



# Hydrogeological Assessment, Level 1 and Level 2 Water Reports and Maximum Predicted Water Table Report

Application for a Class 'A' License  
McKinnon Pit

Part of Lot 6, Concession XI  
Part of Lot 6, Concession X  
Concessions X & XI, in Lot 6  
Lots 5 & 6, Concession X  
Geo. Township of Dalhousie  
Township of Lanark Highlands  
Lanark County

Arnott Bros. Construction Ltd.  
March 2023

**GRI Inc.**  
[www.gri-inc.ca](http://www.gri-inc.ca)



## Executive Summary

Arnott Bros. Construction Ltd. (Arnott) is proposing to amend aggregate license #609261 to permit extraction below the water table at the McKinnon Pit located in the Township of Lanark Highlands (Geo. Twp. Of Dalhousie), County of Lanark. GRI Inc. was retained by Arnott to conduct Level 1 and 2 Water Studies and determine the maximum predicted water table to meet the requirements of the ARA (Ontario Ministry of Natural Resources and Forestry 2020a). The purpose of this report is to address the requirements of the technical standards, determine the maximum predicted water table and to identify any potential impacts of the operation on groundwater and surface water.

The site is located on a major glaciofluvial assemblage that extends from just east of Middleville, southward to Pine Gove, westward to just north of Playfairville, and then parallel to Highland Line and Kingston Line where it crosses County Road 36 and continues into the County of Frontenac. This system, which usually has a central core consisting of sand and gravel surrounded by cavity fills and fans consisting of fine gravel to fine sand (Gorrell and Shaw 1991), has the highest quality ranking for the province's mineral aggregate interests.

The McKinnon Pit is found is situated within the Mississippi Conservation Authorities Mississippi Lake Subwatershed. A 129 ha unevaluated wetland is found around the west, north and east sides of the property. Neighbouring property owners rely on wells for water supply. The wells near the site use the bedrock aquifer.

Arnott current license permits aggregate extraction to within 1.5 m of the water table. The proposed amendment expands the license area and will allow aggregate to be extracted to up to 20 m below the water table. The material will be excavated from below the water table with drag line or other dredging equipment. There will be no diversion, storage or drainage of groundwater from the site.

The application proposes extraction of resources down to, at its deepest, 173 mASL, which is up to 20 m below the water table. The excavated material on the site may be beneficiated with either wet screens or with a classifier.

Three test holes were drilled on the site, and piezometers were installed. In-situ hydraulic conductivity tests were completed and groundwater levels were measured from December 3 2020 to July 28, 2022. Groundwater samples were taken from the wells to measure general groundwater quality characteristics.

This study has found that no significant change or impact to the groundwater recharge or flow on or around the property will occur from the proposed operation. A groundwater monitoring program to extend the database on baseline conditions is recommended, to be followed by data collection when the below water excavation begins. If other beneficiation processes such as a wash plant are planned, a Permit to Take Water and Environmental Compliance Approval will be required. The potential for groundwater contamination is addressed through operations management and due diligence.



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Below, record changes to the report resulting from external peer review or agency comments, or errata.

Section Heading	Change/ Source	Date	Review Version	
Level 1 report	add p 5 to PDF	July 24/23		

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## 1 INTRODUCTION

Arnott Bros. Construction Ltd. (Arnott) is applying to amend existing aggregate licence #609261 to permit extraction below water under the Aggregate Resources Act (ARA). The McKinnon Pit is located on Part of Lots 5 and 6, Concession 10, Part of Lot 6 Concession 11, Part of the Road Allowance between Lots 5 and 6, Concession 10 and Part of the Road Allowance between Concessions 10 & 11 (at Lot 6), Township of Lanark Highlands (Geo. Twp. of Dalhousie), County of Lanark (OS Figure 1).

The McKinnon Pit is one more than 20 active or former sand and gravel pits situated on a sedimentary assemblage that extends southward from the vicinity of Middleton to Pine Grove and then westward to just north of Playfairville (Inset, OS Figure 1). From there, it extends parallel to Highland Line and Kingston Line and crosses County Road 36 before continuing into the County of Frontenac.

A typical assemblage consists of a central core of sand and gravel, surrounded by fans consisting of fine gravel to fine sand; the coarsest material is usually located on the eastern side of the assemblage. An aggregate assessment completed for the area in 1985 (Gorrell, Van Haaften and Fletcher, Aggregate Assessment of the County of Lanark. 1985) a geological paper completed (Gorrell and Shaw, Deposition in an esker, bead and fan complex, Lanark, Ontario, Canada. 1991) and an updated aggregate resource inventory paper (Lee, V. F. 2013) indicate that the material in the assemblage is the highest quality with respect to the province's mineral aggregate interests.

GRI Inc. (GRI) was retained by Arnott to complete Level 1 and 2 Hydrogeological studies to address the requirements of the Aggregate Resources of Ontario Standards.

Elevations referenced in this document refer to the topographic contour plan for the site prepared by TEC Surveying ( TEC Surveying Inc. 2021).

## 2 QUALIFICATIONS

This study was prepared by Jennifer Gorrell, M.Sc. P.Eng. P.Geo. and George A. Gorrell, M.Sc. F.G.A.C, P.Geo.. Together they are partners in the engineering firm GRI Inc. They have provided geological, hydrogeological and associated engineering services since 1988.

The field studies found in the references that have been conducted by George Gorrell M.Sc. F.G.A.C P.Geo. since 1979 (see References) are the source of the personal knowledge used in this report. George Gorrell holds a certificate of registration under the Professional Geoscientists Act, 2000 and is a practicing member of the Association of Professional Geoscientists of Ontario. Mr. Gorrell has demonstrated and post-secondary education, including undergraduate and graduate degrees, in hydrology and sedimentology with specialization in water and resource management. He has spent over 40 years studying the geology and mineral aggregate deposits of Eastern Ontario.

Jennifer Gorrell holds a certificate of registration under the Professional Geoscientists Act, 2000 and is a practicing member of the Association of Professional Geoscientists of Ontario, and the Professional Engineers of Ontario. Mrs. Gorrell has demonstrated and post-secondary education, including undergraduate and graduate degrees, in geotechnical engineering with specialization in hydrogeology, hydrology, environmental consulting, geology and soil mechanics. Ms. Gorrell has 40 years of



professional experience in the fields of geology, hydrogeology, and environmental consulting, with more than 30 years' experience related to pits and quarries.

### 3 PROPOSED OPERATION

The existing conditions of the site, the proposed operation and rehabilitation are described in the draft site plan that were prepared by Milestone Aggregate Consulting Services Inc. (Milestone) dated January 13, 2022. The current license is over 34.3 ha, and lands will be added for an expanded license area of 40.1 ha with an extraction area of 36.1 ha. The elevations on the site plan and used in this report are geodetic from a survey plan prepared by TEC Survey (TEC Surveying Inc. 2021). The current license and proposed expansion area are shown on OS Figure 1, and the site contours are shown on OS Figure 2.

Details provided to GRI by Milestone about the proposed operation are;

- The existing pit has been excavated to an average elevation of 190 mASL (TEC Surveying Inc. 2021). Within the licensed area, the remainder of the material above the water table within the glaciofluvial deposit will be fully excavated, followed by the removal of the material below the water table. The extraction will take place in one or two stages, to a maximum approximate depth of 20 m or approximately 171 mASL;
- A maximum of 250,000 tonnes of aggregate will be removed from the pit annually, an increase from the current 150,000 tonnes;
- Aggregate will be extracted from below the water table using a high-hoe, or dredge or dragline; The material will be excavated without dewatering;
- No off-site diversion of surface water is planned;
- Some of the material that will be excavated will be processed using such types of equipment as wet screens, wash plant or a classifier. If beneficiation methods such as a wash plant or classifier are used, a Permit to Take Water and an Environmental Compliance Approval will be required.
- Fuel storage will be by temporary fuel tank that comply with the Technical Standards and Safety Act, or by fuel bowser
- An asphalt plant or concrete batch plant are not permitted on site.
- Extraction will occur down to the limit of the resource, or a minimum elevation of 171 mASL.

### 4 STUDY SCOPE

The requirements for the water reports and their requirements are outlined in the Aggregate Resources of Ontario: Technical Reports and Information Standards, August 2020 and Aggregate Resources of Ontario: Amendment standards, August 2020.

The Amendment Standards state:

*"1.1.4 Notwithstanding the above, where no water report has been previously completed, applicants must prepare a Water Report following requirements that would apply if the application were being made for a new licence or aggregate permit."* (Ontario Ministry of Natural Resources and Forestry 2020b)

The requirements consist of;



1. Maximum Predicted Water Table Report; and
2. Water Report. The Water Report consists of two parts. Level 1 identifies groundwater and surface water resources and their uses and determines the potential for impact by the proposal. Level 2 is required if potential impacts were identified, and the study provides an impact assessment and if appropriate an adaptive management plan to identify and trigger action if the predicted impacts occur. (Ontario Ministry of Natural Resources and Forestry 2020a)

Sections 5 and 6 address the Level 1 Water Report requirements. Although the details on the regional setting are a requirement of the Level 2 Water Report, they are provided in Section 5 to familiarize the reviewer with the conditions on the site and in the surrounding area. Sections 7 to 14 address the Level 2 Water Report requirements and Section 11 provides the Maximum Predicted Water Table Report.



# Level 1 Water Report

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The following areas are referenced in the report:

“Site” consists of the property, licensed and extraction areas.

the “Site and surrounding 120 m “buffer zone” is shown on OS Figure 2. The Aggregate Resources of Ontario Standards defines 120 m as the area to be examined in assessments for the site.

The “study area” consists of the site and the area up to approximately 2 km around the proposed license (OS Figure 1). Within this area there are enough data to represent the regional conditions and uses.

In addition, a 300 m zone is shown. This zone shows the impact area prescribed in the Mineral Aggregates Resource Policy in the Township of Lanark Highlands Official Plan. For a new or expanded pit operation, a hydrogeological impact assessment is required if the proposed license is within 300 m of a residential, institutional or commercial use.

## **5 REGIONAL SETTING**

The study area is shown on OS Figure 1. The sections below describe the characteristics of the site and study area.

### **5.1 Land Use**

Within the study area, the land use is predominantly undeveloped (forested/wetland/lake, 71.0%\*), agricultural and agroforestry (farm and sugar bush, 20%), industrial (pits, 7.4%) or residential (by severance, 1.2%). The areas are shown on OS Figure 1).

#### **5.1.1 Agricultural, Agroforestry and Farmsteads**

Agricultural and associated rural residences are sporadically located within the 2 km zone that surrounds the site. As shown above, 20% of the area could be characterized as being used for agriculture and agroforestry; 12% for agroforestry and 8% for crop and livestock. The practice of crop and livestock agriculture is sporadic because Precambrian uplands and wetlands are the principle natural features and there is little arable soil.

Directly south of the site is a maple syrup operation. The website<sup>†</sup> details state the operation is one of the largest producers in Ontario and that over 20,000 trees are tapped. Although not all the trees in the area that were delineated as agroforestry are tapped, they are a potential source.

#### **5.1.2 Undeveloped Land – Forested and/or Wetland**

Undeveloped land is the primary land use (71%) for the area around the site. The undeveloped land is either forested, is a wetland or a lake. There are areas of Lanark County Forest and Significant Woodland within 2 km of the site (CGIS Spatial Solutions 2022). It is likely that a good proportion of the forested land could be used for maple syrup production, based on the tree species that can be observed on the satellite imagery and in a driving survey of the area.

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\* proportional use estimated from the satellite imagery

† <https://wheelersmaple.com/wheeler-family/>



forested land could be used for maple syrup production, based on the tree species that can be observed on the satellite imagery and in a driving survey of the area.

Not all the wetlands within 2 km of the site have been evaluated. The Mississippi Valley Conservation Authority (MVCA) regulation Public Mapping Browser (Mississippi Valley Conservation Authority 2021) is a non-evaluated wetland. It appears that part of the existing extraction area may be within the regulatory limit, based on the web map.

The County of Lanark Official Plan designates the area around the site as significant groundwater recharge area (CGIS Spatial Solutions 2022).

#### **5.1.2.1 Ecological Services Natural Environment Technical Report**

A Natural Environment report prepared by Ecological Services (Ecological Services 2022) investigated the natural heritage features within 120 m of the proposed amendment. The report found that within the proposed license boundary, there are a species at risk, a significant woodland feature and significant wildlife habitat. Additionally, within 120 m of the expansion boundary there is a significant woodland feature, significant wildlife habitat, fish habitat, wetland, and the habitat of species at risk. The risks of the proposed operation were classified as low to moderate and mitigation recommendations were provided.

The report additionally cautions that significant alteration by the operation to the hydrological regime in the adjacent wetland could result in significant impacts to the wetland and to fish and significant wildlife habitat.

#### **5.1.3 Aggregate Operations/ Industrial**

Most of the site currently holds an aggregate license (Arnott Brothers Construction Ltd; license #609261). There is one additional licensed property located east of the site that is partly within the study area. The Tackaberry Sand and Stone. Ltd. (Lic.# 4257) is a 63.5 ha pit that is situated north and south of Highland Line. The Lanark Highland's Official Plan shows areas that are designated Mineral Aggregate Resource (holding) but they do not currently hold aggregate licenses. The areas around the site and east along Highland Line to (and beyond) McDonalds Corners Road are shown on OS Figure 1.

The assemblage is one of the largest and principal sources of high-quality aggregate for Lanark County. The sand and gravel assessments that have been completed for the County have indicated that the deposit has primary significance (Gorrell, Van Haaften and Fletcher 1985, Gorrell and Shaw 1991, Lee, V. F. 2013). The references also state that significant proportion of this assemblage has been already extracted or sterilized due to development.

There are more than 8 aggregate pits on the assemblage between the site and Playfairville. There are an additional 7 pits north of Lanark on the Middleville extension. The location of the assemblage and pits is shown on Figure 1.

#### **5.1.4 Residential Development**

Residential development has been developed almost exclusively by severance along the area roads. The residences are serviced by individual wells and septic systems.



## 5.2 Summary of Natural Environment Technical Report (Ecological Services 2022)

The natural environment report investigated whether significant natural heritage features are on or within 120 meters of the pit expansion to address the requirements of the Aggregate Resources Act. The report also addresses the Natural Heritage assessment requirements of an Environmental Impact Statement or Environmental Impact Assessment of the Provincial Policy Statement and the Lanark County Official Plan.

The investigation found there are species at risk, significant woodland feature and significant wildlife habitat within the proposed pit expansion boundary. Within 120 m of the expansion boundary there is a significant woodland feature, significant wildlife habitat, fish habitat, wetland, and the habitat of species at risk. The report identified the risk to these significant features as low to moderate and provided mitigation recommendations.

The mitigation recommendations for the wetlands only are included here as they may relate to the hydrogeological report. The report recommended an additional 15 m buffer be applied to the regulatory 30m buffer administered by Mississippi Valley Conservation Authority for a total of 45 m.

On top of the required 30 m MVCA wetland buffer, it is recommended that a further 15 m buffer be added at the northwest corner of the existing license boundary, for a total 45 m.

The report cautioned that if the proposed below water table expansion were to significantly alter the hydrological regime of the adjacent wetland, this could result in significant impacts to the wetland, to fish habitat, and to significant wildlife habitat, and added there is potential for a net natural environment benefit from the eventual creation of the lake that will be created that will result in the creation of more wetland habitat, more significant wildlife habitat, more fish habitat, and possibly new SAR habitat.

The Level 2 report evaluates the impact of the proposed expansion on the area hydrology (Section 12.2).

## 5.3 Surficial Geology

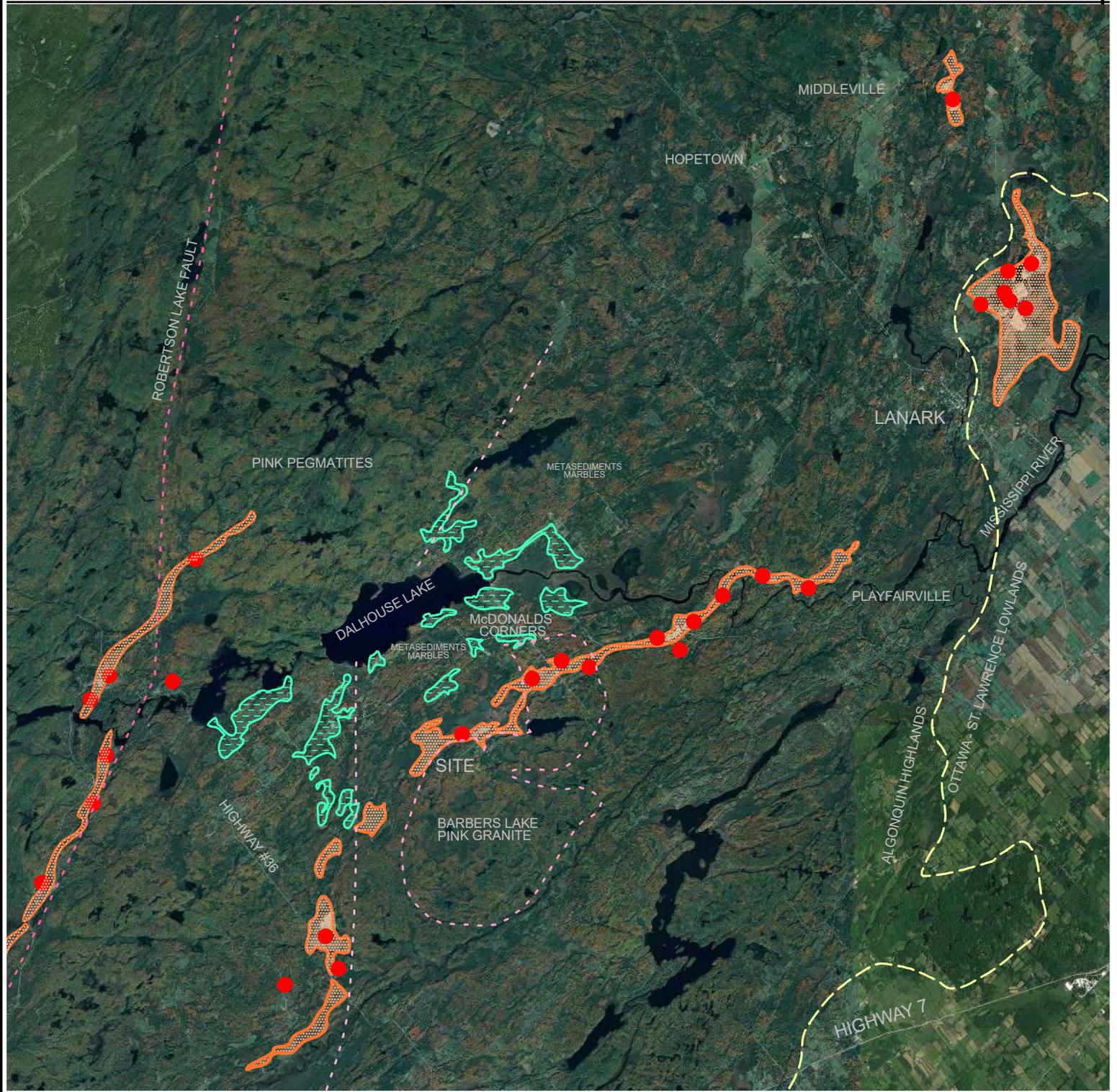
The surficial geology mapping for the area shows that the predominant surficial geology unit in the area is a thin and discontinuous silty till veneer and Precambrian bedrock (E. P. Henderson 1973, Gorrell, Van Haaften and Fletcher 1985, Gorrell and Shaw 1991, Lee, V. F. 2013, Henderson and Kettles 1992). In addition to the Precambrian bedrock, two other surficial units were mapped in the area.

The first is a series of glaciofluvial assemblages that traverse the area in a northeast to southwest orientation (E. P. Henderson 1973, Gorrell, Van Haaften and Fletcher 1985, Gorrell and Shaw 1991). These assemblages appear to originate in the Lanark Highlands. Two of these assemblages, shown on Figure 1, meander through the area and continue to the southwest through Frontenac County.

The material on the site has the characteristics of an esker to proximal cavity fill to bead to mid- to distal- fan (Photo 1, Photo 2). The sediment on the site has a moderate permeability that is consistent with literature values (Gorrell, 1991).

The glaciofluvial assemblages were deposited by meltwater beneath the glacier more than 12,000 years ago. The systems are composed of a central core, located along and south of Highland Line east of the





# LEGEND

-  GLACIOFLUVIAL ASSEMBLAGES
-  GLACIOLACUSTRINE DEPOSITS
-  GEOLOGICAL BOUNDARY
-  ARA-LICENSED SITE

FIGURE 1  
**LANARK-McDONALDS CORNERS  
 GLACIOFLUVIAL ASSEMBLAGE AND  
 BEDROCK GEOLOGY**

CLIENT ARNOTT BROS CONSTRUCTION LTD.  
 PROJECT NO. 21-022  
 DATE: JULY, 2022



**GRI Inc.**  
 Oxford Mills, ON K0G 1S0  
 T - (613) 258-2954

20210720-20210720

site that consists of sand and gravel. The core is flanked by esker beads and fans consisting of gravel to coarse to fine sand. The sediment was most likely deposited in a proglacial lake or series of lakes that were ice-dammed in the Precambrian Highlands. At the time of deposition, the glacier was probably still present in the Ottawa/St Lawrence Lowlands, while the highlands were relatively ice free (Gorrell, Van Haaften and Fletcher 1985, Gorrell and Shaw 1991, I. M. Kettles 1992a, I. Kettles 1992b, Kettles, Henderson and Henderson 1992).

The systems in the study area originated in the highlands to the northeast and transect the area in a northeast to southwest direction. They can be traced through the Dummer Moraine to the Oak Ridges Moraine in the Lake Ontario Basin (Gorrell, Van Haaften and Fletcher 1985, Gorrell and Shaw 1991, Gorrell and Brennand 1997).

The other units formed by glaciolacustrine processes. When the glacier retreated from the Algonquin Highlands, ice remained in the Ottawa/St. Lawrence lowlands that blocked the existing drainage outlets at the contact between the Paleozoic lowlands and Algonquin Highlands. The meltwater, prevented from draining eastward, ponded in basins and lowlands in the highlands. In the larger basins, glaciolacustrine sediment consisting of massive to rhythmically bedded sand, silt and clay were deposited (E. P. Henderson 1973, Gorrell, Van Haaften and Fletcher 1985, Gorrell and Shaw 1991). These deposits are also shown on Figure 1.

#### 5.4 Bedrock Geology

Geological mapping shows the bedrock in the area is of Late Precambrian age (Pauk 1983). The oldest rocks are metavolcanics and metasediments of the Grenville Supergroup. The metavolcanics are generally basalt while the metasediments are feldspathic sandstone and wacke, quartzite, calcareous mudstone and wacke. Locally the underlying bedrock is likely metasediments consisting of calcitic marble and grey and white banded calcitic marble.

The sand and gravel that was encountered during drilling was composed predominantly of marble even though the some of the underlying bedrock appeared to be granite (Photo 3, Photo 4). The geology map (Pauk 1983) indicates there is a nearby contact - the Barbers Lake Intrusion - in this area that consists of pink granite. Blocks or boulders of granite that have likely eroded from the intrusion are found in the cleared areas on the southern portion of the site (Photo 3 and Photo 4).

#### 5.5 Physiography and Topography

The site is completely situated within the Algonquin Highlands. The terrain in the study area generally consists of thinly veneered to bare bedrock and consist of highlands of Precambrian interspersed with lowlands that usually contain wetlands. The physiography of the area was defined as being underlain by Precambrian bedrock and is characterized by rounded ridges extending 15 to 60 m above the surrounding lowlands (Chapman and Putnam 1984). Wetlands are usually found in the lowlands between the bedrock ridges. There are a few exceptions where glacial deposits such as the glaciofluvial assemblages that wind through the basins between the uplands (Figure 1). Many of the lowland wetlands are underlain by glaciofluvial outwash or subwash. Drilling completed on the margins of the license (TW 2) indicate that there is more than 15 m of sand and gravel beneath the water table.



The thickness of the overburden on the uplands is generally thin and typically less than 2 m, but on the lee (downgradient) side of bedrock outcrops the thickness of the overburden can increase. Chapman and Putnam (1985) indicated that agriculture is minor and that no more than 2% of the physiological unit can be used for agriculture. Within 2 km traditional agriculture comprises approximately 8% of the land use (OS Figure 1).

**5.6 Climate**

The Drummond Centre Climate Station (Table 1) is located approximately 19 km northeast of the site just south of Mississippi Lake. It is the nearest station with current and a nearly complete precipitation record from 2015 to 2022. Normal data are also available. Monthly and annual precipitation data for are presented in OS Table 1.

**Table 1: Drummond Centre Climate Station ID and Location**

Climate Station	Drummond Centre
Climate ID	6102j13
Latitude	45°01'56.082" N
Longitude	76°15'10.098" W
Elevation	145.00 m

The Normal and 5-year average precipitation data are compared in OS Table 1, and the precipitation data from the previous 12 months are compared to the precipitation Normal (1981 – 2010) and the 5-year monthly average from 2017 to 2021. The available precipitation data to July 26, 2022 was used in the study.

The precipitation patterns affect groundwater levels and storage, surface water levels and flow, as well as vegetation growth and health. From OS Table 1 and Figure 2 it can be seen that;

The 1981 to 2021 Normal precipitation showed a reasonably small variation in monthly precipitation, between 51.3 mm (February) and 91.8 mm (September). From the lowest precipitation in February, monthly precipitation increased gradually to peak in June, followed by a decrease to August. There was additional increased precipitation in September and November, with a decline through to February again.

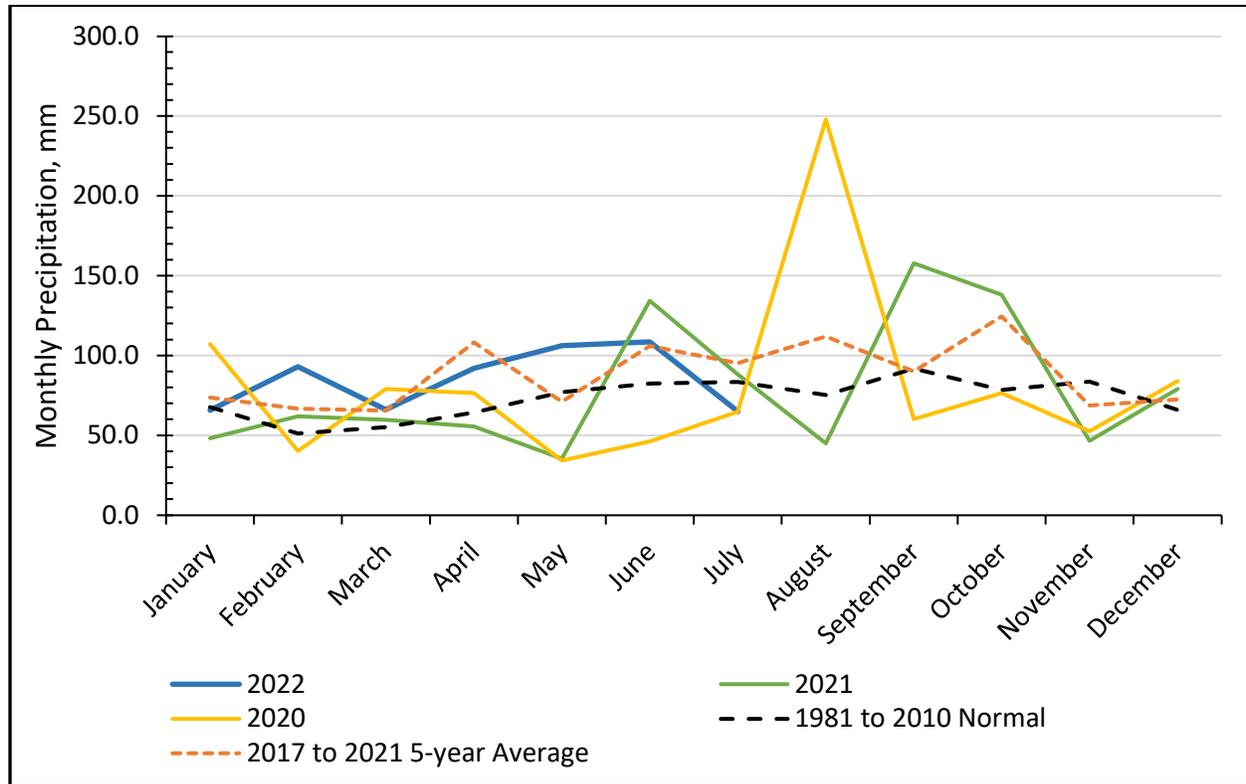
OS Table 1 shows that on average, the precipitation from 2017 to 2021 was about 20.3%, or 177.5 mm higher than Normal. In January, May, September and December, the 5-year average was within 10% of Normal. The variations in the other months ranged from April, which was 68.4% higher than Normal, to November, which was 18.0% lower than Normal.

Over the past 5 years (2017 to 2021) there were precipitation peaks of comparable rainfall in April, June, August, with a slightly higher peak in October. The precipitation was higher than Normal in most months in the past 5 years, and peaks did not occur in a consistent pattern. In 2020, monthly precipitation ranged from 34.2 mm in May to 248 mm in August. In 2021, the range was from 35.4 mm in May to 157.8 mm in September with an additional 138 mm in October. Through to July 26 in 2022, the minimum monthly precipitation was 65 mm in July, and the maximum was 108.6 mm in June. At the end of July, 2022, the precipitation has been 68.1% of Normal and 56.6 of the 5-year average. In comparison, in 2020 and 2021, the precipitation was 51.1% and 55.1% of Normal, and 42.5% and 45.8% of the 5-year average. The precipitation for 2022 to date has on average been slightly higher than Normal.



Approximately 70 to 75% of the annual precipitation falls on the site when the pit will be active (assumed to be between May and December) according to the Normal and 5-year averages.

**Figure 2: Monthly Precipitation, Drummond Centre Climate Station**



### 5.7 Regional Hydrogeology

The Renfrew County-Mississippi-Rideau Groundwater Study (Golder Associates Ltd. 2003) describes and maps the regional groundwater systems within title’s three areas. The study mapped and characterized the aquifers to identify their quantity and quality potential and to classify their susceptibility to contamination.

The primary aquifers in the RCMRGS study area are in bedrock and the well records show that 93% are completed in and obtain water from the bedrock. The remainder reported obtaining water from the overburden. The RMRGS indicated that the identified aquifers are all generally capable of supplying enough water to support residential development on private services, although the study also indicated that yields within some of the Precambrian-age aquifers may be marginal.

The RMRGS shows that west of Mississippi Lake, the bedrock and aquifer consist of Precambrian-age bedrock. The study indicated that interconnected fractures are the primary means of groundwater recharge and flow. East of Mississippi Lake, the aquifers are in sandstone and dolomite bedrock formations. The study indicated that groundwater flow in the sedimentary bedrock formations is mainly horizontal along fractures and bedding planes.

The RMRGS describes both large and small-scale characteristics of the aquifer using published data such as water well records. The data was subsequently refined into the Source Protection Plan of the



Mississippi Valley Conservation Authority (MVCA)<sup>‡</sup>. The nearest source water protection area shown on the geoportal is about 18 km southeast of the site, just west of the Town of Perth. The information also indicates that most of the groundwater in the watershed is highly vulnerable<sup>§</sup> because there is little overburden to provide protection from surface contamination.

Well records from the MOECC database within a 2-km area around the site were reviewed by GRI. The data provide details of specific wells at the provided location. For well records drilled before the 1990s, the UTM coordinates were interpreted from the provided driller's information by Provincial staff when current detailed mapping resources were not available and who were less familiar with the area. Consequently, the locations are occasionally mis-matched. To further refine the regional data, the locations were checked from the driller's sketch on the 53 well records that were identified from the provincial water well record database as being in the surrounding area. This was done to attempt to correlate the well records accurately to addresses. Wells records from the past 10 years regularly include civic addresses that improve the location accuracy but older wells were occasionally mismatched.

The well records were analyzed to refine the assessment of the groundwater characteristics in this report's study area to identify:

- aquifers in the area
- aquifers are being used as a water supply.
- groundwater flow directions
- typical well yield.

The well records are summarized in OS Table 2 and the locations are plotted on OS Figure 1. Graphical representation of some of the well data is shown on Figure 3. The regional groundwater flow is shown on OS Figure 3.

There are two groups of well records in the study area that suggest a site specific detailed investigation was conducted. These well records are dated in March 2007 and April 2009 at 811 11 Concession Dalhousie, and 15 well records for test wells and subsequent abandonment wells were associated with these clusters. These wells are not representative of groundwater use in the area. The remaining 38 wells were analysed for select characteristics. The analysed wells ranged in depth from 16.8 to 118.6 m. Wells were most often less than 40 m deep, with an average depth of 38.7 m. The reported water bearing zones occurred over a broad range between 51.5 and 205.2 mASL. The most common water bearing zones (elevation water found on Figure 3) were between 155 and 185 mASL (68.1%). At the site, this corresponds to 15 m or deeper below the current pit floor, and approximately 30 m or more below the ground surface of the proposed expansion. Bedrock was not reported in two wells of all the wells within 2 km of the site.

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<sup>‡</sup> <http://www.mrsourcewater.ca/PublicMappingTool.html>

<sup>§</sup> <https://www.mrsourcewater.ca/images/Documents/Mississippi-Rideau-Source-Protection-Plan/Schedules/SchL-HVA.pdf>



Out of the wells analysed, none were reported as dry. Wells reporting less than 3 GPM (11.4 L/min) comprised 16.2% of the wells. Most of the wells (70.3%) reported a yield between 3 and 25 GPM (94.6 L/min); 80% reported a yield between 3 and 20 GPM\*\* (Figure 3). A sustainable yield of 3 to 5 GPM (24.3%) is considered suitable for residential use. A residence can be sustained with a yield as low as 1 GPM if the flow is augmented with storage.

Two unconfined aquifers were identified in overburden on and within 500 m around the site. Confined bedrock aquifers were identified from published reports and data.

### 5.7.1 Overburden Aquifers

The study area is highly vulnerable (Mississippi-Rideau Source Protection Committee 2022). There were two reasons for the high vulnerability in the area, the first because of thin overburden in the south and south-west area, which reduces protection to the bedrock aquifer, and the second due to the high permeability of the glaciofluvial deposit.

A large regionally-extensive overburden aquifer was identified on the site and adjacent properties. The aquifer is in the glaciofluvial complex that transects the area (Section 5.3). The characteristics of the unconfined aquifers were classified using sedimentology and depositional facies (Gorrell and Shaw 1991). The report indicated that the hydraulic conductivity in a glaciofluvial deposit, such as the one being excavated on the site, would be on the order of  $10^{-4}$  to  $10^{-6}$  m/s.

This aquifer, which is referred to in this report as the “granular aquifer” was determined to be the key or significant aquifer with respect to the existing and proposed operation. In addition to two test wells, two water well records indicated the wells were completed in this aquifer (WWR 7106890 and 7274335).

A perched unconfined aquifer is found on the highland in the south-west part of the site and along the south boundary. The aquifer is in relatively shallow sand and till that overlies the bedrock.

The aquifer characteristics are discussed in detail in Section 10.

