

Whitewater Hydrogeology Ltd.



COMBINED LEVEL 1 AND 2 HYDROGEOLOGICAL ASSESSMENT

PROPOSED SARAWAK QUARRY EXPANSION

Prepared for:



Harold
Sutherland
CONSTRUCTION

Whitewater Hydrogeology Ltd
Phone: 705.888.7064
Email: tecia@white-water.ca

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1.0 INTRODUCTION

Harold Sutherland Construction Ltd. (HSC) is filing an application with the Ministry of Natural Resources and Forestry (MNRF) for an Aggregate Resources Act (ARA) license for development of the expansion lands adjacent to the existing Sarawak Quarry. The proposed Sarawak Quarry expansion will cover 15.55 ha of the lands located in Lot 36, Concession 2 Township of Georgian Bluffs in the County of Grey (Figure 1). The application is for a Category 2, Class A license, which would permit the extraction of aggregate from below the water table.

The hydrogeological work program for the expansion of the Sarawak Quarry was developed to comply with the relevant legislation. The Provincial Standards, which support the ARA, outline the technical requirements for the various aggregate applications. The supporting documentation for a Category 2 quarry license, must include a Hydrogeological Level 1 Report. If the results of Level 1 identified a potential for adverse effects of the operation on groundwater and surface water resources and their uses, a Level 2 report is required which shall include an impact assessment to determine the significance of the effect and feasibility of mitigation. Due to the proximity to rural properties, a Combined Level 1 and 2 Hydrogeological Assessment has been completed.

2.0 REGIONAL SETTING

2.1 Physiography

The subject property resides within Shale Plains physiographic region also known as the Cape Rich Steps. This area consists of Paleozoic bedrock overlain by shallow overburden, with the plain being incised by the Beaver Valley (in the Thornbury area) and the Bighead Valley (in the Meaford area).

A Digital Elevation Model (DEM) of the region is presented in Figure 2. DEM data files are digital representations of cartographic information in raster format. DEMs consist of a sampled array of elevations for some ground positions at regularly spaced intervals. The DEM model has been conditioned to be hydrologically correct which means, spurious sinks (depressions) within a DEM have been removed and the data has been topologically flowing corrected. The two most dominant features on the DEM are the slopes of the Niagara Escarpment to the west of the site (marked by the dark green shading) and Georgian Bay to the east.

The topography on the proposed expansion lands site is relatively flat with a low elevation of 238 masl and a high 243 masl (Figure 3). The most dominant feature on Figure 3 is the presence of the existing Sarawak Quarry, which has been extracted to a maximum depth of 232 masl.

2.2 Hydrology

There are no significant surface water features within 500 m or more from the site although one small wetland is shown on the OBM (#10 17 5000 49450) approximately 200 m to the southwest of the expansion boundary. Runoff from the proposed expansion lands drains to a topographic low (closed depression) along the western property boundary (Figure 3), limiting surface water from flowing off-site.

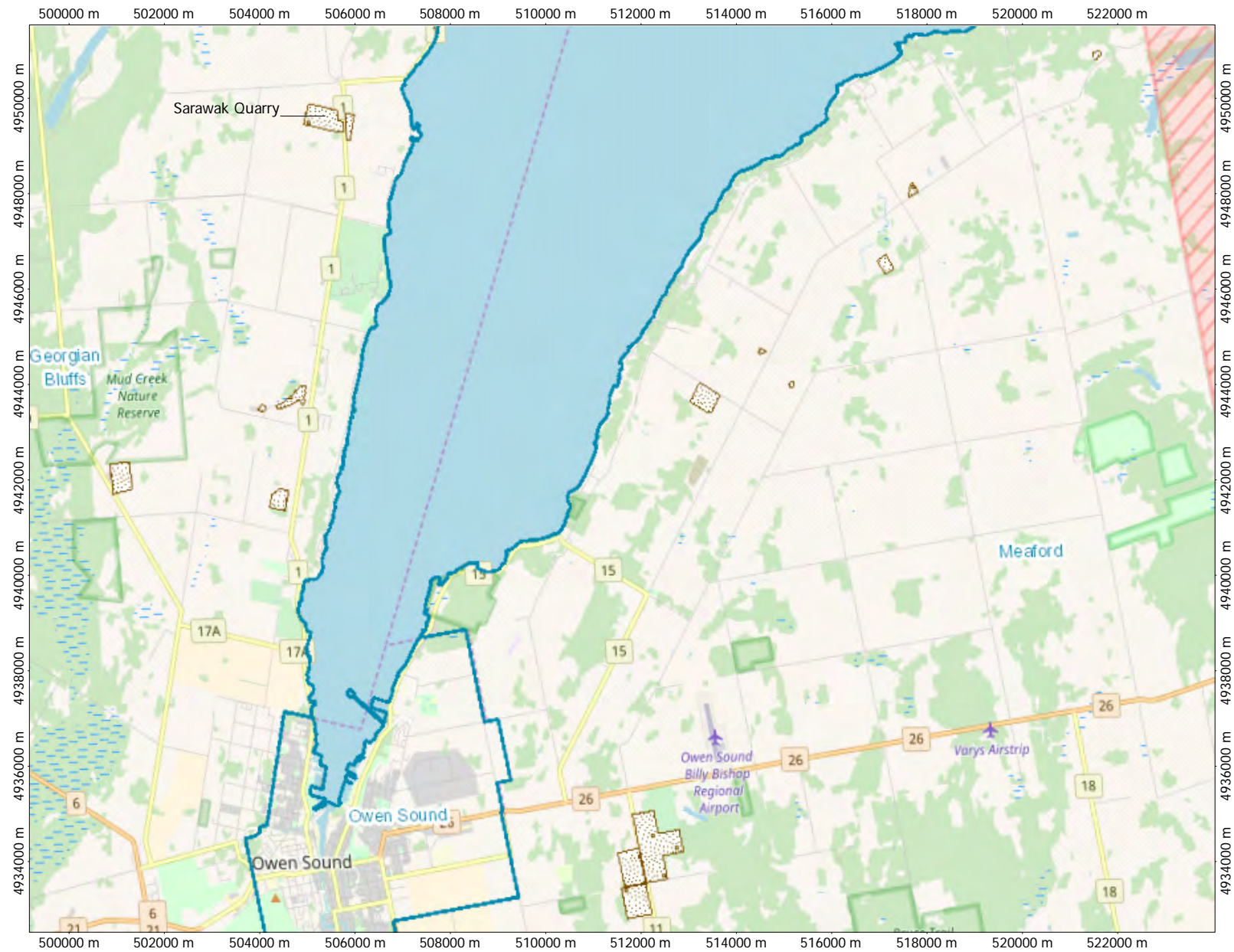


FIGURE 1: REGIONAL LOCATION MAP



FIGURE 2: DIGITAL ELEVATION MAP (DEM)

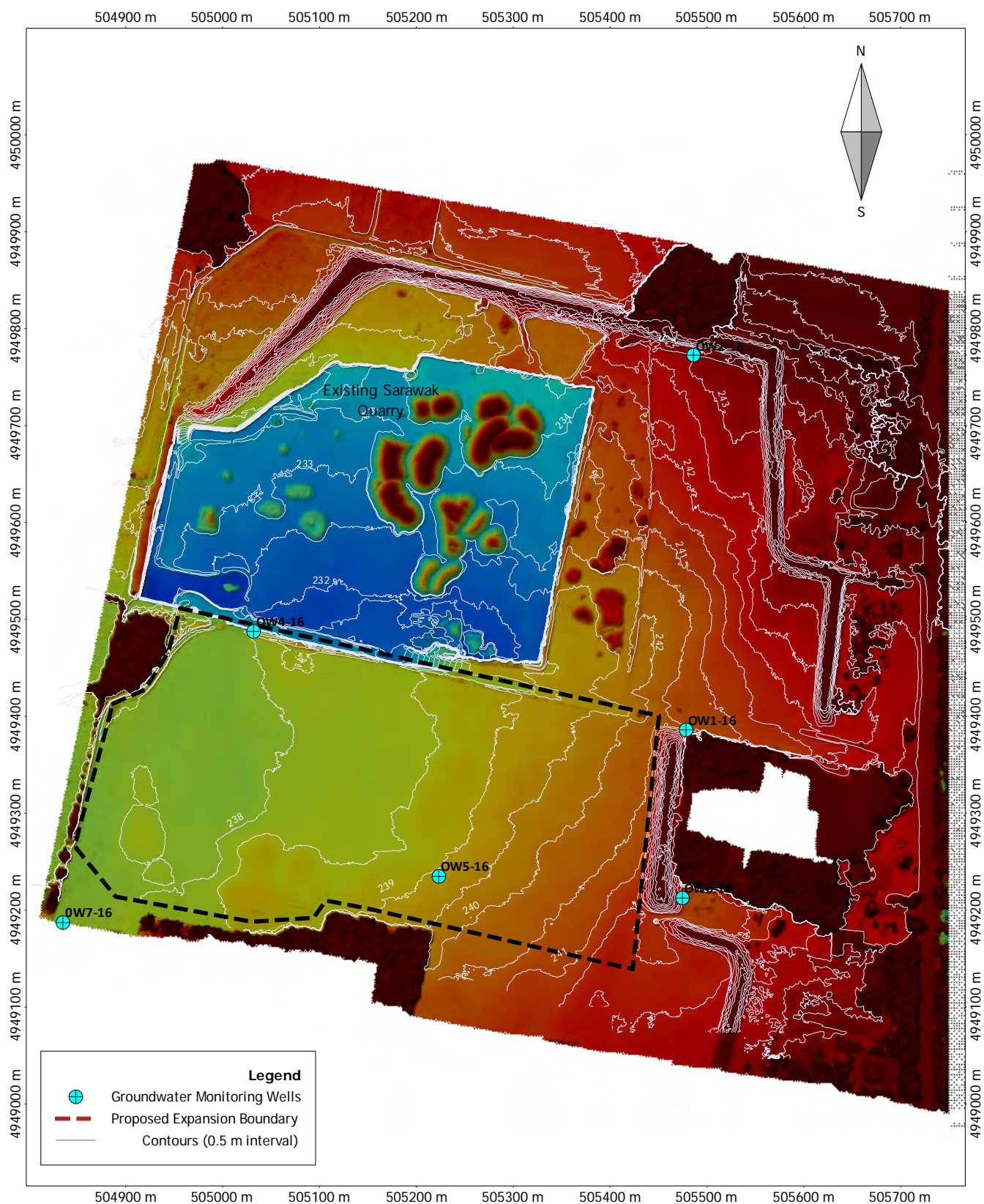


FIGURE 3: SITE DEM

2.3 Geology

The proposed Sarawak Quarry expansion is underlain by the Lower Silurian Manitoulin Formation, which is exposed in a discontinuous escarpment along the western and southeastern shores of Owen Sound. The Manitoulin Formation consists of thin- to thick-bedded, light grey-brown to blue-grey, buff-brown weathering dolostones, calcareous dolostones, and minor limestones. This formation can be grossly subdivided into two informal units: a lower thin- to thick-bedded, fine- to coarse crystalline dolostone, which is commonly planar laminated or cross-stratified; and an upper, thin-bedded, bioturbated, fossiliferous, fine- to medium-crystalline dolostone (Anastas, 1992).

In the southern Bruce Peninsula map area, the basal 0.5 to 2 m of the lower unit is commonly bioturbated, argillaceous, fine crystalline and slightly to very calcareous. Thin shale beds and partings occur locally in these basal beds which limit aggregate extraction depths. Silicified fossils (brachiopods, crinoids, and corals) are common in the upper unit, and thin, discontinuous, silicified, fossil fragment grainstone beds are typical in the lower unit.

The Manitoulin Formation dolostones sharply and disconformably overlie shales of the Queenston Formation. In addition to its characteristic red siliciclastic shales, the Queenston Formation on the Bruce Peninsula contains significant interbeds of grey-green shale, siltstone, and limestone. The Queenston shale is a resource of provincial significance to produce structural clay products. However, analytical data presented by Guillet (1977) indicate that the shale in the Owen Sound area may have less use potential because it tends to have a much higher lime content.



FIGURE 4: BEDROCK ROCK SURFACE AND VERTICAL JOINTING

The Manitoulin Formation at the site is exposed at the existing Sarawak Quarry. Vertical jointing in areas of exposed bedrock has been observed (Figure 4). Jointing is commonly associated with the present or past principal stress orientations in the rock mass.

The vertical depths (joint starting and termination points) were noted on the quarry walls (Figure 5.) The joints appear to only occur in the weathered upper portion of the Manitoulin Formation (upper 2 m).

