Hydrogeological Assessment – Final

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Township of McNab-Braeside

Project Ref. 08360

July 2012

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

a) Preface

The hydrogeological investigations and reports completed for the Braeside Quarry Expansion in 2007 through to 2010 were produced by Jennifer B. Gorrell, M.Sc. P.Eng. P.Geo. and George A. Gorrell, M.Sc. P.Geo. F.G.A.C. operating under the name of Gorrell Resource Investigations (GRI). GRI ceased operations in 2010. Jennifer Gorrell and George Gorrell are now providing hydrogeological services for the Miller Braeside Quarry as employees of BGC Engineering Inc.. BGC Engineering Inc. was not involved from the initial stages of the hydrogeological investigation or reporting. Therefore, the final hydrogeological report in 2012 will be signed by Jennifer B. Gorrell, M.Sc. P.Eng. P.Geo., with Appendix A signed by George A. Gorrell, M.Sc. P.Geo. F.G.A.C. as sole practitioners and members of the Association of Professional Geoscientists of Ontario.

b) Report Version

The hydrogeological report has undergone revisions to incorporate additional work that was conducted on the site and to address questions and issues raised by Golder Associates Inc. who were retained as peer reviewers by the County of Renfrew. The report presented here supersedes previous versions dated from 2007 to 2012 that have been presented for peer review.

c) Document Structure

The document is divided into two parts.

The purpose of Part 1 was to summarize the site data collected in several field investigations and to present a consolidated analysis and interpretation. The key points of interest addressed specific items described in the Provincial Standards, the document which indicates the items that must be addressed in support of an application under the ARA. The summary report was prepared for, and reviewed and accepted by Golder with the agreed-upon changes.

Part 2 contains the conclusions and recommendations of the hydrogeological investigations and presents the author’s signatures and certification. The section also discusses the peer review process that was undertaken, which guided some of the components that were undertaken for the study. In addition, Appendix A is key to the site information, as it contains details on the field testing and historic data collected from the site from 2002 to 2009.

Appendix A includes supplementary information that was compiled for the properties that was used as the base information for the hydrogeological interpretations, opinions, results and conclusions summarized in Part 1. Appendix A provides the details on the field investigations, field methods and includes the data base of site information related to geology and hydrogeology that was acquired in the study. The information was extracted from GRI (2009). The information provided in Appendix A supersedes the November 2009 report, as it incorporates comments from the Golder peer review.

References, Photographs and Appendixes follow Part 2.

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

Note: Directional references on the property and adjacent areas refer to a site north; the relationship between site north and geographical north is shown on Figure 2. Golf Club Road is considered the site north boundary for the purpose of this project.

Appendix B provides an introduction to fundamentals of hydrogeology to assist lay readers with understanding of terms, definitions and basic concepts.

Appendix C contains the well records and borehole logs for the test wells in the study.

d) Limitations

Jennifer B. Gorrell M.Sc. P.Eng. P.Geo. (formerly operating as Gorrell Resource Investigations) prepared this report (the "Report") for the account of Miller Paving Limited (the Client). The material in the Report reflects the judgment of Jennifer B. Gorrell M.Sc. P.Eng. P.Geo. based upon the information made available to her at the time of preparation of the Report, including that information provided to her by the Client and consulting team members. Any use which a third party makes of this Report or any reliance on decisions to be based on it is the responsibility of such third parties. Jennifer B. Gorrell M.Sc. P.Eng. P.Geo. accepts no responsibility whatsoever for damages, loss, expenses, loss of profit or revenues, if any, suffered by any third party as a result of decisions made or actions based on this Report.

As a mutual protection of our Client, the public and Jennifer B. Gorrell M.Sc. P.Eng. P.Geo., the Report, and its drawings are submitted to the Client as confidential information of our Client for a specific project. Authorization for any use and/or publication of the Report or any data, statements, conclusions or abstracts from or regarding the Report and its drawings, through any form of print or electronic media, including without limitation, posting or reproductions of same on any website, is reserved by Jennifer B. Gorrell M.Sc. P.Eng. P.Geo., and is subject to Jennifer B. Gorrell M.Sc. P.Eng. P.Geo. 's prior written approval. Provided however, if the Report is prepared for the purposes of inclusion in an application for a specific permit or other government process, as specifically set forth in the Report, then the applicable regulatory, municipal, or other governmental authority may use the Report only for the specific and identified purpose of the specific permit application or other government process as identified in the Report. If the Report or any portion or extracts thereof is/are issued in electronic format, the original copy of the Report retained by Jennifer B. Gorrell M.Sc. P.Eng. P.Geo. will be regarded as the only copy to be relied on for any purpose and will take precedence over any electronic copy of the Report, or any portion or extracts thereof which may be used or published by others in accordance with the terms of this disclaimer.

Table of Contents

Part 1 – Summary Report

Part 2 - Conclusions and Recommendations

List of Tables

List of Figures

List of Appendices

Part 1 – Summary Report

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Township of McNab-Braeside

Project Ref. 08360

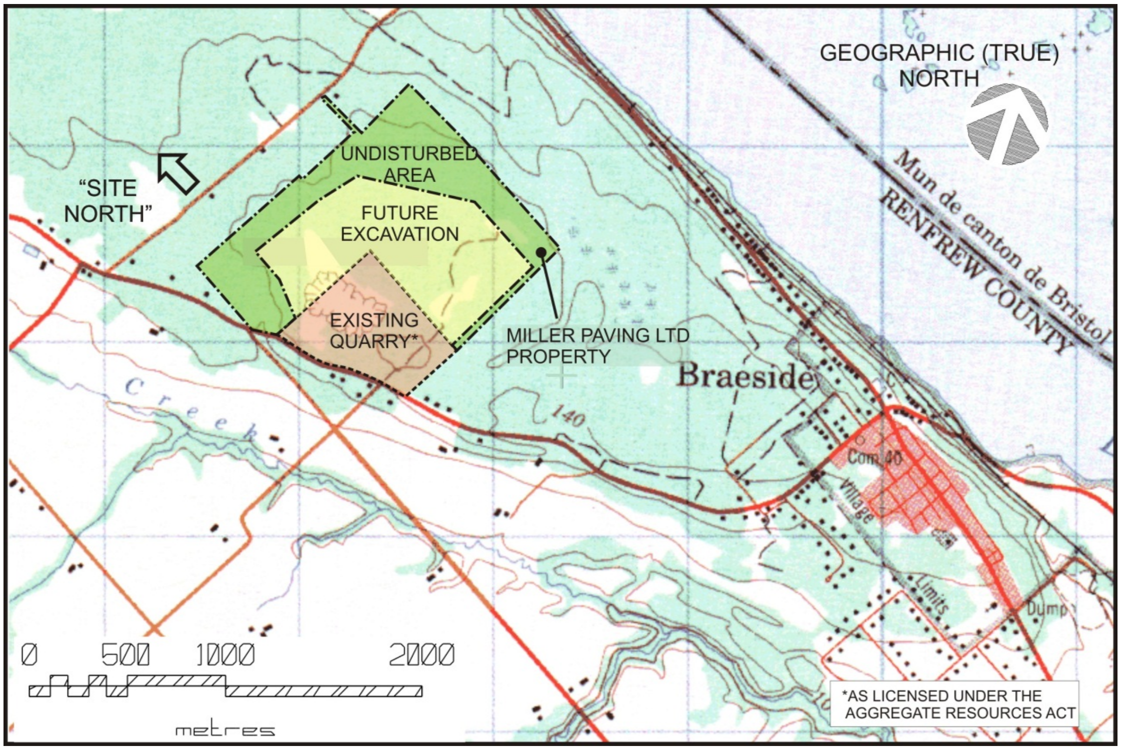
July 2012

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

1 Hydrogeological Assessment- Part 1 – Summary Report

Miller Paving Ltd. (Miller) owns property located on Part of Lots 16 and 17, Concession A, Township of McNab-Braeside (Geographic Township of McNab), Renfrew County. Miller's land holdings, referred to in this document as the Site, or the Braeside Quarry, is shown on Figure 1. As indicated on Figure 1, part of the property is licensed under the Aggregate Resources Act (ARA), ARA License # 16173, to operate a quarry which is currently permitted to extract and process the bedrock reserves, and to operate portable asphalt production and concrete production plants. The existing quarry removes accumulations of water from the quarry under approvals from the Ontario Water Resources Act; Permit to Take Water # 0035-6T8HMJ (PTTW) allows water to be pumped from the excavation at rates greater than 50,000 L/day and Certificate of Approval for Industrial Waste Water Treatment # 6988-6VZJFB allows for the discharge of the pumped water into the off-site surface water receiver.

Figure 1: Miller Paving Limited Braeside Quarry and Proposed Expansion



Jennifer B. Gorrell, M.Sc. P.Eng. P.Geo. (J. Gorrell) was retained by Miller through their subsidiary company Smith's Construction Ltd. and subsequently directly, to conduct hydrogeological investigations at the site. Investigations at the existing quarry were conducted in 2002. Subsequently, the author was retained to investigate the hydrogeological setting of the proposed quarry expansion area and to provide recommendations for development of the expansion area, identify potential impacts of the proposed expanded quarry and to provide recommendations for mitigation if necessary. Reports prepared by Gorrell Resource Investigations (2002, 2007, 2009 and 2010) are listed in the report

Reference section. The supporting field work and data analysis were summarized in a separate report by George A. Gorrell M.Sc. P.Geo. F.G.A.C. (G. Gorrell) and included as Appendix A.

1.1 Study Method

The Miller property was investigated through the construction of 21 test wells drilled using rotary percussion and diamond drill methods. Eleven wells were constructed as sentry wells around the perimeter of the site. The wells were pump tested and are used for groundwater elevation monitoring. Packer tests were conducted on the cored holes, piezometers were installed and rising head hydraulic conductivity tests were completed.

The geology and surface water patterns and features were mapped in detail. Groundwater and surface water samples were taken for groundwater characterization.

A door-to-door survey was conducted to collect available information on neighbouring groundwater use. Interested residents were interviewed, a water sample was taken for general groundwater characteristics and where possible the wells were examined and a water level measured. Thirty eight of 53 residents contacted participated in the survey.

1.2 Site Setting

The existing excavation has been in operation since the 1950s and is currently 17.1 ha with an average depth of 12 to 15 meters or 135 to 138 m above sea level (ASL) with a licensed quarry base of 125 m ASL. The proposed expansion area bounds an existing active quarry on two sides. The proposed expansion area is 103.0 ha with a proposed extraction area of 68.4 ha. The remainder of the licensed property will remain in setbacks that include planning setbacks, operational setbacks, a significant wildlife protection area and a wildlife corridor. The proposed licensed base of the quarry is also 125 m ASL.

The Miller properties are set on the Braeside Plateau that ranges in elevation from 154 m ASL down to 81 m ASL. Area land uses include rural residential, agricultural and recreational activities.

1.3 Geology

The crown and upper margins of the upland are veneered with unconsolidated sediment found as variously sized hummocky hills and long linear ridges. Most of the largest ridges on the Miller property were excavated between 1950 and 1970, and only remnants are found. The bedrock of the upland consists of the lower Bobcaygeon and Gull River Formations. A K-bentonite layer that has been correlated to a widespread volcanic eruption in the middle Ordovician period was found in the vicinity of the formational contact. The Gull River Formation below the contact is on the order of 10 m thick and extends to the base of the upland on the south-west side of the property. The lower bedrock along the Ottawa River side has been identified as the Rockcliffe Formation in regional mapping.

The weathered zone developed on both the flanks of the plateau. On the west side of the Miller property, the upper surface is weathered primarily on the west to south-west side. The existing quarry is completely within a part of the properties where the weathered bedrock zone occurs. In the quarry, fractures extend from the surface to the contact between the Bobcaygeon Formation down to, but no lower than the contact with the Gull River Formation. The proposed extraction area will intercept the weathered bedrock zone primarily on the west side of the property, as illustrated in Figure 2 and in cross section in Appendix A, Figure 3.

1.4 Hydrogeology and Site Hydrology

The topography and competent and weathered geology combine to create an interconnected surface water – shallow groundwater flow system on the plateau and surrounding area that includes runoff, surface water accumulations on upper competent bedrock areas and two levels of springs on the both the east and west side of the upland escarpment faces. Surface water drains into the dissolution fractures and flows below surface to emerge at the base of the dissolution as springs at two distinct levels. Two local wetlands that were identified in the study have developed on upper competent bedrock on or near the Miller property.

A regional analysis of water well records indicates that regional groundwater flows from the plateau to the east and west. Analysis of water well records show that recorded water-bearing zones are generally below the proposed base of the quarry. There were three potential aquifers identified; an overburden aquifer, a weathered bedrock aquifer and a competent bedrock aquifer. There is also an upper competent bedrock zone which is an aquiclude/aquitard.

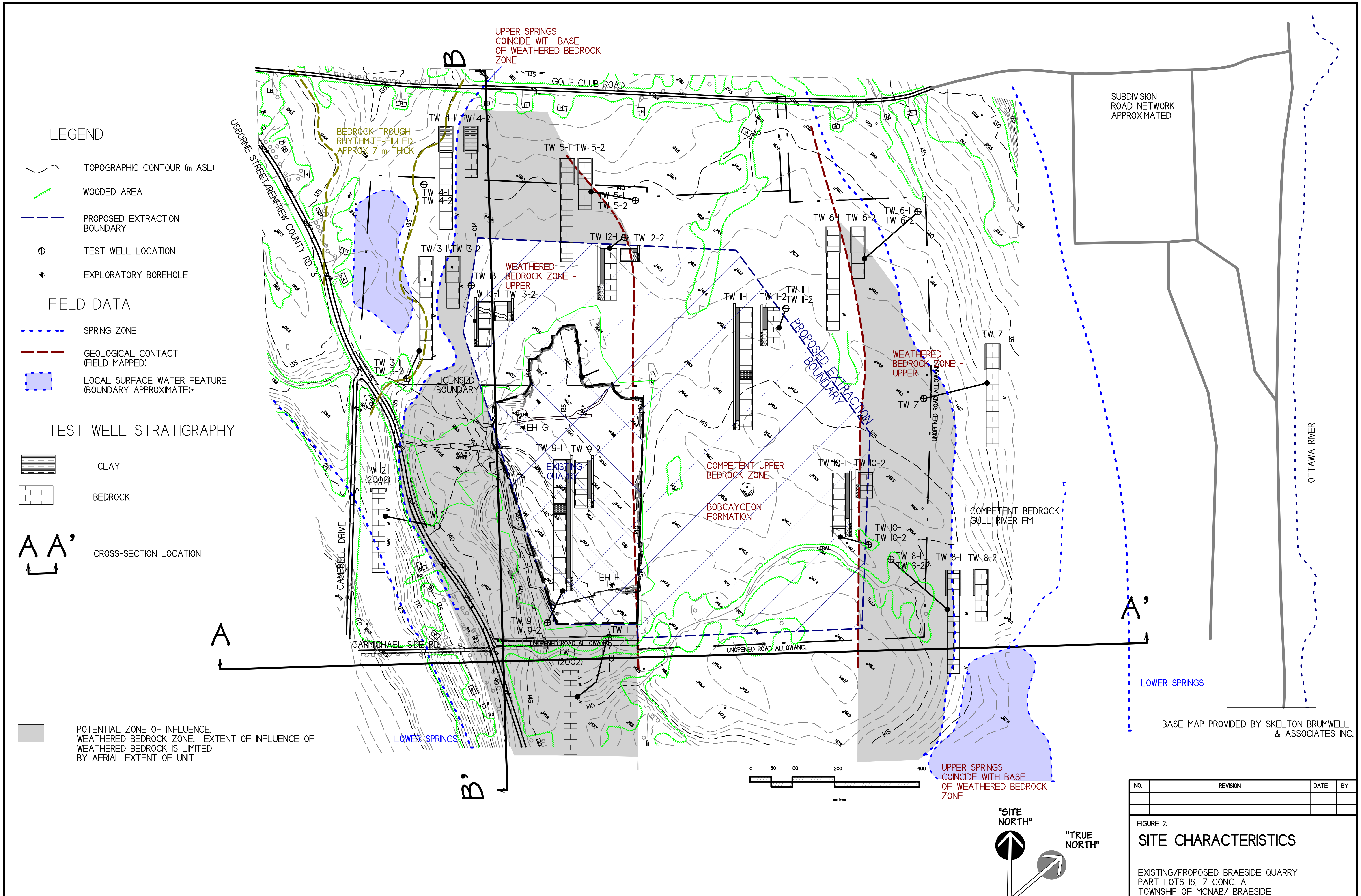
The overburden aquifer is discontinuous and on the Miller property are only found in the west central side. The weathered bedrock aquifer is unconfined, discontinuous and flow varies seasonally. On the Miller property, the aquifer is found along the flanks of the plateau in two distinct and separate layers. While there are small discontinuous water-bearing fractures in the competent bedrock, the first significant water bearing zone is generally encountered between 117 m and 120 m ASL both on the Miller property, and off as identified from MOE well records.

1.5 Impact Assessment

Impacts from the proposed operation were assessed for three stages in the quarry life, the active operation; post-operations when the quarry is filling with water, which will take approximately 27 years; and after full restoration. Impacts to the weathered bedrock and correspondingly to the upper springs that may result in minor impacts to the north-west and south-east local wetlands are predicted.

The weathered bedrock zone is the only part of the hydrostratigraphy that will potentially be impacted by the proposed expansion. Approximately 12 ha of the proposed expansion excavation will extend into weathered bedrock as it progresses northward. Impacts that are predicted for the weathered bedrock have already been experienced in the most severe manner with the existing quarry yet observations and data show that there have been minimal impacts within the weathered bedrock, including on the surface water features.

There will be minimal impact in the competent bedrock aquifer. The minor discontinuous water-bearing zones above the proposed quarry floor are low yielding and alone insufficient to sustain a typical residential water supply. These zones produce marginal flow and, where observed, were exposed on



NO.	REVISION	DATE	BY

FIGURE 2:

SITE CHARACTERISTICS

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

*SURFACE WATER FEATURE BOUNDARIES APPROXIMATE. REFER TO SKELTON BRUMWELL ASSOCIATES INC. "MILLER BRAESIDE QUARRY EXPANSION, HYDROLOGICAL INVESTIGATION, TOWNSHIP OF McNAB/ BRAESIDE, COUNTY OF RENFREW" DATED MAY 2012.

the escarpment faces. The first continuous and significant water bearing zone, commonly encountered between 117 and 120 m ASL, is 5 m below the proposed quarry floor of 125 m ASL. This is also the first significant water-bearing zone (WBZ) below the weathered bedrock that is used by area water wells. The protection to area groundwater users has been designed through definition of the quarry floor and lowest sump elevation to prevent impacts.

AECOM calculated the potential zone of influence of the proposed expanded excavation on the significant WBZ. The calculation assumed conservatively that the aquifer is homogeneous, planar and infinite in aerial extent. The results found a potential drawdown of about one metre in the aquifer at a distance of about 800 m and about 1.5 m at about 350 m from the lower lift sump, *if* the quarry intercepted the water bearing zone through the sump.

Although the local wells are about 300 to 400 m from the west and north boundaries of the proposed excavation, they are located about 600 to 800 m or more from a future lower lift pump chamber to be located in the northeast corner of the existing excavation. At this distance, a drawdown on the order of 1 m is predicted for wells using the first significant water bearing zone (WBZ) exclusively, assuming the lower lift pump-out intercepts the same zone. For most wells, this decline, should it occur, would not result in a significant decline in well water availability.

Details on a monitoring program for groundwater that expands on the existing PTTW program are provided. Monitoring of the springs and wetlands is not required because of the insignificant impact of the proposed quarry expansion on the features.

1.6 Peer Review Process and Report Structure

The initial investigations of the hydrogeology of the Miller property began in 2002 and were conducted by Gorrell Resource Investigations (GRI). The current document consolidates the data and summarizes the interpretation and conclusions from GRI Report 05460 dated September 2007 and the additional testing reported in November 2009.

Golder Associates Ltd. was retained by the County of Renfrew to provide technical peer review services with respect to Miller's application for the Braeside Quarry Expansion as they related to an application for a Zoning By-Law Amendment under the Township of McNab/Braeside Official Plan and an application to the Ministry of Natural Resources (MNR) for a quarry license permitting extraction below the water table. As part of the services, Golder provided a technical review of the hydrogeological work completed, beginning with a letter dated September 11, 2008. The correspondence prepared through the hydrogeological peer review is discussed in Section 12. The 2009 testing program was completed with input from Golder Associates Ltd. (Golder) to ensure that it would provide the necessary level of effort to address the peer review questions and concerns.

This document incorporates the results agreed to from the hydrogeological peer review process. The peer reviews considered in this document are;

- Golder Associates Ltd.; Review of Report Entitled Hydrogeological Investigation, Braeside Quarry Expansion, prepared by Gorrell Resource Investigations, dated September 2007; Project No. 08-1122-0216; letter dated September 11, 2008.
- Golder Associates Ltd.; Preliminary Review of Gorrell Resource Investigations Consolidated 2006 – 2009 Hydrogeological Investigation, Proposed Braeside Quarry Expansion; Project No. 08-1122-0216; letter dated March 9, 2010.
- Golder Associates Ltd.; Natural Environment, Hydrology and Hydrogeology Review Comments, Proposed Braeside Quarry Expansion, Municipality of McNab/Braeside, Ontario; Project No. 08-1122-0216; letter dated May 10, 2010.
- Golder Associates Ltd.; Natural Environment, Hydrology and Hydrogeology Review Comments, Proposed Braeside Quarry Expansion, Municipality of McNab/Braeside, Ontario; Project No. 08-1122-0216; letter dated August 16, 2011.
- 2012 e-mail exchange between Brian Byerley, Golder Associates Ltd., to Gary Bell, Skelton Brumwell & Associates Inc.; Subject: Miller Braeside Quarry Technical Reviews; beginning February 29, 2012.

Pertinent data from the historic GRI studies is provided in the report.

2 Data Collection and Results

The study began with a review of the existing data and published information for the site and surrounding area. This included mapping and studies by Gadd (1963), Richard *et al* (1984), Williams *et al* (1984), Trotter *et al* (1986), Derry *et al* (1989) and Gorrell (Aggregate study of Renfrew County; unpublished). The water wells for the area were examined and statistically analyzed for area water use characteristics. Data on the two site monitoring wells installed in 2002 were reviewed.

Thirteen new test wells were constructed with a rotary percussion drill as sentry monitors around the perimeter of the property. The test wells were completed at eight locations TW1 to TW8. The wells were constructed by Saunders Well Drilling under supervision of George A. Gorrell M.Sc. P.Geo. F.G.A.C.. The wells were drilled to various levels to distinguish, classify and isolate the different hydrogeological parameters that had been identified for the area. The wells were tested in April and May 2007, and surface water and groundwater data were collected over the course of the study. A door-to-door survey was conducted in the summer of 2006 within 500 m of the licensed quarry to collect available information on neighbouring groundwater use.

Ten additional wells were drilled on the site between January 13, 2009 and February 28 2009. The test wells were completed at five locations, designated 9 to 13. The new holes were constructed using a diamond drill with HQ core. The equipment was operated by All-Terrain Drilling Ltd. of Waterloo under supervision by George A. Gorrell M.Sc. P.Geo. F.G.A.C..

Two exploration holes (F and G) were drilled on the quarry floor to depths within the licensed base by All-Terrain for Miller Group between March 1 and March 4 to obtain core for quality testing. This core was sent to a commercial laboratory for analysis and testing. The bedrock core was subsequently photographed and logged at the Smith Construction Ltd. office. The bedrock core was also reviewed separately by AECOM staff. AECOM was retained by Miller Paving to provide an overview function.

The location of the test wells and exploration holes is shown on Figure 2.

Following the test hole construction, the deeper well in each pairing was tested to assess the potential hydraulic conductivity. Two packers were installed to isolate either a 1.5 or 3 m zone. Packers were inflated to 400 psi and flow was induced into isolated zones at the rate required to sustain a constant pressure within the packer. Generally, four pressure steps were used for each test interval. The flow at a given pressure step was measured as pressure steps were both increased and decreased.

Following drilling and packer testing, the boreholes were instrumented with 31.75 mm diameter PVC screens (1.5 to 3.0 m, length based on site conditions) attached to solid 31.75 mm diameter PVC risers. The annulus around the screen was packed with #4 silica sand and the remaining annulus was backfilled with bentonite. The wells were fitted with locking caps.

From May 4 to 8, 2009, rising head hydraulic conductivity tests were completed on the piezometers and on two additional open cored floor holes (F and G).

Borehole logs for the test wells at the site can be found in Appendix C.

3 Site Data

Table 1 summarizes the transmissivity estimated from the initial pumping test data collected at boreholes TW1 to TW8. Table 2 lists hydraulic conductivity measured from the monitoring wells at TW9 to TW13 during the well response tests.

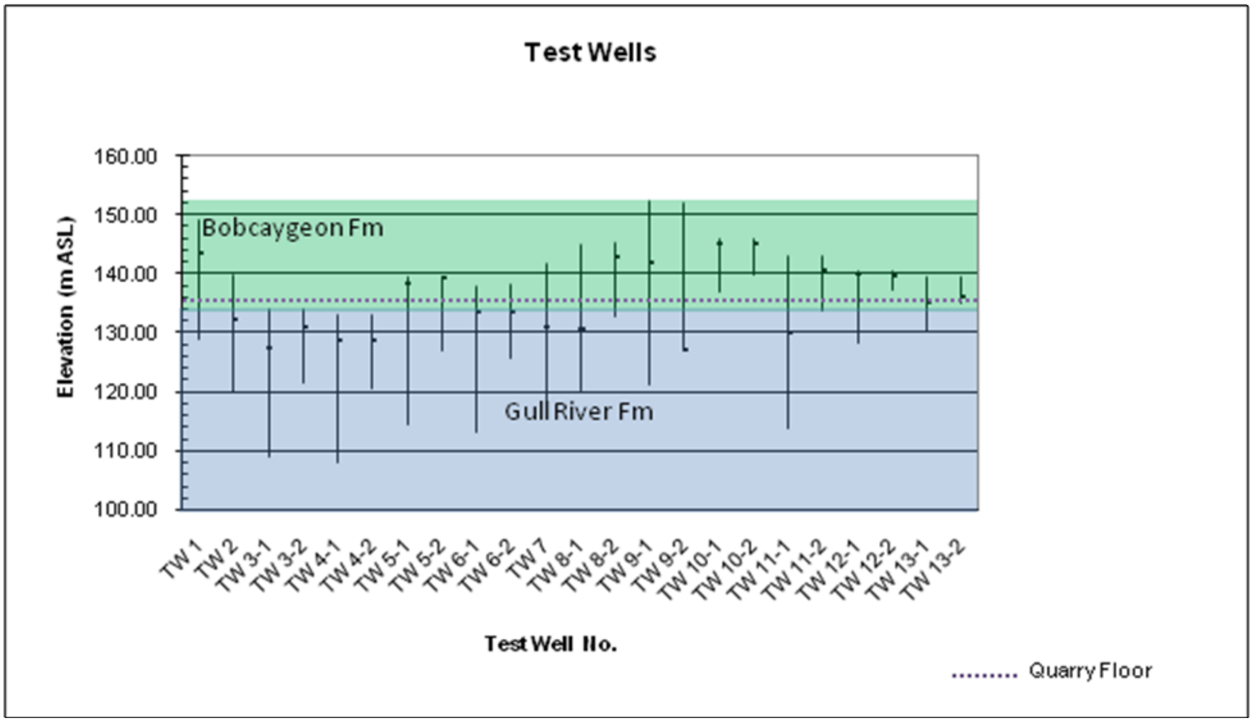
Hydraulic conductivity analysis used the Hvorslev (1951) method. The analysis was originally conducted using an Windows Excel® (Excel) spreadsheet. A discovery by the authors in late 2011 found that the GROWTH function used to extrapolate the observation data did not function well in cases where the hydraulic conductivity was very slow; i.e. the line had to be extracted an extended distance to determine y_0. The data for each well response test were analyzed using Aqtesolv Pro V 4.0® software (Aqtesolv). The results of the analyses are compared in Appendix A, Table 4.

In three of the tests, the calculated values using Aqtesolv were notably different than the original analysis. The adjustment of these presented values did not affect the analysis, impact assessment and recommendations.

The monitors were subdivided into four categories to represent the different hydrogeological conditions on the site as shown in Table 3.

The tables are found in the respective sections of discussion.

Figure 3: Elevation of Test Wells



4 Conceptual Model

Figure 3 shows the elevations of the installations on the site. There are three potential aquifers on the site; the overburden aquifer, the weathered bedrock aquifer and the competent bedrock aquifer. The upper bedrock has been subdivided into the weathered bedrock zone and an upper competent bedrock zone which is considered to be an aquitard. The aquifers and aquitard are shown in plan on Figure 2 and in profile in Appendix A, Figure 3.

4.1 Groundwater

4.1.1 Overburden Aquifer

Although there is some overburden on the site, there is no overburden aquifer (i.e. sustainable water supply aquifer) in the proposed extraction area. There is some saturated overburden that ranges on the site in thickness up to 0.30 to 2.5 m, commonly less than 1 m.

In the north-west part of the Miller property the bedrock trough (Section 5.3, Appendix A) is filled with clay rhythmites. A clay thickness of 5.8 m was recorded in TW4-1, while no clay was recorded in TW 3-1. The clay is saturated but has a very low transmissivity.

4.1.2 Weathered Bedrock Zone Aquifer

The weathered bedrock aquifer is a zone of a variable thickness that has undergone weathering since the last glacial period. Flow in the shallow weathered aquifer is localized in scope, and the available data indicated that the shape of the water table in the zone mimics the topography, controlling the surface water flow. This aquifer is predominantly unconfined. It is the dominant conduit for the drainage of precipitation and meltwater on the site and adjacent areas.

The weathered bedrock aquifer is discontinuous and flow volumes vary seasonally. The more permeable portion of this surface aquifer is restricted to the flanks of the plateau, The thickness of the weathered bedrock varies up to approximately 10 m with the saturated thickness up to about 5 m. The weathered bedrock is developed into the plateau, in widths ranging from approximately 100 to 400 m.

Table 1: Summary of 2007 Borehole Pumping Test Results

Test Well	Test Interval (m ASL)	WBZ[1] Observed (m ASL)	$T_{Pumping}$[2] (m^2/d)	$T_{Recovery}$ (m^2/d)
TW 1	128.9 – 147.8	--	0.06	ID[3]
TW 2	119.8 – 138.1	--	0.17	0.079
TW 3-1	109.5 – 128.4	110.4 and 119.9	1.03	0.29
TW 3-2	121.7 - 128.4	126.9	0.09	0.11
TW 4-1	108.5 – 127.4	112.1	0.26	0.40
TW 4-2	120.9 – 127.6	--	0.08	0.12
TW 5-1	114.9 – 133.8	--	0.11	ID
TW 5-2	127.1 – 133.8	--	0.08	0.16
TW 6-1	113.0 – 133.3	117.3	0.18	ID
TW 6-2	125.7 – 132.5	--	0.02	ID
TW 7	116.8 – 136.3	129.0	0.21	0.37
TW 8-1	120.0 – 139.6	121.8 and 134.0	0.59	0.83
TW 8-2	132.6 – 139.6	--	0.02	0.04

Notes:

1. WBZ – water bearing zone;
2. Jacob and Theis equations are used for calculation of transmissivity (T)
3. ID – insufficient data;
4. Column 2 interpreted from Borehole Logs (Appendix C). Remaining data excerpted from Appendix A, Table 2.

About 25.5 ha in total or 19% of the proposed licensed area, and approximately 12 ha of the proposed extraction area, consists of weathered bedrock at surface. The weathered zone is shown in plan view on Figure 2 and in cross-section in Appendix A, Figure 3.

The hydraulic conductivity measured in the weathered bedrock zone and shown in Table 2 ranged from 7.28 x 10^{-9} (rising head test, TW 13-2) to 7.3 x 10^{-5} m/s (packer test, TW 13-2).

Table 2: Summary of 2009 Well Response Test and Packer Test Results

Test Well	Test Interval[1] (m ASL)	K (m/s)[2] Rising Head Test	Potential K (m/s)[3] Packer Test (Pump in)
TW 9-1	121.0 - 123.1	2.09 x 10^{-6} (T1[4]) 2.59 x 10^{-6} (T2)	4.41 x 10^{-7}
TW 9-2	140.8 – 142.9	4.98 x 10^{-9}	2.58 x 10^{-5}
TW 10-1	130.4 – 134.0	1.15 x 10^{-7}	4.72 x 10^{-8}
TW 10-2	139.6 – 143.3	2.51 x 10-^{6} 2.98 x 10^{-6}	2.4 x 10^{-6}
TW 11-1	113.9 – 116.0	3.64 x 10^{-8}	1.71 x 10^{-8}
TW 11-2	133.8 – 137.4	6.01 x 10^{-9}	3 x 10^{-8}
TW 12-1	128.1 – 131.7	2.45 x 10^{-7}	7.6 x 10^{-8}
TW 12-2	137.3 – 139.7	1.46 x 10^{-8}	2.7 x 10^{-5}
TW 13-1	128.9 – 131.0	7.28 x 10^{-9}	0
TW 13-2	134.8 – 138.5	2.91 x 10^{-8}	7.3 x 10^{-5}

Notes:

1. Test Intervals from Appendix C
2. Hvorslev solution used for analysis of well response test data to estimate hydraulic conductivity (K) (Appendix A, Appendix V)
3. Potential K from Appendix A, Appendix IV
4. T1 = Test 1, etc.

The packer testing at TW 13 in particular showed that in the upper weathered bedrock zone, while there may be voids within the bedrock (vugs, coral) they are not necessarily hydraulically interconnected. For example, the packer tests between 130.3 to 131.8 m ASL, and 133.3 to 134.8 m ASL showed how the voids around the test hole filled with water, but that once they were filled, the medium became impervious.

The existing quarry is situated both entirely within the weathered bedrock zone and within the most highly weathered part of the property. The expansion will extend into weathered bedrock as it progresses northward, but will not be in the weathered bedrock zone as it expands eastward.

4.1.3 Upper Competent Bedrock

The upper competent bedrock zone is shown in plan view on Figures 2 and in cross-section in Appendix A, Figure 3. The zone is an aquiclude to aquitard, mainly consisting of low permeability rock of Bobcaygeon Formation. The 2009 borehole logs showed that from approximately 0.45 m and below, the bedrock is massive with no open fractures or bedding planes. The upper 6 m has a slightly higher hydraulic conductivity than that below. The area on the central to east part of the Miller property, where the zone occurs, corresponds with the surface water accumulations in the depressions or swales on the bedrock surface identified after rainfall events.

The potential hydraulic conductivity for this part of the site, where a value could be measured, ranged from 6.01 x 10^{-9} (TW 11-2) to 2.7 x 10^{-5} m/s, but for over half the test sections where results were representative of in-situ conditions, the results were not calculable. The hydraulic conductivity measured from the well response tests ranged from 1.25 x 10^{-8} (TW 11-2) to 2.45 x 10^{-7} (TW 12-1) m/s.

Select elevation data for the upper competent bedrock is summarized in Table 3. The complete groundwater elevation data set is found in Appendix A, Appendix VI.

