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Hydrogeological Investigation Report
Highway 9 Otter Creek Culvert Replacement
Township of Carrick, Ontario
G.W.P. 3076-14-00, Site No. 02X-0466/C0
Latitude: 44.028747°, Longitude: -81.093200°
GEOCRES No. 41A03-005

Client Name: R.V. Anderson Associates Limited
Date: March 25, 2025
File: 34935

202 – 1908 Ironoak Way, Oakville, Ontario, L6H 0N1

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1. INTRODUCTION

Thurber Engineering Ltd. (Thurber) was retained by R.V. Anderson Associates Limited (RVA) on behalf of the Ministry of Transportation of Ontario (MTO) to conduct a hydrogeological investigation to support the design of the proposed Otter Creek Culvert (Site No. 02X-0466/C0) replacement.

The purpose of this report is to establish baseline hydrogeological conditions, assess groundwater conditions, evaluate construction dewatering requirements, assess the potential impacts that the proposed construction works may have on the local groundwater quality and quantity, determine water taking permit requirements, and develop a groundwater monitoring and contingency plan for the proposed infrastructure improvements.

Thurber's original scope of work for this project was outlined in a proposal dated August 15, 2023. An investigation was completed for the foundation and design of the Otter Creek culvert replacement. The results and recommendations of the foundation investigation should be read in conjunction with this report and were presented under a separate cover as follows:

- Foundation Investigation and Design Report, Highway 9 Otter Creek Culvert Replacement, Township of Carrick, Ontario GWP 3076-14-00, Site No. 02X-0466-C0, Geocres No. 41A03-001, dated April 26, 2024.

The hydrogeological components of the investigation included the following tasks:

- Conduct a background review within 500 m of the Site including the setting, Ministry of the Environment, Conservation and Parks (MECP) well records, geological maps, relevant existing reports, and proposed design drawings as available.

- Install a monitoring well within the concurrent geotechnical investigation, develop the monitoring well, measure groundwater levels, and carry out single-well response tests (SWRTs) on the monitoring well.
- Collect a groundwater sample from the well for testing against the Provincial Water Quality Objectives (PWQO), including Total Suspended Solids, hexavalent chromium (Cr^{6+}), and dissolved metals compared to the PWQO.
- Carry out hydrogeological analysis and reporting, including estimated water taking rates, potential impacts to water users, structures, the natural environment including surface water features, potential existing groundwater contamination, potential mitigation measures, and assessment of construction dewatering water taking permitting needs.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. BACKGROUND REVIEW

2.1 Site and Project Description

The culvert replacement is located on Highway 9, approximately 500 m southeast of Side Road 30, near Mildmay, Ontario (the Site). The Site is in a rural setting and the area adjacent to the roadway is primarily used for agricultural purposes with a few residential homes located along Highway 9. The centreline of the existing culvert is located at approximate Highway 9 Station 20+247. The Study Area is defined as a 500 m radius around the Site. The location and approximate boundary of the Site and Study Area are shown on Figure 1. Otter Creek flows under Highway 9 from northeast to southwest through the culvert. Highway 9 is an approximately 13.5 m wide, two-lane paved roadway with gravel-surfaced shoulders. The land adjacent to the Site is generally occupied by agricultural fields, wetlands, and occasional rural residential dwellings.

Existing site information provided by RVA, MTO, and Doug Dixon and Associates (DDA) indicates that the existing structure is an approximately 18.6 m long, open-footing, concrete box culvert, with a height of 1.5 m and a span of 4.9 m, except at the outlet, where the culvert alignment shifts and has a span of 6.3 m. The estimated culvert invert (top of existing concrete footings) is at approximate Elevation 317.5 m at both the inlet (northeast) and the outlet (southwest). The local creek water level was reportedly measured at Elevation 317.9 m on November 03, 2022. The streambed level within the culvert is at approximate Elevation 317.6 m. The existing road grade at the culvert location is at approximate Elevation 320.3 m, and there is approximately 0.7 m of fill above the culvert.

The proposed box culvert will be installed on a skewed and partially shifted alignment from the existing culvert, which allows for maintaining the existing creek alignment without significant modification of the creek channel. The proposed new culvert is a 23.9 m long precast concrete box, with an opening size of 4.8 m wide by 2.1 m high (exterior dimensions of 5.4 m wide by 2.8 m high). The invert level (bottom of concrete box) is at approximate Elevation 316.7 m.

The Highway 9 embankment is approximately 1.7 to 2 m high near the culvert, with side slopes beyond the culvert structure ranging in inclination from approximately 2H:1V to 2.5H:1V or flatter, except where the existing creek is close to the embankment toe. On the southwest side of Highway 9, the creek alignment closely follows the embankment toe from the culvert outlet for approximately 100 m towards the northwest. A small wood crib retaining wall (approximately 1.6 m long and 0.3 m high) in poor condition is located at the southwest quadrant of the culvert. Erosion of the embankment toe was observed in the vicinity of the existing retaining wall.

Drawings issued for Preliminary Design for the proposed replacement culvert are provided in APPENDIX A. Further detail regarding the culvert replacement is provided in Section 5.2.

2.2 Topography and Drainage

The topography of the Site and surrounding Study Area is shown on Figure 2. The site topography within the culvert area is relatively flat. Ground surface elevation over the entire length of highway widening vary between approximately 330 m and 320 m, with slopes generally to the south or north, following the exiting topography toward Otter Creek. Surface water and runoff at the Site are also directed to Otter Creek.

2.3 Site Physiographic, Geologic and Hydrogeologic Settings

A physiography map of the Site and Study Area is shown on Figure 3. A review of Physiographic Regions of Southern Ontario by Chapman and Putnam (1984) indicated that the Study Area is located entirely within an extensive physiographic region known as The Teeswater Drumlin Field. The Teeswater Drumlin Field is characterized by drumlin fields occupying a 575 square mile area, further characterized by loamy till in texture, moderately compact, highly calcerous, and pale brown to yellowish brown in appearance (Chapman and Putnam, 1984). The physiographic landform present at the Site consists of spillways within the Study Area.

A map of the surficial geology at the Site and Study Area is shown on Figure 4. Based on maps of surficial geology produced by the Ontario Geological Survey (OGS, 2010), the surficial geology around the Site is mapped as modern alluvial deposits consisting of clay, silt, sand, and gravel, and may contain organic remains. Within the Study Area, other surficial geology types occur including glaciofluvial deposits and coarse-textured glaciolacustrine deposits (OGS, 2010).

A map of bedrock geology at the Site and within the Study Area is provided on Figure 5. The bedrock underlying the Site consists of dolostone of the Bass Islands (Armstrong & Dodge, 2007).

2.4 MECP Water Well Records Review

A search of the MECP well records database conducted within a 500 m radius around the Site returned five (5) well records. All five (5) wells were identified as water supply wells for domestic purposes, with installation dates ranging between 1952 and 2016. These wells are expected to still be in use, primarily for drinking water.

The locations of nearby MECP well records are shown on Figure 6. A table summarizing the data provided from the MECP database for all wells within the Study Area is presented in APPENDIX B.

2.5 Existing Water Taking Permits

A search of MECP's Permit to Take Water (PTTW) and Environmental Activity and Sector Registry (EASR) mapping application in January 2025 within the Study Area found no active PTTW and EASR registration for construction dewatering (MECP, 2024a).

2.6 Environmental Setting

The Site is located within the Otter Creek Saugeen River subwatershed and falls under the jurisdiction of the Saugeen Valley Conservation Authority (SVCA) (MECP, 2024b).

Based on a review of the Ministry of Natural Resources and Forestry (MNRF) online mapping (MNRF, 2024), natural features within the Study Area include watercourses and wooded areas. The main watercourse at the Site, Otter Creek, crosses Highway 9 at the culvert location and flows northwest towards Witter's Pond. There are no Provincially Significant Wetlands (PSWs) or Areas of Natural or Scientific Interest (ANSIs) within the Study Area (MNRF, 2024). The natural features within the Site and surrounding Study Area are shown on Figure 7.

A review of the MECP's Source Protection Information Atlas (MECP, 2024b) indicated that the Site is not located within a Wellhead Protection Area (WHPA) or an Intake Protection Zone (IPZ). However, the Site is located within a Highly Vulnerable Aquifer (HVA) and Significant Groundwater Recharge Area (SGRA) with a score of six. The Site is also located within the SVCA regulated areas.

3. INVESTIGATION PROCEDURES

3.1 Geotechnical Investigation

The site investigation and field-testing program for this project was carried out between September 25 and October 31, 2023. The field program consisted of drilling and sampling six (6) boreholes (CULV1-01 to CULV1-06) to depths ranging from 4.0 to 15.2 m below the ground surface.

Boreholes CULV1-03 and CULV1-04 were drilled through the gravel shoulders on Highway 9. Boreholes CULV1-01, CULV1-02, CULV1-05, and CULV1-06 were drilled off-road near the inlet and outlet of the existing culvert. The borehole location plan is provided in Appendix C and the Borehole logs are presented in Appendix D.

The boreholes through the road shoulders were advanced using a rubber track-mounted D-50 drill rig, using hollow stem augers and wash boring techniques. The off-road boreholes were advanced using a portable drill and tripod equipment using wash boring techniques. In all boreholes, soil samples were obtained at selected intervals with a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT). HQ rock coring methods were used at boreholes CULV1-03 and CULV1-04 to collect core samples of the bedrock.

Details of the drilling program, including drilling depths, monitoring well installation, and completion details are summarized in Table 3.1

Table 3.1: Summary of Borehole Locations and Depths

Borehole Number	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
CULV1-01	9.8 / 308.8	-	Backfilled with bentonite holeplug from 9.8 m to ground surface.
CULV1-02	6.1 / 312.4	-	Backfilled with bentonite holeplug from 6.1 m to ground surface.
CULV1-03	14.3 / 305.7	-	Backfilled with bentonite grout from 14.3 m to 1.8 m, bentonite holeplug to 0.2 m, and cold patch asphalt to ground surface.
CULV1-04	15.2 / 304.7	11.3 / 308.7	Backfilled with bentonite grout from 15.2 m to 11.6 m, coated bentonite pellets to 11.3 m, filter sand to 7.9 m, bentonite holeplug to 7.6 m, bentonite mixed with cuttings to 0.2 m, and cold patch asphalt to ground surface.
CULV1-05	4.0 / 314.7	-	Backfilled with bentonite holeplug from 4.0 m to ground surface.

Borehole Number	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
CULV1-06	5.7 / 312.8	5.7 / 312.8	Backfilled with filter sand from 5.7 m to 2.1 m and bentonite holeplug to ground surface.

In general, the Site is underlain by topsoil and fill down to depths ranging from approximately 0.3 m to 3.0 m. Beneath the topsoil, either silty clay or silty sand deposits extend to depths of approximately 1.2 m to 1.4 m. A silt layer, approximately 1 m to 2.3 m thick, was found beneath the fill, silty clay, and silty sand layers. Below the silt, a clayey silt layer was encountered at depths ranging from 1.2 m to 5.6 m. Silty sand to sand and silt materials, up to 3 m thick, were encountered below the clayey silt layer. A layer of sand and gravel was also identified at boreholes CULV1-04, CULV-05, and CULV1-06 at depths ranging between 2.7 m and 10.2 m. Bedrock was found in boreholes CULV1-03 and CULV1-04 at depths ranging from 11.2 m to 13 m.

More detailed information regarding the soil stratigraphy and geologic materials encountered during the drilling program can be found on the Record of Borehole Sheets in APPENDIX D and the geotechnical findings are discussed in detail in the Geotechnical Investigation Report (Thurber, 2024).

3.2 Hydrogeological Investigation and Monitoring Well Installation

To support the hydrogeological investigation, monitoring wells were installed in CULV1-4 and CULV1-06. The monitoring wells consisted of 50 mm and 32 mm diameter (respectively) schedule 40 polyvinyl chloride (PVC) pipe with a slotted screen of 3.1 m length sealed at the bottom of the borehole.

The monitoring wells were used to measure groundwater levels, conduct hydraulic testing of the screened units, and collect a sample for groundwater quality analysis. The installation details of the monitoring wells are illustrated in Table 3.2 and the location of the monitoring wells is shown on Figure 8.

Table 3.2: Monitoring Well Installation Details

Monitoring Well No.	Ground Elevation (m)	Screened Depth Interval (m)	Well Diameter (m)	Screen Length (m)	Screened Geologic Unit(s)
CULV1-04	320.0	8.2 – 11.3	0.05	3.1	Silt and Sand Sand and Gravel
CULV1-06	318.5	2.6 – 5.7	0.03	3.1	Clayey Silt Sand and Gravel

Prior to testing or sampling, the monitoring wells were developed by withdrawing three to ten well volumes of groundwater or until dry, using sterile dedicated Waterra® tubing and foot valves, to remove excess sediment and improve the transmissivity of the sand pack and well screen. During development, qualitative observations were made of the water colour, clarity/turbidity, and presence or absence of sheen or odour. Development was assessed to be completed based on the number of well volumes purged and qualitative observations such as a decrease in turbidity of the removed water.

3.3 Single Well Response Tests

A Single Well Response Tests (SWRT) in the form of a rising head test was carried out in Monitoring Well CULV1-04 and CULV1-06 on June 7, 2024. The SWRT was performed using the following method:

- Once the water level returned to a stabilized level, the static water level was measured and recorded, and a datalogger was inserted into the well approximately 1 cm to 25 cm above the bottom of the well. The datalogger was set to record water levels at a rate of every 0.125 seconds, due on the anticipated rate of recovery of each well.
- A cylindrical bailer full of groundwater was removed from the well to induce an ‘instantaneous’ change in hydraulic head.
- Manual and electronic measurements of the water level were recorded until the water level in the well recovered sufficiently; and
- Manual measurements were compared to electronic measurements for quality control of the data.

3.4 Groundwater Level Monitoring

Groundwater conditions at the Site were observed at Monitoring Well CULV1-04 and CULV1-06 on September 26 and December 1, 2023, and on January 31 and June 7, 2024. Water level measurements were made using nitrile gloves and a water level tape.

3.5 Water Quality Sampling and Chemical Analysis

On June 7, 2024, Thurber personnel visited the Site to collect a groundwater sample from Monitoring Well CULV1-04. The sample set collected included testing and analysis for metals, inorganics, Total Suspended Solids (TSS), Hexavalent Chromium (Cr^{6+}) with criteria defined by the Provincial Water Quality Objectives (PWQO), along with a field-filtered metals bottle for comparison purposes to the PWQO guidelines. The ground water sample was collected using nitrile gloves, and laboratory supplied containers. The sample bottles were stored on ice in an insulated cooler from the time of collection to the time of delivery to the laboratory to maintain

storage temperatures required by MECP Analytical Protocol. The sample was submitted for chemical analysis under Chain-of-Custody protocol to AGAT Laboratories (AGAT). AGAT is an independent laboratory that is part of the Canadian Association for Laboratory Accreditation (CALA) and meets the requirements of Section 47 of O. Reg. 153/04.

4. TESTING RESULTS AND ANALYSIS

4.1 Groundwater and Surface Water Levels

The groundwater level at Monitoring Well CULV1-04 and CULV1-06 was measured manually between September 26, 2023 and June 7, 2024. A summary of the groundwater levels measured at the monitoring well is provided in Table 4.1.

