DILLON CONSULTING

WASTE CONNECTIONS OF CANADA

Ridge Landfill Expansion: Hydrogeological Impact Assessment

Appendix D7

DRAFT

Waste Connections of Canada

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Acronyms, Abbreviations, Definitions

***Act** (the), refers to the Environmental Assessment Act. Also known as EAA, or the EA Act.*

***Alternative Daily Cover,** cover material other than earthen material placed on the surface of the active face of a landfill at the end of each operating day to control odours, blowing litter, scavenging, etc.*[1]

***Aquifer**, a consolidated or unconsolidated geologic unit (material, stratum, or formation) or set of connected units that yields water of sufficient quantity and suitable quality to springs or groundwater wells, to serve as a source of water supply.*

***Aquitard**, a geologic material, stratum, or formation of low permeability (a confining unit) that transmits significant amounts of water on a regional scale or over geologic time.*

***Basal Sands**, refers to the material directly above the bedrock where hydraulic connectivity is very good horizontally but very poor vertically and each of the water-bearing planes can be considered as a separate planar two-dimensional aquifer unit.*

***Baseflow**, (1) Groundwater flow to a surface water body (lake, swamp, or stream); (2) that portion of stream discharge that is derived from groundwater flow or the draining of large lakes swamps or other sources outside the net rainfall that creates surface runoff/overland flow.*

***Bedrock,** refers to consolidated (solid) rock at various depths beneath the earth's surface.*

***Bentonite**, is a commercially produced sealing material used in well construction or decommissioning that consists of more than 50% sodium montmorillonite by weight.*

***BOD (biological oxygen demand)**, the amount of oxygen needed to neutralize (oxidize) organic matter in water.*

***Borehole**, a hole drilled into the earth into which well casings or piezometers may be installed.*

***Casing**, a pipe that is installed in a well or borehole. More specifically, a casing is a tubular, water-tight structure installed in the excavated or drilled hole to maintain the well opening and, along with bentonite, to confine the groundwater to origin and to prevent the entrance of surface contaminants.*

***COD (chemical oxygen demand)**, a measure of chemically oxidizable material in water. COD is an approximation of the amount of organic and reducing material present.*

***Contaminant**, refers to physical, chemical, biological, and radiological substances in water; may also refer to heat, sound, vibration or any combination of the foregoing. The term implies that these substances are harmful or may cause an adverse effect, and have been introduced by human activities.*

***Durov Diagram**, a graphical procedure using anion-cation hydrochemical facies, similar to a Piper Diagram, with a projection to a 4th dimension, such as TDS or isotopic content.*

[1] California Department of Resources, 2016.

***EA**, Environmental Assessment, means an environmental assessment process described in Part II of the EAA and/or report submitted pursuant to subsection 5(1) of the EAA*[2]*.*

***ECA**, Environmental Compliance Approval is a license or permit issued by the Ministry of the Environment, Conservation and Parks for the operation of a waste management facility or site.*

***Effluent**, refers to a liquid waste discharged from the site to the forcemain for treatment at the Blenheim Wastewater Treatment Lagoons.*

***Environment**, defined in the EA Act includes: natural environment (air, land, water, plant and animal life including humans), built environment (building, structure, machine), social, economic, cultural conditions and the interrelationships between them.*

***Facies**, refers to how the groundwater chemistry changes over space; typically reflects the major ionic constituents.*

***Fluvial,** referring to processes occurring in a river.*

***Geological,** refers to the earth's physical structure and make-up and the processes that act on it.*

***Geomorphic**, refers to the configuration of the landscape and other natural features of the earth's surface that are shaped by changes in temperature and precipitation.*

***Glaciolacustrine**, refers to glacial sedimentary material deposited into glacial lakes in a downslope or an outward fan pattern.*

***HIA**, Hydrogeological Impact Assessment.*

***Hydraulic Conductivity (K)**, is the volume of fluid that flows through a unit area of porous medium for a unit hydraulic gradient normal to that area.*

***Hydraulic Gradient (i or ∇h)**, the change in hydraulic head with direction.*

***Hydraulic Head**, the elevation in a well in reference to a specific datum; the mechanical energy per unit weight of water [L].*

***Hydrogeology**, is the study of subsurface water, including its physical and chemical properties, geologic environment, and its role in geologic processes, natural movement, recovery, contamination, and utilization.*

***Hydrograph**, a chart depicting water level as a function of time.*

***Hydrostratigraphic Unit**, refers to a formation, part of a formation, or group of formations of significant lateral extent that compose a unit of reasonably distinct (similar) hydrogeologic parameters and responses.*

***IC&I,** Industrial, Commercial and Institutional.*

[2] MECP, *Environmental Assessment Act*, 1990.

***Isopach**, is a line or contour on a map or diagram illustrating thickness variations of a particular geologic stratum or group of strata that has the same thickness.*

***Lacustrine**, relating to processes occurring in a lake.*

***Leachate,** refers to the liquid produced when water contacts the waste material.*

***Leachate Collection System (LCS),** refers to the on-site system of pipes and drainage aggregate beneath or around a landfill mound that is designed to capture and move leachate to the forcemain and ultimately to the Blenheim Wastewater Treatment Lagoons.*

***Loam**, a soil that is a mixture of sand, silt and clay-sized particles.*

***MECP,** Ministry of the Environment, Conservation and Parks; formerly Ministry of the Environment and Climate Change (MOECC), Ministry of the Environment (MOE), and Ministry of the Environment and Energy (MOEE).*

***Mitigation**, measures applied which can lesson potential negative environmental effects.*

***MODFLOW**, is a finite-difference numerical model for groundwater flow which was developed by the U.S. Geological Survey.*

***MWL**, refers to Meteoric Water Line.*

***ODWS**, Ontario Drinking Water Standards.*

***On-site Study Area**, this refers to the study area within the Ridge Landfill site boundary (also referred to as "on-site").*

***Overburden**, refers to unconsolidated soil material overlying bedrock.*

***Piezometric surface (potentiometric surface)**, a surface of equal hydraulic heads or potentials, typically depicted by a map of equipotentials such as a map of water-table elevations.*

***Porewater**, water held in the pores of soil or rock.*

***Potable water**, also referred to as drinking water.*

***PWQO**, Provincial Water Quality Objectives.*

***Quaternary Geology**, refers to the branch of geologic study of the process and deposits that developed during the quaternary, a time-scale period characterized by glacial-interglacial cycles that occurred 2.58 million years ago to the present.*

***Rip Rap**, refers to loose stone used to armour shorelines, streambeds, bridge abutments, pilings, or other structures against scour and water or ice erosion.*

***Surficial Geology**, refers to the study of landforms and the sediments that lie beneath them, deposited during the last glaciation period.*

***ToR,** Ridge Landfill Expansion Environmental Assessment Approved Amended Terms of Reference (May 2018).*

***Ternary Diagram**, is a diagram with a triangular coordinate system used to plot three dependent variables that add up to a fixed value, as in the composition of rocks or minerals.*

***Till**, refers to unsorted material deposited directly by glacial ice movement.*

***Total Dissolved Solids (TDS)**, is the sum of all organic and inorganic dissolved matter in water.*

***Total Organic Carbon (TOC)**, is the measure of the level of organic molecules or contaminants in purified water. TOC is an analytic technique that helps organizations understand whether the water they are using is pure enough for their processes. All water, no matter how pure, contains some carbon materials. Many of these materials are introduced into the water from the water source, or from materials and systems during purification and production. They can also come directly from workers involved in the processes. They may include natural or altered products of living systems or man-made and synthetic compounds.*

***Transmissivity**, is a function of aquifer thickness and hydraulic conductivity.*

***Undertaking**, as defined in the EA Act is an enterprise, activity or a proposal, plan, or program that a proponent initiates or proposes to initiate.*

***VMSOW**, Vienna Mean Standard Ocean Water.*

***Waste Connections of Canada Inc.,** or "Waste Connections", is the proponent for this Undertaking. Waste Connections was formerly Progressive Waste Solutions Canada Inc. Progressive Waste Solutions and Waste Connections merged in an all-stock transaction as of June 1, 2016.*

	Units
ha	hectare
km	kilometre
L	litre
m	metre
m^3	cubic metres
masl	metres above sea level

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Executive Summary

A Hydrogeological Impact Assessment has been completed to evaluate the potential effects of landfill expansion at the Ridge Landfill to the local groundwater regime. The objectives of the Hydrogeological Impact Assessment were to:

- Determine the contaminating lifespan for leachate concentrations to reduce to acceptable levels within the landfill;
- Identify potential impacts to groundwater quality and quantity;
- Identify potential impacts to water supply wells; and
- Recommend impact management measures and contingency measures.

The Ridge Landfill Site is located on a thick deposit of low permeability clay till. Hydrogeological testing of the low permeability clay indicates very slow downward groundwater flow velocities of approximately 1 cm per year. It would require more than 3,000 years for leachate, if it escaped through the Landfill's leachate collection system, to reach the underlying aquifer by which time the quality of the leachate would meet all current drinking water criteria.

The hydrogeology of the landfill site has been divided into three main hydrostratigraphic units:

- Layer 1 is the surficial aquifer and consists of a variety of soil types including topsoil, sand, silt and gravel. However, the predominant unit is weathered and fractured till. Groundwater flow in this hydrostratigraphic unit is horizontal and migrates towards surface water drainage features. This layer is approximately 4 to 5 metres thick.
- Layer 2 consists of unweathered till, which does not have any significant discontinuities such as fractures. There is a dominant vertical downward groundwater flow direction but there is a very low groundwater flux due to the very low hydraulic conductivity of the till. In addition to very low groundwater velocities, Layer 2 is consistently homogeneous without any significant changes in lithology both laterally and vertically. This layer is over 30 metres thick.
- Layer 3 is the regional aquifer and is made up of a basal overburden sand and gravel unit and/or weathered and fractured bedrock. There is a regionally dominant south-southeast horizontal flow direction in Layer 3. The deposits of sand and gravel, as well as the weathered bedrock surface provide the principal pathway for regional groundwater movement. Layer 3 is relatively heterogeneous and varies in composition, thickness and hydraulic conductivity. The approximate thickness of this layer is 3 m. Water level

measurements taken in Layer 3 wells indicate that horizontal groundwater movement is slow, and occurs under very low hydraulic gradients.

New boreholes and monitoring wells were installed the south of the existing site in 2016, around the perimeter of the proposed horizontal expansion areas. These boreholes / monitoring wells confirmed similar hydrogeological conditions as those at the existing fill areas. Previous investigations, completed in the 1990's at the existing fill areas, identified relatively few significant discontinuities in Layer 2; the drilling completed in 2016 did not identify any significant discontinuities. The Layer 2 thickness in the expansion area was found to be 2 to 3 metres greater than under the existing landfilled areas.

The baseline groundwater quality is well understood and a network of monitoring wells was established in the 1980's. The monitoring program has been expanded throughout the years and includes groundwater, surface water, and landfill leachate and landfill gas. There are 48 monitoring wells included in the existing groundwater monitoring network for the Ridge Landfill. The six additional monitoring well nests (with three monitoring wells installed in each of the three principal hydrostratigraphic units at each nest) that were installed along the perimeter of the expansion area (monitoring well locations 71 through 76) are proposed to be added to the existing monitoring program following ECA approval of the proposed expansion.

The hydrogeological assessment has confirmed that the hydrogeology of the site is predictable such that a groundwater monitoring program can reliably monitor groundwater quality at the site and permit effective implementation of contingency measures if required.

The primary environmental assessment criteria, indicators, rationale and data sources for the hydrogeological impact assessment as outlined in the approved ToR, (explained in Section 2.2 of the report) are the following:

Potential impacts to groundwater quality

Concentrations based on predictive contaminant transport modelling (i.e., POLLUTE™) (assessment of net effects) have been compared to the allowable concentrations (Drinking Water Criteria) derived from the Reasonable Use Guidelines. As documented in Section 6.1 of this report, the predicted concentrations of all contaminants are below the allowable increases calculated from the Reasonable Use Guideline. The models predict that the movement of organic contaminants would only reach a few metres below the landfill base due to the biodegradation process and the extremely low groundwater flow rates. Predicted maximum concentrations of cadmium and lead are less than allowable drinking water criteria and not predicted to occur in Layer 3 for more than 5,000 years from present.

Chloride concentrations are also predicted to be below drinking water criteria and maximum concentrations will not occur for more than 3000 years in Layer 3 from present. Overall, the contaminant transport modelling indicates that the site complies with the Reasonable Use Guideline and that the drinking water aquifer (Layer 3) will be protected.

Contaminating Lifespan

The contaminant transport model predicts that chloride concentrations will be below the allowable concentration in 380 years. Therefore the contaminating lifespan for the landfill is in the order of 380 years. The analysis indicated that the underdrain leachate collection system is not needed to achieve compliance with the drinking water aquifer (Layer 3); however, leachate collection from a perimeter leachate collection system is required from the vertical expansion of the Old Landfill and for the new fill areas, in the future, after the underdrain leachate collection system ceases to function, for the duration of the contaminating lifespan.

Potential impacts to groundwater quantity.

The thick deposit of low permeability till (Layer 2) at the site limits the amount of natural recharge to the drinking water aquifer (Layer 3) to about 1 cm per year. Overall, there is no reduction in infiltration rate to the drinking water aquifer (Layer 3) from landfill development in comparison to the amount of recharge that is presently occurring prior to the landfill expansion.

Potential impacts to water supply wells

The contaminant transport modelling indicates maximum concentrations at Layer 3 will be less than drinking water criteria as per the Reasonable Use Guideline. It is estimated to take more than 3,400 years (3,000 years to travel vertically downwards through Layer 2 to Layer 3, and 400 years to travel horizontally in Layer 3) for water to travel from the base of the landfill to a potential off-site well located within 200 m of the landfill. Therefore, it is concluded that there will be no potential impacts on water supply wells resulting from landfill expansion.

1.0 Introduction

Waste Connections of Canada Inc. (Waste Connections) has undertaken an Environmental Assessment pursuant to the *Environmental Assessment Act* (EA Act) to expand its Ridge Landfill site in the Municipality of Chatham-Kent in accordance with the Amended Terms of Reference, approved by Ontario's Minister of the Environment, Conservation and Parks (MECP) on May 1, 2018; to continue to provide long-term disposal capacity to serve the growing population and economy of the province of Ontario.

The Ridge Landfill has been in operation since 1966 and was expanded in 1999. The landfill is located at 20262 Erieau Road near Blenheim, Ontario in the Municipality of Chatham-Kent, and is operated by Waste Connections (**FIGURE D7-1**). The site is currently approved to receive waste from the industrial, commercial and institutional (IC&I) sectors in Ontario, and residential waste from the Municipality of Chatham-Kent and the surrounding Counties of Essex, Lambton, Middlesex and Elgin.

FIGURE D7-1: LOCATION OF RIDGE LANDFILL

The Landfill Site Area of 262 ha, is permitted by the Environmental Compliance Approval (ECA)[3] from the MECP for waste management and environmental work purposes. The area within

[3] MECP, Waste Environmental Compliance Approval No. A021601

which waste disposal is permitted, called the Approved Waste Fill Area, is 131 ha or half of the Landfill Site Area. The current approved capacity for the Ridge Landfill is 21 million cubic metres (m^3). As per the current ECA for the Ridge Landfill, the annual fill rate at the Ridge Landfill is 1.3 million tonnes.

As of April 2019, it is estimated that the existing Waste Disposal Area at the Ridge Landfill site will provide waste disposal capacity until approximately 2021 at the current fill rate[4]. The expansion would increase the lifespan of the Ridge Landfill from 2021 to 2041. The landfill expansion will not result in an increase in annual waste volumes disposed at the site.

1.1 Work Plans

Work plans were prepared for each impact assessment study. The hydrogeologic work plan was approved by the MECP as part of the Terms of Reference and was finalized in September 2018. The MECP groundwater experts were consulted in the development of the hydrogeological study work plan. The work plans were circulated to interested stakeholders, key government reviewers, Indigenous Communities and Organizations who desired to review them; and they were posted on the Future Plans page of the Ridge Landfill website for public review and comment. The input received during that review has been carefully considered and incorporated into this study, where applicable.

1.2 Role of Hydrogeology Discipline in Site Assessment

In this assessment of the proposed Ridge Landfill expansion, the hydrogeologic discipline considered the potential net effects of the proposed landfill expansion on the hydrogeologic characteristics within the limits of the Ridge Landfill property and the surrounding area. The criteria used in the assessment are designed to identify and evaluate the impacts of the landfill expansion as required by the *EA Act*[5] and related code of practice[6].

The primary objective of this assessment is to address the requirements of **Section 6.1**(2)(c) and (d) of the *EA Act*, as it pertains to the hydrogeologic environment; specifically:

(c) a description of:

(i) the environment that will be affected or that might reasonably be expected to be affected, directly or indirectly,

[4] Golder Associates, Ridge Landfill Annual Monitoring Report, April 2019.
[5] MECP, *Environmental Assessment Act* (EAA), R.S.O. 1990.
[6] MECP, *Code of Practice: Preparing & Reviewing Environmental Assessments in Ontar*io, January 2014.

(ii) the effects that will be caused or that might reasonably be expected to be caused to the environment, and

(iii) the actions necessary or that may reasonably be expected to be necessary to prevent, change, mitigate or remedy the effects upon or the effects that might reasonably be expected upon the environment.

by the Undertaking, the alternative methods of carrying out the Undertaking and the alternatives to the Undertaking;

(d) an evaluation of the advantages and disadvantages to the environment of the Undertaking.

The objectives of the Hydrogeological Impact Assessment are as follows:

- Determine the contaminating lifespan for leachate concentrations to reduce to acceptable levels within the landfill;
- Identify potential impacts to groundwater quality and quantity; and
- Identify potential impacts to water supply wells.

1.3 Scope of the Hydrogeological Impact Assessment

The scope of the HIA includes a review of background conditions and data collection in the field, followed by an examination of potential impacts for the preferred landfill alternative, groundwater modelling, and the cumulative effects of these impacts that may be affected by the proposed expansion. Groundwater modelling can provide insight into hydrogeological setting and help us understand the physical, chemical and biochemical processes occurring in the groundwater environment beneath the site.

1.4 Overview of Report Contents

This report describes the baseline hydrogeologic environment in the area within the limits of the Ridge Landfill property and surrounding the Ridge Landfill site, and potential changes to the future environment due to the proposed expansion. The report consists of the following:

- **Section 1.0** presents an introduction to the study, a description of the site, and the role and scope of the hydrogeologic assessment;
- **Section 2.0** describes the study methods to this assessment including: study areas, criteria and indicators, data collection and method analysis;

- **Section 3.0** provides a description of the existing hydrogeologic conditions and how they would change in the future without the proposed landfill expansion;
- **Section 4.0** provides interpretation of geologic and hydrogeologic data;
- **Section 5.0** presents the hydrogeological conceptual model of the Ridge Landfill site;
- **Section 6.0** presents potential impacts of the proposed landfill expansion on the hydrogeologic environment;
- **Section 7.0** provides the impact management measures recommended to further minimize effects;
- **Section 8.0** summarizes major conclusions and recommendations; and
- Appendices provide information that supports the hydrogeological assessment.

2.0 Methods of Assessment

2.1 Study Areas

The term "study area" refers to those areas for which data was collected and the impact analysis was carried out. Two (2) study areas were examined for the Hydrogeological Impact Assessment. These are:

- **on-site** - consists of the area within the Ridge Landfill site boundary (**FIGURE D7-2**).
- **off-site -** consists of the area that is five (5) km outside of the Ridge Landfill site boundary.

For the purpose of the HIA, the investigative study area extended to the limits of the Ridge Landfill property (on-site) see **FIGURE D7-2**. The rationale for this study area is that there has been a significant level of previous hydrogeological investigation completed at the site.

Major hydrostratigraphic units have been defined and groundwater flow patterns established. As described previously, groundwater movement is very slow at the site, such that the selected study area extents adequately cover the primary area of interest for the impact assessment.

The secondary assessment area (off-site) using secondary sources such as water well records and published hydrogeology/geology reports extends approximately 5 km from the site; justified by the slow movement of groundwater which limits the area of potential hydrogeological effects from waste disposal activities on site. Secondary source information was used to summarize regional geology and hydrogeology and groundwater users in the area.

2.2 Assessment Criteria

The Hydrogeological Impact Assessment criteria are:

- Contaminating Lifespan.
- Potential impacts to groundwater quality.
- Potential impacts to groundwater quantity.
- Potential impacts to water supply wells.

The criteria, indicators, their rationale and data sources for the hydrogeological impact assessment are provided in **Table D7-1**.

2.3 Data Collection

Data collection for the Hydrogeological Impact Assessment included the use of existing published information, comments received through agency consultation, and field data gathering, including the following:

- Review of current and historic groundwater data from the site's annual monitoring reports;
- Leachate generation rates estimated using HELP modelling software;
- Residential groundwater well data collected from locations off-site; and
- Review of secondary source information such as provincial and municipal reports, GIS mapping, aerial photographs, government publications, and existing literature.

2.4 Methods of Analysis

The hydrogeological assessment is documented following the requirements of Section 8 of *O.Reg. 232/98*. As prescribed, it includes borehole logs, geologic cross-sections and piezometric maps; an assessment of the suitability of the site for landfill waste disposal purposes, and proposed monitoring and contingency plans.

The methodology to assess potential effects to nearby receptors used the results of the predictive contaminant transport and fate modelling that was completed as part of the reasonable use assessment. Private groundwater well users in the vicinity of the site will be identified via a survey. See **Section 4.8** – Groundwater Use for results.

FIGURE D7-2: HYDROGEOLOGY STUDY AREAS

The contaminating life span for each alternative method was estimated adapting the method used by "Barrier Systems for Waste Disposal Facilities, 2nd Edition", by R. Kerry Rowe, Robert M. Quigley, Richard W.I. Brachman & John R. Booker. Leachate characteristics used in the contaminating life span estimates were taken from Table 1, Section 10 of *O.Reg. 232/98*.

Potential impacts to nearby receptors such as private drinking water wells were assessed using contaminant transport computer modelling to predict expected concentrations in groundwater in the bedrock aquifer immediately below the landfill. Predicted concentrations were compared to both the *Ontario Drinking Water Standards*[7] and the allowable concentrations determined by the *Reasonable Use Guidelines*[8].

2.5 Study Period

The time horizon for the Hydrogeological Impact Assessment includes the operating life of the facility, assumed to be from 2021 to 2041. This time horizon for the Hydrogeological Impact Assessment (HIA) relates to the anticipated future conditions for hydrogeological characteristics within the limits of the Ridge Landfill property and of the surrounding area.

2.6 Previous Hydrogeological Investigations of the Ridge Landfill Site

Previous hydrogeological investigations and assessments of the Ridge Landfill have included the following:

- Dillon, 1981, Ridge Landfill Site Hydrogeological Study, 81-15 (in association with Gartner Lee Limited).
- Gartner Lee Limited, 1991, BFI Ridge Landfill, Hydrogeological Investigation of New Properties (Data Report), GLL 91-463/421.
- Gartner Lee Limited, 1991. Ridge Landfill Site, Geotechnical Investigation of New BFI
- Properties. GLL 91-421.
- Gartner Lee Limited, 1992. Study of Downward Chemical Migration Beneath the Ridge
- Landfill. GLL 91-462.
- Dillon, 1997, BFI Ridge Landfill Expansion EA, Impact Assessment, Appendix B, Geology / Hydrogeology, 94-2492.

[7] Government of Ontario. *O. Reg. 169/03: Ontario Drinking Water Quality Standards*. 2002.
[8]MECP. *Incorporation of the Reasonable Use Concept into MOEE Groundwater Management Activities, Guideline B-7*, Revised April 1994.

2.6.1 Dillon Consulting Limited, 1981, Hydrogeological Study

The objective of the 1981 report was to "assess the type of design and operations necessary at the Ridge Landfill site to ensure the production and movement of leachate and gas from the site". The “site” is now referred to as the “Old Landfill”.

This report made the following general conclusions:

a) The site property is located on a clayey silt till plain, approximately 145 feet (44 m) deep, which overlays a black shale bedrock unit. The upper zone of the till unit is fractured and the lower dense till unit is an effective aquitard.

b) The site be operated utilizing natural attenuation with a comprehensive monitoring program implemented; a contingency leachate collection system installed if monitoring indicates the need; a toe drain be installed to prevent breakout of leachate on the ground surface.

2.6.2 Gartner Lee Limited, 1991 Hydrogeologic Investigations

This report documents the geological and hydrogeological conditions found to the south and west of the 1991 landfilling area (now referred to as the Old Landfill). This was completed to assist in assessing the suitability of these lands for expansion of the landfill area.

These investigations consisted of drilling and installation of monitoring wells, soil sample collection, hydraulic conductivity testing, water level measurements and groundwater sampling. The drilling program for the property southwest of the Howard Drain was completed during August to October, 1990 with follow-up testing in 1991. This investigation consisted of drilling and monitoring well installations at locations 28, 29, 33, 34 and 35. Three wells, consisting of a shallow (water table) weathered till well, an intermediate depth unweathered till well and a bedrock well, were installed at locations 28, 34 and 35. At locations 29 and 33, only shallow wells and intermediate depth wells were installed. A continuous soil core was collected at each of the bedrock wells. Split spoon soil samples only were taken at 1.5m intervals at locations 29 and 33.

The drilling program for the property southeast of the existing site was completed in April-May 1991. This investigation consisted of drilling and monitoring well installations at locations 45, 46, 47 and 48. Groundwater monitoring wells were installed at three depths (shallow, intermediate, bedrock) for locations 45 and 46. Wells were installed at shallow and intermediate depths for locations 47 and 48. Continuous soil samples to bedrock were collected at the bedrock boreholes. Splitspoon (a 0.6m long, 50 mm diameter split-tube sampling device) sampling was completed at 1.5m intervals at locations 47 and 48.

This report concluded that the geologic and hydrogeologic conditions at the southwest and southeast properties are very similar to those found at the existing site.

2.6.3 Gartner Lee Limited, 1991 Geotechnical Investigations

The geotechnical properties of the clayey silt till which underlies the Ridge Landfill site and adjacent properties are documented in this report. It was concluded that the site is underlain by a massive, relatively uniform deposit of clayey silt till that provides good foundation conditions and has uniform geotechnical properties. There were no complex subsurface conditions or unusual engineering concerns identified and it was concluded that no geotechnical constraints that would affect landfill development on the new properties.

2.6.4 Gartner Lee Limited, 1992, Study of Downward Chemical Migration beneath the Ridge Landfill

This 1992 report documents a study of contaminant migration in the unweathered till beneath the then existing landfill (now referred to as the Old Landfill) in 1991. Soil cores beneath the refuse were taken at three locations. Porewater was extracted from discrete segments of the core and submitted for chemical analysis. Analysis for chloride, petroleum hydrocarbons (specifically benzene, toluene, ethylbenzene and xylenes) and phenol was completed. Computer modelling was completed using the program POLLUTE to simulate contaminant transport to determine the transport mechanisms (advection, dispersion and/or diffusion) responsible for contaminant movement.

Chloride from the landfill was measured to a depth of l.5 m; phenols to 0.05 m; and petroleum hydrocarbons to a depth ranging from 0.07 to 1.39 m below the landfill base. Given that the landfill existed for 12 to 15 years before these tests, modelling indicated that diffusion is the predominant contaminant transport mechanism. Other transport mechanisms such as advection and dispersion were determined to be much less dominant indicative of the low permeability of the unweathered till. It was concluded that the observed versus simulated chemical profiles support a hydraulic conductivity of the unweathered till of 1×10^{-10} m/s, consistent with previous studies.

2.6.5 Dillon Consulting Limited, 1997, Hydrogeological Impact Assessment, Ridge Landfill Expansion EA

This 1997 report documents a complete impact assessment of the expansion of the landfill (current West Landfill and South Landfill). The investigations completed as part of this assessment included installation of 19 monitoring wells at nine drilling locations, water level monitoring, cone penetration testing to depths up to 12.5 m at 22 locations, the excavation of a large test pit to visually assess to degree of weathering and fracturing in the surficial till, and hydraulic and chemical testing of the monitoring wells. Monitoring wells were installed at locations 49 through 55. Porewater samples were taken of the clayey silt aquitard and submitted for isotopic analysis.

Three principal hydrostratigraphic units were identified at the site (see **Section 3.1.3**): Layer 1, weathered and fractured surficial till which has a principal horizontal groundwater flow direction; Layer 2, a greater than 30 m layer of unweathered clayey silt aquitard with a vertical groundwater flow direction estimated to be at 1cm/year; and Layer 3, the regional drinking water aquifer consisting of a basal overburden sand and gravel and/or weathered bedrock. Isotopic analysis indicated that the porewater deeper within the Layer 2 aquitard was many thousands of years old.

Contaminant transport modelling was completed using POLLUTE to simulate the movement of contaminants downward through the Layer 2 aquitard to the Layer 3 drinking water aquifer. The modelling included simulating leachate strength with time due to the effects of leachate collection systems. The contaminant transport modelling indicated a peak chloride concentration of 84 mg/L in Layer 3 occurring more than 3000 years from present. The assessment concluded that the understanding of the hydrogeology of the Ridge Landfill site was sufficient to reliably monitor groundwater at the site and permit the effective implementation of contingency measures.

2.7 Supplemental Hydrogeological Investigation 2016

It is proposed to expand the landfill laterally from the existing west and south mounds, southwards towards Allison Line. As detailed above, the subsurface conditions at the existing landfill site have been investigated and monitored extensively over the past 38 plus years and are well understood. Therefore the focus of the supplemental subsurface investigation was in the proposed new landfilling area which is contiguous with the existing landfill area. Six new monitoring well "nests", consisting of a monitoring well installed in each hydrostratigraphic unit (Layer 1, Layer 2 and Layer 3) were installed in the fall of 2016. These new monitoring well nests are located around the perimeter of the proposed expansion area and will ultimately be incorporated into the monitoring program for the expanded landfill.

The locations of the six new monitoring well nests are:

- Two monitoring well nests located along County Line 10 between Allison Line and the former railway track;
- Three monitoring well nests located along Allison Line between County Road 10 and Erieau Road:
- One monitoring well nest located along Erieau Road north of Allison Line.

The new monitoring wells were installed using hollow-stem augers and a continuous soil core sample barrel system, which produces a 1.5 m-long, 65 mm nominal diameter soil core. The continuous-sample barrel is locked inside the lead hollow stem auger, and does not require the use of any drilling fluids (water, drill muds, etc.) to produce soil cores. The soil cores were logged in the field for the deepest monitoring well (bedrock monitoring well) and stored in the core boxes / sleeves. Select soil samples were submitted for laboratory analysis (described below). The deepest borehole at each monitoring well nest extended into the weathered shale bedrock with the augers to a depth of 3 m or refusal.

At each monitoring well nest location, a monitoring well consisting of a 50 mm diameter, 1.5 m long PVC well screen connected to riser pipe was installed in the deep borehole (a Layer 3 monitoring well). Silica sand was placed in the annulus of the well screen and extending approximately 0.6 m above the top of the screen. A bentonite seal plug was placed above the silica sand, and bentonite grout was placed above the bentonite seal around the PVC riser pipe via a tremie pipe, which was extended to ground surface. Each well is equipped with a protective steel casing, concreted in place at ground surface. The Layer 2 monitoring well was installed in its own borehole at a nominal depth of 15 mbgs (no soil sampling was completed in this borehole). Layer 2 monitoring wells were constructed in a similar fashion as Layer 3 monitoring wells. The shallow Layer 1 monitoring well was installed at a nominal depth of 5 mbgs, and was also installed in its own borehole similar to the Layer 2 wells. The Layer 1 wells have 3.0 m long well screens. As previously stated, soil cores were only obtained from the deep boreholes (i.e., Layer 3 monitoring well borehole). See **Appendix D7-A** – Borehole Logs, which includes the details of monitoring well installations.

2.7.1 Soil and Hydraulic Conductivity Testing

Soil samples were submitted for grain size analysis, water content and to determine the fraction of organic carbon. Grain size testing was completed on five (5) soil samples from each monitoring well nest location and submitted to a geotechnical laboratory to determine grain size distribution. The fraction of organic carbon (f_{OC}) was determined in one soil sample taken at an approximate depth of 10 mbgs at each monitoring well nest location. The results of these tests are included in **Appendix D7-B** – Soil Testing Results. The hydraulic conductivity of the clay till was subsequently assessed using two different methods: in-situ hydraulic conductivity tests and triaxial permeability tests completed on soil cores. Shelby tubes were taken at two depth intervals at each monitoring well nest location and submitted to a geotechnical laboratory for testing in **Appendix D7-C** – Permeability and Well Testing Results.

2.7.2 Water Level Monitoring

Water levels were manually monitored in the new monitoring wells periodically after installation. In addition, water level dataloggers were installed in each new well and in two existing monitoring well nests. The top of wells were surveyed to a geodetic benchmark and all water levels converted to geodetic elevations. Water level hydrographs are located in **Appendix D7-D -** Water Level Data and Hydrographs.

2.7.3 Groundwater Quality

The newly installed monitoring wells were developed and purged. Water samples were taken once from the new monitoring wells and submitted for laboratory analyses to determine baseline groundwater quality at the new monitoring well nest locations. The isotopes of oxygen and hydrogen that were used in the 1996 hydrogeological assessment indicated that the porewater deep in the clay till is many thousands of years old. A similar assessment was completed at two (2) monitoring well nests where porewater from soil cores and groundwater samples from the monitoring wells were analyzed for deuterium and oxygen-18. Water quality and isotope testing results are found in **Appendix D7-E** – Groundwater Quality and Isotope Chemistry.

Table D7-1: Impact Assessment Criteria and Indicators

Criteria	Indicator	Rationale	Data Sources
Contaminating Lifespan	Predicted reduction in leachate concentration over time (in years) based on tonnes of waste per hectare of footprint area and leachate generation rate during operation and closure.	This criterion serves as a measure of potential long term impact of the landfill.	• Three leachate generation rates were evaluated: based on a natural cover, low permeability clay cover and a low permeability geosynthetic cover. • Leachate characteristics used in the contaminating life span estimates were based on Table 1, Section 10 of *O.Reg. 232/98*. • Estimated adapting the method used by Rowe et al. (2004).
Potential impacts to groundwater quality	Concentrations based on predictive contaminant transport modelling (i.e., POLLUTE™) (assessment of net effects) compared to the allowable concentrations derived from the Reasonable Use Guidelines.	Leachate from landfills has the potential to impact groundwater quality. This criterion estimates the potential groundwater quality impact associated with the Ridge landfill.	• Site data collected through intrusive investigations (1981 to present). • Leachate characteristics taken from Table 1, Section 10 of *O.Reg. 232/98*. • Leachate generation rates (HELP™ modelling). • Existing and proposed facility characteristics (Preliminary Design and Operations Report). • Annual Monitoring Reports.
Potential impacts to groundwater quantity	Reduction in infiltration rate to bedrock aquifer based on footprint area of new fill areas versus the amount of recharge that is presently occurring prior to landfill expansion.	This criterion serves as a check to make sure that we are not displacing beneficial infiltration.	• Site data collected through intrusive investigations (1981 to present). • Landfill design input (Preliminary Design and Operations Report). • Annual Monitoring Reports.
Potential impacts to water supply wells	Predictive impact assessment using contaminant transport computer modelling to predict expected concentrations in the bedrock aquifer as well as travel times and flow direction.	Residents in the vicinity of the landfill may be concerned about potential impact to their wells.	• Socio-Economic Interview data. • Historic well monitoring records. • Site data collected through intrusive investigations. • Leachate characteristics taken from Table 1, Section 10 of *O.Reg. 232/98*. • Leachate generation rates (HELP™ modelling). • Existing and proposed facility characteristics (Preliminary Design and Operations Report). • Annual Monitoring Reports.

3.0 Existing Conditions

3.1 Regional Context

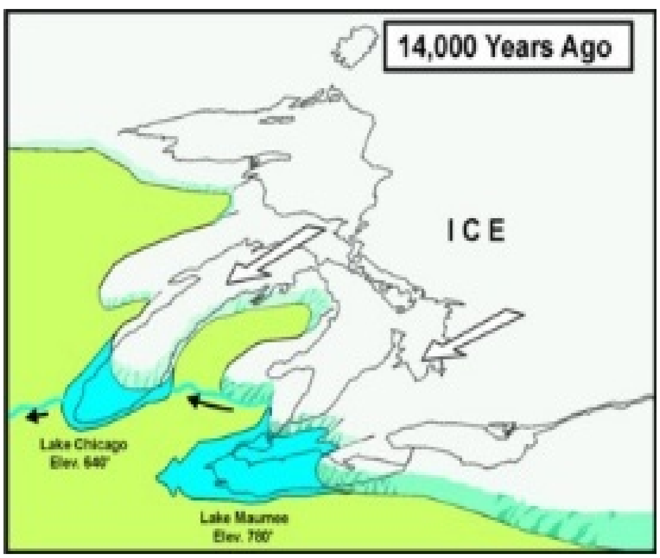
This summary of baseline hydrogeological conditions is based on the existing knowledge of hydrogeological conditions of Chatham-Kent and at the Ridge Landfill site. It is important to note that municipal water supply pipelines extend along both Charing Cross Road and Erieau Road.

3.1.1 Quaternary Geology

As discussed herein, the site overlies a relatively thick layer of Quaternary aged overburden deposits. Underlying the Quaternary deposits are bedrock units, the oldest of which is a deep granitic Precambrian rock, with overlying younger bedrock of the Kettle Point Formation. The Kettle Point Formation consists mainly of black organic-rich shale with some siltstone. In the Chatham area, the Kettle Point Shale is approximately 30 m thick.

The Quaternary deposits overlying the bedrock reflect the glacial and post-glacial history in the area. At the end of the Wisconsin glaciation period, the retreat of the Laurentide ice sheet's frontal lobe (Huron-Erie Lobe), initially formed Glacial Lake Maumee (**Figure D7-3**), covering much of southwestern and central Ontario [9]. Later, as the ice continued to advance and retreat in notable geomorphic events, Glacial Lake Whittlesey, and later Lake Warren were formed[10]; all predecessors of Lake Erie. With each of these stages, deposition of significant aquatic and sediment material occurred, as well as rebounding of the earth's crust after the weight of the ice sheet was withdrawn. The deposited soil materials or overburden, are referred to as glaciolacustrine deposits and tills.

FIGURE D7-3: GLACIAL LAKES



[9] Morris, Tom, *Synthesis of Information on Quaternary Geology in the Vicinity of St. Clair River, Sept* 2008 and Barnett, P.J.
[10] Karrow, P.F. and Calkin,P.E. *Quaternary Evolution of the Great Lakes*, 1985.

As illustrated in **FIGURE D7-4**, in the area of the Ridge Landfill it is called the Tavistock Till. The Tavistock Till is part of the Lake Huron / Georgian Bay Lobe. The Port Stanley Till, an Erie Lobe deposit also occurs at surface both north and south of the site. Previously, the till at the Ridge Landfill was identified as Port Stanley Till but current Quaternary mapping has the surficial till in the area of the site mapped as the Tavistock Till. Regionally, the Tavistock Till overlies the Port Stanley Till but site investigations could not differentiate between these two tills due to the similarities between the tills. The Tavistock Till is characterized as "… a highly calcareous, silty till to clayey silt till of low to medium plasticity in the area south of Lake Huron and Lake St. Clair"[11]. The Port Stanley Till is characterized as "…strongly calcareous, a clayey silt to silty clay till with low plasticity"[12].

Small pockets of oil and natural gas are known to exist in the vicinity of the study area**.** Error! Reference source not found.[13] denotes these pools as abandoned, active, or suspended operation. Sweet, light oil production comes from bedrock formations within Ordovician age carbonates at an average depth of 850 m below ground and natural gas from Silurian carbonates at depths up to 550 m[14].

[11] Barnett, P.J., Quaternary Geology of Ontario, Volume 4, Part 2, 1992.
[12] Ibid.
[13] Ontario Ministry of Natural Resources, Oil & Gas Pools & Pipelines of Southern Ontario, 1:150,000 November 2006.
[14] Dundee Energy Limited, http://dundee-energy.com/Ontario/Onshore-Light-Oil/index.php

FIGURE D7-4: QUATERNARY GEOLOGY

FIGURE D7-5: OIL & GAS RESOURCE

FIGURE D7-6: SURFICIAL GEOLOGY

3.1.2 Surficial Geology & Topography

In the area around the Ridge Landfill, where there is little topographic relief, surface drainage is poor and has been enhanced through man-made municipal drains.

FIGURE D7-6 shows the surficial materials as being Class 5d, a glaciolacustrine-derived, textured clayey silt till (referred to as Diamicton)[15]. Site investigations indicated that the till material has a weathered and fractured upper surface, characterized by vertical to sub-vertical fractions extending to a depth up to 6 m. The unweathered till found at the Ridge Landfill is a grey, dense to very dense clayey silt till with traces of sand and fine gravel[16].

At ground level, the on-site and off-site study areas are composed of Brookston soil, a deep, fine to very fine textured glacial till with subsurface soil materials that are naturally very compacted. This soil is composed of silty clay loam, clay loam, silty clay and clay materials that have poor drainage[17].

3.1.3 Hydrogeology

The hydrogeology of the landfill site has been divided into three main hydrostratigraphic units which are shown on **FIGURE D7-7**:

- Layer 1 is the surficial aquifer and consists of a variety of soil types including topsoil, sand, silt and gravel. However, the predominant unit is weathered and fractured till. Groundwater flow in this hydrostratigraphic unit is horizontal and migrates towards surface water drainage features.
- Layer 2 consists of unweathered till, which does not have significant discontinuities such as fractures. There is a dominant vertical downward groundwater flow direction but there is a very low groundwater flux due to the very low hydraulic conductivity of the till, which is in the order of 10^{-10} m/s.
- Layer 3 is the regional aquifer and is made up of a basal overburden sand and gravel unit and/or weathered and fractured bedrock. There is a regionally dominant south-southeast horizontal flow direction in Layer 3. The deposits of sand and gravel, as well as the weathered bedrock surface provide the principal pathway for regional groundwater movement. Layer 3 is relatively heterogeneous and varies in composition, thickness and hydraulic conductivity. The approximate thickness of this

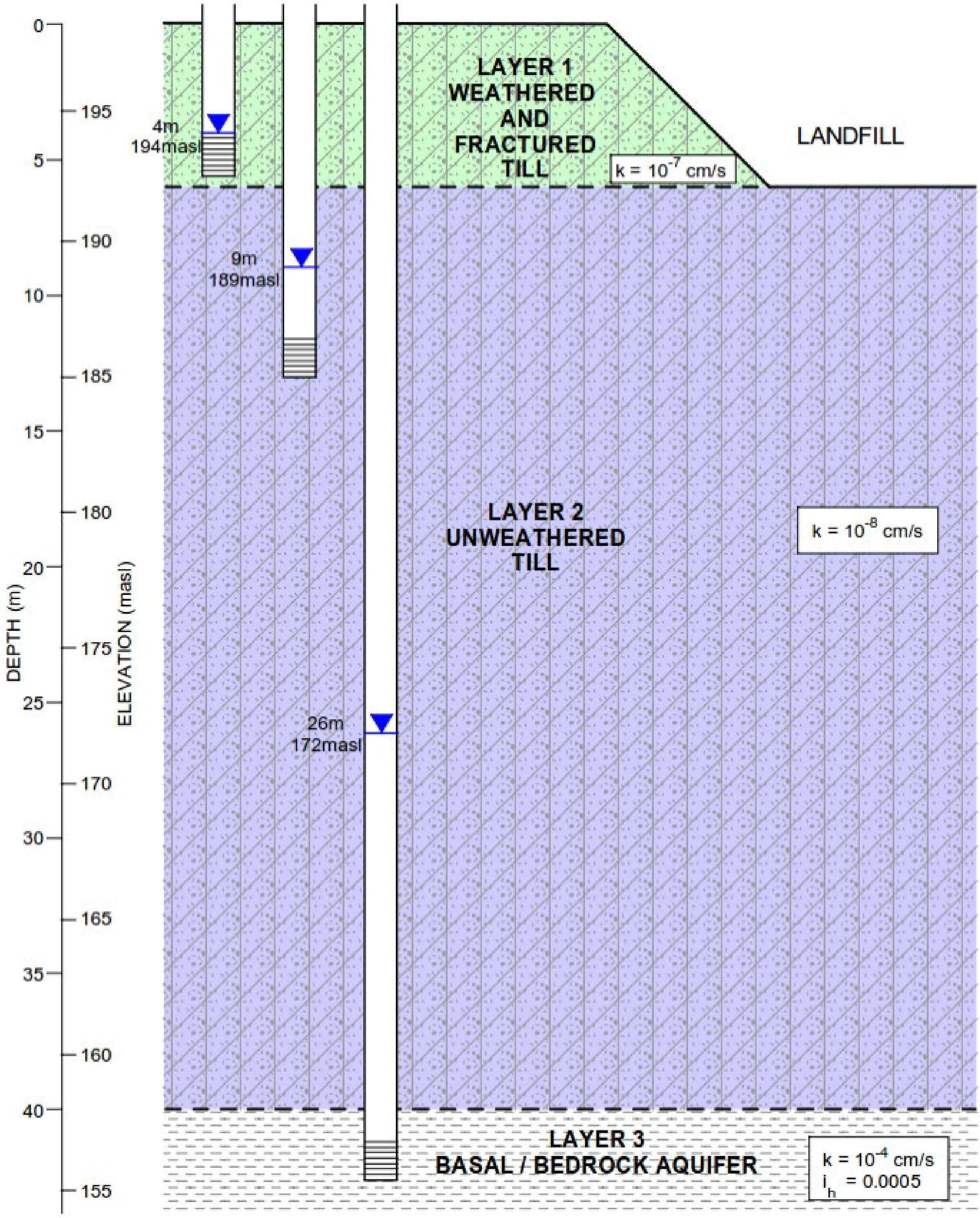
[15] The Ontario Geological Survey, *Surficial Geology of Southern Ontario*, 2003.
[16] Dillon Consulting Limited, 2017 Monitoring Report.
[17] Agriculture and Agri-Food Canada, *Soil Survey of Kent County*, 2012.

layer is 3 m. Water level measurements taken in Layer 3 wells indicate that horizontal groundwater movement is slow, and occurs under very low hydraulic gradients, in the order of 0.0005 m/m. The hydraulic conductivity of Layer 3 is in the order of 10^{-6} m/s.

A network of monitoring wells was established in the 1980's and the baseline groundwater quality is well understood. The monitoring program has been expanded throughout the years and includes groundwater, surface water, landfill leachate and landfill gas.

The monitoring data and assessment are included in the Annual Reports documenting site development, operations and monitoring. No groundwater quality issues resulting from the existing landfill have ever been identified in the monitoring program.

FIGURE D7-7: CONCEPTUAL HYDROGEOLOGY



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3.2 Current Groundwater Monitoring Program

This section provides a summary of the current groundwater monitoring program. The objective of the program is to:

- Identify potential changes in background chemistry in each of the principal hydrostratigraphic units;
- Identify any impact on groundwater quality that is potentially attributable to the landfill operations;
- Identify any changes in the pattern of groundwater movement beneath the site; and
- Trigger the implementation of contingency measures as required.

There are 48 monitoring wells that constitute the current groundwater monitoring program on-site, see **FIGURE D7-8**. **Table D7-2** summarizes the monitoring program for the Old Landfill area, and **Table D7-3** summarizes the monitoring program for the South and West Landfill areas.

Table D7-2: Groundwater Monitoring Program - Old Landfill

Hydrostratigraphic Layer	Sampling Locations	Frequency	Parameters
Layer 1 Shallow Weathered Till	A) 11-I, 16-I, 18-I, 19-I, 20-I, 21-I, 22-I, 25-I, 30-III, 32-III, 44-III B) 1-II, 3-III, 12-I, 5-II, 13-I, 15-I, 31-I	A) Twice per year (May and September) B) Once per year (May)	pH, Conductivity, COD, BOD, Chloride, Phenol, Sulphate, Total Kjeldahl Nitrogen, Calcium, Magnesium, Sodium, Potassium, Iron, Alkalinity, Total Ammonia as N, Anion Scan (Nitrate, Nitrite, Bromide, Iodide, Fluoride), Total Phosphorus, plus (once per year only – May) Volatile Organic Scan
Layer 2 Unweathered Till	3-II, 14-I, 30-II, 32-II, 44-II	Once per year (May)	
Layer 3 Basal/Bedrock Aquifer	BW-1, BW-4, 32-I, 30-I	Twice per year (May and September)	

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Table D7-3: Summary of Groundwater Monitoring Program – Current West and South Landfill Areas

Hydrostratigraphic Layer	Sampling Locations	Frequency	Parameters
Layer 1 Shallow Weathered Till	Existing Wells 28-III, 46-III, 47-I, 48-I, 49-A, 50-A, 58-A, 59-A, 60-A, 61-A New Wells 62-A, 63-A, 64-A	Twice per year (May and September) Once per year (May)	pH, Conductivity, COD, BOD, Chloride, Phenol, Sulphate, Total Kjeldahl Nitrogen, Calcium, Magnesium, Sodium, Potassium, Iron, Alkalinity, Total Ammonia as N, Anion Scan (Nitrate, Nitrite, Bromide, Iodide, Fluoride), Total Phosphorus, plus (once per year only – May) Volatile Organic Scan
Layer 2 Unweathered Till	Existing Wells 28-II, 46-II, 47-II, 49-B, 50-B New Wells 61-B, 64-B	Once per year (May)	
Layer 3 Basal/Bedrock Aquifer	Existing Wells 28-I, 46-I, 49-C, 50-C New Wells 61-C, 64-C	Twice per year (May and September)	

Monitoring well numbers that are followed by an A, B, or C indicate that the well screen is located within hydrostratigraphic Layer 1, Layer 2 or Layer 3 respectively as previously described. There is no specific correlation with the roman numerals I, II and III that follow the well numbers and the different hydrostratigraphic layers. These wells were installed in the 1980s and some were numbered with “I” being the deepest monitoring well and “II” being the next deepest monitoring well at that location.

3.2.1 Water Level Monitoring

Water levels are recorded twice per year, in May and September, prior to purging the groundwater monitoring wells. The data is used to establish long-term trends in groundwater levels and to provide base data for assessment of fluctuation in water quality data. Shallow water levels are influenced by many factors, including: the area of landfilling, the perimeter leachate collection system and cut-off wall, and local drainage features (i.e., municipal drains).

3.2.2 Groundwater Quality

The 48 monitoring wells in the sampling program were chosen for their strategic location in relation to the landfill areas and hydrostratigraphic units (i.e., Layer 1, Layer 2 or Layer 3).

Overall, groundwater quality is evaluated by comparison with the following:

- Ontario Drinking Water Standards (ODWS);
- Background groundwater quality;
- Leachate quality; and
- MECP *Guideline B-7: The Incorporation of the Reasonable Use Concept into Groundwater Management*.

Any concentrations noted to be above the ODWS criteria are highlighted. The background chemistry of groundwater in southwestern Ontario has naturally occurring sulphate concentrations greater than the ODWS in Layer 1 and is expected to be highly variable due to the heterogeneous nature of this hydrostratigraphic unit (i.e. shallow weathered and fractured till are calcium-magnesium-sulphate-bicarbonate type groundwater), while Layer 2 (in unweathered till) and Layer 3 (in basal overburden and/or bedrock), have high sodium and chloride concentrations. The groundwater in Layer 3 wells have high sodium and chloride concentrations, consistent with waters with a long residence time, having undergone chemical alteration by water/rock interactions as it travelled.

FIGURE D7-8: GROUNDWATER MONITORING WELLS

3.2.3 Leachate Quality

Quality monitoring of the leachate collection system is conducted by analysis of samples from the leachate storage tank on-site. The parameter list is summarized in **Table D7-4** below. The COD to BOD ratio generally ranges between 2:1 and 12:1 which is typical of landfill leachate.

Table D7-4: Leachate Collection System Monitoring Program

Parameters Monitored	Monitoring Frequency
pH (field and lab), Conductivity, COD, BOD, DOC, TSS, Chloride, Phenol, Sulphate, Total Kjeldahl Nitrogen, Calcium, Magnesium, Sodium, Potassium, Iron, Alkalinity, Total Ammonia as N, Anion Scan (Nitrate, Bromide, Iodide, Fluoride), Total Phosphorus, Volatile Organic Scan	Once per year
pH (field and lab), Conductivity, COD, BOD, DOC, TSS, Chloride, Sulphate, Calcium, Magnesium, Sodium, Potassium, Iron, Alkalinity, Total Ammonia as N, Nitrate, Dissolved Phosphorus	Two additional times per year

3.2.4 Private Groundwater Well Monitoring

There were 17 private groundwater monitoring wells off-site that historically have been sampled on an annual basis. As of April 2019, there are 15 private groundwater wells being monitored as two (2) well owners withdrew from the program. Samples are collected at a point in the plumbing system prior to any in-line treatment systems or water softeners, if practical. Parameters analyzed include the following:

Ammonia as nitrogen	Manganese
Biochemical Oxygen Demand (BOD)	Iron
Calcium	Nitrate
Chloride	Nitrite
Conductivity	pH
Dissolved organic carbon (DOC)	Phenols
Hardness (as $CaCO^3$)	Total Kjeldahl nitrogen (TKN)
Magnesium	Turbidity

FIGURE D7-19 illustrates the location of the private monitoring wells in relation to the Ridge Landfill. PMW-14 is located on-site and will eventually need to be decommissioned prior to berm construction. Six private monitoring wells are located off-site and within the surface water study area, namely: PMW-1, PMW-3, PMW-6, PMW-8, PMW-9 and PMW-13. There are an additional eight private monitoring wells located off-site and within the groundwater study area but outside the surface water study area, namely: PMW-2, PMW-4, PWM-5, PWM-7, PWM-10, PMW-11, PMW-12, and PMW-15. The two private wells that are no longer being sampled are: PMW-16 and PMW-17.

FIGURE D7-9: PRIVATE MONITORING WELLS

3.3 Summary of Historical Monitoring Programs

An account of the historical monitoring data is described in this section, including waste quantities received, leachate quantities removed, groundwater monitoring and surface water monitoring.

3.3.1 Waste Quantities - Historical

Table D7-5 summarizes the average weekly tonnage for waste and alternative daily cover (ADC) received at the Ridge Landfill, as well as the yearly combined total. Prior to 2006, ADC volumes were not required to be reported as part of the total received for disposal. There have been no exceedances of daily or yearly maximum limits during the lifespan of the Ridge Landfill.

Table D7-5: Tonnages Received at Ridge Landfill[18]

Year	Average Weekly Waste (tonnes)	Average Weekly ADC (tonnes)	Average Weekly Road Base (tonnes)	Average Weekly Wood (tonnes)	Combined Average Weekly Maximum	Combined Total Yearly (tonnes)
1983	1,035	N/A	N/A	N/A	1,035	54,866
1984	1,186	N/A	N/A	N/A	1,186	62,995
1985*	N/A	N/A	N/A	N/A	N/A	N/A
1986*	N/A	N/A	N/A	N/A	N/A	N/A
1987	2,724	N/A	N/A	N/A	2,724	144,367
1988*	2,893	N/A	N/A	N/A	2,893	153,336
1989*	N/A	N/A	N/A	N/A	N/A	N/A
1990*	3,686	N/A	N/A	N/A	3,686	195,358
1991*	3,268	N/A	N/A	N/A	3,268	173,191
1992	3,458	N/A	N/A	N/A	3,458	183,295
1993	4,084	N/A	N/A	N/A	4,084	216,473
1994	4,047	N/A	N/A	N/A	4,047	214,492
1995	3,805	N/A	N/A	N/A	3,805	201,652
1996*	N/A	N/A	N/A	N/A	N/A	N/A
1997	3,961	N/A	N/A	N/A	3,961	209,921
1998	4,065	N/A	N/A	N/A	4,065	215,466
1999	4,939	N/A	N/A	N/A	4,939	261,795

[18] Dillon Consulting Limited, *Annual Site Development, Operations and Monitoring Reports*, 2001 to 2017

Year	Average Weekly Waste (tonnes)	Average Weekly ADC (tonnes)	Average Weekly Road Base (tonnes)	Average Weekly Wood (tonnes)	Combined Average Weekly Maximum	Combined Total Yearly (tonnes)
2000	6,239	N/A	N/A	N/A	N/A	330,669
2001	5,734	N/A	N/A	N/A	5,734	303,919
2002	7,102	N/A	N/A	N/A	7,102	376,403
2003	11,597	N/A	N/A	N/A	11,597	614,640
2004	12,746	N/A	N/A	N/A	12,746	675,541
2005	12,714	N/A	N/A	N/A	12,714	673,855
2006	12,743	2,393	N/A	N/A	15,136	790,269
2007	12,750	3,645	N/A	N/A	16,395	868,954
2008	12,755	3,202	N/A	N/A	15,957	845,751
2009	12,740	2,709	N/A	N/A	15,449	818,778
2010	13,266	3,564	N/A	N/A	16,830	892,006
2011	13,707	3,098	N/A	N/A	16,805	890,677
2012	16,096	3,807	N/A	N/A	19,903	1,054,844
2013	16,517	2,567	N/A	N/A	19,084	1,011,445
2014	21,320	3,167	N/A	N/A	24,487	1,297,801
2015	23,233	1,283	N/A	N/A	24,516	1,299,336
2016	22,486	1,923	N/A	N/A	24,409	1,293,686
2017	21,355	2,751	1,246	373	25,725	1,277,596

* Data unavailable N/A = Not Applicable/Available

In March 2006, an amendment to the Certificate of Approval permitted acceptance of an additional 219,000 tonnes per year for use as alternative daily cover, including the use of dewatered sewage biosolids as alternative daily cover beginning in the fall of 2006. In July 2010, the Provisional Certificate of Approval was amended to combine the waste and ADC quantities for a total limit of 899,000 tonnes per year.

In June 2011, the Provisional Certificate of Approval was reissued to combine all existing waste approvals. The site was approved to accept 899,000 tonnes per year. In 2011, an Environmental Screening process was undertaken to increase the daily maximum fill rate from 4,391 tonnes per day to 6,661 tonnes per day, and the annual maximum fill rate from 899,000 per year to 1,300,000 tonnes per year; approval was received in March 2012.

Table D7-6 provides Percentage Composition of Alternative Daily Cover (ADC) received at the Ridge Landfill between the years 2009 and 2017. Shredded tires were no longer received beginning in 2016. Additional reporting began in 2017 with respect to foundry sand, wood and gravel diverted for construction activities such as roads.

Table D7-6: Alternative Daily Cover (ADC) Percentage Composition[19]

ADC Type	2009	2010	2011	2012	2013	2014	2015	2016	2017
Shredder Fluff	53.0	47.0	42.0	21.8	40.3	82.3	77.8	91.1	80.3
Contaminated/Waste Soil	40.0	49.0	55.0	75.6	55.9	15.5	14.7	4.0	15.4
Biosolids	4.0	2.8	2.7	2.3	3.0	2.1	7.5	4.9	3.2
Foundry Sand									1.0
Wood									.02
Gravel (Road Base)									0.08
Shredded Tires	3.0	1.2	0.4	0.3	0.8	<0.03	0.01	0.00	0.00

3.3.2 Groundwater - Historical

In 1983, ten monitoring wells were installed for the purpose of leachate characterization. An additional three trench monitoring wells were installed to monitor leachate migration through the fractured till. This work was completed in order to help satisfy the Certificate of Approval requirement to characterize leachate. Three shallow monitoring wells were installed in the summer of 2012, namely 62-A, 63-A and 64-A, and were sampled once per year beginning in May 2013.

Beginning in 1994, under Ontario Regulation *903 (Wells Regulation)*, as amended, made under the *Ontario Water Resources Act* set out a new provincial standard for installations of new groundwater wells as well as abandoned or unused wells to be decommissioned by a licensed well contractor. **Table D7-7** lists the groundwater wells decommissioned on-site.

[19] Dillon Consulting Limited, *Annual Site Development, Operations and Monitoring Reports*, 2001 to 2017

Table D7-7: Well Decommissioning On-Site

Well Number	Year Decommissioned
Un-numbered historic residential well	2012
14-I, 21-I	2002
BW-2	2000
7,8,9,23,29,33,34,35,51,53,54,55,56,57	1999

Groundwater elevations at the Ridge Landfill have remained relatively constant with time in Layer 1. The natural water table is found from near surface to a depth of approximately 1.5 m depending on location and season. Groundwater elevations in Layer 3 are approximately 25 m below natural grade with a vertical hydraulic gradient of about 0.6 and horizontal flow direction as predominantly south-southeast away from the Ridge Landfill site.

In 1996, stable isotope chemistry was used to determine an "age" of the groundwater. The results of the analysis for oxygen-18 and deuterium in porewater from soil cores and groundwater from monitoring wells indicated depletion of the isotopes with increasing depth. This trend indicates that the groundwater at the Ridge Landfill was originally recharged during progressively colder/older paleo climates (ice ages); consistent with previous isotope studies conducted. In Layer 3 the groundwater was recharged about 10,000 years ago.[20]

3.3.3 Leachate – Historical

In 1995, the leachate collection system was installed and consisted of 2,900 metres of mainline collector piping, 610 metres of finger drains, 19 manholes, two (2) automated pumping stations and an aboveground storage tank with a capacity of 725,000 litres. From 1997-2000 the system was extended along the eastern, northern, and western sides of the Old Landfill mound 3 area.

Beginning in May 2002, leachate was pumped via forcemain to the Blenheim Wastewater Treatment Lagoons; prior to May 2002 leachate was trucked to the Chatham Wastewater Treatment Plant for treatment.

[20] Dillon Consulting Limited, report, 1997

3.3.4 Surface Water - Historical

Surface water from storm water management ponds and municipal drains has also been monitored at the landfill site. The details of the past historical surface water monitoring program are documented in **Appendix D10** – Surface Water Impact Assessment.

4.0 Interpretation of Geological / Hydrogeological Data

4.1 Approach Used for Interpretation

The overall approach used for the interpretation of the data collected in the expansion area was similar to that completed as part of the hydrogeological investigations that were completed for the 1996 Environmental Assessment and remains appropriate for this EA. This is summarized below:

- Characterization / confirmation of subsurface soils though the identification of specific geologic / stratigraphic units under the site;
- Characterization / confirmation of groundwater movement though the subsurface by identifying / confirming the specific hydrostratigraphic units at the site;
- Review and interpretation of the groundwater and soils data collected to allow development of a conceptual model of groundwater movement beneath the site;
- Establishment of background groundwater quality for impact assessment;
- Development of a contaminant transport model for impact analysis;
- Development of a long term groundwater monitoring program for the site; and
- The identification, along with other technical disciplines, of the contingency measures that can be implemented in the event that the monitoring program identifies issues requiring mitigation.

4.2 Geologic Units Characterization

Soil samples collected during the drilling of boreholes were examined in the field by the drilling supervisor. Select soil samples were submitted for laboratory testing. Detailed borehole logs were completed documenting the soil conditions encountered at each borehole. These borehole logs are found in **Appendix D7-A** – Borehole Logs.

The distribution of the geological formations are shown graphically on cross-sections (**FIGURE D7-10**, **FIGURE D7-11**, and **FIGURE D7-12**). In addition to the cross-sections, maps were prepared that illustrate either the surface of various geological and hydrostratigraphic layers using contour lines or the thickness of the layers using information from new boreholes installed in the expansion area and historical boreholes installed in the existing fill area of the site. The following figures were prepared:

FIGURE D7-13– Bedrock Surface – this figure shows the interpolated surface of the bedrock as identified in boreholes logs from all of the hydrogeological investigations.

FIGURE D7-14– Layer 3 Surface – this figure illustrated the interpolated surface of Layer 3 which occurs at the interface of the unweathered till (Layer 2) and basal overburden sediments (refer to **Table D7-9**).

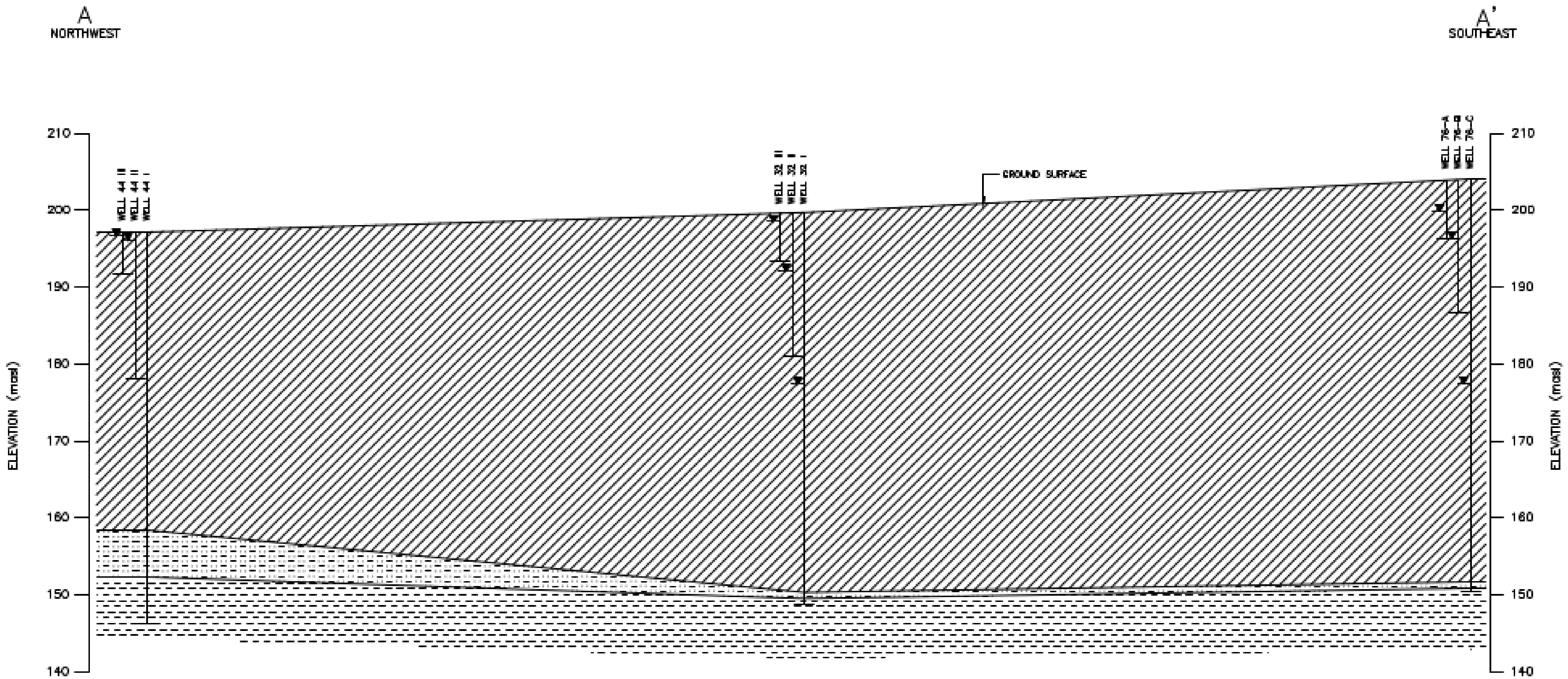
Table D7-8: Summary of Principal Geologic and Hydrostratigraphic Units

Formation	Typical Soil Type	Hydrogeologic Classification	Aquifer Unit Significance (Local/Regional)	Hydrostratigraphic Layer
Surficial Deposits	Topsoil, thin sand and gravel deposits	Aquifer	Local	1
Weathered Till	Clay, silt and sand	Aquitard	Regional	1
Unweathered Till	Clayey silt till	Aquitard	Regional	2
Basal Overburden Sediments	Sand, silt and gravel	Aquifer	Local	3
Kettle Point Shales	Weathered Shale	Aquifer	Regional	3

FIGURE D7-15– Overburden Thickness – this figure includes an isopach of the overburden thickness at the site. This figure was prepared using original ground elevations (i.e., does not include the fill areas).

FIGURE D7-16– Layer 2 Thickness – is an isopach of Layer 2, the thick aquitard identified at the site that consists of low permeability unweathered clayey silt till.

FIGURE D7-10: SECTION A-A



SECTION A-A'

SCALE: HORIZ. = 1:6000
VERT. = 1:600

GROUND WATER LEVEL

MONITOR	WATEL LEVEL*
WELL 44 I	N/A
WELL 44 II	196.08
WELL 44 III	196.68
WELL 32 I	177.40
WELL 32 II	192.13
WELL 32 III	198.53
WELL 76-A	199.82
WELL 76-B	196.37
WELL 76-C	177.53

* AS MEASURED MAY 2018

LEGEND

PORT STANLEY TILL: BROWNISH-GREY, GREY CLAYEY SILT TILL; MINOR SAND AND TRACE GRAVEL. WEATHERED AND FRACTURED AT SURFACE, BECOMING GREY UNFRACTURED AT DEPTH (>5m).