Table 3: Hydrostratigraphic Setting of Site Groundwater Monitors (m ASL)

Station	Surface Elev	Base Hole Elev	Cased to Elev	GROUNDWATER ELEV. 22-Jul-09
Weathered Bedrock Aquifer – flanks and Central Part of plateau				
TW 9-2	152.19	140.8[1]	142.9[1]	141.60
TW 10-1	145.72	130.4[1]	134.0[1]	145.12
TW 10-2	145.72	139.6[1]	143.3[1]	145.19
TW 13-1	139.52	128.9[1]	131.0[1]	136.06
TW 13-2	139.41	134.8[1]	138.5[1]	136.33
Upper Competent Bedrock, Central Part of Plateau				
TW 11-2	142.91	133.8[1]	137.4[1]	142.34
TW 12-1	140.33	128.1[1]	131.7[1]	139.89
TW 12-2	140.28	137.3[1]	139.7[1]	139.73
Competent Bedrock - Significant Water Bearing Zone Likely Intercepted				
TW 2	139.60	119.80	138.10	133.14
TW 3-1	133.90	108.90	128.41	126.39
TW 4-1	132.92	107.92	127.43	128.38

Station	Surface Elev	Base Hole Elev	Cased to Elev	GROUNDWATER ELEV. 22-Jul-09
TW 4-2	133.09	120.59	127.60	128.47
TW 5-1	139.26	114.26	133.77	138.14
TW 6-1	137.95	112.95	133.28	133.41
TW 7	141.79	116.79	136.30	130.56
TW 8-1	144.97	119.97	139.48	130.41
TW 9-1	152.04	121.0[1]	123.1[1]	125.93
TW 11-1[2]	142.81	113.9[1]	116.0[1]	129.74
Competent Bedrock above Significant Water Bearing Zone				
TW 1	148.98	128.87	147.78	141.05
TW 3-2	133.88	121.38	128.39	130.91
TW 5-2	139.27	126.77	133.78	139.17
TW 6-2	138.23	125.73	132.46	133.38
TW 8-2	145.05	132.55	139.56	143.16

Notes:

1. Elevations refer to the top of sand pack and base of well screen.
2. TW 11-1 passed through the zoned commonly intercepted by the significant WBZ, but in testing did not exhibit typical characteristics observed in other test wells

4.1.4 Competent Bedrock Aquifer

This aquifer was observed below the Upper Competent Bedrock zone and consists of the thick Gull River Formation underlain by the Rockcliffe Formation as shown on Appendix A, Figure 3. The Upper Competent Bedrock and Competent Bedrock can be considered synonymous, and the variability in hydrogeologic characteristics between the portions of the zone in which no significant water bearing zone occurs should be considered interchangeable. They were differentiated for this examination to illustrate the portions of the upper bedrock that consist of the Weathered Bedrock from those that is not. The aquifer with discrete water bearing zones is generally a poor aquifer as a whole and confined below the Miller property. The aquifer may become unconfined where exposed at surface at lower elevations along the flanks of the plateau. Between the water bearing zones, the bedrock is essentially impervious.

The hydraulic conductivity measured in the competent bedrock zone and shown in Table 2 ranged from 3.84 x 10^{-8} (rising head test, TW 11-1) to 2.7 x 10^{-5} m/s (packer test, TW 12-2) .

The 2006 door to door interviews of the area found that two significant water bearing zones are generally used. The upper one was usually reported from 119 m to 109.5 m ASL. A deeper one, encountered at an elevation of approximately 80 m ASL or 61 m below the surface. None of the test wells intercepted this lower zone as the hydrostratigraphy was not investigated to this depth. Elevations of off-site water-bearing zones are approximate. It is normal for the elevation of the water-bearing zone to vary spatially. The upper significant water bearing zone is situated within the Gull River Formation. Analysis of the geology for the area indicates that the lower water bearing zone is within the Rockcliffe Formation.

4.1.5 Discontinuous Water Bearing Zones

Open test holes TW 7 and TW 8-1 along the east property limit reported water bearing zones in the competent bedrock of 129.0 and 134.0 m, respectively, as shown on the borehole logs in Appendix C. These zones at the higher elevations were not logged in any of the other test wells. These discontinuous water bearing zones were encountered in the competent bedrock zone at elevations higher than the more laterally extensive significant water bearing zone. These zones may intersect the side of the plateau within a distance of approximately 300 to 350 m. An examination of the groundwater elevation data for these two wells (Appendix A, Appendix VI) illustrates that the confined zones provide a very small contribution to the water levels in the open boreholes. Figure 13 of Appendix A shows how the water level measurements varied, rising above the water bearing zone in the spring recharge period, but dropping down to and below the zone through the season.

These discrete water bearing zones, which occur at or just below the contact between the Bobcaygeon and Gull River Formations, are of low yield and are very localized and discontinuous across the site. Therefore, they are insignificant from a water supply point of view.

4.1.6 First Significant Water-Bearing Zone

The first significant or highest consistent water bearing zone found on the Miller property was situated typically between 117 and 120 m ASL in the competent bedrock aquifer (Table 1 and Appendix C), but the top of the zone was measured as high as 121.8 m ASL (TW 8-1) at the south east corner.

Like the contact between the Bobcaygeon and Gull River Formations (Appendix A, Section 5.2), the significant water bearing zone rises at the south end of the properties, where the upper limit of the zone was mapped at 121.0 m (BH 9-1) and 121.8 m ASL (BH 8-1). In the southern-most +/-100 m of the proposed excavation, the water-bearing zone rises slightly to its maximum recorded in the south-east corner of the properties. The zone is most *commonly* found between 117 and 120 m ASL on the Miller property and as reported in area water well records.

There are 10 monitors on the Miller property that potentially intercept the significant water bearing zone, based on depth penetrated by the borehole. The degree of development was variable; for example TW 5-1 and TW 5-2 reported no notable water bearing zones. Eight of the monitors are open boreholes, and two (TW 9-1, and TW 11-1) are piezometers. The monitors are listed in Table 3 and the groundwater elevation data is found in Appendix A, Appendix VI. The groundwater elevation across the plateau was reported at between 125 m ASL at the flanks of the plateau increasing to approximately 135 m ASL in the centre. The data show that the groundwater elevation rises as high as 138.3 m ASL in the central part of the Miller property (TW 5-1), decreasing to the east and west. The interpreted general direction of groundwater flow in the competent bedrock aquifer, including the significant water bearing zone is shown on Appendix A, Figure 12. The groundwater flows easterly and westerly from the centre of the plateau. The variation of groundwater elevation with time is shown in Appendix A, Figure 13.

The aquifer is confined below the Miller property and may become unconfined where exposed at surface at lower elevations, such as at the springs along the lower flanks of the plateau. The groundwater elevation on site, combined with the evidence of the lower springs, suggest that the topography of the escarpment is a strong controlling factor on even the confined aquifer hydrogeology.

Information from area wells in the door to door survey identified additional water bearing zones within the Gull River and Rockcliffe Formations. Below the first significant water bearing zone described above, the next recorded significant water bearing zones in the area are between 105 m ASL and 110 m ASL, and around 79 m ASL. The groundwater elevation surface of the deeper confined bedrock aquifer is deep, at around 80 m ASL.

4.2 Surface Water and Drainage

The surface water and drainage mapped over the period of March through June 2010 is shown on Figure 14 in Appendix A. The surface drainage on the site and in the surrounding area consists of overland flow integrated with localized sub-surface migration.

4.2.1 Surface Water Accumulations on Competent Bedrock

Surface water accumulates in the saturated overburden and lower lying surfaces and depressions of the competent bedrock portions of the site. These areas are predominantly on the top of the plateau, and on the steps on the slopes, including the sediment-filled trough in the north-west corner of the site. The areas shown on Figure 14 in Appendix A are typical; there may be others that are intermittent or were not found in the site mapping. The boundaries of the wetland features shown on Appendix A, Figure 14 are approximate and reflect the conditions observed during mapping by George A. Gorrell M.Sc. P.Geo. F.G.A.C.. The hydrology and natural environment reports (Skelton Brumwell Associates (SBA), 2011) should be referred to for boundaries of key features.

4.2.2 Springs

The accumulated surface water flows overland following the surface topography until the weathered bedrock zone is encountered. At this point, the surface water drains into the dissolution fractures and flows below surface to emerge at the base of the dissolution as springs. The upper spring elevation is found approximately between 133 m ASL and 137 m ASL, initially developed because of the position on the flank of the plateau during the late glacial period.

The surface water that emerges in the form of the upper springs flows again along the base of the upland of Bobcaygeon Formation and then subsequently overland following the local surface topography until it nears the edge of another topographic drop where it meets the lower dissolution/ weathered bedrock zone. The surface water drains into this dissolution zone and emerges below in the form of the lower springs, at around elevation 125 m ASL. This is just above the base of the escarpment and the contact between clay (referred to as Renfrew clay loam in the hydrology report) and upland till/ bedrock (referred to as Farmington loam in the hydrology report). This flow pattern can be observed along the entire plateau, on both east and west sides.

4.2.3 North-West Local Wetland

On the north-west corner of the study, the natural environment report shows a local wetland feature that is partially on the Miller property. The topographic mapping shows that this feature is originally present because of a natural bedrock trough filled with clay that had natural drainage constrained by the construction of Usborne St (Figure 2). The feature originally received drainage from up-gradient to the north which was augmented, due to its topographical positioning at to just below the upper spring elevation, with seasonal spring water. Currently, this surface water feature is now also augmented with the quarry discharge and a beaver dam.

The path that the quarry discharge takes through the wooded area was mapped and is shown on Appendix A, Figure 14. The flow follows a channel partially constructed (for approximately 4 to 5 m) and then through a natural channel, until it emerges into the wetland on the Miller property. The wetland has an outlet that is beyond the Miller property, which exits at Usborne Street at Campbell Drive and then meanders back through the Miller site before discharging again into the east roadside ditch on Usborne Street at the culvert.

The water level in the wetland was observed to increase noticeably by 5 to 10 centimetres initially for a short time when the quarry is discharging. These specific observations were made on July 3 following an extended rainfall period so the increase could not be attributed exclusively to quarry discharge since as noted above, there are other sources of recharge to this wetland. It was observed at this same visit that the water level did not increase at the wetland outlet at Usborne Street. A new beaver dam was found in the approximate location shown on Appendix A, Figure 14.

4.2.4 South-East Local Wetland

A small local wetland area located on private property and found south-east of the Miller property originated because of a combination of factors; a topographically suitable bedrock depression on the competent bedrock step directly at, to slightly below, the elevation that the upper springs emerge. The natural heritage evaluation indicates that the wetland appears to be a typical example of the small, shallow, beaver-maintained ponds found commonly across southern Renfrew County. Although the pond has not been evaluated, it is the opinion of the team ecologists that there are no indications of significant natural features or functions here nor strong indications of the potential for such values to occur .

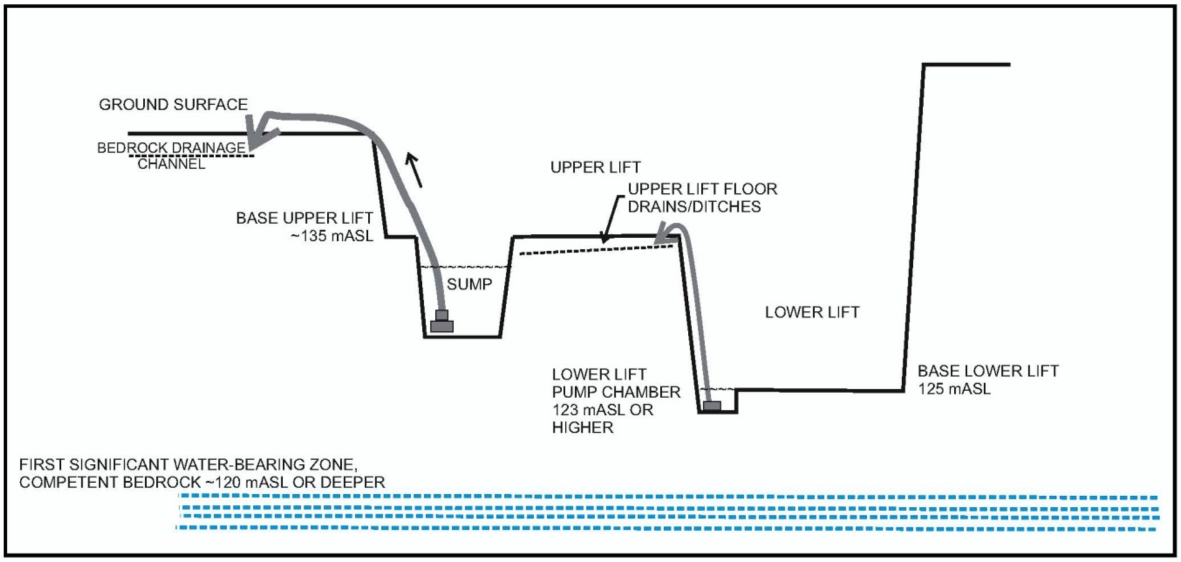
This wetland has an outlet, shown on Appendix A, Figure 14. The water level will vary seasonally, depending on the spring flow and beaver activity. The flow from the outlet had significantly decreased in the May 22-26 2009 visit in comparison to the peak flows observed in mid-April. The water level in the pond is also controlled by extensive beaver activity in the area.

5 Impact Assessment

The following sections provide assessment of potential impacts on groundwater and surface water due to long term quarry dewatering. As discussed in Section 4.1 above, only two aquifers, the weathered bedrock aquifer and the first significant WBZ within the competent bedrock aquifer beneath the future quarry floor, are identified to be more permeable and laterally extensive across the site and on adjacent properties. The groundwater impact assessment in this section, focuses on these two aquifers. The impact assessment for surface water focuses on the springs, the onsite north-west local wetland and offsite south-east local wetland as well as the adjacent Ryan Creek.

A schematic cross-section showing the various levels in the existing quarry profile and defining the terminology used in the following sections is provided in Figure 4.

Figure 4: Schematic Cross-Section Illustrating Quarry Lifts and Internal Water Management System



5.1 Weathered Bedrock

In the pre-quarry hydrogeological setting area, local groundwater recharge occurred by the infiltration of precipitation and snowmelt into the upper weathered bedrock that would subsequently migrate down into the competent bedrock zones. Springs through the base of the escarpment on the clay plain and Ottawa River side would provide recharge to the surface water systems and overburden aquifer, where present.

Mapping shows that approximately 25.5 ha in total or 19% of the proposed licensed area and approximately 12 ha of the proposed extraction area, has weathered bedrock upon it. The existing excavation, as noted previously is entirely within the weathered bedrock zone and the zone has been fully penetrated.

The weathered bedrock zone has an in-situ hydraulic conductivity of 4.98 x 10^{-9} (TW-9-2) to 2.98 x 10^{-6} m/s (TW 10-2), and a potential K of 4.72 x 10^{-8} (TW 10-1) to 7.3 x 10^{-5} m/s (TW 13-2) (Table 2). The dissolution develops from none, at the competent bedrock, and increases to the outer edge, where the degree of development is highest. The location of TW 10 represents characteristics of a lower degree of development, while the locations of TW 9 and TW 13 represent an area of the site with the highest degree of weathering. The highest potential k was measured in TW 13-2, which is situated hydrostratigraphically in the range of the upper spring elevation in an area with the most highly-developed dissolution on the Miller property. This higher value represents this particular discrete interval and there is no coincidence that the higher k corresponds with the part of the stratigraphy where the upper springs are located. The lower values would represent a more average value over a broader profile – the voids filling and then having no outlet or a more restricted outlet, and discrete competent bedrock in the intervening beds.

AECOM calculated the potential radius of influence of the proposed quarry excavation on the weathered bedrock zone (Appendix D). The drainage equation, Hooghoudt (1936), was used to estimate the radius of influence from quarry dewatering in the surrounding unconfined, weathered bedrock.

The normal infiltration rate (190.5 mm/yr) used by AECOM was estimated based on a water budget derived from the long term meteorological data at the local weather station (Claybank Station, Ottawa) and the MOE infiltration factors for land development applications[1]. An average saturated thickness of weathered bedrock of about 2.5 m was assumed, with a more permeable upper 2 m and less permeable lower 0.5 m. The radius of influence was calculated to be in the range of about 90 m for a hydraulic conductivity of K_a = 1x10^{-5} m/s to about 190 m for a K_a = 5x10^{-5} m/s, with K_b = 5x10^{-6} m/s unchanged (K_a refers to the upper 2 m and K_b the lower 0.5 m). Calculations are found in Appendix D.

The extent of the potential impact on the weathered bedrock zone interpreted from the AECOM calculation and the mapped geology is shown on Figure 5. The impact on the weathered bedrock zone will be limited by the physical extent of the feature. Figure 5 combines the conservative distance of 190 m calculated by AECOM with the geological conditions of the site. Therefore, on portions of the aquifer, the radius of influence will be less than the calculated value.

The down-gradient impact of the expanded excavation on the weathered bedrock zone will be restored as long as the quarry sump discharge continues in the same pattern as it now does while the quarry is operated and during the period when the final excavation is filling. The existing discharge pattern restores the weathered bedrock zone hydrogeology by distributing the accumulated water back into the pathway it would have followed in pre-development. There is one small zone where the upper spring will be disrupted by the excavation, but again, the system will be restored to the lower elevations by the discharge.

---

[1] This value is within 2 percent of the estimated annual infiltration rate of 187 mm/yr provided by SBA, 2012.

LEGEND

⌒	TOPOGRAPHIC CONTOUR (m ASL)
⌒	WOODED AREA
— —	PROPOSED EXTRACTION BOUNDARY
⊕	TEST WELL LOCATION

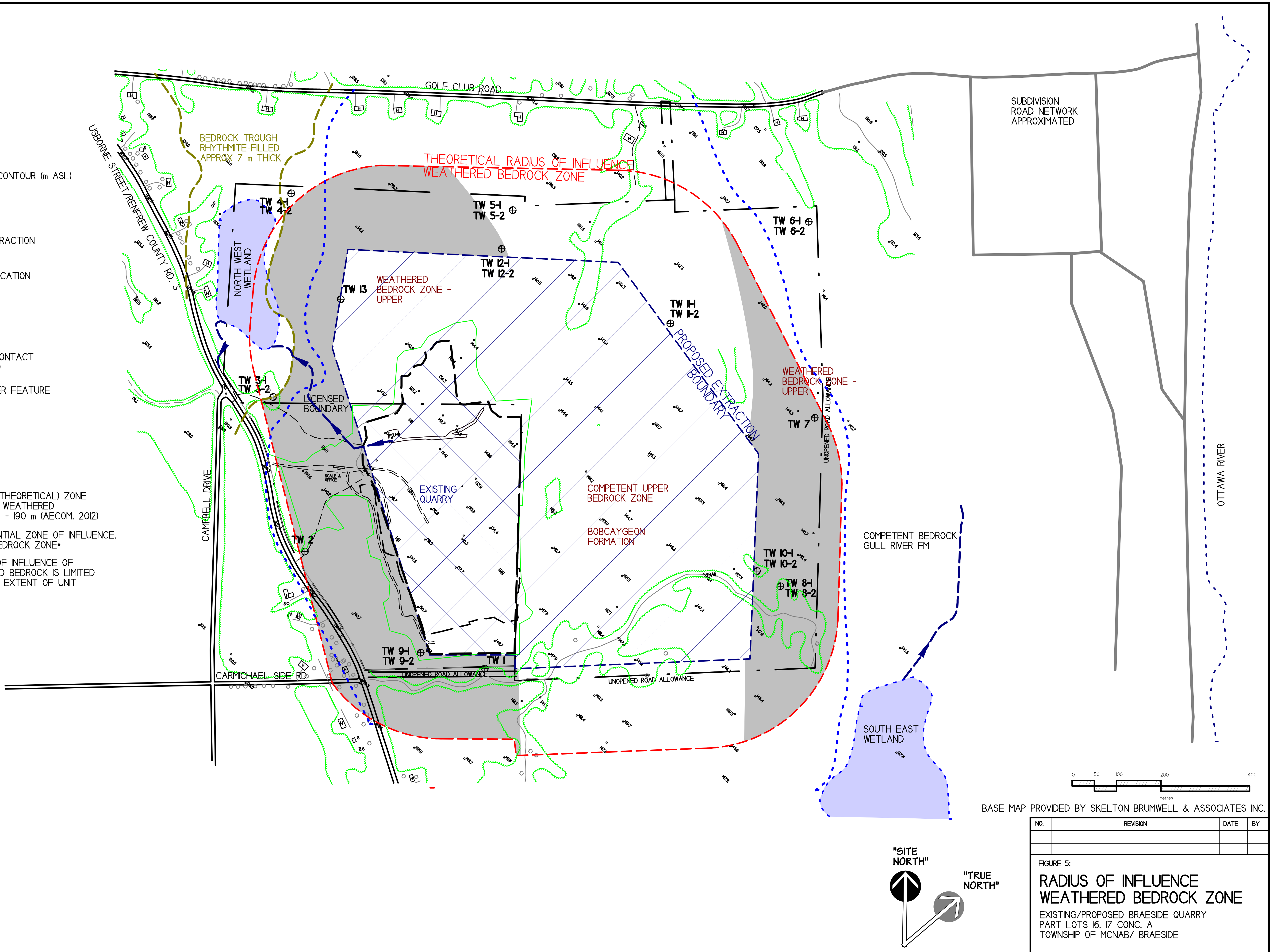
FIELD DATA

— —	GEOLOGICAL CONTACT (FIELD MAPPED)
▨	SURFACE WATER FEATURE

ANALYSIS

— —	CALCULATED (THEORETICAL) ZONE OF INFLUENCE. WEATHERED BEDROCK ZONE - 190 m (AECOM, 2012)
▨	ACTUAL POTENTIAL ZONE OF INFLUENCE. WEATHERED BEDROCK ZONE*

*EXTENT OF INFLUENCE OF WEATHERED BEDROCK IS LIMITED TO AERIAL EXTENT OF UNIT



BASE MAP PROVIDED BY SKELTON BRUMWELL & ASSOCIATES INC.

NO.	REVISION	DATE	BY

FIGURE 5:

RADIUS OF INFLUENCE WEATHERED BEDROCK ZONE

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

Any impacts to the weathered zone and the springs are mitigated by the discharge pattern from the sump. The water that accumulates in the sump originates from overland runoff and drainage through the weathered bedrock zone. This accumulated water is discharged back to surface contributing to the north-west wetland shown on Appendix A, Figure 14, restoring the flow to its original flow pattern.

Therefore, in the north-west area of the Miller property where the weathered bedrock may potentially be impacted by the proposed expansion, the effects are now and will continue to be, mitigated as long as the present operational practices re the sump discharge are continued.

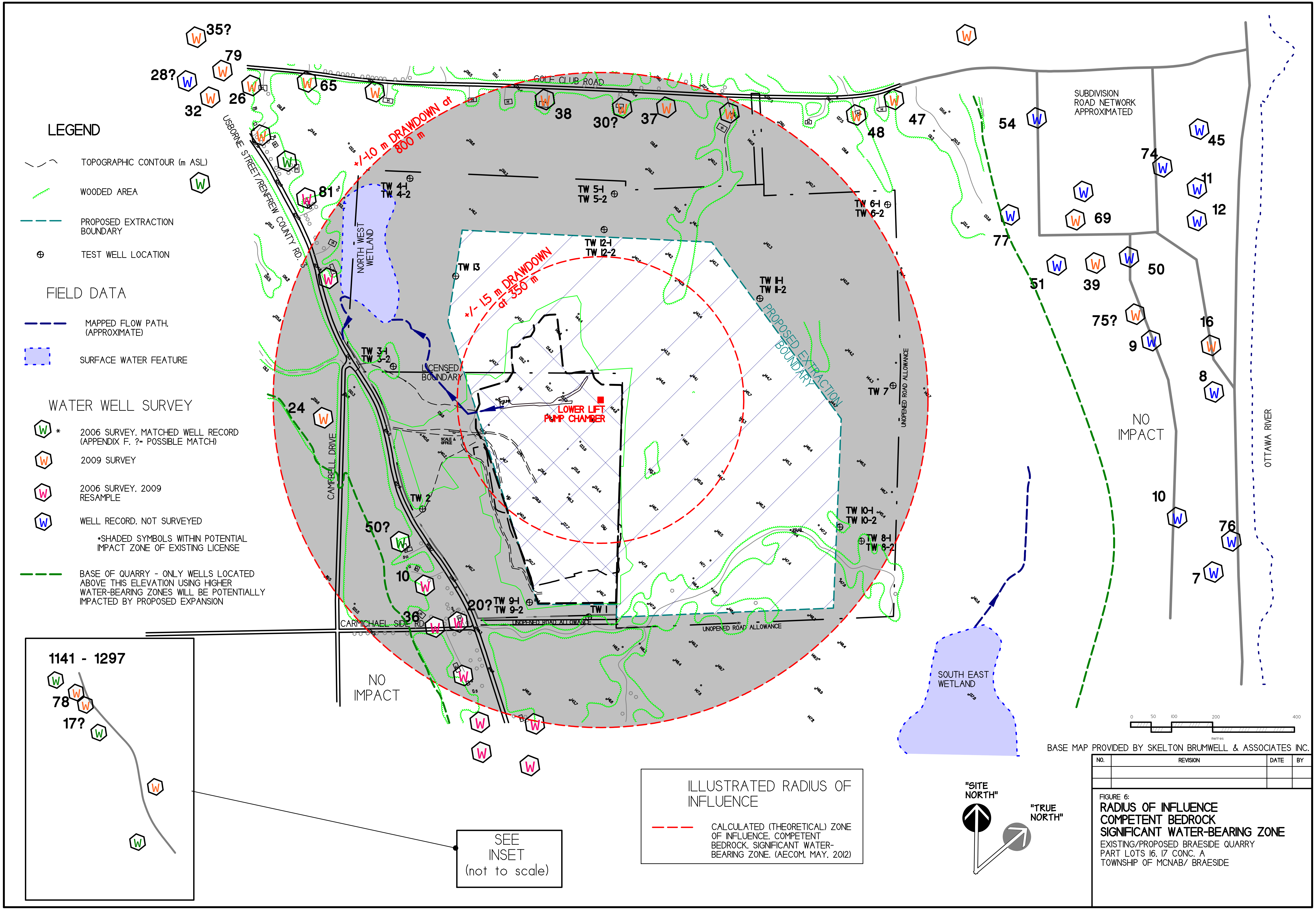
The offsite south-east local wetland was not identified as a significant feature as discussed in Section 4.2.4. The wetland is mainly fed by surface runoff from a drainage area exclusive of the quarry lands, although minor inputs from the upper spring zone may occur in wet seasons. As contribution from the springs is negligible compared to surface runoff, no significant effect on the wetland will be expected as a result of loss of the contribution from the springs due to impacted weathered bedrock immediately south-east of the quarry excavation. Potential impact on the wetland due to loss of the drainage area is further discussed in Section 5.10.

5.2 Competent Bedrock Aquifer

The competent bedrock aquifer, mainly consisting of the Gull River Formation, has a low transmissivity, and is generally a poor aquifer overall. The first significant WBZ, found in the Gull River Formation is a more permeable zone within the formation. The significant WBZ is more continuous and consistent across the site and potentially extends offsite representing a source of local water supply.

AECOM evaluated the potential zone of influence of the proposed expansion on the water-bearing zone *commonly* encountered between 117 and 120 m ASL. The calculation assumed, conservatively, that the aquifer is homogeneous, planar and of indefinite extent. The results found a potential drawdown of about one metre in the aquifer at a distance of about 800 m and about 1.5 m at about 350 m from the lower lift pump chamber, if the quarry intercepted the water bearing zone through it. The lower lift pump chamber is proposed in the northeast area of the existing quarry. The lower lift pump chamber has also been referred to in previous hydrogeological reports and in other technical reports as the lower lift sump. The decision to refer to the feature as the lower lift pump chamber in this and the final hydrology report was made to prevent confusion with the use of the word sump. “Sump” refers to the sump used for discharging accumulated water from the excavation, and which is part of a Works described on the Certificate of Approval for Industrial Wastewater Treatment (the Discharge Permit, now known legally, effectively October 31, 2011, as an Environmental Compliance Approval (ECA).

The radius of influence is shown on Figure 6 along with potentially-affected groundwater and surface water features. Wells shown on Figure 6 in the shaded area are within the radius of influence of the future lower lift pump chamber and would theoretically experience approximately one m drawdown at the distance of about 800 m. There has been no reported decrease in well water availability resulting from the existing quarry operation. Monitoring wells within this zone of influence have not exhibited drawdown effects attributable to the existing quarry operation.



BASE MAP PROVIDED BY SKELTON BRUMWELL & ASSOCIATES INC.

NO.	REVISION	DATE	BY

FIGURE 6:

RADIUS OF INFLUENCE
COMPETENT BEDROCK
SIGNIFICANT WATER-BEARING ZONE
EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16. 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

The closest off-site well is approximately 200 m from the southwest corner of the existing excavation, but about 700 m from the future lower lift pump chamber. At this distance, a potential drawdown of 1.2 m would occur. Even if the chamber was located at the southwest corner of the excavation, about 250 m from the nearest well, the drawdown effect would be approximately 1.6 m.

The proposed extraction boundary was specifically drawn to maintain a minimum of 300 m from neighbouring residences to conform to the McNab-Braeside zoning requirements. Although most of these wells are about 300 to 400 m of the west and north boundaries of the future excavation, they are located about 600 to 800 m or more from the future proposed lower lift pump chamber in the northeast corner of the existing excavation. At this distance, a drawdown of 1.0 to 1.3 m for wells using the first significant water bearing zone exclusively is predicted assuming the lower lift pump chamber intercepts the same zone. For wells for which available data was examined in this study, this decline (should it occur) would not result in a significant decrease in well water availability.

To avoid the first significant water bearing zone, the pump chamber will not extend below 123 m ASL. Also, to minimize opening of fractures below the quarry floor, the final 2 m of rock will be loosened by jack hammer rather than blasting when drains or pump chambers are installed.

5.3 Analysis of Available Drawdown in Surrounding Water Wells

Surrounding area wells that rely on deeper water-bearing zones in addition to the first significant zone will not be affected by the operation, and will not therefore experience impacts.

The available private water supply well information collected during the door-to-door survey has been compiled to assess available drawdown within wells that may theoretically be affected by the proposed quarry.

The following information (Tables 4 and 5) was compiled from data found in Appendix A, Sections 6 and 10. A statistical evaluation was completed first on all the previously analyzed water well records for the study area, and next locally on the identified water well records within the theoretical radius of influence. The water well records were used to calculate the available drawdown in the wells from the well depth and the reported static level data (Table 4).

Table 4: Analysis of Available Drawdown in Water Wells from MOE Water Well Records

Available Drawdown	Previously Analyzed Wells		Identified Well Records	
	# of records	% of records	# of records	% of records
< 10	0	0	0	0
10 - 15	3	4.2	2	13.2
15 - 20	8	11.3	3	20.0
20 – 25	11	15.5	3	20.0
25 – 30	8	11.3	0	0

Available Drawdown	**Previously Analyzed Wells**		**Identified Well Records**	
	# of records	**% of records**	**# of records**	**% of records**
30 - 35	5	7.0	2	13.3
>35	36	50.7	5	33.3
Total records analyzed	**71**		**15**	

*Gorrell Resource Investigations, November 2007

The analysis also found that the maximum available drawdown was 78.3 m for all previously analyzed well records, and 63.1 m for identified well records within the radius of influence. The minimum available drawdown was 11.3 m, according to the analyzed well record data for all records analyzed.

Next, the door-to-door survey information completed in 2006 and 2009 was examined. The survey provided the following information on the water supply wells within 800 m of the proposed lower lift pump chamber. In Table 5, a water well record could be reliably matched with a specific site, or a measurement was made in the field during the residential survey. There is a moderate to high level of confidence in the accuracy of this information.

Table 5: Well Depth and Available Drawdown in Surrounding Private Wells in the Vicinity of the Proposed Lower Lift Pump Chamber (2006/ 2009 Door to Door Survey Data).

Site Reference^A	**Well Depth (m)^B**	**Date Water Level Measured**	**Measured Water Level (m)**	**Approximate Distance from Lower Lift Sump (m)**	**Available Drawdown^C (m)**
5818	24.4	June 2009	16.4	655	8.0
5729	25.9	June 2009	13.1	735	12.8
5900	35.1	June 2009	10.0	700	25.0
6621	27.1		n/a	1,000	n/a
7318	unk	August 2006	13.0	520	n/a
7543	unk	August 2006	13.8		n/a
6129	unk	June 2009	7.0	770	n/a
7335	54.3	June 2009	20.4	940	33.9
6938	unk	June 2009	13.1	870	n/a
6874	45.7		n/a	810	n/a
6723	38.1	June 2009	10.6	800	27.5

Site Reference[A]	**Well Depth (m)[B]**	**Date Water Level Measured**	**Measured Water Level (m)**	**Approximate Distance from Lower Lift Sump (m)**	**Available Drawdown[C] (m)**
6632	73.2		n/a	780	n/a
6599	32.0	June 2009	4.2	730	27.8
6540	30.5	June 2009	9.5	850	21.0
Ground Surface at Well Head Lower than Quarry Base (By Elevation)					
5764	72.5	June 2009	16.5	670	56.1

Notes:

A. Specific location data cannot be published in a public document for privacy reasons, but is available to authorized personnel.

B. From water well record.

C. Calculated from well depth (column 2) – measured water level depth (column 4).

The calculation by AECOM (Appendix D) indicated a predicted drawdown of 1.1 to 1.2 m at 800 m from the proposed lower lift pump chamber. The percentage of available drawdown depends on distance from the sump; with 1 m drawdown predicted at a distance of 800 m from the lower lift pump chamber. The nearest well for which data was available from the door-to-door survey is approximately 655 m away (5818) from the lower lift pump chamber (Figure 6). The calculation would conservatively predict a theoretical drawdown of between 1.3 and 1.0 m at this location or 16.3 to 12.5 % of available drawdown. For most wells, the available data indicate the predicted drawdown would comprise less than 10% of available drawdown. In summary the predicted declines, should they occur, would result in an insignificant reduction in well water availability.

5.4 Quarry Sump

The sump at the quarry, which is located on the floor of the upper lift in the quarry, has been in the present location since at least 2002. The accumulations in the sump originate from overland runoff and shallow weathered bedrock zone; indications are that contributions from groundwater in the competent bedrock are negligible. The hydrology analysis (SBA 2011) showed that on average over the 5 years of data examined, the quantity of water discharged from the sump matched the water surplus within 18%.

In the mid to late summer when precipitation declines, the water level in the sump gradually lowers as the sump water is used for dust control and other approved purposes. The lowering of the sump level indicates that without runoff, there is no recharge to the sump. Photos 14 to 24 in Appendix A are illustrations of the sump under various seasonal conditions.

5.5 Lower Lift

The initial cut for the second lift was made in August 2009. The lower lift was created with a slope towards the north-east corner, similar to the floor of the upper lift. The lower floor elevation is approximately 125.8 m ASL at the lowest and is generally 126.41 m ASL according to the total station survey completed in late September 2009.

Observations of the lower lift taken since it was created, noted immeasurable seepage on the lift wall in the K-bentonite zone. The K-bentonite zone is located 5 m down from the upper lift marking the contact between the Bobcaygeon and the Gull River Formations. The floor has also been observed to be dry through the fall except after precipitation events. This observational data combines to show that there is no seepage occurring through the lower lift.

5.5.1 Lower lift pump-out

As the quarry advances into the lower lift, operational accommodations will have to be made to remove the water accumulations in it. At some time in the operation it will be necessary to construct a sump in the lower lift. An analysis was completed to assess a suitable maximum depth for the lower lift pump chamber to extend below the floor. The pump chamber on the lower level will act as a “lift station” to the existing sump which will continue to perform as it does now to provide settlement of sediment before discharge.