2.4 Karst

Karst is a particular type of landscape that is formed by the dissolution of soluble rocks, including limestone and dolomite. Relatively thin drift cover over the Bruce Peninsula has exposed the predominantly carbonate bedrock surface to the dissolution action of water. Karst features and processes on the Bruce Peninsula were described by Cowell (1976) and Cowell and Ford (1980).

The expansion site lies within a *Special Policy Area* (Karst) as per 2012 (amended) Grey County Official Plan (Policy 2.8.5). This county policy responds to policy 3.1.1 (c) of the Provincial Policy Statement (PPS)

that specifically identifies karst (“unstable bedrock”) as a type of Hazardous Site requiring assessment. In response to this designation, HSC retained Daryl Cowell & Associates Inc. to undertake a Karst Hazard Assessment (2017).

The conclusions of the Karst Hazard Assessment indicate that no significant karst features occur on or adjacent to the expansion lands. Several small very shallow depressions were observed in the forested areas surrounding the site and are most likely locations of local diffuse recharge to the bedrock via partially open joint planes. The proposed expansion lands are not considered to be a hazardous site as defined in Policy 3.1.1(c) of the PPS.

2.5 Hydrogeology

The hydrogeological conditions near the Sarawak Quarry have been characterized as part of hydrogeological assessments completed under previous ARA and Ontario Water Resources Act applications. Aquifer testing of the Manitoulin Formation indicated that the hydraulic characteristics



FIGURE 5: MANITOULIN FORMATION

(transmissivity and hydraulic conductivity) are indicative of a tight bedrock unit that has limited groundwater flow. Conestoga-Rovers & Associates Limited (1982), reported that an on-site recovery test of the Manitoulin Formation resulted in a prolonged recovery rate and it was not possible to determine any hydraulic parameters.

Subsequent aquifer step testing was completed by Genivar (2011) on two open-hole wells that were drilled to the approved quarry floor elevation, which was assumed to be equivalent to the geological contact between the Manitoulin and Queenston Formation. A step test is a single-well pumping test designed to investigate the performance of a pumping well under controlled variable discharge conditions. In a step-drawdown test, the discharge rate in the pumping well is increased from an initially low constant rate through a sequence of pumping intervals (steps) of progressively higher constant rates.

The step test results indicate that the hydraulic conductivity of the Manitoulin Formation at the Sarawak Quarry ranges between 3.5×10^{-6} m/min to 4.2×10^{-6} m/min. The aquifer transmissivities are less than $0.1 \text{ m}^2/\text{day}$. Aquifers that have transmissivity values less than $0.1 \text{ m}^2/\text{day}$ are reported to be poor water supply sources for domestic water supplies (Krasny, 1993). These results are consistent with field observations of the quarry face, which is free of groundwater seepage (Figure 5) and the reported depth to where water was found in the water well records.

3.0 EXISTING SARAWAK QUARRY OPERATIONS

The existing Sarawak Quarry is currently licensed to extract limestone from below the established water table to a quarry floor elevation ranging from 229 masl to 233 masl. However, the Sarawak Quarry has not and will not be extracting from below the current floor elevation (approximately 232 masl and 233 masl) due to the low quality of the aggregate material (unmarketable).

3.1 Section 34 Permit to Take Water (No.: 1864-8EXH5T)

HSC holds a Section 34 Permit to Take Water (PTTW) under the Ontario Water Resource Act for the Sarawak Quarry (No.: 1864-8EXH5T). This permit was issued on March 16, 2011, and expires on March 31, 2021. The permit allows for the dewatering of the quarry at an instantaneous pumping rate of 9,167 L/min for a period of 24-hours a day and 365 days a year. The maximum daily permitted taking is 13,200,000 L.

The discharge location of the pumped water is at the outlet near the southwestern boundary of the existing quarry. Discharge at this location is directed into an excavated drainage ditch that runs parallel to the western boundary of the proposed licensed area. During periods of low discharge, the water in the channel seeps into the overburden and shallow bedrock. However, during periods of higher discharge volumes, water flows beyond the terminus of the channel and into a pasture field south-west of the quarry. An agreement allowing this intermittent discharge to this property has been made between the property owner and HSC.

Dewatering is predominately due to the accumulation of precipitation and runoff in the quarry footprint. Significant groundwater seepage is not apparent along the quarry faces. Quarry dewatering is conducted on an as-needed basis. A review of the water taking data between 2013 and 2017 shows that less than 30% of the total monthly taking has been pumped from the Sarawak Quarry. The increase in incidental water that will accumulate in the quarry as a result of the proposed expansion can be handled by the water taking limits. Therefore, no amendments to the PTTW will be required from the Ministry of the Environment and Climate Change (MOECC).

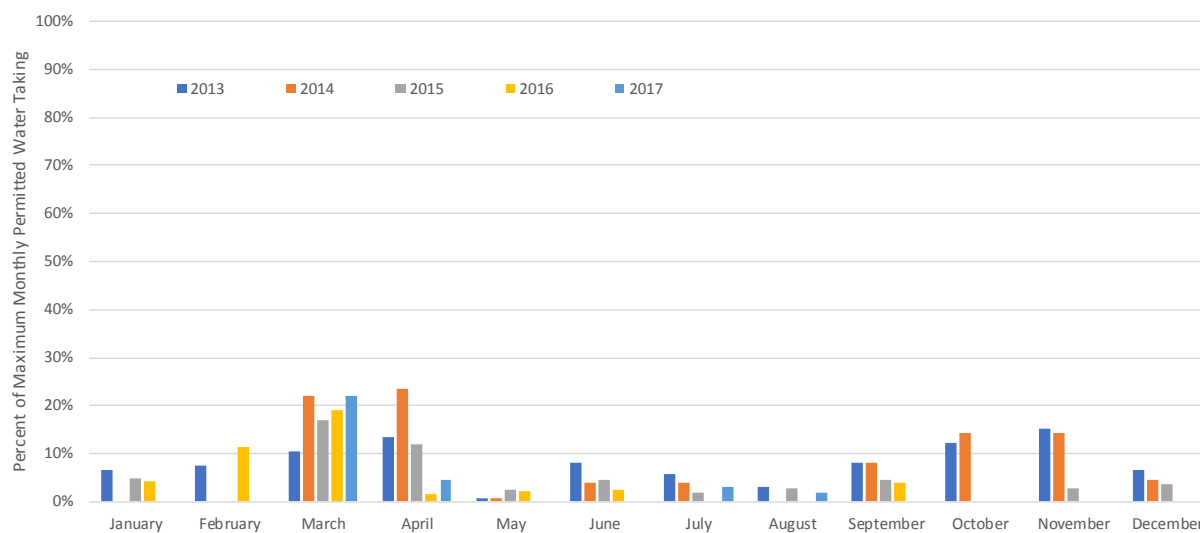


FIGURE 6: HISTORICAL WATER TAKINGS - SARAWAK QUARRY

3.2 Effluent Monitoring

HSC undertakes routine water quality monitoring of the effluent that is discharged from the Sarawak Quarry. The results indicate that there have been no detections of oil and grease, unionized ammonia, or total suspended solids over the monitoring period. pH ranges between 7.86 and 8.25 (Table 1).

TABLE 1: EFFLUENT WATER QUALITY

Parameter	May-16	Sept-16	Oct-16	Nov-16	Apr-17	May-17	Jun-17	Jul-17
pH (Field)	8.04	7.86	7.94	8.1	8.22	8.03	8.17	8.25
Temperature (Field)	14.4	15.1	7.9	8.0	11.3	13.6	15.8	24.0
Unionized Ammonia	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Suspended Solids	<3	<3	<3	<3	<3	<3	<3	<3
Total Oil and Grease	<1	<1	<1	<1	<1	<1	<1	<1

4.0 WORK PROGRAM

4.1 Groundwater Monitoring Program

In May 2016, five groundwater observation wells were installed on the Sarawak expansion lands (OW1-16, OW2-16, OW4-16, OW5-16, and OW7-16). An additional observation well (OW6-16) was added in October of 2016. The wells were drilled to depths ranging between 6.5 and 8 m below ground surface. The wells were constructed with a 6 m screened interval. Therefore, the measured water level value from the monitoring wells applies to a finite interval of aquifer, which will usually contain many fractures as well as sections of unfractured rock. Different hydraulic heads may occur within various fractures, and differences in head may also occur between the fractures and the matrix. The measured hydraulic head will represent an average of the hydraulic heads within the sampled interval but will be dominated by the more significant fractures.

The six observation wells have been equipped with pressure transducers (dataloggers), which are programmed to record the total pressure above the datalogger every 4 hours. Also, there is a barometric pressure transducer on-site which is scheduled to read the atmospheric pressure at the same interval. This data allows for barometric correction to be applied to the pressure reading collected by the six dataloggers. Also, manual water level readings are measured at all wells. The data presented in this report covers the monitoring period from May 2016 to November 2017.

4.2 Water Quality Testing

Four groundwater samples were collected on November 5, 2016. Before sample collection, the equivalent to 3 well casing volumes of water was purged from the borehole. Purging is the process of removing stagnant water from a well, immediately before sampling, causing its replacement by groundwater from the adjacent formation that is representative of actual aquifer conditions.

All samples were put directly into laboratory prepared containers, pre-charged with preservative by the lab where necessary. Only samples for metal analysis were field filtered. Samples were submitted to Testmark Laboratories Ltd. for chemical analysis (general water quality, dissolved metals, and BTEX).



FIGURE 7: SITE GROUNDWATER MONITORING LOCATIONS

4.3 Domestic Water Well Survey

A domestic water well survey was completed on June 10, 2017. Based on the water well records on file with the MOECC and the results of the survey, there are five domestic water wells located within a 500 m radius of the Sarawak Quarry. The water well survey was completed to field verify the water wells and to discuss with the individual homeowner if they have had any previous issues with their potable water supply (quality or quantity). The results indicate that there have been no previous issues associated with the local water supplies.

A summary of the well construction details of each of these wells is provided in Table 2. The elevations of the water-bearing fractures found within the Manitoulin and Queenston Formations are all below the existing and proposed Sarawak Quarry floor (232 masl).

TABLE 2: DOMESTIC WELL DETAILS

Well ID	Address	Well Depth (m)	Water Found (masl)
25-05997	319570 Grey Rd 1	25.9	225.5
25-07536	319600 Grey Rd 1	32.0	226.3 and 215.6
25-09701	319646 Grey Rd 1	22.9	231.7 and 219.3
25-16915	319580 Grey Rd 1	25.9	216.1
25-16844	319586 Grey Rd 1	34.7	221.7 and 218.7



FIGURE 8: DOMESTIC WATER WELL MAP (NOT TO SCALE)

5.0 HYDROLOGICAL / HYDROGEOLOGICAL EVALUATION

5.1 Groundwater Elevations

Typically, in fractured rock aquifers, an increase in hydraulic heads within an interconnected fracture network, which is vertically connected to the surface, will correspond to both seasonal (snowmelt) and large-scale precipitation events (regional storm). The resulting increase in hydraulic head and the rate at which these hydraulic heads return to equilibrium is dependent on the transmissivity of the fracture/joint network or its ability to drain the meltwater.

Water levels measured at OW1-16, OW2-16, OW5-16, and OW6-16 show a pressure response associated with both seasonal and storm events followed by a slow water level decrease back to equilibrium conditions (Figure 9). Water levels fluctuate by up to 4 m and range between approximately 234 and 240 masl. The rapid pressure response recorded during storm or snowmelt events may represent both vertical interconnectivity through the bedrock unit as well as pressure responses due to the transmission of pressure from the flow zones. The pressure is slowly dissipated as the water in the fracture zones is discharged laterally, removing the pressure source. The water level monitoring data indicates the fracture network recharges significantly more rapidly than the systems ability to drain, which supports earlier findings that the Manitoulin Formation has a low transmissivity.