GLACIO-LACUSTRINE DEPOSITS: GREEN-GREY, GREY SANDS SILTS CLAYS

KETTLE POINT FORMATION: BLACK SHALE; WEATHERED, FRACTURED IN UPPER SURFACE (UPPER 1 TO 5 METRES)

WELL 44 — WELL DESIGNATION

WATER LEVEL (SEPTEMBER, 2017)

BOTTOM OF WELL

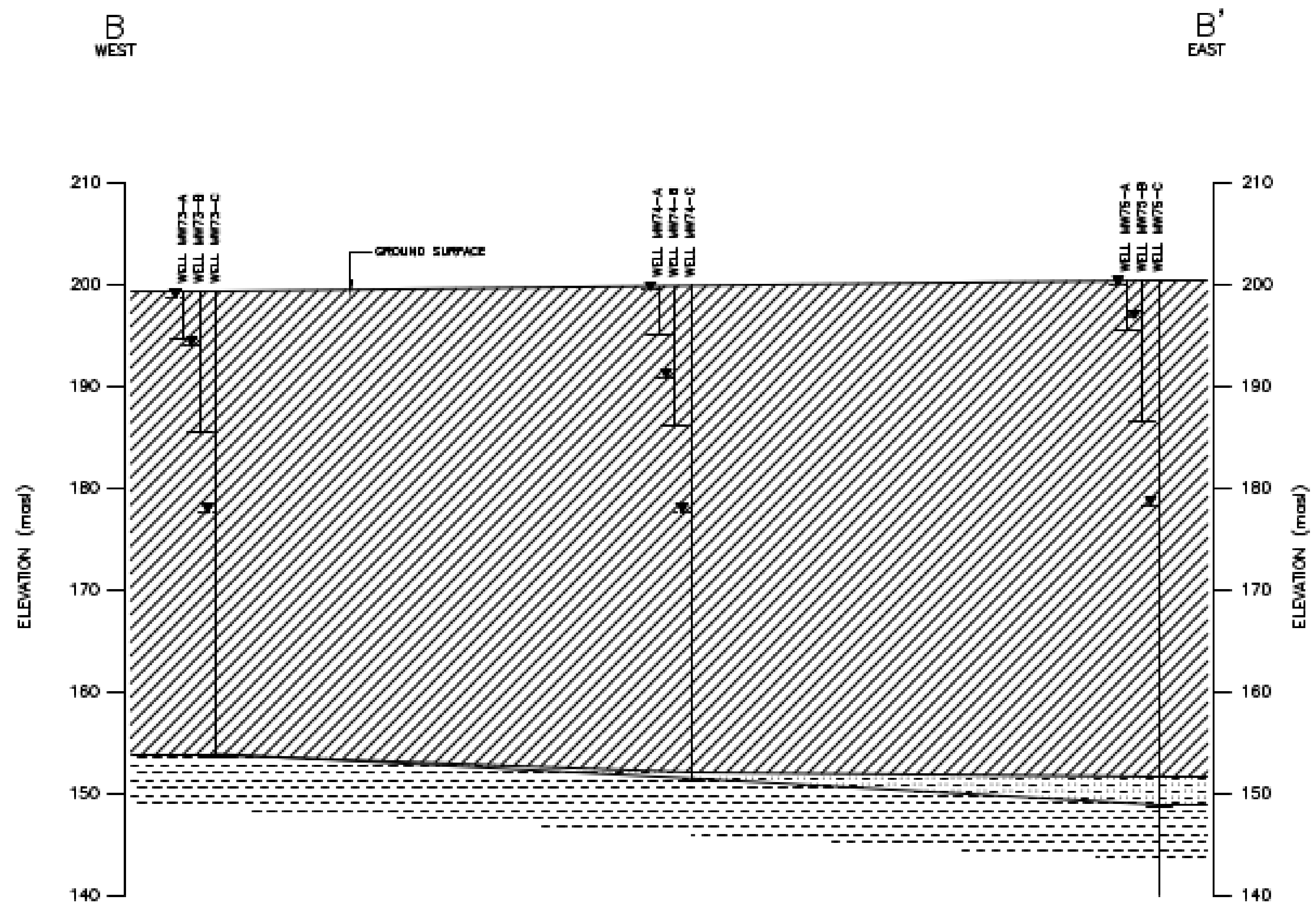
NOTES:
LOCATION OF SECTION IS SHOWN ON DRAWING 1

RIDGE LANDFILL
BLENHEIM, ONTARIO

SECTION A-A'

Project No: 15-2456	Drawn By: J.Z.H.
Project Manager: F.R.G.	Checked By:
Location:	
File Name:	Date Issued: MAY 1 2019
DILLON CONSULTING	Figure No. D7-10

FIGURE D7-11: SECTION B-B



SECTION B-B'
SCALE: HORIZ. = 1:6000
VERT. = 1:600

LEGEND

PORT STANLEY TILL:
BROWNISH-GREY, GREY CLAYEY SILT TILL; MINOR SAND AND TRACE GRAVEL. WEATHERED AND FRACTURED AT SURFACE, BECOMING GREY UNFRACTURED AT DEPTH (>5m).

GLACIO-LACUSTRINE DEPOSITS:
GREEN-GREY, GREY SANDS SILTS CLAYS

KETTLE POINT FORMATION:
BLACK SHALE; WEATHERED, FRACTURED IN UPPER SURFACE (UPPER 1 TO 5 METRES)

WELL 44 — WELL DESIGNATION
WATER LEVEL (MAY, 2018)
BOTTOM OF WELL

GROUND WATER LEVEL

MONITOR	WATER LEVEL *
WELL 73A	198.78
WELL 73B	194.02
WELL 73C	177.63
WELL 74A	199.48
WELL 74B	190.89
WELL 74C	177.66
WELL 75A	199.87
WELL 75B	196.72
WELL 75C	178.36

* AS MEASURED MAY 2018

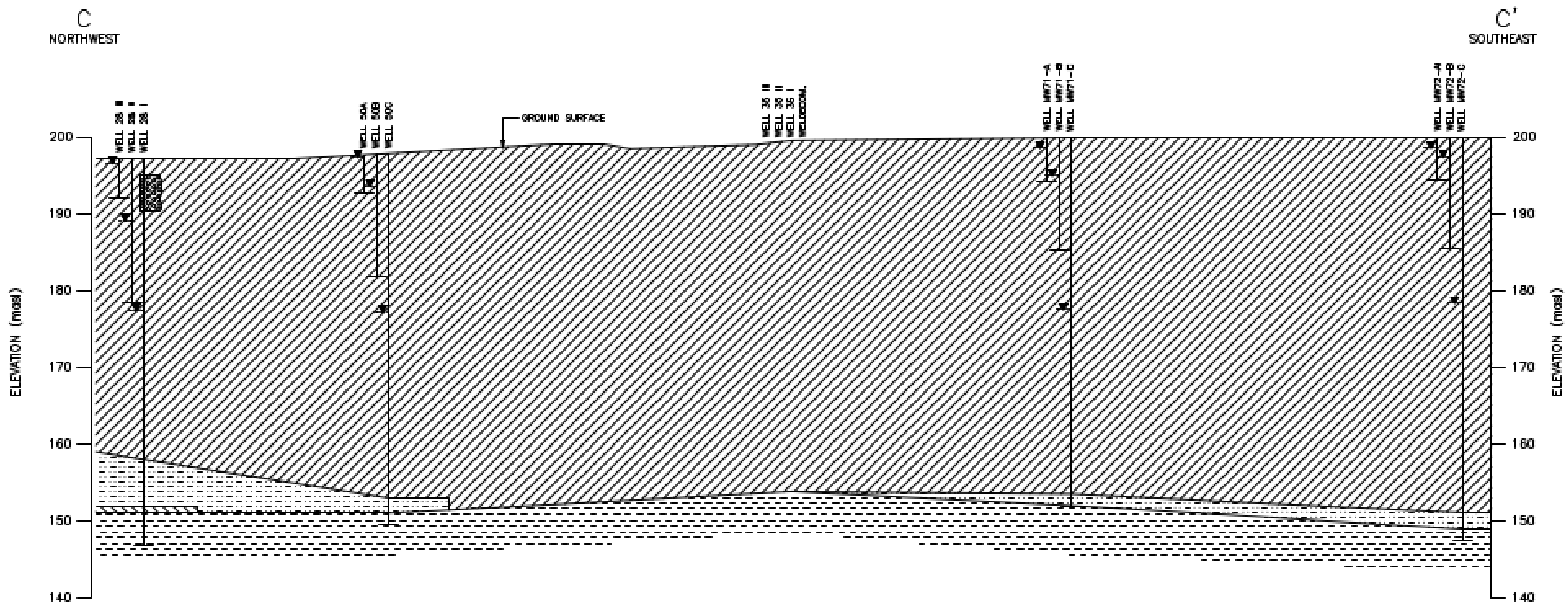
NOTES:
LOCATION OF SECTION IS SHOWN ON DRAWING 1

RIDGE LANDFILL
BLENHEIM, ONTARIO

SECTION B-B'

Project No: 15-2456	Drawn By: J.Z.H.
Project Manager: F.R.G.	Checked By:
Location:	
File Name:	Date Issued: MAY 1 2019
	Figure No. D7-11

FIGURE D7-12: SECTION C-C



SECTION C-C'
SCALE: HORIZ. = 1:6000
VERT. = 1:600

GROUND WATER LEVEL

MONITOR	WATEL LEVEL*
WELL 28 I	177.36
WELL 28 II	189.17
WELL 28 III	196.56
WELL 50A	197.35
WELL 50B	193.56
WELL 50C	177.28
WELL 71A	196.56
WELL 71B	194.97
WELL 71C	177.53
WELL 72A	196.56
WELL 72B	197.40
WELL 72C	178.40

* AS MEASURED MAY 2018

LEGEND

PORT STANLEY TILL:
BROWNISH–GREY, GREY CLAYEY SILT TILL; MINOR SAND AND TRACE GRAVEL. WEATHERED AND FRACTURED AT SURFACE, BECOMING GREY UNFRACTURED AT DEPTH (>5m).

GLACIO–LACUSTRINE DEPOSITS:
GREEN–GREY, GREY SANDS SILTS CLAYS

SANDY SILT, SILTY SAND:
GREY, MINOR SAND AND GRAVEL

KETTLE POINT FORMATION:
BLACK SHALE; WEATHERED, FRACTURED IN UPPER SURFACE (UPPER 1 TO 5 METRES)

SILTY SAND, TILL LENSES

WELL 28 — WELL DESIGNATION

WATER LEVEL (MAY, 2018)

BOTTOM OF WELL

NOTES:
LOCATION OF SECTION IS SHOWN ON DRAWING 1

RIDGE LANDFILL
BLENHEIM, ONTARIO

SECTION C-C'

Project No: 15-2456	Drawn By: J.Z.H.
Project Manager: F.R.G.	Checked By:
Location:	
File Name:	Date Issued: MAY 1 2019
DILLON CONSULTING	Figure No. D7-12

FIGURE D7-13: BEDROCK SURFACE

FIGURE D7-14: LAYER 3 SURFACE

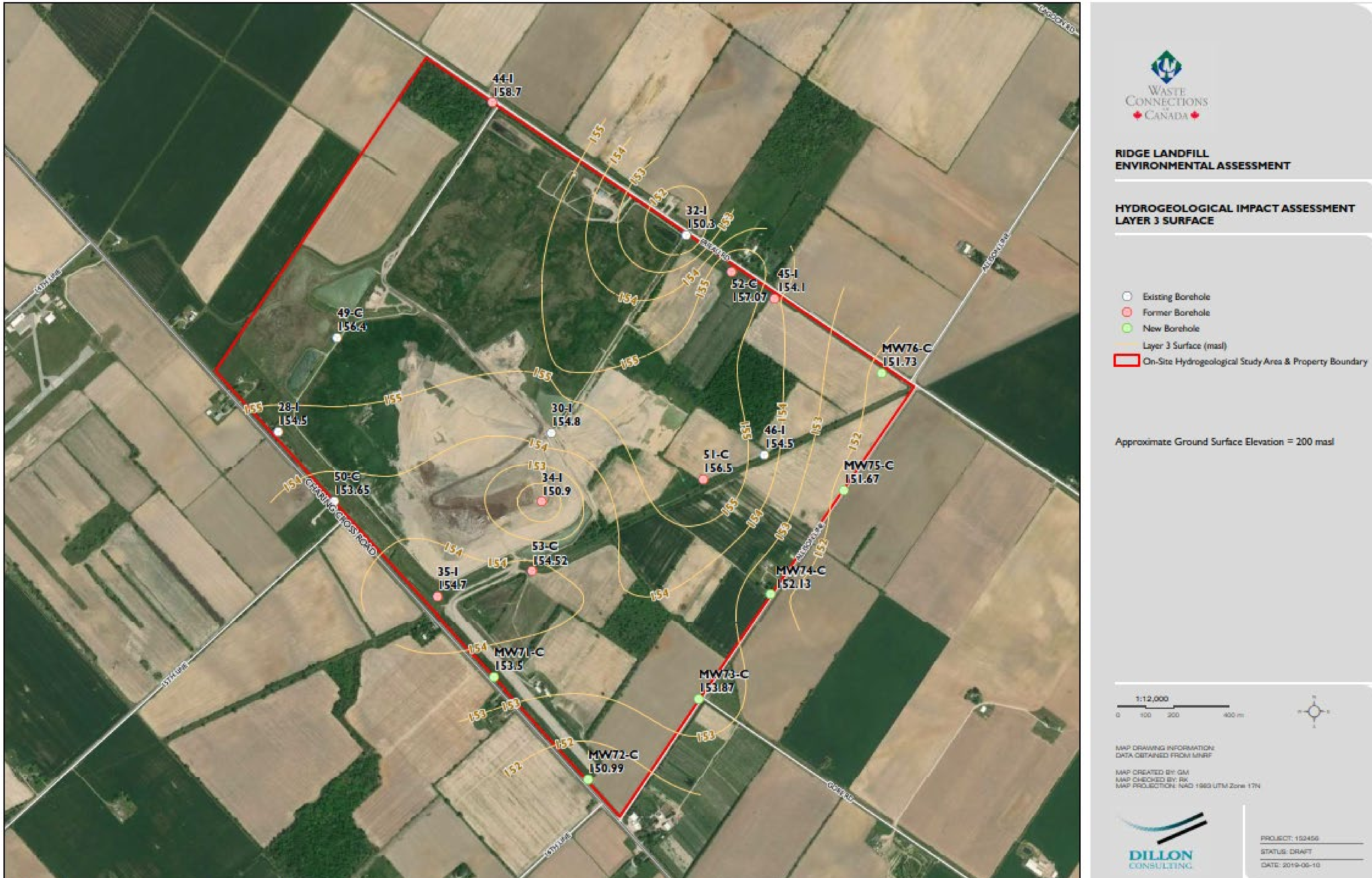


FIGURE D7-15: OVERBURDEN THICKNESS

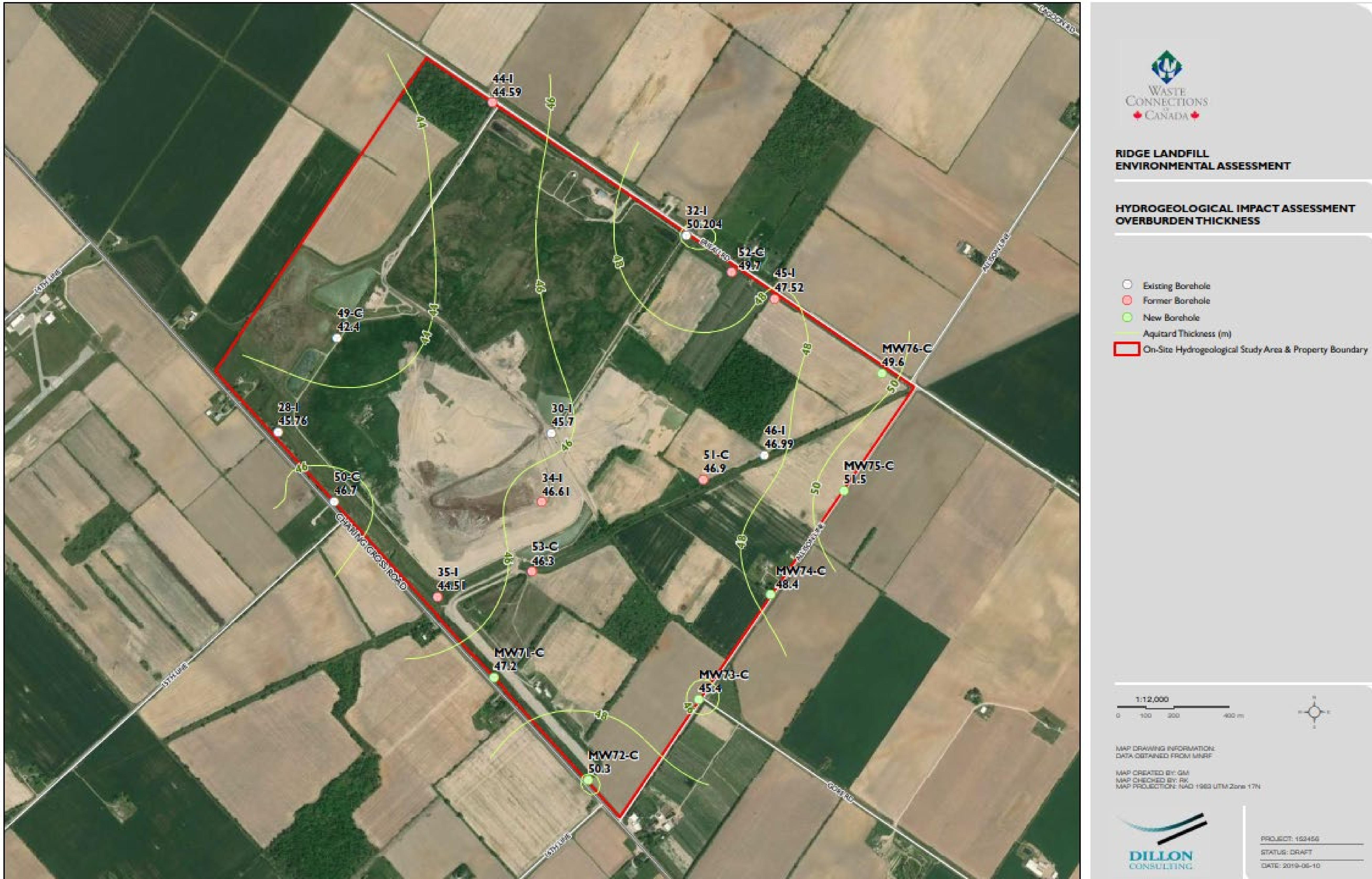


FIGURE D7-16: LAYER 2 THICKNESS

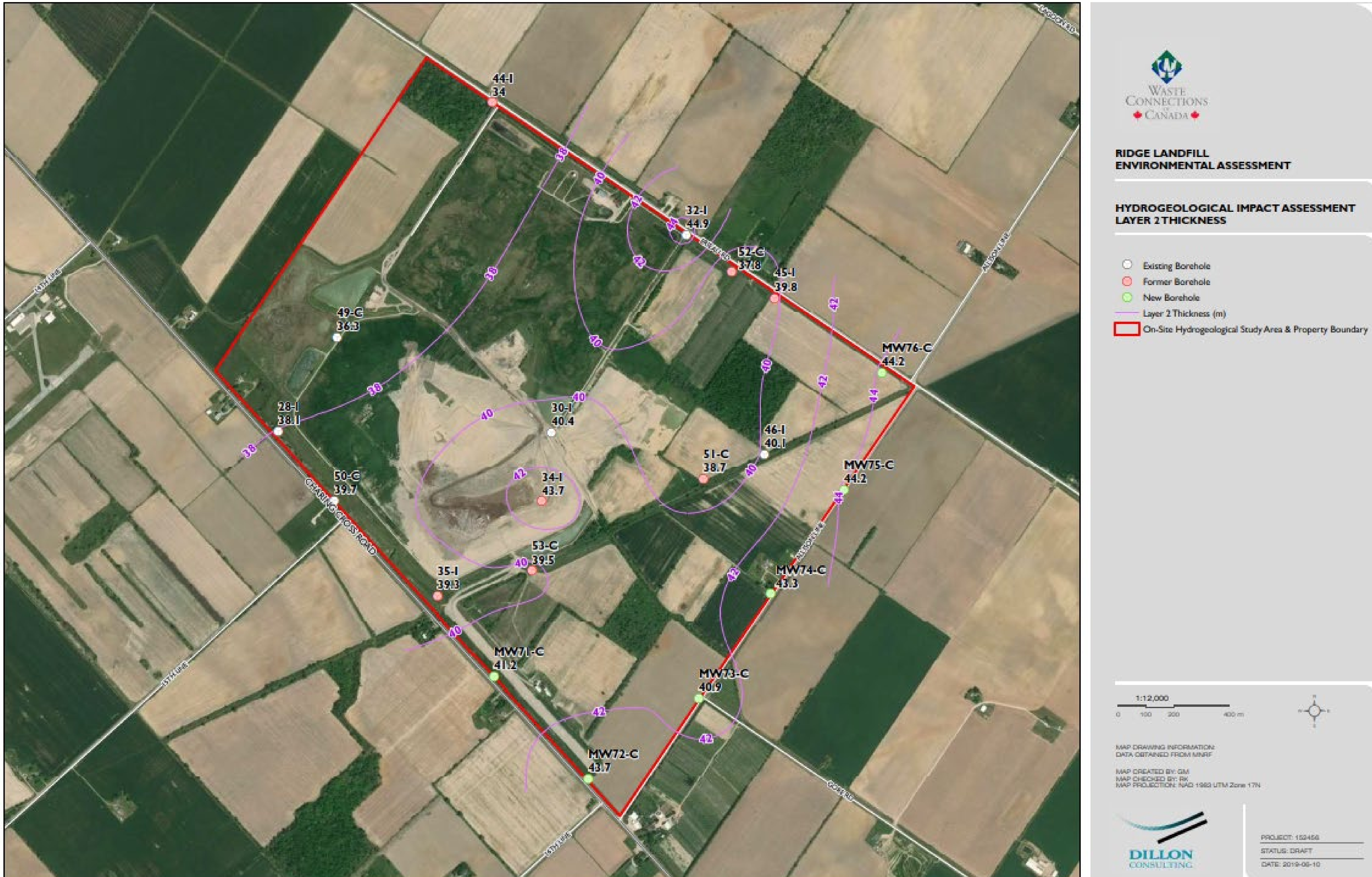
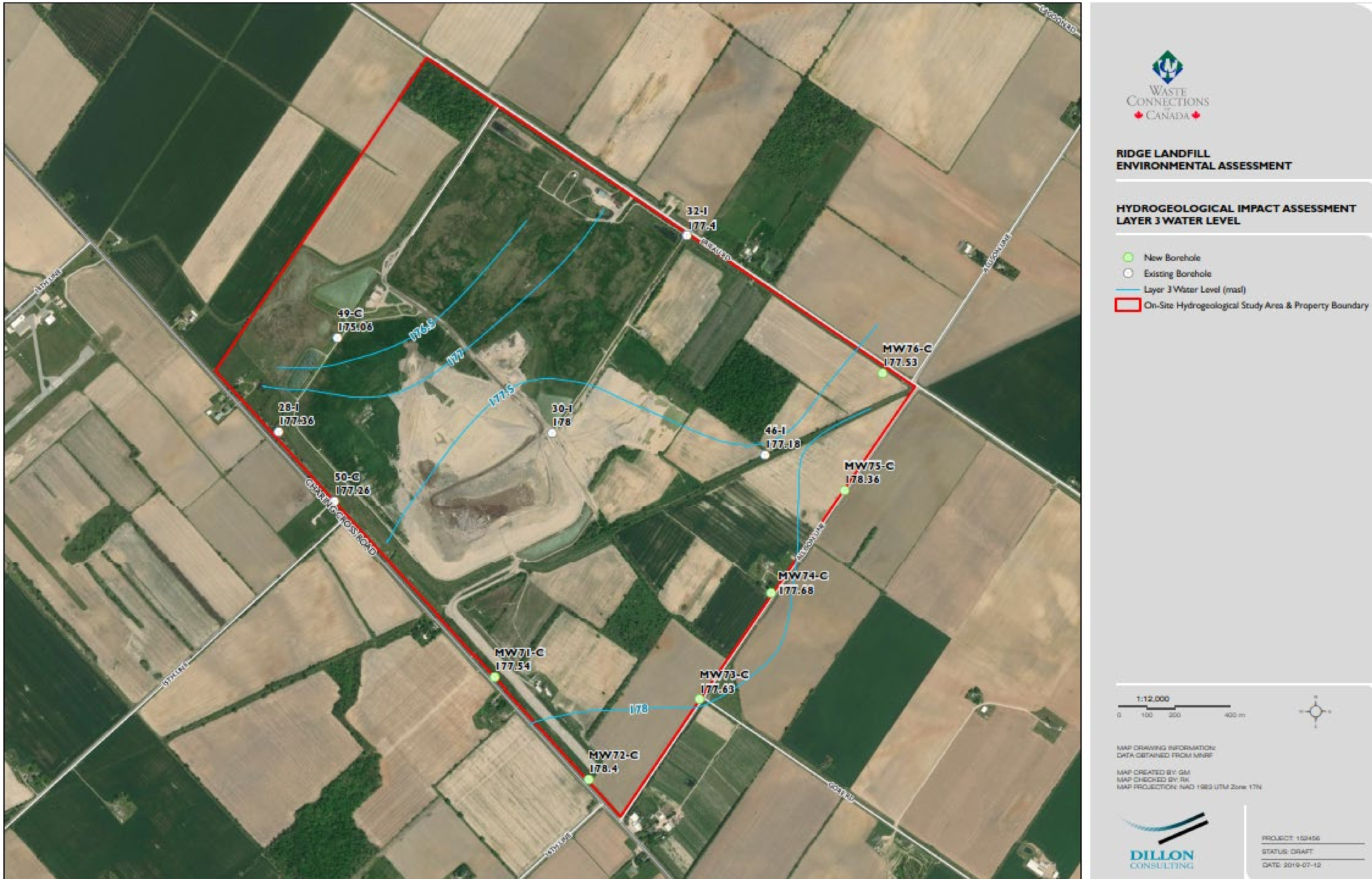


FIGURE D7-17: LAYER I WATER LEVEL

FIGURE D7-18: LAYER 3 WATER LEVEL



4.3 Hydrostratigraphic Characterization

Geological units per se, may or may not, be a significant control over groundwater movement. Hydrostratigraphic units identify one or more contiguous geologic units that have similar hydrogeological characteristics, and therefore provide a better basis for evaluating groundwater movement. Principal hydrostratigraphic units distinguish between aquifers and aquitards, which are defined on the basis of their ability to yield supply of water to a well. An aquifer will yield groundwater at a rate sufficient to allow a water supply well to be installed; and aquitard will not. The hydraulic conductivity of an aquifer or aquitard is a measure of its ability to transmit water.

Hydrostratigraphic units have been identified at the site, based on the above definition of aquifer and aquitard, geologic units and other data such as water level monitoring, groundwater chemistry and hydraulic testing of monitoring wells. These hydrostratigraphic units define the conceptual hydrogeological model for the site.

Layer 1 is a surficial aquifer and incorporates the geologic units that occur at ground surface. This layer consists of weathered and fractured clayey silt till and other discontinuities such as sand lenses and can permit the installation of a large diameter bored well for domestic purposes. This aquifer is not suitable to supply large quantities of groundwater for anything other than a domestic water supply (e.g., irrigation or livestock watering). Yields in the unit are typically less than 10 L/minute and water storage is required, either within the bored well or within the residence, as part of the water supply. Large diameter shallow wells can also be prone to poor water quality due to their unsanitary condition. It is noted that in the previous hydrogeologic investigation in 1996, relatively high permeability surficial sand deposits were identified in the southeastern portion of the existing fill area (drilling locations 50 and 51). No similar surficial sand deposits were identified in the boreholes drilled in 2016 for this assessment. The thickness of Layer 1 is the depth of the weathered and fractured zone of the clay till at an approximate depth of 4.5 m.

Low permeability soils consisting of unweathered clayey silt till constitute the Layer 2 hydrostratigraphic unit. This hydrostratigraphic unit is very thick, as shown on **FIGURE D7-16**, which shows a thickness ranging from 34 to 44 m. Layer 2 is generally thicker in the proposed landfill expansion area boreholes than what was identified in the investigations completed in the 1990's with a thickness ranging from 40.9 m to 44.2 m. Previous investigations identified relatively few significant discontinuities in Layer 2; however, the drilling completed in 2016 (drilling locations 71 through 76) for this landfill expansion did not identify any significant discontinuities.

Layer 3 consists of sandy soils consisting of highly weathered shale referred to as "black sand" that occurs immediately above the bedrock surface and weathered and fractured shale bedrock. Groundwater yields from this aquifer are regionally variable but in the vicinity of the site, they are generally poor with well yields generally less than 20 L/minute. Historically, this aquifer has been used by residents and farms in the area of the site. In addition to relatively low yields, the groundwater quality is generally poor with high dissolved solids and highly odouriferous. Naturally occurring methane gas may also occur in water wells installed in Layer 3.

The base of Layer 3 is unweathered Kettle Point Shale which occurs within a few metres of the bedrock surface. Unweathered shale is an aquitard and it is only the weathered surface of the bedrock that has increased hydraulic conductivity allowing it to be classified as an aquifer.

4.4 Results of Laboratory Analysis of Soil Samples

The results of the grain size analysis of grain size analysis is presented as a ternary diagram (see **FIGURE D7-19**). The results of the soil tests are summarized in **Table D7-9** and detailed test results are in **Appendix D7-B** – Soil Testing Results.

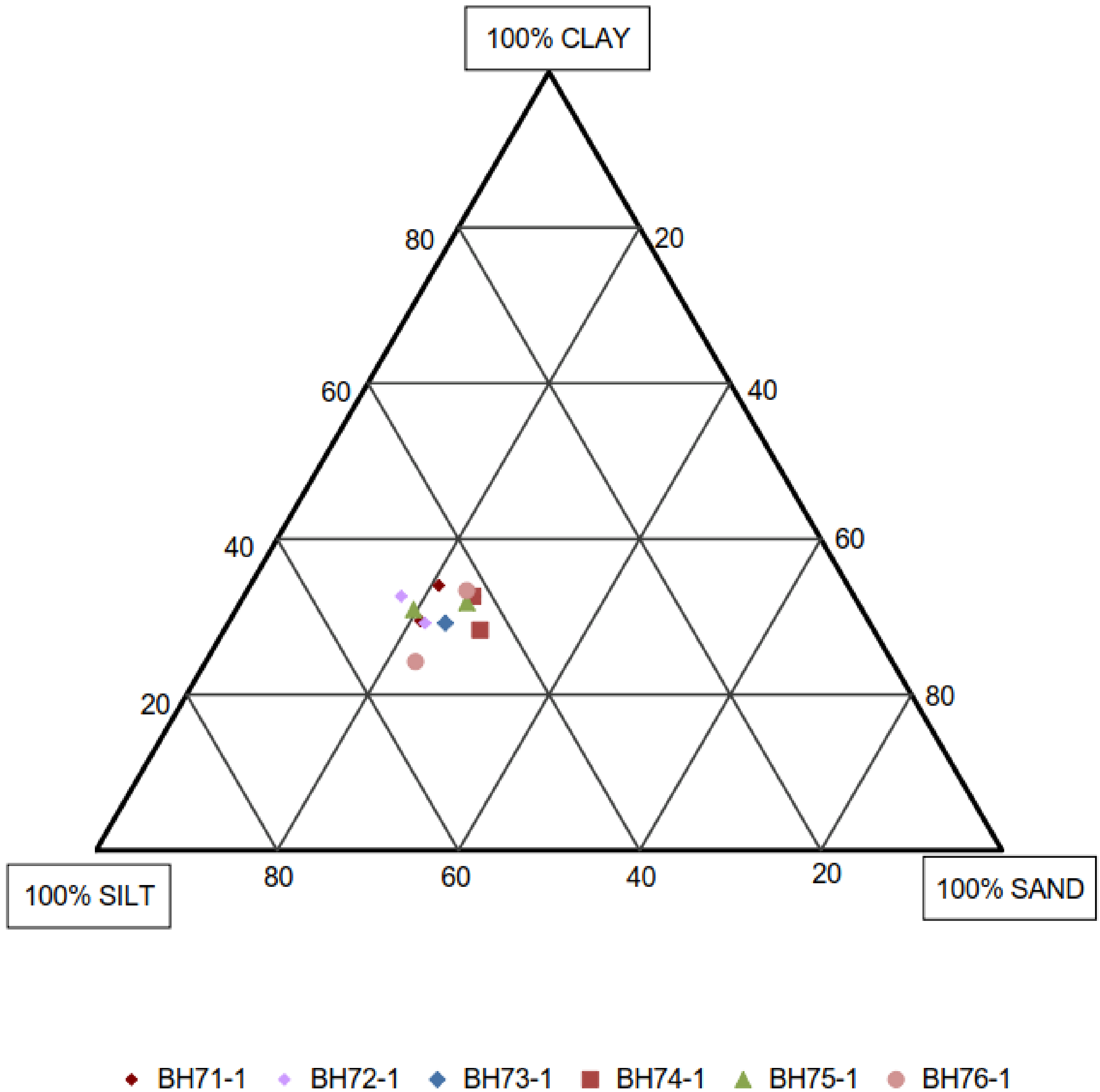
Table D7-9: Results of Laboratory Analysis of Soils

Borehole No.	Sample No.	Depth		Layer	Grain Size Analysis (%)				Water Content %	Total Organic Carbon	
		mbgs	masl		Clay	Silt	Sand	Gravel		<0.6mm	Whole Soil
BH71-1	4	4.5	194.7	1					13.3		
	7	9.1	190.1	2	28	47	20	5	15.5	0.75	0.64
	11	15.2	184	2	33.5	44.5	20.5	1.5	16.5	0.77	0.69
	15	12.3	186.9	2					17.8		
	27	39.9	159.3	2					14.5		
	31	46.6	152.6	3					10.7		
BH72-1	4	4.5	194.7	1					13.8		
	7	9.1	190.1	2	27.5	49	22	1.5	14.5	0.8	0.71
	11	15.3	183.9	2					16		
	16	23.1	176.1	2					16.5		
	27	40.8	158.4	2					16.3		
	33	49.9	149.3	3					6		

Borehole No.	Sample No.	Depth		Layer	Grain Size Analysis (%)				Water Content %	Total Organic Carbon	
BH73-1	4	4.9	194.3	2					14.9		
	7	9.1	190.1	2	24	53	21	2	39.4	0.74	0.65
	11	15.2	184	2	28	45	23	4	16.1	0.88	0.76
	16	22.9	176.3	2					17.4		
	26	41.1	158.1	2					16.3		
	29	44.2	155	2					24.8		
BH74-1	4	4.9	195	2					14.5		
	7	9.1	190.8	2	31	40	24	5	15.6	0.8	0.68
	11	15.2	184.7	2	26	40	26	8	15.4	0.66	0.51
	14	22.9	177	2					17.2		
	26	39.6	160.3	2					16.5		
	31	45.7	154.2	2					18.8		
BH75-1	4	4.9	195.4	2					14.7		
	7	9.1	191.2	2	30	48	19	3	15.5	0.78	0.69
	11	15.2	185.1	2	28	38	22	12	13.5	0.71	0.55
	16	22.9	177.4	2					15.4		
	27	40.4	159.9	2					16.3		
	34	50.3	150	3					20.2		
BH76-1	4	4.6	195.8	2					12.7		
	6	7.6	192.8	2					13.1		
	7	9.1	191.3	2	23	50	22	5	16.2	0.81	0.58
	11	15.2	185.2	2	33	42	24	1	16.7	0.8	0.69
	14	21.3	179.1	2					16.9		
	26	39.6	160.8	2					15.3		
	31	46.9	153.5	2					13		

The grain size analyses from the boreholes installed in 2016 are similar to the results of similar tests completed in 1996. The Layer 2 aquitard consist of consistent low permeability clayey silt till without significant variation by location. This is illustrated on **FIGURE D7-19** where all of the results plot within a very small zone on the ternary diagram.

FIGURE D7-19: GRAIN SIZE DATE



4.5 Hydraulic Conductivity Testing

Hydraulic conductivity testing was completed on a number of monitoring wells. These data were supplemented by hydraulic conductivity tests at the new drilling locations (locations 71 through 76). At the new locations, triaxial permeability tests were completed on soil core obtained by taking Shelby tubes (thin walled steel sample tubes that minimize the disturbance of the soil structure) located at a depth equivalent to the depth of the proposed landfill. Analysis of these data is documented in **Appendix D7-C –** Permeability and Well Testing Results**.**

Table D7-10 summarizes the data from the in situ well tests and the triaxial permeability tests.

Table D7-10: Summary of In Situ Well Tests and Triaxial Permeability Tests

Hydraulic Conductivity (m/s)				
Triaxial Permeability Tests				
Layer	Mean	Minimum	Maximum	No. of Tests
2	6.8 x 10^{-11}	3.2 x 10^{-11}	1.7 x 10^{-10}	12
In Situ Hydraulic Conductivity Tests				
1	2 x 10^{-09}	1 x 10^{-10}	9 x 10^{-7}	14
2	3 x 10^{-10}	7 x 10^{-11}	1 x 10^{-9}	6
3 (BO)	5 x 10^{-6}	9 x 10^{-8}	3 x 10^{-2}	9
3 (KP)	7 x 10^{-07}	5 x 10^{-7}	1 x 10^{-6}	2

4.6 Groundwater Level Monitoring

Water levels from monitoring wells were used to identify groundwater flow directions and calculate hydraulic gradients. Hydrographs for each monitoring location are in **Appendix D7-D –** Water Level Data and Hydrographs**.**

4.6.1 Groundwater Flow Directions

Groundwater flow in Layer 1 and Layer 3 is principally horizontal. Water levels for May 2018 are shown as equipotential lines similar to contour lines. The lines shown on **FIGURE D7-17** (Layer 1) and **FIGURE D7-18** (Layer 3) are based on water levels collected in May 2018 for both new monitoring wells and the existing monitoring wells included in the site monitoring program. The computer geospatial modelling program SURFER was used to provide the initial interpretation of water level data presented in the figures, as noted in the discussion below. Final interpretation required that due consideration be given to boundary conditions and other influences over groundwater movement.

Layer 1

Horizontal groundwater movement in Layer 1 is illustrated on **FIGURE D7-17**. This figure shows groundwater movement at shallow depths (i.e., the water table) which occurs primarily with the fractured and weathered clayey silt till. The water table is approximately 1 m below natural ground surface and is lower near surface water courses that are installed deeper than the water table (i.e., the municipal drains and the surface water ponds).

Layer 1 groundwater flow directions are controlled mainly by surface topography and surface water courses (primarily the municipal drains). Shallow groundwater flow is also influenced by the existing fill areas. The existing fill areas are isolated from the Layer 1 groundwater through the protective design features incorporated into the fill areas. For the existing landfills (the West Landfill and the South Landfill) Layer 1 groundwater flow is deflected around the fill areas by the side wall clay liner and the underdrain leachate collection system. The groundwater level in Layer 1 is higher than the collection system and the side wall liner prevents Layer 1 groundwater from flowing into the fill area. Likewise, for the Old Landfill, a combination of the perimeter cut-off wall and the perimeter collection system isolates the fill area from Layer 1 groundwater.

As noted above, Layer 1 water levels are higher than the inverts of the municipal drains at the site which causes Layer 1 groundwater to have the potential to flow into the water courses. The amount of Layer 1 groundwater flowing into the drains is limited as the drains are seen to be essentially dry during the summer months. The storm water ponds also locally affect Layer 1 groundwater levels: when the water levels in the ponds are low, Layer 1 groundwater tends to flow towards the ponds but when pond levels are high surface water from the ponds flows into the Layer 1 groundwater system. The horizontal hydraulic gradient for Layer 1 groundwater ranges from 0.005 to 0.001 m/m.

Layer 2

There is a significant vertical gradient in Layer 2. However, the rate of movement of groundwater flow is extremely slow (in the order of less than a centimetre per year) based on ‘k and stable isotope data. As such, horizontal movement within the aquitard is not considered to be an important component of groundwater flow direction.

Vertical movement in the aquitard is estimated at 1 cm/year. There is in excess of 30 m of low permeability Layer 2 soils beneath the existing and proposed fill areas. The low groundwater flow velocity and thick layer of low permeability soil means that it would take approximately 3,000 years for water to travel from the base of the landfill to the Layer 3 aquifer.

Layer 3

Horizontal groundwater movement in Layer 3 is illustrated on **FIGURE D7-18.** Layer 3 groundwater movement is through both basal overburden sands that occur immediately above the bedrock surface and the fractured upper portion of the bedrock (Kettle Point

Shale). The transmissivity (a function of aquifer thickness and hydraulic conductivity) of the Layer 3 aquifer is variable as the degree of weathering in the bedrock and the thickness of the basal sands varies by location. This variability results in an irregular Layer 3 potentiometric surface. For instance, the water level at monitoring well 30-I Located near the middle of the existing site had a water level of 178.00 masl in May 2018 which is higher than other wells installed in the existing site and monitoring well 49-C located in the northwest had a water level of 175.06 masl which is about 2 metres lower than the other Layer 3 monitoring wells. Overall the hydraulic gradient is very low at the site in the order of 0.001 m/m or less but increases in areas where there are irregular water levels (such as 49-C and 30-I as noted above). For the monitoring wells installed in the expansion area, water level variability is less than at the existing site but they still do not indicate a consistent groundwater flow direction. Water levels for these monitoring wells varied from 177.53 masl to 178.40 masl.

Groundwater levels in Layer 3 monitoring wells located at the existing site have risen about five (5) metres from the 1990's. The reason for the increase in water levels in these monitoring wells may be related to a decrease in use of the aquifer after the installation of municipal water supply on Charing Cross and Erieau Roads.

The rate of horizontal groundwater flow is based both on hydraulic conductivity and hydraulic gradient. As stated above, the hydraulic gradient is extremely low at the site and there is not a strong dominant direction of groundwater flow in this layer. However, using a gradient of 0.005 m/m, it is estimated that the horizontal groundwater flow velocity is in the order of 0.5 m/year. Given that there is a minimum 100 m buffer between the fill areas and property boundary and the road allowance, the nearest a new water well could be located to a fill area is 200 m (existing off-site wells are typically much more than this distance). Therefore, it is estimated that it will take 400 years for water to travel horizontally in Layer 3 from between the fill area to a potential off-site well. Cumulatively, it is estimated to take 3,400 years (3,000 years to travel vertically downwards through Layer 2 to Layer 3, and 400 years to travel horizontally in Layer 3) for water to travel from the base of the fill area to a potential off-site well.

4.7 Groundwater Chemistry

Groundwater samples were collected from the new monitoring wells installed in the expansion area. The target parameter list was similar to the current groundwater monitoring program and included:

- pH
- Conductivity
- COD
- BOD
- Chloride
- Phenol
- Sulphate
- Total Kjeldahl Nitrogen
- Calcium
- Volatile organic scan
- Magnesium
- Sodium
- Potassium
- Iron
- Alkalinity
- Total ammonia as N
- Anion scan (nitrate, nitrite, bromide, iodide, fluoride
- Total phosphorus

In addition, the isotopes of oxygen and hydrogen were quantified both in groundwater samples taken from monitoring wells and in porewater extracted from soil cores. A similar isotopic analysis was used in the 1996 hydrogeological assessment which indicated that the porewater deep in the clay till is many thousands of years old. Laboratory test results are in **Appendix D7- E** – Groundwater Quality and Isotope Chemistry.

The chemistry of groundwater changes as it moves though soils and rock and can be used to assess the relative residence time in the subsurface. From this perspective, groundwater chemistry “ages” in the subsurface. For instance, relatively fresh groundwater recently recharged from surface infiltration is dominated by a calcium/magnesium cation and bicarbonate (alkalinity) as the dominant anion. As the residence time in the subsurface increases, groundwater chemistry slowly changes so that sodium is the dominant cation and chloride is the dominant anion.

Major ion data from the laboratory analysis of groundwater samples were used to generate Durov diagrams that utilize trilinear diagrams to differentiate groundwater chemical characteristics for different hydrostratigraphic units and locations within the groundwater environment. A Durov diagram plots major cations and anions in trilinear plots and then transfers their location in a general rectangular plot. **FIGURE D7-20** is an explanatory Durov diagram and illustrates the various “types” of groundwater and the general evolution of groundwater quality from “fresh” calcium bicarbonate type water to “old” sodium chloride type water.

FIGURE D7-20: EXPLANATORY DUROV DIAGRAM

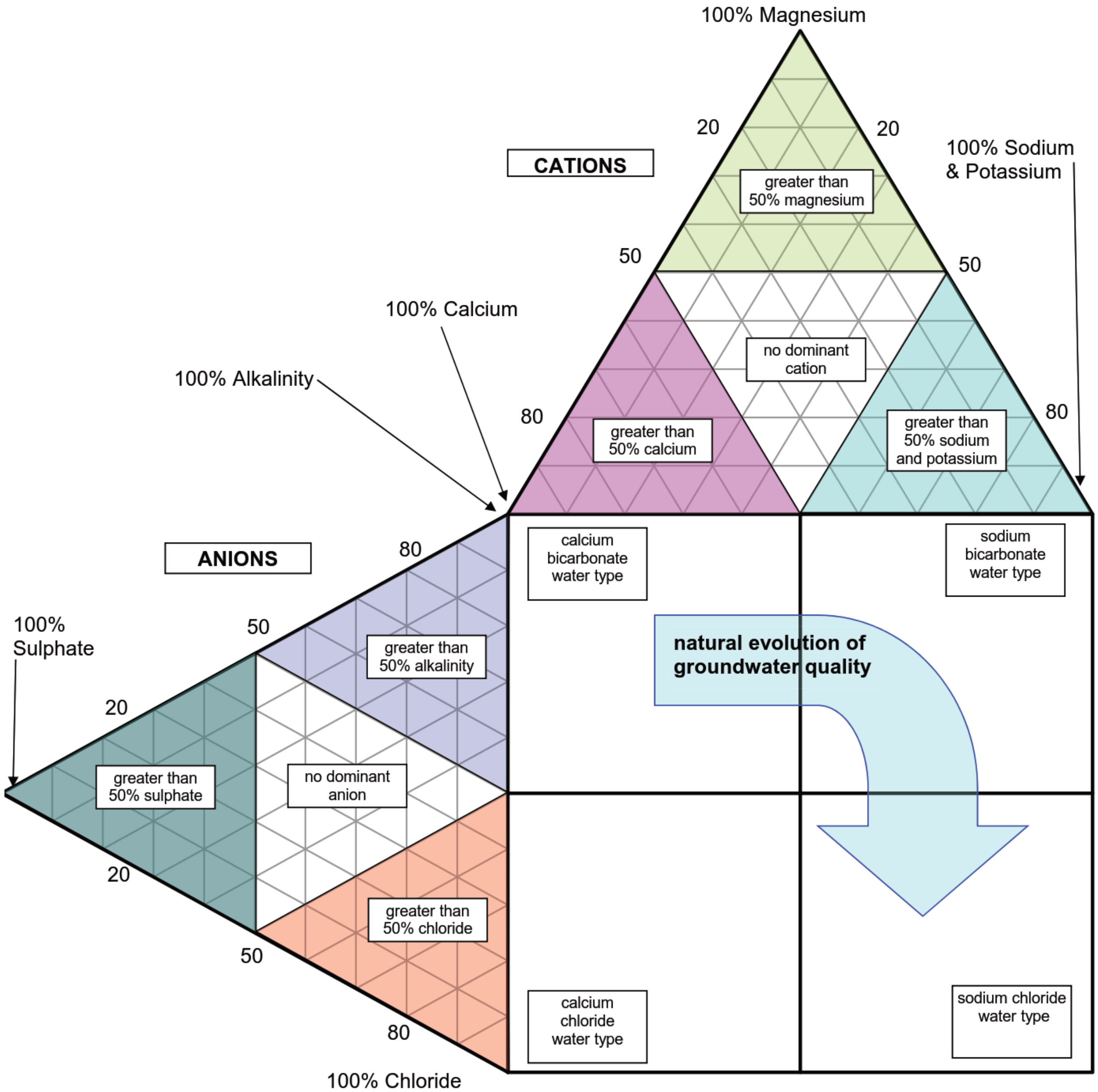
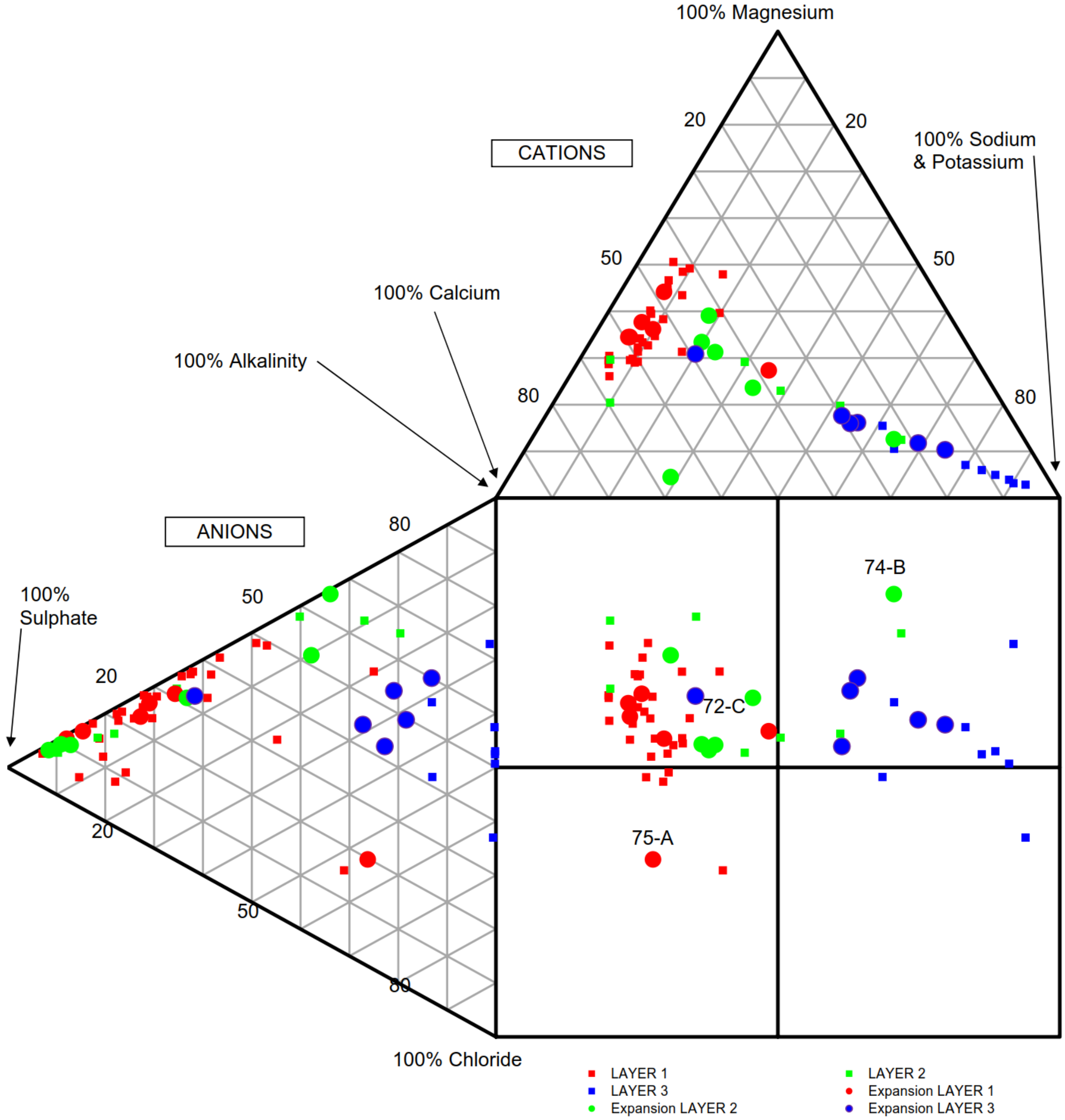


FIGURE D7-21 includes the data collected for the monitoring wells installed in the expansion area (shown as larger circles) as well as existing monitoring wells installed at the existing landfill site (shown as smaller squares). This figure further distinguishes between major ion chemistry data for Layer 1 monitoring wells (red symbols), Layer 2 monitoring wells (green symbols) and Layer 3 monitoring wells (blue symbols).

FIGURE D7-21: DUROV DIAGRAM



Layer 1 groundwater is predominantly a calcium - sulphate type water. High background sulphate concentrations have been noted in Layer 1 monitoring wells at the existing site and the presence of sulphate in Layer 1 groundwater is related to the natural presence of gypsum in the till soils at the site. There is one exception to this trend; monitoring well 75-A had a higher chloride concentration (560 mg/L) than the other new Layer 1 monitoring wells (ranged from 13 mg/L to 42 mg/L). The reason for the high chloride concentration is currently unknown and further chemistry data collected from this well will confirm if high chloride concentrations persist at this monitoring well.

Layer 2 groundwater is predominantly a calcium – sulphate/bicarbonate type water. Three of the new monitoring wells (71-B, 75-B and 76-B) had high sulphate concentrations (>1000 mg/L) while three (72-B, 73-B and 74-B) had sulphate concentrations less than 400 mg/L. One monitoring well (74-B) had a relatively high sodium concentration (410 mg/L) compared to the other new Layer 2 monitoring wells (range of 97 mg/L to 170 mg/L). This water sample had a large charge balance error (>60%) which indicates that there may be an issue with the laboratory analysis for this water sample.

Layer 3 groundwater is classified as a sodium-bicarbonate type water which is consistent with a relatively older groundwater with a long residence time and has undergone chemical alteration by soil/rock/groundwater interactions. The one exception to this trend is monitoring well 72-C which has a high sulphate concentration and calcium/magnesium concentrations than the other new Layer 3 monitoring wells.

4.7.1 Stable Isotope Chemistry

Isotopes of oxygen and hydrogen are other indicators of groundwater movement. They are particularly useful because they are part of the ions which constitute water and are not subject to attenuation processes which can change concentrations of dissolved constituents and have been used to date the age of groundwater.

The depletion of oxygen-18 ($\delta^{18}O$) and deuterium ($\delta^{2}H$) with respect to Vienna Mean Standard Ocean Water (VMSOW) is an age indicator when data are compared to similar data in areas where the relationship between oxygen-18 depletion and groundwater age has been established. Desaulniers, et al, 1981 established that greater depletion indicates greater age. However, Edwards and Fritz, 1987 describes a possible exception to this where groundwater recharged during the Hypsithermal era (between approximately 4,000 and 7,000 years ago) could be less depleted than modern recharge waters. Cross-plots of depletion of Oxygen-18 against deuterium (hydrogen-2) provide insight into groundwater movement and age. Isotopic data is reported as a difference between the sampled water and VMSOW and is reported in per thousand (‰). For instance, a value of

Oxygen-18 of -10‰ means that the water samples has 10‰ less (i.e., is depleted) of Oxygen-18 than the standard. Interpretation of stable isotope data is commonly referenced to the Meteoric Water Line (MWL), representative of these isotopes in global precipitation (Dansgaard, 1964). A more local meteoric water line has been established and is referred to as the Great Lakes Meteoric Water line and it is shown on
FIGURE D7-22.

FIGURE D7-23 and **FIGURE D7-24** summarize the results of the analysis of oxygen-18 and deuterium in porewater from soil samples collected during the drilling of the new monitoring wells 73- C and 76-C. This figure shows that Oxygen-18 and deuterium becomes more depleted, with respect to SMOW, at depth. Porewater collected from less depth had Oxygen-18 values of greater than -10‰. Oxygen-18 and deuterium becomes increasingly depleted with depth. The depletion of stable isotopes in porewater from borehole 73-C remains fairly constant beyond a depth of 30 m.

The results of the analysis of stable isotopes indicate that the porewater in the deeper soil cores is representative of water recharged during progressively colder/older paleoclimates which occurred more than 8,000 years before present. Data collected for this study confirms the similar isotopic analysis assessment competed in 1996.

FIGURE D7-22: ISOTOPES IN POREWATER WITH DEPTH

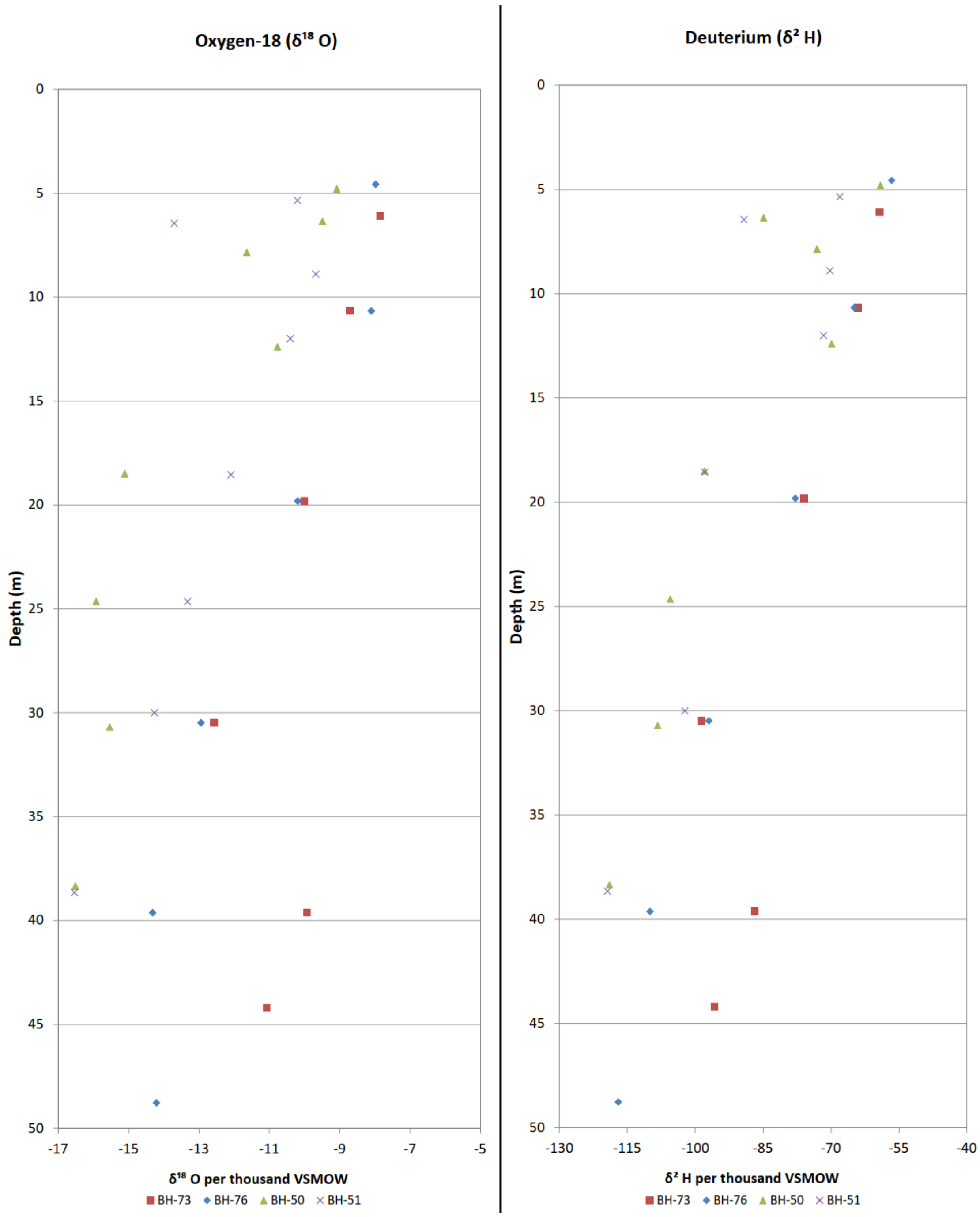


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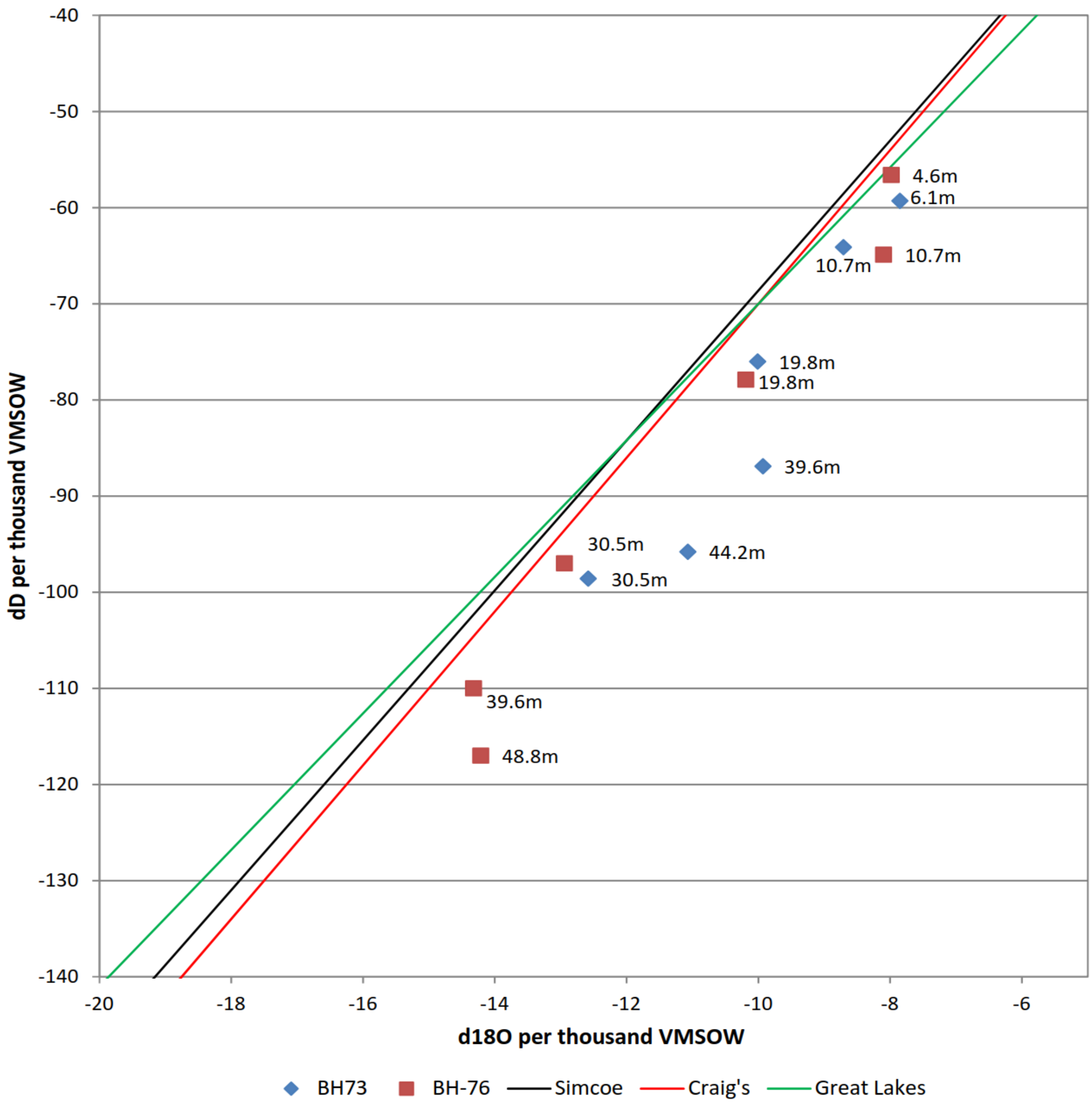
FIGURE D7-23: POREWATER ISOTOPE CHEMISTRY



4.8 Groundwater Use

This section summarizes groundwater use within 1 km of the site. As described earlier, the basal / bedrock aquifer (Layer 3) historically has provided residents with their water supply. The aquifer consists of sandy soils derived from highly weathered shale referred to as "black sand" that occurs immediately above the bedrock surface and weathered and fractured shale bedrock. Groundwater yields from this aquifer are regionally variable but in the vicinity of the site, they are generally poor with well yields generally less than 20 L/minute. Historically, this aquifer has been used by residents and farms in the area of the site. In addition to relatively low yields, the groundwater quality is generally poor with high dissolved solids and highly odouriferous (i.e. objectionable smell). Naturally occurring methane gas may also occur in the water wells. Municipal water supply pipelines are located both on Charing Cross Road and Erieau Road adjacent to the landfill.

A letter was delivered to all residences with 1 km of the landfill and along the haul route inviting them to provide information on a variety of subjects including their source(s) and uses of water. A response was received from 18 residents. Five of the respondents indicated that they did not have a well on their property. Six of the respondents indicated that they have a well on their property and are part of the private water well monitoring program. Seven of the respondents indicated that they had private wells on their property but are not included in the private monitoring program and they were more than 1 km from the site (along the haul route).

FIGURE D7-9 illustrates the location of the known private monitoring wells in relation to the Ridge Landfill. PMW-14 is located on-site and will eventually need to be decommissioned prior to berm construction. Six private monitoring wells are located off-site and within the surface water study area, namely: PMW-1, PMW-3, PMW-6, PMW-8, PMW-9 and PMW-13. There are an additional eight private monitoring wells located off-site and within the groundwater study area but outside the surface water study area, namely: PMW-2, PMW-4, PWM-5, PWM-7, PWM-10, PMW-11, PMW-12, and PMW-15. Two wells that are no longer sampled are PMW-16 and PMW-17.

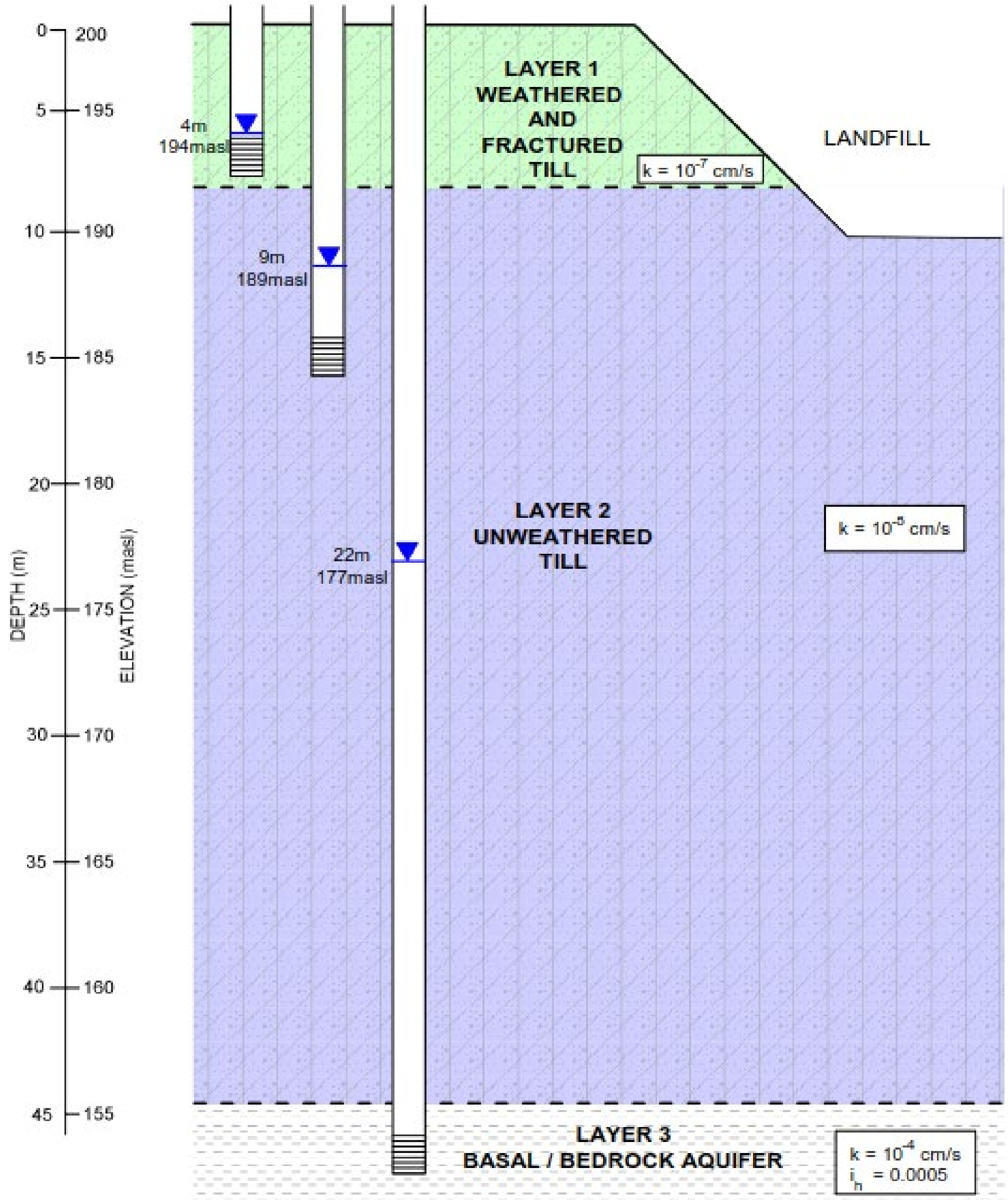
As detailed above, it is estimated to take 3,400 years (3,000 years to travel vertically downwards through Layer 2 to Layer 3, and 400 years to travel horizontally in Layer 3) for water to travel from the base of an on-site fill area to a potential off-site well located within 200 m of a fill area.

5.0 Hydrogeological Conceptual Model of the Ridge Landfill Site

The following is a summary of the site-specific hydrogeology of the Ridge Landfill site using a conceptual model of groundwater movement which is used to develop a contaminant transport model that assesses potential impacts on groundwater quality. The conceptual model was developed initially for the 1996 EA and confirmed by the current hydrogeological investigations.

The principal hydrostratigraphic units discussed in Section 4.3 and water levels in these units provide the building blocks for the conceptual model of groundwater movement. The conceptual model is illustrated in **FIGURE D7-24** (next page).

FIGURE D7-24: CONCEPTUAL HYDROGEOLOGY MODEL



5.1 Principal Hydrostratigraphic Layers

5.1.1 Layer 1

Layer 1 is the surficial aquifer and mainly comprises weathered and fractured clayey silt till. In addition to till soils, there are localized occurrences of sand silt and gravel in Layer 1 although none of these soils were identified at the six drilling locations in the expansion area. Layer 1 is characterized by:

- A heterogeneous nature with preferential flow in the fractures and other discontinuities. Near surface, these discontinuities are rust-stained and weathering processes are evident. The degree of weathering decreases with depth and are substantially absent beneath a depth of 3m. Fractures do exist beneath this depth but the frequency decreases significantly and while fractures were identified at depths up to 6 m in the large test pit completed in 1995, their importance to groundwater diminishes. Therefore, Layer 1 has been defined as surficial soils up to a depth of 4.5 m.