The lower lift pump-out/pump chamber will provide some settlement depending on the frequency of pumping, but it will not be required to provide settlement times for off-site discharge. The discharge from the quarry will continue in the same pattern as currently occurs with the exception of any mitigation measures that might be required. The proposed location of the initial lower lift pump-out/pump chamber is shown on Figure 6, however, the position of the pump chamber on the lower floor may vary as the operation develops.

An analysis of potential upward seepage from the significant water bearing zone for the lower lift pump-out/pump chamber (LPC) depth was completed by AECOM (Calculation Sheet 3, Appendix D). A preferred capacity for LPC of 3,150 m^3/day was provided by Miller’s operations staff to accommodate the equipment. The potential seepage was estimated assuming the significant water bearing zone was encountered by the LPC, although the available site information indicates that it is unlikely this condition will be encountered. The calculation found that the upward seepage to the lower lift sump would be as low as 0.03 to 0.3 L/day per square metre of sump base.

One factor considered in setting the LPC depth was the zone that is affected by blasting, which was inferred to be on the order of 1.5 m from the packer testing. Therefore, to provide for a factor of safety, the sump depth should be no greater than 2.0 m to protect against vertical seepage from the underlying significant WBZ. Using a hoe-ram or comparable equipment to construct the pump chamber may result in lower disturbance of the bedrock beneath floor than blasting. Maintaining the base of the pump chamber at or above 123 m ASL will provide more than enough assurance that the operation will not interfere with the significant water bearing zone.

5.6 Vertical Seepage

As the hydraulic head of the first significant WBZ would likely be above the final quarry floor (125 m ASL) over much of the year, upward gradients would exist and as a result, upward seepage from the WBZ would potentially take place through the quarry floor, albeit, very small.

A supplemental assessment of effects from the upward seepage was provided by AECOM (Appendix D, Section 4.3 and attached Calculation Sheet 2). These calculations considered seasonal variation of upward gradients based on water level data from monitors below the existing quarry floor. The analysis assumed an average hydraulic conductivity for the competent bedrock of k_h=2.5 x 10^{-8} m/s. The vertical hydraulic conductivity was assumed to be 10 to 100 times lower than the horizontal, or k_v = 2.5 x 10^{-9} m/s to 2.5 x 10^{-10} m/s. The potential Darcy flux was calculated to be as low as 0.1 m^3/day to 1 m^3/day per hectare of quarry floor.

AECOM concluded that the results suggest that potential effects on the offsite wells due to the upward leakage would be insignificant largely attributed to the very small upward flow which would decrease over time, the greater distances of the wells from the quarry and the large available drawdown in the wells as well.

5.7 Surface Water

Site observations from 2005 to 2009 suggested that the springs and to a much smaller degree, the identified surface water features (the north-west and south-east local wetlands) are dependent on the groundwater in the weathered bedrock zone. The recharge is seasonal and variable, depending on annual climate and activities of both humans and beavers in the surrounding area.

The quarry discharge is currently directed to the north-west part of the properties. The discharge contributes to maintenance of the wetland in this area which in turn drains offsite into the local drainage network. Any potential impacts to the weathered bedrock zone in this area are already mitigated by this system. Continuation of this practice will provide the mitigation of potential impacts to the north-west wetland from the proposed quarry expansion.

5.8 Springs

The springs in the north-west portion of the Miller property in the vicinity of the proposed excavation could potentially be impacted by the proposed operation. In this area, the excavation approaches and may intercept part of the upper spring zone.

The conceptual model suggests the hydrogeological aspect of the springs are theoretically already affected by the existing quarry. The existing quarry is situated entirely within the weathered bedrock zone (Figure 2). The radius of influence, calculated to be up to 190 m (Appendix D), now encompasses the entire upper weathered zone around the existing excavation. The existing impact area was examined in the natural heritage evaluation (SBA, 2011b), and the evidence collected showed that the vegetation within the theoretical impacted area (hydrogeology) has not been affected by the quarry.

The upper spring zone occurs where the weathered bedrock zone contacts underlying competent bedrock between approximately elevations 133 to 137 m ASL. The discharge from the springs flows across the competent bedrock step in the slope before draining abruptly into dissolution and emerging again at the base of the second weathered zone at the lower spring zone. In the north-west portion of the Miller property, the spring zone emerges into the wetland.

A small portion of this spring may be diverted into the excavation under the proposal. If this occurs, the infiltration will accumulate in the sump and will be pumped back out to the wetland. Therefore, there may be a temporary diversion of a small quantity of water that in the pre-development setting emerged as springs but in the post development will be re-circulated through the quarry.

During the operations, the impact to the local hydrogeological system will be completely mitigated by the quarry de-watering operation. A small portion of the upper springs will be diverted into the excavation between cessation of operations and full rehabilitation. At full rehabilitation, the flow will be re-established to the pre-development condition with the quarry lake as the recharge source.

The groundwater impacts on the weathered bedrock zone will be monitored as described in Section 6. No additional monitoring will be required.

5.9 North-West Local Wetland

This surface water feature developed upon the clay-filled trough scoured into competent bedrock. There is no hydraulic connection between competent bedrock and the identified surface water features in this area.

The current quarry discharge will continue and contribute to the local wetland. The weathered bedrock contributes to this wetland in a minor way through recharge from the upper springs at approximately 135 to 137 m ASL. The upper springs are not the exclusive or primary recharge source to the wetland. The wetland exists primarily because of the Usborne St construction which impeded the natural overland runoff. The runoff will continue post-operation, and it is the significant contributor to the feature.

The natural environment assessment (SBA, 2012b) determined that the north-west local wetland supports common representative vegetation with no special features. The overall natural heritage value of this small wetland is minor, according to the natural environment report, and monitoring of the hydrogeological effects is not required. In the worst case, when the quarry is filling in the post-operations stage, a theoretical 17% reduction in drainage area could be diverted into the quarry (J. Clark, SBA, pers. comm.). However, this area is already within the radius of influence of the existing quarry with no natural heritage impacts evident. Monitoring and mitigation will not be required for this stage.

5.10 South-East Local Wetland

The local wetland is situated within a low-lying area of the competent bedrock. The hydrology report (SBA, 2011) indicates that approximately +/- 1% of the drainage area (approx. 0.8 ha of the total 77 ha area) of the feature is within the proposed excavation of the expansion. The opinion in the hydrology report is that the reduction in runoff and base flow to the feature from the loss of this capture area is "negligible".

The springs that contribute to the wetland are indirect surface water flow within the same drainage area. The recharge source for the springs in this area coincide with the area of competent bedrock within the wetland drainage area, which is equivalent to the area of impact identified in the hydrology report. Since the wetland is not groundwater dependent, the proposed expansion of the quarry will have an insignificant impact. No monitoring of the springs that contribute to the feature is therefore required.

5.11 Ryan Creek

The potential for contribution of the groundwater at the quarry to base flow at Ryan Creek was evaluated. The opinion is formulated from evaluating the Miller property setting and hydrogeology, the surrounding geology and from observing the hydrology between the site and Ryan Creek since monitoring began in 2007 for the Discharge Permit.

The geology of the plateau consists of thin till and sand and gravel over bedrock. As described, there are portions of the escarpment face that consist of weathered bedrock, and the weathering, developing initially during the post-glacial period, but continuing through the last 10,000 years has resulted in an interconnected surface water – shallow groundwater flow system consisting of runoff, abundant surface water accumulations and two levels of springs on the escarpment face on both the east and west sides. The patterns of flow were noted previously but were mapped in detail in the spring and summer of 2009.

The mapping showed a consistent pattern where the springs emerge at the base of the escarpment. Just down-slope on the plain below, the escarpment developed at depth below the surface of the Champlain Sea, and a thickness of clay, determined to be on the order of 7 m from local water well records, was deposited. This clay has a very low primary and secondary hydraulic conductivity, which results in a very low transmissivity. Any groundwater originating from the escarpment emerges as springs to the surface at the base of the escarpment or continues downward through the bedrock flow system.

Due to the low hydraulic conductivity/ transmissivity of the clay, no well or other discharge point such as a creek would be capturing groundwater from no further than 200 to 300 m. Therefore, very little to no groundwater from the escarpment, either from the quarry site or the plateau itself is providing base flow to Ryan Creek.

To verify this conclusion, flows from the discharge point on the quarry site through to Ryan Creek have been observed on a regular basis for 2009.

Groundwater that emerges as springs at the base of the escarpment drains overland through the roadside drainage network. During periods of peak flow, such as spring runoff or significant precipitation events (such as the 1:100-year or more- severe storm that occurred on July 24, 2009), runoff from the base of the escarpment combined with runoff through the drainage network from

Usborne Street, down Campbell Road and then along Carmichael Road does reach Ryan Creek, but this period is brief. In periods other than these peak or anomalous events, the flow in the drainage system was observed to end consistently along Campbell Road.

From this point on, the drainage system is dry to Ryan Creek. The location was marked each time a monitoring event is completed since monitoring for the discharge permit began in the spring of 2009 through that monitoring year. The quarry began dewatering on March 23 2009 and weekly observations were made through to April 28, followed by monitoring events geared to various stream and quarry stages during the season. SW 5, one of the monitoring stations for the discharge permit, is situated approximately half-way between Campbell Road and Ryan Creek. Selected conditions recorded from 2007 to 2009 are noted in Table 6.

During the above-referenced period, there was no flow to Ryan Creek observed from the plateau under normal weather conditions from mid-May through to the end of the year. The actual impact of the quarry discharge is minimal if there is any. In 2009, there was a significant precipitation event on July 24. At that time, roads in the township and cottages along the Ottawa River were severely impacted by

Table 6: Selected Flow Conditions Recorded at Surface Water Monitoring Station SW-5, 2006 - 2009

Quarry Pumping Commences for Season	Observation Date	Status of Flow at SW 5
2007: April 10, 2007	April 19 2007	Spring runoff, flow
	July 20 2007	Significant precipitation event, flow
2008: April 8 2008	April 9 2008	Spring runoff, flow; 15 cm water depth @ 15.5 m/s
	April 28 2008	0.10 cm water@ 7.4 m/s
	May 5 2008	6 cm @ 0.67 m/s
	May 20 2008	Dry
2008: April 8 2008	June 3 2008	Dry
	Oct 10 2008	Dry
	Oct 15 2008	Dry
2009: March 23 2009	April 6 2009	12 cm @ 11.7 m/s
	April 20 2009	7 cm @ 3.13 m/s

Quarry Pumping Commences for Season	Observation Date	Status of Flow at SW 5
2009: March 23 2009	April 30 2009	4 cm @ 1.98 m/s
	June 9 2009	Dry
	July 22 2009	Dry
	July 25 2009	Storm 1:100 yr or more severe on July 24. Significant flow but damage to observed area watercourses widespread. Less than a week later, SW 5 was dry again.

flooding and wash-outs. Post-event photographs of the area where the quarry discharges reaches Ryan Creek showed that the significant impact came from the opposite side of the creek as evidenced from the matted vegetation and the gravel bars that developed in the creek.

In a memorandum dated November 28, 2008, Muncaster Environmental Inc. outlined the work completed on the aquatic habitat of Ryan Creek. The memorandum noted some vegetation that might be indicative of groundwater upwelling that contributed to the watercourse base flow. The areas were examined and the geological and hydrogeological conditions were noted on several occasions through 2009. No seepage was observed on any of the occasions.

Ryan Creek is located about 800 m west of the quarry excavation with the creek bed in low permeability overburden at an elevation of about 105 m ASL well below the final quarry floor (125 m ASL). Even if seepage were observed in the vicinity of the creek, it would be from localized sources and the groundwater would originate from within 200 to 300 m of the top of the banks; there would be no contribution by the quarry or discharge. The reasons include separation distances, the geological composition of the soils and the fact that the quarry will not impact the confined bedrock aquifer.

In the pre-development condition, the discharge from the quarry would have flowed into the system through the springs and then overland towards the creek. There is no groundwater currently entering the quarry from below the weathered zone, so the quarry operation is currently adding no flow to the system. The current quarry discharge management removes water diverted from the pre-development setting but restores it to the normal flow pattern below the upper springs in the small wetland on the Miller property. Therefore, the existing flow pattern from the quarry is consistent in direction and quantity from the flow pattern before any quarry was established.

5.12 Time to Fill Quarry Following End of Operations

The water level in the excavation will fill from precipitation over the excavation, runoff (transmitted in part through the weathered bedrock), and inflow of groundwater from the underlying bedrock aquifer. The final lake elevation is predicted to be approximately 132 m ASL, based on the understanding of the hydrogeology and the available field testing and monitoring data.

5.12.1 Surface Water Runoff into Excavation

An estimate of the time to fill the quarry upon completion of operations can be made as follows:

Quarry Configuration at Completion:

Final excavation area[2]: 684,000 m^2

Final water depth (to +/- 132 m ASL): 7 m

Final drainage area[3]: 916,000 m^2

Volume to fill = Excavation area x depth

= 4,788,000 m^3

Available Inflow from Surface Water Sources were taken from the SBA Hydrology Report:

Excavation will receive Water Surplus (precipitation minus evapotranspiration) at rate of: 0.374 m/yr[4]

For excavation, inflow = 684,000 x 0.374

= 255,816 m^3/yr

Excavation will receive runoff from surrounding drainage area at rate of: 0.187 m/yr[4]

From surrounding drainage area, inflow = (916,000 - 684,000) x 0.187

= 232,000 x 0.187

---

[2] From SBA Site Plans, dated Dec 10, 2007

[3] From SBA, July 2012

[4] SBA, 2012

= 43,384 m^3/year

Total available inflow = 255,816 + 43,385

= 299,200 m^3/year

5.12.2 Groundwater Influx From Water-bearing Zone

The analysis (Section 5.6) indicates that 0.1 to 1 m^3/day per hectare, of groundwater may seep through the quarry floor, which corresponds to about 2,500 to 25,000 m^3/year.

Influx through the floor will contribute until the depth of water in the quarry reaches approximately 2.5 m after approximately 6 years. The influx through the quarry floor will decline as the water depth rises above the static groundwater elevation. The groundwater flux between the quarry and significant water bearing zone will reverse, with the Darcy flux increasing as the water depth increases. The remaining quarry will take approximately 6 years to fill, for a total time to fill of approximately 12 years. The calculation of the quarry filling is found in Table 7.

Table 7: Quarry Fill Rate[5]

		Area	684,000	m^2					
		Annual Runoff	299,200	m^3					
		~static WL	127.5	m					
		quarry floor elev	125	m					
		final WL	132	m					
		elev WBZ	120	m					
		K	2.50E-10	m/s					
Year after dewatering stops	**height of water above WBZ**	**Elevation water Level**	**water depth (m)**	***i***	**Q=k*i*A (m^3/s)**	**Q=k*i*A (m^3/year)**	**rate with runoff**	**cum vol**	**cumulative depth**
1	5.1	125.1	0.1	0.48	8.21E-05	2590	301,790	301,790	2.27
2	5.5	125.5	0.5	0.4	6.84E-05	2159	301,359	603,149	3.40
3	6.0	126.0	1.0	0.3	5.13E-05	1619	300,819	903,968	4.16
4	6.5	126.5	1.5	0.2	3.42E-05	1079	300,279	1,204,247	4.73
5	7.0	127.0	2.0	0.1	1.71E-05	540	299,740	1,503,987	5.18
6	**7.5**	**127.5**	**2.5**	**0**	**0.00E+00**	**0**	**299,200**	**1,803,187**	**5.56**
7	8.0	128.0	3.0	-0.1	-1.71E-05	-540	298,660	2,101,847	5.88
8	8.5	128.5	3.5	-0.2	-3.42E-05	-1079	298,121	2,399,968	6.17
9	9.0	129.0	4.0	-0.3	-5.13E-05	-1619	297,581	2,697,549	6.42
10	9.5	129.5	4.5	-0.4	-6.84E-05	-2159	297,041	2,994,590	6.65
11	10.0	130.0	5.0	-0.5	-8.55E-05	-2698	296,502	3,291,092	6.86
12	**10.5**	**130.5**	**5.5**	**-0.6**	**-1.03E-04**	**-3238**	**295,962**	**3,587,054**	**7.05**

---

[5] Assumes negligible evaporation

6 Groundwater Monitoring Plan

To provide ongoing assessment of the conceptual model, and to refine impact predictions, the bedrock zone will be monitored. Monitoring of groundwater will be used to confirm the assessment on both groundwater and surface water conditions. Under current legislation, the monitoring program will be administered through the PTTW.

Groundwater monitoring is currently undertaken under the direction of the PTTW. That program entails measurement of water levels in the Miller property wells every other month.

The recommended groundwater monitoring program is summarized in Table 8.

The hydrogeological conditions at the site will be reviewed annually by a qualified professional retained by the company, and a report will be provided to the operator by March 31 of each year which will present and interpret the monitoring data for the 12 month period ending December 31 of the previous year.

Table 8: Proposed Groundwater Monitoring Program with Monitoring Wells Representing Hydrostratigraphic Setting Identified

Hydrostratigraphic Setting	**Representative Monitoring Wells**	**Frequency**
Weathered Bedrock Zone	TW 9-2, TW 10-1, TW 10-2, TW 13-1, TW 13-2	Bi-monthly (alternate months) beginning in March and continuing through the operating season to November
Upper Competent Bedrock	TW 11-2, TW 12-1, TW 12-2	
Competent Bedrock Aquifer	TW 2, TW 3-1, TW 4-1, TW 4-2, TW 5-1, TW 6-1, TW 7, TW 8-1, TW 9-1, TW 11-1 (significant water bearing zone likely intercepted) TW 1, TW 3-2, TW 5-2, TW 6-2, TW 8 2	

The annual review will include the annual and historic data, will assess the existing setting, document any groundwater-related problems such as well interference complaints that have occurred since the past review and provide any resultant recommendations for changes in operation, upgrades to the monitoring program, mitigation, or remediation. The report and data will be submitted to the Ministry of Environment, or in accordance with the requirements of the PTTW.

Every 10 years, an update of the hydrogeology report will be prepared. The objective of the report will be to provide the data and analysis that will project impacts in a 10-year advance time frame. The analysis will be based on the projection of the next 10-years' operations and will include an updated well inventory for at least 500 m, or for the predicted area of influence if it is greater, around the projected 10-year excavation.

The rationale for updating and staging the inventory is that it will ensure that data collected and analyzed is current to the operating period and projected operations over a real timeframe, and will contain current information with respect to area water supply requirements and uses, the geographical development of the surrounding area, current (to the application time) legislation and other factors that may influence the hydrogeological regime and impact assessment. The recommended procedure is, in summary;

1. Evaluate past data and identify any changes, improvements, etc. that might be required.
2. Define the projected operations in the next 10-years, and model the predicted impact of the projected operations using current monitoring and pumping information.
3. Update area information, environmental, well uses, etc., in the 500 m or projected radius of influence of the 10-year period, using door to door survey or other measures.
4. Identify any wells or environmental features that may potentially be impacted by the next stage of operations.
5. Implement specific measures to monitor and/or remediate to mitigate the predicted negative impacts before they occur.

It is recommended that the target date for the first update report be July 2015, in preparation for the current PTTW expiry date of July 31, 2017[6], following on a 10-year cycle thereafter.

7 Trigger Mechanism

The trigger mechanism will have two components. The emphasis is on preventing impacts through monitoring and predictive modeling. The monitoring data will be reviewed annually by a qualified professional. This analysis will permit an evaluation of ongoing impacts and will provide a prediction of upcoming problems and will provide advance warning of any off-site impacts. If off-site impacts are forecast as a result of the annual review, the potentially impacted wells will be investigated and an appropriate remedial action taken and/or the operations will be reviewed and modified as necessary to prevent the problem from occurring.

Even with substantial data and an accurate model, occasionally unexpected problems occur. To address this possibility, an emergency response program will be implemented with response triggered by the distance from the properties boundary. If an unexpected problem occurs, an investigation and remediation program will be triggered as described in the Contingency Plan.

One specific trigger mechanism is recommended related to the groundwater monitoring network. Monitors TW 9-1, TW 9-2, TW 10-1, TW 10-2, TW 12-1, TW 12-2, TW 13-1, TW 13-2 will be replaced with new monitors more distant from the extraction boundary if a groundwater level drawdown in excess of

---

[6] Amended PTTW, in process at time of report preparation, has a revised expiry date of July 31, 2007 (June 11, 2012 communication with MOE)

1 metre (maximum yearly drawdown) is indicated to have occurred as a result of extraction. The location of the replacement well(s) will be dependent on the site conditions and available data at the time of the event.

A second specific trigger mechanism is recommended relating to the south-east wetland. If a groundwater level drawdown in excess of 1 metre (maximum yearly drawdown) is indicated to have occurred as a result of quarry extraction in monitors TW 8-1, TW 8-2, TW 10-1 or TW 10-2 further investigation will be instigated on the south-east wetland. With permission of the landowner, the wetland will be surveyed to collect data, if possible, and climate records and other site information will be examined. An evaluation of the impact of the quarry on the south-east wetland will be completed.

8 Mitigation/ Contingency Plan

8.1 Impacts to Weathered Bedrock and Surface Water

The hydrological study (SBA, 2011) and natural environment study (SBA, 2011b) found that the surface water features were not identified in the municipal documents or during the studies as areas requiring environmental protection, as Provincially Significant Wetlands or as sensitive areas of concern. The predicted impacts on the south-east local wetland due to the proposed quarry excavation is small (SBA, 2011 and this report, Section 5.10).

The existing quarry discharge management is currently directed from the sump towards the north-west part of the properties. The discharge contributes to the maintenance of wetland in this area which in turn discharges off site into the off-site drainage network. Any potential impacts to the weathered bedrock zone in this area are already being mitigated by this system. Continuation of this practice through the quarry operation will provide the necessary mitigation of potential impacts to the weathered bedrock zone from the proposed excavation.

Section 7 describes a mechanism that will be used to trigger an additional investigation of potential impacts of the quarry operation on the south-east local wetland. If the requirement is triggered, the impact by the quarry on the south-east wetland will be evaluated and if necessary, recharge to the affected area will be implemented. This will be achieved by construction of a recharge trench in the area identified, and water from the quarry sump will be diverted to the trench as required to restore the conditions.

8.2 Off-Site Groundwater Users

The implementation of the contingency plan for surrounding groundwater users will depend on how a problem is encountered.

8.2.1 Receipt of Unexpected Well Problem

If a well problem is identified to the operator, the operator will undertake the following staged remedial plan:

1. To locations within 500 m of the property boundary, provide an interim potable water supply (within 24 hours, as indicated in PTTW 0035-6T8HMJ);
2. Within 1 kilometer of the site, notify the appropriate regulatory agency or agencies of the complaint;
3. Retain a qualified professional at the operator's expense to conduct a site investigation, determine the cause, and within 15 days provide a report with recommendations on the best way to remediate the problem.
4. If it is found that the quarry operation is responsible, restore the water supply to its original condition or better.

8.2.2 Predicted Negative Impact on Neighbouring Wells

Data will be collected under the prescribed monitoring program agreed to with the appropriate regulatory agency or agencies (i.e. through the Permit to Take Water or Site Plan Conditions) and will be reviewed as described in Section 6. If a negative impact on a neighbouring well or wells is predicted through a hydrogeological review, the specific well conditions will be evaluated, and the predicted impact will be remediated based on the evaluated conditions. The remediation may consist of lowering or replacing the pumping equipment, or deepening the well(s) by Miller Paving Limited or their representative in advance of the impact, with owners' permission, to access the available and proven deeper water bearing zones that will not be affected by the quarry operation.

8.2.3 Replacement Well Quality

Remedial wells constructed within the Rockcliffe Formation may encounter poor natural water quality issues such as natural gas or salt, based on the available data. These problems most likely be limited to wells on the east side of the Miller site. To mitigate the issues of naturally poor water quality in the Rockcliffe Formation, first, the effort will be made to construct the well to a final depth above the Rockcliffe Formation, if possible to obtain a suitable water quantity. If natural water quality exceeding the Ontario Drinking Water Standard is encountered, water treatment will be recommended.

8.2.3.1 General Recommendations for Water Treatment

Natural gas issues would generally be addressed through venting, salt for drinking water can be treated with reverse osmosis, and water softeners or other specific iron treatment systems are available. Bacterial issues are resolved through proper well construction and treatment such as a cartridge filter plus an ultraviolet system, or chlorination or hydrogen peroxide treatment systems. Bacteriological problems are not anticipated in replacement wells as well construction will be to O.R. 903 standards, requiring casing and sealing of the annulus into competent bedrock.

8.3 Protection of Groundwater Quality

Protection to the groundwater and surface water from contaminants from an asphalt plant or other contaminant will be accomplished through management and operation of the materials and equipment to the industry standards and legislative requirements. Equipment such as the asphalt plant or a refuelling area and materials storage will be installed in an appropriate container on an impervious platform with secondary containment. Regulatory requirements of the Technical Standards and Safety Authority will be adhered to as part of the operational practice.

A minimum of 30 m will be maintained between the asphalt plant and any surface water source, including the sump, the settling pond, and the culvert / ditch system used for quarry discharge, or from any other surface water source.

8.4 Emergency Spills Procedure

An emergency spills procedure is already in place at the existing quarry following corporate procedures, and it will continue to be implemented at the expanded operation. Miller senior staff advised that the site manager is trained in the emergency spills procedure and that pertinent telephone numbers are kept at the site office.

It is recommended that the emergency plan include the following components: Any unexplained losses of fuel or other contaminants will immediately be reported to appropriate levels and/or agencies. A quantity of appropriate clean-up material such as absorbent mats and granular absorbent material will be kept on site when the quarry is operating. If a spill occurs, action will immediately be taken to contain and absorb the spilled material. The reporting requirements of the Ministry of Environment will be followed under the responsibilities of the designated staff at the main office, and who will be responsible for assuring that proper clean-up has occurred.

Part 2 –Conclusions and Recommendations

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Township of McNab-Braeside

Project Ref. 08360

July 2012

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

9 Summary and Conclusions

Predicted effects from the proposed Braeside Quarry expansion by Miller Paving Limited will either have limited impacts on the surrounding groundwater and surface water environment, or the impacts can be mitigated.

The testing and data collection on the site identified three potential aquifers in the area, the overburden aquifer, the weathered bedrock aquifer and the deeper confined bedrock aquifer. Area groundwater users rely on the shallow weathered bedrock aquifer and the deeper bedrock aquifer for water supply.

The first potential aquifer, the overburden aquifer, is discontinuous and minimal on the site but may be present in other locations. Where present, it may form a restricted local aquifer. Most commonly in this setting, the overburden provides storage of groundwater, while the underlying weathered bedrock provides the transmission into a well.

Where there is no overburden present, the second potential aquifer, the shallow weathered bedrock aquifer has a high degree of connectivity to the surface and is influenced by precipitation events and runoff.

Underlying the shallow weathered bedrock is the third potential aquifer, the semi-confined to confined bedrock aquifer. Small and discrete water bearing zones occurring within the competent bedrock aquifer are discontinuous and of low yield. The first significant water bearing zone, which is used for local water supply, is found between 120 to 117 m ASL about 5 m below the proposed quarry floor (125 m ASL). The water-bearing zones are not directly connected to the local surface, but are recharged through more regional basis. In the area, this aquifer discharges on either side of the escarpment through springs at approximate elevation 125 m ASL. These springs provide some recharge to the surface water systems and overburden aquifer.

The analysis of the site conditions shows that the proposed excavation will not impact the local groundwater setting due to the natural topography and geology. The escarpment on which the property is situated is a major influence on the hydrogeological regime of the area, controlling the groundwater elevation surface at 125 m ASL. The expansion of the quarry, which will remain at least 5 m above the significant water bearing zones in the area, will not have additional impact.

The predicted drawdown effects on local wells due to quarry dewatering under the worst case scenario are insignificant and can be readily mitigated, if needed. Neither of the two local wetlands adjacent to the site were classified as significant or sensitive wetlands (SBA, 2012a). The continued management of discharge from the quarry in the manner currently used at the site will maintain the natural surface water and shallow groundwater flow regime.

A groundwater monitoring program is proposed that will provide protection to surrounding groundwater users against perceived or actual impact from the proposed quarry operation, even though no additional impacts are predicted. Water level measurements taken every other month in site wells will be evaluated annually and compared to historical results. An annual report will provide any recommendations on changes required, mitigation or remediation.

The comprehensive hydrogeological assessment will be re-evaluated on a 10-year cycle. The groundwater model and impact prediction will be updated based on the prediction of the next 10-year operation, and any predicted impacts will be mitigated before they occur.

Upon completion of the excavation of the quarry, the pumps will be turned off and the quarry will be allowed to fill with the water surplus associated with the quarry and infiltration/ runoff through the shallow weathered bedrock aquifer that drains to the quarry. The final lake level in the excavation is predicted to be approximately 132 m ASL, and the groundwater flow regime will be reinstated to the pre-development setting.

10 Recommendations

The following is a summary of the recommendations from the hydrogeological investigation.

a. The quarry floor should extend no lower than 125 m ASL.

b. A regular groundwater monitoring program will be continued. The details of the program will be amended as necessary based on an annual review and interpretation of the data with input from a qualified professional representing the operator, and the regulatory agency or agencies.

c. An annual review will be completed by a qualified professional. Any predicted problems identified will be addressed before they occur.

d. If an unexpected complaint regarding water supply is received, an investigation will be conducted by a qualified professional, and if the problem is attributed to the quarry operation, remediation or compensation will be offered by the operator as soon as possible.

e. Every 10 years, an update of the hydrogeology report will be prepared. The analysis will be based on the projection of the next 10-years' operations and will include an updated well inventory for at least 500 m around the excavation, or for the predicted area of influence if it is greater. The first review should be conducted a year before the Permit to Take Water expiry date.

f. The depth of the pump chamber installed in the lower lift should not extend below 123 m ASL. The chamber should be constructed with a hoe-ram or comparable equipment to minimize disturbance to the underlying bedrock.

g. The lower lift pump chamber should be located at the northeast corner of the existing quarry excavation to maximize the distance from local wells.

h. The quarry discharge should continue to be managed in the current pattern to maintain existing flows on west, north-west part of the Miller properties.

i. An emergency spills plan should be regularly reviewed by Miller and revised as necessary to meet regulatory requirements. The plan should be posted at the site with pertinent company and MOE telephone numbers. A supply of appropriate materials for containment and absorption should be maintained in a convenient location.

j. The operation should include best management practices with regard to water discharge management and water conservation at the quarry.

11 Qualifications

As required in the Report Standards for Category 2 Applications, Section 2.2.10, we make the following statement. All site investigation and testing was completed by or under the direct supervision of George A. Gorrell M.Sc. F.G.A.C. (reported in Appendix A). The analysis and report were prepared by Jennifer B. Gorrell M.Sc. P.Eng. P.Geo, with acknowledgements to AECOM Canada Ltd. where noted. Curriculum vitae are attached as Appendix E.

12 Peer Review Process

Golder Associates Ltd. (Golder) were retained by the County of Renfrew to conduct a technical review of various reports related to the proposed quarry application. Golder reviewed and provided comment on GRI Reports:

> Hydrogeological Investigation, Braeside Quarry Expansion Part Lots 16 and 17, Conc. A, Township of McNab-Braeside; Report No. 05460, September 2007.
>
> Consolidated 2006-2009 Hydrogeological Investigation, Proposed Braeside Quarry Expansion, Part Lots 16 and 17, Conc. A, Township of McNab-Braeside; Report No. 08360, November 2009.
>
> Summary Report, Hydrogeological Investigations; Proposed Braeside Quarry Expansion, Part Lots 16 and 17, Conc. A, Township of McNab-Braeside; Report No. 08360, June 2010.

The correspondence related to the Peer Review being conducted on behalf of the County of Renfrew, and provided replies are listed below. Since July 2010, BGC Engineering Inc. has acted as a mediator and facilitator for Jennifer B. Gorrell M.Sc. P.Eng. P.Geo..

September 11, 2008	Golder Comments on Assessment Report
November 29, 2009	GRI Reply to Golder Comments
March 9, 2010	Golder Comments on both November 2009 GRI Reply and Consolidated Report
July 31, 2010	GRI Reply to Golder’s March 9, 2010 Comments
November 5, 2010	Golder Comments on GRI Summary Report
March 17, 2011	Response to Golder Comments on Summary Report (BGC, 0910-006)
May 10, 2011	Golder Letter to County on Natural Environment, Hydrology and Hydrogeology
June 9, 2011	BGC Letter to Skelton Brumwell & Associates Ltd. addressing Comments in Golder Letter to County

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

July 4, 2011	Skelton Brumwell & Associates Inc. letter to Tom Jones, Miller Paving Ltd. Re Combined Response to Golder May 10, 2011 Letter.
August 16, 2011	Golder Letter to County on Natural Environment, Hydrology and Hydrogeology
December 11, 2011	Draft Final Hydrogeological Report by GRI submitted
February 29, 2012	e-mail from Brian Byerley, Golder, to Gary Bell, Skelton Brumwell & Associates Inc.; Subject: Miller Braeside Quarry Technical Reviews
April 5, 2012	BGC Reply to February 29 e-mail to Tom Jones
July 2012	Final Hydrogeological Report by Jennifer Gorrell and George Gorrell

13 Closure

The work in this report was conducted by or under the supervision of Jennifer B. Gorrell M.Sc. P.Geo. P.Eng. Mrs. Gorrell's qualifications are found in Appendix E. If you have any questions about this report, please feel free to contact one of the undersigned.

Respectfully submitted;

This document issued as an electronic copy. Original signed and sealed by:

Jennifer B. Gorrell M.Sc. P.Eng. P. Geo.

References

Chapman, L. J. and D. F. Putnam; *The Physiography of Southern Ontario, Third Edition*; OGS special volume 2, Accompanied by Map P.2715, scale 1:600,000; 1984.

Charles E. Mitchell, Adhya, S., Bergstrom, S.M., Joy, M.P., Delano, J.W.; Discovery of the Ordovician Millbrig K-bentonite Bed in the Trenton Group of New York State: implications for regional correlation and sequence stratigraphy in eastern North America; Palaeogeography, Palaeoclimatology, Palaeoecology Vol. 210, pp 331– 346; 2004.

Derry Michener Booth and Wahl and Ontario Geological Survey; *Limestone Industries of Ontario Volume II - Limestone Industries and Resources of Eastern and Northern Ontario*; Ontario Ministry of Natural Resources, Land Management Branch; 196 pp, 1989.

Driscoll, F. G.; *Groundwater and Wells, 2ed*.; Johnson Division, Minnesota; 1986.

Gorrell, G.A. 1991. *Buried sand and Gravel Features and blending sands in Eastern Ontario.* Open File report 5801, Ontario Geological Survey.

Gorrell Resource Investigations; *Preliminary Evaluation of Groundwater Table, Braeside Quarry*; prepared for Smiths Construction; letter to Steve Duncan dated March 17 2000.

Gorrell Resource Investigations; Permit to Take Water Application, Braeside Quarry, Part Lot 16 & 17, Concession A, McNab Township, Renfrew County; GRI Report 02180 dated March 2004.

Gorrell Resource Investigations; RE: Reference # 2520-69WL2P, Ministry of Environment Letter dated May 25, 2005, Permit to Take Water Application, Braeside Quarry, Part Lots 16 and 17, Conc. A, Township of McNabb; letter to Kyle Stephenson dated July 8, 2005.

Gorrell Resource Investigations; Hydrogeological Investigation Braeside Quarry Expansion, Part Lot 16 & 17, Concession A, Municipality of McNab/Braeside, Renfrew County; GRI Report 05460 dated September 2007.

Gorrell Resource Investigations; Consolidated 2006-2009 Hydrogeological Investigation, Proposed Braeside Quarry Expansion, Part Lot 16 & 17, Concession A, Municipality of McNab/Braeside, Renfrew County; GRI Report 08360 dated November 2009 [incorporated into and superseded by current report).