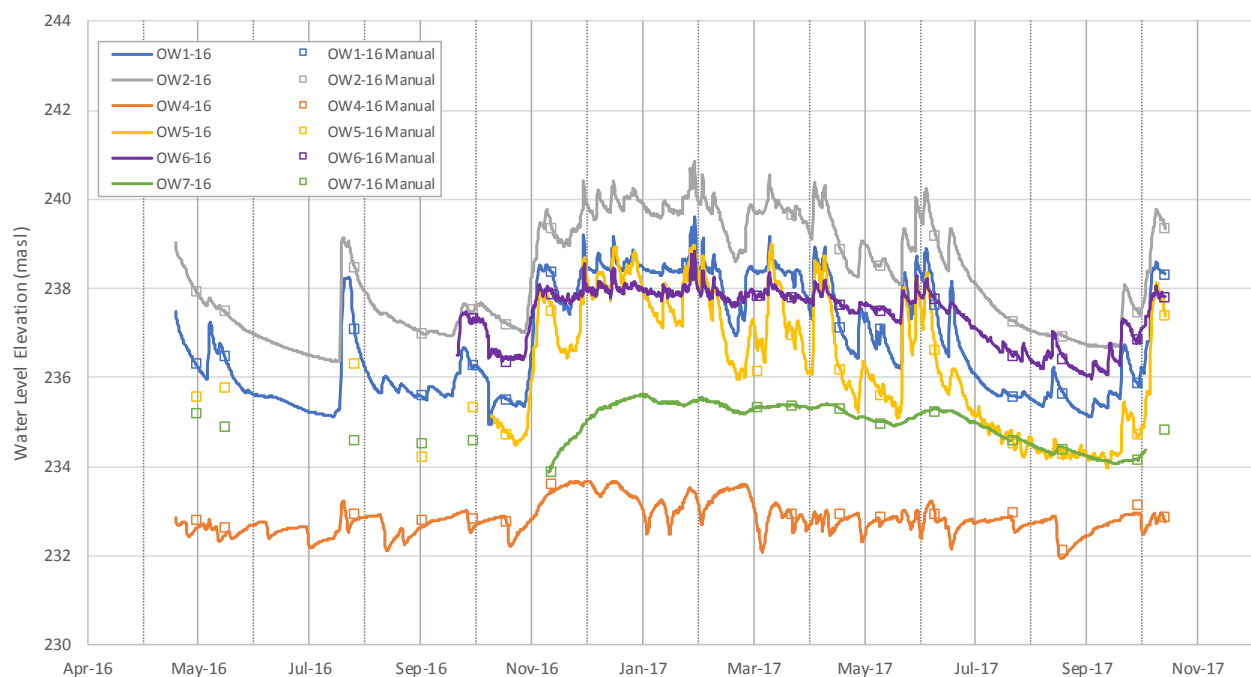


FIGURE 9: GROUNDWATER HYDROGRAPH

The water levels recorded from OW4-16 and OW7-16 behave differently from the those at OW1-16, OW2-16, OW5-16, and OW6-16. OW4-16 is located approximately 20 m from the existing Sarawak Quarry face and have been influenced by the dewatering operations at the site. Water levels fluctuate between approximately 232 and 233.5 masl, which is comparable to the elevation of the quarry floor and dewatering sump. Seasonal and storm event trends are not observed at this location as the quarry

dewatering operations maintain water levels in the quarry sump, which is reflected in the water levels measured at OW4-16.

The hydraulic head measured at OW7-16 is distinctly different compared to the typical response observed in the groundwater monitoring wells across the site. The response to the melting of the accumulated snowpack is much more subdued and delayed. The hydraulic head increases approximately 1.5 m in the fall from an average low of 234 masl to a peak of approximately 235.5 masl. This response is typical of an isolated fracture network.

In summary, the water level data support the findings presented in Section 2.5 which concludes that the Manitoulin Formation at the site is a poor aquifer where the groundwater system is poorly interconnected and does not transmit a significant quantity of water.

5.2 Groundwater Flow Conditions

The local groundwater flow conditions in the Manitoulin Formation before the extraction of aggregate from the existing Sarawak Quarry is showing on Figure 10 (Conestoga-Rovers & Associates Limited, 1982). Groundwater flow was reported to flow radially from a high of approximately 237 masl near OW2 towards the south, west and east boundaries where water levels were approximately 234-235 masl ().

Overall, the groundwater flow is dominantly westward and is influenced by regional conditions including topography and the natural dip of the bedrock. This westward flow was reported to discharge to the Indian River located approximately 1 km from the site (Figure 2). The pre-quarry groundwater flow conditions at the site were reported to be influenced locally by a small bedrock escarpment that runs parallel to Grey County Road 1 resulting in an easterly flow component.



FIGURE 10: GROUNDWATER FLOW MAP (PRE-SARAWAK QUARRY)



FIGURE 11: GROUNDWATER FLOW MAP

The groundwater elevations measured on October 22, 2017, have been relied upon to determine the existing groundwater flow conditions (post-extraction). The presence and operation of the Sarawak Quarry have altered the local groundwater flow pattern near the extraction area (Figure 11). Groundwater levels remain like historical pre-quarry conditions at OW1 and OW2, indicating that drawdown from the Sarawak Quarry does not extend beyond 100 m up-gradient (to the north and east). Similarly, down-gradient the area of influence is limited as the extraction depth below water is only 1.5 m.

5.3 Groundwater Quality

Hydrochemical properties of groundwater depend on lithology, the regional flow pattern of water, and resident time (Domenico 1972). All groundwater can be divided into three main categories: bicarbonate, sulfate, and chloride types (Chebotarev 1955). The chemical signature of water begins to change as it flows from areas of groundwater recharge to areas of groundwater discharge. The groundwater composition changes progressively along the flow path towards the composition of seawater (Chebotarev Sequence: bicarbonate → sulphate → chloride). The dominant ion in the groundwater correlates with distance along the flow path and residence time or age of the groundwater. A Piper diagram (1944) can be used to identify the type of water: bicarbonate (HCO_3^-) plus carbonate (CO_3^{2-}), sulfate (SO_4^{2-}), or chloride (Cl^-).

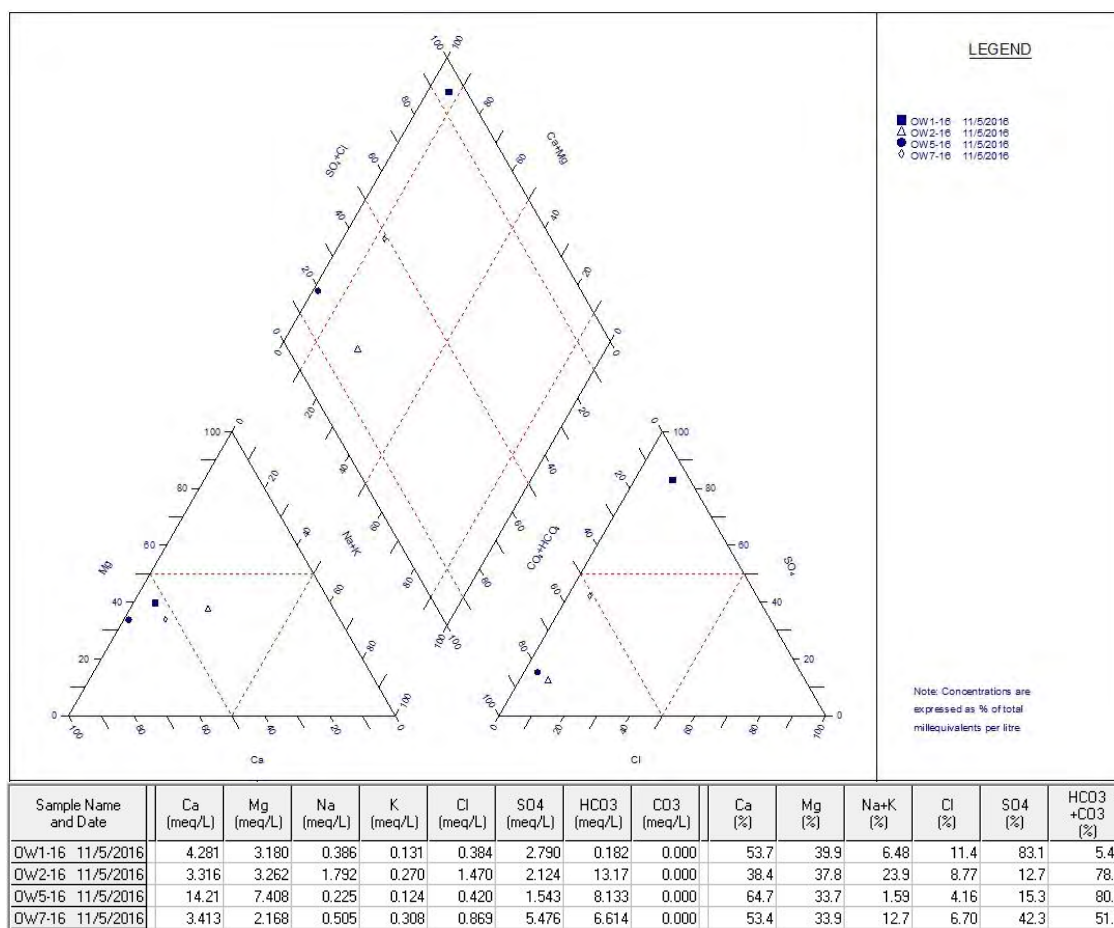


FIGURE 12: PIPER DIAGRAM AND DATA SUMMARY

A Piper diagram (Piper, 1944) was used to characterize the local groundwater signatures of the four groundwater samples collected on November 5th, 2016 (Figure 12). The Piper Diagram shows groundwater at OW2-16 and OW5-16 is strongly calcium bicarbonate in character, typical of natural (uncontaminated) of shallow dolomitic limestone aquifers in southern Ontario.

The groundwater becomes more sulfate-dominated at OW7-16 and OW1-16, respectively. Although OW1-16 is up-gradient, the data suggests that the groundwater is older than the down-gradient wells. OW1-16 may be constructed in an isolated pocket of flow and older groundwater.

The laboratory results are provided in Appendix C.

6.0 SOURCE WATER PROTECTION

The Clean Water Act (CWA S.O. 2006, Chapter 22) is a law enacted by the Legislative Assembly of Ontario. The CWA is not designed to protect all the province's water resources. The Act focuses on sources of water that have been designated by a municipality as being a current or future source of residential municipal drinking water for the community. The Ontario Water Resources Act and the Environmental Protection Act and other provincial and federal laws remain the main legislation for protecting the quality and quantity of Ontario's water resources.

The role of the proposed Sarawak Quarry expansion in the context of Source Water Protection (SWP) has been undertaken. Specifically, the potential impacts associated with the extraction of aggregate on private water supplies in the study area. The closest municipal water supply / Wellhead Protection Area (WHPA) is in the City of Owen Sound, which is located 15 km from the proposed expansion lands. Therefore, there will be no interference with the municipal water supply.

Although the proposed extraction area is located a considerable distance from a municipal groundwater supply/WHPA, the assessment has included a review of the groundwater/aquifer vulnerability (Highly Vulnerable Aquifers [HVA's]) in the area. This review has been applied to the domestic groundwater wells, which are the primary source of potable water for the local residents.

6.1 Significant Groundwater Recharge Areas and Highly Vulnerable Aquifers

Significant Groundwater Recharge Areas (SGRAs) are a type of vulnerable area identified in the Technical Rules (MOE, 2009) under the CWA (2006). In the Grey Sauble Source Protection Area (SPA), SGRAs are defined as an area that has an average annual recharge rate that is 1.15 times greater than the average annual recharge rate. The mean recharge in the Grey Sauble SPA was 270 mm/year, and the corresponding threshold for identifying potential SGRAs was set at (270 mm/year X 1.15) 310 mm/year. Therefore, all modeled recharge values greater than 310 mm/year were identified as potential SGRAs, which included all bedrock areas. The vulnerability of SGRAs was determined to be significant based on the assumption that all recharge areas greater than 1 ha reasonably have the potential to be hydraulically connected to a drinking water system. Therefore, it is not unexpected that areas bedrock areas, such as the proposed expansion lands, are delineated as a SGRA in the Approved Assessment Report for the Grey Sauble Source Protection Area (2015).

The Sarawak Quarry and expansion lands are mapped to contain a Highly Vulnerable Aquifer (HVA) due to the thin unsaturated overburden thickness. Therefore, it is important to assess the threats (if any) associated with an aggregate operation (refer to Section 6.2).

6.2 Source Water Protection and the Aggregate Industry

In response to the CWA, regarding Source Water Protection, the Ontario Stone, Sand and Gravel Association (OSSGA) supported a literature review study by the MNRF to assess the role of the aggregate industry and associated lands in the context of source water programs. The MNRF study (Applied Research on Source Water Protection Issues in the Aggregate Industry; Blackport and Golder, 2006) did not find any documented scientific evidence linking the extraction and processing of stone, sand, and gravel as a threat to drinking water sources.

