

FIGURE 14

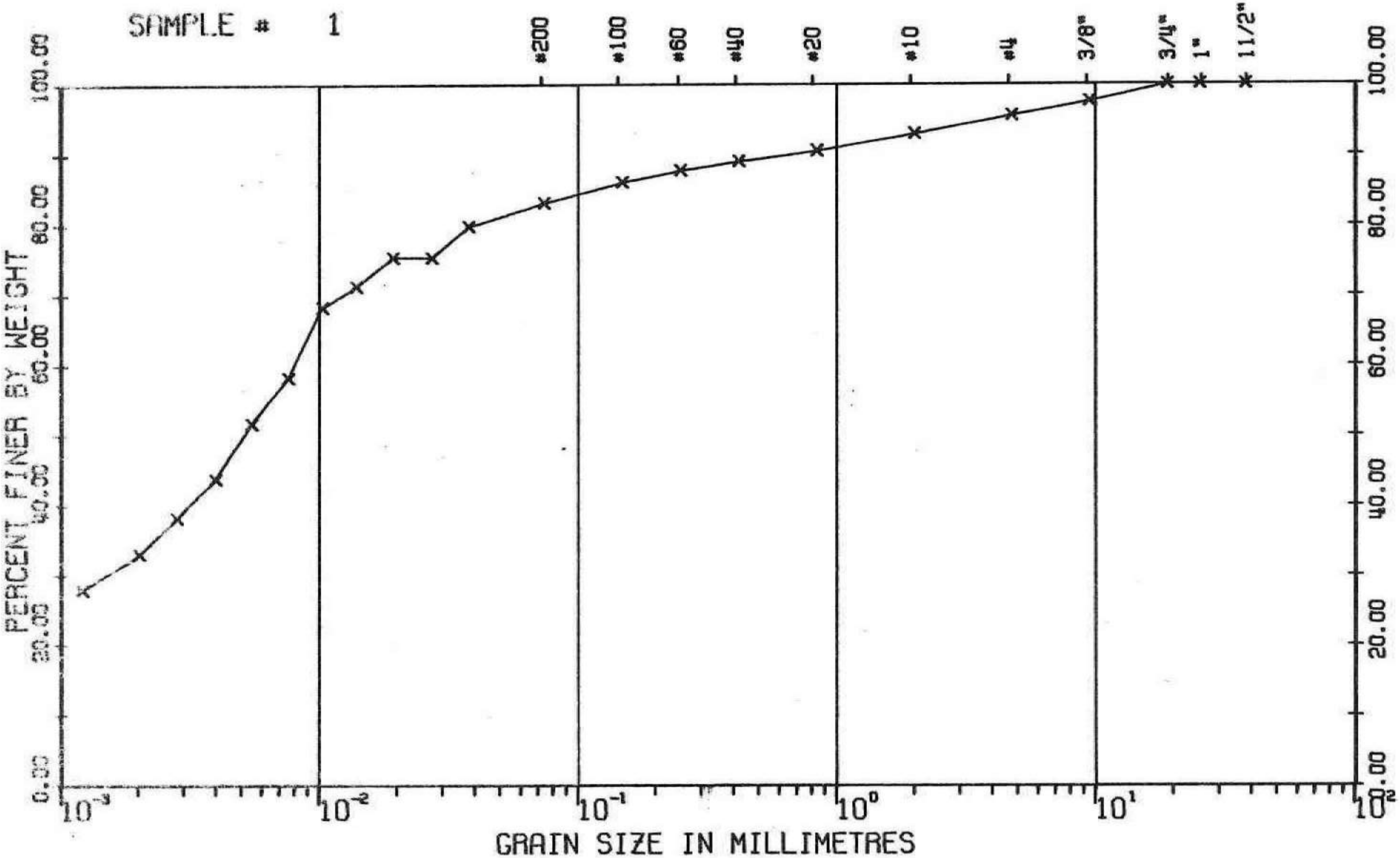
PLOT DATE: November 22, 2004
FILENAME: T:\Projects\2004\04-1112-056 (SCC,Ontario)\-CA- Combined Reports\041112056CA014.dwg

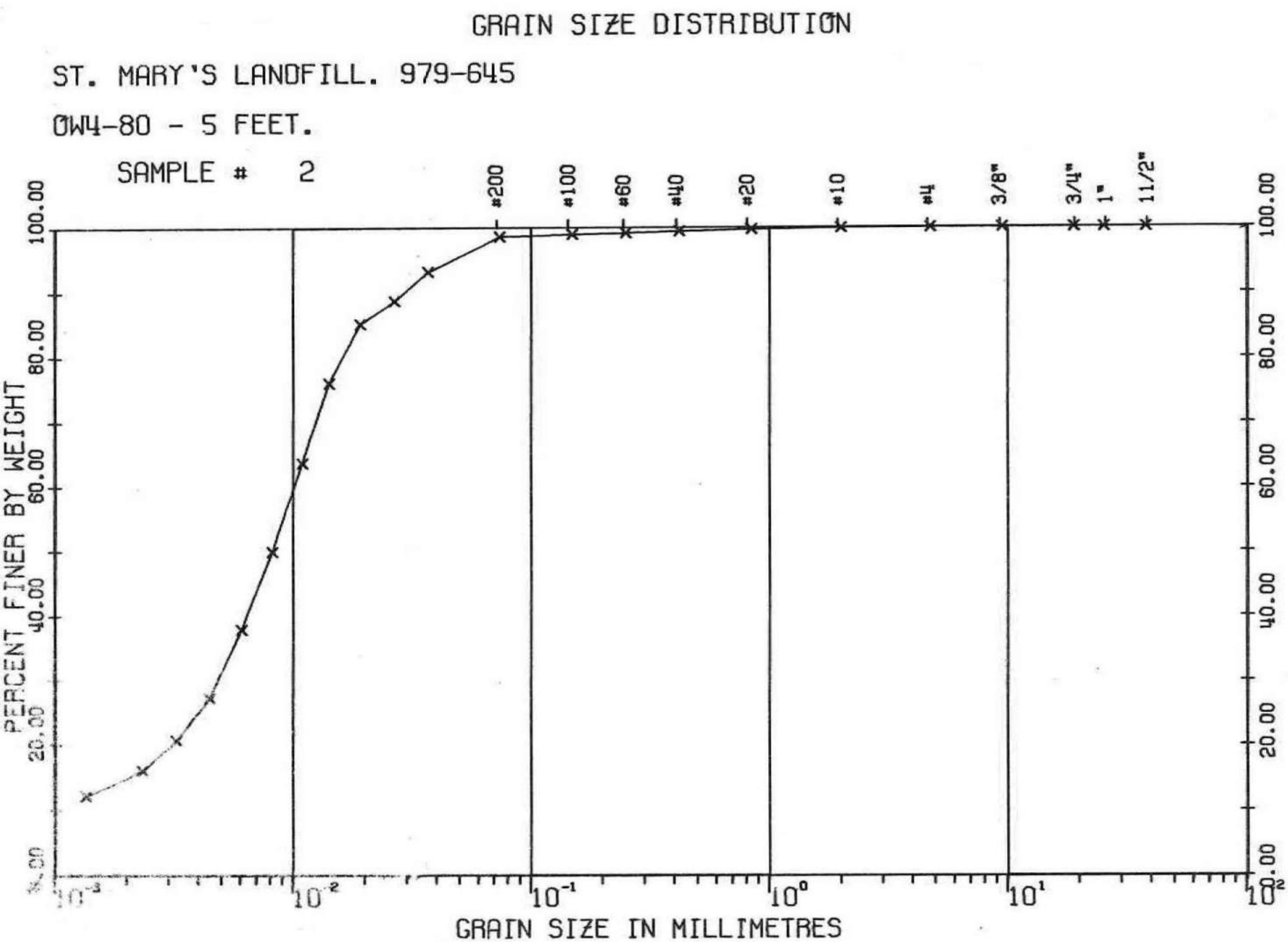
GRAIN SIZE DISTRIBUTION

ST. MARY'S LANDFILL SITE - 979-645.

OW4-80 - 2.5 FEET.

SAMPLE # 1



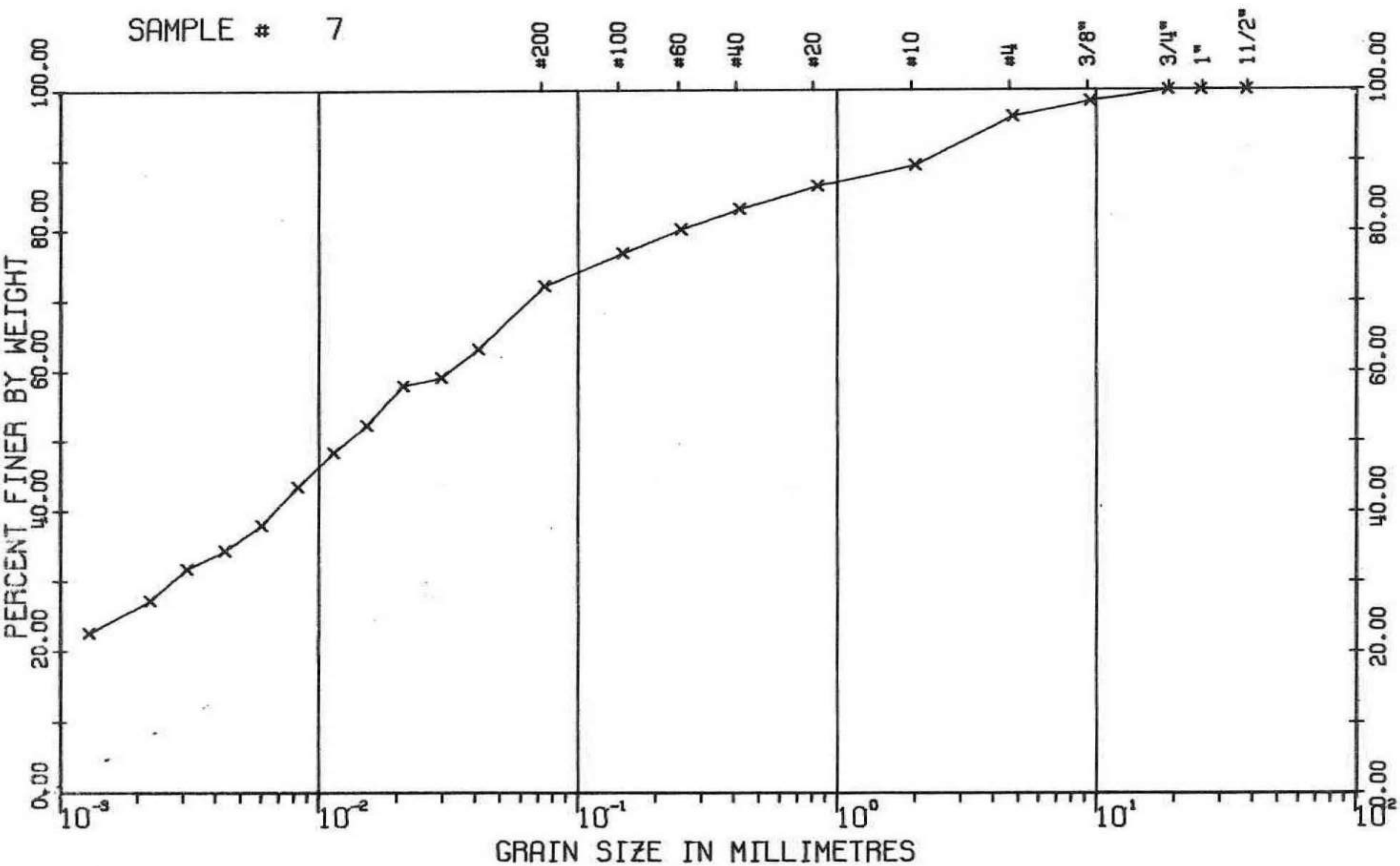

GRAIN SIZE DISTRIBUTION
ST. MARY'S LANDFILL. 979-645
OW4-80 - 5 FEET.
SAMPLE # 2
#200
#100
#60
#40
#20
#10
#4
3/8"
3/4"
1"
11/2"
PERCENT FINER BY WEIGHT
100.00
80.00
60.00
40.00
20.00
0.00
$10^{-3}$
$10^{-2}$
$10^{-1}$
$10^{0}$
$10^{1}$
$10^{2}$
GRAIN SIZE IN MILLIMETRES

GRAIN SIZE DISTRIBUTION

ST. MARY'S LANDFILL. 979-645

OW4-80 - 17.5 FEET.

SAMPLE # 7

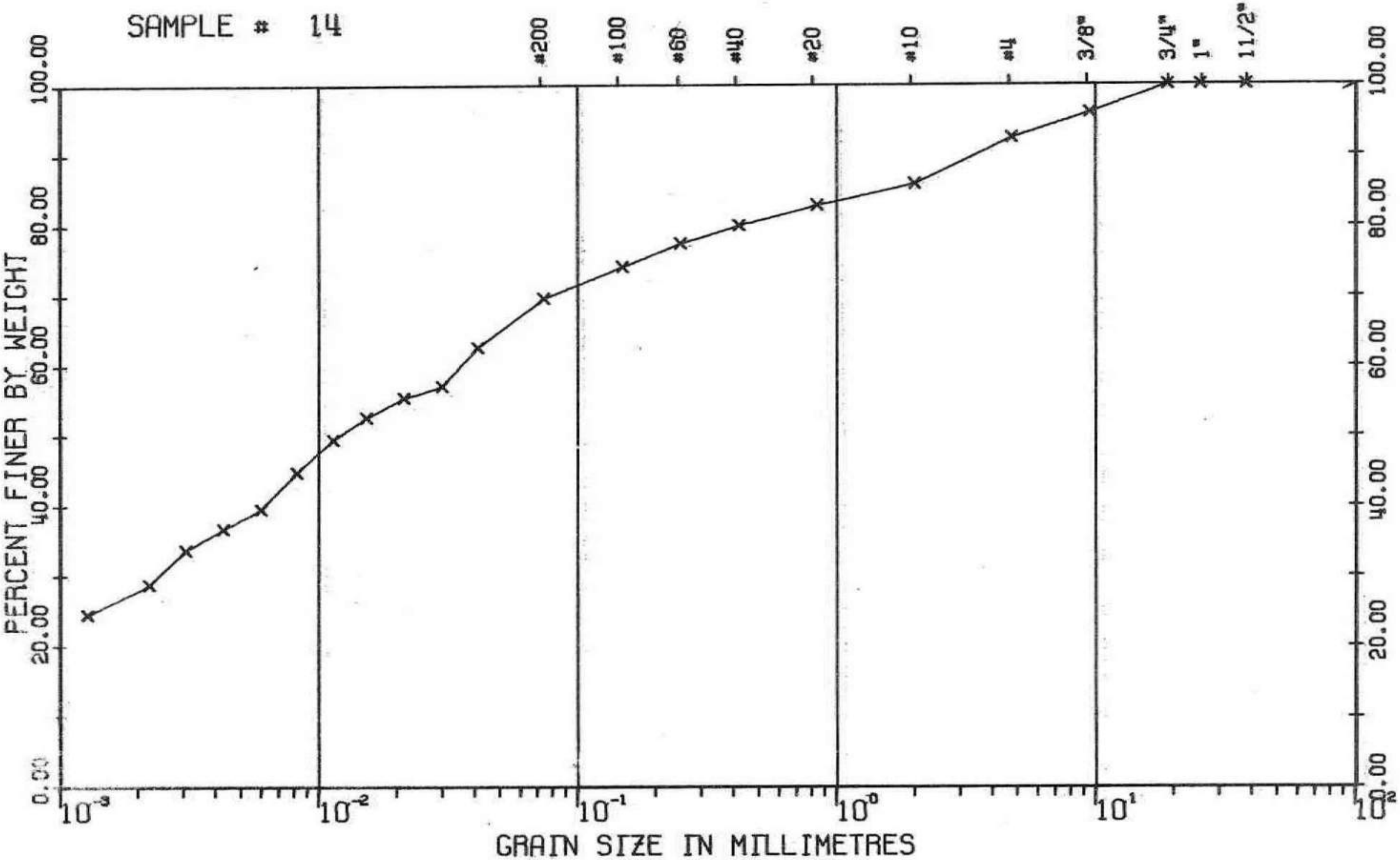


GRAIN SIZE DISTRIBUTION

ST. MARY'S LANDFILL. 979-645

OW1-80 - 20 FEET.

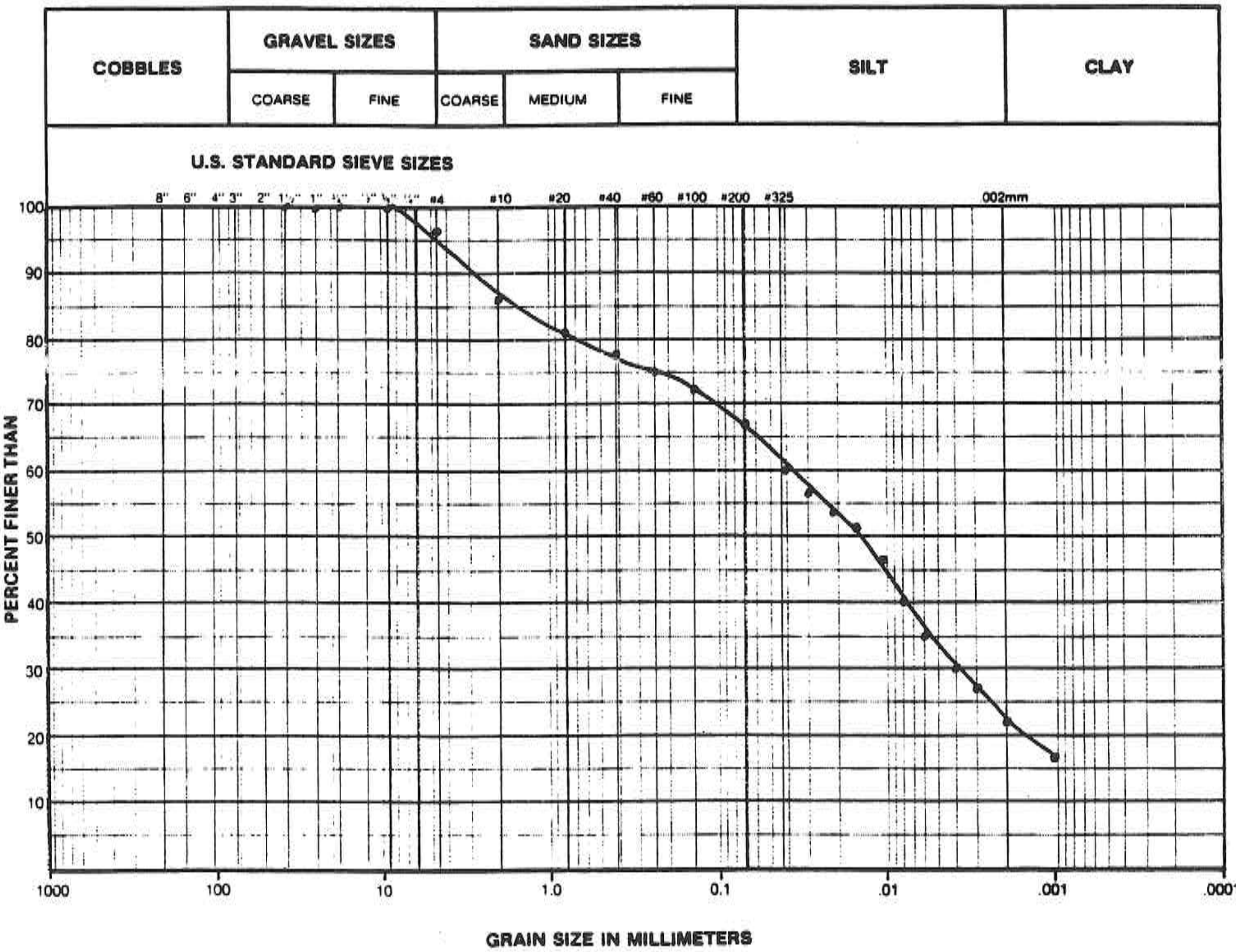
SAMPLE # 14



**CRA** Consulting Engineers
**CONESTOGA-ROVERS & ASSOCIATES**

# GRAIN SIZE CURVE

| | |
|---|---|
| CLIENT: | St. Mary's LF |
| PROJECT NUMBER: | 0645 |
| LAB. NUMBER: | CR 3582 |
| LOCATION: | BH10-91 |
| HOLE: | — |
| SAMPLE: | 2CS |
| DEPTH: | 4 - 7FT. |
| TECHNICIAN: | T. Gerardi |
| DATE: | November 4/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = 4.8E-07 cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS : Silt, Some Sand, Little Clay
Trace Gravel

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50% |
| SOME | 21-35% |
| LITTLE | 11-20% |
| TRACE | 1-10% |

| SUMMARY | | |
|---|---|---|
| GRAVEL | 3.77 | % |
| SAND | 28.68 | % |
| SILT | 46.66 | % |
| CLAY | 20.88 | % |

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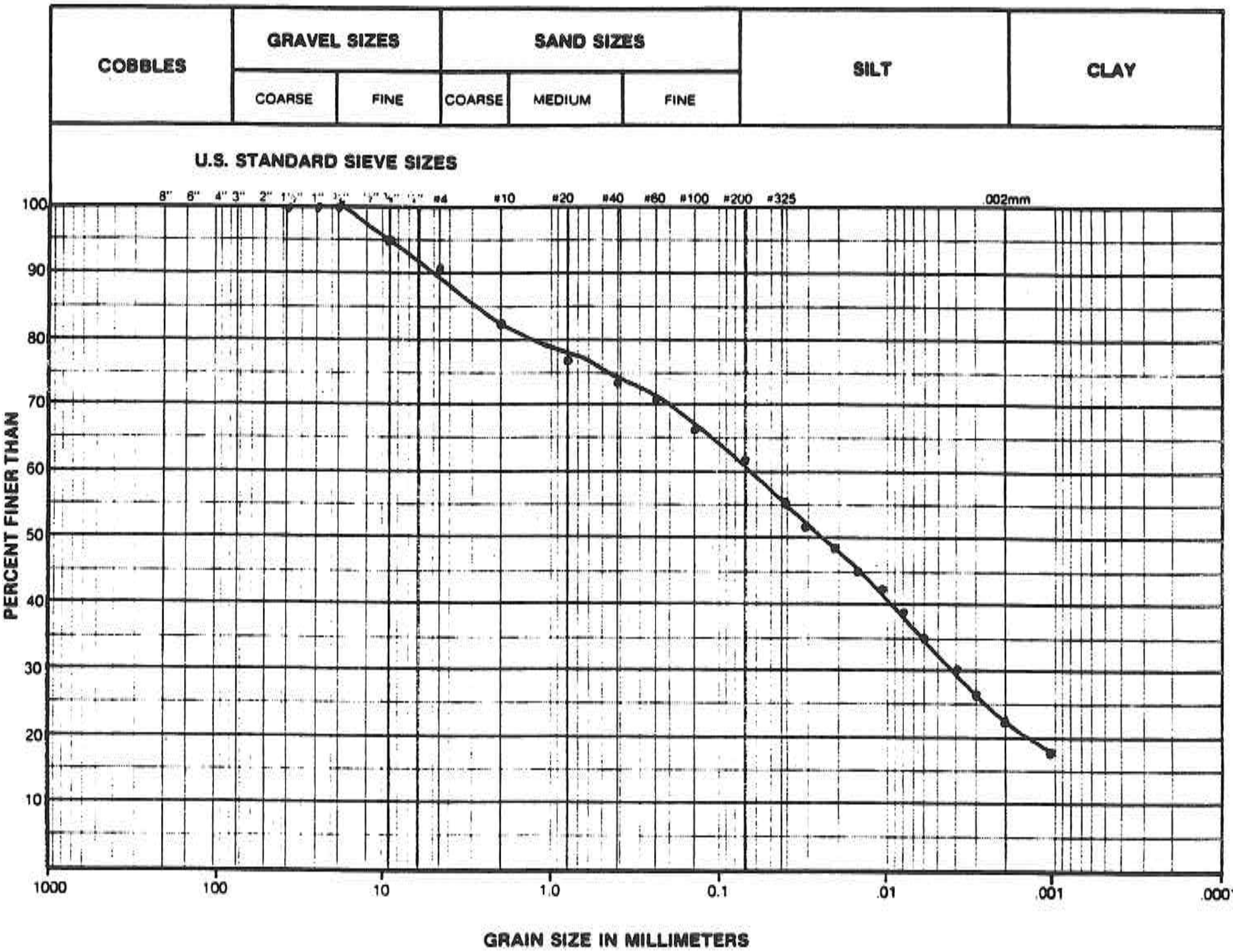
## GRAIN SIZE CURVE

| | |
|---|---|
| CLIENT: | ST. MARY'S LF |
| PROJECT NUMBER: | 0645 |
| LAB. NUMBER: | CR 3583 |
| LOCATION: | BH10 - 91 |
| HOLE: | — SAMPLE: 6CS |
| DEPTH: | 24 - 28 FT |
| TECHNICIAN: | T. GERARDI DATE: NOVEMBER 4/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = 4.1E-07 cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS: SILT, SOME SAND, SOME CLAY, TRACE GRAVEL.

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50 % |
| SOME | 21-35 % |
| LITTLE | 11-20 % |
| TRACE | 1-10 % |

| SUMMARY | | |
|---|---|---|
| GRAVEL | 9.06 | % |
| SAND | 29.34 | % |
| SILT | 39.94 | % |
| CLAY | 21.66 | % |

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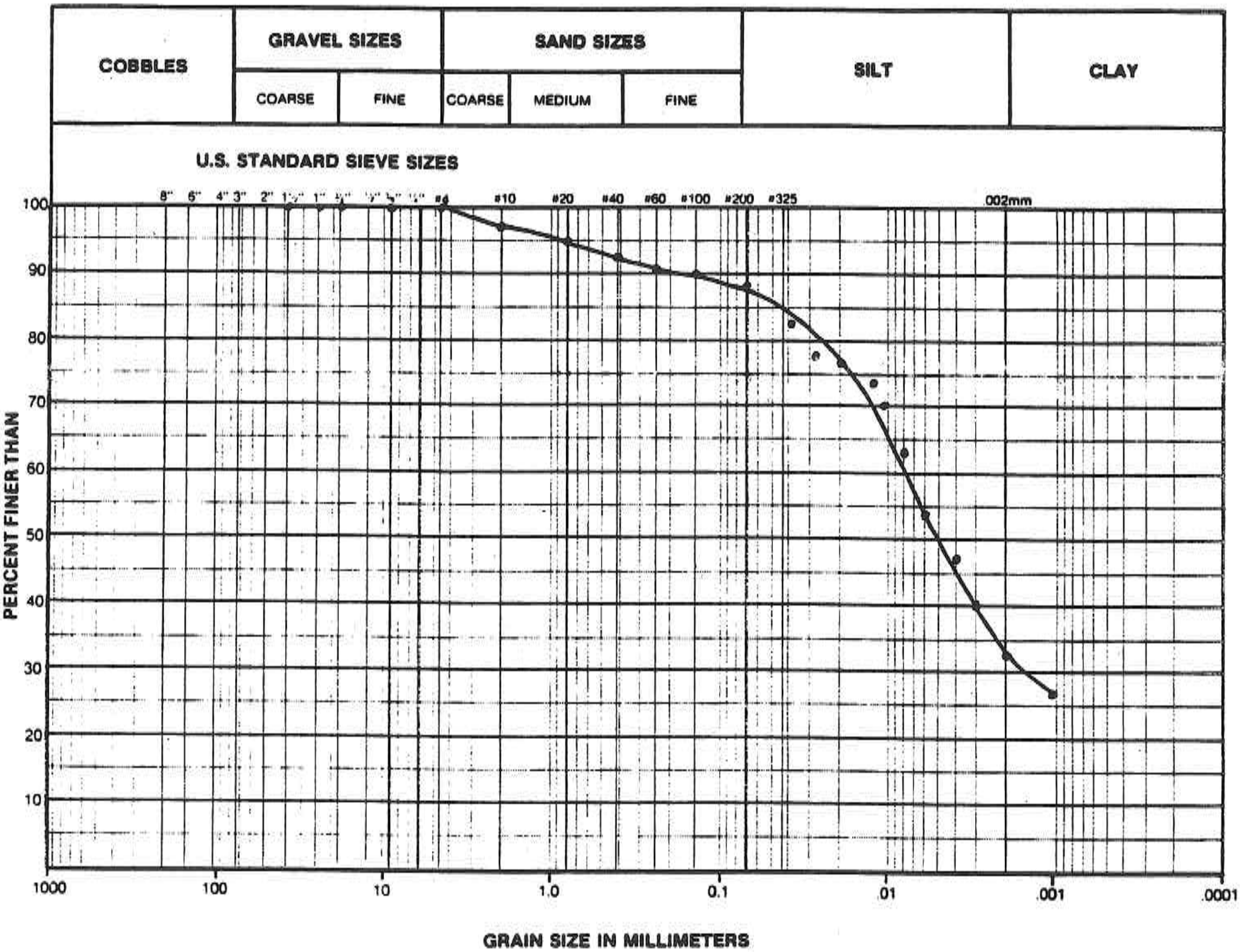
## GRAIN SIZE CURVE

| | |
|---|---|
| CLIENT: | ST. MARY'S LF |
| PROJECT NUMBER: | 0645 |
| LAB. NUMBER: | CR 3587 |
| LOCATION: | BN11 - 91 |
| HOLE: | —— SAMPLE: 2CS |
| DEPTH: | 6 - 10 FT. |
| TECHNICIAN: | T. GERARDI DATE: NOVEMBER 4/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = 1.1E-07 cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS: SILT, SOME CLAY, LITTLE SAND

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50% |
| SOME | 21-35% |
| LITTLE | 11-20% |
| TRACE | 1-10% |

| SUMMARY | | |
|---|---|---|
| GRAVEL | Ø | % |
| SAND | 12.22 | % |
| SILT | 55.93 | % |
| CLAY | 31.85 | % |

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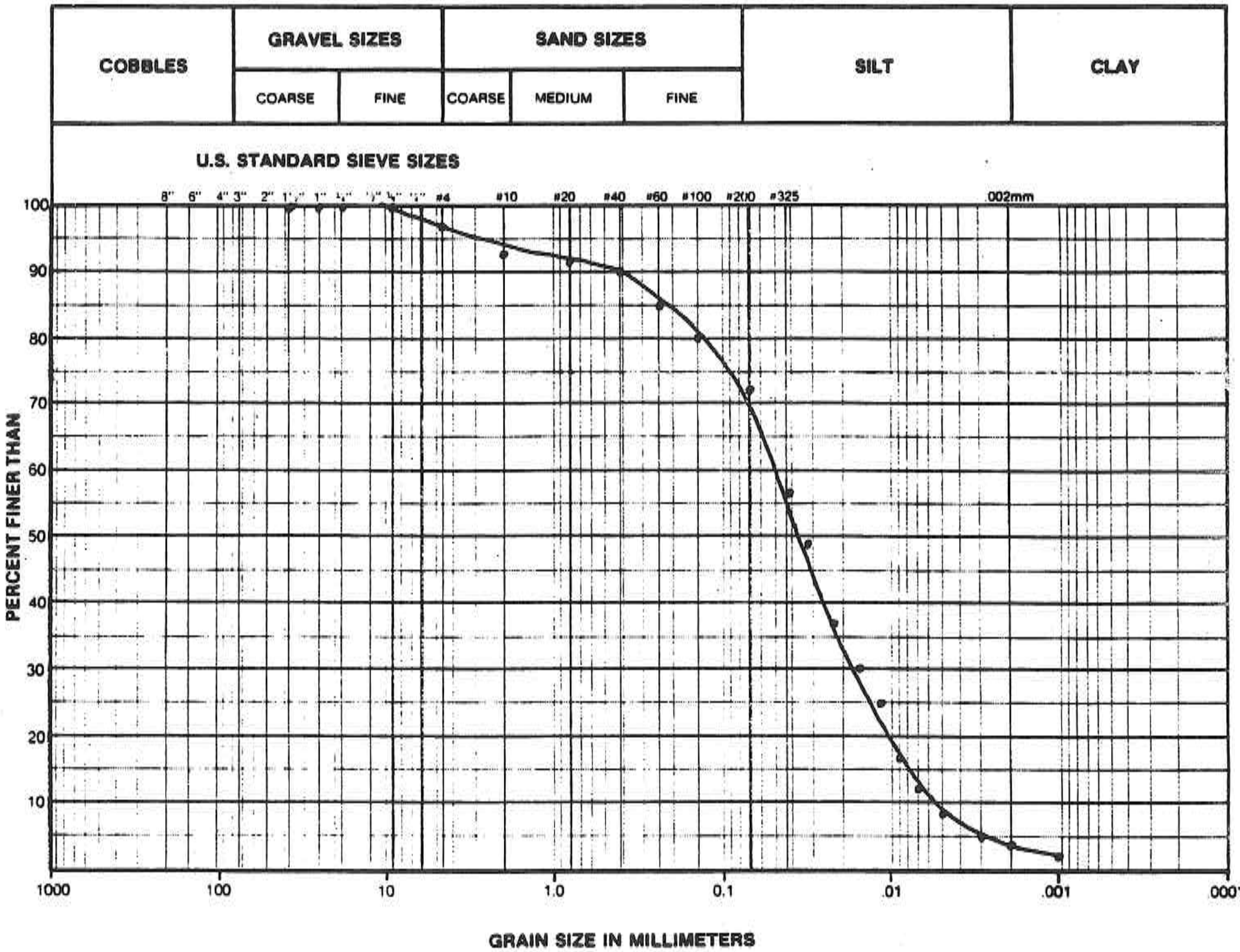
**CONESTOGA-ROVERS & ASSOCIATES**

## GRAIN SIZE CURVE

| | |
|---|---|
| CLIENT: | ST. MARY'S LF |
| PROJECT NUMBER: | 0645 |
| LAB. NUMBER: | CR 3588 |
| LOCATION: | BH12-91 |
| HOLE: | —— SAMPLE: 3CS |
| DEPTH: | 9.5 - 13.5 FT |
| TECHNICIAN: | T. GERARDI DATE: NOVEMBER 4/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = 3.5E-05 cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS : SILT, SOME SAND, TRACE CLAY, TRACE GRAVEL

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50% |
| SOME | 21-35% |
| LITTLE | 11-20% |
| TRACE | 1-10% |

| SUMMARY | | |
|---|---|---|
| GRAVEL | 2.90 | % |
| SAND | 25.51 | % |
| SILT | 68.22 | % |
| CLAY | 3.36 | % |

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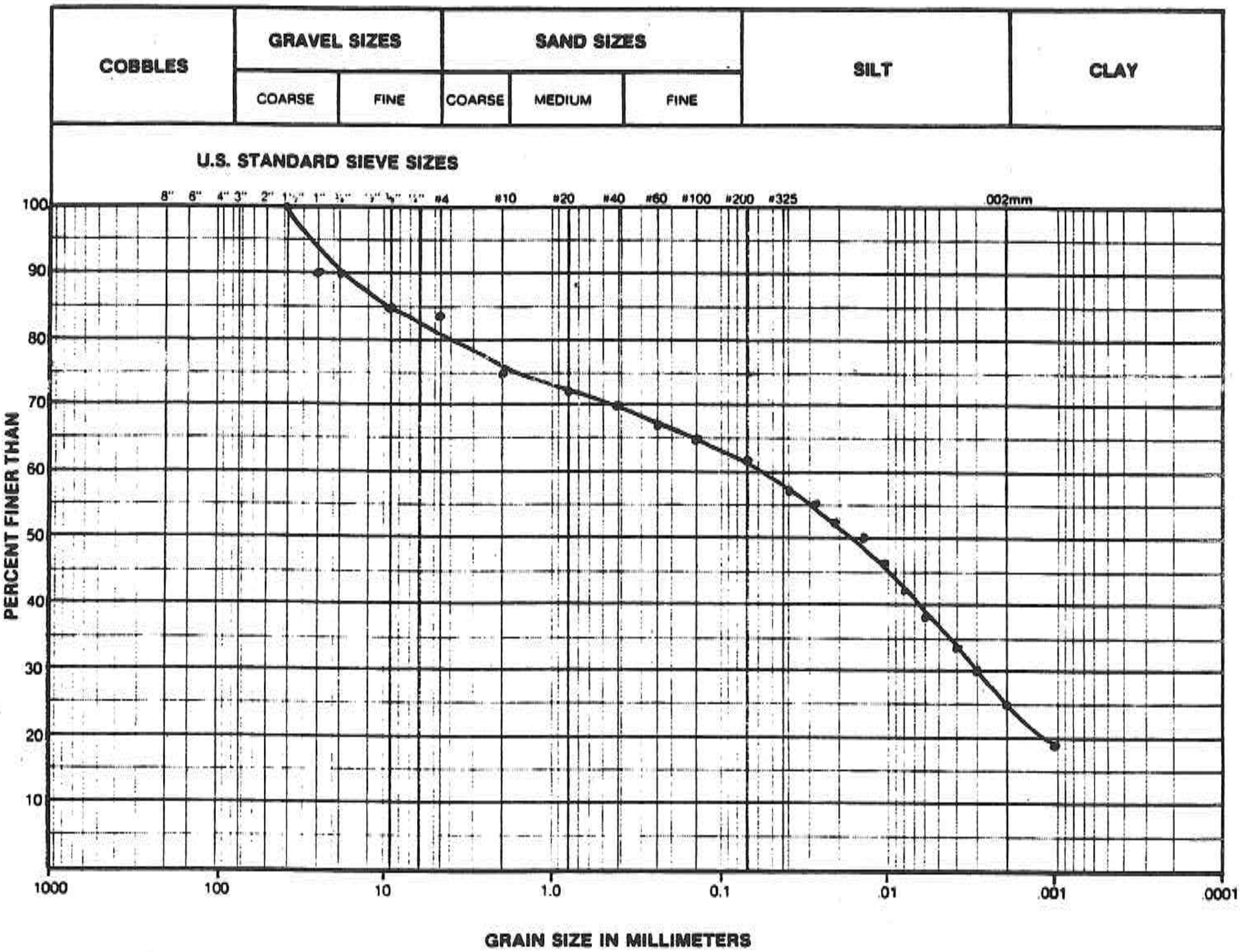
## GRAIN SIZE CURVE

| | |
|---|---|
| CLIENT: | ST. MARY'S LF |
| PROJECT NUMBER: | 0645 |
| LAB. NUMBER: | CR 3589 |
| LOCATION: | BN12-91 |
| HOLE: | — |
| SAMPLE: | 4CS |
| DEPTH: | 14-19 FT |
| TECHNICIAN: | T. GERARDI |
| DATE: | NOVEMBER 6/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = 3.1E-07 cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS: SILT, SOME CLAY, SOME SAND, LITTLE GRAVEL

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50% |
| SOME | 21-35% |
| LITTLE | 11-20% |
| TRACE | 1-10% |

| SUMMARY | |
|---|---|
| GRAVEL | 16.45 % |
| SAND | 21.57 % |
| SILT | 38.33 % |
| CLAY | 23.64 % |

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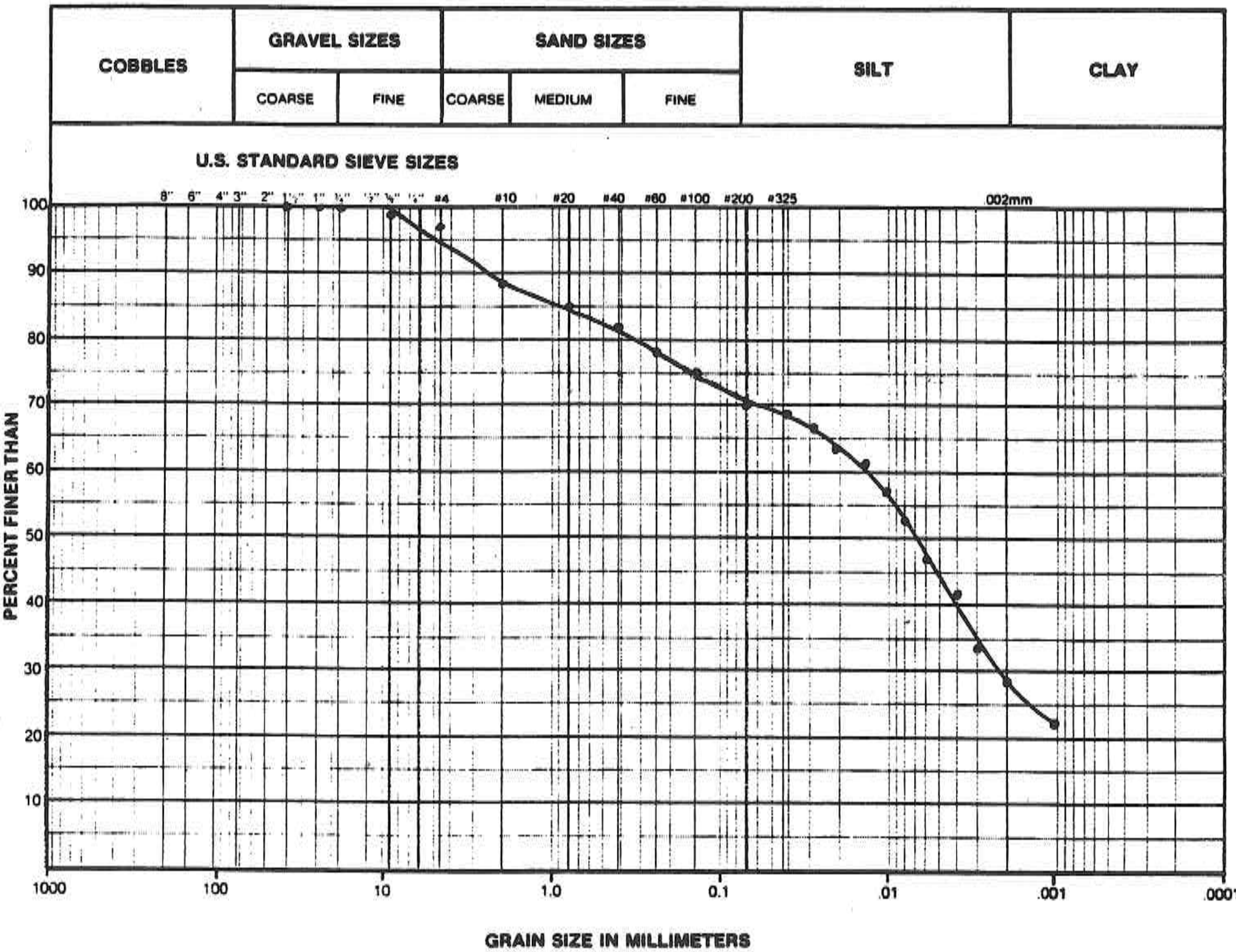
## GRAIN SIZE CURVE

| | |
|---|---|
| CLIENT: | ST. MARY'S LF |
| PROJECT NUMBER: | 0645 |
| LAB. NUMBER: | CR 3590 |
| LOCATION: | BH 13 - 91 |
| HOLE: | —— SAMPLE: 4CS |
| DEPTH: | 15 - 18.5 FT |
| TECHNICIAN: | T. GERARDI DATE: NOVEMBER 4/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = 2.7E-07 cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS: SILT, SOME CLAY, SOME SAND, TRACE GRAVEL

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50% |
| SOME | 21-35% |
| LITTLE | 11-20% |
| TRACE | 1-10% |

| SUMMARY | |
|---|---|
| GRAVEL | 2.93 % |
| SAND | 26.71 % |
| SILT | 42.27 % |
| CLAY | 28.09 % |

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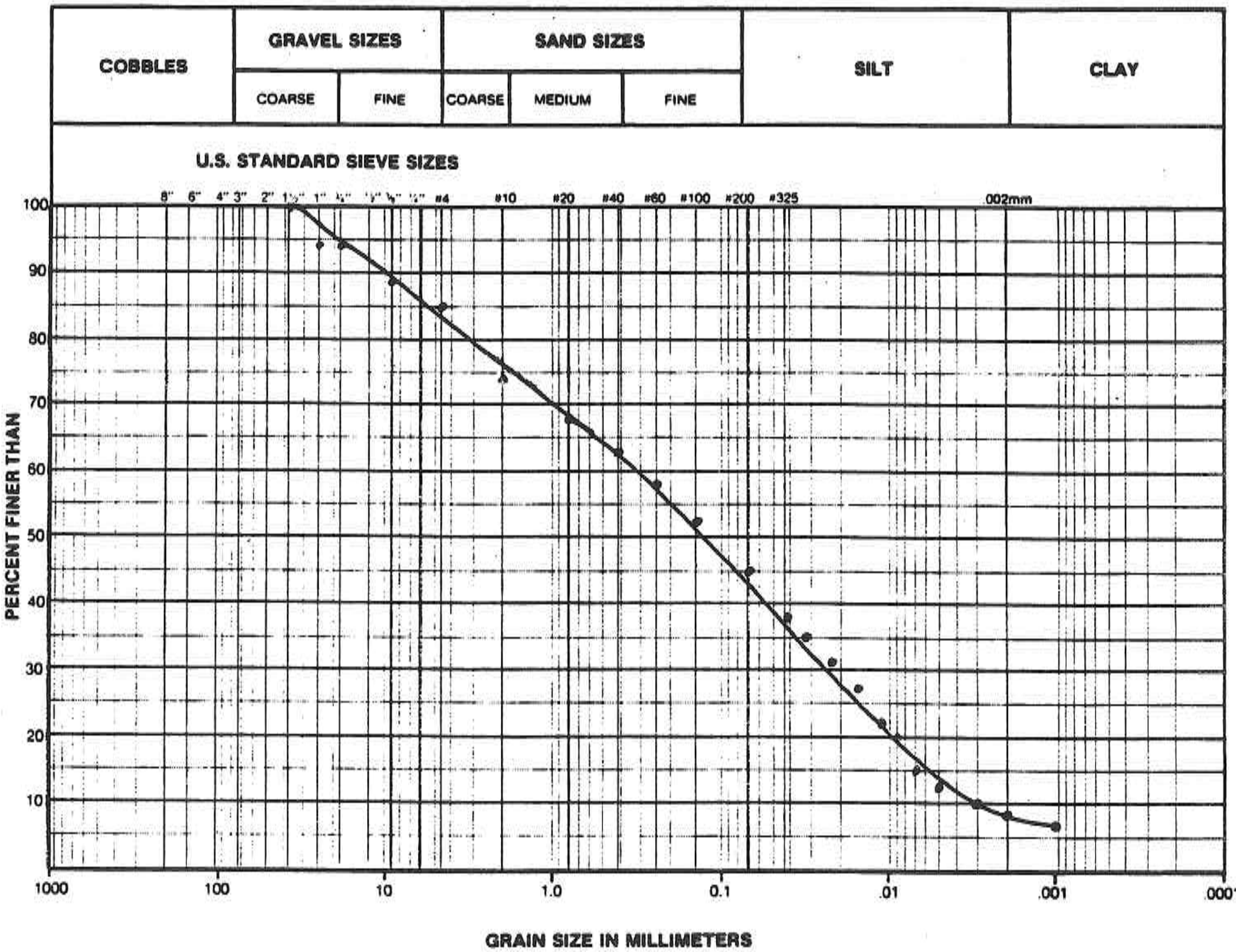
# GRAIN SIZE CURVE

| | | | |
|---|---|---|---|
| CLIENT: | ST. MARY'S LF | | |
| PROJECT NUMBER: | 0645 | | |
| LAB. NUMBER: | CR 3591 | | |
| LOCATION: | BH13-91 | | |
| HOLE: | — | SAMPLE: | 10CS |
| DEPTH: | 43.5 - 48.5 FT | | |
| TECHNICIAN: | T. GERARDI | DATE: | NOVEMBER 6/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = 1.0E - 05 cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS : SAND AND SILT, LITTLE GRAVEL, TRACE CLAY