Gorrell Resource Investigations; Summary Report, Hydrogeological Investigation Braeside Quarry Expansion, Part Lot 16 & 17, Concession A, Municipality of McNab/Braeside, Renfrew County; GRI Report 08360 dated June 2010 (incorporated into and superseded by current report).

Liberty, B. A. Paleozoic Geology of Wolfe Island, Bath, Sydenham and Gananoque Map-Areas, Ontario; Paper 70-35, Report and Maps 17-1970, 18-1970, 19-1970 and 20-1970, Geological Survey of Canada, scale 1:50,000. 1970.

Muncaster Environmental Planning Inc.; Interoffice Memorandum re Miller Braeside Quarry Expansion; Ryan Creek Autumn, 2008 Observations; November 28, 2008.

Richard, S.H., *Surficial geology, Arnprior (1G/3), Ontario and Quebec.* Geological Survey of Canada Map 1599A. scale 1:50,000, 1984a

Royle, Michael; Standard Operating Procedures for Borehole Packer Testing; www.robertsongeoconsultants.com/hydromine/topics/Site_Assessment/Packer_testing.pdf; accessed April 29, 2009.

Skelton Brumwell Associates Inc.; Braeside Quarry Expansion, Hydrological Investigation, Township of McNab/Braeside, County of Renfrew; 2012.

Skelton Brumwell Associates Inc.; Braeside Quarry Expansion, Natural Environment Report Level I and II, Township of McNab/Braeside, County of Renfrew; 2012b.

Skelton Brumwell Associates Inc.; Miller Braeside Quarry Expansion, Hydrological Investigation Report – Response to Golder Peer Review; letter to Miller Paving Limited; December 17, 2008.

Smart, Christopher C.; Glacier hydrology and the potential for subglacial karstification; Norsk Geografisk Tidsskrift - Norwegian Journal of Geography, Volume 38, Issue 3 & 4 1984 , pages 157 – 161.

Taylor, Peter G.; Re: Braeside Revised PTTW; email dated June 11, 2012 to: Jennifer Gorrell, cc: Tom Jones.

Theim, G.; *Hydrologhsche methoden*. Leipzig, 1906 56 p. [Referenced in *Groundwater and Wells*]

Wadham, J.L. 2006 *"Solute enhancement in the proglacial zone"*; Glacier Science and Environmental Change, P. G. Knight (ed); Wiley-Blackwell; August 2006.

Williams, R. R. Wolf and D. A., A. M. Rae; *Palaeozoic Geology of the Arnprior-Quyon Area, Southern Ontario*; Ontario Geological Survey, Map P2726, Geological Series-Preliminary Map, scale 1:50,000, Geology 1982; 1984.

Williams, D.A. and P. Telford *Palaeozoic Geology of the Ottawa Area. Field Trip 8 Guide Book*, G.A.C., M.A.C. and C.G.U. Joint Annual Meeting Ottawa. 25pp. 1986.

Appendix A

Supplementary Information from 2002 to 2009 Field Investigations

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

Supplementary Information from 2002 to 2009 Field Investigations

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Township of McNab-Braeside

Project Ref. 08360

July 2012

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

Table of Contents

List of Tables

List of Figures

List of Appendices

1 Introduction to Appendix A- Supplementary Information

The hydrogeological investigations and reports completed for the Braeside Quarry Expansion in 2007 through to 2010 were produced by Jennifer B. Gorrell, M.Sc. P.Eng. P.Geo. and George A. Gorrell, M.Sc. P.Geo. F.G.A.C. operating under the name of Gorrell Resource Investigations (GRI). GRI ceased operations in 2010. Jennifer Gorrell and George Gorrell are now providing hydrogeological services for the Miller Paving Ltd. (Miller) Braeside Quarry as employees of BGC Engineering Inc.. BGC Engineering Inc. was not involved from the initial stages of the hydrogeological investigation or reporting. Therefore, the final hydrogeological report in 2012 will be signed by Jennifer B. Gorrell, M.Sc. P.Eng. P.Geo. and George A. Gorrell, M.Sc. P.Geo. F.G.A.C. as sole practitioners and members of the Association of Professional Geoscientists of Ontario.

1.1 Investigation History

Gorrell Resource Investigations (GRI) first began investigating the hydrogeology of the Miller properties in 2002 and expanded on the knowledge through a series of drilling and field testing programs in 2005 and 2009. Further groundwater monitoring data was collected up to the present date by G. Gorrell and others. This document consolidates the data and updates the interpretation and conclusions from the 2007 GRI Report 05460 and the additional testing completed in 2009. In 2009, AECOM was retained by Miller to provide an overview function.

The Gorrell's involvement with the Braeside property began in 2000 when the quarry underwent a site plan amendment to permit deepening by a second lift. GRI was retained to recommend a final quarry floor elevation. Data collected from groundwater monitors were then used to secure a Permit to Take Water (PTTW) for the site in 2005, followed by a Section 53 Certificate of Approval for Industrial Wastewater Treatment ("Discharge Permit") in 2007. In 2005, GRI was retained to examine an area for a proposed quarry expansion and to provide documentation on the hydrogeological setting and an impact analysis of the proposed operation. This information was provided in GRI Report 05460, dated October 2007.

Golder Associates Ltd. was retained by the County of Renfrew to review the report in the context of an application for a Zoning By-Law Amendment under the Township of McNab/Braeside Official Plan (Section 9.3(3)) and the application by Miller to the Ministry of Natural Resources (MNR) for a quarry license to extract below the water table (Golder, 2008). Preliminary comments were also received from the Ministry of Environment (MOE) and the Ministry of Natural Resources (MNR). In 2009, additional work was undertaken to corroborate interpretations made in the 2007 report and to address questions and comments provided by peer reviewers and agencies. The 2009 work plan was discussed with the peer reviewers before implementation to ensure that it would provide the additional requested information, but it is also intended to address initial issues raised in conversation with the above-referenced agencies.

The investigated property is adjacent to the existing Braeside Quarry, ARA License # 16173 on Part of Lots 16 and 17, Concession A, Township of McNab-Braeside (Geographic Township of McNab), Renfrew County. The site location is shown on Figure 1.

1.2 Limitations

George A. Gorrell M.Sc. P.Geo. F.G.A.C. (formerly operating as Gorrell Resource Investigations) prepared this report (the "Report") for the account of Miller Paving Limited (the Client). The material in the Report reflects the judgment of George A. Gorrell M.Sc. P.Geo. F.G.A.C. based upon the information made available to him at the time of preparation of the Report, including that information provided to him by the Client and consulting team members. Any use which a third party makes of this Report or any reliance on decisions to be based on it is the responsibility of such third parties. George A. Gorrell M.Sc. P.Geo. F.G.A.C. accepts no responsibility whatsoever for damages, loss, expenses, loss of profit or revenues, if any, suffered by any third party as a result of decisions made or actions based on this Report.

As a mutual protection of our Client, the public and George A. Gorrell M.Sc. P.Geo. F.G.A.C., the Report, and its drawings are submitted to the Client as confidential information of our Client for a specific project. Authorization for any use and/or publication of the Report or any data, statements, conclusions or abstracts from or regarding the Report and its drawings, through any form of print or electronic media, including without limitation, posting or reproductions of same on any website, is reserved by George A. Gorrell M.Sc. P.Geo. F.G.A.C., and is subject to George A. Gorrell M.Sc. P.Geo. F.G.A.C.'s prior written approval. Provided however, if the Report is prepared for the purposes of inclusion in an application for a specific permit or other government process, as specifically set forth in the Report, then the applicable regulatory, municipal, or other governmental authority may use the Report only for the specific and identified purpose of the specific permit application or other government process as identified in the Report. If the Report or any portion or extracts thereof is/are issued in electronic format, the original copy of the Report retained by George A. Gorrell M.Sc. P.Geo. F.G.A.C. will be regarded as the only copy to be relied on for any purpose and will take precedence over any electronic copy of the Report, or any portion or extracts thereof which may be used or published by others in accordance with the terms of this disclaimer.

2 Study Method

The 2005 study began with a review of the existing data and published information for the site and area. This included mapping and studies by Gadd (1963), Richard *et al* (1984), Williams *et al* (1984), Trotter *et al* (1986), Derry *et al* (1989) and Gorrell (Aggregate study of Renfrew County; unpublished). The water wells for the area were obtained from the Environmental Monitoring and Reporting Branch of MOE, examined and statistically analysed for area water use characteristics. Data on the two site monitoring wells installed in 2002 were reviewed.

Thirteen new test wells at eight locations TW1 to TW8 were constructed with a rotary percussion drill as sentry monitors around the perimeter of the property. The wells were constructed by Saunders Well Drilling under observation by George A. Gorrell M.Sc. P.Geo. F.G.A.C. (G. Gorrell). The wells were drilled to variable depths to distinguish, classify and isolate the different hydrogeological characteristics that had been identified for the area. The wells were tested in April and May 2007, and surface water and additional groundwater data were collected over the course of the study. A door-to-door survey was conducted in the summer of 2006 within 500 m of the licensed quarry to collect available information on neighbouring groundwater use.

In the 2009 study, ten additional wells at five locations (TW9 to TW13) were drilled on the site between January 13, 2009 and February 28 2009. The test holes were constructed using a diamond drill with HQ core. The equipment was operated by All-Terrain Drilling Ltd. of Waterloo under observation by G. Gorrell. Two additional exploration holes (F and G) were drilled on the quarry floor to depths within the licensed base by All-Terrain for Miller Group between March 1 and March 4 to obtain core for material quality testing unrelated to the hydrogeological investigation. The bedrock core was photographed and logged at the Smith Construction Ltd. Office in Arnprior, ON. The bedrock core was reviewed separately by AECOM staff.

Following the test hole construction at the TW9 to TW13 locations, the deeper well in each pairing was tested to assess the potential hydraulic conductivity. Two packers were installed to isolate either a 1.5 or 3 m zone. Packers were inflated to 400 psi and water flow was induced into the isolated zones at the rate required to sustain a constant pressure within the packer. Generally, four pressure steps were used for each test interval. The water flow at a given pressure step was measured as pressure steps were both increased and decreased.

Following drilling and packer testing, the boreholes were instrumented with 31.75 mm diameter PVC screens (1.5 to 3.0 m, length based on site conditions) attached to solid 31.75 mm diameter PVC risers. The annulus around the screen was packed with #4 silica sand and the remaining annulus was backfilled with bentonite. The wells were fitted with locking caps.

From May 4 to 8, 2009, rising head hydraulic conductivity tests were completed on the ten piezometers and on two additional open cored floor holes (F and G).

Groundwater levels in the monitoring network were recorded as part of the study and the regular groundwater monitoring program undertaken for the PTTW. Water level monitoring data is available from December 2006 to present.

In July, 2009, groundwater samples were collected from several springs, select monitors and surface water features for analysis of general groundwater geochemistry.

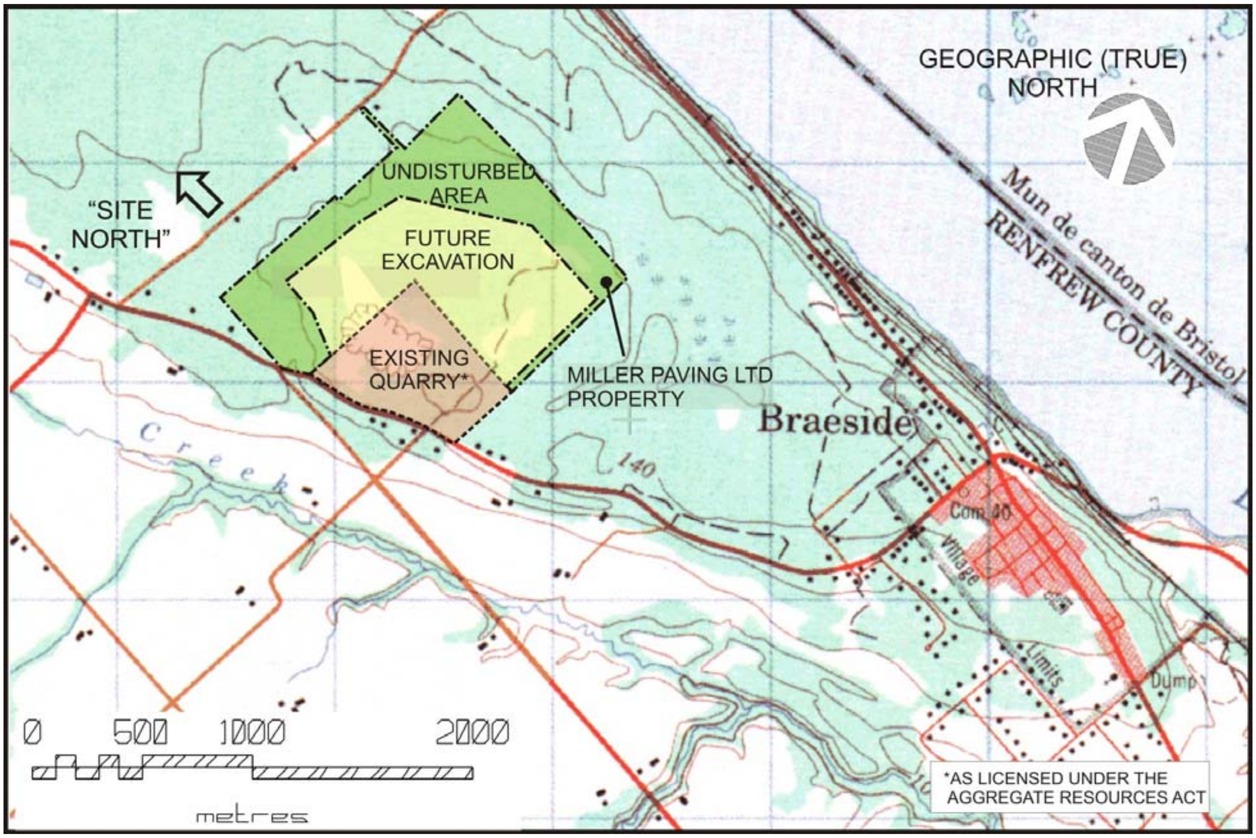
Between March and July 2009, the Miller property was traversed on a number of occasions to observe variations in the geological, hydrogeological and hydrological site conditions, the geological variations in weathering, the locations of springs and surface water features and the pathway that the sump discharge followed through the property. The purpose was to provide a comprehensive understanding of the hydrological/ hydrogeological relationship on the site and in the surrounding area. On April 17, May 22, May 26, June 3 to 8, June 10 and July 3, key or representative areas were documented photographically and by GPS tracking. The time span permitted documentation of changes that occurred through the snowmelt and spring runoff and continued through the summer so that seasonal changes to the system could be observed.

Beginning in June 15 2009, residents at 38 properties within 500 m of the existing quarry and proposed expansion license were interviewed. Where the homeowner was willing to participate, a water sample was taken for general groundwater characteristics. The purpose of collecting the information about area water supply wells, general groundwater use and quality was to add to the baseline information that was collected in 2006.

3 Site Setting

Miller Paving Ltd. (Miller) owns property located on Part of Lots 16 and 17, Concession A, Township of McNab-Braeside (Geographic Township of McNab), Renfrew County. Miller's land holdings, referred to in this document as the Site, or the Braeside Quarry, is shown on Figure 1. As indicated on Figure 1, part of the property is licensed under the Aggregate Resources Act (ARA), ARA License # 16173, to operate a quarry which is currently permitted to extract and process the bedrock reserves, and to operate portable asphalt production and concrete production plants. The existing quarry removes accumulations of water from the quarry under approvals under the Ontario Water Resources Act; Permit to Take Water # 0035-6T8HMJ allows water to be pumped from the excavation at rates greater than 50,000 L/day and Certificate of Approval for Industrial Waste Water Treatment # 6988-6VZJFB allows the treatment and discharge of the pumped water into the off-site surface water receiver.

Figure 1: Miller Paving Limited Braeside Quarry and Proposed Expansion



George A. Gorrell M.Sc. P.Geo. F.G.A.C. (G. Gorrell) was retained by Miller, initially through their subsidiary company Smith's Construction Ltd. and subsequently directly, to conduct hydrogeological investigations at the site.

For this study, the author was retained to investigate the hydrogeological setting of the proposed quarry expansion area and to provide recommendations for development of the expansion area, identify potential impacts of the proposed expanded quarry and to provide recommendations for mitigation if necessary. Reports prepared by Gorrell Resource Investigations (2002, 2007, 2009 and 2010) are listed in the report Reference section.

4 Site Characteristics

The quarry is located approximately three kilometres northwest of the Village of Braeside. The Miller properties are designated for Mineral Aggregate Reserve in the Township of McNab/Braeside Official Plan. The existing quarry property and a large portion of the surrounding area were originally used as a sand and gravel source in the 1930s where the upper 1 to 3 m consisted of wave-wash and wave altered flaggy limestone. Smiths Construction Co. Arnprior Ltd. bought the property in the 1950s and once the sand and gravel depleted, the site was operated as a quarry since approximately 1973 (Derry *et al*).

The site is located upon a bedrock plateau that runs parallel to the Ottawa River and extends for approximately 15 km from south of the Village of Braeside to north of Rhoddy's Bay on the Ottawa River. The majority of this plateau is undeveloped and covered with trees and has a relief on the order of 30 to 40 m with sharply dropping faces westward onto a clay plain and eastward into the Ottawa River.

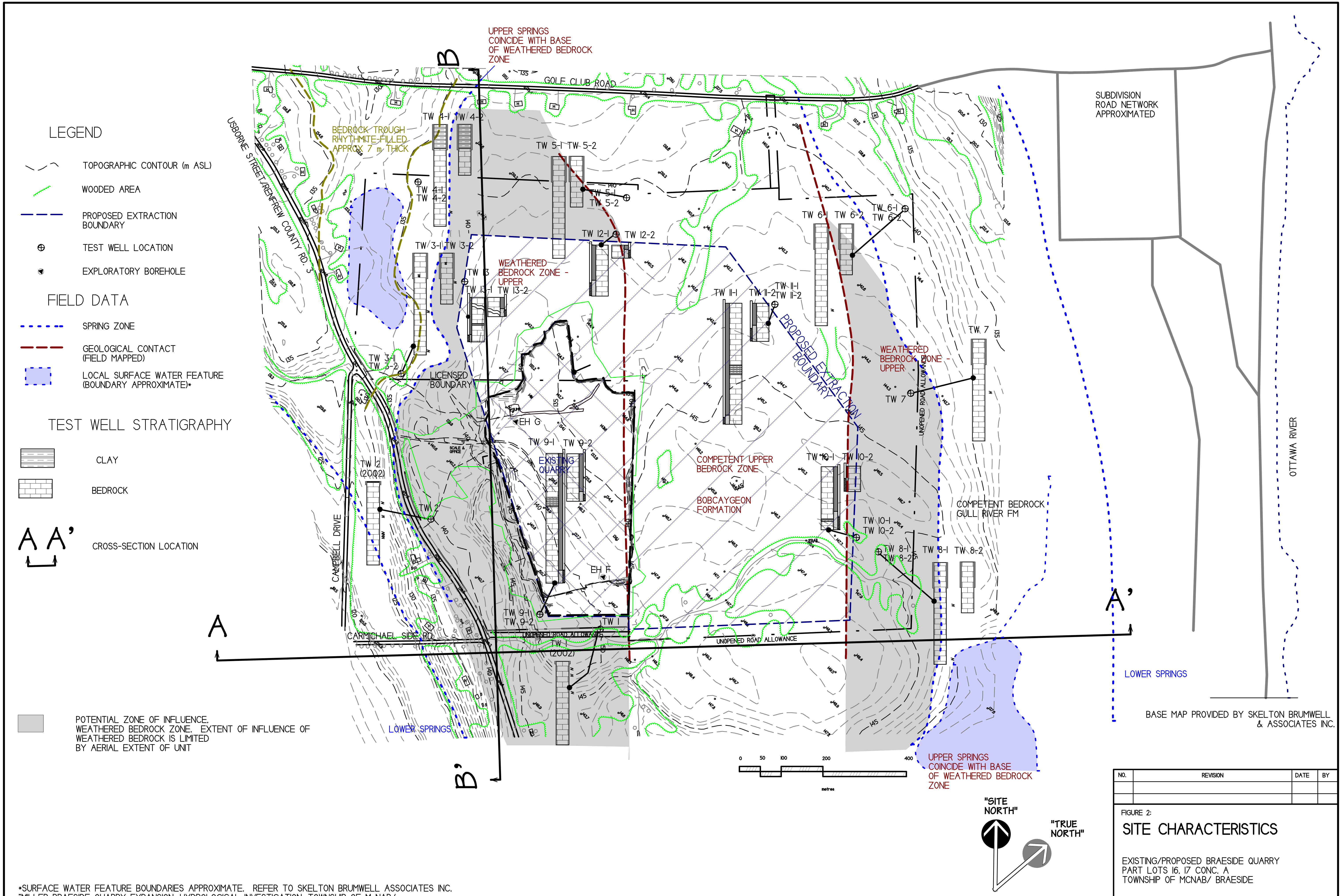
The clay plain is located within the valley that is located just west of the site. As shown on Figure 2, the land surface abruptly drops westward towards Ryan Creek. This is the physiographic region that Chapman and Putnam (1984) describe as Upper Reach of the Ottawa Valley Clay Plain. The feature consists of small to medium size valleys that are separated by uplands consisting of either Palaeozoic bedrock, such as is found on this site, or Precambrian bedrock. The closest Precambrian bedrock upland is located approximately 3 km south of the side.

5 Geological Setting

The Braeside quarry is situated on one of the many Paleozoic uplands located within the upper Ottawa Valley. The upland is an elongated and streamlined ridge that extends approximately six kilometres from Rhoddy's Bay in the northeast[1] to the Village of Braeside to the south. It reaches a maximum elevation of 154 m ASL and decreases on the east side to 81 m ASL (the Ottawa River) and to 106 m ASL on the western side. Geological cross-sections are found on Figure 3.

---

[1] Directions refer to site north, which is towards Golf Club Road, as shown on Figure 2.



LEGEND

- TOPOGRAPHIC CONTOUR (m ASL)
- WOODED AREA
- PROPOSED EXTRACTION BOUNDARY
- ⊕ TEST WELL LOCATION
- EXPLORATORY BOREHOLE

FIELD DATA

- SPRING ZONE
- GEOLOGICAL CONTACT (FIELD MAPPED)
- LOCAL SURFACE WATER FEATURE (BOUNDARY APPROXIMATE)*

TEST WELL STRATIGRAPHY

- CLAY
- BEDROCK

A A' CROSS-SECTION LOCATION

POTENTIAL ZONE OF INFLUENCE.
WEATHERED BEDROCK ZONE. EXTENT OF INFLUENCE OF
WEATHERED BEDROCK IS LIMITED
BY AERIAL EXTENT OF UNIT

BASE MAP PROVIDED BY SKELTON BRUMWELL
& ASSOCIATES INC.

NO.	REVISION	DATE	BY

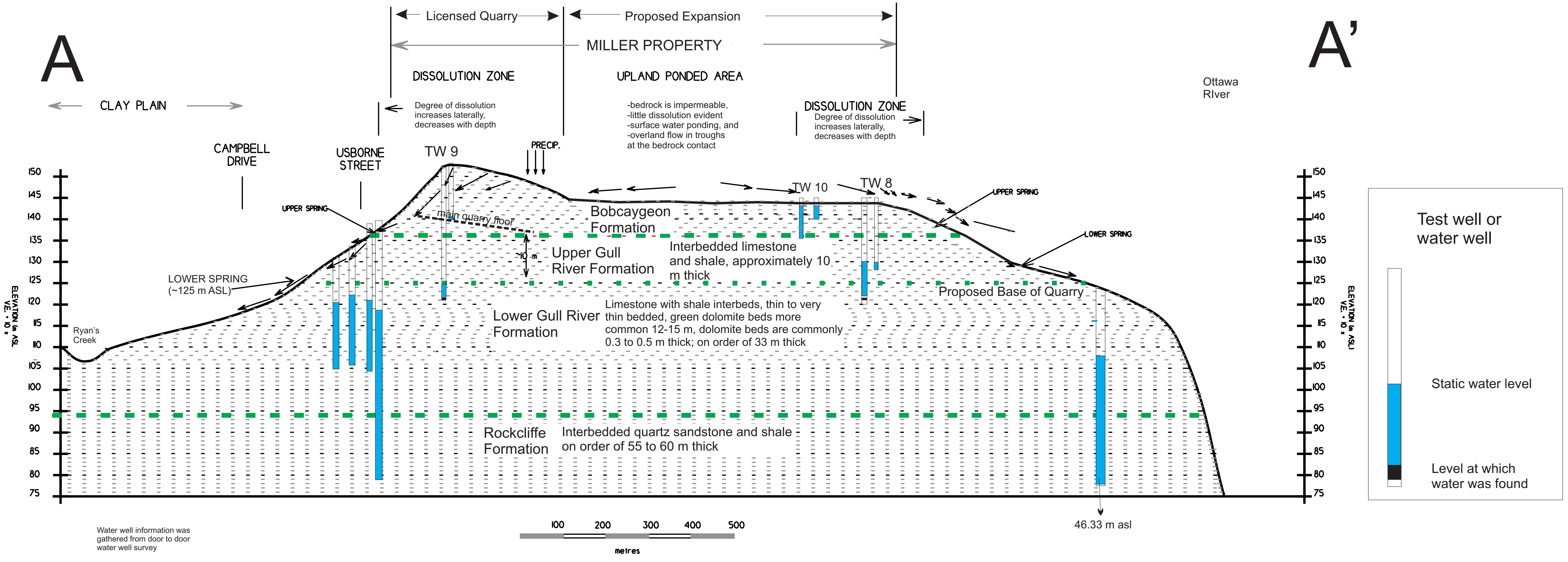
FIGURE 2:

SITE CHARACTERISTICS

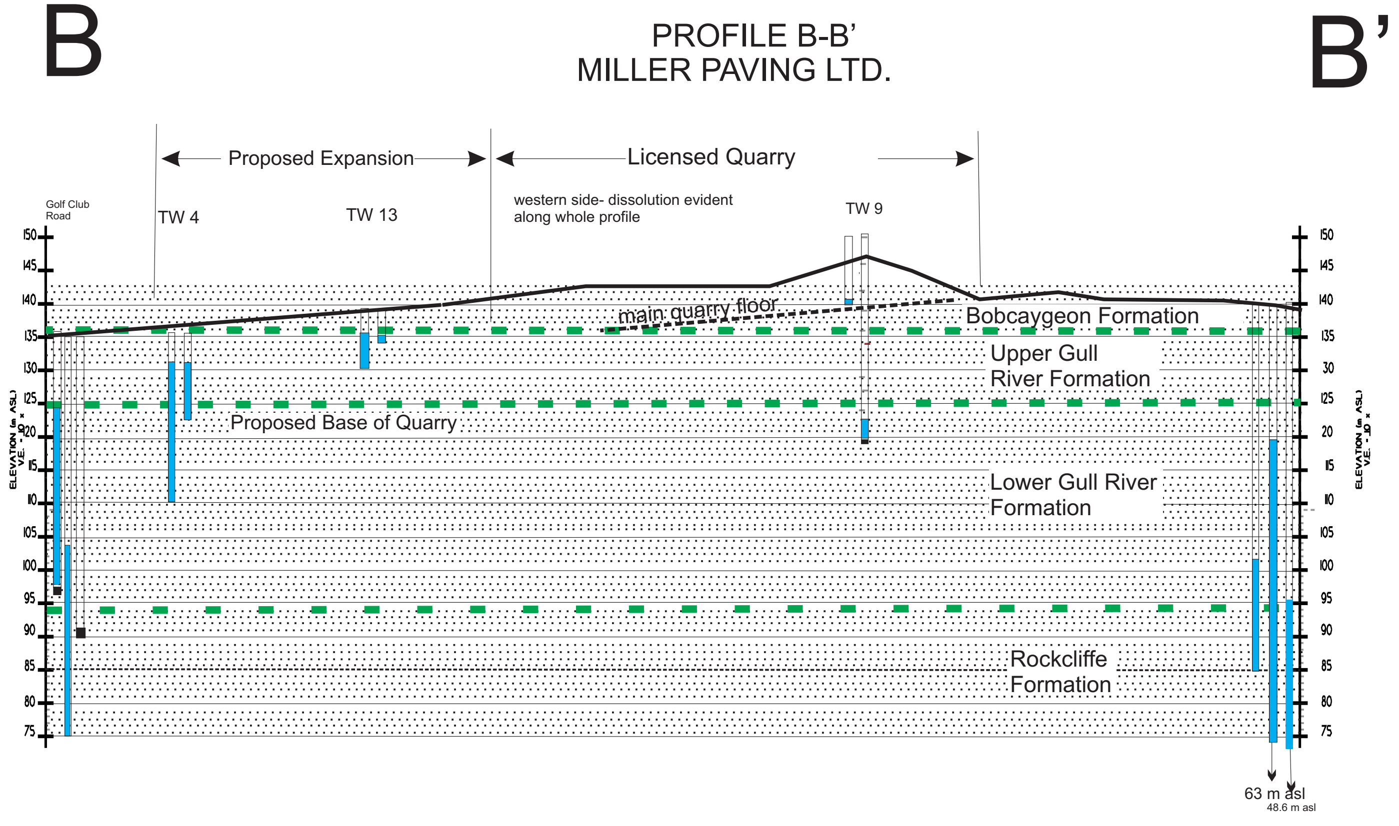
EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17 CONC. A
TOWNSHIP OF McNAB/ BRAESIDE

*SURFACE WATER FEATURE BOUNDARIES APPROXIMATE. REFER TO SKELTON BRUMWELL ASSOCIATES INC.
"MILLER BRAESIDE QUARRY EXPANSION, HYDROLOGICAL INVESTIGATION, TOWNSHIP OF McNAB/
BRAESIDE, COUNTY OF RENFREW" DATED MAY 2012.

PROFILE A -A’
MILLER PAVING LTD



PROFILE B-B’
MILLER PAVING LTD.



NO.	REVISION	DATE	BY

FIGURE 3:

GEOLOGICAL CROSS-SECTIONS A-A’ AND B-B’

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17, CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

5.1 Site Topography

On the site, the highest point of bedrock is in the south-east corner. From this location, the surface slopes gently to the north and north-west, and more steeply to the west. Regionally, the crest of the bedrock ridge has an elevation of 153 m ASL, and the base of the ridge is approximately 125 m ASL. On the site, the maximum elevation is approximately 150 m, sloping down to approximately 130 m in the north-west corner of the existing quarry. At the base of the ridge the gradient drops to less than 10%, and the ground surface slopes gently towards the Ryan Creek, which lies at an approximate elevation of 113 m ASL.

5.2 Bedrock Geology

The upland consists of the middle Ordovician-age bedrock formations, the Bobcaygeon and Gull River Formations, which are part of the Ottawa Group (Williams *et al*, 1984; Williams and Telford; 1986). The youngest bedrock unit on the site is the Bobcaygeon Formation (450 million years). The drilling and bedrock mapping that have been completed for this investigation indicate that this formation extends from an approximate elevation of 136 to 152 m ASL and forms an upper plateau or cap to the upland. The geological boundary of this formation with the underlying Gull River Formation is gradational.

The lower Bobcaygeon consists of light grey to brown microcrystalline to fine crystalline, thick to massively bedded limestone with interbeds of fine to medium grained calcarenite (Photo 1). Shale partings are generally thin, often wispy and are not present between every limestone bed. This formation was probably deposited in an intra-continental shelf environment which was a broad sea between continents that is commonly less than 10 m deep.

The gradational and conformable contact between the Bobcaygeon and the underlying Gull River Formation is defined as the base of the massive limestone unit of high purity. The detailed logging of Drill Holes 9 to 13 indicated that the contact ranged from 133.4 to 140.8 m ASL. The elevation of the contact is higher at the south end of the site, due to some structural changes to the bedrock.

The upper portion of the Gull River Formation below the contact is on the order of 10 m thick, which is consistent with the record from across the province. This upper portion of the formation consists of light grey microcrystalline to fine crystalline thin bedded limestone with shaly partings. The colonial coral tetradium is abundant in this member. A good example of this coral was intercepted in TW 13 (Photo 2).

In Drill Holes 9 to 11 and 13, a clay shale bed was observed in the Upper Gull River Formation between elevations of 127.8 and 140.8 m ASL (Photo 3). This is a K-bentonite layer (Liberty, 1969) that has been correlated to a widespread volcanic eruption in the middle Ordovician period. These beds have been recorded in the Kingston and Simcoe areas of Ontario.

The Gull River Formation stratigraphic column extends to the base of the upland on the west side. The lower bedrock along the Ottawa River has been identified as the Rockcliffe Formation (Williams *et al.*; 1984). That bedrock unit was not encountered during the field investigation for this study, but analysis from water well records and in the door-to-door survey from wells east of the site indicate that the Rockcliffe Formation has been encountered.

The St. Martin Member of the Rockcliffe Formation consists of interbedded fine-grained light greenish-grey quartz sandstone, shaley limestone and shale. The formation is generally reported as “red and green limestone” or comparably in water well records. From area well records it is inferred that the contact between the Gull River and Rockcliffe Formations slope downward to the east, and occurs between 64 m ASL and 94 m ASL.

5.2.1 Regional Bedrock Structure

GRI report 05460 commented that “throughout the area large open fractures are readily apparent”. The fractures were observed [in the quarry] to extend from the surface to appreciable depth. Rust staining and weathering of the bedrock from the surface to the base of the quarry (Photos 4 and 5) is observed on the quarry walls. This staining illustrates how surface water, in places where there are these openings, can migrate down to at least the base of the first lift in the existing quarry.

The weathering and widening of the upper bedrock was initially attributed to the entire Miller site. However, additional data collected in 2009 revealed that this weathering is not found across the undeveloped property, although the existing quarry is completely within the most highly developed part of that identified zone.

The dominant bedrock joint directions throughout North America are 85^{o}, 105^{o} and 175^{o} with spacing on the order of 5 m (Williams and Telford; 1986). Province-wide where the bedrock is within 4 m of the ground surface, these joints are commonly widened by solution. In the study area examined, which included the Miller property and adjacent lands publicly accessible, the investigation found that the joints are typically closed in the centre of the upland and are more open towards the flanks. Photo 6, taken in the lower lift shows that the enhanced fractures extend down to, but not through, the contact between the Bobcaygeon and Gull River Formations in the weathered zone[2].

In the centre of the upland in the area of upper competent bedrock, surface water will accumulate and then flow along the bedrock surface or overburden/bedrock contact to troughs or furrows that are eroded into the bedrock surface. From these furrows the water flows overland or through the overburden/bedrock contact to the margins of the upland, where the water disappears into the widened fractures and grikes. The dissolution[3] enhanced zones are present on both the east and western sides of the upland.

The joints were initially widened by one or more of several mechanisms: i) ancient tectonic and structural movement, ii) expansion of an unconfined face into an open area, with additional enhancement by iii) meltwater drainage through the upper bedrock fractures near the end of the last ice age, and iv) by post-glacial meteoric surface water flow. The manner of dissolution development and

---

[2] Photos 25 to 28 show additional photos of the lower lift

[3] Weathering of the limestone along the joints by water

enhancement continues today in a self-perpetuating pattern because of the upland setting with tight joints in the central portion and widened joints on the flanks.

The development is not restricted to the Braeside upland. The same patterns have been observed by these authors in the Paleozoic upland south of Clay Banks on the Renfrew and Lanark County boundary, on the two uplands near Panmure, and on the uplands near Constance Bay in West Carleton Township in the City of Ottawa.