The Province of Ontario has identified 21 prescribed drinking water threats under the CWA (2006). Nineteen of these relate to water quality and two to water quantity. The current land use of the expansion lands agriculture, which results in at least five potential prescribed drinking water threats. These include:

- Agricultural source material – application to land
- Agricultural source material – storage
- Agricultural source material – management
- Commercial fertilizer – application
- Pesticide – application

The proposed change in land use will reduce the number of prescribed drinking water threats. There is no proposed storage or handling of fuel within the expansion area.

7.0 IMPACT ASSESSMENT

An impact assessment is typically based upon a worst-case evaluation thereby representing a conservative estimate. In this geological environment, a worst-case scenario would assume that the fractured bedrock system is interconnected such that it allows groundwater flow through the Manitoulin Formation. The ability to draw groundwater into the proposed quarry is the central issue in this evaluative process.

However, as discussed in Section 2.5, the hydraulic characteristics (transmissivity and hydraulic conductivity) of the Manitoulin Formation are indicative of a tight bedrock unit that has limited groundwater flow. Therefore, applying a porous media analytical solution to predict the drawdown on the groundwater table from the proposed quarry operations would not result in any realistic understanding of the potential impacts.

Locally, the presence and influence of the existing Sarawak Quarry provides an invaluable physical model on the long-term effect(s) that such an operation would have on the surrounding environment and is considered the best source of information for the impacts associated with the expansion.

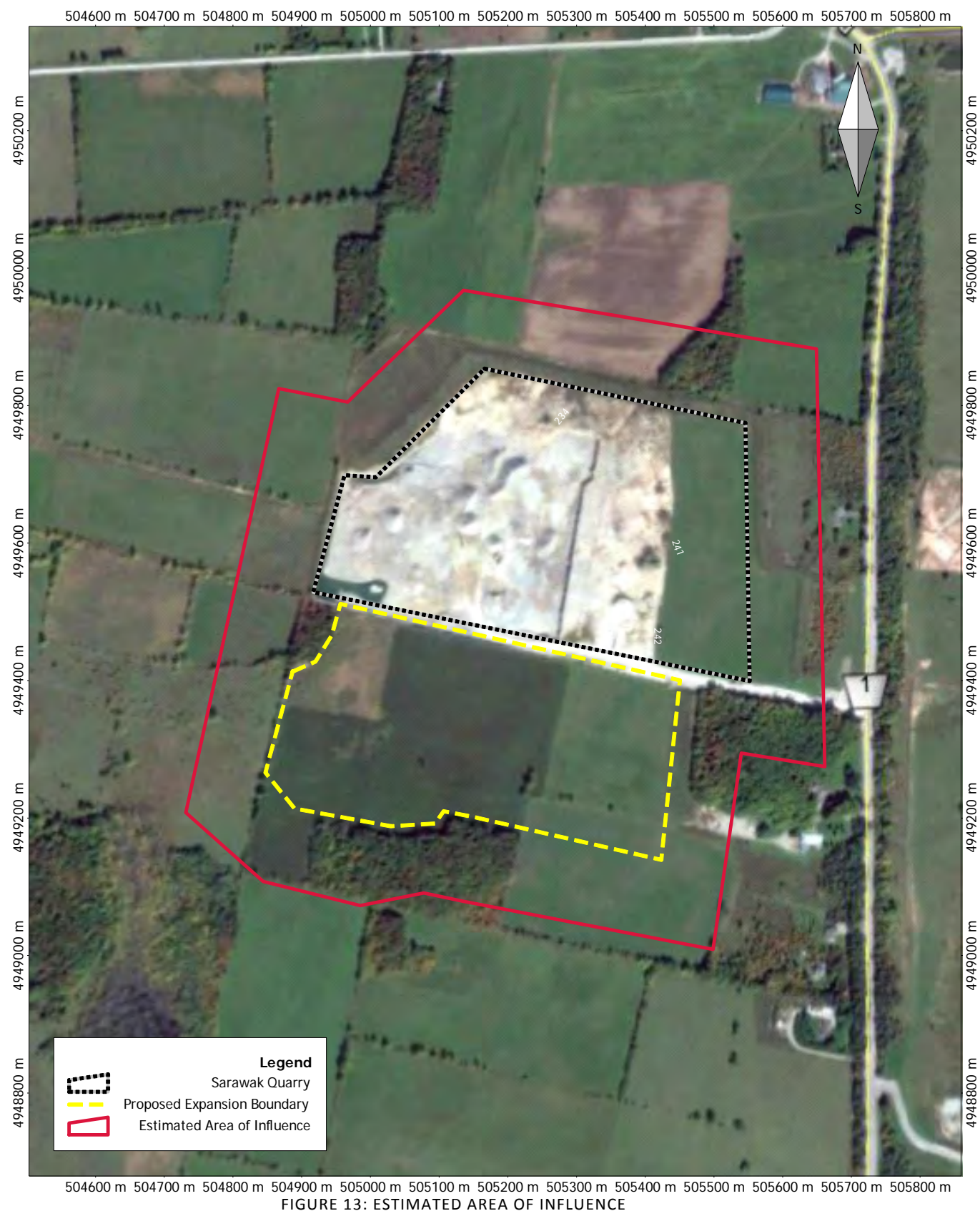


FIGURE 13: ESTIMATED AREA OF INFLUENCE

7.1 Potential Interference with the Groundwater Regime

The groundwater monitoring data indicate that the floor of the existing Sarawak Quarry is between 1.5 and 3 m below the water table and the area of influence from quarry dewatering extends less than 100 m from the extraction face. In order to increase the area of influence the extraction depth must increase, or transmissive fracture zones need to be intersected.

The proposed extraction of aggregate will occur below the water table to a minimum elevation of 232 masl, which is consistent with the current floor elevation of the Sarawak Quarry. There is no hydrogeological evidence to suggest that an active groundwater flow zone will be encountered if extraction occurs on the expansion lands. Therefore, it is anticipated that the area of influence will continue to extend 100 m from the quarry face as extraction proceeds. The estimated area of influence for the final extents of the current and proposed expansion is provided on Figure 13.

There are no domestic water wells located within the predicted area of influence. Furthermore, the local domestic water wells are supplied with groundwater from transmissive fractures located below the proposed base of the Sarawak Quarry (Table 2). Therefore, adverse impacts to domestic water wells are not anticipated.

7.2 Potential Interference with Surface Water Features

There is no potential interference with surface water as there are no significant features reliant upon hydrology functions within 500 m of the site.

8.0 MITIGATION MEASURES

Although there are no anticipated impacts associated with the proposed extraction of aggregate, which will occur below the established water table, there are preventative operational practices that are recommended to further protect groundwater quality:

- Refueling of machinery should not be conducted in areas of the excavation (i.e., on the pit floor).
- No chemical spray (pesticide/herbicide) should be used in areas of the excavation.
- Operator training should include understanding and implementing the preventative measures provided above, in addition to HSC's corporate Spill Contingency Plan.

9.0 RECOMMENDED COMPLIANCE MONITORING PROGRAM

The recommended compliance groundwater monitoring includes:

- Monthly water levels at all on-site monitoring locations
- Continuous water level measurements at OW1-16, OW2-16, OW4-16, OW5-16, OW6-16, and OW7-16
- The monitoring of domestic water wells located within 500 m of the proposed extraction area, if permission is granted. Monitoring should include continuous water levels and an annual collection of water quality (general water quality parameters and oil and grease).

Also, it is recommended that an annual groundwater monitoring report that includes the monitoring requirements of the existing Sarawak Quarry be prepared and submitted to the MNRF before March 31st of each year and include the monitoring data for the 12-month period ending December 31st of the previous year. The report shall include, but not be limited to, the following:

1. Data in tabulated and graphical formats (water level, precipitation, and pumping records);
2. Interpretation of the collected data including discussions of any observed trends in groundwater levels and groundwater quality (analytical) results; and
3. Summary and documentation of any water well complaint(s) and their resolution(s).

10.0 SUMMARY AND CONCLUSIONS

1. HSC is filing an application with the MNRF for an Aggregate Resources Act (ARA) Category 2, Class A Quarry Below Water license for development of the expansion lands adjacent to the existing Sarawak Quarry.
2. The proposed Sarawak Quarry expansion will cover 15.55 ha and extract the Manitoulin Formation to an elevation no lower than 232 masl.
3. The increase in incidental water that will accumulate in the quarry because of the proposed expansion can be handled by the water taking limits on the existing PTTW. Therefore, no amendments to the PTTW will be required.
4. Aquifer testing shows that the Manitoulin Formation is a poor aquifer with limited groundwater flow.
5. The water level monitoring data indicates the fracture network recharges significantly more rapidly than the systems ability to drain, which supports the conclusion that the Manitoulin Formation has a low transmissivity.
6. The water quality is typical of shallow dolomitic limestone aquifers in southern Ontario.
7. Locally, the presence and influence of the existing Sarawak Quarry provides an invaluable physical model on the long-term effect(s) that such an operation would have on the surrounding environment and is considered the best source of information for the impacts associated with the expansion.
8. The estimated area of influence for the final extents of the current and proposed expansion will extend out approximately 100 m from the quarry face.
9. There are no domestic water wells located within the predicted area of influence. Therefore, adverse impacts to domestic water wells are not anticipated.

It is Whitewater's professional opinion that the subject lands are geological, hydrogeologically and hydrologically suited for the proposed aggregate operations.



Tacia White, M.Sc., P.Geo.
Senior Hydrogeologist / President
Whitewater Hydrogeology Ltd.

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Well Record Data

APPENDIX A
MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE
WATER WELL RECORDS



Ministry
of the
Environment

Ontario

The Ontario Water Resources Act

WATER WELL RECORD

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

11

2507536

MUNICIP. 25013

COR. Con

02

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON. BLOCK, TRACT, SURVEY, ETC	LOT
11	Con II	036	036
DATE COMPLETED		DAY	MO
04 46-53		20	81
ELEVATION		BASIN CODE	
49.050		22	

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET	
				FROM	TO
Shale Rock				0	45
Blue Shale				45	55
Red & Blue Shale				55	105

31	0045	1712	0055317	0105717
32				

41 WATER RECORD	
WATER FOUND AT - FEET	KIND OF WATER
10-13	1 <input checked="" type="checkbox"/> FRESH 3 <input type="checkbox"/> SULPHUR
15-18	2 <input type="checkbox"/> SALTY 4 <input type="checkbox"/> MINERAL
20-23	1 <input type="checkbox"/> FRESH 3 <input type="checkbox"/> SULPHUR
25-28	2 <input type="checkbox"/> SALTY 4 <input type="checkbox"/> MINERAL
30-33	1 <input type="checkbox"/> FRESH 3 <input type="checkbox"/> SULPHUR
34-40	2 <input type="checkbox"/> SALTY 4 <input type="checkbox"/> MINERAL

51 CASING & OPEN HOLE RECORD			
INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET
10-11	1 <input checked="" type="checkbox"/> STEEL	138	0 0021
12-13	2 <input type="checkbox"/> GALVANIZED		21 105
14-15	3 <input type="checkbox"/> CONCRETE		
16-17	4 <input type="checkbox"/> OPEN HOLE		
18-19	1 <input type="checkbox"/> STEEL		
20-21	2 <input type="checkbox"/> GALVANIZED		
22-23	3 <input type="checkbox"/> CONCRETE		
24-25	4 <input type="checkbox"/> OPEN HOLE		
26-27	1 <input type="checkbox"/> STEEL		
28-29	2 <input type="checkbox"/> GALVANIZED		
30-31	3 <input type="checkbox"/> CONCRETE		
32-33	4 <input type="checkbox"/> OPEN HOLE		

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

61 PLUGGING & SEALING RECORD	
DEPTH SET AT - FEET	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
FROM TO	
10-13	14-17
18-21	22-25
26-29	30-33

71 PUMPING TEST METHOD	
1 <input checked="" type="checkbox"/> PUMP	2 <input type="checkbox"/> RECOVERY
STATIC LEVEL	WATER LEVEL END OF PUMPING
022	105
IF FLOWING, GIVE RATE	WATER AT END OF TEST
220	105
RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING
1 <input type="checkbox"/> SHALLOW 2 <input checked="" type="checkbox"/> DEEP	090
RECOMMENDED PUMPING RATE	0003