- Horizontal groundwater movement, influenced mainly by surficial drainage features. The surficial topography is very flat and therefore has less influence on horizontal groundwater movement in Layer 1. Existing landfill fill areas are isolated from the Layer 1 groundwater environment by side wall liners and the underdrain leachate collection system (West and South Landfills) and by the perimeter cutoff wall and perimeter leachate collection system (Old Landfill). Generally, groundwater movement in Layer 1 will be around the fill areas but it is noted that, due to the presence of the leachate collection systems lowering water levels within the fill areas to below the water table, any groundwater movement from Layer 1 will be induced to flow into the fill areas (albeit at a very low rate through the side liner and perimeter cutoff wall. Vertical groundwater movement in Layer 1 is very limited by the low permeability of Layer 2.

5.1.2 Layer 2

As documented in **Section 4.3**, Layer 2 comprises low permeability till. Layer 2 soils are differentiated from Layer 1 by:

- The presence of very few discontinuities, vertical or horizontal;
- A dominant vertically downwards groundwater flow direction;
- Relatively low groundwater flux with a hydraulic conductivity in the order of 10^{-10} m/s; and

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- Downward vertical hydraulic gradient in the order of 0.5 m/m.

In addition to very low groundwater velocities, Layer 2 is consistently homogeneous without any significant changes in lithology both laterally and vertically.

5.1.3 Layer 3

Layer 3 comprises the regional aquifer which consists of a basal overburden sand and gravel unit and/or weathered shale bedrock. The horizontal hydraulic gradient is very low in this unit. Based on water level data in on-site monitoring wells installed in Layer 3, groundwater flow is northward but regionally, groundwater flow has been identified as south-southeast.

The hydraulic conductivity of Layer 3 is not constant and depends on the amount of overburden basal sand and gravel and the degree of weathering of the bedrock. The variable hydraulic conductivity of this unit results in some areas with higher water levels (areas with lower hydraulic conductivity) than other locations.

5.2 Contaminant Transport Model

Based on the conceptual model, there are two principal groundwater pathways for impacts to occur:

- Pathway 1 - Horizontal movement of impacted groundwater though the shallow weathered till soils (Layer 1); and
- Pathway 2 - Vertical movement of impacted groundwater through the low permeability till soils (Layer 2) to the basal/bedrock aquifer (Layer 3).

5.2.1 Pathway 1

Engineered works can easily address the first pathway because this pathway is above the landfill base. The leachate collection system controls the levels of leachate in the fill areas to be nominally above the landfill base for the existing West Landfill and South Landfill and their proposed horizontal expansions (Area A and Area B). Since the landfill base is well below the water table elevation, groundwater flow in Layer 1 will be towards the landfill. The leachate collection system has been designed to last at least 100 years. If the leachate collection fails, and if contaminant concentrations in leachate are above criteria, potential impacts can be mitigated by installing a perimeter collection system and a downgradient low permeability cutoff wall similar to that installed at the Old Landfill. For the vertical expansion of the Old Landfill, leachate levels will be controlled by a combination of the perimeter leachate collection system which will be retrofitted with

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finger drains which are perpendicular to the perimeter drain and extend into the fill area. A perimeter cutoff wall further isolates the Old Landfill from Layer 1. Prediction of groundwater impacts via contaminant transport modelling is not warranted for Pathway 1 as the potential for contaminant movement with the engineered controls is negligible.

5.2.2 Pathway 2

Impacts from the second pathway are not entirely eliminated by the site engineering. The low water level in Layer 3 is below the landfill base and there will still be a hydraulic gradient causing downward groundwater flow. This flow rate is quite slow due to the low permeability of the unweathered till (Layer2). Contaminant transport modelling can be used to predict contaminant concentrations with time in Layer 3.

The contaminant transport model considered that the water level (piezometric head) in Layer 3 remains constant. The vertical gradient was calculated by the difference between the leachate level and Layer 3 water level and dividing the thickness of the Layer 2 below the landfill base. The leachate level in the landfill will remain nominally above the landfill base when the underdrain leachate collection system is fully operational. The contaminant transport model assumes that leachate levels will increase in the fill after failure of the leachate collection system (assumed to occur after 100 years (to a point where leachate will be fully collected by a perimeter collection system). For the vertical expansion of the Old Landfill, the contaminant transport model assumes that leachate levels rise in the mound until there is sufficient gradient for leachate to be collected in the perimeter collection system. The contaminant transport model is discussed in **Section 6.**

6.0 Impact Assessment

6.1 Potential Effects & Mitigation Measures

6.1.1 On-site

Groundwater quality will be protected beneath the Ridge Landfill through a combination of a high level of natural protection provided by low permeability clayey silt till combined with the protection provided by landfill engineering. The existing geological and hydrogeologic conditions are described in detail in **Section 3.0**. Engineering systems to control leachate are outlined in **Section 5.0** and are discussed in detail in **Appendix D6** - Design and Operations Report.

Downward vertical movement of groundwater is extremely slow and impacts to layer 3, the regional aquifer are not anticipated for thousands of years. As contaminants move at these slow rates, they will be attenuated by processes such as biodegradation, adsorption and dispersion to the point where they are no longer a concern.

6.1.2 Regulatory Context - Reasonable Use of Groundwater

To determine the significance of an impact on groundwater quality the MECP developed Guideline B 7, The Incorporation of the Reasonable Use Concept into MECP Groundwater Management Activities (RUG). The essence of this guideline is to establish site specific groundwater quality criteria based on criteria established for the "reasonable use" of the groundwater and background concentrations. These criteria are applicable at the site boundary. The Reasonable Use for groundwater at the property boundary is drinking water and thus groundwater at the site boundary must meet applicable MECP drinking water criteria, calculated using the *Reasonable Use Guidelines*.

6.1.3 Leachate Generation Rates

The HELP Model was used to estimate the leachate generation through Ridge Landfill final cover. Details of the HELP model are located in **Appendix D7-F** – Leachate Generation Rate Analysis (HELP Modelling). Five scenarios were simulated:

Scenario 1 – An operating landfill with a 1.35 m thick clay cover with a relatively elevated hydraulic conductivity of 1.7 x 10^{-7} m/s.

Scenario 2 – An operating landfill with a 0.85 m thick clay cover with a relatively elevated hydraulic conductivity of 1.7 x 10^{-7} m/s.

<u>Scenario 3</u> – A closed landfill with a 0.85 m thick clay cover with a hydraulic conductivity of 1×10^{-8} m/s.

<u>Scenario 4</u> – A closed landfill with a 1.35 m thick clay cover with a hydraulic conductivity of 1×10^{-8} m/s.

<u>Scenario 5</u> – A closed landfill with a 0.3 m intermediate cover with a hydraulic conductivity of 1.0×10^{-7} m/s and 0.55 m final cover with $1.0E^{-8}$ m/s (equivalent hydraulic conductivity of 1.47×10^{-8} m/s).

The interim cover scenarios (Scenario 1 and Scenario 2), had a similar leachate generation rate of approximately 260 mm/year for both simulated thicknesses. The final cover scenarios (Scenario 3 and Scenario 4) also have similar predicted leachate generation rates of approximately 136 mm/year. The hybrid scenario has a slightly higher leachate generation rate of 168 mm/year.

The leachate generation recommended to be used in the landfill design is 150 mm/year. This value is consistent with the generic landfills of *O.Reg. 232/98* and reflects the precision of the simulation method.

6.1.4 Critical Contaminants

Critical contaminants are defined as contaminants that due to a combination of a high concentration in leachate, a low allowable concentration and high mobility in the groundwater environment have a higher potential for causing unacceptable impacts than other contaminants. By definition, it is can be demonstrated that where impacts form critical contaminants are below allowable concentrations, other less critical contaminants will also be below allowable concentrations. *O.Reg 232/98* defines eight (8) critical contaminants for landfills:

- Benzene
- Cadmium
- Chloride
- Lead
- 1,4 Dichlorobenzene
- Dichloromethane
- Toluene
- Vinyl Chloride

<u>Background Concentrations</u>

Of all of the critical contaminants, chloride is the only contaminant that occurs naturally in the subsurface. Chloride levels vary from 45 mg/L to 400 mg/L with a median value of 125 mg/L. For the other specified critical contaminants, background concentrations have been assumed to be zero since they do not occur naturally in the subsurface and were not detected in the groundwater quality sampling conducted at the site.

6.1.5 Allowable Concentrations

The *Reasonable Use Guideline* specifies that the maximum concentration of a particular contaminant that would be acceptable in groundwater beneath an adjacent property is calculated using the following equation:

$$Callow = Cb + x(Cr - Cb)$$

where: C_{allow}: Calculated allowable concentration

C_b: Background concentration

C_r: Maximum concentration for the reasonable use of groundwater. Since the reasonable use of groundwater at this site is drinking water, maximum concentrations are based on the Ontario drinking Water Standards.

X: A factor that reduces the contaminant to a level which is considered by the MECP to have only a negligible effect on the use of groundwater. For drinking water, "x" is 0.5 for non-health related parameters or 0.25 for health related parameters.

Table D7-11 summarizes the allowable concentrations for the critical contaminants.

Table D7-11: Allowable Concentrations

Critical Contaminant	Drinking Water Criterion		Background Concentration	Allowable Concentration	Allowable Increase
Benzene (µg/L)	5		0	1.25	1.25
Cadmium (µg/L)	5		0	1.25	1.25
Chloride (mg/L)*	250		125	188	63
Lead (µg/L)	10		0	2.5	2.5
1,4 Dichlorobenzene (µg/L)	5		0	1.25	1.25
Dichloromethane (µg/L)	50		0	12.5	12.5
Toluene (µg/L)*	24		0	12	12
Vinyl Chloride (µg/L)	2		0	0.5	0.5

Table Note: * non-health related parameter; other parameters are health related.

6.1.6 Contaminant Transport Modelling

The potential impacts on groundwater quality were evaluated using a contaminant transport model based on the POLLUTE software. This software was developed specifically for evaluating landfill impacts on groundwater and was used in the development of the generic landfill designs contained in *O.Reg. 232/98*. The geological and hydrogeologic inputs to the model, including the delineation of potential groundwater migration pathways are based on the Conceptual Site Model (see **Section 5.2**). **Appendix D7-G** – Contaminant Transport Modelling.

The contaminant transport model considered impacts at the site boundary via groundwater movement downwards through Layer 2 to Layer 3 and horizontally in Layer 3 to the property boundary.

The results of the contaminant transport modelling are summarized in **Table D7-12.** This table summarizes the maximum concentration predicted in the modelling, the time at which that maximum occurs and the allowable Reasonable Use Concentration (from **Table D7-12**). The table includes model results of the horizontal expansion of the West and South Landfills and the vertical expansion of the Old Landfill. Due to biodegradation, the organic contaminants (Benzene, 1,4 Dichlorobenzene, Dichloromethane, Toluene and Vinyl Chloride) have virtually no impact in the Layer 3. The predicted impacts for cadmium and lead are below that allowed by the RUG and, because of adsorption, the maximum is predicted to occur more than 5000 years from present and still be below the allowable limit.

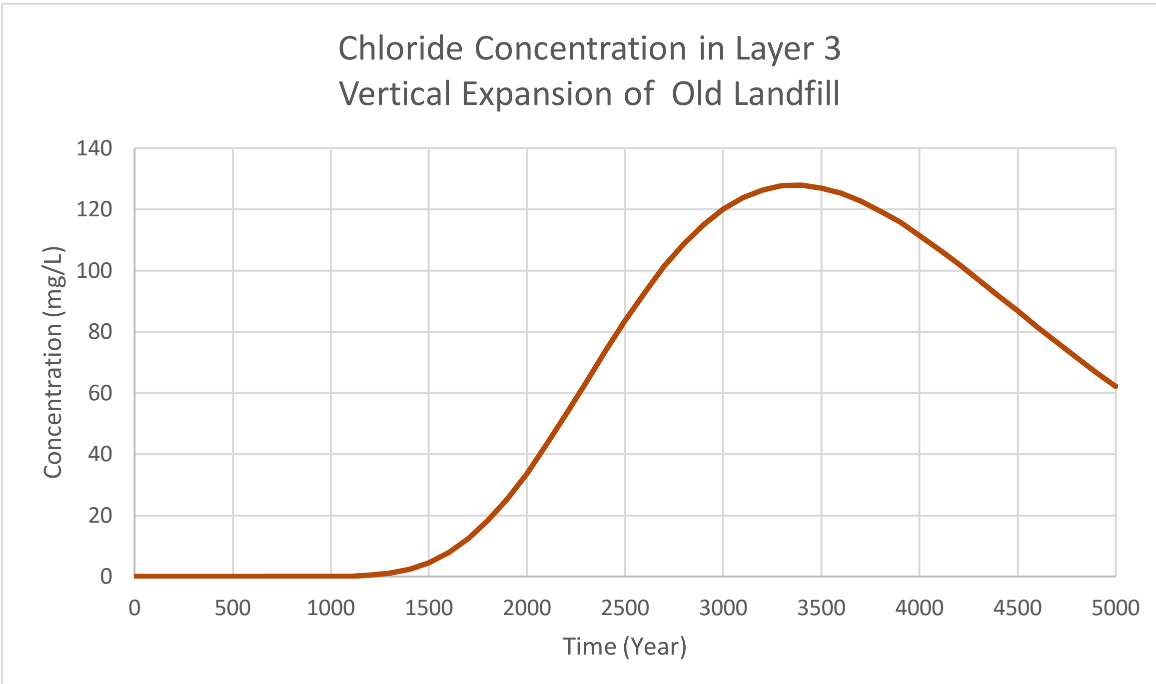
Maximum chloride concentrations are predicted to be below allowable concentrations and occur more than 3000 years from present in Layer 3.

Table D7-12: Predicted Maximum Concentrations

Parameter	Maximum Concentration in Layer 3	Time at Maximum Concentration (years)	Allowable Concentration
West Landfill/Area A and South Landfill/Area B			
Benzene (µg/L)	<0.001	-	1.25
Cadmium (µg/L)	0.12	6400	1.25
Chloride	103.0	3400	188
Lead (µg/L)	0.5	8200	2.5
1,4 Dichlorobenzene (µg/L)	<0.001	-	1.25
Dichloromethane (µg/L)	<0.001	-	12.5
Toluene (µg/L)	<0.001	-	12.0
Vinyl Chloride (µg/L)	<0.001	-	0.5
Vertical Expansion of Old Landfill			
Benzene (µg/L)	<0.001	-	1.25
Cadmium (µg/L)	0.16	6400	1.25
Chloride	129.0	3400	188
Lead (µg/L)	0.3	8300	2.5
1,4 Dichlorobenzene (µg/L)	<0.001	-	1.25
Dichloromethane (µg/L)	<0.001	-	12.5
Toluene (µg/L)	<0.001	-	12.0
Vinyl Chloride (µg/L)	<0.001	-	0.5

FIGURE D7-25 shows the predicted chloride concentration with time in Layer 3 from the Vertical Expansion of Old Landfill simulation. This figure shows the gradual increase in chloride concentrations that reach a maximum concentration after 3,000 years.

FIGURE D7-25: PREDICTED CHLORIDE CONCENTRATIONS IN LAYER 3 – VERTICAL EXPANSION OF OLD LANDFILL SIMULATION



6.1.7 Compliance with Reasonable Use Guideline

The predicted concentrations of all contaminants will be below the allowable increases. The models predict that the movement of organic contaminants will only occur a few metres below the landfill base due to biodegradation process and the extremely low groundwater flow rates. Predicted maximum concentrations of cadmium and lead will be less than allowable concentrations and are predicted to occur in Layer 3 more than 5,000 years from present.

Chloride concentrations are predicted to be below allowable concentration and maximum concentrations will not occur in Layer 3 for more than 3,000 years.

Overall, the contaminant transport modelling indicates that the site complies with the *Reasonable Use Guideline* and that the drinking water aquifer and surrounding drinking water wells will be protected.

6.2 Contaminating Life Span

O.Reg. 232/98 states that "contaminating life span" means:

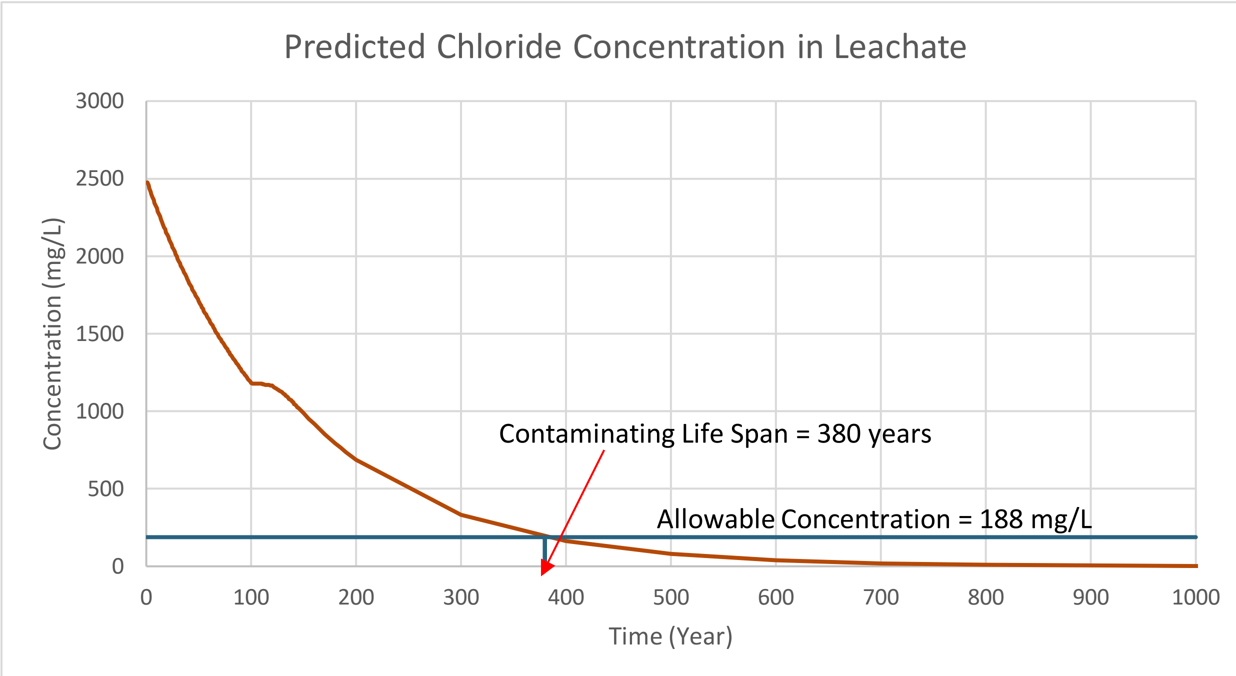
a) in respect of a landfilling site, the period of time during which the site will produce contaminants at concentrations that could have an unacceptable impact if they were to be discharged from the site; and

b) in respect of a landfilling site and a contaminant or group of contaminants, the period of time during which the site will produce the contaminant or a contaminant in the group at concentrations that could have an unacceptable impact if they were to be discharged from the site.

The contaminant transport modelling indicates that chloride is the only contaminant that has predicted concentrations relatively near (but below) the allowable concentration determined by the Reasonable Use Guideline. The modelling results also indicate that Layer 3, the drinking water aquifer, is protected with predicted maximum chloride concentrations below the allowable concentration of 188 mg/L with maximum concentrations not occurring for over 3,000 years. The modelling also indicated that even if the leachate underdrain system in the horizontal expansion areas did not function at all and leachate was allowed to build-up on the landfill base immediately, predicted increases remain below allowable concentrations. However, in this situation a perimeter leachate collection system would be required to prevent landfill seeps on the landfill side slopes and to protect surface water features and the shallow Layer 1 groundwater.

FIGURE D7-26 graphs the predicted chloride concentrations in leachate with time. As indicated in this figure, the contaminant transport model predicts that chloride concentrations will be below the allowable concentration of 188 mg/L in 380 years. The analysis indicated that the underdrain leachate collection system is not needed to achieve compliance with the drinking water aquifer (Layer 3). Leachate collection from a perimeter leachate collection is required from the vertical expansion of the Old Landfill and the new fill areas after the underdrain leachate collection system ceases to function for the duration of the contaminating lifespan.

FIGURE D7-26: PREDICTED CHLORIDE CONCENTRATIONS IN LEACHATE



7.0 Impact Management Measures

7.1 Long-Term Groundwater Monitoring Program

The objectives of the proposed long-term groundwater monitoring program are:

- To be consistent with the existing groundwater monitoring program in place for the existing landfill;
- To identify potential changes in background groundwater quality in each of the principal hydrostratigraphic units;
- To identify impact on groundwater quality potentially attributable to the operation of the landfill;
- To identify changes in the pattern of groundwater movement at the site; and
- To be used as part of the triggering mechanism for contingency measures.

The proposed long-term groundwater monitoring program is based on the existing groundwater monitoring program. There are 48 monitoring wells included in the existing groundwater monitoring network for the Ridge Landfill. The six additional monitoring well nests that were installed along the perimeter of the expansion area (monitoring well locations 71 through 76) are proposed to be added to the existing monitoring program following ECA approval of the proposed expansion. The groundwater monitoring program for the Old Landfill is summarized in **Table D7-13**.

Table D7-14 summarizes the groundwater monitoring program for the West Landfill/Area A and South Landfill/Area B.

The locations of the groundwater monitoring wells are shown on **FIGURE D7-8**.

Table D7-15 summarizes the list of parameters which is based on Schedule 5 of *O.Reg. 232/98*.

In addition, water samples from private drinking water wells will continue to be taken from residences who have expressed an interest in participating in the groundwater monitoring program.

7.1.1 Monitoring Frequency

The proposed frequency of groundwater sampling is based on the existing site's monitoring program. Groundwater samples are taken from shallow monitoring wells installed in Layer 1 and the basal / bedrock aquifer (Layer 3) twice per year (May and September), water samples are taken form monitoring wells installed in the unweathered till (Layer 2) once per year.

Landfill Standards, A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfill Sites[21], recommends that groundwater samples be taken three times per year: once for the comprehensive list of **Table D7-15**, and twice for the indicator parameter list but may be amended due to site specific conditions. Given the extremely slow groundwater velocities at the site and the extensive historical water quality data base, retaining the current sampling frequency as listed in **Table D7-14** and **Table D7-15** is appropriate.

7.1.2 Groundwater Level Monitoring

Water levels in all monitoring wells are to be recorded twice per year (May and September). Levels are used to establish long-term range of groundwater level fluctuations, to assess groundwater flow patterns and provide data to assess fluctuations in groundwater quality data.

7.1.3 Maintenance of the Monitoring System

Groundwater monitoring wells will be visually inspected during each monitoring event. As necessary, minor repairs will be completed. Monitoring wells identified to be damaged beyond repair will be decommissioned in accordance with standard monitoring well decommissioning procedures and Ontario Regulation 903 and, if necessary the monitoring well will be replaced.

7.1.4 Annual Monitoring Reports

The monitoring program will be documented in an annual monitoring report. The report will contain a presentation of the monitoring data and an assessment via comparison to both historical and applicable criteria. Recommendations will be made, as required, for changes to the groundwater monitoring program. As additional data is acquired and the understanding of the water quality at the site increase, it is foreseen that the scope of the

[21] MECP, Landfill Standards: A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfill Sites, 2012

monitoring program may be correspondingly reduced. The annual monitoring report will also document compliance with the Reasonable Use Guideline and potential triggering of contingency measures for the site.

7.1.5 Post-Closure Monitoring

The groundwater monitoring program will remain in place for two years after the landfill is closed. The monitoring program will be reviewed at that time including a review of the sampling frequency, monitoring well locations and the target parameter list. It is expected that the review will lead to recommendations to reduce the frequency of sampling and to reduce the target parameter list.

Table D7-13: Summary of Groundwater Monitoring Program – Old Landfill

Hydrostratigraphic Layer	Sampling Locations	Frequency
Layer 1 Shallow Weathered Till	11-I, 16-I, 18-I, 19-I, 20-I, 21-I, 22-I, 25-I, 30-III, 32-III, 44-III 1-II, 3-III, 12-I, 5-II, 13-I, 15-I, 31-I	Twice per year (May and September)
Layer 2 Unweathered Till	3-II, 14-I, 30-II, 32-II, 44-II	Twice per year (May and September)
Layer 3 Basal/Bedrock Aquifer	BW-1, BW-4, 32-I, 30-I	Twice per year (May and September)

Table D7-14: Summary of Groundwater Monitoring Program – West Landfill/Area A and South Landfill/Area B

Hydrostratigraphic Layer	Sampling Locations	Frequency
Layer 1 Shallow Weathered Till	Existing Wells 28-III, 46-III, 47-I, 48-I, 49-A, 50-A, 58-A, 59-A, 60-A, 61-A, New Wells 62-A, 63-A, 64-A Expansion Wells 71-A, 72-A, 73-A, 74-A, 75-A and 76-A	Twice per year (May and September)
Layer 2 Unweathered Till	Existing Wells 28-II, 46-II, 47-II, 49-B, 50-B Proposed Wells (installed as filling proceeds) 61-B, 64-B Expansion Wells 71-B, 72-B, 73-B, 74-B, 75-B and 76-B	Twice per year (May and September)
Layer 3 Basal/Bedrock Aquifer	Existing Wells 28-I, 46-I, 49-C, 50-C Proposed Wells (installed as filling proceeds) 61-C, 64-C Expansion Wells 71-C, 72-C, 73-C, 74-C, 75-C and 76-C	Twice per year (May and September)

Table D7-15: Target Parameter List

Comprehensive List	Indicator List
Inorganics	**Inorganics**
Alkalinity, Ammonia, Arsenic, Barium, Boron, Cadmium, Calcium, Chloride, Chromium, Electrical Conductivity, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nitrate, Nitrite, Total Kjeldahl Nitrogen, pH, Total Phosphorus, Potassium, Sodium, Suspended Solids (Leachate Only), Total Dissolved Solids, Sulphate, Zinc.	Alkalinity, Ammonia, Barium, Boron, Calcium, Chloride, Electrical Conductivity, Iron, Magnesium, Nitrate, pH, Sodium, Suspended Solids (Leachate Only), Total Suspended Solids, Sulphate.
Volatile Organics	**Volatile Organics**
Benzene, 1,4 Dichlorobenzene, Dichloromethane, Toluene, Vinyl Chloride	Not applicable
Other Organics	**Other Organics**
Biochemical Oxygen Demand (BOD_5) (Leachate Only), Dissolved Organic Carbon, Phenol.	Biochemical Oxygen Demand (BOD5) (Leachate Only), Dissolved Organic Carbon.
Field Measurements	**Field Measurements**
pH, Electrical Conductivity	pH, Electrical Conductivity

7.2 Contingency Plans

A contingency plan is defined as a response to a recognized but unexpected failure event. Results of the monitoring program will be compared with trigger criteria for initiating investigative activities into the cause of an unexpected increase in groundwater contaminant concentrations and preparation of a contingency plan. The description of the contingency plans are included in **Appendix D6** – Design and Operations Report.

8.0 Conclusion

The Ridge Landfill Site is located on a thick deposit of low permeability clay till. Hydrogeological testing of the low permeability clay indicates very slow downward groundwater flow velocities of approximately 1 cm per year. Isotope analysis has indicated that porewater deep within the clay was recharged thousands of years ago. In addition to very low groundwater velocities, Layer 2 is consistently homogeneous without any significant changes in lithology both laterally and vertically. Previous investigations identified relatively few significant discontinuities in Layer 2; the drilling completed in 2016 (drilling locations 71 through 76) did not identify any significant discontinuities in Layer 2. This layer is over 30 metres thick.

Contaminant transport modelling indicated that none of the modelled contaminants are expected to exceed the compliance criteria and that peak concentrations would not occur for thousands of years.

The hydrogeological assessment has confirmed that the hydrogeology of the site is predictable such that a groundwater monitoring program can reliably monitor groundwater quality at the site and permit effective implementation of contingency measures.

The primary environmental assessment criteria, indicators, rationale and data sources for the hydrogeological impact assessment as outlined in the approved ToR, (explained in **Section 2.2** of the report) are the following:

Contaminating Lifespan

Chloride is the indicator parameter used for the Ridge Landfill to calculate the contaminating lifespan. The contaminant transport model predicts that chloride concentrations will be below the allowable concentration in 380 years. Therefore the contaminating lifespan for the landfill is in the order of 380 years. The analysis indicated that the underdrain leachate collection system is not needed to achieve compliance for the drinking water aquifer (Layer 3). Leachate collection from a perimeter leachate collection is required from the vertical expansion of the Old Landfill and the new fill areas after the underdrain leachate collection system ceases to function for the duration of the contaminating lifespan.

A comment received from the MECP during the review of the Hydrogeological work plan requested that the landfill gas contaminating lifespan be determined. This comment is addressed in **Appendix D6** – Design and Operations Report.

Potential Impacts to Groundwater Quality

Concentrations based on predictive contaminant transport modelling (i.e., POLLUTE™) (assessment of net effects) were compared to the allowable concentrations derived from the Reasonable Use Guidelines. As documented in **Section 6.1** of this report, the predicted concentrations of all contaminants will be below the allowable increases calculated from the Reasonable Use Guideline. The models predict that the movement of organic contaminants will only reach a few metres below the landfill base due to biodegradation processes and the extremely low groundwater flow rates. Predicted maximum concentrations of cadmium and lead will be less than allowable concentrations and are predicted to occur in layer 3 more than 5,000 years from present.

Chloride concentrations are predicted to be below allowable concentrations and maximum concentrations will not occur for more than 3000 years from present. Overall, the contaminant transport modelling indicates that the site complies with the Reasonable Use Guideline and the drinking water aquifer (Layer 3) and surrounding drinking water wells will be protected.

Potential Impacts to Groundwater Quantity

The thick deposit of low permeability till (Layer 2) at the site indicates that the amount of natural recharge to the drinking water aquifer (Layer 3) is in the order of 1 cm per year. There will be a slight reduction in the recharge rate during the operating period of the underdrain leachate collection system in the horizontal expansion areas (West Landfill/Area A and South Landfill/Area B) but this is offset by the recharge from the Old Landfill vertical expansion. Overall, there is no reduction in infiltration rate to the drinking water aquifer (Layer 3) from landfill development in comparison to the amount of recharge that is presently occurring prior to landfill expansion.

Potential Impacts to Water Supply Wells

The contaminant transport modelling indicates maximum concentrations will be less than that allowed under the Reasonable Use Guideline. The simulations indicate that organic contaminants will be reduced to below detectable levels only a few metres below the landfill base. Heavy metals (cadmium and lead) are adsorbed onto the clay particles and maximum concentrations (which are less than allowable concentrations are not predicted to occur for more than 5,000 years. Chloride, an aesthetic related parameter, is predicted to take more than 3,000 years immediately below the landfill footprint. In addition, it is estimated to take 3,400 years (3,000 years to travel vertically downwards through Layer 2 to Layer 3, and 400 years to travel horizontally in Layer 3) for water to travel from the base of a fill area to a potential off-site well located within 200 m of a fill area. Therefore, it is concluded that there will be no potential impacts on water supply wells resulting from landfill expansion.

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This Hydrogeological Impact Assessment Report has been prepared based in part on information provided by Waste Connections of Canada Inc. (Waste Connections). This report is intended to provide a reasonable review of available information within an agreed work scope, schedule, and budget. This report was prepared by Dillon Consulting Limited (Dillon) for the sole benefit of Waste Connections. The material in the report reflects Dillon's judgment in light of the information available to Dillon at the time of this report preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

____ DATE: _________________________________

Rob Kell, M.A.Sc., P,Eng., P.Geo.

Appendix D7-A

Borehole Logs

DILLON
CONSULTING

DILLON CONSULTING

Borehole ID: BH71-1/MW71-C

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 10/28/16 Date Completed: 11/1/16

Depth (m)	Stratigraphic Description	Well Construction
0	**Clayey Silt and Sand** Brown, trace gravel, trace organics, loose.	Cement + Sand
0.6	At 0.6 mbgs becomes uniform and compact.	
1.5	**Clayey Silt with Sand** Brown, trace gravel, moist, loose crumbly.	
2.6	At 2.6 mbgs becomes uniform and compact.	
3	At 3.0 mbgs becomes moist-dry fractures, weathered, red staining.	
4	**Clayey Silt Till** Grey, uniform, compact, firm-soft.	Grout
11.2	At 11.2 mbgs - Large Rock, sub-angular, 2.5cm.	

Soil Sample ID	Lab Analysis	Rec %	Type
1		100	ST
2		100	ST
3		100	ST
4	Gs, Mc	100	ST
5		100	ST
6		60	ST
7		100	ST
8		100	ST

Depth scale (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

Elev. (masl): 199, 198, 197, 196, 195, 194, 193, 192, 191, 190, 189, 188, 187

LITHOLOGY SYMBOLS: Sand/Silt/Clay; Silt / Clay; Silty Sand and Gravel

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.2
Reference Point Elevation (m asl) : 199.968

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

DILLON CONSULTING

Borehole ID: BH71-1/MW71-C

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 10/28/16
Date Completed: 11/1/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
13	**Clayey Silt Till** Grey, uniform, compact, firm-soft.*(continued)*			9		100	ST		186
14				10		100	ST		185
15									184
16				11	Gs, Mc, FOC	100	ST		183
17				12		100	ST		182
18									181
19				13		100	ST	∇ *Grout*	180
20									179
21				14	Gs, Mc, FOC	100	ST		178
22				15		100	ST		177
23				16		100	ST		176
24									175

LITHOLOGY SYMBOLS: Sand/Silt/Clay; Silt / Clay; Silty Sand and Gravel

∇ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.2
Reference Point Elevation (m asl) : 199.968

Borehole ID: BH71-1/MW71-C

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 10/28/16 Date Completed: 11/1/16

Depth Scale (m)	Stratigraphic Description	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, uniform, compact, firm-soft.*(continued)*	17		100	ST		174
26		18		100	ST		173
27							172
28		19		22	ST		171
29		20		100	ST		170
30							169
31		21		74	ST	*Grout*	168
32		22		100	ST		167
33							166
34		23		100	ST		165
35		24		100	ST		164
36							163
37		25		76	ST		162

LITHOLOGY SYMBOLS: Sand/Silt/Clay; Silty Sand and Gravel; Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.2
Reference Point Elevation (m asl) : 199.968

Borehole ID: BH71-1/MW71-C

DILLON CONSULTING

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski
Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 10/28/16
Date Completed: 11/1/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
38	**Clayey Silt Till** Grey, uniform, compact, firm-soft.*(continued)*							161
39			26		100	ST		160
40			27	Gs, Mc	80	ST		159
41							*Grout*	158
42	At 42 mbgs becomes dry, hard and crumbly.	42	28		40	ST		157
43			29		100	ST		156
44							*Pelt Plug*	155
45			30		52	ST		154
46	**Silty Sand and Gravel** Trace Clay, wet , loose, large pieces of bedrock.	45.7					*Sand*	153
47	**Bedrock**	47.2						152

LITHOLOGY SYMBOLS: Sand/Silt/Clay; Silt / Clay; Silty Sand and Gravel

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.2
Reference Point Elevation (m asl) : 199.968

DILLON CONSULTING

Borehole ID: BH71-2/MW71-B

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/15/16 Date Completed: 12/15/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
0	**Clayey Silt and Sand** Brown, trace gravel, trace organics, loose.						Cement	199
1								198
1.5	**Clayey Silt with Sand** Brown, trace gravel, moist, loose crumbly.	1.5						
2								197
3							Hole Plug	196
4	**Clayey Silt till** Grey, uniform, compact, firm to soft.	4					∇	195
5								194
6								193

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

LITHOLOGY SYMBOLS
- Sand/Silt/Clay
- Silt / Clay

∇ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.08
Reference Point Elevation (m asl) : 199.969

DILLON CONSULTING

Borehole ID: BH71-2/MW71-B

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/15/16 Date Completed: 12/15/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt till Grey, uniform, compact, firm to soft.*(continued)*								192
8									191
								Hole Plug	
9									190
				1			ST		
10									189
				2			ST		
11									188
								Sand; Sand fell into well actual depth 12.8m	
12									187
13									186
			13.7						

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

LITHOLOGY SYMBOLS
Sand/Silt/Clay
Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

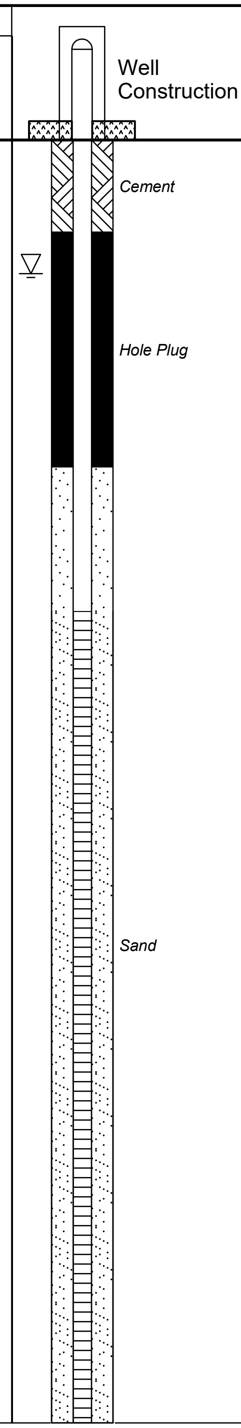
Casing: 2"
Grade Elevation (m asl) : 199.08
Reference Point Elevation (m asl) : 199.969

DILLON CONSULTING

Borehole ID: BH71-3/MW71-A

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/15/16 Date Completed: 12/15/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt and Sand Brown, trace gravel, trace organics, loose.							Cement	199
1								Hole Plug	198
	Clayey Silt with Sand Brown, trace gravel, moist, loose crumbly.		1.5						
2									197
3								Sand	196
4	**Grey Clayey Silt Till** Grey, uniform, compact, firm-soft		4						195
			4.9						



LITHOLOGY SYMBOLS: Sand/Silt/Clay; Silt / Clay

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.09
Reference Point Elevation (m asl) : 200.032

DILLON CONSULTING

Borehole ID: BH72-1/MW72-C

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 10/18/16 Date Completed: 10/26/16

Stratigraphic Description	Depth (m)
Topsoil Medium brown, sandy, silt, trace organics.	
Clayey Silt Brown, weathered, fractured with gray modelled clay, trace gravel, trace fine sand, moist.	0.6
Clayey Silt Till Grey, uniform, compact, firm to soft.	2.8

Soil Sample ID	Lab Analysis	Rec %	Type
1		100	ST
2		100	ST
3		100	ST
4	Gs, Mc	100	ST
5		100	ST
6		73	ST
7	Gs, Mc, FOC	100	ST
8		100	ST

Well Construction: *Cement + Sand*; *Grout*

Depth Scale (m): 1–12; Elev. (masl): 199–187

LITHOLOGY SYMBOLS: Organics; Silty Sand and Gravel; Silt / Clay; Sandy Silt; Shale

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.19
Reference Point Elevation (m asl) : 199.998

DILLON CONSULTING

Borehole ID: BH72-1/MW72-C

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski
Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 10/18/16
Date Completed: 10/26/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, uniform, compact, firm to soft.*(continued)*		9		100	ST		186
	At 13.2 mbgs - Few sand particles, no measurable thickness.	13.2						
14	At 13.7 mbgs - Stones, semi-rounded; Limestone and Shale.	13.7	10		100	ST		185
15								184
16	At 15.3 mbgs - Sub-angular Shale 2 cm.	15.3	11	Gs, Mc	100	ST		183
17			12		100	ST		182
18								181
19	At 18.3 mbgs - Sand parting with large stone, no significant thickness.	18.3	13		98	ST	Grout	180
20			14		98	ST		179
21							▽	178
22			15		96	ST		177
23			16	Gs, Mc	80	ST		176
24								175
25			17		96	ST		174

LITHOLOGY SYMBOLS: Organics; Silty Sand and Gravel; Silt / Clay; Sandy Silt; Shale

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.19
Reference Point Elevation (m asl) : 199.998

DILLON CONSULTING

Borehole ID: BH72-1/MW72-C

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski
Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 10/18/16
Date Completed: 10/26/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, uniform, compact, firm to soft. *(continued)*			18		100	ST		173
27									172
28				19		50	ST		171
29									170
30				20		100	ST		169
31				21		30	ST		168
32									167
33				22		90	ST	*Grout*	166
34				23		60	ST		165
35									164
	At 35.2 mbgs - Becomes soft, slightly clumpy, moist.		35.2	24		90	ST		
36									163
37				25		46	ST		162
38									161
				26		92	ST		

LITHOLOGY SYMBOLS: Organics; Silty Sand and Gravel; Silt / Clay; Sandy Silt; Shale

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.19
Reference Point Elevation (m asl) : 199.998

Borehole ID: BH72-1/MW72-C

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 10/18/16 Date Completed: 10/26/16

Depth (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction
39	**Clayey Silt Till** Grey, uniform, compact, firm to soft.*(continued)* At 39 mbgs - Becomes uniform/smooth.	Silt / Clay	39					Grout
				27	Gs, Mc	66	ST	
				28		100	ST	
42.3	At 42.3 mbgs - Becomes drier, loose, crumbly.	Silt / Clay	42.3					
43.2	At 43.2 mbgs - Becomes dencse, moist, compact.	Silt / Clay	43.2	29		40	ST	
				30		70	ST	
				31		56	ST	
				32		40	ST	
48.2	**Sandy Silt** Fine sand, trace gravel, dry to moist, loose, trace clay.	Sandy Silt	48.2					
49.5	At 49.5 mbgs - Becomes more moist and compact.	Sandy Silt	49.5	33	Gs, MC	100	ST	Pelt Plug
50.1	**Silty Sand and Gravel** Coarse to fine sand, loose, dry to moist, gravel, trace sub-angular pieces of shale.	Silty Sand and Gravel	50.1					Sand
50.3	**Bedrock**	Shale	50.3					
			51.8					

Depth scale (m): 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51

Elev. (masl): 160, 159, 158, 157, 156, 155, 154, 153, 152, 151, 150, 149, 148

LITHOLOGY SYMBOLS: Organics; Silty Sand and Gravel; Silt / Clay; Sandy Silt; Shale

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

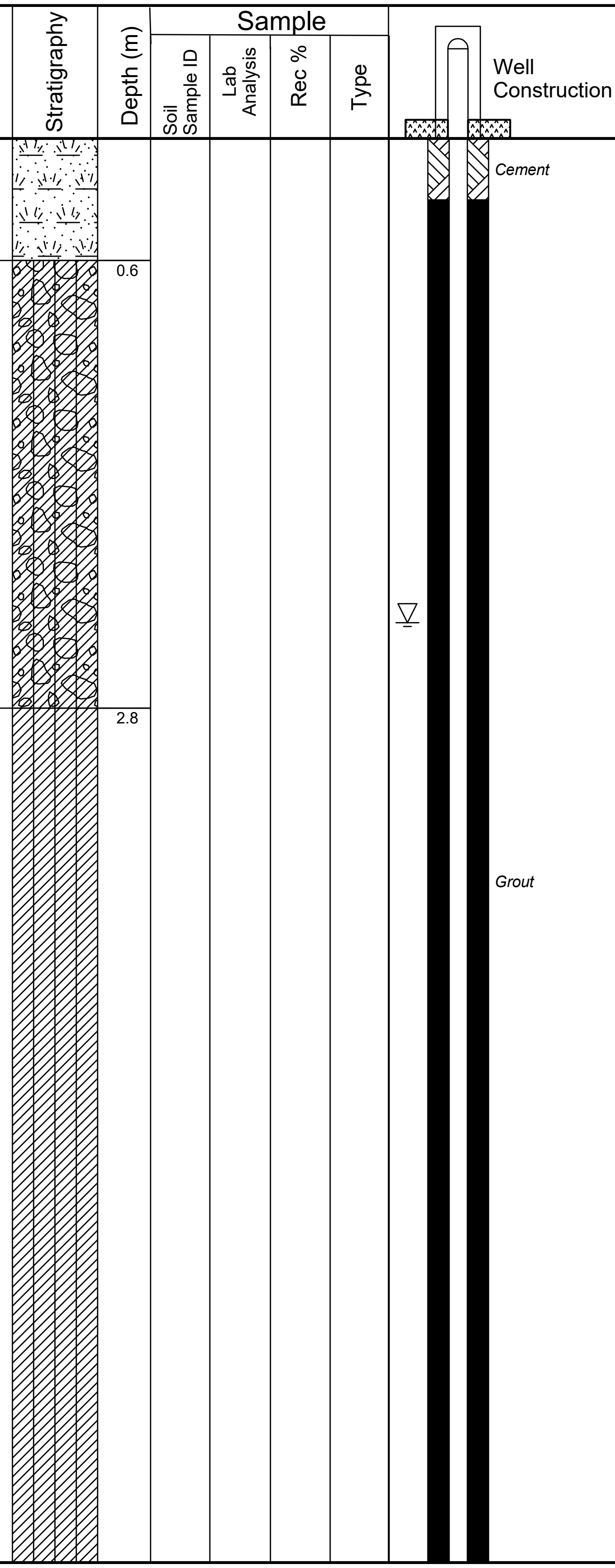
Casing: 2"
Grade Elevation (m asl) : 199.19
Reference Point Elevation (m asl) : 199.998

Borehole ID: BH72-2/MW72-B

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 10/27/16 Date Completed: 10/27/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Topsoil Medium brown, sandy, silt, trace organics.						Cement	199
1	**Clayey Silt** Brown, weathered, fractured with grey modelled clay, trace gravel, trace fine sand, moist.	0.6						198
2								197
3	**Clayey Silt Till** Uniform, compact, firm to soft.	2.8						196
4							Grout	195
5								194
6								193



LITHOLOGY SYMBOLS: Organics; Silty Clay and Gravel; Silt / Clay

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.18
Reference Point Elevation (m asl) : 199.942

Borehole ID: BH72-2/MW72-B

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 10/27/16 Date Completed: 10/27/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
	Clayey Silt Till Uniform, compact, firm to soft.*(continued)*	Silt / Clay							192
8									191
9				1			ST	*Grout*	190
10									189
11				2			ST		188
								Pelt Plug	
12									187
								Sand	
13									186
			13.7						

LITHOLOGY SYMBOLS: Organics; Silty Clay and Gravel; Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.18
Reference Point Elevation (m asl) : 199.942

DILLON CONSULTING

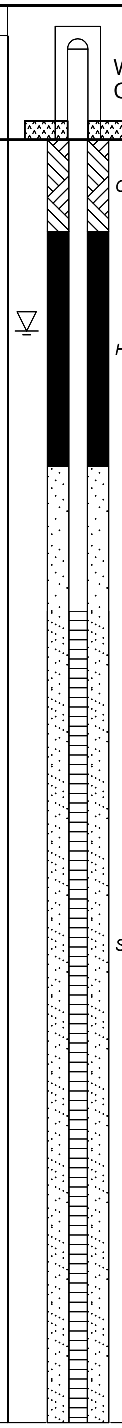
Borehole ID: BH72-3/MW72-A

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 10/27/16
Date Completed: 10/27/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type
	Topsoil Medium brown, sandy, silt, trace organics.					
	Clayey Silt Brown, weathered, fractured with grey modelled clay, trace gravel, trace fine sand, moist.	0.6				
1, 2						
	Clayey Silt Till Grey, uniorm, compact, firm to soft.	2.8				
3, 4		4.9				

Well Construction



Elev. (masl): 199, 198, 197, 196, 195

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

LITHOLOGY SYMBOLS: Organics; Silty Clay and Gravel; Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.21
Reference Point Elevation (m asl) : 199.971

DILLON CONSULTING

Borehole ID: BH73-1/MW73-C

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/8/16 Date Completed: 12/13/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Topsoil Sandy Silt with organics, trace gravel, fractured.	0.15					Cement + Sand	199
1	**Clayey Silt** Brown grey, rust colouring, trace gravel, fractured, modelled clay.		1		100	ST		198
2	At 2.1 mbgs - Becomes uniform, firm to soft.	2.1	2		100	ST		197
3								196
4	**Sand** Trace silt, fine grain, wet.	3.6	3		60	ST		195
5	**Clayey Silt Till** Grey, trace gravel, trace sand along the outside of the core sample, moist	4.5	4	Gs, Mc, IST	100	ST		194
6			5		100	ST	Grout	193
7								192
8	At 7.6 mbgs - Becomes firm to soft, uniform, moist, trace gravel	7.6	6		100	ST		191
9								190
10	At 10.2 mbgs - Becomes wet, slightly loose.	10.2	7	Gs, Mc, FOC, IST	100	ST		189
11			8		100	ST		188
12								187

LITHOLOGY SYMBOLS: Organics; Silty Clay and Gravel; Sand; Silt / Clay; Shale

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.27
Reference Point Elevation (m asl) : 200.027

DILLON CONSULTING

Borehole ID: BH73-1/MW73-C

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location: Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 12/8/16
Date Completed: 12/13/16

Depth Scale (m)	Stratigraphic Description	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
13	**Clayey Silt Till** Grey, trace gravel, trace sand along the outside of the core sample, moist *(continued)*	9		100	ST		186
14		10		100	ST		185
15–16		11	Gs, Mc, FOC	100	ST		184, 183
17		12		100	ST		182
18–19		13	IST	100	ST	*Grout*	181, 180
20–21		14		100	ST		179, 178
22		15		70	ST	▽	177
23–24		16	Gs, Mc	100	ST		176, 175

LITHOLOGY SYMBOLS: Organics; Silty Clay and Gravel; Sand; Silt / Clay; Shale

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.27
Reference Point Elevation (m asl) : 200.027

Borehole ID: BH73-1/MW73-C

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/8/16 Date Completed: 12/13/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, trace gravel, trace sand along the outside of the core sample, moist *(continued)*			17		100	ST		174
26				18		100	ST		173
27									172
28				19		100	ST		171
29				20	IST	50	ST		170
30									169
31				21		100	ST	*Grout*	168
32				22		100	ST		167
33									166
34				23		60	ST		165
35				24		20	ST		164
36									163
37				25		100	ST		162

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

LITHOLOGY SYMBOLS: Organics; Sand; Shale; Silty Clay and Gravel; Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.27
Reference Point Elevation (m asl) : 200.027

DILLON CONSULTING

Borehole ID: BH73-1/MW73-C

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/8/16 Date Completed: 12/13/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
38	**Clayey Silt Till** Grey, trace gravel, trace sand along the outside of the core sample, moist*(continued)*	Silt / Clay							
39				26		0	ST		161, 160
40				27	Gs, Mc, IST	100	ST	*Grout*	159
41–42				28		100	ST		158, 157
43				29		40	ST	*Pelt Plug*	156
44–45				30	Gs, Mc, IST	70	ST	*Sand*	155, 154
	Bedrock	Shale	45.4						
			45.7						

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

LITHOLOGY SYMBOLS: Organics; Silty Clay and Gravel; Sand; Silt / Clay; Shale

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.27
Reference Point Elevation (m asl) : 200.027

DILLON CONSULTING

Borehole ID: BH73-2/MW73-B

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location: Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 12/14/16
Date Completed: 12/15/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Topsoil Sandy silt, organics, trace gravel, fractured.						Cement + Sand	199
	Clayey Silt Brown and grey, trace gravel, fractured, slight rust colouring, modelled clay.	0.15						
1								198
2								197
3								196
	Sand Fine grained, trace silt, wet.	3.6					Hole Plug	
4								195
	Clayey Silt Till Grey, trace gravel, trace sand along the outside of the core sample, moist.	4.5						
5								194
6								193

LITHOLOGY SYMBOLS: Organics; Silty Clay and Gravel; Sand; Silt / Clay

∇ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.23
Reference Point Elevation (m asl) : 200.004

DILLON CONSULTING

Borehole ID: BH73-2/MW73-B

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/14/16 Date Completed: 12/15/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, trace gravel, trace sand along the outside of the core sample, moist.*(continued)*	Silt / Clay							192
8									191
9				1			ST	*Hole Plug*	190
10									189
11				2			ST		188
								Pelt Plug	
12									187
								Sand	
13									186
			13.7						

LITHOLOGY SYMBOLS: Organics; Silty Clay and Gravel; Sand; Silt / Clay

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.23
Reference Point Elevation (m asl) : 200.004

DILLON CONSULTING

Borehole ID: BH73-3/MW73-A

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/15/16 Date Completed: 12/15/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
	Topsoil Sandy silt with organics, trace gravel, fractured.	Organics						Cement + Sand	
	Clayey Silt Brown and grey, trace gravel, fractured, slight rust colouring, modelled clay.	Silty Clay and Gravel	0.15					Hole Plug; Sand	199
1									198
2									197
3									196
	Sand Trace silt, fine grain, wet	Sand	3.6						
4									195
	Clayey Silt Till Grey, trace gravel, trace sand along the outside of the core, moist.	Silt / Clay	4.5						
			4.6						

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

LITHOLOGY SYMBOLS: Organics; Silty Clay and Gravel; Sand; Silt / Clay

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.22
Reference Point Elevation (m asl) : 200.080

DILLON CONSULTING

Borehole ID: BH74-1/MW74-C

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 11/16/16
Date Completed: 11/22/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Topsoil Medium Brown, sandy silt with organics, trace gravel, fractured.		1		60	ST	Cement + Sand; Sand	
1								199
	Clayey Silt Till Brown and grey, trace gravel, trace sand, uniform.	1.2	2		100	ST		
2								198
3	**Clayey Silt Till** Grey, compact, uniform, trace sand, trace gravel, moist.	3	3	Gs, Mc	100	ST		197
4								196
5			4		100	ST		195
6								194
7			5		100	ST	Grout	193
8			6		100	ST		192
9								191
10			7	Gs, Mc, FOC	100	ST		190
11			8		100	ST		189
12								188

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Sand; Shale

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.93
Reference Point Elevation (m asl) : 200.731

Borehole ID: BH74-1/MW74-C

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 11/16/16 Date Completed: 11/22/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
13	**Clayey Silt Till** Grey, compact, uniform, trace sand, trace gravel, moist.*(continued)*	Silt / Clay		9		100	ST		187
14				10		80	ST		186
15									185
16				11		0	ST		184
17	At 16.7 mbgs - Becomes moist, sticky, more "clayey".	Silt / Clay	16.7	11	Gs, Mc, FOC	100	ST		183
18									182
19				12		100	ST	Grout	181
20									180
21				13		100	ST		179
22				14	Gs, Mc	100	ST	∇	178
23									177
24				15		100	ST		176

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Sand; Shale

∇ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.93
Reference Point Elevation (m asl) : 200.731

Borehole ID: BH74-1/MW74-C

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 11/16/16 Date Completed: 11/22/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, compact, uniform, trace sand, trace gravel, moist.*(continued)*	Silt / Clay		16		100	ST		
26									174
				17		100	ST		
27									173
	27.4 mbgs to 33.8 mbgs - Poor recovery due to rock blocking auger.		27.4	18		20	ST		
28									172
	At 28.6 mbgs - Becomes less moist, compact, soft to firm.		28.6						
29									171
				19		30	ST		
30									170
31									169
				20		50	ST	*Grout*	
32									168
				21		100	ST		
33									167
34									166
				22		80	ST		
35									165
				23		100	ST		
36									164
37									163
				24		80	ST		

LITHOLOGY SYMBOLS: Organics, Silt / Clay, Sand, Shale

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.93
Reference Point Elevation (m asl) : 200.731

Borehole ID: BH74-1/MW74-C

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 11/16/16 Date Completed: 11/22/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
38	**Clayey Silt Till** Grey, compact, uniform, trace sand, trace gravel, moist.*(continued)*							162
39			25		50	ST		161
40–41			26	Gs, Mc	100	ST		160, 159
42			27		32	ST	*Grout*	158
43	At 42.9 mbgs - Becomes dry, crumbly, firm. Hit a pocket of methane; pressure made cores hard to recover.	42.9	28		80	ST		157, 156
45			29		40	ST		155
46			30		20	ST	*Pelt Plug*	154
47	At 46.9 mbgs - Becomes moist to wet, trace gravel, trace sand.	46.9					*Sand*	153
48	**Sand** Coarse to fine, moist, trace silt.	47.8	31	Gs, Mc	50	ST		152
	Bedrock	48.4						
		48.7						

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

LITHOLOGY SYMBOLS: Organics, Silt / Clay, Sand, Shale

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.93
Reference Point Elevation (m asl) : 200.731

DILLON CONSULTING

Borehole ID: BH74-2/MW74-B

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 11/23/16 Date Completed: 11/23/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
0–1.2	**Top Soil** Medium brown, sandy silt with organics, trace gravel, fractured.	Organics						Cement + Sand	199
1.2–3	**Clayey Silt Till** Brown to grey, trace gravel, trace sand, uniform.	Silt / Clay	1.2					Hole Plug	198, 197
3–7	**Clayey Silt Till** Grey, compact, uniform, trace sand, trace gravel, moist.	Silt / Clay	3					Hole Plug	196, 195, 194, 193

Depth scale: 1, 2, 3, 4, 5, 6

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Silt / Clay

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.89
Reference Point Elevation (m asl) : 200.648

Borehole ID: BH74-2/MW74-B

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 11/23/16 Date Completed: 11/23/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, compact, uniform, trace sand, trace gravel, moist.*(continued)*	Silt / Clay							
8									192
9									191
				1			ST	*Hole Plug* (water level ∇)	
10									190
				2			ST		
11									189
								Pelt Plug	
12									188
								Sand	
13									187
			13.7						

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Silt / Clay

∇ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

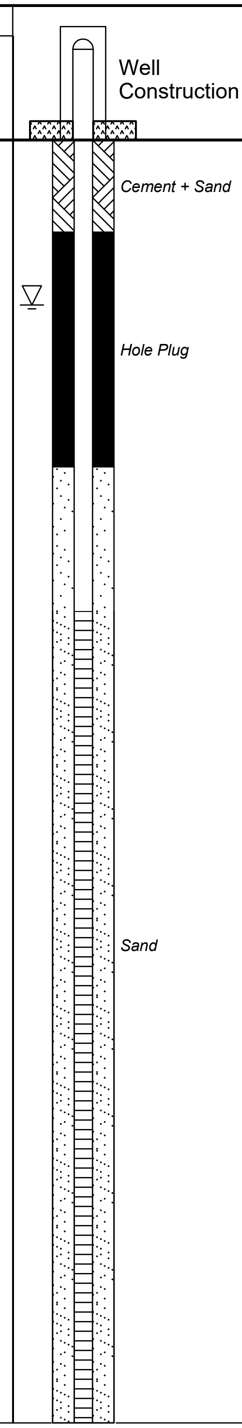
Casing: 2"
Grade Elevation (m asl) : 199.89
Reference Point Elevation (m asl) : 200.648

DILLON CONSULTING

Borehole ID: BH74-3/MW74-A

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 11/23/16 Date Completed: 11/23/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
	Topsoil Medium brown, sandy silt with organics, trace gravel, fractured.	Organics						Cement + Sand; Hole Plug; ▽	
1									199
	Clayey Silt Till Brown and grey, trace gravel, trace sand, uniform.	Silt / Clay	1.2					Sand	
2									198
3	**Clayey Silt Till** Grey, compact, uniform, trace sand, trace gravel, moist.	Silt / Clay	3					Sand	197
4									196
			4.9						



LITHOLOGY SYMBOLS: Organics; Silt / Clay; Silt / Clay

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 199.93
Reference Point Elevation (m asl) : 200.669

DILLON CONSULTING

Borehole ID: BH75-1/MW75-C

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 11/23/16
Date Completed: 11/29/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
0–1.5	**Topsoil** Brown, sandy silt with gravel, rust colouring, fractured, trace clay, crumbly.	Organics		1		100	ST	Cement + Sand; Sand	200, 199
1.5–3.6	**Clayey Silt** Brown and grey, rust colouring, trace gravel, moist to dry.	Silt / Clay	1.5	2		100	ST	Grout	198, 197
3.6–	**Clayey Silt Till** Grey, uniform, compact, firm to soft.	Silt / Clay	3.6	3		100	ST	Grout	196
				4	Gs, Mc	100	ST	Grout	195
				5		100	ST	Grout	194, 193
				6		100	ST	Grout	192
				7	Gs, Mc, FOC	100	ST	Grout	191, 190
				8		100	ST	Grout	189, 188

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.37
Reference Point Elevation (m asl) : 201.056

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

DILLON CONSULTING

Borehole ID: BH75-1/MW75-C

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 11/23/16
Date Completed: 11/29/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, uniform, compact, firm to soft. *(continued)*		9		100	ST		187
14			10		100	ST		186
15								185
16			11	Gs, Mc, FOC	100	ST		184
17			12		100	ST		183
18	At 18.2 mbgs - Poor recovery due to large rock blocking the auger.	18.2						182
19			13		50	ST	*Grout*	181
20			14		100	ST	▽	180
21	At 21.3 mbgs - Poor recovery due to large rock blocking the auger.	21.3						179
22			15		20	ST		178
23	At 22.8 mbgs - Becomes moist and uniform.	22.8						177
24			16	Gs, Mc	100	ST		176
25			17		100	ST		175

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Silt / Clay

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.37
Reference Point Elevation (m asl) : 201.056

DILLON CONSULTING

Borehole ID: BH75-1/MW75-C

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 11/23/16 Date Completed: 11/29/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, uniform, compact, firm to soft.*(continued)*	Silt / Clay		18		100	ST		174
27									173
28				19		100	ST		172
29									171
30				20		100	ST		170
31				21		100	ST		169
32								*Grout*	168
33				22		100	ST		167
34				23		100	ST		166
35									165
36				24		100	ST		164
37				25		100	ST		163
38									162
				26		100	ST		

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Silt / Clay

∇ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.37
Reference Point Elevation (m asl) : 201.056

DILLON CONSULTING

Borehole ID: BH75-1/MW75-C

Client: Ridge Landfill EA | Project: Hydrogeological Study
Project No.: 15-2456 | Location : Blenheim, Ontario
Drilling Co.: AT COST | Drilling Method: CME Auger Continous Core
Observer: J.Sikorski | Date Started: 11/23/16 | Date Completed: 11/29/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, uniform, compact, firm to soft.*(continued)*	Silt / Clay							161
40	At 39.6 mbgs - Poor recovery due to large rock blocking the auger.	Silt / Clay	39.6	27	Gs, Mc	50	ST		160
41–42				28		50	ST		159
43				29		100	ST		158, 157
44–45				30		50	ST	Grout	156, 155
46–47				31		40	ST		154
48				32		20	ST	Pelt Plug	153, 152
49	At 48.7 mbgs - Becomes very wet and loose.	Silt / Clay	48.7	33		100	ST		151
50–51				34	Gs, Mc		ST	Sand	150, 149
			51.5						

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.37
Reference Point Elevation (m asl) : 201.056

Borehole ID: BH75-2/MW75-B

DILLON CONSULTING

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 11/30/16 Date Completed: 11/30/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction
0	**Topsoil** Brown, sandy silt with gravel, rust colouring, fractured, trace clay, crumbly.						Cement + Sand
1.5	**Clayey Silt** Brown and grey, rust colouring, trace gravel, moist to dry.	1.5					
3.6	**Clayey Silt Till** Grey, uniform, compact, firm to soft.	3.6					Hole Plug

Depth Scale (m): 1, 2, 3, 4, 5, 6

Elev. (masl): 200, 199, 198, 197, 196, 195, 194

LITHOLOGY SYMBOLS
Organics
Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.37
Reference Point Elevation (m asl) : 201.101

Borehole ID: BH75-2/MW75-B

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 11/30/16 Date Completed: 11/30/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, uniform, compact, firm to soft.*(continued)*	Silt / Clay							193
8									192
9				1			ST	*Hole Plug*	191
10									190
11				2			ST		189
								Pelt Plug	
12								*Sand*	188
13									187
			13.7						

LITHOLOGY SYMBOLS
Organics
Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.37
Reference Point Elevation (m asl) : 201.101

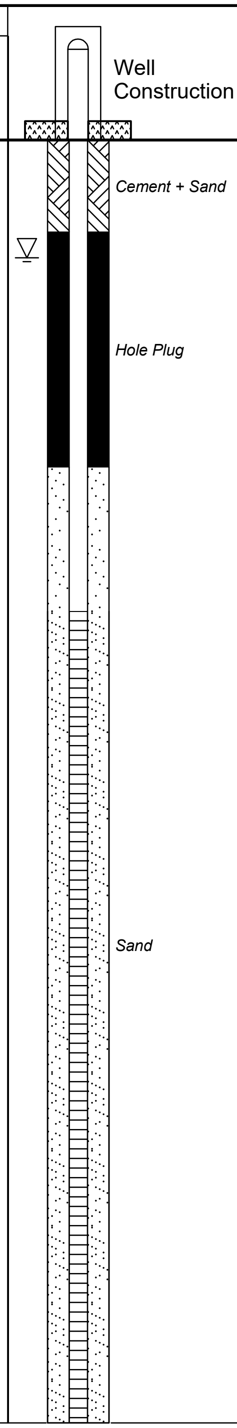
DILLON CONSULTING

Borehole ID: BH75-3/MW75-A

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 12/1/16 Date Completed: 12/1/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
0–1.5	**Top Soil** Brown, sandy silt with gravel, rust colouring, fractured, trace clay, crumbly.	Organics						Cement + Sand; Hole Plug	200
1.5–3.6	**Clayey Silt** Brown grey, rust colouring, trace gravel, moist to dry.	Silt / Clay	1.5					Sand	199, 198, 197
3.6–4.9	**Clayey Silt Till** Grey, uniform, compact, firm to soft.	Silt / Clay	3.6					Sand	196
			4.9						



LITHOLOGY SYMBOLS
Organics
Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.32
Reference Point Elevation (m asl) : 201.071

DILLON CONSULTING

Borehole ID: BH76-1/MW76-C

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location : Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 12/1/16 Date Completed: 12/6/16

Depth (m)	Stratigraphic Description	Soil Sample ID	Lab Analysis	Rec %	Type
0	**Topsoil** Brown, silt with organics, modelled clay, trace gravel, fractured, moist.	1		100	ST
1.5	**Clayey Silt** Brown grey, trace gravel, firm, moist to dry, slight fractures.	2		100	ST
2.1	**Clayey Silt Till** Grey, trace gravel, uniform, moist.				
3	3 mbgs to 3.9 mbgs - Slight rust colouration, fractured.	3	IST	100	ST
3.9	At 3.9 mbgs - Becomes uniform, grey, moist.	4	Gs, Mc	100	ST
		5		100	ST
7.6	**Sand** Fine to coarse, trace gravel and silt.				
8.2	**Clayey Silt Till** Grey, trace gravel, uniform, moist.	6	Gs, Mc	100	ST
		7	Gs, Mc, FOC, IST	100	ST
		8		100	ST

Well Construction: Cement + Sand; Grout

Elev. (masl): 200, 199, 198, 197, 196, 195, 194, 193, 192, 191, 190, 189, 188

LITHOLOGY SYMBOLS: Organics; Sand; Sand/Silt/Clay; Silt / Clay; Silt / Clay; Silty Sand and Gravel

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.43
Reference Point Elevation (m asl) : 201.161

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

Borehole ID: BH76-1/MW76-C

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/1/16 Date Completed: 12/6/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, trace gravel, uniform, moist.*(continued)*	Silt / Clay		9		100	ST		187
14				10		60	ST		186
15									185
16				11	Gs, Mc, FOC	100	ST		184
17				12		100	ST		183
18									182
19				13	IST	100	ST	*Grout*	181
20				14	Gs, Mc	100	ST		180
21									179
22				15		100	ST	∇	178
23				16		100	ST		177
24									176
25				17		100	ST		175

LITHOLOGY SYMBOLS: Organics, Silt / Clay, Sand, Silt / Clay, Sand/Silt/Clay, Silty Sand and Gravel

∇ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.43
Reference Point Elevation (m asl) : 201.161

DILLON CONSULTING

Borehole ID: BH76-1/MW76-C

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/1/16 Date Completed: 12/6/16

Depth Scale (m)	Stratigraphic Description	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, trace gravel, uniform, moist.*(continued)*	18		100	ST		174
27							173
28		19		100	ST		172
29		20	IST	100	ST		171
30							170
31		21		100	ST		169
32		22		100	ST	*Grout*	168
33							167
34		23		100	ST		166
35		24		100	ST		165
36							164
37		25		100	ST		163
38		26	Gs, Mc	100	ST		162

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Sand; Silt / Clay; Sand/Silt/Clay; Silty Sand and Gravel

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.43
Reference Point Elevation (m asl) : 201.161

DILLON CONSULTING

Borehole ID: BH76-1/MW76-C

Client: Ridge Landfill EA
Project: Hydrogeological Study
Project No.: 15-2456
Location : Blenheim, Ontario
Drilling Co.: AT COST
Drilling Method: CME Auger Continous Core
Observer: J.Sikorski
Date Started: 12/1/16
Date Completed: 12/6/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, trace gravel, uniform, moist.*(continued)*							161
40			27		50	ST		160
41								
42			28		40	ST		159
								158
43			29		80	ST	*Grout*	157
44								156
45			30		80	ST		155
46			31	Gs, Mc	40	ST		154
	At 46.6 mbgs - Sandy clayey silt area.							
47		46.9					*Pelt Plug*	153
48			32	IST	60	ST		152
49	**Sand, Silt and Gravel** Trace clay, wet.	48.7					*Sand*	151
	Bedrock	49.6						
50		50						

LITHOLOGY SYMBOLS: Organics; Sand; Sand/Silt/Clay; Silt / Clay; Silt / Clay; Silty Sand and Gravel

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.43
Reference Point Elevation (m asl) : 201.161

DILLON CONSULTING

Borehole ID: BH76-2/MW76-B

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/7/16 Date Completed: 12/7/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
0	**Topsoil** Brown, silt with organics, modelled clay, trace gravel, fractured, moist.	Organics / Sand						Cement + Sand	200
1									199
1.5	**Clayey Silt** Brown and grey, trace gravel, firm, moist to dry, slight fractures.	Silt / Clay	1.5						
2									198
2.1	**Clayey Silt Till** Grey, trace gravel, uniform, moist.	Silt / Clay	2.1						
3								Hole Plug	197
4								▽	196
5									195
6									194

DILLON MW MOD 152456 - RIDGE LANDFILL EA (2019).GPJ 19-6-22

LITHOLOGY SYMBOLS: Organics; Sand; Silt / Clay

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.42
Reference Point Elevation (m asl) : 201.214

DILLON CONSULTING

Borehole ID: BH76-2/MW76-B

Client: Ridge Landfill EA
Project No.: 15-2456
Drilling Co.: AT COST
Observer: J.Sikorski

Project: Hydrogeological Study
Location: Blenheim, Ontario
Drilling Method: CME Auger Continous Core
Date Started: 12/7/16 Date Completed: 12/7/16

Depth Scale (m)	Stratigraphic Description	Stratigraphy	Depth (m)	Sample: Soil Sample ID	Sample: Lab Analysis	Sample: Rec %	Sample: Type	Well Construction	Elev. (masl)
	Clayey Silt Till Grey, trace gravel, uniform, moist. *(continued)*	Silt / Clay							193
8	**Sand** Fine to coarse, trace gravel and silt.	Sand	7.6						
	Clayey Silt Till Grey, trace gravel, uniform, moist.	Silt / Clay	8.2						192
9				1			ST	*Hole Plug*	191
10									190
11				2			ST		189
12								*Pelt Plug*	188
13								*Sand*	187
			13.7						

LITHOLOGY SYMBOLS: Organics; Silt / Clay; Sand

▽ Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

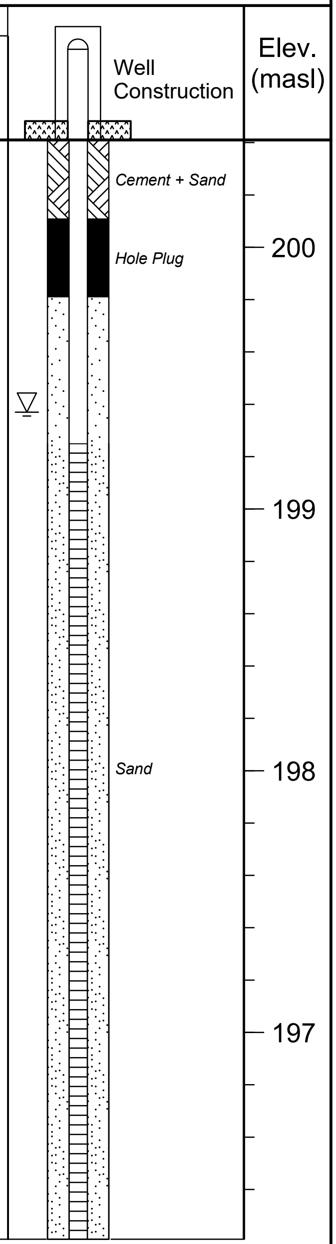
Casing: 2"
Grade Elevation (m asl) : 200.42
Reference Point Elevation (m asl) : 201.214

Borehole ID: BH76-3/MW76-A

DILLON CONSULTING

Client: Ridge Landfill EA	Project: Hydrogeological Study
Project No.: 15-2456	Location : Blenheim, Ontario
Drilling Co.: AT COST	Drilling Method: CME Auger Continous Core
Observer: J.Sikorski	Date Started: 12/8/16 Date Completed: 12/8/16

Depth Scale (m)	Stratigraphic Description	Depth (m)	Soil Sample ID	Lab Analysis	Rec %	Type	Well Construction
0–1.5	**Topsoil** Brown, silt with organics, modelled clay, trace gravel, fractured, moist.						Cement + Sand; Hole Plug; Sand
1.5–2.1	**Clayey Silt** Brown grey, trace gravel, firm, moist to dry, slight fractures.	1.5					Sand
2.1–4.2	**Clayey Silt Till** Grey, trace gravel, uniform, moist.	2.1					Sand
		4.2					



LITHOLOGY SYMBOLS: Organics; Silt / Clay

Water Level (February 19,2019)

Gs - Grain Size
Mc - Moisture Content
FOC - Fraction of Organic Carbon
ST - Split Tube
IST - Isotope

Casing: 2"
Grade Elevation (m asl) : 200.41
Reference Point Elevation (m asl) : 201.158

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 49-1
Sheet 1 of 2

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 14 March 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m) 197.20	DESCRIPTION	NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
	197.0 / 0.2	TOPSOIL	1	AS	6	67	
1		CLAYEY SILT TILL Brownish grey, mottled, some sand, trace gravel, weathered, fractured, moist, DTPL.	2	AS	9	83	
2			3	AS	24	100	
	194.8 / 2.5	2.41m - Becoming dark grey and unweathered.	4	AO		100	b
4	193.1 / 4.2	4.12m - becoming unfractured	5	AO		100	
5			6	AO		100	
6			7	AO		52	b
8			8	AO		81	
9			9	AO		88	b
10			10	AO		70	
12			11	AO		80	b
13			12	AO		82	
15			13	AO		77	b
17				EZ			
19			14	AO		100	

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS (1)

DILLON	PROJECT No. 94 2492-02-02 DATUM: Geodetic	BOREHOLE No. 49-1 Sheet 2 of 2

PROJECT: BFI Ridge Landfill	DATE: 14 March 1995
LOCATION: Blenheim, Ontario	INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
21				15		AO		95	abd		
22			CLAYEY SILT TILL Grey, some sand, trace gravel, moist.	16		AO		77			
23											
24				17		AO		85			
25				18		AO		91			
26											
27				19		AO		100			
28											
29				20		AO		70			
30						EZ					
31											
32	164.9 32.3			21		AO		10			
33			32.31 m - End of Borehole. NOTES: (1) Borehole abandoned due to sampling system malfunction. No well installation. Borehole backfilled to surface with grout.								
34											
35											
36											
37											
38											
39											

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 49-2
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 14 March 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
	197.20										(1)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15	182.0 15.2		15.24 m - End of Borehole. NOTES: (1) Borehole abandoned. No well installation. Borehole backfilled to surface with grout.								
16											
17											
18											
19											

DILLON

PROJECT No.	94 2492-02-02	BOREHOLE No.	49-3
DATUM:	Geodetic	Sheet	1 of 3

PROJECT:	**BFI Ridge Landfill**	**DATE:**	**14 March 1995**
LOCATION:	**Blenheim, Ontario**	**INSPECTOR:**	**MRP**

DEPTH (m)	ELEV. DEPTH (m) 197.20	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 49-C 74cm (1) (2)
	197.0 / 0.2		TOPSOIL								
1			CLAYEY SILT TILL Brownish grey, mottled, some sand, trace gravel, weathered, fractured, moist, DTPL.								
2	194.8 / 2.5		2.41m - Becoming dark grey and unweathered.								
3											
4	193.1 / 4.2		4.12m - becoming unfractured								
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16				22		AO		26			
17											
18				23		AO		32	b		
19											

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 49-3
Sheet 2 of 3

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 14 March 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
21											
22			CLAYEY SILT TILL Grey, some sand, trace gravel, moist.								
23											
24											
25											
26											
27											
28				24		AO		40	abd		
29											
30				25		AO		45			
31				26		AO		73	b		
32											
33				27		AO		70	b		
34				28		AO		30	b		
35											
36				29		AO		30			
37				30		AO		22	abd		
38											
39				31		AO		100	b		

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 49-3

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 14 March 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
	156.4 / 40.8		32	AO		61	
41–42	154.8 / 42.4	SILT Grey, some sand, trace well rounded gravel, saturated.	33	AS		84	b
43	154.0 / 43.2	SHALE Black, weathered.		EZ			

43.22 m - End of Borehole.