Table 4.1: Groundwater Level Measurements in the Monitoring Well

Borehole	Date	Water Level (m)		Screened Interval
		Depth	Elevation	
CULV1-04	September 26, 2023	4.3	315.7	Silt and Sand Sand and Gravel
	December 1, 2023	1.1	318.9	
	January 31, 2024	0.3	319.7	
	June 7, 2024	0.8	319.2	
CULV1-06	October 31, 2023	0.9	317.8	Clayey Silt Sand and Gravel
	December 1, 2023	0.0	318.5	
	January 31, 2024	-0.2	318.7	
	June 7, 2024	0.1	318.4	

Groundwater elevations at the Site ranged from approximately 315.7 m (depth 4.3 m) on September 26, 2023 to 319.7 m (depth 0.3 m) on January 31, 2024. The groundwater level observed in Monitoring Well CULV1-06 on January 31, 2024, indicates small artesian conditions and representative of pressurized condition from the lower confined aquifer.

Based on information provided by RVA, MTO, and DDA, the existing surface water elevation within the watercourse was reported to be approximately 317.9 m on November 3, 2022. It is noted that the groundwater listed in Table 4.1 are short-term readings and are expected to fluctuate seasonally. Higher levels may be expected during wet periods of the year such as during spring snowmelt or after periods of significant or prolonged precipitation.

4.2 Hydraulic Conductivity

4.2.1 Slug Test Analysis

Slug tests were carried out at monitoring wells CULV1-04 and CULV1-06. The SWRT results were analyzed using the Hvorslev method (Hvorslev, 1951) to estimate the hydraulic conductivity

of the screened materials. The hydraulic conductivity values are summarized in Table 4.2. and the corresponding SWRT analysis plot is presented in APPENDIX E.

Table 4.2: Hydraulic Conductivity Estimates from SWRT Analysis

Monitoring Well No.	Screened Interval Depths (m)	Screened Interval Elevations (m)	Geological Unit of Screened Interval	Hydraulic Conductivity, K (m/s)
CULV1-04	8.2 – 11.3	311.8 – 308.7	Silt and Sand Sand and Gravel	4.6×10^{-4}
CULV1-06	2.6 – 5.7	315.4 – 312.8	Clayey Silt Sand and Gravel	7.3×10^{-4}

The estimated hydraulic conductivity values for silt and sand, and sand and gravel unit ranged between 4.6×10^{-4} m/s and 7.3×10^{-4} m/s, with corresponding geomean of 5.8×10^{-4} m/s. For the construction dewatering assessment, hydraulic conductivity value of 5.8×10^{-4} m/s was assumed to represent the hydraulic conductivity of sand and gravel unit.

4.3 Water Quality Results

The groundwater chemical testing results were compared to the PWQO criteria for inorganics and metals, including TSS, Cr^{6+}, and dissolved metals. The laboratory Certificate of Analysis is presented in APPENDIX F. Multiple parameters exceeded the PWQO limits, including the following parameters listed in Table 4.3

Table 4.3: Groundwater Concentrations Exceeding the PWQO

Parameter	PWQO Threshold Value (mg/L)	Measured Concentration (mg/L)
Total Cobalt	0.0009	0.001
Total Copper Dissolved Copper	0.005	0.007 0.006
Total Iron	0.3	0.754
Total Phosphorous	0.01 – 0.03	0.08

On review of the results of the filtered groundwater samples for metal parameters, filtering lowered some metals below the PWQO limits; however, copper exceeded the PWQO limit in the filtered sample.

It is noted that the total suspended solids (TSS) concentration was 56 mg/L. While there are no PWQO thresholds to limit the concentration of TSS, concentrations of TSS should be minimized as best practice.

Groundwater of the quality that was observed herein could not be discharged to surface water without pre-treatment. In addition, it is noted that only selected metal and inorganic parameters were tested in comparison to PWQO.

The results obtained herein were representative of the groundwater sample at the time of sampling and provide a general understanding of ground water quality under those conditions; however, the water quality may vary from the results obtained based on location, time, meteorological conditions. Further, it is expected that groundwater quality will differ from surface water quality.

5. WATER TAKING ASSESSMENT

Water taking rates for construction dewatering and associated radii of influence are provided herein, along with an assessment of potential impacts of construction dewatering on potential receptors, and recommendations for mitigation measures, monitoring, and permitting requirements.

5.1 Water Taking Permit Criteria

Groundwater taking for construction dewatering is governed by the Ontario Water Resources Act (OWRA), Environmental Protection Act (EPA) and the Water Taking and Transfer Regulation 387/04, a regulation under the OWRA.

If the water taking rate will be greater than 50,000 L/day and less than 400,000 L/day, then registration on the EASR will be required. If the water taking rate will be greater than 400,000 L/day, then a Category 3 PTTW will be required.

As will be presented, the total volume of water that may be generated during construction dewatering is anticipated to exceed 400,000 L/day, and a Category 3 PTTW is required, to provide the water taking permit. For the purpose of PTTW submission, the estimated withdrawal rates are conservatively assessed in order to reduce the likelihood that pumping rates would need to be restricted to stay within the permit limit. An estimated rainfall allowance has also been included herein.

For construction dewatering purposes, a qualified dewatering engineer retained by the contractor must complete an independent assessment based on their own assumptions and requirements (e.g., overall analysis, assumptions, predicted dewatering rates, etc.) using the final design specifications and the contractor's proposed construction and dewatering methodologies.

5.2 Construction Dewatering

A copy of the design drawings prepared by DDA for the Ministry of Transportation of Ontario is provided in Appendix A. Based on review of the design drawings and site conditions, it is Thurber's understanding that construction dewatering will be required for replacement of the Otter Creek Culvert.

The design of dewatering systems is the responsibility of the Contractor. The depth of excavations required to construct the bedding and culvert will extend below the water level. Furthermore, groundwater and surface runoff are expected to seep into and accumulate in the excavations. The Contractor must control groundwater and surface water flow at the site to permit the replacement of the culvert in a dry and stable excavation. This report and anticipated PTTW application do not support pumping of creek flows; they must be diverted unless alternate plans and permits are arranged by others.

Based on the design drawings, it is understood that the proposed construction will involve the removal of an open-footing concrete box culvert, measuring approximately 18.6 m long, with a height of 1.5 m and a span of 4.9 m (with the exception of the outlet, where he culvert alignment shifts and has a span of 6.3 m), and replaced with a precast concrete closed box measuring 23.9 m long, with an opening size of 4.8 m wide by 2.1 m high. Material conforming to OPSS.PROV 1010 Granular A or Granular B Type II requirements should be provided under the base of the box culvert. The underside of the bedding layer should be placed on the native silt at or below Elevation 316.4 m (Thurber 2024). The bedding material should be placed and compacted in accordance with OPSS 422 and OPSS.PROV 501.

5.3 Dewatering Estimates

The water taking will be temporary in nature for the purpose of construction dewatering. Dewatering rates discussed herein were estimated using the Dupuit analytical solution for confined and unconfined aquifers provided in Powers et al. (2007). The radius of influence was estimated using the Sichardt equation.

The following approach was used to estimate the budgeted peak water taking rate:

- A base groundwater extraction flow rate was estimated, and a factor of safety of three was applied to this flow rate to provide an allowance for removal of water from storage (initial peak, flush flow), variation in hydraulic conductivity, actual excavation dimensions and geometry, and groundwater levels due to seasonality or other factors.
- An allowance for removal of rainfall into open excavations was included, assuming 24 hours are used to remove 50 mm of rainfall.

- Lowering of groundwater to about 1 m below the base of the excavation to facilitate a dry, stable work area was assumed.

The dewatering estimates have been prepared conservatively by considering the highest groundwater depth measurements observed at the Site during Thurber's investigations and the deepest excavation depth provided in the drawings.

Based on the design drawings, the excavation area was assumed to have dimensions of 26 m length and 20 m width, and the excavation invert elevation has been assumed to be approximately 316.4 m. To achieve a groundwater level 1 m below the base of excavation, the assumed dewatering target elevation is 315.4 m. Lowering the water table elevation from 319.7 m to 315.4 m will result in a maximum water table drawdown of 4.3 m

Based on a review of the design drawings, it is understood that the proposed excavation base will be extended to an approximate depth of 3.6 m (Elev. 316.4 m). According to the Site geology, the excavation will primarily extend into silt and clayey silt units, which will likely behave as an unconfined aquifer. Due to the variability in the subsurface conditions, the excavation may also potentially encounter cohesionless silty sand to sand and silt and/or sand and gravel units that are typically at lower elevation but observed at different depths across the Site, including in boreholes CULV1-04, CULV1-05, and CULV1-06, located in the western portion of the culvert replacement. These layers are expected to behave as a confined aquifer and exhibit artesian groundwater pressure. For construction dewatering assessment, a conservative approach based on the need to dewater the sandy silt to sand and silt / sand and gravel units to maintain a stable, dry excavation base has been assumed. Accordingly, the design hydraulic conductivity was assumed to be 5.8×10^{-4} m/s.

The highest observed groundwater level observed at the Site was approximately 319.7 m elevation (0.3 m below ground surface), measured at Monitoring Well CULV1-04 in January 2024.

A summary of the assumed conditions for dewatering estimation is presented in Table 5.1.

Table 5.1: Summary of Assumed Conditions for Dewatering Area

Dewatering Area	Assumed Hydraulic Conductivity (m/s)	Assumed Excavation Dimensions (m)	Highest Assumed Groundwater Elevation (m)	Assumed Dewatering Target Elevation (m)	Dewatering Units to Dewater
Otter Creek Culvert	5.8×10^{-4}	26 x 20	319.7	315.4	Silt and Sand, Sand and Gravel

The estimated base groundwater flow rate, peak groundwater flow rate, and radius of influence for the culvert replacement are summarized in Table 5.2. The dewatering calculations and equations for peak flow rate and radius of influence are provided in APPENDIX G.

Table 5.2: Estimated Construction Dewatering Rates

Dewatering Area	Base Groundwater Flow Rate (L/day)	Base Rate with Safety Factor of 3 (L/day)	Stormwater Removal Allowance (L/day)	Estimated Peak Flow Rate (L/day)	Approximate Radius of Influence (m)
Otter Creek Culvert	1,275,000	3,825,000	26,000	3,851,000	311

The base groundwater flow rate for the culvert replacement is estimated to be approximately 1,275,000 L/day. With a safety factor of three on groundwater flow and a stormwater removal allowance of 50 mm in 24 hours, the estimated peak flow rate is approximately 3,851,000 L/day The maximum zone of influence (ZOI) of the dewatering is estimated to be 311 from the edge of excavation. Figure 9 shows the extent of the estimated ZOI from the edge of excavation.

5.4 Permanent Drainage

The excavation areas will be backfilled once the new culvert is installed and are not anticipated to be drained. Therefore, there is no anticipated need for long term groundwater drainage at the Site.

6. IMPACT ASSESSMENT

Within the construction dewatering zone of influence, impacts such as ground subsidence, reduction in groundwater flow to groundwater users and watercourses, and other impacts may potentially occur. The potential impacts are discussed herein, and monitoring and potential mitigation measures are discussed in the following section.

6.1 Geotechnical Impacts

The short-term construction dewatering is expected to result in a maximum drawdown of the water table by up to 4.3 m and a maximum estimated radius of influence of 311 m from the edge of temporary excavation for the new culvert. This drawdown is anticipated to cause foundation soil settlement in the order of 10 to 15 mm. This foundation soil settlement will reduce with distance away from the dewatering area, and as such, is not anticipated to adversely impact the residential structure to the northeast of the culvert within the radius of influence as shown on Figure 9. However, an assessment should be made whether these small estimated settlements will impact

the underground utilities, including the gas main parallel to Highway 9 along the toe of the existing embankment. Discussions should be held with the utility owners to confirm whether the magnitude of estimated settlements are acceptable from a serviceability perspective.

It is proposed that settlement monitoring and contingency measures, specifically settlement monitoring, should take place prior to, during, and after the culvert installation as described in APPENDIX H.

6.2 Impacts to Surface Water and Natural Environment

Lowering of the shallow groundwater level could potentially reduce the groundwater discharge to nearby natural ecosystem features due to construction dewatering. In addition, dewatering discharge that may be directed to nearby watercourses could potentially alter the physical, chemical, and thermal regime of the receiving streams. Considering the high estimated dewatering rates, an impact to the tributary from dewatering the silty sand and sand, and sand and gravel cannot be discounted. To mitigate potential impacts of construction dewatering on nearby surface water features, a monitoring and contingency plan should be prepared and implemented during dewatering to track the ZOI. A proposed monitoring plan and a contingency plan is included in Appendix H and discussed in Section 7.3. The proposed monitoring plan includes stream flow monitoring and surface water quality monitoring. If any impact is observed during the dewatering, a contingency plan will be implemented. The proposed contingency plan includes immediate action to mitigate the impact, a detailed investigation of the impact, and long-term action to continually mitigate the impact, as required.

Mitigation measures to minimize potential impacts from reduction of baseflow to the Otter Creek due to construction dewatering could include directing dewatering discharge into the creek to provide baseflow supplementation. Directing dewatering discharge to the creek may require approval from SVCA, MNRF, and/or Department of Fisheries and Oceans (DFO). Consideration of erosion control measures, such as silt controls will be required, as well as pre-treatment measures to minimize changes to the physical, chemical, and thermal characteristics of the receiving surface water features.

If discharge is occurring directly to the surface water or within 30 m of a surface water body, the discharge quality must be tested and routinely monitored to ensure that it meets the PWQO and interim PWQO requirements. Erosion and sediment control plans must be also implemented to ensure that there is no excess sediment being stirred up or into the surface water and to ensure that no erosion is occurring. If discharging to land surface more than 30 m from a watercourse, the discharge must be monitored to ensure that the discharge does not reach a stream (unless it also meets the PWQOs), and an erosion and sediment control plan is still required so there are no other impacts to existing features.

6.3 Impacts to Water Well Users

Construction dewatering is expected to result in a maximum radius of influence of approximately 311 m from the edge of the excavation. Dewatering activities could impact the quantity and/or quality of water available to nearby groundwater users, particularly those dependent on shallow well systems. However, the impacts are typically temporary, and recovery of the groundwater system is expected once the dewatering operation ceases.

As noted in Section 2.4, review of the MECP well records identified five (5) water supply wells within the Study Area. The Study Area is not serviced with a municipal water supply, and it is expected that residents rely on private wells for drinking water. Two (2) wells are located within the construction dewatering ZOI and are installed within bedrock at depths between 29 m and 31. These bedrock wells are not anticipated to be impacted by the short-term construction dewatering occurring solely within the overburden materials.

Since the construction dewatering quantities is estimated to be relatively high, there is risk that local drinking water wells may be adversely impacted in the Study Area. It is recommended that a private well survey be carried out prior to construction to mitigate potential complaints caused by disruptions or interruptions to water availability and/or quality. Local residential wells should be monitored during the period of dewatering and in case of adverse impact, drinking water may have to be trucked into the affected residences until the dewatering operations are complete and the wells regain their water levels.