FINAL STATUS OF WELL	1 <input checked="" type="checkbox"/> WATER SUPPLY	5 <input type="checkbox"/> ABANDONED, INSUFFICIENT SUPPLY
	2 <input type="checkbox"/> OBSERVATION WELL	6 <input type="checkbox"/> ABANDONED, POOR QUALITY
	3 <input type="checkbox"/> TEST HOLE	7 <input type="checkbox"/> UNFINISHED
	4 <input type="checkbox"/> RECHARGE WELL	
WATER USE	1 <input checked="" type="checkbox"/> DOMESTIC	5 <input type="checkbox"/> COMMERCIAL
	2 <input checked="" type="checkbox"/> STOCK	6 <input type="checkbox"/> MUNICIPAL
	3 <input type="checkbox"/> IRRIGATION	7 <input type="checkbox"/> PUBLIC SUPPLY
	4 <input type="checkbox"/> INDUSTRIAL	8 <input type="checkbox"/> COOLING OR AIR CONDITIONING
	9 <input type="checkbox"/> NOT USED	
METHOD OF DRILLING	1 <input type="checkbox"/> CABLE TOOL	6 <input type="checkbox"/> BORING
	2 <input type="checkbox"/> ROTARY (CONVENTIONAL)	7 <input type="checkbox"/> DIAMOND
	3 <input type="checkbox"/> ROTARY (REVERSE)	8 <input type="checkbox"/> JETTING
	4 <input type="checkbox"/> ROTARY (AIR)	9 <input type="checkbox"/> DRIVING
	5 <input checked="" type="checkbox"/> AIR PERCUSSION	

LOCATION OF WELL	
IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.	
DRILLERS REMARKS	
Con 11 Jul 36 Sarnia Trip Grey County	

CONTRACTOR	NAME OF WELL CONTRACTOR	LICENCE NUMBER
	William Wright Well Drillers Ltd	5507
	ADDRESS	
	Box 167, 299 North Ave	
CONTRACTOR	NAME OF DRILLER OR BORE	LICENCE NUMBER
	William Wright	
CONTRACTOR	SIGNATURE OF CONTRACTOR	SUBMISSION DATE
	William Wright	

OFFICE USE ONLY	DATA SOURCE	CONTRACTOR	DATE
	1	5507	29 09 81
	DATE OF INSPECTION	INSPECTOR	
	30/8/81		
OFFICE USE ONLY	REMARKS		

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506-4-77 FORM 7

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

11 2509701 25013 CON 102

COUNTY OR DISTRICT: Grey TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Appleton CON. BLOCK, TRACT, SURVEY, ETC.: D LOT: 37
OWNER (SURNAME FIRST): Dwight Busby ADDRESS: A1051 RR #2 Kemble DATE COMPLETED: 27 37
ZONE: 1 EASTING: 505685 NORTHING: 4949440 ELEVATION: 750 BASIN CODE: II

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)				
GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET
				FROM TO
			limestone	0 28
			blue shale	28 35
			red shale	35 75

31 32

41 WATER RECORD WATER FOUND AT - FEET: <u>28</u> KIND OF WATER: 1 <input checked="" type="checkbox"/> FRESH 3 <input type="checkbox"/> SULPHUR 2 <input type="checkbox"/> SALTY 4 <input type="checkbox"/> MINERALS 6 <input type="checkbox"/> GAS	51 CASING & OPEN HOLE RECORD INSIDE DIAM. INCHES: <u>6 1/4</u> MATERIAL: <u>STEEL</u> WALL THICKNESS INCHES: <u>1.88</u> DEPTH - FEET: <u>0</u> <u>21.8</u> 1 <input type="checkbox"/> STEEL 2 <input type="checkbox"/> GALVANIZED 3 <input type="checkbox"/> CONCRETE 4 <input type="checkbox"/> OPEN HOLE 5 <input type="checkbox"/> PLASTIC 17-18 1 <input type="checkbox"/> STEEL 2 <input type="checkbox"/> GALVANIZED 3 <input type="checkbox"/> CONCRETE 4 <input type="checkbox"/> OPEN HOLE 5 <input type="checkbox"/> PLASTIC 21-8 75 24-25 1 <input type="checkbox"/> STEEL 2 <input type="checkbox"/> GALVANIZED 3 <input type="checkbox"/> CONCRETE 4 <input type="checkbox"/> OPEN HOLE 5 <input type="checkbox"/> PLASTIC	61 PLUGGING & SEALING RECORD DEPTH SET AT - FEET: <u>10-13</u> MATERIAL AND TYPE: <u>CEMENT GROUT</u> FROM TO 10-13 14-17 18-21 22-25 26-28 30-33
--	--	---

71 PUMPING TEST PUMPING TEST METHOD: <u>AIR</u> 1 <input type="checkbox"/> PUMP 2 <input type="checkbox"/> BAILER STATIC LEVEL: <u>20</u> FEET WATER LEVEL END OF PUMPING: <u>75</u> FEET WATER LEVELS DURING: 15 MINUTES: <u>28</u> FEET 30 MINUTES: <u>20</u> FEET 45 MINUTES: <u>20</u> FEET 60 MINUTES: <u>20</u> FEET PUMP INTAKE SET AT: <u>75</u> FEET WATER AT END OF TEST: <u>20</u> FEET RECOMMENDED PUMP TYPE: <u>DEEP</u> RECOMMENDED PUMP SETTING: <u>70</u> FEET RECOMMENDED PUMPING RATE: <u>3</u> GPM	10 PUMPING RATE PUMPING RATE: <u>3</u> GPM 11-14 DURATION OF PUMPING 15-18 HOURS: <u>1</u> 17-18 MINS: <u>1</u>
--	---

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

28206

FINAL STATUS OF WELL 1 <input checked="" type="checkbox"/> WATER SUPPLY 5 <input type="checkbox"/> ABANDONED, INSUFFICIENT SUPPLY 2 <input type="checkbox"/> OBSERVATION WELL 6 <input type="checkbox"/> ABANDONED, POOR QUALITY 3 <input type="checkbox"/> TEST HOLE 7 <input type="checkbox"/> UNFINISHED 4 <input type="checkbox"/> RECHARGE WELL 9 <input type="checkbox"/> DEWATERING	WATER USE 1 <input checked="" type="checkbox"/> DOMESTIC 5 <input type="checkbox"/> COMMERCIAL 2 <input type="checkbox"/> STOCK 6 <input type="checkbox"/> MUNICIPAL 3 <input type="checkbox"/> IRRIGATION 7 <input type="checkbox"/> PUBLIC SUPPLY 4 <input type="checkbox"/> INDUSTRIAL 8 <input type="checkbox"/> COOLING OR AIR CONDITIONING 9 <input type="checkbox"/> NOT USED
METHOD OF CONSTRUCTION 1 <input type="checkbox"/> CABLE TOOL 6 <input type="checkbox"/> BORING 2 <input type="checkbox"/> ROTARY (CONVENTIONAL) 7 <input type="checkbox"/> DIAMOND 3 <input type="checkbox"/> ROTARY (REVERSE) 8 <input type="checkbox"/> JETTING 4 <input type="checkbox"/> ROTARY (AIR) 9 <input type="checkbox"/> DRIVING 5 <input checked="" type="checkbox"/> AIR PERCUSSION 10 <input type="checkbox"/> DIGGING 11 <input type="checkbox"/> OTHER	

CONTRACTOR NAME OF WELL CONTRACTOR: <u>Wm Wright Well Drilling Ltd</u> WELL CONTRACTOR'S LICENCE NUMBER: <u>5507</u> ADDRESS: <u>Box 167, Huronville Ont</u> NAME OF WELL TECHNICIAN: <u>Wm Wright</u> WELL TECHNICIAN'S LICENCE NUMBER: <u>7-0140</u> SIGNATURE OF TECHNICIAN/CONTRACTOR: <u>Wm Wright</u> SUBMISSION DATE: <u>DAY</u> <u>MO</u> <u>YR</u>

OFFICE USE ONLY DATA SOURCE: <u>5507</u> DATE OF INSPECTION: <u>NOV 03 1988</u> REMARKS: <u>CSSS</u>	CONTRACTOR CONTRACTOR: <u>5507</u> DATE RECEIVED: <u>NOV 03 1988</u>
--	---

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 1/10th 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

RR#/Street Number/Name

City/Town/Village

Site/Compartment/Block/Tract etc.		
-----------------------------------	--	--

GPS Reading

NAD

Zone

Eastino

Northrup

Unit Make/Model

Mode of Operation:

P 16 x 3 1/2 in

Handwritten signature: *[Signature]*

Log of Overburden and Bedrock Materials (see instructions)

[illegible]

Hole Diameter			Construction Record				Test of Well Yield			
Depth	From	To	Inside diam	Material	Wall thickness	Depth	Pumping test method	Draw Down	Recovery	
metres	metres	metres	centimetres		centimetres	metres		Time min	Water Level metres	
0	20	10"					AIR			
20	114	6"					Pump intake set at (metres)	Static Level		
							114	19		
							Pumping rate - (litres/min)			
							4	1		
							Duration of pumping			
							1 hrs + min	2		
							Final water level end of pumping			
							114	3		
							Recommended pump type.			
							<input type="checkbox"/> Shallow <input checked="" type="checkbox"/> Deep			
							Recommended pump depth.			
							105	5		
							Recommended pump rate.			
							13	10		
							If flowing give rate - (litres/min)			
							20	20		
							25	25		
							If pumping discontinued, give reason.			
							30	30	68	
							40	40	47	
							50	50	32	
							60	60	34	

Construction Record			
Inside diam	Material	Wall thickness	Depth
centimetres		centimetres	metres
From			To
Casing			
6 1/4	<input checked="" type="checkbox"/> Steel <input type="checkbox"/> Fibreglass	188	4 20
	<input type="checkbox"/> Plastic <input type="checkbox"/> Concrete		
	<input type="checkbox"/> Galvanized		
	<input type="checkbox"/> Steel <input type="checkbox"/> Fibreglass		
	<input type="checkbox"/> Plastic <input type="checkbox"/> Concrete		
	<input type="checkbox"/> Galvanized		
	<input type="checkbox"/> Steel <input type="checkbox"/> Fibreglass		
	<input type="checkbox"/> Plastic <input type="checkbox"/> Concrete		
	<input type="checkbox"/> Galvanized		
Screen			
Outside diam	<input type="checkbox"/> Steel <input type="checkbox"/> Fibreglass	Slot No.	
	<input type="checkbox"/> Plastic <input type="checkbox"/> Concrete		
	<input type="checkbox"/> Galvanized		
No Casing or Screen			
	<input checked="" type="checkbox"/> Open hole	20	114

Plugging and Sealing Record		<input checked="" type="checkbox"/> Annular space	<input type="checkbox"/> Abandonment
Depth set at - Metres		Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
From	To		
0	20	bentonite	

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

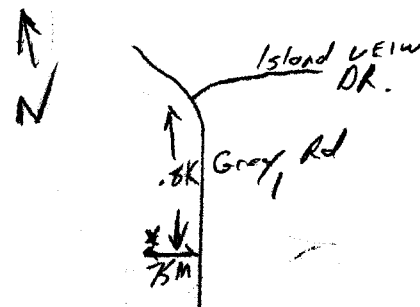
Water Use			
<input type="checkbox"/> Domestic	<input type="checkbox"/> Industrial	<input type="checkbox"/> Public Supply	<input type="checkbox"/> Other
<input type="checkbox"/> Stock	<input type="checkbox"/> Commercial	<input type="checkbox"/> Not used	
<input type="checkbox"/> Irrigation	<input type="checkbox"/>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

Final Status of Well			
<input checked="" type="checkbox"/> Water Supply	<input type="checkbox"/> Recharge well	<input type="checkbox"/> Unfinished	<input type="checkbox"/> Abandoned, (Other) _____
<input type="checkbox"/> Observation well	<input type="checkbox"/> Abandoned, insufficient supply	<input type="checkbox"/> Dewatering	
<input type="checkbox"/> Test Hole	<input type="checkbox"/> Abandoned, poor quality	<input type="checkbox"/> Replacement well	

Well Contractor/Technician Information			
Name of Well Contractor		Well Contractor's Licence No.	
L. J. & L. J. Well Drilling Ltd		5307	
Business Address (street name, number, city etc.)			
Box 167 Sherwood Ont			
Name of Well Technician (last name, first name)		Well Technician's Licence No.	
David Wright		T-0140	
Signature of Technician/Contractor		Date Submitted	
X [Signature]		<div> <div>YYYY</div> <div>MM</div> <div>DD</div> </div>	

Location of Well

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



Audit No.	z 41662	Date Well Completed	YYYY	MM	DD
			06	05	10
Was the well owner's information package delivered?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Date Delivered	YYYY	MM	DD

Ministry Use Only			
Data Source		Contractor	
		5507	
Date Received	YYYY	MM	DD
SEP 07	2006		
Remarks		Well Record Number	

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Map: Well records

This map allows you to search and view well record information from reported wells in Ontario.
Full dataset is available in the [Open Data catalogue](#).