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50% |
| SOME | 21-35% |
| LITTLE | 11-20% |
| TRACE | 1-10% |

| SUMMARY | |
|---|---|
| GRAVEL | 15.20 % |
| SAND | 40.05 % |
| SILT | 36.62 % |
| CLAY | 8.13 % |

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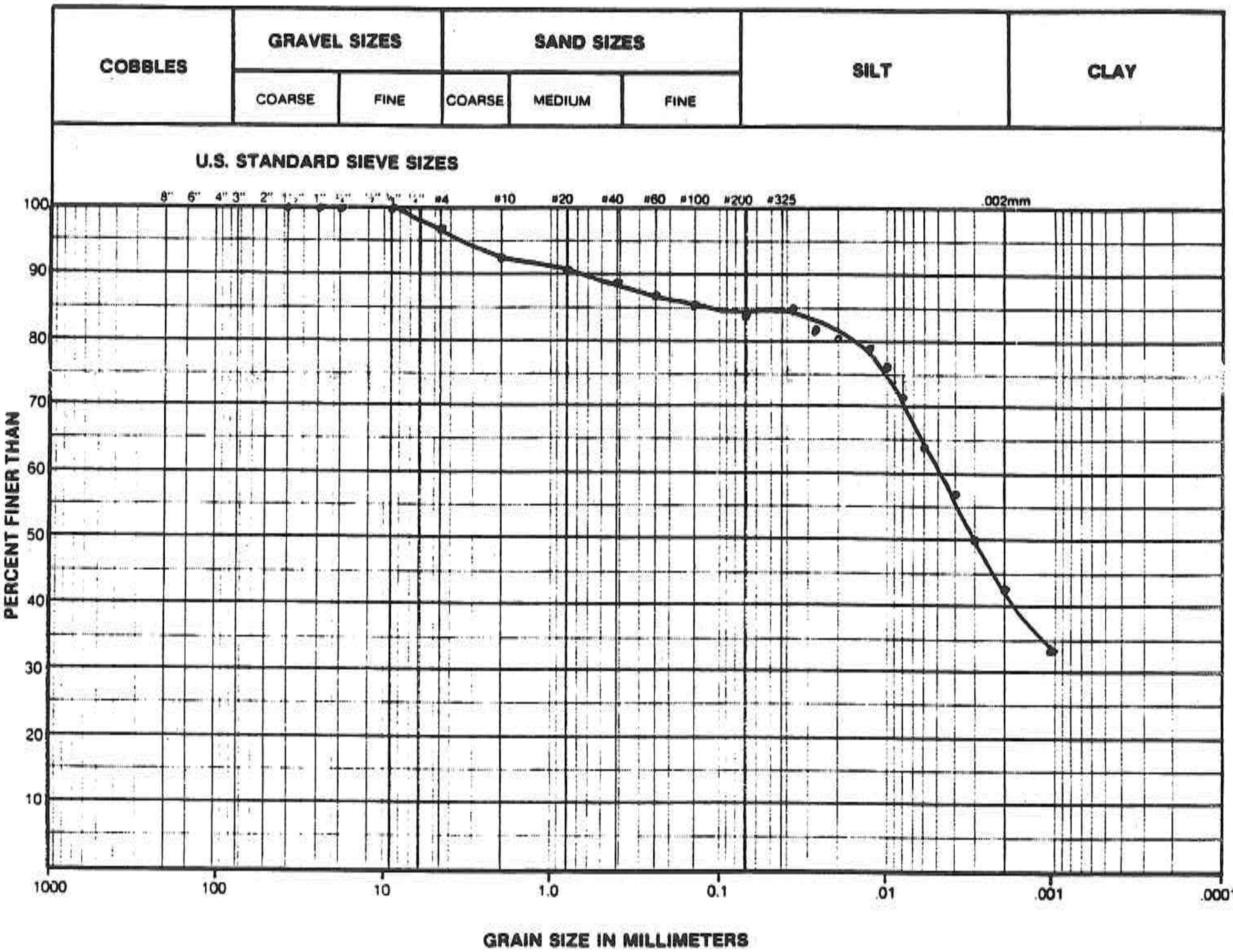
## GRAIN SIZE CURVE

| | |
|---|---|
| CLIENT: | ST. MARY'S LF |
| PROJECT NUMBER: | 0645 |
| LAB. NUMBER: | CR 3584 |
| LOCATION: | OW15-91 |
| HOLE: | — SAMPLE: 1CS |
| DEPTH: | 11.5 - 15 FT |
| TECHNICIAN: | T. GERARDI DATE: NOVEMBER 4/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = 1.2E-07 cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS: SILT AND CLAY, LITTLE SAND, TRACE GRAVEL

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50% |
| SOME | 21-35% |
| LITTLE | 11-20% |
| TRACE | 1-10% |

| SUMMARY | |
|---|---|
| GRAVEL | 2.58 % |
| SAND | 13.64 % |
| SILT | 42.07 % |
| CLAY | 41.72 % |

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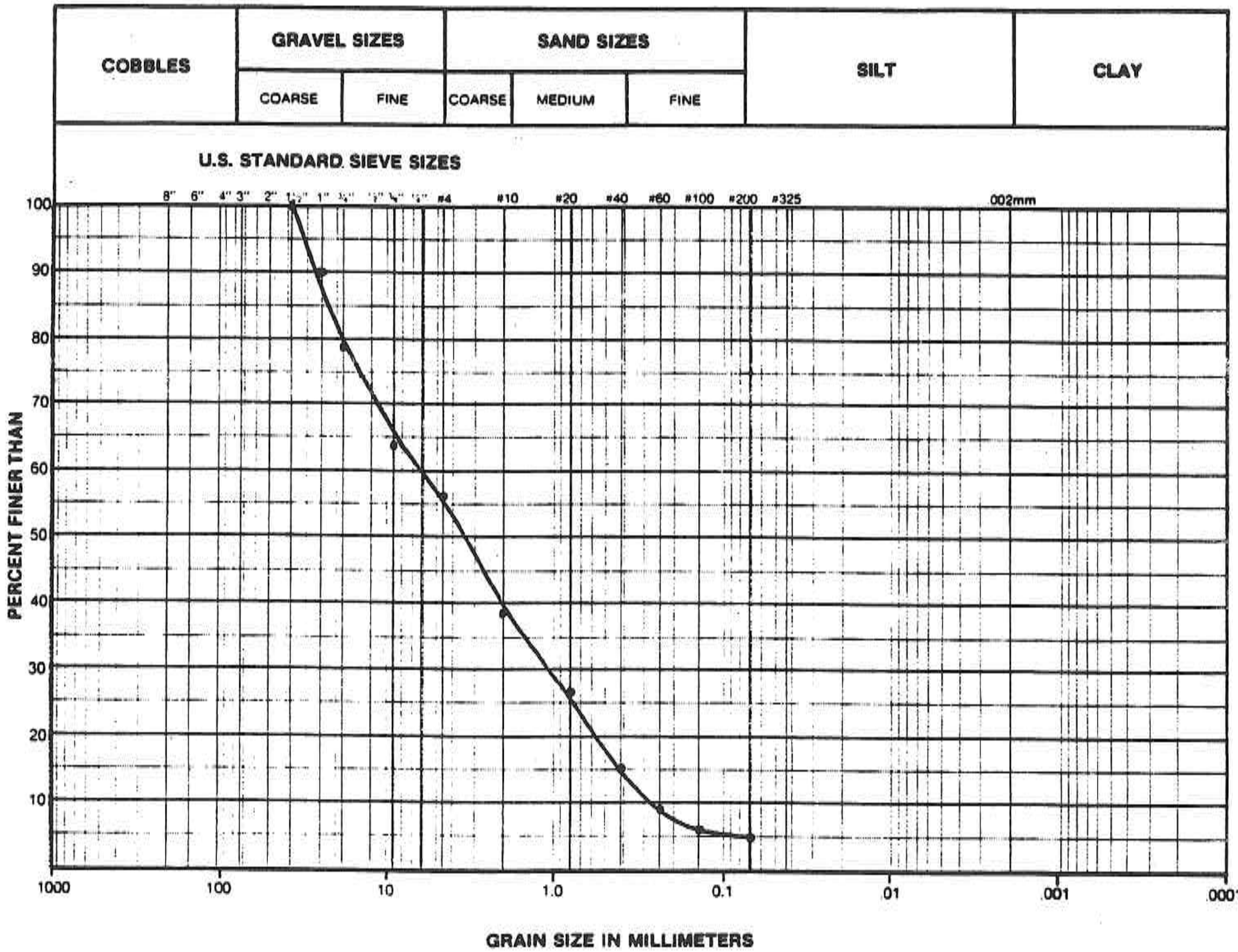
**CONESTOGA-ROVERS & ASSOCIATES**

# GRAIN SIZE CURVE

| | |
|---|---|
| CLIENT: | ST. MARY'S LF |
| PROJECT NUMBER: | 0645 |
| LAB. NUMBER: | CR 3585 |
| LOCATION: | OW15 - 91 |
| HOLE: — | SAMPLE: 2CS |
| DEPTH: | 15 - 19 FT. |
| TECHNICIAN: T. GERARDI | DATE: NOVEMBER 4/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = ______________ cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS:
SAND AND GRAVEL,
TRACE SILT & CLAY

NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50 % |
| SOME | 21-35 % |
| LITTLE | 11-20 % |
| TRACE | 1-10 % |

| SUMMARY | | |
|---|---|---|
| GRAVEL | 43.79 | % |
| SAND | 50.85 | % |
| SILT | — | % |
| & CLAY | 5.36 | % |

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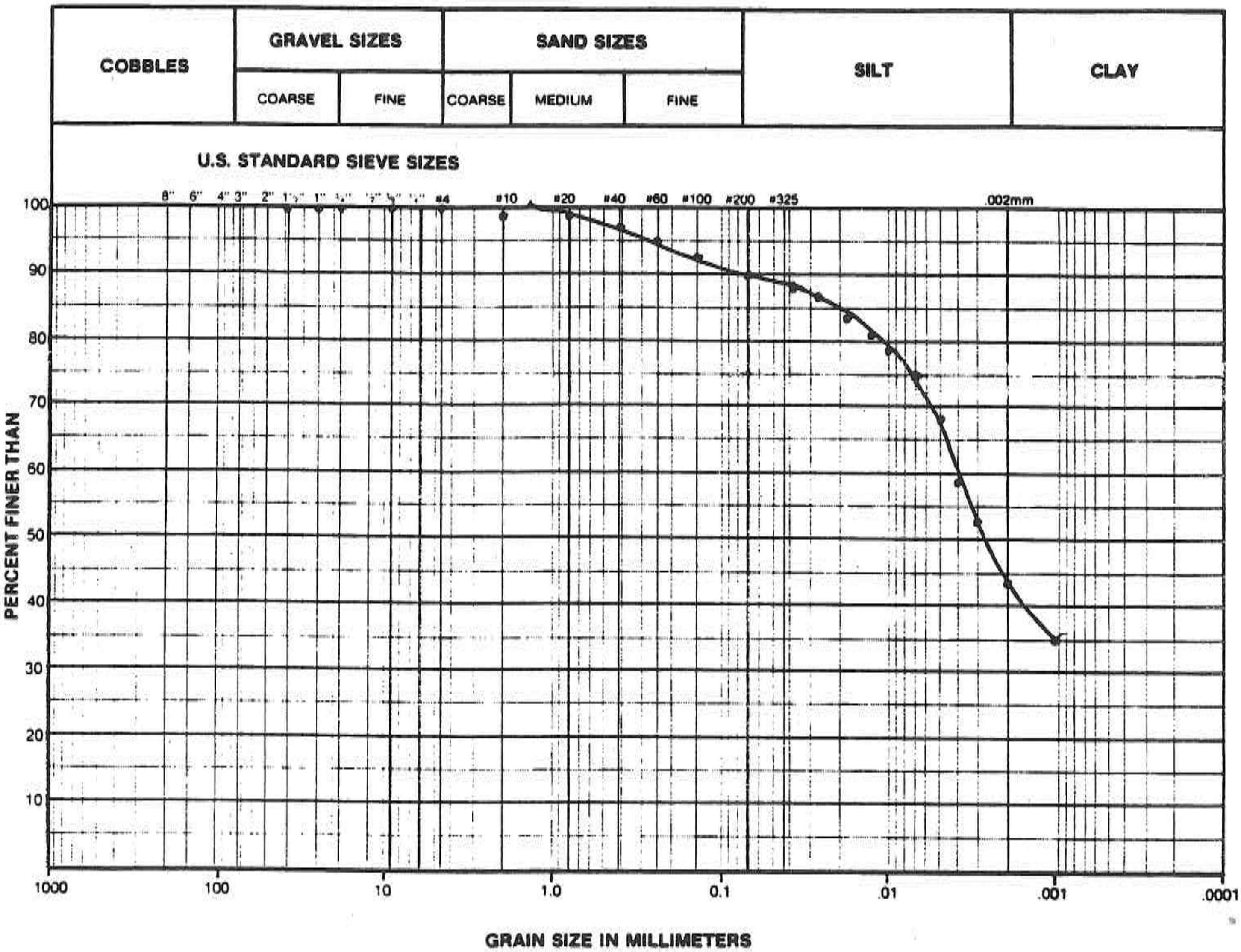
**CONESTOGA-ROVERS & ASSOCIATES**

## GRAIN SIZE CURVE

| | |
|---|---|
| CLIENT: | ST. MARY'S LF |
| PROJECT NUMBER: | 0645 |
| LAB. NUMBER: | CR 3586 |
| LOCATION: | BN16-91 |
| HOLE: | — SAMPLE: 1CS |
| DEPTH: | 9-11 FT |
| TECHNICIAN: | T. GERARDI DATE: NOVEMBER 6/91 |




HAZEN PERMEABILITY ESTIMATE $(D_{10})^2$ = 9.4E-08 cm/sec

NOTE: $D_{10}$ = GRAINSIZE IN mm AT 10% FINER THAN

REMARKS: SILT AND CLAY, TRACE SAND

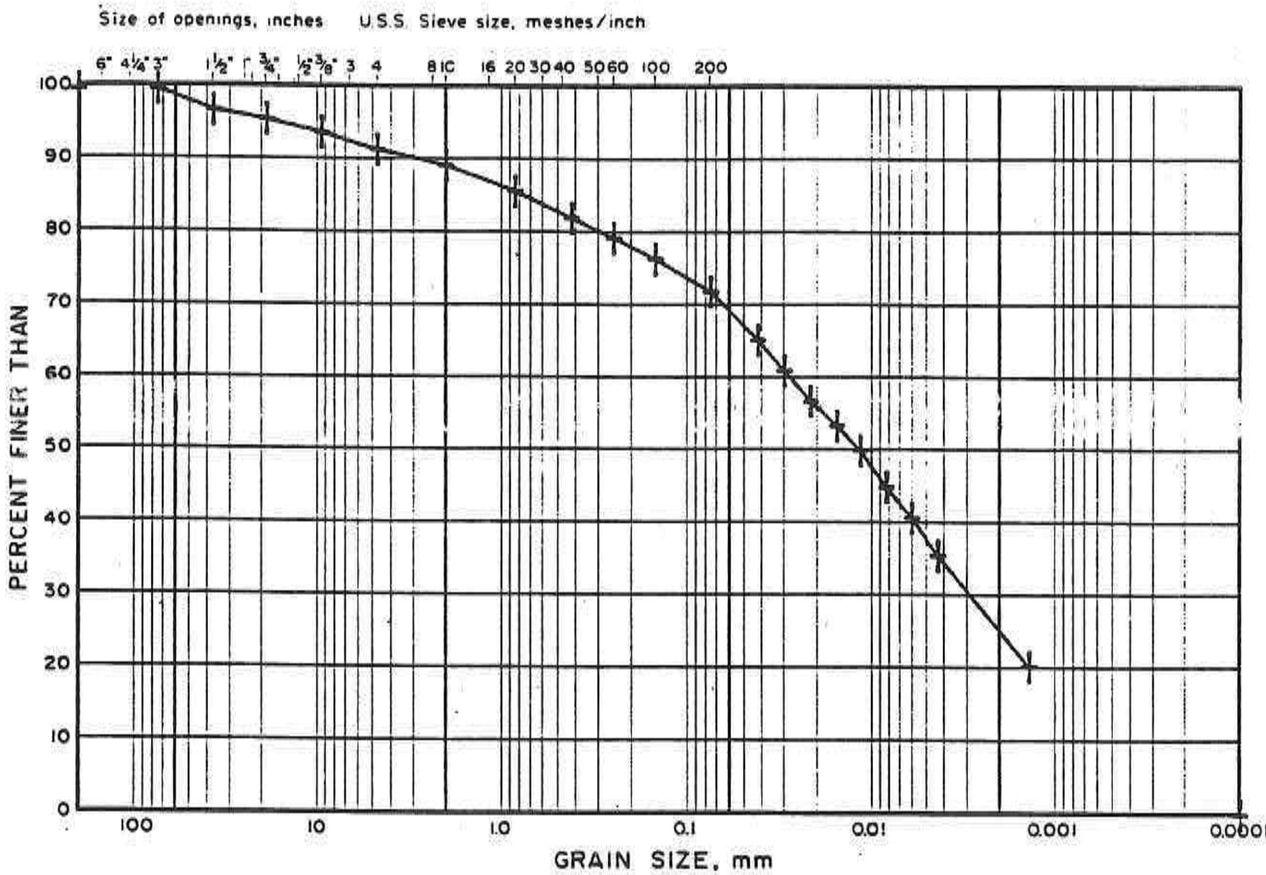
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM

| SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS | |
|---|---|
| AND | 36-50 % |
| SOME | 21-35 % |
| LITTLE | 11-20 % |
| TRACE | 1-10 % |

| SUMMARY | |
|---|---|
| GRAVEL | Ø % |
| SAND | 10.32 % |
| SILT | 46.18 % |
| CLAY | 43.50 % |

## GRAIN SIZE DISTRIBUTION

FIGURE 2




| COBBLE SIZE | COARSE | MEDIUM | FINE | COARSE | MEDIUM | FINE | SILT SIZE | CLAY SIZE |
|---|---|---|---|---|---|---|---|---|
| | GRAVEL SIZE | | | SAND SIZE | | | FINE GRAINED | |

LEGEND

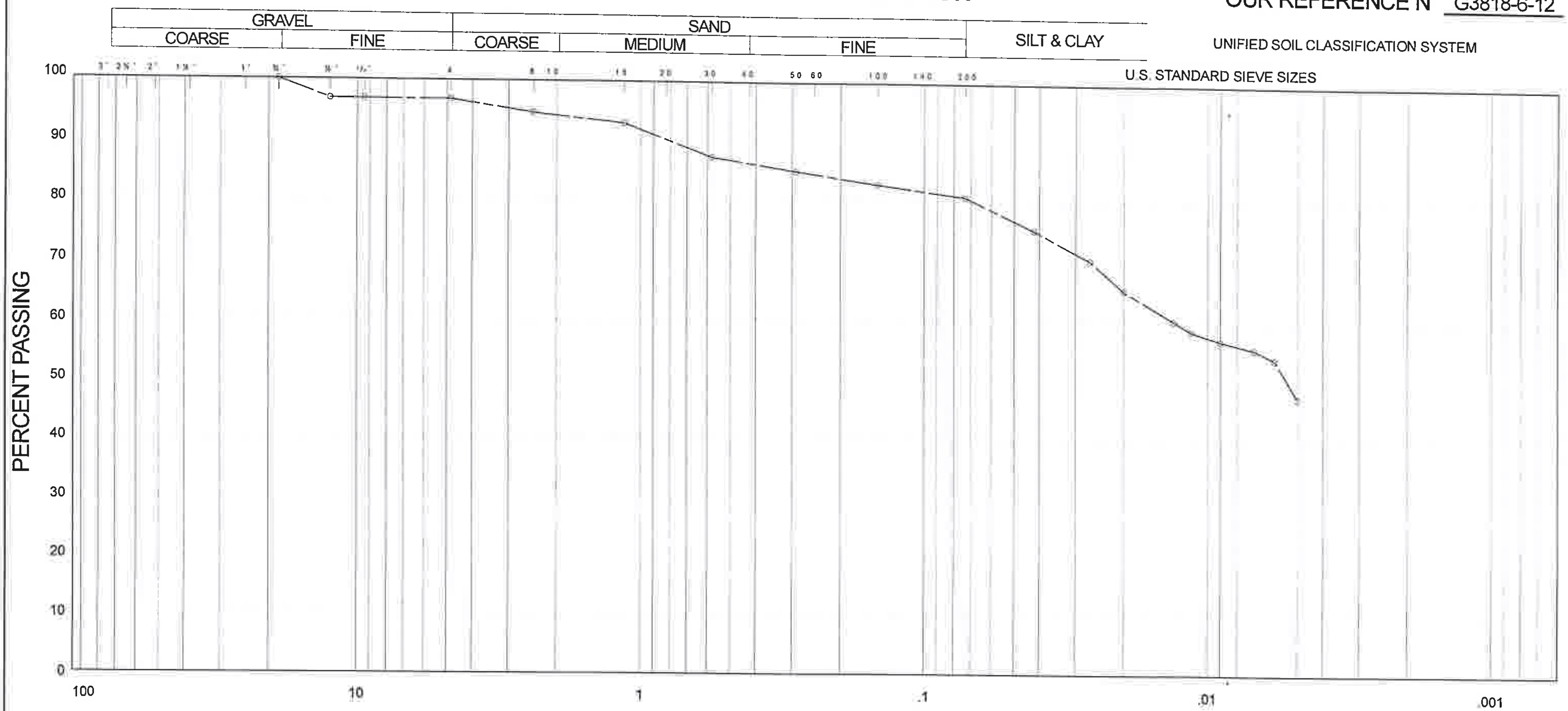
| SYMBOL | BOREHOLE | SAMPLE | DEPTH (m) |
|---|---|---|---|
| + | 17-91 | 1 | 1.22 |

Project 911-1403

Golder Associates

# GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3818-6-12




PROJECT: 300032339.2016
LOCATION: St. Mary's Landfill
BOREHOLE N°: OW 36
SAMPLE N°: SS3B
DEPTH: 7.5 - 9.5 ft.
ELEVATION:

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

**Classification of Sample and Group Symbol:**

SILTY CLAY, some sand, trace gravel

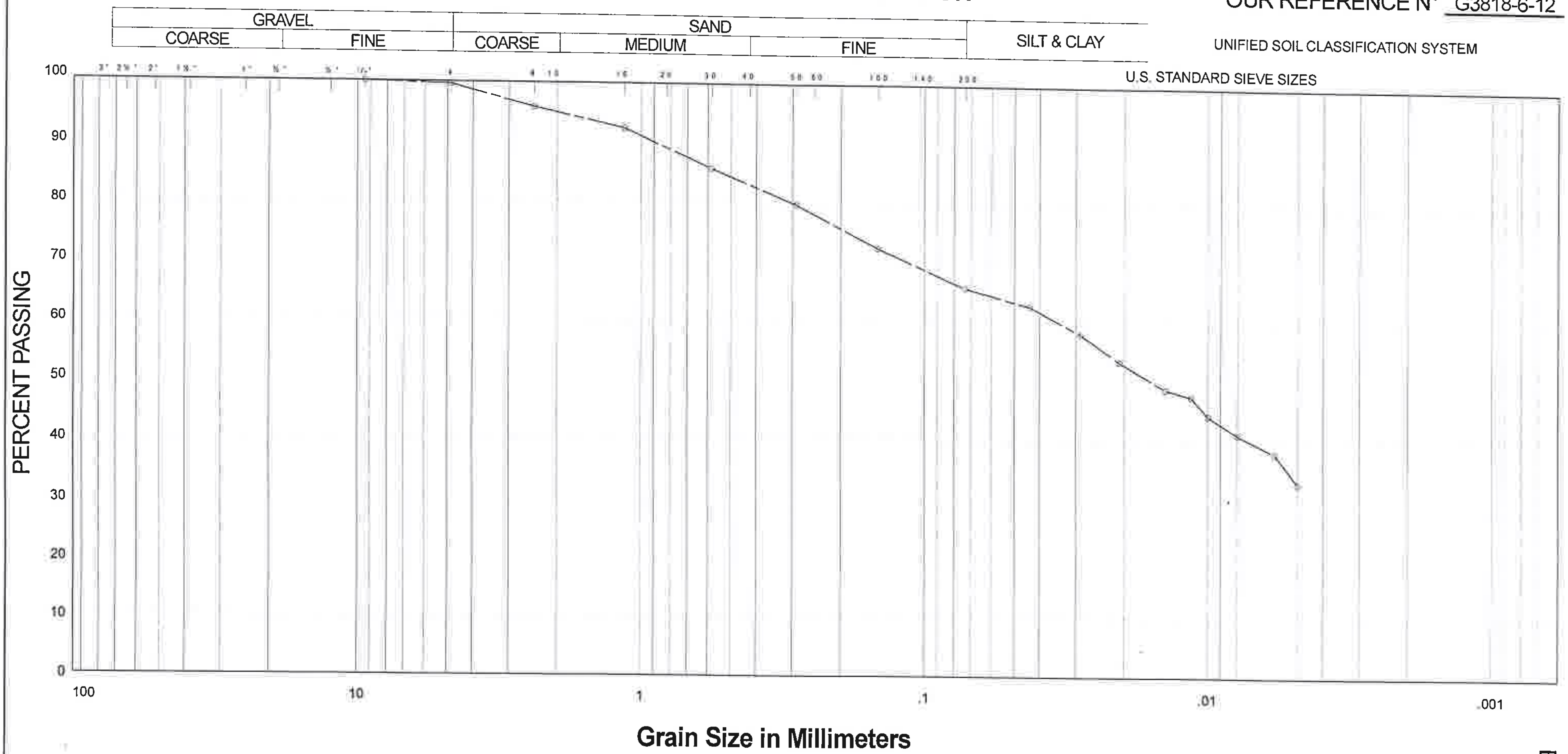
PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 7.6

ENCLOSURE N° 1

**V. A. WOOD (GUELPH) INCORPORATED**

# GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3818-6-12




PROJECT: 300032339.2016
LOCATION: St. Mary's Landfill
BOREHOLE N°: OW 36
SAMPLE N°: SS6
DEPTH: 15 - 17 ft.
ELEVATION:

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

**Classification of Sample and Group Symbol:**

SILTY CLAYEY SAND

PLASTIC PROPERTIES
LIQUID LIMIT % =
PLASTIC LIMIT % =
PLASTICITY INDEX % =
MOISTURE CONTENT % = 8.0

ENCLOSURE N° 2

**V. A. WOOD (GUELPH) INCORPORATED**

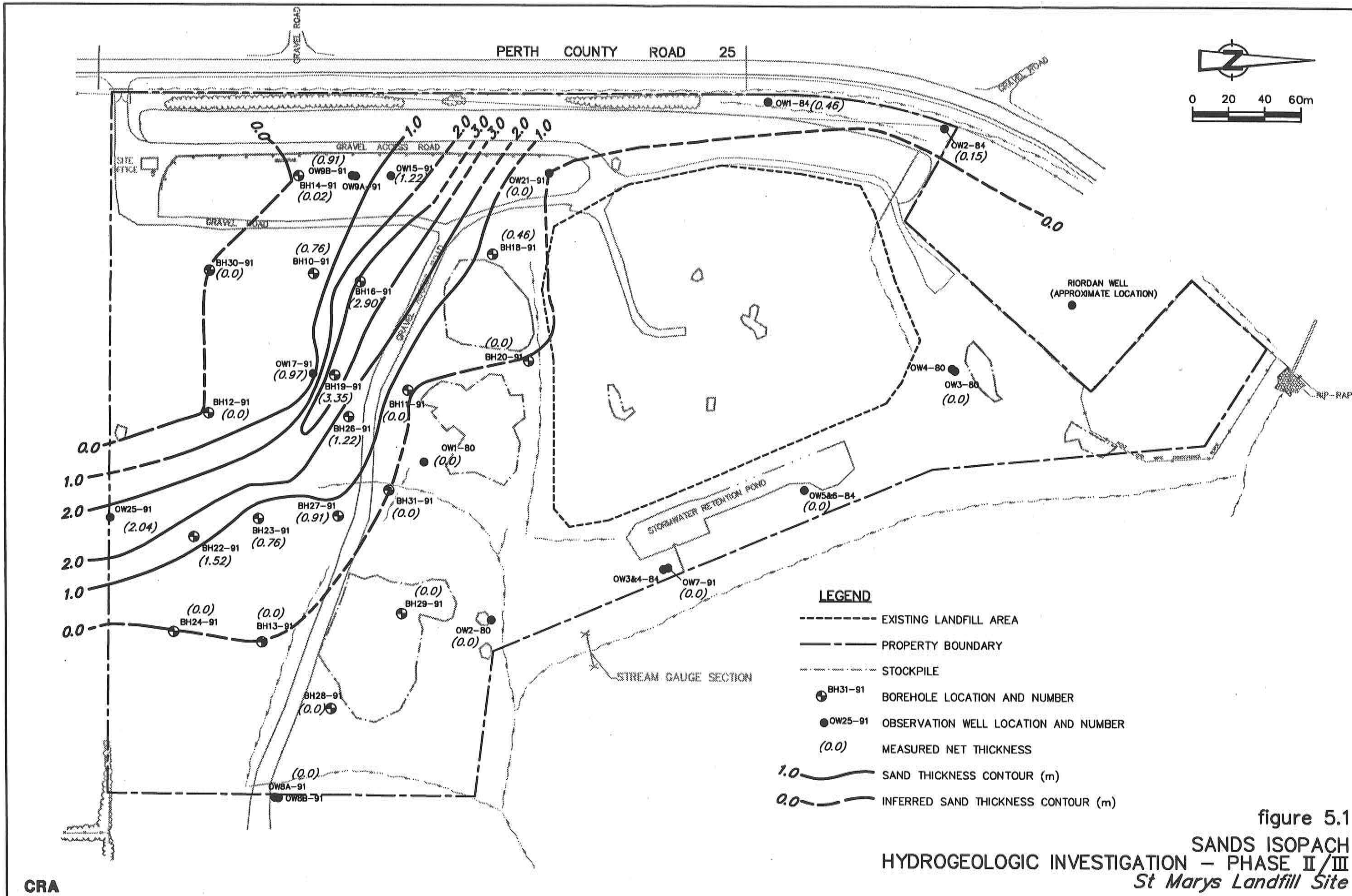



figure 5.1

SANDS ISOPACH
HYDROGEOLOGIC INVESTIGATION – PHASE II/III
*St Marys Landfill Site*

0645 (8) JAN. 16/92 – REV.0 (P-16)

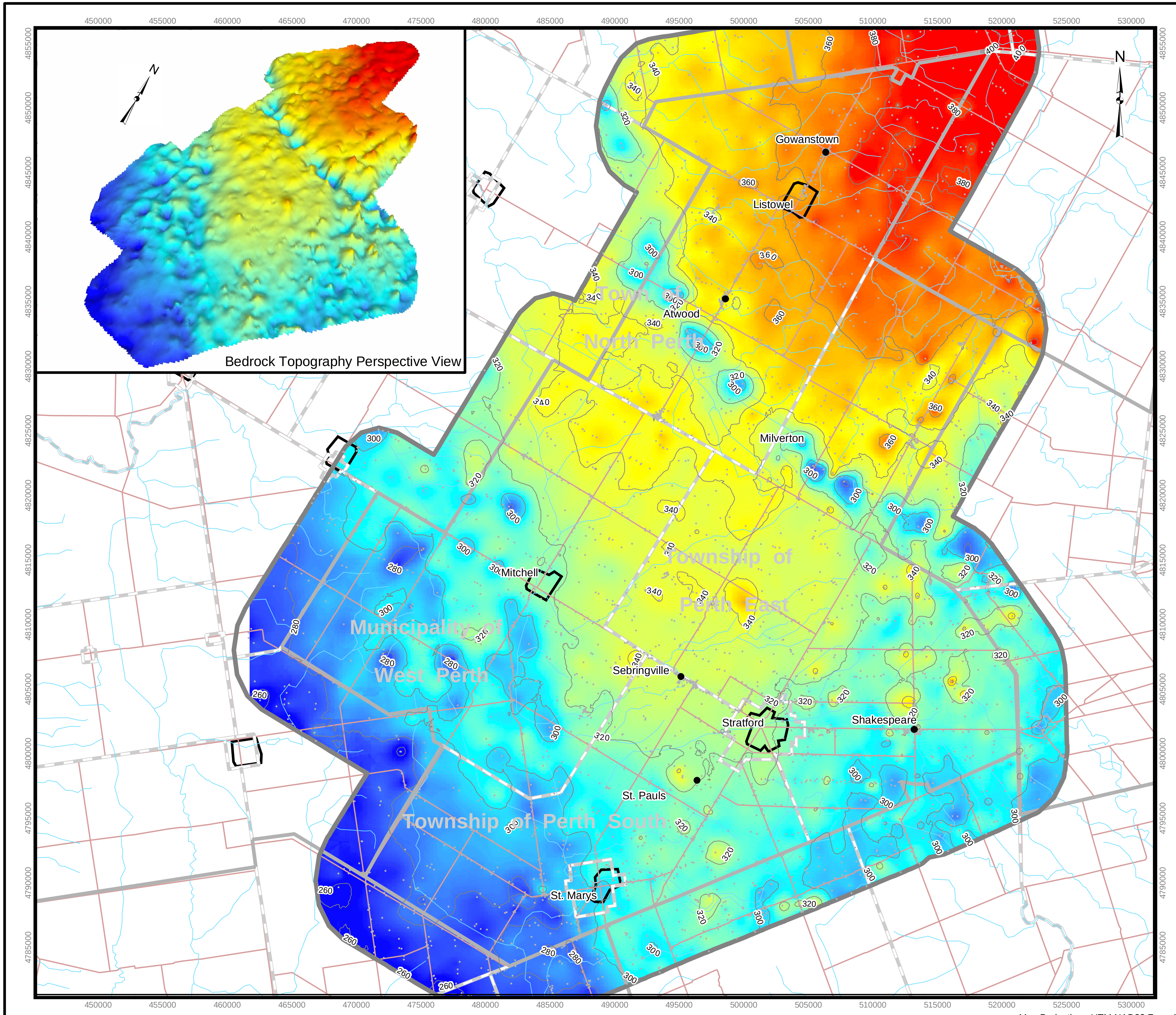
BURNSIDE
[THE DIFFERENCE IS OUR PEOPLE]

# Appendix D

# Perth County Groundwater Study 2003 Mapping

Appendix D

# Perth County Groundwater Management Study




## Legend

- County Boundaries
- Township Boundaries
- Study Area Boundary
- Rivers
- Roads
- Population Centres
- Bedrock Wells

**Value**

High : 410

Medium: 325

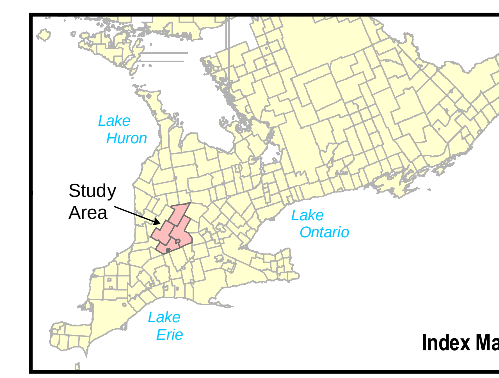
Low : 250

m asl

1:300,000

0 2 4 8 12

Kilometres




Disclaimer: This map is intended for illustrative purposes only. Figure is to be read in conjunction with the Perth County Groundwater Management Study.
Digital Mapping Sources: Base mapping features - Ministry of the Environment.
Water well information - Ministry of the Environment.

Date: April 2003

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*Figure 2.17 : Bedrock Topography*

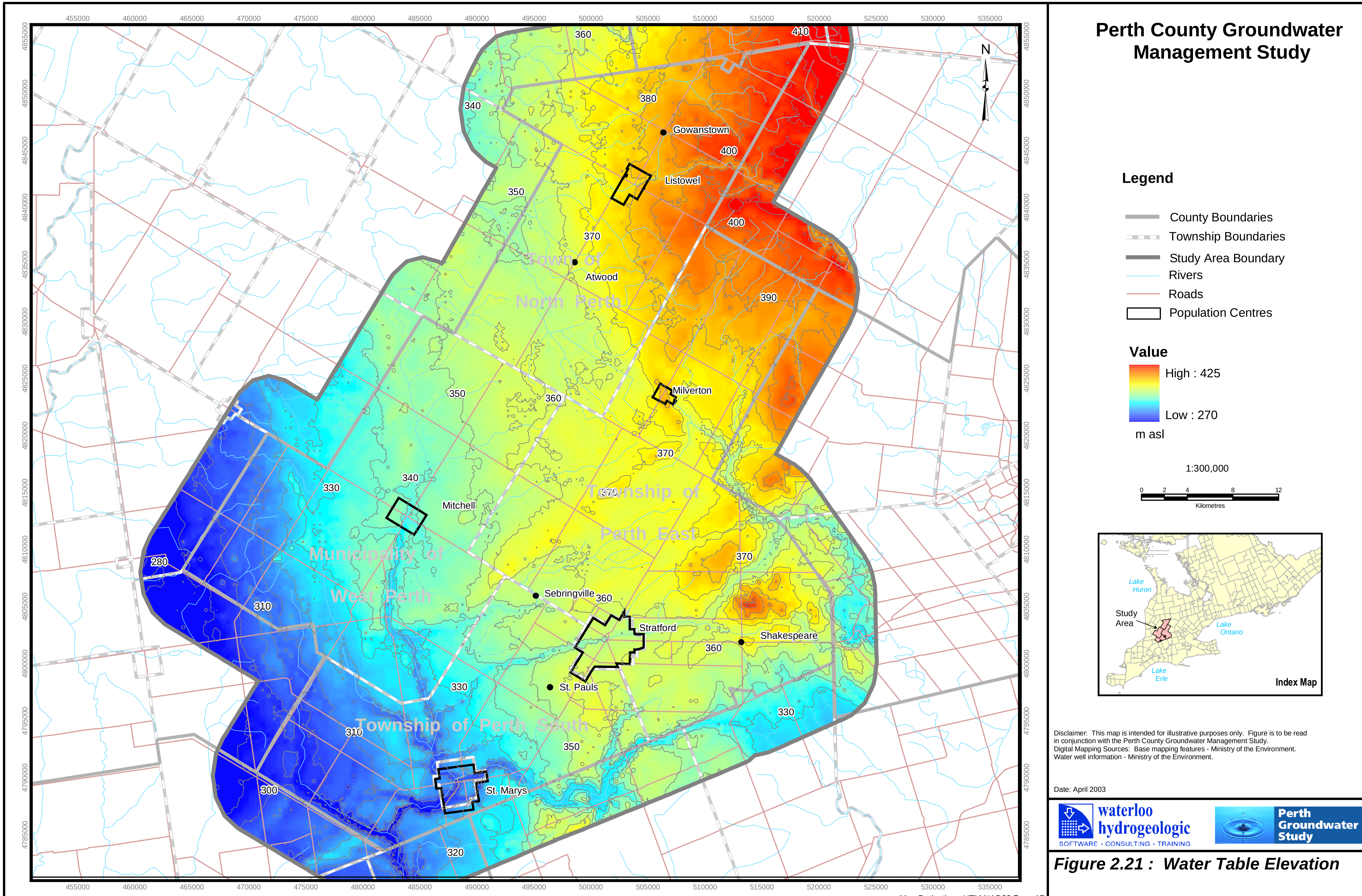
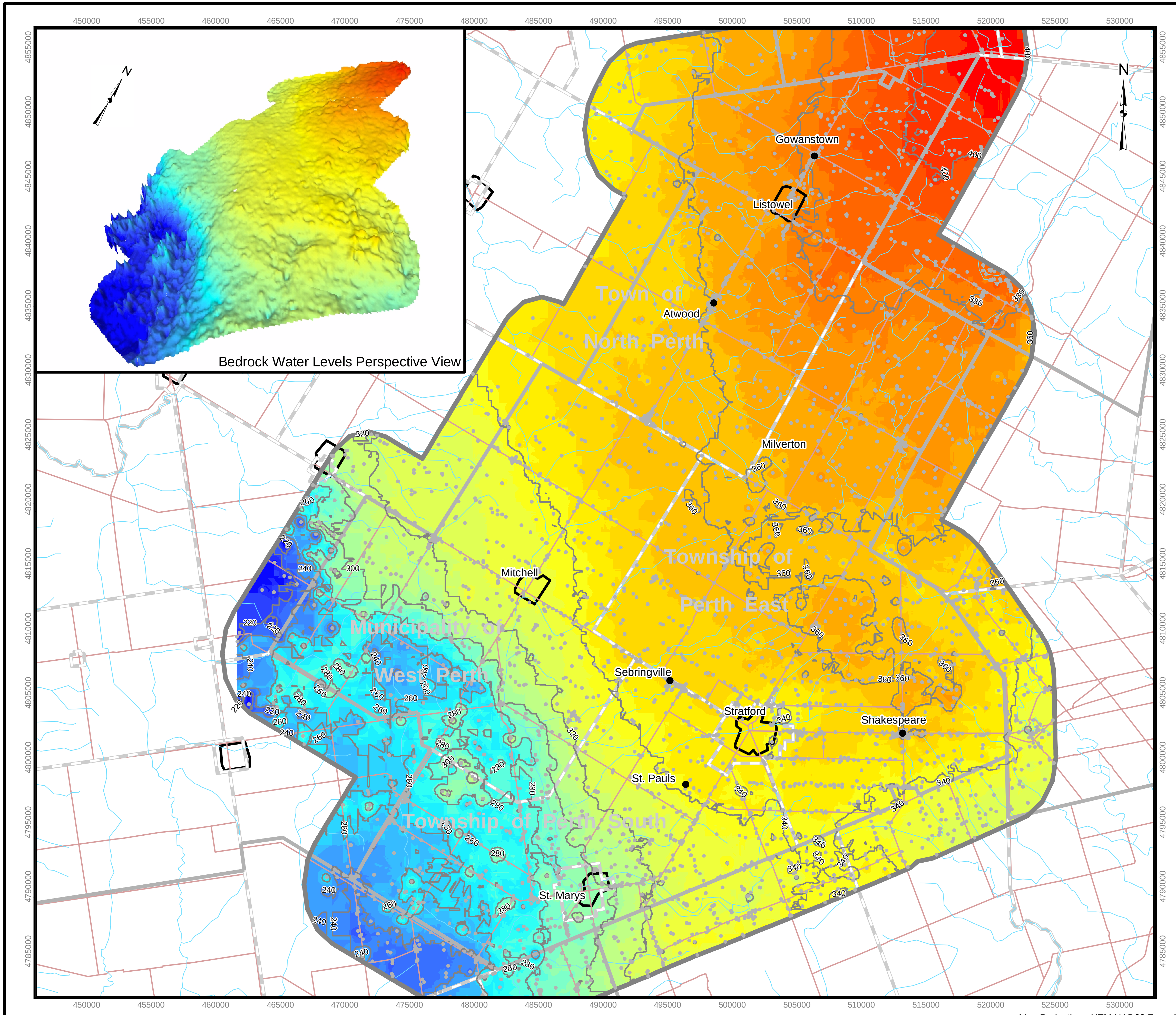



*Figure 2.21 : Water Table Elevation*




# Perth County Groundwater Management Study

**Legend**

- County Boundaries
- Township Boundaries
- Study Area Boundary
- Rivers
- Roads
- Population Centres
- Bedrock Well Locations

**Value**

High : 415

Low : 197

m asl

1:300,000

0 2 4 8 12
Kilometres

Lake Huron
Study Area
Lake Ontario
Lake Erie
Index Map

Disclaimer: This map is intended for illustrative purposes only. Figure is to be read in conjunction with the Perth County Groundwater Management Study.
Digital Mapping Sources: Base mapping features - Ministry of the Environment.
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*Figure 2.22 : Bedrock Water Levels*