6.4 Other Potential Impacts

As discussed in Section 2.6, the Site is located within the SGRAs. An aquifer can be considered vulnerable based on factors of recharge and contaminant transportation. An area designated as a SGRA determines that it contributes substantially to groundwater infiltration and aquifer recharge. Increased caution should be exercised to avoid potential spills of contaminating materials during the culvert replacement project. All mobile equipment refueling should take place at least 30 m away from watercourses to prevent water contamination from accidental fuel or lubricant spills.

If any contaminated groundwater is collected from the dewatering operations, it should be treated to meet specified discharge criteria or disposed of at a facility licensed to handle such materials.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Category 3 Permit to Take Water

The total peak dewatering rate for the replacement of the Otter Creek Culvert, including a safety factor of three on base groundwater flow and removal of 50 mm of rainfall in 24 hours, was estimated to be 3,851,000 L/day. Given that the estimated peak water taking rate was greater than 400,000 L/day, it is anticipated that a Category 3 PTTW would be required. The PTTW would include terms and conditions that must be followed, which include performance, monitoring, and reporting requirements among others. It is recommended that a Category 3 PTTW application be submitted 6 months in advance of construction to ensure the permit has been secured in advance of the work. MECP may request additional information or testing.

7.2 Discharge of Groundwater

Groundwater of the quality that was observed herein could not be discharged to natural environment or within 30 m of a surface water body without pre-treatment due to exceedances of the PWQO and interim PWQO. If considering discharged to surface water, it is anticipated that sediment control / filtration will be required at a minimum. It is recommended that dewatering effluent should not be discharged directly into any watercourse. On-site treatment methods should be identified by the contractor or a water treatment specialist to determine potential treatment options. Discharge of groundwater to the natural environment may require approval by SVCA, MNRF, and/or DFO. The effects of discharge water temperature and the impacts to the natural environment are beyond the scope of this investigation.

Water quality observed during construction will vary based on a number of factors. The extent of suspended solids in the groundwater or in water that is collected during construction dewatering (for example from a sump in an open excavation) will significantly affect the concentrations of many parameters that may be regulated based on discharge location. The value of testing groundwater quality during the investigation is primarily to identify the types of contaminants that may need to be managed, and the presence of anthropogenic contaminants that are listed in the given discharge criteria that may require specific treatment.

As noted previously, water quality observed during construction will vary from the results obtained herein based on a number of factors. An experienced dewatering contractor and water treatment contractor are recommended to be retained to design and operate dewatering and/or treatment operations as required.

7.3 Proposed Monitoring and Contingency Plan

There are two monitoring and contingency plans that are applicable to the project, which are presented in Table H1 and Table H2 in APPENDIX H:

- Table H1: Monitoring and Contingency Plan for Groundwater Taking
- Table H2: Monitoring and Contingency Plan for Discharge to Land Surface Within 30 m of Watercourse

The conditions under which each Monitoring and Contingency Plan is applicable are identified in Table 7.1. Details of each plan are further presented in APPENDIX H.

Table 7.1: Monitoring and Contingency Plan Applicability

Monitoring and Contingency Plan	Applicable Conditions
Table H1 (Groundwater Taking)	Applicable to each water taking location in the PTTW where water is being taken.
Table H2 (Discharge to Land Surface Within 30 m of Watercourse)	Applicable to each discharge location and each new water taking location that is being discharged to said location.

As a minimum, the results of the monitoring program should be reported following completion of the pre-construction monitoring period, after each monitoring event during construction, and after the final post-construction monitoring event. Comments regarding impacts of construction on water levels and the need for additional investigation or mitigation should be provided as required.

Contingency measures are recommended to be developed for every reasonably foreseeable defect or impact. Such measures may include inspections of equipment, additional monitoring, reporting procedures, remedial actions as able, conferring with technical specialists, and the potential to stop the taking and discharging of water provided it is safe to do so, until a remedy can be identified.

In addition to the monitoring and contingency measures proposed herein, monitoring per the project agreement will be required and compliance with all other permits and agreements apply. In particular, any additional measures identified in the PTTW to be issued by MECP. The dewatering system selection is the responsibility of the Contractor.

It is noted that the contractor's means and methods are not known at this time and that the monitoring and contingency plan must be adjusted and further specified once additional details are known. In addition to the monitoring and contingency measures proposed herein, monitoring

per the Project Specifications will be required and compliance with all other permits and agreements apply.

8. CLOSURE

We trust this information meets your present needs. If you have any questions, please contact the undersigned at your convenience.

P.K. Chatterji, Ph.D., P.Eng.
MTO Designated Principal Contact

Rod de Castro, P.Eng..
Associate, Senior Geotechnical Engineer

Eric Sowa, P.Geo.
Hydrogeologist/Environmental Scientist

Alireza Hejazi, Ph.D., P.Eng.
Associate, Senior Hydrogeologist

Date: March 25, 2025
File: 34935

9. REFERENCES

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

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The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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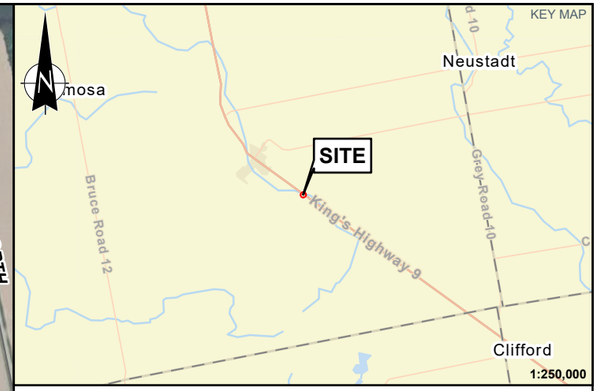
FIGURES



LEGEND

- PROJECT AREA (SITE)
- STUDY AREA (500 m BUFFER)
- LOCAL ROAD
- ARTERIAL ROAD
- HIGHWAY
- WATERCOURSE
- WATERBODY

0 125 250 500

1:10,000 METRES

REFERENCES

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ON
2. SERVICE LAYER CREDITS: WORLD STREET MAP: SOURCES: ESRI, TOMTOM, GARMIN, FAO, NOAA, USGS, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY GOOGLE MAP: © OPENSTREETMAP (AND) CONTRIBUTORS, CC-BY-SA
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CLIENT

MINISTRY OF TRANSPORTATION OF ONTARIO

PROJECT

HYDROGEOLOGICAL REPORT
OTTER CREEK CULVERT REPLACEMENT
HIGHWAY 9 CULVERTS AND HIGHFILL WIDENING
MILDMAY TO CLIFFORD, ONTARIO

SITE LOCATION MAP

PROJECT No.	34935
DESIGNED	ES
DRAWN	JEM
APPROVED	DH
DATE	2025-01-16
FIGURE No.	1

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LEGEND

- PROJECT AREA (SITE)
- STUDY AREA (500 m BUFFER)
- TOPOGRAPHIC ELEVATION CONTOUR, 5 m
- LOCAL ROAD
- ARTERIAL ROAD
- HIGHWAY
- WATERCOURSE
- WATERBODY

0 125 250 500

1:10,000 METRES

REFERENCES

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OTTER CREEK CULVERT REPLACEMENT
HIGHWAY 9 CULVERTS AND HIGHFILL WIDENING
MILDMAY TO CLIFFORD, ONTARIO

TOPOGRAPHY

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FIGURE No.	2

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LEGEND

- PROJECT AREA (SITE)
- STUDY AREA (500 m BUFFER)
- LOCAL ROAD
- ARTERIAL ROAD
- HIGHWAY
- WATERCOURSE
- WATERBODY

PHYSIOGRAPIC REGION

- 12, TEESWATER DRUMLIN FIELD

0 125 250 500

1:10,000 METRES

REFERENCES

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ON
2. CHAPMAN, L.J. AND PUTNAM, D.F. 2007. PHYSIOGRAPHY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE--DATA 228.
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OTTER CREEK CULVERT REPLACEMENT
HIGHWAY 9 CULVERTS AND HIGHFILL WIDENING
MILDMAY TO CLIFFORD, ONTARIO

PHYSIOGRAPHY

PROJECT No.	34935
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DATE	2025-01-16
FIGURE No.	3

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LEGEND

- PROJECT AREA (SITE)
- STUDY AREA (500 m BUFFER)
- LOCAL ROAD
- ARTERIAL ROAD
- HIGHWAY
- WATERCOURSE
- WATERBODY

SURFICIAL GEOLOGY

- 5b. **TILL:** STONE-POOR, SANDY SILT TO SILTY SAND-TEXTURED TILL ON PALEOZOIC TERRAIN
- 6. **ICE-CONTACT STRATIFIED DEPOSITS:** SAND AND GRAVEL, MINOR SILT, CLAY AND TILL
- 7. **GLACIOFLUVIAL DEPOSITS:** RIVER DESPOTS AND DELTA TOPSET FACIES
- 7a. **GLACIOFLUVIAL DEPOSITS:** RIVER DESPOTS AND DELTA TOPSET FACIES; SANDY DEPOSITS
- 8a. **FINE-TEXTURED GLACIOLACUSTRINE DEPOSITS:** SILT AND CLAY, MINOR SAND AND GRAVEL; MASSIVE TO WELL LAMINATED
- 9c. **COARSE-TEXTURED GLACIOLACUSTRINE DEPOSITS:** SAND, GRAVEL, MINOR SILT AND CLAY; FORESHORE AND BASINAL DEPOSITS
- 19. **MODERN ALLUVIAL DEPOSITS:** CLAY, SILT, SAND, GRAVEL, MAY CONTAIN ORGANIC REMAINS
- 20. **ORGANIC DEPOSITS:** PEAT, MUCK, MARL

0 125 250 500

1:10,000 METRES

REFERENCES

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ON
2. ONTARIO GEOLOGICAL SURVEY. 2010. SURFICIAL GEOLOGY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE--DATA 128-REV.
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MINISTRY OF TRANSPORTATION OF ONTARIO

PROJECT

HYDROGEOLOGICAL REPORT
OTTER CREEK CULVERT REPLACEMENT
HIGHWAY 9 CULVERTS AND HIGHFILL WIDENING
MILDMAY TO CLIFFORD, ONTARIO

SURFICIAL GEOLOGY

PROJECT No.	34935
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DRAWN	JEM
APPROVED	DH
DATE	2025-01-16
FIGURE No.	4

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LEGEND

- PROJECT AREA (SITE)
- STUDY AREA (500 m BUFFER)
- LOCAL ROAD
- ARTERIAL ROAD
- HIGHWAY
- WATERCOURSE
- WATERBODY
- APPROXIMATE CONTACT LINE

BEDROCK FORMATION

- 25. **BOIS BLAN FORMATION** LIMESTONE, DOLOSTONE; CHERTY, ARGILLACEOUS; LOCAL GLAUCONITIC SANDSTONE
- 23. **BASS ISLANDS FORMATION:** DOLOSTONE; LAMINATED OR MOTTLED OR ARGILLACEOUS
- 21. **SALINA FORMATION:** ARGILLACEOUS DOLOSTONE, SHALE, GYPSUM, SALT (AT DEPTH)

0 125 250 500

1:10,000 METRES

REFERENCES

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ON
2. ARMSTRONG, D.K. AND DODGE, J.E.P. 2007. PALEOZOIC GEOLOGY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE--DATA 219.
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MINISTRY OF TRANSPORTATION OF ONTARIO

PROJECT

HYDROGEOLOGICAL REPORT
OTTER CREEK CULVERT REPLACEMENT
HIGHWAY 9 CULVERTS AND HIGHFILL WIDENING
MILDMAY TO CLIFFORD, ONTARIO

BEDROCK GEOLOGY

PROJECT No.	34935
DESIGNED	ES
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DATE	2025-01-16
FIGURE No.	5

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LEGEND

- PROJECT AREA (SITE)
- STUDY AREA (500 m BUFFER)
- LOCAL ROAD
- HIGHWAY
- WATERCOURSE
- WATERBODY

MECP WELL RECORD

- WATER SUPPLY

0 62.5 125 250

1:5,000 METRES

REFERENCES

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ON
2. MINISTRY OF THE ENVIRONMENT, CONSERVATION AND PARKS. 2024. WATER WELL RECORD DATABASE
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PROJECT

HYDROGEOLOGICAL REPORT
OTTER CREEK CULVERT REPLACEMENT
HIGHWAY 9 CULVERTS AND HIGHFILL WIDENING
MILDMAY TO CLIFFORD, ONTARIO

MECP WELL RECORDS

PROJECT No.	34935
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DRAWN	JEM
APPROVED	DH
DATE	2025-01-16
FIGURE No.	6

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LEGEND

- PROJECT AREA (SITE)
- STUDY AREA (500 m BUFFER)
- LOCAL ROAD
- ARTERIAL ROAD
- HIGHWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- WOODED AREA

0 125 250 500

1:10,000 METRES

REFERENCES

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ON
2. ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY
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MINISTRY OF TRANSPORTATION OF ONTARIO

PROJECT

HYDROGEOLOGICAL REPORT
OTTER CREEK CULVERT REPLACEMENT
HIGHWAY 9 CULVERTS AND HIGHFILL WIDENING
MILDMAY TO CLIFFORD, ONTARIO

NATURAL HERITAGE AREAS

PROJECT No.	34935
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APPROVED	DH
DATE	2025-01-16
FIGURE No.	7

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LEGEND

- PROJECT AREA (SITE)
- MONITORING WELL LOCATION
- HIGHWAY
- WATERCOURSE

0 10 20 40

1:500 METRES

REFERENCES

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ON
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MINISTRY OF TRANSPORTATION OF ONTARIO

PROJECT

HYDROGEOLOGICAL REPORT
OTTER CREEK CULVERT REPLACEMENT
HIGHWAY 9 CULVERTS AND HIGHFILL WIDENING
MILDMAY TO CLIFFORD, ONTARIO

MONITORING WELL LOCATIONS

PROJECT No.	34935
DESIGNED	ES
DRAWN	JEM
APPROVED	DH
DATE	2025-01-16
FIGURE No.	8

THURBER

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LEGEND

- PROJECT AREA (SITE)
- STUDY AREA (500 m BUFFER)
- ZONE OF INFLUENCE
- LOCAL ROAD
- HIGHWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- WOODED AREA

0 62.5 125 250

1:5,000 METRES

REFERENCES

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ON
2. ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY
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MINISTRY OF TRANSPORTATION OF ONTARIO

PROJECT

HYDROGEOLOGICAL REPORT
OTTER CREEK CULVERT REPLACEMENT
HIGHWAY 9 CULVERTS AND HIGHFILL WIDENING
MILDMAY TO CLIFFORD, ONTARIO

ZONE OF INFLUENCE

PROJECT No.	34935
DESIGNED	ES
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APPROVED	DH
DATE	2025-01-16
FIGURE No.	9