5.3 Geomorphology and Surficial Geology

Figure 4 is an excerpt from the published geological mapping showing the regional surficial geology (Richard, 1984).

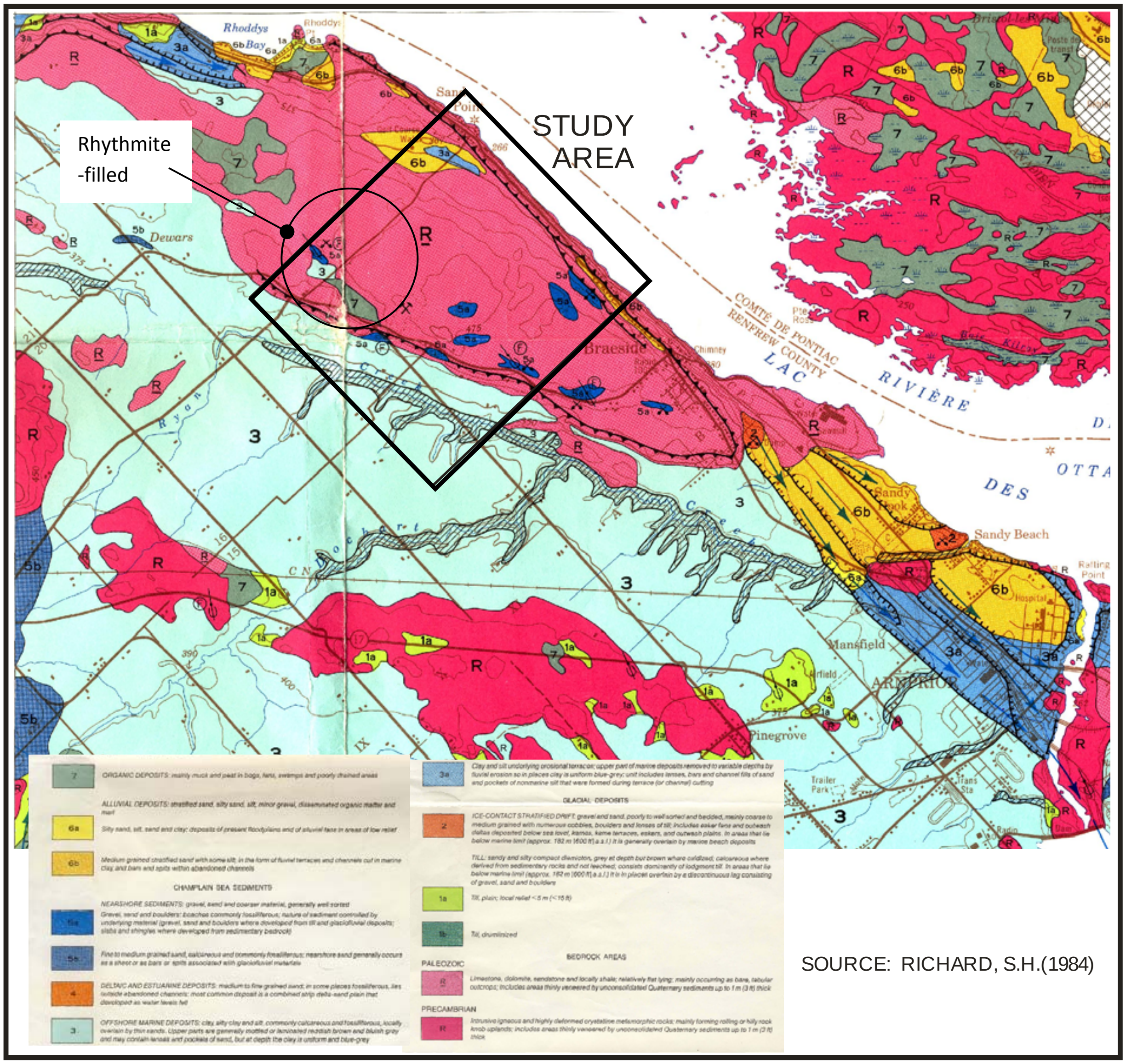
Glaciers covered the study area up until approximately 12,000 years ago. When they initially advanced across the region they eroded the existing sediment and scoured and plucked the exposed bedrock. There would have been influxes of meltwater at the base of the ice from up-ice lakes and water bodies. Meltwater from the ice surface would have drained through moulins and crevasses to the base. The glacier would alternate between being in direct contact with the bed (no water), or being partially supported by meltwater.

Under these circumstances, any bedrock blocks present during this period, such as those created by dissolution or erosion, would have been ripped away as the glacier refroze to the bed and advanced. The Dummer Moraine that extends from the Niagara escarpment to the Tweed area developed in this manner. The very large limestone blocks that are commonly found within the moraine originated when the glacier froze to the bed (ground surface) and plucked them from the surface.

In contrast, the Fort Covington till of this area does not contain these large bedrock blocks and boulders. If dissolution and weathering had occurred before or during the glacier advance, the weathered bedrock blocks would have been ripped away as they were during the formation of the Dummer Moraine that formed in the same period. Similarly to the Dummer Moraine terrain, the blocks and boulders would be found in the area till. This shows that the widened joints that are found along the margins of the upland had to have developed *after* the glacier advanced and actively eroded the area, or within the past 10,000 to 12,000 years.

Near the end of the last ice age, volumes and flows of meltwater at the base of the glacier increased exponentially as the glacier melted. The large glaciofluvial deposits that are present in the County of Renfrew such as those that are in the vicinity of Westmeath, Cobden, Round Lake, Sandy Beach, Arnprior and Galetta were deposited by these sub-glacial (under or through-ice) meltwater flows. Current work by the Geological Survey of Canada (work in 2008, 2009 and in prep) with continuous core drilling and kilometre -long seismic studies suggests that the glaciofluvial gravel is present beneath many of the valleys that are filled with clay in the upper Ottawa Valley basin. Well records for the area west of the upland do report occurrences of gravel, indicating that the condition is probably true for this area, that there are thick glaciofluvial sand and gravel beds below the clay. The clay plain west of the Miller properties may be the northern extension of the glaciofluvial assemblage that extends from the Village of Galetta, through the Town of Stittsville to Richmond (Gorrell, 1991).

Figure 4: Regional Surficial Geology Mapping (Richard, 1984)



SOURCE: RICHARD, S.H.(1984)

As the glacier retreated (melted) the massive volume of runoff generated by the melting glacier did not flow as a sheet covering the whole Ottawa basin, it was channelled around the large bedrock uplands and escarpments that are found in the area (Figure 4). On the top of the uplands, the glacier would have been grounded (frozen to and/or stuck to the ground surface), causing zones of high pressure where there would be no meltwater present. Near the margins of the uplands where the glacier was not grounded, meltwater, if present, was under high pressure due to the proximity to the grounded glacier. The high pressures increase the ability of the meltwater to dissolve calcium carbonate (Smart, 1984, Wadham, 2006), accelerating dissolution of existing weaknesses in the bedrock. The joint enhancement could have begun at this time. With meltwater flowing at the base of the glacier, the ice would have thinned. As the glacier further down-wasted and retreated from the area, the bedrock blocks formed by the enhanced fractures could not have been plucked, because at this late stage, the ice never re-grounded in the affected area due to the presence of water.

In the north-west part of the Miller property, just east of the junction of Golf Club Road and Usborne Street there is a trough in the bedrock surface that extends south-westward to cross Usborne St at the junction of Campbell Drive. This trough was probably cut by a combination of meltwater and glacier ice near the end of the last ice age. The sides of the trough are bedrock, but the base, at 130 m ASL is filled with clay rhythmites. A thickness on the site of up to 5.8 m was recorded in TW4-1 (Figure 2).

When the glacier completely retreated, the area was covered by the Champlain Sea. This sea was an extension of the Atlantic Ocean that covered the area due to the isostatic depression of the land[4] from the weight of the glacier. The sea extended from the Atlantic Ocean and covered most of the Ottawa Valley. Its western limit extended approximately from the Town of Renfrew in the northwest to the Village of Lanark in the west and down to the City of Brockville in the southwest (coinciding approximately with the east side of the Frontenac Axis).

The crown and upper margins of the upland are covered with a veneer of unconsolidated sediment. The majority of the sediment has limnological (shoreline) origin because the upper portion of the Braeside streamlined hill crest was at the wave base (at to slightly below the water surface) of the sea. Such limnological influences as wave/wash and storm surges washed and winnowed the till that was deposited on the top of the upland when the glacier was grounded, and re-deposited the sediment as strand lines or upper shoreface and foreshore bars and ridges on the sides and top of the upland. These features are seen as variably-sized hummocky hills and long linear ridges. Most of the largest of these ridges on both the site and adjacent properties were excavated between 1950 and 1970. Remnants of the deposits can be seen on the site (Figure 4). The quarry was developed after the 1- to 3-m thick sand and gravel deposits were removed.

At the base of the hill, in what would have been deep water because it was well below the wave base of the Champlain Sea, an offshore zone existed. In this area, there would have been little water movement from waves or currents. Consequently, silt- and clay- sediment fractions that originated from spillways north-west of the area and from washing the local till was deposited as the present-day clay plain on the west side of the upland. Clay was also deposited on the eastern side of the ridge, but the ancient Ottawa River in one of several earlier channels eroded the clay on the eastern side.

5.3.1 Modern and Present-Day Processes

The dissolution that started with the flow of meltwater continued once the Champlain Sea drained from the area, and continues today. In the centre of the upland where the joint systems are tight, meteoric water accumulates on the surface and within saturated overburden, and flows along the bedrock

---

[4] The ground surface was pushed down by the mass of the glacier; isostatic rebound is still occurring today.

surface or bedrock/till/gravel interface to troughs or low areas on the bedrock surface. This water drains as overland sheet and localized channelized flow (depending on available pathways) down-slope towards the flanks of the upland on both the east and west sides, where it abruptly drains into the enhanced fractures and flows downward through the weathered fracture system.

The lower member of the Bobcaygeon formation is susceptible to dissolution, unlike the underlying Gull River Formation, and consequently the surface water exits the shallow flow system at the formational contact between 133 to 137 m ASL over most of the site. The Upper Springs are found on the flanks of the plateau at this level on both the western and eastern margins (Figures 2 and 3).

There is another break in the flank surface, subtle on the west side, more prominent on the east flank as the elevation decreases. Near the edge of this lower bedrock step, another zone of increased weathering is found. The spring water that exits the bedrock in the upper springs at the Gull River contact (133 to 137 m ASL) again drains overland or ponds and pools on the competent bedrock until the lower weathered zone is intercepted. Again the flow drains abruptly into this lower dissolution zone and migrates downward through the weathered fracture system. This water exits as a lower level of springs just above the clay plain at about 125 m ASL (Figure 3).

6 Regional Groundwater Analysis

Well records obtained from the Ministry of Environment (MOE) included data from wells drilled May 1959 to present. A summary of the well records is included in Appendix II. Figure 5 shows the location of these wells. The elevations at which water was recorded in the well records is illustrated on Figure 6. In the analysis, it was assumed that the well position was correct and the surface elevation at that location was interpreted from the 1:10,000 Ontario Base Map. The error in the elevation water found is estimated to be +/- 5 m, assuming that the data in the water well record, including the assigned location, is accurate.

The elevation water found analysis shows that area wells obtain their water supply from one or more reported water-bearing zones that for the majority of wells are below the proposed quarry floor of 125 m ASL. The reported water bearing zones are generally deeper on the east side of the property. This is because the surface elevation for most residences in this area is at or below the proposed quarry base.

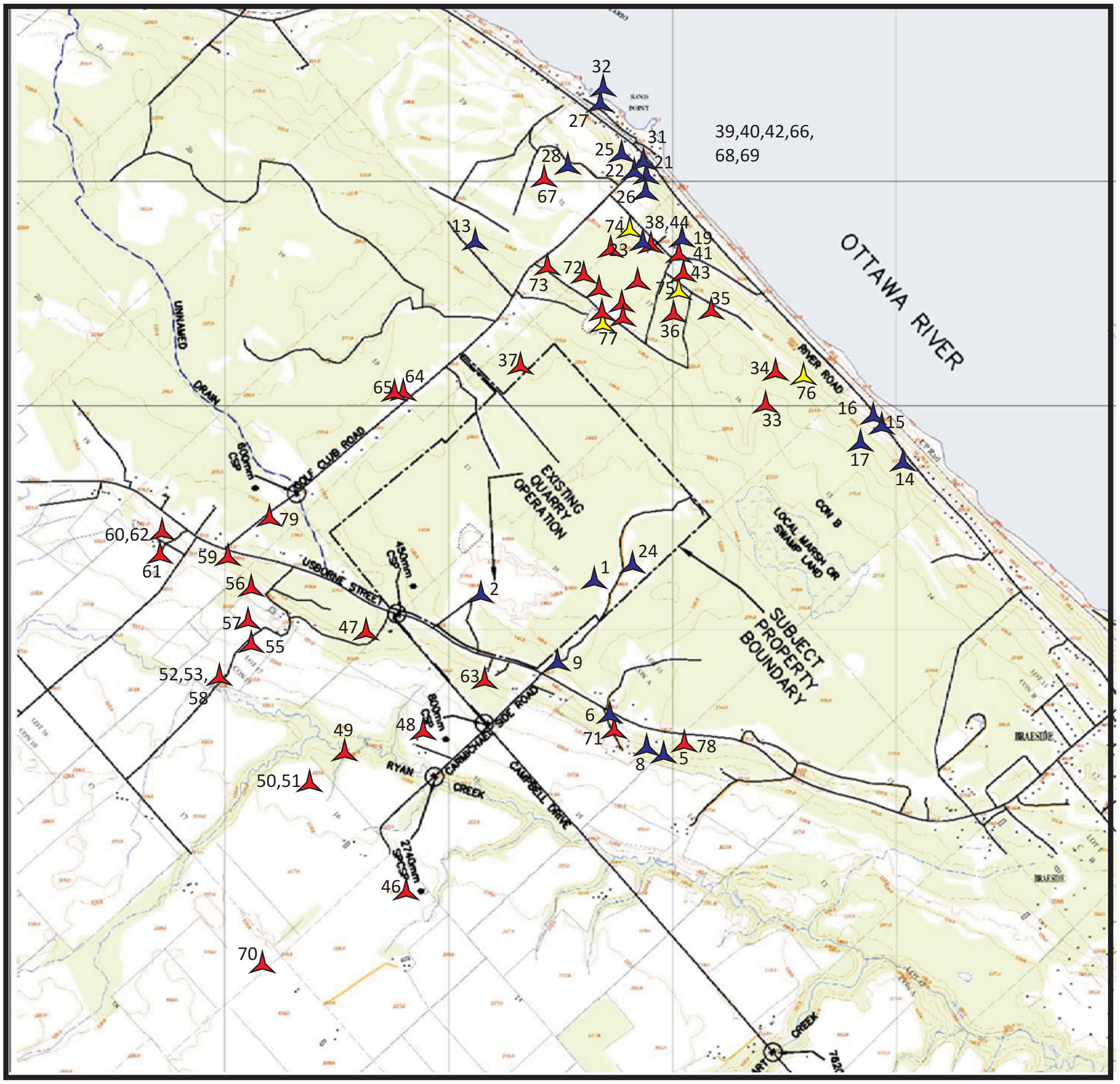
The data can be used to broadly interpret the regional groundwater flow. The groundwater elevation[5], shown on Figure 7, was derived from static level[6] on the well records and surface elevation information. The interpretation shows that the plateau is a zone of local recharge[7] to the bedrock. The plateau is a divide from which bedrock groundwater flows south-westward and north-eastward.

---

[5] Groundwater elevation - stable or “at rest” water level measured in a well expressed as a geodetic (“above sea level”) elevation

[6] Static level – stable or “at rest” level measured in a well, expressed on Ontario water well records as a depth from ground surface

[7] Recharge Zone – where water enters the groundwater system



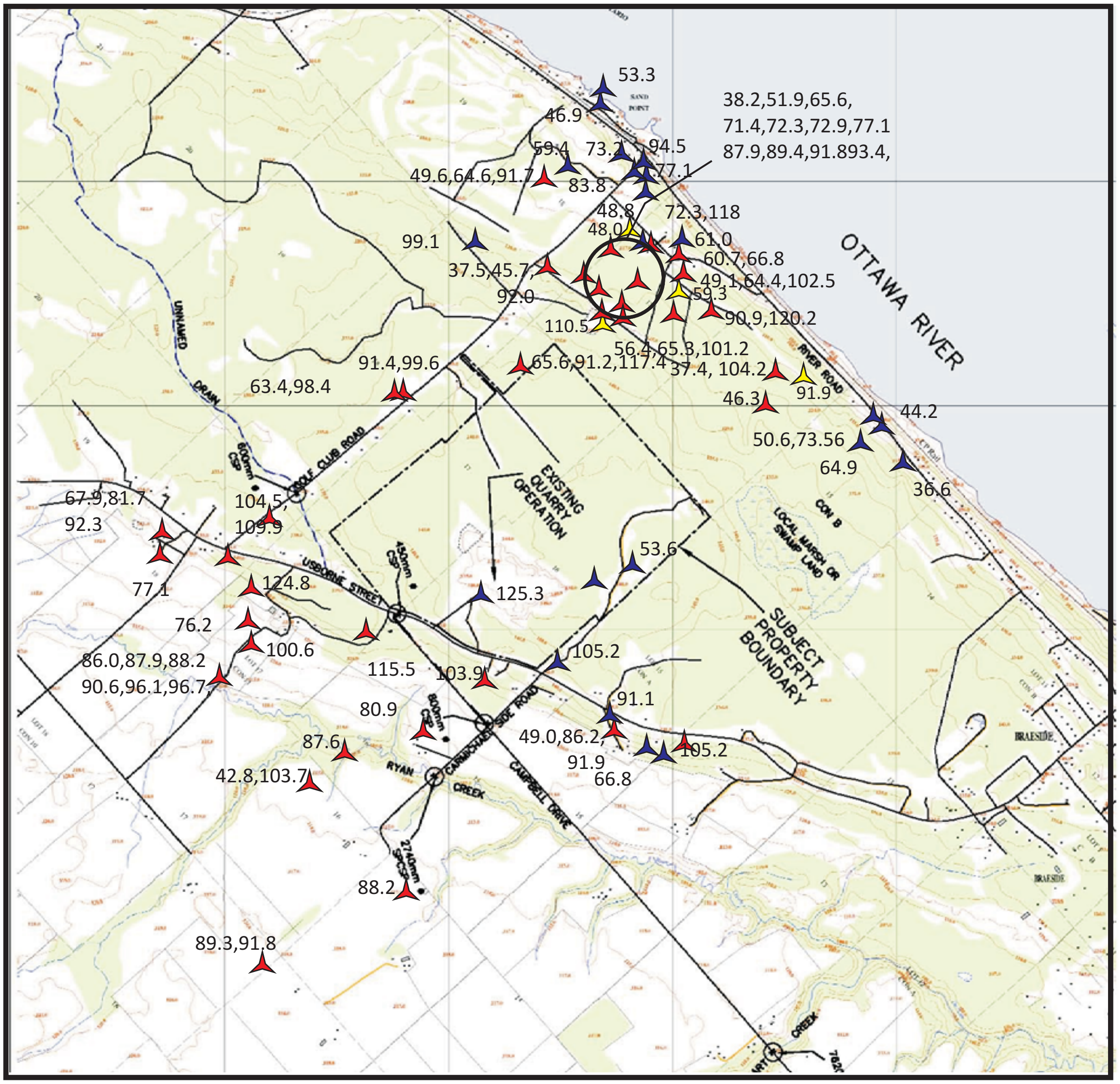
▲ ▲ ▲ Well Location from MOE Well Records
Local reference numbers, refer to Appendix II
(positions are approximate and may not reflect
an actual water well location)

UPDATED FROM gri REPORT 02180, MARCH 2004

FIGURE 5

REGIONAL WATER WELL LOCATIONS

PROPOSED BRAESIDE QUARRY EXPANSION
PART LOTS 16 & 17, CONCESSION A
TOWNSHIP OF MCNAB-BRAESIDE



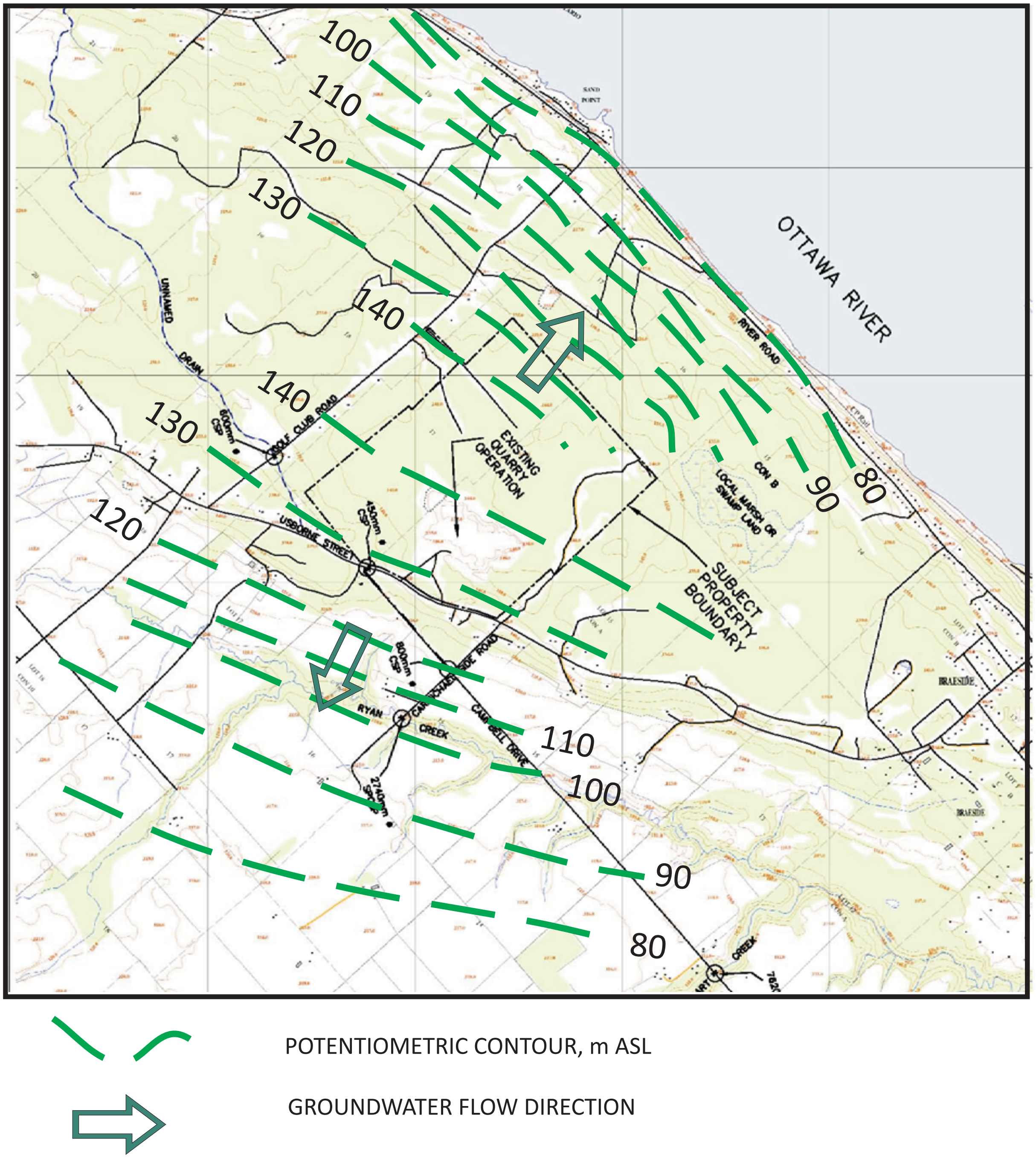
▲ ▲ ▲ Well Location and Reported Elevation Water Found from MOE Well Record data
Refer to Appendix II
(positions are approximate and may not reflect
an actual water well location)

UPDATED FROM gri REPORT 02180, MARCH 2004

FIGURE 6

REGIONAL WELLS: REPORTED ELEVATION WATER FOUND

PROPOSED BRAESIDE QUARRY EXPANSION
PART LOTS 16 & 17, CONCESSION A
TOWNSHIP OF MCNAB-BRAESIDE



UPDATED FROM gri REPORT 02180, MARCH 2004

FIGURE 7

REGIONAL WELLS: GROUNDWATER FLOW

PROPOSED BRAESIDE QUARRY EXPANSION
PART LOTS 16 & 17, CONCESSION A
TOWNSHIP OF MCNAB-BRAESIDE

aquifer. The Ottawa River is a regional discharge zone[§§], and the clay plain area is a local discharge zone. The Miller properties are on the edge of the plateau in a zone of transition.

6.1 Local Climate Data

The quantity of precipitation that occurs during a test may influence the results, particularly in the upper weathered bedrock aquifer. As noted, during most of the testing period, plenty of surface water was present on the site and in the study area. The precipitation received over the 2007 testing period was taken from Environment Canada's Shawville weather station.

The hydrology report (Skelton Brumwell & Associates Inc.,(SBA) 2012) considered data from five nearby Canadian Climate Stations – Arnprior Grandon, Claybank, Renfrew, Shawville and Luskville, and indicates the Shawville or Luskville data are representative of the conditions that would be encountered at the site. The daily precipitation and temperatures from the Shawville station are shown on Figure 8.

Although the Shawville Climate Station is the closest active and representative station (topographically and geographically), it has had intermittent data in the past several years and could not provide a good precipitation record. The hydrology analysis (SBA, 2012) used precipitation data from Luskville to represent the site precipitation. However, the hydrology report notes that to assist in annual analysis of pumping volumes and water level interpretations, a station with similar precipitation patterns to the site is useful.

The analysis (Table 1) indicates that the Luskville Climate Station can provide a suitable record for comparing daily precipitation events, as the precipitation records were in agreement with respect to occurrence 85% of the time. If in addition, anecdotal records are kept at the site on precipitation occurrence and intensity, the information will provide a satisfactory information base for interpretation of pumping data.

The hydrology report (SBA, 2012) recommended a site weather station be installed.

[§§] Discharge Zone – groundwater exits the aquifer system

Figure 8: Weather Conditions during 2007 Testing Period

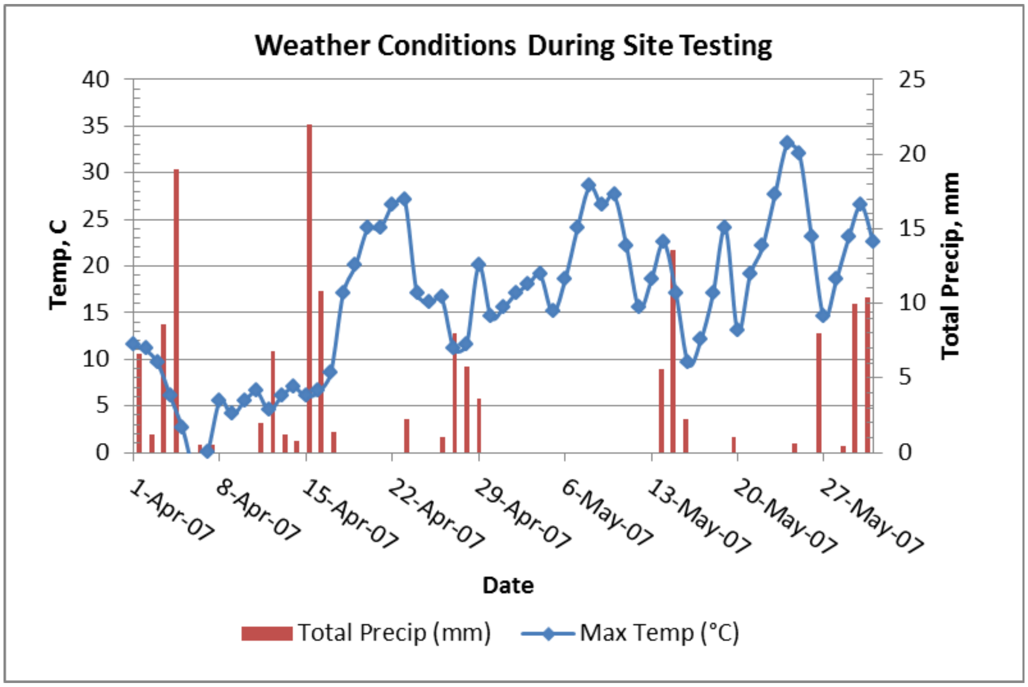


Table 1: Analysis for Selection of Representative Climate Station for use at Braeside Quarry

	Total events, Jan 1 1993 to Sept 30 1994	%
Total Days Analysed	637	
Luskville vs. Claybank Stations		
PP at Luskville but not at Claybank	50	7.8
PP at Claybank but not at Luskville	46	7.2
PP at both Claybank and Luskville	233	36.6
no PP at either station	308	48.4
McDonald-Cartier Airport vs. Claybank Stations		

	Total events, Jan 1 1993 to Sept 30 1994	**%**
PP at M-C but not at Claybank	68	10.7
PP at Claybank but not at M-C	78	12.2
PP at both Claybank and M-C	201	31.6
no PP at either station	290	45.5

7 Site Testing

As of the date of this report, there are 13 test well locations on the property and at most sites there are two wells for a total of 23 test wells. The well locations, which were surveyed by 43 Degrees North Surveying in September 2009, are shown on Figure 2. The drill logs and water well records are found in Appendix I. The well test data and analysis are found in Appendix III.

7.1 2002 Drill Holes

The original two monitoring wells were drilled on the site on July 10, 2002 by George Law and have previously been discussed in GRI Report 02180 dated March 2004.

7.1.1 Test Well 1

Test Well 1 was drilled a depth of 20.11 m or 128.9 m ASL. No overburden was encountered and only limestone of the Bobcaygeon Formation was intercepted. Soft zones were observed in the upper 7.5 m of the hole, but none of the zones yielded groundwater. The well had soft zones at 1.82 m or 147.2 m ASL, 3.05 to 3.65 m or 145.3 to 145.9 m ASL, and 7.32 to 7.62 m or 141.4 to 141.7 m ASL. Below 7.5 m, the bedrock was thin to medium bedded and was generally fine to slightly medium crystalline. The well record reports no water bearing zone, and the well had an estimated yield of less than 1.5 L/min (0.2 IGPM) upon completion. The upper part of the well was cased and grouted to 147.8 m ASL.

Test Well 1 was pumped at a constant rate of 3.8 L/min (0.8 IGPM) for a period of 48 minutes. The well drained to 80% of its available drawdown. The recovery was monitored for 4 hours, at which time the well had recovered to 19% of its original level. The Jacob method was used to calculate a low transmissivity of 0.06 m^2/day. The Theis recovery method could not be used, for the water level in the well did not recover sufficiently; it was essentially dry.

7.1.2 Test Well 2

Test Well 2 was drilled to a depth of 19.8 m to an approximate elevation of 119.8 m ASL. The upper 0.60m of the stratigraphy consisted of fill. Below that through to the base of the hole, limestone of the

Bobcaygeon Formation was encountered. Soft zones were common in the upper 13 m of the hole. One significant soft zone was encountered between 12.19 and 13.72 m depth, or from 125.9 to 127.4 m ASL. Groundwater was encountered in this zone at an estimated yield of less than 1.5 L/min. Other soft zones occurred at 5.02 m or 134.6 m ASL, and 8.23 m or 131.4 m ASL. Below that the bedrock was thin to medium bedded and was generally fine to slightly medium crystalline. Upon completion, the well had an estimated yield of less than 1.5 L/min (0.2 IGPM). The upper part of the well was cased and grouted to 138.1 m ASL.

Test Well 2 was pumped at a constant rate of 2.85 L/min (0.6 IGPM) for a period of 362 minutes. The well drained to 79.7% of its available drawdown. The recovery was monitored for 4 hours at which point the well had recovered to 79% of its original level. An analysis of the test data found that the well could sustain a pumping rate of less than 0.5 IGPM. Jacob and Theis recovery methods were used to calculate the transmissivity from the test. The calculated value was very low at between 0.079 and 0.10 m^2/day.

7.2 2006 Drill Holes

The well groups at locations 3 to 8 were drilled in August 2006. The wells were drilled by Saunders Well Drilling Ltd. of Braeside using rotary air percussion with water circulation with observation by G. Gorrell. Wells were cased with 6 m of casing and the annulus was grouted with bentonite slurry. With the exception of TW 7, each site had two wells drilled. The deep levels were drilled to at least 5 m below the proposed quarry floor. The shallow level targeted the shallow bedrock aquifer. TW 3 was positioned and constructed to address a condition in the PTTW to construct a third well monitor.

The 2006 wells were drilled with a rotary well rig in the same manner as the majority of the local wells were completed. The objective of the well construction was to provide sentry wells to represent area water well conditions and provide an early indication of groundwater impacts from the operation, were they to occur. The well construction followed current well drilling regulations.

None of the wells were dry although significant water bearing zones of comparable development to those reported in area water well records were not encountered. Specifically any of the wells drilled in the competent bedrock above the proposed quarry floor had little water. This showed that there would be minimal groundwater intercepted within the profile that would be intercepted by the quarry if wells are constructed to regulatory standards. A few of the wells that were drilled below the quarry floor had yields that are characteristic of the wells that are being used by the surrounding homes that are completed to a similar depth.

Although the wells in the 2006 drilling program were constructed during the summer to permit access to the locations around the site perimeter, the testing was conducted in the spring during high flow/ recharge.

7.2.1 Test Wells 3-1 and 3-2

The test wells are located on the west side of the site, north of the main site entrance with a surface elevation of 133.9 m ASL. Test Well 3-1 was drilled to 24.4 m, or approximate elevation 108.9 m ASL. Water bearing zones were noted at 14.0 m (119.9 m ASL) and 23.5 m (110.4 m ASL) depths. The well was cased and grouted to 128.4 m ASL. Test Well 3-2 is 12.2 m deep and is completed to an approximate elevation of 121.4 m ASL. A water-bearing zone was noted on the well record at 7.0 m (126.9 m ASL). The well was cased and grouted to 128.4 m ASL.

TW 3-1 was pumped at a rate of 49.5 L/min for 250 mins at which time the water level was drained to the pump intake. The recovery of the water level was measured for 50 minutes following pump shut off. During the test, the water level was lowered to 98.8% of the available drawdown and the water level recovered to within 97.3% of the original static level during the recovery.

During the pumping, no change was noted around 14 m, but cascading was noted at approximately 24 m depth. Cascading is observed when groundwater can be detected flowing into the well after the water level has lowered to below a water-bearing zone. It can be audible or determined from a response observed in the water level equipment. The level noted corresponds to the noted 23.5 m water level reported on the well record. Once the water level in the well was drained below the water-bearing zone, the well drained in 10 minutes.

The transmissivity from the test was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.29 to 1.03 m^2/day. The lower value, calculated from the recovery data, is representative of the aquifer characteristics; the higher value represents combined characteristics of well storage and the surrounding aquifer.

Observations were made in TW 3-2, located adjacent to TW 3-1 approximately 6 m away. During the pumping of TW 3-1, the water level in TW 3-2 lowered to a maximum of 0.84 m, and recovered slightly to 0.63 m.

Test Well 3-2 was pumped at a rate of 3.6 L/min for 100 minutes, at which time the well was drained to the pump intake. The water level in the well was monitored for 2 hours following the pump shut off, and the water level recovered to 41.5% of the original static level. During pumping, the water level in TW 3-1 was monitored. The water level in the well lowered a maximum of 0.04 m, but was recovering as TW 3-2 was drained.

The transmissivity from the test was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.09 to 0.11 m^2/day.