### 5.7.2 Bedrock Aquifer

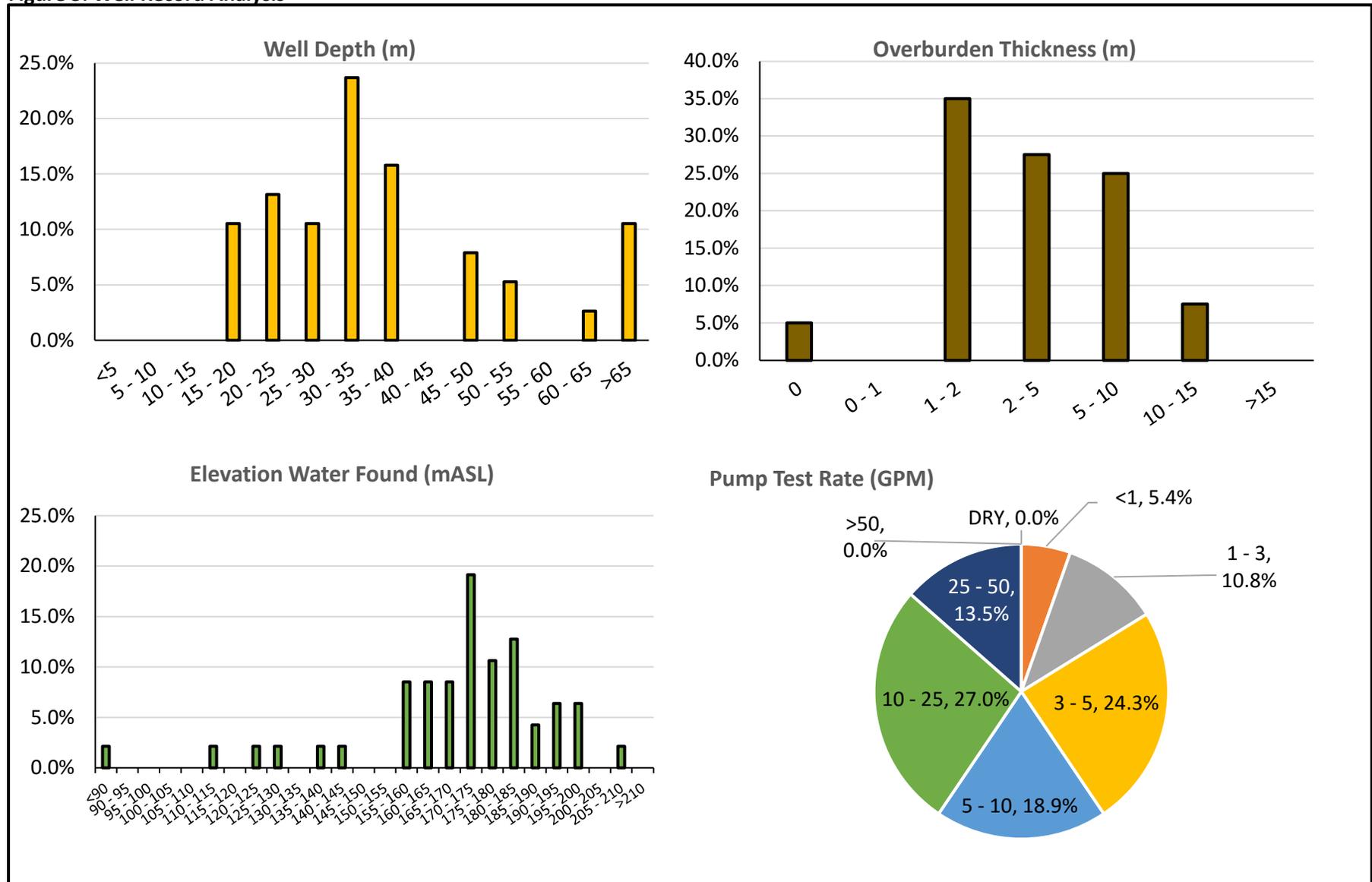
The underlying bedrock formations are the most common regional groundwater sources for wells. The licensed area is situated along a bedrock contact (Figure 1). Along Highland Line the mapped bedrock is part of the Barbers Lake intrusion that consists of pink granite. This formation was intercepted at the base of TW 1. North, and over most of the license the bedrock formation consist of metasediments such as marble (Pauk 1983). There are two bedrock aquifers, situated within different bedrock formations within the study area, but the description in this report does not differentiate between the two. The bedrock aquifer was evaluated through the water well records in the area (Ministry of Environment, Conservation and Parks 2022).

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\*\* Based on driller’s test rate. Recommended rate for use may be lower.



Figure 3: Well Record Analysis



The analysis show the wells in the area have reported moderate to high yields of good quality water (Figure 3). The RMRGS (Golder Associates Ltd. 2003) also indicates that the wells drilled in the area generally provide sufficient potable water to support a residence.

Groundwater in the Precambrian bedrock flows through fractures, gaps and voids, or in metasediments, along bedding planes. The transmissivity of the aquifer depends on the fracture connectivity. The geometric mean of transmissivity from wells tested in the Precambrian bedrock is approximately  $2 \times 10^{-4}$  m<sup>2</sup>/day (Singer, Cheng and Scafe 2003).

The regional groundwater flow in the bedrock aquifer was also interpreted from the water well records. From the data, groundwater in the bedrock flows from the north-west and south to southwest towards a discharge area that is in the low-lying area between the two bedrock highs (OS Figure 3).

### **5.7.3 Springs**

One spring was confirmed on the southern side of the site, approximately 120 m east of TW 1 (OS Figure 2). Infiltration into the sand and till on the height of land along Highland Line emerges as a spring on the slope when a contrastingly lower permeability material (dense till or bedrock) is encountered. After the groundwater discharges from the spring, it flows along the contact for approximately 100 m before completely infiltrating into the glaciofluvial deposit.

The natural environment report (Ecological Services 2022) did not identify any seeps or springs.

### **5.7.4 Wells**

From a review of the individual well records, 7 were matched to locations within 500 m of the site. Out of these, two were records of deepening an existing well. The physical characteristics and details from the water wells are summarized in OS Table 2. The matched well records, which are shown on OS Figure 1, are found in Appendix A. All but two of the well records are completed in bedrock. One of these wells is located approximately 900 m away, and both are located north-east of the site on Highland Road. The well stratigraphy indicates they are completed in gravel at depths of 16.8 and 30.5 m.

Southwest of the site, the bedrock is within 6 m of the surface and although the overburden may contribute some of the water to the well, the water bearing zones represent Precambrian bedrock where the water bearing zones are discrete and are not consistent among nearby wells. West, northwest and southeast of the site there are appreciable thicknesses of sorted material above the bedrock. For wells drilled through this deposit, some of the groundwater may be derived from the overburden.

## **5.8 Regional Hydrology**

The site is within the Mississippi Lake subwatershed, situated at the southeastern end of the Mississippi Valley watershed (Mississippi Valley Conservation Authority 2021). The site comprises less than 0.14% of the Mississippi Lake subwatershed.

The boundary between the subwatershed and the adjacent Fall River subwatershed (south-east) is shown on OS Figure 1.



The Mississippi Lake Subwatershed has a drainage area of 294 km<sup>2</sup> <sup>††</sup> within the overall Mississippi River Watershed of approximately 3,750 km<sup>2</sup> <sup>††</sup>. Long Sault Creek, which is a tributary of the Mississippi River, is approximately 80 m north of the site. Surface drainage on the site is towards the creek, based on topography. However, as indicated above, most precipitation and snow melt infiltrates into the ground. The Highland Line roadside ditch is diverted through the property.

The boundary of an unevaluated wetland is found west, north and east of the site. It has an approximate area of 129 ha and approaches to within 55 m of the north and west boundaries of the site (Ecological Services 2022). The natural environment report found that the wetland boundary within 120 m of the site closely matched the mapping shown by MVCA (Mississippi Valley Conservation Authority 2021). The boundary is shown on OS Figure 1.

The roadside ditch along Highland Line has been diverted through the site about midway along the south property boundary (OS Figure 2) where sand and till overly bedrock. Water in the ditch meanders northerly across the proposed expansion to the pit, and completely infiltrates the pit floor within 65 m. There was no flow or runoff observed from the site into Long Sault Creek. Similarly, most, if not all the precipitation and snow melt on the glaciofluvial deposit is expected to infiltrate into the sand and gravel (OS Figure 2).

## 5.9 Water Budget

The water budget describes the relationship between the inputs and outputs of a water system. The water budget is defined as;

$$P = E + I + R + \Delta S$$

Where;

P = total precipitation

E = evaporation

I = infiltration

R = runoff

$\Delta S$  = change in storage.

Storage change ( $\Delta S$ ) is assumed to be zero in the analysis that considers the long term or steady state condition. The precipitation, evaporation, seepage, water surplus, topography, soil conditions, vegetative cover, infiltration and runoff characteristics at the site are described below. OS Table 1 provides the 1981 – 2010 Normal, 5-year average and the monthly data for precipitation and temperature at the Drummond Centre climate station.

### 5.9.1 Precipitation

The Normal precipitation is 876.3 mm, compared to the 5-year average (2017 to 2021), which was 1,024.0 mm.

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<sup>††</sup> <https://mvc.on.ca/wp-content/uploads/2020/08/BGTHREE.pdf>

<sup>††</sup> <https://mvc.on.ca/watershed-facts/mississippi-river-watershed/>



### 5.9.2 Evaporation

The Thornthwaite Method was used to evaluate evaporation (Thornthwaite 1948). The Thornthwaite equation, is;

$$U = 1.6 \times \sum (10t / TE)^{0.9916}$$

where:

U - Evaporation (cm)

t - mean monthly temperature (OP)

TE - Annual Heat Index =  $(t/5)^{1.514}$

The annual evaporation was calculated as **593 mm** from the mean monthly normal temperature data (1981 to 2010).

### 5.9.3 Water Surplus

The water surplus is the quantity remaining after evaporation,

$$876 - 593 = 283.4 \text{ mm, is available for runoff or infiltration.}$$

The water surplus component of the water cycle can be subdivided into infiltration and runoff components.

#### 5.9.3.1 Infiltration

An infiltration factor has been used for this report, following MECP criteria (Ministry of Environment and Energy 1995). The infiltration factor is the sum of topographic, soil and vegetative factors.

The property slopes to the west and northwest at approximately 115 m/km. The topographic factors in the reference show “hilly land, average slope of 28 to 47 m/km” has a topographic factor of 0.10. A steeper site would have a lower slope factor.

The factor of 0.1 that has been used for the site overestimates the slope factor within the site boundary. However, over a wider area, the average slope is about 25 m/km from the highland at the site and just south, down to the wetland. The slope factor is representative for the accuracy of the method.

The soil on the site consists of sand and sand and gravel and is classified as a Type A soil (MTC, 1997). A factor of 0.4 (open sandy loam) was used for the soil factor.

The property is generally clear of trees. Therefore, a cover factor of 0.12 was used.

The infiltration factor is the total of the topography, soil and cover factors, or 0.62.

Applied to the water surplus, the resultant infiltration is.

$$0.62 \times 283.4 = 175.7 \text{ mm.}$$

As described above the drainage from Highland Line infiltrates into the ground before it reaches Long Sault Creek.

**Table 2: Water Budget**

Water Budget	Site (m/yr)
Precipitation	0.8763
Evaporation	0.5929
Seepage	0
Water Surplus	0.2834
Infiltration	0.1757
Runoff	0.1077



### 5.9.3.2 Runoff

Runoff remains when the infiltration is subtracted from the water surplus. The annual runoff is an estimated 107.7 mm for the site.

The water budget is found in Table 2.

## 6 CONCLUSIONS, LEVEL 1 WATER REPORT

The Level 1 preliminary investigation identified that the pit will be extracted below groundwater and area surface water features. A review of available references, the natural environment report for the application (Ecological Services 2022), and an examination of the site and study area in moderate detail, there are area features that may potentially be affected by the proposed operation. The features that should be assessed in more detail are;

- water wells,
- groundwater aquifers,
- surface water courses and bodies and potentially discharge areas, and
- springs.

The site is not within a Wellhead Protection Area for quantity or quality (Mississippi-Rideau Source Protection Committee 2022). The site is within an area considered to be a highly vulnerable aquifer.

The preliminary hydrogeological review found the potential for impact by the proposed pit to features identified in the Level 1 Water Report. Consequently, a Level 2 Hydrogeological Report, consisting of a field investigation was completed and a detailed analysis of the potential impacts was undertaken.



# Level 2 Water Report

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## 7 LEVEL 2 WATER REPORT REQUIREMENTS

The Level 2 Water Report requirements must consider features described in Table 3 (Ontario Ministry of Natural Resources and Forestry 2020a, Ontario Ministry of Natural Resources and Forestry 2020b).

**Table 3: Hydrogeology Level 2 Assessment Requirements**

<b>Setting and Existing Hydrogeological Features</b>	<ul style="list-style-type: none"> <li>a. Description of physical setting including local geology, hydrogeology and surface water system</li> <li>b. Water wells</li> <li>c. Springs</li> <li>d. Groundwater aquifers</li> <li>e. Surface water courses and bodies</li> <li>f. Discharge to surface water</li> </ul>
<b>Proposed Operation</b>	<ul style="list-style-type: none"> <li>g. Proposed water diversion, storage and drainage facilities on site</li> <li>h. Method of extraction</li> </ul>
<b>Impact Assessment and Mitigation</b>	<ul style="list-style-type: none"> <li>i. Impact assessment</li> <li>j. Mitigation measures including trigger mechanisms</li> <li>k. Contingency plan</li> <li>l. Monitoring plan</li> </ul>
<b>Technical Report</b>	<ul style="list-style-type: none"> <li>m. Technical support data is the form of tables, graphs and figures</li> </ul>

## 8 SITE INVESTIGATION

The hydrogeological assessment consisted of; reviewing the available hydrogeological information on the site and surrounding area, installing three test wells and installing groundwater monitors, field-testing the physical characteristics of the encountered stratigraphy, measuring the groundwater level in the monitors periodically from December 2020 to July 2022, and sampling the ambient groundwater quality. The data was analyzed and the potential impact to the surface and groundwater features was assessed. Recommendations to assess whether the impacts occur over the site life are provided.

### 8.1 Information Review

The data sources reviewed for the background on the site and study area included;

- Preliminary notes dated February 2022 prepared by Milestone Aggregate regarding the site and the proposed operation;
- water well records from the provincial well record database maintained by the Ministry of the Environment, Conservation and Parks (MECP) accessed on June 2022;
- geological mapping by the Ontario Geological Survey, Geological Survey of Canada and Ministry of Northern Development and Mines;

- aggregate resource studies completed by the Ministry of Northern Development and Mines;
- aggregate resource studies completed by the Ontario Geological Survey.
- Renfrew County -Mississippi -Rideau Groundwater Study
- The Rideau-Mississippi Source Protection Plan
- groundwater, surface water and flow data and mapping identified and outlined by the Mississippi Valley Conservation Authority.

## **8.2 Drilling and Monitoring Well Installation**

The pit faces in the pits in the immediate area were examined by GRI staff and three monitoring wells were drilled on the site using hollow-stem augers on November 26 and 27, 2020 by George Downing Estate Drilling Ltd (Photo 5 to Photo 7) .

Each hole examined the stratigraphy from the ground surface down to bedrock refusal or to 18 m below the water table. The fineness modulus (FM) was estimated from the sediment grain size. A piezometer constructed of 40-mm diameter PVC screen attached to solid PVC riser was installed in each borehole. A sand pack of #3 silica sand (2.46 mm effective size) was placed around, and for 0.61 m above, the screen. Bentonite chips were used to fill the bore hole from the sand pack to surface. A protective casing and a locking well cap completed the installation. The surface elevation at the test wells was interpolated from the topographic base map (TEC Surveying Inc. 2021).

## **8.3 Water Level Monitoring**

Groundwater levels in the piezometers were seasonal measured manually with a water level meter on December 3 and 21 in 2020, January 11, March 30, April 23, June 10, July 12 and September 16 in 2021 and July 28, 2022 (Table 5).

## **8.4 Hydraulic Conductivity Testing**

In-situ rising and falling head tests were conducted in the piezometers on December 21, 2020 using a “slug” (PVC and copper cylinder filled with sand and capped at both ends). The timed response to an instantaneous change in water level was used to estimate the hydraulic conductivity of the sediment. In falling head tests, a rise in water level is caused by introducing the slug into the well. Rising head tests measure a rising water level created by the removal of a slug after the water level has stabilized. The water levels during the test were measured every half second using a pressure transducer (data logger) installed in the piezometer below the tested zone. A barologger was used to gather barometric data to correct the readings from the loggers. The summary of the tests are found in Table 4.

## **8.5 Geochemical Sampling**

Samples for geochemical analysis were collected from the piezometers on December 3, 2020 and January 11, 2021. To prepare the wells for sampling, they were pumped for approximately one hour to remove more than 20 well volumes using a Waterra™ foot valve set at the level of the well screen, until the discharge appeared clear. Water samples were filtered through 0.45 µm Waterra™ filters into laboratory-supplied bottles. The sample temperature was maintained with ice and submitted to Eurofins Environmental Laboratories in Ottawa within 5 hours.



## 9 SITE CONDITIONS

### 9.1 Site Geology

The depositional environment on the site was assessed by the review of surficial mapping for the area, consultant reports which supported the licensing of pits, examining the pit faces on the site and also in the neighbouring pits in the area (Tackaberry Sand and Gravel, Tackaberry & Sons Constr. Co. Ltd., Robert Anderson, Lanark County, and Cavanagh Constr. Pit and Crain Pit), and examining the sediment from the three drill holes. The pit locations are shown on OS Figure 1.

As described in Section 5.3, the site is on a glaciofluvial assemblage that extends from the Village of Middleville, through the Town of Lanark and then extends westward through the Playfairville area to the Frontenac/Lanark County Boundary. The site is situated on the esker, esker-bead and fan portions of the deposit (Gorrell and Shaw 1991).

Four glaciofluvial sedimentological facies were identified on the site: 1) esker, 2) esker/fan, 3) cavity/bead fills and lacustrine sands over esker sediment (Gorrell and Shaw 1991). An esker can be traced from Playfairville along County Road 12 and Highland Line to the central highland portion of the site (Figure 1). The internal sediment arrangement was observed in the Tackaberry and Cavanaugh pits along these roads (OS Figure 1). The core of the esker consists of +30% stone and medium to very coarse sand. The clasts are often imbricated indicating that the clasts bounced and rolled along the base of the flow (Gorrell and Shaw 1991). TW 3 is situated on the north side of the esker, just before the feature crosses Highland Line.

The esker fan formed either at the grounding line of the glacier where the under-ice flow system opened out into a large proglacial lake or a large subglacial cavity. In either case, the flow expanded and sand was deposited in large diffusely bedded beds, and subsequently tabular crossed beds and foresets of sand. The flow expansion resulted in a rapid deceleration of the depositing current and the particle size change from gravel to sand. The esker fan is found south of TW 2 and westward on the site (OS Figure 2). The height of land located south of the existing face roughly corresponds to the zone where the confined flow in the esker expanded into an opening at a grounding line or very large cavity.

In some areas, the flow deposited sediment in small cavities beneath the glacier. The two conical hills located on the western side of the site were deposited in such cavities (Photo 1 and Photo 2). The material in the conical hills will consist of faulted beds of sand and gravel. The faults developed as the glacier melted and the ice supported sides of the deposit were removed. The upper 7 m of TW 1 represents the edge of one of the cavity fills.

The final environment occurred as the ice front retreated from the area. Low lying areas were later covered by sand eroded from the side of the esker assemblage or carried to the site by limnological currents as bars or spits. The finer sand that overlies the sand and gravel at TW 3 is lacustrine sand.

The fineness modulus<sup>55</sup> of the sediment was estimated to range from less than 1 (medium to medium fine sand with silt/clay layers, TW1) to greater than 3 (sand, gravel TW2 and TW 3). Overall, the deposit appears to coarsen downwards, which is characteristic of a fan (G. A. Gorrell 1991, Gorrell and Shaw 1991).

The drill hole logs and water well records for the test wells are found in Appendix B. OS Table 3 summarizes the characteristics, stratigraphy and installation details of each hole. The sediment thickness measured on the site ranged from 7.62 at TW 1 to greater than 18.9 at TW 2 and TW 3. Bedrock was intercepted only at TW 1 and the hole intercepted the Barber Lake granite intrusion upland located along the southwest periphery of the site. TW 2 and TW 3 did not encounter the underlying bedrock which, based on the geology maps for the area (Pauk 1983) is metasediment marble.

The approximate bedrock elevation ranges from 194.9 at TW 1 to below 174.2 at TW 2 and TW 3. As shown in OS Figure 4 the bedrock rises towards the south-west and is estimated to be at 212 mASL south of Highland Line. Cross-sections of the geology through the site are interpreted on OS Figure 4..

## 9.2 Water Balance

An annual water surplus of 0.2834 m was calculated from the 1981-2010 climate Normals (Section 5.9.3). In the analysis, the water surplus was used to estimate the recharge and throughflow, assuming all runoff and infiltration was fully absorbed within the catchment. The conditions within the catchment area were averaged with the infiltration factor of 0.62 (Table 2). The permeability of the sediment was a key influence on the relatively high contribution of infiltration compared to runoff. In the site visits for the study, little runoff off site was observed.

The approximate catchment area of the site is shown on OS Figure 2. The two terrain units on the site have different characteristics. At the perched aquifer the slope factor is very low due to the steep terrain (+/-115 m/km). The infiltration slope factor cannot less than 0.1, so even though the slope in the granular aquifer is about 25% of the highland area, 0.1 was used. There are small differences in the hydraulic conductivity of the two areas. The sediment in the granular aquifer has a 1.7 to 1.9 times higher hydraulic conductivity than the perched aquifer. An average infiltration factor of 0.62 was used for the site.

The recharge to the catchment area was calculated to be 138,566 m<sup>3</sup> annually (Calculation 1).

### Calculation 1: Site Recharge

Water Budget from Normal (Section 5.9)			Runoff and Infiltration Areas		
Precipitation	0.876	m/yr	Catchment Area:	488,941	m <sup>2</sup>
Evaporation	0.593	m/yr	Infiltration Area	488,941	m <sup>2</sup>
Seepage					
Water Surplus	0.283	m/yr	Infiltration	85,907	m <sup>3</sup>

<sup>55</sup> Fineness modulus of sand (fine aggregate) is an index that represents the mean size of the particles in sand. It is calculated by adding the cumulative percentage of a sample of aggregate retained on a specified series of sieves and dividing the sum by 100.



Water Budget from Normal (Section 5.9)			Runoff and Infiltration Areas		
Infiltrate	0.1757	m/yr	Runoff	52,659	m <sup>3</sup>
Runoff	0.1077	m/yr	<b>Total (Water Surplus)</b>	<b>138,566</b>	<b>m<sup>3</sup></b>

### 9.3 Site Hydrogeology

The test wells intercepted two overburden aquifers, a perched aquifer in the sand/till in the south-west part of the site, and the unconfined aquifer in the sand and gravel (OS Figure 2). A piezometer was installed in each drill hole and in-situ hydraulic conductivity tests were conducted. The data from the hydraulic conductivity testing and analyses are found in Appendix C. The data were analysed using AQTESOLV software. The Hvorslev method (Hvorslev 1951) was used for the analysis, and the results are tabulated in Table 4.

The literature provides a hydraulic conductivity range for medium fine to medium coarse sand between  $9 \times 10^{-7}$  m/s to  $5 \times 10^{-4}$  m/s (Domenico and Schwartz 1990). The perched “highland” aquifer is represented by TW 1 and the spring (Photo 8 and OS Figure 2). The analysis found the hydraulic conductivity ranged from  $2.74 \times 10^{-5}$  m/s to  $2.21 \times 10^{-4}$  m/s in the perched aquifer. The granular aquifer is represented by TW 2 and TW 3. The hydraulic conductivity ranged from  $4.57 \times 10^{-5}$  m/s (TW 2) to  $2.97 \times 10^{-4}$  m/s (TW 3). The average hydraulic conductivity from the test results for each well and for each aquifer is found in Table 4. The average hydraulic conductivity for the highland unit is  $1.07 \times 10^{-4}$  m/s and the average for the granular unit is approximately 1.8 times higher, at  $1.92 \times 10^{-4}$  m/s.

**Table 4: Summary of Hydraulic Conductivity Tests in Terrain Units and Test Wells**

perched “Highland” Unit (sand/till)		Granular Unit (glaciofluvial sand and gravel)			
TW 1		TW 2		TW 3	
Hydraulic Conductivity (m/s)	Type of Test	Hydraulic Conductivity (m/s)	Type of Test	Hydraulic Conductivity (m/s)	Type of Test
6.00E-05	FH	1.63E-04	FH	2.79E-04	FH
7.72E-05	RH	4.57E-05	RH	1.58E-04	RH
4.27E-05	RH (Calc 1)	4.90E-05	FH (Calc 1)	1.75E-04	FH
2.74E-05	RH (Calc 2)	8.27E-05	FH (Calc 2)		
2.02E-04	FH	1.01E-04	RH		
1.15E-04	RH	9.04E-05	FH		
3.94E-05	FH				
2.21E-04	RH				
1.78E-04	FH				
<b>Average</b>	1.07E-04	1.80E-04		2.04E-04	
<b>MAX</b>	2.21E-04	7.32E-04		2.79E-04	
<b>MIN</b>	2.74E-05	4.57E-05		1.58E-04	

The groundwater elevation measured on 9 occasions are found in Table 5. Figure 4 shows the water level variation over the study, which can be compared to monthly precipitation. The groundwater

elevation and flow for select dates are shown in plan view on OS Figure 5 to OS Figure 7, which capture spring recharge, mid-summer and fall. The data illustrate how the groundwater at TW 1 was 8.38 to 11.15 m higher than TW 2 or TW 3.

The spring was at approximately the same elevation as the groundwater in TW 1 (TEC Surveying Inc. 2021) and was interpreted to represent the perched aquifer. Two other areas of ponded water were found near the base of the granular deposit along the north edge and near the eastern end of the existing south license boundary (OS Figure 2). The standing water was in local depressions, and although springs were not observed at the locations, they are possible contributors to the surface water accumulations. The groundwater levels at TW 2 and TW 3 were 0.98 to 3.26 m, and 2.26 to 2.66 m below the ground surface, respectively, and with the site topography, springs would be expected. The boundaries were traversed several times by GRI staff and no springs were found. None were found either in the natural environment field study (Ecological Services 2022).

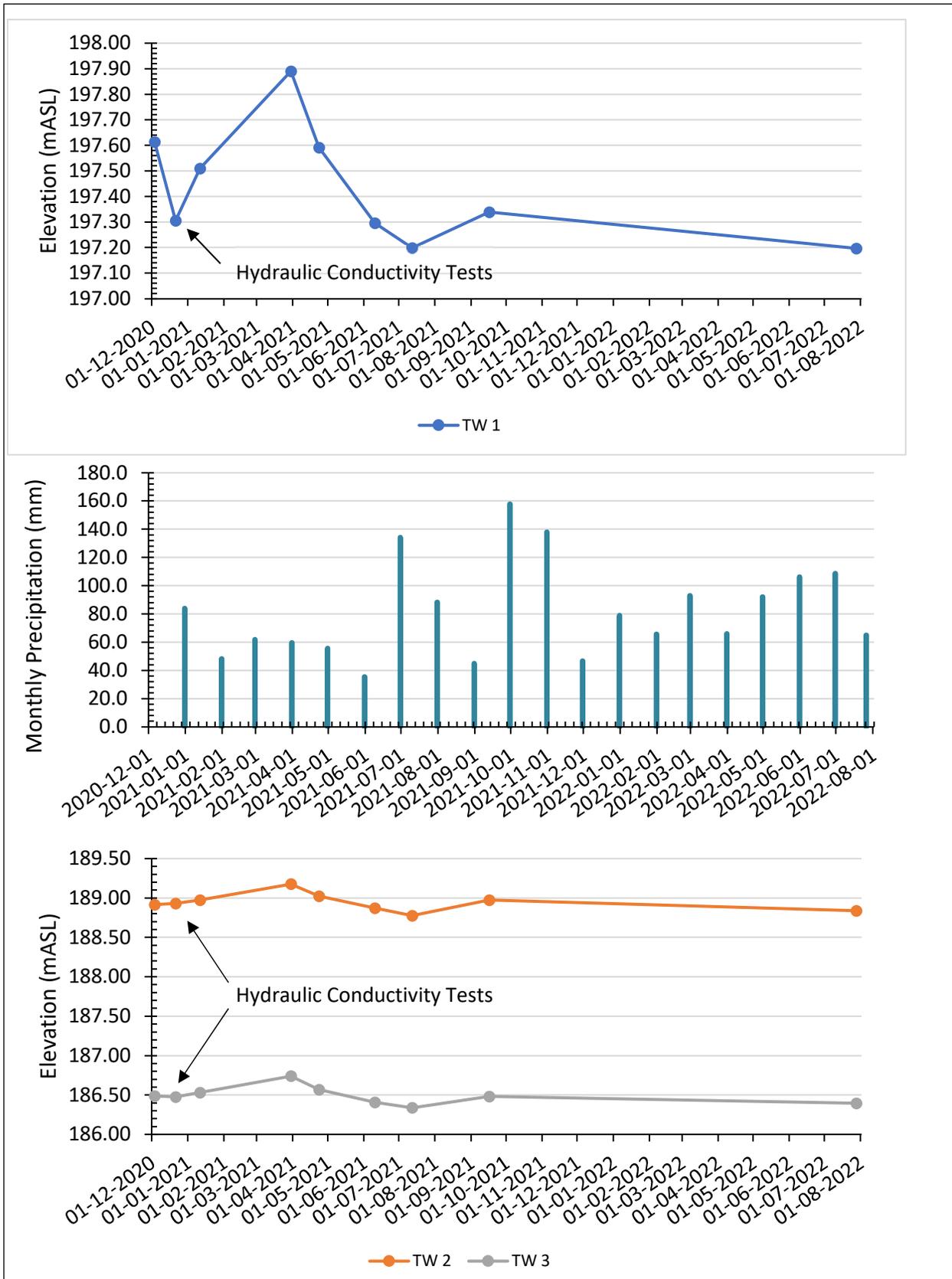
The groundwater elevation at TW 1 was relatively consistent, with a fluctuation between highest and lowest measured levels of 0.69 m. At TW 2 the groundwater elevation fluctuated 0.25 m. The groundwater elevation in TW 3 fluctuated 0.4 m over the period monitored and was an average of 2.45 m lower than TW2 in the granular aquifer. The groundwater flow in the catchment area of the site is interpreted to drain from the perched aquifer on the Barbers Lake intrusion in the south-west part of the site, into the granular aquifer. Within the granular aquifer on the site the flow direction is, it can be inferred that the flow will have localized multi-directional components that are controlled by grain size and structure. The difference in groundwater elevation between TW 2 and TW 3 suggests an eastward flow component, but the flow direction on the site is expected to be variable and reflects the surficial and bedrock geology as is seen in other similar deposits. There is an interpreted smaller northward flow component that may contribute recharge to the wetland, since the water table in the granular aquifer is slightly higher or approximately at the surface elevation in the north buffer zone. This could be confirmed with the presence of springs, but this area of the site was not completely accessible because of the tangled undergrowth.

Over the monitoring period, the highest water level in both unconfined aquifers was recorded on March 30, 2020 (TW 1 and TW 3), and April 23, 2021 (TW 2). The lowest groundwater level occurred on July 12, 2021 in all three wells. The groundwater levels on July 28 just over one year later were nearly identical.

**Table 5: Potentiometric Levels in Test Wells**

	<b>Dec 3, 2020</b>	<b>Dec 21, 2020</b>	<b>Jan 11, 2021</b>	<b>Mar 30, 2021</b>	<b>Apr 23, 2021</b>	<b>June 10, 2021</b>
TW 1	197.61	197.31	197.51	197.89	197.59	197.30
TW 2	188.91	188.93	188.98	188.87	189.02	188.87
TW 3	186.49	186.48	186.53	186.74	186.57	186.41
	<b>July 7, 2021</b>	<b>Sept 16, 2021</b>	<b>July 28, 2022</b>			
TW 1	197.20	197.34	197.20			
TW 2	188.78	188.98	188.84			
TW 3	186.34	186.48	186.40			

Figure 4: Variation in Groundwater Level, TW 1 to TW 3



The March and April high groundwater levels usually coincide with spring rainfall and snowmelt. Although the precipitation from January to April In 2021 was slightly below Normal (94.5%) and 71.7% of the previous 5 year average (OS Table 1), the water levels still followed the expected seasonal pattern.

The groundwater flow through the site, from west to east was estimated (Calculation 2). The flow through the site is approximately 469,787 m<sup>3</sup>/yr.

Groundwater flow in the unconfined granular aquifer is eastward, towards Barbers Lake.

**Calculation 2: Groundwater Throughflow, Site**

**Q=k i A**  
 Where:

<b>Q =</b>	groundwater flow, m <sup>3</sup> /yr	
<b>k =</b>	hydraulic conductivity, m/yr	
<b>i =</b>	hydraulic gradient in the direction of flow,	
	= $d_v/d_h$	
		$d_v$ =change in groundwater level across the site      9.5 m
		$d_h$ =distance over which the change occurs      386 m
<b>i =</b>	9.5/386	
	= 0.02461	
		average depth of excavation below water table      12.95 m
		width of cross section      285 m
<b>A =</b>	3,691	m <sup>2</sup>
<b>k =</b>	1.64E-04	average for site, m/s
	= 5,172	m/yr
<b>Q = k i A</b>		
	5,172 * 0.02461 * 3,691	m <sup>3</sup> /yr
	<b>469,787.42</b>	<b>m<sup>3</sup>/yr</b>

The confined bedrock aquifer will not be intercepted by the proposed operation. Along Highland Line the mapped bedrock is part of the Barbers Lake intrusion that consists of pink granite. This formation was intercepted at the base of TW 1.

The potentiometric groundwater elevation in the confined bedrock aquifer is approximately 200 mASL at the site, based on the analysis of water well records.

**9.4 Site Hydrology**

The Long Sault Creek/Wetland abuts the site on its northern and western peripheries. The granular aquifer may also provide some recharge to the feature, again based on the groundwater elevation in the aquifer compared to the surface elevation.



The flow in the Highland Line ditch turns and flows through the site about midway along the south property boundary ( Photo 9, Photo 10 and OS Figure 2). Water in the ditch initially meanders northerly across the shallow bedrock, but completely infiltrates the pit floor within 65 m once it drains into the granular unit.

#### 9.4.1 Wetland

Part of an approximately 129 ha wetland is found within 120 m around the site on the north and east boundaries of the site. The published mapping indicates it is part of the Long Sault Creek watercourse. The wetland is not identified as Provincially significant, but Ministry of Mines and Development, Natural Resources and Forestry considers non-evaluated wetlands as significant, until otherwise shown. It is reasonable to expect a wetland of this size to score as significant (Ecological Services 2022).

The wetland is within 55 m of the north and west parts of the proposed extraction boundary of the existing license area and immediately east of the proposed expansion boundary (OS Figure 2). The Mississippi Valley Conservation Authority limits activity within 30 m from the wetland. The natural environment report (Ecological Services 2022) recommends the buffer be increased to 45 m along the northeast end of the existing license area due to steep slopes.

Four wetland communities, a meadow marsh, a thicket swamp and two conifer swamp types, were identified within 120 m of the existing and expansion pit areas in the study. These wetlands will be buffered from the pit by a band of woodland.

The report concluded that biological features such as diversity are not expected to be impacted by the proposed pit, since the existing pit license, which for the most part will be between the expansion areas and the wetland has little value to wetland species needs. It also observed that significant changes to wetland features such as diversity appeared to be controlled by factors that are not related to the pit activity, such as beaver activity.

The report finally notes that the lake that will result at rehabilitation may add value to the wetland by adding diversity. Finally, the report does caution that the creation of the lake should not divert water from the wetland, as a negative impact to the wetland could result. This concern is addressed in the impact assessment (Section 12).

### 9.5 Groundwater Quality

Groundwater samples were collected from TW1, TW2 and TW3 on December 3, 2020 and January 11, 2021. The water samples were clear and odourless. The laboratory reports are found in Appendix D and the geochemical results are presented in OS Table 4. The geochemistry was consistent in the three site wells.

The Ontario Drinking Water Standard provides the limits and objectives for groundwater quality that range through a maximum allowable concentration, (MAC), an interim maximum allowable concentration, an aesthetic objective (AO) or an operation guideline (OG). The limits are included on OS Table 4. The laboratory results from the samples met the respective Ontario drinking water standards.