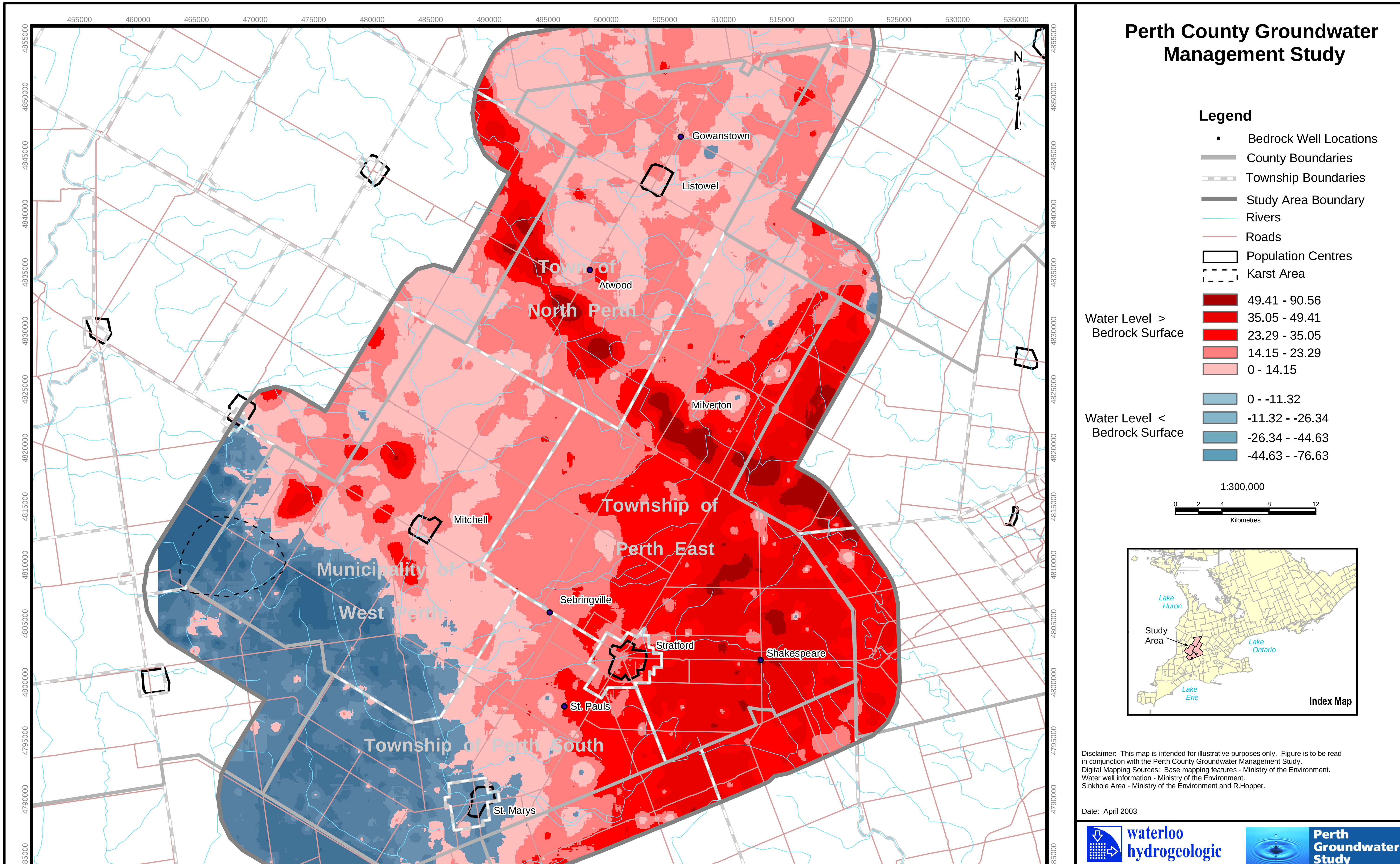
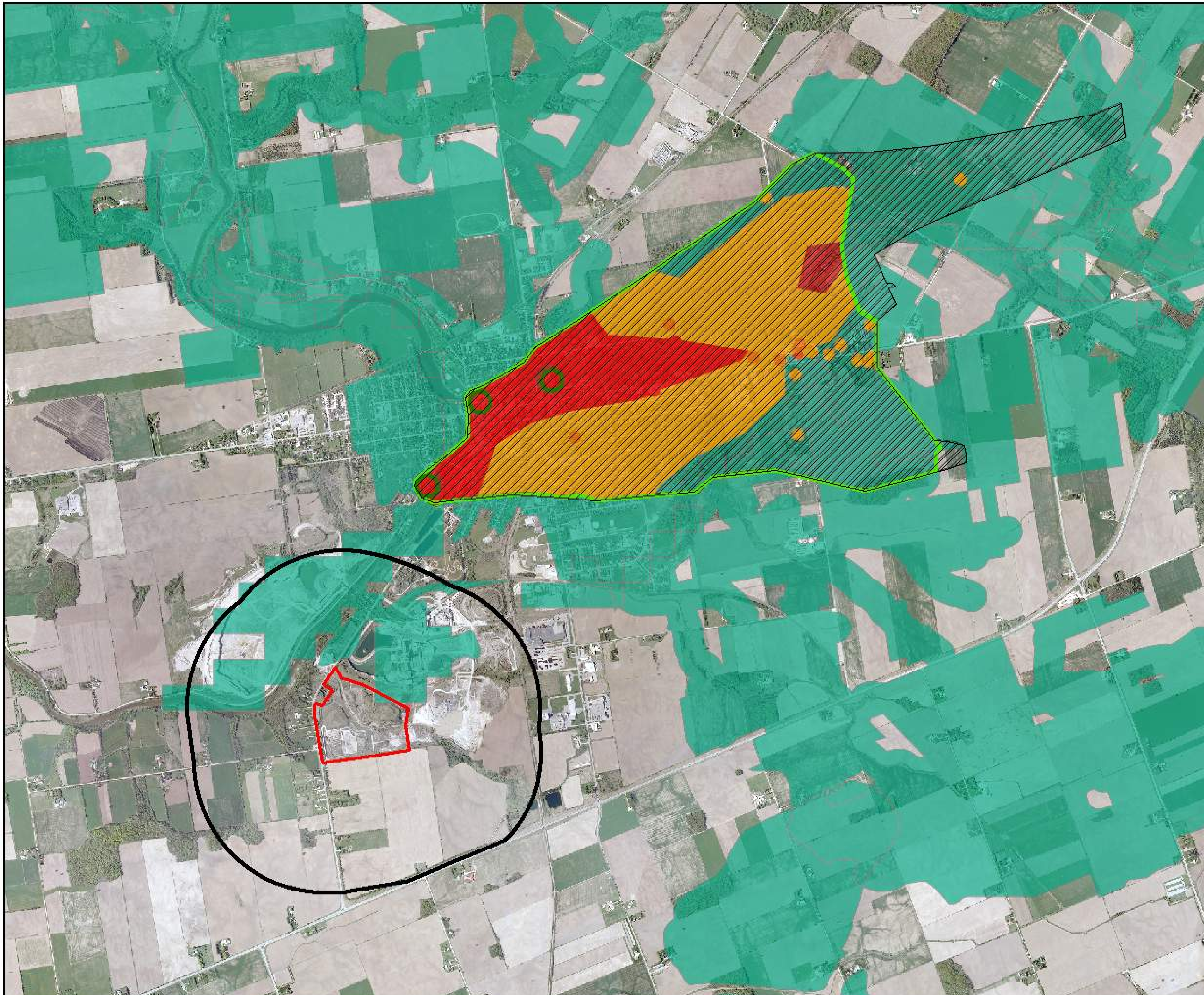



*Figure 2.23 : Bedrock Water Levels Relative to Bedrock Topography*

# Appendix E

## Source Protection Mapping



LEGEND

- ON-SITE STUDY AREA
- STUDY AREA VICINITY
- WHPA-A
- WHPA-B
- DNAPL POLICY AREA WHPA-A,B,C
- VULNERABILITY SCORE OF 10
- VULNERABILITY SCORE OF 8
- Moderate and Low Threat Policy Area - Approved

Sources:

Mapping obtained from Upper Thames River Valley Conservation Authority. Upper Thames River Source Protection Area Assessment Report, September 16, 2015.

N

0 500 1,000 1,500 2,000

Metres

BURNSIDE

Client

TOWN OF ST. MARYS

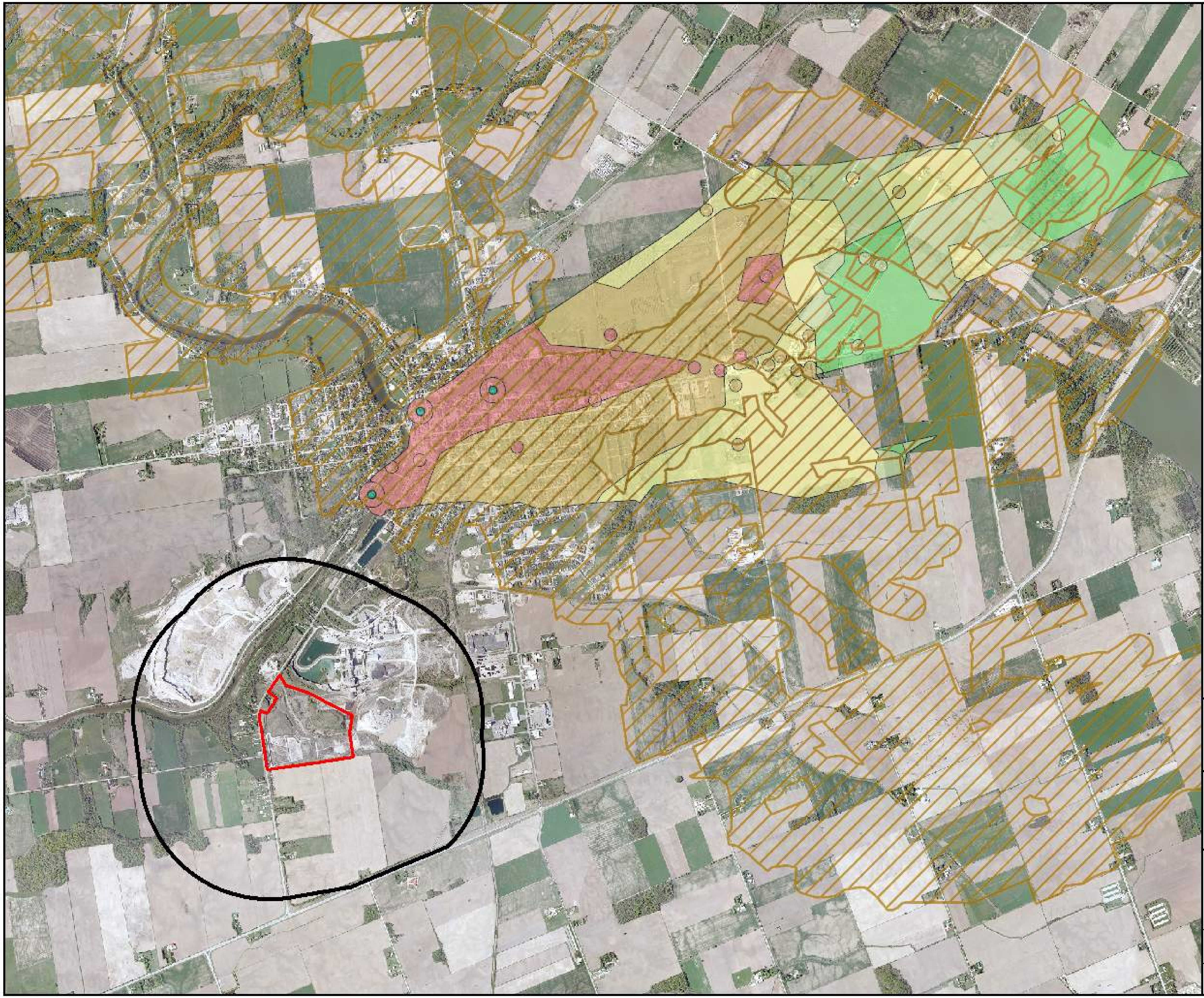
*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**SIGNIFICANT THREAT POLICY AREAS**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | APRIL 2017 | E1 |
| Scale | | Project No. | |
| 1:30,000 | | 300032339 | |

File Path: H:\032339 (St. Marys)\2016 EA Figures\E1.mxd Print Date: 2017/05/11 Time: 12:48 PM



**Legend**

On-Site Study Area
Study Area Vicinity
Municipal Wells
Wellhead Protection Area Vulnerability - Approved
Vulnerability Score
- Vulnerability = 2
- Vulnerability = 4
- Vulnerability = 6
- Vulnerability = 8
- Vulnerability = 10
- Vulnerability = 6.3 (WHPA-E)
- Vulnerability = 7.0 (WHPA-E)
- Vulnerability = 7.2 (WHPA-E)
- Issue Contributing Area

Intake Protection Zone/Vulnerability - Approved
IPZ_Zone
- IPZ-1
- IPZ-2
- IPZ-3
- EBA
- See Essex SPA

Sources:

Mapping obtained from Upper Thames River Valley Conservation Authority. Upper Thames River Source Protection Area Assessment Report, September 16, 2015.

N

0 500 1,000 1,500 2,000
Metres

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*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title
**WELLHEAD PROTECTION AREAS**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
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| Scale | | Project No. | |
| 1:30,000 | | 300032339 | |

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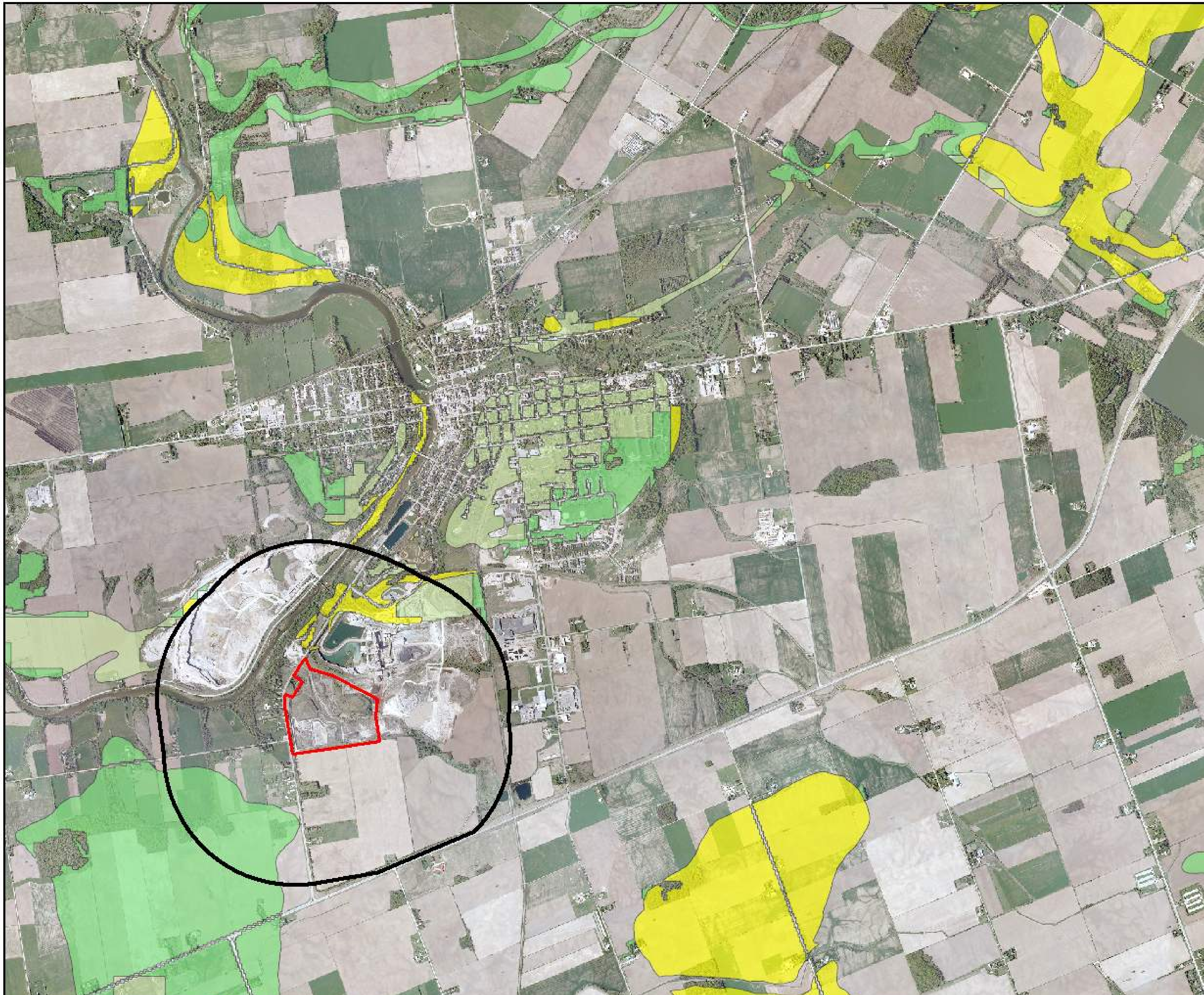


**Legend**

On-Site Study Area

Study Area Vicinity

Significant Groundwater Recharge Area - Approved

Vulnerabilty Score

Vulnerability = 2

Vulnerability = 4

Vulnerability = 6

Sources:

Mapping obtained from Upper Thames River Valley Conservation Authority. Upper Thames River Source Protection Area Assessment Report, September 16, 2015.

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*HYDROGEOLOGICAL STUDY*

Figure Title

**SIGNIFICANT GROUNDWATER RECHARGE AREAS**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | APRIL 2017 | **E3** |
| Scale | | Project No. | |
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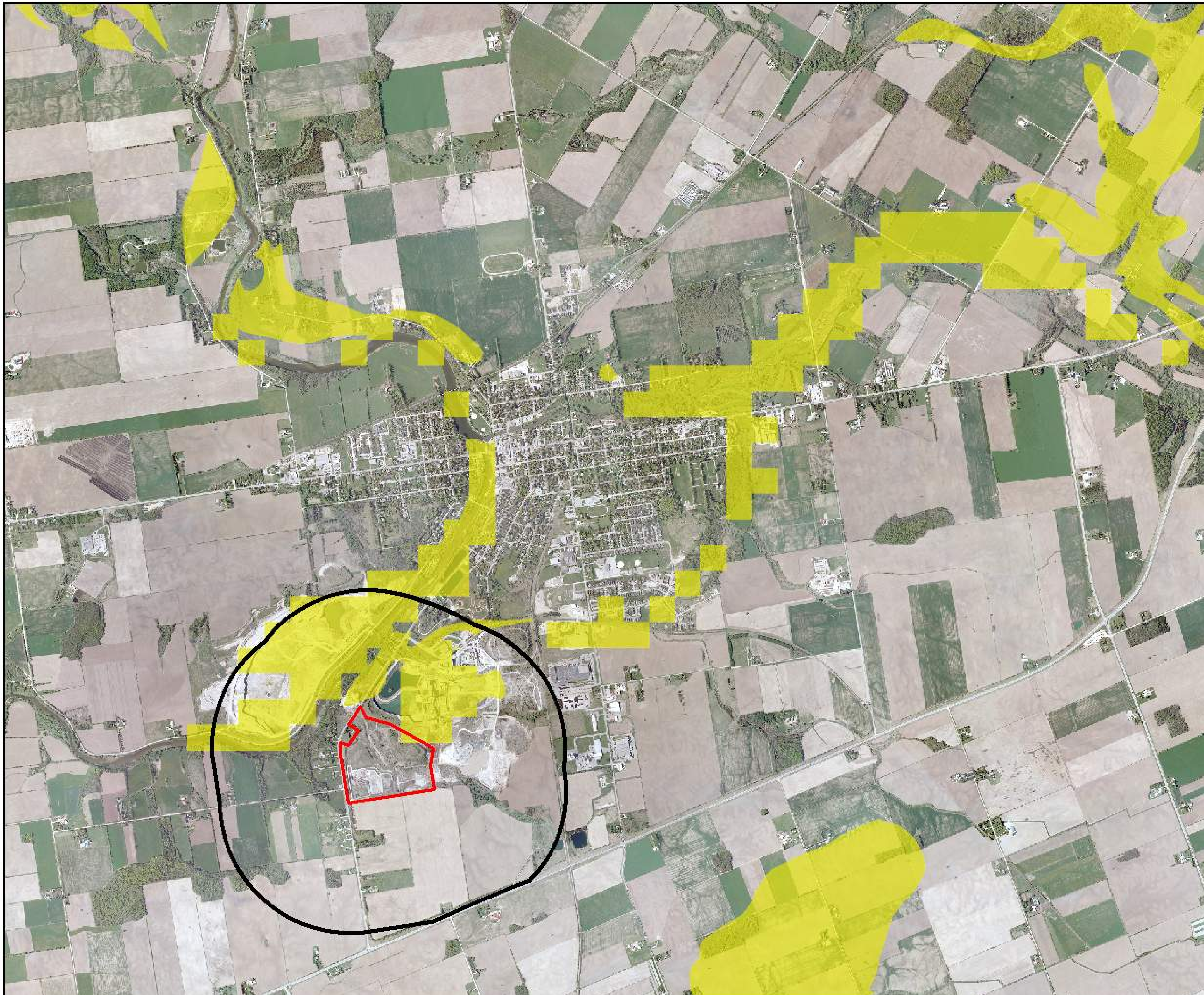


**Legend**

- On-Site Study Area
- Study Area Vicinity
- Highly Vulnerable Aquifer

Sources:

Mapping obtained from Upper Thames River Valley Conservation Authority. Upper Thames River Source Protection Area Assessment Report, September 16, 2015.

N

0 500 1,000 1,500 2,000

Metres

BURNSIDE

Client

TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**HIGHLY VULNERABLE AQUIFERS**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | APRIL 2017 | **E4** |
| Scale | | Project No. | |
| 1:30,000 | | 300032339 | |

File Path: H:\0032339 (St. Marys)\2016 EA Figures\E4.mxd Print Date: 2017/05/11 Time: 01:10 PM

[THE DIFFERENCE IS OUR PEOPLE]

# Appendix F

## Water Level Monitoring

**Table F1.2**
**Vertical Gradients**
**St. Marys Landfill**

| Vertical Gradients | | | | | |
|---|---|---|---|---|---|
| **Shallow well** | **OW4-84** | **OW8B-10** | **OW9B-91** | **OW32-96** | **OW34-96** |
| Top of screen | 312.77 | 308.89 | 313.64 | 316.61 | 316.48 |
| Bottom of screen | 311.47 | 307.99 | 311.64 | 311.11 | 311.78 |
| Mid-point | 312.12 | 308.44 | 312.64 | 313.86 | 314.13 |
| **Deep well** | **OW7-91** | **OW8A-91** | **OW9A-91** | **OW32A-02** | **OW33-96** |
| Top of screen | 280.89 | 287.59 | 280.56 | 281.86 | 310.95 |
| Bottom of screen | 275.49 | 281.89 | 277.36 | 278.81 | 307.25 |
| Mid-point | 278.19 | 284.74 | 278.96 | 280.34 | 309.10 |
| Sep-91 | -0.79 | | -0.85 | | |
| Sep-91 | -0.79 | | -0.85 | | |
| Nov-91 | -0.79 | | -0.86 | | |
| Nov-91 | | | -0.86 | | |
| Dec-91 | -0.78 | | -0.85 | | |
| Dec-91 | -0.77 | | -0.85 | | |
| Dec-91 | | | -0.84 | | |
| Dec-91 | | | -0.84 | | |
| Dec-91 | -0.75 | | -0.83 | | |
| Jan-92 | -0.73 | | -0.82 | | |
| Feb-92 | -0.72 | | -0.85 | | |
| Feb-92 | -0.72 | | -0.82 | | |
| Mar-92 | -0.69 | | -0.80 | | |
| May-92 | -0.72 | | -0.82 | | |
| Aug-92 | -0.76 | | -0.83 | | |
| Nov-92 | -0.71 | | -0.81 | | |
| Feb-93 | -0.68 | | -0.77 | | |
| May-93 | | | -0.80 | | |
| Aug-93 | | | -0.82 | | |
| Apr-94 | -0.71 | | -0.80 | | |
| Sep-94 | | | -0.86 | | |
| Apr-95 | -0.74 | | -0.84 | | |
| Sep-95 | | | -0.87 | | |
| Apr-96 | -0.70 | | -0.83 | | |
| Sep-96 | | | -0.86 | | -1.41 |
| Apr-97 | -0.71 | | -0.81 | | -1.64 |
| Sep-97 | | | -0.84 | | -1.39 |
| Apr-98 | -0.78 | | -0.84 | | -1.64 |
| Sep-98 | | | -0.89 | | -1.24 |
| Apr-99 | | | -0.88 | | -1.64 |
| Sep-99 | | | -0.90 | | -1.23 |
| Apr-00 | | | -0.90 | | -1.65 |
| Sep-00 | | | -0.88 | | -1.57 |
| Apr-01 | -0.71 | | -0.85 | | -1.63 |
| Sep-01 | | | -0.88 | | -1.23 |
| Apr-02 | -0.74 | | -0.87 | | -1.64 |
| Sep-02 | | | -0.88 | | -1.27 |
| Apr-03 | -0.74 | | -0.87 | -0.94 | -1.67 |
| Sep-03 | | | -0.89 | -0.94 | -1.26 |
| May-04 | -0.73 | | -0.85 | -0.93 | -1.65 |
| Sep-04 | | | -0.89 | -0.95 | -1.35 |
| Apr-05 | -0.76 | | -0.88 | -0.96 | -1.67 |
| Nov-05 | | | -0.93 | -0.99 | -1.27 |
| Apr-06 | -0.73 | | -0.86 | -0.94 | -1.65 |
| Nov-06 | -0.75 | | -0.88 | -0.96 | -1.67 |
| Apr-07 | -0.73 | | -0.86 | -0.94 | -1.63 |
| Nov-07 | -0.80 | | -0.92 | -0.95 | -1.16 |
| Apr-08 | -0.70 | | -0.84 | -0.92 | -1.67 |
| Nov-08 | -0.79 | | -0.89 | -0.96 | -1.58 |
| Apr-09 | -0.73 | | -0.84 | -0.92 | -1.63 |
| Nov-09 | | | -0.88 | -0.96 | -1.43 |
| Mar-10 | -0.74 | | -0.87 | -0.95 | -1.63 |
| Nov-10 | -0.80 | | -0.89 | -0.97 | -1.44 |
| Mar-11 | | | -0.85 | -0.94 | -1.65 |
| Dec-11 | -0.77 | -0.88 | -0.87 | -0.96 | -1.68 |
| Apr-12 | | -0.90 | -0.87 | -0.95 | -1.54 |
| Nov-12 | | -0.95 | -0.87 | -0.95 | -1.33 |
| May-13 | -0.72 | -0.84 | -0.85 | | -1.66 |
| Oct-13 | -0.78 | -0.92 | -0.88 | -0.96 | -1.68 |
| Jun-14 | | -0.92 | -0.88 | -0.95 | -1.52 |
| Nov-14 | | -0.96 | -0.89 | -0.98 | -1.54 |
| May-15 | | -0.94 | -0.88 | -0.96 | -1.55 |
| Sep-15 | | -0.97 | -0.90 | -0.97 | -1.31 |
| 14-Dec-15 | | -0.96 | -0.90 | -0.98 | -1.44 |
| 8-Mar-16 | -0.79 | -0.91 | -0.88 | -0.96 | -1.65 |
| 29-Mar-16 | -0.79 | -0.92 | -0.87 | -0.96 | -1.67 |
| 27-Apr-16 | -0.72 | -0.88 | -0.86 | -0.95 | -1.62 |
| 31-May-16 | | -0.90 | -0.88 | -0.96 | -1.56 |
| 29-Jun-16 | | -0.93 | -0.89 | -0.96 | -1.42 |
| 27-Jul-16 | | -0.95 | -0.89 | -0.95 | -1.24 |
| 4-Oct-16 | | -0.98 | -0.91 | -0.94 | -1.15 |

Notes:

- downward gradient  + upward gradient

**Table F1.3**
**Surface Water Measurements**
**St. Marys Landfill**

| Location | | Upstream | | Basin B | | Midstream | Basin A | | | Downstream | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SP1-10* | | SP1B-94 (Inlet) | SP2B-94 (Outlet) | SP2-93 | SP3A-94 (South Inlet) | SP5A-94 (North Inlet) | SP4A-94 (Outlet) | SP3-93 | |
| Reference Elevation | | 311.240 | Flow (4) | 314.63 | (2) | 310.190 | 314.42 | 314.62 | (2) | 310.32 (Shallow) 309.38 (Deep) | Flow (4) |
| Feb-93 | | 310.01 | | | | 309.2 | | | | 308.44 | |
| Aug-93 | | Dry | | | | Dry | | | | Dry | |
| Apr-94 | | 310.3 | | 313.1 | | 309.7 | 313.19 | 313.19 | | 309.22 | 167 L/s |
| Sep-94 | | 310.06 | | 312.45 | Dry | 309.39 | Dry | Dry | Dry | 308.9 | 12.7 L/s |
| Apr-95 | | 310.25 | | 313.56 | Flowing | 309.64 | 313.81 | 313.48 | Flowing | 309.23 | 170 L/s |
| Sep-95 | | 310.06 | | 312.49 | Dry | 309.33 | Dry | Dry | Dry | 309.25 | 28 L/s |
| Oct-95 | 3 | 310.17 | | NA | Flowing | 309.48 | -- | 313.08 | Flowing | 309.13 | 130 L/s |
| Apr-96 | | 310.19 | | NA | Flowing | 309.49 | Dry | Dry | Flowing | 309.04 | 160 L/s |
| Sep-96 | | 310.08 | | 312.57 | Dry | 309.32 | Dry | Dry | Dry | 308.87 | 9 L/s |
| Oct-96 | 3 | 310.23 | | NA | Flowing | 309.52 | 313.54 | 313.03 | Flowing | 309.11 | 230 L/s |
| Apr-97 | | 310.11 | | 313.37 | Flowing | 309.35 | 313.63 | 313.02 | Flowing | 308.96 | 58.6 L/s |
| Sep-97 | | 309.95 | | NA | Flowing | 309.19 | Dry | Dry | Flowing | NA | 4.7 L/s |
| Apr-98 | 3 | 310.11 | | NA | Flowing | 309.42 | 313.51 | 313.06 | Flowing | 309.06 | 118 L/s |
| Apr-98 | | 310.01 | | 312.64 | Flowing | 309.29 | Dry | 313.01 | Flowing | 309.03 | 220 L/s |
| Sep-98 | | 309.91 | | 312.1 | Flowing | 309.22 | Dry | Dry | Dry | NA | 10 L/s |
| Apr-99 | | 310.05 | | 312.60 | Flowing | 309.37 | Dry | Flowing | Flowing | 309.07 | 60 L/s |
| Jun-99 | 3 | 310.12 | | 313.33 | Flowing | 309.41 | Dry | Flowing | Flowing | 309.06 | 35 L/s |
| Sep-99 | | 310.00 | | 313.01 | Flowing | 309.28 | Dry | Dry | Dry | 309.01 | 41 L/s |
| Apr-00 | | 310.05 | | 313.54 | Flowing | 309.44 | Dry | 313.23 | Flowing | 309.04 | 146 L/s |
| Jun-00 | 3 | 310.46 | | 313.74 | Flowing | 310.05 | 313.69 | 313.54 | Flowing | >309.38 | 4012 L/s |
| Sep-00 | | 310.03 | | 313.59 | Flowing | 309.44 | 313.77 | 313.62 | Flowing | 309.01 | 98 L/s |
| Apr-01 | | 310.02 | | 313.39 | Flowing | 309.70 | 314.03 | 313.81 | Flowing | 309.05 | 89 L/s |
| Jun-01 | 3 | 310.01 | | 313.49 | Dry | 309.73 | Dry | 312.54 | Dry | 309.08 | 784 L/s |
| Sep-01 | | 309.92 | | Dry | Dry | 309.54 | Dry | Dry | Dry | 308.99 | 17 L/s |
| Apr-02 | | 309.96 | | 313.58 | Dry | 309.61 | 314.14 | 313.92 | Flowing | Dry | 143.62 L/s |
| Sep-02 | | 309.88 | | Dry | Dry | 309.45 | Dry | Dry | Dry | Dry | 31.16 L/s |
| Apr-03 | | 309.93 | | 313.43 | Flowing | 309.69 | Dry | Dry | Dry | 309.06 | 118.52 L/s |
| Jun-03 | 3 | 309.93 | | 313.6 | Flowing | 309.65 | Flowing | Flowing | Flowing | 309.06 | 42.08 L/s |
| Sep-03 | | 309.82 | | Dry | Dry | 309.50 | Dry | Dry | Dry | Dry | 28.15 L/s |
| May-04 | | 309.86 | | NA | | 309.81 | 314.21 | NA | Dry | NA | 504 L/s |
| Sep-04 | | 309.78 | | No Flow | No Flow | 309.51 | Dry | Dry | Dry | Dry | 3.54 L/s |
| Apr-05 | | 309.89 | | Bent | No Flow | 309.73 | Too Deep/No Flow | Too Deep/Low flow | Flowing | 309.07 | 168 L/s |
| Jul-05 | 3 | 309.83 | | 313.41 | Flowing | 309.66 | Dry | Dry | Flowing | NA | NA |
| Nov-05 | | 309.83 | | 313.51 | Flowing | 309.67 | Dry | Dry | Flowing | NA | 20 L/s |
| Apr-06 | | 310.05 | | 313.18 | Flowing | 309.70 | Too Deep | Flowing | Flowing | 309.03 | 66 L/s |
| Jul-06 | 3 | 310.62 | | 313.48 | Flowing | Too Deep | Too Deep | 313.73 | Flowing | NA | NA |
| Nov-06 | | 309.98 | | 313.19 | Flowing | 309.77 | Too Deep/No Flow | Flowing | Flowing | 309.05 | 51 L/s |
| Apr-07 | | 310.00 | | Dry | Flowing | 309.78 | 313.97 | Too Deep/Flowing | Flowing | Dry | 69.23 L/s |
| Nov-07 | | 309.77 | | 313.64 | Flowing | Dry | Dry | Dry | Dry | Dry | 9.01 L/s |
| Apr-08 | | 309.98 | | 313.70 | Flowing | 309.77 | T-Bar Removed | Dry | NA | Dry | 97.01 L/s |
| Aug-08 | | 309.94 | | 313.76 | Flowing | 309.74 | Dry | Dry | Flowing | Dry | 105.0 L/s |
| Nov-08 | | 310.23 | | 313.74 | Flowing | 309.97 | Flowing | Flowing | Flowing | 309.25 | 398.82 L/s |
| Apr-09 | | 310.42 | | 313.49 | Flowing | 309.85 | Dry | Flowing | Flowing | 309.15 | 324.72 L/s |
| Nov-09 | | NA | | 313.20 | Flowing | 309.36 | Dry | Dry | Flowing | Dry | 15.41 L/s |
| Mar-10 | | 309.88 | | 313.79 | Flowing | 309.69 | Dry | Flowing | Flowing | Dry | 49.34 L/s |
| Nov-10 | | NA | | 313.84 | Flowing | 309.78 | Dry | Flowing | Flowing | 309.255 | 310.50 L/s |
| Mar-11 | | 310.39 | | 313.73 | Flowing | 309.56 | Dry | Dry | Flowing | 308.88 | 528.48 L/s |
| Oct-11 | | 310.08 | | 313.83 | Flowing | T-Bar Missing | Dry | Dry | Flowing | 309.01 | 217.41 L/s |
| Dec-11 | | 310.47 | | 313.84 | Flowing | T-Bar Missing | Dry | Dry | Flowing | Dry | 639.20 L/s |
| Apr-12 | | 310.35 | | 313.73 | Flowing | Dry | Dry | Dry | Flowing | Dry | 48.0 L/s |
| Aug-12 | | 310.08 | | 313.83 | Flowing | T-Bar Missing | Dry | Dry | Flowing | 309.01 | 40.0 L/s |
| Nov-12 | | 310.47 | | 313.84 | Flowing | T-Bar Missing | Dry | Dry | Flowing | Dry | 11.12 L/s |
| May-13 | | 310.83 | | 313.82 | Flowing | 309.52 | Ponded | Dry | Flowing | 308.95 | (6) |
| Oct-13 | | 310.94 | | 313.86 | Flowing | NA | Ponded | Dry | Flowing | 308.98 | 170.57 L/s |
| Jun-14 | | 310.79 | | Trickle | Dry | 309.43 | Dry | Dry | Dry | 308.95 | 3.13 L/s |
| Nov-14 | | 310.83 | | 313.87 | Flowing | 309.55 | Ins | Dry | Flowing | 309.07 | 13.61 L/s |
| May-15 | | 310.80 | | Trickle | Dry | 309.52 | Ponded | Dry | Dry | 308.91 | 1.49 L/s |
| Sep-15 | | 310.75 | | Dry | Dry | Dry | Dry | Dry | Dry | Dry | Dry |
| Mar-16 | | 310.93 | 167.27 L/s | | | 309.74 | | | | 309.05 | 170.55 L/s |
| Apr-16 | | 310.82 | 15.04 L/s | | Flowing | 309.57 | Ponded | Dry | Flowing | 308.79 | 16.47 L/s |
| May-16 | | 310.81 | 8.88 L/s | | | 309.50 | | | | 308.73 | 10.60 L/s |
| Jun-16 | | 310.79 | 1.71 L/s | | | 309.44 | | | | Dry | 0.64 L/s |
| Jul-16 | | 310.77 | Ins | | | Dry | | | | Dry | Dry |
| Oct-16 | | 310.80 | Ins | Dry | Dry | 309.45 | Dry | Dry | Dry | 308.94 | 1.84 L/s |

Notes:

Reference elevation refers to top of staff gauge (T-bar) elevation based on most recent survey information of top of staff gauge.

| | |
|---|---|
| * | SP1-10 replaced SP1-93 after the Town took ownership of the Site property in 2009 |
| ** | Reference elevation - top of culvert - Surveyed October 12, 2006 used for SP1B as of July 2005. |
| (1) | T -bar removed during reconstruction of Retention Pond. |
| (2) | Water levels are not recorded. Dry or flowing conditions are noted. |
| (3) | Water levels recorded after rainfall event. |
| Ins | Insufficient water to obtain a sample |
| NA | T-bar not accessible (area flooded, bent or missing T-bar, overgrowth of weeds) |
| (4) | Rectangular channel cross section assumed |
| (5) | T-Bar elevation not consistent with historical information; Resurveyed in 2009 |
| (6) | Flow meter did not work properly |
| Dry | Dry at T-bar |

**Table F1.4**
**Phase I Leachate Elevations**
**St. Marys Landfill**

| Manhole ID | M.H.-1 | M.H.-2 | M.H.-3 | M.H.-4 | M.H.-5 | M.H.-6 | M.H.-7 | M.H.-8 | M.H.-16A | M.H.-15A |
|---|---|---|---|---|---|---|---|---|---|---|
| Invert Elev. | 314.199 | 314.928 | 316.04 | 316.767 | 316.366 | 315.966 | 315.532 | 315.147 | 313.91 | 313.536 |
| Reference Elev. | 320.47 | 319.88 | 319.08 | 319.91 | 319.49 | 319.31 | 319.36 | 319.55 | 319.02 | 316.65 |
| May-89 | 318.57 | 317.53 | 317.57 | 319.50 | 319.21 | 318.91 | 319.25 | 319.21 | | |
| Aug-89 | 318.69 | 319.60 | 317.68 | 317.78 | 317.80 | Buried | 317.50 | 317.67 | | |
| Nov-89 | 318.70 | 317.91 | 317.75 | 318.00 | 317.81 | 317.87 | 317.64 | 317.87 | | |
| Feb-90 | -- | -- | -- | -- | -- | -- | -- | -- | | |
| Apr-90 | 317.50 | -- | 317.85 | 318.15 | -- | -- | -- | -- | | |
| May-90 | 317.07 | 317.02 | 317.07 | 317.17 | 317.16 | 317.97 | 317.94 | Buried | | |
| May-90 | 316.86 | 318.14 | 316.20 | 318.73 | 318.26 | 319.25 | 318.07 | 317.85 | | |
| Aug-90 | 317.11 | 318.06 | 316.44 | A | 317.63 | Buried | 319.11 | 317.74 | | |
| Nov-90 | 315.06 | Dry | Dry | Flooded | 316.06 | Buried | Flooded | Dry | | |
| Feb-91 | 316.70 | 316.70 | 316.68 | 316.72 | 316.70 | Buried | Buried | 316.64 | | |
| May-91 | 316.08 | 316.21 | 316.18 | 316.71 | 316.56 | Buried | 317.87 | 316.22 | | |
| Aug-91 | 314.65 | Dry | Dry | Dry | Dry | Dry | Dry | Dry | | |
| Nov-91 | 314.62 | Dry | Dry | Dry | Dry | Dry | Dry | Dry | | |
| Feb-92 | -- | -- | -- | -- | -- | -- | -- | -- | | |
| May-92 | 314.88 | 315.37 | Dry | Dry | Dry | Dry | * | * | | |
| Aug-92 | 316.36 | * | * | Dry | Dry | Dry | Dry | 315.53 | | |
| Nov-92 | 316.44 | 316.45 | 316.43 | Dry | 316.44 | 316.44 | 316.43 | 316.44 | | |
| Feb-93 | 315.68 | 315.68 | Dry | Dry | Dry | Dry | 315.65 | 315.66 | | |
| May-93 | 316.79 | 316.78 | 316.81 | 316.8 | 316.8 | 316.81 | 316.79 | 316.8 | | |
| Aug-93 | 316.42 | 316.42 | 316.41 | Dry | 316.41 | 316.43 | 316.4 | 316.42 | | |
| Apr-94 | 316.52 | 316.54 | 316.51 | Dry | 316.52 | 316.53 | 316.52 | 316.53 | | |
| Sep-94 | 314.90 | 315.13 | Dry | Dry | Dry | 315.73 | 315.49 | 315.05 | | |
| Apr-95 | 316.35 | 316.36 | 316.35 | Dry | 316.35 | 316.36 | 316.34 | 316.35 | | |
| Nov-95 | 316.20 | 316.21 | 316.2 | Dry | Dry | 316.21 | 316.19 | 316.19 | | |
| Apr-96 | 316.61 | 316.67 | 316.67 | Dry | 316.67 | 316.68 | 316.66 | 316.66 | | |
| Sep-96 | 315.99 | 316.00 | Dry | Dry | Dry | 316 | 315.98 | 315.98 | | |
| Apr-97 | 316.93 | 316.93 | 316.93 | 316.91 | 317.12 | 316.94 | 316.92 | 316.93 | | |
| Sep-97 | 315.14 | Dry | Dry | Dry | Dry | Dry | Dry | Dry | | |
| Apr-98 | 314.27 | 315.14 | Dry | Dry | Dry | 315.83 | 315.5 | 315.08 | | |
| Sep-98 | 314.26 | 315.14 | Dry | Dry | Dry | 315.83 | 315.5 | 315.08 | | |
| Apr-99 | 314.26 | 315.12 | Dry | Dry | 316.12 | 315.83 | 315.5 | 315.08 | | |
| Sep-99 | Wet | Wet | Dry | Dry | Wet | Wet | Wet | Wet | | |
| Apr-00 | Flowing | Flowing | Dry | Dry | Wet | Flowing | 315.53 | Flowing | | |
| Sep-00 | Flowing | Wet | Dry | Dry | Dry | Wet | 315.53 | Wet | | |
| Apr-01 | Flowing | Flowing | Dry | Dry | Wet | Flowing | 315.55 | Flowing | | |
| Sep-01 | Wet | Dry | Dry | Dry | Dry | Dry | Dry | Dry | | |
| Apr-02 | Flowing | Flowing | Dry | Dry | Flowing | Flowing | Flowing | Flowing | | |
| Sep-02 | -- | Wet | Dry | Dry | Dry | Wet | 315.55 | Wet | | |
| Apr-03 | 314.63 | Flowing | Wet | Dry | Flowing | Flowing | Flowing | Flowing | | |
| Sep-03 | Dry | Dry | Dry | Dry | Dry | Dry | Wet | Flowing | | |
| May-04 | 315.89 | 315.96 | Wet/No Flow | Dry | Wet/Flowing | 315.98 | 315.93 | 315.96 | Flowing | Flowing |
| Sep-04 | Wet/Flowing | Dry | Dry | Dry | Dry | Dry | Wet/No Flow | Wet/No Flow | -- | Wet/Flowing |
| Apr-05 | 315.89 | 315.93 | Wet/No Flow | Dry | Wet/Flowing | 316.11 | 315.90 | 315.90 | Wet/Flowing | Wet/Flowing |
| Nov-05 | 314.58 | Wet/Flowing | Dry | Dry | Dry | Wet/Flowing | Wet/Flowing | Wet/Flowing | Flowing | Flowing |
| Apr-06 | 315.62 | 315.65 | Wet | Dry | Wet | Flowing | 315.63 | 315.63 | Flowing | Flowing |
| Nov-06 | 315.76 | 315.78 | Wet/No Flow | Dry | Wet/No Flow | Wet/Flowing | 315.77 | 315.77 | Flowing | Flowing |
| Apr-07 | Wet/Flowing | Wet/Flowing | Dry | Dry | Wet/No Flow | Wet/No Flow | Wet/No Flow | Wet/Flowing | -- | -- |
| Nov-07 | Wet/Flowing | Dry | Dry | Dry | Dry | Wet/Flowing | Wet/No Flow | Wet/No Flow | Wet/Flowing | Wet/Flowing |
| Apr-08 | Wet/Flowing | Wet/Flowing | Wet/Flowing | Dry | Wet/No Flow | Wet/No Flow | Wet/No Flow | Wet/Flowing | Wet/Flowing | Wet/Flowing |
| Nov-08 | Wet/Flowing | Wet/Flowing | Wet/Flowing | Dry | Flowing | Flowing | Flowing | Wet/Flowing | Wet/Flowing | Wet/Flowing |
| Apr-09 | Dry | Dry | Flowing | Dry | Flowing | Flowing | Flowing | Flowing | Flowing | Flowing |
| Nov-09 | Wet/Flowing | Wet | Dry | Dry | Wet | Wet | Wet | Wet | Flowing | Flowing |
| Mar-10 | Flowing | Flowing | Wet | Dry | Wet | Flowing | Wet | Wet | Flowing | Flowing |
| Nov-10 | Flowing | Flowing | Dry | Dry | Flowing | Flowing | Flowing | Flowing | Flowing | Flowing |
| Mar-11 | Flowing | Flowing | Wet | Dry | Flowing | Flowing | Flowing | Flowing | Flowing | Flowing |
| Dec-11 | Flowing | Flowing | Wet | Dry | Flowing | Flowing | Flowing | Flowing | Flowing | Flowing |
| Apr-12 | Flowing | Wet | Dry | Dry | Wet | Wet | Wet | Wet | Flowing | Flowing |
| Nov-12 | Flowing | Flowing | Dry | Dry | Wet | Wet | Wet | Flowing | Flowing | Flowing |
| May-13 | Flowing | Flowing | 316.09 | Dry | Flowing | Flowing | Flowing | Flowing | Flowing | Flowing |
| Oct-13 | Flowing | Flowing | 317.43 | Dry | 316.45 | Flowing | Flowing | Flowing | Flowing | Flowing |
| Jun-14 | Flowing | Wet | 317.42 | Dry | Wet | Wet | Wet | Wet | Flowing | Flowing |
| Nov-14 | Very Slow Flow | Very Slow Flow | 317.42 | Dry | Wet/No Flow | Wet/No Flow | Wet/No Flow | Very Slow Flow | Flowing | Very Slow Flow |
| May-15 | Very Slow Flow | Very Slow Flow | 317.52 | Dry | Pond/No Flow | Pond/No Flow | Pond/No Flow | Pond/No Flow | Flowing | Very Slow Flow |
| Sep-15 | Very Slow Flow | Pond/No Flow | 317.42 | Dry | Dry | Pond/No Flow | Pond/No Flow | Pond/No Flow | Slow Flow | Flowing |
| Apr-16 | Very Slow Flow | Very Slow Flow | 317.55 | Very Slow Flow | 316.58 | Very Slow Flow | Very Slow Flow | Very Slow Flow | Very Slow Flow | Very Slow Flow |
| Oct-16 | Very Slow Flow | Pond/No Flow | 317.43 | Dry | Pond/No Flow | Pond/No Flow | Pond/No Flow | Dry | Very Slow Flow | Very Slow Flow |