7.2.1.1 General Observations

TW 3-1 is a groundwater-producing well. The yield was estimated by back-calculating from the recovery data to determine that the water-bearing zone at around 110.4 m ASL was producing a small flow approximately 6.8 L/min. The remainder of the 12,375 litres removed during pumping came from storage in the well bore and in the bedrock surrounding.

TW 3-2, representing the upper part of the bedrock, was dry at the end of pumping. The well did recharge after it was drained by pumping; approximately 73 L infiltrated in the 2 hour recovery measurement period, in contrast to the 360 litres that were pumped out during the test. The source of the recharge is most probably the storage in TW 3-1, flowing between the boreholes along bedding plane that was noted as being common between the two adjacent wells. At the close distance, and with the high flux induced by the drained well, infiltration from TW 3-1 is the most likely recharge source. When TW 3-1 was pumped a few days after TW 3-2, the water levels in both wells had recharged to levels about 20 cm lower than the static levels measured in the earlier test. In summary, the groundwater that recharged TW 3-2 originated from TW 3-1 and entered the well from along a bedding plane. If TW 3-1 was not in as close proximity the recovery in TW 3-2 would have been less.

The results of the hydraulic conductivity analysis indicate a low permeability for the intercepted bedrock.

7.2.2 Test Wells 4-1 and 4-2

The test wells are located in the north-west corner of the site. It was drilled in the area where the bedrock escarpment or plateau gradient changes. Test Well 4-1 was drilled to 24.4 m, or approximate elevation 107.9 m ASL. At this location, 5.8 m of clay were recorded over the bedrock. A water bearing zone was noted at a depth of 21.0 m (112.1 m ASL). The well was cased and grouted to 127.4 m ASL

Test Well 4-2 is 12.2 m deep and is completed at approximately elevation 120.6 m ASL. No water-bearing zone is recorded on the well record. The well was cased and grouted to 127.6 m ASL.

TW 4-1 was pumped at a rate of 16.65 L/min for 6 hours at which time the water level was drained to 77.6% of the available level. The recovery of the water level was measured for 251 minutes following pump shut off. The water level recovered to within 98.5% of the original static level during the recovery. A volume of 5,994 L were pumped from the well during testing, and a volume of 298 L entered during the recovery.

Between 110 and 200 mins, the water level in the well rose briefly before continuing to draw down at slightly decreased rate. The discharge rate was checked and no adjustment was required. This signifies that a small local recharge source – such as a groundwater-filled void in the bedrock – was intercepted. In the recovery period an opposite “blip” occurred at a comparable water level.

The transmissivity from the test was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.26 to 0.40 m^2/day.

Observations were made in TW 4-2, located adjacent to TW 4-1 approximately 6 m away. During the pumping of TW 4-1, the water level in TW 4-2 lowered to a maximum of 1.07 m. The drawdown on the observation well accelerated after approximately 118 minutes of pumping and the drawdown continued through the recovery period.

Test Well 4-2 was pumped at a rate of 2.03 L/min for 35 minutes, at which time the well was drained to the pump intake. The water level in the well was monitored for 160 minutes following the pump shut off, and the water level recovered to 23.2% of the original static level. During pumping, the water level in TW 4-1 was monitored. The water level in the well lowered a maximum of 0.19m, which continued to decline during the recovery period. A volume of 71 L were pumped from the well during testing, and a volume of 37 L entered during the recovery.

The transmissivity from the test was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.08 to 0.12 m^2/day.

7.2.2.1 General Observations

When the recharge source was encountered during pumping of TW 4-1, the drawdown in the monitoring well, TW 4-2 accelerated. During the recovery, an opposite change in slope occurred when the water levels in the two wells were the same. The recharge source that was intercepted was TW 4-2, and the analysis indicates that this source contributed to the groundwater in the TW 4-1 test. In pumping, the slope changed when the water level was at approximately 17.5 m deep. In recovery, the change occurred when the water levels in the two wells coincided, at approximately 4.5 m deep.

The fact that recovery did occur during each test indicates that there is a small amount of recharge occurring, 0.3 L/min at TW 4-1 and 0.06 L/min at TW 4-2. Groundwater was transmitted between the wells during the testing. The zone through which the transmission occurred was between 11 and 17.5 m deep, or 117.5 to 124 m ASL. If TW 4-1 was not present TW 4-2 would have recovered much less.

7.2.3 Test Wells 5-1 and 5-2

The test wells are located along the north boundary, approximately half-way along the northern perimeter at a surface elevation of 139.3 m ASL. Test Well 5-1 was drilled to 24.4 m, or approximate elevation 114.3 m ASL. Test Well 5-2 is 12.2 m deep and is completed at approximately elevation 127.1 m ASL. No water bearing zones were noted in either well. The wells were cased and grouted to 133.8 m ASL.

TW 5-1 was pumped at a rate of 12.4 L/min for 43 minutes, at which time the water level was drained to 98.5% of the available drawdown. The recovery of the water level was measured for 197 minutes following pump shut off. The water level recovered only 5.7% of the original static level. A volume of 533 L were pumped from the well during testing, and a volume of 24 L entered during the recovery. The well drained steadily during the test and did not recover.

The transmissivity from the test was calculated using the Jacob method. The calculated transmissivity for this well is 0.11 m^2/day. Observations were made in TW 5-2, located adjacent to TW 5-1 approximately 6 m away. During the pumping of TW 5-1, the water level in TW 5-2 declined 0.01 m. The rise is most probably due to changes in atmospheric pressure, not to a connection between wells.

Test Well 5-2 was pumped at a rate of 4.5 L/min for 55 minutes, at which time the water level had declined to 47.5% of the available drawdown. The well drained steadily during the test. The water level in the well was monitored for 2 hours following the pump shut off, and the water level recovered to 22.3% of the original static level. A volume of 247.5 L were pumped from the well during testing, and a volume of 46 L entered during the recovery for an inflow rate of 0.4 L/min.

The transmissivity from the test was calculated using methods by Theis and Jacob. The range of calculated transmissivity for this well is 0.08 to 0.16 m^2/day.

7.2.3.1 General Observations

The static level at TW 5-2 was consistently at the ground surface during the spring. This suggests a direct connection between the surface drainage and the shallow weathered bedrock aquifer in this area of the site. The area where the wells were drilled was an island completely surrounded by standing water to a depth greater than 0.45 m during the testing period.

The data collected on this well – the static level is the same as the ground surface elevation, the lack of interconnection during testing and the low hydraulic conductivity of the upper weathered bedrock zone combine to illustrate that in this area of the site, the bedrock has a very low to impermeable hydraulic conductivity in the absence of an immediately open dissolution enhanced fracture.

7.2.4 Test Wells 6-1 and 6-2

The test wells are located in the north-east corner of the site. Test Well 6-1 was drilled to 24.4 m, or approximate elevation 113.0 m ASL. The well was cased and grouted to 133.3 m ASL. A water bearing zone was noted at 20.72 m deep (117.3 m ASL). Test Well 6-2 is 12.2 m deep and is completed at approximately elevation 125.7m ASL. No water-bearing zone is recorded on the well record. The well was cased and grouted to 132.5 m ASL.

TW 6-1 was pumped at a rate of 10.35 L/min for 40 minutes, at which time the water level was drained to 98% of the available drawdown. The recovery of the water level was measured for 120 minutes following pump shut off during which the water level recovered 5.3% of the original static level. A volume of 414 L were pumped from the well during testing, and a volume of 19 L entered during the recovery. After four minutes of pumping (water level 7.3 m), the well drained steadily during the test, accelerating further after 30 minutes (water level 19.8 m) and did not recover.

The transmissivity from the test was calculated using the Jacob method. The calculated transmissivity for this well is 0.18 m^2/day.

Test Well 6-2 was pumped at a rate of 0.75 L/min for 40 minutes, at which time the water level had drained the available drawdown. The well drained steadily during the test. The water level in the well was monitored for 90 minutes following the pump shut off, and the water level recovered to 13.9% of the original static level. A volume of 30 L were pumped from the well during testing, and a volume of 17 L entered during the recovery for an inflow rate of 0.2 L/min.

The transmissivity from the test was calculated using the Jacob method. The calculated transmissivity for this well is 0.02 m^2/day.

Observations were made in TW 6-1, located adjacent to TW 6-2 approximately 6 m away. During the pumping of TW 6-2, the water level in TW 6-1 rose 0.02 m. The rise is most probably due to changes in atmospheric pressure, not to a connection between wells.

7.2.4.1 General Observations

The acceleration of drawdown after 30 minutes of pumping corresponds to the water level declining below the noted water-bearing zone. Once the water-bearing zone was bypassed, the effect of the contribution of the zone diminishes due to pressures in the aquifer, resulting in an increased rate of drawdown in the well. The change in rate of drawdown helps pinpoint the water-bearing zone elevation.

7.2.5 Test Well 7

Test Well 7 was constructed along the east side, approximately mid-way along the north-south property boundary. Test Well 7 was drilled to 24.4 m, or approximate elevation 116.8 m ASL. A water bearing zone was noted at 12.8 m deep (129.0 m ASL). The well was cased and grouted to 136.3 m ASL.

TW 7 was pumped at a rate of 7.2 L/min for 58 minutes, at which time the water level was drained to 95.3% of the available level. The recovery of the water level was measured for 120 minutes following pump shut off during which the water level recovered 25.3% of the original static level. A volume of 418 L were pumped from the well during testing, and a volume of 77 L entered during the recovery (0.6 L/min). The well drained steadily during the test, accelerating after approximately 22 minutes (water level +/- 15 m).

The transmissivity from the test was calculated using methods by Theis and Jacob. The calculated transmissivity for this well ranges from 0.21 to 0.37 m^2/day.

7.2.5.1 General Observations

The acceleration of drawdown after 22 minutes of pumping corresponds to the water level declining below the noted water-bearing zone. Once the water-bearing zone was bypassed, the effect of the contribution of the zone diminishes due to pressures in the aquifer, resulting in an increased rate of drawdown in the well. The change in rate of drawdown helps pinpoint the water-bearing zone elevation.

7.2.6 Test Wells 8-1 and 8-2

The test wells are located in the south-east corner of the site. Test Well 8-1 was drilled to 24.4 m, or approximate elevation 120.0 m ASL. Water bearing zones were noted at 10.97 m (134 m ASL) and 23.16

m (121.8 m ASL). The well was cased and grouted to 139.5 m ASL. Test Well 8-2 is 12.2 m deep and is completed at approximately elevation 132.6 m ASL. No water-bearing zone is recorded on the well record. The well was cased and grouted to 139.6 m ASL.

TW 8-1 was pumped at a rate of 15.75 L/min for 6 hours, at which time the water level was drained to 76.5% of the available drawdown. The recovery of the water level was measured for 120 minutes following pump shut off during which the water level recovered 54.3% of the original static level. A volume of 5,670 L were pumped from the well during testing, and a volume of 87 L entered during the recovery. A slight decrease in the rate of acceleration of the drawdown occurred around t=140 minutes.

The transmissivity from the test was calculated using methods by Theis and Jacob. The calculated transmissivity for this well ranges from 0.59 to 0.83 m^2/day.

Observations were made in TW 8-2, located adjacent to TW 8-1 approximately 6 m away. During the pumping of TW 8-1, the water level in TW 8-2 rose over the test to a maximum of 0.22 m. The discharge hose was sufficiently close to TW 8-2 that it is most probable that the discharge recharged the well.

Test Well 8-2 was pumped at a rate of 1 L/min for 49 minutes, at which time the water level had drained the available drawdown. The well drained steadily during the test. The water level in the well was monitored for 120 minutes following the pump shut off, and the water level recovered to 15.9% of the original static level. A volume of 49 L were pumped from the well during testing, and a volume of 29 L entered during the recovery for an inflow rate of 0.2 L/min. The transmissivity from the test was calculated using methods by Theis and Jacob. The calculated transmissivity for this well ranges from 0.02 to 0.04 m^2/day.

The analysis of the pumping tests conducted on TW 1 to TW 8 are summarized in Table 2.

Table 2: Summary of 2002 and 2007 Well Testing

Pumping Well, Test #	Observed Water-Bearing Zones (WBZ) m ASL*	Pump Rate & Duration; L/min (Hr:Min)	Measured Test Drawdown (%)	Range of Calculated T (m^2/day)	Obser. Well	Maximum Drawdown (m)
TW 1 (2002)	Soft zones, dry @ 141.4 to 141.7, 145.3 to 145.9, 147.2	3.8 (0:48)	80.6	0.06	None	N/A
TW 2 (2002)	Soft zones, dry @ 125.9 to 127.4	2.85 (6:02)	79.7	0.08 – 0.10	None	N/A
TW 3-1	WBZ @ 110.4, 119.9	49.5 (4:10)	98.8	0.29 – 1.03	TW 3-2	0.84
TW 3-2	WBZ @ 126.9	3.6 1:40	99.2	0.09 – 0.11	TW 3-1	0.04

Pumping Well, Test #	Observed Water-Bearing Zones (WBZ) m ASL*	Pump Rate & Duration; L/min (Hr:Min)	Measured Test Drawdown (%)	Range of Calculated T (m^2/day)	Obser. Well	Maximum Drawdown (m)
TW 4-1	WBZ @ 112.1	16.65 (3)	77.6	0.26 – 0.40	TW 4-2	1.07
TW 4-2	None	2.03 (0:35)	96.5	0.08 – 0.12	TW 4-1	0.19
TW 5-1	None	12.38 (0:43)	98.5	0.11	TW 5-2	0.01
TW 5-2	None	4.5 (0:55)	47.5	0.08 – 0.16	None	N/A
TW 6-1	WBZ @ 117.3	10.35 (0:40)	98	0.18	None	N/A
TW 6-2	none	0.75 (0:40)	97.5	0.02	TW 6-1	-0.02
TW 7	WBZ @ 129.0	7.2 (0:58)	95.3	0.21 – 0.37	None	N/A
TW 8-1	WBZ @ 121.8, 134.0	15.75 (6:00)	76.5	0.59 - 0.83	TW 8-2	-0.22
TW 8-2	None	1 (0:48)	80.6	0.02 – 0.04	None	N/A
* Elevations in Table 2 have been adjusted to reflect the total station survey of wells completed in 2009. Values differ from those reported in GRI Report 05460 dated September 2007.						

7.2.6.1 General Observations

The rise in water level in TW 8-2 during the pumping of TW 8-1 suggests that the discharge was providing recharge to the observation well. The response illustrates the high degree of interconnection of the surface to the shallow weathered bedrock on parts of the site. A similar rapid response of water level in wells to spring melt, a comparable recharge source, has been observed by George A. Gorrell M.Sc. P.Geo. F.G.A.C. at several locations in similar geological setting in the Brockville area.

7.3 Groundwater Temperature

During some tests, the groundwater temperature was measured. The purpose of the temperature measurements was to assist in the evaluation of potential impacts of discharge water on Ryan Creek which was identified by MNR as a cold water creek. The measured temperatures from the tests are reported in Table 3.

The measurements indicate a noticeable difference in the groundwater temperatures between the discharges originating from the shallow aquifer and the deeper aquifer. The 8.8°C reading is within the range typical of groundwater. The 14.2°C is significantly warmer than what would be expected. This reinforces the conclusion that the water in the shallow well originates directly from surface water infiltration.

Table 3: Discharge Temperature in Well Tests

Well	Date Measured	Dissolved Oxygen (mg/L)	Discharge Temp (^{O} Celcius)
TW 3-1	May 1	5.37	8.8
TW 8-2	May 2	9.09	14.2

7.4 2009 Testing

GRI Report 05460 and the other supporting environmental reports (hydrology and natural environment, SBA, 2012 and 2012b) describe a variable and dynamic system of surface water and shallow groundwater interaction on the study site and surrounding area. The peer reviewers requested additional hydrogeological investigation of the upper bedrock zones to provide support for the conclusion that the proposed quarry would not have an impact on hydrological or natural features as a result of this connection.

Between January 13, 2009 and March 4, 2009, twelve new holes were drilled on the site. To provide additional site information to address questions by the peer reviewers, the holes were constructed to: i) gather textural, lithological and other characteristic (colour, grain size, bed thickness) information to augment the geological information in GRI Report 05460, ii) provide additional detail on fractures and bedding planes, iii) permit potential hydraulic conductivity testing using the packer method to augment data obtained in 2006, and iv) install piezometers at additional levels within the hydrostratigraphy. In addition, some drilling was conducted to provide core for formation quality testing for use by Miller in their operation. The hole locations and drill depths were determined from the review of the data that has been gathered since 2006 and the holes were designed to add to and enhance the data and knowledge that was available from the earlier work.

The new holes were constructed using a diamond drill with HQ core. The equipment was operated by All-Terrain Drilling Ltd. of Waterloo under supervision by George A. Gorrell M.Sc. P.Geo. F.G.A.C.. The water well records and borehole logs are found in Appendix I.

The packer tests were conducted using the Lugeon injection method. For each deep hole in the well pair, flow was induced into isolated zones of 1.5 m or 3 m. Within each test zone, the flow was maintained at a rate required to sustain a constant pressure within the packer. Generally, 4 pressure steps were used. The flow at a given pressure step was measured both as pressure steps were increased and decreased.

Using both increasing and decreasing pressure steps assists in the interpretation of potential hydraulic conductivity, as the plot indicates whether the induced pressure is clearing or clogging undeveloped fracture zones or hydrofracturing the test zone. The packer test data and analyses are found in Appendix IV. Type curves for the different responses to testing, excerpted from Royle are found at the front of the appendix.

The packer test measures potential hydraulic conductivity. Additionally, the results of the specific tests have to be interpreted to differentiate between in-situ conditions and induced conditions due to hydrofracturing or development of fractures, or conversely clogging. Although a given zone may have the capability to transmit groundwater, a water source is still required. To illustrate, consider the following: If water is injected into a dry sponge, the quantity of water that the sponge could absorb would be high. However, if the attempt was made to withdraw water from the originally dry sponge, the results would be significantly different. This illustrates the importance of establishing the in-situ condition to evaluate potential impacts. One way to accomplish this is to conduct other comparable forms of testing, such as rising head hydraulic conductivity tests, on the same setting. This method will consider whether there actually is water present or not, representing the real site conditions. An assessment of whether groundwater not present during the testing might be present under other seasonal conditions or situations is still made, but the values used in analysis consider the representative setting overall.

Brief details of each packer interval are provided in Appendix IV so that the validity of each result can be assessed. In the tests at the base of the borehole, only an upper packer was used. In every borehole, this appeared to affect the test results, and as a consequence, the final tests for each hole were not used in any analysis. A review of the data other hydrogeological professional peers solicited by George A. Gorrell M.Sc. P.Geo. F.G.A.C. suggested that during the single packer tests, some leakage may have been experienced. For this reason, the analyses from the single-packer tests, which comprised one test per well at the lowest level in the borehole, were not used in the assessment. Note that “effects” such as hydrofracturing or washing of, or clogging by sediment or gouge that appear significant on the packer test graphs are actually microscopic in scale, as the hydraulic conductivities (K) determined for the bedrock, with the exception of the weathered zone, are generally on the order of magnitude of 10^{-5} m/s or less.

AECOM reviewed the packer test data found in Appendix IV. Representative packer test results were screened by AECOM, and K values from the packer tests for shallow test intervals were used to calculate the radius of influence in the weathered bedrock zone.

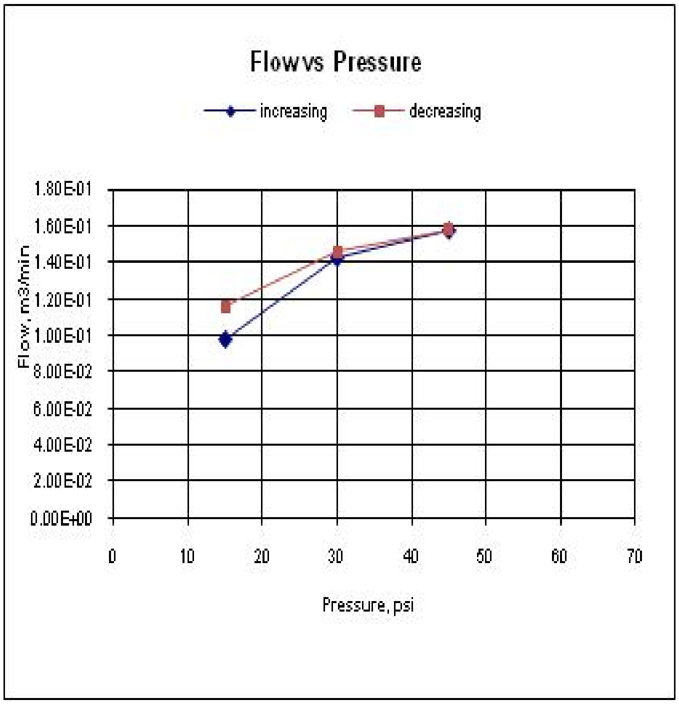
7.4.1 Drill Holes 9-1 and 9-2

These holes were drilled in the south-western corner of the existing licensed quarry (Figure 2). They are located between the quarry and residences that are located west and southwest of the site. The holes were drilled on the portion of the site where dissolution features can be observed on the surface. The highest degree of dissolution is found in this area.

The location is the topographically highest part of the Braeside upland in the study area. Drill Hole 9-1 was constructed to a depth of 31.09 m or to an elevation of 120.95 m ASL. Two formations were encountered in this hole; the Lower Bobcaygeon Formation and the Gull River Formation.

Several interesting observations were made at this location, which helped highlight the differences in geology between the flanks and the central part of the plateau. The first is that the upper 7 to 10 m is very highly weathered and tree roots or mat were encountered to depths of 7 m within the Bobcaygeon Formation (Photo 7). When packer tests were completed on this zone (Figure 9), tanker truck-loads of water could be pumped through the isolated interval, limited only by the rate that the pump could operate. This zone accepted the available water with little resistance.

Figure 9: Flows through Weathered Zone at 144.6 to 147.6 m ASL, TW 9-1. Induced flows at higher test pressures could not be stabilized due to rapid inflow



Below this level, at a depth of 11.3 to 11.7 m below surface (140.8 to 140.9 m ASL) a clayey shale bed was intercepted. The zone could be penetrated easily. Because of its position within the highly weathered zone, when it was first encountered it was thought that sediment had reached this depth by filtering through the open fractures. The water flow rate was increased when this zone was encountered in an attempt to clean out the hole and to permit drilling to advance. However, when the outer barrel passed by this level, the material collapsed around it, and the barrel became stuck. Water could not be circulated through the hole and the outer barrel had to be vigorously agitated before it was brought to the surface. This indicated that the zone is laterally extensive, not just an isolated zone. The first hole was terminated at 11.4 m, and a piezometer was installed with a screen interval from 141.8 to 143.3 m ASL as TW 9-2.

The clay unit was intercepted in every 2009 drill site except at TW 12, at approximately the same elevation. It is a distinct unit that has been identified as K-bentonite. The unit is attributed by geologists to widespread volcanic eruptions in the Middle Ordovician around 473 to 462 million years ago. The events deposited ash over much what would become eastern North America and has been observed at the Bobcaygeon/ Gull River contact in other parts of Ontario as well as in their equivalent formations in the northern United States (Charles E. Mitchell, 2004). Within and below this zone the volume of water that could be pumped into the test sections decreased significantly.

TW 9-1 was drilled 10 m away and when the K-bentonite zone was intercepted the outer barrel was slightly raised and the hole was then flushed for an extended period to ensure that the unconsolidated sediment was removed from the hole. The amount of time it took to clean the hole and advance the barrel corroborates that the zone is laterally extensive and a distinct unit. The test hole was completed at a depth of 31.1 m (121.0 m ASL), and following packer testing, the hole was instrumented with a piezometer that targets 122.0 to 123.5 m ASL. The description of the individual packer test results are found in Appendix IV.

7.4.2 Drill Holes 10-1 and 10-2

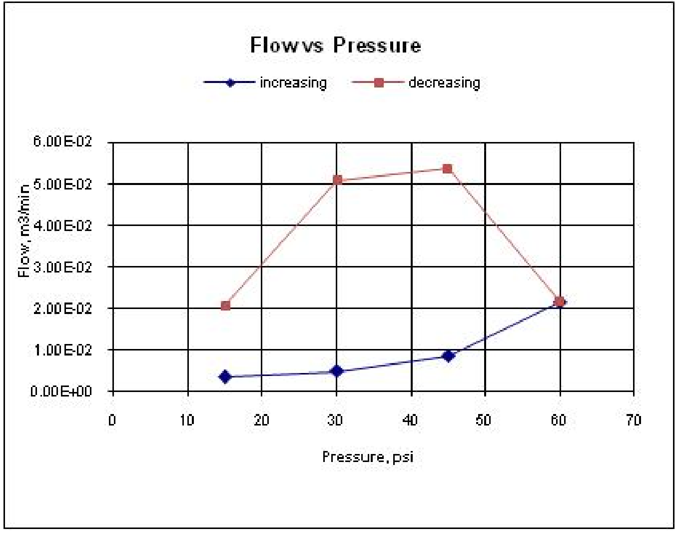
These holes were drilled in the southeast corner of the site. They were drilled approximately 65 m northwest of TW 8. The purpose of this hole was to augment the data on the shallow bedrock. It was drilled in the area where there is little surface water, and where some dissolution is evident.

7.4.2.1 General Observations

TW 10-1 was drilled to a depth of 15.36 m (130.36 m ASL) and encountered the Lower Bobcaygeon and Gull River Formations. A clayey-shale zone encountered between 12.50 to 13.11 m below ground surface (133.23 to 132.62 m ASL) was interpreted as K-bentonite.

Packer tests were completed on TW 10-1. Between 139.6 m ASL to surface (upper 6.13 m), the test zones did not accept water at low pressure. However, when the pressure was increased to levels higher than 45 psi, the isolated zone started to absorb significant volumes of water (Figure 10). During the decreasing pressure stage of the test, the zones continued to absorb significant volumes indicating that the increasing the water pressure resulted in hydrofracturing of the zone. Below 139 m ASL the higher pressure in the test zones did not result in a hydrofractured pressure profile (Figure 11). Upon completion of the packer tests, a piezometer was installed between 131.4 and 134.4 m ASL. Drill Hole 10-2 was completed to 6.1 m and instrumented with a piezometer that targets 140.7 to 143.7 m ASL.

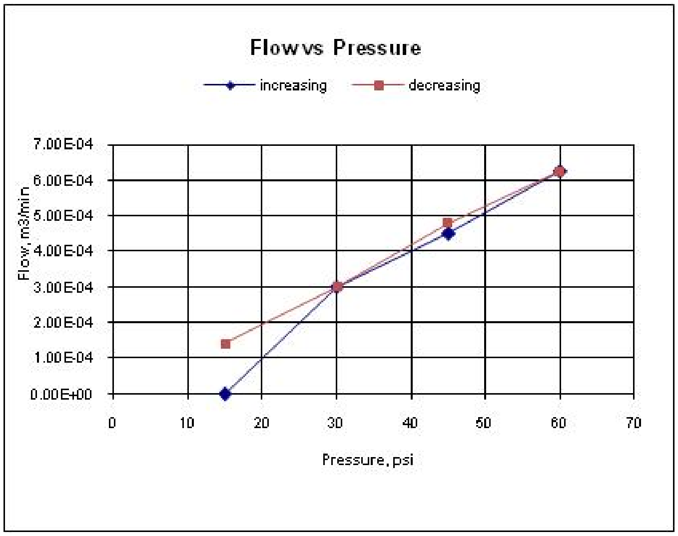
Figure 10: Flows at 142.7 to 139.6 m ASL, TW 10-1. Induced flows at higher test pressures result in hydrofracturing of test section which were not sustained in decreasing pressure



7.4.3 Drill Holes 11-1 and 11-2

These holes were drilled in the east to north eastern portion of the site. They were drilled approximately 430 m northwest of TW 7 and approximately 440 m southwest of TW 6. The purpose of these holes was to augment data on both the deep and the shallow bedrock units. Surface water accumulates on the surface in the area surrounding the area.

Figure 11: Flows at 130.5 to 133.6, DH 10-1. Induced flows result in little to no hydrofracturing of test section, but may have been slight development of fractures.



7.4.3.1 General Observations

TW 11-1 was drilled to a depth of 28.96 m (113.85 m ASL) and encountered the Lower Bobcaygeon and Upper Gull River Formations. The K-bentonite zone was encountered between 14.81 to 15.04 m below ground surface (127.99 to 127.76 m ASL). Following packer testing, a piezometer was installed between 114.9 and 117.9 m ASL.

The packer tests that were completed on the zones 139.6 m ASL to surface (upper 6.13 m) did not accept water at lower pressures.

TW 11-2 was drilled to 9.14 m and instrumented with a piezometer that targets 134.8 to 136.3 m ASL.

7.4.4 Drill Holes 12-1 and 12-2

These holes were drilled in the north central part of the site, approximately 70 m southwest of TW 5, to augment data on the shallow bedrock characteristics. Surface water is present in the area surrounding the site.

7.4.4.1 General Observations

TW 12-1 was constructed to a depth of 12.19 m (128.13 m ASL) and encountered the Lower Bobcaygeon and Upper Gull River Formations. This was the only borehole in which the K-bentonite was not intercepted. Very large vugs and the coral tetradium were encountered near the base of the hole. Following packer testing, a piezometer was installed between 129.2 and 132.2 m ASL.

The packer tests that were completed on the zones 139.6 m ASL to surface (upper 6.13 m) in TW 12-1 did not accept water at lower pressures. However, when the pressure was increased to levels greater than 45 psi the isolated zone started to take significant volumes of water. When the pressure was decreased the zones continued to take significant volumes indicating that by increasing the water pressure, hydrofracturing had been induced. Below 139.6 m ASL, the increased pressure did not result in a hydrofractured pressure profile.

TW 12-2 was drilled to 3.1 m and instrumented with a piezometer that targets 138.3 to 140.4 m ASL.

7.4.5 Drill Holes 13-1 and 13-2

These holes were drilled in the north western part of the site approximately 220 m southwest of TW 4 and approximately 285 m northeast of TW 3. The purpose of these holes was to augment the data on the shallow bedrock unit in the area where wetland had been identified in the natural environment study (SBA, 2012b). There is little surface water accumulation in the area surrounding the site and some dissolution can be seen in the immediate vicinity.

7.4.5.1 General Observations

TW 13-1 was drilled to a depth of 9.37 m (130.04 m ASL) and encountered the Lower Bobcaygeon and Upper Gull River Formations. The clayey-shale zone was encountered between 6.34 to 6.71 m below ground surface (133.11 to 132.74 m ASL) and was interpreted to the K-bentonite. A large gap was encountered between 136.8 and 137.5 m ASL. For drilling logistics, this zone was penetrated and following packer testing, the lower piezometer was installed below it targeting elevation 131.0 – 132.5 m ASL.

TW 13-2 was drilled to 4.6 m and a piezometer was installed to target the gap zone, between 135.9 m ASL and 137.4 m ASL.

7.5 Rising Head Hydraulic Conductivity Tests

Hydraulic conductivity analysis used the Hvorslev (1951) method. The analysis was originally conducted using an Windows Excel® (Excel) spreadsheet. A discovery by the authors in late 2011 found that the GROWTH function used to extrapolate the observation data did not function well in cases where the hydraulic conductivity was very slow; i.e. the line had to be extracted an extended distance to determine y_0. The data for each well were analysed using Aqtesolv Pro V 4.5® software (Aqtesolv). The results of the analyses are compared in Table 4. In three of the tests, the calculated values using Aqtesolv were notably different than the original analysis, as shown in Table 4.

Table 4: Comparison of Hydraulic Conductivity Calculated using 2009 and 2012 Software Packages

Test Location	2009 Calculated Value using Excel (m/s)	2012 Revised Analysis using Aqtesolv (m/s)
TW 9-1	$2.09E^{-06}$	$2.39E^{-06}$
TW 9-1 Test 2	$2.54E^{-06}$	$2.26E^{-06}$
TW 9-2	$1.41E^{-07}$	$4.98E^{-09}$
TW 10-1	$1.15E^{-07}$	$1.30E^{-07}$
TW 10-2	$2.51E^{-06}$	$1.33E^{-06}$
TW 10-2 Test 2	$2.98E^{-06}$	not re-analysed
TW 11-1	$3.64E^{-08}$	$4.19E^{-08}$
TW 11-2	$3.74E^{-19}$	$1.25E^{-08}$

Test Location	2009 Calculated Value using Excel (m/s)	2012 Revised Analysis using Aqtesolv (m/s)
TW 12-1	$2.45E^{-07}$	$3.01E^{-07}$
TW 12-2	$2.28E^{-08}$	$3.61E^{-08}$
TW 13-1	$7.28E^{-09}$	$6.38E^{-08}$
TW 13-2	$2.91E^{-08}$	$7.46E^{-08}$
Floor Hole F	$1.31E^{-07}$	$3.90E^{-07}$
Floor Hole G	$1.18E^{-09}$	$1.68E^{-07}$
(Shading denotes results with notable difference due to method used) Text colour = Weathered Bedrock Aquifer Text colour = Upper Competent Bedrock Text colour = Competent Bedrock, Significant Water Bearing Zone intercepted Text colour = Competent Bedrock, above Significant Water Bearing Zone intercepted		

The analyses of the rising head hydraulic conductivity tests are summarized in Table 5. The test data and analyses for both 2009 and 2012 are found in Appendix V.

Table 5 illustrates how the packer test measures *potential* hydraulic conductivity and not necessarily the in-situ condition. Rising head tests are required to determine whether the results are truly in-situ. As an example, tree roots were cored in TW 9 to a depth of 7 m. Observations of the surface in this area indicate that this area is on the edge of the upland and that dissolution in the area is common. The addition of water in this zone induces flow along existing open pathways. However, the tree roots extend to that depth because there *is* no water normally – to sustain the vegetation, the roots have to extend for significant depths. The packer test result indicated a potential hydraulic conductivity value on the order of 10^{-5} m/s, but the in-situ condition was measured on the order of 10^{-9} m/s, or four orders of magnitude lower.