The sodium and chloride concentrations were elevated at TW 3 in comparison to TW 1 and TW2, which suggests that some local contamination, likely road salt on Highland Line, has occurred. The hardness

concentration was also slightly elevated comparatively as was nitrate. These combined to elevate the total dissolved solids and conductivity. There is high throughflow in the granular aquifer that will help dilute any local contaminants.

The water samples did not indicate the presence of total petroleum hydrocarbons or selected volatile organics that would indicate an impact from the current operation has occurred.

## 10 CONCEPTUAL HYDROSTRATIGRAPHIC MODEL

Four aquifers were identified on the site and study area; two unconfined aquifers underlain by confined bedrock aquifers.

A large regionally-extensive overburden aquifer was identified on the site and adjacent properties. The aquifer is in the glaciofluvial complex that transects the area (Section 5.3). Where the assemblage is at the surface, such as in the study area, the aquifer is unconfined, but it may be semi-confined to confined elsewhere where it has been buried by organics and fine-grained lacustrine sediments, (G. A. Gorrell 1991). The site mapping and interpretation of the deposit facies suggest this may be the case in the wetland north of the site

The proposed operation will extract below the water table will intercept the unconfined granular aquifer. The investigation determined this aquifer (the granular aquifer) is the key or significant aquifer with respect to the existing and proposed operation. In addition to two of the test wells, two off-site water well records indicated the wells were completed in this aquifer (WWR 7106890 and 7274335). Water levels measured seasonally and over a period between December 3 to July 28, 2022 ranged from 186.3 to 189.0 mASL. In the site wells, the hydraulic conductivity ranged from  $4.57 \times 10^{-5}$  m/s (TW 2) to  $2.79 \times 10^{-4}$  m/s (TW 3) in the granular aquifer and terrain unit.

A second aquifer, perched and unconfined, is found in highland part of the site in the south-west and along the south boundary. The aquifer is in sand and till that overlies the bedrock. This aquifer currently discharges on the north side of the highland terrain. The behaviour of the aquifer theoretically would not have changed as a result of the current site operation, and there was no evidence that an impact occurred. The aquifer may have originally discharged into the glaciofluvial sediment before it was excavated for aggregate, similarly to the possible spring located near TW 3 (OS Figure 2). The hydraulic conductivity ranged from  $2.74 \times 10^{-5}$  m/s to  $2.21 \times 10^{-4}$  in the perched highland aquifer. Water levels in the perched aquifer varied between 197.2 and 197.9 mASL.

The field investigation found one seep/spring on the site but no others were confirmed. One was confirmed on the south side of the site where the bedrock of the Barbers Lake intrusion and the till overburden intersect the surface (Photo 8). Others would be expected along the north face of the highland, as described in Section 5.7.3 (OS Figure 2). Water from this seep infiltrates within 70 m as it flows over the into the granular aquifer.

Springs or seeps would also be expected along the north boundary of the site, and one potential location identified from aerial photography is shown on OS Figure 2. The lower elevation along the north edge of the deposit would control the groundwater level in the granular aquifer.

The site and study area have an infiltration and runoff rate comprise approximately 20 and 12% of the precipitation. Runoff on the site is northward.



## 11 MAXIMUM WATER TABLE

The maximum water table was determined in the hydrogeological investigation. The groundwater levels were measured in three site wells between December 3, 2020 and July 28, 2022. TW 1 represents the perched unconfined aquifer. The other two wells, TW 2 and TW 3 represent the granular aquifer. The granular aquifer is the pertinent aquifer to use to establish the maximum water table for the proposed operation.

At TW 2 the groundwater elevation fluctuated 0.25 m. The groundwater elevation in TW 3 fluctuated 0.4 m over the period monitored and was an average of 2.45 m lower than TW2 in the granular aquifer.

Over the monitoring period, the highest water level in the granular aquifer was recorded on April 23, 2021 in TW 2. The lowest groundwater level occurred on July 12, 2021 (Figure 4). The groundwater levels on July 28 just over one year later were nearly identical (Table 5).

The maximum water table for the site is 189 mASL, determined from the water level data.

## 12 IMPACT ASSESSMENT

The proposal will excavate the economical material above, and up to 20 m below the water table. The site investigation showed the aggregate extends down to an elevation ranging approximately from 193 mASL in the southwest area near TW 1, to lower than 171 mASL at TW 2 and TW 3 over the remainder of the site. It is highly probable that the base of the resource will not be intercepted over the proposed depth. Before water is required for processing, such as crushing or washing, pertinent permits including a Permit to Take Water, would have to be obtained.

No change to the water table is planned through either pumping or ditching. The planned operation method will excavate below the water table using a dragline or cutter dredge. In general, an operation where the water table is not pumped or lowered by some other means usually does not result in significant hydraulic impacts (Green, Merritt and Leete 2005).

The proposed excavation will be a maximum of 20 m below the water table in the granular aquifer, or to approximately 173 mASL. The water level in the open water in the pit will be +/- 187.7 mASL (the average of the water table measurements over the study period in the granular aquifer).

Overall, the hydraulic impact of the proposed operation on the groundwater and surface water is predicted to be minimal. This is primarily because the operation will not change the groundwater level in the granular aquifer. The operation will not change the current flow or contribution of the perched highland aquifer or divert runoff from the area. The runoff from Highland Line already flows through the pit, presumably by the municipality with the property owner's permission. This will not be changed with the proposed operation.

### 12.1 Surrounding Groundwater Users

Seven water well records matched to sites within 500 m of the site show the wells use the bedrock aquifer. The nearest well completed in the granular aquifer is approximately 1 km east of the site.

Five of the wells are on Wheeler's Maple at 1001 Highland Line. The wells are clustered at the buildings, at or slightly farther than 500 m from the expansion license boundary. The two closest wells, according

to well records, are south of Highland Line. One of the wells, at 1121 Highland Line south-west of the expansion license boundary was drilled in 2005. The other was drilled in 1962. The drillers map on the record shows the well at 1025 Highland Lane, but only an old foundation remains. The status of this well is unknown, but it would not appear to be in use.

The well records are found in Appendix A, and the pertinent details of the nearby wells are summarized in Table 6. The table contains data from the well record as well as interpreted data.

**Table 6: Summary of Neighbouring Wells Data (Appendix A)**

WELL ID	UTM	DATE	SURF ELEV <sup>^</sup>	BEDROCK ELEV	REPORTED WBZ	POT ELEV	PUMP RATE*	FORMATION <sup>@</sup>
3500651	378359 4976642	Jan-62	212	205.9	193.7	206.2	7 (26.5)	LOAM MSND 6.1 GRNT 21.9
3511715	378090 4976138	Mar-96	215	209.5	205.2, 198.5, 194.3	212.3	12 (45.4)	SAND GRVL 005.5 RED GRNT 24.4
3512581	378090 4976139	Mar-99	215		171.4	211.0	10 (37.9)	(3511715 deepened) PRDR 24.4 RED GRNT 54.9
3512912	378090 4976139	Apr-00	215	210.7	198.2	203.7	7 (26.5)	CLAY GRVL BLDR 4.3 RED GRNT 9.8 RED GRNT GRVL 11.3 RED GRNT18.3
3514108	378087 4976139	May-03	215				7 (26.5)	(3512912 deepened) PRDR 18.3 RED GRNT 30.5
3514109	378087 4976139	May-03	216	214.2			1 (3.8)	SAND BLDR 1.8 RED GRNT 118.6
3515148	377434 4976291	Sep-05	195	192.0	137.4	189.2	3 (11.5)	BLCK LOAM 3.0 RED GRNT 61.0

<sup>^</sup> Surface elevation approximated from Google Earth

\* Recommended pumping rate on well record, GPM (L/min)

<sup>@</sup> Depths converted to metres

Elevations calculated from well record data and surface elevation

The off-site wells are completed in bedrock, although depending on the construction they may also derive some water from the overburden. Two of the well records show existing wells were deepened (“PRDR”). Well 3512581 is the record of deepening WWR 3511715 and WWR 3514108 records the deepening of WWR 3512912. The wells may have been deepened both to try and intercept additional groundwater and to provide in-well storage to compensate for lower yields. Wheeler’s operation consists of a restaurant as well as water requirements associated with processing the maple syrup ([www.wheelersmaple.com](http://www.wheelersmaple.com)).

The study found the proposed operation will not have an impact on the bedrock aquifer. This is because regionally the bedrock aquifer discharges at the topographically low area along and the north side of the site (OS Figure 3). The wells are also up-gradient of the site, and will intercept the bedrock aquifer before it reaches the site. These are the reasons the bedrock wells would not be impacted by the proposed operation. The five wells completed on the Wheeler property are at or more than 500 m from the site when plotted correctly according to the drillers' maps.

There are two other wells reported that are within +/- 100 m of the proposed expansion boundary. As noted, the status of one well is unknown as it is an old well and all that remains on the lot is a foundation (1025 Highland Lane).

The second well (1121 Highland Lane), drilled in 2005 appears to be in use at an established residence. The well is 100 m or less from the proposed license boundary but will be on the order of 145 m from the excavation boundary determined from the geology (Section 9.1). The information from well record showed there was 3.0 m of overburden over the bedrock and the encountered water bearing zone was deep at +/- 137.4 mASL with a static level was +/- 189.2 mASL. It is most unlikely that this well will be affected by the operation, but as a precautionary measure it is recommended that site specific information on the well be documented for future reference. If possible, and the owner is willing to participate, the well could be included in the groundwater monitoring program.

## 12.2 Hydrology Impact

There is no predicted change to the groundwater or surface water flow from the proposed operation. Runoff and flow in the perched highland unconfined aquifer will not be redirected from the existing condition by the operation. The proposed excavation below the water table in the granular unconfined aquifer will not have an impact on the water level. There is a potential seepage component from the aquifer to the wetland, and there is possibly a very minor interconnection between the features as a result. However, since the water table is not expected to change, this component will also not be affected. The natural environment report attributed the standing water in the marsh north of the site to beaver activity.

The natural environment report (Ecological Services 2022) cautioned that the creation of the lake should not divert water from the wetland, as a negative impact to the wetland could result.

Evaporation from the open water will be greater than from the original terrain. Extraction below the water table will increase the evaporation rate. This transition from terrestrial to open water will occur gradually. The groundwater system will adapt by initially lowering the open water surface, with gradual restoration to pre-development levels as the natural groundwater surface adjusts to a steady state flow.

The rate of evaporation is related to temperature, humidity and wind speed, as well as to the surface area of the open water.

An average annual evaporation from open water of 597 mm was determined for pits that have been excavated below the water table (Brown, McKay and Chapman 1980). The existing evaporation for the site was calculated as 593 mm (Section 5.9.2). Therefore, there will be minimal change or resulting impact to the system.



### 12.3 Cumulative Impact

There are currently no aggregate operations within 500 m of the site. GRI understands an application for another pit south-east of the site is pending or has been submitted. The closest pit is the 63.5 ha Tackaberry Sand and Stone Ltd Pit located more than 800 m east of the site. The Tackaberry Pit currently holds a Class A license.

### 12.4 Groundwater Quality

The greatest potential impact of the proposed operation is from contamination. The groundwater in the study area is classified as highly vulnerable (Mississippi-Rideau Source Protection Committee 2022).

Two sets of water samples taken from the site wells show no indication of contamination from the operation. Field measurements could not be taken because of the winter conditions. Slightly elevated sodium and chloride at TW 3 likely originates from road salting.

Hydrocarbons would be the most likely contaminants from the operation. No concrete or asphalt plant is proposed. The potential for spills should be addressed on the site plan, with prevention as the key objective. It can be achieved with reasonable care and caution in the operational practice.

### 12.5 Thermal Impacts

The natural environment report provides details on fish sampling that was completed in 2006 by Muncaster Environmental Planning Inc. and other sources. It indicates that Brook Trout were historically stocked in Long Sault Creek although none were identified by Muncaster within 120 m of the site. Ecological Services' Natural Environment Technical Report commented that the potential for Brook Trout to be found within 120 m of the existing and proposed pit expansion is low due to many fish obstructions between Long Sault Creek.

The exposure of the groundwater in the final lake could potentially result in thermal changes to the local groundwater system. Published data indicate the impacts are usually localized. Groundwater returns to normal background temperature within 10s of metres of the pit ponds (Harden Environmental Services Limited 1995, Ostrander, et al. 1998).

The natural environment report recommended a buffer zone of 30 to 45 m between the excavation and the wetland. This zone will provide distance for the groundwater temperature to decrease towards the original temperature as it approaches the wetland. Considering that the natural environment report feel it is unlikely that Brook Trout will be found near the pit, no mitigation is recommended. The other fish species found by Muncaster are considered to be tolerant or intermediate (Ecological Services 2022).

### 12.6 Flooding

Since there will be no discharge from the pit the operation will not contribute to flooding in the surrounding drainage feature.

## 12.7 Base Flow

It is not anticipated that the proposed operation will change these flow paths or that changes to the base flow will occur.

## 13 RECOMMENDATIONS

No impacts are anticipated from the operation as proposed. However, it is recommended that groundwater monitoring program be implemented for several years to support the impact assessment and provide data to protect both Arnott and surrounding groundwater and surface water interests.

Piezometers TW-01, TW-02 and TW-03 were positioned as sentry wells between the proposed operation and neighbouring groundwater users. They will be used to confirm the data analyses, provide continued groundwater assessment and monitor groundwater quality. If the owner is willing to participate, the well at 1121 Highland Line could be included in the groundwater monitoring program.

### 13.1 Groundwater and Surface Water Level Monitoring

Water levels should be recorded before operations begin each year, and on alternate months through the operating season up to one month after the season ends.

After two years, if a representative baseline has been established, recommendations can be made for changes to the monitoring program, including the necessity to continue it, until below water excavation begins.

When below water excavation begins, the groundwater monitoring program described above should be repeated as a minimum (i.e. assuming no changes have resulted from the original program). A staff gauge should be installed in the pond, and monthly water level measurements should be recorded on the same day as the groundwater levels. As the lake expands, it may be beneficial to install a second staff gauge to record the change in water level across the open surface. For the long-term data loggers could be installed to monitor the water levels in the ponds.

When measurements are taken, observations and/or photos of the site activity should be recorded. Weather conditions on, and for two or three days before the monitoring, should also be noted.

When the monitoring of the below water excavation begins, the data should be checked by a qualified professional as the measurements are taken.

An annual review of the data should be prepared annually by a QP. During the annual review, recommendations may be made for changes to the monitoring program. The reviews should be kept at the company office for future reference.

#### 13.1.1 Off-Site Groundwater Users

Site specific information on the wells at 1025, 1101 and 1121 Highland Line should be documented through a well interview before excavation into the expansion begins. The survey should document the property setting, well location and construction, and confirm the water well record match if possible. A water sample should be taken to establish baseline water quality. As with the baseline groundwater monitoring, the pre-operations sample provides a reference for future use. The recommended list for baseline and any future water quality analysis is found in Table 7.



## 13.2 Adaptive Management Plan

An Adaptive Management Plan incorporates the information from the monitoring plan to reduce uncertainty about the impact that the pit will have on natural systems on the site and surrounding area.

**Table 7: Recommended Baseline Water Quality Analysis, Residences**

Group	Parameters
Field Measurements	Total Dissolved Solids, pH, conductivity, dissolved oxygen, turbidity, water temperature, residual chlorine
Bacteriological	Total coliforms, faecal coliforms, e. coli, background plate count
General Characteristics	Total Suspended Solids, Alkalinity as CaCO <sub>3</sub> , TDS, pH, Conductivity, Hardness as CaCO <sub>3</sub> , Ca, Mg, Na, K, Cl, Total P, N-NO <sub>2</sub> , N-NO <sub>3</sub> , SO <sub>4</sub> , Total Kjeldahl Nitrogen, N-NH <sub>3</sub> , phenols,
Metals	B, Ba, Be, Cd, Cu, Cr, Fe, Mn, Mo, Ni, Pb, Si, Ag, Sr, Tl, V, Zn
Hydrocarbons	Total Petroleum Hydrocarbons (F1 - F4)

### 13.2.1 Trigger Mechanism

Water levels in the site wells will be measured seasonally. The monitoring will be done for two years. At the end of two years the data will be analysed and recommendations will be made on the need for changes to the monitoring program.

#### 13.2.1.1 Changes in Site Groundwater Level

The data to date found the annual fluctuation in groundwater level ranged from 0.25 m at TW 2 to 0.69 m at TW 1. The groundwater elevation on July 12, 2021 and July 28, 2022 was comparable. For the initial two years of monitoring, if a groundwater level has declined by more than 30% from the previous year at any monitoring period, the cause will be assessed and addressed. The analysis at the end of the initial two years of monitoring will include a recommendation for changes to the trigger mechanism if required.

#### 13.2.1.2 Receipt of Unexpected Well Problem

If an unexpected complaint arises, the license holder will retain a Qualified Professional, who will investigate. If the problem is attributed to the pit operation, remediation or compensation will be offered by the operator as soon as possible. This response will apply within 500 m of the license boundary.

- a. A Qualified Person will be retained at the license holder's expense to investigate the issue, and within 15 days provide an opinion on cause and provide recommendations to remediate the issue.
- b. In addition, if the issue occurs within 500 m of the license boundary, the operator will provide an interim potable water supply to the affected well, within 24 hours. The interim supply will be continued until the matter is considered resolved by the MOECC or the resident.

If the issue occurs more than 500 km of the license boundary, the MOECC will be notified of the issue. Any direction by the MOECC will be followed by the license holder.

#### **13.2.1.3 Predicted Negative Impact on Neighbouring Wells**

The objective is to prevent the predicted impact from occurring. This is because of the low yields and mineralized water that is associated with some Precambrian aquifers.

If a negative impact on a neighbouring well is predicted through hydrogeological data review, the specific well conditions will be evaluated, and the predicted impact will be remediated. The remediation may consist of lowering or replacing the pumping equipment or deepening the well(s) by the operator or their representative (with owners' permission).

#### **13.2.1.4 Replacement Well Quality**

To mitigate the potential issue of naturally poor water quality in remediated wells, the effort will be made to construct the well to a final depth as shallow as possible to obtain a suitable water quantity. If natural water quality exceeding the Ontario Drinking Water Standard is encountered, suitable water treatment will be recommended.

### **13.2.2 Protection of Groundwater and Surface Water Quality**

Protection to the groundwater and surface water from contaminants will be accomplished through management and operation of the materials and equipment to the industry standards and legislative requirements. Re-fueling will take place on an impervious surface, and materials storage will be in an appropriate container, with secondary containment. Regulatory requirements of the Technical Standards and Safety Authority will be followed.

A minimum of 30 m will be maintained between a contaminant source, and any surface water source including but not limited to, the pit pond, or any ditch system.

Material imported to the site should meet the regulatory requirements of O. Reg. 347.

#### **13.2.2.1 Emergency Spills Procedure**

An emergency spills procedure will be prepared for the site. The site manager should be trained in the emergency spills procedure and pertinent telephone numbers should be kept at the site office. A quantity of appropriate clean-up material such as absorbent mats and granular absorbent material should be kept on site when the quarry is operating.

It is recommended that the emergency plan also include the following components:

- Any unexplained losses of fuel or other contaminants will immediately be reported to appropriate management levels and/or agencies.
- If a spill occurs, action will immediately be taken to contain and absorb the spilled material. The reporting requirements of the Ministry of Environment and Climate Change will be followed under the responsibilities of the designated staff, who will be responsible for assuring that proper clean-up has occurred.

### 13.2.3 Additional Recommendations

- Operational permits, such as a Permit to Take Water or a Certificate of Approval for Industrial Wastewater Treatment (part of the Environmental Compliance Approval) should be obtained, if necessary.

## 14 SUMMARY AND CONCLUSIONS, LEVEL 2 HYDROGEOLOGICAL REPORT

Arnott Bros. Construction Ltd. is applying for a site plan amendment that will enlarge the extraction area and permit the excavation to extend below the water table at their pit located in Township of Lanark Highlands (Geo. Twp. of Dalhousie), County of Lanark. The site is approximately 40.1 ha on Part of Lots 5 and 6, Concession 10, Part of Lot 6 Concession 11, Part of the Road Allowance between Lots 5 and 6, Concession 10 and Part of the Road Allowance between Concessions 10 & 11 (at Lot 6).

The property is on part of a glaciofluvial assemblage that extends from near Middleton, southward to Pine Grove westward to just north of Playfairville, parallel to Highland Line and Kingston Line and crosses County Road 36 before continuing into the County of Frontenac. Published reports indicate that the material in the assemblage is the highest quality with respect to the province's mineral aggregate interests

The proposal will extract aggregate from above and below the water table using an excavator, drag line or other dredging equipment. No diversion, storage or drainage of groundwater is planned in the proposed operation.

Three test wells were drilled on the site on November 26 and 27, 2020 and a piezometer was installed in each. The holes were drilled to bedrock refusal or a maximum 18 m below the water table. Rising head and falling head tests were conducted to measure the hydraulic conductivity. Groundwater levels were measured between December 3, 2020 and July 28, 2022. Water samples were taken on December 3, 2020 and January 11, 2021.

Four aquifers were identified on the site; a perched unconfined aquifer ("highland aquifer"), an unconfined aquifer in the glaciofluvial deposit ("granular aquifer") and confined aquifers in two bedrock formations. The highland aquifer drains into the granular aquifer. This condition existed pre-excavation and will continue through and after the site has been excavated. The aquifer flows northward from the bedrock high south of the site, and is found in the south-west part of the property. The granular aquifer has a groundwater elevation that is 10.9 to 11.6 m lower than the highland aquifer.

One spring was found along the existing south property boundary, and two possible springs were identified from aerial photography. The thick and tangled undergrowth prevented a closer examination of the north face. If more springs are found, they will be located where the highland aquifer discharges to the granular aquifer, and where the water table in the granular aquifer intersects the north slope of the deposit along the north property boundary.

A 129 ha wetland is near the property along the west, north and east boundaries. The natural environment report concluded that the proposed operation would not affect the wetland unless the final lake diverted flow from the wetland. This study found that this will not occur.

The bedrock aquifer was examined through a water well record analysis. There were seven well records found within 500 m of the site, all finished in bedrock. The wells are upgradient of the site and the information indicates there will be no impacts from the operation.

A monitoring and mitigation plan has been recommended to provide additional baseline data during the above water excavation, with a second monitoring period once the below water operation begins. It is also recommended that baseline information and water quality be collected on the neighbouring wells.

In summary, hydrogeological investigation found the proposed expansion and below water excavation will not result in a significant impact to the surrounding hydrogeological environment.

Sincerely;



**George A. Gorrell M.Sc. P.Geo. F.G.A.C.**  
**Senior Geoscientist**



**Jennifer B. Gorrell M.Sc. P.Eng. P.Geo.**  
**Senior Geoscientist**



(647) 502-5224 | [george.gorrell@gri-inc.ca](mailto:george.gorrell@gri-inc.ca) |

(647) 998-0850 | [jennifer.gorrell@gri-inc.ca](mailto:jennifer.gorrell@gri-inc.ca)

**GRI Inc.**

**911 County Road 18 | RR 1 | Oxford Mills, ON K0G 1S0**

(613) 258-2954 | F (647) 503-2713

## 15 LIMITATIONS

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# Photographs

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**Photo 1**

October 7, 2020

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Section in central portion of deposit.  
This is a typical section in a cavity fill/bead deposit



**Photo 2**

October 7, 2020

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Section in central portion of deposit.  
Slightly coarsening downward which is typical of a fan/cavity deposit.  
With processing could meet requirements for high quality aggregate such as concrete or asphalt sand.



**Photo 3**

April 23, 2021

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Pink Granite boulder on southern side of license. This boulder is from the underlying Barbers Lake Granite Intrusion. Hill in background would be the sand and gravel deposit.

**Photo 4**

April 23, 2021



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Pink granite boulder on side western side of license. The boulder is derived from the underlying Barbers Lake Granite Intrusion. The hill in background (on right) would be the sand and gravel deposit.

**Photo 5**

November 27, 2020.



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Drilling on the site to determine type of material and to install monitoring wells. This would be TW 3 and camera is facing east from height of land.

**Photo 6**

November 27, 2020



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Drilling TW 3. Facing north.

**Photo 7**

December 21, 2020



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TW 1. Drilled near the contact between the sand and gravel deposit and Barbers Lake Granite Intrusion.

**Photo 8**

April 23, 2021



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Spring on the Arnott site. The spring discharges where the Barbers Lake Granite Intrusion and the overlying till intercept the base of the hill. Water from spring flows 50 to 60 m towards gravel ridges in background before it infiltrates into ground.

**Photo 9**

March 30, 2021



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Culvert under Highland Line that directs roadside water to the Arnott property. Facing northeast

**Photo 10**

March 30, 2021

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Roadside ditch along Highland Line.  
Water from properties south of the  
road and along the road are directed  
onto the Arnott property.



# Oversize Tables

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OS Table 1: Precipitation and Mean Daily Temperature Analysis, Drummond Centre Climate Station

	PPT (mm)						2017 to 2021 5-year Average	2022
	1981 to 2010 Normal	2017	2018	2019	2020	2021		
January	67.7	73.8	67.0	72.4	107.2	48.2	73.7	65.6
February	51.3	90.2	67.2	74.4	40.2	61.8	66.8	93.0
March	55.1	74.8	52.2	62.0	79.0	59.6	65.5	66.0
April	64.2	126.2	133.4	149.0	76.4	55.6	108.1	92.0
May	77.0	164.8	33.0	87.8	34.2	35.4	71.0	106.2
June	82.4	166.2	62.8	120.4	46.2	134.2	106.0	108.6
July	83.5	175.0	106.2	42.0	64.6	88.2	95.2	65.0
August	75.3	131.6	82.2	52.4	248.0	45.0	111.8	
September	91.8	28.4	98.6	105.6	60.0	157.8	90.1	
October	78.5	142.8	86.6	179.4	76.4	138.0	124.6	
November	83.6	78.2	108.2	57.2	52.6	46.6	68.6	
December	65.9	60.0	80.8	58.0	84.0	79.0	72.4	
<b>Annual</b>	<b>876.3</b>	<b>1,312.0</b>	<b>978.2</b>	<b>1,060.6</b>	<b>968.8</b>	<b>949.4</b>	<b>1,053.8</b>	<b>596.4</b>

	Average Mean Temperature (°C)						2017 to 2021 5-year Average	2022
	Normal	2017	2018	2019	2020	2021		
January	-9.8	-5.2	-9.0	-10.7	-5.5	-6.2	-7.3	-13.9
February	-8.5	-4.3	-4.5	-8.4	-6.3	-7.9	-6.3	-8.7
March	-2.0	-4.7	-1.5	-3.7	1.2	0.3	-1.7	-1.5
April	6.0	7.8	2.7	5.2	5.0	7.7	5.7	5.6
May	12.7	12.2	15.5	11.5	12.6	13.3	13.0	15.0
June	17.8	17.5	17.6	17.5	18.8	19.3	18.1	16.8
July	20.3	19.6	22.3	22.2	23.7	19.3	21.4	16.9
August	19.1	18.5	20.9	19.2	19.7	21.7	20.0	
September	14.4	16.9	16.7	15.2	13.9	14.8	15.5	
October	7.8	11.6	7.4	8.7	7.5	11.4	9.3	
November	1.6	0.6	-1.0	-1.6	4.1	1.4	0.7	
December	-5.8	-9.4	-5.6	-4.6	-2.7	-3.1	-5.1	
<b>Annual</b>	<b>6.1</b>	<b>6.8</b>	<b>6.8</b>	<b>5.9</b>	<b>7.7</b>	<b>7.7</b>	<b>7.0</b>	<b>30.1</b>



10:01:16 AM		2022-07-09											
CON LOT	WELL ID	UTM	DATE	CNTR	WATER ZONES	STATIC LEVEL	PUMPED LEVEL	PUMP RATE	P TEST DUR	WELL USE	FORMATION		
<u>DALHOUSIE &amp; N. SHERB</u>													
09 006	7106890	18	379607 4977703 W	Jun-07	4905 FR 0052	7	47	4	1:00	DO	BRWN LOAM GRVL 0034 GREY GRNT 0050 GREY GRVL 0055		
08 006	7169100	18	380283 4978972 W	Aug-11	2558 UT 0115 UT		198	4	1:00	DO	RED SAND STNS 0007 BLCK GRNT 0030 RED GRNT SOFT 0035 BLCK GRNT 0050 GREY GRNT 0055 BLCK GRNT 0110 BLCK GRNT 0240		
09 005	3511352	18	380199 4977906 L	Dec-94	2558 FR 0195 FR 0215	26		4	1:00	DO	RED SAND 0010 GRVL 0014 GREN LMSN 0193 BLCK LMSN 0220		
09 005	7274335	18	380116 4978215 W	Oct-16	2558 UT 0065 UT 0093		21	21	1:00	DO	SAND 0020 GRVL 0050 GRVL 0100		
09 006	3506773	18	380429 4978621 W	Mar-84	1567 FR 0040	13	50	30	1:00	DO	PRDG 0017 BRWN GRVL BLDR PCKD 0037 BLUE LMSN HARD 0088 BLCK GRNT HARD 0098 GREY GRNT HARD 0106		
09 007	3507744	18	379397 4978834 L	Sep-86	2558 FR 0320			2	1:00	DO	LOAM STNS 0006 GREY LMSN 0245 GREN LMSN 0325		
09 007	3514322	18	379394 4978835 L	Oct-03	2558 UK 0157	17		40	1:00	DO	BLDR GRVL 0020 SAND STNS 0026 GREY LMSN 0097 BLCK GRNT 0124 GREY LMSN 0138 BLCK GRNT 0160		
09 007	3509906	18	379397 4978834 L	Jul-91	2558 FR 0095	41		5	0:30	DO	SAND STNS 0034 GREY LMSN 0060 BLCK LMSN 0150		
10 002	3511072	18	380348 4975622 L	May-94	2558 FR 0115	4		12	1:00	DO	CLAY LOAM 0008 CLAY BLDR 0034 WHIT LMSN 0113 RED LMSN 0120		
10 007	3505108	18	378629 4978221 W	Jun-78	2558 FR 0168	15		4	0:30	DO	GREY SAND GRVL 0017 BLCK GRNT 0136 WHIT LMSN 0174		
10 008	3511921	18	377947 4978425 L	Nov-96	2558 FR 0057 FR 0090	20		15	1:00	DO	SAND FILL 0005 GREY LMSN 0025 BRWN LMSN 0028 GREY LMSN 0057 GREY LMSN 0090 BRWN LMSN 0092 GREY LMSN 0095		
10 008	3505954	18	377829 4978221 W	Sep-80	2558 FR 0062 UK 0079	20		6	0:30	DO	CLAY BLDR 0020 GRVL 0023 GREY LMSN 0084		
10 008	3511634	18	377947 4978425 L	Nov-95	2558 FR 0115	11		4	1:00	DO	GRVL BLDR 0030 GREY LMSN 0114 BRWN LMSN 0116 GREY LMSN 0120		
10 009	3500645	18	377190 4978721 W	Apr-52	3902 FR 0046	31	35	11	0:30	DO	LOAM MSND 0020 LMSN SHLE 0022 WHIT LMSN 0055		
10 009	3514525	18	377544 4978893 L	May-04	1567 FR 0028 FR 0060	6		26	1:00	DO	BRWN SAND BLDR PCKD 0016 GREY LMSN HARD 0028 BLCK GRNT HARD 0091		
10 009	3508395	18	377547 4978892 L	Jul-88	2558 FR 0060	14		15	0:30	DO	CLAY BLDR 0018 GREY LMSN 0060 BRWN LMSN 0063 GREY LMSN 0074 BRWN LMSN 0076 GREY LMSN 0080		

		10:01:16 AM		2022-07-09										
CON	LOT	WELL ID	UTM	DATE	CNTR	WATER ZONES	STATIC LEVEL	PUMPED LEVEL	PUMP RATE	P TEST DUR	WELL USE	FORMATION		
10	009	3507737	18 377547 4978892 L	May-86	2558	FR 0099	33		15	0:30	DO	BLDR STNS 0024 GREY LMSN 0082 BRWN LMSN 0100 GREY LMSN 0104		
10	009	7114314	18 377001 4978613 W	Oct-08	4905	FR 0046 FR 0089	24	33	12	1:00	DO	BLCK LOAM 0004 GREY SNDS 0100		
10	009	3504605	18 377430 4978872 W	Jul-76	2558	FR 0075	11		10	1:00	DO	RED SAND 0005 WHIT LMSN 0080		
10	009	3503965	18 377237 4978638 W	Sep-74	4904	FR 0111	48	117	3	1:30	DO	PRDR 0050 WHIT LMSN 0077 GREY GRNT 0106 BLUE LMSN 0117		
10	009	7185431	18 377552 4978647 W	Jul-12	2558	UT 0072 UT 0094		14	7	1:00	DO	CLAY GRVL STNS 0012 GREY LMSN FCRD 0100		
10	009	3509848	18 377547 4978892 L	May-91	2558	FR 0100	25		8	0:30	DO	CLAY STNS 0017 GREY LMSN 0097 BRWN LMSN 0101 GREY LMSN 0105		
11	005	3512912	18 378090 4976139 L	Apr-00	2558	FR 0055	37		30	1:00	DO	CLAY GRVL BLDR 0014 RED GRNT 0032 RED GRNT GRVL 0037 RED GRNT 0060		
11	005	3511715	18 378090 4976138 L	Mar-96	2558	FR 0032 FR 0054 FR 0068	9		15	1:00	DO CO	SAND GRVL 0018 RED GRNT 0080		
11	005	3500651	18 378359 4976642 W	Jan-62	3902	FR 0060	19	41	7	1:00	ST DO	LOAM MSND 0020 GRNT 0072		
11	005	3512581	18 378090 4976139 L	Mar-99	2558	FR 0143	13		12	:	DO CO	PRDR 0080 RED GRNT 0180		
11	005	3514109	18 378087 4976139 L	May-03	2558	UK	31		1	1:00	DO	SAND BLDR 0006 RED GRNT 0389		
11	005	3515148	18 377434 4976291 W	Sep-05	4905	FR 0189	19	52	3	1:00	DO	BLCK LOAM 0010 RED GRNT 0200		
11	005	3514108	18 378087 4976139 L	May-03	2558		41		40	1:00	DO	PRDR 0060 RED GRNT 0100		
11	008	3500652	18 377130 4978047 W	Sep-62	4904	FR 0038	18	40	5	1:00	DO	LOAM CLAY 0008 WHIT LMSN 0050 BRWN LMSN 0065		
11	008	7122905	18 377278 4977711 W	Apr-09	6571							PRDR 0008		
11	008	7122906	18 377328 4977944 W	Apr-09	6571							PRDR 0008		
11	008	7122904	18 377291 4977727 W	Apr-09	6571							PRDR 0008		
11	008	7122910	18 377277 4977729 W	Apr-09	6571							PRDR 0008		
11	008	7122911	18 377285 4977697 W	Apr-09	6571							PRDR 0016		
11	008	7045408	18 377320 4977943 W	Apr-07	6571							BRWN SAND SILT STNS 0006 GREY LMSN 0023		
11	008	3505569	18 377329 4978021 W	Oct-79	1922	FR 0129	40	120	3	0:15	DO	BRWN LOAM 0010 SNDS 0131		
11	008	7045407	18 377328 4977944 W	Apr-07	6571							BRWN SAND SILT STNS 0011 GREY LMSN 0026		
11	008	7102998	18 377320 4977943 W	Nov-07	6571					:		PRDR 0023		
11	008	7045405	18 377285 4977697 W	Mar-07	6571							BRWN SAND STNS 0005 GREY LMSN 0016		
11	008	7122912	18 377339 4977945 W	Apr-09	6571							PRDR 0025		
11	008	7045404	18 377278 4977711 W	Mar-07	6571							BRWN SAND STNS 0005 GREY LMSN 0026		
11	008	7045403	18 377277 4977729 W	Mar-07	6571							BRWN CLAY SAND STNS 0005 GREY LMSN 0026		