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APPENDIX A

Design Drawings

METRIC

DISTRICT
CONT. No.
WP No. 3102-21-01

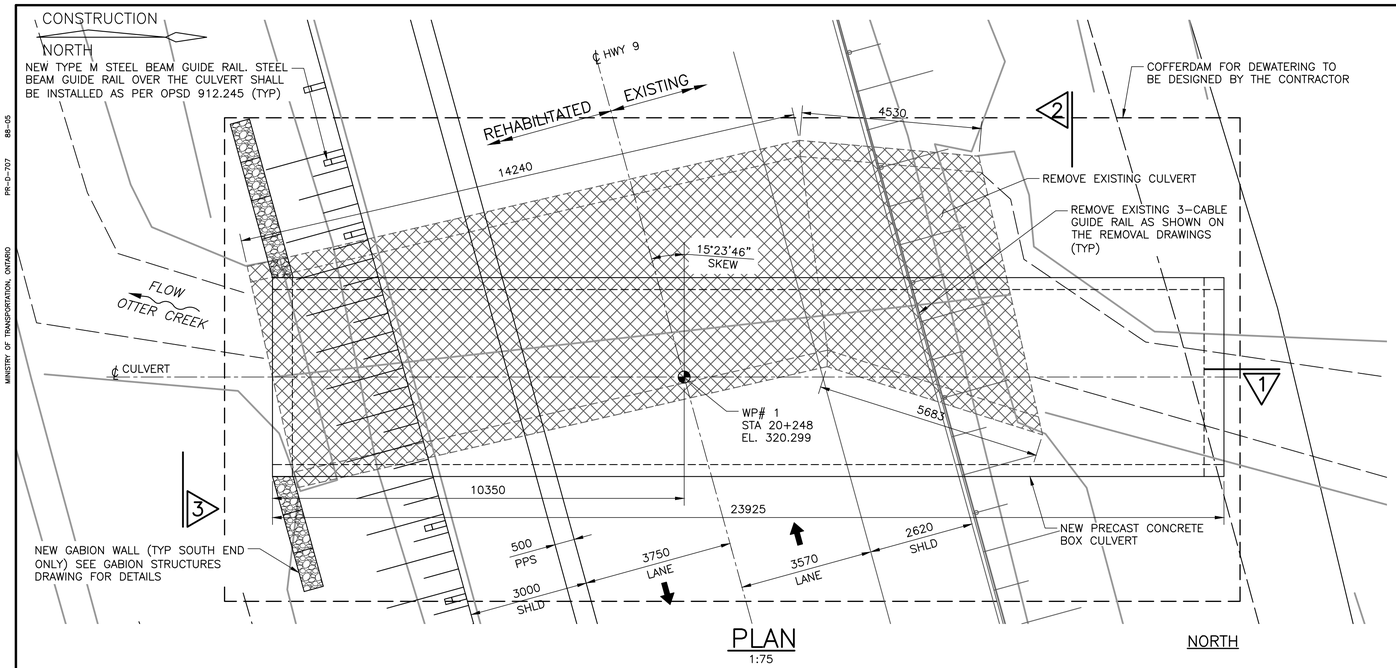
CONCRETE CULVERT
02X-0466/CO

GENERAL ARRANGEMENT

SHEET

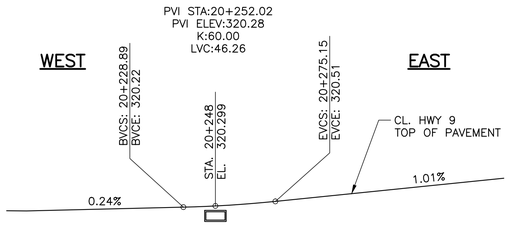
DOUG DIXON & ASSOCIATES INC

GHD



PLAN
1:75

NORTH



PROFILE OF HWY 9
NTS

GENERAL NOTES

SPECIFIED 28-DAY COMPRESSIVE STRENGTH

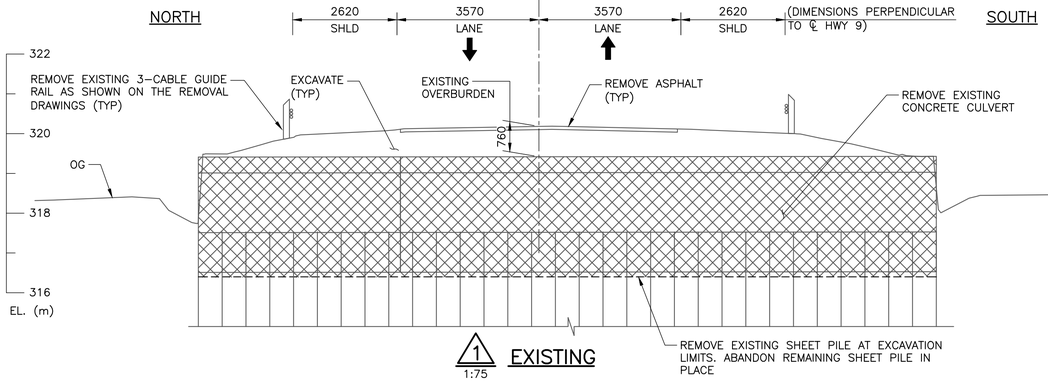
PRECAST CULVERT	45MPa
ALL OTHER CONCRETE	30MPa

CLEAR COVER TO REINFORCING STEEL

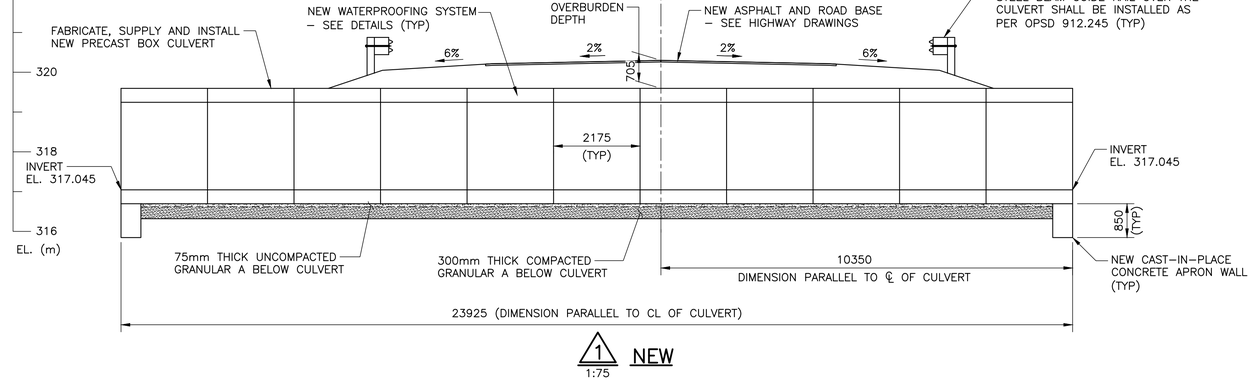
UNLESS OTHERWISE NOTED	50±10mm

REINFORCING STEEL

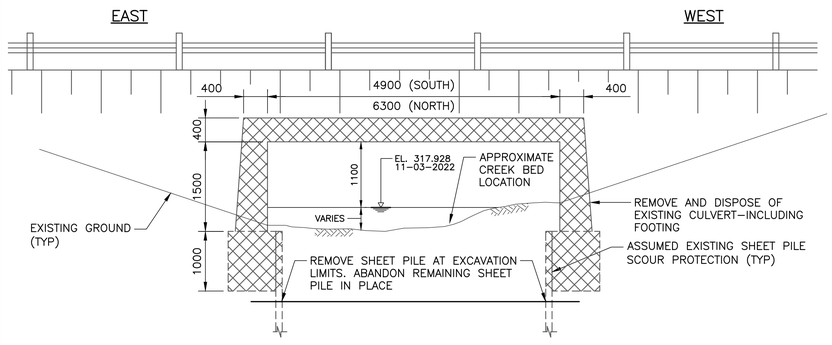
1. REINFORCING STEEL SHALL BE GRADE 500W.



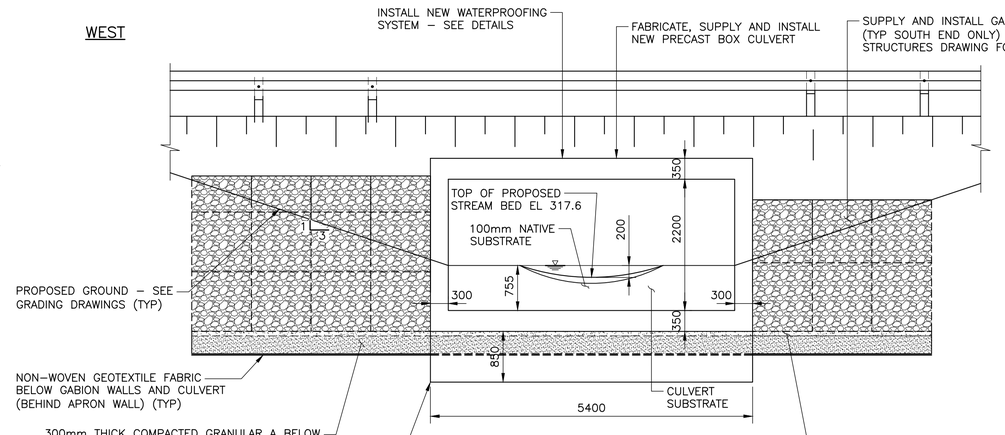
1 EXISTING
1:75



1 NEW
1:75



2 EXISTING CULVERT – ELEVATION
1:50



3 NEW CULVERT – ELEVATION
1:50
(SOUTH SHOWN, NORTH SIMILAR)

REVISIONS			
DESCRIPTION			
DESIGN HK	CHK DD	CODE CHBDC 2019	LOAD	DATE MAY/24
DRAWN AZ	CHK HK	SITE 2-466/CO	STRUCT	SCHEME	DWG S1

MINISTRY OF TRANSPORTATION, ONTARIO PR-D-707 88-05

CAD FILE: P:\Projects\21-113 Highway 9 Greenock Creek Bridge DB Ready GHD_113E Hwy 9 Culverts\DDA CAD files\2-466\21-113E-466-01GA.dwg
MODIFIED: 2024-05-03 8:39:41 AM Zhenlin Pan
PLOTTED: 2024-05-03 2:31:04 PM Zhenlin Pan

APPENDIX B

MECP Well Record Summary

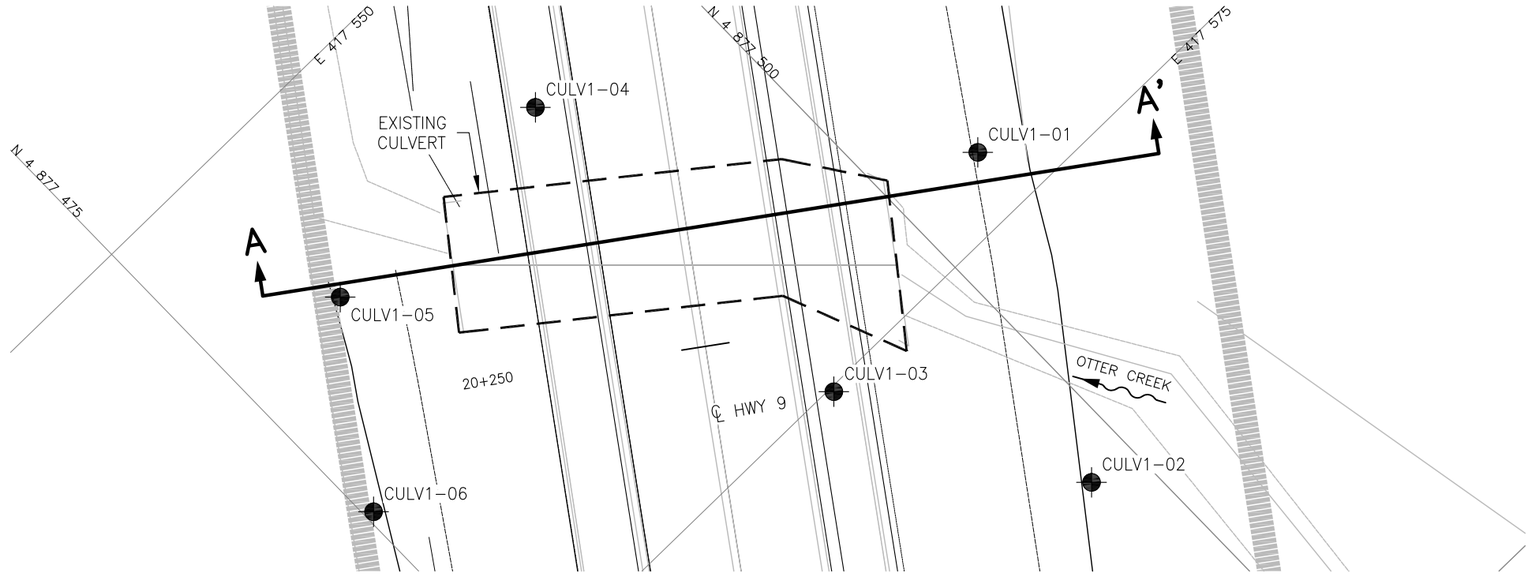
Appendix B - MECP Well Record Database Search

Well ID	UTM Coordinates, Zone 17		Completed Date	Depth (meters below grade surface)	Depth to Bedrock (meters below grade surface)	Well Use
	Easting	Northing				
1400908	492264.20	4875473	1952-03-15	36.6	14	Domestic Water Suply
1400918	492339.20	4875073	1962-09-13	31.1	11.6	Domestic Water Suply
1404466	492264.20	4875423	1977-05-26	16.5	11.9	Domestic Water Suply
1408904	492515.00	4875165	1996-09-04	29	28.3	Domestic Water Suply
7283990	492823.00	4874699	2016-06-29	22.9	0	Domestic Water Suply

APPENDIX C

Borehole Location Plan

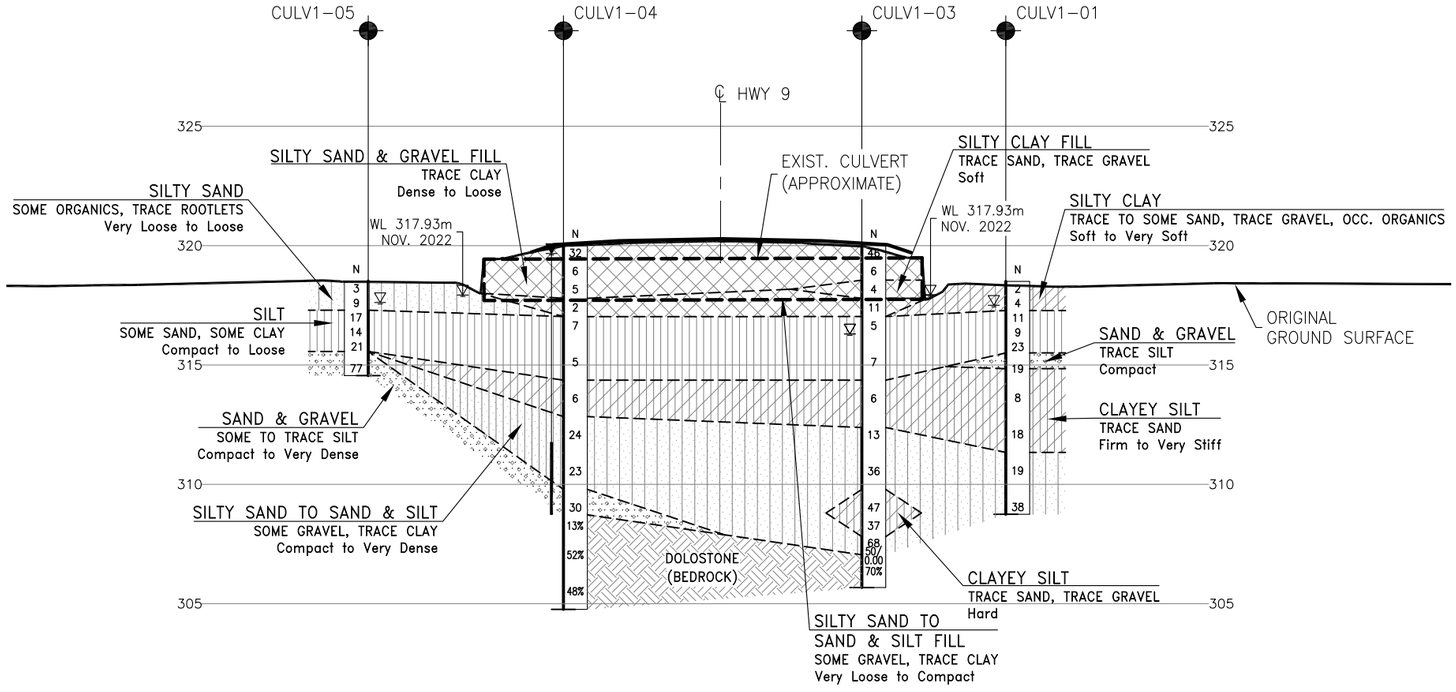
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