Notes:

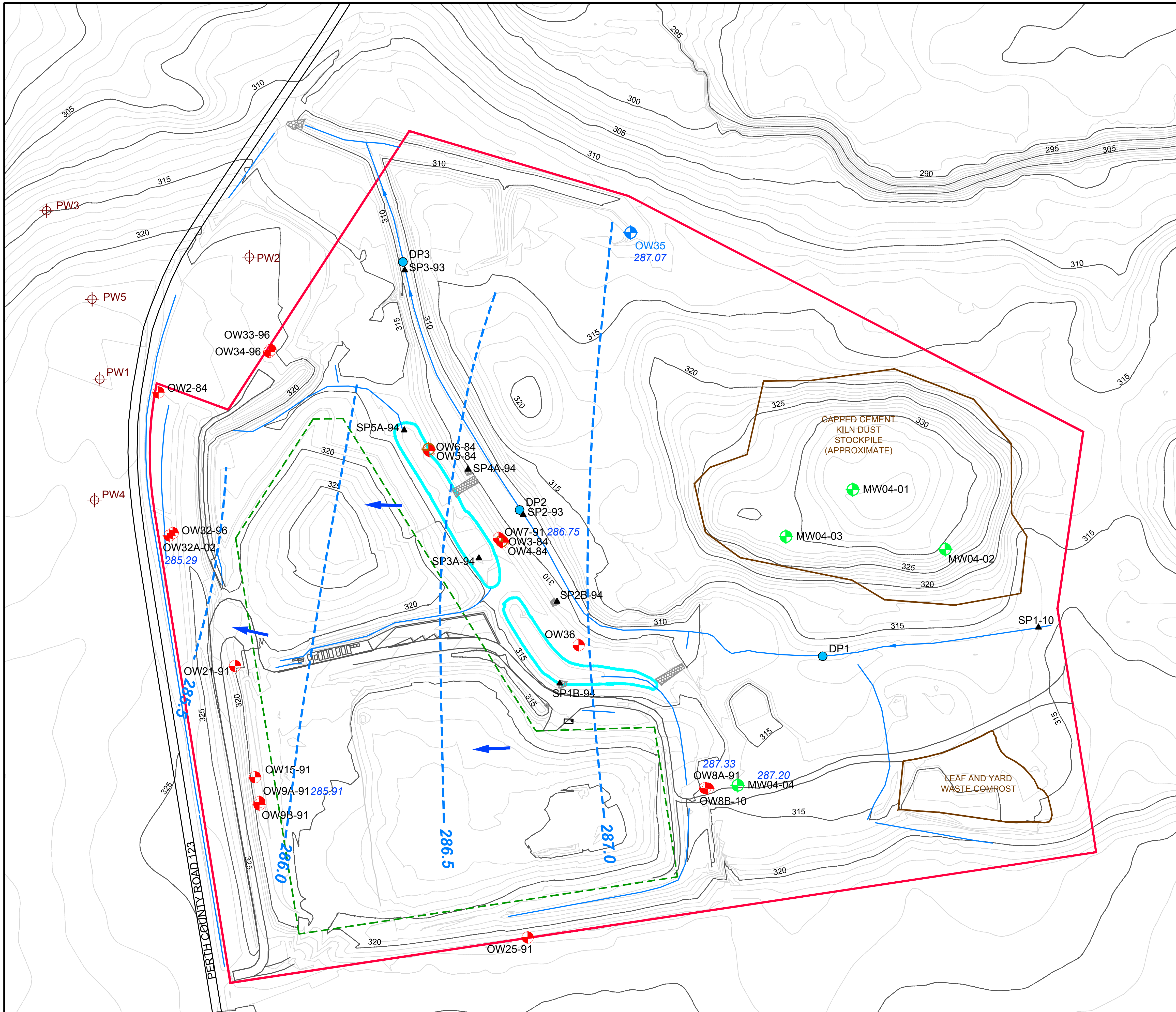
All elevations in metres above mean sea level (m AMSL).
Reference elevation is elevation of top of steel frame and grate.
* Data obtained during monitoring is not consistent with other data.
Buried - MH covered by waste or interim cover material

-- No Data
A - Leachate running into manhole.
(1) - Leachate pumped from holding tank prior to measuring levels.
Wet - bottom of MH wet, but no leachate accumulation

**Table F1.5**
**Phase II/III Leachate Elevations**
**St. Marys Landfill**

| Manhole ID | | MH1 | MH2 | MH3 | MH4 | MH5 | MH6 [2] | MH7 | MH8 | MH9 | MH10 | MH11 | MH12 | MH13 | MH14 | MH15 | MH16 | MH17 | MH18 | MH19 | MH20 | MHA | MHB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Invert Elev. | | 313.25 | 312.81 | 312.12 | | | 314.79 | 315.07 | 315.42 | 315.81 | 316.13 | 317.60 | 317.45 | 317.13 | 316.79 | 316.28 | | | 313.93 | 314.397 | 314.871 | 311.76 | 310.79 |
| Reference Elev. | 1 | 317.24 | 318.27 | 318.26 | 319.31 | 318.13 | 320.00 | 320.29 | | | | | | | 321.82 | 321.75 | 319.77 | 319.13 | 319.11 | 318.57 | 318.13 | 318.33 | 315.72 |
| May-93 | | NA | NA | NA | | | | | | | | | | | | | | | | | | | |
| Aug-93 | | NA | NA | NA | | | | | | | | | | | | | | | | | | | |
| Apr-94 | | NA | NA | NA | | | | | | | | | | | | | | | | | | | |
| Sep-94 | | Dry | Dry | 312.73 | | | | | | | | | | | | | | | | | | | |
| Apr-95 | | Dry | 312.84 | 312.84 | | | | | | | | | | | | | | | Dry | Dry | | | |
| Sep-95 | | Dry | Dry | 312.55 | | | | | | | | | | | | | | | Dry | Dry | | | |
| Apr-96 | | Dry | 313.24 | 313.26 | | | | | | | | | | | | | | | Dry | Dry | | | |
| Sep-96 | | Dry | 313.3 | 313.3 | | | | | | | | | | | | | | | Dry | Dry | | | |
| Apr-97 | | Dry | Dry | 312.64 | | | | | | | | | | | | | | | Dry | Dry | | | |
| Sep-97 | | Dry | 313.06 | 313.06 | | | | | | | | | | | | | | | Dry | 314.28 | | | |
| Apr-98 | | Dry | Dry | 312.14 | | | | | | | | | | | | | | | Dry | 314.36 | | | |
| Sep-98 | | Dry | Dry | 312.15 | | | | | | | | | | | | | | | Dry | Dry | | | |
| Apr-99 | | 312.27 | 312.83 | 312.14 | | | | | | | | | | | | | | | Dry | Dry | | | |
| Sep-99 | | Dry | Flowing | Flowing | | | | | | | | | | | | | | | Dry | No Flow | | | |
| Apr-00 | | Wet | Flowing | Flowing | | | | | | | | | | | | | | | Wet | Dry | | | |
| Sep-00 | | Dry | Wet | 312.49 | | | | | | | | | | | | | | | Dry | Wet | | | |
| Apr-01 | | Wet | Flowing | Flowing | | | | | | | | | | | | | | | Dry | Wet | | | |
| Sep-01 | | Dry | Dry | 312.69 | | | | | | | | | | | | | | | Dry | Dry | | | |
| Apr-02 | | Flowing | Flowing | 312.29 | | | | | | | | | | | | | | | Flowing | Flowing | | | |
| Sep-02 | | Dry | 313.2 | 310.88 | | | | | | | | | | | | | | | Wet | Dry | Dry | | |
| Apr-03 | | Flowing | Flowing | Flowing | | | | | | | | | | | | | | | Flowing | Flowing | Wet | | |
| Sep-03 | | Dry | Dry | Dry | | | | | | | | | | | | | | | Dry | Dry | Dry | | |
| May-04 | | Wet/Flowing | Wet/Slight Flow | Wet/Slight Flow | Wet/Flowing | | | | | | | | | | | | | Dry | Wet/Flowing | Wet/Flowing | Wet/Flowing | | Overflowing |
| Sep-04 | | Dry | Dry | 308.25 | Wet/Slight Flow | | | | | | | | | | | | | Dry | Dry | Dry | 314.85 | Dry | Top Flowing |
| Apr-05 | | Wet/No Flow | Wet/No Flow | Wet/Flowing | Flowing | Flowing | | | | | | | | | | | Wet/No Flow | Wet/No Flow | Wet/No Flow | Dry | Dry | 315.34 | Overflowing |
| Nov-05 | | Dry | Wet/No flow | Flowing | Wet/Flowing | Wet/Flowing | Wet/Flowing | | | | | | | | | | Wet/Flowing | Wet | Flowing | 314.74 | Dry | 315.33 | Top Flowing |
| Apr-06 | | Wet | Wet | Flowing | Flowing | Flowing | Wet | | | | | | | | | | Wet | Wet | Flowing | 315.00 | Dry | 315.32 | Top Flowing |
| Nov-06 | | Wet/No Flow | Wet/No Flow | Flowing | Flowing | Wet/Flowing | Wet/Flowing | | | | | | | | | | Wet/Flowing | Wet/No Flow | Wet/Flowing | 315.23 | Dry | 315.32 | Top Flowing |
| Apr-07 | | Wet/No Flow | Wet/No Flow | Flowing | Wet/Flowing | Wet/Flowing | Wet/Flowing | | | | | | | | | | Wet/Flowing | Dry | Wet/Flowing | 315.19 | Dry | 315.32 | Top Flowing |
| Nov-07 | | Dry | Dry | Wet/Flowing | Wet/No Flow | Wet/No Flow | Wet/Flowing | NA | | | | | | | NA | | Wet/No Flow | Wet/No Flow | Wet/No Flow | 314.91 | Dry | 315.12 | 315.12 |
| Apr-08 | | Wet/No Flow | Wet/No Flow | 312.59 | Wet/No Flow | Wet/Flowing | Wet/Flowing | NA | | | | | | | NA | NA | NA | Wet/Flowing | Wet/No Flow | Wet/Flowing | Dry | 315.35 | 315.37 |
| Nov-08 | | Dry | Dry | Flowing | Flowing | Flowing | Flowing | NA | | | | | | | NA | Wet/Flowing | Wet/Flowing | Wet/Flowing | Wet/Flowing | 315.38 | Wet | 315.14 | Top Flowing |
| Apr-09 | | Dry | Dry | Flowing | Flowing | Flowing | Flowing | NA | | | | | | | NA | Flowing | Flowing | Wet | Flowing | 315.05 | Flowing | 315.14 | Top Flowing |
| Nov-09 | | Wet | Wet | Flowing | Flowing | Wet | Wet | 315.11 | | | | | | | NA | Wet | Dry | Wet | Wet | 314.85 | Wet | 315.29 | 315.34 |
| Mar-10 | 3 | NA | NA | NA | NA | NA | NA | NA | | | | | | | NA | NA | NA | NA | NA | NA | NA | NA | Top Flowing |
| Nov-10 | | Wet | Flowing | Flowing | Flowing | Flowing | Flowing | NA | NA | | | | | NA | NA | Flowing | Flowing | Flowing | Flowing | 314.87 | Wet | 315.11 | Top Flowing |
| Mar-11 | | Wet | Flowing | Flowing | Flowing | 313.38 | Flowing | NA | NA | | | | | NA | NA | Flowing | Flowing | Wet | Flowing | 315.04 | Dry | 315.13 | Top Flowing |
| Dec-11 | | Wet | Flowing | Flowing | Flowing | Flowing | Flowing | Flowing | NA | | | | | NA | NA | Flowing | Flowing | Flowing | Flowing | 315.27 | Wet | 315.08 | Top Flowing |
| Apr-12 | | Dry | Flowing | Flowing | 312.84 | Flowing | Flowing | Flowing | NA | | | | | Dry | Wet | Flowing | Flowing | Wet | Flowing | 314.95 | Dry | 315.12 | Top Flowing |
| Nov-12 | | Wet | Wet | Flowing | Flowing | Wet | Flowing | Wet | NA | | | | | Wet | Wet | Wet | Wet | Wet | Wet | 314.96 | Wet | 315.12 | Top Flowing |
| May-13 | | Dry | Flowing | Flowing | Dry | Flowing | Flowing | 315.23 | NA | | | | | Flowing | 316.66 | Flowing | Flowing | Flowing | Flowing | 315.11 | Dry | 315.11 | Top Flowing |
| Oct-13 | | Dry | Dry | Flowing | 313.75 | Flowing | Flowing | 315.24 | Flowing | | | | | Flowing | 316.65 | Flowing | Flowing | Flowing | Flowing | 315.29 | Dry | 315.09 | Top Flowing |
| Jun-14 | | Wet | Wet | Trickle | 314.48 | 314.52 | Flowing | 315.16 | Wet | | | | | Trickle | 316.65 | Trickle | Wet | Wet | Trickle | 315.05 | 314.9 | 315.12 | 315.36 |
| Nov-14 | | Dry | Dry | Trickle | NA | 314.52 | Flowing | 315.22 | Trickle | | | | | Trickle | 316.66 | Wet/No Flow | Wet/No Flow | Dry | Wet/No Flow | 315.08 | Dry | 315.14 | 315.37 |
| May-15 | | Pond/No Flow | Pond/No Flow | Trickle | NA | 314.55 | Flowing | 315.23 | Trickle | NA | Trickle | Dry | Trickle | Pond/No Flow | 316.65 | Pond/No Flow | Trickle | Pond/No Flow | Trickle | 314.77 | Dry | 315.11 | 315.35 |
| Sep-15 | | Dry | Dry | Trickle | NA | 314.43 | Trickle | 315.29 | NA | NA | NA | Wet | Dry | Dry | 316.57 | Dry | Dry | Dry | Pond/No Flow | 314.82 | Pond/No Flow | 315.13 | 315.36 |
| Apr-16 | | Trickle | Trickle | Trickle | NA | Trickle | Trickle | 315.23 | NA | Trickle | Trickle | Trickle | Dry | Trickle | 316.65 | Trickle | Trickle | Trickle | Trickle | 314.91 | Trickle | 315.13 | 315.35 |
| Oct-16 | | Trickle | Trickle | Trickle | Trickle | 314.60 | Trickle | Dry | Trickle | Trickle | Trickle | Dry | Dry | Dry | 316.67 | Trickle | Trickle | Trickle | Trickle | Dry | Trickle | 315.03 | 315.26 |

Notes:
All elevations in metres above mean sea level (m amsl).
Reference elevation of manholes is elevation of top of steel frame and grate.
1. Reference elevations resurveyed November 23, 2009
2. 1.46 m spacer added to MH 6 in 2008 to bring MH cover elevation above grade.
3. Phase II/III Manholes were not inspected during the March 2010 event due to the disposal of ACM at the site on the day of the inspection.
NA - not accessible
Wet - bottom of MH wet, but no leachate accumulation
Overflowing - indicates that groundwater was flowing out the top of the MH cover.
Top Flowing - indicates that groundwater was flowing out of the manhole riser.
Invert elevations MH8 to MH13 from 2013 Cell 8 Construction documents




## LEGEND

- PROPERTY BOUNDARY
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- STORM WATER MANAGEMENT BASIN
- OBSERVATION WELL
- SURFACE WATER MONITORING LOCATION
- PRIVATE DOMESTIC WELL (APPROXIMATE LOCATION)
- MONITORING WELL (NOT SAMPLED)
- MONITORING WELL (REMOVED FROM MONITORING PROGRAM)
- MONITORING WELL (SOURCE UNKNOWN)
- DRIVE POINT PIEZOMETER
- INTERPRETED GROUNDWATER CONTOUR (masl)
- 287.90 MEASURED WATER LEVEL (MARCH 29, 2016)
- INTERPRETED GROUNDWATER FLOW DIRECTION

N

0 60 120 180 240

Metres

BURNSIDE

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TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**GROUNDWATER FLOW IN BEDROCK (MARCH 29, 2016)**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
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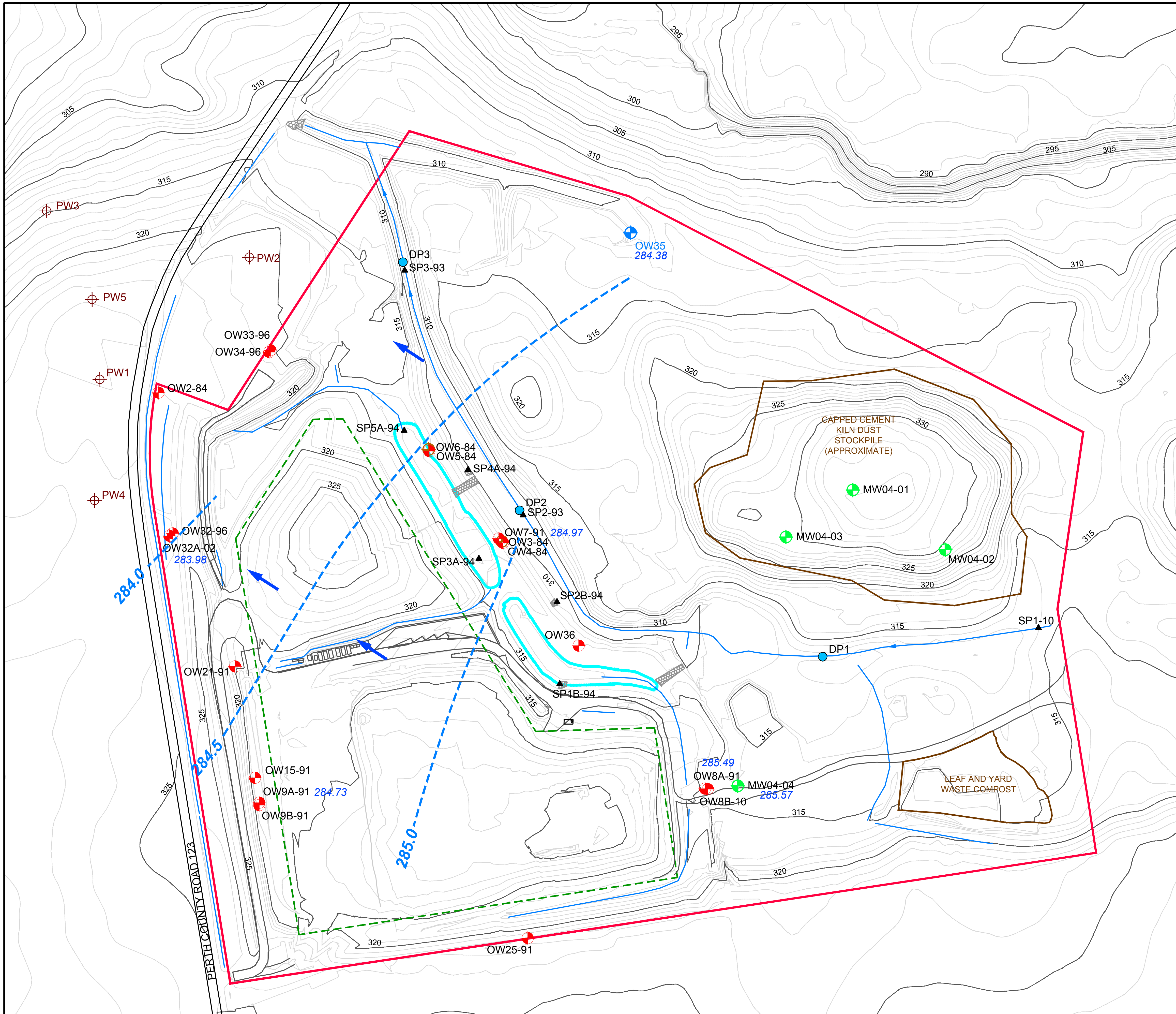


## LEGEND

- PROPERTY BOUNDARY
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- STORM WATER MANAGEMENT BASIN
- OBSERVATION WELL
- SURFACE WATER MONITORING LOCATION
- PRIVATE DOMESTIC WELL (APPROXIMATE LOCATION)
- MONITORING WELL (NOT SAMPLED)
- MONITORING WELL (REMOVED FROM MONITORING PROGRAM)
- MONITORING WELL (SOURCE UNKNOWN)
- DRIVE POINT PIEZOMETER
- INTERPRETED GROUNDWATER CONTOUR (masl)
- 287.90 MEASURED WATER LEVEL (OCTOBER 4, 2016)
- INTERPRETED GROUNDWATER FLOW DIRECTION

N

0 60 120 180 240

Metres

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*HYDROGEOLOGICAL STUDY*

Figure Title

**GROUNDWATER FLOW IN BEDROCK (OCTOBER 4, 2016)**

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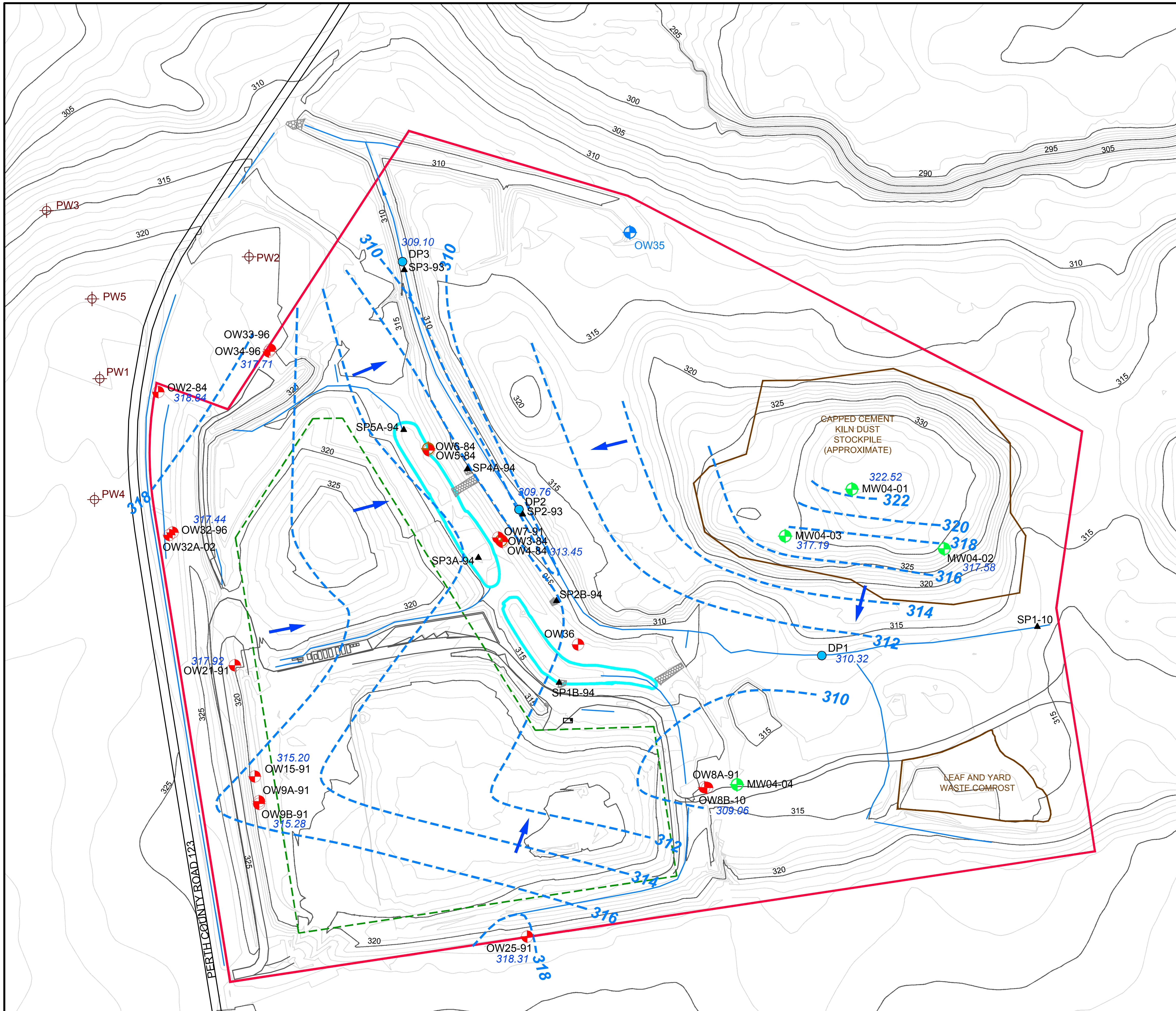


## LEGEND

- PROPERTY BOUNDARY
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- STORM WATER MANAGEMENT BASIN
- OBSERVATION WELL
- SURFACE WATER MONITORING LOCATION
- PRIVATE DOMESTIC WELL (APPRO□IMATE LOCATION)
- MONITORING WELL (NOT SAMPLED)
- MONITORING WELL (REMOVED FROM MONITORING PROGRAM)
- MONITORING WELL (SOURCE UNKNOWN)
- DRIVE POINT PIE□OMETER
- INTERPRETED GROUNDWATER CONTOUR (masl)
- 287.90 MEASURED WATER LEVEL (MARCH 29, 2016)
- INTERPRETED GROUNDWATER FLOW DIRECTION

N

0 60 120 180 240

Metres

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*HYDROGEOLOGICAL STUDY*

Figure Title

**GROUNDWATER FLOW IN OVERBURDEN (MARCH 29, 2016)**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2017 | F2.3 |
| Scale | | Project No. | |
| 1:3,000 | | 300032339 | |

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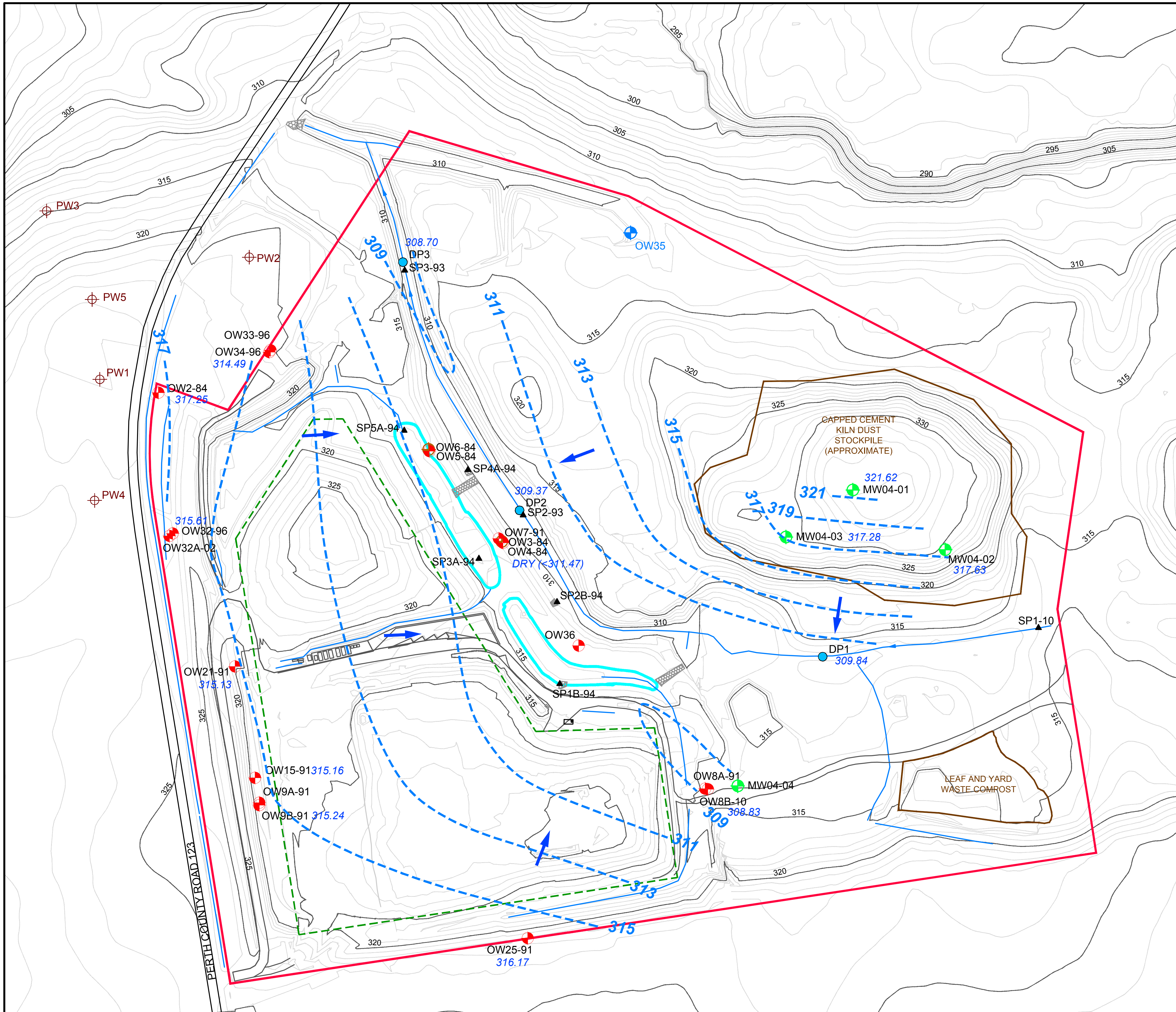


## LEGEND

- PROPERTY BOUNDARY
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- STORM WATER MANAGEMENT BASIN
- OBSERVATION WELL
- SURFACE WATER MONITORING LOCATION
- PRIVATE DOMESTIC WELL (APPRO□IMATE LOCATION)
- MONITORING WELL (NOT SAMPLED)
- MONITORING WELL (REMOVED FROM MONITORING PROGRAM)
- MONITORING WELL (SOURCE UNKNOWN)
- DRIVE POINT PIE□OMETER
- INTERPRETED GROUNDWATER CONTOUR (masl)
- 287.90 MEASURED WATER LEVEL (OCTOBER 4, 2016)
- INTERPRETED GROUNDWATER FLOW DIRECTION

N

0 60 120 180 240

Metres

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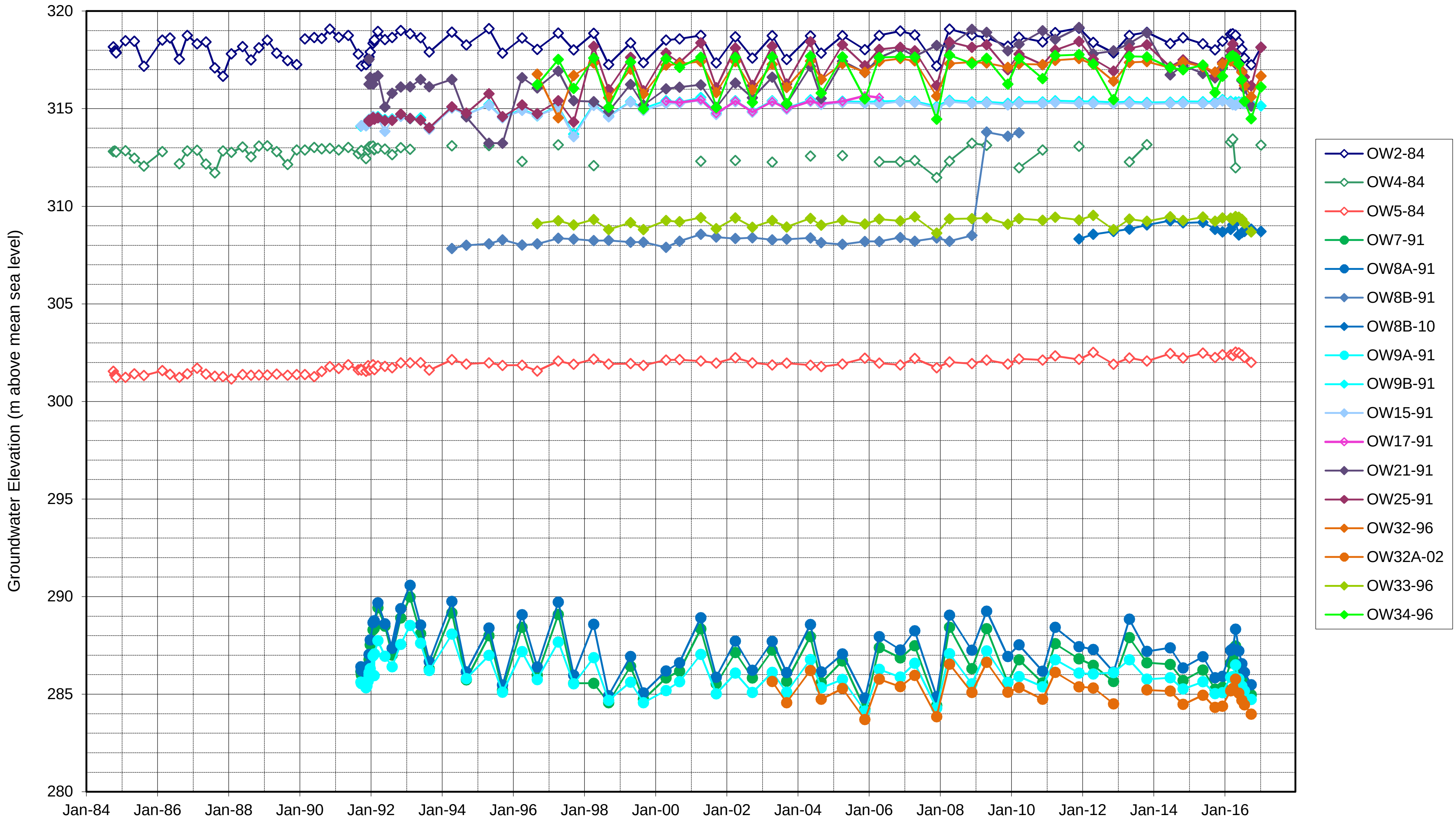
*HYDROGEOLOGICAL STUDY*

Figure Title

**GROUNDWATER FLOW IN OVERBURDEN (OCTOBER 4, 2016)**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | CM | March 2017 | F2.4 |
| Scale | | Project No. | |
| 1:3,000 | | 300032339 | |

**Figure F1.5**
**Groundwater Hydrographs**




R.J. Burnside & Associates Limited
File: 032339 St. Marys 2017 EA HG Study Tables.xlsx
Date: 4/13/2017

Town of St. Marys Landfill
Environmental Assessment Hydrogeology Study
300032339.0000

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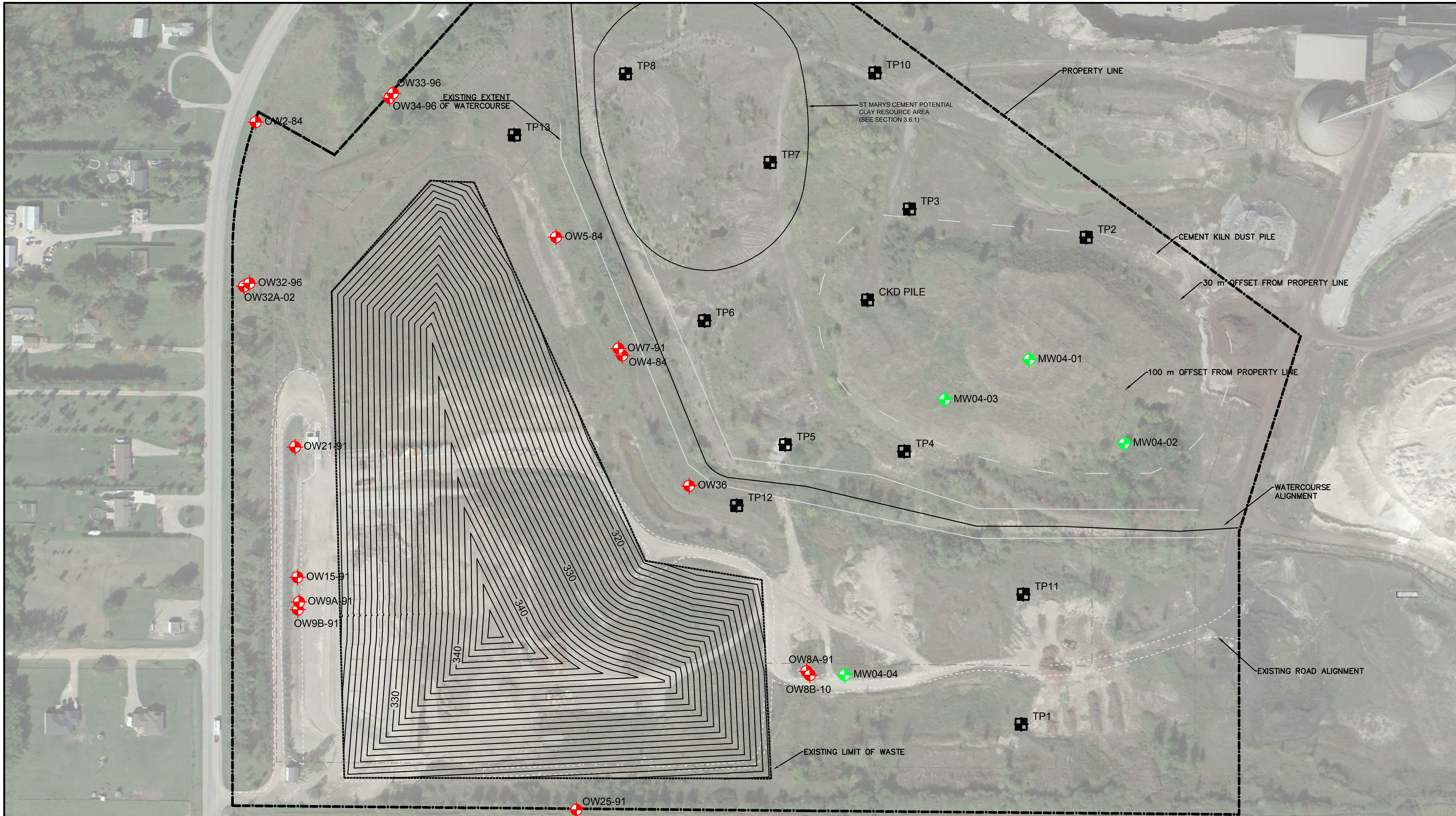
[THE DIFFERENCE IS OUR PEOPLE]

# Appendix G

# Alternative Methods Conceptual Drawings

Appendix G




## LEGEND

OBSERVATION WELL (ANNUAL MONITORING REPORT)

OBSERVATION WELL

TEST PIT

OBTAINED CAPACITY - 577,000 m³

N

0 50 100 150 200

Metres

BURNSIDE

Figure Title

**SOLID WASTE CAPACITY DEVELOPMENT**

ALTERNATIVE METHOD 1 - VERTICAL E□PANSION

Client

**TOWN OF ST. MARYS**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| AE | □RH | APRIL 2016 | 1 |
| Scale | | Project No. | |
| 1:2500 | | 300032339 | |

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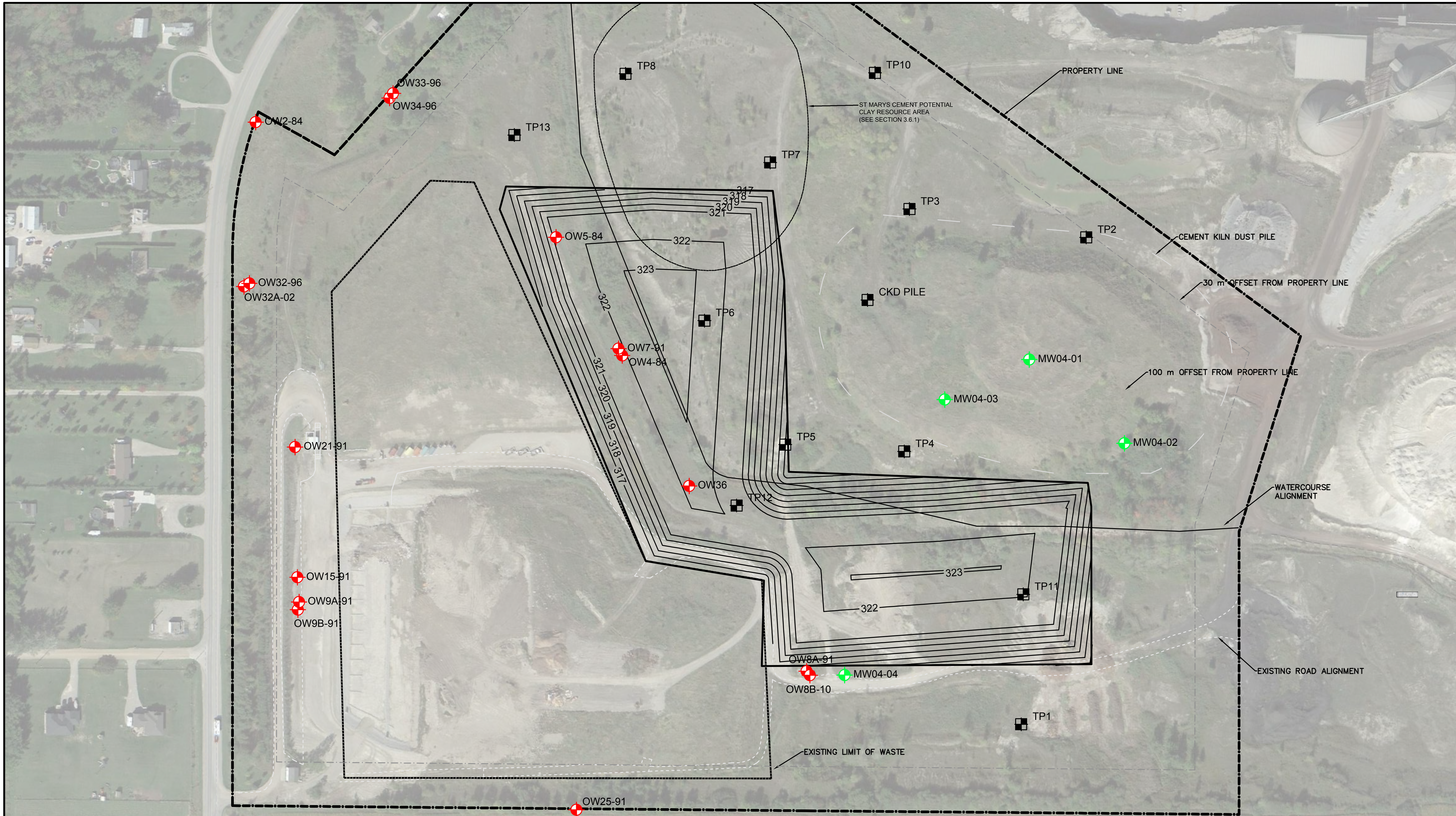


## LEGEND

- OBSERVATION WELL (ANNUAL MONITORING REPORT)
- OBSERVATION WELL
- TEST PIT

0 50 100 150 200
Metres

N

| | |
|---|---|
| OBTAINED CAPACITY - | 733,000 m³ |
| ABOVE GRADE - | 403,000 m³ |
| BELOW GRADE- | 330,000 m³ |

E□PANSION VOLUME IS ATTAINED FROM A 4:1 SIDESLOPE FROM THE EDGE OF WASTE TO m ELEVLATION 321 m. FOLLOWED BY A 20:1 GRADE TO THE PEAK AT 323m. COMBINED WITH A 5 m VERTICAL E□CAVATION (CKD PILE E□CLUDED).