Table 5: Summary of Rising Head Hydraulic Conductivity and comparison to Potential Hydraulic Conductivity for Same Interval

Drill Hole	Surf Elev (m ASL)	Screen (m ASL)		k from rising head, (m/s)	potential k from packer test (m/s)	Comment
		Base	Top of Sand Pack			
TW 9-1	152.04	121.0	123.1	2.09×10^{-6}	4.41×10^{-7}	Water-bearing zone
TW 9-1 (Test 2)	152.04	121.0	123.1	2.59×10^{-6}		
TW 9-2	152.19	140.8	142.9	4.98×10^{-9}	2.58×10^{-5}	Dissolution zone

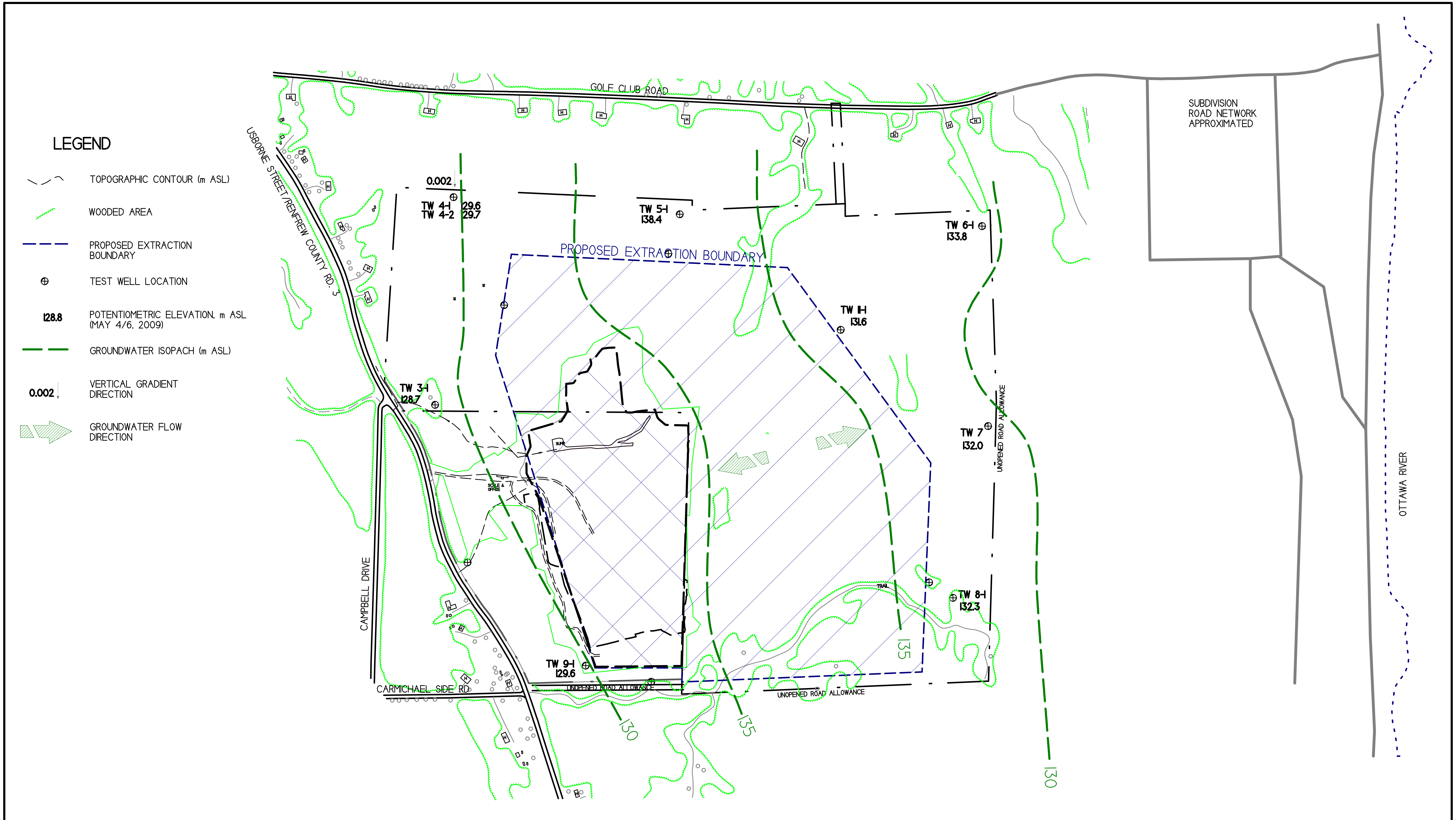
Drill Hole	**Surf Elev (m ASL)**	**Screen (m ASL)**		**k from rising head, (m/s)**	**potential k from packer test (m/s)**	**Comment**
		Base	**Top of Sand Pack**			
TW 10-1	145.74	130.4	134.0	1.15×10^{-7}	4.72×10^{-8}	In-situ Not as well developed
TW 10-2	145.72	139.6	143.3	2.51×10^{-6}	2.4×10^{-6}	Dissolution zone
TW 10-2 (Test 2)	145.72	139.6	143.3	2.98×10^{-6}		
TW 11-1	142.81	113.9	116.0	3.64×10^{-8}	3.45×10^{-10}	In-situ
TW 11-2	142.91	133.8	137.4	1.25×10^{-8}	3×10^{-8}	Dissolution
TW 12-1	140.33	128.1	131.7	2.45×10^{-7}	7.6×10^{-8}	In-situ
TW 12-2	140.28	137.3	139.7	1.46×10^{-8}	2.7×10^{-5}	Dissolution
TW 13-1	139.52	128.9	131.0	7.28×10^{-9}	0	In-situ Not as well developed
TW 13-2	139.41	134.8	138.5	2.91×10^{-8}	7.3×10^{-5}	Dissolution
Add'l Floor Holes						
F	136.33	127.186		1.31×10^{-7}	8.3×10^{-7}[***]	
G	138.27	129.126		1.68×10^{-7}	9.2×10^{-7}	
(Shading denotes results amended from previous reports due to update in analytical software used. Un-modified results were comparable with both methods, see Table 4)						

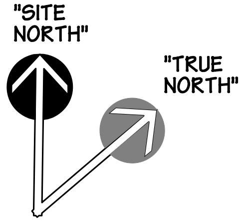
8 Groundwater Elevation Data

The data collected in the groundwater monitoring program is summarized in Appendix VI. The groundwater elevation data has been plotted for the competent bedrock aquifer, including the significant water bearing zone in Figure 12. Water levels from the open boreholes represent a composite of water levels measured within the stratigraphy intercepted by the well, and represent the hydrostratigraphic conditions over the zone intercepted. In these wells, the represented condition is the competent bedrock aquifer, including the significant water bearing zone. The data plotted in plan view show that generally groundwater within the competent bedrock aquifer, which includes the significant water bearing zone, flows easterly and westerly from the centre of the plateau.

The variations in water levels from 2006 to 2009 is shown on the graphs in Figure 13.

[***] Averaged over borehole. Upper approximately 1.5 m of bedrock below quarry floor has slightly higher potential k which has been attributed to blasting effects.





NO.	REVISION	DATE	BY
1.	READINGS REVISED TO REFLECT UPDATE IN SITE ELEVATION SURVEY	07/11	JBG

FIGURE 12:

GROUNDWATER ELEVATIONS, COMPETENT BEDROCK AQUIFER

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

POTENTIOMETRIC ELEVATIONS MEASURED MAY 4 AND 6, 2009. POTENTIOMETRIC ISOPACHS ARE INTERPRETED FROM COLLECTED DATA AND ARE GENERALIZED, BASED ON READINGS AND SITE SETTING.

Figure 13: Variation in Potentiometric Elevation, 2006 - 2009

9 Surface Water and Drainage

The surface water and drainage mapped over the period of March through June is shown on Figure 14. The surface drainage on the site and in the surrounding area consists of overland flow integrated with localized sub-surface migration.

9.1 Surface Water Accumulations on Competent Bedrock

Surface water accumulates in the saturated overburden and lower lying surfaces and depressions of the competent bedrock portions of the site (Figure 14). These areas are predominantly on the top of the plateau, and on the steps on the slopes, including the sediment-filled trough in the north-west corner of the site. The areas shown on Figure 14 are typical; the mapping is not complete. The boundaries of the local wetland features shown on Figure 14 are approximate and reflect the conditions observed during mapping by G. Gorrell . The hydrology and natural environment reports (SBA, 2012 and 2012b) should be referenced for boundaries of key features.

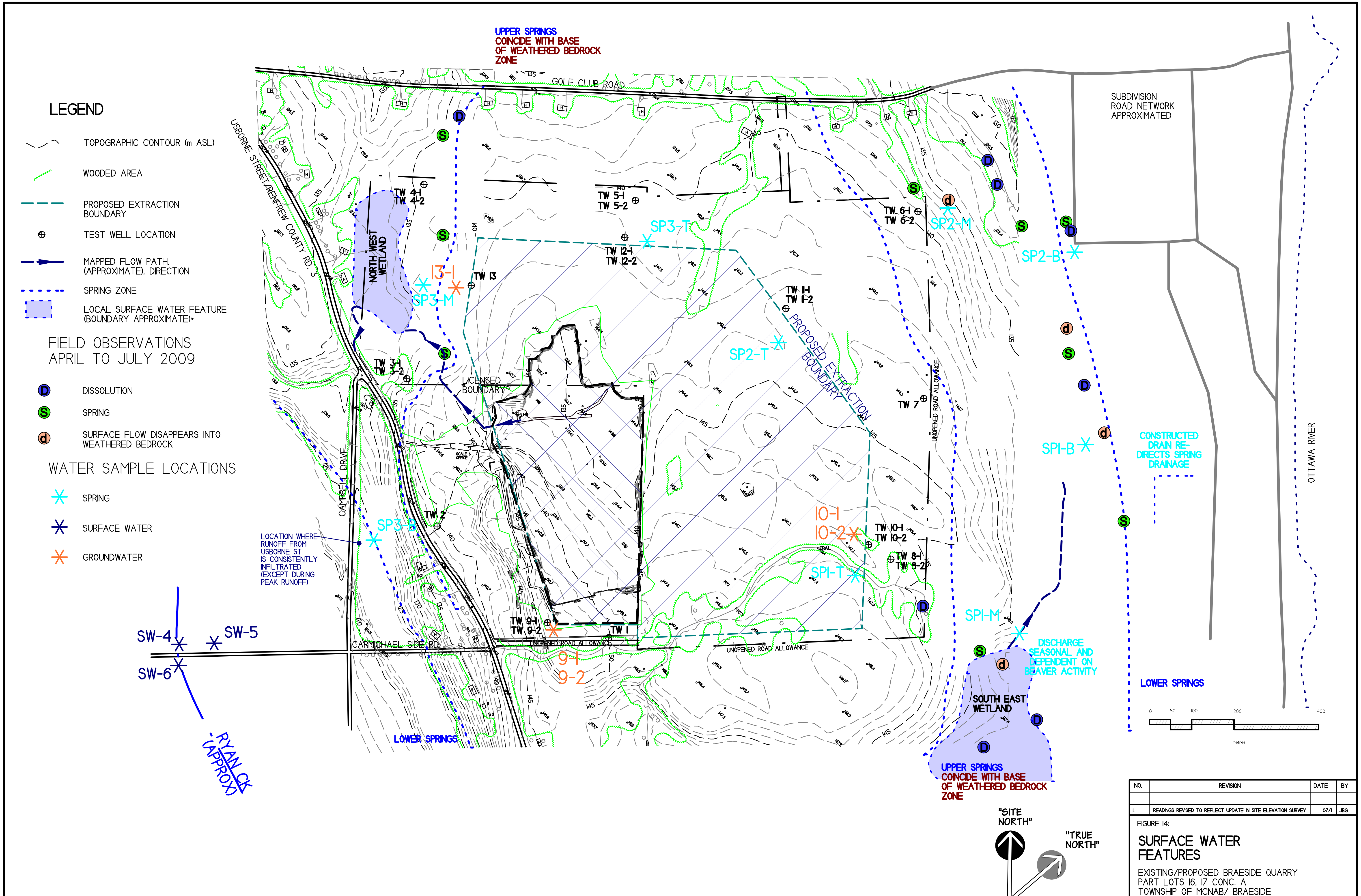
9.2 Springs

The accumulated surface water flows overland following the surface topography until the weathered bedrock zone is encountered. At this point, the surface water drains into the dissolution fractures and flows sub-surficially to emerge at the base of the dissolution zone as springs. The upper spring elevation is found approximately between 133 m ASL and 137 m ASL, and as indicated in Section 5.3.1, initially developed because of the position on the flank of the plateau during the late glacial period.

The surface water that emerges in the form of the upper springs flows again along the base of the upland of Bobcaygeon Formation and then subsequently overland following the local surface topography until it nears the edge of another topographic drop where it meets the lower dissolution/ weathered bedrock zone. The surface water drains into this dissolution zone and emerges below in the form of the lower springs, at around elevation 125 m ASL. This is just above the base of the escarpment and the contact between clay (referred to as Renfrew clay loam in the hydrology report) and upland till/ bedrock (referred to as Farmington loam in the hydrology report). This flow pattern can be observed along the length of the plateau on both the east and west sides. Photos 12 and 13 show drainage works constructed to manage the flow from the springs.

9.3 North-West Wetland (Local)

On the north-west corner of the study area, the natural environment report shows a local wetland feature that is partially on the Miller property. The topographic mapping shows that this feature is originally present, as described in Section 5.3, because of a natural bedrock trough filled with clay that had natural drainage constrained by the construction of Usborne St (Figure 2). The feature originally received drainage from up-gradient to the north which was augmented, due to its topographical positioning at to just below the upper spring elevation, with seasonal spring water. Currently, this surface water feature is augmented with the quarry discharge.



*SURFACE WATER FEATURE BOUNDARIES APPROXIMATE. REFER TO SKELTON BRUMWELL ASSOCIATES INC. "MILLER BRAESIDE QUARRY EXPANSION, HYDROLOGICAL INVESTIGATION, TOWNSHIP OF McNAB/ BRAESIDE, COUNTY OF RENFREW" DATED MAY 2012.

NO.	REVISION	DATE	BY
1.	READINGS REVISED TO REFLECT UPDATE IN SITE ELEVATION SURVEY	07/11	JBG

FIGURE 14:

SURFACE WATER FEATURES

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16, 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

9.3.1 Quarry Discharge Contribution to Surface Water Features

The path that the quarry discharge takes through the wooded area was mapped and is shown on Figure 14. The flow follows a channel partially constructed (for a length of approximately 4 to 5 m) and from that point naturally developed, until it emerges into the wetland on the Miller property. The quarry discharge entering the local wetland is clear (Photo 8). The wetland has an outlet that is beyond the Miller property, which exits at Usborne Street at Campbell Drive and then meanders back through the Miller site before discharging again into the east roadside ditch on Usborne Street at the culvert (SBA, 2012).

There are several contributors to the local North-West wetland in addition to the quarry discharge. There is an active beaver community in the area, and dams have a significant effect on the water level. Photos 9 and 10 show a point on the wetland before and after the removal of beaver dams by municipal staff near Usborne Street. The increases/changes in flow from to the beaver activity were observed to result in noticeable turbidity in the adjacent water (Photo 11). Despite the turbidity of the water entering the wetland from the north, the water was clear though slightly coloured where it emerged into the Usborne St roadside ditch.

9.4 South-East Wetland (Local)

A small local wetland area found south-east of the Miller property originated because of a combination of factors; a topographically suitable bedrock depression on the competent bedrock step directly at to slightly below the elevation that the upper springs emerge. The natural heritage evaluation indicates that the wetland appears to be a typical example of the small, shallow, beaver-maintained ponds found commonly across southern Renfrew County. Although the pond has not been evaluated, it is the opinion of the evaluator that there are no indications of significant natural features or functions here nor strong indications of the potential for such values to occur (these indications would include the existence of exceptional adjacent habitats, a strategically important location for wildlife passage, representation of particularly good potential habitat for potential Species At Risk; etc.).

This wetland has an outlet, shown on Figure 14. The water level will vary seasonally, depending on the spring flow and beaver activity. The flow from the outlet had significantly decreased in the May 22-26 2009 visit in comparison to the peak flows observed in mid-April. The water level in the pond is also controlled by extensive beaver activity in the area.

9.5 Geochemical Analysis

The general geochemistry taken from features at select locations was used in a limited preliminary analysis of surface water/ groundwater interaction in the study area. The purpose of the sampling was to endeavour to associate the different levels of surface water observed over the site. Samples from surface water from the central area of the site were taken, and designated as SP*-T in the spring sample series. Samples were also taken from the upper (SP*-M) and lower (SP*-B) springs at locations that had were associated with the top samples. The potential connection between the three levels was inferred from site observations and the topography, and assumed reasonably direct connections between the features above and below the ground surface. The laboratory reports are found in Appendix VII and the data used in the analysis is found in Table 6 and shown on Figure 15. Water quality results from the surface water monitoring program, the sump and different levels of groundwater were also analysed.

On a Piper plot, samples of like origin or composition cluster together. The graph permits a view of how various components may contribute to one another. The water quality from springs on the east side (SP-1 series and SP-2 series, points 5 to 10) differs from the water quality on the west side (SP-3 series, points 11 to 13). For each spring series on the east side, the results plot in a close distinct group indicating their similar origin.

Table 6: General Characteristics of Groundwater and Surface Water Components (Concentration in mg/L)

Date	Sample	Graph Ref.	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	F
30-Apr-09	Sump	1	97.00	12.00	48.00	1.00	207	0.0	83.00	55.00	0.13
30-Apr-09	SW 4	2	51.00	15.00	43.00	3.00	177	0.0	68.00	9.00	0.12
30-Apr-09	SW 5	3	135.00	16.00	51.00	1.00	292	0.0	98.00	84.00	<0.10
30-Apr-09	SW 6	4	51.00	15.00	43.00	3.00	174	3.0	72.00	10.00	0.12
17-Apr-09	SP1-B	5	59.00	3.00	<2.00[†††]	1.00	168	0.0	2.00	5.00	<0.10
17-Apr-09	SP1-M	6	63.00	3.00	<2.00	1.00	168	0.0	3.00	5.00	<0.10
17-Apr-09	SP1-T	7	61.00	1.00	<2.00	1.00	164	0.0	2.00	2.00	<0.10
17-Apr-09	SP2-B	8	71.00	4.00	<2.00	1.00	203	0.0	3.00	6.00	<0.10
17-Apr-09	SP2-M	9	65.00	2.00	<2.00	1.00	179	0.0	2.00	4.00	<0.10
17-Apr-09	SP2-T	10	66.00	2.00	<2.00	1.00	175	0.0	2.00	4.00	<0.10
17-Apr-09	SP3-B	11	109.00	13.00	38.00	1.00	261	0.0	104.00	17.00	<0.10
17-Apr-09	SP3-M	12	63.00	5.00	<2.00	1.00	175	0.0	1.00	14.00	<0.10
17-Apr-09	SP3-T	13	67.00	2.00	2.00	<1.00	181	0.0	1.00	14.00	<0.10
03-Jul-09	TW 9-2	14	189.00	21.00	11.00	4.00	228	0.0	13.00	322.00	0.16
03-Jul-09	TW 10-1	15	64.00	25.00	15.00	7.00	262	0.0	7.00	24.00	0.58
03-Jul-09	TW 13-1	16	70.00	12.00	16.00	3.00	221	0.0	2.00	28.00	0.26

[†††] where result was below the detection limit, the MDL was used in the graphing

Date	Sample	Graph Ref.	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	F
03-Jul-09	TW 9-1	17	93.00	20.00	4.00	2.00	250	0.0	2.00	78.00	0.46
03-Jul-09	TW 10-2	18	56.00	23.00	3.00	5.00	250	0.0	2.00	14.00	0.46

On the west side, the source water sample (SP3-T) and upper spring sample (SP3-M) have a different quality than the lower spring sample (SP3-B). This suggests either that the location assumed to be the source of the lower spring was incorrect, or that the lower springs on the west side have other influences than the upper springs. The base spring, SP3-B has a similar quality to surface water from SW5 suggesting that it is receiving recharge flow from along Campbell Drive.

Samples 14 (south-west), 16 (north-west) and 18 (south-east) represent the shallow bedrock quality. Sample 14, from TW 9-2, has a high sulphate concentration unlike any samples from the rest of the site. The location of the piezometer is just above the quarry floor and 24 m from the quarry face. Sample 16 is similar to the water quality of the springs on the west side, suggesting that they come from a similar source. This makes sense, as the elevation of TW 13-1 from which the sample was taken is approximately 130 m, within the same stratigraphic zone and the vicinity of the springs. Sample 18, from TW 10-2 is one of the highest monitoring points on the site and would be considered recharge water.

Sample 15 is from within the weathered bedrock zone, deeper in the profile, and Sample 17 is from the significant water bearing zone. The chemistry from the east and west sides is different, with the sample from TW 9-1 being farthest from the sample cluster, again because the sulphates are elevated although not as high as in TW 9-2.

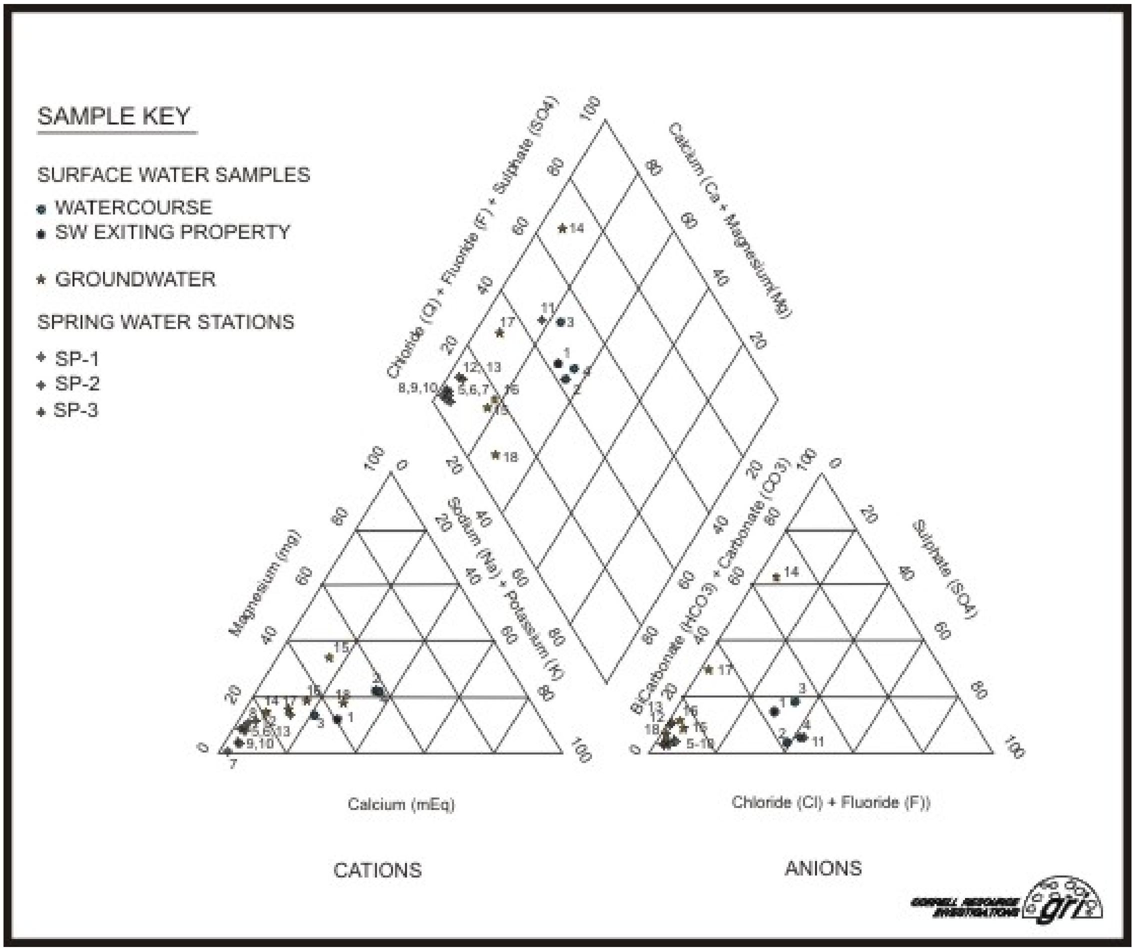
10 Door to Door Survey

Two door to door surveys have been conducted in the study area as part of the hydrogeological studies being reported upon. The methods, observations and results are summarized below.

10.1 2006 Survey

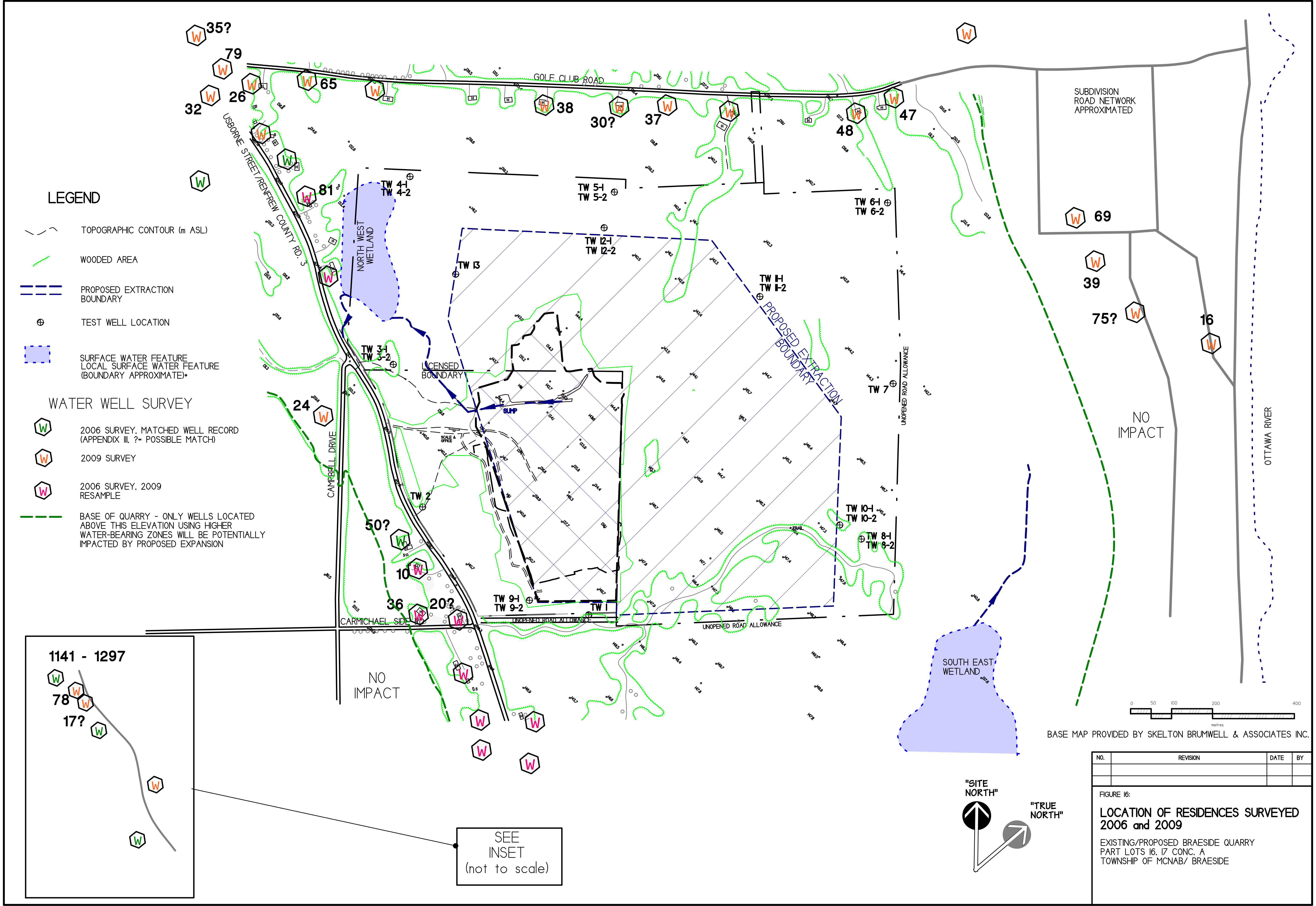
A door to door survey was first conducted between May and August 2006 as part of the PTTW monitoring program. An initial door-to-door survey of wells within 500 m of the licensed quarry boundary was conducted. Owners or residents of 17 sites were personally contacted out of the possible 18. The survey consisted of an interview, collection of a baseline water sample, and where possible and permitted, a direct water level measurement. The locations of the sites are shown on Figure 16. Participants were informed privately of the water quality results.

Figure 15: General Characteristics of Groundwater and Surface Water Components



The general analysis from the collected data found the following. The survey found that area users rely on two aquifers, the unconfined weathered bedrock, and the deeper confined bedrock aquifer. Within the deep aquifer, water is obtained from two distinct levels. Wells that use the unconfined weathered bedrock aquifer exclusively have a less reliable yield, and wells that include this zone are susceptible to bacteriological contamination. Of the wells examined in the upper aquifer, 7 were found to be unpotable in 2006 due to the presence of bacteria at unacceptable concentrations. This was not surprising considering the direct connection between surface water and the weathered bedrock zone down to an appreciable depth, partially discussed in Section 9.5. If the wells are not constructed to case off and seal the weathered zone, water from the surface can directly enter the well bore through the stratigraphy and the well annulus.

Anecdotal information from several sources described potability problems with area wells. One local driller indicated that some newer and in some cases older wells in the area that do not have casing grouted to 15 m or deeper are being retro-fitted with sleeves. These sleeves are being installed in the



BASE MAP PROVIDED BY SKELTON BRUMWELL & ASSOCIATES INC.

NO.	REVISION	DATE	BY

FIGURE 16:

LOCATION OF RESIDENCES SURVEYED 2006 and 2009

EXISTING/PROPOSED BRAESIDE QUARRY
PART LOTS 16. 17 CONC. A
TOWNSHIP OF MCNAB/ BRAESIDE

wells to ensure that the upper bedrock zones, which are directly connected to the surface, are shut off so groundwater of shallow origin cannot contribute to the well.

10.2 2009 Survey

The door to door survey was expanded in 2009 to include the properties within 500 m of the expansion property boundary. The initial intent was to conduct the survey in late 2007, but the survey was deferred until after initial peer review comments were received and other site activities were completed.

In the initial contact, in October 2007, information packages were either hand delivered or left in a mailbox or door. The package consisted of a letter from Miller introducing the Gorrells and the purpose of the survey, and a response page with an addressed postage paid envelope and response date for indication of interest. Of the 31 packages delivered, one refusal was received by telephone and 8 requests for inclusion in the survey were received.

As awareness of the project increased, additional requests were received by Miller for well water testing. Between November 2007 and December 2009, 15 additional requests for sampling were made, including residents in the area that had been surveyed previously. Of the requests, 5[‡‡‡] were determined to be outside the 500 m survey radius, and the owners were informed accordingly. The remaining 10 were advised of the proposed sampling and interview program details and were added to the survey list.

To ensure that contact had been made, a repeat package of information was mailed to the property contacts that had not been surveyed in the 2006 survey and to those within the original survey area who had requested updated water samples. The contact information for the properties was provided by the County of Renfrew. The packages were mailed by ExpressPost© with delivery confirmation or hand delivered to the civic address where contact information could not be correlated (13 locations). At the end of the 2009 survey, an attempt had been made to contact or re-contact the owners within 500 m of the existing and expansion quarry property boundary with an offer to conduct a new interview or collect a replicate water sample. Altogether, 53 owners were included in the survey, including two owners beyond the 500 m area who were included before the terms of reference for the survey were finalized. At completion of the survey, 38 owners had participated.

Following the interview, the water samples were delivered within 24 hours to the Bodycote Test Group laboratory in Ottawa for bacteriological and chemical analysis. Upon receipt of unpotable bacteriological results, the owners were immediately informed. As a courtesy, disinfecting pellets and instructions for disinfection were provided to most affected sites by G. Gorrell. Upon receipt of the laboratory results, a courtesy letter providing the results and short interpretation of water quality

---

[‡‡‡] Two properties were included in the survey before the radius to be surveyed was communicated to team members, and these wells are included in analysis

results in comparison to the Ontario Drinking Water Standard (ODWS) was mailed to each participant. Specific questions about well quality that had arisen during the interview were answered.

The survey locations are shown on Figure 16. The results of the survey are summarized In Table 7. The results do not show any identifying information, but they show the following general trends. Some specific local groundwater quality issues are highlighted below.

Table 7: Summary of General Household Quality, 2009 Surveyed Residences

Study ID	Bact Contam	NO_3 (mg/L)	Cl (mg/L)	Na (mg/L)	Hardness (as $CaCO_3$ mg/L)	Fl (mg/L)	Fe (mg/L)
6621		<0.10	288	356	12	0.25	<0.03
5461	x	<0.10	71	43	309	0.13	<0.03
5504	x	<0.10	2	3	234	<0.10	0.13
6129		<0.10	126	258	<1	0.17	<0.03
6361		<0.10	179	39	603	0.31	<0.03
5478	x	0.25	78	44	332	0.11	<0.03
5900	x	0.88	63	38	425	0.15	<0.03
7631		0.69	14	16	324	0.14	<0.03
7495		<0.10	24	32	455	0.14	0.24
7500		<0.10	9	55	197	0.45	<0.03
6480		<0.10	143	29	510	0.28	0.57
7570		<0.10	<1	<1	260	0.12	<0.03
6632		0.16	17	45	461	0.45	0.07
5525	x	0.5	51	27	334	<0.10	<0.03
6452		<0.10	678	261	783	0.25	0.1
7335	x	<0.10	1	<2	234	<0.10	<0.03
6540		<0.10	36	10	357	0.2	<0.03
6938	x	<0.10	179	319	<1	0.71	<0.03
7321		<0.10	9	22	355	0.2	<0.03
6277		0.32	340	169	524	0.22	<0.03
6874		<0.10	9	57	1440	0.67	<0.03

Study ID	Bact Contam	NO_3 (mg/L)	Cl (mg/L)	Na (mg/L)	Hardness (as $CaCO_3$ mg/L)	Fl (mg/L)	Fe (mg/L)
5764		<0.10	64	29	360	0.31	0.03
6599		<0.10	10	163	<1	0.68	<0.03
5729		<0.10	3	3	287	<0.10	<0.03
6723	x	<0.10	8	60	1590	0.84	0.3
5818	x	0.12	26	16	354	0.13	<0.03
6335	x	0.77	42	23	350	<0.10	<0.03
7318	x	2.57	75	31	501	0.19	<0.03
6284		0.16	9	178	<1	0.35	<0.03

10.3 Bacteriological Potability Impacts

Of the 25 samples taken, nine, or 36% of the wells showed bacteriological contamination that resulted in an unpotable water supply, compared to 7 of 17, or 41% in 2006. There is overlap in the contaminated sites between 2006 and 2009. Two-thirds of the identified wells are clustered on the south-west part of the survey area within the geological setting that has a high degree of weathering in the upper zones. In this part of the study area, the available information indicates that localized surface water regularly migrates down to approximate elevation 134 m ASL.

While the minimum standards for well casing and grouting prevent direct drainage of surface water through the annulus due to the well construction, they do not necessarily prevent surface water from entering a well water supply depending on site specific conditions. Wells may be constructed to the regulatory standards of the well drilling regulations (O.R. 903) with the minimum 20 ft (6.1 m) of casing and grout and still permit surface water to circumvent the casing and enter the well because of the surrounding stratigraphy. In some hydrostratigraphic settings (the more obvious one addressed in the regulations where an overburden thickness is greater than 6 m) more casing is added. Similarly in subdivisions, the subdivision conditions require greater than regulatory casing length[§§§]. The subdivision conditions may specify that well construction be supervised by the developer's hydrogeological consultant to ensure that their recommendations are followed.

However, in most planning situations, there is no method of enforcing a greater casing length. In the particular hydrostratigraphic setting of the study area, found on both sides of the escarpment, a casing length of 60 ft (20 m) reportedly provides the necessary protection from surface water contaminants. A local well driller informed us that he had successfully retrofitted several contaminated wells in the

---

[§§§] For the Sullivan subdivision, the consultant's report specifies a minimum of 12 m of casing and grouting.

Sullivan subdivision using this method. One well amendment record was found documenting this remediation.

10.4 Natural Gas

Natural gases, notably hydrogen sulphide were detected by the interviewer and/or reported by the interviewee in 8 of the sites, for 32%. These sites are predominantly located on the east side of the escarpment. Impacts of the gas range from variable concentrations of odour that may or may not have been treated, to sputtering when the taps were run, to corrosion impacts in fixtures. At one particularly severe site, when the outside tap sputtered, puffs of gas were observed wafting from the faucet.

To determine whether other harmful gas such as methane was present, a photo-ionization meter with and without methane elimination was used at a follow-up visit to that site, with the owner's permission, and no gas concentrations were detected in the well head.

Wells with natural gas can be hazardous both during drilling, if the driller is unaware of the area presence, and during use if the gas is not vented sufficiently. Methane gas is colorless and odorless. At high enough levels, the gas can be seen or heard bubbling in the well. At the particularly severe site, when the water was taken the effervescence in the sample resulted in cloudiness.