CON LOT	WELL ID	UTM	DATE	CNTR	WATER ZONES	STATIC LEVEL	PUMPED LEVEL	PUMP RATE	P TEST DUR	WELL USE	FORMATION
11 008	7045402	18 377291 4977727 W	Mar-07	6571							BRWN CLAY SAND STNS 0006 GREY LMSN 0026
11 009	3500653	18 376831 4978622 W	Aug-62	3902	FR 0069	43	43	5	1:00	DO	LOAM MSND 0005 LMSN SHLE 0026 WHIT LMSN 0072
11 009	3505747	18 376880 4978672 W	Jul-79	1922	FR 0097	30	30		:	DO	BRWN LOAM 0004 GREY LMSN 0096 UNKN 0097
11 009	3506203	18 376829 4978521 W	Jul-81	2558	FR 0100	19		1	1:00	DO	SAND GRVL 0009 GREY LMSN 0105
11 009	3512524	18 376493 4978015 L	Nov-98	2558	FR 0135	41		7	1:00	DO	CLAY GRVL 0004 GREY LMSN 0018 BRWN LMSN 0024 GREY LMSN 0125 GREY LMSN 0135 BRWN LMSN 0140 GREY LMSN 0160
11 009	3507380	18 376493 4978015 L	Aug-85	2558	FR 0112	32		6	0:30	DO	GREY LMSN 0118
11 009	3511070	18 376493 4978015 L	Apr-94	2558	FR 0115	26	120	5	1:00	DO	GREY LMSN 0120
11 009	3511276	18 376493 4978015 L	Oct-94	2558	FR 0083	18		20	1:00	DO	CLAY BLDR 0010 GREY LMSN 0083 GREY LMSN 0094 GREY LMSN 0101

**LANARK TOWNSHIP**

11 002	7045406	18 377339 4977945 W	Apr-07	6571							BRWN SAND SILT STNS 0010 GREY LMSN 0025
11 008	7102974	18 377319 4977943 W	Nov-07	6571					:		BRWN SAND SILT STNS 0006 GREY LMSN 0023

**NOTES (SOURCE - ONTARIO WATER WELL RECORD DATABASE):**

Notes:

UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid  
 DATE CNTR: Date Work Completed and Well Contractor Licence Number  
 CASING DIA: .Casing diameter in inches

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes  
 WELL USE: See Table 3 for Meaning of Code  
 SCREEN: Screen Depth and Length in feet

**1. Core Material and Descriptive terms**

Code Description	Code Description	Code Description	Code Description	Code
BLDR BOULDERS	FCRD FRACTURED	IRFM IRON FORMATION	PORS POROUS	SOFT
SOFT				
BSLT BASALT	FGRD FINE-GRAINED	LIMY LIMY	PRDG PREVIOUSLY DUG	SPST
SOAPSTONE				
CGRD COARSE-GRAINED	FGVL FINE GRAVEL	LMSN LIMESTONE	PRDR PREV. DRILLED	STKY
STICKY				
CGVL COARSE GRAVEL	FILL FILL	LOAM TOPSOIL	QRTZ QUARTZITE	STNS
STONES				
CHRT CHERT	FLDS FELDSPAR	LOOS LOOSE	QSND QUICKSAND	STNY
STONE				
CLAY CLAY	FLNT FLINT	LTCL LIGHT-COLOURED	QTZ QUARTZ	THIK
THICK				
CLN CLEAN	FOSS FOSILIFEROUS	LYRD LAYERED	ROCK ROCK	THIN
THIN				
CLYY CLAYEY	FSND FINE SAND	MARL MARL	SAND SAND	TILL
TILL				
CMTD CEMENTED	GNIS GNEISS	MGRD MEDIUM-GRAINED	SHLE SHALE	UNKN
UNKNOWN TYPE				
CONG CONGLOMERATE	GRNT GRANITE	MGVL MEDIUM GRAVEL	SHLY SHALY	VERY
VERY				

**2. Core Color**

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREEN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED

**3. Well Use**

Code Description	Code Description
DO Domestic	OT Other
ST Livestock	TH Test Hole
IR Irrigation	DE Dewatering
IN Industrial	MO Monitoring
CO Commercial	MT Monitoring TestHole
	MN Municipal
	PS Public

**4. Water Detail**

Code Description	Code Description
FR Fresh	GS Gas
SA Salty	IR Iron
SU Sulphur	
MN Mineral	
UK Unknown	

OS Table 3: Summary of Drill Holes

	Elevation (mASL)	Depth (m)		Sample	Blows	Description/Comments	Piezometer	
		Easting	Northing				Depth (m)	
<b>TW 1</b>	<b>UTM</b>	<b>Easting</b>	<b>Northing</b>					
		377946	4976710					
	199.5	0.00	3.66			medium to medium coarse sand, layered with stones, FM ~2 to 3; ALCS < 5 cm	<b>Screen</b>	4.60 7.64
	195.8	3.66	4.27			Stone layer, ALCS < 5 cm	<b>Sand</b>	3.71 7.64
	195.2	4.27	5.18			medium to medium fine sand, occasional stone layer, but less than 5 cm	<b>Hole plug</b>	2.44 3.71
	194.3	5.18	6.10	1	60-28-73	layered medium to medium coarse sand, with stone layers; pushed stn after 48 blows	<b>Native backfill</b>	1.52 2.44
	193.4	6.10	7.01			layered medium to medium coarse sand, with stone layers	<b>Hole plug</b>	0.00 1.52
	192.5	7.01	7.62		23-25-rfsl	till, grey, dense sandy silt, stny		
	191.9	7.62	7.92			weathered/broken rock		
	191.6	7.92				Bedrock, pink granite, rfsl		
*ALCS - average large clast size, FM - fineness modulus								
<b>TW 2</b>	<b>UTM</b>	<b>Easting</b>	<b>Northing</b>					
		378266	4976951					
	190.0	0.00	6.10	2	1-1-2-6	layers of medium to medium coarse sand and to very coarse gravel, ALCS <5 cm	<b>Screen</b>	5.79 8.84
	183.9	6.10	9.14			layers of medium coarse to very coarse sand, ALCS 0.5 to 2 cm, likely<25% stone	<b>Sand</b>	5.18 8.84
	180.9	9.14	18.29			layers of medium coarse to very coarse sand, ALCS 0.5 to 2 cm, likely<25% stone	<b>Hole plug</b>	4.52 5.18
	171.7						<b>Native backfill</b>	1.98 4.52



	Elevation (mASL)	Depth (m)		Sample	Blows	Description/Comments	Piezometer		
							Depth (m)		
<b>TW 3</b>	<b>UTM</b>	<b>Easting</b>	<b>Northing</b>	3	1-2-18- 16	loose silty sand medium coarse to very coarse sand , pea gravel, ALCS 1 to 2 cm, FM 3 to 3.5 medium coarse to very coarse sand , pea gravel, ALCS 1 to 2 cm, FM 3 to 3.5 layered, 10 to 20 cm layers, medium coarse to coarse sand to silty fine sand layers	<b>Hole plug</b>	0.00	1.98
							<b>metres</b>		
							<b>Screen</b>	5.18	8.84
							<b>Sand</b>	3.96	5.18
							<b>Hole plug</b>	2.44	3.96
							<b>Native backfill</b>	0.00	2.44
	189.0	0.00	4.57						
	184.4	4.57	6.10						
	182.9	6.10	13.72						
	175.3	13.72	18.29						
	170.7								



OS Table 4: Groundwater Quality Analysis

Parameter	Units	Guideline	TW 1	TW 2	TW 3	TW 1	TW 2	TW 3
			December 3, 2020			January 11, 2021		
blank = not analysed or calculated								
<b>Field Readings</b>								
Field readings were not possible due to winter conditions								
<b>General Chemistry</b>								
Alkalinity as CaCO <sub>3</sub>	mg/L		245	236	274	203	226	284
Hardness	mg/L		319	277	271	219	276	383
Chloride (Cl)	mg/L		67	22	83	18	20	111
Conductivity	µS/cm		655	499	811	470	506	927
pH		6.5-8.5	8.33	8.20	8.27	8.33	8.18	8.18
TDS (COND - CALC)	mg/L					306	329	603
Total Suspended Solids	mg/L					<2	2	<2
Sulphate (SO <sub>4</sub> )	mg/L		14	13	45	24	16	24
Ion Balance	mg/L		1.03	1.03	0.98	1.03	1.06	1.03
<b>Nutrients</b>								
Nitrite (NO <sub>2</sub> )	mg/L					<0.10	<0.10	<0.10
Nitrate (NO <sub>3</sub> )	mg/L		0.18	0.57	1.95	<0.10	0.64	3.19
N-NH <sub>3</sub>	mg/L					<0.010	<0.010	<0.010
Un-ionized Ammonia (calc)	mg/L	PWQO - 0.02				0.000	0.000	0.000
Total Kjeldahl Nitrogen	mg/L					0.280	0.131	0.453
Total P	mg/L					<0.020	<0.020	<0.020
Phenols	mg/L					<0.001	<0.001	<0.001
<b>Metals</b>								
Silver (Ag)	mg/L	PWQO - 0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic (As)	mg/L	PWQO 0.005	<0.001	<0.001	<0.001			



Parameter	Units	Guideline	TW 1	TW 2	TW 3	TW 1	TW 2	TW 3
			December 3, 2020			January 11, 2021		
Boron (B)	mg/L	IPWQO - 0.2	0.07	0.01	0.03	0.04	0.01	0.03
Barium (Ba)	mg/L		0.11	0.21	0.10	0.09	0.25	0.19
Beryllium (Be)	mg/L	PWQO - 0.011	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Calcium (Ca)	mg/L		70	78	77	53	81	112
Cadmium (Cd)	mg/L	PWQO - 0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt (Co)	mg/L	PWQO 0.0009	0.0034	0.0007	<0.0002			
Chromium (Cr)	mg/L	PWQO-0.001 (Cr VI) 0.0089 (Cr III)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (Cu)	mg/L	PWQO - 0.005	0.002	<0.001	0.002	<0.001	<0.001	<0.001
Fluoride (F <sup>-</sup> )	mg/L		0.19	<0.10	<0.10	0.18	<0.10	<0.10
Iron (Fe)	mg/L	PWQO - 0.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Potassium (K)	mg/L		4	2	3	2	2	2
Magnesium (Mg)	mg/L		35	20	19	21	18	25
Manganese (Mn)	mg/L	IPWQO - 0.04	0.07	0.02	<0.01	0.06	0.01	<0.01
Molybdenum (Mo)	mg/L	IPWQO - 0.040	0.016	<0.005	0.018	0.010	<0.005	<0.005
Sodium (Na)	mg/L		19	5	75	19	5	50
Nickel (Ni)	mg/L	PWQO - 0.025	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lead (Pb)	mg/L	PWQO - 0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony (Sb)	mg/L	IPWQO 0.020	<0.0005	<0.0005	<0.0005			
Selenium (Se)	mg/L	PWQO 0.100	<0.001	<0.001	<0.001			
Silicon (Si)	mg/L					4.8	4.4	5.4
Strontium (Sr)	mg/L					0.122	0.139	0.175
Thallium (Tl)	mg/L	IPWQO - 0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Uranium (U)	mg/L		<0.001	<0.001	<0.001			
Vanadium (V)	mg/L	IPWQO - 0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc (Zn)	mg/L	PWQO - 0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01



Parameter	Units	Guideline	TW 1	TW 2	TW 3	TW 1	TW 2	TW 3
			December 3, 2020			January 11, 2021		
<b>Hydrocarbons</b>								
F1 (C6-C10)	ug/L					<20	<20	<20
F1BTEX (C6-C10)	ug/L					<20	<20	<20
F2 (C10-C16)	ug/L					<20	<20	<20
F3 (C16-C34)	ug/L					<50	<50	<50
F4 (C34-C50)	ug/L					<50	<50	<50
<b>Volatiles</b>								
Benzene	ug/L					<0.5	<0.5	<0.5
Ethylbenzene	ug/L					<0.5	<0.5	<0.5
m/p-xylene	ug/L					<0.4	<0.4	<0.4
o-xylene	ug/L					<0.4	<0.4	<0.4
Toluene	ug/L					<0.5	<0.5	<0.5
Xylene; total	ug/L					<0.5	<0.5	<0.5



# Oversize Figures

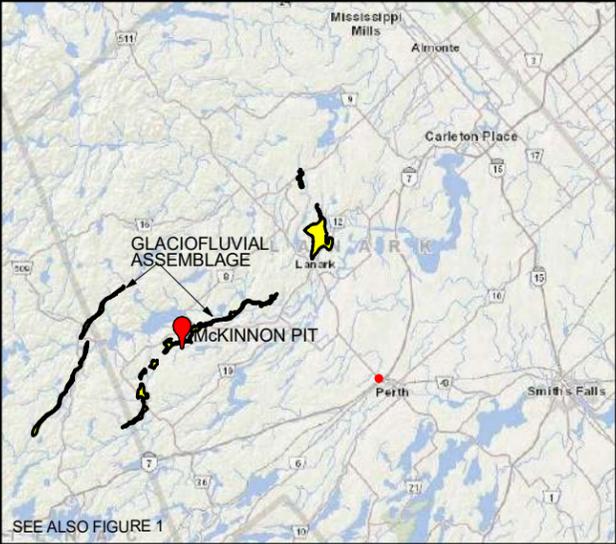
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### LEGEND

- McKINNON PIT, EXISTING LICENSE (SITE)
  - EXPANSION AREA (SITE)
  - 2 KM DISTANCE AROUND SITE
  - MAR-h ZONED LAND (IN STUDY AREA)
  - INDUSTRIAL - PITS
  - ARA LICENSES
  - SUB-WATERSHED BOUNDARY
- LAND USE**
- RESIDENTIAL
  - AGRICULTURE - CROPS AND PASTURE
  - AGROFORESTRY - MAPLE SYRUP
  - UNDEVELOPED / WETLAND (NO PATTERN)
- 3506674   WATER WELL RECORD , REF.



NOTES:  
 1. BOUNDARIES AND DISTANCES ARE APPROXIMATE  
 2. PHOTO IMAGE - GOOGLE EARTH SATELLITE IMAGERY 10/10/2019  
 3. <https://www.ontario.ca/environment-and-energy/find-pits-and-quarries/>  
 4. MVCA PORTAL - <https://camaps.maps.arcgis.com/apps/webappviewer/index.html?id=70831905961e470988262c7a703a56af>  
 5. <http://www.ontario.ca/environment-and-energy/map-well-record-data>  
 6. LAND USE FROM AIR PHOTO INTRPRETATION AND DRIVE-BY SURVEY

### OS FIGURE 1 SITE AND SURROUNDING DETAILS

CLIENT: ARNOTT BROS. CONST.  
 PROJECT NO: 21-022  
 DATE: AUGUST, 2022

**GRI Inc.**  
 Oxford Mills, ON K0G 1S0  
 T - (613) 258-2954



# LEGEND

- SITE BOUNDARY
- 120 M SURROUNDING LICENSE BOUNDARY
- CROSS SECTION LOCATION
- TW 3  
 TEST WELL (GRI, DEC. 2020)
- WATERCOURSE
- CULVERT

(p)

NOTES:  
 1. BOUNDARIES AND DISTANCES ARE APPROXIMATE  
 2. PHOTO IMAGE - GOOGLE EARTH SATELLITE IMAGERY 10/10/2019  
 3. GROUNDWATER FLOW INTERPRETED FROM SITE DATA

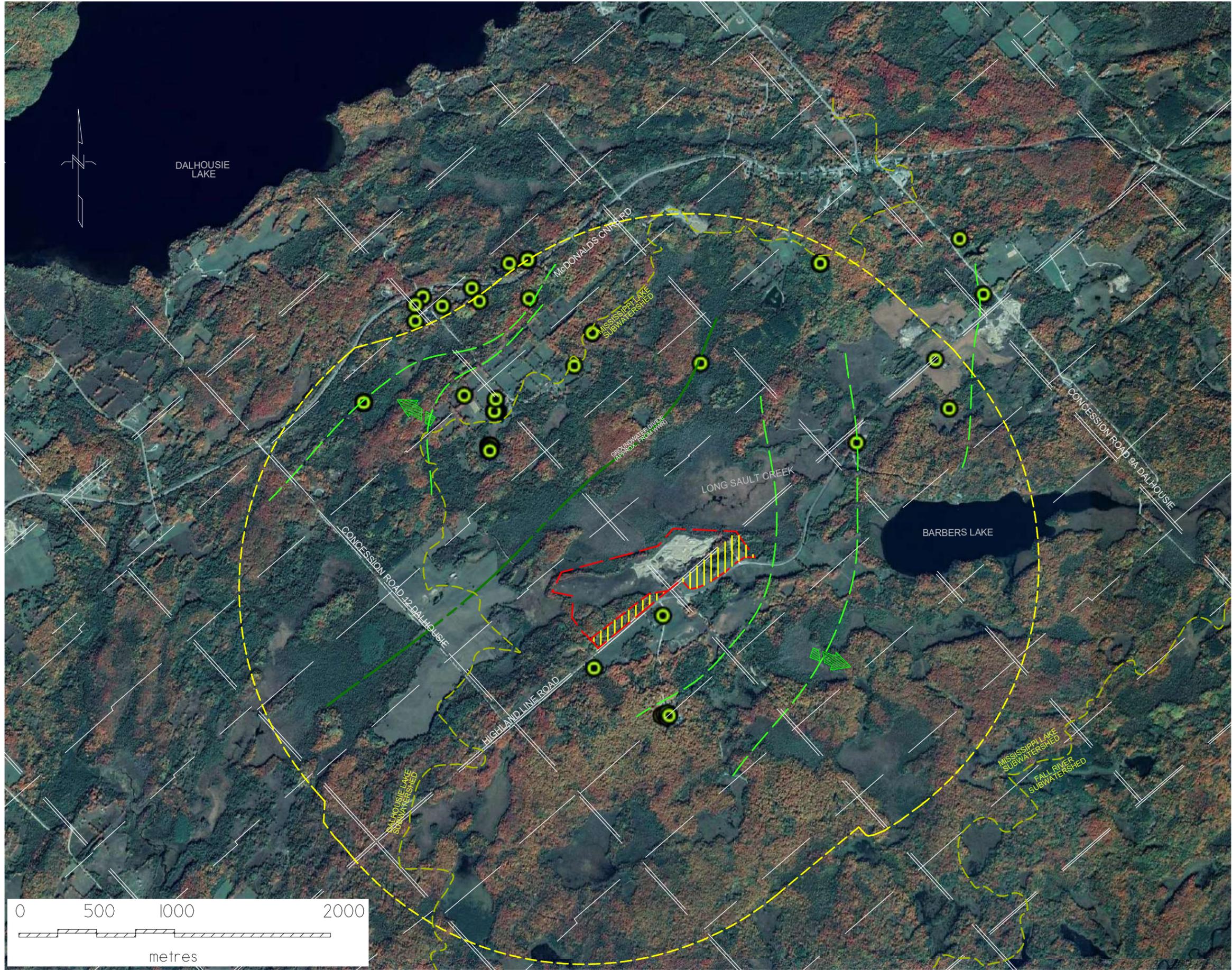
OS FIGURE 2

## SITE DETAILS

CLIENT: ARNOTT BROS. CONST.  
 PROJECT NO: 21-022  
 DATE: APRIL, 2022



GRI/2022/04/2022



### LEGEND

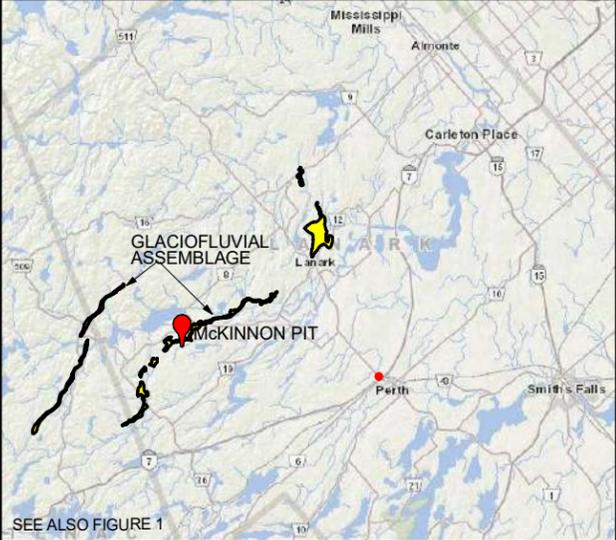
- McKINNON PIT, EXISTING LICENSE (SITE)
- EXPANSION AREA (SITE)
- 2 KM DISTANCE AROUND SITE

SUB-WATERSHED BOUNDARY

POTENTIOMETRIC CONTOUR (mASL)

← GROUNDWATER FLOW DIRECTION

POTENTIOMETRIC CONTOUR (mASL)

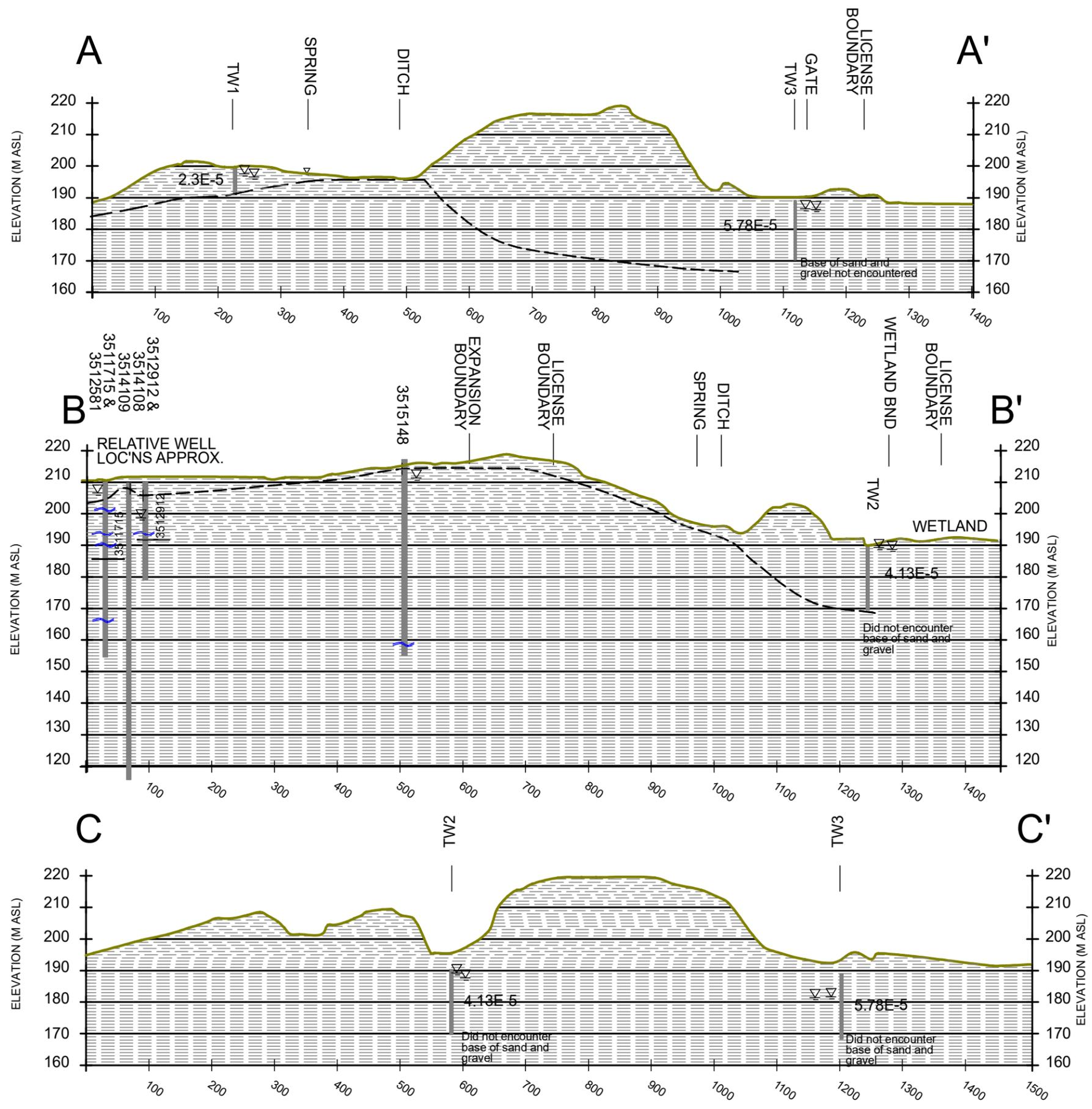


- NOTES:  
 1. BOUNDARIES AND DISTANCES ARE APPROXIMATE  
 SOURCES:  
 2. PHOTO IMAGE - GOOGLE EARTH SATELLITE IMAGERY 10/10/2019  
 3. <https://www.ontario.ca/environment-and-energy/find-pits-and-quarries>  
 4. MVCA PORTAL - <https://camaps.maps.arcgis.com/apps/webappviewer/index.html?id=70831905961e470383262c7a703a56af>  
 5. <http://www.ontario.ca/environment-and-energy/map-well-record-data>  
 6. LAND USE FROM AIR PHOTO INTERPRETATION AND DRIVE-BY SURVEY

### OS FIGURE 3 REGIONAL GROUNDWATER FLOW (FROM WWR)

CLIENT: ARNOTT BROS. CONST.  
 PROJECT NO: 21-022  
 DATE: AUGUST, 2022



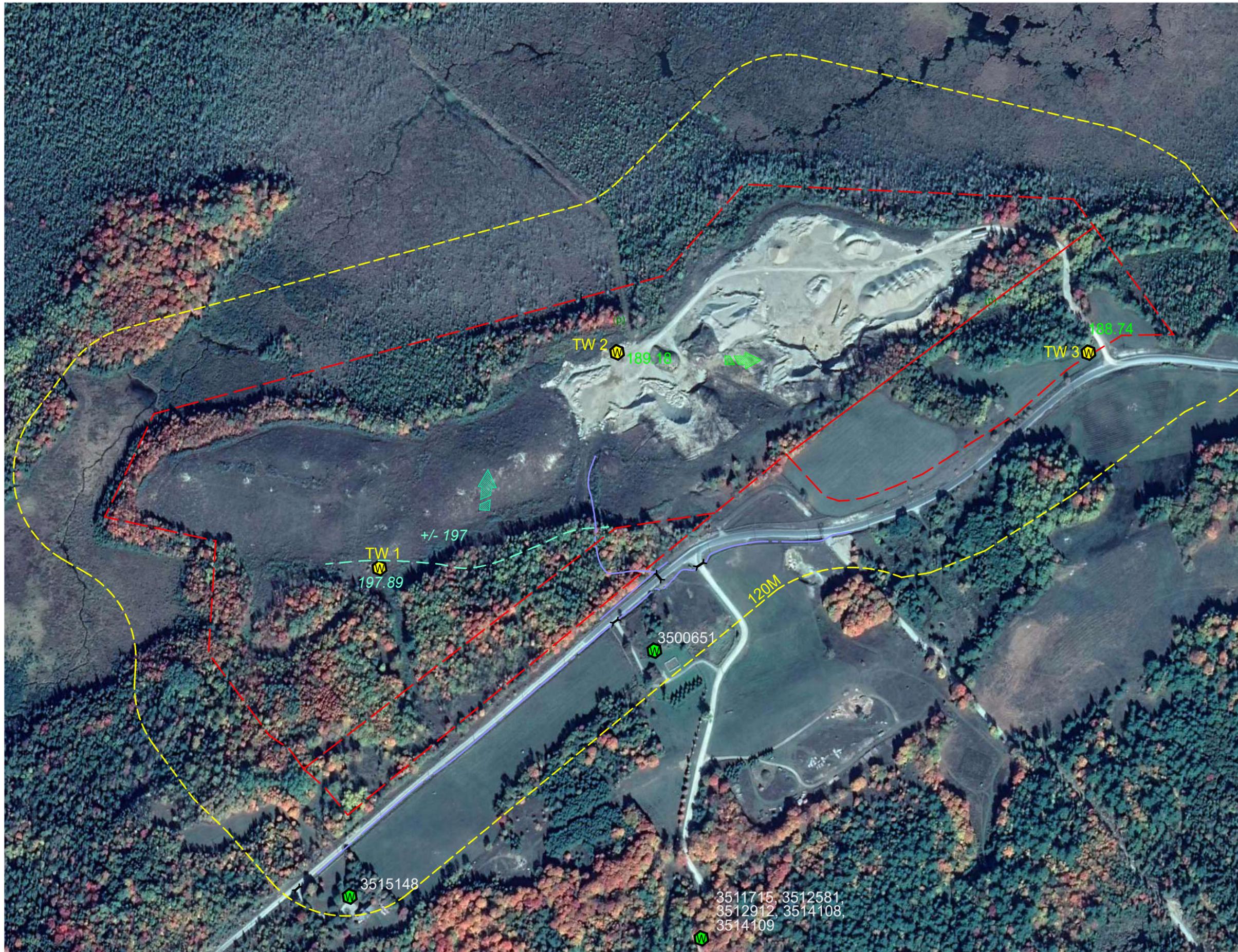


OS FIGURE 4

# CROSS SECTIONS

CLIENT: ARNOTT BROS. CONST.  
 PROJECT NO: 21-022  
 DATE: APRIL, 2022





# LEGEND

- SITE BOUNDARY
- 120 M SURROUNDING LICENSE BOUNDARY
- CROSS SECTION LOCATION
- TW 3  
 TEST WELL (GRI, DEC. 2020)
- WATERCOURSE
- CULVERT
- (p)

- 3500651  
 WATER WELL RECORD, REF.
- 190.90 GROUNDWATER LEVEL, SAND AND GRAVEL UNCONF. AQUIFER
- 190.90 GROUNDWATER LEVEL, TILL (PERCHED) UNCONF. AQUIFER
- GROUNDWATER ELEVATION CONTOUR (mASL)
- FLOW DIRECTION, PERCHED AQUIFER
- FLOW DIRECTION, GRANULAR AQUIFER

NOTES:  
 1. BOUNDARIES AND DISTANCES ARE APPROXIMATE  
 2. PHOTO IMAGE - GOOGLE EARTH SATELLITE IMAGERY 10/10/2019  
 3. GROUNDWATER FLOW INTERPRETED FROM SITE DATA

OS FIGURE 5  
**GROUNDWATER ELEVATION**  
**MARCH 30, 2021**

CLIENT: ARNOTT BROS. CONST.  
 PROJECT NO: 21-022  
 DATE: APRIL, 2022



3511715, 3512581,  
 3512912, 3514108,  
 3514109

3515148

197.89

+/- 197

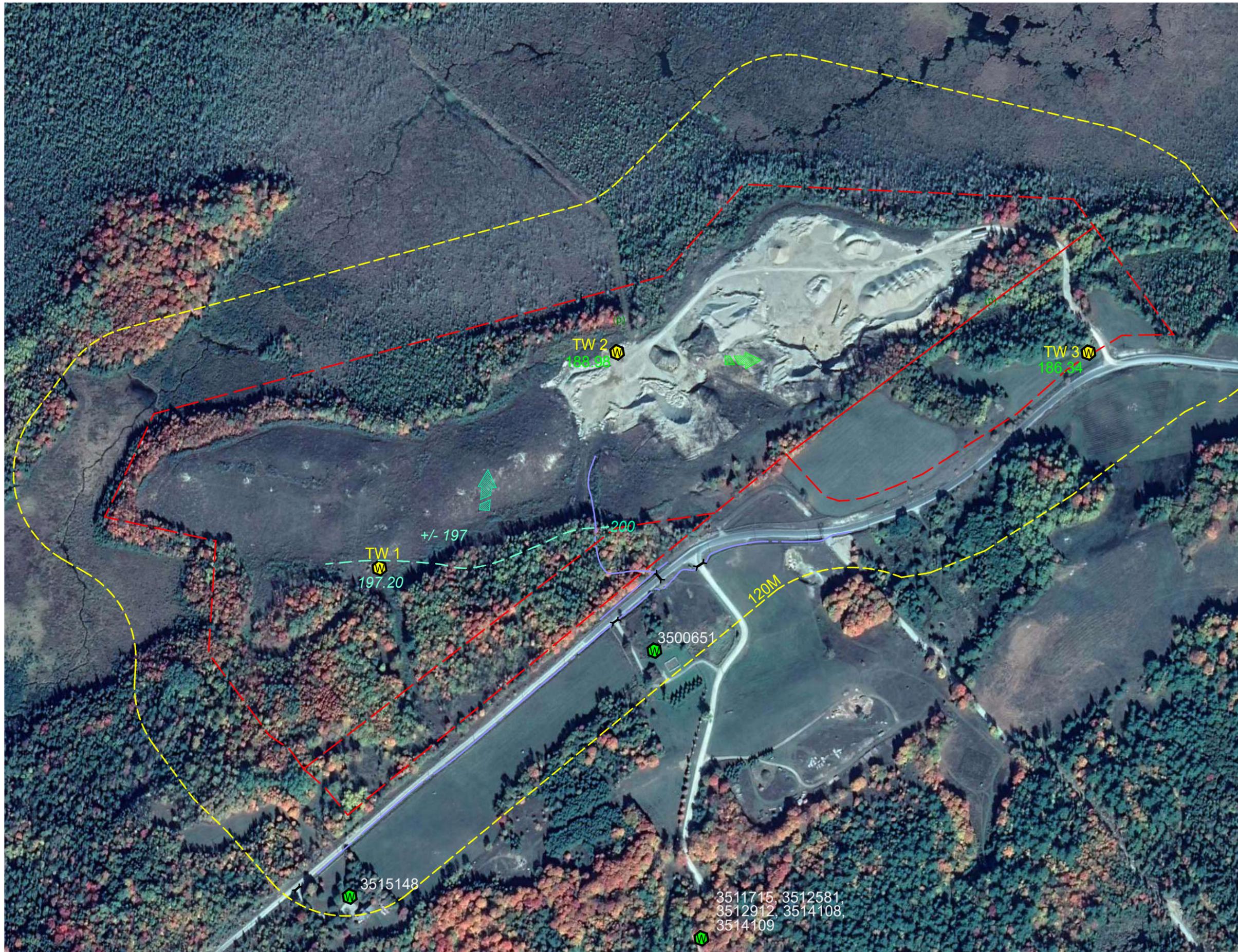
TW 2  
 189.18

TW 3  
 188.73

120M

3500651

23FREPCAM267A



# LEGEND

- SITE BOUNDARY
- 120 M SURROUNDING LICENSE BOUNDARY
- CROSS SECTION LOCATION
- TW 3  
 TEST WELL (GRI, DEC. 2020)
- WATERCOURSE
- CULVERT
- (P)

- 3500651  
 WATER WELL RECORD, REF.
- 190.90 GROUNDWATER LEVEL, SAND AND GRAVEL UNCONF. AQUIFER
- 190.90 GROUNDWATER LEVEL, TILL (PERCHED) UNCONF. AQUIFER
- GROUNDWATER ELEVATION CONTOUR (mASL)
- FLOW DIRECTION, PERCHED AQUIFER
- FLOW DIRECTION, GRANULAR AQUIFER

NOTES:  
 1. BOUNDARIES AND DISTANCES ARE APPROXIMATE  
 2. PHOTO IMAGE - GOOGLE EARTH SATELLITE IMAGERY 10/10/2019  
 3. GROUNDWATER FLOW INTERPRETED FROM SITE DATA

OS FIGURE 6  
**GROUNDWATER ELEVATION**  
**JULY 12, 2021**

CLIENT: ARNOTT BROS. CONST.  
 PROJECT NO: 21-022  
 DATE: APRIL, 2022



3511715, 3512581,  
 3512912, 3514108,  
 3514109

3515148

120M

+/- 197

200

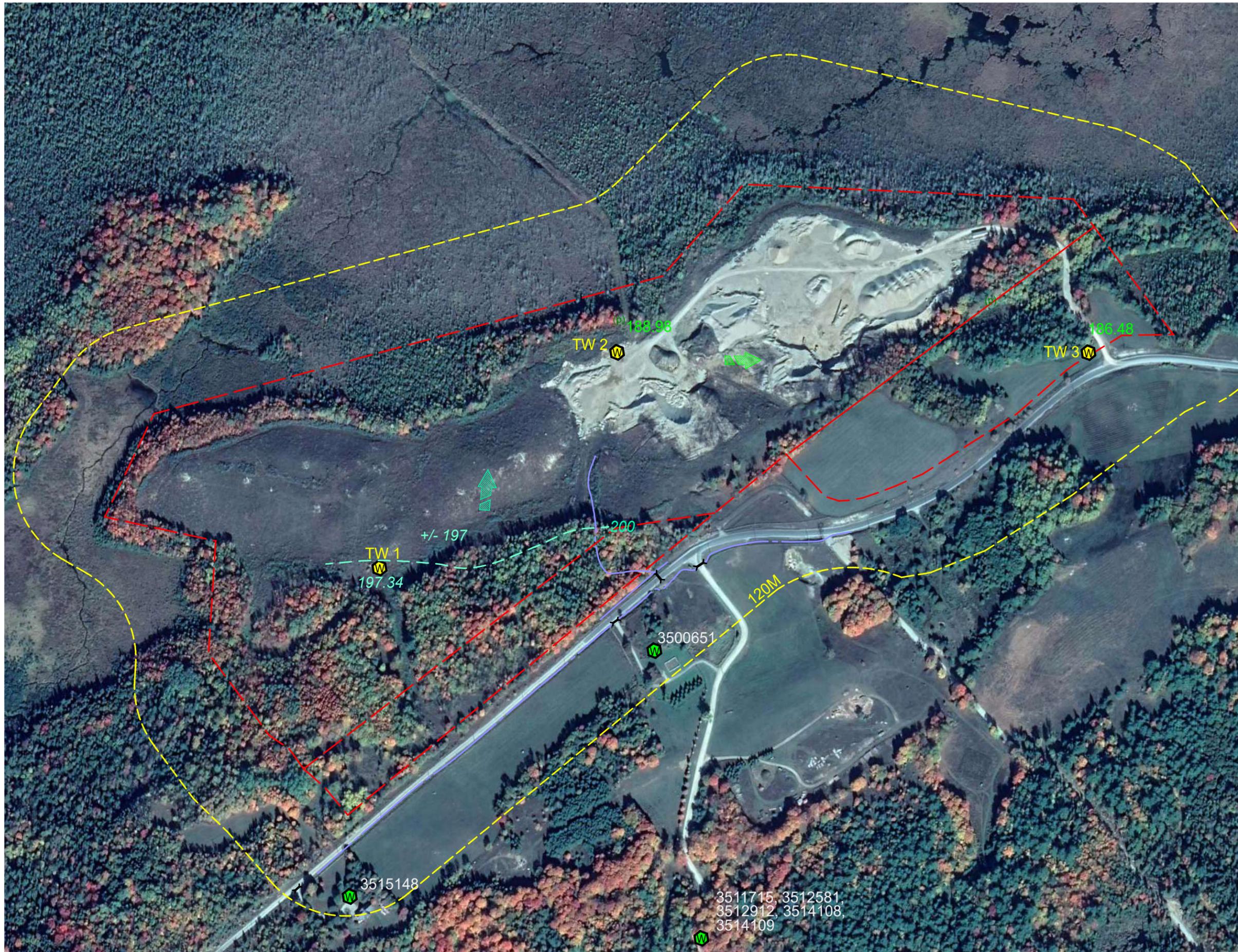
TW 1  
 197.20

TW 2  
 199.98

TW 3  
 199.24

3500651

23FREPCAM267A



# LEGEND

- SITE BOUNDARY
- 120 M SURROUNDING LICENSE BOUNDARY
- CROSS SECTION LOCATION
- TW 3  
 TEST WELL (GRI, DEC. 2020)
- WATERCOURSE
- CULVERT
- (P)

- 3500651  
 WATER WELL RECORD, REF.
- 190.90 GROUNDWATER LEVEL, SAND AND GRAVEL UNCONF. AQUIFER
- 190.90 GROUNDWATER LEVEL, TILL (PERCHED) UNCONF. AQUIFER
- GROUNDWATER ELEVATION CONTOUR (mASL)
- FLOW DIRECTION, PERCHED AQUIFER
- FLOW DIRECTION, GRANULAR AQUIFER

NOTES:  
 1. BOUNDARIES AND DISTANCES ARE APPROXIMATE  
 2. PHOTO IMAGE - GOOGLE EARTH SATELLITE IMAGERY 10/10/2019  
 3. GROUNDWATER FLOW INTERPRETED FROM SITE DATA

OS FIGURE 7  
**GROUNDWATER ELEVATION**  
**SEPTEMBER 16, 2021**

CLIENT: ARNOTT BROS. CONST.  
 PROJECT NO: 21-022  
 DATE: APRIL, 2022



23FREPCAM267A

# Appendix A

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## Water Well Records





Print only in spaces provided.  
Mark correct box with a checkmark, where applicable.