MINIMUM MOECC SETBACK FROM PROPERTY BOUNDARY = 30 m
GUIDELINE SETBACK = 100 m

BURNSIDE

Client
TOWN OF ST. MARYS

Figure Title
**SOLID WASTE CAPACITY DEVELOPMENT**

METHOD 2 - HORI□ONTAL E□PANSION OF THE E□ISTING LANDFILL

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| AE | □RH | APRIL 2016 | 2 |
| Scale | | Project No. | |
| 1:2500 | | 300032339 | |

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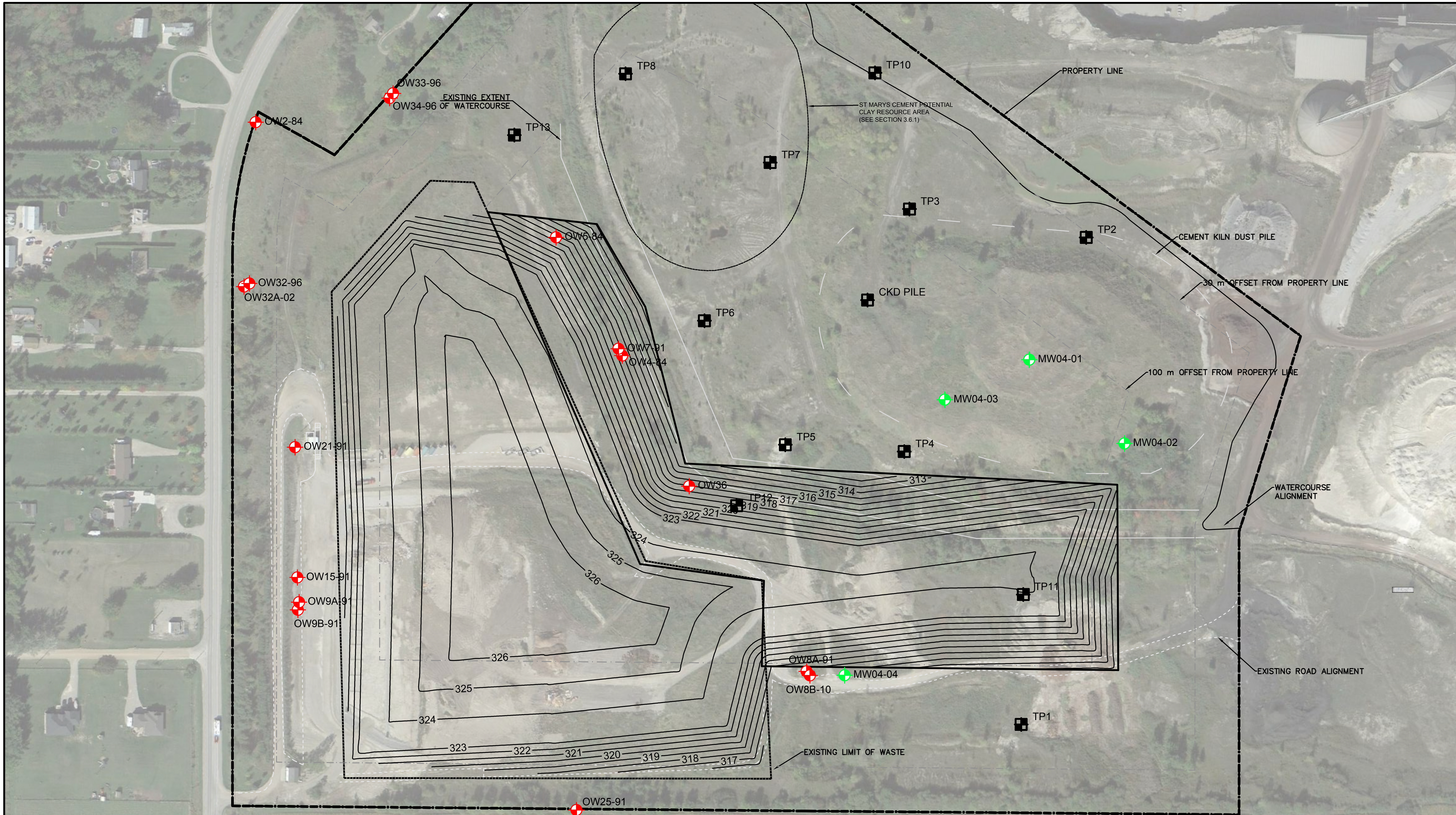



## LEGEND

- OBSERVATION WELL (ANNUAL MONITORING REPORT)
- OBSERVATION WELL
- TEST PIT

0 50 100 150 200
Metres

N

| | |
|---|---|
| OBTAINED CAPACITY - | 756,000 m³ |
| ABOVE GRADE - | 506,000 m³ |
| BELOW GRADE- | 250,000 m³ |

E□PANSION VOLUME IS ATTAINED FROM A 4:1 SIDESLOPE FROM THE EDGE OF THE WASTE TO ELEVATION OF 323m, FOLLOWED BY A 20:1 SLOPE ON THE PEAK. COMBINED WITH A 5m VERTICAL E□CAVATION (CKD PILE E□CLUDED).

MINIMUM MOECC SETBACK FROM PROPERTY BOUNDARY = 30 m
GUIDELINE SETBACK = 100 m

BURNSIDE

Figure Title

**SOLID WASTE CAPACITY DEVELOPMENT**

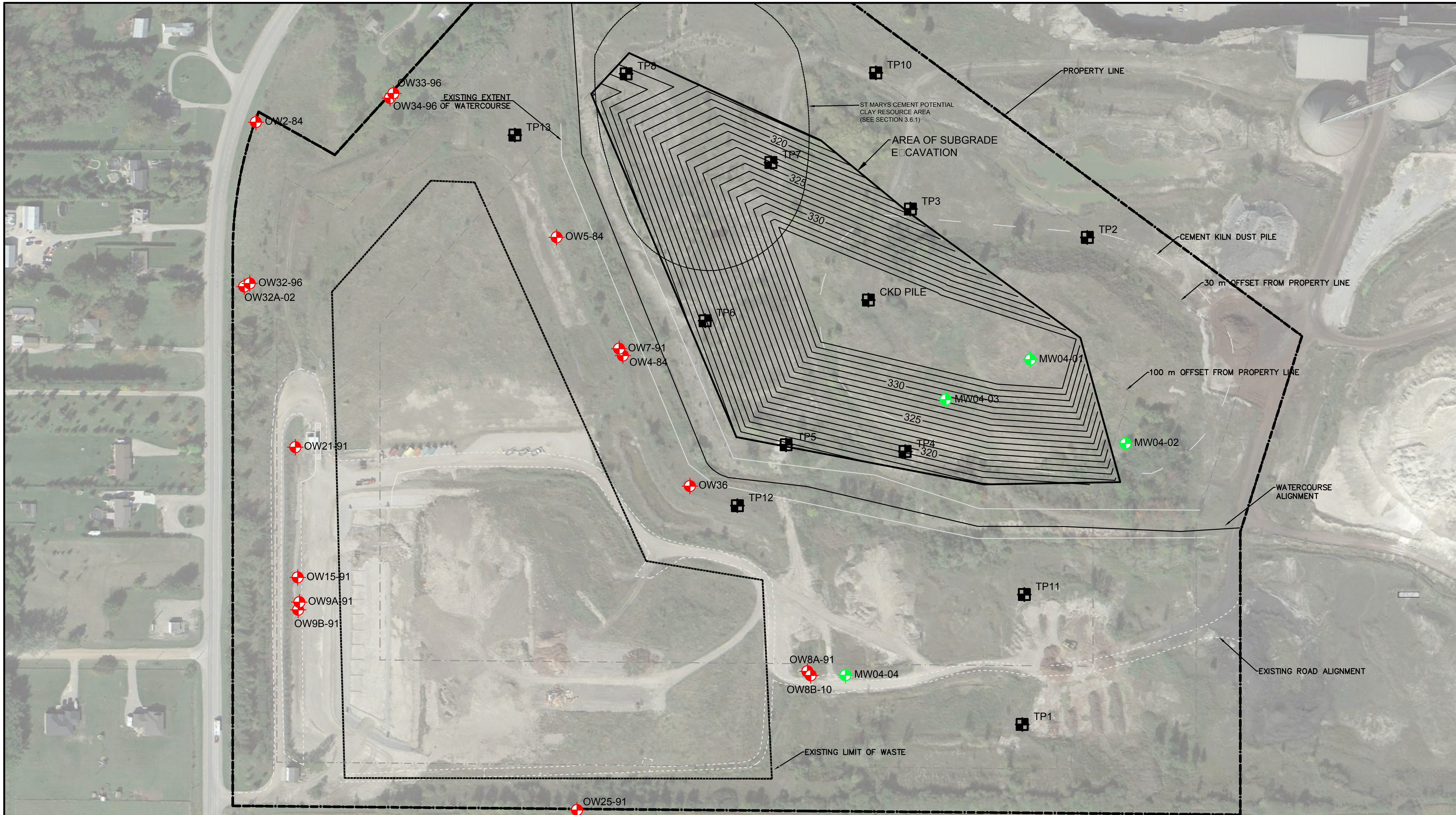
METHOD 3 - COMBINATION OF VERTICAL AND HORI□ONTAL E□PANSION

Client

**TOWN OF ST. MARYS**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| AE | □RH | APRIL 2016 | 3 |
| Scale | | Project No. | |
| 1:2500 | | 300032339 | |

File: U: 032339 - St. Marys Waste CIVIL 02 ProductionDwg EA Figures Appendix G Alternative Method 3.dwg Date Plotted: May 17, 2017 - 3:19 PM




## LEGEND

OBSERVATION WELL
(ANNUAL MONITORING REPORT)

OBSERVATION WELL

TEST PIT

0 50 100 150 200
Metres

N

| | |
|---|---|
| OBTAINED CAPACITY - | 397,000 m³ |
| ABOVE GRADE - | 252,000 m³ |
| BELOW GRADE- | 145,000 m³ |

E□PANSION VOLUME IS ATTAINED FROM A 4:1 SIDESLOPE FROM THE EDGE OF THE WATERCOURSE BANK TO THE ELEVATION OF THE E□ISTING TOPOGRAPHY. COMBINED WITH A 5 m VERTICAL E□CAVATION (CKD PILE E□CLUDED).

BURNSIDE

Client

TOWN OF ST. MARYS

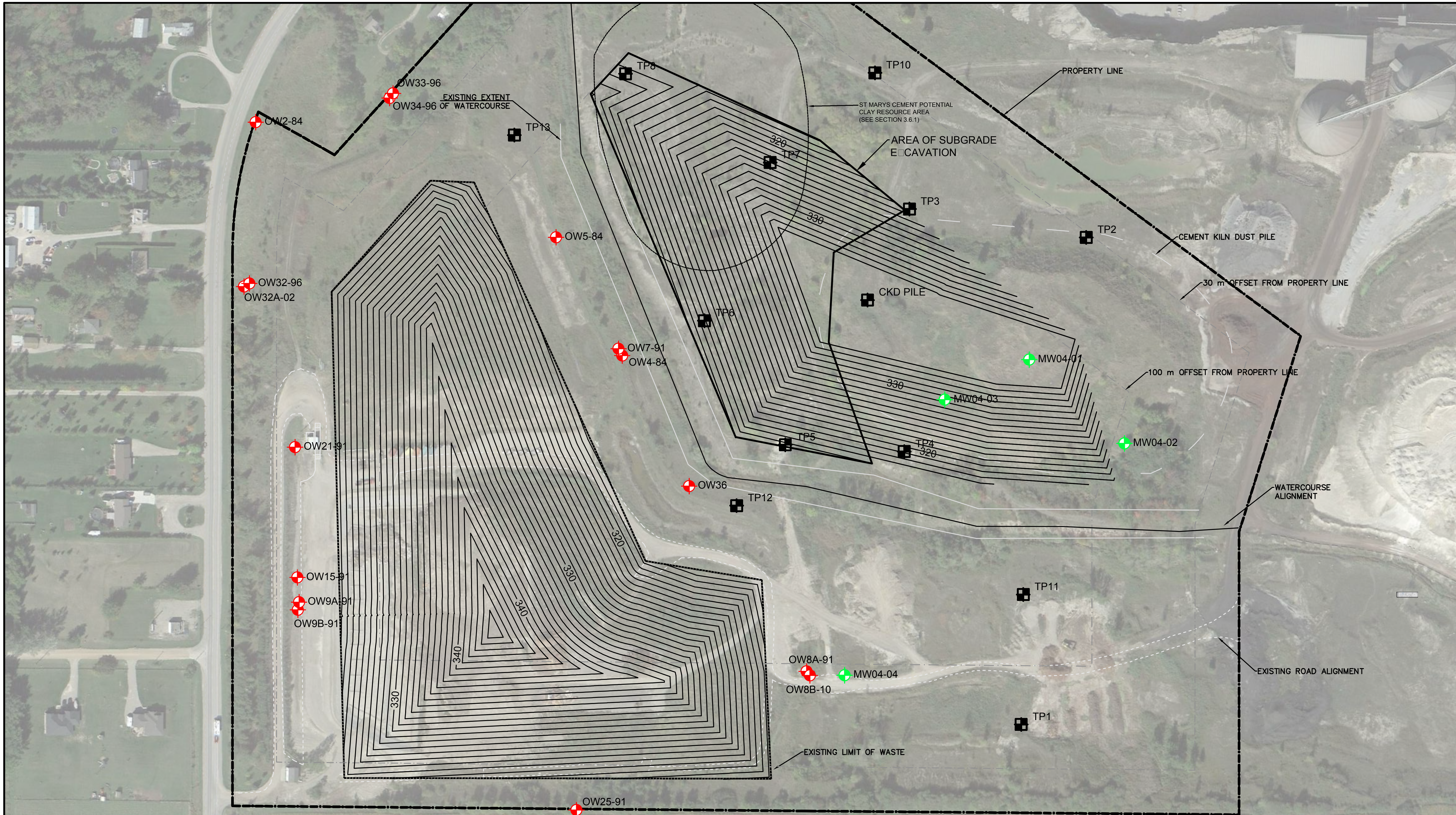
Figure Title

**SOLID WASTE CAPACITY DEVELOPMENT**

ALTERNATIVE METHOD 4 -
NEW LANDFILL FOOTPRINT

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| AE | □RH | APRIL 2016 | 4 |
| Scale | | Project No. | |
| 1:2500 | | 300032339 | |

File: U: 032339 - St. Marys Waste CIVIL 02 - ProductionDwg EA Concepts Alternative Method 4.dwg Date Plotted: April 20, 2017 - 12:29 PM




## LEGEND

- OBSERVATION WELL (ANNUAL MONITORING REPORT)
- OBSERVATION WELL
- TEST PIT

0 50 100 150 200
Metres

N

| | |
|---|---|
| OBTAINED CAPACITY - | 974,000 m³ |
| ABOVE GRADE - | 827,000 m³ |
| BELOW GRADE- | 145,000 m³ |

E□PANSION VOLUME IS ATTAINED FROM A 4:1 SIDESLOPE FROM THE EDGE OF THE WATERCOURSE BANK TO THE ELEVATION OF THE E□ISTING TOPOGRAPHY. COMBINED WITH A 5 m VERTICAL E□CAVATION (CKD PILE E□CLUDED). ADDITIONALLY WASTES WILL BE PLACED OVERTOP OF THE E□ISTING PHASES.

MINIMUM MOECC SETBACK FROM PROPERTY BOUNDARY = 30 m
GUIDELINE SETBACK = 100 m

BURNSIDE

Client
TOWN OF ST. MARYS

Figure Title
**SOLID WASTE CAPACITY DEVELOPMENT**
METHOD 5 - COMBINATION OF VERTICAL E□PANSION AND SEPARATE DEVELOPMENT OF A NEW LANDFILL FOOTPRINT

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| AE | □RH | APRIL 2016 | 5 |
| Scale | | Project No. | |
| 1:2500 | | 300032339.0000 | |

File: U:\032339 - St. Marys Waste CIVIL 02_ProductionDwg EA Figures Appendix G Alternative Method 5.dwg Date Plotted: April 20, 2017 - 12:40 PM

# Appendix H

# Impacts and Mitigation

**Table H1**
**Potential Impacts**

| Description of Site Alteration | Leachate Generation | | Groundwater | | | | Surface Water | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quantity | | Quality | | Quantity | | Quality | |
| **Method 1 Vertical Expansion of Existing Landfill (577,000 m3)** | | | | | | | | | | |
| Added height to Phase I and Phase II/III during operation | N1 | Increased leachate strength | o | | N2 | Potential for increased leachate elevation - increased head could drive leachate into sand/silt seam and into till | o | | N3 | Potential for contaminated runoff from footprint during filling |
| Added height to Phase I and Phase II/III when closed | P | Decreased generation - increased runoff on longer side slopes | o | | N2 | Potential for increased leachate elevation - increased head could drive leachate into sand/silt seam and into till | N4 | Increased runoff from footprint - longer side slopes<br>No change outside footprint | N5 | Potential for leachate breakout on final side slope |
| Filled between Phase I and Phase II/III - increased waste footprint | N6 | Increased infiltration into waste | o | Potential decreased infiltration (increased runoff) - minor | N7 | Potential for migration of leachate downward into sand/silt seam | o | Decreased runoff during filling<br>Increased runoff from finished slopes | N8 | Potential for contaminated runoff from fill area |
| Footprint does not encroach on stormwater basins | o | | o | | P | No alterations to stormwater basin with regard to sand/silt seam | P | No alterations to stormwater basin location | o | |
| Footprint does not encroach on watercourse | o | | o | | o | | P | No alterations to water course location | o | |
| **Method 2 Horizontal Expansion of Existing Landfill (733,000 m3)** | | | | | | | | | | |
| Height slighlty less than current Phase I and Phase II/III | o | | o | | o | | o | | o | |
| Increased waste footprint | N6 | Increased infiltration into waste | o | Potential decreased infiltration (increased runoff) - minor | N7 | Potential for migration of leachate downward into sand/silt seam | o | Decreased runoff during filling<br>Increased runoff from finished slopes | N8 | Potential for contaminated runoff from fill area |
| New waste footprint in centre of property - farther from boundary | o | | o | | P | Creates large buffer between fill and property boundary | o | | P | Creates large buffer between fill and property boundary |
| Create long narrow depressions between footprint expansion and existing Phases | N9 | could cause surface ponding and increased infiltration | o | | N2 | Potential for increased leachate elevation - increased head could drive leachate into sand/silt seam | P | Decreased stormwater runoff | N5 | Potential for leachate breakout on final side slope |
| 5 metre excavation | o | | N10 | Could intersect saturated soil or sand/silt seam | N10 | Could intersect saturated soil or sand/silt seam | o | | o | |
| Bottom of waste may be closer to bedrock surface | o | | o | | N11 | Shorter travel distance between bottom of waste and bedrock | o | | o | |
| Displaces stormwater basins - requires relocation | o | | o | | N12 | Potential for migration of stormwater downward into sand/silt seam | o | | o | |
| Displaces watercourse - requires relocation | o | | N13 | Potential to change flow direction in shallow groundwater | N14 | Potential for migration of leachate laterally into sand/silt seam (exposed on bank of watercourse) | N15 | Will require alterations of surface water movement to reach new watercourse | P<br>N16 | Increase waste to watercourse distance<br>Decrease CKD to watercourse distance |

**Legend**

| | |
|---|---|
| o | No net impact or neutral when compared to the existing site |
| P | Positive Impact |
| N2 | Negative impact - numbered in order in which they appear on table<br>Follow number to mitigation tables |

**Table H1**
**Potential Impacts**

| Description of Site Alteration | Leachate Generation | | Groundwater | | | | Surface Water | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quantity | | Quality | | Quantity | | Quality | |
| **Method 3 Combionation of Vertical and Horizontal Expansion of Existing Landfill (Method 1 and Method 2) (756,000 m3)** | | | | | | | | | | |
| Filled between Phase I and Phase II/III - increased waste footprint | N6 | Increased infiltration into waste | o | Potential decreased infiltration (increased runoff) - minor | N7 | Potential for migration of leachate downward into sand/silt seam | o | Decreased runoff during filling Increased runoff from finished slopes | N8 | Potential for contaminated runoff from fill area |
| Increased waste footprint but less area than Method 2 | N6 | Increased infiltration into waste | o | Potential decreased infiltration (increased runoff) - minor | N7 | Potential for migration of leachate downward into sand/silt seam | o | Decreased runoff during filling Increased runoff from finished slopes | N8 | Potential for contaminated runoff from fill area |
| New waste footprint in centre of property - farther from boundary | o | | o | | P | Creates large buffer between fill and property boundary | o | | P | Creates large buffer between fill and property boundary |
| Eliminates long narrow depressions between footprint expansion and existing Phases created by Method 2 | o | | o | | o | | o | | o | |
| 5 metre excavation | o | | N10 | Could intersect saturated soil or sand/silt seam | N10 | Could intersect saturated soil or sand/silt seam | o | | o | |
| Displaces stormwater basins - requires relocation | o | | o | | N12 | Potential for migration of stormwater downward into sand/silt seam | o | | o | |
| Displaces watercourse - requires relocation | o | | N13 | Potential to change flow direction in shallow groundwater | N14 | Potential for migration of leachate laterally into sand/silt seam (exposed on bank of watercourse) | N15 | Will require alterations of surface water movement to reach new watercourse | P<br>N16 | Increase waste to watercourse distance<br>Decrease CKD to watercourse distance |
| **Method 4 Development of a New Landfill Footprint (397,000 m3)** | | | | | | | | | | |
| Adds height to currently flat area | | | N13 | Potential to change flow direction in shallow groundwater | N2 | Potential for increased leachate elevation - increased head could drive leachate into sand/silt seam | o | | N8 | Potential for contaminated runoff from fill area |
| Adds slopes to currently flat area | o | | o | Potential decreased infiltration (increased runoff) - minor | o | | N17 | Increased runoff from western side slopes into watercourse | | |
| Increases waste footprint | N6 | Increased infiltration into waste | o | Potential decreased infiltration (increased runoff) - minor | N7 | Potential for migration of leachate downward into sand/silt seam | o | Decreased runoff during filling Increased runoff from finished slopes | N8 | Potential for contaminated runoff from fill area |
| New waste footprint closer to eastern property boundary | o | | o | | N11 | Shorter travel distance between bottom of waste and bedrock | o | | o | |
| 5 metre excavation | o | | N10 | Could intersect saturated soil or sand/silt seam | N10 | Could intersect saturated soil or sand/silt seam | o | | o | |
| Bottom of waste may be closer to bedrock surface | o | | o | | N11 | Shorter travel distance between bottom of waste and bedrock | o | | o | |
| Footprint does not encroach on stormwater basins | o | | o | | P | No alterations to stormwater basin with regard to sand/silt seam | P | No alterations to stormwater basin location | o | |
| Footprint does not encroach on watercourse but is close to top of bank | o | | o | | P | No alterations to water course with regard to sand/silt seam | N17 | Increased runoff from western side slopes into watercourse | N8 | Potential for contaminated runoff from fill area |
| Overlaps part of cement kiln dust stockpile | N18 | CKD leachate unknown Combination unknown | N19 | Potential to change current mounding in CKD stockpile and change shallow flow direction | o | | o | | o | |

**Table H1**
**Potential Impacts**

| Description of Site Alteration | Leachate Generation | | Groundwater | | | | Surface Water | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quantity | | Quality | | Quantity | | Quality | |
| **Method 5 Vertical Expansion of Existing plus Development of a New Landfill Footprint (Method 1 and Method 4) (974,000 m3)** | | | | | | | | | | |
| Added height to Phase I and Phase II/III during operation | N1 | Increased leachate strength | o | | N2 | Potential for increased leachate elevation - increased head could drive leachate into sand/silt seam and into till | o | | N3 | Potential for contaminated runoff from footprint during filling |
| Added height to Phase I and Phase II/III when closed | P | Decreased generation - increased runoff on longer side slopes | o | | N2 | Potential for increased leachate elevation - increased head could drive leachate into sand/silt seam and into till | N4 | Increased runoff from footprint - longer side slopes No change outside footprint | N5 | Potential for leachate breakout on final side slope |
| Added height to currently flat area | o | | N13 | Potential to change flow direction in shallow groundwater | N2 | Potential for increased leachate elevation - increased head could drive leachate into sand/silt seam | o | | N8 | Potential for contaminated runoff from fill area |
| Added slopes to currently flat area | o | | o | Potential decreased infiltration (increased runoff) - minor | o | | N17 | Increased runoff from western side slopes into watercourse | o | |
| Increased waste footprint | N6 | Increased infiltration into waste | o | Potential decreased infiltration (increased runoff) - minor | N7 | Potential for migration of leachate downward into sand/silt seam | o | Decreased runoff during filling Increased runoff from finished slopes | N8 | Potential for contaminated runoff from fill area |
| Filled between Phase I and Phase II/III - increases waste footprint | N6 | Increased infiltration into waste | o | Potential decreased infiltration (increased runoff) - minor | N7 | Potential for migration of leachate downward into sand/silt seam | o | Decreased runoff during filling Increased runoff from finished slopes | N8 | Potential for contaminated runoff from fill area |
| New waste footprint closer to eastern property boundary | o | | o | | N11 | Shorter travel distance between bottom of waste and bedrock | o | | o | |
| 5 metre excavation east of watercourse | o | | N10 | Could intersect saturated soil or sand/silt seam | N10 | Could intersect saturated soil or sand/silt seam | o | | o | |
| Bottom of waste may be closer to bedrock surface | o | | o | | N11 | Shorter travel distance between bottom of waste and bedrock | o | | o | |
| Footprint does not encroach on stormwater basins | o | | o | | P | No alterations to stormwater basin with regard to sand/silt seam | P | No alterations to stormwater basin location | o | |
| Footprint does not encroach on watercourse but is close to top of bank | o | | o | | P | No alterations to water course with regard to sand/silt seam | N17 | Increased runoff from western side slopes into watercourse | N8 | Potential for contaminated runoff from fill area |
| Overlaps part of cement kiln dust stockpile | N18 | CKD leachate unknown Combination unknown | N19 | Potential to change current mounding in CKD stockpile and change shallow flow direction | o | | o | | o | |

**Legend**

| | |
|---|---|
| o | No net impact or neutral when compared to the existing site |
| P | Positive Impact |
| N2 | Negative impact - numbered in order in which they appear on table Follow number to mitigation tables |

**Table H2**
**Groundwater Mitigation Measures and Ranking**

| Impact No | Alternative Methods 1 | 2 | 3 | 4 | 5 | Impact | Site Alteration Leading to Impact | Impacted Feature | Possible Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| N1 | ◕ | | | | ◕ | Increased leachate strength | Added height to Phase I and Phase II/III | Leachate | · Monitor leachate quality and quantity in leachate collection system<br>· Review capacity of sewage treatment plant |
| N2 | ○ | | | | ○ | Potential for increased leachate elevation - increased head could drive leachate into sand/silt seam | Added height to Phase I and Phase II/III | GW | · Monitor flow rate from leachate collection system<br>· Leachate head control by enchanced or modified leachate collection system |
| | | ◑ | | | | | Create long narrow depressions between footprint expansion and existing Phases | Leachate | · Design stormwater control between existing and expansion footprints for operation and closed stages to prevent ponding and infiltration into waste |
| | | | | ◔ | ◔ | | Added height to currently flat area | GW | · Map presence and remove sand/silt seams<br>· Install a leachate collection system of similar design to current system |
| N6 | ◑ | | ◑ | | ◑ | Increased infiltration into waste (increased leachate generation) | Filled between Phase I and Phase II/III - increased waste footprint | Leachate | · Design and operations to reduce work area & interim cover to promote clean runoff<br>· Evaluate leachate generation potential against sewage treatment plant capacity |
| | | ◑ | ◑ | ◑ | ◑ | | Increased footprint area | Leachate | · Design and operations to reduce work area & interim cover to promote clean runoff<br>· Evaluate leachate generation potential against sewage treatment plant capacity |
| N7 | ◔ | | ◔ | | ◔ | Potential for migration of leachate downward into sand/silt seam | Filled between Phase I and Phase II/III - increased waste footprint | GW | · Map presence and remove sand/silt seams<br>· Extend leachate collection system between Phase I and Phase II/III |
| | | ◔ | ◔ | ◔ | ◔ | | Increased footprint area | GW | · Map presence and remove sand/silt seams<br>· Install a leachate collection system of similar design to current system |
| N9 | | ◑ | | | | Could cause surface ponding and increased infiltration | Create long narrow depressions between footprint expansion and existing Phases | Leachate | · Design stormwater control between existing and expansion footprints for to prevent ponding and infiltration into waste |
| N10 | | ○ | ○ | ○ | ○ | Could intersect saturated soil or sand/silt seam | 5 metre excavation | GW | · Map presence and remove sand/silt seam<br>· Map depth to water table and maintain landfill base above water table<br>· Liner designed to separate groundwater in the seam from the waste<br>· Induce groundwater from sand/silt seam toward leachate collection system |
| N11 | | ○ | | ○ | ○ | Reduced separation distance between bottom of waste and bedrock | Bottom of waste may be closer to bedrock surface | GW | · Confirm depth to bedrock and soil characteristic between waste and bedrock<br>· Enhance leachate collection system (e.g. liner) |
| | | | | ○ | ○ | | New waste footprint closer to eastern property boundary | GW | · Confirm depth to bedrock and soil characteristic between waste and bedrock<br>· Confirm groundwater flow direction in bedrock at northeast corner<br>· Enhance leachate collection system (e.g. liner) |
| N12 | | ◑ | ◑ | | | Potential for migration of stormwater downward into sand/silt seam | Displaces stormwater basins - requires relocation | GW | · Determine presence and depth of sand/silt seam in new basin location<br>· Remove seam or maintain separation distance from basin bottom to seam |
| N13 | | ○ | ○ | | | Potential to change flow direction in shallow groundwater | Displaces watercourse - requires relocation | GW | · Create conceptual model of new flow direction<br>· Design leachate collection system to induce flow from CKD stockpile toward former watercouse location |
| | | | | ◔ | ◔ | | Added height to currently flat area | GW | · Create conceptual model of new flow direction<br>· Install a leachate collection system of similar design to current system |

**Table H2**
**Groundwater Mitigation Measures and Ranking**

| Impact No | Alternative Methods 1 | 2 | 3 | 4 | 5 | Impact | Site Alteration Leading to Impact | Impacted Feature | Possible Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| N14 | | ○ | ○ | | | Potential for migration of leachate laterally into sand/silt seam (exposed on bank of watercourse) | Displaces watercourse - requires relocation | GW | · Map presence and remove sand/silt seams<br>· Design leachate collection system to induce flow toward former watercouse location |
| N18 | | | | ◕ | ◕ | CKD leachate unknown<br>Combination unknown | Overlaps part of cement kiln dust stockpile | Leachate | · Monitoring samples from wells in CKD |
| N19 | | | | ◕ | ◕ | Potential to change current mounding in CKD stockpile and change shallow flow direction | Overlaps part of cement kiln dust stockpile | GW | · Monitor water levels in wells in CKD |

**Negative Impacts for Each Method**

| | 1 | 2 | 3 | 4 | 5 | Legend |
|---|---|---|---|---|---|---|
| ◕ | 1 | - | - | 2 | 3 | Minor Impact - monitoring with potential mitigation (e.g. monitoring of groundwater around CKD stockpile) |
| ◑ | 1 | 4 | 3 | 1 | 2 | Low Impact - feature alteration with monitoring (e.g. stormwater controls) |
| ◔ | 1 | 1 | 2 | 3 | 4 | Medium Impact - enhanced engineering with monitoring (e.g. extension of current leachate control system) |
| ○ | 1 | 4 | 3 | 3 | 4 | Major Impact - major mitigation engineering required (e.g. liner, redesigned leachate control system) |

| | | | | | |
|---|---|---|---|---|---|
| Positive Impacts | 2 | 1 | 1 | 2 | 3 |

**Overall Impact Ranking**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Least | ■ | | | | |
| ⇩ | | | ■ | ■ | |
| ⇩ | | ■ | | | |
| Most | | | | | ■ |

**Table H3**
**Surface Water Mitigation Measures and Ranking**

| | Alternative Methods | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Impact No | 1 | 2 | 3 | 4 | 5 | Impact | Site Alteration Leading to Impact | Impacted Feature | Possible Mitigation |
| N3 | ◑ | | | | ◑ | Potential for contaminated runoff from footprint during filling | Added height to Phase I and Phase II/III | SW | • Storm water diversion and sedimentation control away from fill area<br>• Leachate containment within footprint to LCS |
| N4 | ◑ | | | | ◑ | Increased runoff from footprint - longer side slopes | Added height to Phase I and Phase II/III | SW | • Design storm water and erosion control for side slopes and toe |
| N5 | ○ | | | | ○ | Potential for leachate breakout on final side slopes | Added height to Phase I and Phase II/III | SW | • Leachate head control by enhanced or modified leachate collection system |
| | | ◑ | | | | | Create long narrow depressions between footprint expansion and existing Phases | SW | • Design stormwater control between existing and expansion footprints for closed stage to prevent ponding and infiltration into waste |
| N8 | ◑ | | ◑ | | ◑ | Potential for contaminated runoff from fill area | Filled between Phase I and Phase II/III - increased waste footprint | SW | • Design and operations to reduce work area & interim cover to promote clean runoff |
| | | ◑ | ◑ | ◑ | ◑ | | Increased footprint area | SW | • Design and operations to reduce work area & interim cover to promote clean runoff |
| | | | | ◑ | ◑ | | Added height to currently flat area | SW | • Create soil berm along watercourse to contain water within waste area |
| | | | | ◑ | ◑ | | Footprint does not encroach on watercourse but is close to top of bank | SW | • Create soil berm along watercourse to contain water within waste area |
| N15 | | ◑ | ◑ | | | Will require alterations of surface water movement to reach new watercourse | Displaces watercourse - requires relocation | SW | • Grading, storm water and erosion control to redirect, slow or hold runoff |
| N16 | | ◕ | ◕ | | | Decrease CKD to watercourse distance | Displaces watercourse - requires relocation | SW | • Monitoring samples from wells in CKD and new watercourse |
| N17 | | | | ◑ | ◑ | Increased runoff from western side slopes into watercourse | Added slopes to currently flat area | SW | • Create vegetated water control buffer strip between landfill toe and watercourse |
| | | | | ◑ | ◑ | | Footprint does not encroach on watercourse but is close to top of bank | SW | • Create vegetated water control buffer strip between landfill toe and watercourse |

**Negative Impacts for Each Method**

| | 1 | 2 | 3 | 4 | 5 | **Legend** |
|---|---|---|---|---|---|---|
| ◕ | - | 1 | 1 | - | - | Minor Impact - monitoring with potential mitigation (e.g. monitoring of groundwater around CKD stockpile) |
| ◑ | 3 | 3 | 3 | 5 | 8 | Low Impact - feature alteration with monitoring (e.g. stormwater controls) |
| ◔ | - | - | - | - | - | Medium Impact - enhanced engineering with monitoring (e.g. extension of current leachate control system) |
| ○ | 1 | - | - | - | 1 | Major Impact - major mitigation engineering required (e.g. liner, redesigned leachate control system) |

| | | | | | |
|---|---|---|---|---|---|
| Positive Impacts | 2 | 3 | 2 | 1 | 1 |

**Overall Impact Ranking**

| | | | | | |
|---|---|---|---|---|---|
| Least | | ▨ | ▨ | | |
| ⇩ | | | | ▨ | |
| Most | ▨ | | | | ▨ |

BURNSIDE

[The Difference is our People]

# Appendix I

## Hydrogeology Technical Meeting Summary and CKD Ground Water Testing

# Appendix I - Hydrogeology Technical Meeting Summary and CKD Groundwater Testing

## Town of St. Marys

R.J. Burnside & Associates Limited
292 Speedvale Avenue West Unit 20
Guelph ON N1H 1C4 CANADA

December 2019
300032339.0000

## Record of Revisions

| Revision | Date | Description |
|---|---|---|
| 0 | September 12, 2019 | Draft Submission for MECP Technical Support |
| 1 | December 19, 2019 | Final |

**R.J. Burnside & Associates Limited**

**Report Prepared By:**

PROFESSIONAL GEOSCIENTIST
Dec 19 2019
N. J. RUTHERFORD
PRACTISING MEMBER
0405
ONTARIO

Joy Rutherford, P.Geo
Senior Hydrogeologist
JR:tp

# Table of Contents



## Tables



## Figures



## Attachments



## Disclaimer

# 1.0 Introduction

The purpose of this document is to summarize discussions undertaken between the Town, Burnside and the MECP since the 2017 *Draft Hydrogeology Study* was reviewed by the MECP. Additional information and interpretation is also provided herein.

### Events Timeline

- May 2017 – *Draft Hydrogeology Study*: Attachment F-2 of the Future Solid Waste Disposal Needs Environmental Assessment, Town of St. Marys completed and submitted for review.
- September 2017 – Review comments received from MECP. Areas of concern for the MECP hydrogeologist included:
  - Groundwater impact downgradient of existing footprint and potential impact of the expansion footprint
  - Effectiveness of the existing leachate collection system
  - Cement Kiln Dust (CKD) stockpile impacts on ground and surface water
- May 7 and July 5, 2018 – Teleconferences between Town, EA team and MECP to discuss overall review comments.
- October 12 and November 21, 2018 – Meetings between Town, EA team and MECP to discuss overall review comments.
- February 2019 – Hydrogeology technical meeting between Burnside and MECP to discuss hydrogeology specific review comments. There was a general understanding reached and the MECP requested that the meeting discussion and the data presented be submit for formal review.

This document contains a summary of the information discussed at the February 2019 meeting. It also contains discussions regarding the Cement Kiln Dust Stockpile (CKD) that occurred after the 2017 *Draft Hydrogeology Study* was submitted to the MECP for review. To avoid presenting data already included in the 2017 *Draft Hydrogeology Study* report, references will be made to Figures, Tables and Appendices in that report as "(*Hydrogeology Study*, Figure #).

### Note on the Preferred Alternative

The Environmental Assessment looked at five alternatives for expansion of the waste footprint within the existing landfill site property. The 2017 *Draft Hydrogeology Study* concluded that, from a groundwater perspective, Alternative 3 was the preferred alternative. This alternative included vertical expansion on the existing fill areas and horizontal expansion between and to the east of the existing fill areas. Alternative 3 was eventually selected by the overall EA process. Figure I-1: Site Plan shows the footprint of Alternative 3 overlaid on the existing fill areas and current monitoring locations.


## LEGEND

- PROPERTY BOUNDARY
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- LEACHATE COLLECTION SYSTEM
- STORM WATER MANAGEMENT BASIN
- LANDFILL OBSERVATION WELL
- LANDFILL OBSERVATION WELL (ABANDONED AND SEALED)
- EA MONITORING WELL
- BOREHOLE
- PRIVATE DOMESTIC WELL (APPRO□IMATE LOCATION)
- SURFACE WATER MONITORING LOCATION
- TEST PIT
- DRIVE POINT PIE□OMETER
- ALTERNATIVE 3 FOOTPRINT
- A A' CROSS-SECTION LOCATION KEY
- INTERPRETED GROUNDWATER CONTOUR (masl)
- INTERPRETED GROUNDWATER FLOW DIRECTION

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TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

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## Note on Monitoring Wells

The 2015 Hydrogeological Draft Work Plan proposed environmental drilling and monitoring well installation. This was necessary because the Town did not have well logs for the existing monitoring wells on the site. Therefore, there was no geology data and no well details available. In addition, there were no reports for the previous investigations completed for the landfill design and no wells on the east side of the watercourse.

However, during the Site work leading up to the EA report, all of the logs from previous Site work were located, as were the reports for the 1982 and 1993 hydrogeology investigations. These provided a substantial amount of geologic and hydrogeologic data. In addition, wells from previous studies were found within the cement kiln dust stockpile and at the north end of the Site. These wells were added to the 2016 EA field monitoring. Finally, St Marys Cement was also able to provide information on their wells, excavations and dewatering.

All of this information allowed for the creation of detailed Site cross-sections and a good understanding of the Site conceptual model without the need for additional drilling.

One new well was added to the landfill monitoring program in November 2016. OW36 was installed downgradient of the Phase II/III fill area. This well was dry for several months following installation and therefore the 2017 Draft Hydrogeology Study did not include data from this new well. Water samples were collected during the regular monitoring events in September 2017, May 2018 and October 2018. The data is presented and discussed below.

# 2.0 Groundwater Impact Downgradient of Existing Landfill and in Expansion Footprint

The Site is protective of groundwater. There is minimal movement of groundwater on the Site due to a combination of a dense glacial till and a deep water table that is below the top of the limestone bedrock. There is currently no groundwater impact downgradient of Phase I and a low level of groundwater impact downgradient of Phase II/III. These areas downgradient of the existing footprints will become the expansion footprint in Alternative 3. Assuming the expansion area uses a similar leachate collection system to the one in place for the existing waste, the same level of impact is expected for the expansion given the geology and hydrogeology. This conclusion was based on the information presented below.

## 2.1 Background

The following is a brief summary of the site history, geology and hydrogeology discussed in the February 2019 meeting. The full description is contained in the 2017 *Draft Hydrogeology Study*

### 2.1.1 Site History

The landfill site (Site) was originally owned by St Marys Cement. A historic aerial photograph from 1963 shows the overburden stripped from the northeast corner of the Site (*Hydrogeology Study* Appendix A). Sometime between 1963 and 1978, clay was also mined from the Site for use in cement manufacturing. By 1978 the entire Site had been disturbed and none of the original topography remained. The watercourse was realigned between 1963 and 1978 with a new channel created west of the original location.

A low stockpile is visible in the area of the CKD pile in the 1978 photo. By 1989, the stockpile appears to have been completed. Subsequent photos show only changes in vegetation growth. This indicates that the stockpile had been in place for at least 30 years.

Phase I of the landfill was filled between 1984 and 1993. A peripheral leachate collection system (LCS) was installed around the outer slope of Phase I. The purpose of the system was to control leachate mounding within the waste. The date of installation is not known, but it was thought to have been installed during closure in 1993.

Phase II/III began in 1993. Filling occurred from east to west in eight constructed cells. The LCS incorporated perimeter collectors as well as lateral collectors beneath the waste. The system was extended westward as each new cell was constructed.

In 1997, a sewer line was installed to gravity drain the leachate directly from the leachate collection systems to the Town's wastewater treatment plant. Previous to this, a storage tank was used, with leachate trucked from the site.

### 2.1.2 Site Geology

Three cross-sections through the landfill Site were prepared for the 2017 *Draft Hydrogeology Study*. Those sections were later updated and discussed in the February 2019 meeting. The updated versions have been included with this meeting summary.

The main stratigraphic units at the Site from top to bottom are:

1. Lacustrine (clay and/or silt removed by mining)
2. Upper till (possibly Tavistock)
3. Melt-water deposits (silt, sand, gravel), localized
4. Lower till (possibly Catfish Creek) characterized as hard to very hard (N>100)
5. Till/bedrock interface sand, localized, 0.8 to 2 m thick, observed in 3 of 9 deep boreholes
6. Limestone

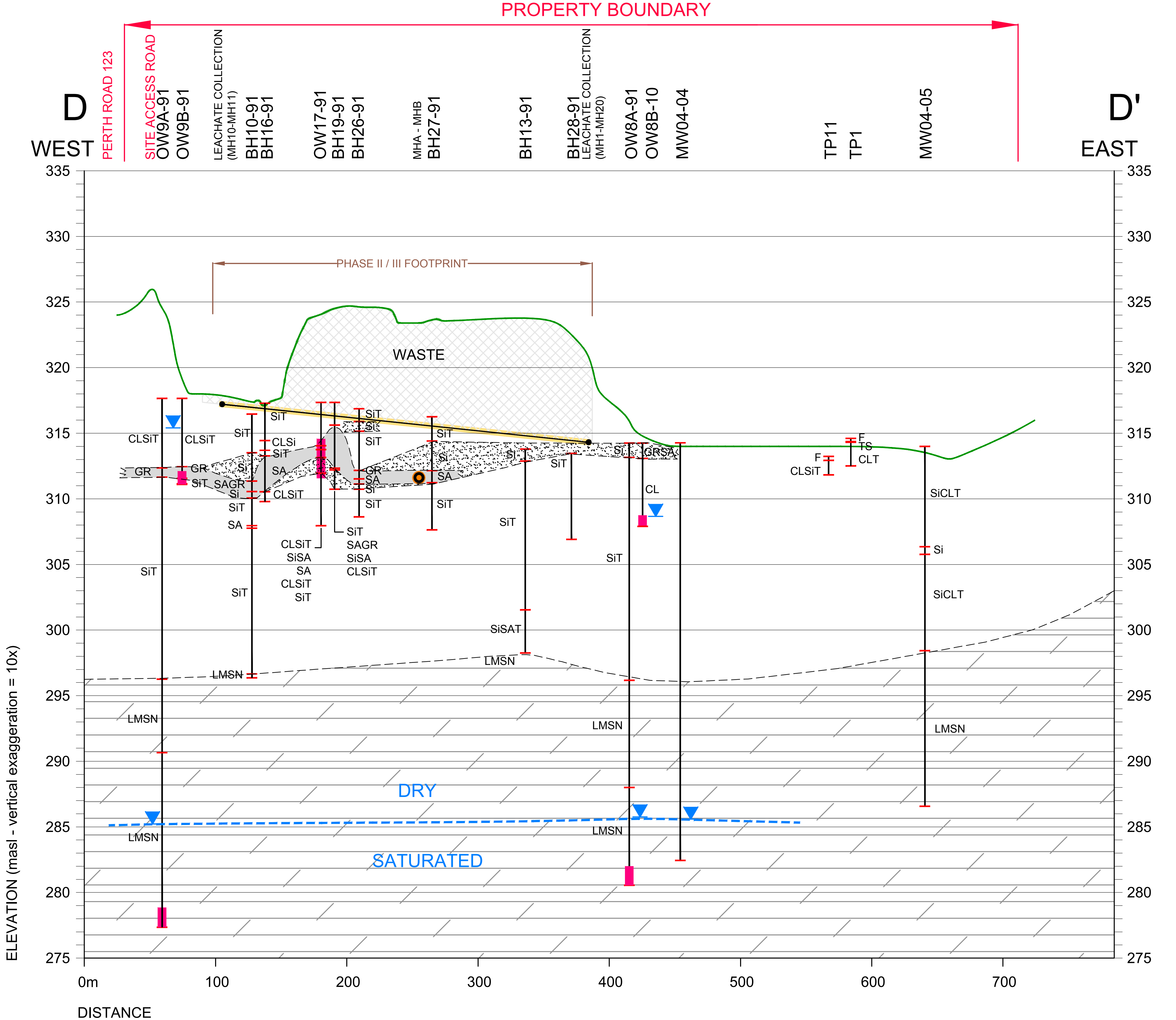
The overburden thickness varies from 20 m in the south and west areas the Site to 10 m on the north edge of the Site. This is the result of soil mining/stripping and an upward slope on the bedrock surface from southwest to northeast.