Recommended for you

[How to use a Ministry of the Environment map](#)
[Technical documentation: Metadata record](#)

Go Back to Map

Well ID

Well ID Number: 2516844
Well Audit Number: Z40987
Well Tag Number: A012744

This table contains information from the original well record and any subsequent updates.

Well Location

Address of Well Location	R.R.2
Township	SARAWAK TOWNSHIP
Lot	
Concession	
County/District/Municipality	GREY
City/Town/Village	KENBLE
Province	ON
Postal Code	n/a
UTM Coordinates	NAD83 — Zone 17
	Easting: 505619
	Northing: 4948981
Municipal Plan and Sublot Number	
Other	

Overburden and Bedrock Materials Interval

General Colour	Most Common Material	Other Materials	General Description	Depth From	Depth To
	LMSN			0 m	10.36 m
GREY	SHLE			10.36 m	11.89 m
RED	SHLE			11.89 m	18.29 m
RED	SHLE	LYRD		18.29 m	25.91 m

Annular Space/Abandonment Sealing Record

Depth From	Depth To	Type of Sealant Used (Material and Type)	Volume Placed
0 m	10.36 m	QUICK GEL	

Method of Construction & Well Use

Method of Construction	Well Use
Cable Tool	Domestic

Status of Well

Water Supply

Construction Record - Casing

Inside Diameter	Open Hole or material	Depth From	Depth To
15.87 cm	STEEL	0 m	10.67 m
	OPEN HOLE	10.67 m	25.91 m

Construction Record - Screen

Outside Diameter	Material	Depth From	Depth To
------------------	----------	------------	----------

Well Contractor and Well Technician Information

Well Contractor's Licence Number: 1565

Results of Well Yield Testing

After test of well yield, water was	CLEAR
If pumping discontinued, give reason	
Pump intake set at	20.73 m
Pumping Rate	22.75 LPM
Duration of Pumping	18 h:0 m
Final water level	10.71 m
If flowing give rate	
Recommended pump depth	22.86 m

Recommended pump rate	22.75 LPM
Well Production	PUMP
Disinfected?	Y

Draw Down & Recovery

Draw Down Time(min)	Draw Down Water level	Recovery Time(min)	Recovery Water level
SWL	7.77 m		
1	8.69 m	1	9.14 m
2	8.84 m	2	8.84 m
3	8.94 m	3	8.84 m
4	9.04 m	4	8.84 m
5	9.07 m	5	8.84 m
10	9.14 m	10	8.69 m
15	9.17 m	15	8.64 m
20	9.19 m	20	8.64 m
25	9.22 m	25	8.58 m
30	9.25 m	30	8.58 m
40	9.3 m	40	8.38 m
45		45	
50	9.32 m	50	8.38 m
60	9.32 m	60	8.28 m

Water Details

Water Found at Depth	Kind
22.86 m	Fresh

Hole Diameter

Depth From	Depth To	Diameter
0 m	10.36 m	20.32 cm
10.36 m	25.91 m	15.87 cm

Audit Number: Z40987

Date Well Completed: May 30, 2006

Date Well Record Received by MOE: July 18, 2006

Updated: March 20, 2017

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Tags

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[Glen Murray](#)

Minister of the Environment and Climate Change

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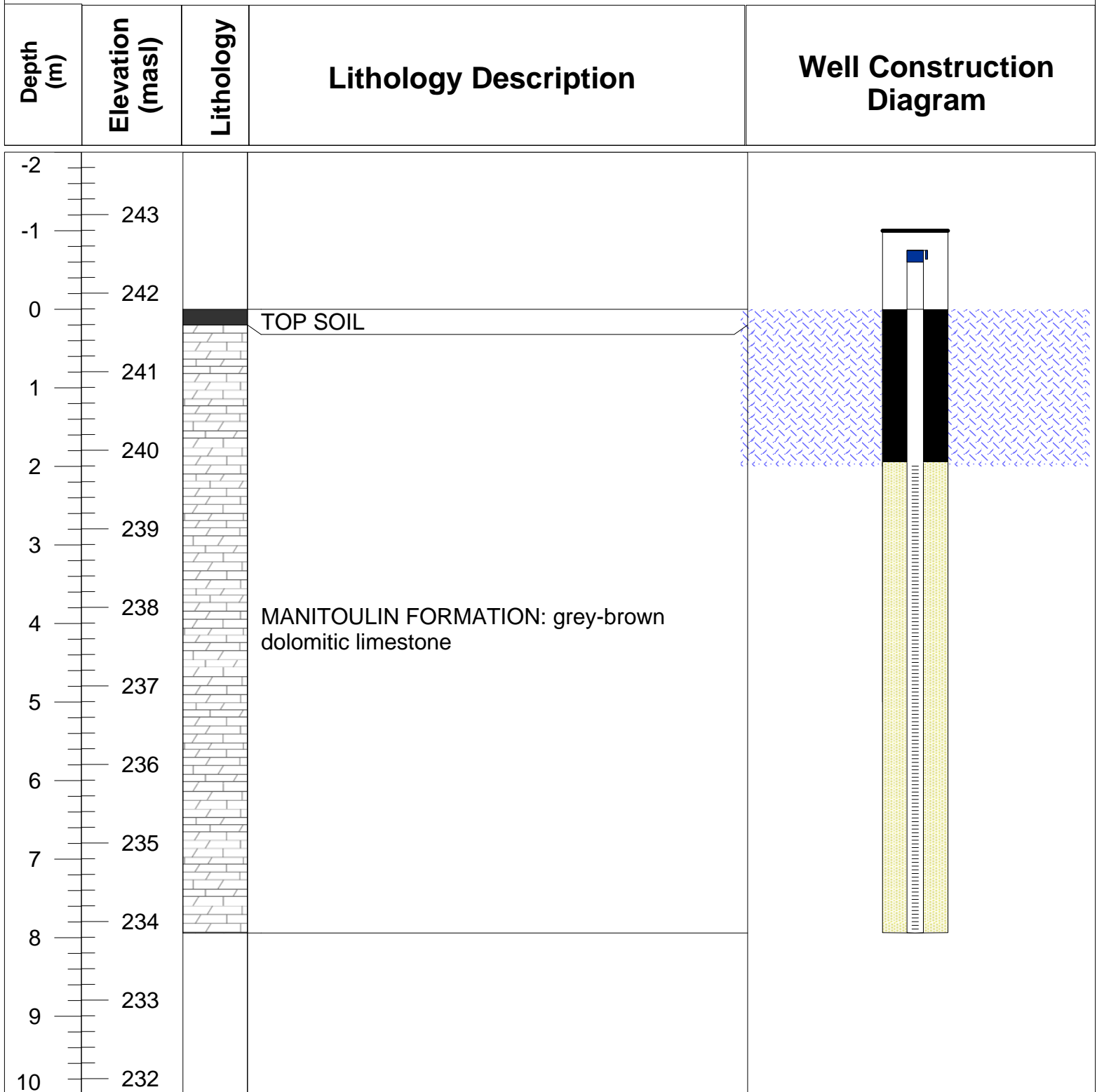
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- [Business and economy](#)
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- [Education and training](#)
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APPENDIX B
SITE BOREHOLE RECORDS