NOTES:

(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen.

(2) Waterlevel measured May 1, 1995 at 24.40m below ground surface.

(3) Some stratigraphic information taken from borehole 49-1.

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS

Depth scale (m): 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 49-4
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 21 March 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m) 197.20	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 49-B 74cm (1) (2)
	197.0 0.2		TOPSOIL								
1			**CLAYEY SILT TILL** Brownish grey, mottled, some sand, trace gravel, weathered, fractured, moist, DTPL.								
2	194.8 2.5		2.41m - Becoming dark grey and unweathered.								
3											
4	193.1 4.2		4.12m - becoming unfractured								
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16	181.2 16.0		16.03 m - End of Borehole.								
17											
18											
19											

NOTES:
(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen.
(2) Waterlevel measured May 1, 1995 at 14.70m below ground surface.
(3) Drilled without sampling. For stratigraphic information, refer to borehole 49-1 and 49-3.

DILLON

PROJECT No.	94 2492-02-02	BOREHOLE No.	49-5
DATUM:	Geodetic	Sheet	1 of 1

PROJECT:	BFI Ridge Landfill	DATE:	1 March 1995
LOCATION:	Blenheim, Ontario	INSPECTOR:	MRP

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 49-A 94cm (1) (2)
	197.20										
	197.0 0.2		TOPSOIL								
1			CLAYEY SILT TILL Brownish grey, mottled, some sand, trace gravel, weathered, fractured, moist, DTPL.								
2	194.8 2.4		2.41m - Becoming dark grey and unweathered.								
3											
4	193.1 4.2		4.12m - becoming unfractured								
5	192.6 4.6		4.62m - End of Borehole.								

NOTES:
(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 3.05 m long, No. 10 slot, screen.
(2) Waterlevel taken May 1, 1995 was 2.62m below ground surface.
(3) Drilled without sampling. Stratigraphic information taken from boreholes 49-1 and 49-3.

Depth scale (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. **50-1**
Sheet 1 of 3

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 28 March 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m) 197.85	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
1		CLAYEY SILT TILL Trace sand & fine gravel, moist, weathered, fractured, mottled, DTPL, very firm. 1.52m - Becoming grey.	1	AO		58	
2			2	AO		63	b
3		3.05m - Dark grey, becoming unweathered with mostly vertical oxidized fractures.	3	AO		100	
4		3.81m - Unweathered with occasional closed vertical fractures.	4	AO		70	ab
5		4.67m to 4.78m - Higher sand and gravel content.	5	AO		100	t
	192.3 / 5.5	SILTY SAND Moist, trace fine gravel.	6	AO		100	
6	192.0 / 5.8	CLAYEY SILT AND SILTY SAND Interbedded, moist.	7	AO		100	t
7	191.9 / 6.0	CLAYEY SILT TILL Grey, trace sand and gravel, DTPL, moist, firm.	8	AO		100	b
8			9	AO		63	abdt
9, 10			10	AO		100	b
11			11	AO		80	
12	186.0 / 11.9	CLAYEY, SANDY SILT TILL Grey, dry to moist, trace gravel.	12	AO		100	abt
13	184.8 / 13.1	SILTY SAND Grey, moist, trace fine gravel.	13	AO		100	
14	184.7 / 13.2	CLAYEY SILT TILL Grey, some sand, trace gravel, moist.	14	AO		100	
15			15	AO		100	
16			16	AO		80	
17			17	AO		55	b
18			18	AO		100	abdt
19			19	AO		100	

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS: 50-C 72cm (1) (2)

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 50-1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 28 March 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
				20		AO		100			
21				21		AO		100	b		
22				22		AO		100			
				23		AO		93			
23				24		AO		100	b		
24				25		AO		87			
25				26		AO		100	t		
26				27		AO		100	b		
				28		AO		70			
27				29		AO		100			
28				30		AO		100	b		
29				31		AO		100			
				32		AO		97			
30				33		AO		100	b		
31				34		AO		100	t		
32				35		AO		100			
				36		AO		100	abd		
33			Sand content increased, soft.	37		AO		63			
34				38		AO		73			
35			34.76m - Becoming reddish grey, APL, moist, soft, with silt interbeds.	39		AO		100	b		
				40		AO		100			
36				41		AO		100			
37				42		AO		100	b		
38				43		AO		100			
				44		AO		73	t		
39				45		AO		80	b		

DILLON

PROJECT No. 94 2492-02-02 | DATUM: Geodetic | BOREHOLE No. **50-1** | Sheet 3 of 3

PROJECT: BFI Ridge Landfill | **DATE:** 28 March 1995
LOCATION: Blenheim, Ontario | **INSPECTOR:** MRP

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
		40.05m - Becoming reddish grey, trace sand.	46		AO		100	
41		40.85m - Interbedded with thin dry silt.	47		AO		100	
			48		AO		37	abd
42			49		AO		100	
43			50		AO		100	b
44	153.6 44.2		51		AO		100	b
45		SILT Grey green, some gravel.	52		AO		100	
			53		AO		100	
46			54		AO		100	
47	151.2 46.7	SHALE Black, fractured, saturated.	55		AO		100	
	150.9 47.0	SILT Grey green, some gravel.	56		AO		100	
48	149.9 48.0	SHALE	57		EZ			
	149.6 48.2	48.22m - End of Borehole.						
49		NOTES: (1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen. (2) Water level measured May 1, 1995 at 26.91m below ground surface.						
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 50-2
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 28 March 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION
	197.85	
0–5.5	192.3 / 5.5	CLAYEY SILT TILL Trace sand & fine gravel, moist, weathered, fractured, mottled, DTPL, very firm. 1.52m - Becoming grey. 3.05m - Dark grey, becoming unweathered with mostly vertical oxidized fractures. 3.81m - Unweathered with occasional closed vertical fractures. 4.67m to 4.78m - Higher sand and gravel content.
5.5–5.8	192.0 / 5.8	SILTY SAND Moist, trace fine gravel.
5.8–6.0	191.9 / 6.0	CLAYEY SILT AND SILTY SAND Interbedded, moist.
6.0–11.9	186.0 / 11.9	CLAYEY SILT TILL Grey, trace sand and gravel, DTPL, moist, firm.
11.9–13.1	184.8 / 13.1	CLAYEY, SANDY SILT TILL Grey, dry to moist, trace gravel.
13.1–13.2	184.7 / 13.2	SILTY SAND 13.15m - End of Borehole.

Sample columns: NUMBER | INTERVAL | TYPE | N VALUE | %RECOVERY — LABORATORY ANALYSIS — N VALUE (□) (Blows/0.3m) 20 40 60 80 — MONITOR INSTALLATION DETAILS: 50-B, 74cm, (1) (2)

NOTES:
(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen.
(2) Waterlevel measured May 1, 1995 at 12.50m below ground surface.
(3) Drilled without sampling. For stratigraphic information, refer to borehole 50-1.

DILLON	PROJECT No. 94 2492-02-02 DATUM: Geodetic	BOREHOLE No. 50-3 Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario
DATE: 28 March 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m) 197.85	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 50-A 70cm (1) (2)
1–4			CLAYEY SILT TILL Trace sand & fine gravel, moist, weathered, fractured, mottled, DTPL, very firm. 1.52m - Becoming grey. 3.05m - Dark grey becoming unweathered with mostly vertical oxidized fractures. 3.81m - Unweathered with occasional closed vertical fractures.								
5	193.3 4.6		4.57m - End of Borehole. NOTES: (1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 3.05 m long, No. 10 slot, screen. (2) Waterlevel measured May 1, 1995 at 3.42m below ground surface. (3) Drilled without sampling. For stratigraphic information, refer to borehole 50-1.								
6–19											

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 51-1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 10 April 1995
INSPECTOR: MRP/CGR

DEPTH (m)	ELEV. DEPTH (m) 199.70	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 51-C 89cm (1) (2)
	199.5 0.2		TOPSOIL								
			SILTY SAND Light brown, some gravel, trace clay, moist, weathered.	1		AO		63	b		
1	198.6 1.1			2		AO		90			
	198.6 1.2		SAND - Medium, wet.								
2			CLAYEY SILT TILL Grey, some sand and trace gravel, fractures becoming predominantly vertical with depth, weathered, moist. Becoming unweathered with mostly vertical fractures. No fractures below 3.05m.	3		AO		87			
3				4		AO		100	b		
				5		AO		37			
4				6		AO		17			
5				7		AO		100	abt		
6				8		AO		100			
				9		AO		100	t		
7				10		AO		100	b		
8				11		AO		100			
9			8.38m to 9.15m - Increased sand content.	12		AO		100	abt		
				13		AO		100			
10				14		AO		100			
11				15		AO		93			
12				16		AO		100	bt		
				17		AO		100			
13				18		AO		100	b		
14				19		AO		87			
15				20		AO		100			
16				21		AO		100	ab		
				22		AO		93			
17				23		AO		47			
18				24		AO		50			
19				25		AO		63	bt		
				26		AO		77			

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 51-1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 10 April 1995
INSPECTOR: MRP/CGR

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
			27	AO		70	b
21		CLAYEY SILT TILL Grey, some sand, trace gravel, moist to dry.	28	AO		100	
22			29	AO		63	
			30	AO		87	b
23			31	AO		40	
24			32	AO		57	
			33	AO		53	abdt
25			34	AO		60	
26			35	AO		67	
27			36	AO		77	b
28			37	AO		70	
			38	AO		70	
29			39	AO		60	b
30			40	AO		60	t
31			41	AO		70	
			42	AO		70	
32			43	AO		73	b
33			44	AO		13	
34			45	AO		77	
35			46	AO		40	b
			47	AO		97	
36			48	AO		100	abd
37	162.9 36.8	CLAY Reddish grey, trace silt and sand, occasional thin interbeds of dry silt, soft, APL, moist.	49	AO		83	
38		38.26m - Becoming firm, DTPL.	50	AO		100	
			51	AO		100	t
39			52	AO		83	b

N VALUE (□) (Blows/0.3m) 20 40 60 80

MONITOR INSTALLATION DETAILS

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 51-1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 10 April 1995
INSPECTOR: MRP/CGR

ELEV. / DEPTH (m)	DESCRIPTION
	40.24m - Becoming grey, APL, moist, firm,
	41.13m - 13cm limestone cobble.
156.5 / 43.2	**CLAYEY SILT** Grey, some sand and gravel, moist
156.4 / 43.4	**SILTY SAND** Grey, some gravel, wet. Becoming trace clay 43.80m - 2mm thick dry silt interbed. Becoming trace gravel, moist, dense.
154.3 / 45.4	**SANDY SILT** Green, some gravel, trace clay.
152.8 / 46.9	**SHALE** Black, weathered.
152.6 / 47.2	47.15m - End of Borehole.

SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
53	AO		0	
54	AO		27	
55	AO		100	b
56	AO		100	
57	AO		100	abd
58	AO		87	
59	AO		43	
60	AO		81	b

DEPTH (m): 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS

NOTES:
(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen.
(2) Waterlevel measured May 1, 1995 at 27.63m below ground surface.

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. **51-2**
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 11 April 1995
INSPECTOR: MRP/CGR

ELEV. DEPTH (m)	DESCRIPTION
199.70	
199.5 / 0.2	TOPSOIL
	SILTY SAND Light brown, some gravel, trace clay, moist, weathered.
198.6 / 1.1	SAND - Medium, wet.
198.6 / 1.2	CLAYEY SILT TILL Grey, some sand and trace gravel, fractures becoming predominantly vertical with depth, weathered, moist. Becoming unweathered with mostly vertical fractures. No fractures below 3.05m. 8.38m to 9.15m - Increased sand content.
186.0 / 13.7	13.72m - End of Borehole.

Column headings: DEPTH (m); ELEV. DEPTH (m); SYMBOLIC LOG; DESCRIPTION; SAMPLE (NUMBER, INTERVAL, TYPE, N VALUE, %RECOVERY); LABORATORY ANALYSIS; N VALUE (□) (Blows/0.3m) 20 40 60 80; MONITOR INSTALLATION DETAILS: 51-B, 86cm, (1) (2)

Depth scale (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

NOTES:
(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen.
(2) Waterlevel measured May 1, 1995 at 13.30m below ground surface.
(3) Drilled without sampling. For stratigraphic information, refer to borehole 51-1.

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. **51-3**
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 11 April 1995
INSPECTOR: MRP/CGR

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 51-A 79cm (1) (2)
	199.70										
	199.5 / 0.2		TOPSOIL								
1	198.6 / 1.1		SILTY SAND Light brown, some gravel, trace clay, moist, weathered.								
	198.6 / 1.2		SAND - Medium, wet.								
2, 3, 4			CLAYEY SILT TILL Grey, some sand and trace gravel, fractures becoming predominantly vertical with depth, weathered, moist. Becoming unweathered with mostly vertical fractures. No fractures below 3.05m.								
5	195.1 / 4.6		4.57m - End of Borehole.								

NOTES:
(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 3.05 m long, No. 10 slot, screen.
(2) Waterlevel measured May 1, 1995 at 4.34m below ground surface.
(3) Drilled without sampling. For stratigraphic information, refer to borehole 51-1.

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 52-1
Sheet 1 of 3

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 3 April 1995
INSPECTOR: MRP/RFK

DEPTH (m)	ELEV. DEPTH (m) 199.37	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 52-C 84cm (1) (2)
	199.1 0.3		TOPSOIL	1		AO		83			
1	198.0 1.4		CLAYEY SILT TILL Orange brown mottled, weathered, fractured, trace sand and gravel, moist, cobble at 0.61m.	2		AO		30	b		
2			SAND AND GRAVEL Grey black, gravel, saturated, silty from 2.13 to 2.24m.	3		AO		100			
	196.5 2.9			4		AO		100	b		
3				5		AO		100			
4			CLAYEY SILT TILL Grey, some sand, trace gravel, unfractured, unweathered.	6		AO		100			
5				7		AO		100	ab		
6				8		AO		87			
				9		AO		100			
7				10		AO		100			
8				11		AO		100	b		
9				12		AO		100	abd		
10											
11				13		AO		65			
12				14		AO		100			
				15		AO		80	b		
13				16		AO		100			
14				17		AO		100	b		
15				18		AO		100			
16				19		AO		100	b		
17				20		AO		100			
18				21		AO		100			
				22		AO		93			
19				23		AO		90			

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. **52-1**

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 3 April 1995
INSPECTOR: MRP/RFK

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
				24		AO		100			
21				25		AO		100	abd		
22				26		AO		100			
			CLAYEY SILT TILL Grey, some sand, trace gravel, unfractured, unweathered.	27		AO		100			
23				28		AO		100	b		
24				29		AO		100			
25				30		AO		58	b		
26											
27				31		AO		50			
28				32		AO		100	b		
29				33		AO		100			
				34		AO		100			
30				35		AO		100			
31				36		AO		100	abd		
				37		AO		83			
32				38		AO		100			
33				39		AO		100			
34				40		AO		100	b		
35				41		AO		100			
36				42		AO		67			
37				43		AO		45	b		
38				44		AO		97	b		
39				45		AO		63			

DILLON	PROJECT No. 94 2492-02-02 DATUM: Geodetic	BOREHOLE No. 52-1 Sheet 3 of 3
PROJECT: BFI Ridge Landfill LOCATION: Blenheim, Ontario		DATE: 3 April 1995 INSPECTOR: MRP/RFK

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
		39.75m - 3cm thick bed of dry silty fine sand.	46	AO		60	
41			47	AO		77	abd
			48	AO		70	
42	157.1 42.3		49	AO		77	
43		SILTY SAND AND GRAVEL Grey, some clay.	50	AO		63	b
44	155.6 43.7	CLAYEY SILT TILL Grey, some sand, trace gravel.	51	AO		100	b
	155.3 44.0	CLAY Reddish grey, trace silt and sand. 44.86m - 2mm thick silt interbed.	52	AO		90	
45			53	AO		100	
46			54	AO		87	b
	152.9 46.4	SILTY SAND Grey, trace gravel and clay, moist, dense.	55	AO		90	
47	152.5 46.9	SILT Greenish grey, some angular limestone gravel, some clay and sand, with 1 to 2mm thick dry silt interbeds.	56	AO		87	
48			57	AO		47	b
49			58	AO		44	
50	149.7 49.7	49.68m - End of Borehole. NOTES: (1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen. (2) Water level measured May 1, 1995 at 27.09m below ground surface.					
51							
52							
53							
54							
55							
56							
57							
58							
59							

Columns also shown: SYMBOLIC LOG, INTERVAL, N VALUE (□) (Blows/0.3m) 20 40 60 80, MONITOR INSTALLATION DETAILS.

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 52-2
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 4 April 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 52-B 81cm (1) (2)
	199.37										
	199.1 / 0.3		TOPSOIL								
1	198.0 / 1.4		CLAYEY SILT TILL Orange brown mottled, weathered, fractured, trace sand and gravel, moist.								
2	196.5 / 2.9		SILTY SAND AND GRAVEL Brown grey, some gravel, moist.								
3–12	186.4 / 13.0		CLAYEY SILT TILL Grey, some sand, trace gravel, unfractured, unweathered.								
13			12.96m - End of Borehole.								

NOTES:

(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen.

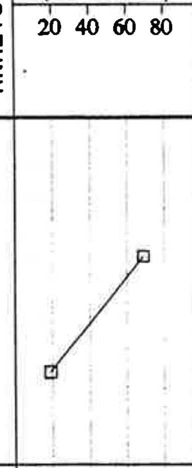
(2) Waterlevel measured May 1, 1995 at 12.34m below ground surface.

DILLON

PROJECT No.	94 2492-02-02
DATUM:	Geodetic
BOREHOLE No.	52-3
Sheet	1 of 1
PROJECT:	BFI Ridge Landfill
LOCATION:	Blenheim, Ontario
DATE:	5 April 1995
INSPECTOR:	MRP

ELEV. / DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
199.37						
199.1 / 0.3	TOPSOIL					
198.0 / 1.4	CLAYEY SILT TILL Orange brown mottled, weathered, fractured, trace sand and gravel, moist.					
196.5 / 2.9	SILTY SAND AND GRAVEL Brown grey, some gravel, moist.	1	AS	69	83	
		2	AS		100	
194.8 / 4.6	CLAYEY SILT TILL Grey, some sand, trace gravel, unfractured, unweathered.	3	AS	19	100	

N VALUE (□) (Blows/0.3m)



MONITOR INSTALLATION DETAILS: 52-A, 69cm, (1) (2)

4.57m - End of Borehole.

NOTES:

(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 3.05 m long, No. 10 slot, screen.

(2) Waterlevel measured May 1, 1995 at 0.44m below ground surface.

(3) Drilled without sampling. For stratigraphic information, refer to borehole 52-1.

DILLON	PROJECT No. 94 2492-02-02	BOREHOLE No. 53-1
	DATUM: Geodetic	Sheet 1 of 3

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario
DATE: 19 April 1995
INSPECTOR: MRP/CGR

DEPTH (m)	ELEV. DEPTH (m) 198.52	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 53-C 80cm (1) (2)
	198.2 0.3		TOPSOIL	1		AO		63			
1			CLAYEY SILT TILL Brown grey becoming grey with depth, some sand, trace gravel, weathered, fractured. 1.07m - Becoming unweathered.	2		AO		100			
2				3		AO		100	b		
			2.44m - Becoming unfractured.	4		AO		87			
3				5		AO		100			
4				6		AO		100	ab		
5				7		AO		100			
6				8		AO		100			
				9		AO		93	b		
7				10		AO		100			
8				11		AO		100			
9				12		AO		100	ab		
				13		AO		100			
10				14		AO		100	b		
11				15		AO		100			
12				16		AO		100			
13				17		AO		100	b		
				18		AO		100			
14				19		AO		77	b		
15											
16				20		AO		100			
				21		AO		100			
17				22		AO		100	abd		
18				23		AO		100			
19				24		AO		100			
				25		AO		100	b		

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. **53-1**
Sheet 2 of 3

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 19 April 1995
INSPECTOR: MRP/CGR

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
				26		AO		100			
21				27		AO		100			
22			CLAYEY SILT TILL Grey, some sand, trace gravel, unweathered, unfractured.	28		AO		100	b		
				29		AO		100			
23				30		AO		93			
24				31		AO		70	b		
25	173.4 25.2			32		AO		100			
			Becoming reddish between 25.18m and 27.44m .	33		AO		100	abd		
26				34		AO		97			
27	171.1 27.4			35		AO		100			
28				36		AO		100	b		
				37		AO		100			
29				38		AO		100			
30				39		AO		100	b		
31				40		AO		100			
				41		AO		100	b		
32				42		AO		100			
33	165.0 33.5			43		AO		100			
34			Becoming reddish grey between 33.53m and 35.81m.	44		AO		100	abd		
35				45		AO		100			
	162.7 35.8			46		AO		100			
36				47		AO		63	b		
37				48		AO		100			
				49		AO		70			
38				50		AO		80	b		
39				51		AO		70			

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 53-1
Sheet 3 of 3

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 19 April 1995
INSPECTOR: MRP/CGR

ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
		52	AO		73	
		53	AO		67	b
157.1 / 41.4	CLAY Reddish grey, trace silt and fine sand. Dry silty fine sand laminations at 43.46m and 43.59m.	54	AO		63	
		55	AO		67	
		56	AO		100	b
		57	AO		100	
154.5 / 44.0	SAND Grey, fine, some silt.	58	AO		100	
154.1 / 44.5	SILT Grey, some fine sand.	59	AO		0	
153.5 / 45.1	CLAY Reddish grey.	60	AO		59	
153.1 / 45.5	SILT Green grey, interbedded with clay and silt.					
152.3 / 46.3	SHALE Black, weathered.					
152.1 / 46.4	46.41m - End of Borehole.					

NOTES:
(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen.
(2) Water level measured May 1, 1995 at 25.83m below ground surface.

DEPTH (m): 41 – 59

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 53-2
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 20 April 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m) 198.52	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 53-B 91cm (1) (2)
	198.2 0.3		TOPSOIL								
1			CLAYEY SILT TILL Brown grey becoming grey with depth, some sand, trace gravel, weathered, fractured. 1.07m - Becoming unweathered.								
2			2.44m - Becoming unfractured.								
3											
4											
5											
6											
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9											
10											
11											
12											
13	185.6 12.9		12.88m - End of Borehole. NOTES: (1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 1.52 m long, No. 10 slot, screen. (2) Waterlevel measured May 1, 1995 at 12.88m below ground surface. (3) Drilled without sampling. For stratigraphic information, refer to borehole 53-1.								
14											
15											
16											
17											
18											
19											

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. 53-3
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 20 April 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 53-A 84cm (1) (2)
	198.52										
	198.2 / 0.3		TOPSOIL								
1			CLAYEY SILT TILL Brown grey becoming grey with depth, some sand, trace gravel, weathered, fractured. 1.07m - Becoming unweathered.								
2											
3			2.44m - Becoming unfractured.								
4											
5	193.2 / 5.3										
6			5.34m - End of Borehole. NOTES: (1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 3.05 m long, No. 10 slot, screen. (2) Waterlevel measured May 1, 1995 at 5.34m below ground surface. (3) Drilled without sampling. For stratigraphic information, refer to borehole 53-1.								
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17											
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19											

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. **54-1**
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 20 April 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m) 198.16	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 54-A 85cm (1) (2)
	197.9 0.3		TOPSOIL	1		AO		47			
1			CLAYEY SILT TILL Grey mottled with brown and orange, some sand, and trace gravel, weathered, fractured.	2		AO		67			
2			1.83m - Becoming grey, unweathered.	3		AO		57			
3			3.35m - Becoming unfractured.	4		AO		100			
4	193.6 4.6			5		AO		100			
5			4.57m - End of Borehole. NOTES: (1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 3.05 m long, No. 10 slot, screen. (2) Water level measured May 1, 1995 at 4.17m below ground surface.								
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19											

DILLON

PROJECT No.	94 2492-02-02	BOREHOLE No.	55-1
DATUM:	Geodetic	Sheet	1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario
DATE: 28 February 1995
INSPECTOR: MRP

ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
197.39								55-A 89cm (1) (2)
197.1 0.3	TOPSOIL	1	AS	8	79			
	CLAYEY SILT TILL Grey mottled with brown, some sand, and trace gravel, weathered, fractured. 1.57m - Becoming grey, unweathered.	2	AS	6	67			
	2.59m - Becoming unfractured.	3	AO		100			
		4	AO		100			
192.8 4.6	4.57m - End of Borehole. NOTES: (1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 3.05 m long, No. 10 slot, screen. (2) Water level measured May 1, 1995 at 3.04m below ground surface.							

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

BOREHOLE No. **56-1**
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 5 April 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m) 198.70	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 56-A 72cm (1) (2)
	198.6 0.1		TOPSOIL	1		AO		60			
1			CLAYEY SILT TILL Orange brown mottled, some sand, and trace gravel, weathered, fractured.	2		AO		100			
2			1.52m - Becoming brown grey, unweathered, and dense.	3		AO		87			
3			2.77m - Becoming grey.	4		AO		100			
				5		AO		90			
4	194.1 4.6		3.96m - Becoming unweathered.	6		AO		87			
5			4.60m - End of Borehole. NOTES: (1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 3.05 m long, No. 10 slot, screen. (2) Water level measured May 1, 1995 at 3.77m below ground surface.								
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17											
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19											

DILLON

PROJECT No. 94 2492-02-02
DATUM: Geodetic

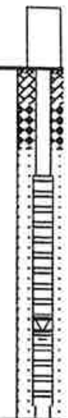
BOREHOLE No. **57-1**
Sheet 1 of 1

PROJECT: BFI Ridge Landfill
LOCATION: Blenheim, Ontario

DATE: 5 April 1995
INSPECTOR: MRP

DEPTH (m)	ELEV. DEPTH (m) 199.02	DESCRIPTION	NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS 57-A 87cm (1) (2)
	198.9 0.2	TOPSOIL	1		AO		73			
1		CLAYEY SILT TILL Yellow brown mottled, some sand, and trace gravel, weathered, fractured.	2		AO		100			
2		1.52m - Becoming brown grey and unweathered. 2.28m - Fractures becoming mostly oxidized and vertical.	3		AO		80			
3		2.77m - Becoming grey.	4		AO		100			
			5		AO		100			
4		3.81m - Becoming unweathered.	6		AO		100			
5	194.4 4.7	4.65m - End of Borehole.								

NOTES:
(1) Monitoring well constructed of 50mm diameter, sch 40, flush-threaded, PVC riser pipe with a 3.05 m long, No. 10 slot, screen.
(2) Water level measured May 1, 1995 at 3.49m below ground surface.



Appendix D7-B

Soil Testing Results

DILLON CONSULTING

SUMMARY OF WATER CONTENT [1] / ATTERBERG LIMITS[2] DETERMINATIONS

[1]ASTM D2216 / [2]ASTM D4318

PROJECT NUMBER	1535446
PROJECT NAME	DillonConsult/SiltTesting/Miss
DATE	November 2016

Borehole No.	Sample No.	Depth (ft)	Depth (m)	Water Content (%)	Atterberg Limits LL=, PL=, PI=,
71-1	SS4		4.572	13.3%	
71-1	SS7		9.144	15.5%	
71-1	SS11		15.24	16.5%	
71-1	SS15		21.336	17.8%	
71-1	SS27		39.92	14.5%	
71-1	SS31		46.63	10.7%	
72-1	SS4		4.57	13.8%	
72-1	SS7		9.14	14.5%	
72-1	SS11		15.39	16.0%	
72-1	SS16		23.16	16.5%	
72-1	SS27		40.84	16.3%	
72-1	SS33		49.98	6.0%	

Checked By: LU

SUMMARY OF WATER CONTENT [1] / ATTERBERG LIMITS[2] DETERMINATIONS

[1]ASTM D2216 / [2]ASTM D4318

PROJECT NUMBER	1535446(4000)
PROJECT NAME	Dillon Consultants, Silt Testing, Mississauga
DATE	January, 2017

Borehole No.	Sample No.	Depth (ft)	Depth (m)	Water Content (%)	Atterberg Limits LL=, PL=, PI=,
73-1	SS4	16.0	4.9	14.9%	
73-1	SS7	30.0	9.1	39.4%	
73-1	SS11	50.0	15.2	16.1%	
73-1	SS16	75.0	22.9	17.4%	
73-1	SS26	135.0	41.1	16.3%	
73-1	SS29	145.0	44.2	24.8%	
74-1	SS4	16.0	4.9	14.5%	
74-1	SS7	30.0	9.1	15.6%	
74-1	SS11	50.0	15.2	15.4%	
74-1	SS14	75.0	22.9	17.2%	
74-1	SS26	130.0	39.6	16.5%	
74-1	SS31	150.0	45.7	18.8%	
75-1	SS4	16.0	4.9	14.7%	
75-1	SS7	30.0	9.1	15.5%	
75-1	SS11	50.0	15.2	13.5%	
75-1	SS16	75.0	22.9	15.4%	
75-1	SS27	132.5	40.4	16.3%	
75-1	SS34	165.0	50.3	20.2%	
76-1	SS4	15.0	4.6	12.7%	
76-1	SS6	25.0	7.6	13.1%	
76-1	SS7	30.0	9.1	16.2%	
76-1	SS11	50.0	15.2	16.7%	
76-1	SS14	70.0	21.3	16.9%	
76-1	SS26	130.0	39.6	15.3%	
76-1	SS31	154.0	46.9	13.0%	

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TOTAL ORGANIC CARBON CONTENT (TOC)

PROJECT NUMBER 1535446 (4000)

PROJECT NAME DillonConsult/SiltTesting/Miss

DATE TESTED November, 2016

Borehole No.	Sample No.	Depth (m)	Soil Passing 0.6mm (%)	Grain Size Distribution Retained Gravel (%)	Sand (%)	Silt (%)	Clay (%)	TOC <0.6mm (%)	TOC* Whole Soil (%)
71-1	SS7	9.14	86.0	5.0	20.0	47.0	28.0	0.75	0.64
71-1	SS11	15.24	89.0	1.5	20.5	44.5	33.5	0.77	0.69
72-1	SS7	9.14	89.0	1.5	22.0	49.0	27.5	0.80	0.71
72-1	SS7 (Repeat)	9.14	89.0	1.5	22.0	49.0	27.5	0.83	0.74

Notes:

1. Samples dried at 110 degree centigrade prior to testing.
2. Test performed on minus 600 micron soil fraction, using the method of Walkley and Black (Walkley, 1946)
3. Grain size distribution of sand, silt and clay based on Unified Soil Classification.

* Corrected TOC for whole (ie. unfractionated) soil assuming negligible organic carbon content associated with the plus 600 micron soil.

Checked By:

Golder Associates

TOTAL ORGANIC CARBON CONTENT (TOC)

PROJECT NUMBER 1535446 (4000)

PROJECT NAME DillonConsult/SiltTesting/Miss

DATE TESTED January, 2017

Borehole No.	Sample No.	Depth (m)	Soil Passing 0.6mm (%)	Grain Size Distribution Retained Gravel (%)	Sand (%)	Silt (%)	Clay (%)	TOC <0.6mm (%)	TOC* Whole Soil (%)
73-1	SS7	9.14	88.0	2.0	21.0	53.0	24.0	0.74	0.65
73-1	SS11	15.24	86.0	4.0	23.0	45.0	28.0	0.88	0.76
74-1	SS7	9.14	85.0	5.0	24.0	40.0	31.0	0.80	0.68
74-1	SS11	15.24	78.0	8.0	26.0	40.0	26.0	0.66	0.51
75-1	SS7	9.14	88.0	3.0	19.0	48.0	30.0	0.78	0.69
75-1	SS11	15.24	77.0	12.0	22.0	38.0	28.0	0.71	0.55
76-1	SS7	9.14	84.0	5.0	22.0	50.0	23.0	0.81	0.68
76-1	SS11	15.24	87.0	1.0	24.0	42.0	33.0	0.80	0.69
76-1	SS11(Repeat)	15.24	87.0	1.0	24.0	42.0	33.0	0.83	0.73

Notes:

1. Samples dried at 110 degree centigrade prior to testing.
2. Test performed on minus 600 micron soil fraction, using the method of Walkley and Black (Walkley, 1946)
3. Grain size distribution of sand, silt and clay based on Unified Soil Classification.

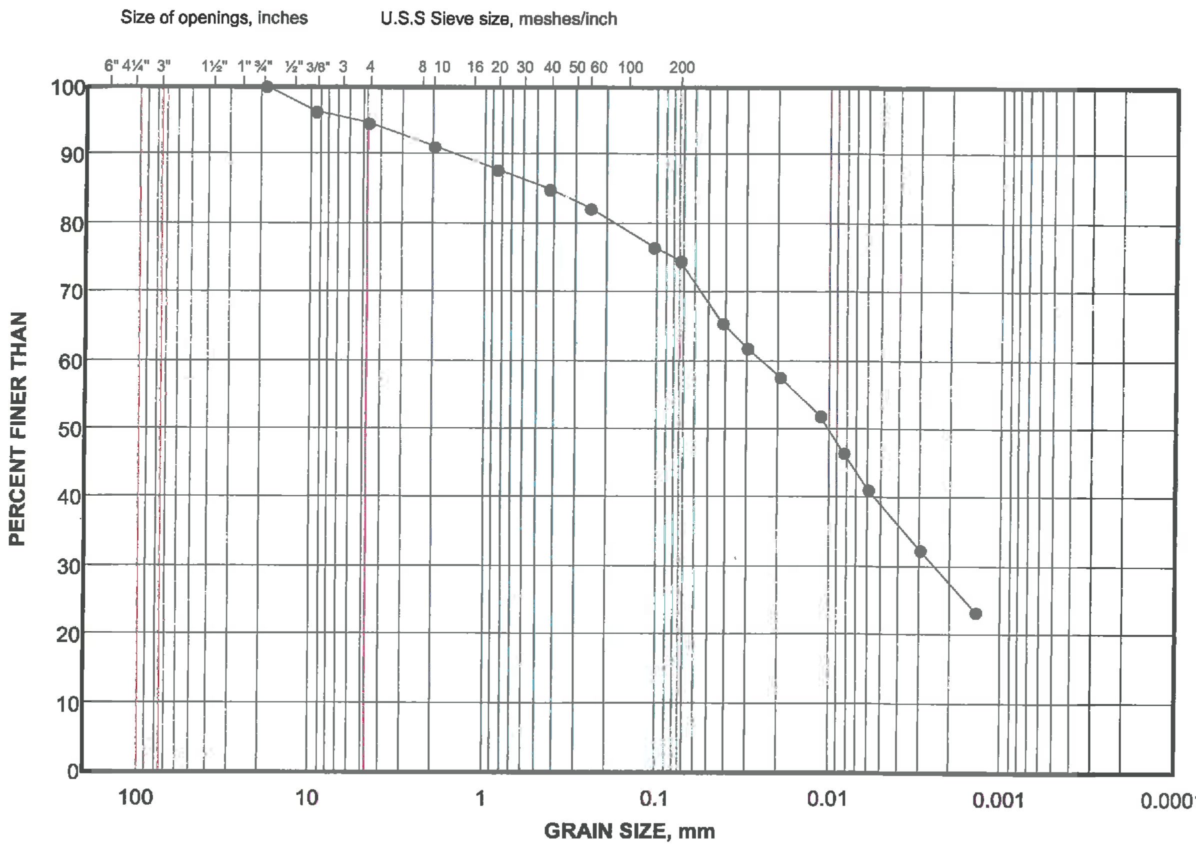
* Corrected TOC for whole (ie. unfractionated) soil assuming negligible organic carbon content associated with the plus 600 micron soil.

Checked By: [signature]

Golder Associates

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	71-1	SS7	9.144

Project Number: 1535446

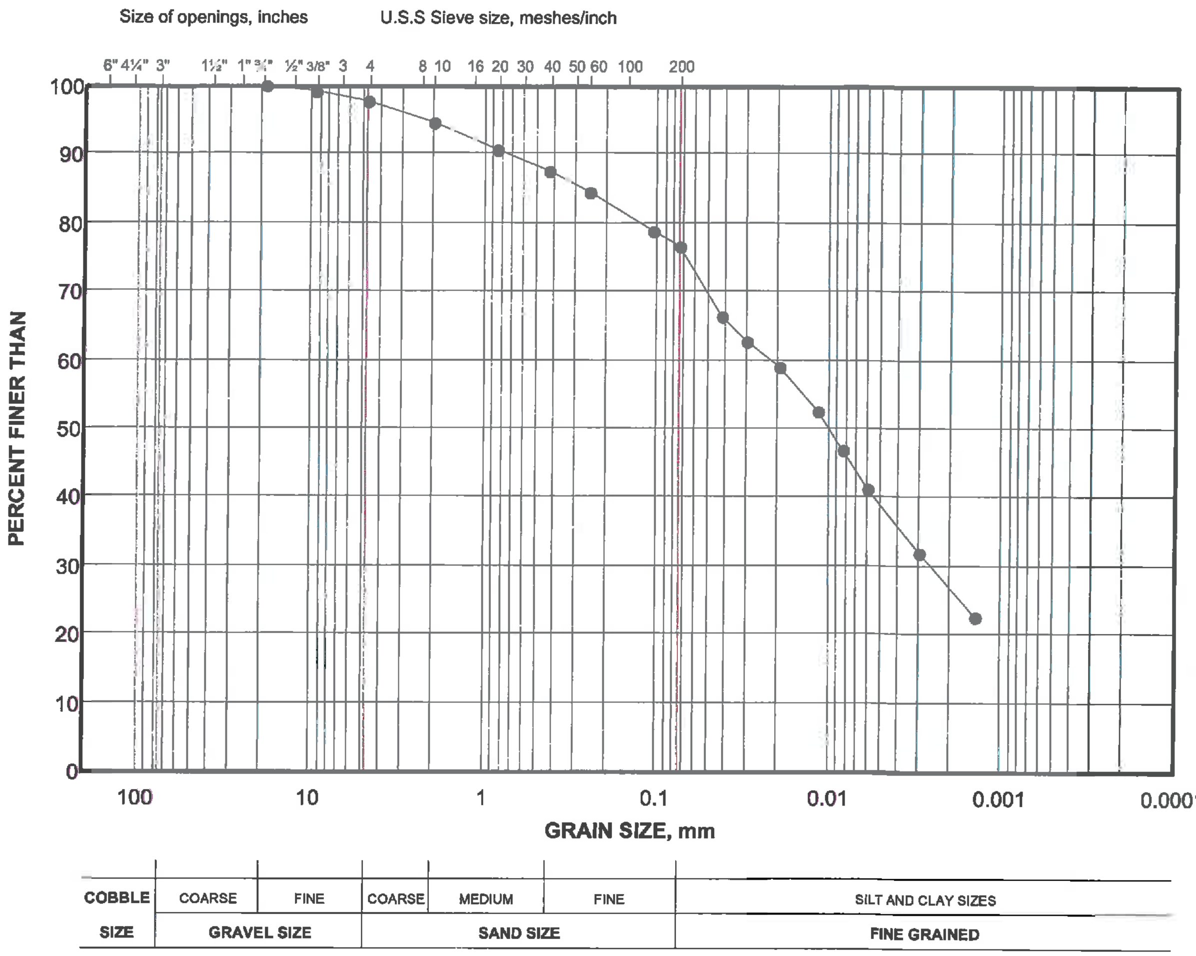
Checked By: [signature]

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION

FIGURE



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	72-1	SS7	9.14

Project Number: 1535446

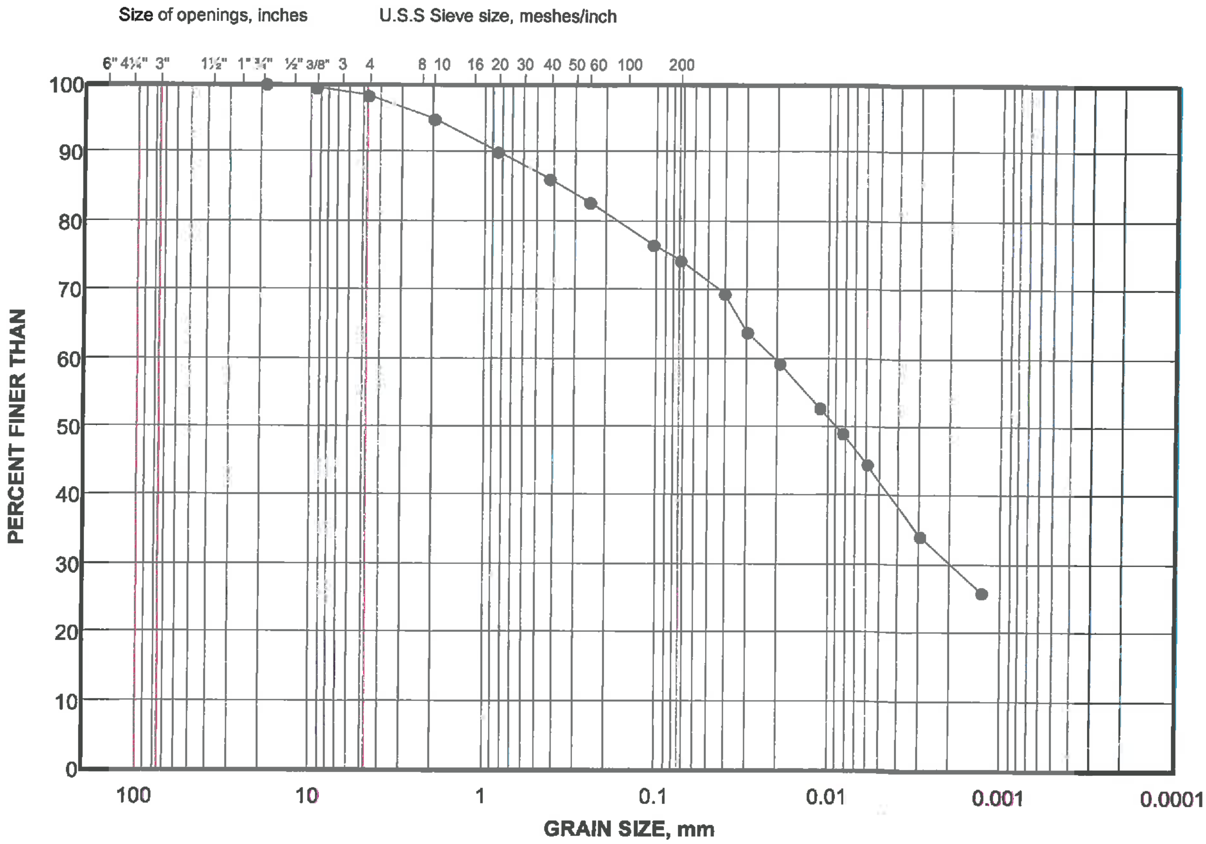
Checked By: LY

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	71-1	SS4	4.572

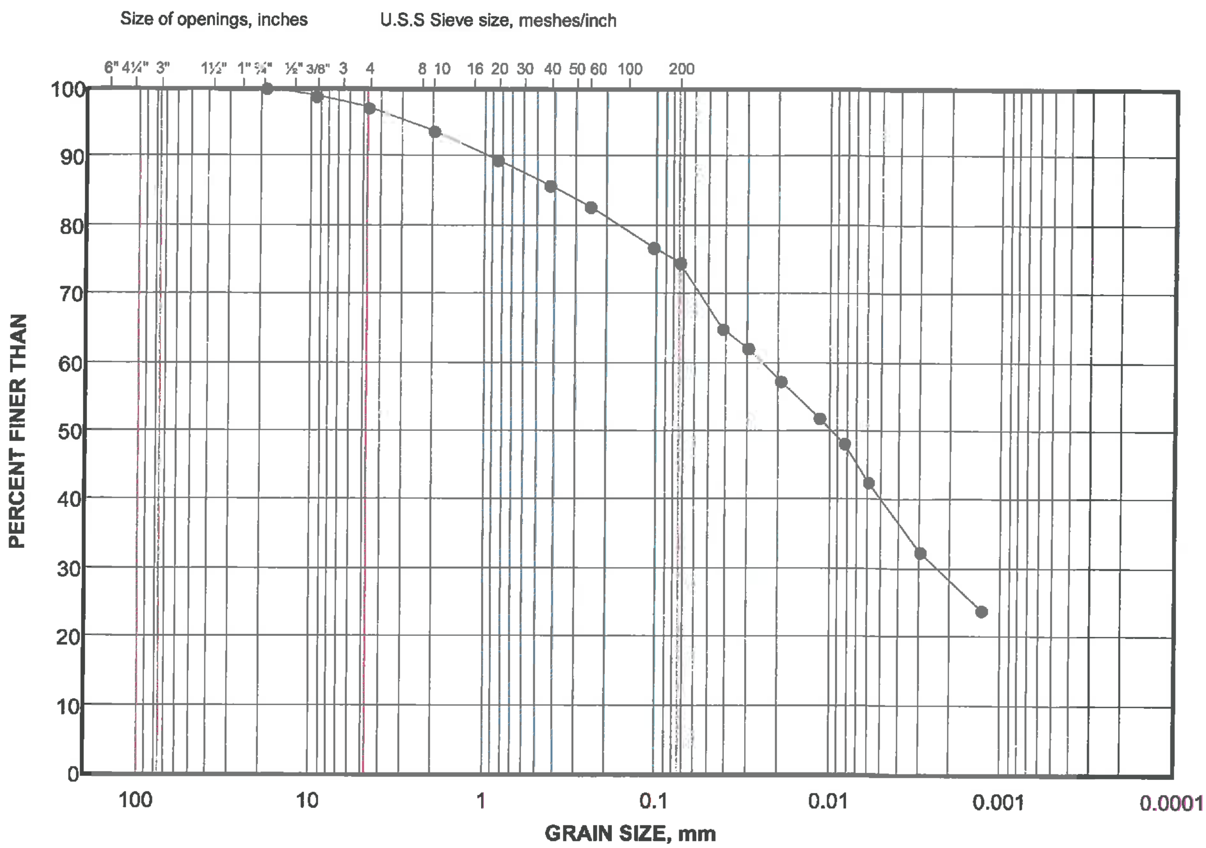
Project Number: 1535446

Checked By: [signature]

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	72-1	SS4	4.57

Project Number: 1535446

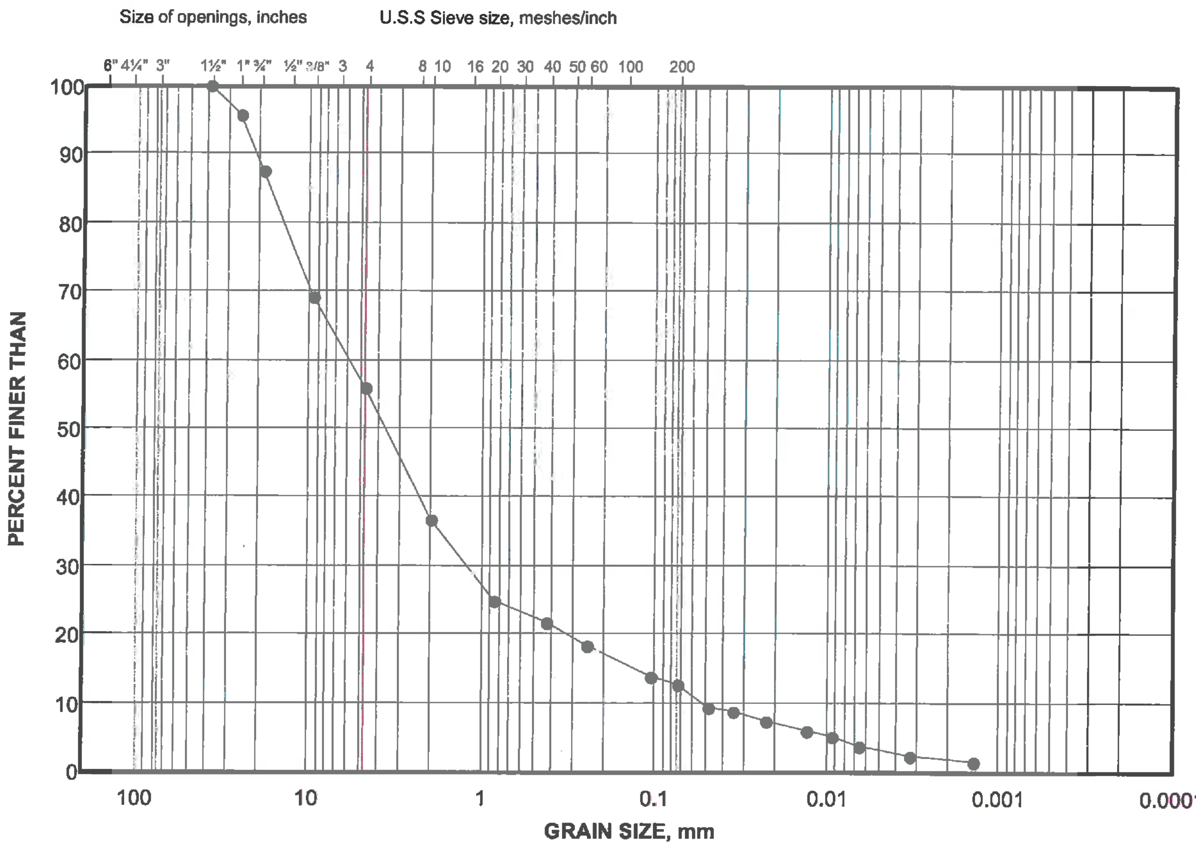
Checked By: [signature]

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	72-1	SS33	49.98

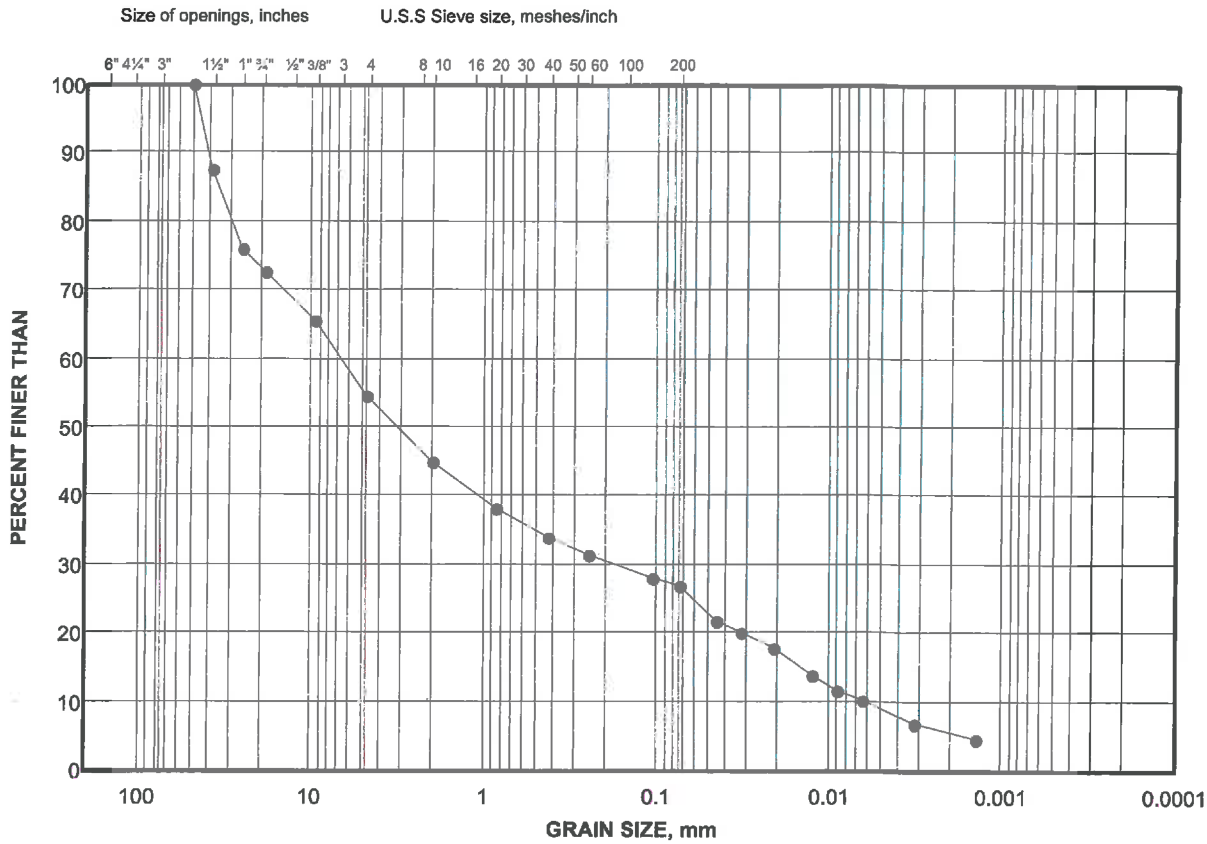
Project Number: 1535446

Checked By: [signature]

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	71-1	SS31	46.63

Project Number: 1535446

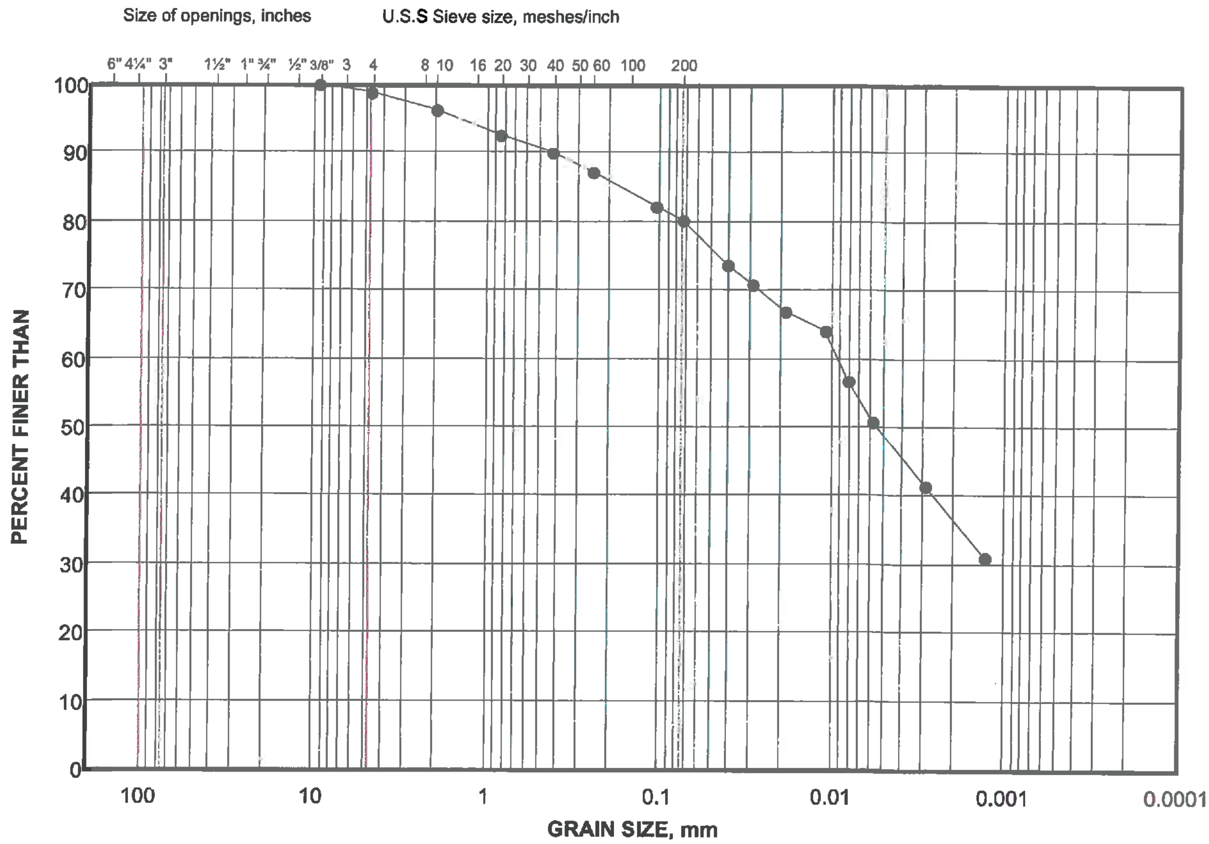
Checked By: [signature]

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	71-1	SS27	39.92

Project Number: 1535446

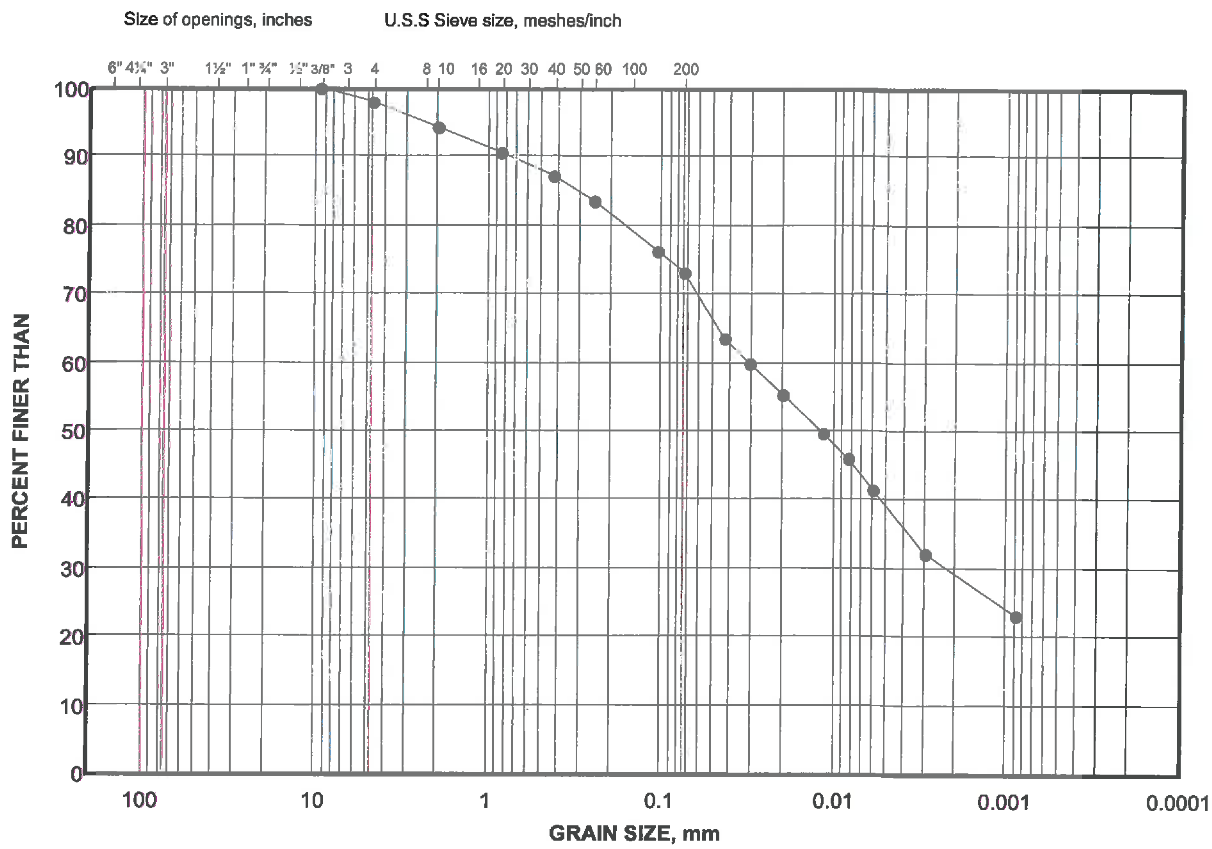
Checked By: [signature]

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	72-1	SS27	40.84

Project Number: 1535446

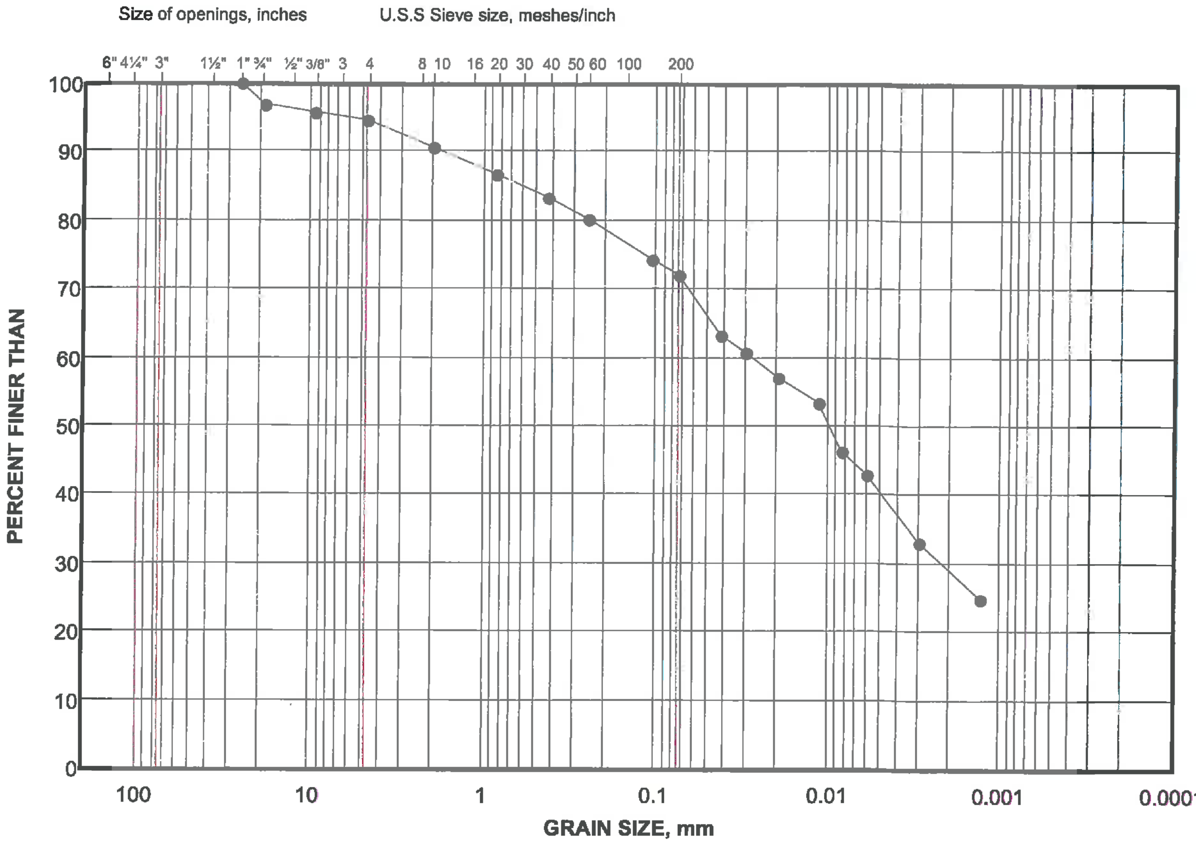
Checked By: [signature]