### 2.1.3 Site Hydrogeology

The three Site cross-sections show a piezometric surface 10 m to 15 m below the top of the bedrock. This is based on water levels from six bedrock wells on the Site. Dewatering of the quarry directly north of the Site may have contributed to lowering the water levels, however, the 2003 Perth County Groundwater Study (*Hydrogeology Study* Appendix D) found that the water level was below the top of the bedrock over the western part of Perth County.

The water level below the top of the bedrock indicates that the bedrock is not fully saturated and is not a confined aquifer. Therefore, there is a substantial thickness of dry limestone below the overburden and any water present in the overburden is perched.

The presence of isolated, meltwater deposits between and below the less permeable tills, combined with under-draining of the overburden by unsaturated bedrock results in the sporadic saturated zones in the overburden. This is reflected by dry or intermittently dry monitoring wells at different depths.




## LEGEND

MW9 — WELL NUMBER

GEOLOGICAL STRATIGRAPHY

MEASURED WATER LEVEL (DEC.14, 2015)

WELL SCREEN

| | | | |
|---|---|---|---|
| cl | clayey | TS | Topsoil |
| si | silty | T | Till |
| sa | sandy | F | Fill |
| gr | gravelly | HPAN | Hardpan |
| CL | Clay | BLD | Boulder |
| Si | Silt | RCK | Rock |
| SA | Sand | CKD | Cemented Kiln Dust |
| GR | Gravel | LMSN | Limestone |
| STN | Stones | | |

INTERPRETED GEOLOGICAL CONTACT

INTERPRETED WATER TABLE

LEACHATE COLLECTION SYSTEM

DRAIN PIPE BETWEEN MHA AND MHB

MELTWATER SAND AND GRAVEL

MELTWATER SILT

TILL

LIMESTONE

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*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**SITE CROSS SECTION D-D'**

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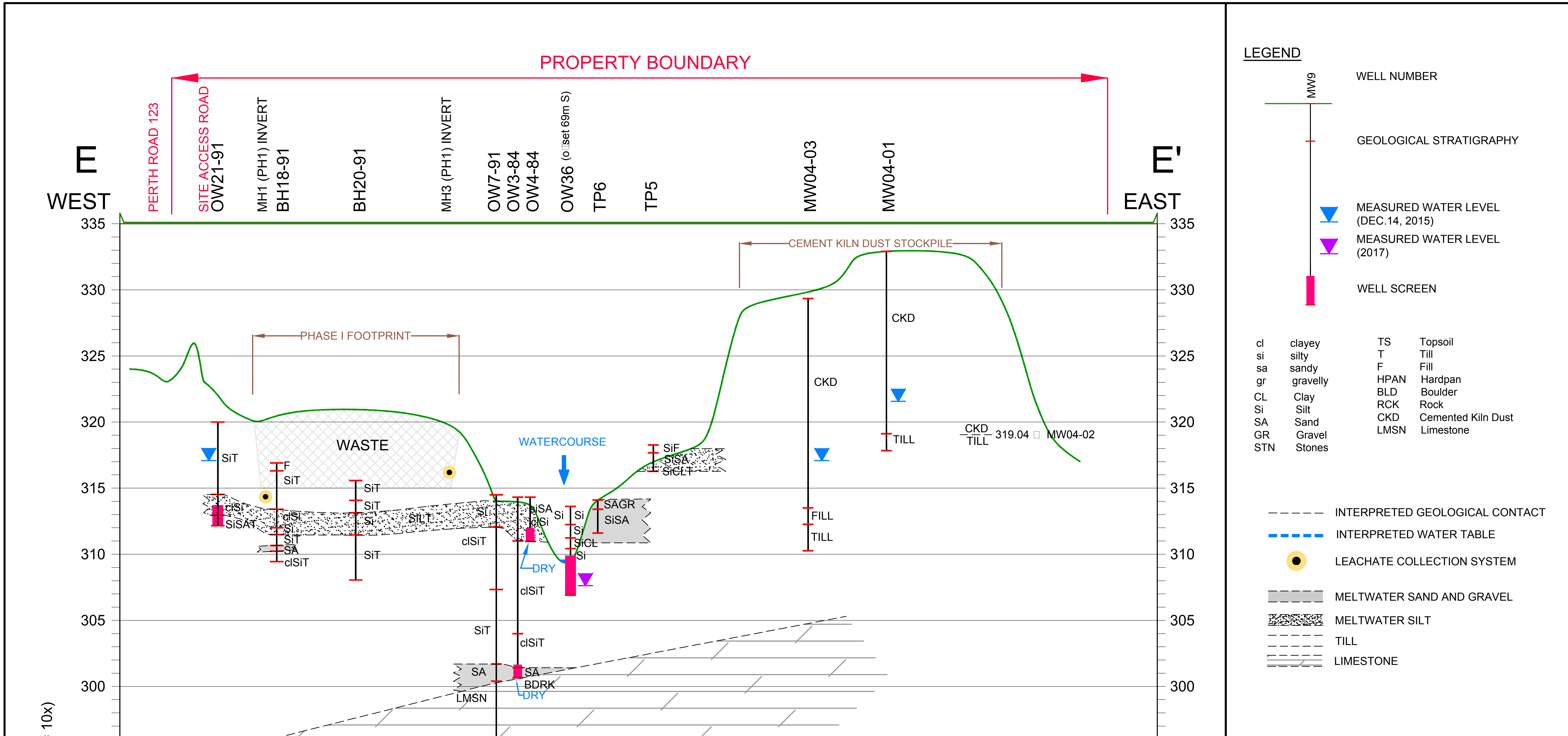


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Figure Title

**SITE CROSS SECTION E-E'**

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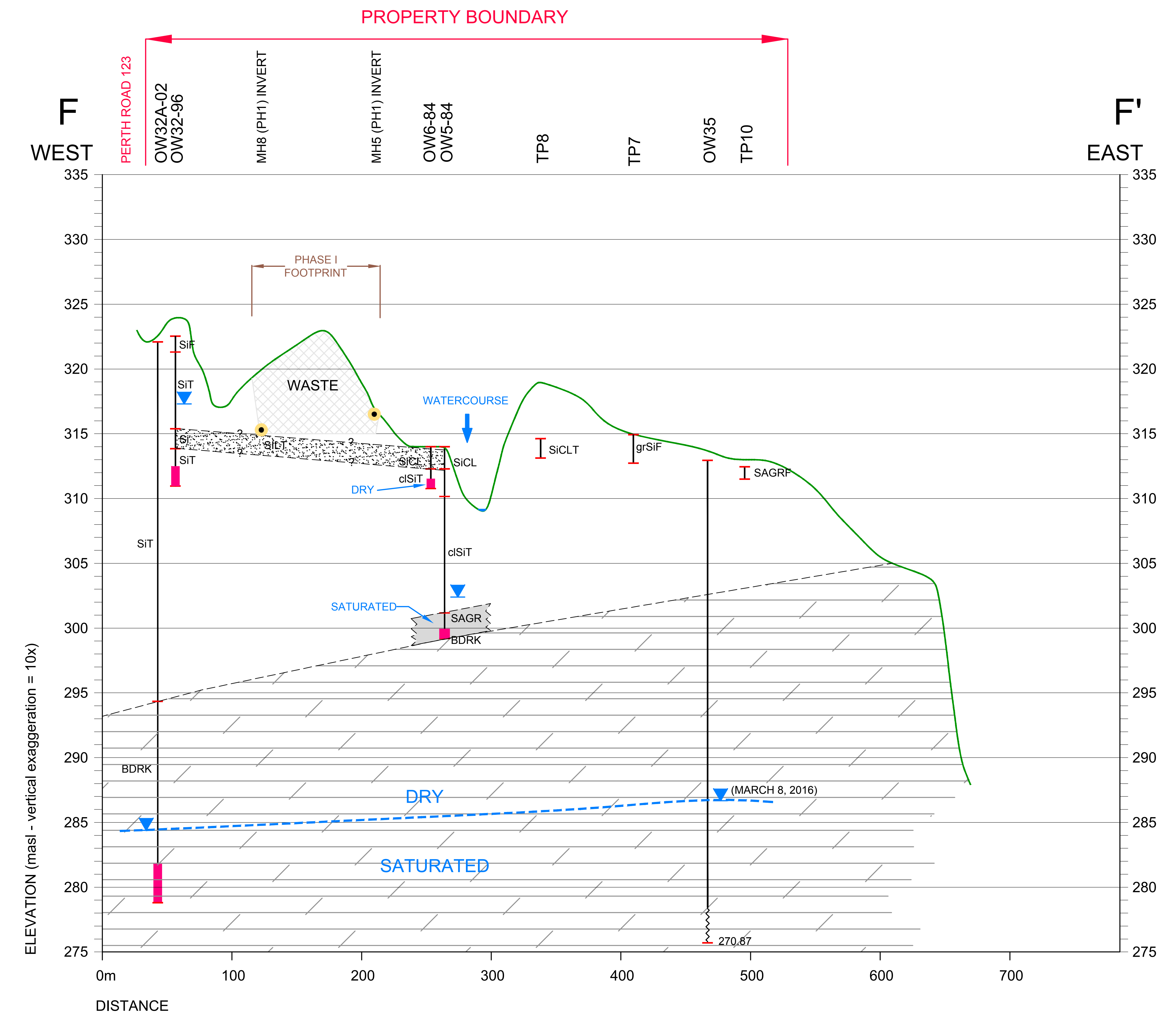


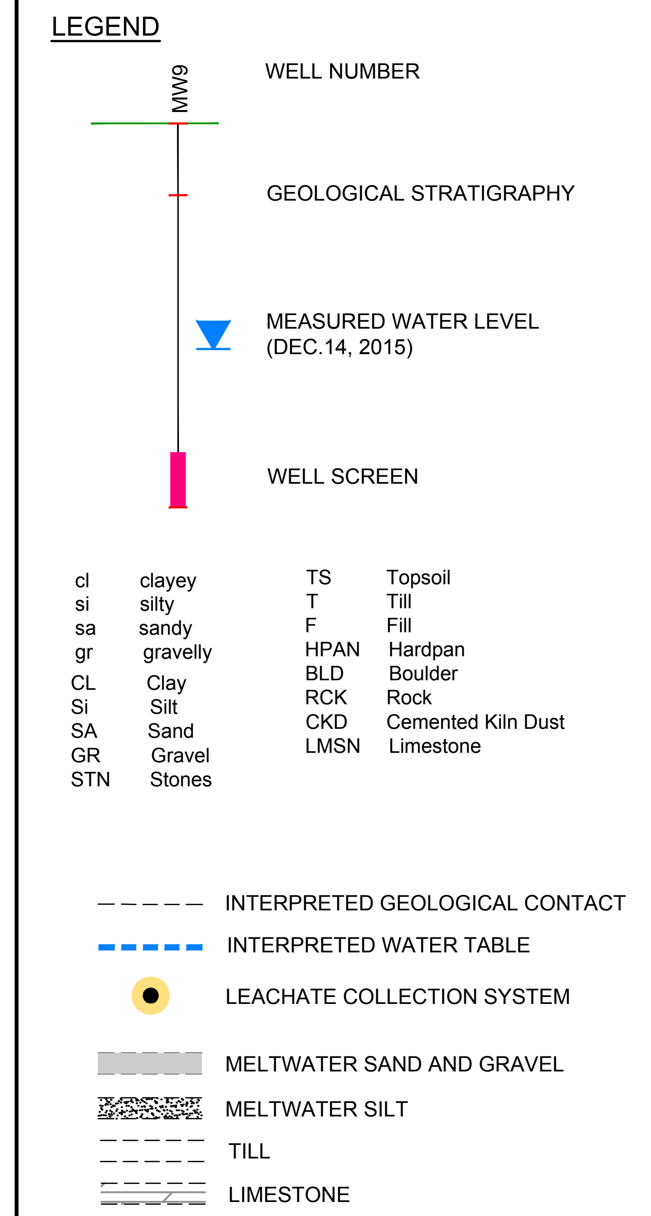


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Figure Title

**SITE CROSS SECTION F-F'**

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For example, of the eleven wells and boreholes drilled to the bedrock, only three (OW3-84, OW5-84 and BH12-91) reported sand at the overburden/bedrock interface. At the remaining eight (BH10-91, BH11-91, BH13-91, OW8A-91, OW9A-91, OW32A-02, MW04-04 and MW04-05) the till is directly over the bedrock. This indicates isolated pockets of permeable soil at the interface. OW3-84 and OW5-84 are 90 m apart, both screened across sand & gravel at the interface. The 0.8 m of sand & gravel at OW3-84 is always dry. The 2.0 m of sand & gravel at OW5-84 has always yielded enough water to sample. The hydrostatic pressure within the sand & gravel at OW5-84 is low (approximately 1 m above the top of the sand & gravel). This maybe due to low infiltration/recharge to the sand & gravel under the till and under draining by the limestone.

The conclusion drawn from this information is that groundwater movement through the overburden is minimal at the Site. Therefore, groundwater is not a pathway for significant landfill leachate movement.

## 2.2 Phase I Geology and Hydrogeology

The inter-till meltwater deposits are present below the Phase I fill area. They occur as a layer of silt approximately 1.5 to 2 m thick (see Figure I-3 Cross-Section E-E' and Figure I-4 Cross-Section F-F'). The silt layer is also present east of the landfill up to the edge of the watercourse. The silt layer is overlain by the upper till west of the fill area and below the waste footprint. However, the upper till is missing east of the fill area where the silt is at surface. The watercourse, at an elevation of around 309 m to 310 m above mean sea level (amsl), was cut through the silt with the bottom of the channel in the lower till.

OW4-84 and OW6-84 are located on the west bank of the watercourse (between Phase I and the watercourse). The well logs reported a 3.6 m to 3.8 m thick silt layer at surface (*Hydrogeology Study* Appendix C2). The silt was underlain by the lower till. The well logs describe the lower till as dry at the time of drilling. Both wells were screened in the silt layer.

OW4-84 was sampled regularly between 1984 and 1993. After 1993, sampling became intermittent as the well was often dry (possibly due to effectiveness of the Phase I LCS discussed in Section 3.2). OW6-84 was never sampled as it has always been dry. The lack of groundwater in the silt layer means that there is also no leachate moving horizontally through this layer. If there is a perched water table in the overburden it is in the lower till. Leachate moving in the till will move very slowly due to the low permeability.

## 2.3 Phase II/III Geology and Hydrogeology

The inter-till meltwater deposits also occur under Phase II/III. Boreholes drilled in the footprint for the 1992 investigation reported a varying thickness of sand, gravel and silt. The sand & gravel was predominant in an area from OW9B east to BH27-91 and then south to OW25-91. Figure I-2 Cross-section D-D' was drawn though this area and the sand & gravel is highlighted on the section by shading. Above and below the sand & gravel, as well as to the north and south of the D-D' section line, the meltwater deposit is predominantly silt.

Groundwater is present in the meltwater deposit below the landfill (at OW9B-91, OW15, OW25) and is picked up by a drain pipe below the LCS. The drain pipe has no outlet and runs south to north between two manholes, MHA and MHB. The drain pipe inverts at MHA and MHB are 311.76 m and 310.79 m respectively which are below the base of the landfill at approximately 315 m. The drain pipe was installed as a potential mitigation measure, allowing water to be pumped from below the LCS if necessary.

The water in the pipe is under pressure and intermittently overflows the top of MHB at an elevation of 315.72 m amsl. The invert of the leachate collection manhole MH6, near MHB, is 314.79 m. Based on these elevations, there is potential for groundwater to move from the meltwater deposits into the LCS. Low levels of leachate indicators have been detected in samples of overflow from MHB. Therefore, there is also potential for leachate to move into the sand & gravel core in areas where the meltwater deposits are close to the fill base. This is discussed further in Section 3.3 below.

However, there is no significant movement of groundwater eastward in the meltwater deposits. The deposits thin toward the watercourse and may be absent east of Phase II/III. The meltwater deposits are thickest below the Phase II/III fill area. At the west end of the fill area, they occur below the upper till. At the east end, they occur at surface (no upper till). At OW36, east of the fill area, the lower till was encountered 3.2 m below ground overlain by silt and clay (meltwater deposits). The silt and clay were reported to be moist to wet (not saturated). The bottom of the well screen was set at 6.93 m below ground surface (bgs). The water level in the well is approximately 6 m bgs and is in the till.

There was 1.22 m of gravel and sand reported at OW8B-10, 0.9 m of silt at OW8A-91, and 0.1 m of sand and gravel fill at MW04-04. The deposits were only moist with the wells being screened in the till below. The water level in OW8B-10 is more than 5 m below ground and is in the till.

Therefore, if groundwater is moving east and toward the watercourse, it is moving through the till as the more permeable meltwater deposits are missing or (if present) are not carrying water. Three water samples were collected from OW36 in 2017 and 2018. Table I-1 summarizes the results. Conductivity, chloride and sulphate are elevated compared to background and indicated a low level of impact. However, the impact is relatively minor and the results over the three samples may be showing a slight improving trend. The well has been added to the annual monitoring program.

## Table I-1: OW36 Water Quality Data

| Parameter | Units | ODWQS | Sampling Date (1) | | |
|---|---|---|---|---|---|
| | | | 27-Sep-17 | 14-May-18 | 25-Oct-18 |
| Field pH | | 6.5 - 8.5 | 7.46 | 8.2 | 7.52 |
| Field Conductivity | µS/cm | - | 1061 | 1005 | 962 |
| Hardness | mg/L | 80 - 100 | 607 | 617 | 624 |
| DOC | mg/L | 5.0 | 2.9 | 1.7 | 1.9 |
| Alkalinity | mg/L | 30-500 | 291 | 256 | 245 |
| Chloride | mg/L | 250 | 20.6 | 19.4 | 18.7 |
| Sulphate | mg/L | 500 | 485 | 478 | 471 |
| Calcium | mg/L | - | 119 | 123 | 133 |
| Magnesium | mg/L | - | 75.2 | 75.2 | 73.4 |
| Sodium | mg/L | 200 | 59.6 | 55.7 | 55.5 |
| Nitrate | mg/L | 10 | 0.98 | - | - |
| Nitrite | mg/L | 1 | <0.25 | - | - |
| Ammonia | mg/L | | 0.03 | - | - |
| TKN | mg/L | | 0.35 | - | - |
| Boron | mg/L | 5 | 0.246 | 0.214 | 0.208 |
| Iron | mg/L | 0.3 | <0.010 | <0.010 | <0.01 |
| Manganese | mg/L | 0.05 | 0.046 | 0.019 | 0.007 |
| Phenols | mg/L | - | <0.001 | - | <0.001 |
| Benzene | µg/L | 5 | <0.20 | <0.20 | <0.20 |
| m,p-Xylene | µg/L | | <0.20 | <0.20 | <0.20 |
| Ethylbenzene | µg/L | 2.4 | <0.10 | <0.10 | <0.10 |
| Toluene | µg/L | 24 | <0.20 | <0.20 | <0.20 |
| o-Xylene | µg/L | | <0.10 | <0.10 | <0.10 |

(1) 2017 monitoring by Burnside, 2018 monitoring by GM BluePlan

## 2.4 Watercourse

Shallow groundwater flow mapping included in the 2017 *Draft Hydrogeology Study* (Appendix F, Figure F-2.3 and Figure F-2.4) show water movement toward the watercourse from the west (landfill) and east (CKD). This indicates that shallow groundwater discharges to the watercourse.

However, the water level in OW36 was below the bottom of the watercourse in spring and fall 2017. The elevation of the bottom of the channel is approximately 310 m at the upstream end and 309 m downstream. The water level elevation in OW36 was 307.05 m in April 2017 and 307.83 m in September 2017. Where the water level in the till is below the watercourse there is no discharge surface water.

Flow monitoring for the Hydrogeology Study also indicated that the watercourse may be both a gaining stream and a losing stream during different seasons (*Hydrogeology Study* Appendix F, Table F-1.3). Flow volumes have been measured at SP3-93 (downstream station) since 1994. Volumes have varied from 200 to 600 L/s in wet seasons to less than 5 L/s in dry seasons. The channel was dry in September 2015. As part of the EA work, flows were measured at upstream and downstream stations from March to October 2016. The comparison between the stations showed a gaining stream in the spring and fall and a losing stream in the summer. It is expected that the pattern will vary each year with weather changes.

The watercourse also gains and loses across the site. At an upstream drivepoint (DP1), the 2016 water levels in the watercourse were slightly higher than in DP1, indicating that water is moving from the watercourse to the groundwater. At DP2 (midsite), the gradient is neutral. At DP3 (downstream), the movement is slightly upward indicating groundwater discharge to the watercourse.

These observations, combined with the low permeability of the lower till, means the groundwater contributes little to the streamflow even when there is discharge to the watercourse. Water quality samples upstream and downstream are similar with little change to water quality through the site. However, to produce the flow patterns noted on the groundwater flow maps Figures F-2.3 and F-2.4, there must be some movement of groundwater (although expected to be low volume) into or below the watercourse.

The selection of Alternative 3 will result in the edge of the waste footprint extending up to the watercourse east of Phase I and covering the watercourse east of Phase II/III. The design of the extended LCS could incorporate a collector drain in the location of the watercourse to maintain the current groundwater flow pattern at the Site. This would continue to intercept any flow from either the landfill or the CKD stockpile that reaches the location of the current channel.

# 3.0 Effectiveness of Leachate Collection System

The existing LCS is working and has been controlling leachate migration from the landfill footprints since 1993. The following are indictors that the LCS is working in both fill areas.

## 3.1 Leachate Elevation Control in the Waste Footprint

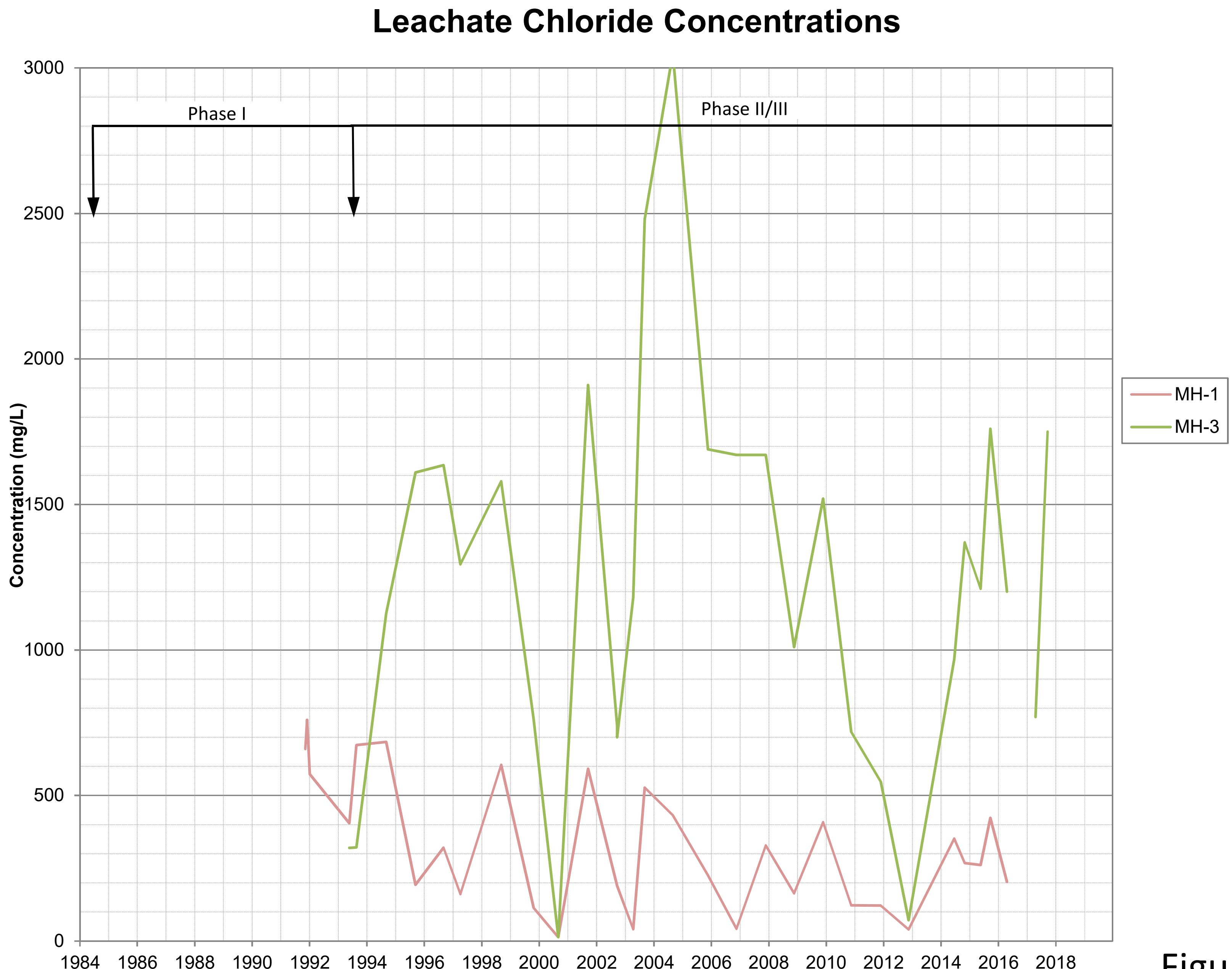
The absence of leachate outbreaks on the side slopes is an indicator that the LCS is working correctly. Both fill areas were constructed primarily above grade. If the leachate level were not controlled, natural mounding of leachate within a waste combined with a high waste permeability (relative to native soils) would result in leachate breaking out on the side slopes or at the toe of waste mound. No outbreaks have been reported. Leachate levels in the LCS manholes are checked twice yearly and reported in the annual report. The levels are consistently low reflecting no leachate mounding. If the LCS failed, rising water levels in the MHs and leachate break outs at the toe would occur.

## 3.2 OW4-84 Water Level History

OW4-84 has been monitored twice a year since 1984. There was water in the well at every monitoring event from 1984 to Feb 1993. The Phase I LCS was installed around 1993 when that Phase was closed. After 1993, the water levels in OW4-84 declined and the well became intermittently dry. The Phase I LCS is capturing leachate from the area upgradient of OW4-84, lowering the water level below the footprint and downgradient. The cross-sections E-E’ and F-F’ confirm that LCS is intercepting upgradient groundwater on the west side of the fill area. The water level elevations at OW2-84, OW32-96, and OW21-91 (west of Phase I) are in the 315 m to 319 m range, while the LCS at MH1 is at 314.2 m amsl. The lowering of the water level at OW4-84 supports the effectiveness of the Phase I LCS.

## 3.3 Water Quality Data

Figure I-5 shows the chloride concentrations in the leachate samples. The samples were taken from MH-1 in Phase I and MH-3 in Phase II/III. Phase II/III has higher concentrations because it is newer waste and the volume of waste is larger. Figure I-6 compares the chloride concentration for MH-1 with the upgradient well OW2-84 and downgradient wells OW4-84 (meltwater silt), OW5-84 (OB-BR interface) and OW7-91 (BR).




# Figure I-5

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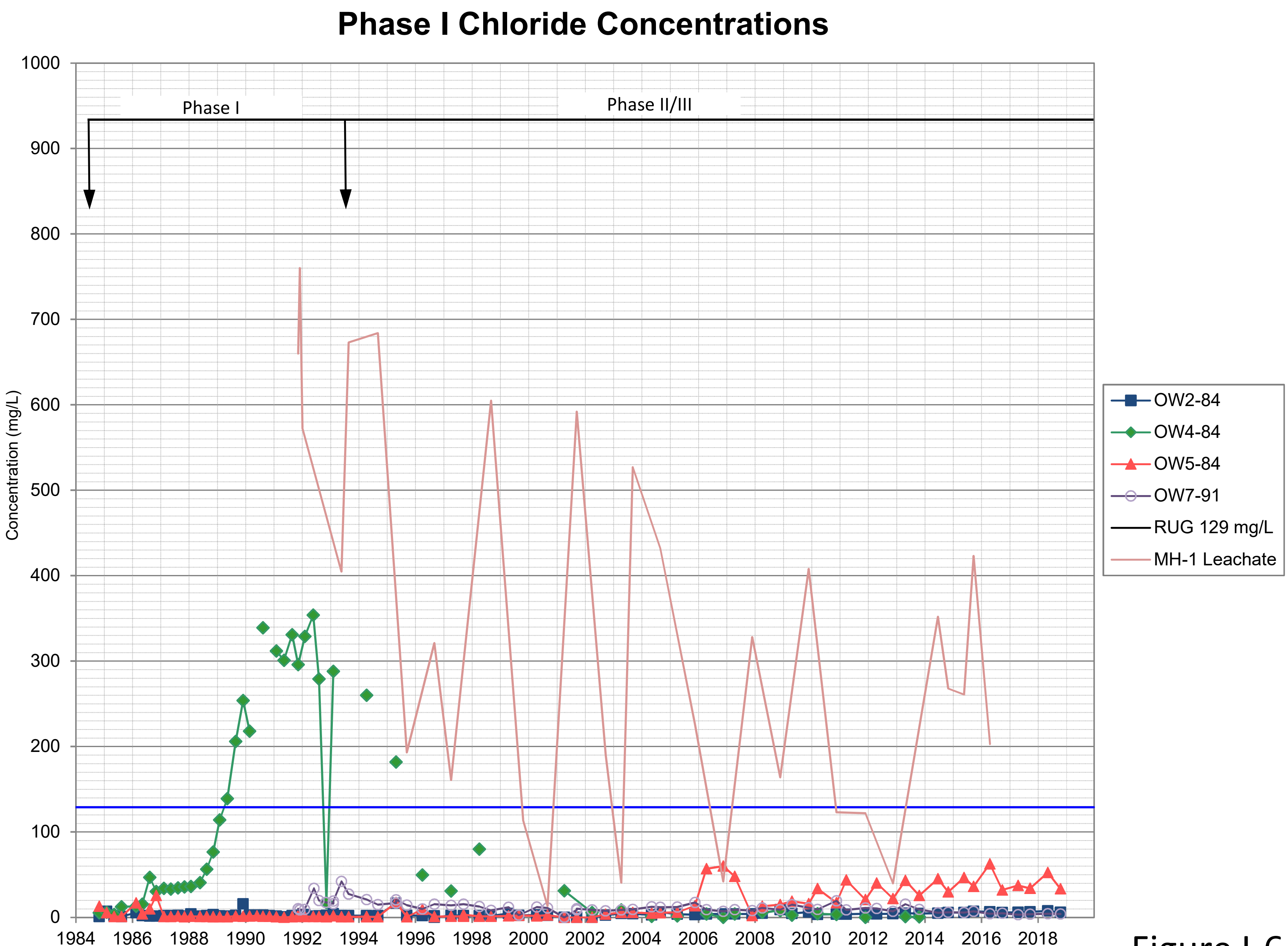


# Figure I-6

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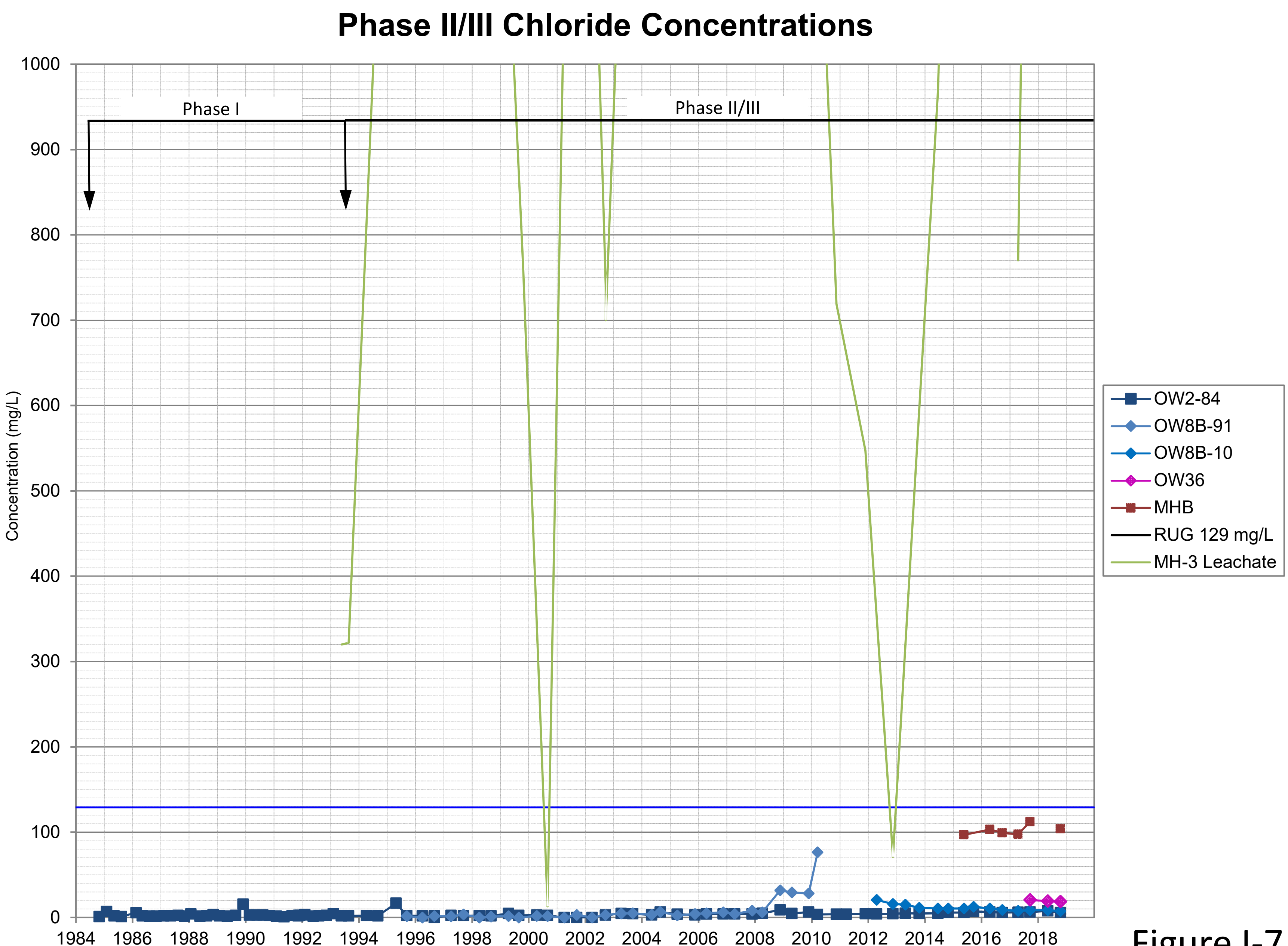


Figure I-7

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St. Marys Landfill
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Leachate sampling began in Phase I at the end of 1991. In 1991, the chloride concentration was 760 mg/L (earlier peaks may have been missed). OW4-84 has been monitored twice a year since 1984. The chloride concentrations from 1984 to 1993 climbed from background level to a high of 354 mg/L. After 1993, when the LCS was added to Phase I, the concentration declined and by 2002 was again at background. Due to the relatively permeable silt that OW4-84 is screened in, it is reasonable to attribute the declining concentration to the effectiveness of the LCS.

The concentration in OW5-84 shows in increasing trend from 2006 to 2016. This may not be landfill related. A comparison with the water quality in the bedrock wells indicates that the water in this interface sand lense may be influenced by the bedrock at the interface. Sulphate, alkalinity, hardness and iron are at levels similar to bedrock wells.

Figure I-7 compares chloride concentrations for MH-3 with upgradient OW2-84, downgradient OW8B, OW36 and MHB. MHB is the overflow of water from the drain pipe in the meltwater deposits below the LCS.

Elevated chlorides at MHB and OW36 are likely leachate impact. However, the concentrations are still quite low (around 100 mg/L at MHB and 20 mg/L at OW36) compared with the leachate at 1,000 to 3,000 mg/L, again indicating that the LCS has been effective at intercepting the leachate.

# 4.0 Cement Kiln Dust Stockpile

In 2005, a report on the CKD stockpile was compiled by Golder Associates for St. Marys Cement. The work included drilling three boreholes through the CKD, collecting and testing samples of the material, installing three monitoring wells and collecting a round of water samples for testing.

This report was made available to the Town of St. Marys when the Town acquired that part of the site. However, the report contents were confidential and were not available for inclusion in the 2017 *Draft Hydrogeology Study*. That stipulation was lifted in 2019. The report was submitted to the MECP in an email to Jenny Archibald (April 4, 2019) for review by the MECP. The MECP returned the following comments in an email from Jenny Archibald (May 23, 2019).

**Comments from the Ministry's Surface Water Specialist**:

> From a surface water perspective, the contaminants of concern identified in the CKD pile would most likely be an alkaline pH of 10 and sulphate concentrations which pose a problem if they come in contact with surface water. Since the report and the sampling was completed in 2005, some weathering of the material may have occurred since then and a second scoped set of samples for metals, pH, alkalinity, conductivity, and sulphates should update the analytical information and offer us a better perspective about which methods of control may be applicable.
>
> As an example, pending further analyses a management solution could be something like ensuring a setback of the proposed surface water realignment so that overland runoff can't access the drain, and some way to ensure that any precipitation on the pile may be excluded from the stormwater system and handled separately though an alternate collection and treatment process.
>
> Based on the report, it appears that ensuring that the material doesn't get mobilized into the receiver may be the best option.

Water samples were collected from the three monitoring wells in the CKD stockpile on June 4, 2019. The laboratory report from SGS is contained in Attachment A at the end of this Appendix. Table I-2 compares the 2019 results with the 2005 study.

Two conclusions from the water quality testing are:

- The water quality is not homogeneous throughout the stockpile. The water quality at the southeast corner of the stockpile is considerably better than the quality in the centre.
- The water quality, while still exceeding some Reg 153 Table 2 criteria, has improved overall from the 2005 testing.

**Table 2** **Cement Kiln Dust Stockpile - Groundwater Quality**

| | | Well No | MW04-01 | | MW04-02 | MW04-03 | |
|---|---|---|---|---|---|---|---|
| | Reg 153 | Location | Centre | | SE Corner | SW Corner | |
| **Inorganics** | **Table 2** | Units | **2005** | **2019** | **2019** | **2005** | **2019** |
| pH | | mg/L | 10.1 | 10.03 | 7.39 | 7.18 | 7.07 |
| Specific Conductivity | | uS/cm | 66 000 | 30 500 | 7 410 | 42 200 | 11 100 |
| Alkalinity | | mg/L CaCO3 | 716 | 4 510 | 2 400 | 1 350 | 947 |
| C-Hardness | | mg/L CaCO3 | 188 800 | 6.3 | 202.0 | 1 733 000 | 908 |
| DOC | | mg/L | NA | 78.2 | 25.6 | NA | 14.2 |
| Bromide | | mg/L | 46 | 38 | 2 | 30 | 13 |
| Chloride | 790 | mg/L | 3 830 | 2 500 | 81 | 2 270 | 950 |
| Fluoride | | mg/L | 21.2 | 23.3 | 0.42 | 0.7 | 1.00 |
| Nitrate | | N mg/L | < 2 | < 0.6 | 9.21 | < 2 | < 0.06 |
| Nitrite | | N mg/L | < 2 | < 0.3 | 0.10 | < 2 | < 0.3 |
| TKN | | N mg/L | NA | 22.9 | 0.6 | NA | 2.1 |
| Phosphate | | mg/L | < 10 | 0.86 | < 0.03 | < 10 | < 0.03 |
| Sulphate | | mg/L | 18 700 | 7 400 | 1 300 | 13 300 | 3 700 |
| Phenols | 0.89 | mg/L | 0.015 | 0.05 | < 0.01 | 0.003 | 0.01 |
| TDS | | mg/L | 41 960 | 22 100 | 5 850 | 29 396 | 8 350 |
| **Metals** | | | | | | | |
| Aluminum | | mg/L | < 0.5 | 0.06 | 0.02 | 0.714 | < 0.01 |
| Antimony | 0.006 | mg/L | *< 0.05* | < 0.003 | < 0.003 | *< 0.05* | < 0.003 |
| Arsenic | 0.025 | mg/L | *< 0.2* | 0.0731 | < 0.002 | *< 0.2* | 0.0046 |
| Barium | 1 | mg/L | < 0.5 | 0.0099 | 0.017 | < 0.5 | 0.0458 |
| Beryllium | 0.004 | mg/L | *< 0.1* | < 0.002 | < 0.002 | *< 0.1* | < 0.002 |
| Bismuth | | mg/L | < 0.1 | < 0.002 | < 0.002 | < 0.1 | < 0.002 |
| Boron | 5 | mg/L | 0.528 | 0.16 | 0.08 | 1.24 | 0.12 |
| Cadmium | 0.0027 | mg/L | *< 0.01* | 0.00012 | 0.0007 | *< 0.01* | 0.00010 |
| Calcium | | mg/L | < 50 | 1.27 | 64.10 | 425 | 313 |
| Chromium | 0.05 | mg/L | *< 0.5* | 0.0294 | < 0.003 | *< 0.5* | < 0.003 |
| Cobalt | 0.0038 | mg/L | *< 0.01* | 0.00106 | 0.0014 | *< 0.01* | < 0.0005 |
| Copper | 0.087 | mg/L | < 0.05 | < 0.003 | <0.003 | < 0.05 | < 0.003 |
| Iron | | mg/L | < 3 | 0.310 | 0.03 | 42.5 | 12.0 |
| Lead | 0.01 | mg/L | *< 0.05* | < 0.001 | < 0.001 | *< 0.05* | < 0.001 |
| Magnesium | | mg/L | 15.5 | 0.770 | 10.1 | 162 | 30.7 |
| Manganese | | mg/L | < 0 .5 | 0.004 | 0.028 | 3.5 | 0.969 |
| Mercury | 0.001 | mg/L | < 0.0001 | 0.00004 | < 0.00001 | < 0.0001 | 0.00004 |
| Molybdenum | 0.07 | mg/L | 0.553 | 0.266 | 0.004 | < 0.1 | 0.123 |
| Nickel | 0.1 | mg/L | < 0.1 | 0.030 | 0.009 | < 0.1 | < 0.003 |
| Phosphorus | | mg/L | <5 | 0.90 | < 0.03 | < 5 | < 0.03 |
| Potassium | | mg/L | 19 200 | 11 200 | 2 660 | 11 700 | 3 090 |
| Selenium | 0.01 | mg/L | *< 0.2* | 0.021 | <0.004 | *< 0.2* | < 0.004 |
| Silicon | | mg/L | 5.87 | 120 | 4 | <5 | 3.97 |
| Silver | 0.0015 | mg/L | *< 0.01* | < 0.0001 | < 0.0001 | *< 0.01* | < 0.0001 |
| Sodium | 490 | mg/L | 1 780 | 1 090 | 140 | 978 | 212 |
| Strontium | | mg/L | < 0.1 | 0.0253 | 0.573 | 1.75 | 0.980 |
| Thallium | 0.002 | mg/L | *< 0.005* | < 0.00005 | 0.00010 | *< 0.005* | < 0.00005 |
| Tin | | mg/L | < 0.1 | < 0.002 | 0.003 | < 0.1 | < 0.002 |
| Titanium | | mg/L | < 0.5 | 0.00599 | < 0.0005 | < 0.5 | < 0.0005 |
| Uranium | 0.02 | mg/L | 0.0285 | 0.00888 | 0.00697 | < 0.01 | 0.00097 |
| Vanadium | 0.0062 | mg/L | 0.0921 | 0.158 | < 0.002 | *< 0.05* | < 0.002 |
| Zinc | 1.1 | mg/L | < 0.5 | < 0.02 | 0.02 | < 0.5 | < 0.02 |
| **PCBs** | | | | | | | |
| Polychlorinated Biphenyls | 3 | µg/L | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| **PAHs** | | | | | | | |
| Naphthalene | 11 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 2-Methylnapthalene | 3.2 | µg/L | 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 1-Methylnapthalene | 3.2 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Acenaphthylene | 1 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Acenaphthene | 4.1 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Fluorene | 120 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Phenanthrene | 1 | µg/L | 0.8 | 0.38 | < 0.2 | 0.3 | 0.24 |
| Anthracene | 2.4 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Fluoranthene | 0.41 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Pyrene | 4.1 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Benzo(a)anthracene | 1 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Chrysene | 0.1 | µg/L | *< 0.2* | *< 0.2* | *< 0.2* | *< 0.2* | *< 0.2* |
| Benzo(b)fluoranthene | 0.1 | µg/L | *< 0.2* | *< 0.2* | *< 0.2* | *< 0.2* | *< 0.2* |
| Benzo(k)fluoranthene | 0.1 | µg/L | *< 0.2* | *< 0.2* | *< 0.2* | *< 0.2* | *< 0.2* |
| Benzo(a)pyrene | 0.01 | µg/L | *< 0.2* | *< 0.2* | *< 0.2* | *< 0.2* | *< 0.2* |
| Indeno(1,2,3-cd)pyrene | 0.2 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Dibenzo(a,h)anthracene | 0.2 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Benzo(ghi)perylene | 0.2 | µg/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |

Parameter Exceeds Reg. 153 Table 2 Criteria

*< 0.5* Lab Reporting Limit Exceeds Reg. 153 Table 2 Criteria

The cement kiln dust stockpile (CKD) has been in place for approximately 30 years. The cap and side slopes are well vegetated, and no erosion has been noted in recent field work in the area. The current watercourse wraps around the south and west sides of the stockpile. Water quality samples from the watercourse since 1985 (as part of the landfill monitoring) have not detected an impact from the landfill or the CKD stockpile. The water quality upstream and downstream is typically similar.