5 0 5 10m

SCALE 1:250



SECTION ALONG A–A'

5 0 5 10m

SCALE 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
April 26, 2024
PROVINCE OF ONTARIO

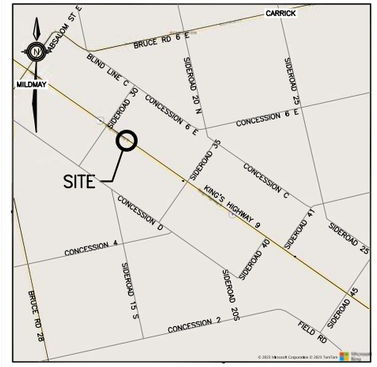
LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
April 26, 2024
PROVINCE OF ONTARIO

CONT No
GWP No 3076-14-00

SHEET

HIGHWAY 9
OTTER CREEK CULVERT REPLACEMENT
(SITE NO 02X-0466/C0)
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
▮	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
CULV1-01	318.5180	4877504.0382	417572.1995
CULV1-02	318.5400	4877497.8372	417585.4415
CULV1-03	319.9970	4877492.7277	417575.1981
CULV1-04	319.9810	4877492.0404	417557.9409
CULV1-05	318.6540	4877480.6325	417557.9544
CULV1-06	318.5250	4877475.3773	417565.3816

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 11.

GEOCRES No. 41A03-001

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MEF	CHK PKC	CODE	LOAD	DATE APR 2024
DRAWN	AN	CHK MEF	SITE 02X-0466/C0	STRUCT	DWG 1

FILENAME: H:\Drafting\34000\34935\TED-34935-PLPR.dwg
PLOTDATE: 4/26/2024 3:13 PM

APPENDIX D

Record of Borehole Sheets

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CULV1-01 1 OF 2 METRIC

GWP# 3076-14-00 LOCATION Highway 9; MTM 83-11: N 4 877 504.0 E 417 572.2 ORIGINATED BY SG

DIST West HWY 9 BOREHOLE TYPE Wash Boring / Coring Portable Rig COMPILED BY RdC

DATUM Geodetic DATE 2023.10.30 - 2023.10.30 LATITUDE 44.028863 LONGITUDE -81.093154 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
318.5	GROUND SURFACE										
0.0	**TOPSOIL** (30mm)										
0.0	Silty **CLAY**, trace to some sand, trace gravel, occasional organics Very Soft to Soft Dark Brown to Brown Moist to Wet		1	SS	2		318				
317.3			2	SS	4	▽					
1.2	**SILT**, some clay, trace sand Compact to Loose Brown Wet (ML)		3	SS	11		317				
			4	SS	9						0 3 86 11
315.5			5	SS	23		316				
3.0	**SAND** and **GRAVEL**, trace silt Compact Brown Wet										
314.9			6	SS	19		315				
3.7	Clayey **SILT**, trace sand Stiff to Very Stiff Brown Moist to Wet (CL-ML)										
			7	SS	8		314				0 5 75 20
							313				
			8	SS	18		312				
311.4											
7.2	Silty **SAND**, some gravel Compact to Dense Brown Wet										
			9	SS	19		311				17 59 24 (SI+CL)
							310				
308.8			10	SS	38		309				
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CULV1-01 2 OF 2 METRIC

GWP# 3076-14-00 LOCATION Highway 9; MTM 83-11: N 4 877 504.0 E 417 572.2 ORIGINATED BY SG

DIST West HWY 9 BOREHOLE TYPE Wash Boring / Coring Portable Rig COMPILED BY RdC

DATUM Geodetic DATE 2023.10.30 - 2023.10.30 LATITUDE 44.028863 LONGITUDE -81.093154 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	WATER LEVEL AT 1.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CULV1-02 1 OF 1 METRIC

GWP# 3076-14-00 LOCATION Highway 9; MTM 83-11: N 4 877 497.8 E 417 585.4 ORIGINATED BY JF

DIST West HWY 9 BOREHOLE TYPE Wash Boring / Coring Portable Rig COMPILED BY RdC

DATUM Geodetic DATE 2023.10.14 - 2023.10.14 LATITUDE 44.028805 LONGITUDE -81.092990 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
318.5	GROUND SURFACE										
0.0	**TOPSOIL**, some rootlets Very Soft Dark Brown Moist		1	SS	2		318				
317.6			2	SS	5						
0.9	Silty **SAND**, trace clay, some organics Loose Dark Brown										
317.2			3	SS	12		317				0 13 77 10
1.4	Moist **SILT**, some sand, some clay Compact Brown Moist to wet (ML)		4	SS	18						
316.1											
2.4	Clayey **SILT**, trace sand Very Stiff Brown Moist to wet (CL-ML)		5	SS	17		316				0 5 79 16
							315				
							314				
313.7			6	SS	16						
4.9	Silty **SAND**, some gravel, trace clay Compact Brown Wet						313				
312.4											
6.1	END OF BOREHOLE AT 6.1m. * ARTESIAN CONDITION ENCOUNTERED AT 6.1m. WATER LEVEL APPROXIMATELY 0.25m ABOVE EXISITING GRADE. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CULV1-03 1 OF 2 METRIC

GWP# 3076-14-00 LOCATION Highway 9; MTM 83-11: N 4 877 492.7 E 417 575.2 ORIGINATED BY SG

DIST West HWY 9 BOREHOLE TYPE Hollow Stem Augers / Wash Boring / HQ Core Barrel COMPILED BY RdC

DATUM Geodetic DATE 2023.09.26 - 2023.09.28 LATITUDE 44.028760 LONGITUDE -81.093119 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
320.0	GROUND SURFACE										
0.0	Silty **SAND** and **GRAVEL**, trace clay Dense to Loose Brown Dry (FILL)		1	SS	46						
			2	SS	6		319				34 32 28 6
318.5											
1.4	Silty **CLAY**, trace sand, trace gravel Soft Dark Brown Moist		3	SS	4		318				
317.8	(FILL)										
2.2	Silty **SAND**, some gravel, trace clay, some organics Compact Dark Brown Moist to Wet		4	SS	11						
317.0	(FILL)						317				
3.0	**SILT**, some clay, trace sand Loose Brown Wet		5	SS	5	▽					0 2 84 14
			6	SS	7		316				
314.4							315				
5.6	Clayey **SILT**, trace sand Firm Brown Wet (CL-ML)		7	SS	6		314	8.0			0 4 73 23
312.4							313				
7.6	Silty **SAND**, some gravel, some clay Compact to Dense Brown Wet		8	SS	13		312				
			9	SS	36		311				
							310				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CULV1-03 2 OF 2 METRIC

GWP# 3076-14-00 LOCATION Highway 9; MTM 83-11: N 4 877 492.7 E 417 575.2 ORIGINATED BY SG

DIST West HWY 9 BOREHOLE TYPE Hollow Stem Augers / Wash Boring / HQ Core Barrel COMPILED BY RdC

DATUM Geodetic DATE 2023.09.26 - 2023.09.28 LATITUDE 44.028760 LONGITUDE -81.093119 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
309.8											
10.2	Clayey **SILT**, trace sand, trace gravel Hard Brown Wet (CL-ML)		10	SS	47		309		○		0 4 76 20
			11	SS	37				○		
307.8							308				
12.2	Silty **SAND**, some gravel, trace clay Very Dense Grey Wet		12	SS	68				○		18 49 28 5
307.0			~~13~~	~~SS~~	~~50/~~					FI	
13.0	**BEDROCK (DOLOSTONE),** moderately weathered, grey with brown interbeds Rubble zone zone from 13.0m to 13.1m		1	RUN	0.000		307			>10 2 5	RUN #1 TCR=100% SCR=89% RQD=70%
305.7							306			6	
14.3	END OF BOREHOLE AT 14.3m. WATER LEVEL AT 3.7m IN OPEN BOREHOLE. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO 1.8m, BENTONITE HOLEPLUG TO 0.2m, THEN ASPHALT COLD PATCH TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CULV1-04 1 OF 2 METRIC

GWP# 3076-14-00 LOCATION Highway 9; MTM 83-11: N 4 877 492.0 E 417 557.9 ORIGINATED BY SG

DIST West HWY 9 BOREHOLE TYPE Hollow Stem Augers / Wash Boring / HQ Core Barrel COMPILED BY RdC

DATUM Geodetic DATE 2023.09.25 - 2023.09.26 LATITUDE 44.028757 LONGITUDE -81.093334 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
320.0	GROUND SURFACE										
0.0	Silty **SAND** and **GRAVEL**, trace clay Dense to Loose Brown Dry (FILL)		1	SS	32	▼			○		
			2	SS	6		319		○		
			3	SS	5		318		○		
317.8											
2.2	**SAND** and **SILT**, trace clay, trace gravel, trace organics Very Loose Brown Moist (FILL)		4	SS	2				○		6 49 39 6
317.0							317				
3.0	**SILT**, some clay, trace sand Loose Brown Wet (CL-ML)		5	SS	7				⊣○		0 1 84 15
			6	SS	5		316				
							315		○		
314.3											
5.6	Clayey **SILT**, trace sand Firm Brown Wet (CL-ML)		7	SS	6		314		⊣ ○		0 4 73 23
312.8							313				
7.2	**SILT** and **SAND**, some gravel, trace clay Compact Brown Wet (ML)		8	SS	24		312		○		
							311				
			9	SS	23				⊣		12 34 46 8
							310				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CULV1-04 2 OF 2 METRIC

GWP# 3076-14-00 LOCATION Highway 9; MTM 83-11: N 4 877 492.0 E 417 557.9 ORIGINATED BY SG

DIST West HWY 9 BOREHOLE TYPE Hollow Stem Augers / Wash Boring / HQ Core Barrel COMPILED BY RdC

DATUM Geodetic DATE 2023.09.25 - 2023.09.26 LATITUDE 44.028757 LONGITUDE -81.093334 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.8	Continued From Previous Page										
10.2	**SAND** and **GRAVEL**, some silt Dense Brown Wet		10	SS	30		309			FI	
308.7											
11.3	**BEDROCK (DOLOSTONE),** moderately weathered, grey with brown interbeds Rubble zones from 11.3 to 11.5m, 12.0 to 12.1m and 12.2 to 12.5m		1	RUN			308			>10 6 >10 >10	RUN #1 TCR=100% SCR=40% RQD=13%
			2	RUN			307			6 4 1 1	RUN #2 TCR=100% SCR=73% RQD=52%
			3	RUN			306			>10 >10 2 3	RUN #3 TCR=100% SCR=77% RQD=48%
304.7							305			2	
15.2	END OF BOREHOLE AT 15.2m. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE / DEPTH(m) / ELEV.(m) 2023.09.26 / 4.3 / 315.7 2023.12.01 / 1.1 / 318.8 2024.01.31 / 0.3 / 319.7										

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CULV1-05 1 OF 1 METRIC

GWP# 3076-14-00 LOCATION Highway 9; MTM 83-11: N 4 877 480.6 E 417 558.0 ORIGINATED BY SG

DIST West HWY 9 BOREHOLE TYPE Wash Boring / Coring Portable Rig COMPILED BY RdC

DATUM Geodetic DATE 2023.10.31 - 2023.10.31 LATITUDE 44.028654 LONGITUDE -81.093336 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
318.7	GROUND SURFACE										
0.0 / 0.1	**TOPSOIL:** (50mm)										
	Silty **SAND**, trace clay, some organics, trace rootlets Very Loose to Loose Dark Brown Wet		1	SS	3						
317.4			2	SS	9	▽	318				0 67 30 3
1.2	**SILT**, some clay, trace sand Compact Brown Wet (CL-ML)		3	SS	17		317				
			4	SS	14						0 4 83 13
315.7			5	SS	21		316				
2.9	**SAND** and **GRAVEL**, trace silt Very Dense Brown Wet										
314.7			6	SS	77		315				60 36 4 (SI+CL)
4.0	END OF BOREHOLE AT 4.0m UPON REFUSAL. WATER LEVEL AT 0.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No CULV1-06 1 OF 1 METRIC

GWP# 3076-14-00 LOCATION Highway 9; MTM 83-11: N 4 877 475.4 E 417 565.4 ORIGINATED BY JF

DIST West HWY 9 BOREHOLE TYPE Wash Boring / Coring Portable Rig COMPILED BY RdC

DATUM Geodetic DATE 2023.10.13 - 2023.10.13 LATITUDE 44.028606 LONGITUDE -81.093245 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
318.5	GROUND SURFACE										
0.0	**TOPSOIL**, trace silt, trace rootlets Very Soft Dark Brown Moist to Wet		1	SS	2						
317.8							318				
0.8	Silty **SAND,** trace gravel, trace clay Compact Dark Brown		2	SS	16						
317.3											
1.2	Moist Clayey **SILT**, trace sand Stiff to Very Stiff Brown Wet (CL)		3	SS	10		317				0 7 75 18
			4	SS	14						0 5 79 16
315.8							316				
2.7	**SAND** and **GRAVEL**, trace silt Compact to Very Dense Brown Wet		5	SS	30						
							315				
			6	SS	12		314				
312.8							313				
5.7	END OF BOREHOLE AT 5.7m UPON REFUSAL. Piezometer installation consists of 32mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.		7	SS	100/ 0.050						

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2023.12.01	0.0	318.5
2024.01.31	-0.2	318.7

"-" Above ground surface

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO) - COPY.GLB MTO-34935.GPJ 2/5/24

APPENDIX E

Single Well Response Test Analysis

THURBER ENGINEERING LTD.