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	72-1	SS16	23.16

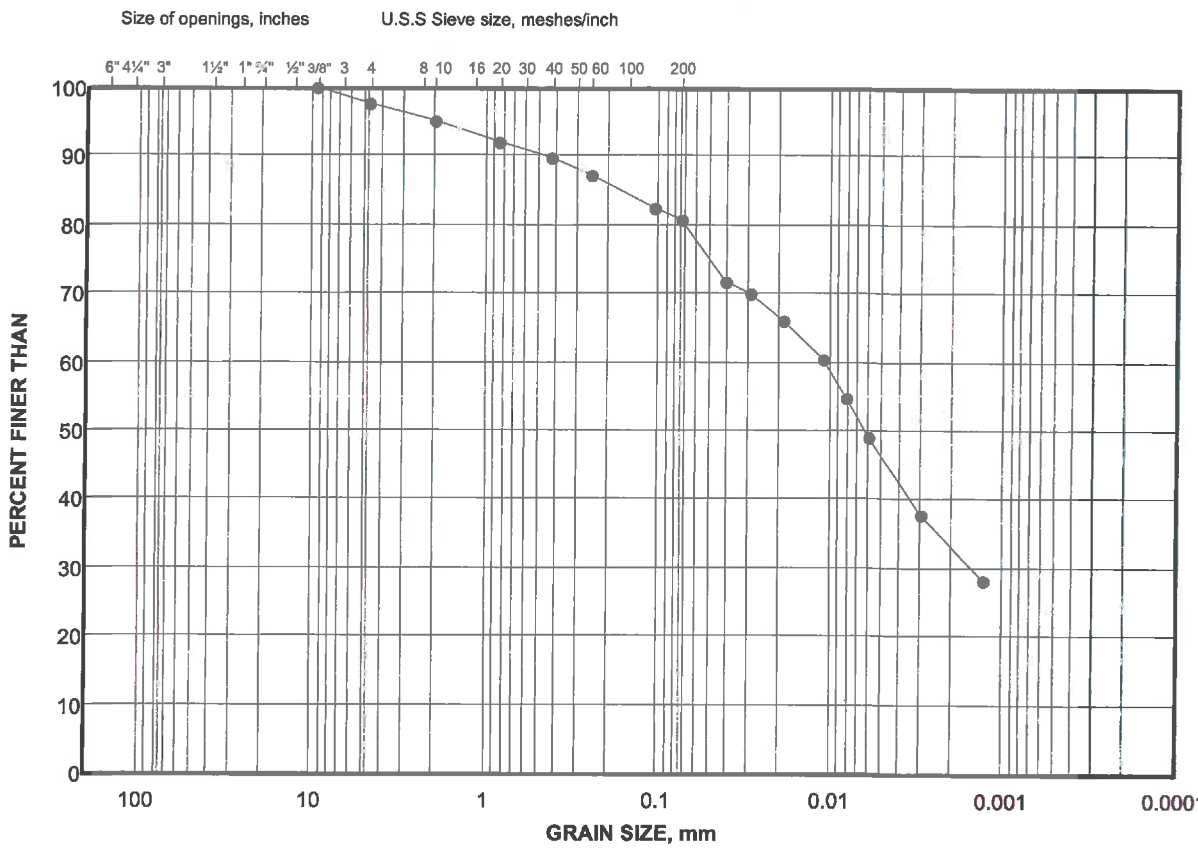
Project Number: 1535446

Checked By: [signature]

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	STATION	SAMPLE	DEPTH(m)
●	71-1	SS15	21.33

Project Number: 1535446

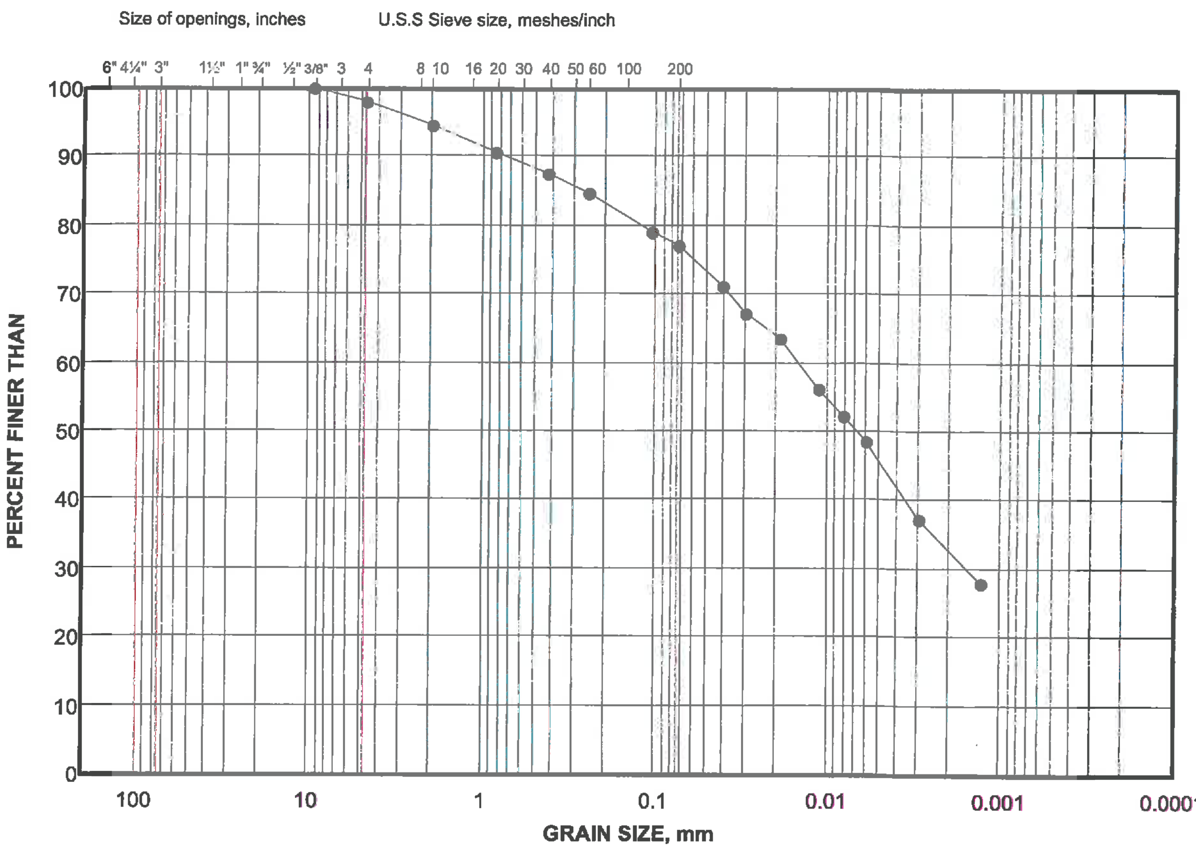
Checked By: ______

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	71-1	SS11	15.24

Project Number: 1535446

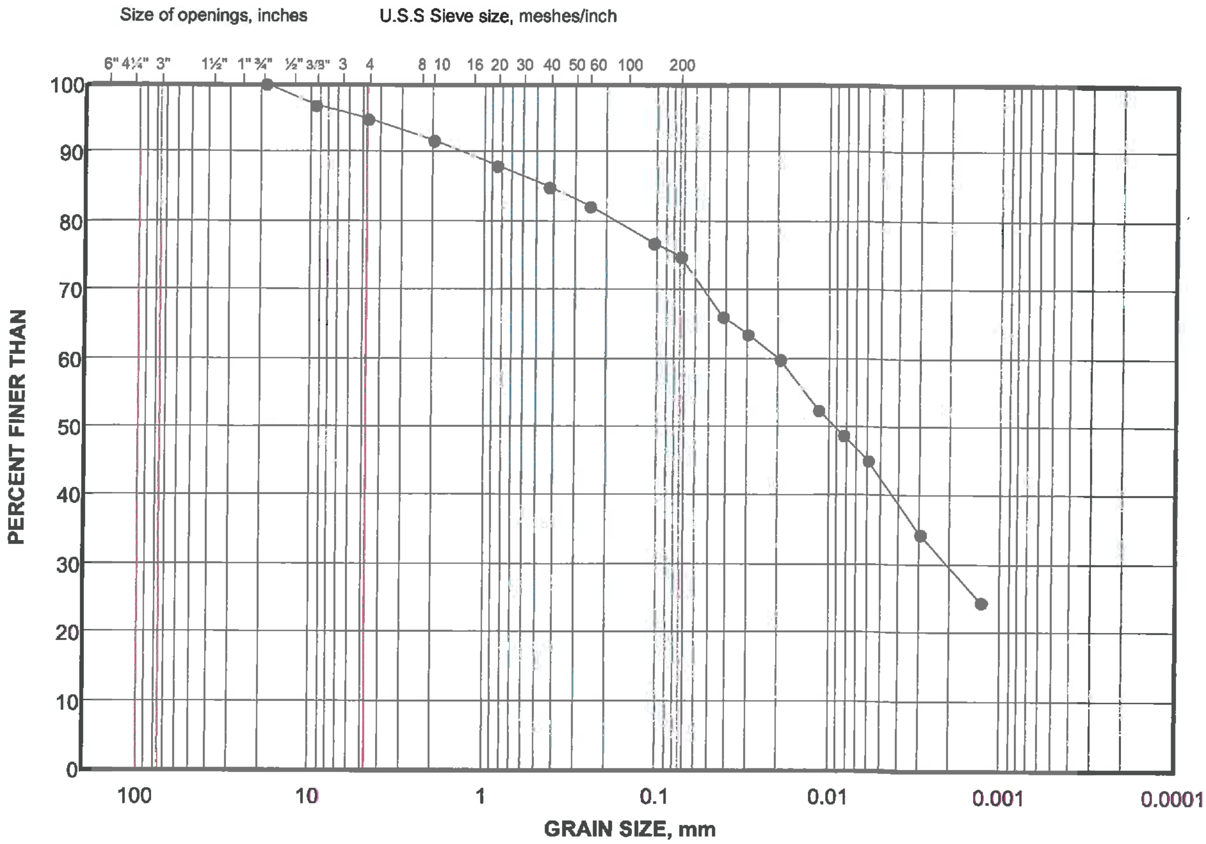
Checked By: ______

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	72-1	SS11	15.39

Project Number: 1535446

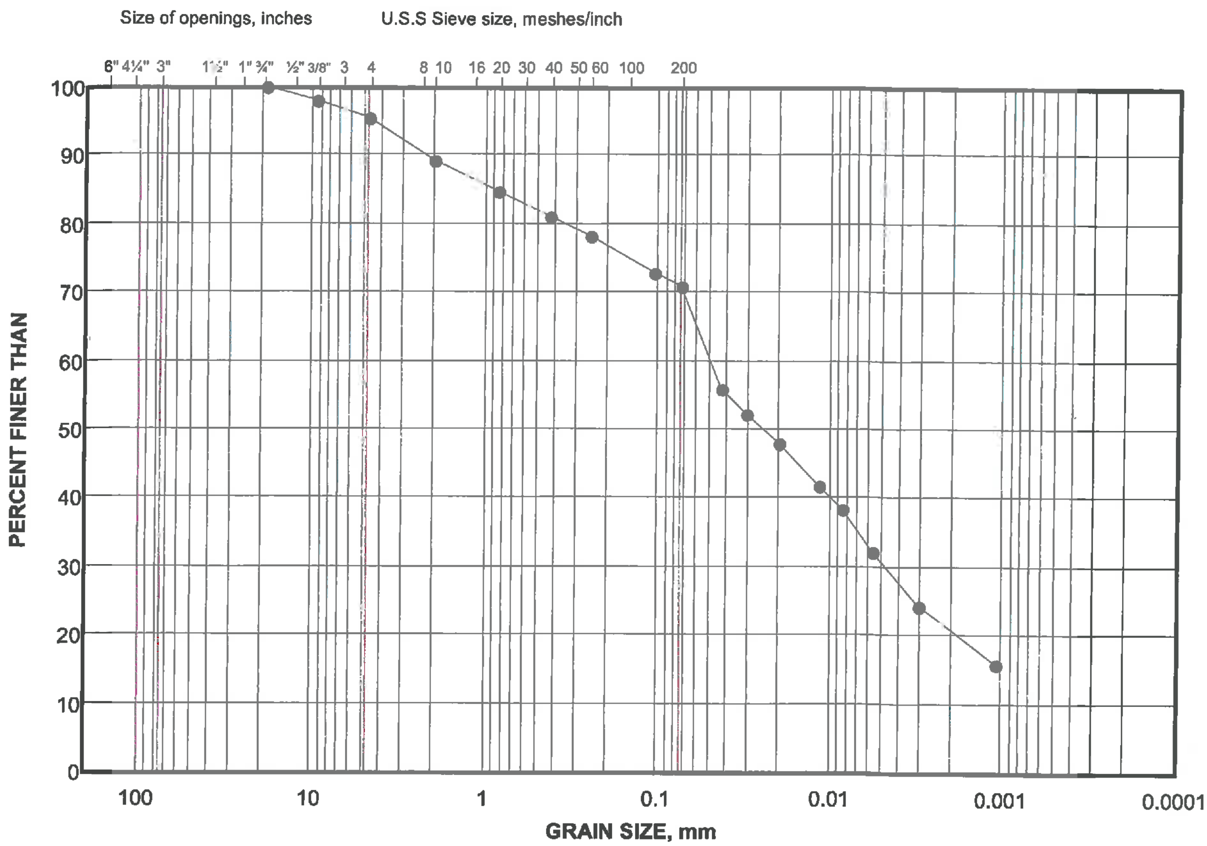
Checked By: [signature]

Golder Associates

Date: 28-Nov-16

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	73-1	SS4	4.88

Project Number: 1535446 (4000)

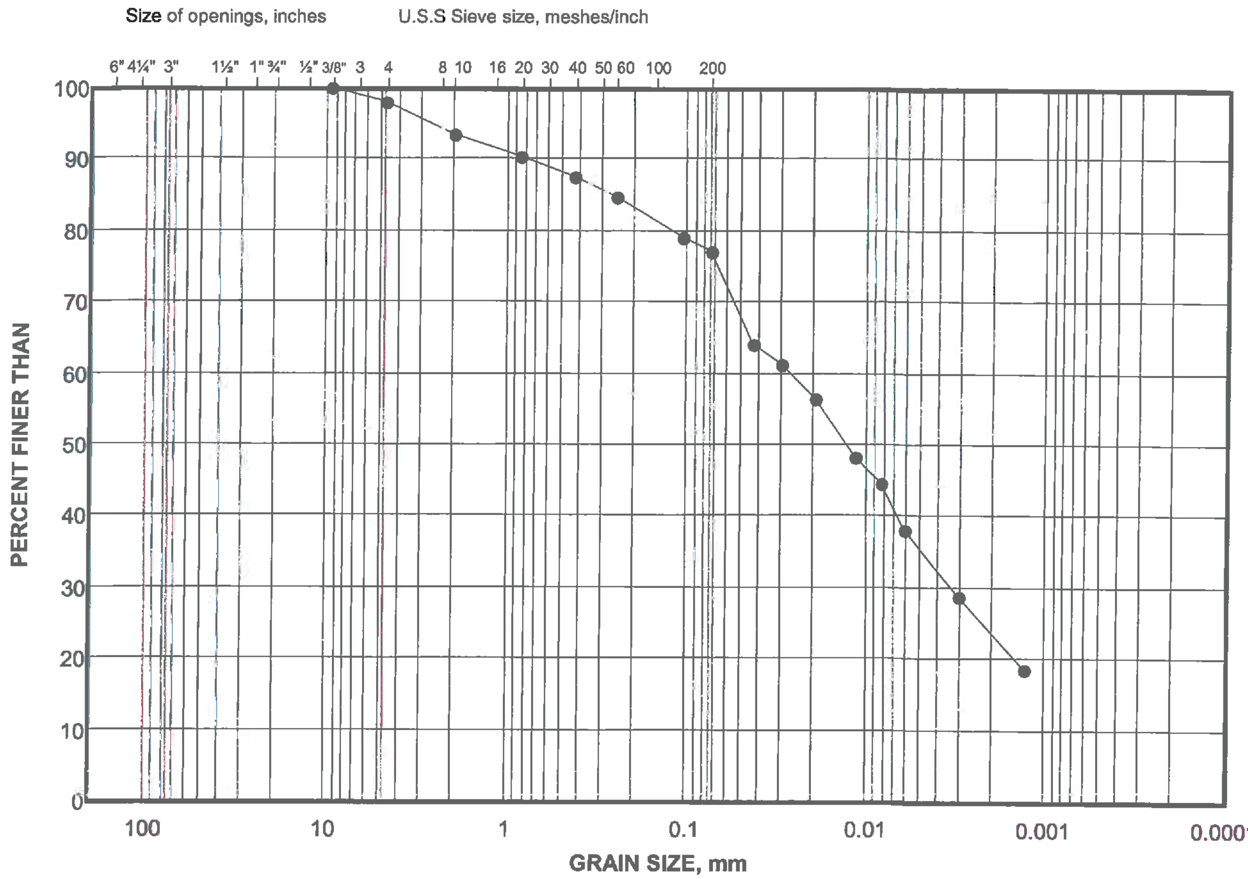
Checked By: ______________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	73-1	SS7	9.14

Project Number: 1535446

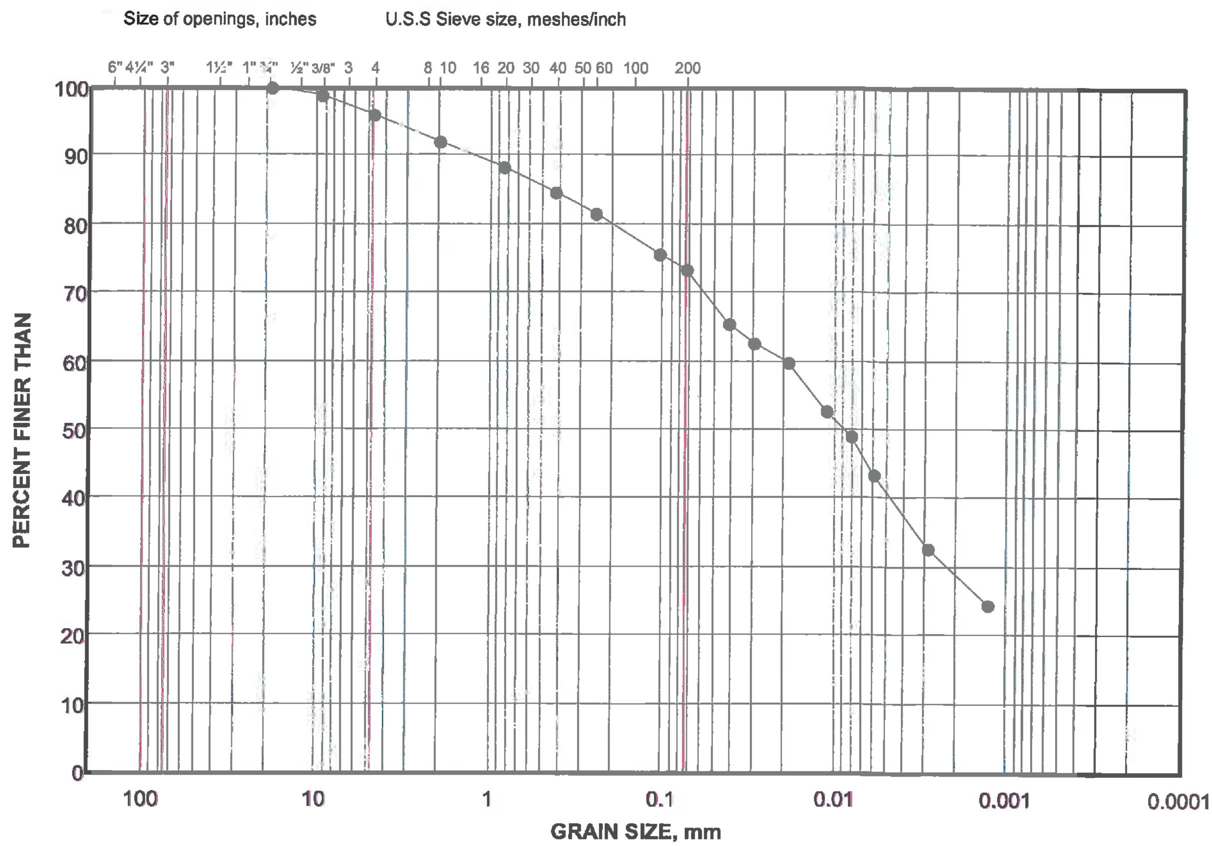
Checked By: ____________

Golder Associates

Date: 30-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	73-1	SS11	15.24

Project Number: 1535446 (4000)

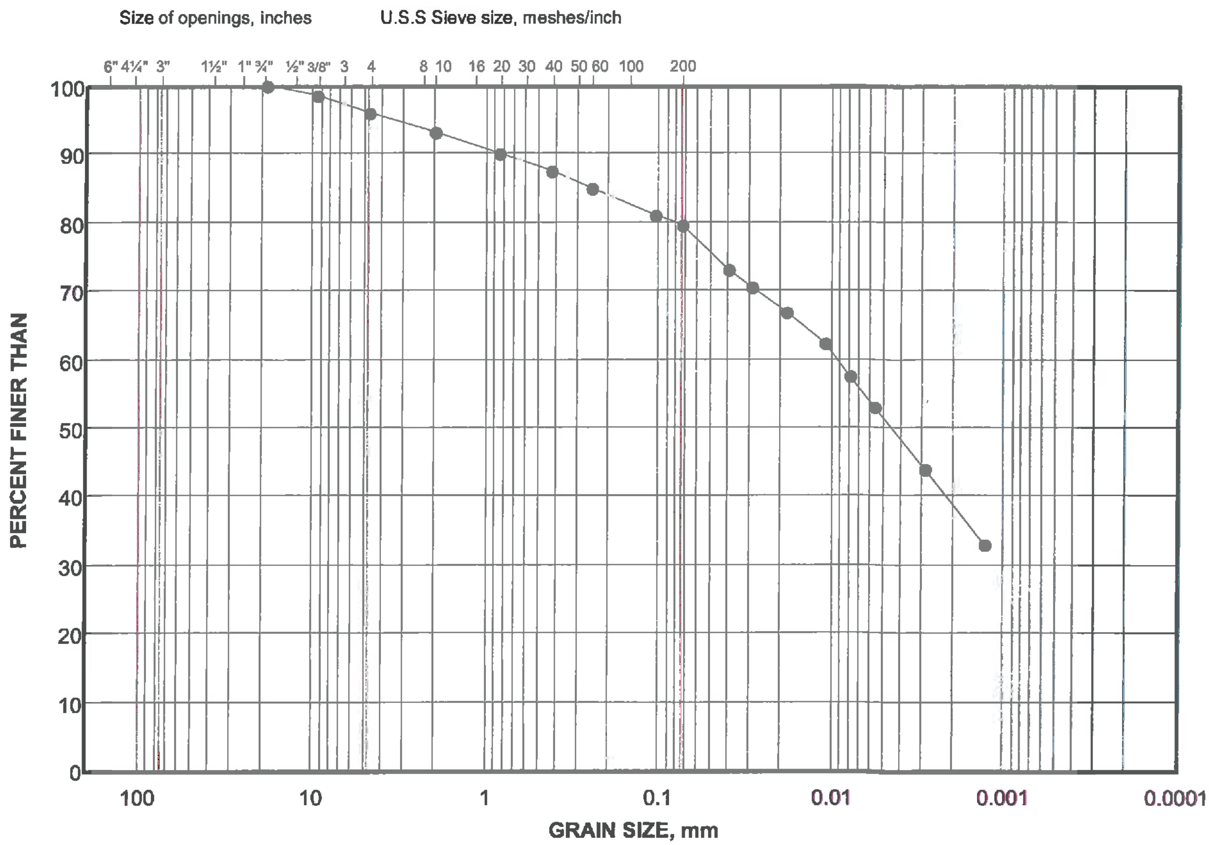
Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	73-1	SS29	44.20

Project Number: 1535446 (4000)

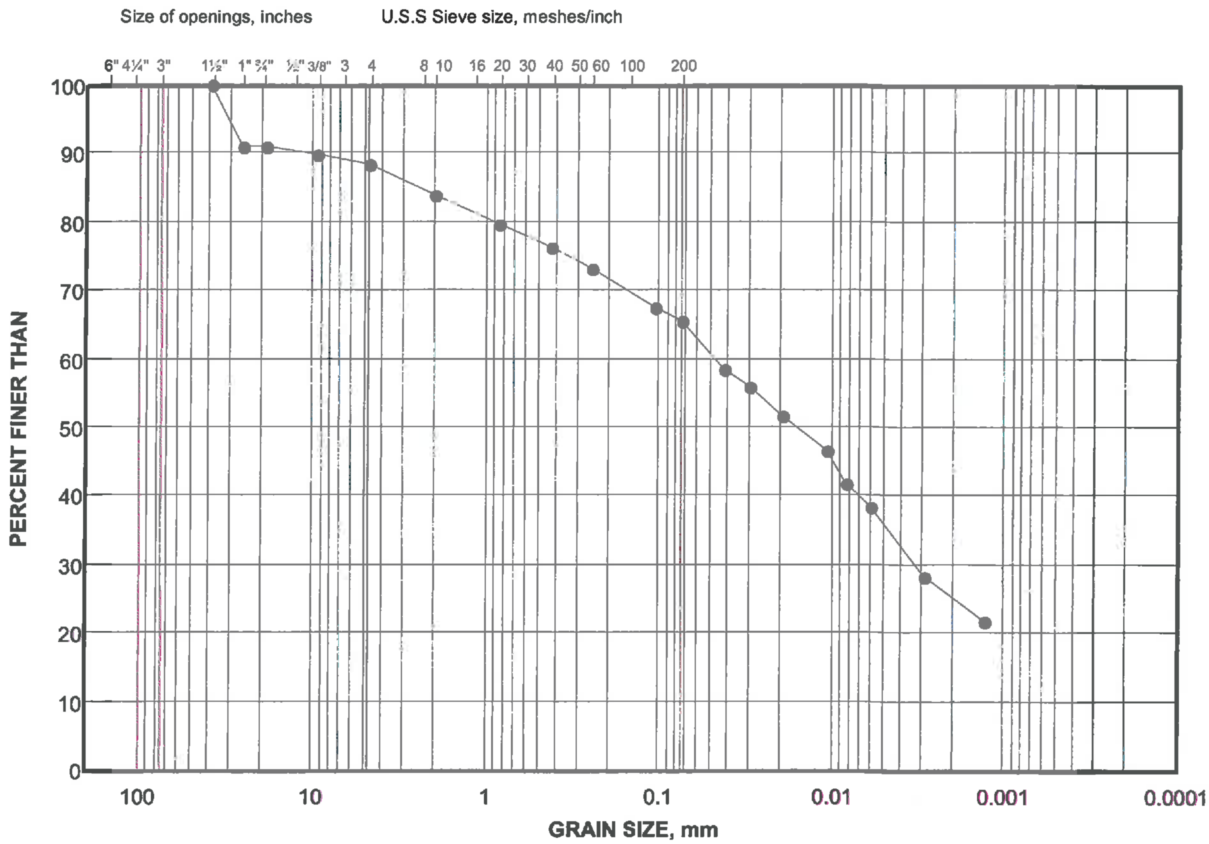
Checked By: ______

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	73-1	SS16	22.86

Project Number: 1535446 (4000)

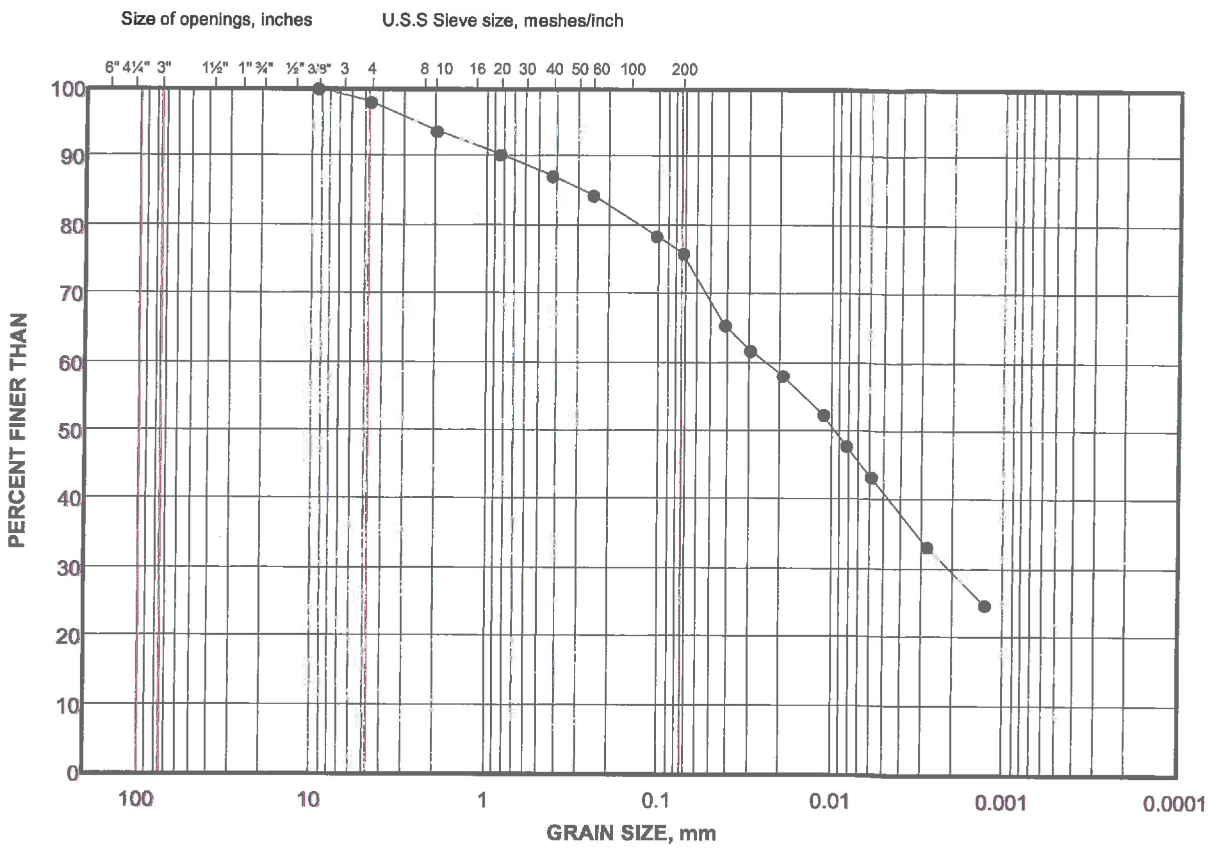
Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	73-1	SS26	41.15

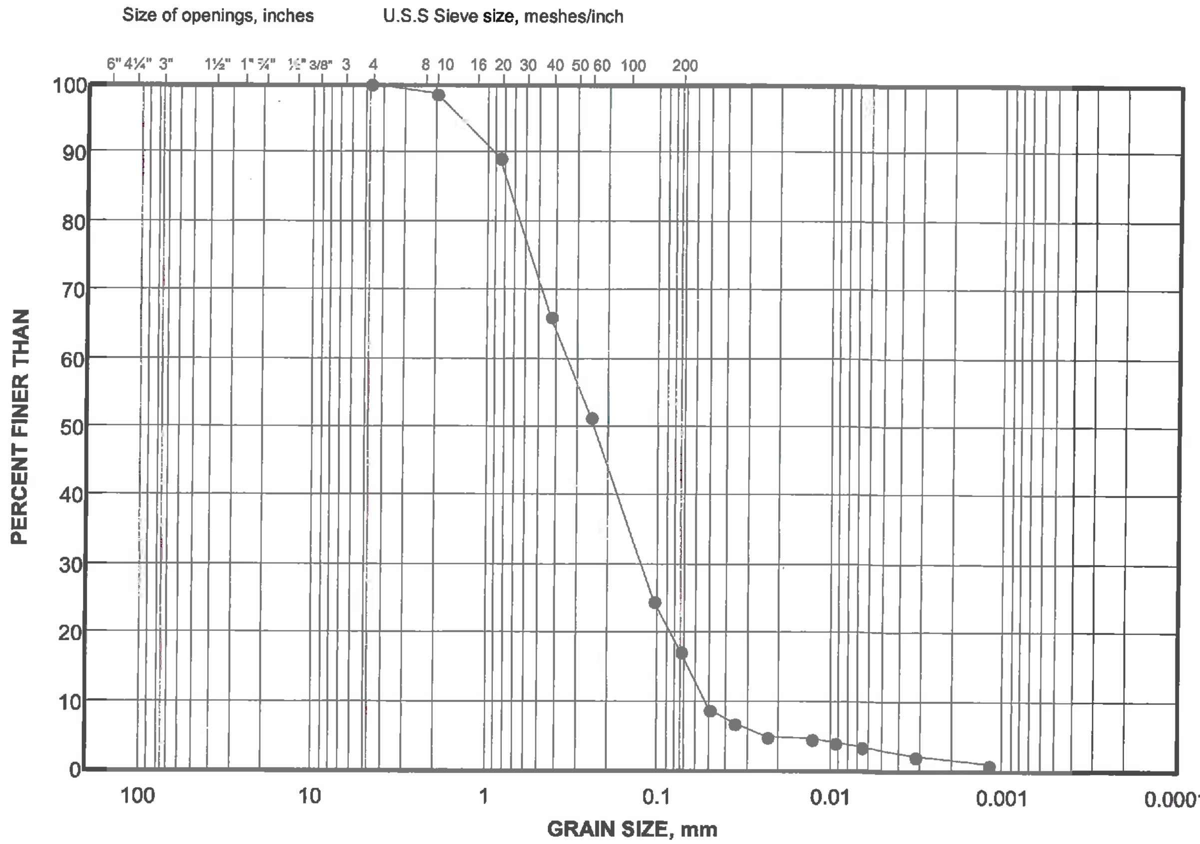
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	74-1	SS31	47.85

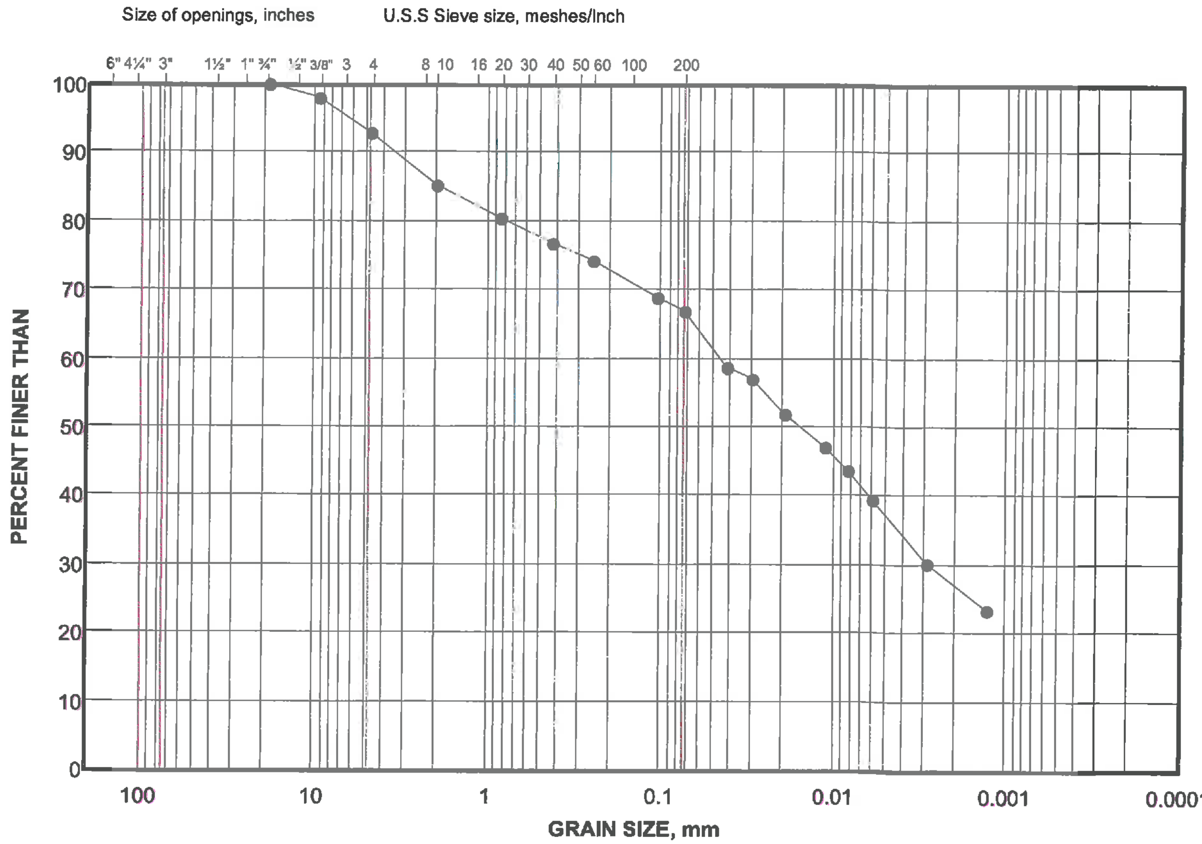
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	74-1	SS11	15.24

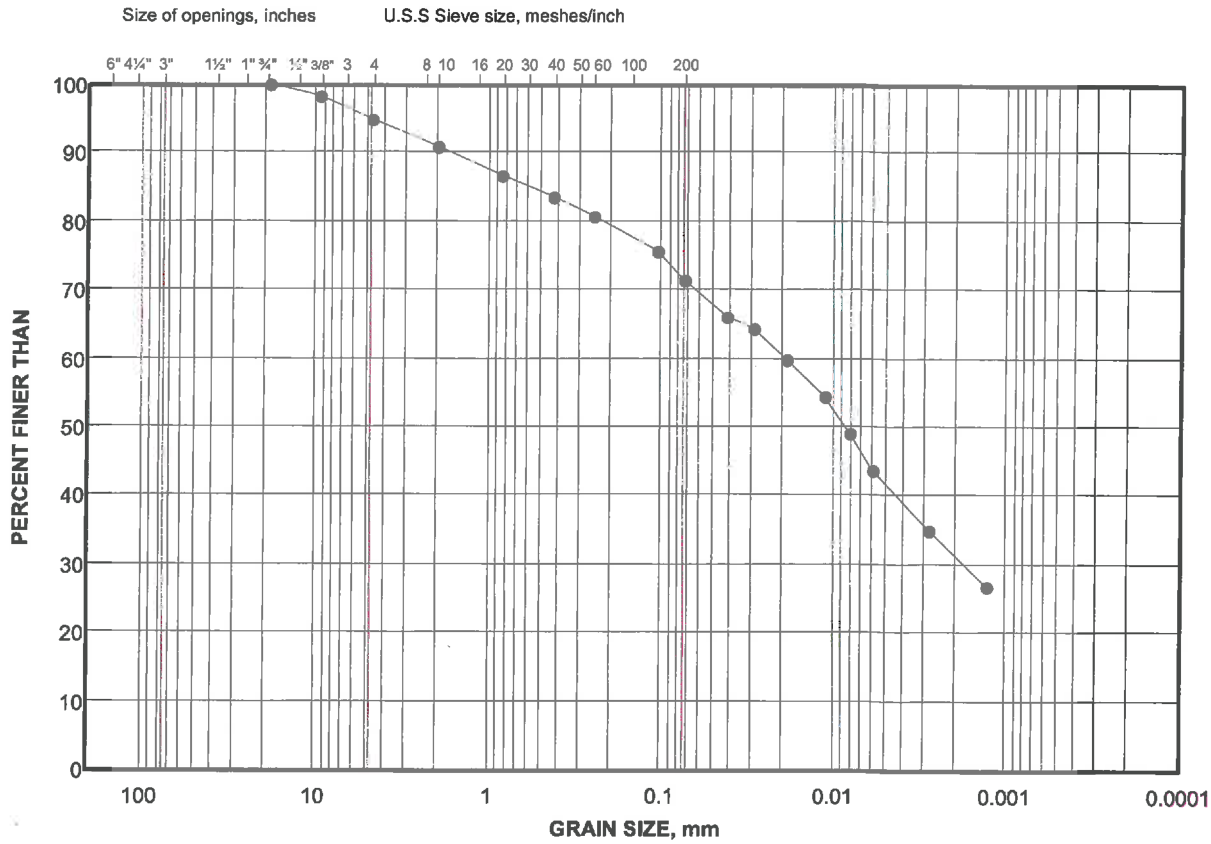
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	74-1	SS7	9.14

Project Number: 1535446 (4000)

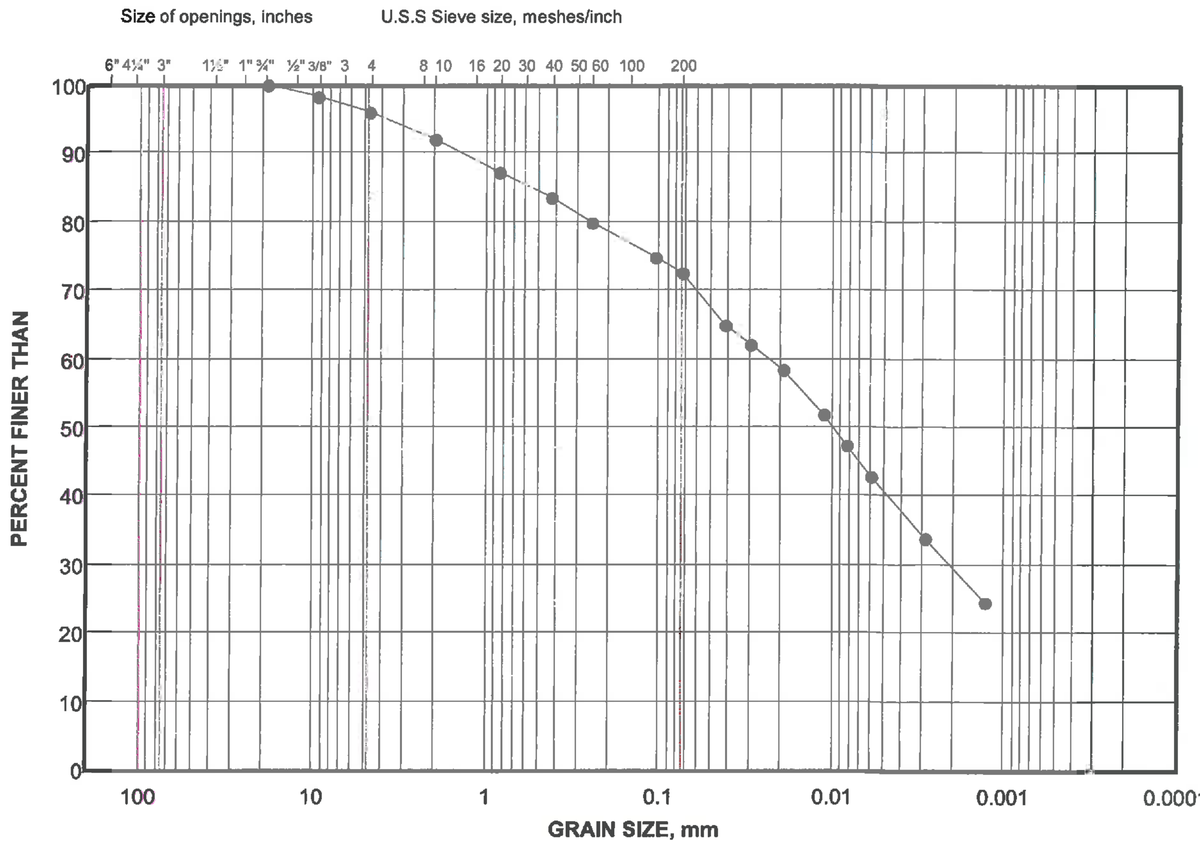
Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	74-1	SS4	4.88

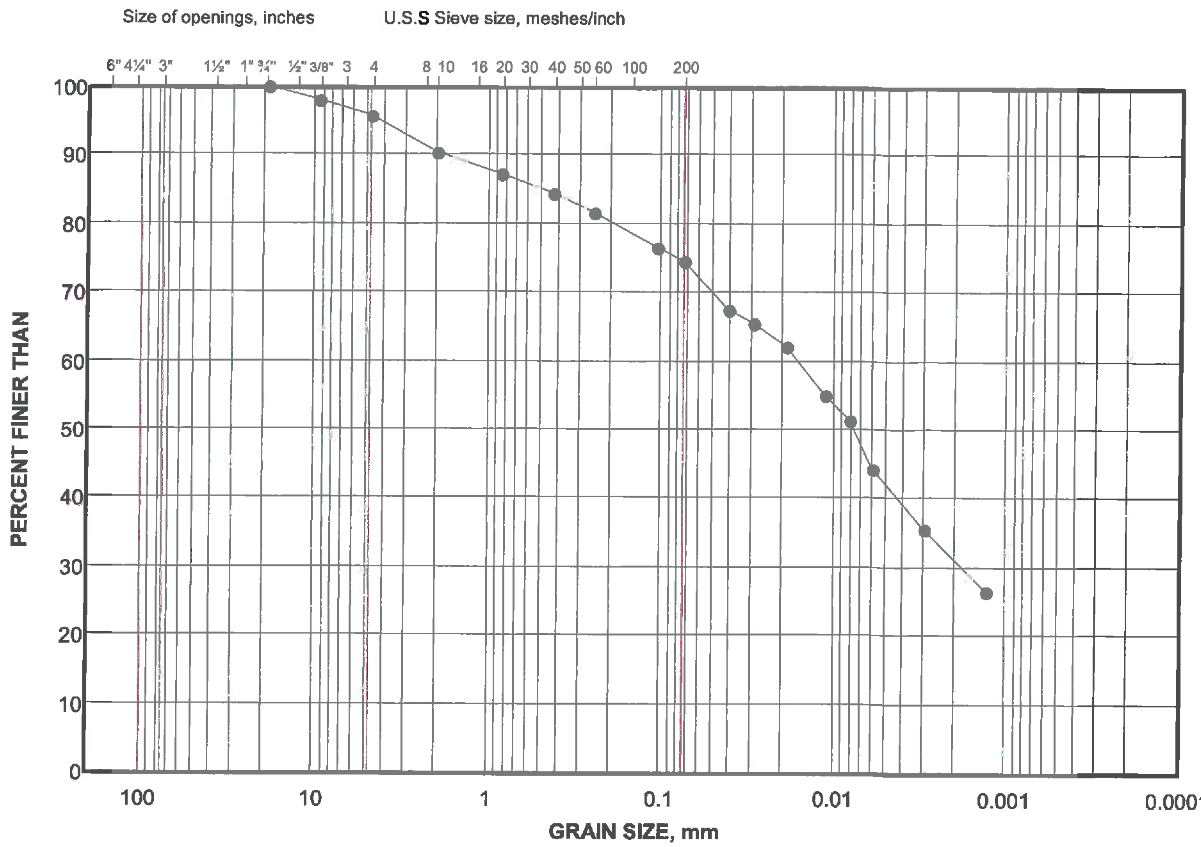
Project Number: 1535446 (4000)

Checked By: ______________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	74-1	SS14	22.86

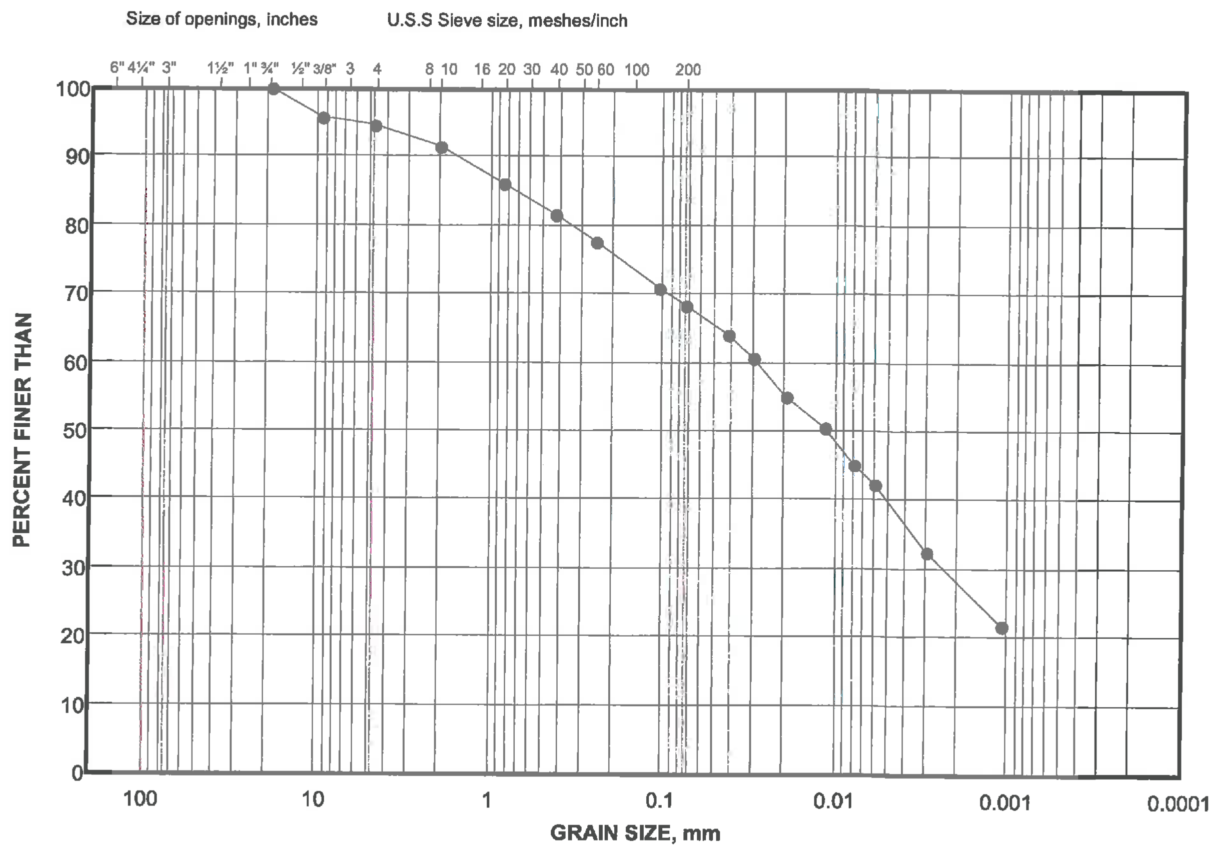
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	74-1	SS26	39.62

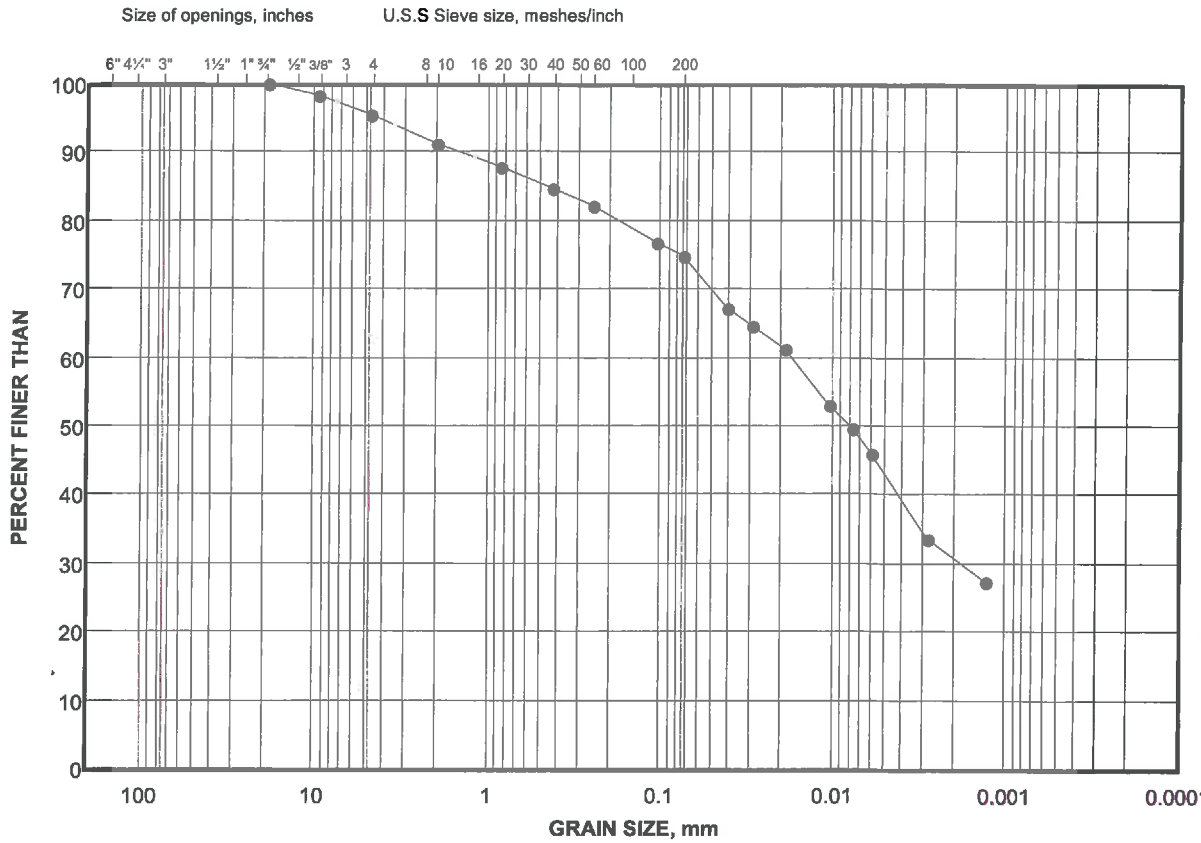
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	75-1	SS16	22.86

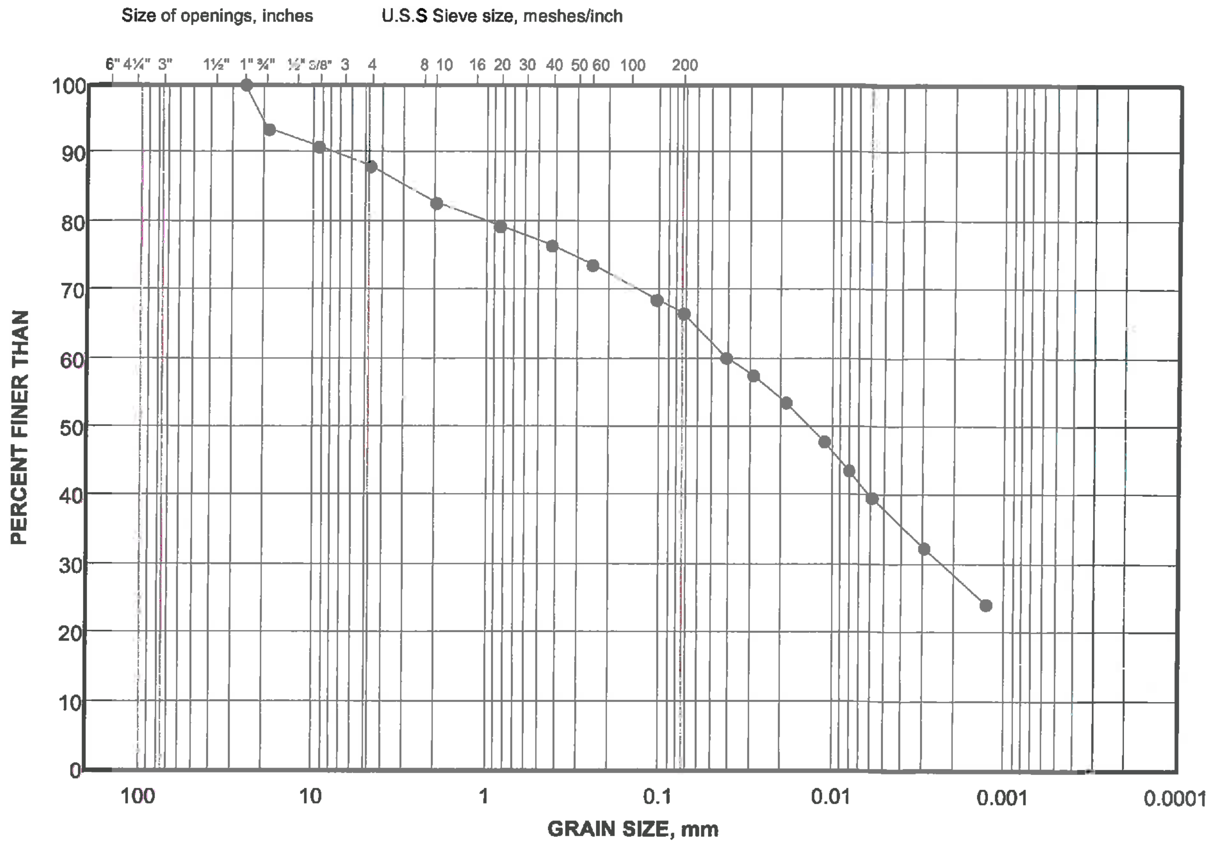
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	75-1	SS11	15.24

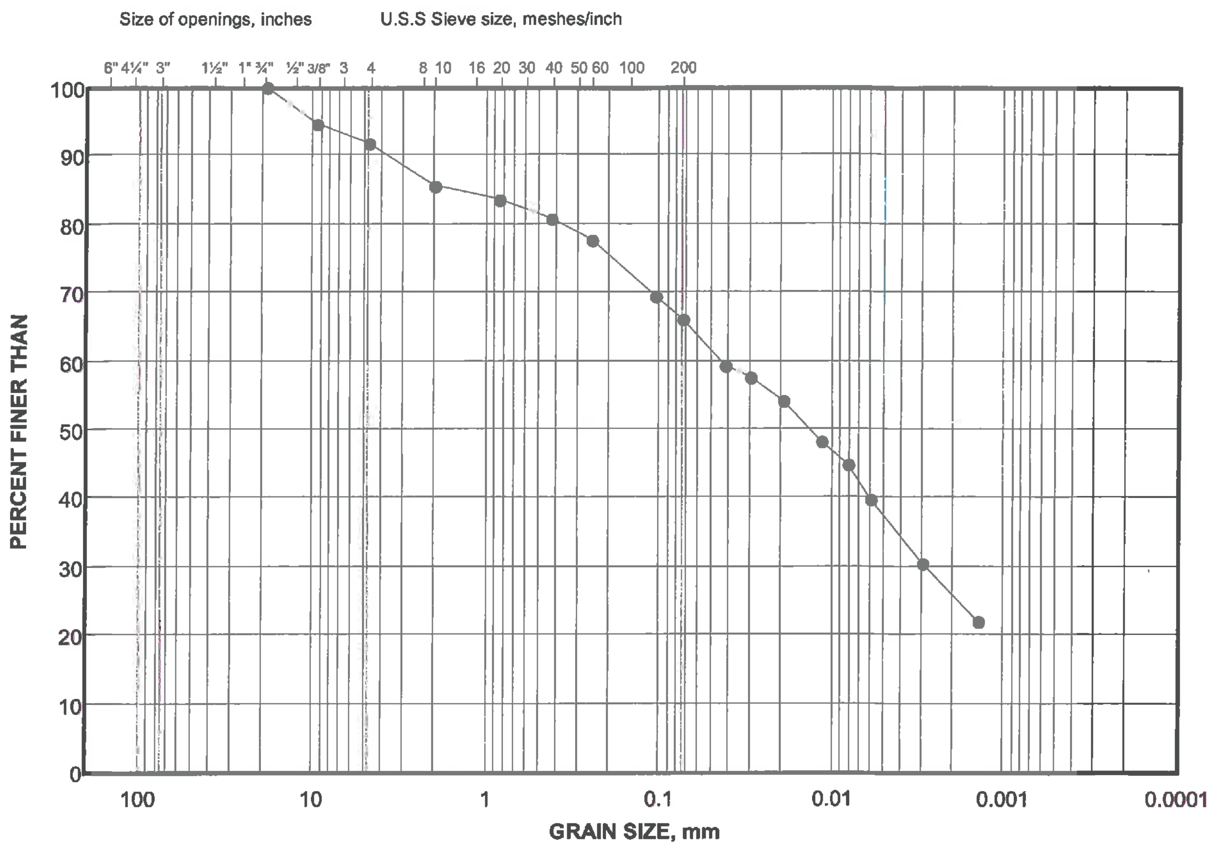
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	75-1	SS34	50.29

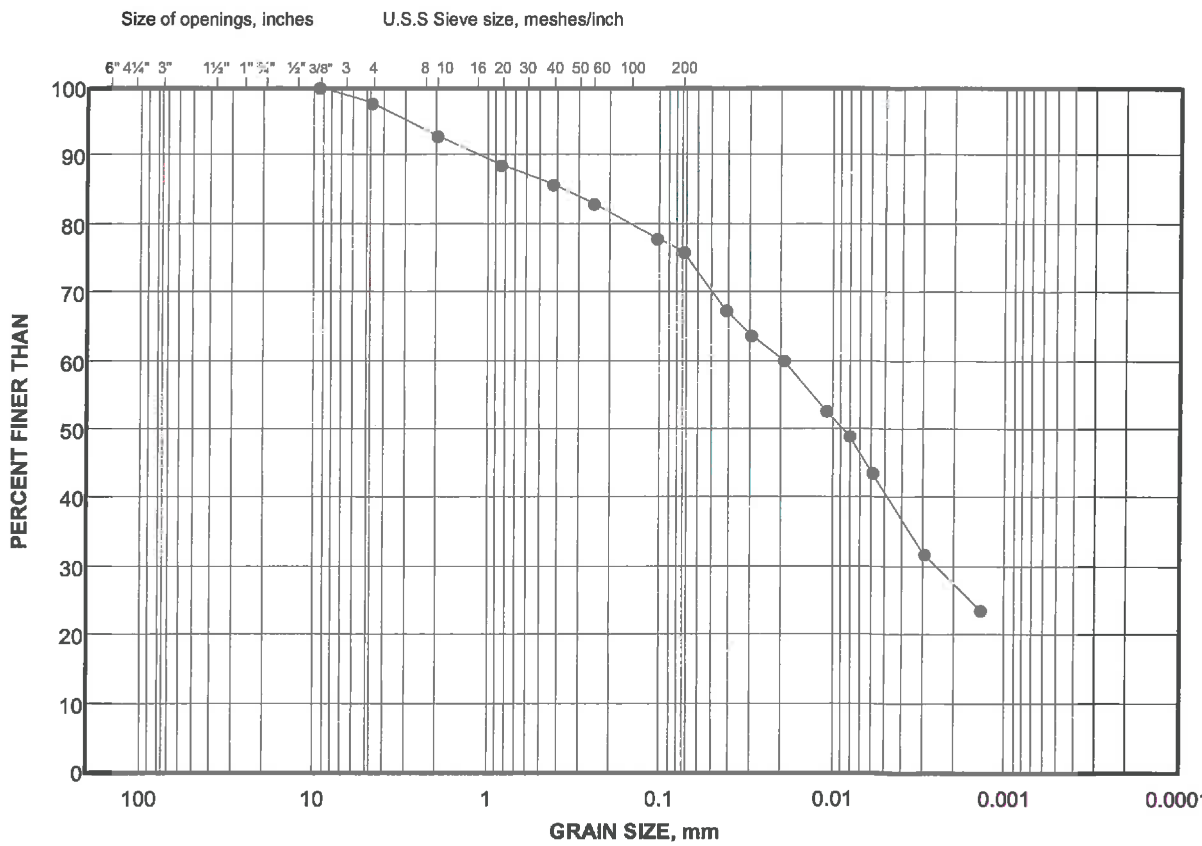
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	75-1	SS27	40.39

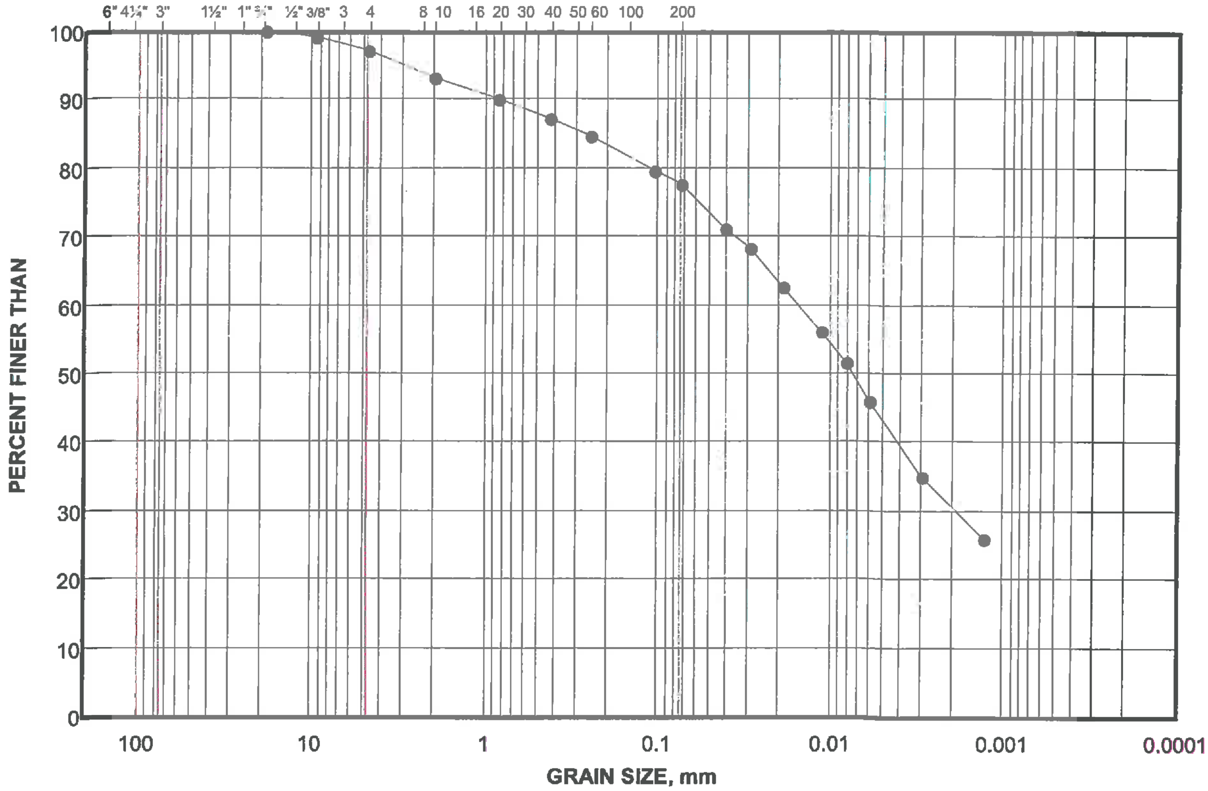
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	75-1	SS7	9.14

Project Number: 1535446 (4000)

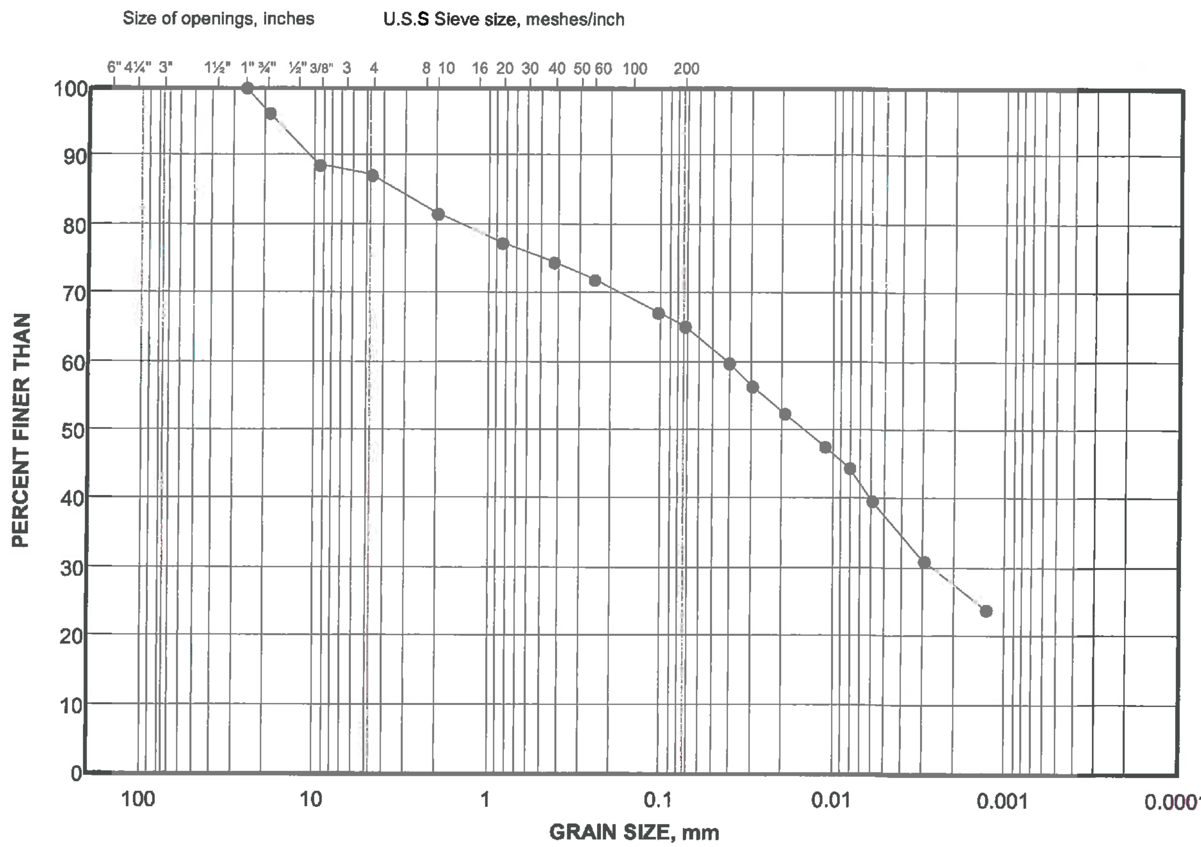
Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	75-1	SS4	4.88