11

3511715

Municipality 35004 Con. CAN

County or District: [Redacted] Township/Borough/City/Town/Village: Dalhousie Con block tract survey, etc.: 11 Lot: 5  
Address: RR, McDonalds Corners, Ont. Date completed: 27 3 96  
day month year

Basin Code: 1067100

General colour	Most common material	Other materials	General description	Depth - feet	
				From	To
<u>Red</u>	<u>sand/gravel</u> <u>granite</u>			<u>0'</u>	<u>18'</u> <u>18'</u> <u>80'</u>

31  
32

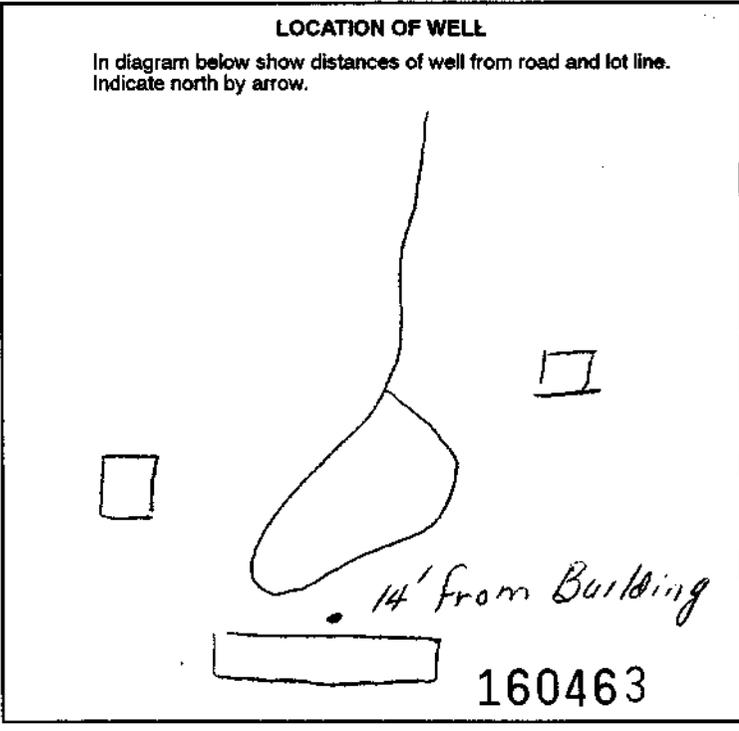
Water found at - feet	Kind of water
<u>32</u>	<input checked="" type="checkbox"/> Fresh <input type="checkbox"/> Sulphur <input type="checkbox"/> Salty <input type="checkbox"/> Minerals <input type="checkbox"/> Gas
<u>54</u>	<input checked="" type="checkbox"/> Fresh <input type="checkbox"/> Sulphur <input type="checkbox"/> Salty <input type="checkbox"/> Minerals <input type="checkbox"/> Gas
<u>68</u>	<input checked="" type="checkbox"/> Fresh <input type="checkbox"/> Sulphur <input type="checkbox"/> Salty <input type="checkbox"/> Minerals <input type="checkbox"/> Gas
	<input type="checkbox"/> Fresh <input type="checkbox"/> Sulphur <input type="checkbox"/> Salty <input type="checkbox"/> Minerals <input type="checkbox"/> Gas
	<input type="checkbox"/> Fresh <input type="checkbox"/> Sulphur <input type="checkbox"/> Salty <input type="checkbox"/> Minerals <input type="checkbox"/> Gas

Inside diam inches	Material	Wall thickness inches	Depth - feet	
			From	To
<u>6</u>	<input checked="" type="checkbox"/> Steel <input type="checkbox"/> Galvanized <input type="checkbox"/> Concrete <input type="checkbox"/> Open hole <input type="checkbox"/> Plastic	<u>188</u>	<u>0'</u>	<u>22'</u>
<u>17-18</u>	<input type="checkbox"/> Steel <input type="checkbox"/> Galvanized <input type="checkbox"/> Concrete <input type="checkbox"/> Open hole <input type="checkbox"/> Plastic			<u>20-23</u>
<u>24-25</u>	<input type="checkbox"/> Steel <input type="checkbox"/> Galvanized <input type="checkbox"/> Concrete <input type="checkbox"/> Open hole <input type="checkbox"/> Plastic			<u>27-30</u>

Sizes of opening (Slot No.)	Diameter inches	Length feet
Material and type		Depth at top of screen feet

Depth set at - feet		Material and type (Cement grout, bentonite, etc.)
From	To	
<u>0</u>	<u>22'</u>	<u>Cement</u>
<u>18-21</u>	<u>22-25</u>	
<u>26-29</u>	<u>30-33</u>	

Pumping test method <input checked="" type="checkbox"/> Pump <input type="checkbox"/> Bailer	Pumping rate <u>10</u> GPM	Duration of pumping <u>1</u> Hours <u>12</u> Mins
Static level <u>9'</u> feet	Water level end of pumping <u>9'</u> feet	Water levels during Pumping 15 minutes: <u>9'</u> feet 30 minutes: <u>9'</u> feet 45 minutes: <u>9'</u> feet 60 minutes: <u>9'</u> feet
If flowing give rate GPM	Pump intake set at <u>80</u> feet	Water at end of test <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Cloudy
Recommended pump type <input checked="" type="checkbox"/> Shallow <input type="checkbox"/> Deep	Recommended pump setting <u>5'5"</u> feet	Recommended pump rate <u>12</u> GPM



<input checked="" type="checkbox"/> Water supply	<input type="checkbox"/> Abandoned, insufficient supply	<input type="checkbox"/> Unfinished
<input type="checkbox"/> Observation well	<input type="checkbox"/> Abandoned, poor quality	<input type="checkbox"/> Replacement well
<input type="checkbox"/> Test hole	<input type="checkbox"/> Abandoned (Other)	
<input type="checkbox"/> Recharge well	<input type="checkbox"/> Dewatering	

<input checked="" type="checkbox"/> Domestic	<input checked="" type="checkbox"/> Commercial	<input type="checkbox"/> Not used
<input type="checkbox"/> Stock	<input type="checkbox"/> Municipal	<input type="checkbox"/> Other
<input type="checkbox"/> Irrigation	<input type="checkbox"/> Public supply	
<input type="checkbox"/> Industrial	<input type="checkbox"/> Cooling & air conditioning	

<input type="checkbox"/> Cable tool	<input type="checkbox"/> Air percussion	<input type="checkbox"/> Driving
<input checked="" type="checkbox"/> Rotary (conventional)	<input type="checkbox"/> Boring	<input type="checkbox"/> Digging
<input type="checkbox"/> Rotary (reverse)	<input type="checkbox"/> Diamond	<input type="checkbox"/> Other
<input checked="" type="checkbox"/> Rotary (air)	<input type="checkbox"/> Jetting	

Name of Well Contractor <u>Thief Well Ltd</u>	Well Contractor's Licence No. <u>2558</u>
Address <u>RR, McDonalds Corners, Ont.</u>	
Name of Well Technician <u>Mark Hall</u>	Well Technician's Licence No. <u>T2228</u>
Signature of Technician/Contractor <u>Thief Well</u>	Submission date <u>27</u> <u>3</u> <u>96</u> day mo yr

MINISTRY USE ONLY	Date source	Contract No. <b>2558</b>	Date received <b>APR 23 1996</b>
	Date of inspection	Inspector	
	Remarks		

CSS.ES

Print only in spaces provided.  
Mark correct box with a checkmark, where applicable.

11

3512581

Municipality 35004 Con. CON  
10 14 15 22 23 24

County or District <i>Lambton</i>	Township/Borough/City/Town/Village <i>Salisbury</i>	Con block tract survey, etc. <i>11</i>	Lot <i>5</i>
Address <i>RR1 McDonalds Corners Ont K0G1M0</i>		Date completed <i>23 3 99</i> day month year	
Northing		RC	Elevation
RC		Basin Code	

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)					
General colour	Most common material	Other materials	General description	Depth - feet	
				From	To
	<i>Previously drilled to 80'</i>				
	<i>red &amp; pink granite</i>			<i>80'</i>	<i>130'</i>

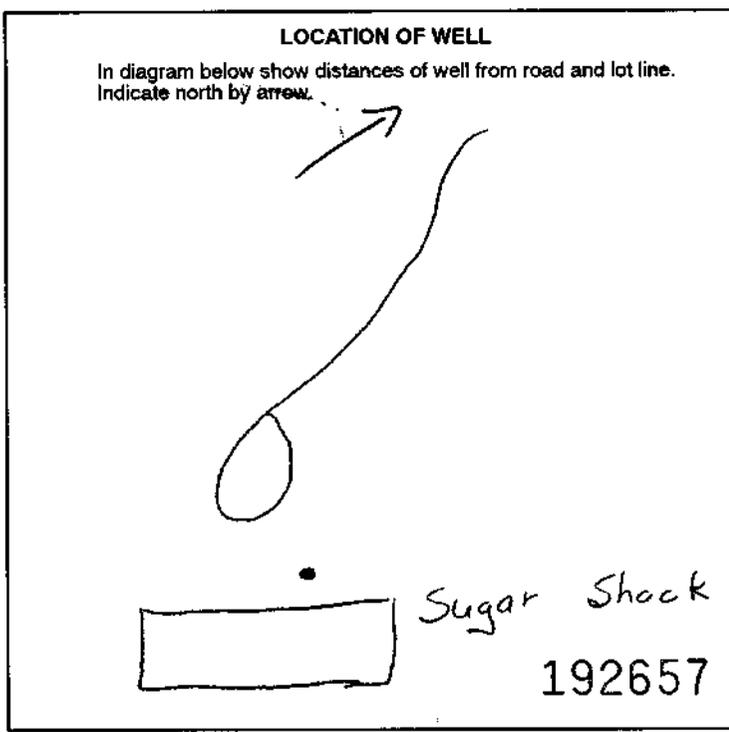
41 WATER RECORD			
Water found at - feet	Kind of water		
<i>143</i>	<input checked="" type="checkbox"/> Fresh	<input type="checkbox"/> Sulphur	<input type="checkbox"/> Minerals
	<input type="checkbox"/> Salty	<input type="checkbox"/> Gas	

51 CASING & OPEN HOLE RECORD				
Inside diam inches	Material	Wall thickness inches	Depth - feet	
			From	To
10-11	<input type="checkbox"/> Steel <input type="checkbox"/> Galvanized <input type="checkbox"/> Concrete <input type="checkbox"/> Open hole <input type="checkbox"/> Plastic			13-16
17-18	<input type="checkbox"/> Steel <input type="checkbox"/> Galvanized <input type="checkbox"/> Concrete <input type="checkbox"/> Open hole <input type="checkbox"/> Plastic			20-23
24-25	<input type="checkbox"/> Steel <input type="checkbox"/> Galvanized <input type="checkbox"/> Concrete <input type="checkbox"/> Open hole <input type="checkbox"/> Plastic			27-30

SCREEN	Sizes of opening (Slot No.)	Diameter	Length
		Inches	feet
	Material and type		Depth at top of screen

61 PLUGGING & SEALING RECORD			
Depth set at - feet		Material and type (Cement grout, bentonite, etc.)	
From	To		
16-13	14-17		
18-21	22-25		
28-21	30-33		

71 Pumping test method <input checked="" type="checkbox"/> Pump <input type="checkbox"/> Bailor	Pumping rate <i>12</i> GPM	Duration of pumping Hours <i>12</i> Mins
Static level <i>13'</i> feet	Water levels during <input checked="" type="checkbox"/> Pumping <input type="checkbox"/> Recovery	
	15 minutes <i>32</i> feet	30 minutes <i>13</i> feet
	45 minutes <i>13</i> feet	60 minutes <i>13</i> feet
If flowing give rate GPM	Pump intake set at <i>180</i> feet	Water at end of test <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Cloudy
Recommended pump type <input type="checkbox"/> Shallow <input checked="" type="checkbox"/> Deep	Recommended pump setting <i>160</i> feet	Recommended pump rate <i>10</i> GPM



FINAL STATUS OF WELL			
<input checked="" type="checkbox"/> Water supply	<input type="checkbox"/> Abandoned, insufficient supply	<input type="checkbox"/> Unfinished	
<input type="checkbox"/> Observation well	<input type="checkbox"/> Abandoned, poor quality	<input type="checkbox"/> Replacement well	
<input type="checkbox"/> Test hole	<input type="checkbox"/> Abandoned (Other)		
<input type="checkbox"/> Recharge well	<input type="checkbox"/> Dewatering		
WATER USE			
<input checked="" type="checkbox"/> Domestic	<input checked="" type="checkbox"/> Commercial	<input type="checkbox"/> Not used	
<input type="checkbox"/> Stock	<input type="checkbox"/> Municipal	<input type="checkbox"/> Other	
<input type="checkbox"/> Irrigation	<input type="checkbox"/> Public supply		
<input type="checkbox"/> Industrial	<input type="checkbox"/> Cooling & air conditioning		
METHOD OF CONSTRUCTION			
<input type="checkbox"/> Cable tool	<input type="checkbox"/> Air percussion	<input type="checkbox"/> Driving	
<input type="checkbox"/> Rotary (conventional)	<input type="checkbox"/> Boring	<input type="checkbox"/> Digging	
<input type="checkbox"/> Rotary (reverse)	<input type="checkbox"/> Diamond	<input type="checkbox"/> Other	
<input checked="" type="checkbox"/> Rotary (air)	<input type="checkbox"/> Jetting		

Name of Well Contractor <i>Thrup Hall Ltd</i>	Well Contractor's Licence No. <i>2558</i>
Address <i>RR1 McDonalds Corners Ont K0G1M0</i>	
Name of Well Technician <i>Mark Hall</i>	Well Technician's Licence No. <i>T2228</i>
Signature of Technician/Contractor <i>Thrup Hall</i>	Submission date <i>23 3 99</i> day mo yr

MINISTRY USE ONLY	Data source <i>2558</i>	Contractor <i>2558</i>	Date received <i>APR 06 1999</i>
	Date of inspection	Inspector	
	Remarks  <i>CSS.ES9</i>		

Print only in spaces provided.  
Mark correct box with a checkmark, where applicable.

11

3512912

Municipality **35004** Con. **CON**

County or District <i>Lambton</i>	Township/Borough/City/Town/Village <i>Delaware</i>	Con block tract survey, etc. <i>11</i>	Lot <i>5</i>
Address <i>R.R. McDonald's Corner Ont K0G1M0</i>		Date completed <i>19 4 00</i>	

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)					
General colour	Most common material	Other materials	General description	Depth - feet	
				From	To
	<i>Clay/gravel/boulders</i>			<i>0'</i>	<i>14'</i>
<i>red</i>	<i>granite</i>			<i>14'</i>	<i>32'</i>
<i>red</i>	<i>granite/gravel/beam</i>			<i>32'</i>	<i>37'</i>
<i>red/black</i>	<i>granite</i>			<i>37'</i>	<i>60'</i>

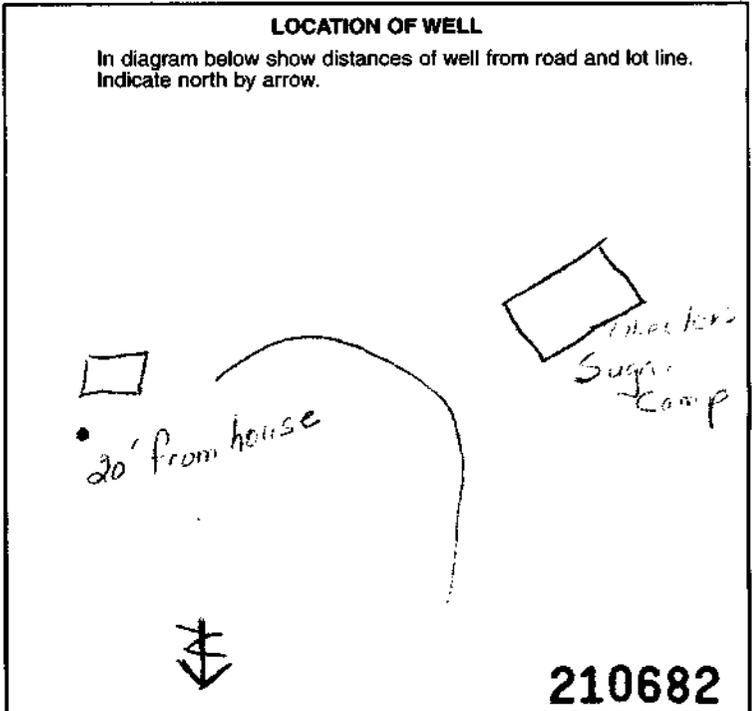
41 WATER RECORD	
Water found at - feet	Kind of water
<i>55'</i>	<input checked="" type="checkbox"/> Fresh <input type="checkbox"/> Salty <input type="checkbox"/> Sulphur <input type="checkbox"/> Minerals <input type="checkbox"/> Gas

51 CASING & OPEN HOLE RECORD				
Inside diam inches	Material	Wall thickness inches	Depth - feet	
			From	To
<i>6"</i>	<input checked="" type="checkbox"/> Steel <input type="checkbox"/> Galvanized <input type="checkbox"/> Concrete <input type="checkbox"/> Open hole <input type="checkbox"/> Plastic	<i>188</i>	<i>0'</i>	<i>44'</i>

SCREEN	Sizes of opening (Slot No.)	Diameter inches	Length feet

61 PLUGGING & SEALING RECORD		
<input type="checkbox"/> Annular space		<input type="checkbox"/> Abandonment
Depth set at - feet		Material and type (Cement grout, bentonite, etc.)
From	To	
<i>0</i>	<i>44'</i>	<i>Cement</i>

71 PUMPING TEST	
Pumping test method <input checked="" type="checkbox"/> Pump <input type="checkbox"/> Bailer	Pumping rate <i>30</i> GPM
Static level <i>37'</i> feet	Water level end of pumping <i>37'</i> feet
Water levels during <input checked="" type="checkbox"/> Pumping <input type="checkbox"/> Recovery	
15 minutes <i>37'</i> feet	30 minutes <i>37'</i> feet
45 minutes <i>37'</i> feet	60 minutes <i>37'</i> feet
If flowing give rate GPM	Pump intake set at <i>60</i> feet
Recommended pump type <input checked="" type="checkbox"/> Shallow <input type="checkbox"/> Deep	Recommended pump setting <i>5'2</i> feet
	Water at end of test <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Cloudy
	Recommended pump rate <i>7</i> GPM



FINAL STATUS OF WELL		
<input checked="" type="checkbox"/> Water supply	<input type="checkbox"/> Abandoned, insufficient supply	<input type="checkbox"/> Unfinished
<input type="checkbox"/> Observation well	<input type="checkbox"/> Abandoned, poor quality	<input type="checkbox"/> Replacement well
<input type="checkbox"/> Test hole	<input type="checkbox"/> Abandoned (Other)	
<input type="checkbox"/> Recharge well	<input type="checkbox"/> Dewatering	

WATER USE		
<input checked="" type="checkbox"/> Domestic	<input type="checkbox"/> Commercial	<input type="checkbox"/> Not use
<input type="checkbox"/> Stock	<input type="checkbox"/> Municipal	<input type="checkbox"/> Other
<input type="checkbox"/> Irrigation	<input type="checkbox"/> Public supply	
<input type="checkbox"/> Industrial	<input type="checkbox"/> Cooling & air conditioning	

METHOD OF CONSTRUCTION		
<input type="checkbox"/> Cable tool	<input type="checkbox"/> Air percussion	<input type="checkbox"/> Driving
<input type="checkbox"/> Rotary (conventional)	<input type="checkbox"/> Boring	<input type="checkbox"/> Digging
<input type="checkbox"/> Rotary (reverse)	<input type="checkbox"/> Diamond	<input type="checkbox"/> Other
<input checked="" type="checkbox"/> Rotary (air)	<input type="checkbox"/> Jetting	

Name of Well Contractor <i>Huff Hall Ltd</i>	Well Contractor's Licence No. <i>2558</i>
Address <i>R.R. McDonald's Corner Ont K0G1M0</i>	
Name of Well Technician <i>Mark Hall</i>	Well Technician's Licence No. <i>T2228</i>
Signature of Technician/Contractor <i>Huff Hall</i>	Submission date <i>19 4 00</i>

MINISTRY USE ONLY	
Data source <b>2558</b>	Date received <b>MAY 04 2000</b>
Date of inspection	Inspector
Remarks <b>CSS.ESO</b>	





**Instructions for Completing Form**

- For use in the Province of Ontario only. This document is a permanent legal document. Please retain for future reference.
- All Sections must be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Management Coordinator at 416-235-6203.
- All metre measurements shall be reported to 1/10<sup>th</sup> of a metre.
- Please print clearly in blue or black ink only.

**Well Owner's Information and Location of Well Information**

Ministry Use Only											
MUN										CON	LOT

LANARK COUNTY Bathurst 5 11  
RR#/Street Number/Name Highland Line Road City/Town/Village McDonalds Corners Site/Compartment/Block/Tract etc.  
GPS Reading NAD Zone Easting Northing Unit Make/Model Mode of Operation:  Undifferentiated  Averaged  
8.3 18 392434 497629.1 Magellan Meridian  Differentiated, specify

**Log of Overburden and Bedrock Materials (see instructions)**

General Colour	Most common material	Other Materials	General Description	Depth From	Metres To
Black	Earth			0	3.0
Red	Granite			3.0	61.0

**Hole Diameter**

Depth From	Metres To	Diameter Centimetres
6.1	61.0	15.24

**Water Record**

Water found at: 5.76m Metres Kind of Water:  Fresh  Sulphur  Gas  Salty  Minerals  Other:

After test of well yield, water was  Clear and sediment free  Other, specify

Chlorinated  Yes  No

**Construction Record**

Inside diam centimetres	Material	Wall thickness centimetres	Depth From	Metres To
15.85	<input checked="" type="checkbox"/> Steel <input type="checkbox"/> Fibreglass <input type="checkbox"/> Plastic <input type="checkbox"/> Concrete <input type="checkbox"/> Galvanized	.188	0	6.1

**Screen**

Outside diam  Steel  Fibreglass  Plastic  Concrete  Galvanized Slot No.

**No Casing or Screen**

Open hole  6.1  61.0

**Test of Well Yield**

Pumping test method	Draw Down	Recovery	
Time min	Water Level Metres	Time min	Water Level Metres
Pump			
Pump intake set at - (metres) 5.8	Static Level 5.8		
Pumping rate (litres/min) 14	1 7	1 13.9	
Duration of pumping 1 hrs + min	2 7.2	2 13.7	
Final water level end of pumping 5.8 metres	3 7.3	3 13.5	
Recommended pump type <input type="checkbox"/> Shallow <input checked="" type="checkbox"/> Deep	4 7.5	4 13.3	
Recommended pump depth 5.8 metres	5 8.0	5 13.1	
Recommended pump rate (litres/min) 20	10 9.2	10 12.3	
If flowing give rate (litres/min) 25	15 10	15 11.5	
	20 10.9	20 10.7	
	25 11.9	25 9.9	
If pumping discontinued, give reason.	30 12.0	30 9.1	
	40 13.9	40 7.7	
	50 14.8	50 6.6	
	60 15.8	60 5.8	

**Plugging and Sealing Record**  Annular space  Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.1	Cement Slurry	120 Kg.

**Method of Construction**

Cable Tool  Rotary (air)  Diamond  Digging  Rotary (conventional)  Air percussion  Jetting  Other  Rotary (reverse)  Boring  Driving

**Water Use**

Domestic  Industrial  Public Supply  Other  Stock  Commercial  Not used  Irrigation  Municipal  Cooling & air conditioning

**Final Status of Well**

Water Supply  Recharge well  Unfinished  Abandoned, (Other)  Observation well  Abandoned, insufficient supply  Dewatering  Test Hole  Abandoned, poor quality  Replacement well

**Location of Well**

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

Audit No. **Z 32915** Date Well Completed **2005 09 27**

Was the well owner's information package delivered?  Yes  No Date Delivered **2005 09 27**

**Well Contractor/Technician Information**

Name of Well Contractor **J.R. Thompson** Well Contractor's Licence No. **4905**

Business Address (street name, number, city, etc.) **511 Wildfire Rd. Poth On.**

Name of Well Technician (last name, first name) **Darrell Stevenson** Well Technician's Licence No. **T2919**

Signature of Technician/Contractor **x Brian M Braden** Date Submitted **2005 09 27**

**Ministry Use Only**

Data Source Contractor **4905**

Date Received **NOV 07 2005** Date of Inspection **MM DD**

Remarks Well Record Number

**Instructions for Completing Form**

- For use in the **Province of Ontario** only. This document is a permanent **legal** document. Please retain for future reference.
- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Help Desk (Toll Free) at 1-888-396-9355.
- **All metre measurements shall be reported to 1/10<sup>th</sup> of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only									
MUN						CON			LOT

**Well Owner's Information and Location of Well Information**

RR#/Street Number/Name: **Conc 9** City/Town/Village: \_\_\_\_\_ Site/Compartment/Block/Tract etc.: \_\_\_\_\_

GPS Reading: NAD **83** Zone **18** Easting **379607** Northing **4977703** Unit Make/Model: **Magellan** Mode of Operation:  Undifferentiated  Averaged  Differentiated, specify \_\_\_\_\_

**Log of Overburden and Bedrock Materials (see instructions)**

General Colour	Most common material	Other Materials	General Description	Depth Metres	
				From	To
Brown	Earth	Gravel		0	10.4
Grey	Granite			10.4	15.2
Grey	Gravel			15.2	16.8

**Hole Diameter**

Depth From	Metres To	Diameter Centimetres
13.4	16.8	15.24

**Construction Record**

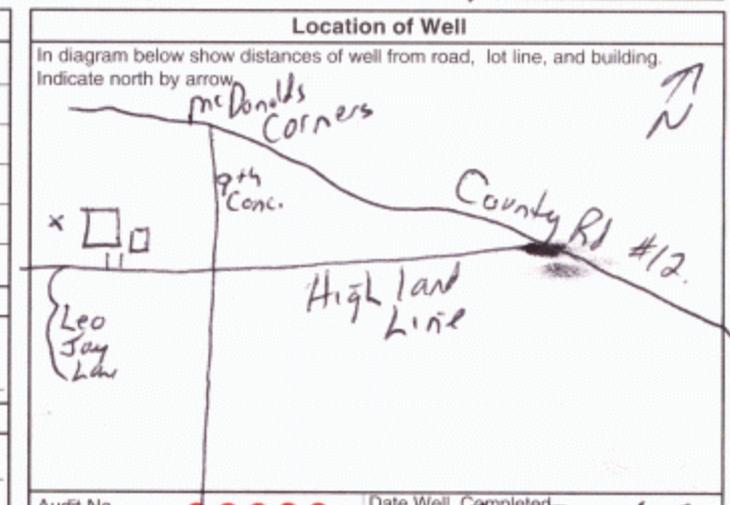
Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres	
			From	To
15.24	<input checked="" type="checkbox"/> Steel <input type="checkbox"/> Fibreglass <input type="checkbox"/> Plastic <input type="checkbox"/> Concrete <input type="checkbox"/> Galvanized	.188	0	13.4
<b>Screen</b>				
Outside diam	<input type="checkbox"/> Steel <input type="checkbox"/> Fibreglass <input type="checkbox"/> Plastic <input type="checkbox"/> Concrete <input type="checkbox"/> Galvanized	Slot No.		
<b>No Casing or Screen</b>				
<input checked="" type="checkbox"/> Open hole			13.4	16.8

**Test of Well Yield**

Pumping test method	Draw Down		Recovery	
	Time min	Water Level Metres	Time min	Water Level Metres
Pump				
Pump intake set at - (metres)	15	Static Level 2.2		
Pumping rate - (litres/min)	18	1 4.6	1 12.7	
Duration of pumping	2	6.9	2 11.0	
Final water level end of pumping	3	9.2	3 9.4	
Recommended pump type	4	11.7	4 7.9	
Recommended pump depth	5	13.1	5 6.5	
Recommended pump rate	10	14.2	10 3.9	
	15	14.2	15 2.2	
If flowing give rate - (litres/min)	20	14.2	20 2.2	
	25	14.2	25 2.2	
If pumping discontinued, give reason.	30	14.2	30 2.2	
	40	14.3	40 2.2	
	50	14.3	50 2.2	
	60	14.2	60 2.2	

**Plugging and Sealing Record**  Annular space  Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	13.4	Cement Slurry	



**Method of Construction**

Cable Tool  Rotary (air)  Diamond  Digging

Rotary (conventional)  Air percussion  Jetting  Other

Rotary (reverse)  Boring  Driving

**Water Use**

Domestic  Industrial  Public Supply  Other

Stock  Commercial  Not used

Irrigation  Municipal  Cooling & air conditioning

**Final Status of Well**

Water Supply  Recharge well  Unfinished  Abandoned, (Other)

Observation well  Abandoned, insufficient supply  Dewatering

Test Hole  Abandoned, poor quality  Replacement well

Audit No. **Z 60000** Date Well Completed **2007 06 20**

Was the well owner's information package delivered?  Yes  No Date Delivered **2007 06 20**

**Well Contractor/Technician Information**

Name of Well Contractor: **J.R. Thompson** Well Contractor's Licence No.: **4905**

Business Address (street name, number, city etc.): **511 Wildlife Rd. PERTH ON.**

Name of Well Technician (last name, first name): **Darrell Stevenson** Well Technician's Licence No.: **T2919**

Signature of Technician/Contractor: **Simon Brady** Date Submitted: **2007 06 20**

**Ministry Use Only**

Data Source: \_\_\_\_\_ Contractor: \_\_\_\_\_

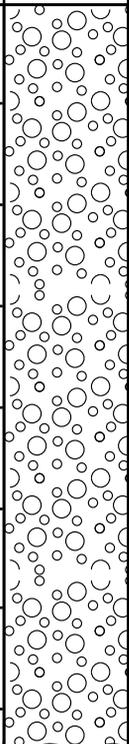
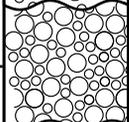
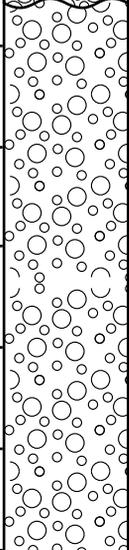
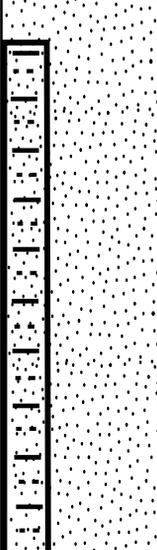
Date Received: **JUN 25 2008** Date of Inspection: \_\_\_\_\_

Remarks: \_\_\_\_\_ Well Record Number: \_\_\_\_\_

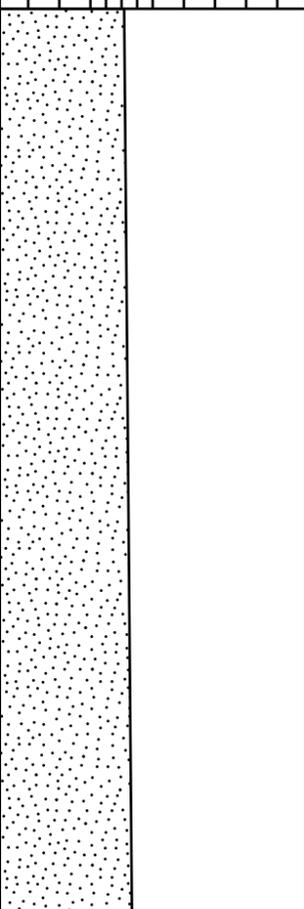
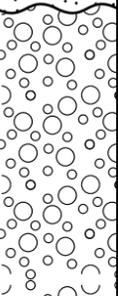
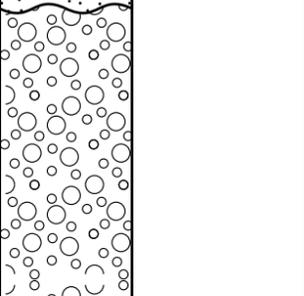
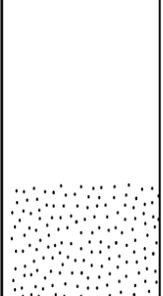
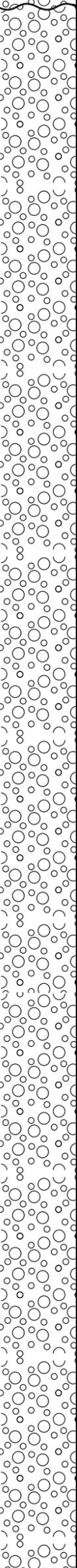
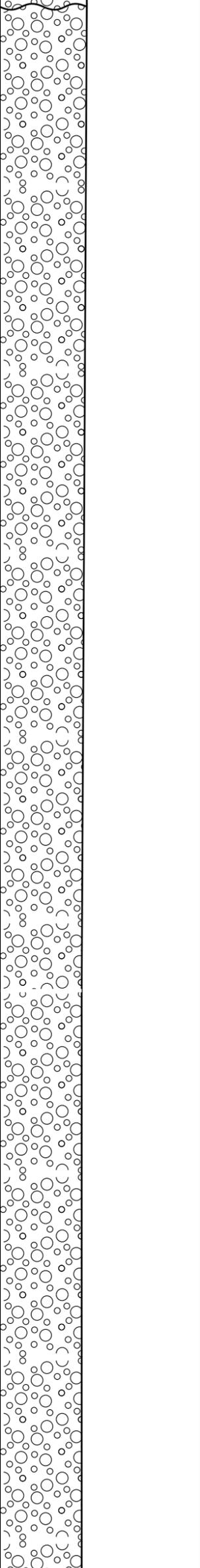
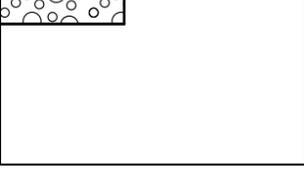
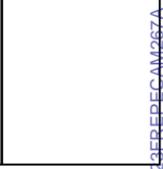
# Appendix B

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## Drill Hole Logs and MOECC Cluster Record

ELEVATION (mASL)	SCALE (m)	LITHOLOGY	MUD SANDGRAVEL	NOTES	SAMPLE NO.	INSTALLATION
202.5	1 2 3		clay silt vf m vc gran pebb cobb boul	layered, layers of medium to medium coarse sand layers of pebbles and stones, sets 20 to 60 cm thick		
198.8	4			stone layer		
198.2	5 6 7			medium to medium fine sand, occasional stone layer, ALCS <5 cm, layered, sets 10 to 20 cm thick, sample 1 at 6.10 m bgs. Calculated hydraulic conductivity was 2.3E-5 m/s	1 60-28-73	
195.5				Till, dense sandy silt, stone layers		
194.9				weathered/broken bedrock		

ELEVATION (mASL)	SCALE (m)	LITHOLOGY	MUD SANDGRAVEL	NOTES	SAMPLE NO.	INSTALLATION
			clay silt vf m vc f c gran pebb cobb boul			
192.5	1 2 3 4 5			layers of medium to medium coarse sand and to very coarse gravel, ALCS <5 cm		
186.4	6 7 8			layers of medium coarse to very coarse sand, ALCS 0.5 to 2 cm, likely <25% stone; SA 2 medium coarse to very coarse sand, pebbles. ALCS < 2 cm	sa2 1-1-2-6	
183.4	9 10 11 12 13 14 15 16 17			layers of medium coarse to very coarse sand, ALCS 0.5 to 2 cm, likely <25% stone. Calculated hydraulic conductivity 4.1E-5 m/s	1 60-28-73	
174.2	18			Stopped at 18.29 mBGS, sand coming up augers		

ELEVATION (mASL)	SCALE (m)	LITHOLOGY	MUD SANDGRAVEL	NOTES	SAMPLE NO.	INSTALLATION
			clay silt vf m vc gran pebb cobb boul			
193.5	1 2 3 4			loose silty sand		
188.9	5 6			medium coarse to very coarse sand , pea gravel, ALCS 1 to 2 cm, FM 3 to 3.5		
187.4	7 8 9 10 11 12 13			medium coarse to very coarse sand , pea gravel, ALCS 1 to 2 cm, FM 3 to 3.5. Calculated hydraulic conductivity was 5.8E-05 m/s	sa3 1-2-18-16	
175.2	14 15 16 17 18			layered, 10 to 20 cm layers, medium coarse to coarse sand to silty fine sand layers Overall, medium to medium coarse. FM 2 to 2.5. Less than 10% stone.		
				EOH at 18.29 mBGS. No refusal, just stopped due to augers filling with sand		

All measurements recorded in:  Metric  Imperial

Follow instructions on the front and back of this form. Print or Type

Well Tag No. of Deepest Well: (Print Well Tag No.)