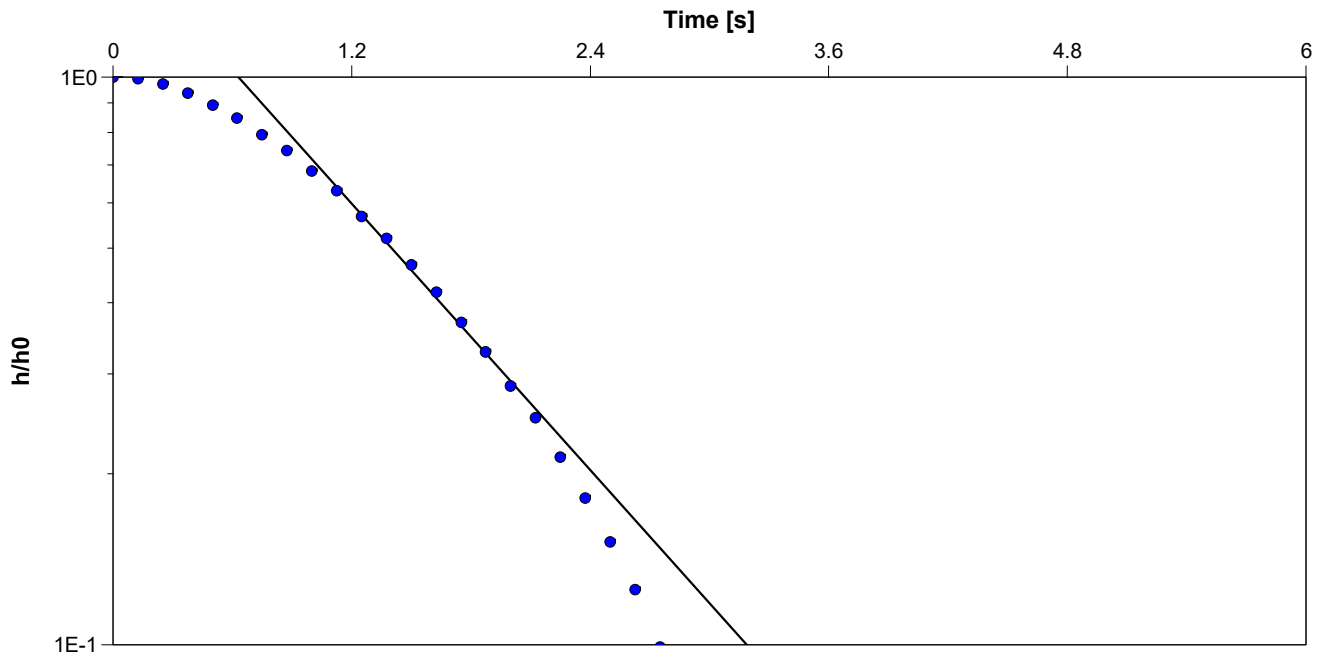
Slug Test Analysis Report

Project: Highway 9 Culverts & High Fills Widening

Number: 34935

Client: R.V. Anderson Associates Ltd.

Location: Midmay, Ontario	Slug Test: CULV01-04	Test Well: CULV01-04
Test Conducted by: GA		Test Date: 2024-06-07
Analysis Performed by: ES	CULV01-4 SWRT Analysis	Analysis Date: 2024-06-14
Aquifer Thickness:		
	Checked By: DH	



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
CULV01-04	4.6×10^{-4}	

THURBER ENGINEERING LTD.

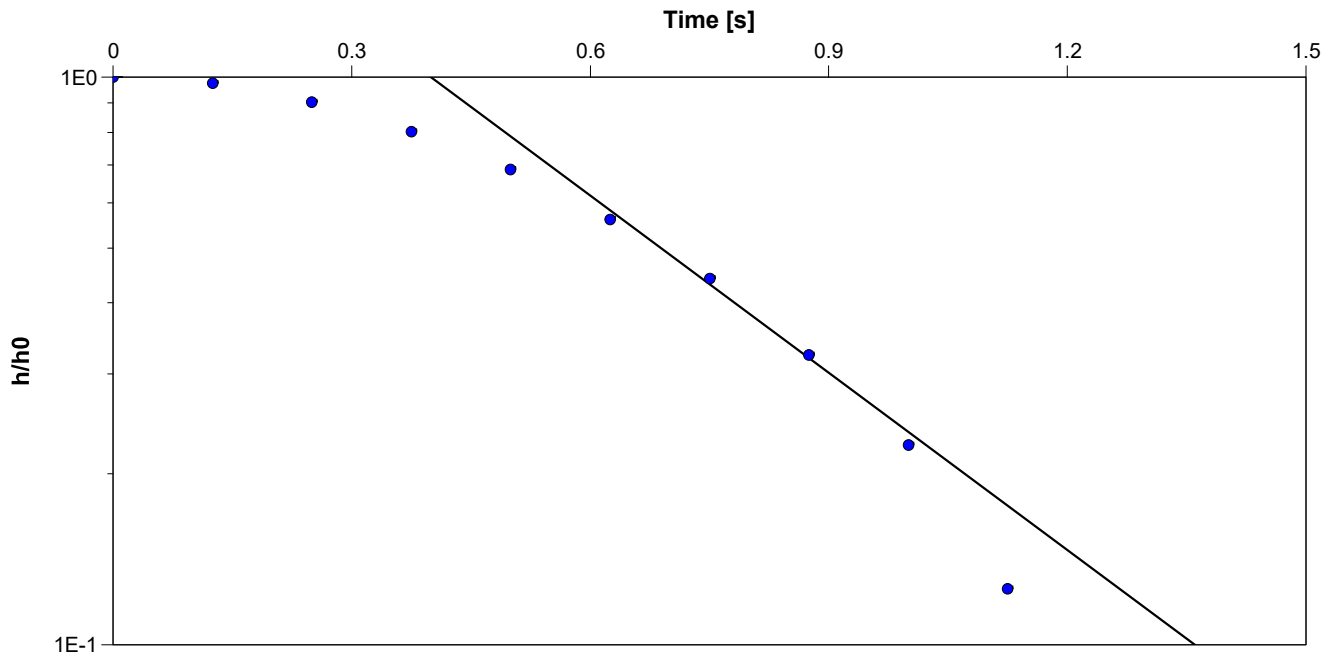
Slug Test Analysis Report

Project: Highway 9 Culverts & High Fills Widening

Number: 34935

Client: R.V. Anderson Associates Ltd.

Location: Midmay, Ontario	Slug Test: CULV01-06	Test Well: CULV01-06
Test Conducted by: GA		Test Date: 2024-06-07
Analysis Performed by: ES	CULV01-06 SWRT Analysis	Analysis Date: 2024-06-14
Aquifer Thickness:		
	Checked By: DH	



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
CULV01-06	7.3×10^{-4}	

THURBER

APPENDIX F

Ground Water Quality Certificate of Analysis

AGAT Laboratories

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CLIENT NAME: THURBER ENGINEERING LTD
SUITE 202, 1908 IRONOAK WAY
OAKVILLE, ON L6H 7G4
(905) 829-8666
ATTENTION TO: Liviu Parpalea
PROJECT: 349935
AGAT WORK ORDER: 24T160749
WATER ANALYSIS REVIEWED BY: Yris Verastegui, Inorganic Team Lead
DATE REPORTED: Jun 18, 2024
PAGES (INCLUDING COVER): 14
VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.*
- *AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.*
- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
- *All reportable information is available on request from AGAT Laboratories, in accordance with ISO/IEC 17025:2017, ISO/IEC 17025:2005 (Quebec), DR-12-PALA and/or NELAP Standards.*
- *This document is signed by an authorized signatory who meets the requirements of the MELCCFP, CALA, CCN and NELAP.*
- *For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.*

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Certificate of Analysis

AGAT WORK ORDER: 24T160749

PROJECT: 349935

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

(Water) TSS, Cr.6

DATE RECEIVED: 2024-06-11 **DATE REPORTED: 2024-06-18**

				SAMPLE DESCRIPTION:	CULV-1-04
				SAMPLE TYPE:	Water
				DATE SAMPLED:	2024-06-07 15:20
Parameter	**Unit**	**G / S**	**RDL**	**5922334**	
Total Suspended Solids	mg/L		10	56	
Chromium VI	mg/L	0.001	0.001	<0.001	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO * Variable - refer to guideline reference document
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Iris Verástegui

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AGAT WORK ORDER: 24T160749

PROJECT: 349935

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

Metals - Total Metals in Water (mg/L)

DATE RECEIVED: 2024-06-11

DATE REPORTED: 2024-06-18

			SAMPLE DESCRIPTION:	Field Filtered - CULV-1-04
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2024-06-07 15:35
Parameter	Unit	G / S	RDL	5922742
Total Aluminum	mg/L		0.010	<0.010
Total Antimony	mg/L	0.020	0.003	<0.003
Total Arsenic	mg/L	0.1	0.003	<0.003
Total Barium	mg/L		0.002	0.031
Total Beryllium	mg/L	*	0.001	<0.001
Total Boron	mg/L	0.2	0.010	0.021
Total Cadmium	mg/L	0.0002	0.0001	<0.0001
Total Chromium	mg/L		0.003	<0.003
Total Cobalt	mg/L	0.0009	0.0005	<0.0005
Total Copper	mg/L	0.005	0.002	**0.006**
Total Iron	mg/L	0.3	0.050	<0.050
Total Lead	mg/L	*	0.0005	<0.0005
Total Manganese	mg/L		0.002	0.005
Total Molybdenum	mg/L	0.040	0.002	0.004
Total Nickel	mg/L	0.025	0.003	0.007
Total Selenium	mg/L	0.1	0.002	<0.002
Total Silver	mg/L	0.0001	0.0001	<0.0001
Total Strontium	mg/L		0.005	1.39
Total Thallium	mg/L	0.0003	0.0003	<0.0003
Total Tin	mg/L		0.002	<0.002
Total Titanium	mg/L		0.010	<0.010
Total Tungsten	mg/L	0.030	0.010	0.015
Total Uranium	mg/L	0.005	0.0005	0.0030
Total Vanadium	mg/L	0.006	0.002	<0.002
Total Zinc	mg/L	0.030	0.020	<0.020
Total Zirconium	mg/L	0.004	0.004	<0.004

Certified By: Iris Verástegui

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Certificate of Analysis

AGAT WORK ORDER: 24T160749

PROJECT: 349935

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

Metals - Total Metals in Water (mg/L)

DATE RECEIVED: 2024-06-11

DATE REPORTED: 2024-06-18

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO * Variable - refer to guideline reference document
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Iris Verástegui

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Certificate of Analysis

AGAT WORK ORDER: 24T160749

PROJECT: 349935

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

Water Quality Assessment - PWQO (mg/L)

DATE RECEIVED: 2024-06-11

DATE REPORTED: 2024-06-18

		SAMPLE DESCRIPTION:		CULV-1-04
		SAMPLE TYPE:		Water
		DATE SAMPLED:		2024-06-07 15:20
Parameter	**Unit**	**G / S**	**RDL**	**5922334**
Electrical Conductivity	µS/cm		2	824
pH	pH Units	6.5-8.5	NA	7.41
Saturation pH (Calculated)				6.77
Langelier Index (Calculated)				0.642
Hardness (as CaCO3) (Calculated)	mg/L		0.5	408
Total Dissolved Solids	mg/L		10	558
Alkalinity (as CaCO3)	mg/L		5	325
Bicarbonate (as CaCO3)	mg/L		5	325
Carbonate (as CaCO3)	mg/L		5	<5
Hydroxide (as CaCO3)	mg/L		5	<5
Fluoride	mg/L		0.05	<0.05
Chloride	mg/L		0.12	64.7
Nitrate as N	mg/L		0.05	7.26
Nitrite as N	mg/L		0.05	<0.05
Bromide	mg/L		0.05	<0.05
Sulphate	mg/L		0.10	77.7
Ortho Phosphate as P	mg/L		0.10	<0.10
Ammonia as N	mg/L		0.02	<0.02
Ammonia-Un-ionized (Calculated)	mg/L	0.02	0.000002	<0.000002
Total Phosphorus	mg/L	*	0.02	0.08
Total Organic Carbon	mg/L		0.5	6.2
True Colour	TCU		2.50	14.6
Turbidity	NTU		0.5	40.9
Total Calcium	mg/L		0.20	105
Total Magnesium	mg/L		0.10	35.3
Total Potassium	mg/L		0.50	2.04
Total Sodium	mg/L		0.10	49.5
Aluminum-dissolved	mg/L	*	0.004	0.005
Total Antimony	mg/L	0.020	0.003	<0.003

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AGAT WORK ORDER: 24T160749

PROJECT: 349935

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

Water Quality Assessment - PWQO (mg/L)

DATE RECEIVED: 2024-06-11

DATE REPORTED: 2024-06-18

		SAMPLE DESCRIPTION:		CULV-1-04
		SAMPLE TYPE:		Water
		DATE SAMPLED:		2024-06-07 15:20
Parameter	**Unit**	**G / S**	**RDL**	**5922334**
Total Arsenic	mg/L	0.1	0.003	<0.003
Total Barium	mg/L		0.002	0.050
Total Beryllium	mg/L	*	0.001	<0.001
Total Boron	mg/L	0.2	0.010	0.025
Total Cadmium	mg/L	0.0002	0.0001	0.0001
Total Chromium	mg/L		0.003	<0.003
Total Cobalt	mg/L	0.0009	0.0005	**0.0010**
Total Copper	mg/L	0.005	0.002	**0.007**
Total Iron	mg/L	0.3	0.050	**0.754**
Total Lead	mg/L	*	0.0005	0.0010
Total Manganese	mg/L		0.002	0.040
Dissolved Mercury	mg/L	0.0002	0.0001	<0.0001
Total Molybdenum	mg/L	0.040	0.002	0.005
Total Nickel	mg/L	0.025	0.003	0.006
Total Selenium	mg/L	0.1	0.002	<0.002
Total Silver	mg/L	0.0001	0.0001	<0.0001
Total Strontium	mg/L		0.005	1.23
Total Thallium	mg/L	0.0003	0.0003	<0.0003
Total Tin	mg/L		0.002	0.003
Total Titanium	mg/L		0.010	0.018
Total Tungsten	mg/L	0.030	0.010	0.015
Total Uranium	mg/L	0.005	0.0005	0.0036
Total Vanadium	mg/L	0.006	0.002	0.003
Total Zinc	mg/L	0.030	0.020	<0.020
Total Zirconium	mg/L	0.004	0.004	<0.004
Lab Filtration Aluminum Dissolved				1

Certified By: Iris Verástegui

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Certificate of Analysis

AGAT WORK ORDER: 24T160749

PROJECT: 349935

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

Water Quality Assessment - PWQO (mg/L)

DATE RECEIVED: 2024-06-11 **DATE REPORTED: 2024-06-18**

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO * Variable - refer to guideline reference document
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

5922334 Diss.Al analysis completed on a lab filtered sample.
Dilution required, RDL has been increased accordingly.
Un-ionized Ammonia detection limit is a calculated RDL. The calculation of Un-ionized Ammonia is based on lab measured parameters (ammonia as N, pH and temperature).Values are reported as calculated.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Iris Verástegui