The potential for future impact remains low as the stockpile is to be left largely undisturbed with the vegetation in place. The relocation of the watercourse may necessitate relocating some of the CKD material along the north side of the stockpile. The work would need to be completed prior to relocation of the watercourse and a cap re-established on the material.

Runoff from the surface of the stockpile does not appear to be a significant issue. Of more importance is ensuring that the realigned watercourse is separated from the actual CKD material and that groundwater discharge from the stockpile to the watercourse is minimized.

**Comments from the Ministry's Hydrogeologist:**

> The EA will need to consider whether or not the CKD will influence conditions at the landfill site. For example, wells installed in the CKD pile have shown extremely high concentrations of chloride, potassium and sulphate. Will water draining from the CKD bring this impact to the ground water or surface water around the landfill? Is there a chance that impacts from the CKD will influence water sampling that is intended to characterize the impacts of the landfill?
>
> We note that the current configuration of the property has a small creek flowing between the existing landfill mound and the CKD. By moving the location of the creek to the far side of the CKD, a potential barrier to surface or ground water movement is being altered. Thus, we are questioning whether the new site configuration might result in the CKD having different effects to water resources.
>
> The applicant should consider the existing information and try to determine whether there is a risk that the CKD may influence water quality near the landfill. There may already be sufficient information to determine that this is unlikely to occur, and to explain this with just a few paragraphs. Alternatively, is there a need for changes to the monitoring plan? It would be unfortunate if impacts from the CKD were somehow able to be confused with impacts from the landfill.

There is a potential for groundwater contaminated by the CKD to migrate west of the stockpile and influence water quality near the expanded landfill footprint. If necessary, this can be mitigated by including an underdrain in the location of the current watercourse as part of the landfill extension of the LCS. This drain would continue to intercept shallow groundwater moving east from the landfill and west from the CKD and maintain the current groundwater movement pattern on the Site.

There will have to be changes made to the monitoring program. The selection of Alternative 3 will result in the edge of the waste footprint extending up to the watercourse east of Phase I and covering the watercourse east of Phase II/III (see Figure I-1). Eventually nine of the current monitoring wells will have to be decommissioned because they will be in the expansion footprint. These include OW3-84, OW4-84, OW5-84, OW6-84, OW7-91, OW8A-91, OW8B-91, MW04-04 and OW36. New monitoring wells to replace the decommission wells will have to be installed on the east side of the landfill. The locations of these new wells will need to take into account the engineering design, the location of the current watercourse channel, the presence or absence of the meltwater deposits at surface east of the watercourse and the CKD stockpile. The locations should be submitted for approval with the landfill Design and Operations Plan and be included in ECA approval.

Appendix A

[The Difference is our People]

# Attachment A

# SGS Laboratory Report

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

**Project :** 300032339 St. Mary's Landfill GW

10-July-2019

**R.J. Burnside & Associates Limited**
Attn : Alex Maenza

449 Josephine St. PO Box 10, Wingham
Canada, N0G 2W0
Phone: 226-476-3110, Fax:

**Date Rec. :** 06 June 2019
**LR Report:** **CA15123-JUN19**
**Reference:** 300032339 Alex Maenza

**Copy:** 3

# CERTIFICATE OF ANALYSIS

## Final Report - Revised

| Analysis | 1: Analysis Start Date | 2: Analysis Start Time | 3: Analysis Completed Date | 4: Analysis Completed Time | 5: Client Reporting Limit | 6: MW4-01 | 7: MW4-02 | 8: MW4-03 |
|---|---|---|---|---|---|---|---|---|
| Sample Date & Time | | | | | | 04-Jun-19 12:00 | 04-Jun-19 12:00 | 04-Jun-19 12:00 |
| Temp Upon Receipt [°C] | *** | *** | *** | *** | *** | *** | *** | *** |
| pH [no unit] | 07-Jun-19 | 11:14 | 13-Jun-19 | 13:16 | --- | 10.03 | 7.39 | 7.07 |
| Conductivity [uS/cm] | 07-Jun-19 | 12:10 | 10-Jun-19 | 21:11 | --- | 30500 | 7410 | 11100 |
| Hardness [mg/L as CaCO3] | 10-Jun-19 | 18:00 | 13-Jun-19 | 12:07 | 0.5 | 6.3 | 202 | 908 |
| Cl [mg/L] | 07-Jun-19 | 15:03 | 10-Jun-19 | 12:37 | --- | 2500 | 81 | 950 |
| DOC-Low [mg/L] | 07-Jun-19 | 17:09 | 13-Jun-19 | 11:33 | --- | 78.2 | 25.6 | 14.2 |
| TDS [mg/L] | 06-Jun-19 | 17:05 | 10-Jun-19 | 15:53 | --- | 22100 | 5850 | 8350 |
| NO2 [as N mg/L] | 07-Jun-19 | 13:59 | 10-Jun-19 | 15:18 | --- | < 0.3 | 0.10 | < 0.3 |
| NO3 [as N mg/L] | 07-Jun-19 | 13:59 | 10-Jun-19 | 15:18 | --- | < 0.6 | 9.21 | < 0.06 |
| TKN [as N mg/L] | 14-Jun-19 | 17:00 | 17-Jun-19 | 16:06 | --- | 22.9 | 0.6 | 2.1 |
| Br [mg/L] | 07-Jun-19 | 13:59 | 10-Jun-19 | 15:18 | --- | 38 | 1.7 | 13 |
| F [mg/L] | 12-Jun-19 | 10:57 | 12-Jun-19 | 14:12 | --- | 23.3 | 0.42 | 1.00 |
| SO4 [mg/L] | 06-Jun-19 | 15:09 | 10-Jun-19 | 12:36 | --- | 7400 | 1300 | 3700 |
| Tot.Reactive P [mg/L] | 06-Jun-19 | 19:37 | 10-Jun-19 | 15:58 | --- | 0.86 | < 0.03 | < 0.03 |
| Alkalinity [mg/L as CaCO3] | 07-Jun-19 | 08:42 | 13-Jun-19 | 16:25 | --- | 4510 | 2400 | 947 |

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Lakefield - Ontario - KOL 2HO
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| Analysis | 1: Analysis Start Date | 2: Analysis Start Time | 3: Analysis Completed Date | 4: Analysis Completed Time | 5: Client Reporting Limit | 6: MW4-01 | 7: MW4-02 | 8: MW4-03 |
|---|---|---|---|---|---|---|---|---|
| Al (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:12 | --- | 0.06 | 0.02 | < 0.01 |
| As (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:12 | 0.002 | 0.073 | < 0.002 | 0.005 |
| B (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.01 | 0.16 | 0.08 | 0.12 |
| Ba (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.002 | 0.010 | 0.017 | 0.046 |
| Ca (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | --- | 1.27 | 64.1 | 313 |
| Cd (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.0001 | 0.0001 | 0.0007 | 0.0001 |
| Cr (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.003 | 0.029 | < 0.003 | < 0.003 |
| Cu (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.003 | < 0.003 | < 0.003 | < 0.003 |
| Fe (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.01 | 0.31 | 0.03 | 12.0 |
| K (diss) [mg/L] | 11-Jun-19 | 19:01 | 10-Jul-19 | 09:44 | 0.05 | 11200 | 2660 | 3090 |
| Mg (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.05 | 0.77 | 10.1 | 30.7 |
| Mn (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.002 | 0.004 | 0.028 | 0.969 |
| Na (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | --- | 1090 | 140 | 212 |
| Ni (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.003 | 0.030 | 0.009 | < 0.003 |
| Pb (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Se (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | 0.004 | 0.021 | < 0.004 | < 0.004 |
| Zn (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:11 | --- | < 0.02 | 0.02 | < 0.02 |
| Ag (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 |
| Be (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | 0.002 | < 0.002 | < 0.002 | < 0.002 |
| Bi (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | 0.002 | < 0.002 | < 0.002 | < 0.002 |
| Co (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | 0.0005 | 0.0011 | 0.0014 | < 0.0005 |
| Mo (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | 0.002 | 0.266 | 0.004 | 0.123 |
| P (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | --- | 0.90 | < 0.03 | < 0.03 |
| Si (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | --- | 120 | 3.81 | 3.97 |
| Sb (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | 0.003 | < 0.003 | < 0.003 | < 0.003 |
| Sr (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | --- | 0.0253 | 0.573 | 0.980 |
| Tl (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | --- | < 0.00005 | 0.00010 | < 0.00005 |
| Sn (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:10 | 0.002 | < 0.002 | 0.003 | < 0.002 |
| Ti (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:09 | --- | 0.0060 | < 0.0005 | < 0.0005 |

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

**Project :** 300032339 St. Mary's Landfill GW

**LR Report :** CA15123-JUN19

| Analysis | 1: Analysis Start Date | 2: Analysis Start Time | 3: Analysis Completed Date | 4: Analysis Completed Time | 5: Client Reporting Limit | 6: MW4-01 | 7: MW4-02 | 8: MW4-03 |
|---|---|---|---|---|---|---|---|---|
| U (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:09 | --- | 0.00888 | 0.00697 | 0.00097 |
| V (diss) [mg/L] | 10-Jun-19 | 18:00 | 12-Jun-19 | 17:09 | 0.002 | 0.158 | < 0.002 | < 0.002 |
| Hg (tot) [mg/L] | 07-Jun-19 | 14:00 | 10-Jun-19 | 09:44 | --- | 0.00004 | < 0.00001 | 0.00004 |
| 4AAP-Phenolics [mg/L] | 14-Jun-19 | 12:28 | 17-Jun-19 | 16:01 | | 0.05 | < 0.01 | 0.01 |
| PCB (tot) [µg/L] | 08-Jun-19 | 06:31 | 12-Jun-19 | 09:59 | | < 0.05 | < 0.05 | < 0.05 |
| Acenaphthene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Acenaphthylene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Anthracene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Benzo(a)anthracene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Benzo(a)pyrene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Benzo(b)fluoranthene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Benzo(ghi)perylene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Benzo(k)fluoranthene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Chrysene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Dibenzo(a,h)anthrace [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Fluoranthene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Fluorene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Indeno(1,2,3-cd)pyre [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 1-Methylnaphthalene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 2-Methylnaphthalene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Methylnaphthalene, 2 [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Naphthalene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Phenanthrene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | 0.38 | < 0.2 | 0.24 |
| Pyrene [µg/L] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Surr 2-Methylnaphtha [Surr Rec %] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | | 93 | 64 | 80 |
| Surr Fluoranthene-D1 [Surr Rec %] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | | 107 | 90 | 85 |
| Surr 2-Fluorobipheny [Surr Rec %] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | | 65 | 51 | 64 |
| Surr 4-Terphenyl-d14 [Surr Rec %] | 08-Jun-19 | 10:08 | 12-Jun-19 | 14:12 | | 76 | 77 | 59 |

MAC - Maximum Acceptable Concentration
AO/OG - Aesthetic Objective / Operational Guideline

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
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MDL - SGS Method Detection Limit

Temperature of Sample upon Receipt: 1 degrees C
Cooling Agent Present:Yes
Custody Seal Present:No

Chain of Custody Number:NA

## Method Descriptions

| Parameter | Description | SGS Method Code |
|---|---|---|
| 1-Methylnaphthalene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| 2-Methylnaphthalene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| 4AAP-Phenolics | phenol by Skalar -solution | ME-CA-[ENV]SFA-LAK-AN-006 |
| Acenaphthene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Acenaphthylene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Alkalinity | Alkalinity by Titration | ME-CA-[ENV]EWL-LAK-AN-006 |
| Aluminum (dissolved) | Al by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Anthracene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Antimony (dissolved) | Sb by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Arsenic (dissolved) | As by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Barium (dissolved) | Ba by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Benzo(a)anthracene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Benzo(a)pyrene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Benzo(b)fluoranthene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Benzo(ghi)perylene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Benzo(k)fluoranthene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Beryllium (dissolved) | Be by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Bismuth (dissolved) | Bi by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Boron (dissolved) | B by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Bromide | Bromide by Ion Chromatography | ME-CA-[ENV]IC-LAK-AN-001 |
| Cadmium (dissolved) | Cd by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Calcium (dissolved) | Ca by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Chloride | Chloride by discrete colourmetric analysis | ME-CA-[ENV]EWL-LAK-AN-026 |
| Chromium (dissolved) | Cr by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Chrysene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Cobalt (dissolved) | Co by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |

SGS Canada Inc.
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Lakefield - Ontario - KOL 2HO
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| Parameter | Description | SGS Method Code |
|---|---|---|
| Conductivity | Conductivity by Conductivity Meter | ME-CA-[ENV]EWL-LAK-AN-006 |
| Copper (dissolved) | Cu by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Dibenzo(a,h)anthracene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Dissolved Organic Carbon | DOC by Combustion/Oxidation | ME-CA-[ENV]EWL-LAK-AN-023 |
| Fluoranthene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Fluorene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Fluoride | Fluoride by specific ion electrode | ME-CA-[ENV]EWL-LAK-AN-014 |
| Hardness | Hardness (CaCO3) by ICP | ME-CA-[ENV]SPE-LAK-AN-003 |
| Indeno(1,2,3-cd)pyrene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Iron (dissolved) | Fe by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Lead (dissolved) | Pb by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Magnesium (dissolved) | Mg by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Manganese (dissolved) | Mn by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Mercury (total) | Hg solutions by CVAAS | ME-CA-[ENV]SPE-LAK-AN-004 |
| Methylnaphthalene, 2-(1-) | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Molybdenum (dissolved) | Mo by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Naphthalene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Nickel (dissolved) | Ni by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Nitrate (as N) | Nitrate by Ion Chromatography | ME-CA-[ENV]IC-LAK-AN-001 |
| Nitrite (as N) | Nitrite by Ion Chromatography | ME-CA-[ENV]IC-LAK-AN-001 |
| pH | pH - solution | ME-CA-[ENV]EWL-LAK-AN-006 |
| Phenanthrene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Phosphorus (dissolved) | P by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Phosphorus (total reactive) | Tot. Reactive Phos. by Skalar or Spec.- no reagents or heat | ME-CA-[ENV]SFA-LAK-AN-004 |
| Polychlorinated Biphenyls (PCBs) - Total | PCB wtr | ME-CA-[ENV]GC-LAK-AN-001 |
| Potassium (dissolved) | K by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Pyrene | SVOC wtr - PAH | ME-CA-[ENV]GC-LAK-AN-005 |
| Selenium (dissolved) | Se by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Silicon (dissolved) | Si by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Silver (dissolved) | Ag by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Sodium (dissolved) | Na by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Strontium (dissolved) | Sr by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Sulphate | Sulphate by discrete colourmetric analysis | ME-CA-[ENV]EWL-LAK-AN-026 |
| Surr 2-Fluorobiphenyl | Surr | ME-CA-[ENV]GC-LAK-AN-005 |
| Surr 2-Methylnaphthalene-D10 | Surr | ME-CA-[ENV]GC-LAK-AN-005 |

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Phone: 705-652-2000 FAX: 705-652-6365



| Parameter | Description | SGS Method Code |
|---|---|---|
| Surr 4-Terphenyl-d14 | Surr | ME-CA-[ENV]GC-LAK-AN-005 |
| Surr Fluoranthene-D10 | Surr | ME-CA-[ENV]GC-LAK-AN-005 |
| Thallium (dissolved) | Tl by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Tin (dissolved) | Sn by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Titanium (dissolved) | Ti by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Total Dissolved Solids | Total Dissolved Solids by Gravimetric | ME-CA-[ENV]EWL-LAK-AN-005 |
| Total Kjeldahl Nitrogen | Tot. kjeldahl Nitrogen by Skalar | ME-CA-[ENV]SFA-LAK-AN-002 |
| Uranium (dissolved) | U by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Vanadium (dissolved) | V by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |
| Zinc (dissolved) | Zn by ICP-MS solution (dissolved) | ME-CA-[ENV]SPE-LAK-AN-006 |

*Brad Moore Hon. B.Sc*
*Project Specialist,*
*Environment, Health & Safety*

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

**Project :** 300032339 St. Mary's Landfill GW

**LR Report :** CA15123-JUN19

# Quality Control Report

| Parameter | Reporting Limit | Unit | Method Blank | Duplicate Result 1 | Duplicate Result 2 | Duplicate RPD | Duplicate Acceptance Criteria % | LCS / Spike Blank Spike Recovery (%) | LCS / Spike Blank Recovery Limits (%) Low | LCS / Spike Blank Recovery Limits (%) High | Matrix Spike / Reference Material Spike Recovery (%) | Matrix Spike / Reference Material Recovery Limits (%) Low | Matrix Spike / Reference Material Recovery Limits (%) High |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Organic Analysis** | | | | | | | | | | | | | |
| *Polychlorinated Biphenyls - QCBatchID: GCM0157-JUN19* | | | | | | | | | | | | | |
| Polychlorinated Biphenyls (PCBs) - Total | 0.05 | ug/L | < 0.04 | | | NSS | 30 | 110 | 60 | 140 | 96 | 60 | 140 |
| *Semi-Volatile Organics - QCBatchID: GCM0166-JUN19* | | | | | | | | | | | | | |
| 1-Methylnaphthalene | 0.2 | ug/L | < 0.5 | | | ND | 30 | 110 | 50 | 140 | 107 | 50 | 140 |
| 2-Methylnaphthalene | 0.2 | ug/L | < 0.5 | | | ND | 30 | 110 | 50 | 140 | 107 | 50 | 140 |
| Acenaphthene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 106 | 50 | 140 | 105 | 50 | 140 |
| Acenaphthylene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 104 | 50 | 140 | 102 | 50 | 140 |
| Anthracene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 104 | 50 | 140 | 104 | 50 | 140 |
| Benzo(a)anthracene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 106 | 50 | 140 | 106 | 50 | 140 |
| Benzo(a)pyrene | 0.2 | ug/L | < 0.01 | | | ND | 30 | 97 | 50 | 140 | 97 | 50 | 140 |
| Benzo(b)fluoranthene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 113 | 50 | 140 | 114 | 50 | 140 |
| Benzo(ghi)perylene | 0.2 | ug/L | < 0.2 | | | ND | 30 | 101 | 50 | 140 | 103 | 50 | 140 |
| Benzo(k)fluoranthene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 106 | 50 | 140 | 107 | 50 | 140 |
| Chrysene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 101 | 50 | 140 | 101 | 50 | 140 |
| Dibenzo(a,h)anthracene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 94 | 50 | 140 | 94 | 50 | 140 |
| Fluoranthene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 105 | 50 | 140 | 106 | 50 | 140 |
| Fluorene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 109 | 50 | 140 | 108 | 50 | 140 |
| Indeno(1,2,3-cd)pyrene | 0.2 | ug/L | < 0.2 | | | ND | 30 | 96 | 50 | 140 | 97 | 50 | 140 |
| Naphthalene | 0.2 | ug/L | < 0.5 | | | ND | 30 | 112 | 50 | 140 | 107 | 50 | 140 |
| Phenanthrene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 107 | 50 | 140 | 107 | 50 | 140 |
| Pyrene | 0.2 | ug/L | < 0.1 | | | ND | 30 | 105 | 50 | 140 | 105 | 50 | 140 |

| Parameter | Reporting Limit | Unit | Method Blank | Duplicate Result 1 | Duplicate Result 2 | Duplicate RPD | Duplicate Acceptance Criteria % | LCS / Spike Blank Spike Recovery (%) | LCS / Spike Blank Recovery Limits (%) Low | LCS / Spike Blank Recovery Limits (%) High | Matrix Spike / Reference Material Spike Recovery (%) | Matrix Spike / Reference Material Recovery Limits (%) Low | Matrix Spike / Reference Material Recovery Limits (%) High |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganic Analysis** | | | | | | | | | | | | | |
| *Alkalinity - QCBatchID: EWL0119-JUN19* | | | | | | | | | | | | | |
| Alkalinity | 2 | mg/L as Ca | < 2 | | | 1 | 10 | 102 | 80 | 120 | NA | | |
| *Alkalinity - QCBatchID: EWL0223-JUN19* | | | | | | | | | | | | | |
| Alkalinity | 2 | mg/L as Ca | < 2 | | | 5 | 10 | 102 | 80 | 120 | NA | | |
| *Anions by discrete analyzer - QCBatchID: DIO0111-JUN19* | | | | | | | | | | | | | |
| Chloride | 1 | mg/L | <1 | | | 7 | 20 | 100 | 80 | 120 | 96 | 75 | 125 |
| Sulphate | 2 | mg/L | <2 | | | 8 | 20 | 100 | 80 | 120 | 93 | 75 | 125 |
| *Anions by discrete analyzer - QCBatchID: DIO0113-JUN19* | | | | | | | | | | | | | |
| Chloride | 1 | mg/L | <1 | | | 0 | 20 | 100 | 80 | 120 | 105 | 75 | 125 |
| Sulphate | 2 | mg/L | <2 | | | 3 | 20 | 101 | 80 | 120 | 101 | 75 | 125 |

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P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365



**Inorganic Analysis**

| Parameter | Reporting Limit | Unit | Method Blank | Duplicate | | | | LCS / Spike Blank | | | Matrix Spike / Reference Material | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Result 1 | Result 2 | RPD | Acceptance Criteria % | Spike Recovery (%) | Recovery Limits (%) Low | Recovery Limits (%) High | Spike Recovery (%) | Recovery Limits (%) Low | Recovery Limits (%) High |
| *Anions by IC - QCBatchID: DIO0114-JUN19* | | | | | | | | | | | | | |
| Bromide | 0.3 | mg/L | <0.3 | | | 3 | 20 | 102 | 80 | 120 | 106 | 75 | 125 |
| Nitrate (as N) | 0.06 | mg/L | <0.06 | | | ND | 20 | 98 | 80 | 120 | 107 | 75 | 125 |
| Nitrite (as N) | 0.03 | mg/L | <0.03 | | | ND | 20 | 99 | 80 | 120 | 104 | 75 | 125 |
| *Carbon by Combustion/Oxidation - QCBatchID: EWL0132-JUN19* | | | | | | | | | | | | | |
| Dissolved Organic Carbon | 0.5 | mg/L | <0.5 | | | 0 | 20 | 102 | 90 | 110 | 105 | 75 | 125 |
| *Carbon by Combustion/Oxidation - QCBatchID: EWL0183-JUN19* | | | | | | | | | | | | | |
| Dissolved Organic Carbon | 0.5 | mg/L | <0.5 | | | 0 | 20 | 101 | 90 | 110 | 98 | 75 | 125 |
| *Conductivity - QCBatchID: EWL0119-JUN19* | | | | | | | | | | | | | |
| Conductivity | 2 | uS/cm | 2 | | | 0 | 10 | 99 | 90 | 110 | NA | | |
| *Conductivity - QCBatchID: EWL0123-JUN19* | | | | | | | | | | | | | |
| Conductivity | 2 | uS/cm | < 2 | | | 0 | 10 | 98 | 90 | 110 | NA | | |
| *Fluoride by Specific Ion Electrode - QCBatchID: EWL0203-JUN19* | | | | | | | | | | | | | |
| Fluoride | 0.06 | mg/L | <0.06 | | | 4 | 10 | 94 | 90 | 110 | 100 | 75 | 125 |
| *Mercury by CVAAS - QCBatchID: EHG0006-JUN19* | | | | | | | | | | | | | |
| Mercury (total) | 0.00001 | mg/L | < 0.00001 | | | ND | 20 | 119 | 80 | 120 | 116 | 70 | 130 |
| *Metals in aqueous samples - ICP-MS - QCBatchID: EMS0040-JUN19* | | | | | | | | | | | | | |
| Aluminum (dissolved) | 0.01 | mg/L | < 0.001 | | | 2 | 20 | 99 | 90 | 110 | NV | 70 | 130 |
| Antimony (dissolved) | 0.003 | mg/L | < 0.0009 | | | 7 | 20 | 101 | 90 | 110 | NV | 70 | 130 |
| Arsenic (dissolved) | 0.002 | mg/L | < 0.0002 | | | ND | 20 | 97 | 90 | 110 | 91 | 70 | 130 |
| Barium (dissolved) | 0.002 | mg/L | < 0.00002 | | | 0 | 20 | 101 | 90 | 110 | NV | 70 | 130 |
| Beryllium (dissolved) | 0.002 | mg/L | < 0.000007 | | | 20 | 20 | 101 | 90 | 110 | 86 | 70 | 130 |
| Bismuth (dissolved) | 0.002 | mg/L | < 0.000007 | | | ND | 20 | 101 | 90 | 110 | 118 | 70 | 130 |
| Boron (dissolved) | 0.01 | mg/L | < 0.002 | | | 5 | 20 | 100 | 90 | 110 | NV | 70 | 130 |
| Cadmium (dissolved) | 0.0001 | mg/L | < 0.000003 | | | ND | 20 | 99 | 90 | 110 | 90 | 70 | 130 |
| Calcium (dissolved) | 0.1 | mg/L | < 0.01 | | | 3 | 20 | 102 | 90 | 110 | NV | 70 | 130 |
| Chromium (dissolved) | 0.003 | mg/L | < 0.00008 | | | 12 | 20 | 97 | 90 | 110 | 73 | 70 | 130 |
| Cobalt (dissolved) | 0.0005 | mg/L | < 0.000004 | | | 4 | 20 | 97 | 90 | 110 | 82 | 70 | 130 |
| Copper (dissolved) | 0.003 | mg/L | < 0.0002 | | | 13 | 20 | 96 | 90 | 110 | NV | 70 | 130 |
| Iron (dissolved) | 0.01 | mg/L | < 0.007 | | | 1 | 20 | 100 | 90 | 110 | NV | 70 | 130 |
| Lead (dissolved) | 0.001 | mg/L | < 0.00001 | | | 20 | 20 | 95 | 90 | 110 | 88 | 70 | 130 |
| Magnesium (dissolved) | 0.05 | mg/L | < 0.001 | | | 3 | 20 | 103 | 90 | 110 | 82 | 70 | 130 |
| Manganese (dissolved) | 0.002 | mg/L | < 0.00001 | | | 4 | 20 | 99 | 90 | 110 | NV | 70 | 130 |
| Molybdenum (dissolved) | 0.002 | mg/L | < 0.00004 | | | 0 | 20 | 102 | 90 | 110 | NV | 70 | 130 |
| Nickel (dissolved) | 0.003 | mg/L | < 0.0001 | | | 5 | 20 | 98 | 90 | 110 | NV | 70 | 130 |
| Phosphorus (dissolved) | 0.03 | mg/L | < 0.003 | | | 7 | 20 | 102 | 90 | 110 | NV | 70 | 130 |
| Selenium (dissolved) | 0.004 | mg/L | < 0.00004 | | | ND | 20 | 103 | 90 | 110 | NV | 70 | 130 |
| Silicon (dissolved) | 0.2 | mg/L | < 0.02 | | | ND | 20 | 106 | 90 | 110 | NV | 70 | 130 |
| Silver (dissolved) | 0.0001 | mg/L | < 0.00005 | | | ND | 20 | 101 | 90 | 110 | NV | 70 | 130 |

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P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365



**Inorganic Analysis**

| Parameter | Reporting Limit | Unit | Method Blank | Duplicate | | | | LCS / Spike Blank | | | Matrix Spike / Reference Material | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Result 1 | Result 2 | RPD | Acceptance Criteria | Spike Recovery (%) | Recovery Limits (%) | | Spike Recovery (%) | Recovery Limits (%) | |
| | | | | | | | % | | Low | High | | Low | High |
| Sodium (dissolved) | 0.1 | mg/L | < 0.01 | | | 3 | 20 | 103 | 90 | 110 | NV | 70 | 130 |
| Strontium (dissolved) | 0.0002 | mg/L | < 0.00002 | | | 2 | 20 | 101 | 90 | 110 | NV | 70 | 130 |
| Thallium (dissolved) | 0.00005 | mg/L | < 0.000005 | | | 7 | 20 | 105 | 90 | 110 | 95 | 70 | 130 |
| Tin (dissolved) | 0.002 | mg/L | < 0.00006 | | | 4 | 20 | 104 | 90 | 110 | NV | 70 | 130 |
| Titanium (dissolved) | 0.0005 | mg/L | < 0.00005 | | | ND | 20 | 103 | 90 | 110 | NV | 70 | 130 |
| Uranium (dissolved) | 0.00002 | mg/L | < 0.000002 | | | 9 | 20 | 104 | 90 | 110 | 90 | 70 | 130 |
| Vanadium (dissolved) | 0.002 | mg/L | < 0.00001 | | | ND | 20 | 97 | 90 | 110 | 83 | 70 | 130 |
| Zinc (dissolved) | 0.02 | mg/L | < 0.002 | | | 5 | 20 | 99 | 90 | 110 | NV | 70 | 130 |
| *Metals in aqueous samples - ICP-MS - QCBatchID: EMS0050-JUN19* | | | | | | | | | | | | | |
| Aluminum (dissolved) | 0.01 | mg/L | < 0.001 | | | 12 | 20 | 101 | 90 | 110 | NV | 70 | 130 |
| Antimony (dissolved) | 0.003 | mg/L | < 0.0009 | | | ND | 20 | 108 | 90 | 110 | NV | 70 | 130 |
| Arsenic (dissolved) | 0.002 | mg/L | < 0.0002 | | | 8 | 20 | 101 | 90 | 110 | 103 | 70 | 130 |
| Barium (dissolved) | 0.002 | mg/L | < 0.00002 | | | 1 | 20 | 101 | 90 | 110 | NV | 70 | 130 |
| Beryllium (dissolved) | 0.002 | mg/L | < 0.000007 | | | 13 | 20 | 98 | 90 | 110 | 110 | 70 | 130 |
| Bismuth (dissolved) | 0.002 | mg/L | < 0.000007 | | | 18 | 20 | 94 | 90 | 110 | 108 | 70 | 130 |
| Boron (dissolved) | 0.01 | mg/L | < 0.002 | | | 2 | 20 | 97 | 90 | 110 | NV | 70 | 130 |
| Cadmium (dissolved) | 0.0001 | mg/L | < 0.000003 | | | ND | 20 | 98 | 90 | 110 | 93 | 70 | 130 |
| Calcium (dissolved) | 0.1 | mg/L | < 0.01 | | | 2 | 20 | 98 | 90 | 110 | NV | 70 | 130 |
| Chromium (dissolved) | 0.003 | mg/L | < 0.00008 | | | 2 | 20 | 96 | 90 | 110 | 93 | 70 | 130 |
| Cobalt (dissolved) | 0.0005 | mg/L | < 0.000004 | | | 2 | 20 | 103 | 90 | 110 | 106 | 70 | 130 |
| Copper (dissolved) | 0.003 | mg/L | < 0.0002 | | | ND | 20 | 97 | 90 | 110 | NV | 70 | 130 |
| Iron (dissolved) | 0.01 | mg/L | < 0.007 | | | 20 | 20 | 96 | 90 | 110 | NV | 70 | 130 |
| Lead (dissolved) | 0.001 | mg/L | < 0.00001 | | | ND | 20 | 98 | 90 | 110 | 95 | 70 | 130 |
| Magnesium (dissolved) | 0.05 | mg/L | < 0.001 | | | 5 | 20 | 100 | 90 | 110 | NV | 70 | 130 |
| Manganese (dissolved) | 0.002 | mg/L | < 0.00001 | | | 3 | 20 | 104 | 90 | 110 | NV | 70 | 130 |
| Molybdenum (dissolved) | 0.002 | mg/L | < 0.00004 | | | 9 | 20 | 102 | 90 | 110 | 101 | 70 | 130 |
| Nickel (dissolved) | 0.003 | mg/L | < 0.0001 | | | 4 | 20 | 102 | 90 | 110 | 99 | 70 | 130 |
| Phosphorus (dissolved) | 0.03 | mg/L | < 0.003 | | | 15 | 20 | 100 | 90 | 110 | NV | 70 | 130 |
| Potassium (dissolved) | 0.05 | mg/L | < 0.009 | | | 3 | 20 | 98 | 90 | 110 | NV | 70 | 130 |
| Selenium (dissolved) | 0.004 | mg/L | < 0.00004 | | | 15 | 20 | 104 | 90 | 110 | 107 | 70 | 130 |
| Silicon (dissolved) | 0.2 | mg/L | < 0.02 | | | 4 | 20 | 103 | 90 | 110 | NV | 70 | 130 |
| Silver (dissolved) | 0.0001 | mg/L | < 0.00005 | | | ND | 20 | 91 | 90 | 110 | 74 | 70 | 130 |
| Sodium (dissolved) | 0.1 | mg/L | < 0.01 | | | 5 | 20 | 104 | 90 | 110 | NV | 70 | 130 |
| Strontium (dissolved) | 0.0002 | mg/L | < 0.00002 | | | 4 | 20 | 102 | 90 | 110 | NV | 70 | 130 |
| Thallium (dissolved) | 0.00005 | mg/L | < 0.000005 | | | 0 | 20 | 98 | 90 | 110 | 96 | 70 | 130 |
| Tin (dissolved) | 0.002 | mg/L | < 0.00006 | | | ND | 20 | 97 | 90 | 110 | NV | 70 | 130 |
| Titanium (dissolved) | 0.0005 | mg/L | < 0.00005 | | | 20 | 20 | 97 | 90 | 110 | NV | 70 | 130 |
| Uranium (dissolved) | 0.00002 | mg/L | < 0.000002 | | | 0 | 20 | 98 | 90 | 110 | 117 | 70 | 130 |
| Vanadium (dissolved) | 0.002 | mg/L | < 0.00001 | | | 1 | 20 | 100 | 90 | 110 | 104 | 70 | 130 |

**SGS Canada Inc.**
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365



**Inorganic Analysis**

| Parameter | Reporting Limit | Unit | Method Blank | Duplicate: Result 1 | Duplicate: Result 2 | Duplicate: RPD | Duplicate: Acceptance Criteria % | LCS / Spike Blank: Spike Recovery (%) | LCS / Spike Blank: Recovery Limits (%) Low | LCS / Spike Blank: Recovery Limits (%) High | Matrix Spike / Reference Material: Spike Recovery (%) | Matrix Spike / Reference Material: Recovery Limits (%) Low | Matrix Spike / Reference Material: Recovery Limits (%) High |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zinc (dissolved) | 0.02 | mg/L | < 0.002 | | | ND | 20 | 101 | 90 | 110 | NV | 70 | 130 |
| *Metals in aqueous samples - ICP-OES - QCBatchID: EMS0040-JUN19* | | | | | | | | | | | | | |
| Hardness | 0.05 | mg/L as Ca | <0.05 | | | 3 | 20 | 102 | 90 | 110 | NV | 70 | 130 |
| *Metals in aqueous samples - ICP-OES - QCBatchID: EMS0050-JUN19* | | | | | | | | | | | | | |
| Hardness | 0.05 | mg/L as Ca | <0.05 | | | 2 | 20 | 98 | 90 | 110 | NV | 70 | 130 |
| *pH - QCBatchID: EWL0119-JUN19* | | | | | | | | | | | | | |
| pH | 0.05 | no unit | NA | | | 0 | | 100 | | | NA | | |
| *pH - QCBatchID: EWL0121-JUN19* | | | | | | | | | | | | | |
| pH | 0.05 | no unit | NA | | | 0 | | 100 | | | NA | | |
| *Phenols by SFA - QCBatchID: SKA0133-JUN19* | | | | | | | | | | | | | |
| 4AAP-Phenolics | 0.01 | mg/L | <0.002 | | | ND | 10 | 106 | 90 | 110 | 110 | 75 | 125 |
| *Phenols by SFA - QCBatchID: SKA0137-JUN19* | | | | | | | | | | | | | |
| 4AAP-Phenolics | 0.01 | mg/L | <0.002 | | | 4 | 10 | 100 | 90 | 110 | 89 | 75 | 125 |
| *Reactive Phosphorus by SFA - QCBatchID: SKA0064-JUN19* | | | | | | | | | | | | | |
| Phosphorus (total reactive) | 0.03 | mg/L | <0.03 | | | ND | 10 | 98 | 90 | 110 | 109 | 75 | 125 |
| *Solids Analysis - QCBatchID: EWL0104-JUN19* | | | | | | | | | | | | | |
| Total Dissolved Solids | 30 | mg/L | <30 | | | 5 | 20 | 98 | 90 | 110 | NA | | |
| *Total Nitrogen - QCBatchID: SKA5051-JUN19* | | | | | | | | | | | | | |
| Total Kjeldahl Nitrogen | 0.5 | as N mg/L | <0.5 | | | ND | 10 | 94 | 90 | 110 | 75 | 75 | 125 |

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# Appendix J

# MECP Technical Comments and Response

**R.J. Burnside & Associates Limited** 449 Josephine Street P.O. Box 10 Wingham ON N0G 2W0 CANADA
**telephone** (519) 357-1521 **fax** (519) 357-3624 **web** www.rjburnside.com

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# Technical Memorandum

**Date:** December 21, 2020 **Project No.:** 300032339.0000

**Project Name:** St. Marys Landfill - Future Solid Waste Disposal Needs Environmental Assessment

**Client Name:** Town of St. Marys

**Submitted To:** MECP Technical Support

**Submitted By:** Caitlin Fergusson, P.Eng. **Reviewed By:** Joy Rutherford, P.Geo

This memorandum is intended to address the comments on the December 2019 Hydrogeology Study Report received in a letter from the Ministry of Environment, Conservation and Parks (MECP) dated March 18, 2020. The two comments are summarized as follows:

1. Reasonable Use Policy - The primary issue that remains is for the EA document to discuss how the facility is expected to meet the Reasonable Use Guideline (RUG). This is achieved by demonstrating that the site is likely to comply with the Ministry's Reasonable Use Guideline (RUG), supported through predictive modeling or by showing that engineering safeguards (e.g. liner) will protect ground water resources. The current report does not conclude that the proposal will meet the RUG. The EA document must identify how the site will address RUG, even if the final technical analysis and actions are to be completed at the ECA stage.

2. Monitoring Wells – The construction will require the removal of existing monitoring wells, additional monitoring wells will be constructed, the exact location of wells will be determined following construction. The EA document should identify the purpose of the monitoring wells (for example sentry wells at the property boundaries or up-gradient of the private homes on Perth Rd 123).

The Hydrogeology Study Report compared five Alternative Methods for landfill expansion and rated the methods for groundwater protection. However, the determination of the final preferred Alternative Method was made in the main EA report. Reasonable Use and monitoring considerations for each Alternative Method were not included in the original Hydrogeology Study. The main EA report concluded that Alternative Method 3 was preferred. This was also the preference of the Hydrogeology Study for groundwater protection. The responses provided below are based on the EA preference of Alternative Method 3 which is a combined vertical and horizontal expansion that will include an expansion of the existing leachate collection system.

## 1.0 Reasonable Use Guideline (RUG)

Key points from the Hydrogeology Study are provided below to summarize the hydrogeology at the Site.

- There are no regional overburden aquifers in the Site vicinity. Therefore, the primary aquifer in the area is the limestone bedrock.
- The water table in the bedrock is 8 to 10 m below the bedrock surface. Therefore, water found above the bedrock is perched in localized and possibly isolated permeable seams.
- Most of the shallow lacustrine soils have been removed; therefore, overburden flow is either through the shallow till or the inter-till deposits. Findings at OW36 indicate there is little movement of water in the shallow till.
- The hydraulic conductivity of the clayey silt till is $9.9 \times 10^{-11}$ m/s.
- The hydraulic conductivity of the limestone bedrock is $2.2 \times 10^{-4}$ m/s.
- The horizontal velocity through the till is < 0.001 m/year and through the sand is 3 m/year.
- The primary direction of groundwater movement is expected to be downward. While some horizontal movement occurs in the inter-till silt/sand seams and till-bedrock interface sand, the perched conditions and deep bedrock water levels create a dominant downward movement. The average vertical gradient at the till/bedrock well nests is 0.94.

Since the primary direction of groundwater movement is expected to be downward, the following calculations consider the downward migration of leachate, through the till, to the bedrock aquifer. There is an established leachate collection system for the existing landfill footprint and an expansion of this system is planned for the future footprint. The leachate collection system is expected to capture the majority of leachate generated at the site. However, to illustrate the worst-case scenario, the maximum leachate volume that could be transmitted through the till to the bedrock has been calculated based on site permeability and vertical gradients.

Chloride was the contaminant considered since it is a conservative parameter. It migrates at the rate of groundwater flow, is not altered by biological degradation or oxidation/reduction and is not adsorbed by the soil. The background and leachate chloride concentrations were determined from historical monitoring data.

The vertical velocity of water through the till was calculated to be approximately 0.0086 m/year. The thickness of the till layer varies from 13 to 17 m. This results in a travel time through the till, to the bedrock, of 1,500 to 2,000 years.

The maximum volume of leachate that could travel through the till was calculated for existing conditions (Phase I and Phase II/III) and future conditions (Alternative Method 3). The calculations are provided in Attachment A and summarized below.

**Table 1: Calculated Maximum Leachate Volume Through Till**

| | |
|---|---|
| Existing Phase I | 58,100 L/yr |
| Existing Phase II | 143,500 L/yr |
| Alternative Method 3 | 380,500 L/yr |

The chloride concentrations calculated in a 3 m thick mixing zone below the water table in the bedrock are summarized below for existing and future conditions.

**Table 2: Calculated Bedrock Chloride Concentrations**

| | |
|---|---|
| Existing Phase I | 7.7 mg/L |
| Existing Phase II | 19 mg/L |
| Alternative Method 3 | 31 mg/L |

Based on historical monitoring data, the bedrock chloride RUG is approximately 130 mg/L. The bedrock chloride concentration calculated for Alternative Method 3 is 31 mg/L. This is significantly below the RUG. As previously stated, the calculations assume leachate dilution does not occur within the overburden; only within the bedrock aquifer. Furthermore, this is the concentration below the landfill footprint. Some additional dilution will occur between the landfill footprint and the site boundary; the actual chloride concentration in the bedrock aquifer is expected to be less. Therefore, the proposed landfill expansion is expected to meet the RUG.

## Additional Monitoring Wells

During the various stages of cell construction for Alternative 3, the following eight wells are expected to require decommissioning:

- Overburden Wells: OW3-84, OW4-84, OW5-84, OW6-84, OW8B-10 and OW36.
- Bedrock Wells: OW7-91 and OW8A-91.

Figure 1 and Figure 2 show the proposed general areas for future monitoring well construction. The interpreted overburden groundwater flow direction is shown on Figure 1; the interpreted bedrock flow direction is shown on Figure 2. The six areas for future monitoring well construction are discussed below.

<u>Shallow Water Table Wells</u>

There are three locations (Area 1, 2 and 3) recommended for the installation of a shallow water table well. The depth of these wells will vary depending on the water bearing zone found at the time of drilling. The purpose of these wells is to provide water level data for determining groundwater contours and flow direction at the site. They will also provide cross-gradient and/or downgradient groundwater quality data for identifying any leachate migration.

Overburden and Bedrock Well Nests

There are two locations (Area 4 and 5) recommended for the installation of a monitoring well nest. Each nest should consist of, at minimum, a shallow water table well and a bedrock well. In addition, any permeable water-bearing seams (inter-till deposit) encountered should be screened with a monitoring well. The purpose of the bedrock wells is to provide an upgradient well and cross-gradient well for groundwater flow mapping and water quality sampling. The overburden wells will also provide additional data for flow mapping, as well as cross-gradient or downgradient water quality data.

At this time, the four wells located just west of the existing footprint (OW9A-91, OW9B-91, OW15-91 and OW21-91) are not expected to be removed during Alternative 3 construction. However, if these wells do require removal, the sixth area shown on Figures 1 and 2 is recommended to replace these wells. Just like Area 4 and 5, each nest should consist of a shallow water table well, a bedrock well and a well installed in any permeable water-bearing seams (inter-till deposit) encountered during drilling.

Cement Kiln Dust (CKD) Stockpile Wells

It is also recommended that the monitoring wells previously installed in the CKD Stockpile (MW04-01, MW04-02 and MW04-03) be maintained and water level measurements collected for determining groundwater contours and flow direction at the site. Periodic sampling of these wells (i.e. once every three years) could also be considered.

**R.J. Burnside & Associates Limited**

Caitlin Fergusson, P.Eng.
Project Engineer

Joy Rutherford, P.Geo
Senior Hydrogeologist

CF/JR:tp

Enclosure(s) Attachment A – RUG Calculations
Figure 1 – Proposed Areas for New Overburden Monitoring Wells
Figure 2 – Proposed Areas for New Bedrock Monitoring Wells



In the preparation of the various instruments of service contained herein, R.J. Burnside & Associates Limited was required to use and rely upon various sources of information (including but not limited to: reports, data, drawings, observations) produced by parties other than R.J. Burnside & Associates Limited. For its part R.J. Burnside & Associates Limited has proceeded based on the belief that the third party/parties in question produced this documentation using accepted industry standards and best practices and that all information was therefore accurate, correct and free of errors at the time of consultation. As such, the comments, recommendations and materials presented in this instrument of service reflect our best judgment in light of the information available at the time of preparation. R.J. Burnside & Associates Limited, its employees, affiliates and subcontractors accept no liability for inaccuracies or errors in the instruments of service provided to the client, arising from deficiencies in the aforementioned third party materials and documents.