A215041

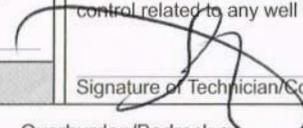
Well No. on Drawing of Deepest Well: TW-2

Dewatering wells

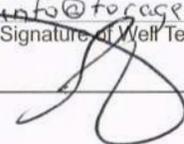
Test holes

No. of wells reported 3

Page 1 of 1

Well Cluster Location Information								Mandatory Attachments/Additional Information							
Address of Well Location (Street Number(s)/Name(s), RR, if available)				Lot(s)		Concession(s)		Geographic Township		County/District/Upper Tier Municipality					
890 HIGHLAND LINE ROAD															
City, Town, Village or Hamlet				Province		GPS Unit Make		Model		Unit Mode of Operation <input type="checkbox"/> Undifferentiated <input checked="" type="checkbox"/> Averaged					
PERTH				Ontario		GARMIN		ETREX		<input type="checkbox"/> Differentiated, specify: _____					
Well Details								Signature of Technician/Contractor				Date (yyyy/mm/dd)			
												2021/01/15			

Well # on Drawing	UTM Coordinates			Hole Depth (m/ft)	Hole Diameter (cm/in)	Method of Construction	Casing Material; Diameter (cm/in)	Casing (m/ft)		Screen Interval (m/ft)		Annular Space Material (m/ft)			Overburden/Bedrock or Abandonment Filing Material Intervals (m/ft)	Static Water Level (m/ft)	Date of Completion (yyyy/mm/dd)
	Zone	Easting	Northing					From	To	From	To	From	To	Material:			
TW-1	18	377946	4976712	7.92	20.3	HSA	5.08	0	4.88	4.88	7.92	0.9	4.27	BENTONITE	0-6.1 SAND, TILL	N/A	2020/11/26
TW-2	18	378239	4976967	9.14	20.3	HSA	5.08	0	6.1	6.1	9.14	0.9	5.18	BENTONITE	SAND	0.91	2020/11/26
TW-3	18	378828	4976960	9.14	20.3	HSA	5.08	0	6.1	6.1	9.14	0.2	5.18	BENTONITE	SAND	1.52	2020/11/27

Well Contractor and Well Technician Information					Date First Well in Cluster Constructed or Abandoned (yyyy/mm/dd)		Date Last Well in Cluster Completed (yyyy/mm/dd)		Ministry Use Only		
Business Name of Well Contractor		Business Address (Street Number/Name, RR)		Municipality	Province	2020/11/26		2020/11/27		Date Received (yyyy/mm/dd)	Audit No.
GEORGE DOWNING ESTATE DRILLING LTD		410 RUE PRINCIPALE		GRENVILLE-SUR-LA-ROUGE	QC						C 50689
Postal Code	Bus. Telephone No.	Well Contractor's Licence No.	Business E-mail Address			Well Abandonment					
J0V1B0	(819) 242-6469	1844	info@forage-downing-drilling.com			Person Abandoning the Wells:					
Name of Well Technician (First Name, Last Name)		Well Technician's Licence No.	Signature of Well Technician		Date Submitted (yyyy/mm/dd)	Name					
STEPHEN DOWNING		3326			2021/01/15	N/A					
(Print or Type) - See instruction 11 on the back of this form											

# PERMISSION TO FILE A WELL CLUSTER RECORD

**\*leave with onsite technician, for clusters only\***

Our firm was recently contracted to either install or abandon groundwater monitoring wells at your property. When this type of well is installed or abandoned, provincial law requires us to file a well record with the Ministry of Environment.

The well record does not provide any information about your property use, your business, or information about the structural or environmental qualities of your property. The purpose of the record is simply to inform the Ministry that a well exists at this location, and provide details illustrating that the well has been properly constructed or decommissioned.

We can file a single record for each well, but it is more economical to file one record for the entire cluster of wells. In order to file this "cluster record", we are required to obtain written permission from the owner of the land. [Ref: Reg 903 16.4(1)4]

It would be greatly appreciated if you would sign and return the following, so that we can comply with the legislation and file the well record. Scanned, emailed or faxed copies are acceptable.

I hereby authorize George Downing Estate Drilling / Eastern Ontario Diamond Drilling to file a cluster of wells installed at the address below

## Well Location Information

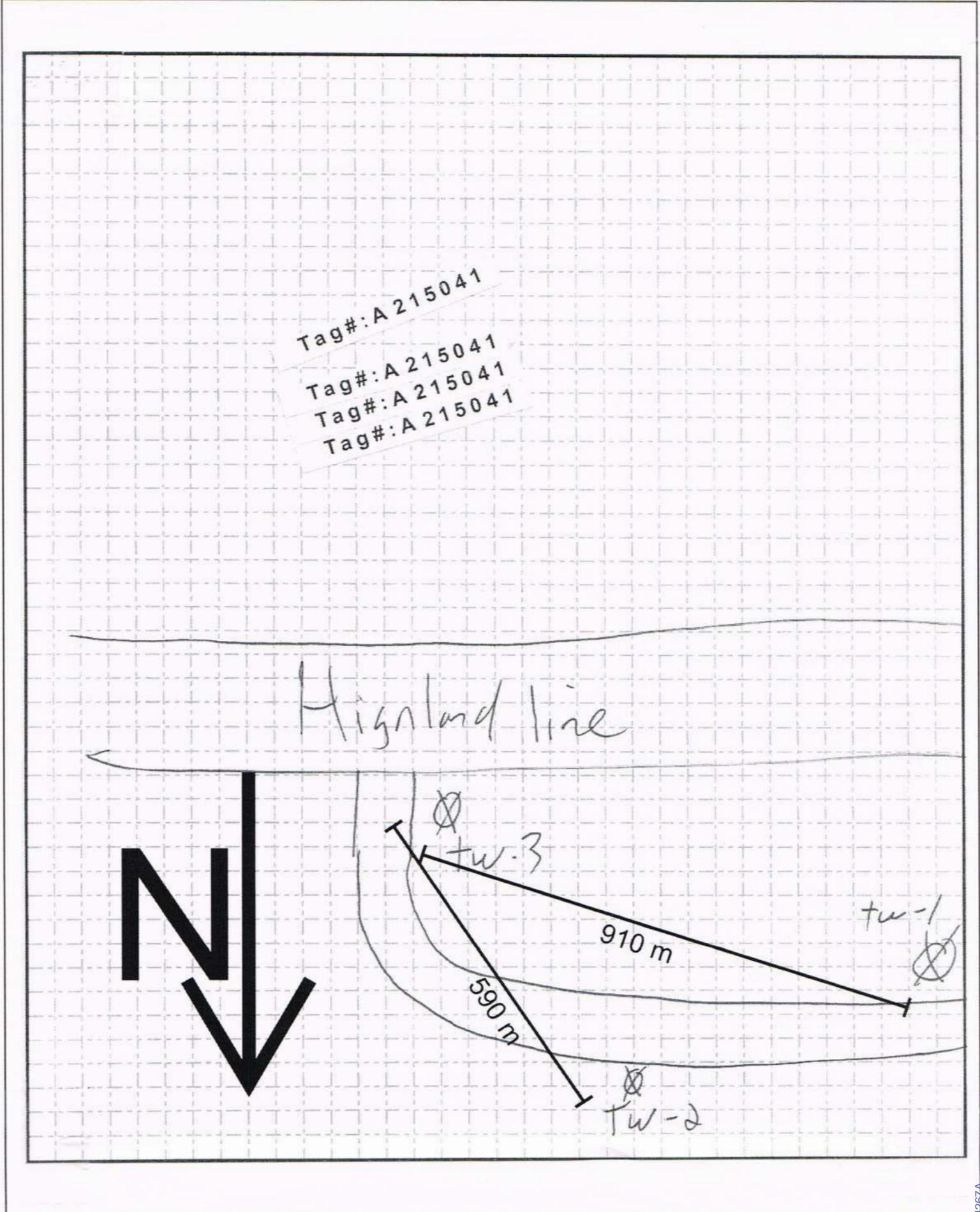
Street Address : Highland Line  
(if no address) Lot & Concession : Lot 5 and 6. Concession X and XI  
County/District/Municipality : Township of Lanark Highlands, Geo Dalhousie  
City/Town/Village : McDonalds Corners  
Postal Code : K0G 1M0  
Well Tag Number : A215041 Number of Wells : 3  
Audit No. : C50689 Wells : TW-1, TW-2, TW-3

## Property Owners's Information

Company Name (if applicable): Arnott Bros Construction Ltd.  
Name: Mike Crain  
Mailing Address: #36 Highway 511, Perth Ontario  
Email Address : info@arnottbros.com  
Phone Number : 613-812-8764 (cell) 613-267-5722 (office)  
Signature :  Date: Jan 12 2021



**Note:** This Well Record for Well Cluster Part 3 - Detailed Drawing of all Well Locations, must be attached to Parts 1 and 2. The drawing must include all property boundaries, an arrow indicating the North direction, all named roads and sufficient measurements to locate all wells in the cluster in relation to fixed points. The drawing must show the location of each well and each well must be numbered on the drawing to match number used for that well on the Well Record for Well Cluster Parts 1 and 2. The well with the well tag must be clearly identified on the Drawing. UTM coordinates should appear beside each well, if space permits. Additional comments on wells can be included on the drawing

Well Tag Number: # A215041"Well Record for Well Cluster" Form Audit Number: # C50689

# Appendix C

---

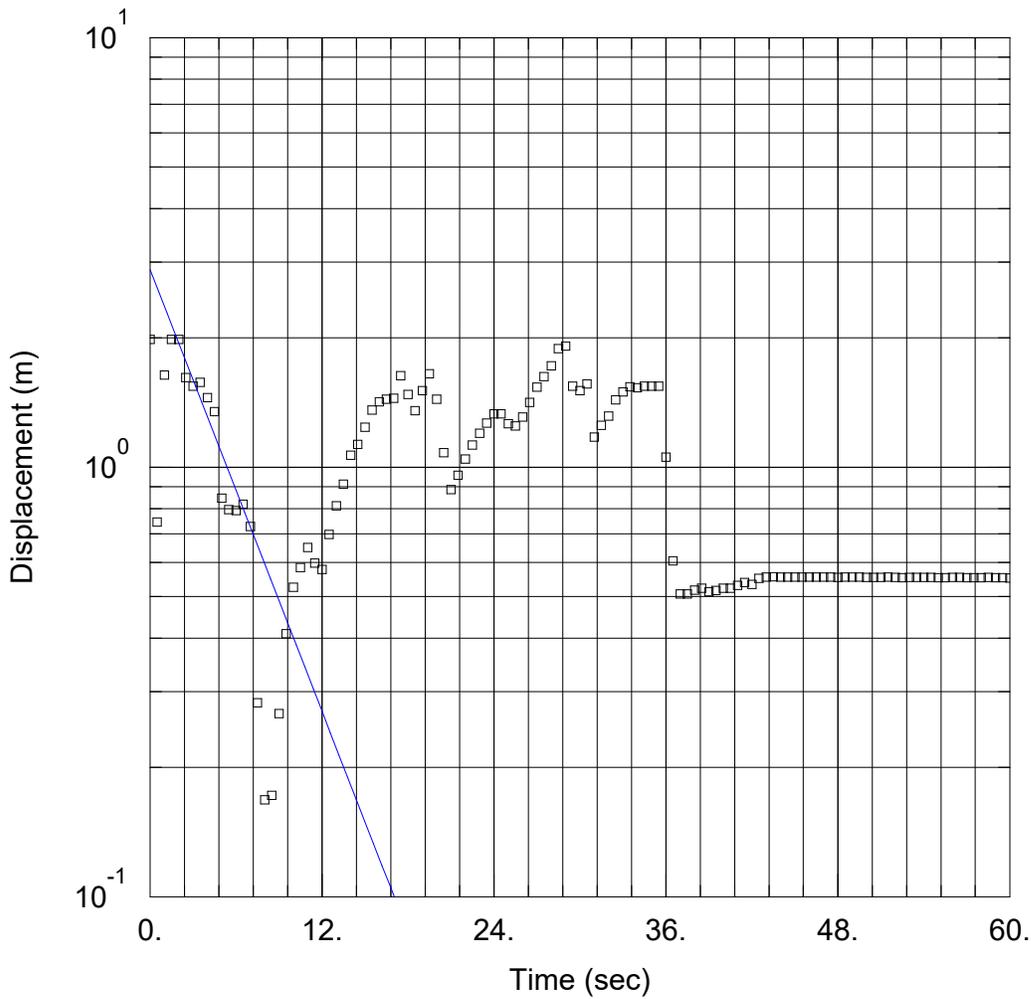
## Hydraulic Conductivity Test Data and Analysis



# Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
GRI  
Project:  
21-022

Prepared For:  
Arnott Sand and Gravel  
Location:  
Highland Road



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 6.005E-5 m/sec                       $y_0 = \underline{2.883}$  m

### AQUIFER DATA

Saturated Thickness: 5.81 m    Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 1)

Initial Displacement: 1.983 m  
Static Water Column Height: 5.81 m  
Total Well Penetration Depth: 7.7 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

# Arnott Sand and Gravel - Below Water Excavation

Prepared By:

GRI

Project:

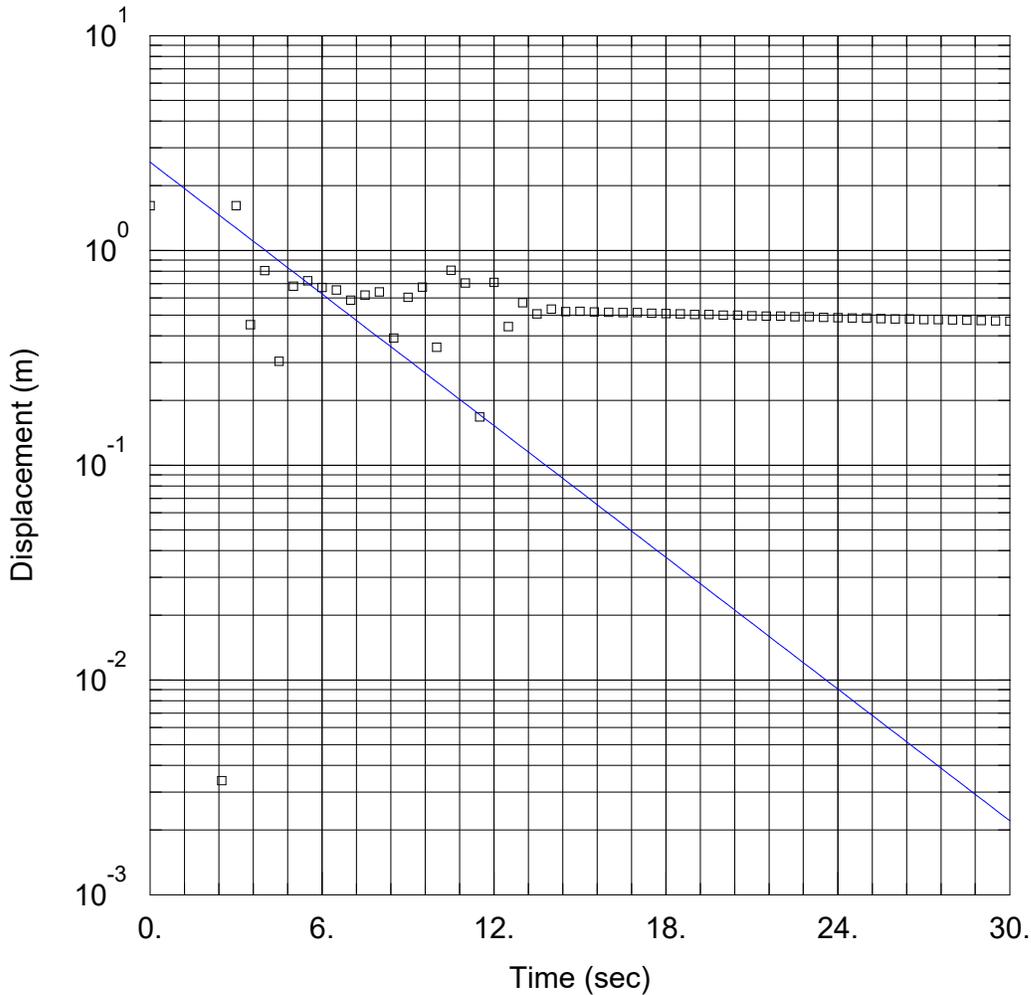
21-022

Prepared For:

Arnott Sand and Gravel

Location:

Highland Road



### SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

$K = 7.168E-5$  m/sec       $y_0 = 2.574$  m

### AQUIFER DATA

Saturated Thickness: 5.81 Anisotropy Ratio ( $K_z/K_r$ ): 1.

### WELL DATA (TW 1)

Initial Displacement: 1.615 m

Static Water Column Height: 5.81 m

Total Well Penetration Depth: 7.7 m

Screen Length: 3.05 m

Casing Radius: 0.0254 m

Well Radius: 0.0254 m

Gravel Pack Porosity: 0.

# Arnett Sand and Gravel - Below Water Excavation

Prepared By:

GRI

Project:

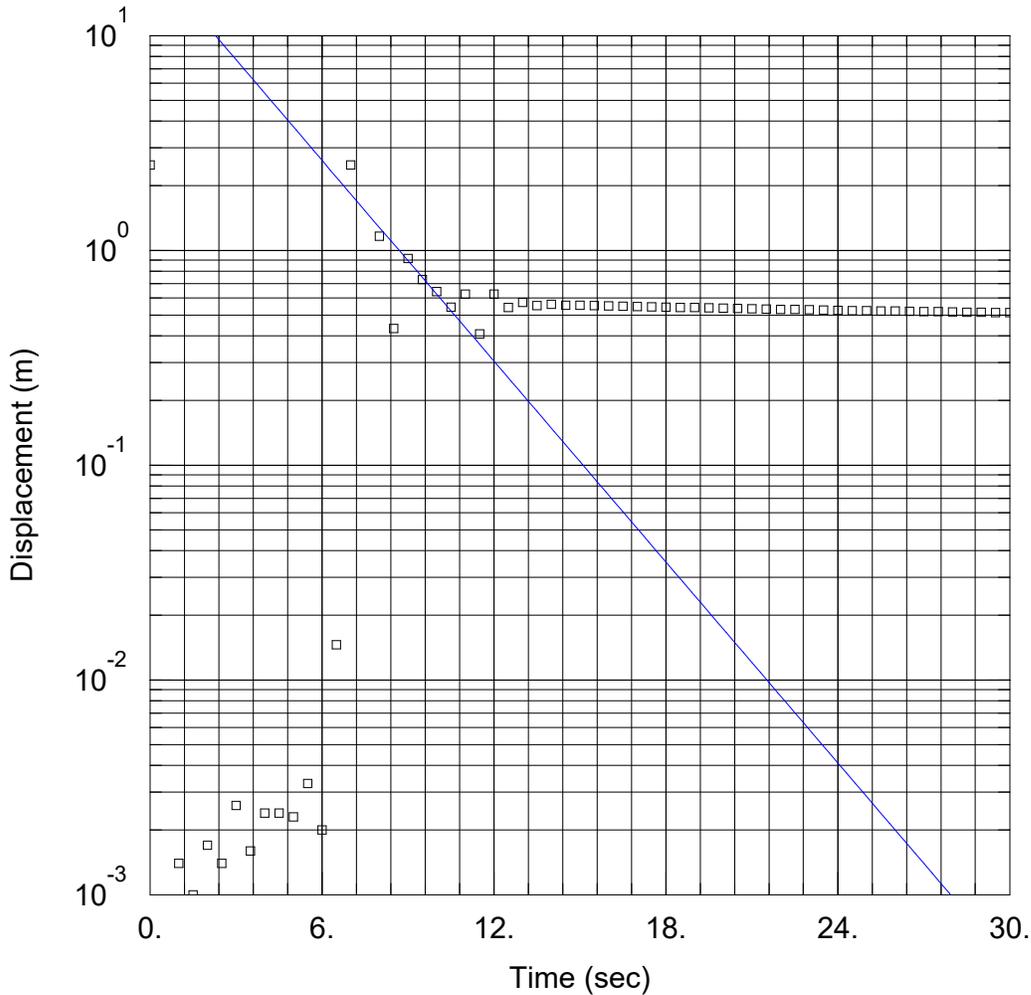
21-022

Prepared For:

Arnett Sand and Gravel

Location:

Highland Road



### SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 0.0001093 m/sec      y<sub>0</sub> = 22.67 m

### AQUIFER DATA

Saturated Thickness: 5.81 Anisotropy Ratio (K<sub>z</sub>/K<sub>r</sub>): 1.

### WELL DATA (TW 1)

Initial Displacement: 2.495 m

Static Water Column Height: 5.81 m

Total Well Penetration Depth: 7.7 m

Screen Length: 3.05 m

Casing Radius: 0.0254 m

Well Radius: 0.0254 m

Gravel Pack Porosity: 0.

## Arnott Sand and Gravel - Below Water Excavation

Prepared By:

GRI

Project:

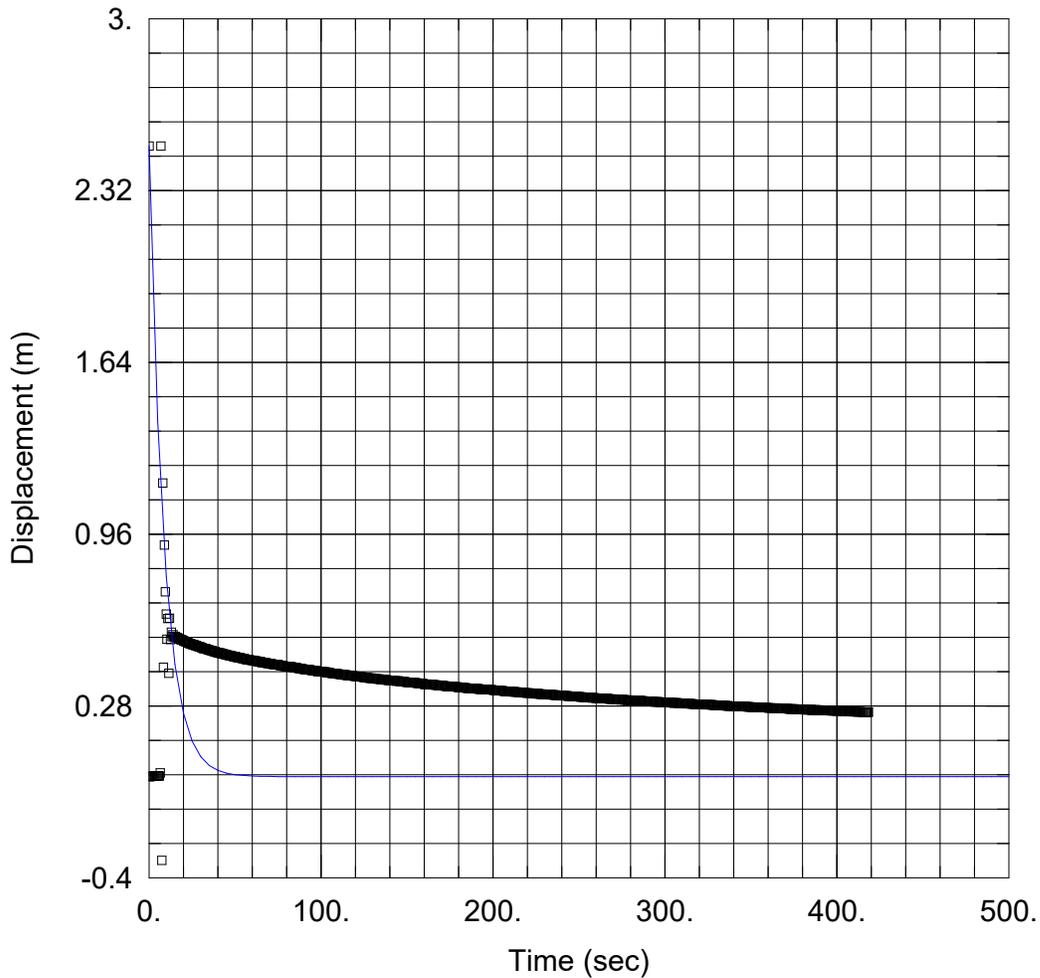
21-022

Prepared For:

Arnott Sand and Gravel

Location:

Highland Road



### SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 2.737E-5 m/sec      Le = 1. m

### AQUIFER DATA

Saturated Thickness: 5.81 Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 1)

Initial Displacement: 2.495 m

Static Water Column Height: 5.81 m

Total Well Penetration Depth: 7.7 m

Screen Length: 3.05 m

Casing Radius: 0.0254 m

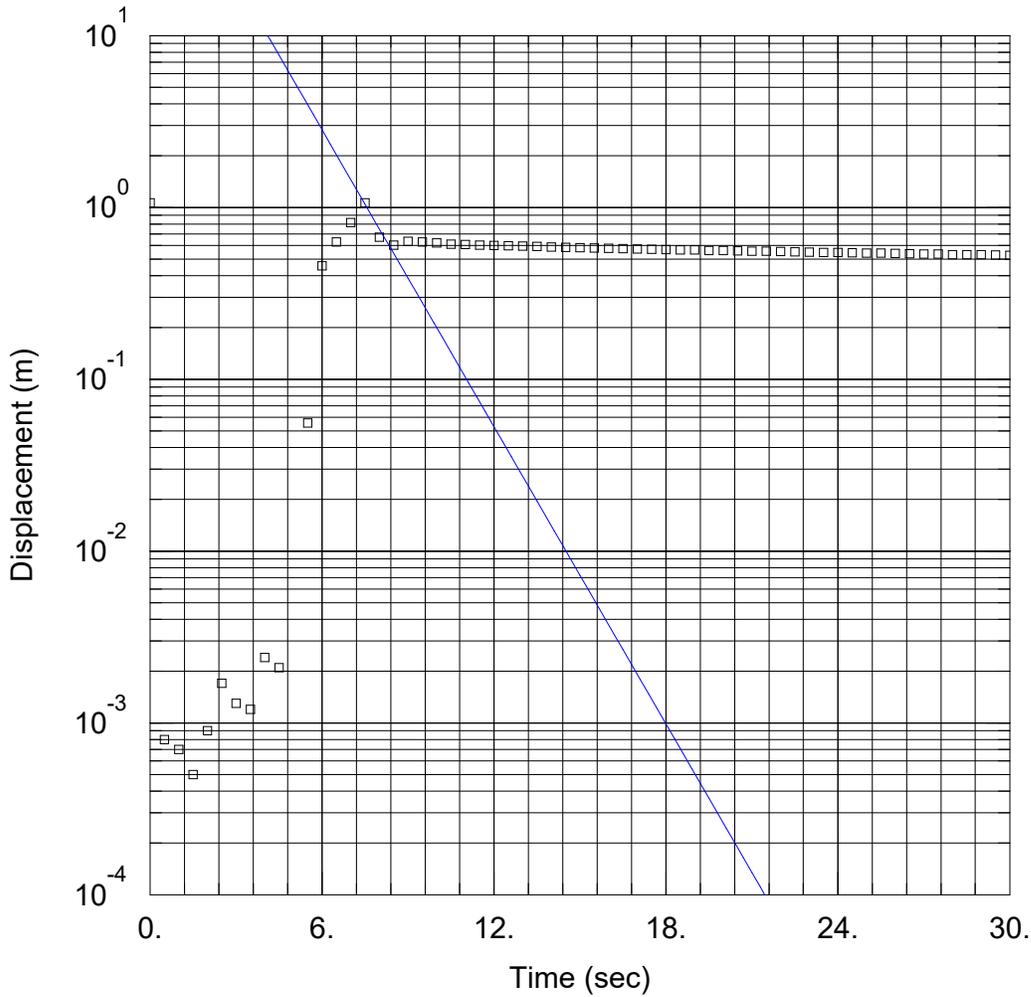
Well Radius: 0.0254 m

Gravel Pack Porosity: 0.

# Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**  
Project:  
**21-022**

Prepared For:  
**Arnott Sand and Gravel**  
Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0002021 m/sec      y<sub>0</sub> = 152.4 m

### AQUIFER DATA

Saturated Thickness: 5.81 m    Anisotropy Ratio (K<sub>z</sub>/K<sub>r</sub>): 1.

### WELL DATA (TW 1)

Initial Displacement: 1.062 m  
Static Water Column Height: 5.81 m  
Total Well Penetration Depth: 7.7 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

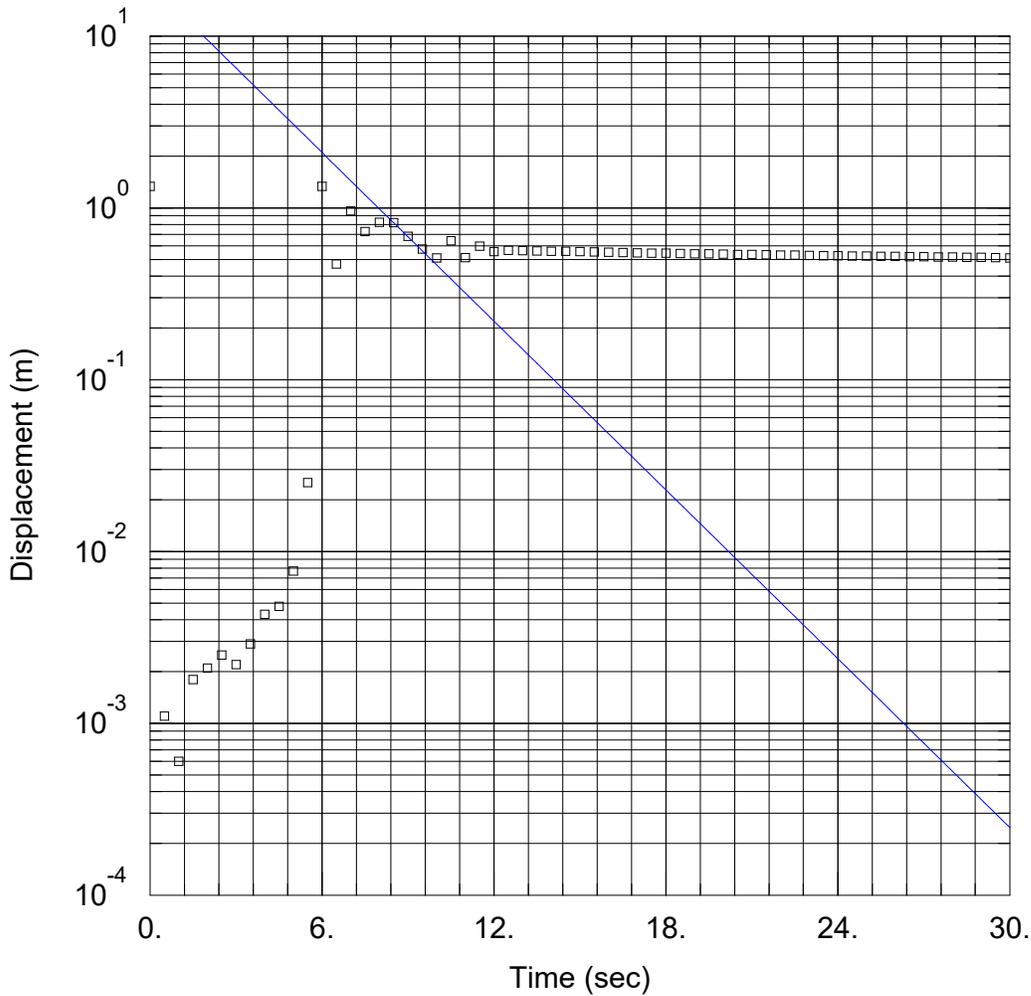
# Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnott Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0001148 m/sec      y<sub>0</sub> = 20.18 m

### AQUIFER DATA

Saturated Thickness: 5.81 m    Anisotropy Ratio (K<sub>z</sub>/K<sub>r</sub>): 1.