AGAT Laboratories

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Exceedance Summary

AGAT WORK ORDER: 24T160749

PROJECT: 349935

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Liviu Parpalea

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
5922334	CULV-1-04	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Cobalt	mg/L	0.0009	0.0010
5922334	CULV-1-04	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Copper	mg/L	0.005	0.007
5922334	CULV-1-04	ON PWQO	Water Quality Assessment - PWQO (mg/L)	Total Iron	mg/L	0.3	0.754
5922742	Field Filtered - CULV-1-04	ON PWQO	Metals - Total Metals in Water (mg/L)	Total Copper	mg/L	0.005	0.006

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Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 24T160749

PROJECT: 349935

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

Water Analysis

RPT Date: Jun 18, 2024			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Water Quality Assessment - PWQO (mg/L)															
Electrical Conductivity	5922334	5922334	824	816	1.0%	< 2	91%	90%	110%						
pH	5922334	5922334	7.41	7.49	1.1%	NA	99%	90%	110%						
Total Dissolved Solids	5916515		358	358	0.0%	< 10	98%	80%	120%						
Alkalinity (as CaCO3)	5922334	5922334	325	321	1.2%	< 5	98%	80%	120%						
Bicarbonate (as CaCO3)	5922334	5922334	325	321	1.2%	< 5	NA								
Carbonate (as CaCO3)	5922334	5922334	<5	<5	NA	< 5	NA								
Hydroxide (as CaCO3)	5922334	5922334	<5	<5	NA	< 5	NA								
Fluoride	5922334	5922334	<0.05	<0.05	NA	< 0.05	98%	70%	130%	101%	80%	120%	95%	70%	130%
Chloride	5922334	5922334	64.7	62.2	3.9%	< 0.10	96%	70%	130%	106%	80%	120%	102%	70%	130%
Nitrate as N	5922334	5922334	7.26	6.94	4.5%	< 0.05	102%	70%	130%	106%	80%	120%	98%	70%	130%
Nitrite as N	5922334	5922334	<0.05	<0.05	NA	< 0.05	97%	70%	130%	104%	80%	120%	95%	70%	130%
Bromide	5922334	5922334	<0.05	<0.05	NA	< 0.05	99%	70%	130%	102%	80%	120%	97%	70%	130%
Sulphate	5922334	5922334	77.7	74.0	4.9%	< 0.10	102%	70%	130%	107%	80%	120%	99%	70%	130%
Ortho Phosphate as P	5922334	5922334	<0.10	<0.10	NA	< 0.10	103%	70%	130%	105%	80%	120%	100%	70%	130%
Ammonia as N	5920884		<0.02	<0.02	NA	< 0.02	108%	70%	130%	101%	80%	120%	92%	70%	130%
Total Phosphorus	5923076		0.38	0.38	0.0%	< 0.02	101%	70%	130%	102%	80%	120%	NA	70%	130%
Total Organic Carbon	5923076		2.3	2.2	NA	< 0.5	103%	90%	110%	106%	90%	110%	110%	80%	120%
True Colour	5913523		5.31	5.44	NA	< 2.5	98%	90%	110%						
Turbidity	5922334	5922334	40.9	46.8	13.5%	< 0.5	95%	80%	120%						
Total Calcium	5932547		68.8	78.9	13.7%	< 0.20	97%	70%	130%	105%	80%	120%	104%	70%	130%
Total Magnesium	5932547		27.6	31.7	13.8%	< 0.10	95%	70%	130%	100%	80%	120%	93%	70%	130%
Total Potassium	5932547		1.39	1.61	NA	< 0.50	91%	70%	130%	102%	80%	120%	91%	70%	130%
Total Sodium	5932547		6.57	7.51	13.4%	< 0.10	97%	70%	130%	111%	80%	120%	92%	70%	130%
Aluminum-dissolved	5913123		0.012	0.012	NA	< 0.004	90%	70%	130%	81%	80%	120%	92%	70%	130%
Total Antimony	5932547		<0.003	<0.003	NA	< 0.003	101%	70%	130%	100%	80%	120%	106%	70%	130%
Total Arsenic	5932547		<0.003	<0.003	NA	< 0.003	94%	70%	130%	94%	80%	120%	97%	70%	130%
Total Barium	5932547		0.111	0.121	8.6%	< 0.002	100%	70%	130%	100%	80%	120%	104%	70%	130%
Total Beryllium	5932547		<0.001	<0.001	NA	< 0.001	101%	70%	130%	109%	80%	120%	105%	70%	130%
Total Boron	5932547		0.021	0.022	NA	< 0.010	100%	70%	130%	108%	80%	120%	102%	70%	130%
Total Cadmium	5932547		<0.0001	<0.0001	NA	< 0.0001	102%	70%	130%	100%	80%	120%	101%	70%	130%
Total Chromium	5932547		<0.003	<0.003	NA	< 0.003	98%	70%	130%	97%	80%	120%	95%	70%	130%
Total Cobalt	5932547		<0.0005	<0.0005	NA	< 0.0005	100%	70%	130%	92%	80%	120%	95%	70%	130%
Total Copper	5932547		<0.002	<0.002	NA	< 0.002	99%	70%	130%	100%	80%	120%	95%	70%	130%
Total Iron	5932547		0.265	0.259	2.3%	< 0.050	99%	70%	130%	94%	80%	120%	96%	70%	130%
Total Lead	5932547		<0.0005	<0.0005	NA	< 0.0005	97%	70%	130%	101%	80%	120%	94%	70%	130%
Total Manganese	5932547		0.015	0.014	6.9%	< 0.002	101%	70%	130%	90%	80%	120%	94%	70%	130%
Dissolved Mercury	5922334	5922334	<0.0001	<0.0001	NA	< 0.0001	101%	70%	130%	99%	80%	120%	99%	70%	130%
Total Molybdenum	5932547		<0.002	0.002	NA	< 0.002	100%	70%	130%	100%	80%	120%	97%	70%	130%
Total Nickel	5932547		<0.003	<0.003	NA	< 0.003	99%	70%	130%	95%	80%	120%	94%	70%	130%

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Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 24T160749

PROJECT: 349935

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

Water Analysis (Continued)

RPT Date: Jun 18, 2024			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Selenium	5932547		<0.002	<0.002	NA	< 0.002	99%	70%	130%	101%	80%	120%	105%	70%	130%
Total Silver	5932547		<0.0001	<0.0001	NA	< 0.0001	103%	70%	130%	94%	80%	120%	98%	70%	130%
Total Strontium	5932547		0.371	0.363	2.2%	< 0.005	102%	70%	130%	100%	80%	120%	99%	70%	130%
Total Thallium	5932547		<0.0003	<0.0003	NA	< 0.0003	90%	70%	130%	90%	80%	120%	90%	70%	130%
Total Tin	5932547		<0.002	<0.002	NA	< 0.002	109%	70%	130%	99%	80%	120%	105%	70%	130%
Total Titanium	5932547		<0.010	<0.010	NA	< 0.010	103%	70%	130%	95%	80%	120%	94%	70%	130%
Total Tungsten	5932547		<0.010	<0.010	NA	< 0.010	83%	70%	130%	87%	80%	120%	85%	70%	130%
Total Uranium	5932547		<0.0005	<0.0005	NA	< 0.0005	102%	70%	130%	105%	80%	120%	102%	70%	130%
Total Vanadium	5932547		<0.002	<0.002	NA	< 0.002	101%	70%	130%	96%	80%	120%	96%	70%	130%
Total Zinc	5932547		<0.020	<0.020	NA	< 0.020	99%	70%	130%	99%	80%	120%	100%	70%	130%
Total Zirconium	5932547		<0.004	<0.004	NA	< 0.004	94%	70%	130%	93%	80%	120%	92%	70%	130%
(Water) TSS, Cr.6															
Total Suspended Solids	5925691		<10	<10	NA	< 10	90%	80%	120%						
Chromium VI	5922334	5922334	<0.001	<0.001	NA	< 0.001	109%	70%	130%	109%	80%	120%	100%	70%	130%
Metals - Total Metals in Water (mg/L)															
Total Aluminum	5923919		0.020	0.024	NA	< 0.010	93%	70%	130%	104%	80%	120%	105%	70%	130%
Total Antimony	5923919		<0.003	<0.003	NA	< 0.003	99%	70%	130%	102%	80%	120%	103%	70%	130%
Total Arsenic	5923919		<0.003	<0.003	NA	< 0.003	97%	70%	130%	100%	80%	120%	99%	70%	130%
Total Barium	5923919		0.012	0.012	0.0%	< 0.002	101%	70%	130%	103%	80%	120%	98%	70%	130%
Total Beryllium	5923919		<0.001	<0.001	NA	< 0.001	101%	70%	130%	101%	80%	120%	102%	70%	130%
Total Boron	5923919		0.036	0.038	NA	< 0.010	101%	70%	130%	100%	80%	120%	105%	70%	130%
Total Cadmium	5923919		0.0805	0.0901	11.3%	< 0.0001	98%	70%	130%	103%	80%	120%	104%	70%	130%
Total Chromium	5923919		<0.003	<0.003	NA	< 0.003	87%	70%	130%	106%	80%	120%	94%	70%	130%
Total Cobalt	5923919		<0.0005	<0.0005	NA	< 0.0005	98%	70%	130%	97%	80%	120%	102%	70%	130%
Total Copper	5923919		0.014	0.017	19.4%	< 0.002	94%	70%	130%	102%	80%	120%	98%	70%	130%
Total Iron	5923919		0.196	0.193	NA	< 0.050	91%	70%	130%	98%	80%	120%	104%	70%	130%
Total Lead	5923919		<0.0005	<0.0005	NA	< 0.0005	94%	70%	130%	97%	80%	120%	95%	70%	130%
Total Manganese	5923919		0.009	0.008	NA	< 0.002	90%	70%	130%	96%	80%	120%	99%	70%	130%
Total Molybdenum	5923919		0.005	<0.002	NA	< 0.002	100%	70%	130%	107%	80%	120%	107%	70%	130%
Total Nickel	5923919		0.006	<0.003	NA	< 0.003	96%	70%	130%	98%	80%	120%	100%	70%	130%
Total Selenium	5923919		<0.002	<0.002	NA	< 0.002	100%	70%	130%	92%	80%	120%	96%	70%	130%
Total Silver	5923919		<0.0001	<0.0001	NA	< 0.0001	99%	70%	130%	99%	80%	120%	99%	70%	130%
Total Strontium	5923919		0.351	0.370	5.3%	< 0.005	93%	70%	130%	105%	80%	120%	110%	70%	130%
Total Thallium	5923919		<0.0003	<0.0003	NA	< 0.0003	92%	70%	130%	95%	80%	120%	91%	70%	130%
Total Tin	5923919		<0.002	<0.002	NA	< 0.002	102%	70%	130%	96%	80%	120%	98%	70%	130%
Total Titanium	5923919		<0.010	<0.010	NA	< 0.010	82%	70%	130%	102%	80%	120%	113%	70%	130%
Total Tungsten	5923919		<0.010	<0.010	NA	< 0.010	91%	70%	130%	94%	80%	120%	91%	70%	130%
Total Uranium	5923919		<0.0005	<0.0005	NA	< 0.0005	92%	70%	130%	96%	80%	120%	97%	70%	130%
Total Vanadium	5923919		<0.002	<0.002	NA	< 0.002	89%	70%	130%	96%	80%	120%	94%	70%	130%

AGAT Laboratories

5835 COOPERS AVENUE
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CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 24T160749

PROJECT: 349935

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

Water Analysis (Continued)

RPT Date: Jun 18, 2024			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Zinc	5923919		<0.020	0.025	NA	< 0.020	95%	70%	130%	98%	80%	120%	100%	70%	130%
Total Zirconium	5923919		<0.004	<0.004	NA	< 0.004	97%	70%	130%	97%	80%	120%	99%	70%	130%

Comments: NA signifies Not Applicable.
Duplicate NA: results are under 5X the RDL and will not be calculated.
Matrix spike NA: Spike level < native concentration. Matrix spike acceptance limits do not apply and are not calculated.

Certified By: Iris Verástegui

AGAT Laboratories

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CANADA L4Z 1Y2
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Method Summary

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 24T160749

PROJECT: 349935

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Total Suspended Solids	INOR-93-6028	modified from EPA 1684,ON MOECC E3139,SM 2540C,D	BALANCE
Chromium VI	INOR-93-6073	modified from SM 3500-CR B	LACHAT FIA
Total Aluminum	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Antimony	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Arsenic	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Barium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Beryllium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Boron	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Cadmium	MET -93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Chromium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Cobalt	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Copper	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Iron	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Lead	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Manganese	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Molybdenum	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Nickel	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Selenium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Silver	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Strontium	INOR-93-6003	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Thallium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Tin	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Titanium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Tungsten	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Uranium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Vanadium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Zinc	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS
Total Zirconium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP-MS

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Method Summary

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 24T160749

PROJECT: 349935

ATTENTION TO: Liviu Parpalea

SAMPLING SITE:Midmay

SAMPLED BY:GA

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Electrical Conductivity	INOR-93-6000	modified from SM 2510 B	PC TITRATE
pH	INOR-93-6000	modified from SM 4500-H+ B	PC TITRATE
Saturation pH (Calculated)		SM 2320 B	CALCULATION
Langelier Index (Calculated)		SM 2330B	CALCULATION
Hardness (as CaCO3) (Calculated)	MET-93-6105	modified from EPA SW-846 6010C & 200.7 & SM 2340 B	CALCULATION
Total Dissolved Solids	INOR-93-6028	modified from EPA 1684,ON MOECC E3139,SM 2540C,D	BALANCE
Alkalinity (as CaCO3)	INOR-93-6000	Modified from SM 2320 B	PC TITRATE
Bicarbonate (as CaCO3)	INOR-93-6000	modified from SM 2320 B	PC TITRATE
Carbonate (as CaCO3)	INOR-93-6000	modified from SM 2320 B	PC TITRATE
Hydroxide (as CaCO3)	INOR-93-6000	modified from SM 2320 B	PC TITRATE
Fluoride	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Chloride	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Bromide	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Ortho Phosphate as P	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-93-6059	modified from SM 4500-NH3 H	LACHAT FIA
Ammonia-Un-ionized (Calculated)		MOE REFERENCE, PWQOs Tab 2	CALCULATION
Total Phosphorus	INOR-93-6022	modified from SM 4500-P B and SM 4500-P E	SPECTROPHOTOMETER
Total Organic Carbon	INOR-93-6049	modified from SM 5310 B	SHIMADZU CARBON ANALYZER
True Colour	INOR-93-6074	modified from SM 2120 B	LACHAT FIA
Turbidity	INOR-93-6000	modified from SM 2130 B	PC TITRATE
Total Calcium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP/MS
Total Magnesium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP/MS
Total Potassium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP/MS
Total Sodium	MET-93-6103	modified from EPA 200.8, 3005A, 3010A & 6020B	ICP/MS
Aluminum-dissolved	MET-93-6103	modified from EPA 200.8 and EPA 3005A	ICP-MS
Dissolved Mercury	MET-93-6100	modified from EPA 245.2 and SM 3112 B	CVAAS
Lab Filtration Aluminum Dissolved	SR-78-9001		FILTRATION

AGAT Laboratories
5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
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Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only
Work Order #: 24T160749
Cooler Quantity: 1 med
Arrival Temperatures: 5.9 | 6.0 | 6.2
Custody Seal Intact: ☐ Yes ☐ No ☑ N/A
Notes: loose ice