Drilling Date: May-16

Drilling Company: Keith Lang Drilling

Geologist: Tecia White

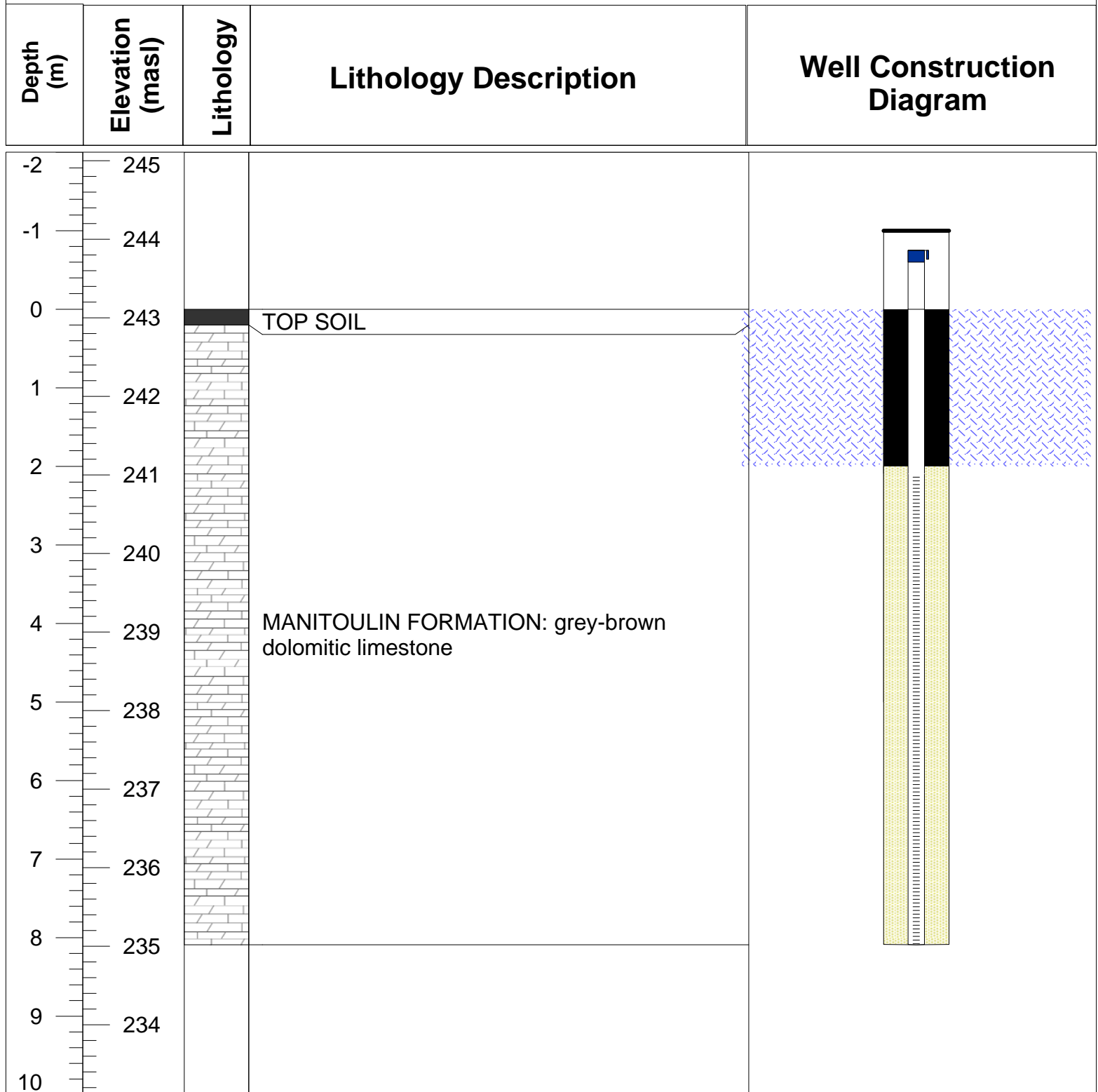
Location: Township of Georgian Bluffs

Easting: 505,479

Northing: 4,949,385



Harold
Sutherland
CONSTRUCTION



Drilling Date: May-16

Drilling Company: Keith Lang Drilling

Geologist: Tecia White

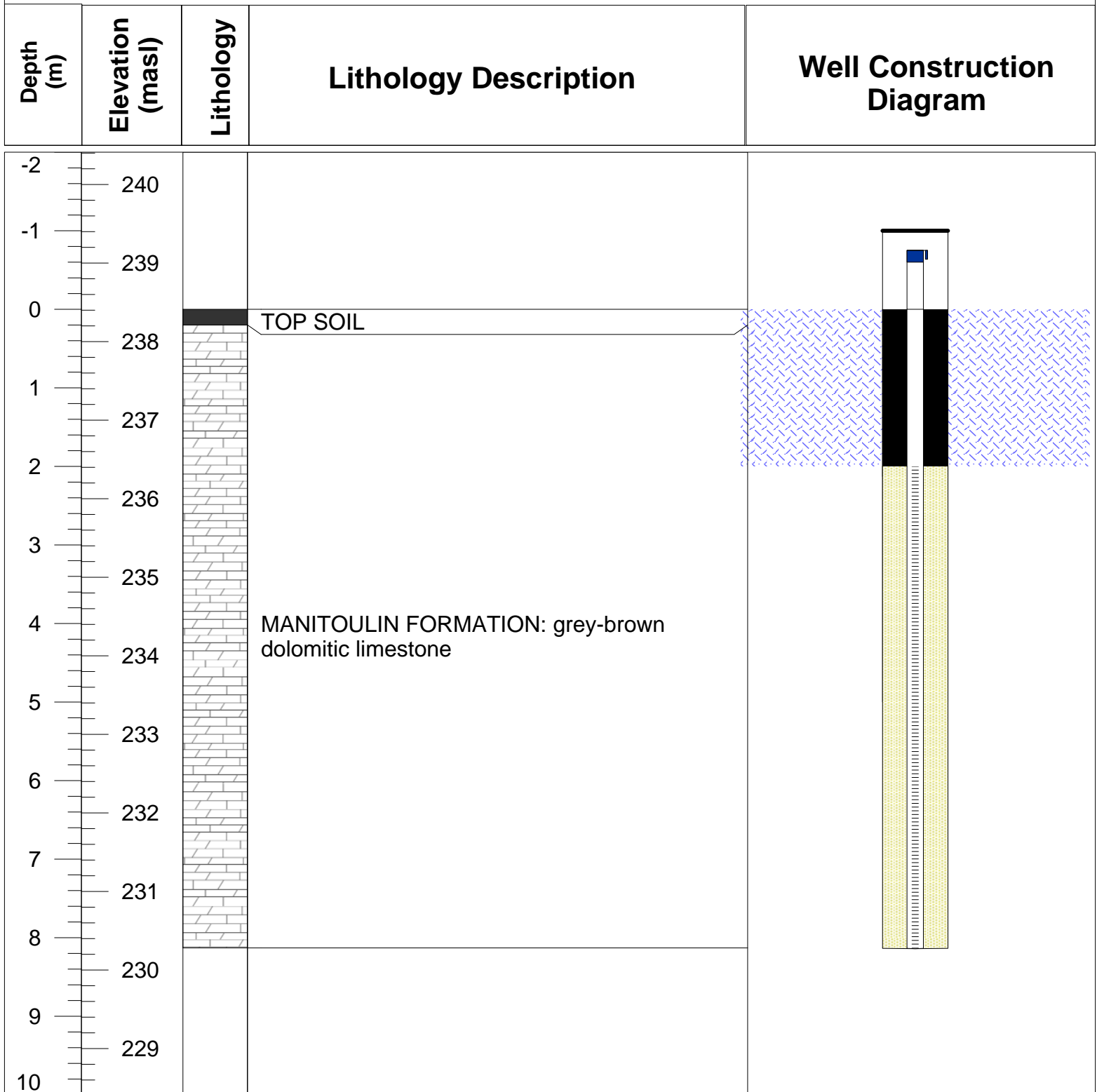
Location: Township of Georgian Bluffs

Easting: 505,502

Northing: 4,949,785



Harold
Sutherland
CONSTRUCTION



Drilling Date: May-16

Drilling Company: Keith Lang Drilling

Geologist: Tecia White

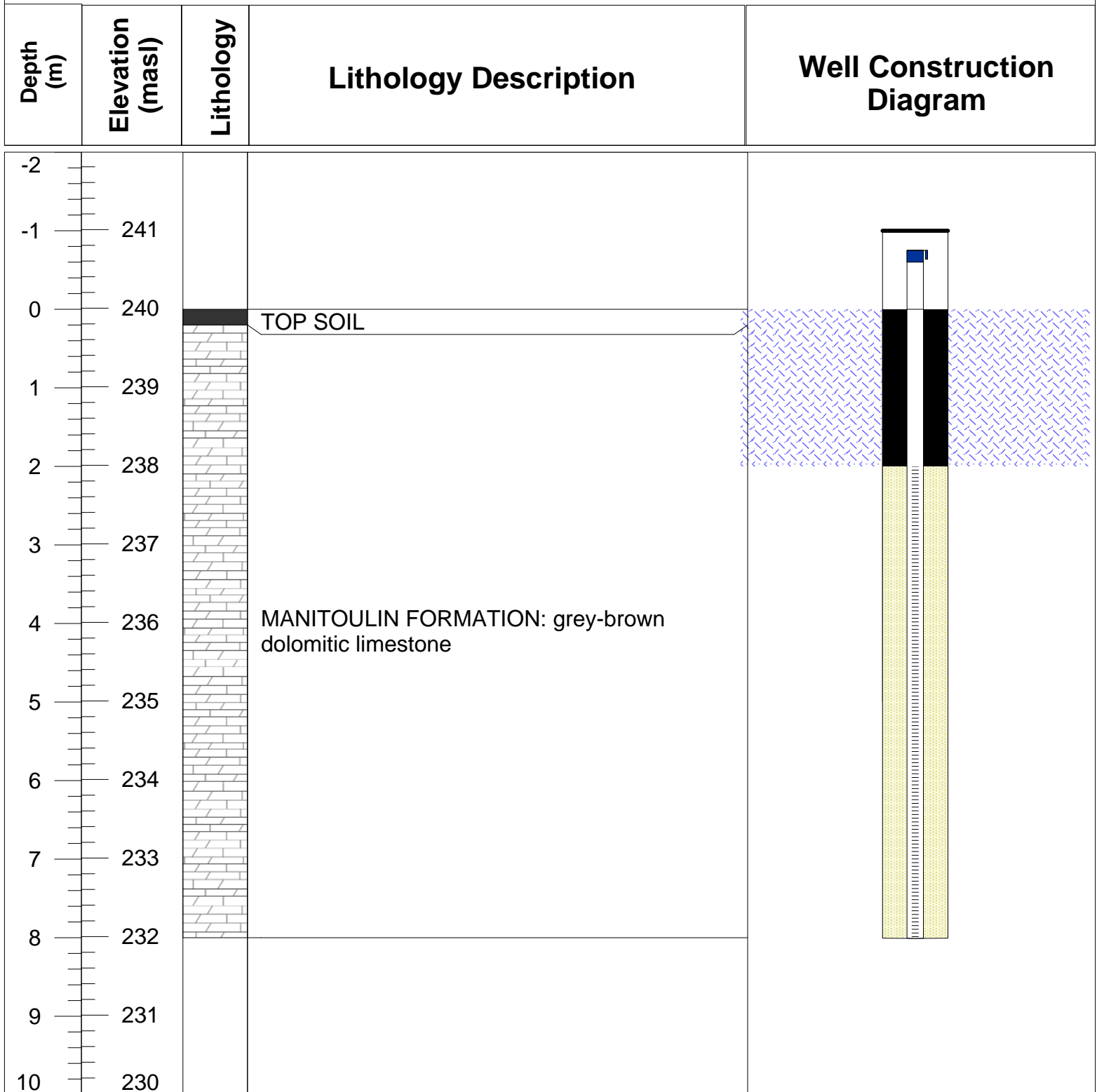
Location: Township of Georgian Bluffs

Easting: 505,033

Northing: 4,949,490



Harold
Sutherland
CONSTRUCTION



Drilling Date: May-16

Drilling Company: Keith Lang Drilling

Geologist: Tecia White

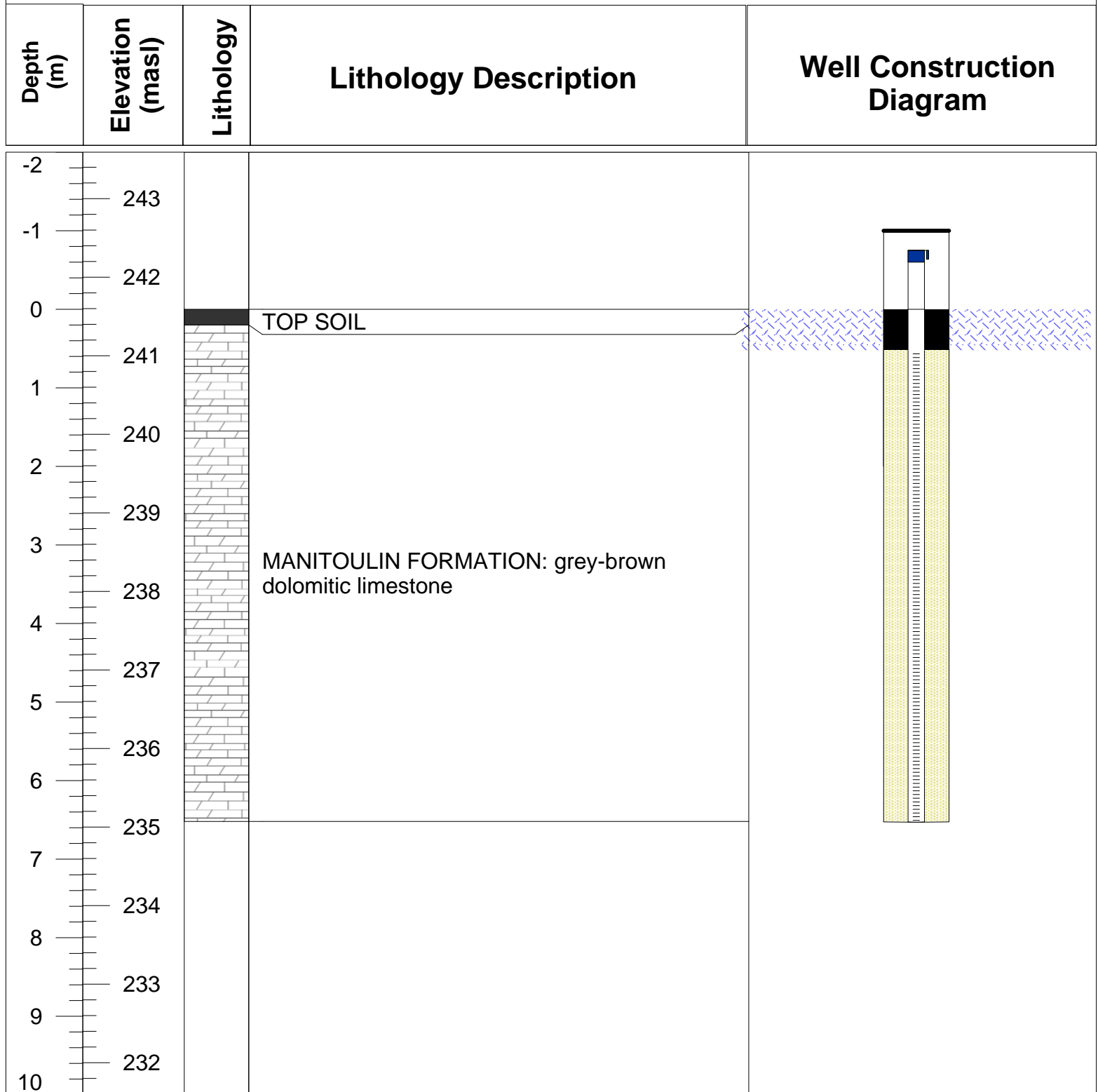
Location: Township of Georgian Bluffs

Easting: 505,236

Northing: 4,949,257



Harold
Sutherland
CONSTRUCTION



Drilling Date: Oct-16

Drilling Company: Keith Lang Drilling

Geologist: Tecia White

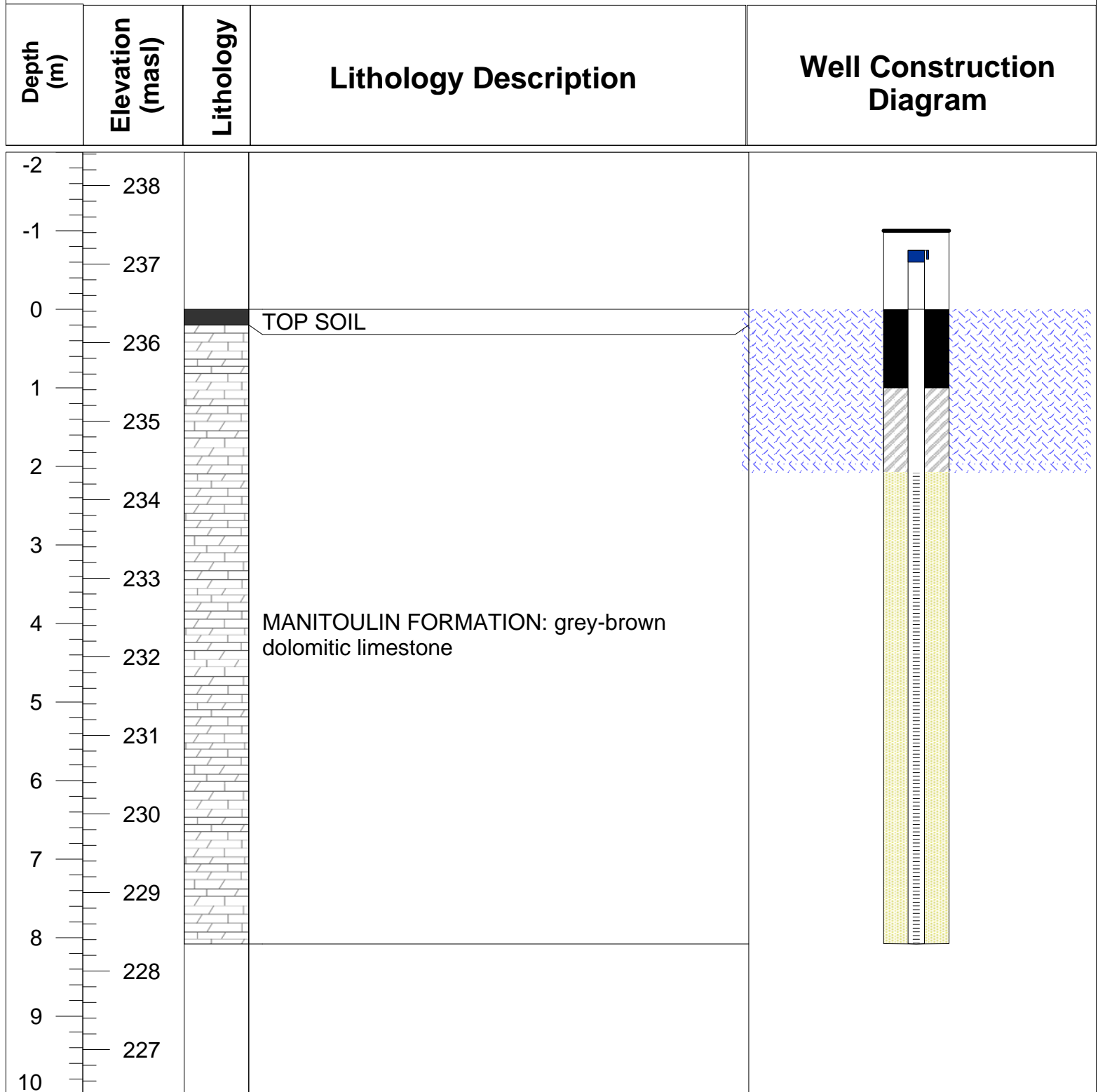
Location: Township of Georgian Bluffs

Easting: 505,477

Northing: 4,949,213



Harold
Sutherland
CONSTRUCTION



Drilling Date: May-16

Drilling Company: Keith Lang Drilling

Geologist: Tecia White

Location: Township of Georgian Bluffs

Easting: 504,823

Northing: 4,949,179



Harold
Sutherland
CONSTRUCTION

APPENDIX C

WATER QUALITY RESULTS

**TESTMARK Laboratories Ltd.***Committed to Quality and Service***CERTIFICATE OF ANALYSIS - REVISED**

Client: Tecia White
Company: Whitewater Hydrogeology Ltd.
Address: 80 Chamberlain Cres
Collingwood, Ontario, L9Y 0C8
Phone: (705) 888-7064
Email: tecia@white-water.ca

Work Order Number: 289760
PO #:
Regulation: ODWS
Project #: Sarawak Quarry Construction
DWS #:
Sampled By:

Date Order Received: 11/8/2016
Arrival Temperature: 16.8 °C

Analysis Started: 11/8/2016
Analysis Completed: 11/16/2016

WORK ORDER SUMMARY

ANALYSES WERE PERFORMED ON THE FOLLOWING SAMPLES. THE RESULTS RELATE ONLY TO THE ITEMS TESTED.

Sample Description	Lab ID	Matrix	Type	Comments	Date Collected	Time Collected
Sarawak 1	827033	Ground Water	None	SAMPLE CONTAINED RESULT EXCEEDENCES.	11/5/2016	9:00 AM
Sarawak 2	827034	Ground Water	None	SAMPLE CONTAINED RESULT EXCEEDENCES.	11/5/2016	9:15 AM
Sarawak 3	827035	Ground Water	None	SAMPLE CONTAINED RESULT EXCEEDENCES.	11/5/2016	10:00 AM
Sarawak 4	827036	Ground Water	None	SAMPLE CONTAINED RESULT EXCEEDENCES.	11/5/2016	11:00 AM

METHODS AND INSTRUMENTATION

THE FOLLOWING METHODS WERE USED FOR YOUR SAMPLE(S):

Method	Lab	Description	Reference
ICPMS Water (A13.1)	Mississauga	Determination of Metals in Water by ICP/MS	Modified from SW846-6020
T01-Alkalinity	Mississauga	Determination of Alkalinity in Water	Modified from APHA-2320
T02-pH Water	Mississauga	Determination of pH in Water	Modified from APHA-4500-H+B
T05-Anions Water	Mississauga	Determination of Anions by Ion Chromatography	Modified from SW846-9056
T12-Cond Water	Mississauga	Determination of Conductivity in Water	Modified from APHA-2510
T13-Hardness (T13.1)	Mississauga	Determination of Total Hardness	Modified from APHA-2340B
T13-ICPMS Dis Water (T13.3)	Mississauga	Determination of Dissolved (Field Filtered) Metals in Water by ICP/MS	Modified from SW846-6020
T94-Carbonate	Mississauga	Determination of Carbonate and Bi-Carbonate	Based on APHA-2330



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CERTIFICATE OF ANALYSIS - REVISED

Whitewater Hydrogeology Ltd.

Work Order Number: 289760

This report has been approved by:

Nancy Yin, Ph.D.
Laboratory Director



CERTIFICATE OF ANALYSIS - REVISED

Whitewater Hydrogeology Ltd.

Work Order Number: 289760

WORK ORDER RESULTS

Sample Description	Sarawak 1		Sarawak 2		Sarawak 3		Sarawak 4		Units	Criteria: ODWS
Lab ID	827033		827034		827035		827036			
Anions	Result	MDL	Result	MDL	Result	MDL	Result	MDL		
Chloride	13.6	0.05	52.1	0.05	14.9	0.05	30.8	0.05	mg/L	250
Nitrate (as N)	<0.05	0.05	0.62	0.05	0.7	0.05	<0.05	0.05	mg/L	10
Nitrite (as N)	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	mg/L	1