## Attachment A - RUG Calculations

### Input Parameters

| | |
|---|---|
| *Hydraulic Conductivities (m/s)* | |
| Sand/Gravel | 3.0E-06 |
| Clayey Silt Till | 9.9E-11 |
| Bedrock | 2.2E-04 |
| *Vertical Gradient (m/m)* | |
| Till/Bedrock | 0.94 |
| *Horizontal Gradient (m/m)* | |
| Bedrock | 0.0045 |
| *Porosity* | |
| Clayey Silt Till | 0.34 |
| Bedrock | 0.2 |
| *Landfill Footprints (m2)* | |
| Phase I | 19,801 |
| Phase II/III | 48,907 |
| Alternative 3 | 129,648 |
| *Bedrock Mixing Zone (m)* | |
| Depth | 3 |
| Phase I Width | 180 |
| Phase II/III Width | 210 |
| Alternative 3 Width | 400 |
| *Chloride Concentrations (mg/L)* | |
| Bedrock Background | 6 |
| Phase I Leachate | 500 |
| Phase II/III Leachate | 1,750 |
| Alternative 3 Leachate | 2,500 |

### Vertical Velocity (VV) in Clayey Silt Till

| | | |
|---|---|---|
| VV = | Ki/n | |
| VV = | 2.74E-10 | m/s |
| VV = | 8.63E-03 | m/year |
| VV = | 8.6 | mm/year |

### Vertical Flow through Till - Phase I

| | | |
|---|---|---|
| Q = | KiA | |
| Q = | 1.8E-06 | m3/s |
| Q = | 1.8E-03 | L/s |
| Q = | 58,111 | L/year |

### Vertical Flow through Till - Phase II/III

| | | |
|---|---|---|
| Q = | KiA | |
| Q = | 4.6E-06 | m3/s |
| Q = | 4.6E-03 | L/s |
| Q = | 143,529 | L/year |

### Vertical Flow through Till - Alternative 3

| | | |
|---|---|---|
| Q = | KiA | |
| Q = | 1.2E-05 | m3/s |
| Q = | 1.2E-02 | L/s |
| Q = | 380,483 | L/year |

### Horizontal Velocity (HV) in Bedrock

| | | |
|---|---|---|
| HV = | Ki/n | |
| HV = | 5.0E-06 | m/s |
| HV = | 156 | m/year |

### Horizontal Flow through Bedrock Below - Phase I

| | | |
|---|---|---|
| Q = | KiA | |
| Q = | 5.3E-04 | m3/s |
| Q = | 5.3E-01 | L/s |
| Q = | 16,859,146 | L/year |

### Horizontal Flow through Bedrock Below - Phase II/III

| | | |
|---|---|---|
| Q = | KiA | |
| Q = | 6.2E-04 | m3/s |
| Q = | 6.2E-01 | L/s |
| Q = | 19,669,003 | L/year |

### Horizontal Flow through Bedrock Below - Alternative 3

| | | |
|---|---|---|
| Q = | KiA | |
| Q = | 1.2E-03 | m3/s |
| Q = | 1.2E+00 | L/s |
| Q = | 37,464,768 | L/year |

## Attachment A - RUG Calculations

$$\textit{Dilution Formula} = \frac{(\text{Cl conc. In leachate} \times \text{volume of leachate}) + (\text{Cl conc. in bedrock} \times \text{volume of water in bedrock})}{\text{volume of leachate} + \text{volume of water in bedrock}}$$

<u>Chloride Concentration in Bedrock Mixing Zone - Phase I</u>

$$Cl = \frac{29{,}055{,}395 + 101{,}154{,}874}{58{,}111 + 16{,}859{,}146}$$

Cl = 7.7 mg/L

<u>Chloride Concentration in Bedrock Mixing Zone - Phase II/III</u>

$$Cl = \frac{251{,}176{,}340 + 118{,}014{,}019}{143{,}529 + 19{,}669{,}003}$$

Cl = 18.6 mg/L

<u>Chloride Concentration in Bedrock Mixing Zone - Phase I & II/III</u>

$$Cl = \frac{280{,}231{,}735 + 219{,}168{,}893}{201{,}640 + 36{,}528{,}149}$$

Cl = 13.6 mg/L

<u>Chloride Concentration in Bedrock Mixing Zone - Alternative 3</u>

$$Cl = \frac{951{,}207{,}981 + 224{,}788{,}608}{380{,}483 + 37{,}464{,}768}$$

Cl = 31.1 mg/L


## LEGEND

- PROPERTY BOUNDARY
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- LEACHATE COLLECTION SYSTEM
- STORM WATER MANAGEMENT BASIN
- LANDFILL OBSERVATION WELL
- EA MONITORING WELL
- PRIVATE DOMESTIC WELL (APPROXIMATE LOCATION)
- SURFACE WATER MONITORING LOCATION
- DRIVE POINT PIEZOMETER
- ALTERNATIVE 3 FOOTPRINT
- INTERPRETED GROUNDWATER CONTOUR - masl (Based on April 2017 water levels in overburden wells)
- INTERPRETED GROUNDWATER FLOW DIRECTION
- EXISTING MONITORING WELLS TO BE DECOMMISSIONED
- PROPOSED AREA FOR FUTURE MONITORING WELLS
- PROPOSED AREA FOR FUTURE MONITORING WELLS (IF REQUIRED)

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TOWN OF ST. MARYS
*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title
**PROPOSED AREAS FOR NEW OVERBURDEN MONITORING WELLS**

| Drawn | Checked | Date | Figure No. |
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LEGEND

- PROPERTY BOUNDARY
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- LEACHATE COLLECTION SYSTEM
- STORM WATER MANAGEMENT BASIN
- LANDFILL OBSERVATION WELL
- PRIVATE DOMESTIC WELL (APPROXIMATE LOCATION)
- SURFACE WATER MONITORING LOCATION
- DRIVE POINT PIEZOMETER
- ALTERNATIVE 3 FOOTPRINT
- INTERPRETED GROUNDWATER CONTOUR - masl (Based on April 2017 water levels in bedrock wells)
- INTERPRETED GROUNDWATER FLOW DIRECTION
- EXISTING MONITORING WELLS TO BE DECOMMISSIONED
- PROPOSED AREA FOR FUTURE MONITORING WELLS
- PROPOSED AREA FOR FUTURE MONITORING WELLS (IF REQUIRED)

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TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT HYDROGEOLOGICAL STUDY*

Figure Title

**PROPOSED AREAS FOR NEW BEDROCK MONITORING WELLS**

| Drawn | Checked | Date | Figure No. |
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| SK | CF | June 2020 | 2 |
| Scale | | Project No. | |
| 1:3,000 | | 300032339.0000 | |

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**R.J. Burnside & Associates Limited** 449 Josephine Street P.O. Box 10 Wingham ON N0G 2W0 CANADA
**telephone** (519) 357-1521 **fax** (519) 357-3624 **web** www.rjburnside.com

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# Technical Memorandum

| | |
|---|---|
| **Date:** | December 21, 2020 **Project No.:** 300032339.0000 |
| **Project Name:** | St Marys Landfill - Future Solid Waste Disposal Needs Environmental Assessment |
| **Client Name:** | Town of St Marys |
| **Submitted To:** | Ministry of Environment, Conservation and Parks<br>Technical Support, Surface Water Specialist |
| **Submitted By:** | Joy Rutherford, P.Geo. |

This memorandum addresses the March 27, 2020 comments provided by the Ministry of Environment, Conservation and Parks (MECP) Surface Water Specialist on the draft Hydrogeology Study Report dated December 2019.

The Hydrogeology Study Report compared five Alternative Methods for landfill expansion and rated the methods for groundwater protection. However, the determination of the preferred Alternative Method was made in the main EA report. The main EA report concluded that Alternative Method 3 was preferred. This was also the preference of the Hydrogeology Study for groundwater protection.

Alternative Method 3 is a combined vertical and horizontal expansion. The vertical expansion places waste above the existing Phase I and Phase II/III footprints. The horizontal expansion creates new footprint areas between and east of the existing Phases. The new footprint area will include an expansion of the existing leachate collection system.

Expansion to the east will necessitate the relocation of the existing watercourse. Its current location is through the centre of the landfill property between the landfill and a Cement Kiln Dust stockpile (CKD). The CKD stockpile was created by St. Marys Cement when that company owned the property. The comments provided by the surface water specialist pertain to the relocation of the watercourse to the east side of the CKD stockpile. The comments are summarized (not quoted) as follows:

> *The proponent has not properly characterized, delineated or identified how the CKD pile may affect surface water or groundwater resources at the site once the landfill expansion and watercourse realignment occur through the selection of Alternative #3.*

*The pile still contains several contaminants of concern with elevated concentrations capable of causing unacceptable surface water quality impairment if it were to access the proposed relocated watercourse.*

- *Using the guidance provided by O. Reg 153/04 is a reasonable approach and one that could provide the necessary direction to assess the potential impacts from the CKD pile to the proposed surface water receiver.*
- *If further characterization work around the pile were to identify that the risk to the watercourse is limited to overland flow and not through groundwater, the risk assessment could be scoped and limited to the section of the pile that will need to be excavated/modified to accommodate the watercourse alteration*
- *The report has identified "potential effects from relocating the watercourse" and therefore, the MECP will require, as a minimum,*
  - *a plan identifying the types of work which will be required to characterize chemicals of concern,*
  - *delineate the areas of exposure,*
  - *identify potential migration pathways (overland vs leachate creation) and*
  - *develop a monitoring/contingency plan to "consider mitigation measures, net effects and monitoring measures"*

**Watercourse Relocation**

A field investigation was completed in 2016 by Parish Aquatic Services (Division of Matrix Solutions) to identify a potential design for the relocated watercourse. The design allows for appropriate base flow capacity while incorporating banks that provide flood stage capacity, without infringing on the CKD stockpile. Figure 1, attached, shows the proposed stream alignment, a 20 m wide floodplain and the grading (or disturbance) limits.

The section of the proposed watercourse that wraps around the east and north side of the CKD stockpile is approximately 300 m. The distance from the toe of the CKD stockpile (as mapped on Figure 1) to the proposed watercourse channel along the 300 m generally varies from 18 to 36 m. For comparison, the current watercourse channel is 28 to 36 m from the south side of the CKD stockpile for approximately 140 m (where the watercourse enters the site).

To assist in visualizing the proposed watercourse in relation to the adjacent topography and soil, three cross-sections are shown in Figures 2 to 4. The sections include the existing watercourse, the CKD stockpile, and the proposed watercourse. The locations of the cross-sections are shown on Figure 1.

The sections show the position and materials logged in the three 2004 monitoring wells installed in the CKD. According to the well logs, the CKD is capped with a layer of topsoil. At MW04-01 and MW04-03 there is also a layer of fill (sand and silt) below the topsoil. The stockpile comprises a mix of CKD material and soil or fill. The soil varies from sand to silt to clay.

The wells all ended in the native glacial till below the CKD/fill. Based on the cross-sections developed from the well logs, the existing watercourse appears to be separated from the CKD by this glacial till. If the proposed watercourse is also separated from the CKD by the till, the low permeability of the till will protect the surface water due to the slow travel time of groundwater through the till. However, the monitoring wells are located in the south part of the CKD stockpile and the extent of the CKD material has not been determined, particularly along the north edge of the stockpile.

**Water Quality**

Three monitoring wells were installed in the CKD stockpile between July 30 and August 12, 2004. Table 1, attached, compares the 2019 water quality data from those wells to O.Reg. 153 Table 8. Table 8 (for potable groundwater conditions) is to be used where all or part of a property lies within 30 m of a surface water body. These standards were derived with the objective of protecting surface water bodies from movement of soil directly into surface water to become sediment, and assuming that there is no dilution in the groundwater for the aquatic protection pathway.

The table below summarizes the 2019 criteria exceedances at the CKD stockpile wells.

| Parameter | MW04-01 | MW04-02 | MW04-03 |
|---|---|---|---|
| Chloride | X | | X |
| Sodium | X | | |
| Arsenic | X | | X |
| Molybdenum | X | | X |
| Selenium | X | | |
| Vanadium | X | | |

There were six exceedances at MW04-01 located in the centre of the stockpile. No criteria exceedances occurred at MW04-02 which is located at the southeast corner of the stockpile adjacent to both the existing watercourse and the proposed watercourse. MW04-03, located at the southwest corner of the stockpile, had three exceedances. Table 1 also shows all three wells have alkalinity, sulphate and total dissolved solids (TDS) concentrations above the site background levels (these parameters are not listed in O.Reg 153, Table 8).

MW04-01 is more than the 30 m required by O.Reg. 153 from the proposed watercourse. The water quality improves between MW04-01 (at the centre of the stockpile) and MW04-02 (at the southeast corner). There are no O.Reg. 153 exceedances at MW04-02 which is within 30 m of the proposed watercourse. However, the water quality between MW04-01 and the proposed watercourse along the north side of the stockpile is not known. Engineered measures, noted later in this memo, may be required to address the quantity and quality of groundwater flow north toward the proposed watercourse.

**Contaminant Pathway - Overland Stormwater and Sediment**

The historical aerial photographs show no evidence of the CKD stockpile in 1963. In 1978, stockpiling can be seen in the area of the CKD. In 1989, a stockpile matching the current CKD outline is visible. Therefore, the completed stockpile has been in place and stable for over 30 years. The cap and side slopes are well vegetated, and no erosion was noted during Burnside's field work in the area. Stormwater flow over the surface will not contact the CKD while a sufficient cap remains in place. Sediment is also unlikely if there is no erosion along the side slopes.

The proposed route was selected by Parish to prevent disturbance of the stockpile during construction of the watercourse channel. Further, the channel design was developed to provide the required base flow while protecting against erosion during flood stage. This necessitated moving outside the landfill property boundary along the north side of the stockpile. This route was discussed with St. Marys Cement, the adjacent property owner, who agreed to channel construction occurring on their property.

The final channel design will require an investigation to determine if the CKD extends beyond the toe of the stockpile and the type of soil below the channel.

**Contaminant Pathway - Groundwater Contribution to the Watercourse**

The groundwater within the CKD stockpile exceeds Table 8 criteria at the monitoring well in the centre of the stockpile. Therefore, discharge of groundwater to the watercourse is a potential pathway for contaminants. The cross-sections indicate that the watercourse may be separated from the CKD by native glacial till. However, the final channel design investigation will need to verify the soil type along the watercourse route.

The volume of groundwater that would migrate through the till to the watercourse can be estimated using the equation $Q=KiA$ where:

$Q$ = volume of groundwater transmitted through the glacial till
$K$ = the hydraulic conductivity of the till
$i$ = the horizontal gradient from the CKD stockpile to the watercourse, and
$A$ = the area of discharge along the stream bank

Table 2, attached, shows the input values and the calculations.

The horizontal gradient is an average of gradients measured along the cross-sections from the top of the proposed grading limits to the nearest CKD monitoring well. The gradient of 0.08 is relatively steep due to the groundwater mounding in the stockpile.

The area is calculated for the full channel depth (which averages 5.7 m) along the 300 m of watercourse around the CKD. This is likely overestimating the area as the discharge typically occurs closer to the level of the stream within the channel and not the entire channel depth.

The volume is estimated at $1.4 \times 10^{-8}$ $m^3$/s or 427 L per year. This represents the groundwater contribution from one direction only (CKD side). For comparison, the calculation is also completed for the existing watercourse at $4.6 \times 10^{-9}$ $m^3$/s or 146 L per year. This compares to the measured flows in the existing channel ranging from 0.0014 to 0.167 $m^3$/s. Therefore, groundwater as a contaminant pathway will not be significant if the watercourse is in the glacial till.

During the final channel design, monitoring wells can be installed between the CKD stockpile and the watercourse channel to assess the presence of groundwater and the groundwater quality. Little impact is expected if the boreholes encounter the glacial till. If necessary, the design can incorporate additional measures to protect against groundwater impacts on the realigned watercourse. These are discussed below.

**Potential Mitigation Measures**

1. Channel Design
    - Prior to channel design and construction, an investigation will be completed within the grading limits. This will determine soil adjacent to and below the watercourse and if there is any CKD or other material that must be relocated.
    - Groundwater monitoring wells can be installed between the CKD and the watercourse channel to measure groundwater quality adjacent to the watercourse. This will determine if further mitigation measures are needed. These may be temporarily added to the Site's monitoring program to confirm the watercourse design is operating as expected.
2. Stormwater Runoff and Sediment
    - Any area between the CKD and the new watercourse disturbed during construction must be stabilized and vegetated to prevent sediment from entering the watercourse.
    - No further surface disturbance can take place on the CKD stockpile. This is to prevent exposure of the CKD or creation of erosion channels.
    - If stabilization and vegetation is not sufficient along specific sections of the proposed watercourse, shallow stormwater ditches or drains can be incorporated into the watercourse construction to divert runoff to a stormwater basin. The basin will allow for sediment settlement and if needed, water quality testing prior to release to the watercourse.

3. Groundwater Discharge to Watercourse

- A collection drain can be constructed where warranted between the CKD stockpile and the watercourse to prevent groundwater discharge from entering the watercourse. This is not necessary if the watercourse is constructed in the glacial till as it will act as a natural barrier.

- Improvements to the CKD stockpile cover can be considered to reduce precipitation infiltration. This in turn will reduce the head level within the CKD and therefore the driving force for (CKD contaminated) discharge into the watercourse.

**Net Effects**

The mitigation measures are expected to produce a neutral net effect for the watercourse. The existing watercourse is not being impacted by the landfill or CKD stockpile under current conditions. Moving the watercourse away from the landfill eliminates future impacts. Mitigation measures, where warranted around the CKD stockpile, will control future impacts.

**Recommended Monitoring**

- Inspection of the CKD stockpile should be undertaken to check for stability, erosion and vegetation cover of any areas disturbed by construction of the realigned watercourse.

- Surface water monitoring for the existing watercourse will be replaced by similar monitoring of the new watercourse. As with the existing monitoring, this will include water quality monitoring and flow data where the watercourse enters the site, downstream of the CKD stockpile and as it leaves the site.

**R.J. Burnside & Associates Limited**

PROFESSIONAL GEOSCIENTIST
Dec 21 2020
N. J. RUTHERFORD
PRACTISING MEMBER
0405
ONTARIO

LICENSED PROFESSIONAL ENGINEER
2020 DEC. 21
J. R. HOLLINGSWORTH
PROVINCE OF ONTARIO

Joy Rutherford, P.Geo.
Senior Hydrogeologist

James R. Hollingsworth, P.Eng.
Technical Leader, Solid Waste

JR/CF/JH:tp

Enclosure(s) Figure 1 – Site Plan
Figure 2 – Cross-Section A-A'
Figure 3 – Cross-Section B-B'
Figure 4 – Cross-Section C-C'
Table 1 – Cement Kiln Dust Stockpile – Groundwater Quality
Table 2 – Groundwater Contribution to Streamflow



SW response to MECP comments
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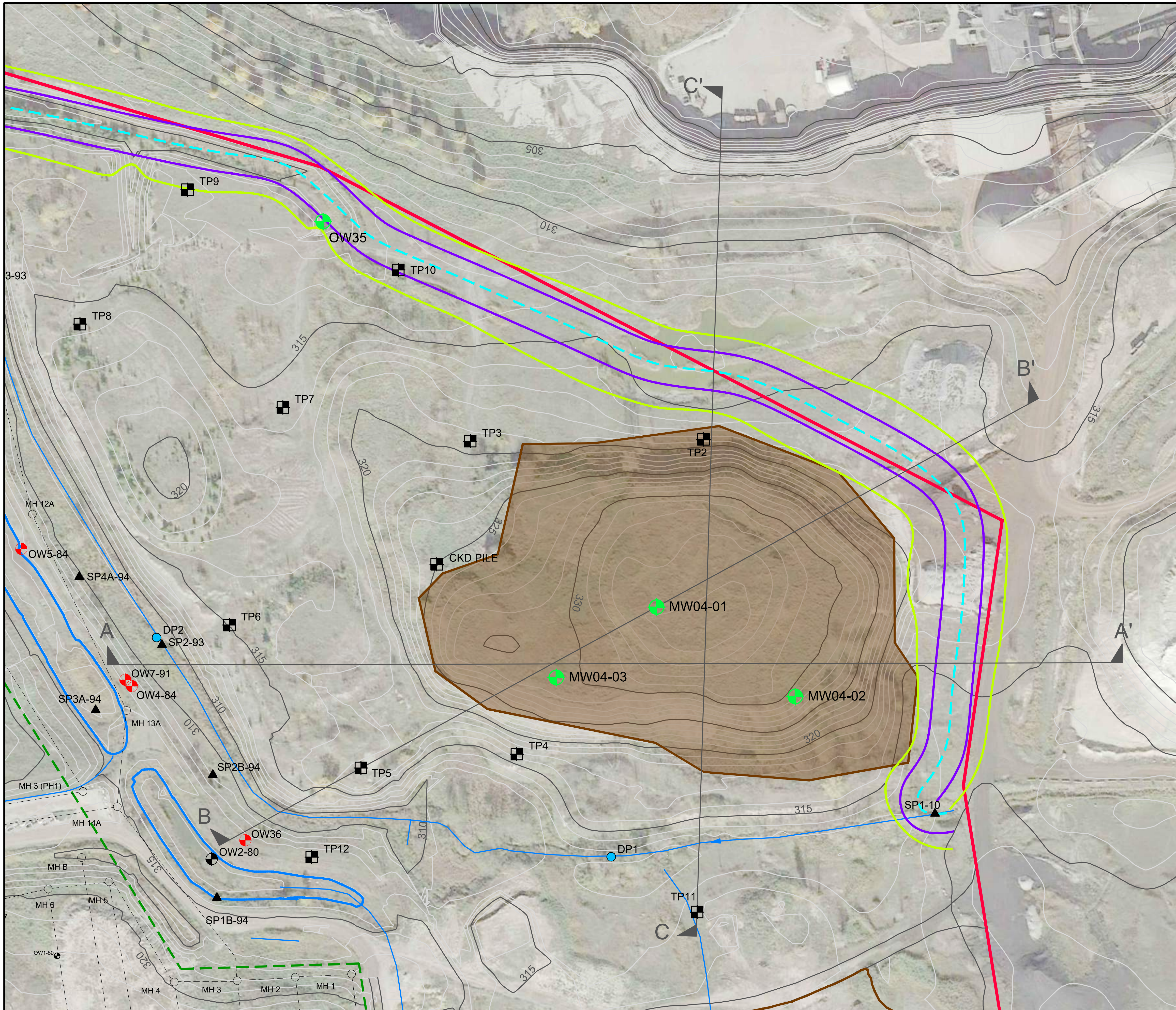


## LEGEND

- PROPERTY BOUNDARY
- LIMIT OF REFUSE DISPOSAL
- WATERCOURSE
- LEACHATE COLLECTION SYSTEM
- STORM WATER MANAGEMENT BASIN
- CAPPED CEMENT KILN DUST STOCKPILE (APPROXIMATE)
- GRADING LIMIT
- FLOOD PLAIN LIMIT
- PROPOSED DRAINAGE CHANNEL
- LANDFILL OBSERVATION WELL
- LANDFILL OBSERVATION WELL (ABANDONED AND SEALED)
- EA MONITORING WELL
- SURFACE WATER MONITORING LOCATION
- TEST PIT
- DRIVE POINT PIEZOMETER
- A A' CROSS-SECTION LOCATION KEY

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Client / Report

TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**SITE PLAN**

| Drawn | Checked | Date | Figure No. |
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| SK | JR | July 2020 | 1 |
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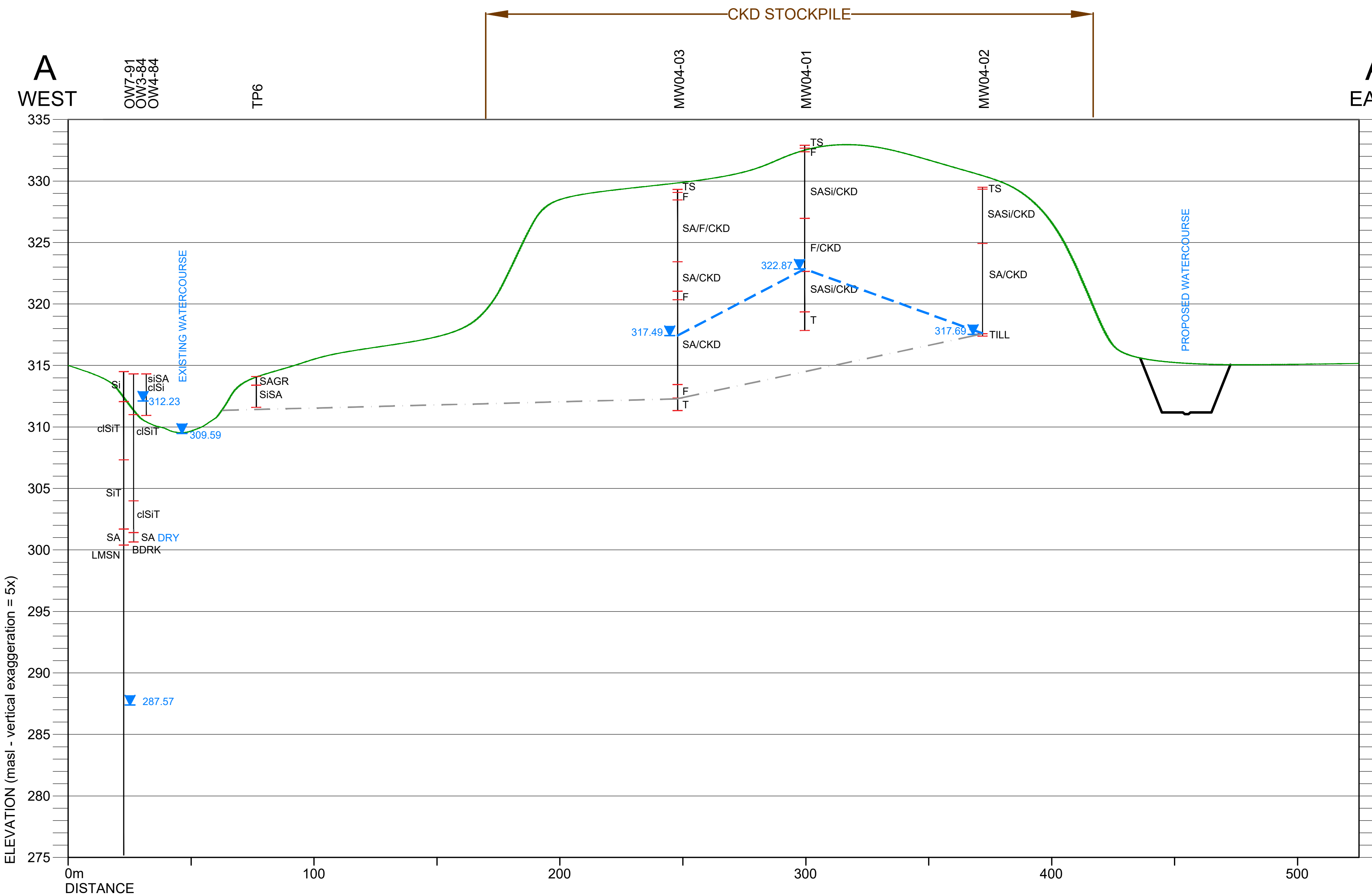



LEGEND

MW04-1 WELL NUMBER / ID

EXISTING GROUND PROFILE

GEOLOGICAL CONTACT

WELL SCREEN

| | |
|---|---|
| si | SILTY |
| sa | SANDY |
| cl | CLAYEY |
| GR | GRAVEL |
| TS | TOPSOIL |
| F | FILL |
| T | TILL |
| SA | SAND |
| Si | SILT |
| CL | CLAY |
| ST | STONES |
| CKD | CEMENT KILN DUST |
| LSMN | LIMESTONE |
| BDRK | BEDROCK |

INTERPRETED STRATIGRAPHY

SAND / SILT / GRAVEL

SILT CLAY TILL

BEDROCK

317.69 WATER LEVELS (APRIL, 2017)

TOP OF TILL

BURNSIDE

Client / Report

TOWN OF ST. MARYS

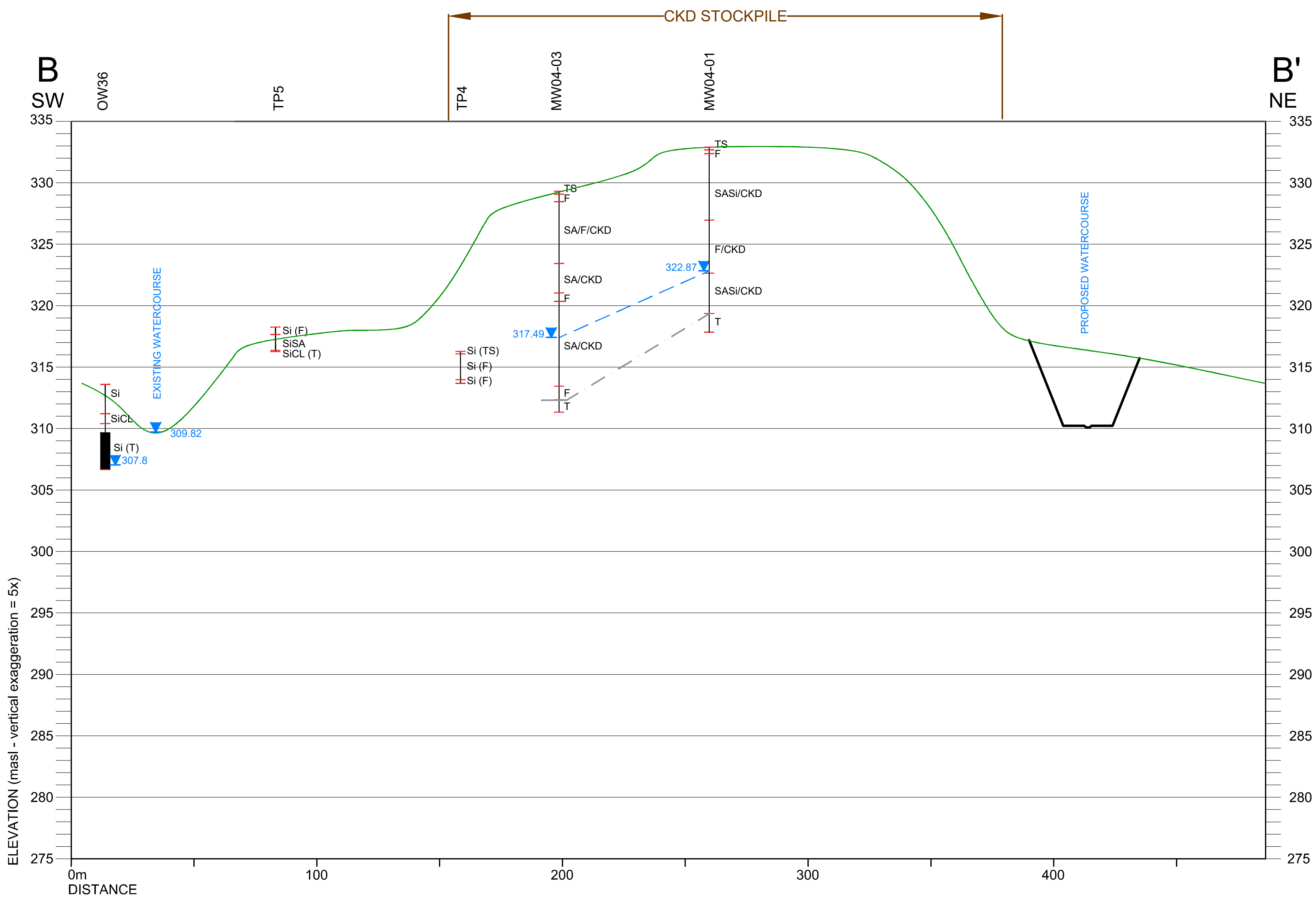
*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**INTERPRETED GEOLOGICAL CROSS-SECTION A-A'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | JR | July 2020 | 2 |
| Scale | | Project No. | |
| 1:2,000 | | 300032339.4500 | |

File Name: Elmo/gis/Projects/300/032339 St Marys/2020 Stream Alignment Study/032339 Stream Alignment Study.dwg Date Plotted: July 22, 2020 - 7:49 AM




## LEGEND

| | |
|---|---|
| MW04-1 | WELL NUMBER / ID |
| | EXISTING GROUND PROFILE |
| | GEOLOGICAL CONTACT |
| | WELL SCREEN |
| si | SILTY |
| sa | SANDY |
| cl | CLAYEY |
| GR | GRAVEL |
| TS | TOPSOIL |
| F | FILL |
| T | TILL |
| SA | SAND |
| Si | SILT |
| CL | CLAY |
| ST | STONES |
| CKD | CEMENT KILN DUST |
| LSMN | LIMESTONE |
| BDRK | BEDROCK |
| | INTERPRETED STRATIGRAPHY |
| | SAND / SILT / GRAVEL |
| | SILT CLAY TILL |
| | BEDROCK |
| 317.69 | WATER LEVELS (APRIL, 2017) |
| | TOP OF TILL |

BURNSIDE

Client / Report

TOWN OF ST. MARYS

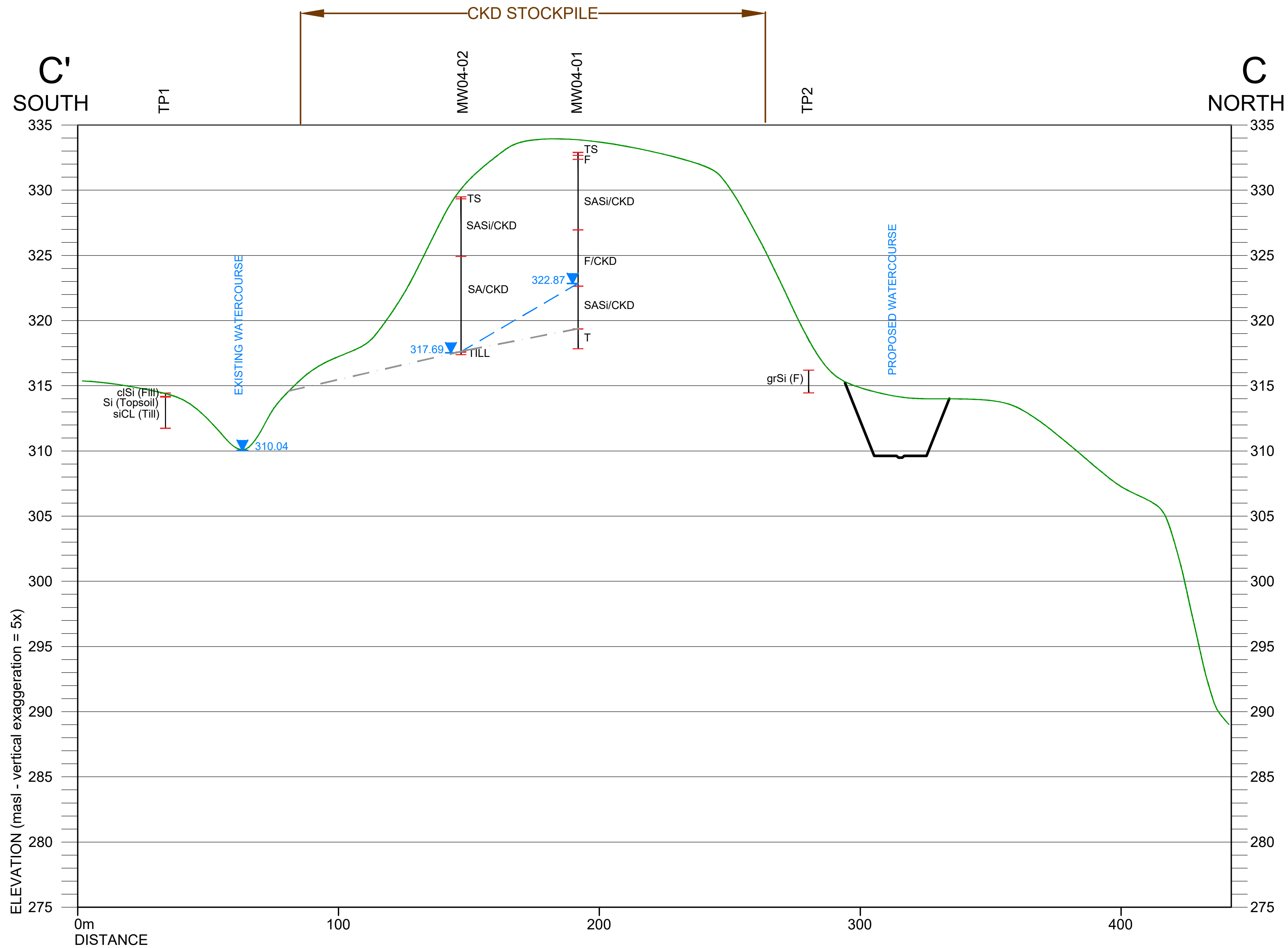
*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**INTERPRETED GEOLOGICAL CROSS-SECTION B-B'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | JR | July 2020 | 3 |
| Scale | | Project No. | |
| 1:2,000 | | 300032339.4500 | |

File Name: Elmo/gis/Projects/300/032339 St Marys/2020 Stream Alignment Study/032339 Stream Alignment Study.dwg Date Plotted: July 30, 2020 - 8:06 AM




## LEGEND

| | |
|---|---|
| MW04-1 | WELL NUMBER / ID |
| | EXISTING GROUND PROFILE |
| | GEOLOGICAL CONTACT |
| | WELL SCREEN |

| | |
|---|---|
| si | SILTY |
| sa | SANDY |
| cl | CLAYEY |
| GR | GRAVEL |
| TS | TOPSOIL |
| F | FILL |
| T | TILL |
| SA | SAND |
| Si | SILT |
| CL | CLAY |
| ST | STONES |
| CKD | CEMENT KILN DUST |
| LSMN | LIMESTONE |
| BDRK | BEDROCK |

INTERPRETED STRATIGRAPHY

SAND / SILT / GRAVEL

SILT CLAY TILL

BEDROCK

317.69 WATER LEVELS (APRIL, 2017)

TOP OF TILL

BURNSIDE

Client / Report

TOWN OF ST. MARYS

*ENVIRONMENTAL ASSESSMENT*
*HYDROGEOLOGICAL STUDY*

Figure Title

**INTERPRETED GEOLOGICAL CROSS-SECTION C-C'**

| Drawn | Checked | Date | Figure No. |
|---|---|---|---|
| SK | JR | July 2020 | 4 |
| Scale | | Project No. | |
| 1:2,000 | | 300032339.4500 | |

| Table 1: Cement Kiln Dust Stockpile - Groundwater Quality | | | | | |
|---|---|---|---|---|---|
| | | Well No | MW04-01 | MW04-02 | MW04-03 |
| | | Location | Centre | SE Corner | SW Corner |
| **Inorganics** | **Table 8** | Units | 2019 | 2019 | 2019 |
| pH | | mg/L | 10.03 | 7.39 | 7.07 |
| Specific Conductivity | NA | uS/cm | 30 500 | 7 410 | 11 100 |
| Alkalinity | | mg/L CaCO3 | 4 510 | 2 400 | 947 |
| C-Hardness | | mg/L CaCO3 | 6.3 | 202.0 | 908 |
| DOC | | mg/L | 78.2 | 25.6 | 14.2 |
| Bromide | | mg/L | 38 | 2 | 13 |
| Chloride | 790 | mg/L | 2 500 | 81 | 950 |
| Fluoride | | mg/L | 23.3 | 0.42 | 1.00 |
| Nitrate | | N mg/L | < 0.6 | 9.21 | < 0.06 |
| Nitrite | | N mg/L | < 0.3 | 0.10 | < 0.3 |
| TKN | | N mg/L | 22.9 | 0.6 | 2.1 |
| Phosphate | | mg/L | 0.86 | < 0.03 | < 0.03 |
| Sulphate | | mg/L | 7 400 | 1 300 | 3 700 |
| Phenols | | mg/L | 0.05 | < 0.01 | 0.01 |
| TDS | | mg/L | 22 100 | 5 850 | 8 350 |
| **Metals** | | | | | |
| Aluminum | | mg/L | 0.06 | 0.02 | < 0.01 |
| Antimony | 0.006 | mg/L | < 0.003 | < 0.003 | < 0.003 |
| Arsenic | 0.025 | mg/L | 0.0731 | < 0.002 | 0.0046 |
| Barium | 1 | mg/L | 0.0099 | 0.017 | 0.0458 |
| Beryllium | 0.004 | mg/L | < 0.002 | < 0.002 | < 0.002 |
| Bismuth | | mg/L | < 0.002 | < 0.002 | < 0.002 |
| Boron | 5 | mg/L | 0.16 | 0.08 | 0.12 |
| Cadmium | 0.0021 | mg/L | 0.00012 | 0.0007 | 0.00010 |
| Calcium | | mg/L | 1.27 | 64.10 | 313 |
| Chromium | 0.05 | mg/L | 0.0294 | < 0.003 | < 0.003 |
| Cobalt | 0.0038 | mg/L | 0.00106 | 0.0014 | < 0.0005 |
| Copper | 0.069 | mg/L | < 0.003 | <0.003 | < 0.003 |
| Iron | | mg/L | 0.310 | 0.03 | 12.0 |
| Lead | 0.01 | mg/L | < 0.001 | < 0.001 | < 0.001 |
| Magnesium | | mg/L | 0.770 | 10.1 | 30.7 |
| Manganese | | mg/L | 0.004 | 0.028 | 0.969 |
| Mercury | 0.00029 | mg/L | 0.00004 | < 0.00001 | 0.00004 |
| Molybdenum | 0.07 | mg/L | 0.266 | 0.004 | 0.123 |
| Nickel | 0.1 | mg/L | 0.030 | 0.009 | < 0.003 |
| Phosphorus | | mg/L | 0.90 | < 0.03 | < 0.03 |
| Potassium | | mg/L | 11 200 | 2 660 | 3 090 |
| Selenium | 0.01 | mg/L | 0.021 | <0.004 | < 0.004 |
| Silicon | | mg/L | 120 | 4 | 3.97 |
| Silver | 0.0012 | mg/L | < 0.0001 | < 0.0001 | < 0.0001 |
| Sodium | 490 | mg/L | 1 090 | 140 | 212 |
| Strontium | | mg/L | 0.0253 | 0.573 | 0.980 |
| Thallium | | mg/L | < 0.00005 | 0.00010 | < 0.00005 |
| Tin | | mg/L | < 0.002 | 0.003 | < 0.002 |
| Titanium | | mg/L | 0.00599 | < 0.0005 | < 0.0005 |
| Uranium | 0.02 | mg/L | 0.00888 | 0.00697 | 0.00097 |
| Vanadium | 0.0062 | mg/L | 0.158 | < 0.002 | < 0.002 |
| Zinc | 0.89 | mg/L | < 0.02 | 0.02 | < 0.02 |
| **PCBs** | | | | | |
| Polychlorinated Biphenyls | 0.2 | µg/L | < 0.05 | < 0.05 | < 0.05 |
| **PAHs** | | | | | |
| Naphthalene | 11 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| 2-Methylnapthalene | 3.2 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| 1-Methylnapthalene | 3.2 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Acenaphthylene | 1 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Acenaphthene | 4.1 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Fluorene | 120 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Phenanthrene | 1 | µg/L | 0.38 | < 0.2 | 0.24 |
| Anthracene | 1 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Fluoranthene | 0.41 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Pyrene | 4.1 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Benzo(a)anthracene | 1 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Chrysene | 0.1 | µg/L | *< 0.2* | *< 0.2* | *< 0.2* |
| Benzo(b)fluoranthene | 0.1 | µg/L | *< 0.2* | *< 0.2* | *< 0.2* |
| Benzo(k)fluoranthene | 0.1 | µg/L | *< 0.2* | *< 0.2* | *< 0.2* |
| Benzo(a)pyrene | 0.01 | µg/L | *< 0.2* | *< 0.2* | *< 0.2* |
| Indeno(1,2,3-cd)pyrene | 0.2 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Dibenzo(a,h)anthracene | 0.2 | µg/L | < 0.2 | < 0.2 | < 0.2 |
| Benzo(ghi)perylene | 0.2 | µg/L | < 0.2 | < 0.2 | < 0.2 |

Table 8 - Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the EPA: Updated May 7, 2020

Generic site condition standards for use wihtin 30 m of a water body in a potable groundwater condition

Parameter Exceeds Reg. 153 Table 8 Criteria

Lab Reporting Limit Exceeded Reg. 153 Table 8 Criteria

## Table 2: Groundwater Contribution to Steamflow

| Input Parameters | |
|---|---|
| *Hydraulic Conductivities (m/s)* | |
| Clayey Silt Till | 9.9E-11 |
| *Horizontal Gradient (m/m)* | |
| Water table/shallow groundwater | 0.08 |
| *Porosity* | |
| Clayey Silt Till | 0.34 |
| *Length of Watercourse Channel (m)* | |
| Proposed | 300 |
| Existing | 140 |
| *Depth of Channel Proposed Watercourse (m)* | |
| Depth of  channel at A-A' | 4.4 |
| Depth of channel at B-B' | 7.0 |
| Depth of channel at C-C' | 5.7 |
| Average channel depth | 5.7 |
| *Depth of Channel for Existing Watercourse (m)* | |
| Depth of  channel at A-A' | 4.5 |
| Depth of channel at B-B' | 4.5 |
| Depth of channel at C-C' | 3.5 |
| Average channel depth | 4.2 |

Horizontal Flow through Till to Proposed Watercourse

| | | |
|---|---|---|
| Q = | KiA | |
| Q = | 1.4E-08 | m3/s |
| Q = | 0.000014 | L/s |
| Q = | 427 | L/year |

Horizontal Flow through Till to Existing Watercourse

| | | |
|---|---|---|
| Q = | KiA | |
| Q = | 4.6E-09 | m3/s |
| Q = | 0.000005 | L/s |
| Q = | 146 | L/year |

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