Report Information:
Company: Thurber Engineering Ltd
Contact: Liviu Parpalea
Address: Suite 202, 1908 Ironoak Way, Oakville, Ontario, L6H7G4
Phone: (905) 829-8666 Fax:
Reports to be sent to:
1. Email: lparpalea@thurber.ca
2. Email: rdecastro@thurber.ca

Project Information:
Project: 34935
Site Location: Midmay
Sampled By: George Azzopardi
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:
Bill To Same: Yes ☑ No ☐
Company:
Contact:
Address:
Email: AccountingON@thurber.ca

Regulatory Requirements:
(Please check all applicable boxes)

☐ Regulation 153/04
Table (Indicate One): ☐ Ind/Com ☐ Res/Park ☐ Agriculture
Soil Texture (Check One): ☐ Coarse ☐ Fine

☐ Excess Soils R406
Table (Indicate One)
☐ Regulation 558
☐ CCME

☐ Sewer Use ☐ Sanitary ☐ Storm
Region
☑ Prov. Water Quality Objectives (PWQO)
☐ Other
(Indicate One)

Is this submission for a **Record of Site Condition?** ☐ Yes ☑ No

Report Guideline on *Certificate of Analysis* ☑ Yes ☐ No

Turnaround Time (TAT) Required:
Regular TAT ☑ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays
For 'Same Day' analysis, please contact your AGAT CPM

Sample Matrix Legend
B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC (Y/N)	O. Reg 153: Metals & Inorganics	O. Reg 153: Metals - ☐ CrVI, ☐ Hg, ☐ HWSB	O. Reg 153: BTEX, F1-F4 PHCs - Analyze F4G if required ☐ Yes ☐ No	O. Reg 153: PAHs	O. Reg 153: PCBs	O. Reg 153: VOC	O. Reg 558: Landfill Disposal Characterization TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	O. Reg 406: Excess Soils SPLP Rainwater Leach - SPLP: ☐ Metals ☐ VOCs ☐ SVOCs	O. Reg 406: Excess Soils Characterization Package - pH, ICPMS Metals, BTEX, F1-F4	Salt - EC/SAR	PWQO	Potentially Hazardous or High Concentration (Y/N)
CULV-1-04	06/07/24	15:20 AM/PM	9	GW	FILTERED SAMPLES ARE LISTED SEPARATELY												☑	
CULV-1-04	06/07/24	15:35 AM/PM	2	GW	AMPOULE TO A 15 MIN DIFFERENCE IN	Y											☑	
		AM/PM			SAMPLING TIME BUT ARE FOR THE PWQO													
		AM/PM			PACKAGE													
		AM/PM			IF THERE ARE ANY													
		AM/PM			ADDITIONAL SAMPLING BOTTLES WHICH ARE													
		AM/PM			NOT REQUIRED FOR PWQO PACKAGE,													
		AM/PM			PLEASE DISREGARD													
		AM/PM			SINCE THEY WERE ORDERED FOR													
		AM/PM			ANALYSIS WHICH ARE													
		AM/PM			NO LONGER REQUIRED													

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Liviu Parpalea	06/11/24	9:45			
			Tiffany	June 11	10:37 AM

Page ____ of ____

Pink Copy - Client | Yellow Copy - AGAT | White Copy- AGAT

APPENDIX G

Dewatering Estimates

THURBER

Dewatering Calculations for Confined Aquifer - Highway 9 Otter Creek Culvert Replacement

Parameter	Units	Otter Creek Culvert
Geologic Unit to Dewater		Silt and Sand, Sand and Gravel
Input Hydraulic Conductivity (K)	m/s	5.8E-04
Hydraulic Conductivity converted to m/day	m/day	5.0E+01
Input height of groundwater pressure (H)	m	7.3
Input dewatering height (h)	m	3.0
Net depressurization	m	4.3
Input length of excavation (x, a)	m	26
Input width of excavation (b)	m	20
Vertical extraction interval thickness	m	3
Aquifer thickness	m	3
Length to width ratio a/b	unitless	1.3
Equivalent radius Rs, where applicable	m	12.9
Radius of Influence (Ro based on Sichardt)	m	311
Ratio Ro/Rs		24.1
Flow equation based on a/b and Ro/Rs		Equiv. Well
Calculated Flow Rate		
Groundwater flow prior to factor reductions	L/day	1,275,000
Partial Penetration Factor	unitless	1.00
Base groundwater flow	L/day	1,275,000
Safety factor on groundwater flow	unitless	3
Groundwater flow with safety factor	L/day	3,825,000
Rainfall entering excavation, if applicable	mm	50
Duration to remove rainfall	hours	24
Flow rate to remove rainfall	L/day	26,000
Budgeted peak flow rate	L/day	3,851,000
=	L/s	44.6
=	gal/min	588

Flow rate estimates rounded to nearest 1,000 L/day.
Where Ro/Rs < 1.5, calculate flow as perimeter trenches.

Theory and Formulae

Trench flow in unconfined aquifer

Use this equation when a/b > 1.5.

$$Q = \frac{\pi K(H^2 - h^2)}{\ln(R_0/r_s)} + 2\left[\frac{xK(H^2 - h^2)}{2L}\right]$$

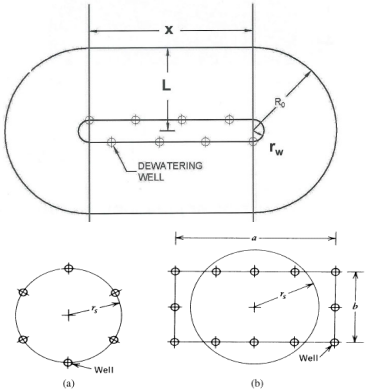
Circular System

$$r_s = \sqrt{\frac{a \times b}{\pi}}$$

Trench flow in confined aquifer

Use this equation when a/b > 1.5.

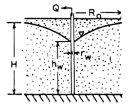
$$Q = \frac{2\pi KB(H - h)}{\ln(R_0/r_s)} + 2\left[\frac{xKB(H - h)}{L}\right]$$



Radial flow in unconfined aquifer

$$Q = \frac{\pi K(H^2 - h^2)}{\ln(R_0/r_s)}$$

rs = well radius for single well

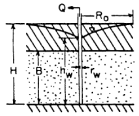


Radial flow, water table aquifier

Radial flow in confined aquifer

$$Q = \frac{2\pi KB(H - h)}{\ln(R_0/r_s)}$$

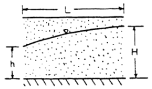
rs = well radius for single well



Radial flow, confined aquifer

Unconfined flow from a line source to a drainage trench, 2 sides

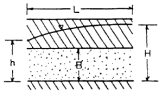
$$Q = \frac{xK(H^2 - h^2)}{L}$$



Water table flow from a line source to a drainage trench

Confined flow from a line source to a drainage trench, 2 sides

$$Q = \frac{2xKB(H - h)}{L}$$



Confined flow from a line source to a drainage trench

if Ro<1.5Rs, then assume confined flow to trench from 4 sides

Radius of Influece

Sichardt Equation:

$$R_0 = 3000\,(H - h)\sqrt{K}$$

Partial Penetration Factor (F) Kozeny 1933

$$F = \frac{L}{b}\{1 + 7\cos(\frac{\pi L}{2b})\sqrt{\frac{r}{2L}}\}$$

where:

L = Vertical length from which water is being extracted

r = Single well radius

b = Saturated aquifer thickness

L/r must be > 30 L/b must be < 0.5

Assumption made that same factor may be applied to equivalent well and trench equations.

---

where:

Q = Pumping rate (m^3/s)

K = Hydraulic conductivity (m/s)

H = Depth from the initial static water level to bottom of the saturated aquifer (m)

h = Depth from the dewatering target water level to bottom of the saturated aquifer (m)

R_0 = Radius of influence (m)

r_s = Equivalent radius of excavation or distance to the wellpoints from the centre of the trench (half trench width) (m)

x = Trench length (m)

L = Distance from a line source to the trench, equivalent to R_0 (m)

B = Aquifer thickness (m)

a = Excavation length (m)

b = Excavation width (m)

Reference: Powers, J. P., Corwin, A. B., Schmall, Paul C. and Kaeck, W. E. 2007. Construction Dewatering and Groundwater Control: New Methods and Applications, Third Edition, New York, New York: John Wiley & Sons.

APPENDIX H

Monitoring and Contingency Plans

THURBER

Table H1. Monitoring and Contingency Plan for Groundwater Taking

Category	Item	Performance Requirement	Monitoring Requirements	Initial Action(s) Upon Exceedance	Potential Mitigations if Exceedance not Eliminated
Groundwater Quantity	Quantity Taken	Total quantity taken at each water taking location per day must be less than permitted value at the given water taking location per the PTTW	Water quantity taken at each water taking location as specified in the PTTW registration must be measured accurately and recorded daily.	- Advise MECP and Contract Authority of exceedance of PTTW limit. - Reduce flow rate being taken such that it is less than the permitted value, provided it is not unsafe to do so.	Contact the Geotechnical or Hydrogeological engineer to identify further options, potentially including working in the wet or temporary water-tight shoring to act as cut-off walls.
	Reporting	The quantity taken each day must be reported on the Ontario government's website titled Water Taking Reporting System by March 31st for the prior year's takings.	As above	Not reporting quantities is a violation of the terms and conditions of the PTTW. Report immediately, if overdue.	Not applicable
Settlement Monitoring	Pre-construction Survey	Establish pre-construction elevations of structures within anticipated radius of influence.	Conduct pre-construction and post-construction survey of elevations of existing structures within anticipated radius of influence.	Not applicable	Not applicable
Surface Water Quantity	Surface Water Monitoring	Surface water flow immediately downstream of the dewatering location to not be decreased by more than 10% than the surface water flow upstream of the water taking location.	- Manual water level measurements at stream bank mini-piezometer nest. - Monitor upstream and downstream flow using flow meter. - Upstream and downstream water level measurements using the staff gauge. - Monitor stream flow and water levels on a daily to weekly basis to track potential changes, reduced to biweekly to monthly after stabilization of the dewatering rate and groundwater levels.	- Review water taking volumes and climatological data and identify a list of potential contributing factors. - Modify water taking rates, methods, and potentially cofferdams to mitigate impacts and re-evaluate impact. - Notify MECP if impact to environment has occurred.	- If cause of exceedance potentially due to water taking, reduce water taking rate if safe to do so. Engineer, and assess additional options. - Consider stopping water taking and/or diversion if safe to do so until alternate methods developed.

THURBER

Table H2. Monitoring and Contingency Plan for Discharge to Land Surface Within 30 m of a Watercourse

Category	Item	Performance Requirement	Monitoring Requirements	Initial Action(s) Upon Exceedance	Potential Mitigations if Exceedance not Eliminated
Groundwater Quality	Raw Groundwater Quality (Pre-Treatment)	- No pure product, combustible liquid, fuel, or ignitable waste in raw water. - Ensure treatment system suitable for water quality observed. - Results reviewed by Qualified Person.	- Prior to first discharge, sample raw groundwater for TSS, PWQO metals & inorganics, and PWQO PAHs. Include field measurement of temperature, pH, dissolved oxygen and turbidity. - Weekly sampling for the first four weeks during active dewatering, monthly thereafter	- If any pure product, combustible liquid, fuel, or ignitable waste is observed in raw water, notify Hydrogeologist/Hydrogeological Engineer. - Collect a second sample to confirm following development. - Dispose of any collected water off-site at licensed facility.	- Modify intake procedures if possible. - Reduce water taking rate if possible. - Stop dewatering operations until addressed, unless stopping would create safety risk.
		No excessive sediment. Excessive sediment may be sign of ground loss.	Monitor twice daily during dewatering with active construction; once daily during dewatering without active construction. Record on weekly inspection report.	- Review extraction methodology and equipment for possible changes. - Review area for signs of ground loss. - Modify water intake setup, procedures and equipment to reduce solids intake.	- Modify intake procedures if possible. - Reduce water taking rate if possible. - Stop dewatering operations until addressed, unless stopping would create safety risk.
		No pure product, combustible liquid, fuel, or ignitable waste	Monitor twice daily during dewatering with active construction; once daily during dewatering without active construction. Record on weekly inspection report.	- Assess potential sources of new impact. - Assess risk of continuing to receive new contaminant and determine options for proceeding.	- Modify intake procedures if possible. - Reduce water taking rate if possible. - Stop dewatering operations until addressed, unless stopping would create safety risk.
	Treated Discharge Water Quality Prior to Discharge at Each Location	- PWQO and interim PWQO criteria met. - No sheen or pure product. - Results reviewed by Qualified Person.	Sample analyzed by CALA accredited laboratory of treated water meeting requirements prior to first discharge.	- Modify treatment methods and/or intake methods. - Retest until performance requirements met.	Further modifications as needed to meet criteria before discharging.
	Treated Discharge Water Quality	- PWQO and interim PWQO criteria met. - No sheen or pure product. - Results reviewed by Qualified Person.	Testing frequency per MECP Discharge Agreement.	- Notify MECP District Office - Cease discharge and immediately resample on rush basis. - Review function of water treatment system and repair any deficiencies. - Review changes to water intake and modify if necessary.	- Enhance water treatment system or modify intake until rectified. - Submit additional PWQO water quality samples to lab to determine if treatment sufficient to permit discharge to sewer.
		- Turbidity measurement less than 8 NTU above background surface water turbidity. - Total suspended solids less than 25 mg/L. - No visual or olfactory signs of any other type of contaminant in discharge.	Monitor for listed performance requirements twice daily during dewatering with active construction; once daily during dewatering without active construction. - Measure turbidity twice daily both upstream and downstream of Site.	- Review function of water treatment system and repair any deficiencies. - Review changes to water intake and modify if necessary.	- Cease discharge of water to surface water until performance requirement being met. - Enhance water treatment system or modify intake until rectified. - Submit additional water quality samples to lab to assess quality of treatment prior to further discharge.
Erosion	Erosion at Discharge Point	No significant erosion occurring, and all water entering intended sewer.	Monitor twice daily during dewatering with active construction; once daily during dewatering without active construction. Record on weekly inspection report.	- Review discharge setup and repair any deficiencies.	- Cease discharge of water to sewer until performance requirement being met.
Surface Water Quality	Upstream and Downstream Surface Water Quality	No significant degredation in surface water quality from baseline conditions caused by groundwater discharge runoff reaching surface water, based on assement by Qualified Person	- Samples analyzed for TSS, select PWQO Metals and Inorganics, and any additional parameters identified by the Qualified Person following field measuremnet of temperature, pH, dissolved oxygen and turbidity. - Once prior to water taking, weekly sampling for the first four weeks during dewatering, monthly thereafter. - Measure turbidity twice daily at both upstream and downstream of each discharge location.	- Qualified Person to investigate whether degredation in surface water quality may be partly due to groundwater discharge. - Review function of water treatment system and repair any deficiencies. - Review changes to discharge setup or location and modify if necessary. -Collect additional surface water samples. - Additional recommendations per Qualified Person	- Cease discharge of water to natural environment until performance requirement being met. - Enhance water treatment system or modify intake until rectified. - Submit additional water quality samples to lab to assess quality of treatment prior to further discharge to environment.