Project Number: 1535446 (4000)

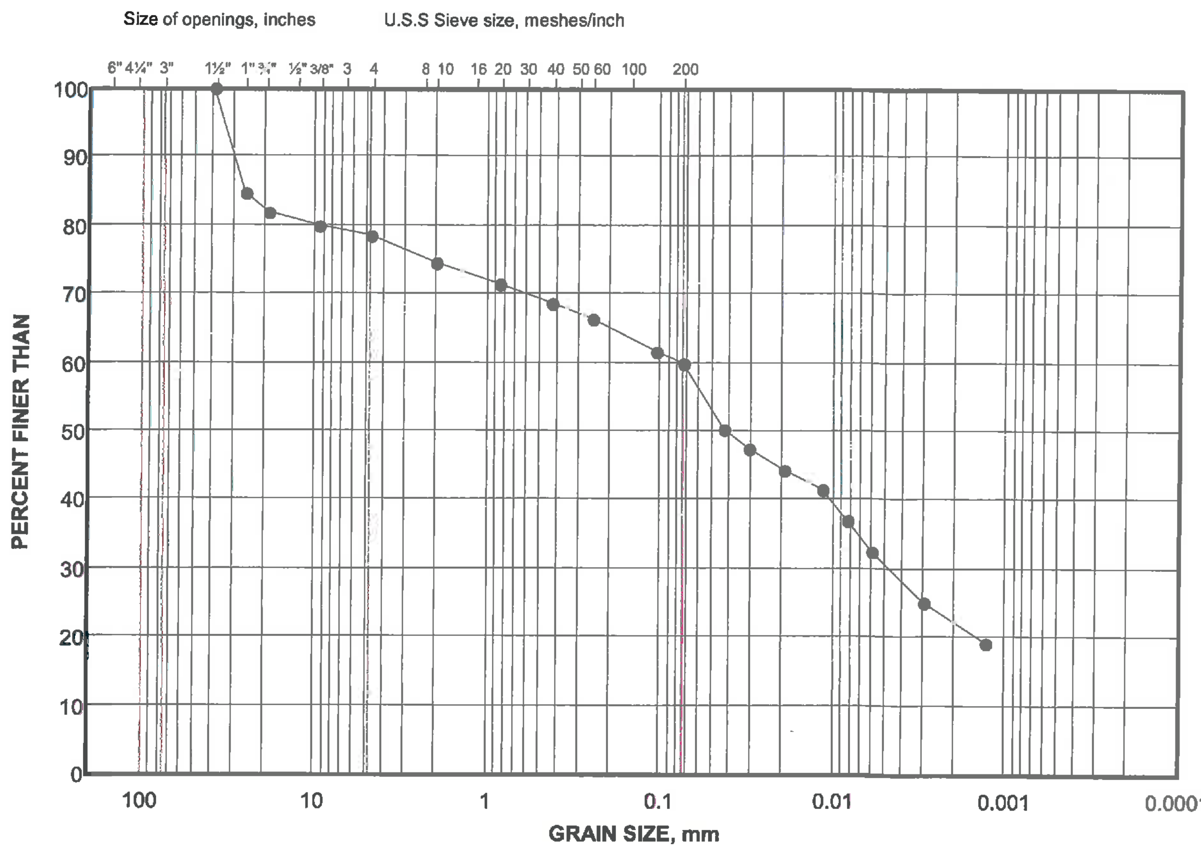
Checked By: ______

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	76-1	SS4	4.57

Project Number: 1535446 (4000)

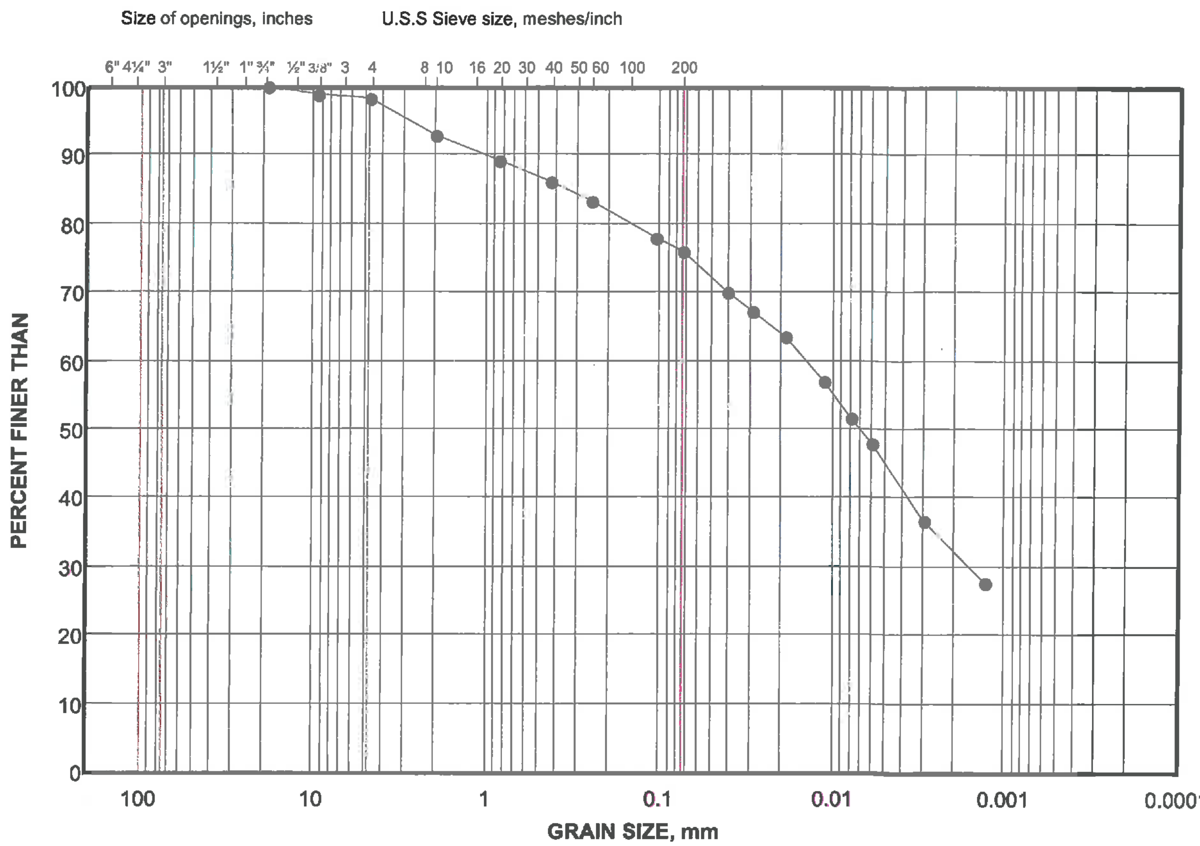
Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	76-1	SS11	15.24

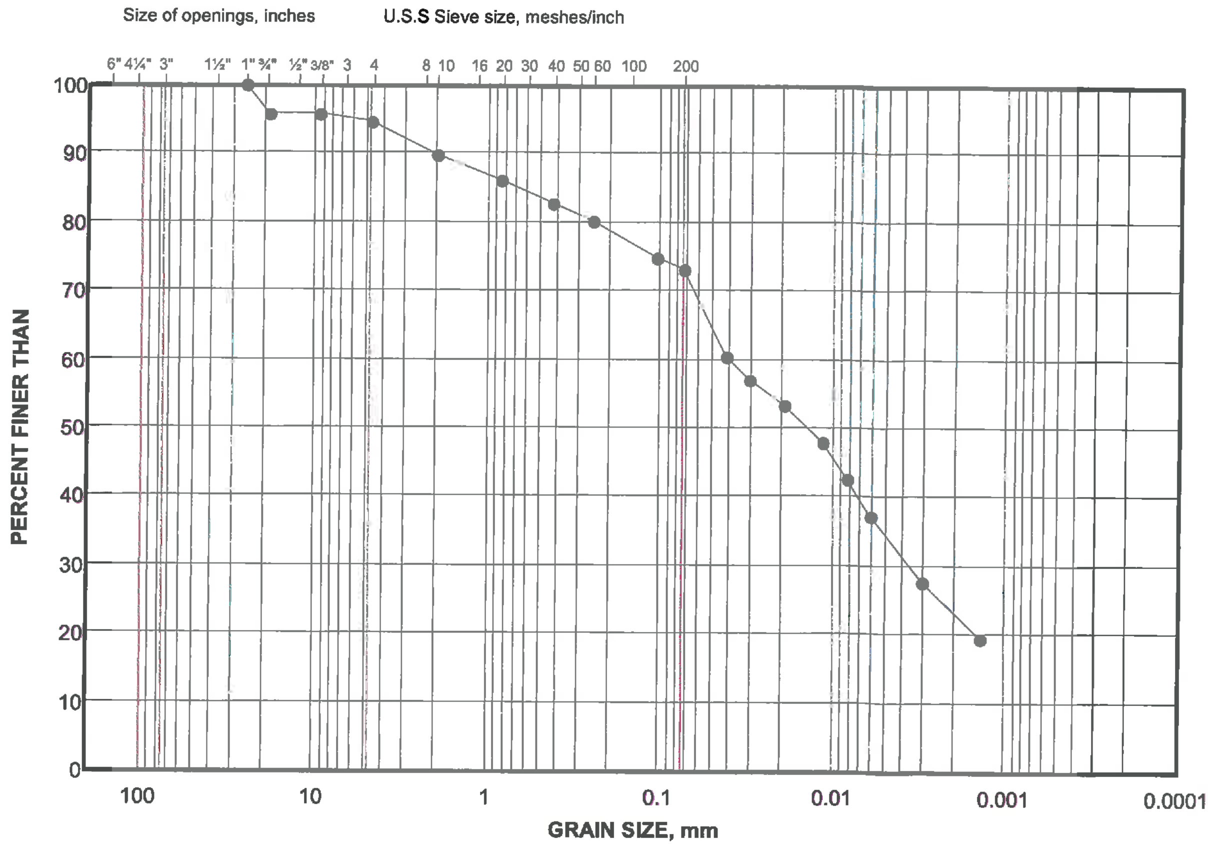
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	76-1	SS7	9.14

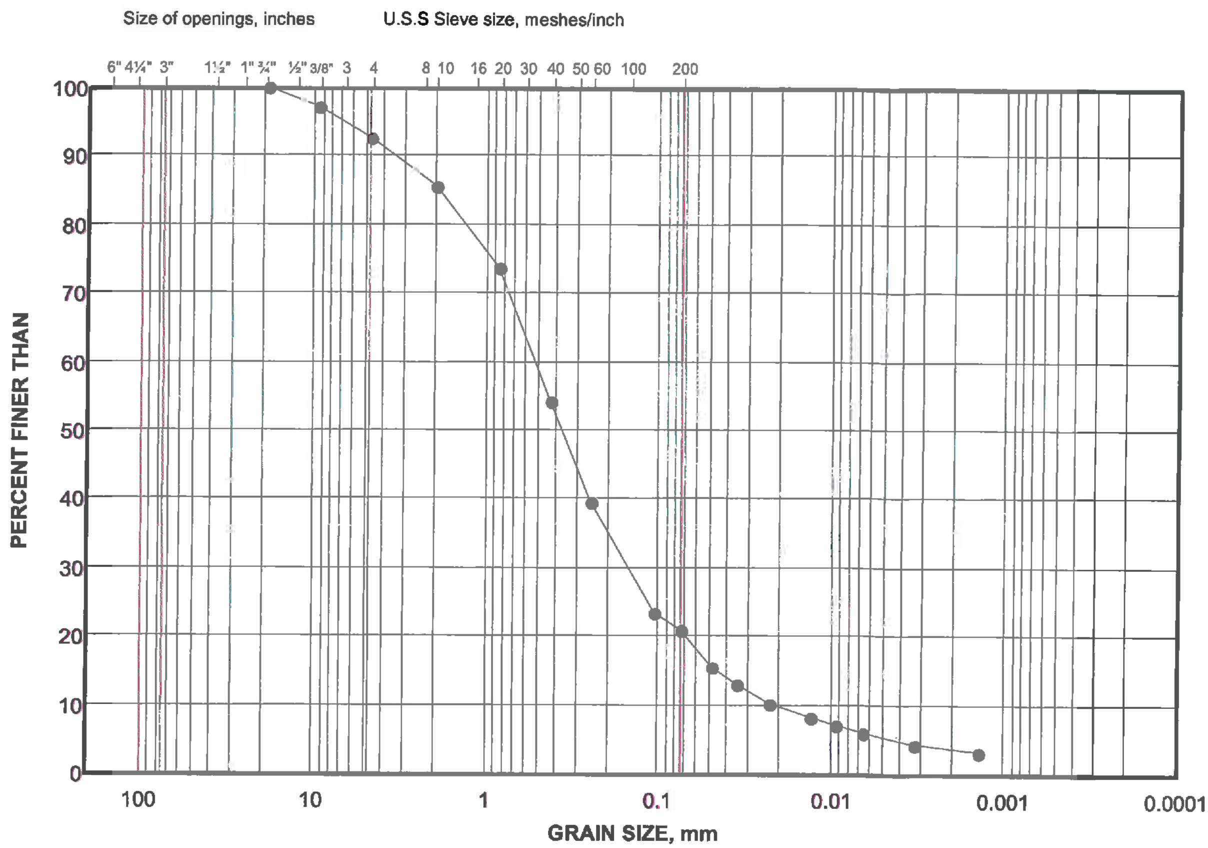
Project Number: 1535446 (4000)

Checked By: ________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	76-1	SS6	7.62

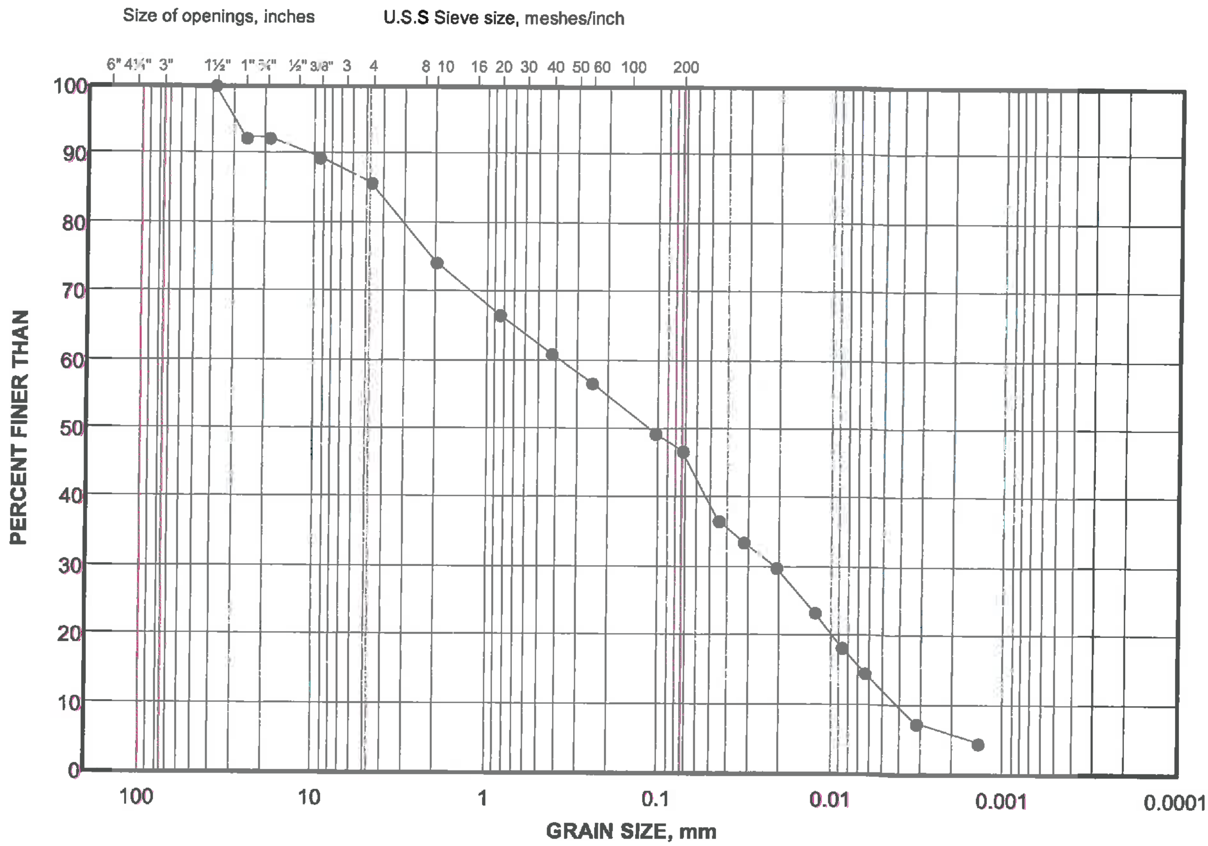
Project Number: 1535446 (4000)

Checked By: ______

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	76-1	SS31	46.94

Project Number: 1535446 (4000)

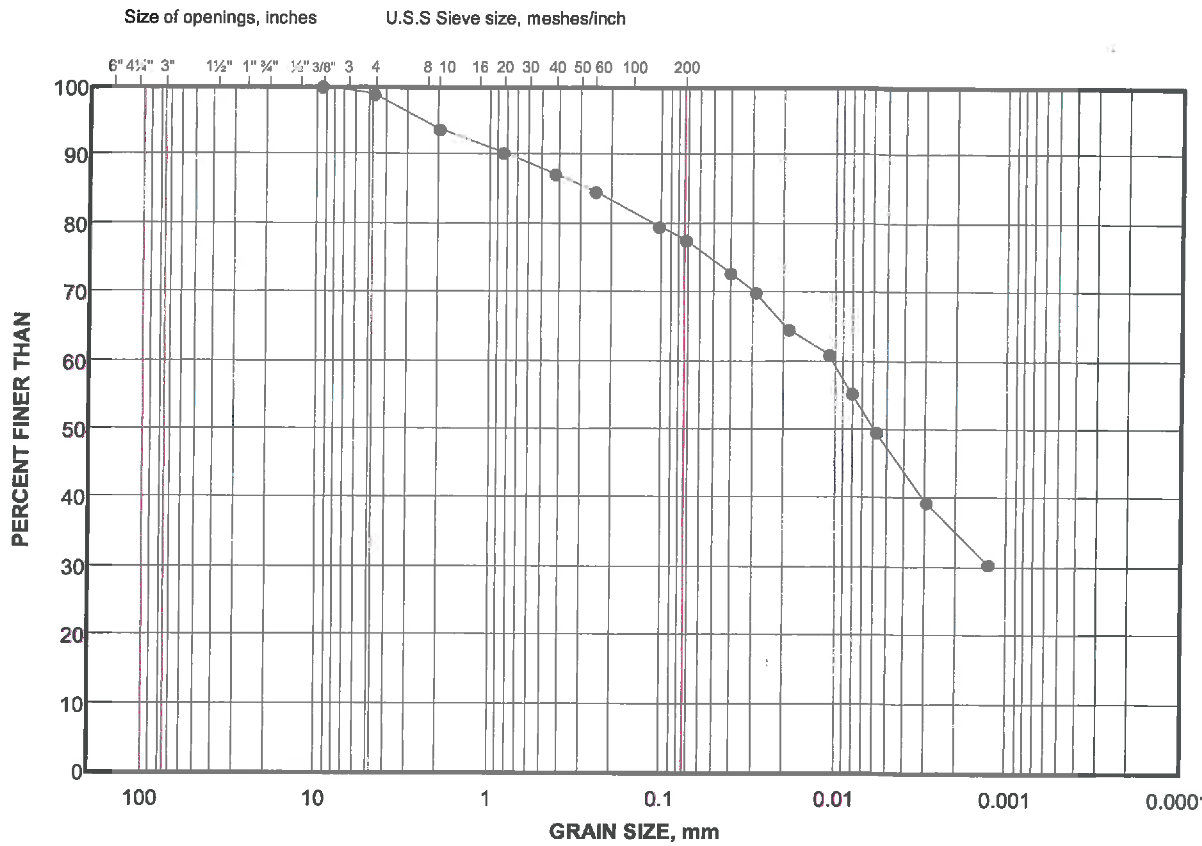
Checked By: ________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION

FIGURE



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	76-1	SS26	39.62

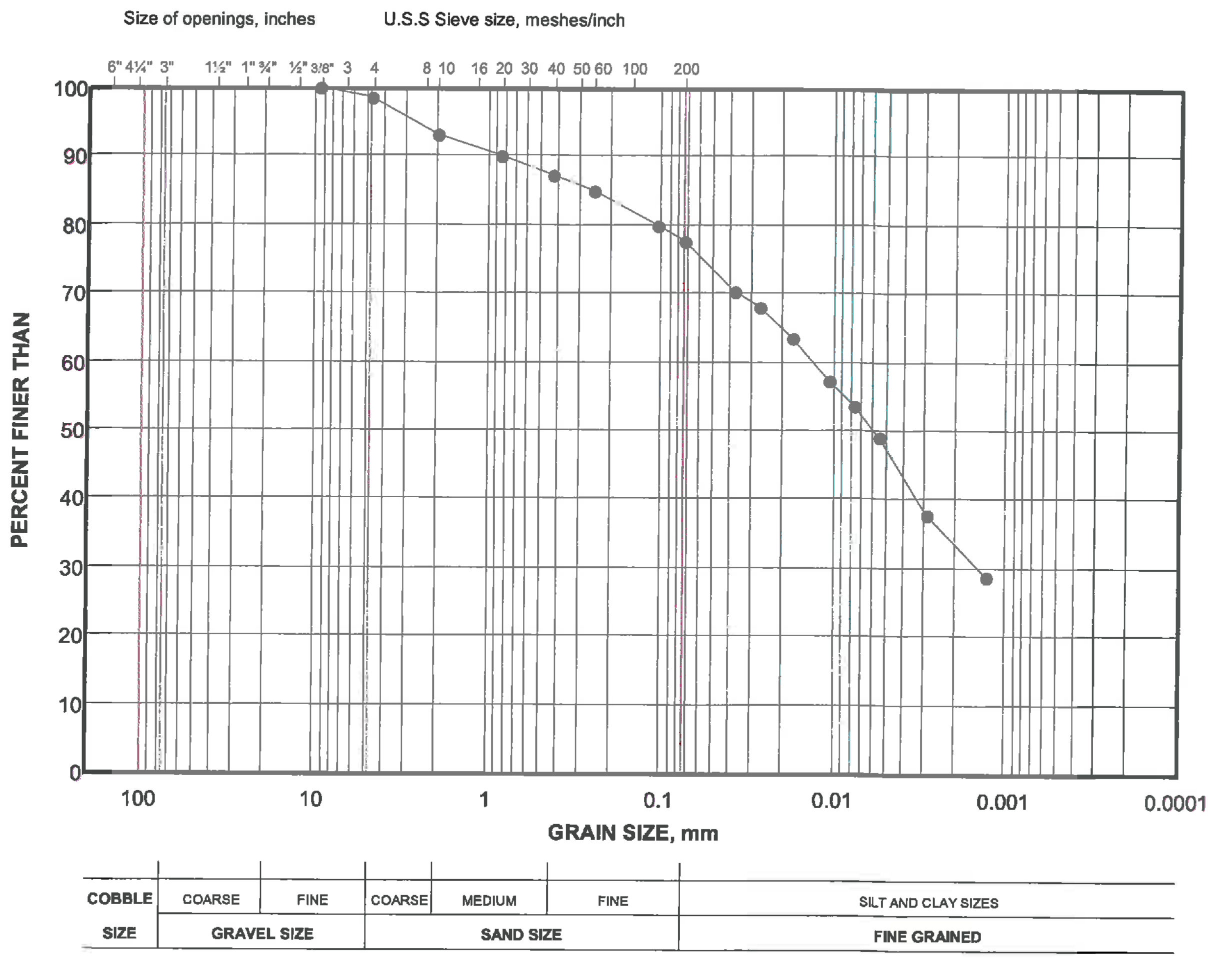
Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

GRAIN SIZE DISTRIBUTION	FIGURE



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	76-1	SS14	21.34

Project Number: 1535446 (4000)

Checked By: ____________

Golder Associates

Date: 23-Jan-17

Appendix D7-C

Permeability and Well Testing Results

DILLON CONSULTING

Summary of Hydraulic Conductivity Testing

Drilling Location	Well Number	Layer Tested	Hydraulic Conductivity (m/s)	Drilling Location	Depth of Shelby Tube	Layer Tested	Hydraulic Conductivity (m/s)
9	9-I	3	9×10^{-8}	71	9.1m	2	8.0×10^{-11}
28	28-I	3	3×10^{-6}	71	10.7m	2	5.7×10^{-11}
	28-II	2	7×10^{-10}	72	9.1m	2	6.6×10^{-11}
	28-III	1	4×10^{-8}	72	10.7m	2	6.4×10^{-11}
29	29-I	2	1×10^{-9}	73	9.1m	2	6.2×10^{-11}
	29-II	1	2×10^{-10}	73	10.7m	2	1.3×10^{-10}
30	30-I	3	4×10^{-6}	74	9.1m	2	6.4×10^{-11}
	30-III	1	2×10^{-9}	74	10.7m	2	5.4×10^{-11}
31	31-I	1	1×10^{-8}	75	9.1m	2	5.6×10^{-11}
32	32-I	3	6×10^{-5}	75	10.7m	2	9.5×10^{-11}
	32-II	1	7×10^{-9}	76	9.1m	2	4.0×10^{-11}
33	33-I	2	1×10^{-10}	76	10.7m	2	1.7×10^{-10}
	33-II	1	1×10^{-9}	Geometric Mean			6.8×10^{-11}
34	34-I	3	5×10^{-7}	Maximum			1.7×10^{-10}
	34-III	1	9×10^{-7}	Minimum			3.2×10^{-11}
35	35-I	3	7×10^{-5}				
	35-II	2	7×10^{-11}				
	35-III	1	1×10^{-9}				
44	44-I	3	3×10^{-4}				
	44-III	1	1×10^{-10}				
45	45-I	3	1×10^{-6}				
	45-II	2	2×10^{-10}				
	45-III	1	2×10^{-10}				
46	46-II	2	3×10^{-8}				
	46-III	1	8×10^{-10}				
47	47--I	2	3×10^{-10}				
	47-II	1	6×10^{-10}				
48	48-I	1	2×10^{-10}				
49	49C	3	1×10^{-6}				
53	53C	3	1×10^{-6}				

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH71-2 30'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	01/23/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	5.75	UNIT WEIGHT, kN/m^3	21.04
SAMPLE DIAMETER, cm	6.87	DRY UNIT WEIGHT, kN/m^3	18.11
SAMPLE AREA, cm^2	37.07	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	213.14	VOLUME OF SOLIDS, cm^3	145.76
TOTAL MASS, g	457.36	VOLUME OF VOIDS, cm^3	67.38
DRY MASS, g	393.56	VOID RATIO	0.46
WATER CONTENT, %	16.2		

SATURATION STAGE

CELL PRESSURE, kPa	350.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	340.00	DURATION, min	7,272
BACK PRESSURE, kPa	340.00	B COEFFICIENT	0.99

CONSOLIDATION STAGE

CELL PRESSURE, kPa	690.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	340.00	DURATION, min	1,016
BACK PRESSURE, kPa	340.00	VOLUME CHANGE, cm^3	10.50
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	5.66	SAMPLE AREA, cm^2	35.85
SAMPLE DIAMETER, cm	6.76	SAMPLE VOLUME, cm^3	202.76

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	700	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	350	DURATION, min	18664
BACK PRESSURE, kPa	340	HYDRAULIC GRADIENT, i	18

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	5.66	UNIT WEIGHT, kN/m^3	21.93
SAMPLE DIAMETER, cm	6.76	DRY UNIT WEIGHT, kN/m^3	19.04
SAMPLE AREA, cm^2	35.85	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	202.76	VOLUME OF SOLIDS, cm^3	145.76
TOTAL MASS, g	453.39	VOLUME OF VOIDS, cm^3	56.99
DRY MASS, g	393.56	VOID RATIO	0.39
WATER CONTENT, %	15.2		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	18664
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	6.3
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	6.1
INFLOW TO OUTFLOW RATIO	1.0
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	8.70E-09
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	8.43E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	8.56E-09
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**7.98E-09**

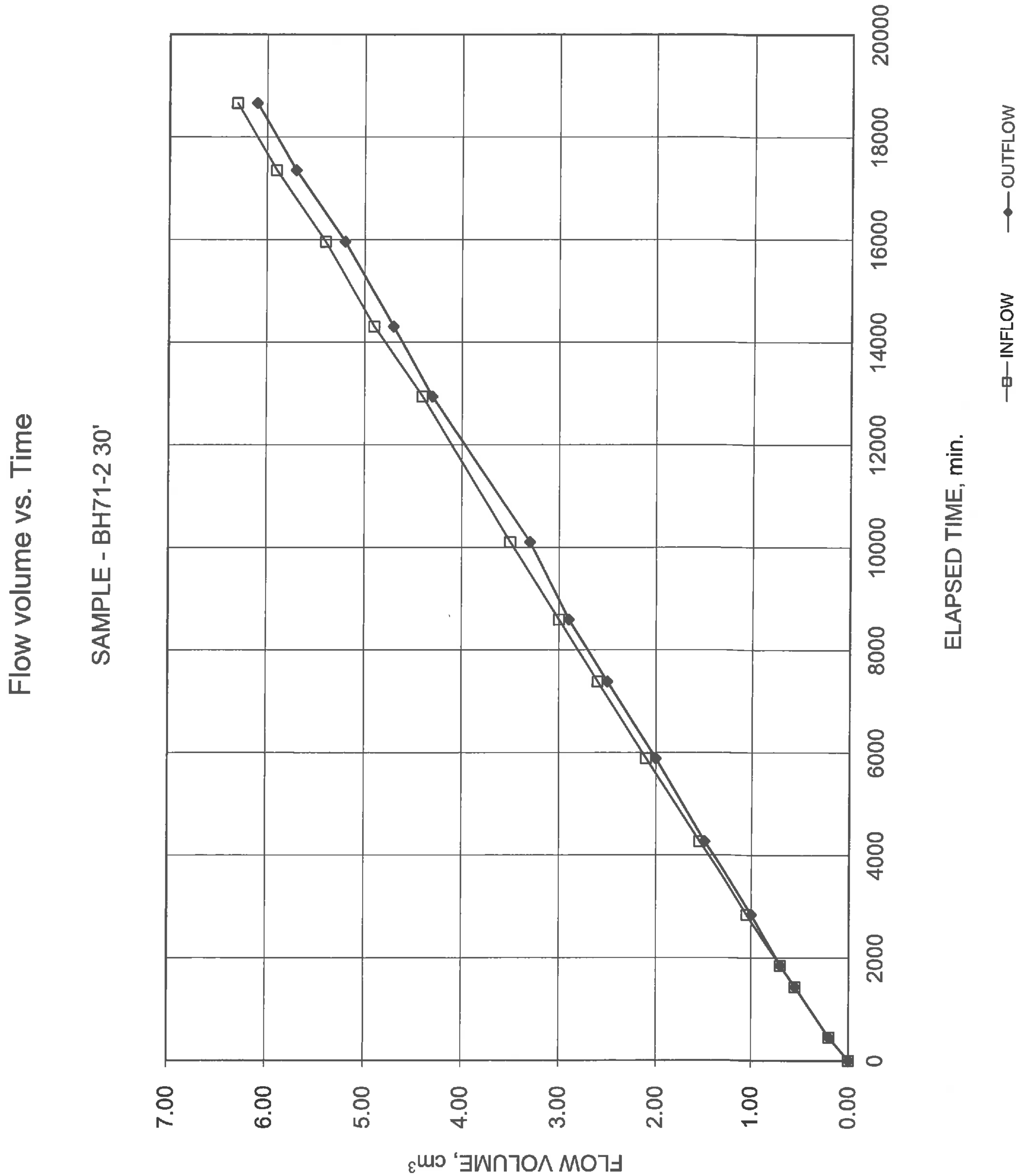
NOTES:

Effective consolidation stress assigned, by the client.

PERMEANT FLUID	De-Aired Tap Water
AVERAGE TEST TEMPERATURE	23.0 °C

Prepared By: LH   **Golder Associates**   Checked By: MM

HYDRAULIC CONDUCTIVITY TEST 01/23/2017	Project title: DillonConsult/SiltTesting/Miss Borehole number: - Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH71-2 35'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	01/10/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	5.51	UNIT WEIGHT, kN/m^3	21.34
SAMPLE DIAMETER, cm	6.88	DRY UNIT WEIGHT, kN/m^3	18.39
SAMPLE AREA, cm^2	37.18	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	204.84	VOLUME OF SOLIDS, cm^3	142.31
TOTAL MASS, g	445.74	VOLUME OF VOIDS, cm^3	62.54
DRY MASS, g	384.23	VOID RATIO	0.44
WATER CONTENT, %	16.0		

SATURATION STAGE

CELL PRESSURE, kPa	350.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	340.00	DURATION, min	7,266
BACK PRESSURE, kPa	340.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	690.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	340.00	DURATION, min	1,134
BACK PRESSURE, kPa	340.00	VOLUME CHANGE, cm^3	9.10
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	5.43	SAMPLE AREA, cm^2	36.08
SAMPLE DIAMETER, cm	6.78	SAMPLE VOLUME, cm^3	195.83

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	700	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	350	DURATION, min	4218
BACK PRESSURE, kPa	340	HYDRAULIC GRADIENT, i	19

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	5.43	UNIT WEIGHT, kN/m^3	22.40
SAMPLE DIAMETER, cm	6.78	DRY UNIT WEIGHT, kN/m^3	19.24
SAMPLE AREA, cm^2	36.08	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	195.83	VOLUME OF SOLIDS, cm^3	142.31
TOTAL MASS, g	447.40	VOLUME OF VOIDS, cm^3	53.53
DRY MASS, g	384.23	VOID RATIO	0.38
WATER CONTENT, %	16.4		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	4218
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	1.0
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	1.1
INFLOW TO OUTFLOW RATIO	0.9
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	5.83E-09
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	6.41E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	6.12E-09
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**5.70E-09**

NOTES:

Effective consolidation stress assigned, by the client.

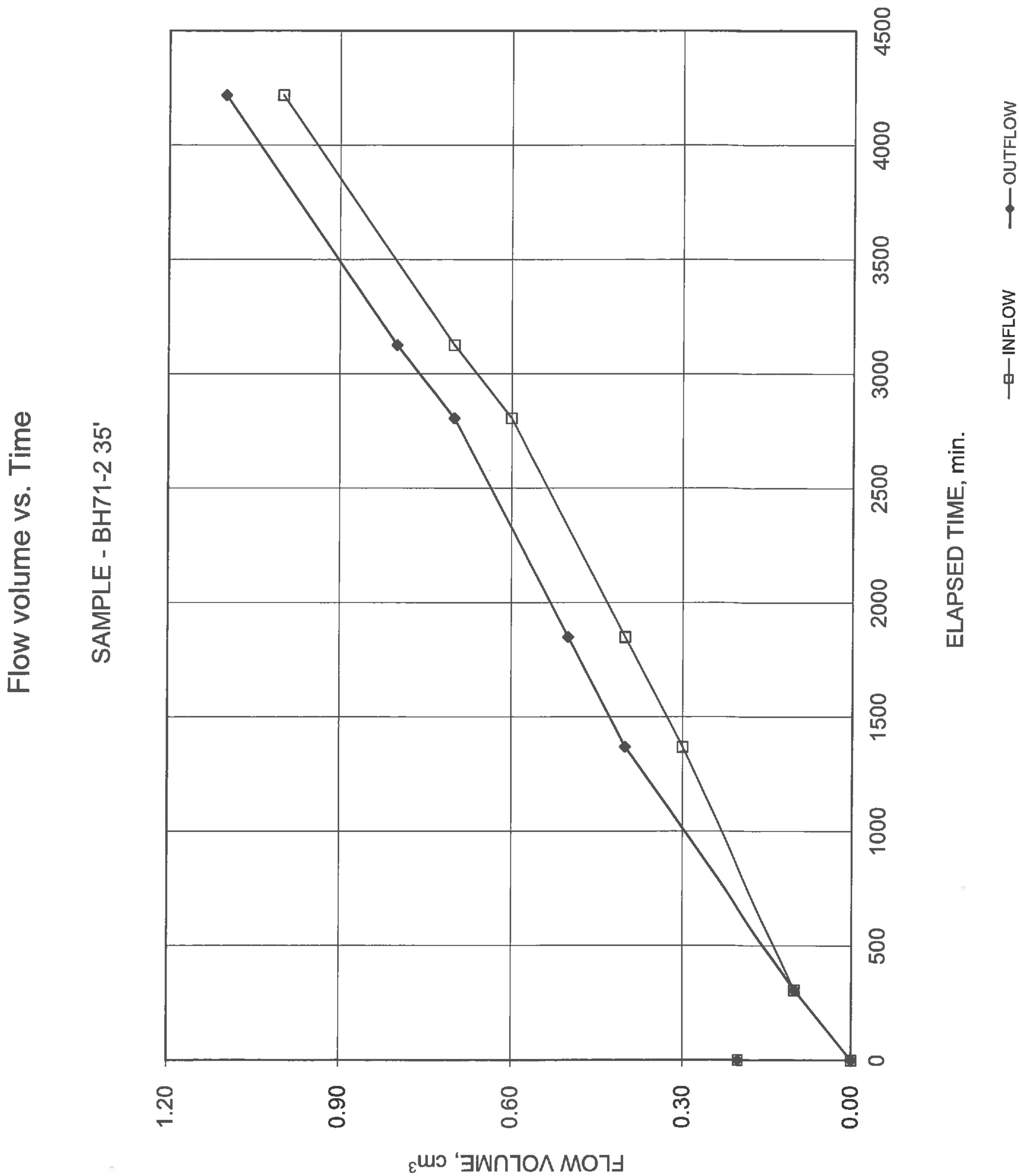
PERMEANT FLUID	De-Aired Tap Water
AVERAGE TEST TEMPERATURE	23.0 °C

Prepared By: LH

Golder Associates

Checked By: MM

HYDRAULIC CONDUCTIVITY TEST 01/10/2017	Project title: DillonConsult/SiltTesting/Miss Borehole number: - Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH72-1 30'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	11/15/2016

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	6.02	UNIT WEIGHT, kN/m^3	21.09
SAMPLE DIAMETER, cm	6.91	DRY UNIT WEIGHT, kN/m^3	18.19
SAMPLE AREA, cm^2	37.52	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	225.96	VOLUME OF SOLIDS, cm^3	155.21
TOTAL MASS, g	485.92	VOLUME OF VOIDS, cm^3	70.75
DRY MASS, g	419.08	VOID RATIO	0.46
WATER CONTENT, %	16.0		

SATURATION STAGE

CELL PRESSURE, kPa	280.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	270.00	DURATION, min	5,272
BACK PRESSURE, kPa	270.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	620.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	270.00	DURATION, min	3,991
BACK PRESSURE, kPa	270.00	VOLUME CHANGE, cm^3	9.40
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	5.94	SAMPLE AREA, cm^2	36.48
SAMPLE DIAMETER, cm	6.82	SAMPLE VOLUME, cm^3	216.65

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	632	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	282	DURATION, min	2977
BACK PRESSURE, kPa	270	HYDRAULIC GRADIENT, i	21

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	5.94	UNIT WEIGHT, kN/m^3	22.01
SAMPLE DIAMETER, cm	6.82	DRY UNIT WEIGHT, kN/m^3	18.97
SAMPLE AREA, cm^2	36.48	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	216.65	VOLUME OF SOLIDS, cm^3	155.21
TOTAL MASS, g	486.25	VOLUME OF VOIDS, cm^3	61.44
DRY MASS, g	419.08	VOID RATIO	0.40
WATER CONTENT, %	**16.0**		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	2977
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	1.0
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.9
INFLOW TO OUTFLOW RATIO	1.1
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	7.07E-09
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	6.70E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	6.89E-09
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**6.41E-09**

NOTES:

Effective consolidation stress assigned, by the client.

PERMEANT FLUID De-Aired Tap Water

AVERAGE TEST TEMPERATURE 23.0 °C

Prepared By: LH

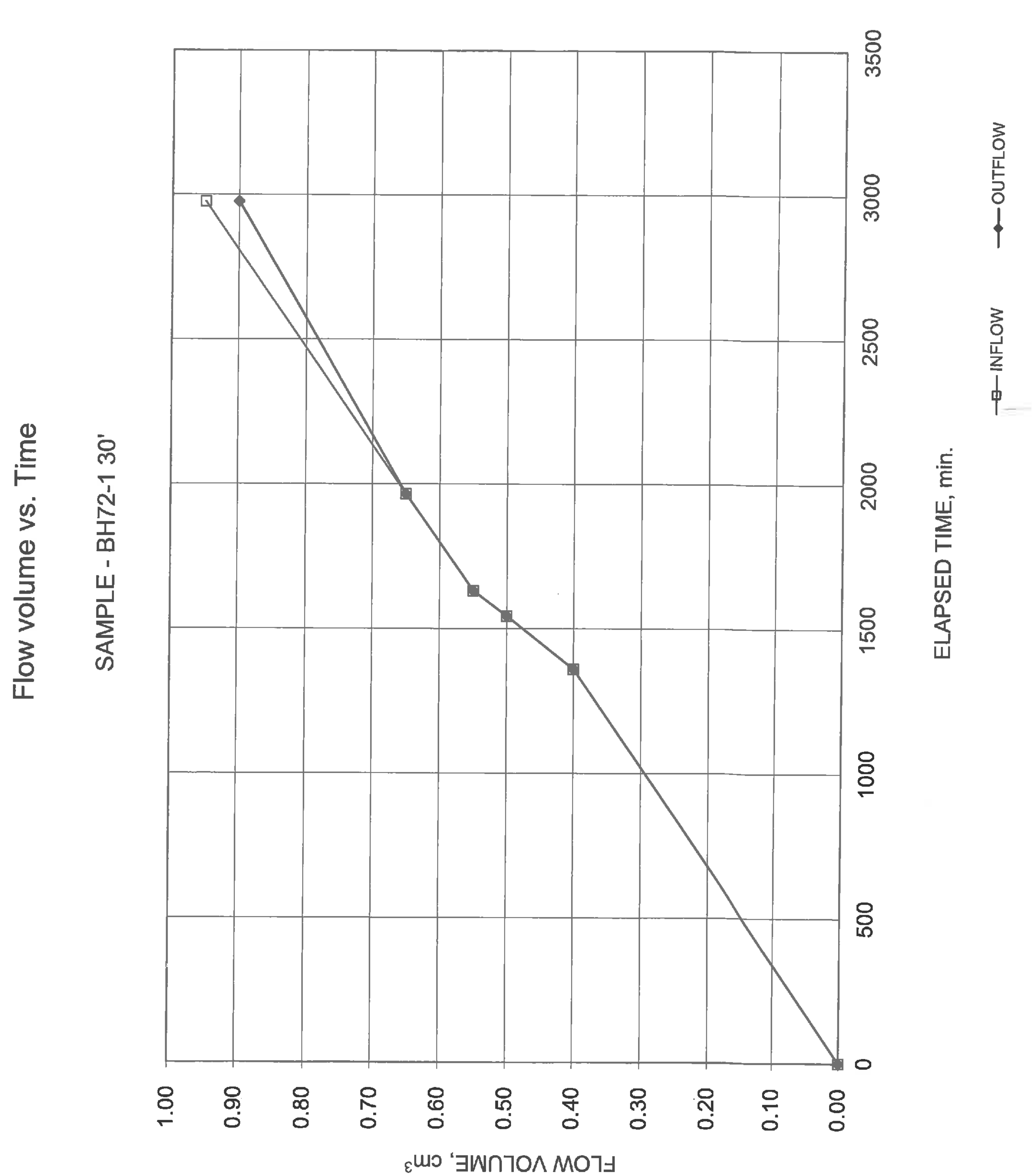
Golder Associates

Checked By: [signature]

HYDRAULIC CONDUCTIVITY TEST

11/15/2016

Project title: DillonConsult/SiltTesting/Miss
Borehole number: -
Sample depth: -



Project number : 1535446 (4000)
Prepared by : AH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH72-1 35'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	12/08/2016

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	4.58	UNIT WEIGHT, kN/m^3	20.70
SAMPLE DIAMETER, cm	5.06	DRY UNIT WEIGHT, kN/m^3	17.93
SAMPLE AREA, cm^2	20.11	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	92.10	VOLUME OF SOLIDS, cm^3	62.37
TOTAL MASS, g	194.44	VOLUME OF VOIDS, cm^3	29.73
DRY MASS, g	168.40	VOID RATIO	0.48
WATER CONTENT, %	15.5		

SATURATION STAGE

CELL PRESSURE, kPa	210.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	200.00	DURATION, min	4,020
BACK PRESSURE, kPa	200.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	550.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	200.00	DURATION, min	4,490
BACK PRESSURE, kPa	200.00	VOLUME CHANGE, cm^3	9.71
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	4.42	SAMPLE AREA, cm^2	18.70
SAMPLE DIAMETER, cm	4.88	SAMPLE VOLUME, cm^3	82.62

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	559	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	209	DURATION, min	5682
BACK PRESSURE, kPa	200	HYDRAULIC GRADIENT, i	21

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	4.42	UNIT WEIGHT, kN/m^3	20.19
SAMPLE DIAMETER, cm	4.88	DRY UNIT WEIGHT, kN/m^3	19.99
SAMPLE AREA, cm^2	18.70	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	82.62	VOLUME OF SOLIDS, cm^3	62.37
TOTAL MASS, g	170.05	VOLUME OF VOIDS, cm^3	20.24
DRY MASS, g	168.40	VOID RATIO	0.32
WATER CONTENT, %	1.0		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	5682
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	1.0
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.9
INFLOW TO OUTFLOW RATIO	1.1
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	7.33E-09
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	6.87E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	7.10E-09
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**6.61E-09**

NOTES:

Effective consolidation stress assigned, by the client.

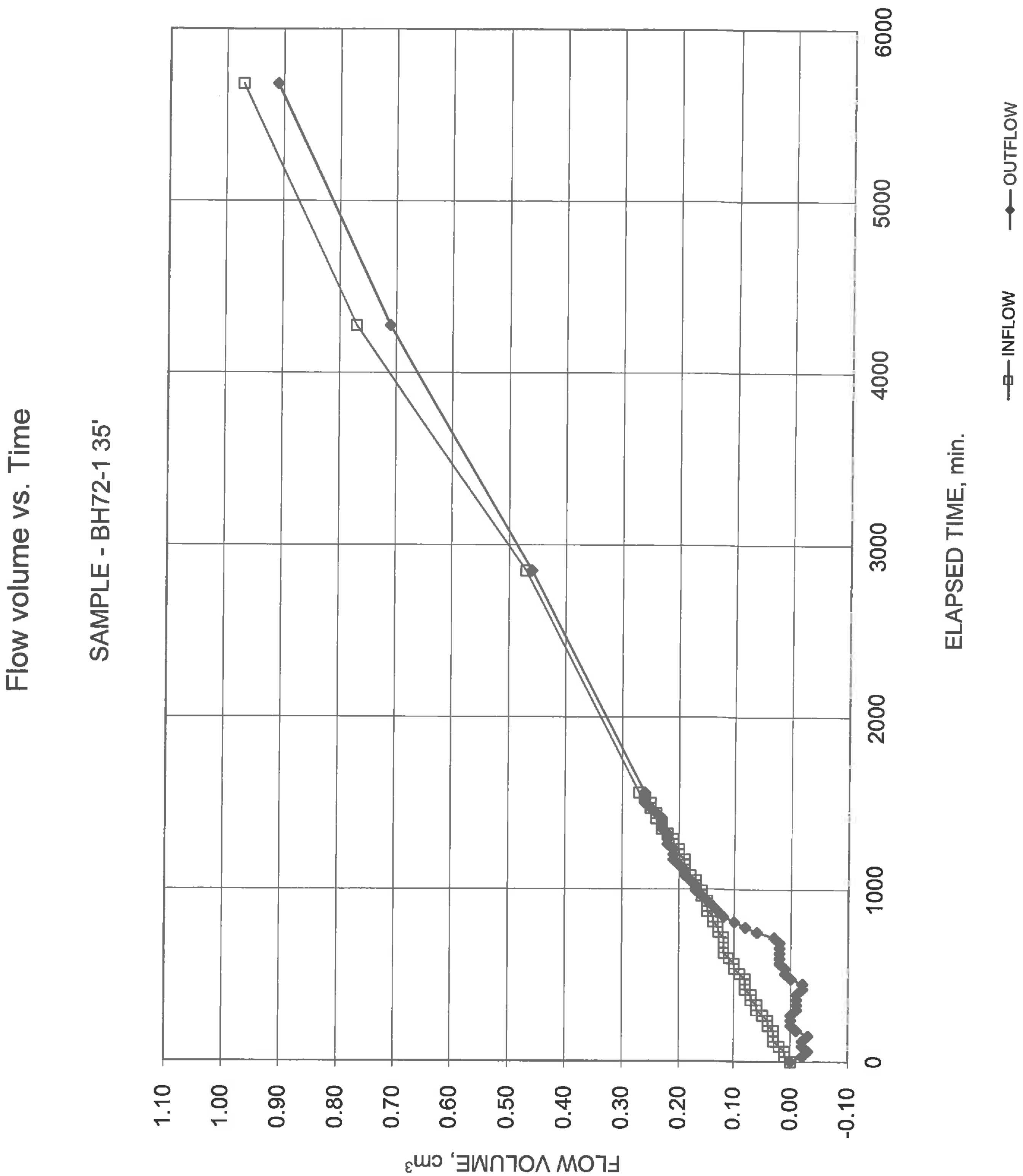
PERMEANT FLUID De-Aired Tap Water

AVERAGE TEST TEMPERATURE 23.0 °C

HYDRAULIC CONDUCTIVITY TEST

12/08/2016

Project title: DillonConsult/SiltTesting/Miss
Borehole number: -
Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH73-2 30'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	01/25/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	5.94	UNIT WEIGHT, kN/m^3	20.96
SAMPLE DIAMETER, cm	4.87	DRY UNIT WEIGHT, kN/m^3	19.24
SAMPLE AREA, cm^2	18.63	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	110.65	VOLUME OF SOLIDS, cm^3	80.41
TOTAL MASS, g	236.47	VOLUME OF VOIDS, cm^3	30.24
DRY MASS, g	217.10	VOID RATIO	0.38
WATER CONTENT, %	8.9		

SATURATION STAGE

CELL PRESSURE, kPa	280.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	0.27	DURATION, min	3,977
BACK PRESSURE, kPa	270.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	620.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	270.00	DURATION, min	1,532
BACK PRESSURE, kPa	270.00	VOLUME CHANGE, cm^3	5.25
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	5.85	SAMPLE AREA, cm^2	18.04
SAMPLE DIAMETER, cm	4.79	SAMPLE VOLUME, cm^3	105.45

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	631	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	281	DURATION, min	11472
BACK PRESSURE, kPa	270	HYDRAULIC GRADIENT, i	19

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	5.85	UNIT WEIGHT, kN/m^3	21.87
SAMPLE DIAMETER, cm	4.79	DRY UNIT WEIGHT, kN/m^3	20.19
SAMPLE AREA, cm^2	18.04	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	105.45	VOLUME OF SOLIDS, cm^3	80.41
TOTAL MASS, g	235.15	VOLUME OF VOIDS, cm^3	25.04
DRY MASS, g	217.10	VOID RATIO	0.31
WATER CONTENT, %	8.3		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	11472
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	1.4
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	1.8
INFLOW TO OUTFLOW RATIO	0.8
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	5.67E-09
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	7.56E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	6.61E-09
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**6.16E-09**

NOTES:

Effective consolidation stress assigned, by the client.

PERMEANT FLUID: De-Aired Tap Water

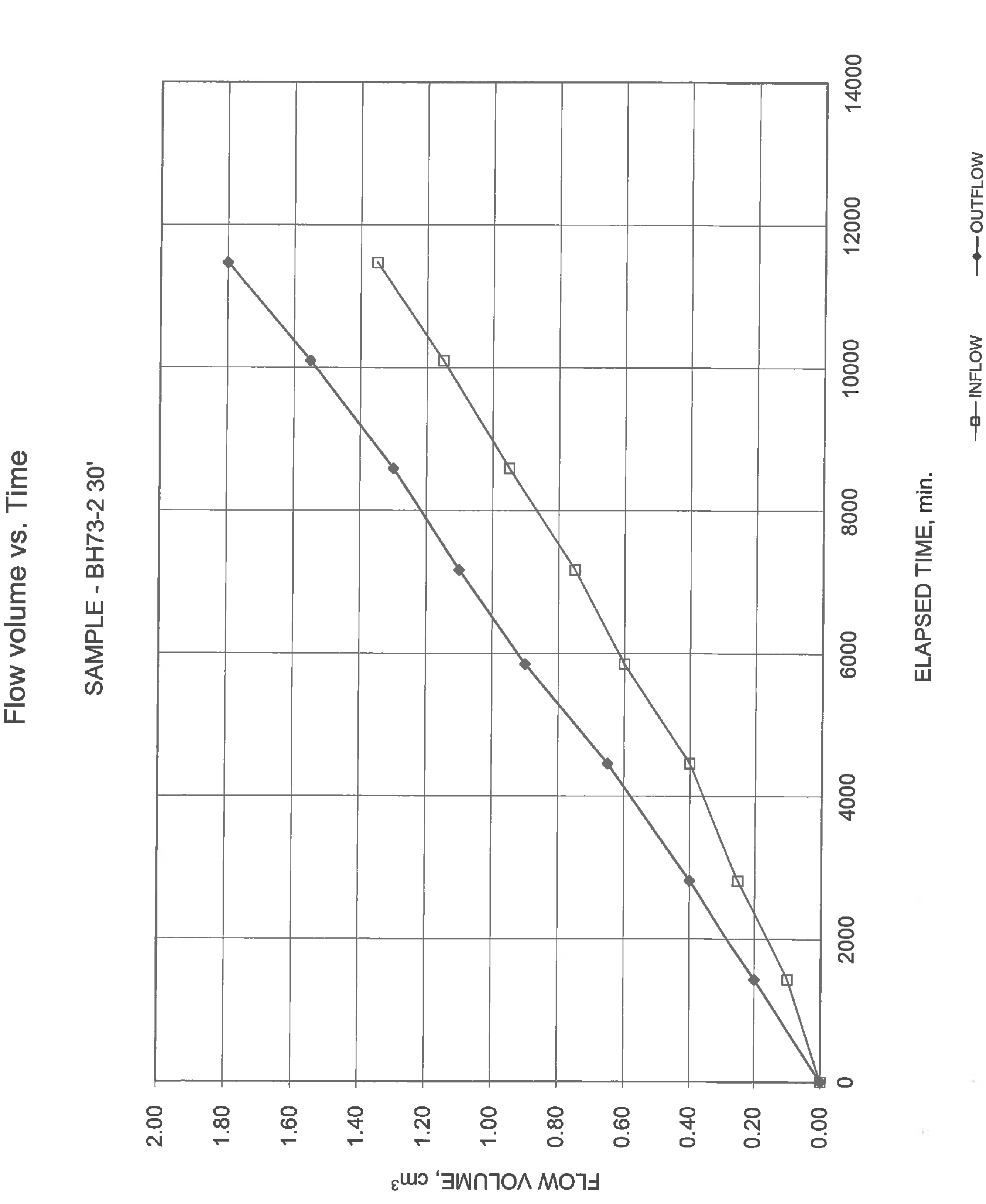
AVERAGE TEST TEMPERATURE: 23.0 °C

Prepared By: LH

Golder Associates

Checked By: MM

HYDRAULIC CONDUCTIVITY TEST 01/25/2017	Project title: DillonConsult/SiltTesting/Miss Borehole number: - Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH73-2 35'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	02/01/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	5.98	UNIT WEIGHT, kN/m^3	20.99
SAMPLE DIAMETER, cm	4.85	DRY UNIT WEIGHT, kN/m^3	19.29
SAMPLE AREA, cm^2	18.45	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	110.36	VOLUME OF SOLIDS, cm^3	80.42
TOTAL MASS, g	236.25	VOLUME OF VOIDS, cm^3	29.94
DRY MASS, g	217.12	VOID RATIO	0.37
WATER CONTENT, %	8.8		

SATURATION STAGE

CELL PRESSURE, kPa	350.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	340.00	DURATION, min	5,413
BACK PRESSURE, kPa	340.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	690.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	340.00	DURATION, min	1,630
BACK PRESSURE, kPa	340.00	VOLUME CHANGE, cm^3	4.80
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	5.89	SAMPLE AREA, cm^2	17.92
SAMPLE DIAMETER, cm	4.78	SAMPLE VOLUME, cm^3	105.61

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	700	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	350	DURATION, min	8799
BACK PRESSURE, kPa	340	HYDRAULIC GRADIENT, i	17

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	5.89	UNIT WEIGHT, kN/m^3	21.79
SAMPLE DIAMETER, cm	4.78	DRY UNIT WEIGHT, kN/m^3	20.16
SAMPLE AREA, cm^2	17.92	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	105.61	VOLUME OF SOLIDS, cm^3	80.42
TOTAL MASS, g	234.64	VOLUME OF VOIDS, cm^3	25.19
DRY MASS, g	217.12	VOID RATIO	0.31
WATER CONTENT, %	8.1		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	8799
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	2.4
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	2.0
INFLOW TO OUTFLOW RATIO	1.2
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	1.47E-08
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	1.22E-08
HYDRAULIC CONDUCTIVITY, K, cm/s	1.34E-08
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**1.25E-08**

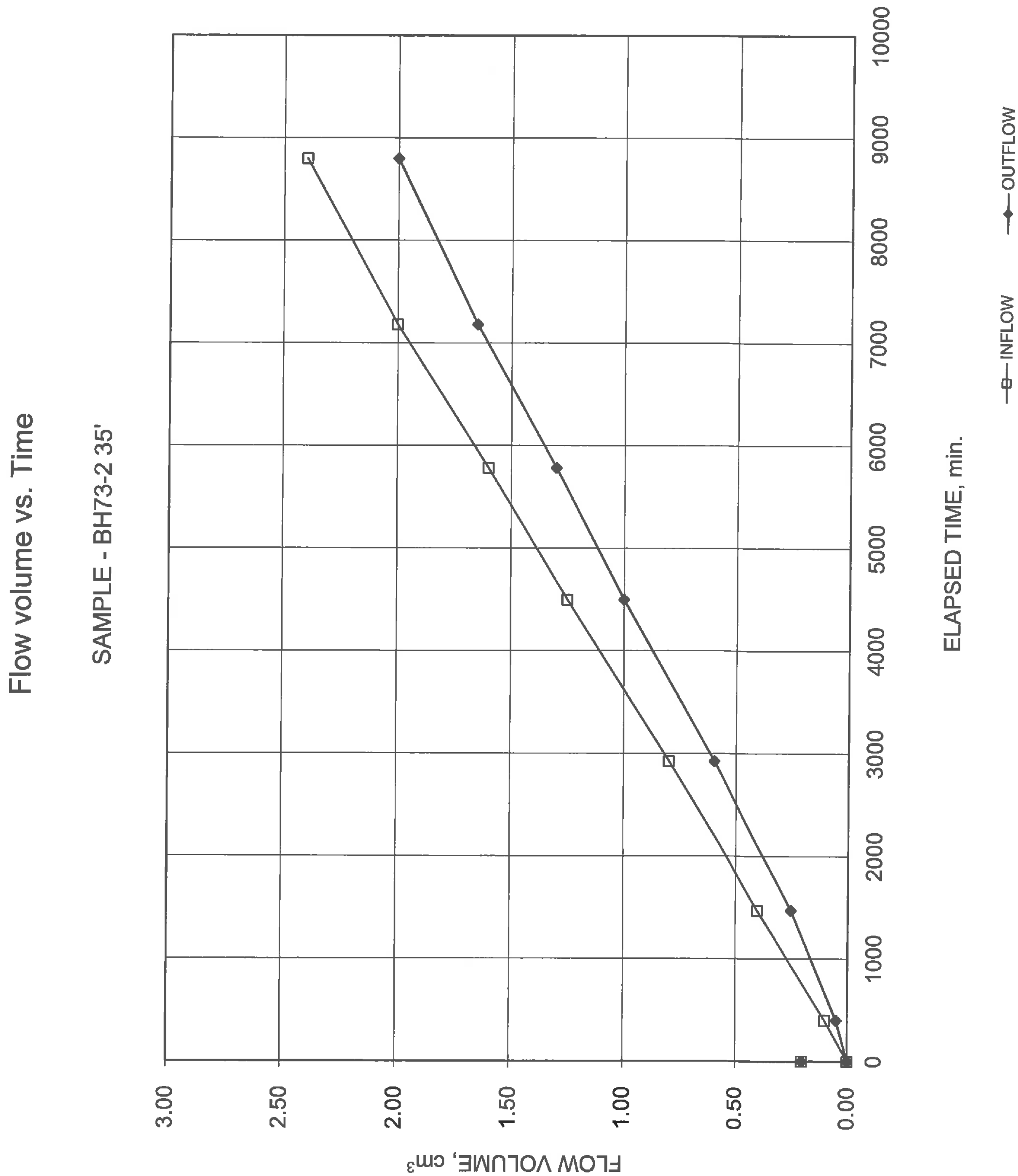
NOTES:

Effective consolidation stress assigned, by the client.

PERMEANT FLUID	De-Aired Tap Water
AVERAGE TEST TEMPERATURE	23.0 °C

Prepared By: LH — **Golder Associates** — Checked By: MM

HYDRAULIC CONDUCTIVITY TEST 02/01/2017	Project title: DillonConsult/SiltTesting/Miss Borehole number: - Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH74-2 30'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	02/2/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	6.15	UNIT WEIGHT, kN/m^3	20.94
SAMPLE DIAMETER, cm	4.93	DRY UNIT WEIGHT, kN/m^3	18.14
SAMPLE AREA, cm^2	19.11	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	117.60	VOLUME OF SOLIDS, cm^3	80.55
TOTAL MASS, g	251.12	VOLUME OF VOIDS, cm^3	37.05
DRY MASS, g	217.48	VOID RATIO	0.46
WATER CONTENT, %	15.5		

SATURATION STAGE

CELL PRESSURE, kPa	350.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	340.00	DURATION, min	0
BACK PRESSURE, kPa	340.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	690.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	340.00	DURATION, min	1,299
BACK PRESSURE, kPa	340.00	VOLUME CHANGE, cm^3	6.80
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	6.03	SAMPLE AREA, cm^2	18.38
SAMPLE DIAMETER, cm	4.84	SAMPLE VOLUME, cm^3	110.89

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	701	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	351	DURATION, min	7065
BACK PRESSURE, kPa	340	HYDRAULIC GRADIENT, i	19

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	6.03	UNIT WEIGHT, kN/m^3	22.35
SAMPLE DIAMETER, cm	4.84	DRY UNIT WEIGHT, kN/m^3	19.23
SAMPLE AREA, cm^2	18.38	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	110.89	VOLUME OF SOLIDS, cm^3	80.55
TOTAL MASS, g	252.71	VOLUME OF VOIDS, cm^3	30.34
DRY MASS, g	217.48	VOID RATIO	0.38
WATER CONTENT, %	16.2		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	7065
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.9
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	1.1
INFLOW TO OUTFLOW RATIO	0.8
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	6.22E-09
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	7.60E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	6.91E-09
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**6.43E-09**

NOTES:

Effective consolidation stress assigned, by the client.

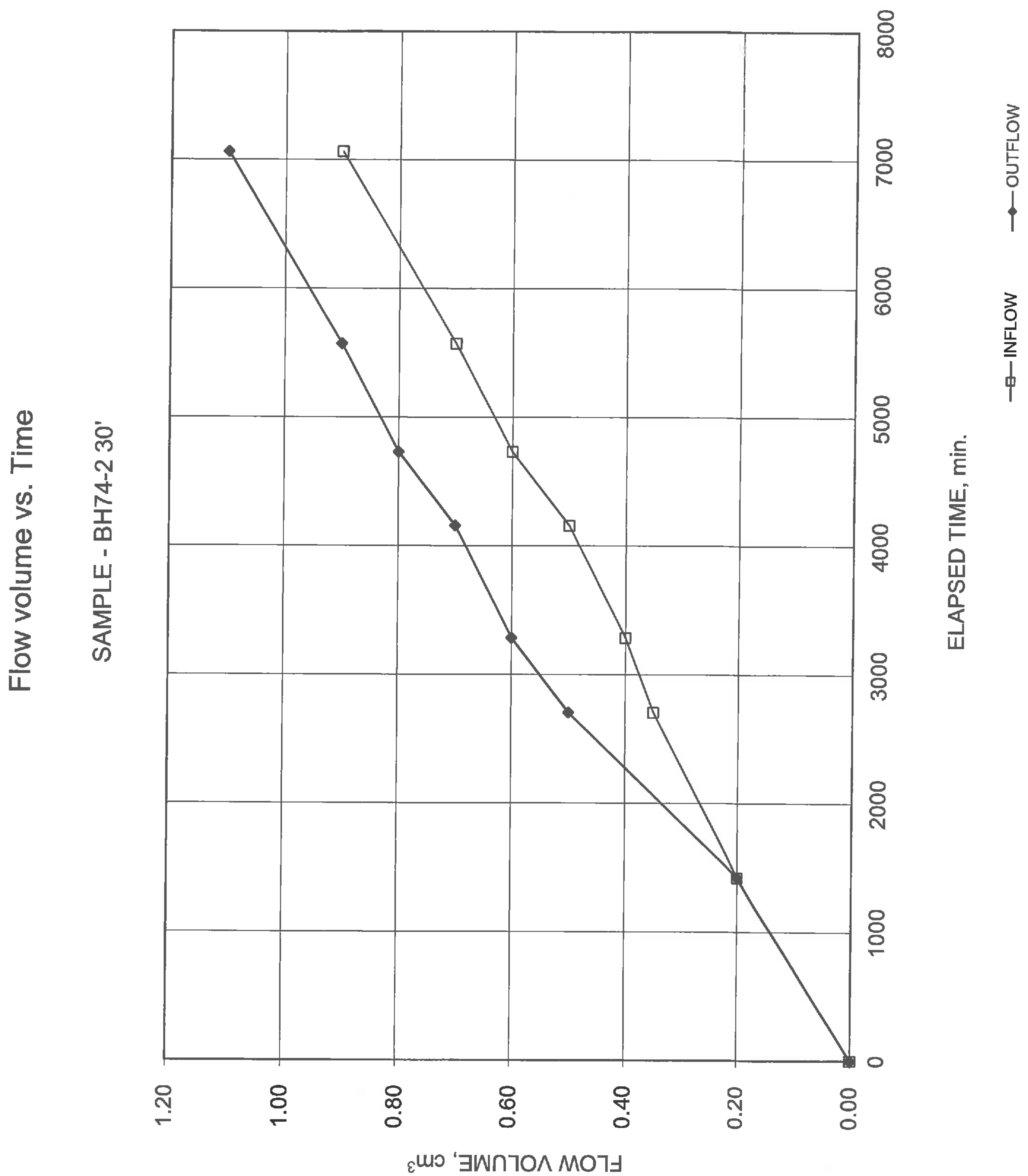
PERMEANT FLUID	De-Aired Tap Water
AVERAGE TEST TEMPERATURE	23.0 °C

Prepared By: LH | **Golder Associates** | Checked By: MM

HYDRAULIC CONDUCTIVITY TEST

02/2/2017

Project title: DillonConsult/SiltTesting/Miss
Borehole number: -
Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH74-2 35'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	01/12/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	6.63	UNIT WEIGHT, kN/m^3	21.24
SAMPLE DIAMETER, cm	4.97	DRY UNIT WEIGHT, kN/m^3	18.59
SAMPLE AREA, cm^2	19.38	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	128.37	VOLUME OF SOLIDS, cm^3	90.11
TOTAL MASS, g	278.00	VOLUME OF VOIDS, cm^3	38.26
DRY MASS, g	243.30	VOID RATIO	0.42
WATER CONTENT, %	14.3		

SATURATION STAGE

CELL PRESSURE, kPa	350.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	340.00	DURATION, min	7,466
BACK PRESSURE, kPa	340.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	690.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	340.00	DURATION, min	1,524
BACK PRESSURE, kPa	340.00	VOLUME CHANGE, cm^3	4.78
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	6.54	SAMPLE AREA, cm^2	18.90
SAMPLE DIAMETER, cm	4.90	SAMPLE VOLUME, cm^3	123.63

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	700	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	350	DURATION, min	4505
BACK PRESSURE, kPa	340	HYDRAULIC GRADIENT, i	16

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	6.54	UNIT WEIGHT, kN/m^3	22.20
SAMPLE DIAMETER, cm	4.90	DRY UNIT WEIGHT, kN/m^3	19.30
SAMPLE AREA, cm^2	18.90	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	123.63	VOLUME OF SOLIDS, cm^3	90.11
TOTAL MASS, g	279.91	VOLUME OF VOIDS, cm^3	33.52
DRY MASS, g	243.30	VOID RATIO	0.37
WATER CONTENT, %	**15.0**		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	4505
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.4
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.5
INFLOW TO OUTFLOW RATIO	0.8
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	5.28E-09
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	6.41E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	5.84E-09
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**5.44E-09**

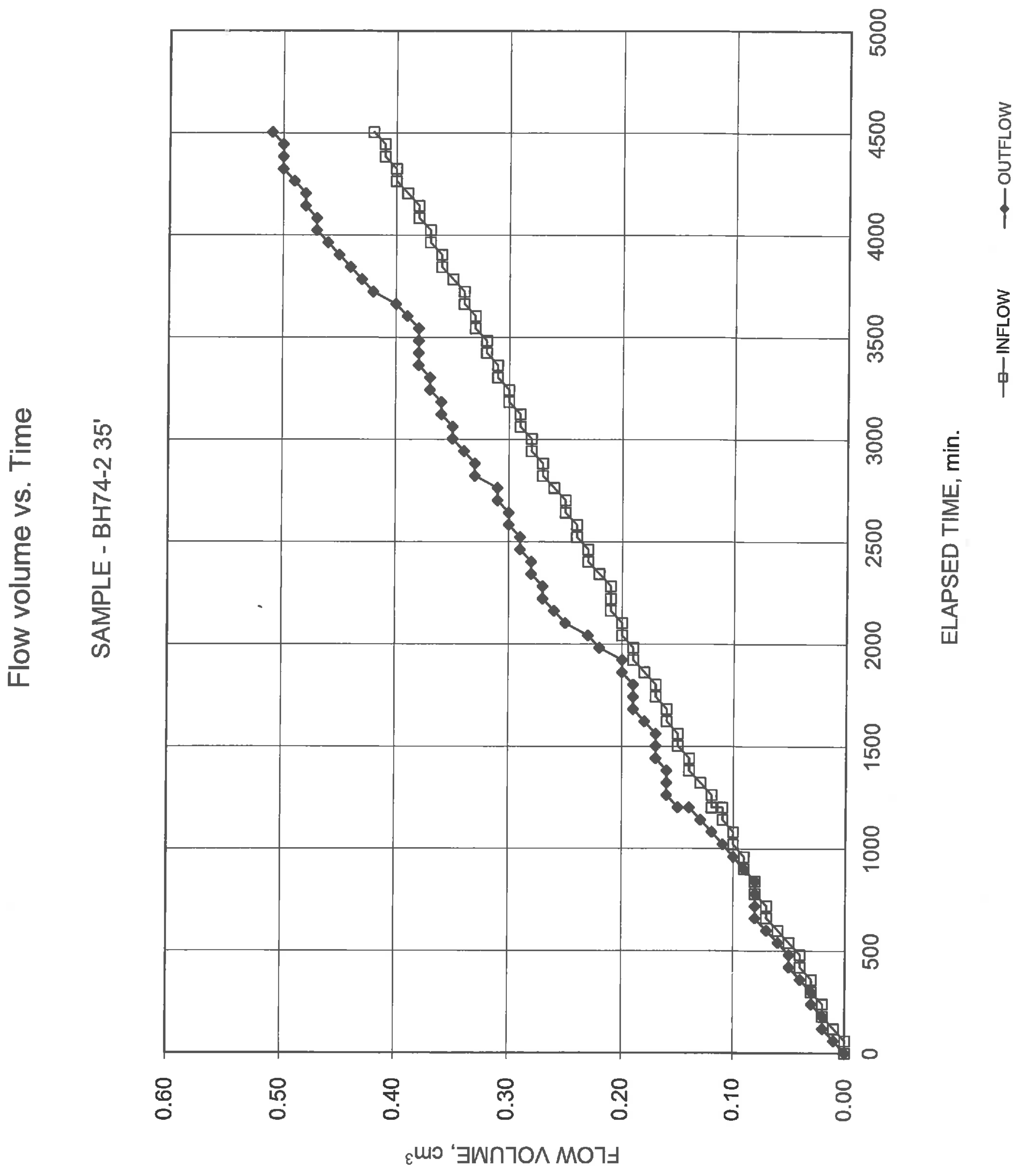
NOTES:

Effective consolidation stress assigned, by the client.