Sulphate	134	0.05	102	0.05	74.1	0.05	263	0.5	mg/L	500

Sample Description	Sarawak 1		Sarawak 2		Sarawak 3		Sarawak 4		Units	Criteria: ODWS
Lab ID	827033		827034		827035		827036			
General Chemistry	Result	MDL	Result	MDL	Result	MDL	Result	MDL		
Bicarbonate (Calc.)	9.1	1	659	1	407	1	331	1	mg/L	~
Carbonate (Calc.)	<1	1	5.3	1	3.2	1	2	1	mg/L	~
Conductivity	1072	1	900.4	1	662	1	553.1	1	µS/cm	~
M-Alkalinity (pH 4.5)	9.1	2	664	2	410	2	333	2	mg/L as CaCO3	~
pH	6.41	N/A	7.93	N/A	7.92	N/A	7.84	N/A	pH	~
Total Hardness (as CaCO3) (Calc.)	362	0.1	323	0.1	1870	0.1	265	0.1	mg/L	100

Sample Description	Sarawak 1		Sarawak 2		Sarawak 3		Sarawak 4		Units	Criteria: ODWS
Lab ID	827033		827034		827035		827036			
Metals	Result	MDL	Result	MDL	Result	MDL	Result	MDL		
Calcium	87200	500	65500	500	505000	500	66100 [65200]	50	ug/L	~
Magnesium	35000	4	38700	4	147000	40	24200 [24200]	4	ug/L	~
Potassium	4950	1	11400	10	5160	1	11200 [11100]	1	ug/L	~
Sodium	8470	1	40200	1	3920	1	8000 [8080]	1	ug/L	20000



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Sample Description	Sarawak 1		Sarawak 2		Sarawak 3		Sarawak 4		Units	Criteria: ODWS
Lab ID	827033		827034		827035		827036			
Metals (Dissolved - Field Filtered)	Result	MDL	Result	MDL	Result	MDL	Result	MDL		
Dissolved Aluminum	9	2	35.5	2	<2	2	<2 [<2]	2	ug/L	~
Dissolved Antimony	<0.5	0.5	3.9	0.5	0.8	0.5	<0.5 [<0.5]	0.5	ug/L	~
Dissolved Arsenic	7.3	1	4.5	1	<1	1	1 [<1]	1	ug/L	~
Dissolved Barium	83.9	1	107	1	78.1	1	59.6 [60.9]	1	ug/L	~
Dissolved Beryllium	<0.5	0.5	<0.5	0.5	<0.5	0.5	<0.5 [<0.5]	0.5	ug/L	~
Dissolved Bismuth	<1	1	<1	1	<1	1	<1 [<1]	1	ug/L	~
Dissolved Boron	206	2	229	2	111	2	842 [866]	2	ug/L	~
Dissolved Cadmium	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1 [<0.1]	0.1	ug/L	~
Dissolved Calcium	84400	500	67400	50	64500	500	70700 [73000]	50	ug/L	~
Dissolved Chromium	3	1	2	1	2	1	2 [2]	1	ug/L	~
Dissolved Cobalt	3.15	0.1	1.17	0.1	0.85	0.1	2.12 [2.13]	0.1	ug/L	~
Dissolved Copper	<1	1	2	1	2	1	<1 [<1]	1	ug/L	~
Dissolved Iron	970	200	130	20	130	20	190 [190]	20	ug/L	~
Dissolved Lanthanum	2	1	2	1	2	1	2 [2]	1	ug/L	~
Dissolved Lead	<1	1	<1	1	<1	1	<1 [<1]	1	ug/L	~
Dissolved Lithium	<5	5	<5	5	<5	5	7 [7]	5	ug/L	~
Dissolved Magnesium	42300	4	40600	4	33100	4	28500 [28900]	4	ug/L	~
Dissolved Manganese	598	10	73.9	1	63.2	1	339 [329]	10	ug/L	~
Dissolved Mercury	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1 [<0.1]	0.1	ug/L	~



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Sample Description	Sarawak 1		Sarawak 2		Sarawak 3		Sarawak 4		Units	Criteria: ODWS
Lab ID	827033		827034		827035		827036			
Metals (Dissolved - Field Filtered)	Result	MDL	Result	MDL	Result	MDL	Result	MDL		
Dissolved Molybdenum	12.9	1	180	10	18	1	6.7 [6.5]	1	ug/L	~
Dissolved Nickel	3	1	12.7	1	2	1	3 [3]	1	ug/L	~
Dissolved Potassium	5320	100	9750	100	4560	100	12900 [12400]	1000	ug/L	~
Dissolved Selenium	<1	1	<1	1	<1	1	<1 [<1]	1	ug/L	~
Dissolved Silver	<0.1	0.1	<0.1	0.1	0.32	0.1	<0.1 [<0.1]	0.1	ug/L	~
Dissolved Sodium	9270	100	42200	100	6430	100	15200 [15300]	100	ug/L	~
Dissolved Strontium	522	1	542	1	659	1	616 [599]	1	ug/L	~
Dissolved Sulfur	39700	800	33800	800	21200	800	23500 [24300]	800	ug/L	~
Dissolved Thallium	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1 [<0.1]	0.1	ug/L	~
Dissolved Thorium	<1	1	<1	1	<1	1	<1 [<1]	1	ug/L	~
Dissolved Tin	1	1	<1	1	<1	1	<1 [<1]	1	ug/L	~
Dissolved Titanium	1	1	<1	1	<1	1	<1 [<1]	1	ug/L	~
Dissolved Tungsten	3	1	3	1	1	1	1 [1]	1	ug/L	~
Dissolved Uranium	6.3	1	3.8	1	3.5	1	5.3 [5.3]	1	ug/L	~
Dissolved Vanadium	1	1	2	1	<1	1	<1 [<1]	1	ug/L	~
Dissolved Zinc	3	1	10.8	1	5.6	1	8 [7.9]	1	ug/L	~



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LEGEND

Dates: Dates are formatted as mm/dd/year throughout this report.

MDL: Method detection limit or minimum reporting limit.

[]: Results for laboratory replicates are shown in square brackets immediately below the associated sample result for ease of comparison.

~: In a criteria column indicates the criteria is not applicable for the parameter row..

Quality Control: All associated Quality Control data is available on request.