### WELL DATA (TW 1)

Initial Displacement: 1.335 m  
Static Water Column Height: 5.81 m  
Total Well Penetration Depth: 7.7 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

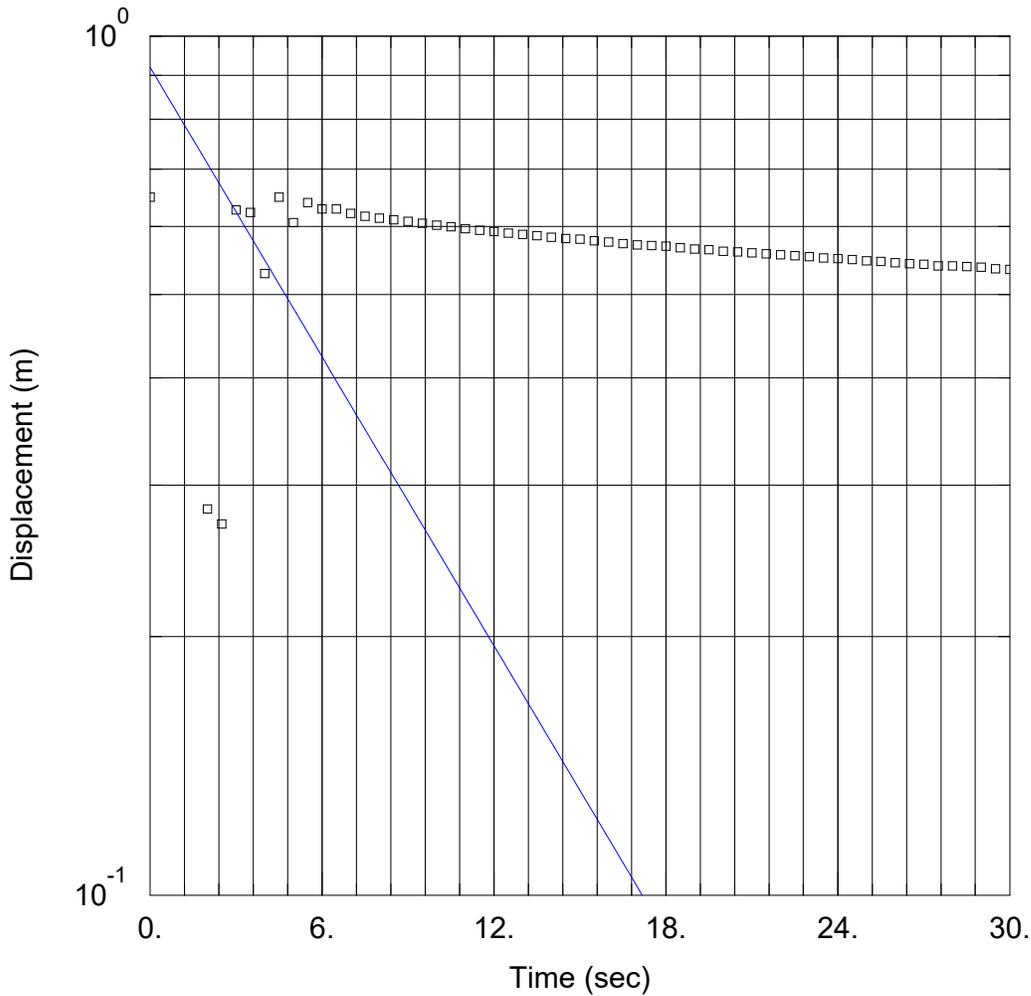
## Arnett Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnett Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 3.935E-5 m/sec      y0 = 0.9196 m

### AQUIFER DATA

Saturated Thickness: 5.81 m    Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 1)

Initial Displacement: 0.6494 m  
Static Water Column Height: 5.81 m  
Total Well Penetration Depth: 7.7 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

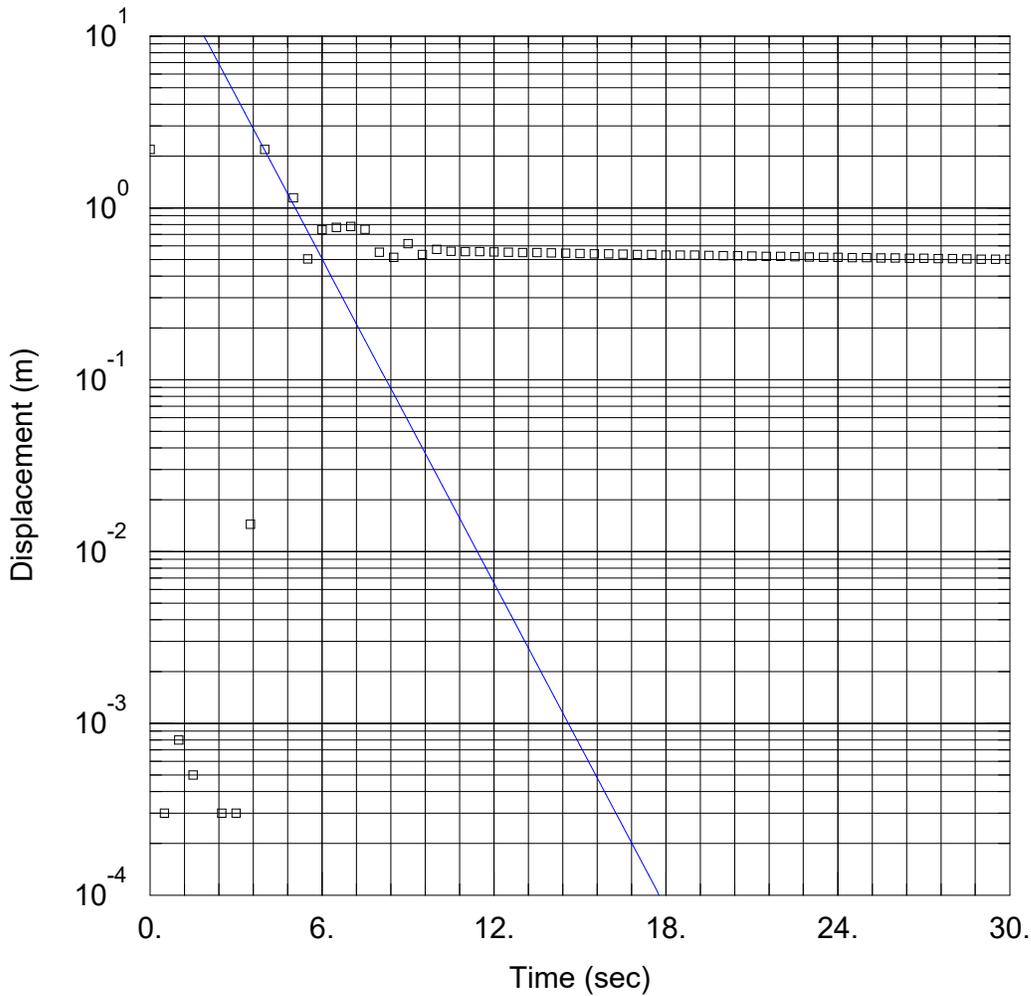
## Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnott Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0002208 m/sec       $y_0 =$ 39.28 m

### AQUIFER DATA

Saturated Thickness: 5.81 m    Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 1)

Initial Displacement: 2.191 m  
Static Water Column Height: 5.81 m  
Total Well Penetration Depth: 7.7 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

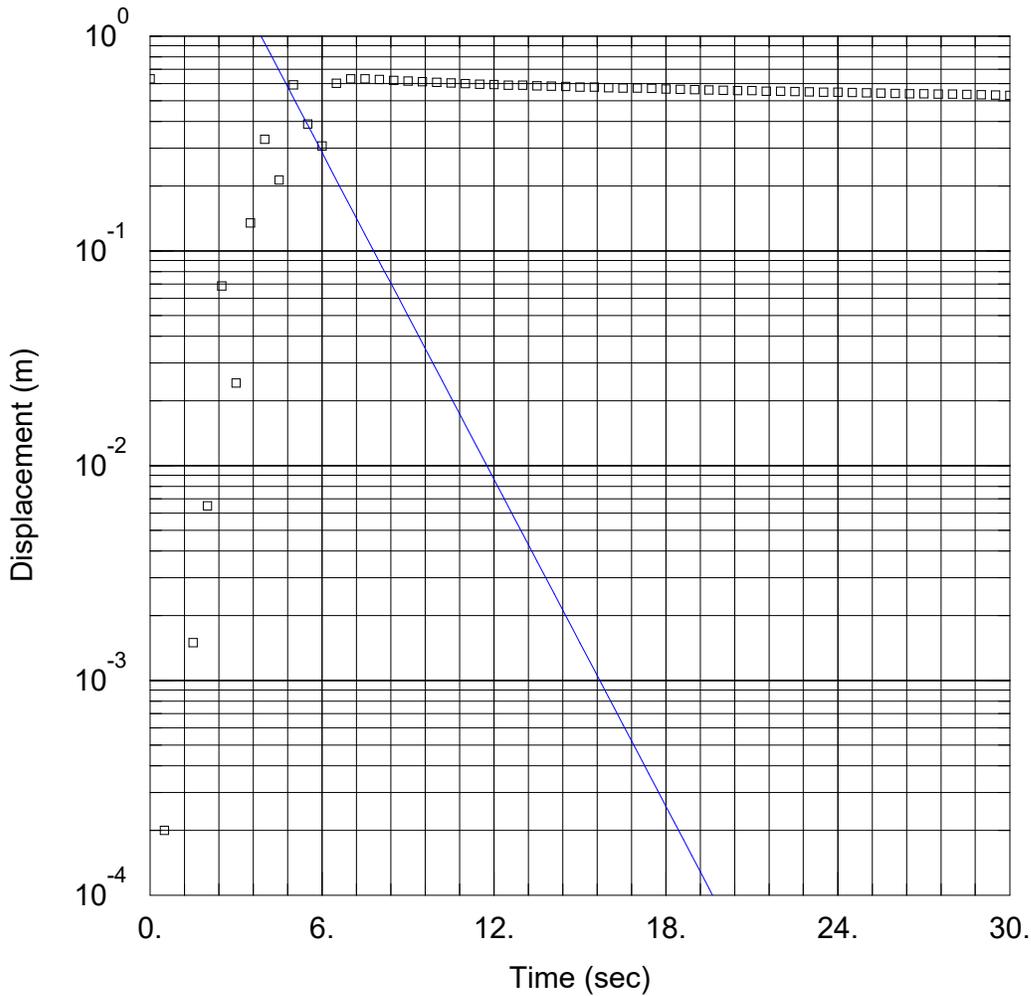
# Arnett Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnett Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.000178 m/sec      y<sub>0</sub> = 9.587 m

### AQUIFER DATA

Saturated Thickness: 5.81 m    Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 1)

Initial Displacement: 0.6323 m  
Static Water Column Height: 5.81 m  
Total Well Penetration Depth: 7.7 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

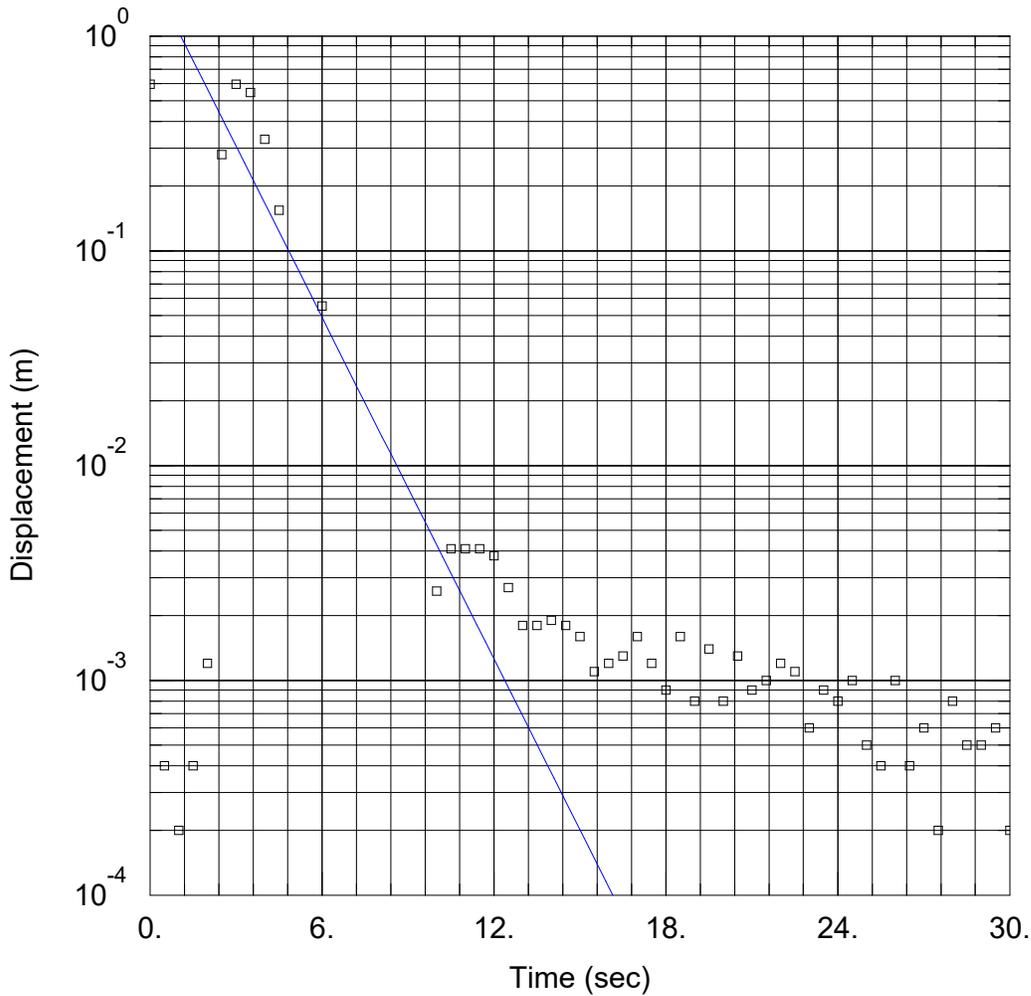
# Arnett Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnett Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0001625 m/sec      y0 = 1.921 m

### AQUIFER DATA

Saturated Thickness: 17.2 m    Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 2)

Initial Displacement: 0.5967 m  
Static Water Column Height: 7.75 m  
Total Well Penetration Depth: 8.84 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

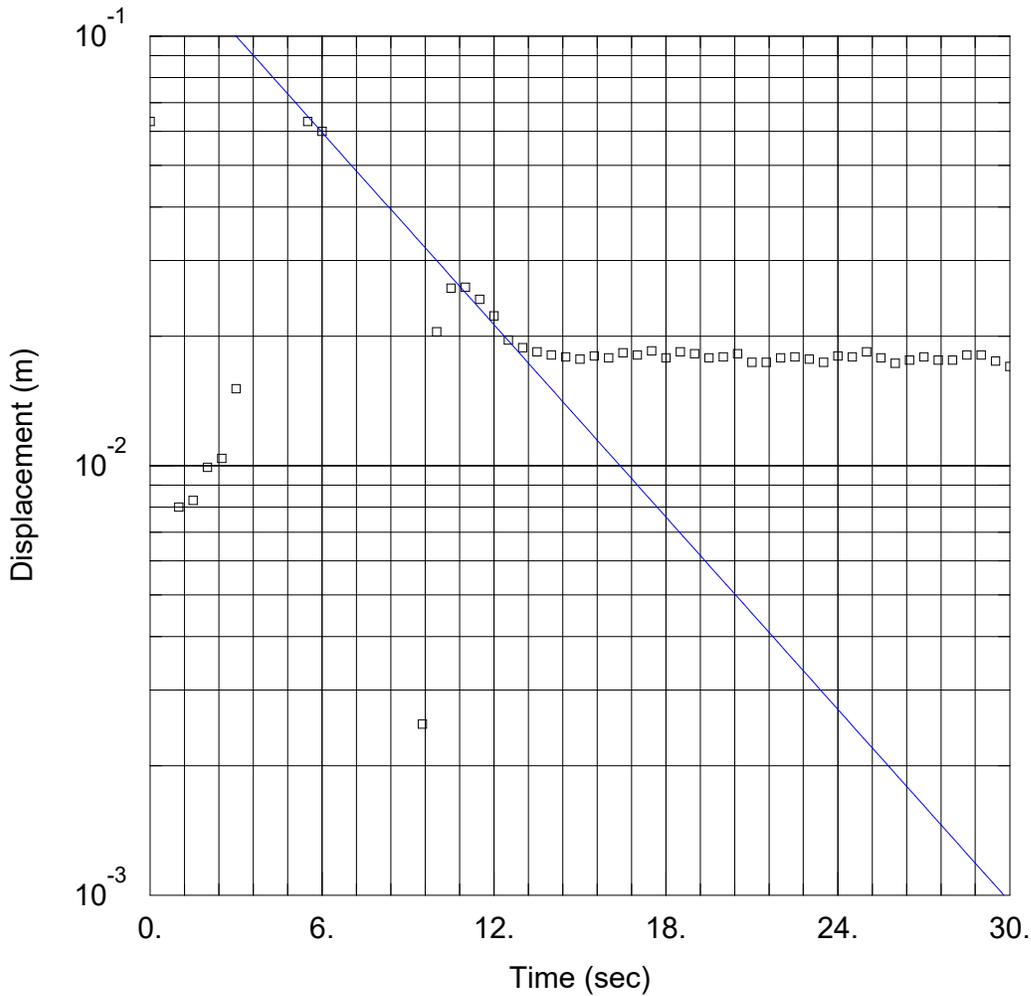
# Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnott Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 4.573E-5 m/sec      y0 = 0.1674 m

### AQUIFER DATA

Saturated Thickness: 17.2 m    Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 2)

Initial Displacement: 0.0633 m  
Static Water Column Height: 7.75 m  
Total Well Penetration Depth: 8.84 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

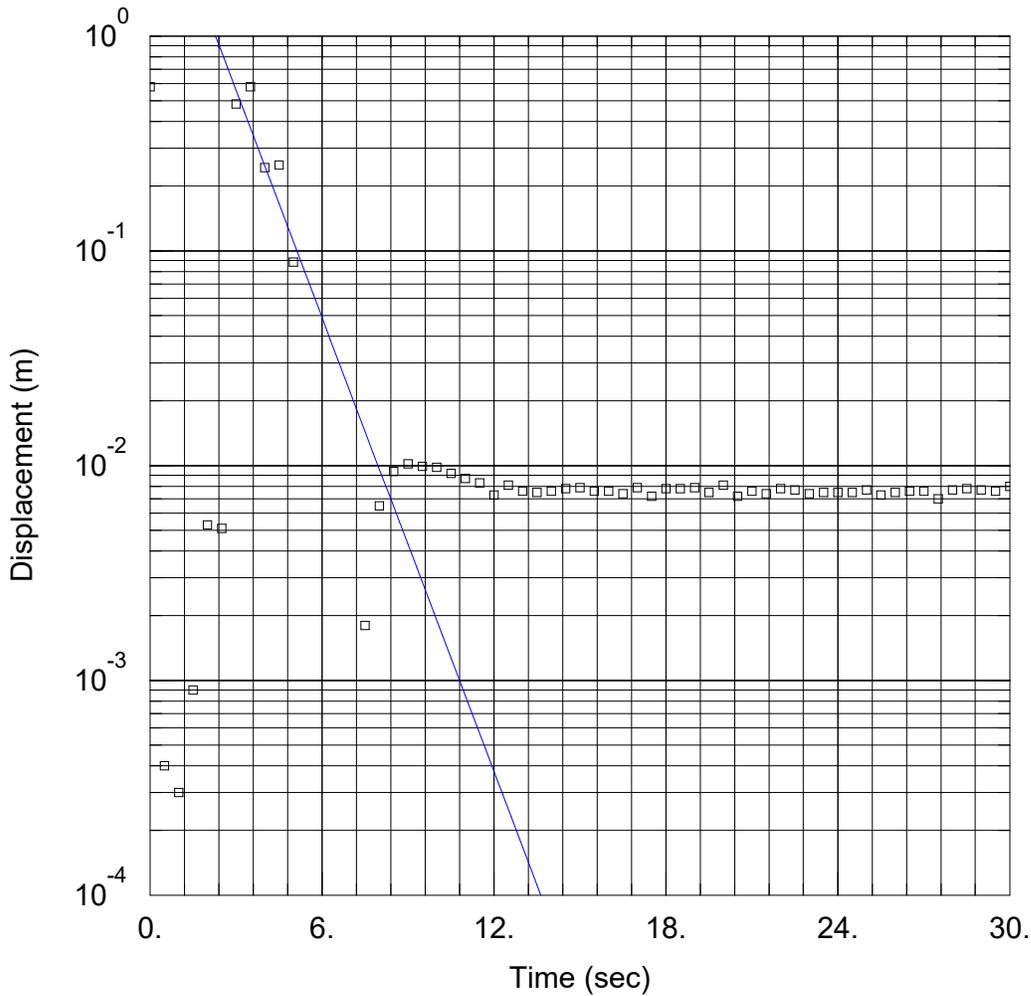
# Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnott Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0002159 m/sec      y<sub>0</sub> = 6.387 m

### AQUIFER DATA

Saturated Thickness: 17.2 m    Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 2)

Initial Displacement: 0.5797 m  
Static Water Column Height: 7.75 m  
Total Well Penetration Depth: 8.84 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

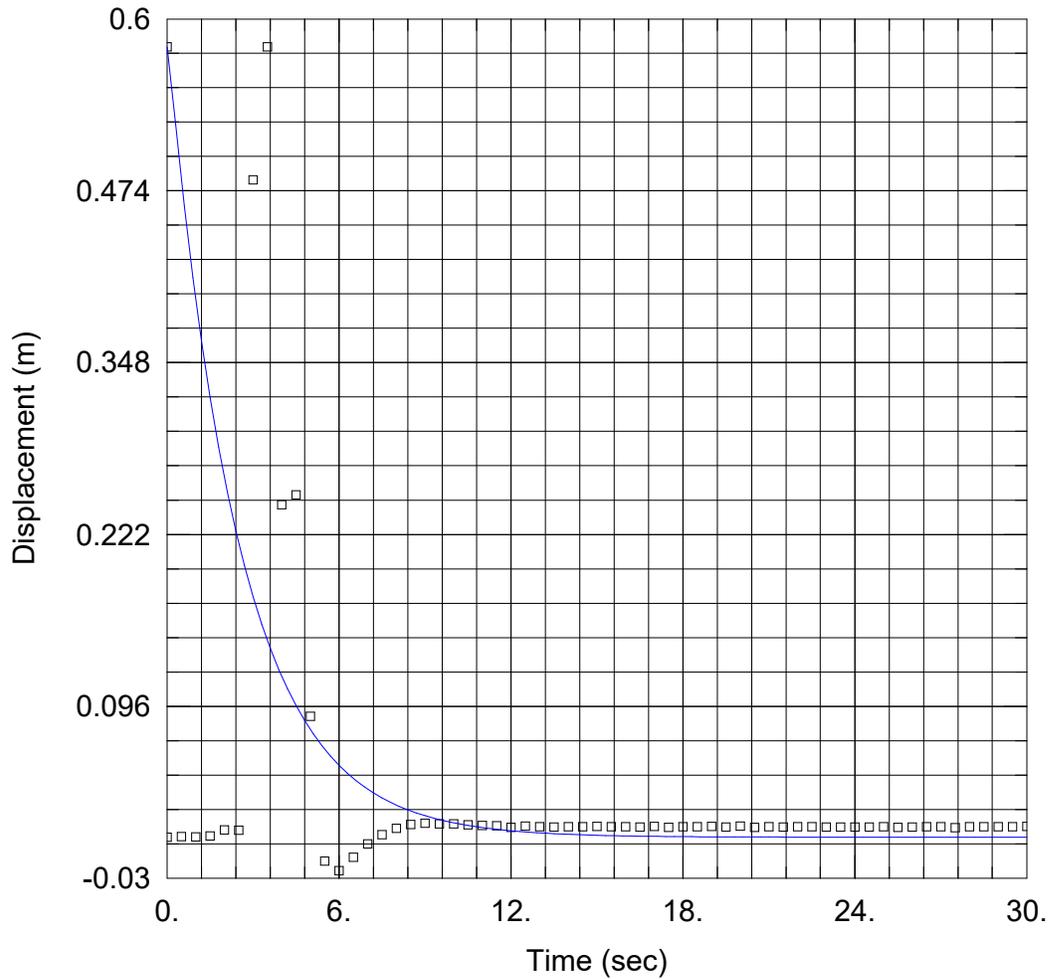
## Arnett Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnett Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 8.268E-5 m/sec

Le = 1. m

### AQUIFER DATA

Saturated Thickness: 17.2 m Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 2)

Initial Displacement: 0.5797 m

Static Water Column Height: 7.75 m

Total Well Penetration Depth: 8.84 m

Screen Length: 3.05 m

Casing Radius: 0.0254 m

Well Radius: 0.0254 m

Gravel Pack Porosity: 0.

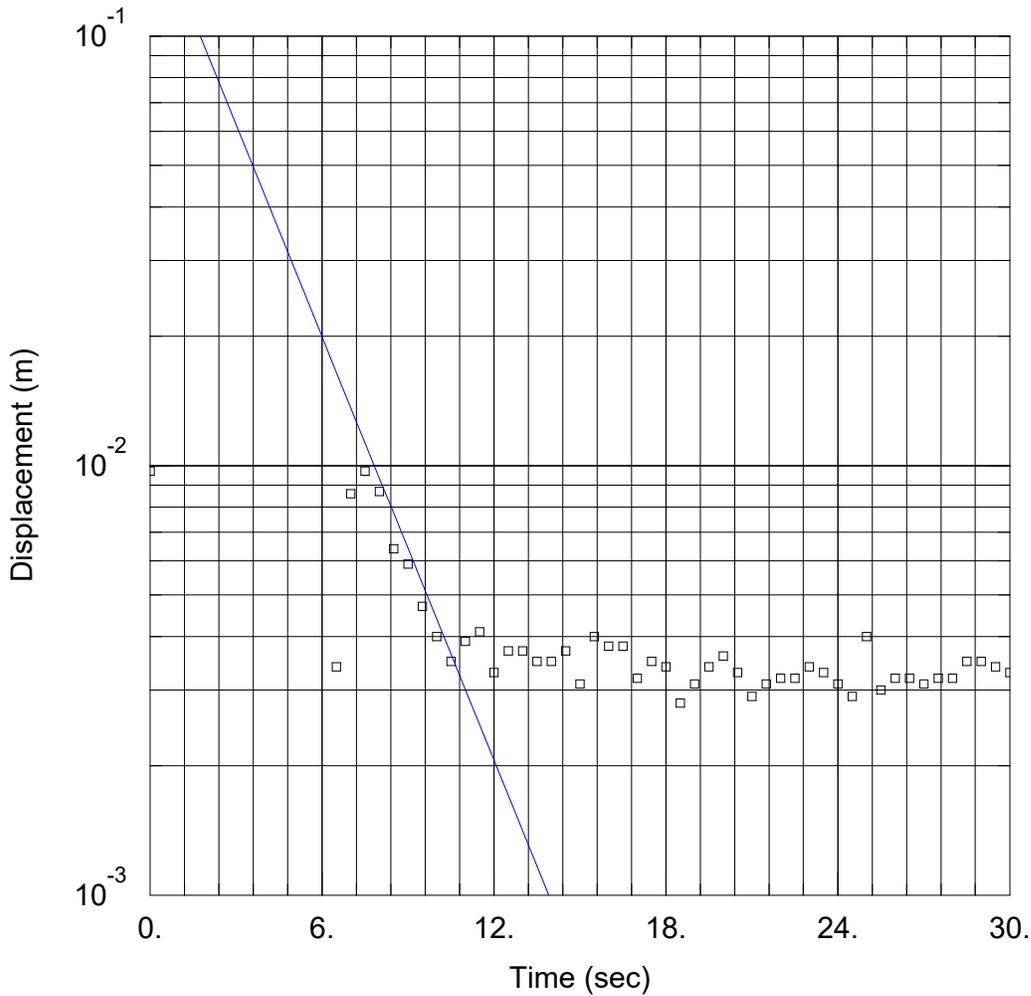
# Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnott Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0001007 m/sec      y0 = 0.1937 m

### AQUIFER DATA

Saturated Thickness: 17.2 m    Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 2)

Initial Displacement: 0.0097 m  
Static Water Column Height: 7.75 m  
Total Well Penetration Depth: 8.84 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

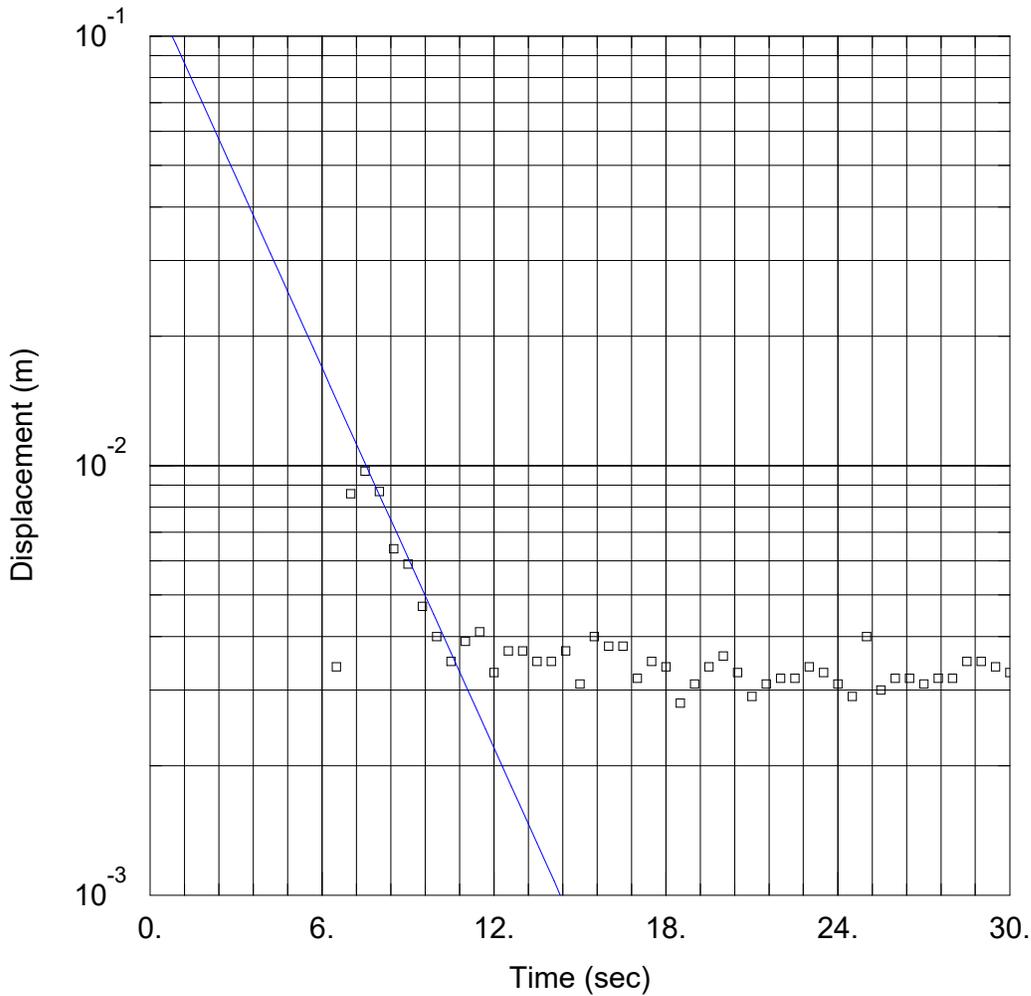
## Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnott Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 9.042E-5 m/sec      y0 = 0.13 m

### AQUIFER DATA

Saturated Thickness: 17.2 m    Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 2)

Initial Displacement: 0.5755 m  
Static Water Column Height: 7.75 m  
Total Well Penetration Depth: 8.84 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

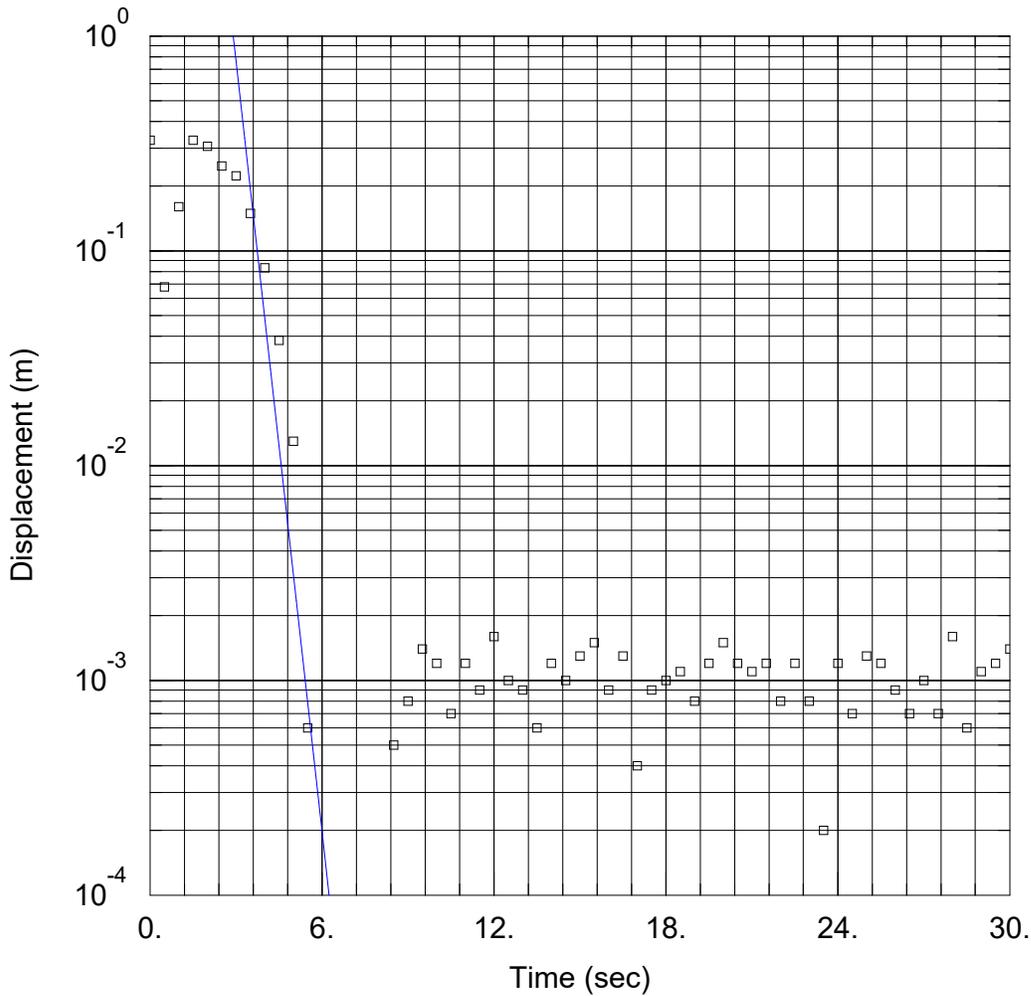
# Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnott Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0007321 m/sec      y<sub>0</sub> = 2932.1 m

### AQUIFER DATA

Saturated Thickness: 17.2 m    Anisotropy Ratio (K<sub>z</sub>/K<sub>r</sub>): 1.