PERMEANT FLUID: De-Aired Tap Water

AVERAGE TEST TEMPERATURE: 23.0 °C

HYDRAULIC CONDUCTIVITY TEST	Project title: DillonConsult/SiltTesting/Miss Borehole number: - Sample depth: -
01/12/2017	



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH75-2 30'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	01/11/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	4.91	UNIT WEIGHT, kN/m^3	21.25
SAMPLE DIAMETER, cm	4.93	DRY UNIT WEIGHT, kN/m^3	18.56
SAMPLE AREA, cm^2	19.06	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	93.65	VOLUME OF SOLIDS, cm^3	65.64
TOTAL MASS, g	202.91	VOLUME OF VOIDS, cm^3	28.01
DRY MASS, g	177.23	VOID RATIO	0.43
WATER CONTENT, %	14.5		

SATURATION STAGE

CELL PRESSURE, kPa	350.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	340.00	DURATION, min	5,652
BACK PRESSURE, kPa	340.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	690.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	340.00	DURATION, min	1,296
BACK PRESSURE, kPa	340.00	VOLUME CHANGE, cm^3	4.87
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm^2	18.40
SAMPLE DIAMETER, cm	4.84	SAMPLE VOLUME, cm^3	88.84

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	700	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	350	DURATION, min	5104
BACK PRESSURE, kPa	340	HYDRAULIC GRADIENT, i	21

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	4.83	UNIT WEIGHT, kN/m^3	22.52
SAMPLE DIAMETER, cm	4.84	DRY UNIT WEIGHT, kN/m^3	19.56
SAMPLE AREA, cm^2	18.40	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	88.84	VOLUME OF SOLIDS, cm^3	65.64
TOTAL MASS, g	203.97	VOLUME OF VOIDS, cm^3	23.20
DRY MASS, g	177.23	VOID RATIO	0.35
WATER CONTENT, %	15.1		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	5104
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.6
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.8
INFLOW TO OUTFLOW RATIO	0.8
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	5.29E-09
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	6.64E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	5.97E-09
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**5.56E-09**

NOTES:

Effective consolidation stress assigned, by the client.

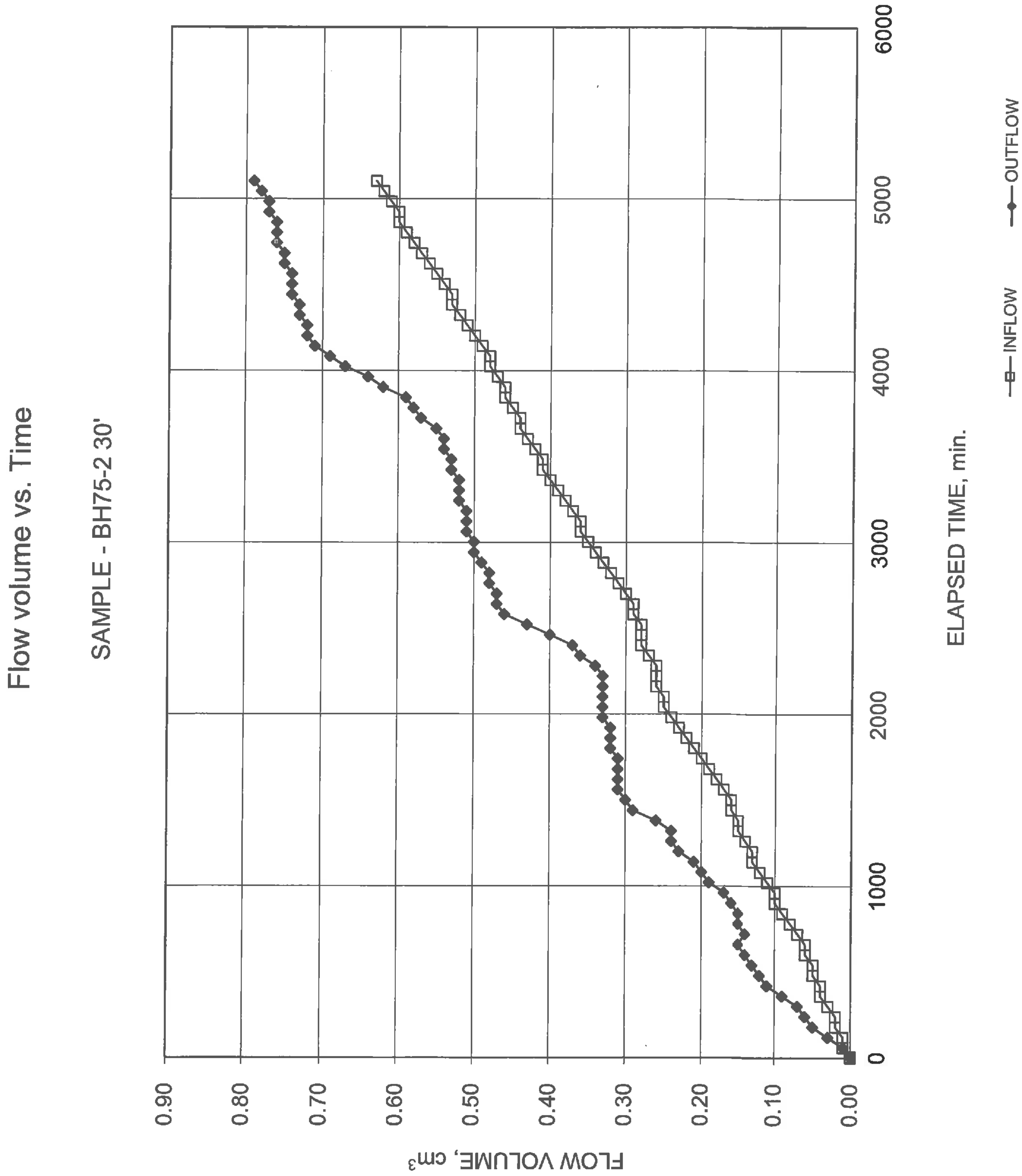
PERMEANT FLUID	De-Aired Tap Water
AVERAGE TEST TEMPERATURE	23.0 °C

Prepared By: LH | **Golder Associates** | Checked By: MM

HYDRAULIC CONDUCTIVITY TEST

01/11/2017

Project title: DillonConsult/SiltTesting/Miss
Borehole number: -
Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH75-2 35'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	01/28/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	5.79	UNIT WEIGHT, kN/m^3	21.05
SAMPLE DIAMETER, cm	4.91	DRY UNIT WEIGHT, kN/m^3	18.22
SAMPLE AREA, cm^2	18.92	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	109.52	VOLUME OF SOLIDS, cm^3	75.35
TOTAL MASS, g	235.09	VOLUME OF VOIDS, cm^3	34.17
DRY MASS, g	203.45	VOID RATIO	0.45
WATER CONTENT, %	15.6		

SATURATION STAGE

CELL PRESSURE, kPa	420.00	EFFECTIVE CONSOLIDATION STRESS,	80
HEAD PRESSURE, kPa	340.00	DURATION, min	5,638
BACK PRESSURE, kPa	340.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	690.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	340.00	DURATION, min	1,295
BACK PRESSURE, kPa	340.00	VOLUME CHANGE, cm^3	5.65
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	5.69	SAMPLE AREA, cm^2	18.27
SAMPLE DIAMETER, cm	4.82	SAMPLE VOLUME, cm^3	103.94

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	701	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	351	DURATION, min	12760
BACK PRESSURE, kPa	340	HYDRAULIC GRADIENT, i	20

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	5.69	UNIT WEIGHT, kN/m^3	22.16
SAMPLE DIAMETER, cm	4.82	DRY UNIT WEIGHT, kN/m^3	19.20
SAMPLE AREA, cm^2	18.27	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	103.94	VOLUME OF SOLIDS, cm^3	75.35
TOTAL MASS, g	234.90	VOLUME OF VOIDS, cm^3	28.58
DRY MASS, g	203.45	VOID RATIO	0.38
WATER CONTENT, %	15.5		

TEST RESULTS

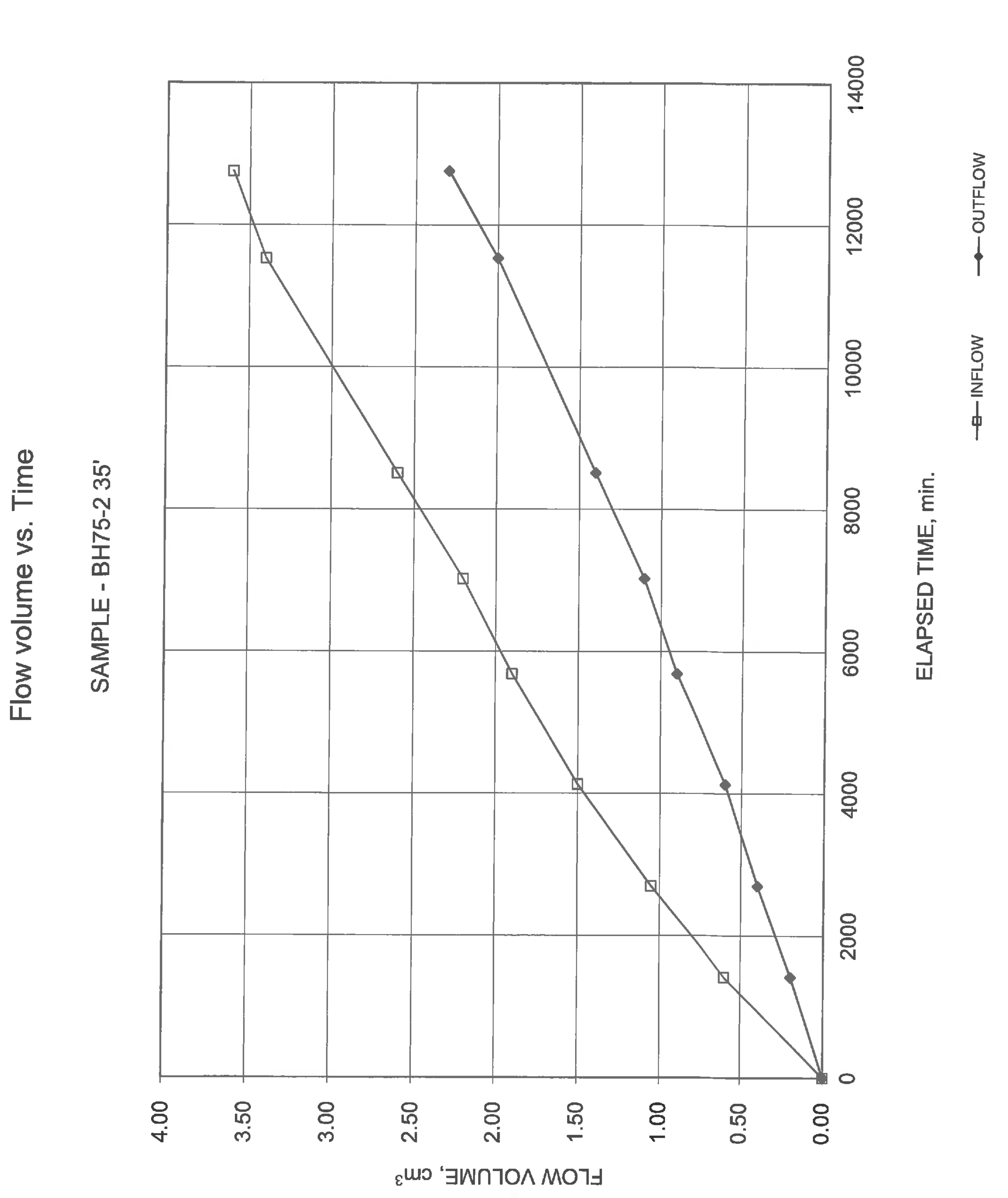
ELAPSED TIME TO STEADY STATE FLOW (min)	4130.0
DURATION OF STEADY STATE FLOW (min)	8630
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	2.1
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	1.7
INFLOW TO OUTFLOW RATIO	1.2
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	1.13E-08
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	9.12E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	1.02E-08
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**9.49E-09**

NOTES:

Effective consolidation stress assigned, by the client.

PERMEANT FLUID	De-Aired Tap Water
AVERAGE TEST TEMPERATURE	23.0 °C

HYDRAULIC CONDUCTIVITY TEST 01/28/2017	Project title: DillonConsult/SiltTesting/Miss Borehole number: - Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH76-2 30'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	01/10/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	6.21	UNIT WEIGHT, kN/m^3	21.37
SAMPLE DIAMETER, cm	6.91	DRY UNIT WEIGHT, kN/m^3	18.23
SAMPLE AREA, cm^2	37.50	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	232.88	VOLUME OF SOLIDS, cm^3	160.33
TOTAL MASS, g	507.58	VOLUME OF VOIDS, cm^3	72.55
DRY MASS, g	432.90	VOID RATIO	0.45
WATER CONTENT, %	17.3		

SATURATION STAGE

CELL PRESSURE, kPa	280.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	270.00	DURATION, min	5,656
BACK PRESSURE, kPa	270.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	620.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	270.00	DURATION, min	1,067
BACK PRESSURE, kPa	270.00	VOLUME CHANGE, cm^3	11.03
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	6.11	SAMPLE AREA, cm^2	36.32
SAMPLE DIAMETER, cm	6.80	SAMPLE VOLUME, cm^3	221.97

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	632	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	282	DURATION, min	2642
BACK PRESSURE, kPa	270	HYDRAULIC GRADIENT, i	20

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	6.11	UNIT WEIGHT, kN/m^3	22.33
SAMPLE DIAMETER, cm	6.80	DRY UNIT WEIGHT, kN/m^3	19.13
SAMPLE AREA, cm^2	36.32	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	221.97	VOLUME OF SOLIDS, cm^3	160.33
TOTAL MASS, g	505.40	VOLUME OF VOIDS, cm^3	61.63
DRY MASS, g	432.90	VOID RATIO	0.38
WATER CONTENT, %	16.7		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	180.2
DURATION OF STEADY STATE FLOW (min)	2462
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.4
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.6
INFLOW TO OUTFLOW RATIO	0.6
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	3.26E-09
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	5.31E-09
HYDRAULIC CONDUCTIVITY, K, cm/s	4.28E-09
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**3.99E-09**

NOTES:

Effective consolidation stress assigned, by the client.

PERMEANT FLUID De-Aired Tap Water

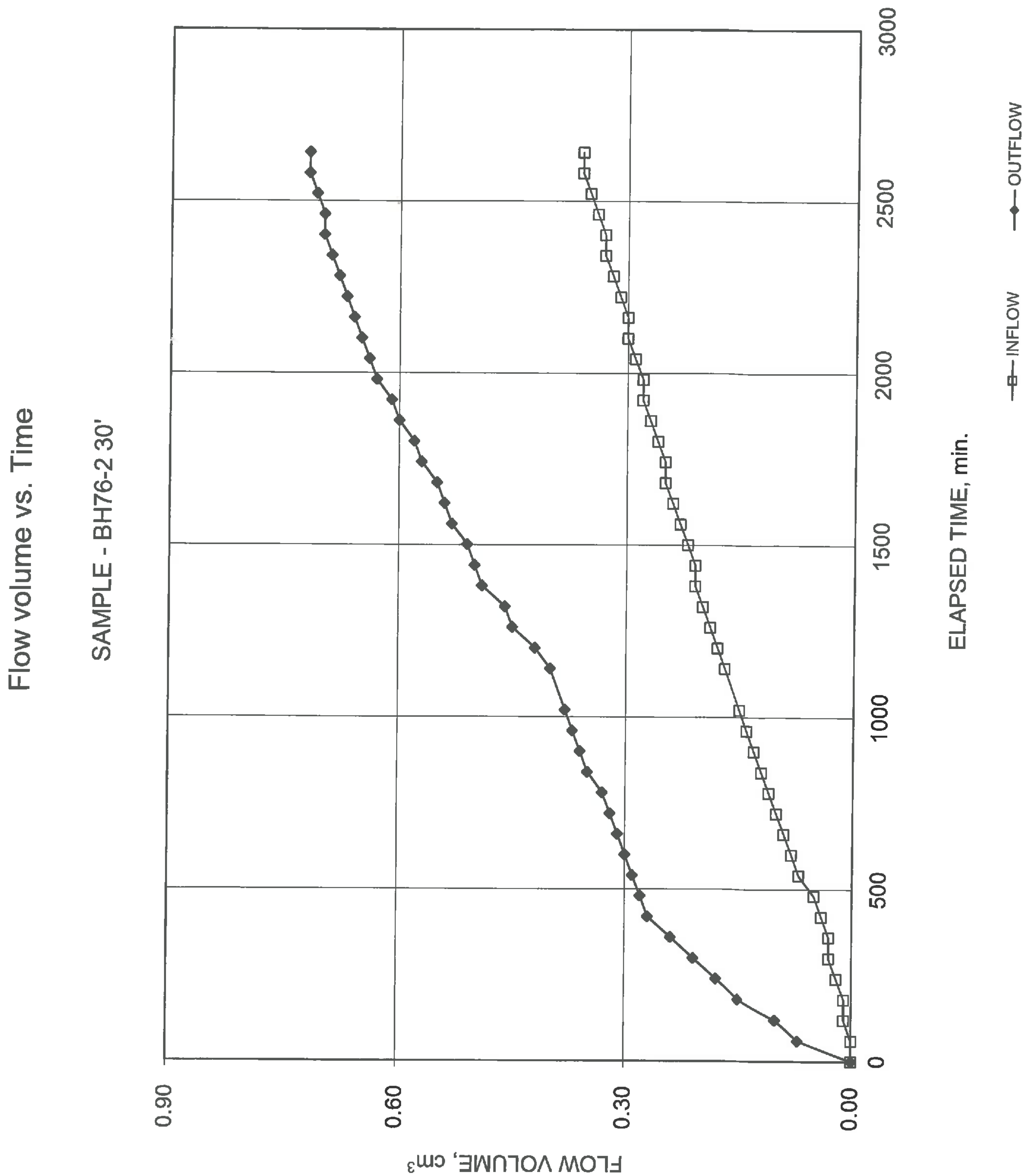
AVERAGE TEST TEMPERATURE 23.0 °C

Prepared By: LH

Golder Associates

Checked By: MM

HYDRAULIC CONDUCTIVITY TEST 01/10/2017	Project title: DillonConsult/SiltTesting/Miss Borehole number: - Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1535446 (4000)	SAMPLE	BH76-2 35'
PROJECT TITLE	DillonConsult/SiltTesting/Miss	SAMPLE DEPTH, m	-
BOREHOLE NUMBER	-	DATE	01/10/2017

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	5.83	UNIT WEIGHT, kN/m^3	21.21
SAMPLE DIAMETER, cm	6.90	DRY UNIT WEIGHT, kN/m^3	18.13
SAMPLE AREA, cm^2	37.39	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	218.00	VOLUME OF SOLIDS, cm^3	149.31
TOTAL MASS, g	471.50	VOLUME OF VOIDS, cm^3	68.69
DRY MASS, g	403.13	VOID RATIO	0.46
WATER CONTENT, %	17.0		

SATURATION STAGE

CELL PRESSURE, kPa	280.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	270.00	DURATION, min	5,681
BACK PRESSURE, kPa	270.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	620.00	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	270.00	DURATION, min	1,061
BACK PRESSURE, kPa	270.00	VOLUME CHANGE, cm^3	8.42
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	5.75	SAMPLE AREA, cm^2	36.43
SAMPLE DIAMETER, cm	6.81	SAMPLE VOLUME, cm^3	209.65

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	631	EFFECTIVE CONSOLIDATION STRESS,	350
HEAD PRESSURE, kPa	281	DURATION, min	16804
BACK PRESSURE, kPa	270	HYDRAULIC GRADIENT, i	19

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	5.75	UNIT WEIGHT, kN/m^3	21.83
SAMPLE DIAMETER, cm	6.81	DRY UNIT WEIGHT, kN/m^3	18.86
SAMPLE AREA, cm^2	36.43	SPECIFIC GRAVITY, assumed	2.70
SAMPLE VOLUME, cm^3	209.65	VOLUME OF SOLIDS, cm^3	149.31
TOTAL MASS, g	466.76	VOLUME OF VOIDS, cm^3	60.35
DRY MASS, g	403.13	VOID RATIO	0.40
WATER CONTENT, %	15.8		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	0.0
DURATION OF STEADY STATE FLOW (min)	16804
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	12.8
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	13.3
INFLOW TO OUTFLOW RATIO	1.0
HYDRAULIC CONDUCTIVITY (INFLOW) (cm/s)	1.79E-08
HYDRAULIC CONDUCTIVITY (OUTFLOW) (cm/s)	1.85E-08
HYDRAULIC CONDUCTIVITY, K, cm/s	1.82E-08
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, cm/s	**1.70E-08**

NOTES:

Effective consolidation stress assigned, by the client.

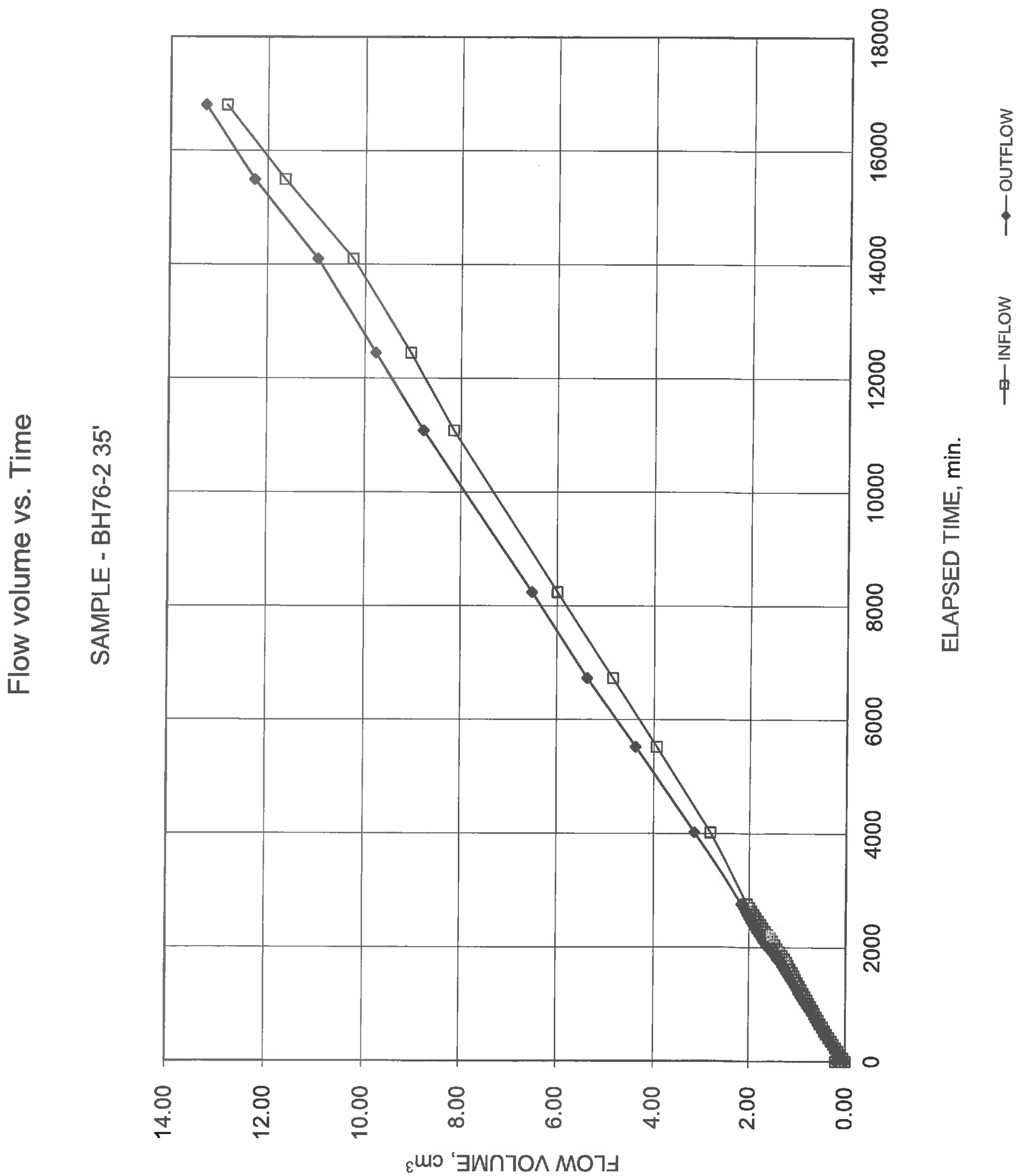
PERMEANT FLUID	De-Aired Tap Water
AVERAGE TEST TEMPERATURE	23.0 °C

Prepared By: LH | **Golder Associates** | Checked By: MM

HYDRAULIC CONDUCTIVITY TEST

01/10/2017

Project title: DillonConsult/SiltTesting/Miss
Borehole number: -
Sample depth: -



Project number : 1535446 (4000)
Prepared by : LH

Golder Associates

Checked by : MM

Appendix D7-D

Water Level Data and Hydrographs

DILLON CONSULTING

Ridge Landfill Waterlevels							Screened Interval			
Well Name	Easting	Northing	Well Depth (mbtoc)	Top of Casing Elevation (masl)	Stick-Up (m)	Ground Surface Elevation (masl)	Bottom		Top	
							(mbgs)	(masl)	(mbgs)	(masl)
MW71-A	412893	4683511	5.34	200.032	0.94	199.09	4.40	194.69	1.35	197.74
MW71-B	412892	4683512	14.42	199.969	0.89	199.08	13.53	185.55	10.48	188.60
MW71-C	412891	4683514	47.6	199.968	0.77	199.20	46.83	152.37	43.78	155.42
MW72-A	413231	4683142	4.35	199.971	0.76	199.21	3.59	195.62	0.54	198.67
MW72-B	413230	4683143	15.53	199.942	0.76	199.18	14.77	184.41	11.72	187.46
MW72-C	413229	4683144	53.66	199.998	0.81	199.19	52.85	146.34	49.80	149.39
MW73-A	413624	4683431	5.42	200.080	0.86	199.22	4.56	194.66	1.51	197.71
MW73-B	413625	4683432	14.44	200.004	0.78	199.23	13.66	185.56	10.62	188.61
MW73-C	413626	4683434	48.56	200.027	0.76	199.27	47.80	151.47	44.75	154.52
MW74-A	413882	4683810	5.21	200.669	0.74	199.93	4.47	195.46	1.42	198.51
MW74-B	413883	4683812	10.45	200.648	0.76	199.89	9.69	190.20	6.64	193.25
MW74-C	413884	4683814	50.54	200.731	0.80	199.93	49.74	150.19	46.69	153.24
MW75-A	414150	4684188	5.36	201.071	0.75	200.32	4.61	195.71	1.56	198.76
MW75-B	414149	4684187	14.65	201.101	0.73	200.37	13.92	186.45	10.87	189.50
MW75-C	414148	4684186	52.16	201.056	0.68	200.37	51.48	148.90	48.43	151.94
MW76-A	414281	4684608	4.83	201.158	0.74	200.41	4.09	196.33	1.04	199.38
MW76-B	414282	4684607	14.51	201.214	0.79	200.42	13.72	186.70	10.67	189.75
MW76-C	414284	4684606	50.2	201.161	0.73	200.43	49.47	150.96	46.42	154.01
32-I	413593	4685317	-	200.07						
32-II	413594	4685318	19.3	200.11						
32-III	413595	4685320	6.95	200.05						
49-A	412325	4684948	5.45	198.14	0.94	197.2	4.51	192.69	1.462	195.738
49-B	412344	4684952	16.2	197.94	0.74	197.2	15.46	181.74	12.412	184.788
49-C	412339	4684951	44.68	197.94	0.74	197.2	43.94	153.26	40.892	156.308
59-A			5.45							
60-A			5.96							
13-I			4.64							
14-I			5.48							
22-I			6.1							
21-I			5.62							
M1W1			19.02							
M1W2			16.08							
M2W1			16.14							
M2W2			23.69							
M3W1			19.1							
M3W2			19.8							

DILLON CONSULTING

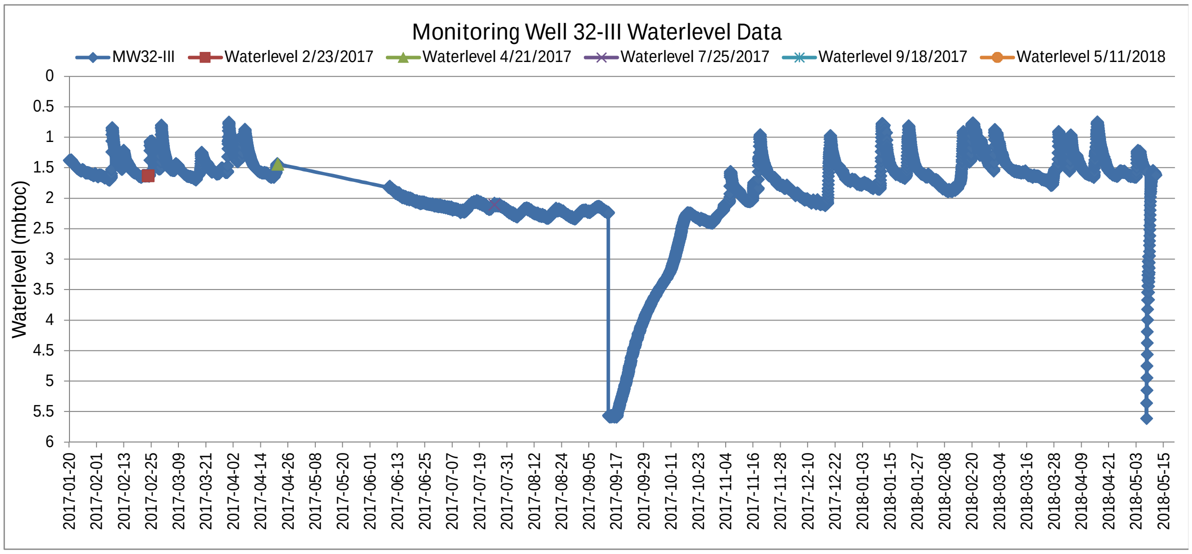
2/23/2017-2/24/2017			2017-04-21			2017-05-21		
Waterlevel (mbtoc)	Water Level (m below ground)	Waterlevel (masl)	Waterlevel (mbtoc)	Water Level (m below ground)	Waterlevel (masl)	Waterlevel (mbtoc)	Water Level (m below ground)	Waterlevel (masl)
1.7	0.76	198.332	1.735	0.79	198.297	1.79	0.85	198.242
12.57	11.68	187.399	8.23	7.34	191.739	7.26	6.37	192.709
1.31	0.54	198.658	22.38	21.61	177.588	22.56	21.79	177.408
1.6	0.84	198.371	1.42	0.66	198.551	1.675	0.92	198.296
1.62	0.86	198.322	2.085	1.32	197.857	3.03	2.27	196.912
16.02	15.21	183.978	16.12	15.31	183.878	17.21	16.40	182.788
1.29	0.43	198.790	1.35	0.49	198.73	1.37	0.51	198.71
9.92	9.14	190.084	7.08	6.30	192.924	6.84	6.06	193.164
22.34	21.58	177.687	21.79	21.03	178.237	22.81	22.05	177.217
1.31	0.57	199.359	1.14	0.40	199.529	1.275	0.53	199.394
10.34	9.58	190.308	9.29	8.53	191.358	9.75	8.99	190.898
23.64	22.84	177.091	23.44	22.64	177.291	23.53	22.73	177.201
1.07	0.32	200.001	1.155	0.41	199.916	1.85	1.10	199.221
10.87	10.14	190.231	6.982	6.25	194.119	6.35	5.62	194.751
17.695	17.01	183.361	17.45	16.77	183.606	17.85	17.17	183.206
1.26	0.52	199.898	1.245	0.50	199.913	1.32	0.58	199.838
4.43	3.64	196.784	4.32	3.53	196.894	4.7	3.91	196.514
22.67	21.94	178.491	22.72	21.99	178.441	23.19	22.46	177.971
22.82		177.25	22.84		177.23			
8.52		191.59	8.23		191.88			
1.63		198.42	1.44		198.61			
0.72	-0.22	197.42	1.05	0.11	197.09			
5.79	5.05	192.15	5.715	4.97	192.225			
21.01	20.27	176.93	21.04	20.30	176.9			
2.33								
1.7								
1.57								
0.91								
1.75								
0.98								
5.9								
5.96								
8.02								
9.97								
15.1								
15.93								

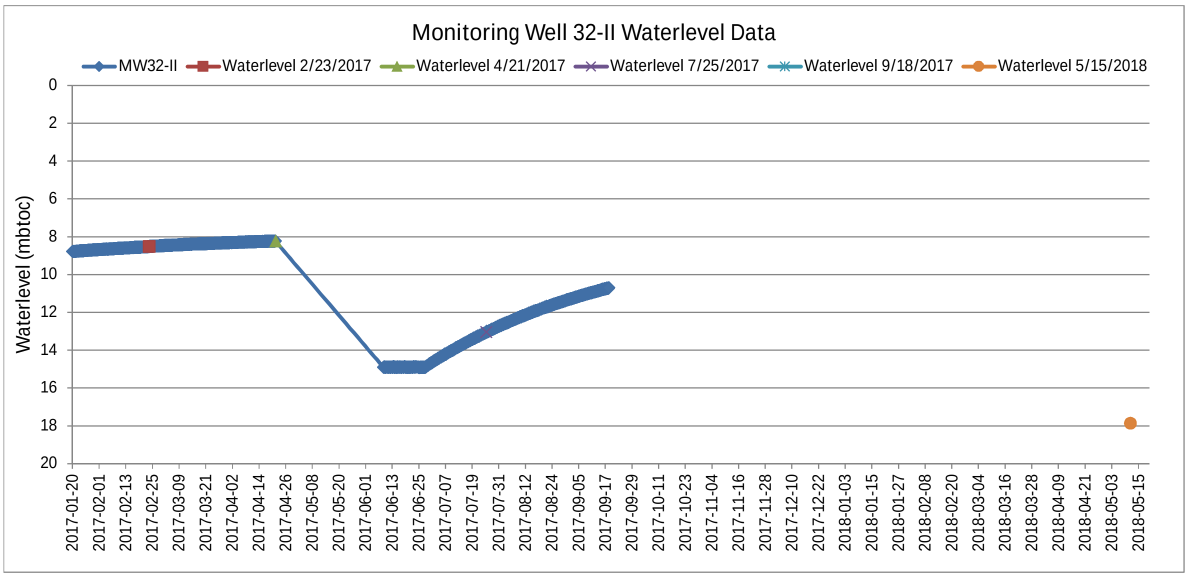
DILLON CONSULTING

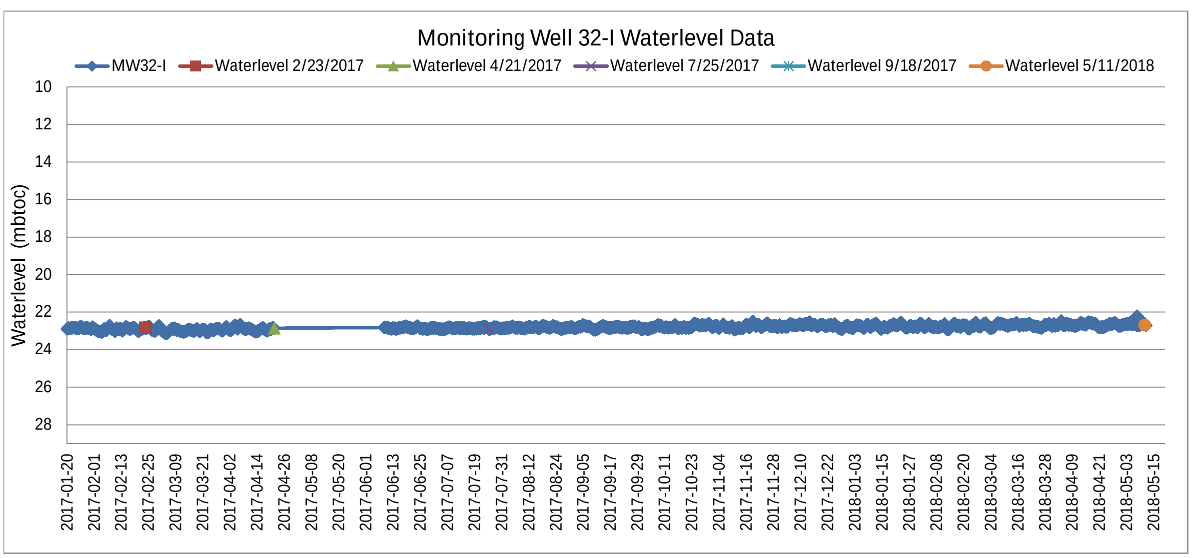
2017-05-24			6/7/2017-6/8/2017			2017-08-25		
Waterlevel (mbtoc)	Water Level (m below ground)	Waterlevel (masl)	Waterlevel (mbtoc)	Water Level (m below ground)	Waterlevel (masl)	Waterlevel (mbtoc)	Water Level (m below ground)	Waterlevel (masl)
1.948	1.01	198.084	1.91	0.97	198.122	2.34	1.40	197.692
6.985	6.09	192.984	12.79	11.90	187.179	9.98	9.09	189.989
22.55	21.78	177.418	23.06	22.29	176.908	22.73	21.96	177.238
1.741	0.98	198.23	3.93	3.17	196.041	2.86	2.10	197.111
3.209	2.45	196.733	13.48	12.72	186.462	9.91	9.15	190.032
19.12	18.31	180.878	27.16	26.35	172.838	22.52	21.71	177.478
1.35	0.49	198.73	1.41	0.55	198.67	1.65	0.79	198.43
6.68	5.90	193.324	13.38	12.60	186.624	11.53	10.75	188.474
22.8	22.04	177.227	22.72	21.96	177.307	22.73	21.97	177.297
1.23	0.49	199.439	4.22	3.48	196.449	2.37	1.63	198.299
9.71	8.95	190.938	9.75	8.99	190.898	9.75	8.99	190.898
23.43	22.63	177.301	32.55	31.75	168.181	24.12	23.32	176.611
1.13	0.38	199.941	1.48	0.73	199.591	1.32	0.57	199.751
6.99	6.26	194.111	12.5	11.77	188.601	7.827	7.10	193.274
17.82	17.14	183.236	24.49	23.81	176.566	23.765	23.08	177.291
1.24	0.50	199.918	1.345	0.60	199.813	1.57	0.83	199.588
4.66	3.87	196.554	10.55	9.76	190.664	6.46	5.67	194.754
23.17	22.44	177.991	24.185	23.45	176.976	23.96	23.23	177.201
						22.86	22.86	177.21
						13.04	13.04	187.07
						2.105	2.11	197.945
						1.66	0.72	196.48
						10.235	9.49	187.705
						21.11	20.37	176.83
			5.7					
			4.175					
			10.07					
			10.155					
			15.075					
			16.32					

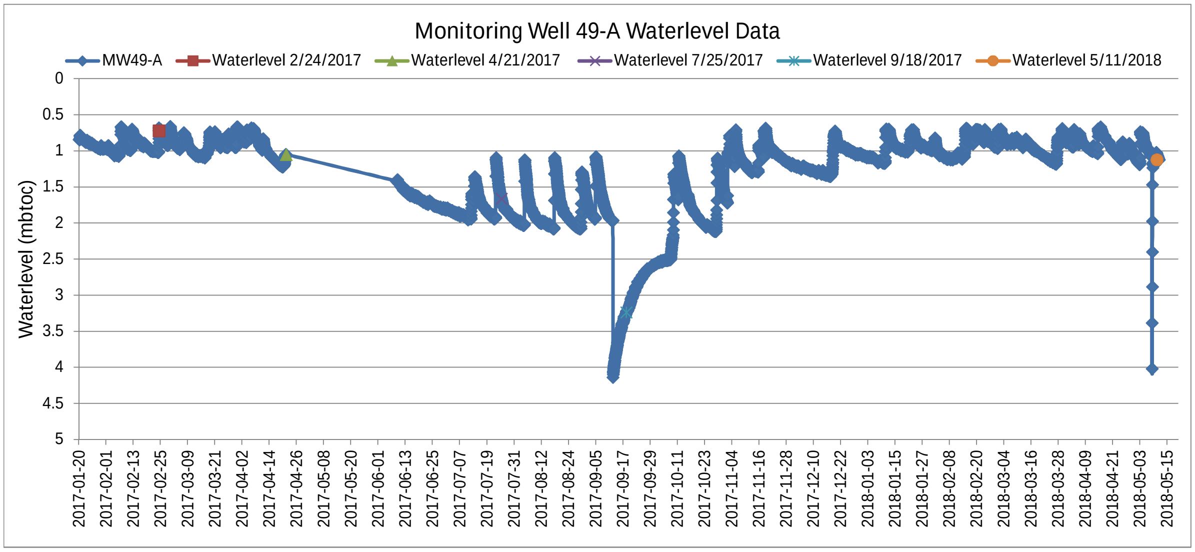
DILLON CONSULTING

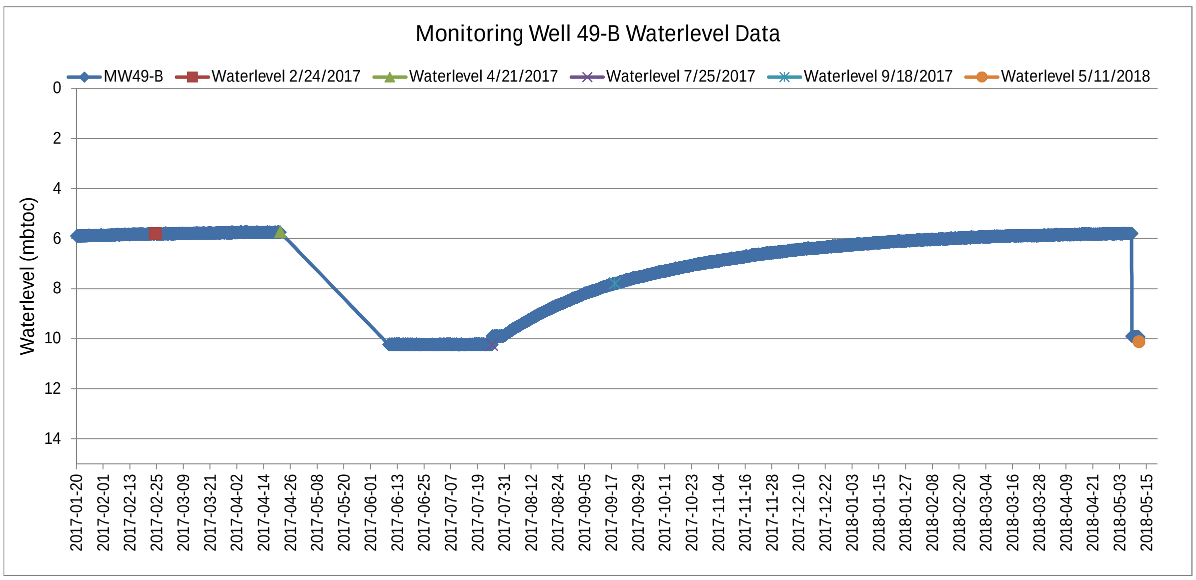
2017-09-18			2018-05-11		
Waterlevel (mbtoc)	Water Level (m below ground)	Waterlevel (masl)	Waterlevel (mbtoc)	Water Level (m below ground)	Waterlevel (masl)
2.65	1.71	197.382	1.47	0.53	198.562
6.915	6.02	193.054	4.99	4.10	194.979
22.63	21.86	177.338	22.43	21.66	177.538
2.71	1.95	197.261	1.41	0.65	198.561
7.8	7.04	192.142	2.54	1.78	197.402
20.63	19.82	179.368	21.60	20.79	178.40
2.41	1.55	197.67	1.30	0.44	198.78
8.885	8.11	191.119	5.98	5.20	194.024
23.635	22.88	176.392	22.40	21.64	177.63
1.74	1.00	198.929	1.18	0.44	199.489
9.75	8.99	190.898	9.75	8.99	190.898
23.125	22.33	177.606	23.05	22.25	177.681
1.52	0.77	199.551	1.10	0.35	199.97
5.81	5.08	195.291	4.38	3.65	196.721
23.62	22.94	177.436	22.70	22.02	178.36
1.88	1.14	199.278	1.23	0.49	199.928
5.41	4.62	195.804	4.84	4.05	196.374
23.94	23.21	177.221	23.63	22.90	177.531
22.78	22.78	177.29	22.67	22.67	177.4
10.69	10.69	189.42	17.85	17.85	182.26
5.36	5.36	194.69	1.62	1.62	198.43
3.235	2.30	194.905	1.12	0.18	197.02
7.775	7.03	190.165	14.11	13.37	183.83
21	20.26	176.94	22.88	22.14	175.06

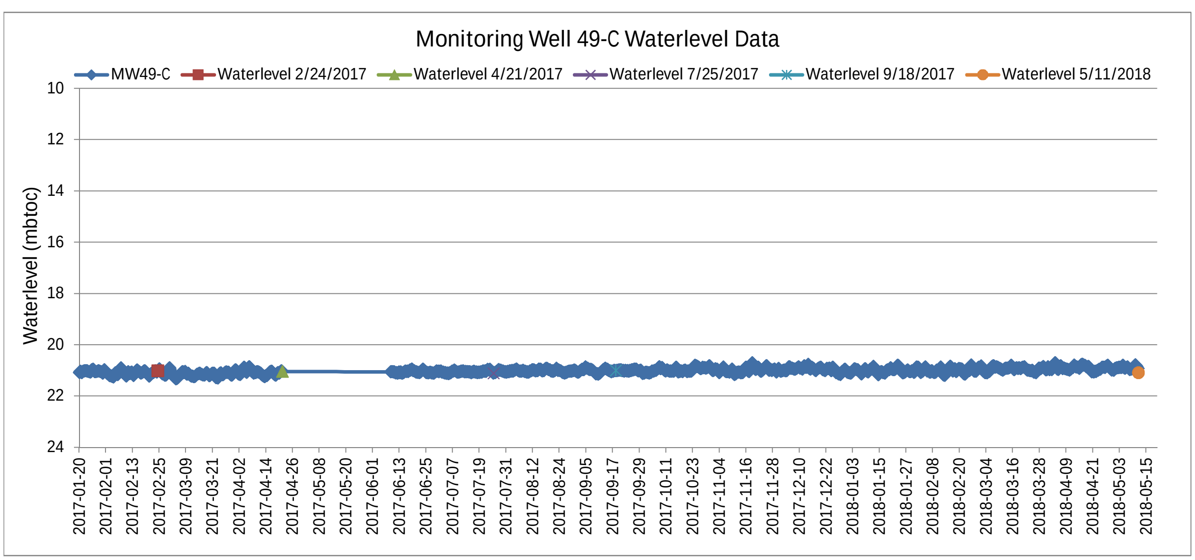

Monitoring Well 32-III Waterlevel Data
MW32-III
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (mbtoc)

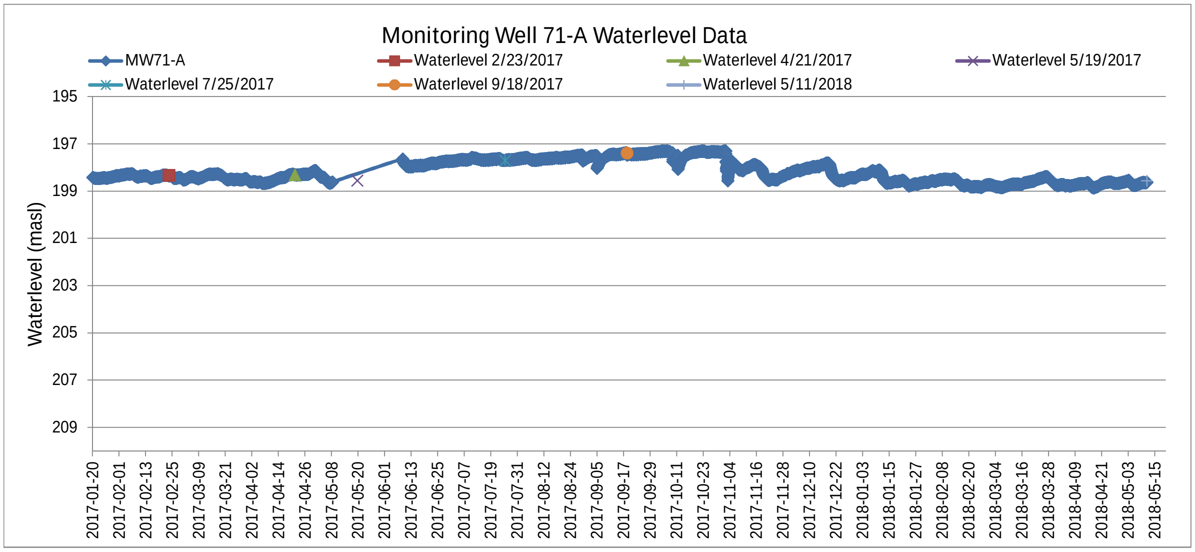

Monitoring Well 32-II Waterlevel Data
MW32-II
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/15/2018
Waterlevel (mbtoc)

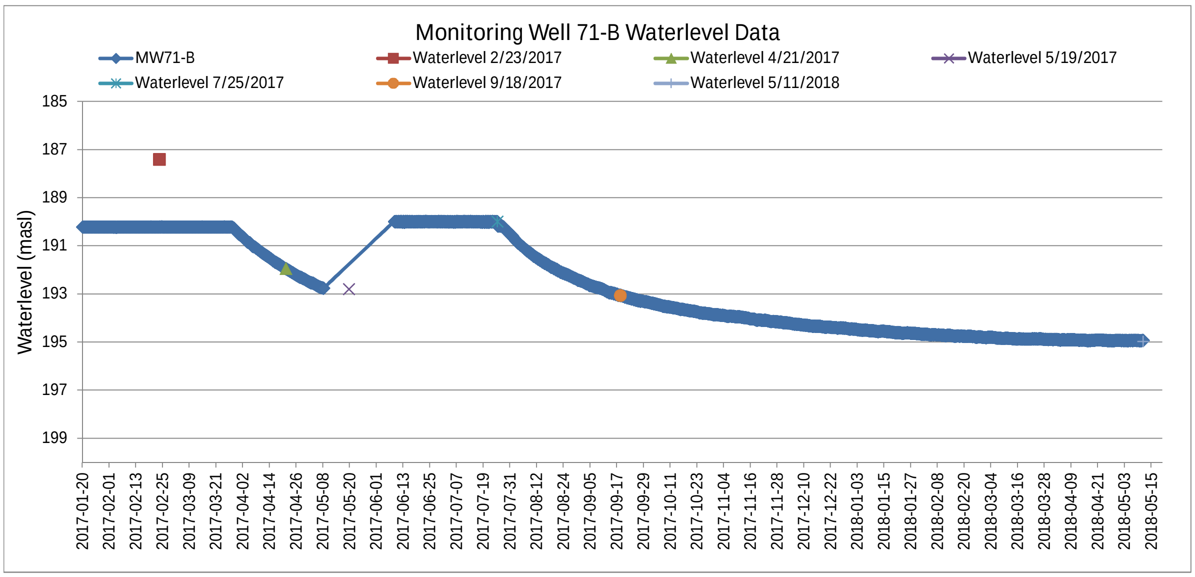

Monitoring Well 32-I Waterlevel Data
MW32-I
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (mbtoc)

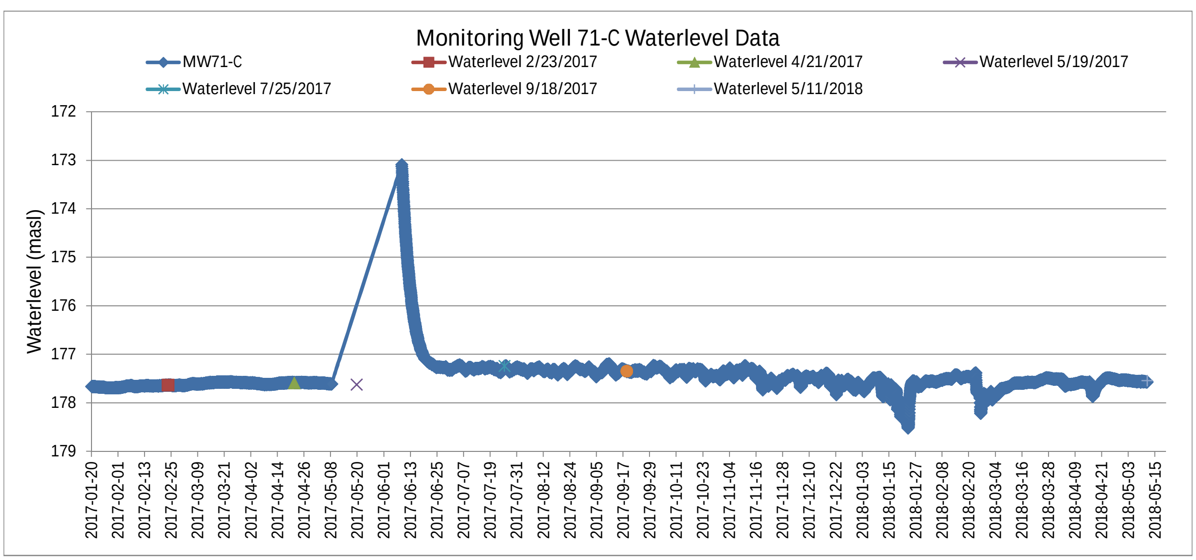

Monitoring Well 49-A Waterlevel Data
MW49-A
Waterlevel 2/24/2017
Waterlevel 4/21/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (mbtoc)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
2017-01-20
2018-05-15

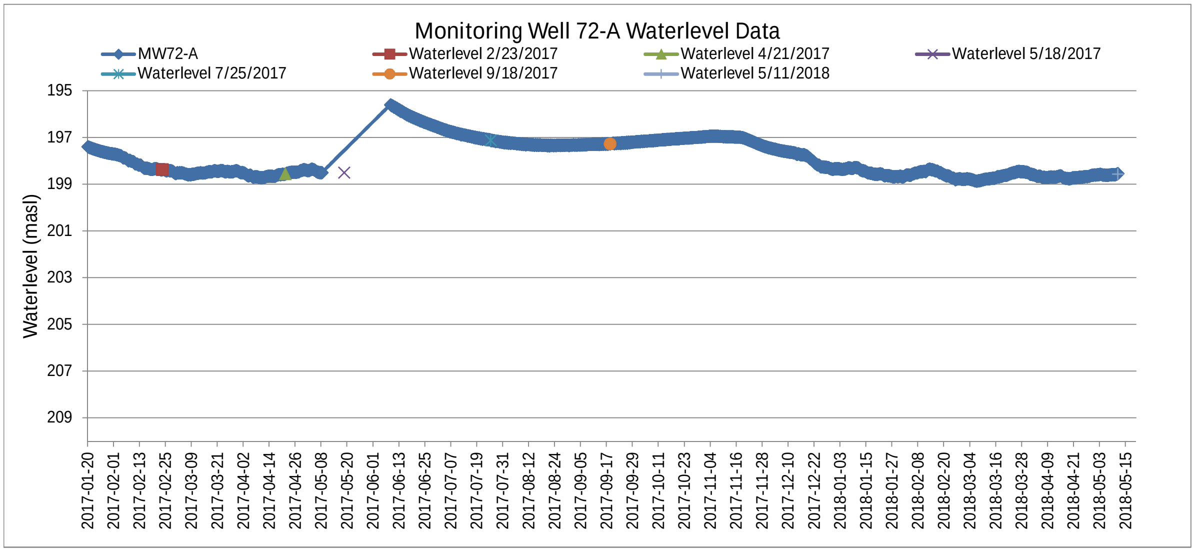

Monitoring Well 49-B Waterlevel Data
MW49-B
Waterlevel 2/24/2017
Waterlevel 4/21/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (mbtoc)
0
2
4
6
8
10
12
14
2017-01-20
2018-05-15

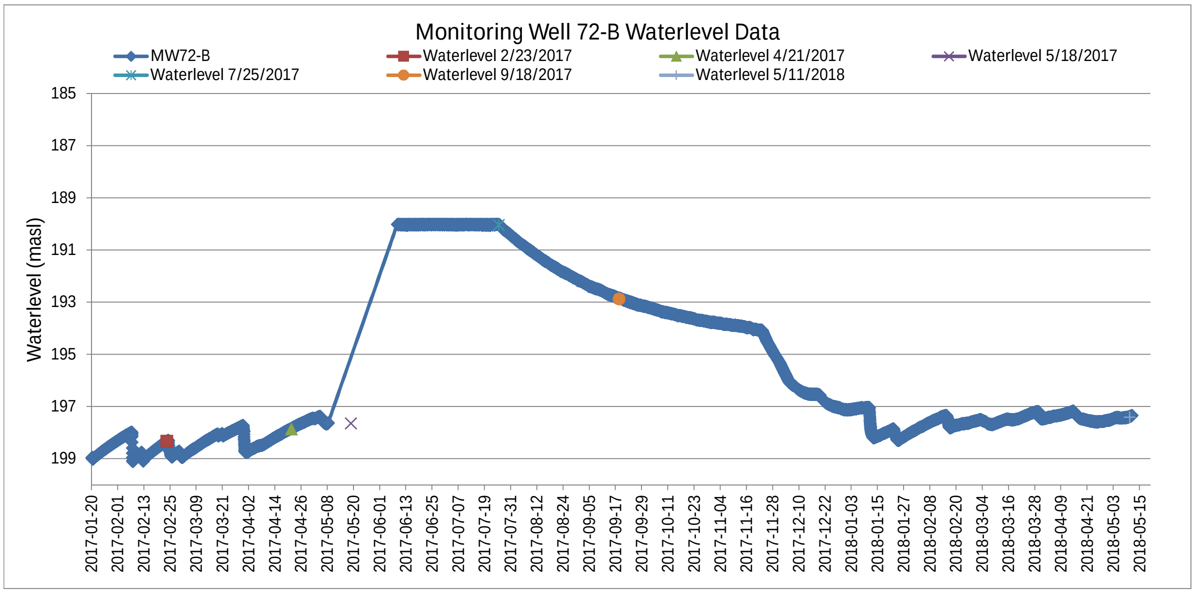

Monitoring Well 49-C Waterlevel Data
MW49-C
Waterlevel 2/24/2017
Waterlevel 4/21/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (mbtoc)
10
12
14
16
18
20
22
24
2017-01-20
2018-05-15

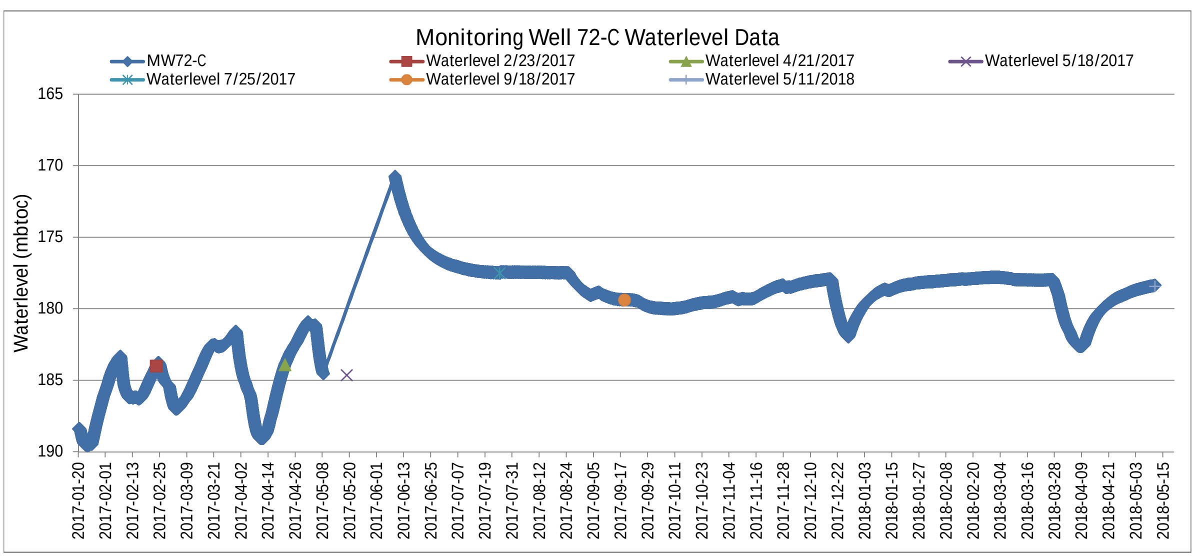

Monitoring Well 71-A Waterlevel Data
MW71-A
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/19/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
195
197
199
201
203
205
207
209
2017-01-20
2018-05-15

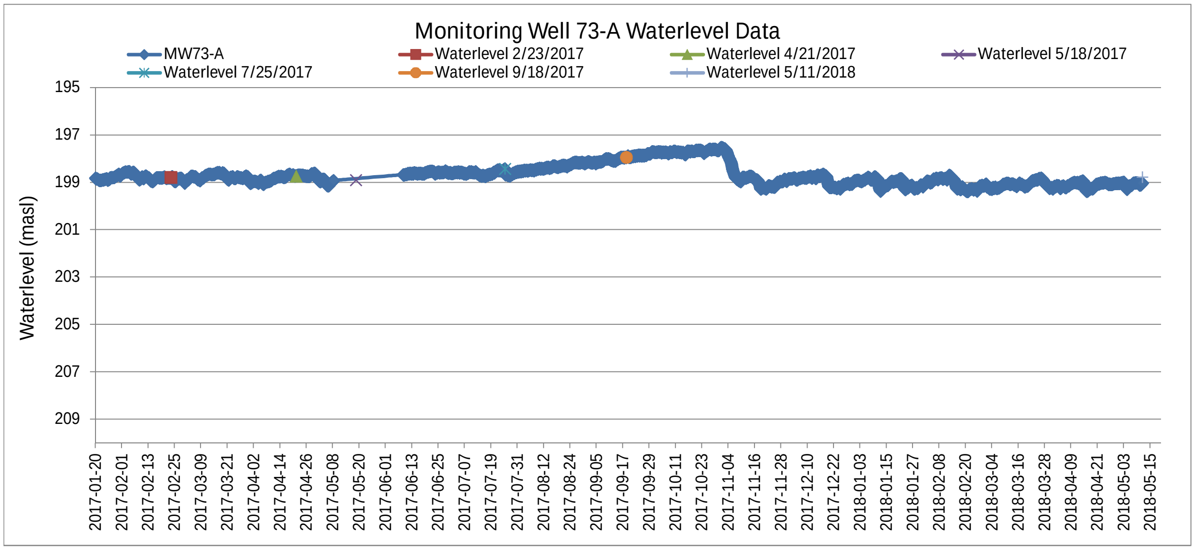

Monitoring Well 71-B Waterlevel Data
MW71-B
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/19/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
185
187
189
191
193
195
197
199
2017-01-20
2018-05-15

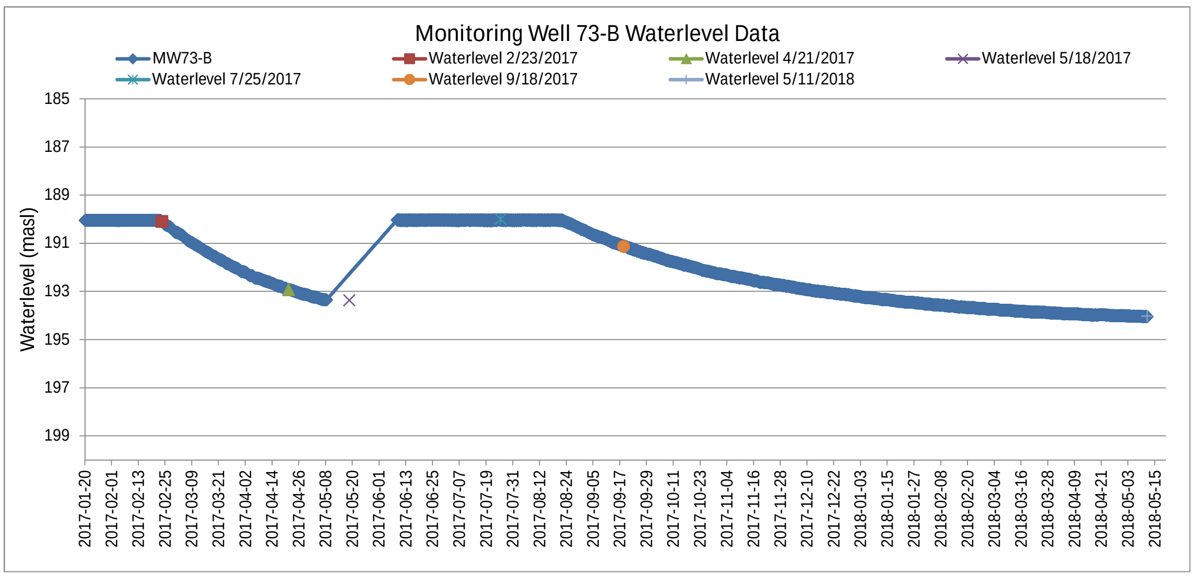

Monitoring Well 71-C Waterlevel Data
MW71-C
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/19/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
172
173
174
175
176
177
178
179
2017-01-20
2018-05-15


Monitoring Well 72-A Waterlevel Data
MW72-A
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
195
197
199
201
203
205
207
209
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
2018-03-04
2018-03-16
2018-03-28
2018-04-09
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 72-B Waterlevel Data
MW72-B
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
185
187
189
191
193
195
197
199
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
2018-03-04
2018-03-16
2018-03-28
2018-04-09
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 72-C Waterlevel Data
MW72-C
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (mbtoc)
165
170
175
180
185
190
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
2018-03-04
2018-03-16
2018-03-28
2018-04-09
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 73-A Waterlevel Data
MW73-A
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
195
197
199
201
203
205
207
209
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
2018-03-04
2018-03-16
2018-03-28
2018-04-09
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 73-B Waterlevel Data
MW73-B
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
185
187
189
191
193
195
197
199
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
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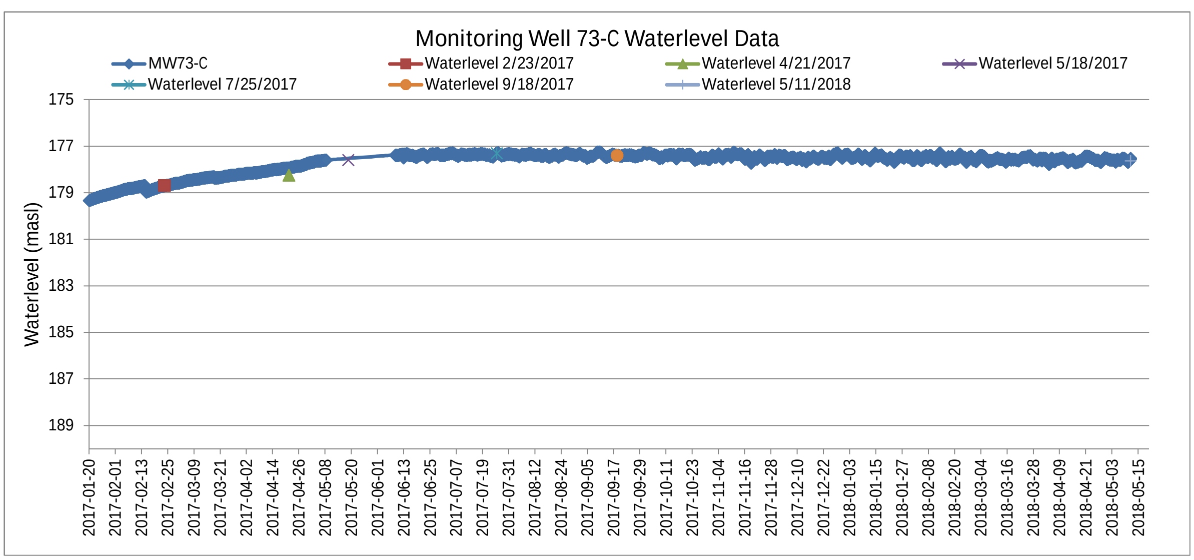
2018-05-03
2018-05-15


Monitoring Well 73-C Waterlevel Data
MW73-C
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
175
177
179
181
183
185
187
189
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
2018-03-04
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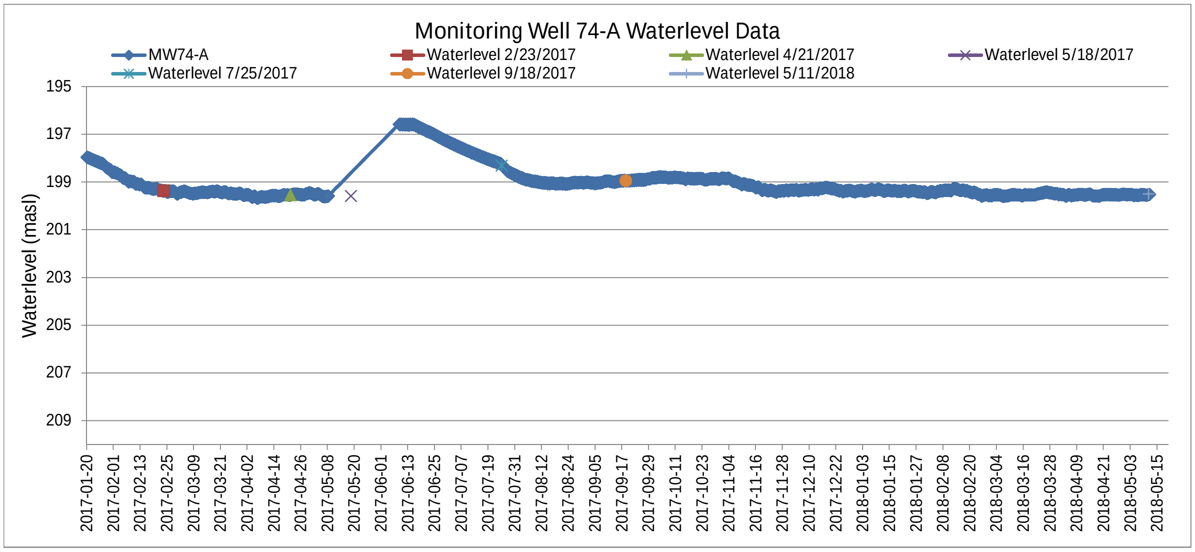
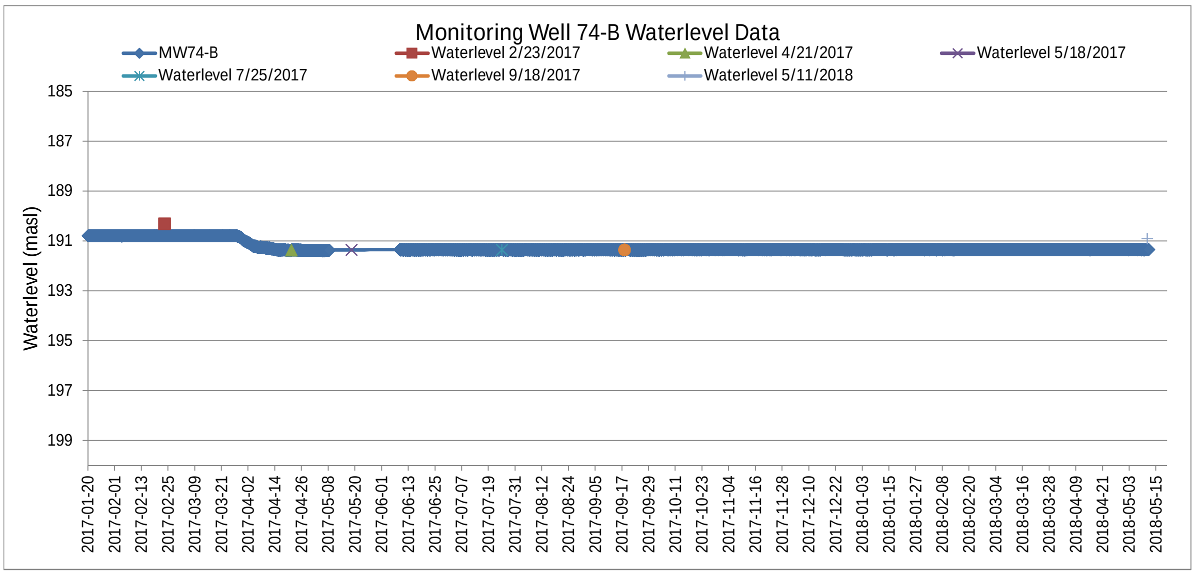
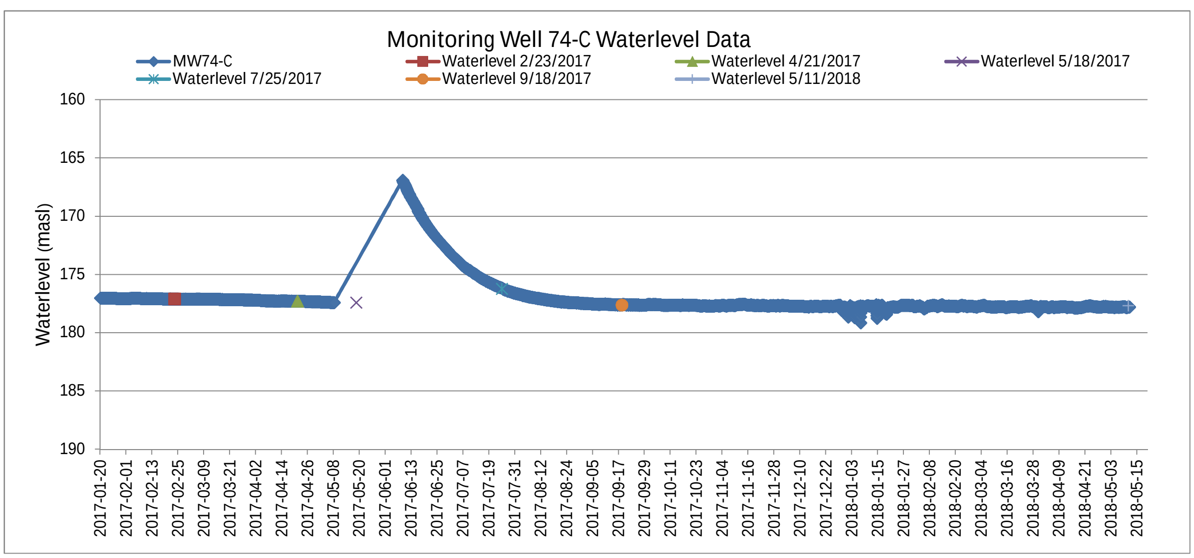
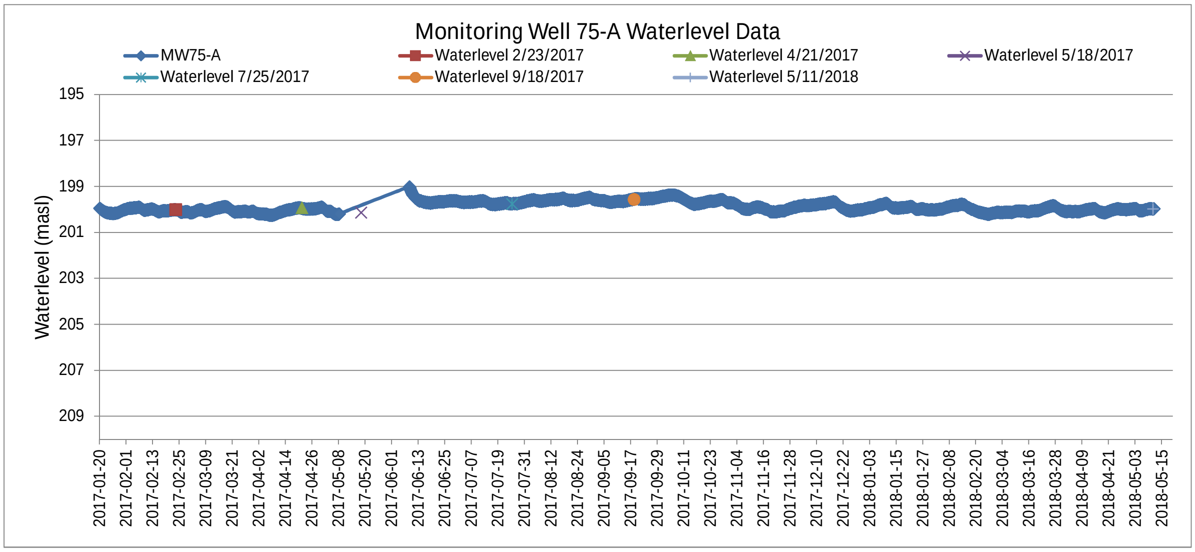
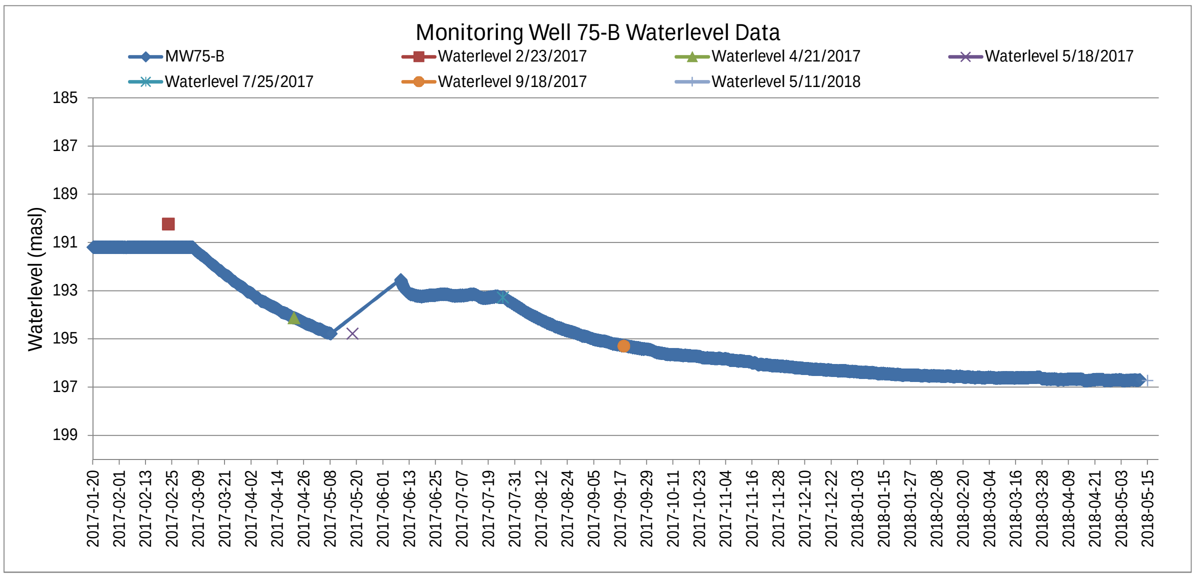
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 74-A Waterlevel Data
MW74-A
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
195
197
199
201
203
205
207
209
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
2018-03-04
2018-03-16
2018-03-28
2018-04-09
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 74-B Waterlevel Data
MW74-B
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
185
187
189
191
193
195
197
199
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
2018-03-04
2018-03-16
2018-03-28
2018-04-09
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 74-C Waterlevel Data
MW74-C
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
160
165
170
175
180
185
190
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
2018-03-04
2018-03-16
2018-03-28
2018-04-09
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 75-A Waterlevel Data
MW75-A
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
195
197
199
201
203
205
207
209
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
2017-07-19
2017-07-31
2017-08-12
2017-08-24
2017-09-05
2017-09-17
2017-09-29
2017-10-11
2017-10-23
2017-11-04
2017-11-16
2017-11-28
2017-12-10
2017-12-22
2018-01-03
2018-01-15
2018-01-27
2018-02-08
2018-02-20
2018-03-04
2018-03-16
2018-03-28
2018-04-09
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 75-B Waterlevel Data
MW75-B
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
185
187
189
191
193
195
197
199
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
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2017-08-12
2017-08-24
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2017-09-29
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2017-11-16
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2018-01-03
2018-01-15
2018-01-27
2018-02-08
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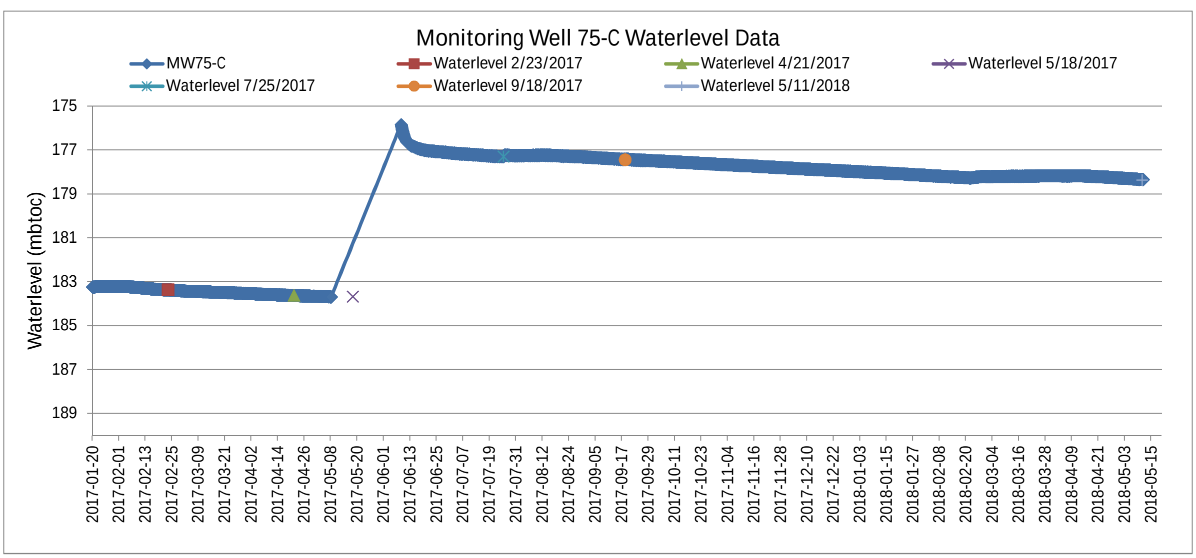
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 75-C Waterlevel Data
MW75-C
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (mbtoc)
175
177
179
181
183
185
187
189
2017-01-20
2017-02-01
2017-02-13
2017-02-25
2017-03-09
2017-03-21
2017-04-02
2017-04-14
2017-04-26
2017-05-08
2017-05-20
2017-06-01
2017-06-13
2017-06-25
2017-07-07
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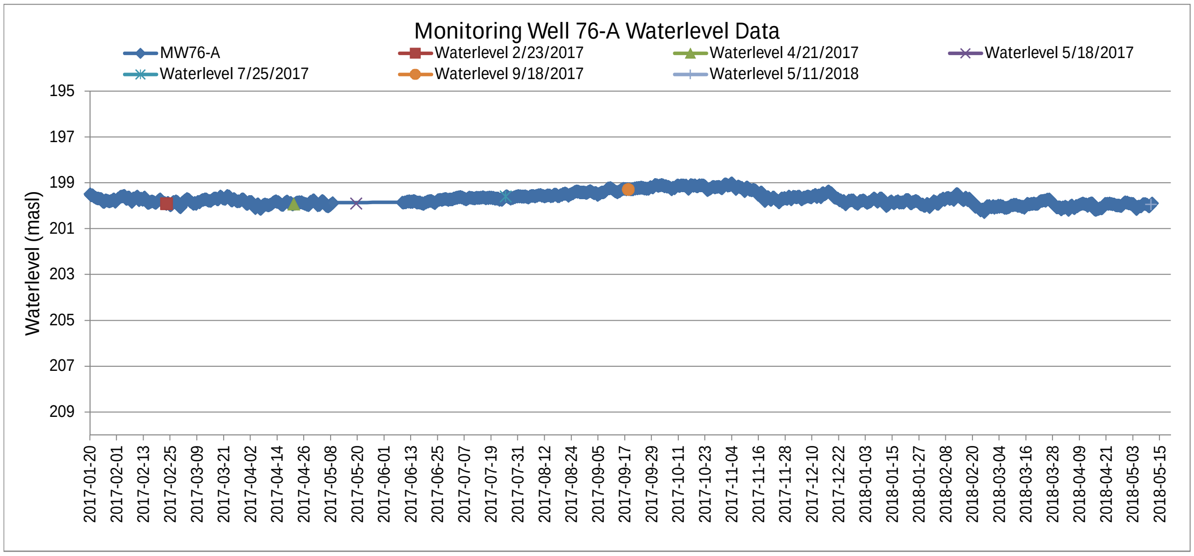
2018-02-08
2018-02-20
2018-03-04
2018-03-16
2018-03-28
2018-04-09
2018-04-21
2018-05-03
2018-05-15


Monitoring Well 76-A Waterlevel Data
MW76-A
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
195
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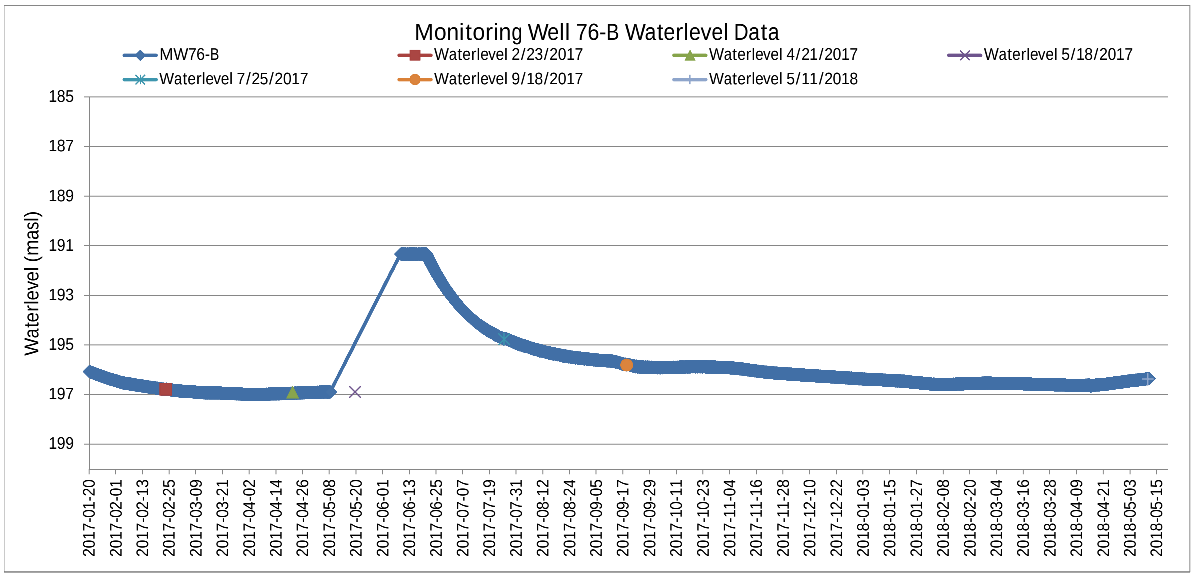
2017-01-20
2018-05-15


Monitoring Well 76-B Waterlevel Data
MW76-B
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
185
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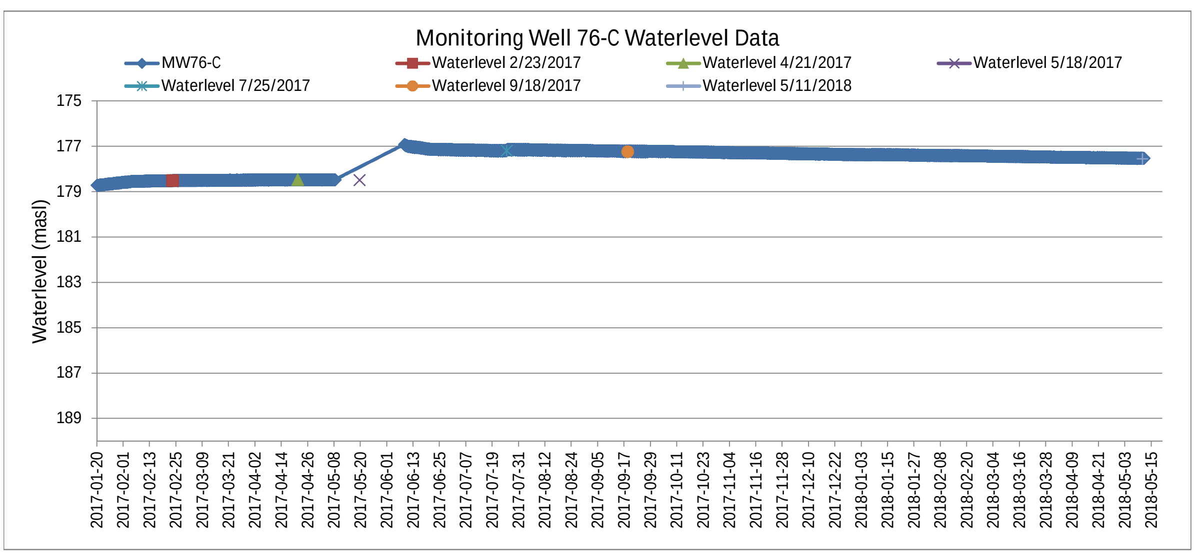
2017-01-20
2018-05-15


Monitoring Well 76-C Waterlevel Data
MW76-C
Waterlevel 2/23/2017
Waterlevel 4/21/2017
Waterlevel 5/18/2017
Waterlevel 7/25/2017
Waterlevel 9/18/2017
Waterlevel 5/11/2018
Waterlevel (masl)
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2017-01-20
2018-05-15

Appendix D7-E

Groundwater Quality and Isotope Chemistry

DILLON CONSULTING

Table 1
Groundwater Quality Data

DILLON CONSULTING

Sampling Date		2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07
Location	UNITS	MW71-A	MW71-B	MW71-C	MW72-A	MW72-B	MW72-C	MW73-A	MW73-B	MW73-C	MW74-A	MW74-B
Calculated Parameters												
Hardness (CaCO3)	mg/L	2100	960	120	1300	110	860	1200	420	130	1200	
Inorganics												
Total Ammonia-N	mg/L	0.15	0.22	0.53	<0.050	0.80	0.23	0.42	0.36	0.54	0.076	2.7
Total BOD	mg/L	<2.0	3.0	6.0	3.0	3.0	6.0	<2.0	3.0	10	<2.0	3.0
Total Chemical Oxygen Demand (COD)	mg/L	<4.0	5.7	17	6.6	16	<4.0	<4.0	<4.0	13	<4.0	16
Conductivity	umho/cm	3100	2100	1000	2200	730	1800	2100	1100	630	2300	
Fluoride (F-)	mg/L	0.52	0.37	0.95	0.33	0.81	0.43	0.48	0.51	1.1	0.29	
Total Kjeldahl Nitrogen (TKN)	mg/L	0.92	0.51	1.1	0.93	1.4	0.51	0.97	0.98	0.78	0.69	4.5
pH	pH	7.43	7.72	8.08	7.49	8.06	7.72	7.50	7.83	8.07	7.62	
Phenols-4AAP	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Phosphorus	mg/L	<0.004	<0.004	<0.004	0.005	0.006	<0.004	<0.004	<0.004	<0.004	<0.004	
Dissolved Sulphate (SO4)	mg/L	1800	1100	130	980	140	640	860	350	38	1000	110
Alkalinity (Total as CaCO3)	mg/L	320	140	220	380	200	350	420	180	180	330	220
Dissolved Chloride (Cl)	mg/L	15	21	100	26	28	45	33	22	57	42	2.0
Nitrite (N)	mg/L	0.035	0.067	<0.010	<0.010	<0.050	<0.010	0.048	0.013	<0.010	0.034	
Nitrate (N)	mg/L	<0.10	0.39	<0.10	0.40	<0.50	<0.10	<0.10	<0.10	<0.10	0.13	
Nitrate + Nitrite (N)	mg/L	<0.10	0.46	<0.10	0.40	<0.50	<0.10	<0.10	<0.10	<0.10	0.17	
Dissolved Bromide (Br-)	mg/L	<5.0	<5.0	<1.0	<5.0	<1.0	<5.0	<5.0	<1.0	<1.0	<5.0	<1.0
Metals												
Dissolved Aluminum (Al)	ug/L	<5.0	8.8	<5.0	<5.0	<5.0	<5.0	<5.0	1500	150	<5.0	<5.0
Dissolved Calcium (Ca)	ug/L	480000	230000	29000	340000	31000	210000	290000	110000	34000	310000	130000
Dissolved Chromium (Cr)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Dissolved Iron (Fe)	ug/L	6200	<100	480	<100	<100	<100	300	3800	310	<100	<100
Dissolved Magnesium (Mg)	ug/L	210000	96000	12000	120000	8600	80000	120000	37000	12000	110000	43000
Dissolved Potassium (K)	ug/L	5200	8000	5400	6800	6100	6000	5100	4800	7800	8600	6700
Dissolved Sodium (Na)	ug/L	50000	130000	160000	37000	100000	94000	39000	97000	74000	34000	410000

Table 1
Groundwater Quality Data

DILLON CONSULTING

Sampling Date		2017-06-08	2017-06-07	2017-06-07	2017-06-08	2017-06-08	2017-06-08	2017-06-08
Location	UNITS	MW74-C	MW75-A	MW75-B	MW75-C	MW76-A	MW76-B	MW76-C
Calculated Parameters								
Hardness (CaCO3)	mg/L	130	1300	1300	150	2500	1700	100
Inorganics								
Total Ammonia-N	mg/L	0.31	<0.050	0.12	0.43	0.53	0.70	0.57
Total BOD	mg/L	4.0	<2.0	3.0	2.0	<2.0	3.0	3.0
Total Chemical Oxygen Demand (COD)	mg/L	10	<4.0	<4.0	<4.0	6.6	8.4	9.7
Conductivity	umho/cm	570	2800	2500	700	3700	3200	690
Fluoride (F-)	mg/L	1.0	0.47	0.28	0.93	0.84	0.51	1.2
Total Kjeldahl Nitrogen (TKN)	mg/L	0.44	<0.50 (1)	0.81	0.71	1.2	1.5	0.68
pH	pH	7.92	7.54	7.75	8.00	7.50	7.73	8.14
Phenols-4AAP	mg/L	0.0016	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dissolved Phosphorus	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Dissolved Sulphate (SO4)	mg/L	56	370	1400	72	2300	1900	57
Alkalinity (Total as CaCO3)	mg/L	150	290	160	140	310	160	160
Dissolved Chloride (Cl)	mg/L	50	560	13	81	13	15	73
Nitrite (N)	mg/L	<0.010	<0.010	0.041	<0.010	<0.010	0.016	<0.010
Nitrate (N)	mg/L	<0.10	<0.10	0.86	<0.10	<0.10	<0.10	<0.10
Nitrate + Nitrite (N)	mg/L	<0.10	<0.10	0.90	<0.10	<0.10	<0.10	<0.10
Dissolved Bromide (Br-)	mg/L	<1.0	<5.0	<5.0	<1.0	<1.0	<5.0	<1.0
Metals								
Dissolved Aluminum (Al)	ug/L	6.5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Dissolved Calcium (Ca)	ug/L	33000	320000	300000	39000	520000	360000	25000
Dissolved Chromium (Cr)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Dissolved Iron (Fe)	ug/L	<100	<100	<100	<100	11000	1600	<100
Dissolved Magnesium (Mg)	ug/L	11000	130000	130000	14000	290000	200000	9300
Dissolved Potassium (K)	ug/L	5300	5400	9200	4600	8800	10000	10000
Dissolved Sodium (Na)	ug/L	68000	63000	140000	76000	90000	170000	97000

Table 2
Groundwater VOC Data

DILLON CONSULTING

Sampling Date		2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07
Location	UNITS	MW71-A	MW71-B	MW71-C	MW72-A	MW72-B	MW72-C	MW73-A	MW73-B	MW73-C
Volatile Organics										
Acetone (2-Propanone)	ug/L	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzene	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bromodichloromethane	ug/L	<0.10	<0.10	0.21	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bromoform	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Bromomethane	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Carbon Tetrachloride	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorobenzene	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chloroethane	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chloroform	ug/L	<0.10	<0.10	0.86	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chloromethane	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dibromochloromethane	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dichlorobenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,3-Dichlorobenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,4-Dichlorobenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1-Dichloroethane	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloroethane	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1-Dichloroethylene	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1,2-Dichloroethylene	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1,2-Dichloroethylene	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloropropane	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1,3-Dichloropropene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
trans-1,3-Dichloropropene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Ethylene Dibromide	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Methylene Chloride(Dichloromethane)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Methyl Ethyl Ketone (2-Butanone)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Methyl Isobutyl Ketone	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Methyl t-butyl ether (MTBE)	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

Table 2
Groundwater VOC Data

Sampling Date		2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07	2017-06-07
Location	UNITS	MW71-A	MW71-B	MW71-C	MW72-A	MW72-B	MW72-C	MW73-A	MW73-B	MW73-C
Volatile Organics										
1,1,1,2-Tetrachloroethane	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1,2,2-Tetrachloroethane	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachloroethylene	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	ug/L	<0.20	0.21	0.63	<0.20	<0.20	0.71	<0.20	<0.20	0.41
1,1,1-Trichloroethane	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,2-Trichloroethane	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Trichloroethylene	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Trichlorofluoromethane (FREON 11)	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Vinyl Chloride	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	ug/L	<0.10	<0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
o-Xylene	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Xylenes	ug/L	<0.10	<0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Surrogate Recovery (%)										
4-Bromofluorobenzene	%	100	98	100	100	100	99	101	99	107
D4-1,2-Dichloroethane	%	108	101	107	109	104	108	109	107	105
D8-Toluene	%	98	98	98	98	91	98	99	98	96

Table 2
Groundwater VOC Data

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Sampling Date		2017-06-07	2017-06-07	2017-06-08	2017-06-07	2017-06-07	2017-06-08	2017-06-08	2017-06-08	2017-06-08
Location	UNITS	MW74-A	MW74-B	MW74-C	MW75-A	MW75-B	MW75-C	MW76-A	MW76-B	MW76-C
Volatile Organics										
Acetone (2-Propanone)	ug/L	<10	<20	<10	<10	<10	<10	<10	<10	<10
Benzene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bromodichloromethane	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	4.3	<0.10	<0.10	<0.10
Bromoform	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	0.95	<0.20	<0.20	<0.20
Bromomethane	ug/L	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Carbon Tetrachloride	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chlorobenzene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chloroethane	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chloroform	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	7.6	<0.10	<0.10	0.28
Chloromethane	ug/L	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dibromochloromethane	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	3.2	<0.20	<0.20	<0.20
1,2-Dichlorobenzene	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,3-Dichlorobenzene	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,4-Dichlorobenzene	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1-Dichloroethane	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloroethane	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1-Dichloroethylene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1,2-Dichloroethylene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
trans-1,2-Dichloroethylene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloropropane	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
cis-1,3-Dichloropropene	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
trans-1,3-Dichloropropene	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Ethylene Dibromide	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Methylene Chloride(Dichloromethane)	ug/L	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.65
Methyl Ethyl Ketone (2-Butanone)	ug/L	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Methyl Isobutyl Ketone	ug/L	<5.0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Methyl t-butyl ether (MTBE)	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

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Table 2
Groundwater VOC Data

Sampling Date		2017-06-07	2017-06-07	2017-06-08	2017-06-07	2017-06-07	2017-06-08	2017-06-08	2017-06-08	2017-06-08
Location	UNITS	MW74-A	MW74-B	MW74-C	MW75-A	MW75-B	MW75-C	MW76-A	MW76-B	MW76-C
Volatile Organics										
1,1,1,2-Tetrachloroethane	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1,2,2-Tetrachloroethane	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachloroethylene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	ug/L	<0.20	<0.40	<0.20	<0.20	0.21	0.25	<0.20	<0.20	<0.20
1,1,1-Trichloroethane	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,2-Trichloroethane	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Trichloroethylene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Trichlorofluoromethane (FREON 11)	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Vinyl Chloride	ug/L	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	0.16	<0.10	<0.10
o-Xylene	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	0.11	<0.10	<0.10
Total Xylenes	ug/L	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	0.28	<0.10	<0.10
Surrogate Recovery (%)										
4-Bromofluorobenzene	%	100	99	99	99	100	99	100	100	100
D4-1,2-Dichloroethane	%	106	104	105	105	105	100	107	108	106
D8-Toluene	%	98	99	100	99	98	99	98	98	99

ISOTOPE TRACER TECHNOLOGIES INC

Isotope Analyses for:
Dillon Consulting Ltd.

IT2 FILE # 160407

2017-05-05

Approved by:

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2017-05-05

ISOTOPE TRACER TECHNOLOGIES INC

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File Number: 160407
Project Name: Ridge Landfill Expansion EA
Project Number: 15-2456

#	Sample ID	Date	Sample #	$\delta^{18}O$	Aver	Stdv	$\delta^{2}H$	Aver	Stdv
				Core	VSMOW		Core	VSMOW	
1	BH76-1 15ft SS3	December 1, 2016	41667	X	-7.98	0.08	X	-56.6	1.1
2	BH76-1 160ft SS32	December 7, 2016	41668	X	-14.21	0.12	X	-117.0	1.0
3	BH76-1 35ft SS7	December 1, 2016	41669	X	-8.10	0.12	X	-64.9	0.5
4	BH76-1 65ft SS13	December 1, 2016	41670	X	-10.19	0.08	X	-77.9	1.3
5	BH76-1 100ft SS20	December 2, 2016	41671	X	-12.94	0.14	X	-97.0	0.5
6	BH76-1 130ft SS26	December 2, 2016	41672	X	-14.32	0.05	X	-110.0	0.5
7	BH73-1 20ft SS4	December 8, 2016	41673	X	-7.85	0.05	X	-59.3	1.0
8	BH73-1 145ft SS29	December 12, 2016	41674	X	-11.07	0.02	X	-95.8	1.2
9	BH73-1 35ft SS7	December 8, 2016	41675	X	-8.71	0.13	X	-64.1	0.2
10	BH73-1 65ft SS13	December 8, 2016	41676	X	-10.01	0.03	X	-76.0	1.0
11	BH73-1 100ft SS20	December 9, 2016	41677	X	-12.58	0.09	X	-98.6	2.5
12	BH73-1 130ft SS26	December 12, 2016	41678	X	-9.93	0.13	X	-86.9	0.4
13	BH100	December	41679	X	-14.35	0.11	X	-116.4	1.7

18O (IRMS)

Instrument Used:
Delta[Plus] Isotope Ratio Mass Spectrometry (IRMS), Finnigan MAT, Germany.
Coupled with a TC/EA ThermoFinnigan, Germany.

Standard Used:
IT^2-12A / IT^2-13A / IT2-00 Calibrated with IAEA Standards (V-SMOW, SLAP, and GISP)

Typical Standard deviation:
±0.3‰

2H (IRMS)

Instrument Used:
Delta[Plus] XL, Thermo Finnigan, Germany.
Coupled with a Chrom reduction System, Heraeus, Germany

Standard Used:
IT^2-12A / IT^2-13A / IT2-00 Calibrated with IAEA Standards (V-SMOW, SLAP, and GISP)

Typical Standard deviation:
±2‰

Approved by:

Orfan SStash

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Appendix D7-F

Leachate Generation Rate Analysis (HELP Modelling)

MEMO

TO:	Cathy Smith, Project Manager, Ridge Landfill EA, Waste Connections
FROM:	Robin Kell, Hydrogeologist, Dillon Consulting Limited
cc:	Bill Allison
DATE:	July 9, 2019
SUBJECT:	Ridge Landfill HELP Model
OUR FILE:	15-2456

The HELP Model was used to estimate the leachate generation through Ridge Landfill final cover. From HELP weather database, weather data from Windsor meteorological station was used. 25% surface slope and 25 m slope length was used in the models. The main input data included final cover layers information (***Table 1***), and evapotranspiration and weather information (***Table 2***). Based on the available information, 7 m deep municipal waste and 0.3 m drainage layer were included in the simulations. The simulation period is 20 years.

Five scenarios were simulated:

Scenario 1 – An operating landfill with a 1.35 m thick clay cover with a relatively elevated hydraulic conductivity of 1.7 x 10^{-5} cm/s.

Scenario 2 – An operating landfill with a 0.85 m thick clay cover with a relatively elevated hydraulic conductivity of 1.7 x 10^{-5} cm/s.

Scenario 3 – A closed landfill with a 0.85 m thick clay cover with a hydraulic conductivity of 1 x 10^{-6} cm/s.

Scenario 4 – A closed landfill with a 1.35 m thick clay cover with a hydraulic conductivity of 1 x 10^{-6} cm/s.

Scenario 5 – A closed landfill with a 0.3 m intermediate cover with k = 1.0E^{-5} cm/s and 0.55 m final cover with 1.0E^{-6} cm/s (equivalent hydraulic conductivity of 1.47 x 10^{-6}).

A summary of the output results is presented in ***Table 3***.

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Table 1: Final Cover Layers Input Parameters

Layer Name	Type	Description	Thickness (cm)	Hydraulic Conductivity (cm/s)
Top Soil	VPL*	Fine Sandy Loam	15	5.2×10^{-4}
Cover Soil	BSL*	Clay	Varies	Varies

* VPL: Vertical Percolation Layer, BSL: Barrier Soil Liner

Table 2: Evapotranspiration and Weather Data

Input Parameter	Value	Reference
Vegetation Class	Fair stand of grass	
Evaporation Zone Depth	0.15 m	The depth will be equal to the depth of the topsoil after run.
Maximum leaf area index	2	Based on HELP Manual for a fair stand of grass.
Q1 humidity	74	https://www.timeanddate.com/weather/canada/windsor/climate (average of 1985-2015)
Q2 humidity	66	https://www.timeanddate.com/weather/canada/windsor/climate (average of 1985-2015)
Q3 humidity	71	https://www.timeanddate.com/weather/canada/windsor/climate (average of 1985-2015)
Q4 humidity	74	https://www.timeanddate.com/weather/canada/windsor/climate (average of 1985-2015)

Table 3: Models Output

Scenario	Final Cover Hydraulic Conductivity (cm/s)	Final Cover Thickness (m)	Annual Average Precipitation (in mm/year)	Runoff in mm/year (%)	Evapotranspiration in mm/year (%)	Leachate Generation (mm/year)
1	1.7×10^{-5}	1.35	930	143 (15%)	527 (57%)	260 (28%)
2	1.7×10^{-5}	0.85	930	143 (15%)	527 (57%)	261 (28%)
3	1.0×10^{-6}	0.85	929.6	204.8 (22.0%)	586.9 (63.1%)	137.6 (14.8%)
4	1.0×10^{-6}	1.35	929.6	206.6 (22.2%)	587.5 (63.2%)	135.2 (14.5%)

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Scenario	Final Cover Hydraulic Conductivity (cm/s)	Final Cover Thickness (m)	Annual Average Precipitation (in mm/year)	Runoff in mm/year (%)	Evapotranspiration in mm/year (%)	Leachate Generation (mm/year)
5	1.47 x 10^{-6}*	0.85	929.6	187.3 (20.1%)	573.9 (61.7%)	168.2 (18.1 %)

* Equivalent hydraulic conductivity of 0.3 m intermediate cover with k = 1.0E-5 cm/s and 0.55 m final cover with 1.0E-6 cm/s.

The interim cover scenarios (Scenario 1 and Scenario 2), have a similar leachate generation rate of approximately 260 mm/year for both simulated thicknesses. The final cover scenarios (Scenario 3 and Scenario 4) also have similar predicted leachate generation rates of ~136 mm/year. The hybrid scenario has a slightly higher leachate generation rate of 168 mm/year.

Recommendation

The leachate generation recommended to be used in the landfill design is 150 mm/year. This value is consistent with the generic landfills of *O.Reg. 232/98* and reflects the precision of the simulation method.

Appendix D7-G

Contaminant Transport Modelling

MEMO

TO: Cathy Smith, Project Manager, Ridge Landfill EA, Waste Connections
FROM: Robin Kell, Hydrogeologist, Dillon Consulting Limited
cc: Bill Allison
DATE: July 9, 2019
SUBJECT: Ridge Landfill Contaminant Transport Modelling
OUR FILE: 15-2456

1.0 Introduction

Contaminant transport modelling was completed to predict potential groundwater impacts resulting from the proposed landfill expansion. The computer program POLLUTE was used to by simulating the movement of contaminants to predict groundwater quality in time and space as contaminants migrate from the landfill into the groundwater environment. The simulations incorporate the performance of the leachate control system and the hydrogeologic setting.

2.0 Reasonable Use Guideline

To determine the significance of an impact on groundwater quality the Ministry of the Environment and Energy (MOEE) developed Guideline B 7, the Incorporation of the Reasonable Use Concept into MOEE Groundwater Management Activities. The essence of this guideline is to establish site specific groundwater quality criteria based on criteria established for the "reasonable use" of the groundwater and background concentrations. These criteria are applicable at the site boundary. The Reasonable Use for groundwater at the property boundary is drinking water and thus groundwater at the site boundary must meet criteria calculated using the Reasonable Use Guidelines.

2.1 Reasonable Use of Groundwater

The guideline states that the Reasonable Use of groundwater in most cases will be drinking water. This is the case for Layer 3 (the basal / bedrock aquifer) which is the principal water supply aquifer in the area of the site. Therefore, the “reasonable use” of groundwater at the site is drinking water.

Critical contaminants are defined as contaminants that due to a combination of a high concentration in leachate, a low allowable concentration and high mobility in the groundwater environment have a higher potential for causing unacceptable impacts than other contaminants.. *O.Reg 232/98* defines eight critical contaminants for landfills:

- Benzene
- Cadmium
- Chloride
- Lead
- 1,4 Dichorobenzene
- Dichloromethane
- Toluene
- Vinyl Chloride

2.2 Background Concentrations

Of all of the critical contaminants, chloride is the only contaminant that occurs naturally in the subsurface. Chloride levels vary from 45 mg/L to 400 mg/L with a median value of 125 mg/L. For the other specified critical contaminants, background concentrations have been assumed to be zero since they do not occur naturally in the subsurface and were not detected in the groundwater quality sampling conducted at the site.

2.3 Allowable Concentrations

The Reasonable Use Guideline specifies that the maximum concentration of a particular contaminant that would be acceptable in groundwater beneath an adjacent property is calculated using the following equation:

$$Callow = Cb + x(Cr - Cb)$$

where: C_{allow}: Calculated allowable concentration

C_b: Background concentration

C_r: Maximum concentration for the reasonable use of groundwater. Since the reasonable use of groundwater at this site is drinking water, maximum concentrations are based on the Ontario drinking Water Standards.

X: A factor that reduces the contaminant to a level which is considered by the MECP to have only a negligible effect on the use of groundwater. For drinking water, "x" is 0.5 for non-health related parameters or 0.25 for health related parameters.

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Table 1 summarizes the allowable concentrations for the critical contaminants.

Table 1: Allowable Concentrations

Critical Contaminant	Drinking Water Criterion	Background Concentration	Allowable Concentration	Allowable Increase
Benzene (µg/L)	5	0	1.25	1.25
Cadmium (µg/L)	5	0	1.25	1.25
Chloride (mg/L)*	250	125	188	63
Lead (µg/L)	10	0	2.5	2.5
1,4 Dichlorobenzene (µg/L)	5	0	1.25	1.25
Dichloromethane (µg/L)	50	0	12.5	12.5
Toluene (µg/L)*	24	0	12	12
Vinyl Chloride (µg/L)	2	0	0.5	0.5

* - non-health related parameter, other parameters are health related.

3.0 POLLUTE Model Description

The computer program POLLUTE was used to simulate contaminant transport in time and space. This program is a finite layer contaminant transport model which is based on one-dimensional advection-dispersion equation for porous media (Rowe et al, 2004). In general, POLLUTE is applicable where the hydrostratigraphy can be conceptualized as being horizontal layers with soil properties being the same at any given layer. The hydrostratigraphy of the Ridge Landfill is ideally suited for the POLLUTE program. The model considers a slice of one metre width through the landfill in the direction of principal groundwater flow. The model simulates the contaminant source (i.e., the waste within the landfill) as a finite mass. The finite mass approach assumes that the mass of any potential contaminant within the landfill is finite and the process of clean water infiltration through the landfill cover coupled with leachate collection removes contaminants from the waste, thereby resulting in a decrease in leachate concentrations with time. Loss of contaminants through the landfill base and biological/chemical decay process, if applicable, are calculated within the program and also decrease the finite mass and reduce leachate concentrations with time.

Transport mechanisms simulated by POLLUTE are advection, dispersion (which includes mechanical mixing and diffusion), adsorption and biological / chemical decay. Advection is a

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process whereby the solute is transported as a result of groundwater movement. Dispersion is a mechanism where the solute is transported due to a concentration gradient (the diffusion mechanism where a contaminant moves from an area of high concentration to an area of low concentration) and due to the mixing of groundwater due to small scale heterogeneities in the size and geometry of the soil pore space (the hydrodynamic mechanism). Due to the very low groundwater velocities through Layer 2 hydrodynamic dispersion is considered to be negligible (Rowe et al, 2004). Adsorption onto soil particles and biological/chemical decay are transport processes which remove solute from the porewater phase and thereby decrease the net rate of migration. Linear adsorption was considered for the metal parameters cadmium and lead.

POLLUTE outputs contaminant concentrations at any specified depth at or below the landfill base at any specified time of interest.

3.1 POLLUTE Model Input Parameters

The hydrogeological input parameters are detailed in Section 5 of the main hydrogeological assessment report and are summarized in **Table 2**.

Table 2: Hydrogeological Input Parameters

Parameter	Value
Layer 2 (Unweathered Till)	
Hydraulic Conductivity	10^{-10} m/s
Porosity	0.3
Layer 3 (Basal / Bedrock Aquifer)	
Hydraulic Conductivity	10^{-6} m/s
Porosity	0.3
Hydraulic Gradient	0.0005
Length Along Groundwater Flow Path	1000 m

Leachate, landfill and engineered system input parameters are summarized in **Table 3**, **Table 4** and **Table 5**, respectively,

Table 3: Leachate Input Parameters

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Contaminant	Initial Source Concentration (mg/L)[1]	Mass as a Proportion of Total (wet) Mass of Waste (mg/kg)[1]	Half-Life in Leachate (yrs)[1]	Organic Carbon Partitioning Coefficient Koc[2]	Partitioning Coefficient Kd [2] foc = 0.65%
Benzene	0.02	0.014	25	60	0.39
Cadmium	0.05	0.035	-	-	30
Chloride	2500	1800	-	-	-
Lead	0.6	0.42	-	-	72
1,4 Dichlorobenzene	0.01	0.007	50	616	4.0
Dichloromethane	3.3	2.3	10	110	0.72
Toluene	1	0.7	15	140	0.91
Vinyl Chloride	0.055	0.039	25	56	0.36

Source: [1]Table 1, O.Reg 232/98; [2]Soil Screening Guidance, USEPA /540/R95/128.

Table 4: Landfill Size Parameters

Expansion Area	Area (m^2)	Waste Volume (M m^3)	Tonnage (tonnes)	Tonnes/ ha	Reference Height of Leachate, Hr (m)
West Landfill + 'A'	874,400	27.5	24,774,300	283,329	20.4
South Landfill +'B'	430,800	12.2	11,018,700	255,773	18.4
West Landfill + 'A' and South Landfill + 'B'	1,305,200	39.8	35,793,000	274,234	19.7
Old Landfill +Infill + Vertical Expansion + East Infill	552,000	14.6	13,167,900	238,549	17.2
Total	3,162,400	94.2	84,753,900	268,005	19.3

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Table 5: Engineered Systems Parameters

Parameter	Value
Drainage Length between Perimeter Drains West Landfill + 'A' and South Landfill + 'B' Old Landfill +Infill + Vertical Expansion + East Infill	 600 m 620 m
Depth of Excavation West Landfill + 'A' and South Landfill + 'B' Old Landfill +Infill + Vertical Expansion + East Infill	 9 m 8 m
Leachate Generation Rate	0.15 m^3/m^2/year
Average Leachate Head on Landfill Base During Operation of Underdrain Leachate Collection System West Landfill + 'A' and South Landfill + 'B'	0.3m
Service Life of Underdrain, West Landfill + 'A' and South Landfill + 'B'	100 years
Total Waste Porosity	0.5
Field Capacity of Waste	0.25

3.2 Equations for Performance of Engineered Systems

Leakage through the landfill base through the un-weathered till (Layer 2) is calculated using Darcy's Law, via

$$V_d = \frac{k_{till}(h_w + H - h_t)}{H}$$

Where:

V_d: Darcy flux through till

k_{till}: Hydraulic conductivity of the un-weathered till

h_w: Leachate pressure head on landfill base (m)

h_t: Pressure head at bottom of Layer 2, equals he pressure head in Layer 3 (Basal/Bedrock Aquifer) equals 22 m (based on a piezometric head of 177 m.a.s.l in Layer 3 and the surface of Layer 3 at 155 m.a.s.l)

H: Thickness of Layer 2 beneath the landfill (m); taken as the surface elevation (199 m.a.s.l minus the depth of excavation minus the surface of Layer 3, 155 m.a.s.l)

The head increase on the landfill base after the assumed failure of the leachate collection system is calculated using the following equations:

$$h_{w(t+\Delta t)} = \frac{\Delta t(q_I - q_{toe(t)} - V_{d(t)})}{n - W_{fc}} + h_{w(t)}$$

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Where:

$h_{w(t)}$: Head on landfill base (m)

q_1: Leachate generation rate per unit area (m^3/m^2/year)

q_{toe}: Perimeter drain collection rate per unit area (m^3/m^2/year)

$V_{d(t)}$: Darcy flux through Layer 2, determined by Darcy's Law as above, based on $h_{w(t)}$ (m/a)

n: Waste porosity (0.5)

W_{fc}: Field capacity if waste (0.25)

The collection via the perimeter drain ($q_{perimeter}$) can be calculated by using the Houghoutdt equation (Wesseling, 1972):

$$q_{toe(t)} = 0 \qquad when\ h_{w(t)} < D_{drain/base}$$

$$q_{toe} = \frac{8k_w dh + 4k_w(h_{w(t)} - D_{drain/base})^2}{\mathrm{L}^2} \qquad when\ h_{w(t)} \geq D_{drain/base}$$

Where:

k_w: Waste hydraulic conductivity (2 x 10^{-4} cm/s = 64 m/a)

L: Distance between perimeter drains (m)

$D_{drain/base}$: Distance between the landfill base and invert perimeter drain (m); assumed to equal the depth of excavation.

and:

$$\boldsymbol{d} = \frac{\mathbf{L}}{\mathbf{8F}_{\boldsymbol{H}}}$$

and:

$$\boldsymbol{F_H} = \frac{\left(\boldsymbol{L} - \boldsymbol{D}\sqrt{\mathbf{2}}\right)^2}{\mathbf{8DL}} + \frac{\mathbf{1}}{\boldsymbol{\pi}}\mathbf{ln}\left(\frac{\boldsymbol{D}}{\boldsymbol{r_o}\sqrt{\mathbf{2}}}\right)$$

where:

r_o: Radius of collector pipes (0.1m).

Table 6 and **Table 7** summarize the results of the calculations using these equations that are used as input into the POLLUTE simulations

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Table 6: Results of Calculations

Horizontal Expansion of West Landfill/Area A and South Landfill/Area B Engineered Systems Parameters

Time Period (years)	Head on Landfill Base (m)	Darcy Flux from Landfill Base (m/year)	Leachate Collection Rate (m^3/m^2/year)	Darcy Flux in Layer 3 (m/year)
0-100	0.30	0.0012	0.1488	0.4211
101-105	2.08	0.0014	0.0000	0.4650
106-110	5.05	0.0017	0.0000	0.5555
111-120	9.43	0.0021	0.0121	0.6888
121-130	13.81	0.0025	0.0722	0.8224
131-140	15.97	0.0026	0.1145	0.8881
141-150	16.87	0.0027	0.1343	0.9156
151-200	17.37	0.0028	0.1457	0.9307
201-5000	17.43	0.0028	0.1472	0.9326

Table 7: Results of Calculations

Vertical Expansion of Old Landfill

Time Period (years)	Head on Landfill Base (m)	Darcy Flux from Landfill Base (m/year)	Leachate Collection rate (m^3/m^2/year)	Darcy Flux in Layer 3 (m/year)
0-5	1.49	0.00137	0.0000	0.4726
6-10	4.46	0.00164	0.0000	0.5526
11-20	8.82	0.00204	0.0132	0.6854
21-30	13.22	0.00244	0.0694	0.8195
31-40	15.52	0.00265	0.1108	0.8895
40-5000	17.24	0.00281	0.1467	0.9421

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4.0 Results

Contaminant concentrations were calculated using the contaminant transport model, POLLUTE, at specified times and depths at and below the landfill base. These results were used to assess potential impacts on groundwater quality. The predicted increases are compared with the increase in concentration allowed in the Reasonable Use Guideline (RUG) referred hereafter as the Reasonable Use Concentration (RUC) and the increase which would result in meeting the Ontario Drinking Water Objective (hereafter referred to as the Ontario Drinking Water Objective Increase).

The results of the contaminant transport modelling is summarized in **Table 8**. This table summarizes the maximum concentration predicted in the modeling, the time at which that maximum occurs and the allowable Reasonable Use Concentration (from **Table 1**). The table includes model results of the horizontal expansion of the West and South Landfills and the vertical expansion of the Old Landfill. Due to biodegradation, the organic contaminants (Benzene, 1,4 Dichlorobenzene, Dichloromethane, Toluene and Vinyl Chloride) have virtually no impact in the Layer 3. The predicted impacts for cadmium and lead are always below that allowed by the RUG and, because of adsorption, the maximum is predicted to occur more than 5000 years from present. **Figure 1** shows predicted chloride concentration in Layers for the Horizontal Expansion of West Landfill/Area A and South Landfill/Area B simulation while **Figure 2** is a similar graph for the vertical expansion of the Old Landfill.

Maximum chloride concentrations are predicted to be always below allowable concentrations and occur more than 3000 years from present.

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Table 8: Predicted Maximum Concentrations

Parameter	Maximum Concentration in Layer 3	Time at Maximum Concentration (years)	Allowable Concentration
Horizontal Expansion of West Landfill/Area A and South Landfill/Area B			
Benzene (µg/L)	<0.001	-	1.25
Cadmium (µg/L)	0.12	6400	1.25
Chloride (mg/L)	103.0	3400	188
Lead (µg/L)	0.5	8200	2.5
1,4 Dichlorobenzene (µg/L)	<0.001	-	1.25
Dichloromethane (µg/L)	<0.001	-	12.5
Toluene (µg/L)	<0.001	-	12.0
Vinyl Chloride (µg/L)	<0.001	-	0.5
Vertical Expansion of Old Landfill			
Benzene (µg/L)	<0.001	-	1.25
Cadmium (µg/L)	0.16	6400	1.25
Chloride (mg/L)	129.0	3400	188
Lead (µg/L)	0.3	8300	2.5
1,4 Dichlorobenzene (µg/L)	<0.001	-	1.25
Dichloromethane (µg/L)	<0.001	-	12.5
Toluene (µg/L)	<0.001	-	12.0
Vinyl Chloride (µg/L)	<0.001	-	0.5

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FIGURE 1: PREDICTED CHLORIDE CONCENTRATIONS IN LAYER 3 - HORIZONTAL EXPANSION OF WEST AND SOUTH LANDFILLS SIMULATION

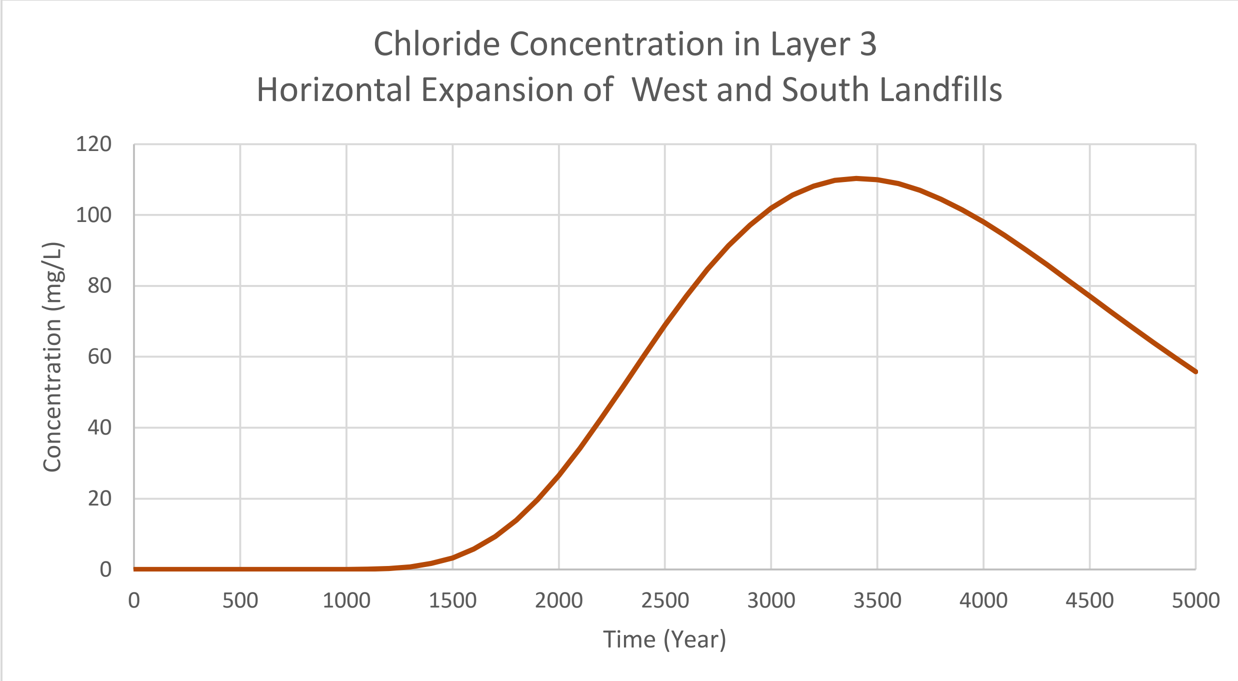
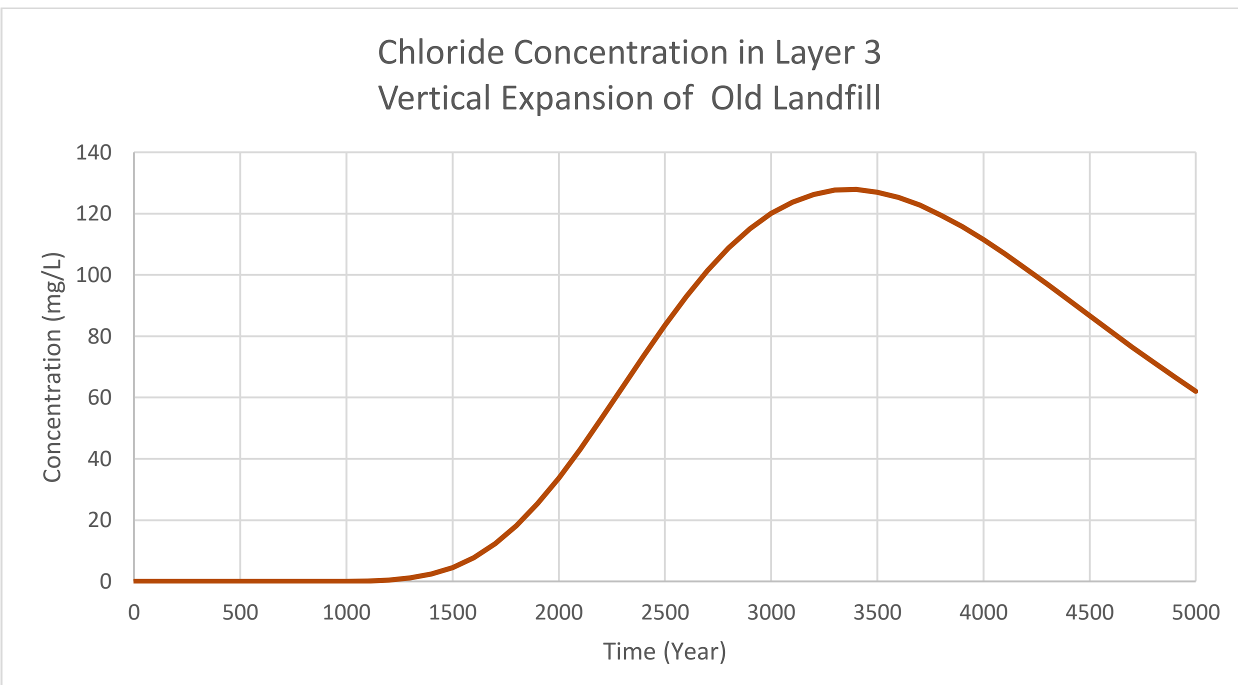


FIGURE 2: PREDICTED CHLORIDE CONCENTRATIONS IN LAYER 3 - VERTICAL EXPANSION OF OLD LANDFILL SIMULATION



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5.0 Sensitivity Assessment

A sensitivity assessment was completed on the various model parameters for all critical contaminants. The intent of this assessment is to provide insight into the relative sensitivity of input parameters used in the simulations. The sensitivity discussion is divided between sensitivity to hydrogeologic input parameters and landfill related input parameters. Since chloride has the largest predicted increases for the expanded site, it is used exclusively in the sensitivity assessment.

The results of the sensitivity assessment are summarized in **Table 9**. All sensitivity simulations predicted maximum chloride concentrations less than the allowable concentration of 188 mg/L. Decreasing the thickness of Layer 2 overburden beneath the landfill base by 2.8 m (based on the lowest sump elevation) increased the maximum predicted chloride concentration by only 10 mg/L. Assuming a lower groundwater elevation in Layer 3 (thereby increasing the hydraulic gradient through Layer 2) increased the maximum predicted concentration by just 15 mg/L.

Two sensitivity values of the leachate generation rate were also simulated. A higher leachate generation rate results in a lower predicted maximum chloride concentrations due to a decrease in the contaminating life span of the leachate source, while the opposite occurs if there is a decrease in leachate generation rate. A perimeter drain spacing of 700 m was used in the sensitivity simulations which slightly increased the predicted maximum concentration by 10 mg/L. An analysis of the effects of the service life of the leachate underdrain system was also completed by assuming that the underdrain was not present and leachate would be allowed to build-up on the landfill base and eventually collected in a perimeter collection system. This simulation predicted a maximum chloride concentration of 137 mg/L, still below the allowable concentration of 188 mg/L. The simulations indicated that maximum concentrations are more sensitive to reductions in leachate generation rates, but remained below the allowable concentration in all scenarios.

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Table 9: Summary of Sensitivity Assessment

Sensitivity Case	Maximum Predicted Chloride Concentration (mg/L) in Layer 3
Allowable Concentration	188
Horizontal Expansion of West Landfill/Area A and South Landfill/Area B	
Base Case	111
A Layer 2 thickness of 32.2 m instead of 35 m (difference between lowest sump elevation of 187.2 m and average base elevation of 190 m)	119
Leachate Generation Rate of 0.2 m^3/m^2/year instead of 0.15 m^3/m^2/year	87
Leachate Generation Rate of 0.1 m^3/m^2/year instead of 0.15 m^3/m^2/year	160
Perimeter Drain Spacing of 700 m instead of 600 m	121
Assuming that the Underdrain does not function at all compared to the predicted service life of 100 years	137
Assuming a Layer 3 groundwater level elevation of 175 m instead of 177 m	122
Assuming a Layer 3 groundwater level elevation of 173 m instead of 177 m	126
Vertical Expansion of Old Landfill	
Base Case	129
A Layer 2 thickness of 31.7 m instead of 35 m (difference between deepest base elevation in Mound 3 of 186.7 instead of average base elevation of 190m)	150
Perimeter Drain Spacing of 700 m instead of 620 m	139

6.0 Contaminating Life Span

O.Reg. 232/98 states that "contaminating life span" means,

a) in respect of a landfilling site, the period of time during which the site will produce contaminants at concentrations that could have an unacceptable impact if they were to be discharged from the site, and

b) in respect of a landfilling site and a contaminant or group of contaminants, the period of time during which the site will produce the contaminant or a contaminant in the group at concentrations that could have an unacceptable impact if they were to be discharged from the site.

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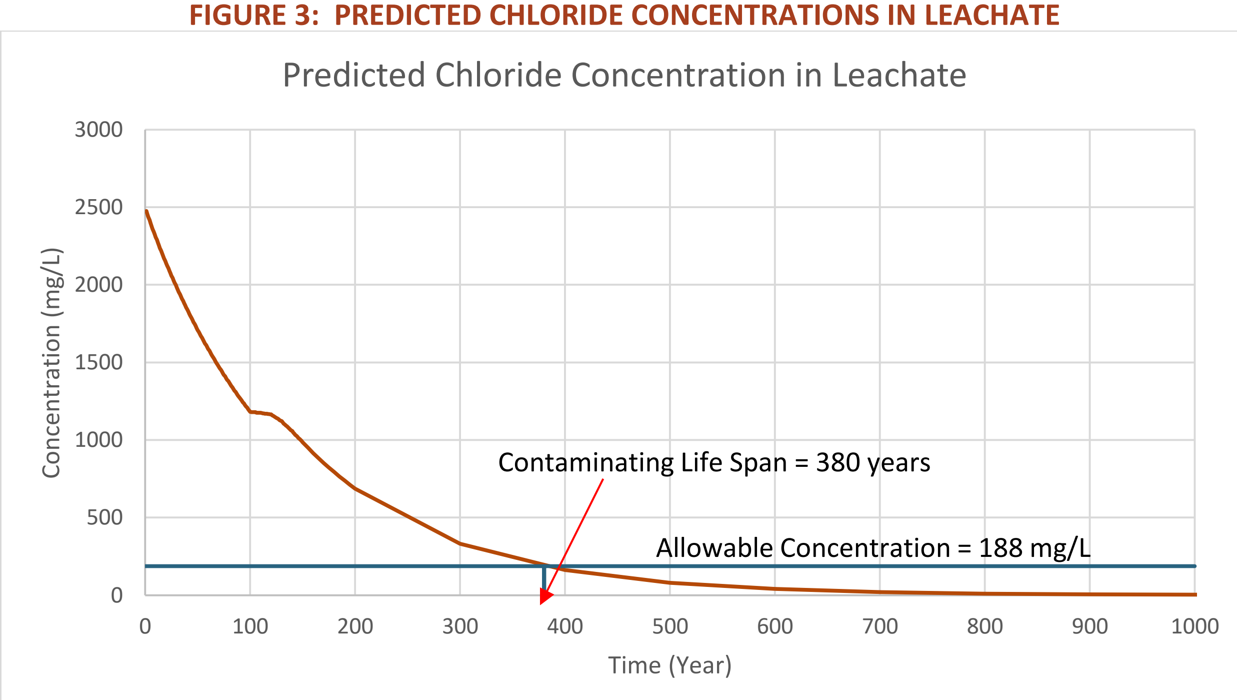
The contaminant transport modelling indicates that chloride is the only contaminant that has predicted concentrations relatively near (but below) the allowable concentration determined by the Reasonable Use Guideline. The modelling results also indicate that Layer 3, the drinking water aquifer, is protected with predicted maximum chloride concentrations below the allowable concentration of 188 mg/L with the maximum concentration of 103 mg/L not occurring for over 3,000 years. The modelling also indicated that even if the leachate underdrain system in the horizontal expansion areas did not function at all and leachate was allowed to build-up on the landfill base immediately, predicted contaminant concentrations remain below allowable concentrations. However, a perimeter leachate collection system is required to prevent landfill seeps at on the landfill side slopes and protect surface water features and the shallow Layer 1 groundwater.

Figure 3 graphs the predicted chloride concentrations in leachate with time. As indicated in this figure, the contaminant transport model predicts that chloride concentrations will be below the allowable concentration of 188 mg/L in 380 years. The analysis indicated that the underdrain leachate collection system is not needed to achieve compliance with the drinking water aquifer (Layer 3). Leachate collection from a perimeter leachate collection is required from the vertical expansion of the Old Landfill and the new fill areas after the underdrain leachate collection system ceases to function for the duration of the contaminating lifespan.

FIGURE 3: PREDICTED CHLORIDE CONCENTRATIONS IN LEACHATE



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