### WELL DATA (TW 2)

Initial Displacement: 0.3272 m  
Static Water Column Height: 7.75 m  
Total Well Penetration Depth: 8.84 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

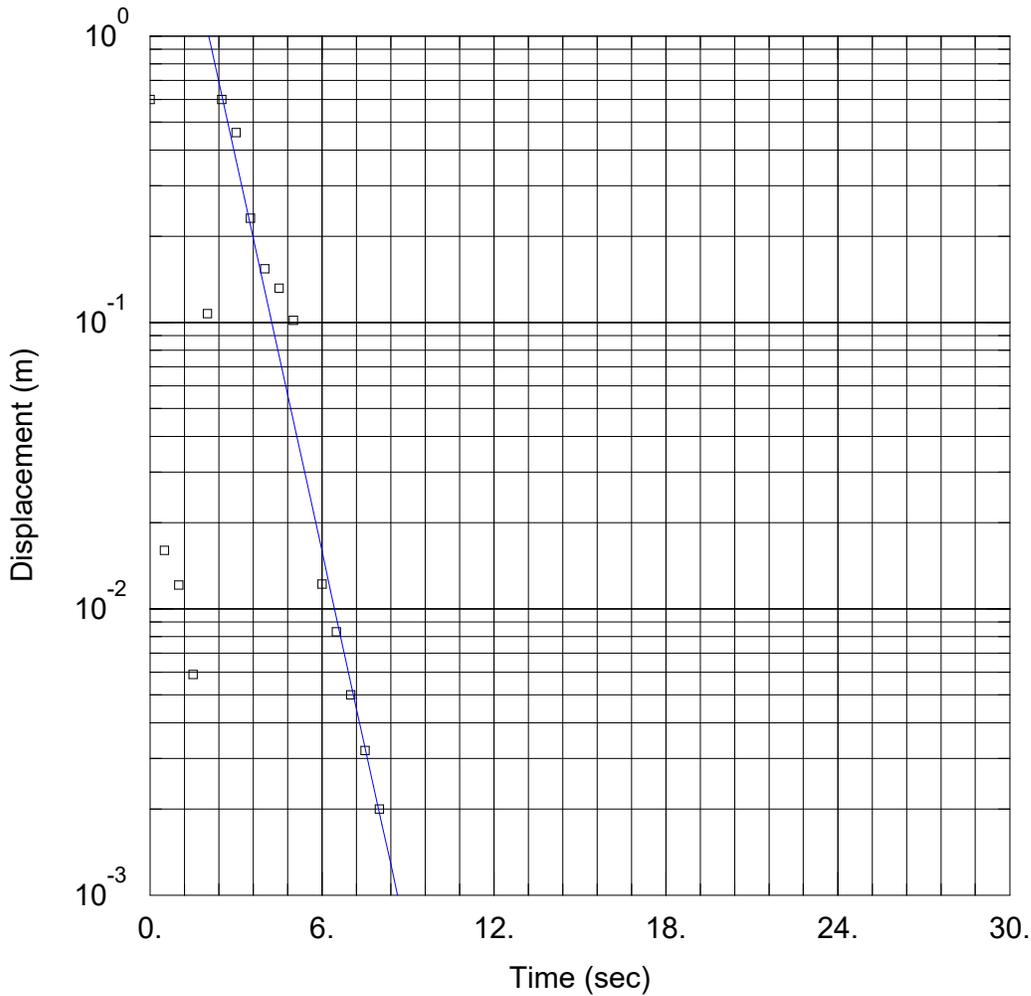
## Arnett Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnett Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0002787 m/sec      y<sub>0</sub> = 8.546 m

### AQUIFER DATA

Saturated Thickness: 15.78 m Anisotropy Ratio (K<sub>z</sub>/K<sub>r</sub>): 1.

### WELL DATA (TW 3)

Initial Displacement: 0.5998 m  
Static Water Column Height: 6.82 m  
Total Well Penetration Depth: 9.15 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

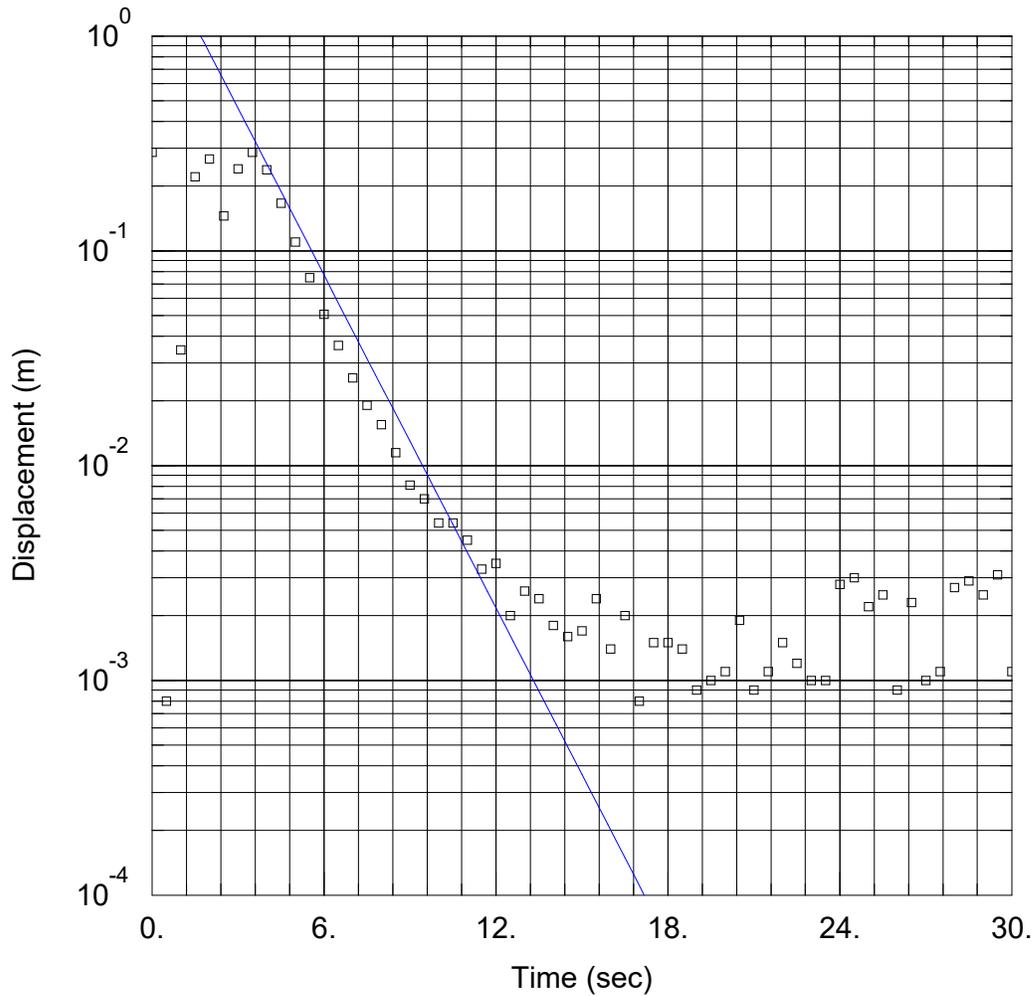
## Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnott Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0001583 m/sec      y<sub>0</sub> = 2.747 m

### AQUIFER DATA

Saturated Thickness: 15.78 m Anisotropy Ratio (K<sub>z</sub>/K<sub>r</sub>): 1.

### WELL DATA (TW 3)

Initial Displacement: 0.2875 m  
Static Water Column Height: 6.63 m  
Total Well Penetration Depth: 9.15 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

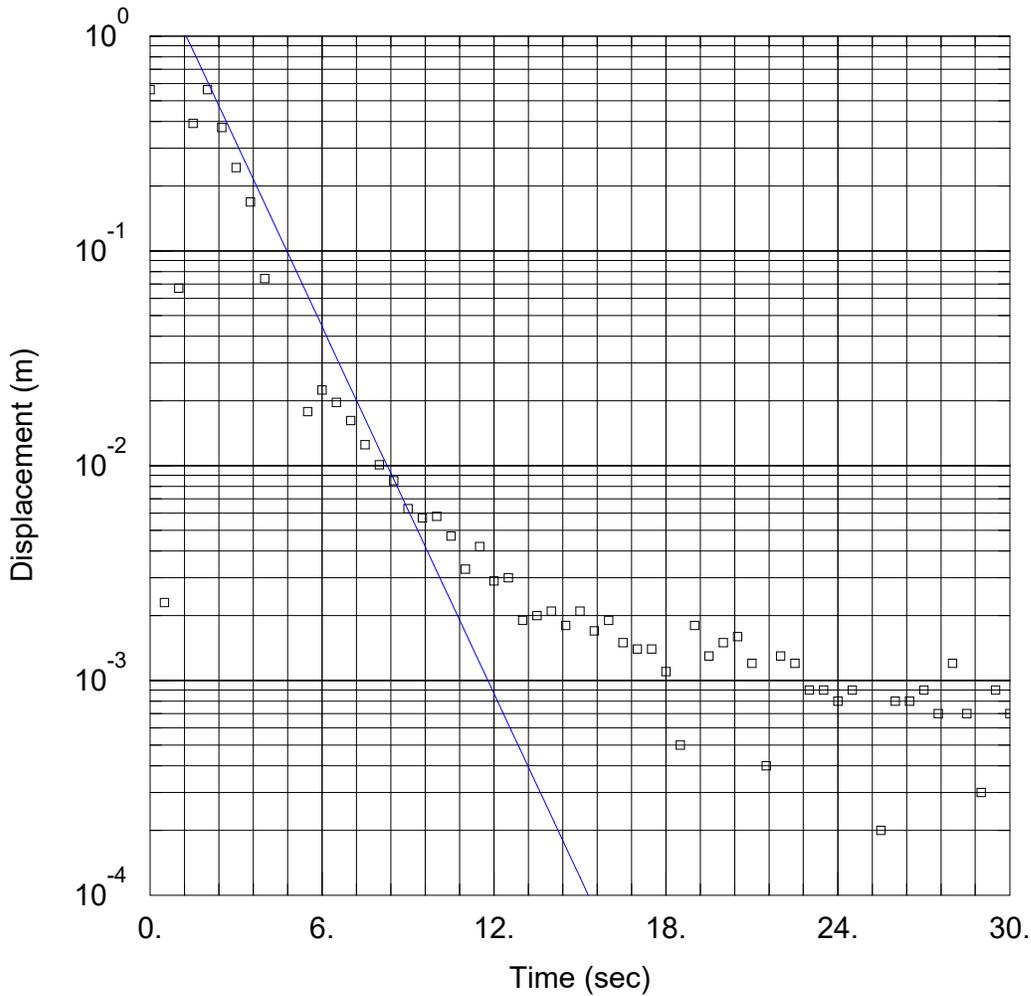
# Arnott Sand and Gravel - Below Water Excavation

Prepared By:  
**GRI**

Prepared For:  
**Arnott Sand and Gravel**

Project:  
**21-022**

Location:  
**Highland Road**



### SOLUTION

Aquifer Model: Unconfined  
Solution Method: Hvorslev

K = 0.0001746 m/sec      y0 = 2.289 m

### AQUIFER DATA

Saturated Thickness: 15.78 m Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (TW 3)

Initial Displacement: 0.5622 m  
Static Water Column Height: 6.63 m  
Total Well Penetration Depth: 9.15 m  
Screen Length: 3.05 m  
Casing Radius: 0.0254 m  
Well Radius: 0.0254 m  
Gravel Pack Porosity: 0.

# Appendix D

---

## Laboratory Reports



Client: GRI Inc.  
R.R. #1  
Oxford Mills, ON  
K0G 1S0  
Attention: Mr. George Gorrell  
PO#:  
Invoice to: GRI Inc.

Report Number: 1944180  
Date Submitted: 2020-12-03  
Date Reported: 2020-12-10  
Project: 21-022  
COC #: 211448

Page 1 of 6

---

**Dear George Gorrell:**

**Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).**

Report Comments:

APPROVAL:



Addrine Thomas  
2020.12.10  
10:34:00 -05'00'

---

Addrine Thomas, Inorganics Supervisor

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: <http://www.cala.ca/scopes/2602.pdf>.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

**Certificate of Analysis**

Client: GRI Inc.  
 R.R. #1  
 Oxford Mills, ON  
 K0G 1S0  
 Attention: Mr. George Gorrell  
 PO#:  
 Invoice to: GRI Inc.

Report Number: 1944180  
 Date Submitted: 2020-12-03  
 Date Reported: 2020-12-10  
 Project: 21-022  
 COC #: 211448

Group	Analyte	MRL	Units	Guideline	Lab I.D.	1532529	1532530	1532531
					Sample Matrix	Water	Water	Water
					Sample Type	2020-12-03	2020-12-03	2020-12-03
					Sampling Date	TW1	TW2	TW3
					Sample I.D.			
Anions	Cl	1	mg/L			67	22	83
	F	0.10	mg/L			0.19	<0.10	<0.10
	N-NO3	0.10	mg/L			0.18	0.57	1.95
	SO4	1	mg/L			14	13	45
General Chemistry	Alkalinity as CaCO3	5	mg/L			245	236	274
	Conductivity	5	uS/cm			655	499	811
	pH	1.00				8.33	8.20	8.27
Hardness	Hardness as CaCO3	1	mg/L			319	277	271
Indices/Calc	Ion Balance	0.01				1.03	1.03	0.98
Metals	Ag	0.0001	mg/L			<0.0001	<0.0001	<0.0001
	As	0.001	mg/L			<0.001	<0.001	<0.001
	B	0.01	mg/L			0.07	0.01	0.03
	Ba	0.01	mg/L			0.11	0.21	0.10
	Be	0.0005	mg/L			<0.0005	<0.0005	<0.0005
	Ca	1	mg/L			70	78	77
	Cd	0.0001	mg/L			<0.0001	<0.0001	<0.0001
	Co	0.0002	mg/L			0.0034	0.0007	<0.0002
	Cr	0.001	mg/L			<0.001	<0.001	<0.001
	Cu	0.001	mg/L			0.002	<0.001	0.002
	Fe	0.03	mg/L			<0.03	<0.03	<0.03
	K	1	mg/L			4	2	3
	Mg	1	mg/L			35	20	19
	Mn	0.01	mg/L			0.07	0.02	<0.01
	Mo	0.005	mg/L			0.016	<0.005	0.018
	Na	2	mg/L			19	5	75

**Guideline =** \* = **Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.  
 Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

**Certificate of Analysis**

Client: GRI Inc.  
 R.R. #1  
 Oxford Mills, ON  
 K0G 1S0  
 Attention: Mr. George Gorrell  
 PO#:  
 Invoice to: GRI Inc.

Report Number: 1944180  
 Date Submitted: 2020-12-03  
 Date Reported: 2020-12-10  
 Project: 21-022  
 COC #: 211448

Group	Analyte	MRL	Units	Guideline	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1532529 Water 2020-12-03 TW1	1532530 Water 2020-12-03 TW2	1532531 Water 2020-12-03 TW3
Metals	Ni	0.005	mg/L			<0.005	<0.005	<0.005
	Pb	0.001	mg/L			<0.001	<0.001	<0.001
	Sb	0.0005	mg/L			<0.0005	<0.0005	<0.0005
	Se	0.001	mg/L			<0.001	<0.001	<0.001
	Tl	0.0001	mg/L			<0.0001	<0.0001	<0.0001
	U	0.001	mg/L			<0.001	<0.001	<0.001
	V	0.001	mg/L			<0.001	<0.001	<0.001
	Zn	0.01	mg/L			<0.01	<0.01	<0.01

**Guideline =**                      \* = **Guideline Exceedence**

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**Certificate of Analysis**

Client: GRI Inc.  
 R.R. #1  
 Oxford Mills, ON  
 K0G 1S0  
 Attention: Mr. George Gorrell  
 PO#:  
 Invoice to: GRI Inc.

Report Number: 1944180  
 Date Submitted: 2020-12-03  
 Date Reported: 2020-12-10  
 Project: 21-022  
 COC #: 211448

**QC Summary**

Analyte	Blank	QC % Rec	QC Limits
<b>Run No</b> 393435 <b>Analysis/Extraction Date</b> 2020-12-04 <b>Analyst</b> H D <b>Method</b> EPA 200.8			
Silver	<0.0001 mg/L	101	80-120
Arsenic	<0.001 mg/L	92	80-120
Boron (total)	<0.01 mg/L	94	80-120
Barium	<0.01 mg/L	94	80-120
Beryllium	<0.0005 mg/L	103	80-120
Cadmium	<0.0001 mg/L	99	80-120
Cobalt	<0.0002 mg/L	96	80-120
Chromium Total	<0.001 mg/L	99	80-120
Copper	<0.001 mg/L	103	80-120
Iron	<0.03 mg/L	91	80-120
Manganese	<0.01 mg/L	94	80-120
Molybdenum	<0.005 mg/L	86	80-120
Nickel	<0.005 mg/L	103	80-120
Lead	<0.001 mg/L	94	80-120
Antimony	<0.0005 mg/L	81	80-120
Selenium	<0.001 mg/L	94	80-120

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 Project: 21-022  
 COC #: 211448

**QC Summary**

Analyte	Blank	QC % Rec	QC Limits
Thallium	<0.0001 mg/L	93	80-120
Uranium	<0.001 mg/L	85	80-120
Vanadium	<0.001 mg/L	95	80-120
Zinc	<0.01 mg/L	105	80-120
<b>Run No</b> 393500 <b>Analysis/Extraction Date</b> 2020-12-08 <b>Analyst</b> QT <b>Method</b> SM2320,2510,4500H/F			
Alkalinity (CaCO3)	<5 mg/L	103	90-110
Conductivity	<5 uS/cm	99	90-110
F	<0.10 mg/L	100	90-110
pH		102	90-110
<b>Run No</b> 393505 <b>Analysis/Extraction Date</b> 2020-12-08 <b>Analyst</b> Z S <b>Method</b> M SM3120B-3500C			
Calcium	<1 mg/L	104	90-110
Potassium	<1 mg/L	101	87-113
Magnesium	<1 mg/L	101	76-124
Sodium	<2 mg/L	105	82-118
<b>Run No</b> 393649 <b>Analysis/Extraction Date</b> 2020-12-10 <b>Analyst</b> SKH <b>Method</b> SM 4110			
Chloride	<1 mg/L	100	90-110

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**QC Summary**

Analyte	Blank	QC % Rec	QC Limits
N-NO3	<0.10 mg/L	104	90-110
SO4	<1 mg/L	100	90-110
<b>Run No</b> 393657 <b>Analysis/Extraction Date</b> 2020-12-10 <b>Analyst</b> AET <b>Method</b> C SM2340B			
Hardness as CaCO3			
Ion Balance			

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CLIENT INFORMATION				INVOICE INFORMATION (SAME AS CLIENT INFORMATION: YES <input type="checkbox"/> NO <input type="checkbox"/> )																	
Company: <b>GRI Inc</b>				Company:				Fax:													
Contact: <b>George Garrell</b>				Contact:				Email: #1:													
Address: <b>911 County Rd 18</b>				Address:				Email: #2:													
Telephone: <b>647 502 5224</b>		Cell:		Telephone:				PO #:													
Email: #1: <b>george.garrell@gri-inc.ca</b>				<b>REGULATION/GUIDELINE REQUIRED</b> <input type="checkbox"/> Sanitary Sewer, City: _____ <input type="checkbox"/> Storm Sewer, City: _____ <input type="checkbox"/> ODWSOG <input type="checkbox"/> PWQO <input type="checkbox"/> O. Reg 347/558 <input type="checkbox"/> Other: _____ <input type="checkbox"/> None				<input type="checkbox"/> O. Reg 153  Table # ____, Course / Fine, Surface / subsurface, Type: Com-Ind / Res-Park / Agri / GW / All Other / Sediment  <input type="checkbox"/> Excess Soil, Table: _____ Type: _____				The sample results from this submission will form part of a formal Record of Site Condition (RSC) under O.Reg. 153/04 <input type="checkbox"/> Yes <input type="checkbox"/> No									
Email: #2:																					
Project: <b>21-022</b>		Quote #: <b>190843</b>																			
TURN-AROUND TIME (Business Days)																					
<input type="checkbox"/> 1 Day* (100%)		<input type="checkbox"/> 2 Day** (50%)		<input type="checkbox"/> 3-5 Days (25%)		<input checked="" type="checkbox"/> 5-7 Days (Standard)															
Please contact Lab in advance to determine rush availability.																					
*For results reported after rush due date, surcharges will apply: before 12:00 - 100%, after 12:00 - 50%.																					
**For results reported after rush due date, surcharges will apply: before 12:00 - 50%, after 12:00 - 25%.																					
The optimal temperature conditions during transport should be less than 10°C. Sample(s) cannot be frozen, unless otherwise indicated or agreed upon with the Laboratory. Note that this COC is not to be used for drinking water samples. The COC must be complete upon submission of the samples, there will be a \$25 surcharge if required information is missing (required fields are shaded in grey).				Sample Details								Sample Analysis Required								RN# (Lab Use Only)	
				Field Filtered ->		Sample Matrix		# of Containers		O.Reg.153 parameters											
						PHC E1 - E4	BTEX	VOCs	PAHs	PCBs	Metals + Inorganics	Metals only	generals	metals							
Sample ID	Date/Time Collected																				
TW1	12/3/20 10:27			W	2							X	X	1532829 30 31							
TW2	12/3/20 11:51			W	2							X	X								
TW3	12/3/20 12:49			W	2							X	X								
PRINT				SIGN				DATE/TIME				TEMP (°C)				COMMENTS:					
Sampled By: <b>George Garrell</b>				2000 33021				12/3/20				11.1									
Relinquished By: <b>George Garrell</b>								12/3/20													
Received By:																					
CUSTODY SEAL: <input type="checkbox"/> YES <input type="checkbox"/> NO Ice packs submitted: <input type="checkbox"/> Yes <input type="checkbox"/> No																					

Certificate of Analysis

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Report Number: 1946164  
Date Submitted: 2021-01-12  
Date Reported: 2021-01-19  
Project: 21-022  
COC #: 212159

Page 1 of 8

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**Dear George Gorrell:**

**Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).**

Report Comments:

  
Charlie  
Long Qu  
2021.01.1  
9 13:39:00  
-05'00'

APPROVAL: \_\_\_\_\_

Long Qu, Organics Supervisor

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: <http://www.cala.ca/scopes/2602.pdf>.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Client: GRI Inc.  
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 Oxford Mills, ON  
 K0G 1S0  
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 PO#:  
 Invoice to: GRI Inc.

Report Number: 1946164  
 Date Submitted: 2021-01-12  
 Date Reported: 2021-01-19  
 Project: 21-022  
 COC #: 212159

Group	Analyte	MRL	Units	Guideline	Lab I.D.	1537850	1537851	1537852
					Sample Matrix	Water	Water	Water
					Sample Type	2021-01-11	2021-01-11	2021-01-11
					Sampling Date	TW1	TW2	TW3
					Sample I.D.			
Anions	Cl	1	mg/L			18	20	111
	F	0.10	mg/L			0.18	<0.10	<0.10
	N-NO2	0.10	mg/L			<0.10	<0.10	<0.10
	N-NO3	0.10	mg/L			<0.10	0.64	3.19
	SO4	1	mg/L			24	16	24
General Chemistry	Alkalinity as CaCO3	5	mg/L			203	226	284
	Conductivity	5	uS/cm			470	506	927
	pH	1.00				8.33	8.18	8.18
	TDS (COND - CALC)	1	mg/L			306	329	603
	Total Suspended Solids	2	mg/L			<2	2	<2
Hardness	Hardness as CaCO3	1	mg/L			219	276	383
Hydrocarbons	F1 (C6-C10)	20	ug/L			<20	<20	<20
	F1-BTEX (C6-C10)	20	ug/L			<20	<20	<20
	F2 (C10-C16)	20	ug/L			<20	<20	<20
	F3 (C16-C34)	50	ug/L			<50	<50	<50
	F4 (C34-C50)	50	ug/L			<50	<50	<50
Indices/Calc	Ion Balance	0.01				1.03	1.06	1.03
Metals	Ag	0.0001	mg/L			<0.0001	<0.0001	<0.0001
	B	0.01	mg/L			0.04	0.01	0.03
	Ba	0.01	mg/L			0.09	0.25	0.19
	Be	0.0005	mg/L			<0.0005	<0.0005	<0.0005
	Ca	1	mg/L			53	81	112
	Cd	0.0001	mg/L			<0.0001	<0.0001	<0.0001
	Cr	0.001	mg/L			<0.001	<0.001	<0.001
	Cu	0.001	mg/L			<0.001	<0.001	<0.001

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Group	Analyte	MRL	Units	Guideline	Lab I.D.	1537850	1537851	1537852
					Sample Matrix	Water	Water	Water
					Sample Type	2021-01-11	2021-01-11	2021-01-11
					Sampling Date	TW1	TW2	TW3
					Sample I.D.			
Metals	Fe	0.03	mg/L			<0.03	<0.03	<0.03
	K	1	mg/L			2	2	2
	Mg	1	mg/L			21	18	25
	Mn	0.01	mg/L			0.06	0.01	<0.01
	Mo	0.005	mg/L			0.010	<0.005	<0.005
	Na	2	mg/L			19	5	50
	Ni	0.005	mg/L			<0.005	<0.005	<0.005
	Pb	0.001	mg/L			<0.001	<0.001	<0.001
	Si	0.1	mg/L			4.8	4.4	5.4
	Sr	0.001	mg/L			0.122	0.139	0.175
	Tl	0.0001	mg/L			<0.0001	<0.0001	<0.0001
	V	0.001	mg/L			<0.001	<0.001	<0.001
	Zn	0.01	mg/L			<0.01	<0.01	<0.01
Nutrients	N-NH3	0.010	mg/L			<0.010	<0.010	<0.010
	Total Kjeldahl Nitrogen	0.100	mg/L			0.280	0.131	0.453
	Total P	0.020	mg/L			<0.020	<0.020	<0.020
PHC Surrogate	Alpha-androstrane	0	%			77	74	79
Subcontract-Inorg	Phenols	0.001	mg/L			<0.001	<0.001	<0.001
VOCs Surrogates	Toluene-d8	0	%			100	102	99
Volatiles	Benzene	0.5	ug/L			<0.5	<0.5	<0.5
	Ethylbenzene	0.5	ug/L			<0.5	<0.5	<0.5
	m/p-xylene	0.4	ug/L			<0.4	<0.4	<0.4
	o-xylene	0.4	ug/L			<0.4	<0.4	<0.4
	Toluene	0.5	ug/L			<0.5	<0.5	<0.5
	Xylene; total	0.5	ug/L			<0.5	<0.5	<0.5

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 COC #: 212159

**QC Summary**

Analyte	Blank	QC % Rec	QC Limits
<b>Run No</b> 395019 <b>Analysis/Extraction Date</b> 2021-01-13 <b>Analyst</b> AET			
<b>Method</b> SM2320,2510,4500H/F			
Alkalinity (CaCO3)	<5 mg/L	100	90-110
Conductivity	<5 uS/cm	97	90-110
F	<0.10 mg/L	102	90-110
pH		101	90-110
<b>Run No</b> 395039 <b>Analysis/Extraction Date</b> 2021-01-14 <b>Analyst</b> C M			
<b>Method</b> CCME O.Reg 153/04			
Petroleum Hydrocarbons F2	<20 ug/L	88	60-140
Petroleum Hydrocarbons F3	<50 ug/L	88	60-140
Petroleum Hydrocarbons F4	<50 ug/L	88	60-140
<b>Run No</b> 395048 <b>Analysis/Extraction Date</b> 2021-01-14 <b>Analyst</b> SKH			
<b>Method</b> EPA 350.1			
N-NH3	<0.010 mg/L	104	80-120
<b>Run No</b> 395057 <b>Analysis/Extraction Date</b> 2021-01-14 <b>Analyst</b> SKH			
<b>Method</b> EPA 351.2			
Total Kjeldahl Nitrogen	<0.100 mg/L	93	70-130
<b>Run No</b> 395060 <b>Analysis/Extraction Date</b> 2021-01-14 <b>Analyst</b> Z S			
<b>Method</b> M SM3120B-3500C			

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**QC Summary**

Analyte	Blank	QC % Rec	QC Limits
Calcium	<1 mg/L	102	90-110
Potassium	<1 mg/L	95	87-113
Magnesium	<1 mg/L	100	76-124
Sodium	<2 mg/L	96	82-118
<b>Run No</b> 395064 <b>Analysis/Extraction Date</b> 2021-01-14 <b>Analyst</b> H D <b>Method</b> EPA 200.8			
Silver	<0.0001 mg/L	110	80-120
Boron (total)	<0.01 mg/L	98	80-120
Barium	<0.01 mg/L	100	80-120
Beryllium	<0.0005 mg/L	105	80-120
Cadmium	<0.0001 mg/L	109	80-120
Chromium Total	<0.001 mg/L	108	80-120
Copper	<0.001 mg/L	109	80-120
Iron	<0.03 mg/L	95	80-120
Manganese	<0.01 mg/L	109	80-120
Molybdenum	<0.005 mg/L	97	80-120
Nickel	<0.005 mg/L	109	80-120
Lead	<0.001 mg/L	106	80-120

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**QC Summary**

Analyte	Blank	QC % Rec	QC Limits
Silicon	<0.1 mg/L	100	80-120
Strontium	<0.001 mg/L	104	80-120
Thallium	<0.0001 mg/L	102	80-120
Vanadium	<0.001 mg/L	104	80-120
Zinc	<0.01 mg/L	111	80-120
<b>Run No</b> 395091 <b>Analysis/Extraction Date</b> 2021-01-14 <b>Analyst</b> AET <b>Method</b> SUBCONTRACT P-INORG			
Phenols	<0.001 mg/L	76	69-132
<b>Run No</b> 395105 <b>Analysis/Extraction Date</b> 2021-01-15 <b>Analyst</b> SKH <b>Method</b> SM 4110			
Chloride	<1 mg/L	100	90-110
N-NO2	<0.10 mg/L	104	90-110
N-NO3	<0.10 mg/L	104	90-110
SO4	<1 mg/L	100	90-110
<b>Run No</b> 395135 <b>Analysis/Extraction Date</b> 2021-01-15 <b>Analyst</b> SKH <b>Method</b> SM 4110			
Chloride	<1 mg/L	100	90-110
<b>Run No</b> 395167 <b>Analysis/Extraction Date</b> 2021-01-18 <b>Analyst</b> SKH <b>Method</b> EPA 365.1			

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**QC Summary**

Analyte	Blank	QC % Rec	QC Limits
Total P	<0.020 mg/L	95	80-120
<b>Run No</b> 395180 <b>Analysis/Extraction Date</b> 2021-01-18 <b>Analyst</b> SKH <b>Method</b> C SM2340B			
Hardness as CaCO3			
Ion Balance			
TDS (COND - CALC)			
<b>Run No</b> 395196 <b>Analysis/Extraction Date</b> 2021-01-19 <b>Analyst</b> SKH <b>Method</b> C SM2540			
Total Suspended Solids	<2 mg/L	100	90-110
<b>Run No</b> 395209 <b>Analysis/Extraction Date</b> 2021-01-19 <b>Analyst</b> YH <b>Method</b> CCME O.Reg 153/04			
Petroleum Hydrocarbons F1	<20 ug/L	95	60-140
<b>Run No</b> 395222 <b>Analysis/Extraction Date</b> 2021-01-18 <b>Analyst</b> YH <b>Method</b> EPA 8260			
Benzene	<0.5 ug/L	116	60-130
Ethylbenzene	<0.5 ug/L	91	60-130
m/p-xylene	<0.4 ug/L	88	60-130
o-xylene	<0.4 ug/L	103	60-130
Toluene	<0.5 ug/L	90	60-130

**Guideline =**

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 Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

**Certificate of Analysis**

Client: GRI Inc.  
 R.R. #1  
 Oxford Mills, ON  
 K0G 1S0  
 Attention: Mr. George Gorrell  
 PO#:  
 Invoice to: GRI Inc.

Report Number: 1946164  
 Date Submitted: 2021-01-12  
 Date Reported: 2021-01-19  
 Project: 21-022  
 COC #: 212159

**QC Summary**

Analyte	Blank	QC % Rec	QC Limits
<b>Run No</b> 395223 <b>Analysis/Extraction Date</b> 2021-01-19 <b>Analyst</b> YH <b>Method</b> EPA 8260			
Xylene Mixture			
<b>Run No</b> 395224 <b>Analysis/Extraction Date</b> 2021-01-19 <b>Analyst</b> YH <b>Method</b> CCME O.Reg 153/04			
Petroleum Hydrocarbons F1-BTEX			

**Guideline =**                      \* = **Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.  
 Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

CLIENT INFORMATION		INVOICE INFORMATION (SAME AS CLIENT INFORMATION: YES <input checked="" type="checkbox"/> NO <input type="checkbox"/> )	
Company: <b>GRI Inc</b>		Company:	Fax:
Contact: <b>George Gertel</b>		Contact:	Email: #1:
Address: <b>911 County Rd 18 Oxford, ON</b>		Address:	Email: #2:
Telephone: <b>613 258 2954</b>	Cell: <b>647 502 5224</b>	Telephone:	PO #:
Email: #1: <b>george.gertel@gri-inc.ca</b>		<b>REGULATION/GUIDELINE REQUIRED</b>	
Email: #2:			
Project: <b>21-022</b>	Quote #: <b>190938</b>		

**TURN-AROUND TIME (Business Days)**

1 Day\* (100%)   
  2 Day\*\* (50%)   
  3-5 Days (25%)   
  5-7 Days (Standard)

Please contact Lab in advance to determine rush availability.  
 \*For results reported after rush due date, surcharges will apply: before 12:00 - 100%, after 12:00 - 50%.  
 \*\*For results reported after rush due date, surcharges will apply: before 12:00 - 50%, after 12:00 - 25%.

Sanitary Sewer, City: \_\_\_\_\_  
 Storm Sewer, City: \_\_\_\_\_  
 ODWSOG  
 PWQO  
 O. Reg 347/558  
 Other: \_\_\_\_\_  
 None

O. Reg 153  
 Table # \_\_\_\_, Course / Fine, Surface / subsurface.  
 Type: Com-Ind / Res-Park / Agri / GW / All Other / Sediment  
 Excess Soil, Table: \_\_\_\_\_ Type: \_\_\_\_\_

The sample results from this submission will form part of a formal Record of Site Condition (RSC) under O.Reg. 153/04  
 Yes  No

The optimal temperature conditions during transport should be less than 10°C. Sample(s) cannot be frozen, unless otherwise indicated or agreed upon with the Laboratory. Note that this COC is not to be used for drinking water samples. The COC must be complete upon submission of the samples, there will be a \$25 surcharge if required information is missing (required fields are shaded in grey).

Sample Details		Sample Analysis Required														RN# (Lab Use Only)			
		O.Reg.153 parameters																	
		PHC F1 - F4	BTEX	VOCs	PAHs	PCBs	Metals - Inorganics	Metals only	BTEX	F1 - F4	TDS	NO2	TKN	NH3	phenols				
Sample ID	Date/Time Collected																		
Ta1	01/11/21 1409									X	X	X	X	X	X	X	X	X	1537850
Ta2	01/11/21 1342									X	X	X	X	X	X	X	X	X	51
Ta3	01/11/21 1534									X	X	X	X	X	X	X	X	X	52

PRINT	SIGN	DATE/TIME	TEMP (°C)	COMMENTS:
Sampled By: <b>George Gertel</b>		01/11/20 13:47		
Relinquished By: <b>George Gertel</b>		01/12/20 11:46	13.5	
Received By:				