The gas may be dissolved in the water due to high pressure and low temperature in the well. When the well is pumped, the water level lowers and pressure in the well is reduced, bringing the gas out of solution. It may be released to the atmosphere if the well is vented, or may build up in the well if it is sealed. If the gas is trapped, such as in a well pit or pump house, it can build up to an explosive level. The spark from a pump motor or pressure switch can set off an explosion. This is more likely to occur in older wells which may be buried in well pits or situated in a pump house or basement.

To prevent a dangerous situation, the well casing has to be vented to the outside. Most new wells are located away from buildings and use a pitless adapter and vented cap, but the risk remains for the older-type wells.

Natural gas can accumulate in pressure tanks and hot water heaters. When this happens, the pressure from the gas accumulations builds up until it spurts out of the household taps. Gas release vents can be installed on some pressure tanks and on hot water heaters.

The origin of the natural gas is most probably the Rockcliffe Formation. The formation was not encountered on the Miller properties because of its depth, but on the east flank of the escarpment it is reported in many well records. It is distinguished by the description "red and green layers", characteristic of the formation in the area west of Ottawa.

Within the Rockcliffe Formation, it is the shale layers that are gas producing. The St. Martin Member has more frequent shale beds in the study area. The approximate elevation of the contact between the Rockclliffe Formation and the overlying Gull River Formation was reported in well records at between 64 m ASL and 94 m ASL, so only wells on properties with lower surface elevations, such as those found in the subdivision, or very deep wells are likely to encounter it.

10.5 Nuisance Bacteria

Iron and sulphur bacteria are also often found in water supplies, and the study area was no exception. The bacteria are considered a nuisance but do not render a water supply unpotable. The strains originate in overburden and can migrate down into the lower aquifers through natural or anthropogenic means. The well drilling regulations require disinfection of drilling equipment between wells to prevent cross contamination of bacteria, but they can be introduced from activities related to equipping a well, such as pump installation. The strains frequently thrive in a deeper well environment, particularly if it is slightly reducing.

Iron bacteria can be identified as red slime in the toilet tank or hot water heater; sulphur bacteria cause a black residue in fixtures and sometimes appear as feather-like particles. Iron bacteria especially can cause clogging in water treatment equipment, hot water heaters or other similar fixtures. They can be removed by oxidizing the water. In cases where they are prolific, down-the-well treatment systems using hydrogen peroxide or chlorine can be used to adjust the environment within the well itself and discourage or prevent growth.

The samples were not analysed for iron or sulphur bacteria, but anecdotal information was collected during the interviews that indicate that both strains are common to a degree in the study area. There are no laboratories in Ontario, including the MOE's own laboratory, that are currently licensed to analyse for iron or sulphur bacteria from a drinking water supply.

10.6 General Groundwater Quality

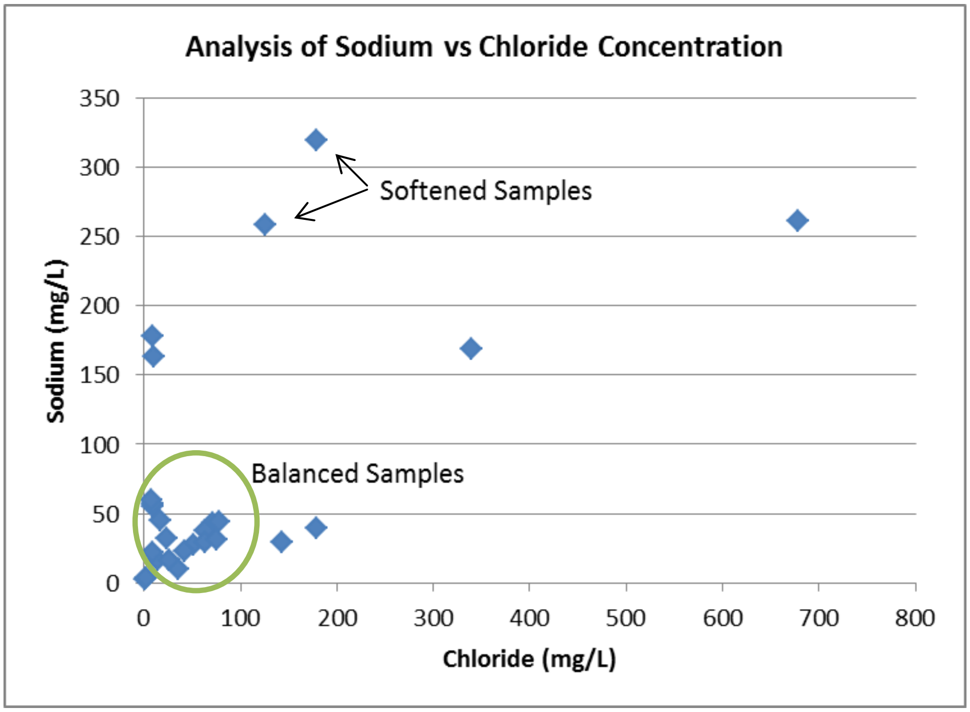
In general, the groundwater quality from the local aquifers was very hard, similar to the rest of Eastern Ontario where sedimentary bedrock is prevalent. The high hardness results in scale build-up in appliances and fixtures. A water softener is generally used to reduce the concentration. In the softener, the dissolved calcium and magnesium ions are replaced with sodium ions from induced salt brine. The resulting treated water usually has a sodium concentration that is close to, or exceeds, the Ontario Drinking Water Standard. Thirteen of the homes reported the use of a water softener. At two of the homes, only a softened supply was available for sampling.

A naturally high iron concentration is common in Eastern Ontario groundwater, but for most homes that a raw sample was obtained (16 sites or 64%) the iron concentration was below the analytical detection limit. The remainder have variable iron concentration ranging from 0.03 to 0.57 mg/L. The iron results in staining of fixtures and appliances. A moderate iron concentration can be removed with a water softener. More severe concentrations can be removed with iron removal units. Five homes reported the use of oxidizing units; none report the use of greensand filters.

At five of the sites (20%), residents indicated that they have detected sediment in their well water on occasion. The possible relationship of blasting events to the sediment encounters is being examined in conjunction with the blasting engineers.

Nitrate was not found to be prevalent in the analysed samples. The highest nitrate concentration recorded from the samples was 0.88 mg/L. The results for 13 of the sites (52%) was less than the method detection limit of 0.1 mg/L.

Figure 17: Analysis of Sodium vs Chloride Concentration in Sampled Wells



Sodium and chloride and their relationship were also examined. At the homes with softened samples, the sodium concentration exceeded the ODWS aesthetic objective. In normal balance, the sodium and chloride ions are approximately equal. The balanced samples are circled on Figure 17. The softened water samples can be identified by the high sodium and chloride concentration combined with the minimal calcium and magnesium ion concentration, and there are two such samples labelled on Figure 17.

There are five remaining samples unaccounted for. There are natural variations of sodium and chloride associated with some bedrock formations. The Rockcliffe Formation is one that can produce “salty” water, particularly along the Ottawa River in West Carleton Township. Another explanation is the influence of road salt applied in winter. This is usually identified by the well location in relation to the road network where road salt is applied, with particular attention to locations such as corners, stop signs or curves. Either are possible explanations for the anomalous concentrations noted from the survey.

11 Closure

The work in this report was conducted by or under the supervision of George A. Gorrell M.Sc. P.Geo. F.G.A.C. Mr. Gorrell's qualifications are found in Appendix VIII. If you have any questions about this report, please feel free to contact one of the undersigned.

Respectfully submitted;

This document issued as an electronic copy. Original signed and sealed by:

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

12 References

Chapman, L. J. and D. F. Putnam; *The Physiography of Southern Ontario, Third Edition*; OGS special volume 2, Accompanied by Map P.2715, scale 1:600,000; 1984.

Charles E. Mitchell, Adhya, S., Bergstrom, S.M., Joy, M.P., Delano, J.W.; Discovery of the Ordovician Millbrig K-bentonite Bed in the Trenton Group of New York State: implications for regional correlation and sequence stratigraphy in eastern North America; Palaeogeography, Palaeoclimatology, Palaeoecology Vol. 210, pp 331– 346; 2004.

Derry Michener Booth and Wahl and Ontario Geological Survey; *Limestone Industries of Ontario Volume II - Limestone Industries and Resources of Eastern and Northern Ontario*; Ontario Ministry of Natural Resources, Land Management Branch; 196 pp, 1989.

Driscoll, F. G.; *Groundwater and Wells, 2ed*.; Johnson Division, Minnesota; 1986.

Gorrell, G.A. 1991. *Buried sand and Gravel Features and blending sands in Eastern Ontario.* Open File report 5801, Ontario Geological Survey.

Gorrell Resource Investigations; *Preliminary Evaluation of Groundwater Table, Braeside Quarry*; prepared for Smiths Construction; letter to Steve Duncan dated March 17 2000.

Gorrell Resource Investigations; Permit to Take Water Application, Braeside Quarry, Part Lot 16 & 17, Concession A, McNab Township, Renfrew County; GRI Report 02180 dated March 2004.

Gorrell Resource Investigations; RE: Reference # 2520-69WL2P, Ministry of Environment Letter dated May 25, 2005, Permit to Take Water Application, Braeside Quarry, Part Lots 16 and 17, Conc. A, Township of McNabb; letter to Kyle Stephenson dated July 8, 2005.

Gorrell Resource Investigations; Hydrogeological Investigation Braeside Quarry Expansion, Part Lot 16 & 17, Concession A, Municipality of McNab/Braeside, Renfrew County; GRI Report 05460 dated September 2007.

Gorrell Resource Investigations; Consolidated 2006-2009 Hydrogeological Investigation, Proposed Braeside Quarry Expansion, Part Lot 16 & 17, Concession A, Municipality of McNab/Braeside, Renfrew County; GRI Report 08360 dated November 2009 [incorporated into and superseded by current report).

Gorrell Resource Investigations; Summary Report, Hydrogeological Investigation Braeside Quarry Expansion, Part Lot 16 & 17, Concession A, Municipality of McNab/Braeside, Renfrew County; GRI Report 08360 dated June 2010 (incorporated into and superseded by current report).

Hvorslev, M. J., 1951, ''Time Lag and Soil Permeability in Ground-Water Observations", Bull. No. 36, Waterways Experiment Station, Corps. of Engineers, U. S. Army, 50 pp.

Liberty, B. A. Paleozoic Geology of Wolfe Island, Bath, Sydenham and Gananoque Map-Areas, Ontario; Paper 70-35, Report and Maps 17-1970, 18-1970, 19-1970 and 20-1970, Geological Survey of Canada, scale 1:50,000. 1970.

Muncaster Environmental Planning Inc.; Interoffice Memorandum re Miller Braeside Quarry Expansion; Ryan Creek Autumn, 2008 Observations; November 28, 2008.

Richard, S.H., *Surficial geology, Arnprior (1G/3), Ontario and Quebec.* Geological Survey of Canada Map 1599A. scale 1:50,000, 1984a

Royle, Michael; Standard Operating Procedures for Borehole Packer Testing; www.robertsongeoconsultants.com/hydromine/topics/Site_Assessment/Packer_testing.pdf; accessed April 29, 2009.

Skelton Brumwell Associates Inc.; Braeside Quarry Expansion, Hydrological Investigation, Township of McNab/Braeside, County of Renfrew; 2012.

Skelton Brumwell Associates Inc.; Braeside Quarry Expansion, Natural Environment Report Level I and II, Township of McNab/Braeside, County of Renfrew; 2012b.

Skelton Brumwell Associates Inc.; Miller Braeside Quarry Expansion, Hydrological Investigation Report – Response to Golder Peer Review; letter to Miller Paving Limited; December 17, 2008.

Smart, Christopher C.; Glacier hydrology and the potential for subglacial karstification; Norsk Geografisk Tidsskrift - Norwegian Journal of Geography, Volume 38, Issue 3 & 4 1984 , pages 157 – 161.

Theim, G.; *Hydrologhsche methoden*. Leipzig, 1906 56 p. [Referenced in *Groundwater and Wells*]

Wadham, J.L. 2006 *"Solute enhancement in the proglacial zone"*; Glacier Science and Environmental Change, P. G. Knight (ed); Wiley-Blackwell; August 2006.

Williams, R. R. Wolf and D. A., A. M. Rae; *Palaeozoic Geology of the Arnprior-Quyon Area, Southern Ontario*; Ontario Geological Survey, Map P2726, Geological Series-Preliminary Map, scale 1:50,000, Geology 1982; 1984.

Williams, D.A. and P. Telford *Palaeozoic Geology of the Ottawa Area. Field Trip 8 Guide Book*, G.A.C., M.A.C. and C.G.U. Joint Annual Meeting Ottawa. 25pp. 1986.

Photographs

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

List of Photographs

Photo 23: Close up of Sump level, September 18, 2009

Photo 24: October 14, 2009 – note the sump level is below the base of the floor ditch

Lower Lift

Photo 25: After initial blast, August 12 2009. Face shows dampness below K-bentonite layer probably due to disturbance during blast

Photo 26: Annotated Photo taken September 3, 2009 as last of blasted rock removed from lower lift cut (Miller photo)

Photo 27: Sept 18, 2009; showing dry lower floor (approx date of previous precipitation Sept 14 from Macdonald-Cartier Climate Sta.

Photo 28: Taken Oct 8 09; No seepage on walls. Water on floor is accumulation of rainfall that occurred intermittently on daily basis that week. Note contact between Bobcaygeon and Gull River Formations

Photo 1

Lower Member, Bobcaygeon Formation, massively bedded limestone

Photo 2

Teradium Coral in Gull River Formation

Photo 3

K-bentonite Layer

Photo 4

Iron staining on face shows how surface water migrates down to significant levels – note minor seepage from lower 3 m.

Photo 5

Iron staining in lower quarry face, upper lift

Photo 6

Joints, enhanced in weathered bedrock zone, extend down to the contact

Location, Photos 7 and 8

Photo 7
May 9, 2011

Photo 8
September 22, 2011

Photo 9

TW 9-1

Root Mass and K-Bentonite at 145 m ASL,

Photo 10

Clear Water from Quarry Discharge entering North-West Wetland

Photo 11

Discharge from up-gradient recharge to wetland from north showing sediment load

Photo 12

Infiltration Drains around home in Ridge View Estates, typical

Photo 13

July 24 2009

Portion of Ditch constructed to Divert Seasonal Springwater Flow in the Subdivision

Photos 14 to 28 - Sump and Lower Lift

Photo 14

July 30. 2007

Photo 15
August 16 2007

Photo 16
April 9, 2008

Second Day of Pumping

Photo 17
May 20, 2008

Photo 18
October 15, 2008

Photo 19

April 16 2009

Still winter accumulations in north-east corner, shows drainage ditch in floor and sump

Photo 20

July 22, 2009

Sump level is significantly lowered and floor ditch has no flow

Photo 21

July 25, 2009

This photo was taken following the July 24 2009 significant storm event that occurred along Ottawa River, striking Kanata (Ottawa, ON) and areas north-west

Photo 22

September 18, 2009

Very dry period. Water level in sump can be seen in Photo 21

Photo 23

September 18, 2009

Close up of Sump level

Photo 24

October 14, 2009 –

The sump level is below the base of the floor ditch

Lower Lift – August to October, 2009

Photo 25

August 12 2009.

After initial blast, face shows dampness below K-bentonite layer probably due to disturbance during blast

Photo 26

September 3, 2009

Annotated Photo taken as last of blasted rock removed from lower lift cut (Miller photo)

Photo 27

Sept 18, 2009; showing dry lower floor

Approx. date of previous precipitation Sept 14 from Luskville climate station

Photo 28

Oct 8 09

No seepage on walls. Water on floor is accumulation of rainfall that occurred intermittently on daily basis that week. Note contact between Bobcaygeon and Gull River Formations

Sub Appendices to Appendix A

July 2012

Appendix I

Borehole Logs

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

Ontario Ministry of the Environment

The Ontario Water Resources Act

WATER WELL RECORD

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

County or District	Township/Borough/City/Town/Village	Con block tract survey, etc.	Lot
Renfrew	McNab	Con 4	16

Owner's surname	First Name	Address	Date completed (day month year)
Smith's Construction Company		PO Box 218 276 Madawaska Blvd. Arnprior, Ont	10 07 2002

Zone | Easting | Northing

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth - feet From	Depth - feet To
brown	loose fill			0	1'
gray	Shaile limestone			1'	65'

GRI TW 1

WATER RECORD

Water found at - feet	Kind of water
NO water	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas

CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth - feet From	Depth - feet To
6¼	☒ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	.188	0	4'
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			

SCREEN

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

Material and type	Depth at top of screen feet

PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at - feet From	To	Material and type (Cement grout, bentonite, etc.)
4'	0	Cement Grout

PUMPING TEST

Pumping test method	Pumping rate	Duration of pumping
☐ Pump ☐ Bailer	GPM	Hours Mins

Static level	Water level end of pumping	Water levels during ☐ Pumping ☐ Recovery 15 minutes	30 minutes	45 minutes	60 minutes
feet	feet	feet	feet	feet	feet

If flowing give rate	Pump intake set at	Water at end of test
GPM	feet	☐ Clear ☐ Cloudy

Recommended pump type	Recommended pump setting	Recommended pump rate
☐ Shallow ☐ Deep	feet	GPM

FINAL STATUS OF WELL

- ☐ Water supply
- ☐ Observation well
- ☒ Test hole
- ☐ Recharge well
- ☐ Abandoned, insufficient supply
- ☐ Abandoned, poor quality
- ☐ Abandoned (Other)
- ☐ Dewatering
- ☐ Unfinished
- ☐ Replacement well

WATER USE

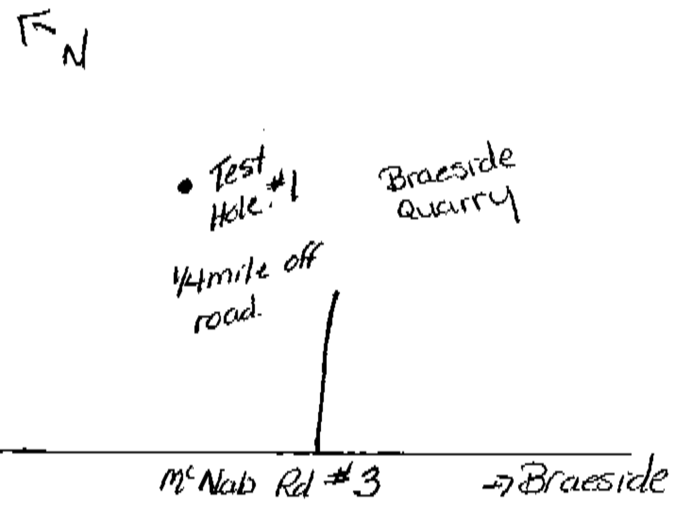
- ☐ Domestic
- ☐ Stock
- ☐ Irrigation
- ☐ Industrial
- ☐ Commercial
- ☐ Municipal
- ☐ Public supply
- ☐ Cooling & air conditioning
- ☐ Not use
- ☐ Other Reading

METHOD OF CONSTRUCTION

- ☐ Cable tool
- ☐ Rotary (conventional)
- ☐ Rotary (reverse)
- ☐ Rotary (air)
- ☒ Air percussion
- ☐ Boring
- ☐ Diamond
- ☐ Jetting
- ☐ Driving
- ☐ Digging
- ☐ Other

LOCATION OF WELL

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



248451

Name of Well Contractor	Well Contractor's Licence No.
George H. Law + Son Ltd	3323

Address: Box 155 Calabogie, Ont K0J-1H0

Name of Well Technician	Well Technician's Licence No.
Allan Fougere	T-0432

Signature of Technician/Contractor | Submission date: 10 07 2002 (day mo yr)

MINISTRY USE ONLY

1 - CONTRACTOR'S COPY

0506 (07/00) Front Form 9

Ontario Ministry of the Environment

The Ontario Water Resources Act

WATER WELL RECORD

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

County or District	Township/Borough/City/Town/Village	Con block tract survey, etc.	Lot
Renfrew	McNab	Con 4	16

Owner's surname	First Name	Address	Date completed (day month year)
Smiths Construction Company		Po Box 218, 276 Madawaska Blvd. Arnprior, Ont K7S-3H4	10 07 2002

Zone ☐☐ Easting ☐☐☐☐☐☐ Northing ☐☐☐☐☐☐☐

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth - feet From	Depth - feet To
brown	loose fill			0	2'
gray	Shaile limestone			2'	65'

GRI TW 2

WATER RECORD

Water found at - feet	Kind of water	
unknown	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas

CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth - feet From	Depth - feet To
6 1/4	☑ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	.188	0	5
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			

SCREEN

Sizes of opening (Slot No.)	Diameter	Length
	Inches	feet

Material and type	Depth at top of screen
	feet

PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at - feet From	Depth set at - feet To	Material and type (Cement grout, bentonite, etc.)
5'	0	Cement Grout

PUMPING TEST

Pumping test method ☐ Pump ☐ Bailer
Pumping rate ____ GPM
Duration of pumping ____ Hours ____ Mins

Static level	Water level end of pumping	Water levels during ☐ Pumping ☐ Recovery: 15 minutes	30 minutes	45 minutes	60 minutes
feet	feet	feet	feet	feet	feet

If flowing give rate ____ GPM
Pump intake set at ____ feet
Water at end of test ☐ Clear ☐ Cloudy
Recommended pump type ☐ Shallow ☐ Deep
Recommended pump setting ____ feet
Recommended pump rate ____ GPM

FINAL STATUS OF WELL

- ☐ Water supply
- ☐ Observation well
- ☑ Test hole
- ☐ Recharge well
- ☐ Abandoned, insufficient supply
- ☐ Abandoned, poor quality
- ☐ Abandoned (Other)
- ☐ Dewatering
- ☐ Unfinished
- ☐ Replacement well

WATER USE

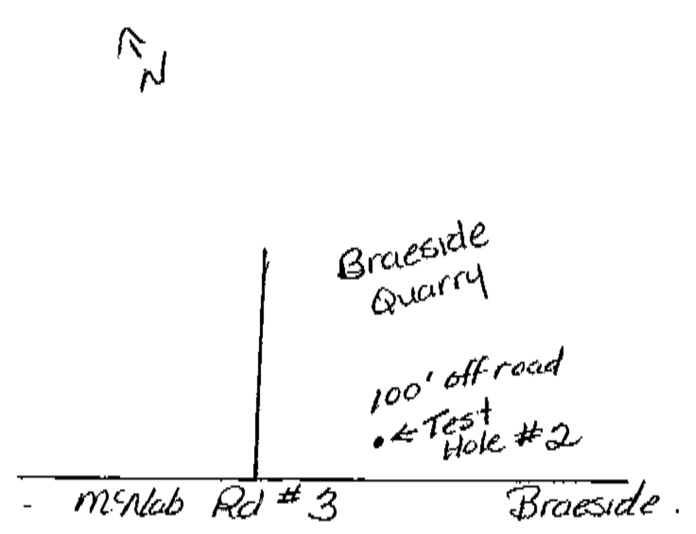
- ☐ Domestic
- ☐ Stock
- ☐ Irrigation
- ☐ Industrial
- ☐ Commercial
- ☐ Municipal
- ☐ Public supply
- ☐ Cooling & air conditioning
- ☐ Not use
- ☐ Other

METHOD OF CONSTRUCTION

- ☐ Cable tool
- ☐ Rotary (conventional)
- ☐ Rotary (reverse)
- ☐ Rotary (air)
- ☑ Air percussion
- ☐ Boring
- ☐ Diamond
- ☐ Jetting
- ☐ Driving
- ☐ Digging
- ☐ Other

LOCATION OF WELL

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



234770

Name of Well Contractor	Well Contractor's Licence No.
George H. Law + Son Ltd	3323

Address: Box 155 Calabogie, Ont K0J-1H0

Name of Well Technician	Well Technician's Licence No.
Allan Fougere	T-0432

Signature of Technician/Contractor	Submission date (day mo yr)
Alfred Law	10 07 2002

MINISTRY USE ONLY

1 - CONTRACTOR'S COPY

0506 (07/00) Front Form 9

Ontario Ministry of the Environment

Well Tag Number (place sticker and print number below): **A 054429**
A054429

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: M^cNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 386848 Northing 5036125
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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	24.38

GRI # 3-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres	Kind of Water	
4.08	☐ Fresh ☐ Salty ☐ Gas	☐ Sulphur ☐ Minerals ☐ Other: UNTESTED
23m46	☐ Fresh ☐ Salty ☐ Gas	☐ Sulphur ☐ Minerals ☐ Other: UNTESTED
m	☐ Fresh ☐ Salty ☐ Gas	☐ Sulphur ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+ .60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at (metres): 24.0
Pumping rate - (litres/min): 22.5
Duration of pumping: 6 hrs + 0 min
Final water level end of pumping: 7.02 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ______ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	5.08		
1	6.2	1	6.99
2	6.4	2	6.48
3	6.45	3	6.08
4	6.5	4	6.45
5	6.5	5	5.82
10	6.8	10	5.53
15	6.8	15	5.59
20	6.85	20	5.69
25	6.97	25	5.69
30	7.0	30	5.44
40	7.0	40	5.52
50	7.05	50	5.37
60	7.07	60	5.34

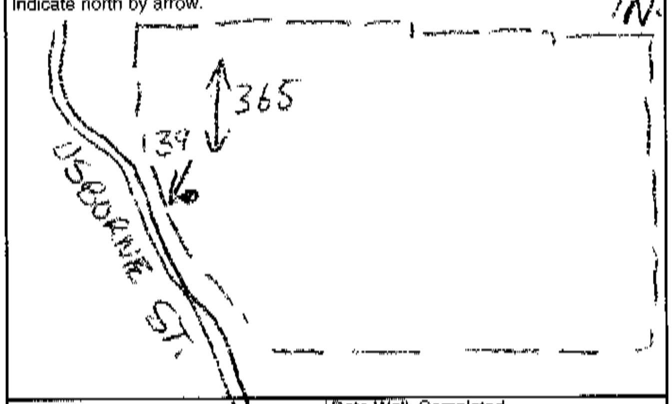
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction

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

Water Use

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

Final Status of Well

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

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: x Troy Saund
Date Submitted: YYYY 2007 MM 06 DD 25

Audit No. Z 55056
Date Well Completed: YYYY 2007 MM 05 DD 25
Was the well owner's information package delivered? ☐ Yes ☐ No
Date Delivered: YYYY 2007 MM 05 DD 25

Ministry Use Only
Data Source | Contractor
Date Received YYYY MM DD | Date of Inspection YYYY MM DD
Remarks | Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formulaire est disponible en français

Ontario Ministry of the Environment

Well Tag Number (place sticker and/or print number below): **A 054430**

A 054430

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR, Lot, Concession): 276 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 8 3 Zone 18 Easting 386845 Northing 5036122
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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	12.19
	GRI # 3-2				

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres	Kind of Water		
7.01 m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	☐ Other: UNTESTED
m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	☐ Other:
m	☐ Fresh	☐ Sulphur	
☐ Gas	☐ Salty	☐ Minerals	☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0 + .60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 12.19
Pumping rate - (litres/min): 3.6
Duration of pumping: 1 hrs + 40 min
Final water level end of pumping: 12.19 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ______ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	2.67		
1	3.68	1	11.72
2	4.70	2	11.71
3	5.71	3	11.69
4	6.72	4	11.67
5	7.74	5	11.65
10	5.27	10	11.42
15	5.67	15	11.18
20	6.17	20	10.97
25	6.55	25	10.87
30	6.97	30	10.61
40	7.97	40	10.27
50	8.77	50	9.94
60	8.25	60	9.82

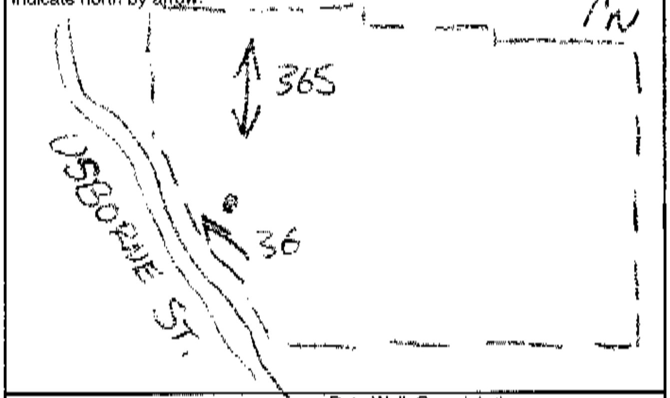
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Audit No. Z 55057
Date Well Completed (YYYY MM DD): 2007 05 25
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered (YYYY MM DD): 2007 05 25

Method of Construction

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

Water Use

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

Final Status of Well

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

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: x
Date Submitted (YYYY MM DD): 2007 06 25

Ministry Use Only
Data Source:
Contractor:
Date Received (YYYY MM DD):
Date of Inspection (YYYY MM DD):
Remarks:
Well Record Number:

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (place sticker and print number below)
A 054436
A 054436

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3141
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 8 3 Zone 18 Easting 386564 Northing 5036502
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	Depth Metres To
BROWN	CLAY		DENSE	0	4.87
GREY	CLAY			4.87	5.79
BROWN	LIMESTONE	GREY LIMESTONE		5.79	24.38

GRI # 4-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres: 21.03 m
Kind of Water: ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED

☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.50	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 24.38
Pumping rate - (litres/min): 5.63
Duration of pumping: 4 hrs + 57 min
Final water level end of pumping: 14.78 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	3.21		
1	3.85	1	14.78
2	3.98	2	14.78
3	4.00	3	
4	4.16	4	
5	4.20	5	
10	4.34	10	
15	4.56	15	
20	5.10	20	
25	5.22	25	
30	5.42	30	
40	5.95	40	
50	6.03	50	
60	6.26	60	

WELL DID NOT RECOVER

Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Method of Construction

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

Water Use

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

Final Status of Well

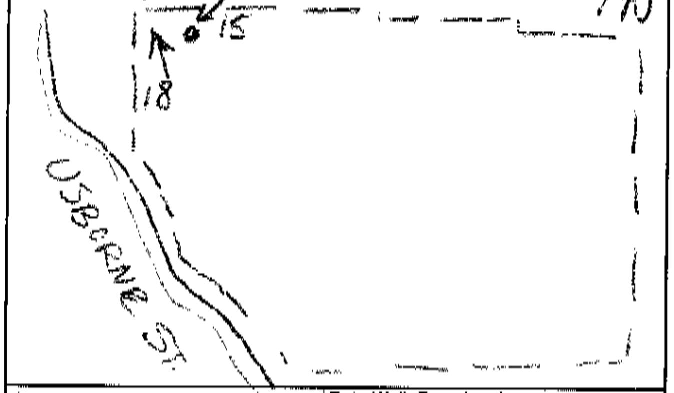
☐ Water Supply ☒ Observation well ☐ Test Hole
☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality
☐ Unfinished ☐ Dewatering ☐ Replacement well
☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saun
Date Submitted: YYYY 2007 MM 06 DD 28

Location of Well

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



Audit No. **Z 55054**
Date Well Completed: YYYY 2007 MM 05 DD 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered: YYYY 2007 MM 05 DD 28

Ministry Use Only
Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well T[illegible] [illegible]mber below) **A 054437**

A054437

Well Record

Regulation 903 Ontario Water Resources Act

page ___ of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3141
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 385571 Northing 5036496
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	Depth Metres To
BROWN	CLAY		DENSE	0	4.87
GREY	CLAY		SOFT	4.87	5.79
BROWN	LIMESTONE	GREY LIMESTONE		5.79	12.1

GRI # 4-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres	Kind of Water
___ m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN
___ m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
___ m	☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+0.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 12.19
Pumping rate - (litres/min): 2.03
Duration of pumping ___ hrs + 30 min
Final water level end of pumping: 11.50 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WELL PUMPED DRY

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	3.42		
1	5.5	1	11.29
2	6.10	2	11.28
3	6.65	3	11.27
4	6.90	4	11.25
5	7.15	5	11.25
10	8.51	10	11.20
15	9.49	15	11.19
20	10.20	20	11.13
25	10.90	25	11.08
30	11.50	30	11.03
40	/	40	10.98
50	/	50	10.87
60	/	60	10.80

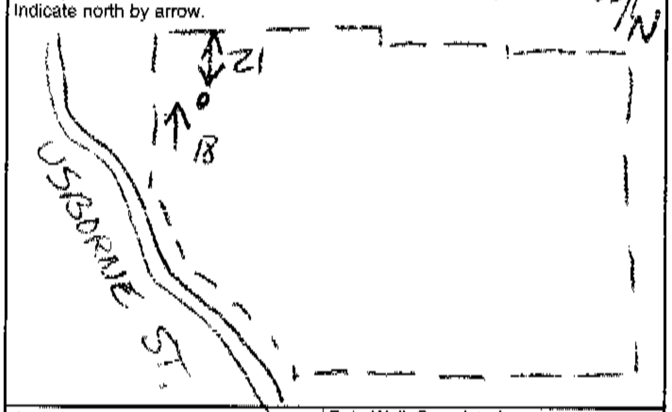
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction

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

Water Use

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

Final Status of Well

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

Audit No. Z 55055
Date Well Completed (YYYY MM DD): 2007 05 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered (YYYY MM DD): 2007 05 28

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT, K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: x Troy Saul
Date Submitted (YYYY MM DD): 2007 06 28

Ministry Use Only
Data Source:
Contractor:
Date Received (YYYY MM DD):
Date of Inspection (YYYY MM DD):
Remarks:
Well Record Number:

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well T mber below)
A 054438
A054438

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name	Last Name	Mailing Address (Street Number/Name, RR,Lot,Concession)		
	MILLER CONSTRUCTION	276 MADAWASKA BLVD		
County/District/Municipality	**Township/City/Town/Village**	**Province**	**Postal Code**	**Telephone Number (include area code)**
RENFREW	ARNPRIOR	Ontario	K7S 3N2	613-623-3144
Address of Well Location (County/District/Municipality)	**Township**	**Lot**	**Concession**	
RENFREW	M'NAB/BRAESIDE			
RR#/Street Number/Name	**City/Town/Village**	**Site/Compartment/Block/Tract etc.**		
1498 USBORNE ST.	BRAESIDE			

GPS Reading NAD 8 3 Zone 18 Easting 386988 Northing 5036840 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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	24.38

GRI # 5-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres	Kind of Water	
___ m	☐ Fresh	☐ Sulphur
☐ Gas	☐ Salty	☐ Minerals
☐ Other: UNKNOWN		
___ m	☐ Fresh	☐ Sulphur
☐ Gas	☐ Salty	☐ Minerals
☐ Other:		
___ m	☐ Fresh	☐ Sulphur
☐ Gas	☐ Salty	☐ Minerals
☐ Other:		

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify WELL PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

	Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Pumping test method SUB. PUMP				
Pump intake set at - (metres) 21.38	Static Level	1.43		
Pumping rate - (litres/min) 12.74	1	3.05	1	23.64
Duration of pumping ___ hrs + 45 min	2	3.96	2	23.64
Final water level end of pumping 23.64 metres	3	4.25	3	23.61
Recommended pump type. ☐ Shallow ☐ Deep	4	4.47	4	23.57
Recommended pump depth. ___ metres	5	5.08	5	23.55
Recommended pump rate. (litres/min)	10	7.61	10	23.50
	15	10.51	15	23.49
If flowing give rate - (litres/min)	20	13.28	20	23.48
	25	15.51	25	23.48
If pumping discontinued, give reason. (WELL PUMPED DRY)	30	18.58	30	23.47
	40	23.64	40	23.47
	50		50	23.47
	60		60	23.33

Plugging and Sealing Record ☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.04	BENTONITE SLURRY	.192

Method of Construction

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

Water Use

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

Final Status of Well

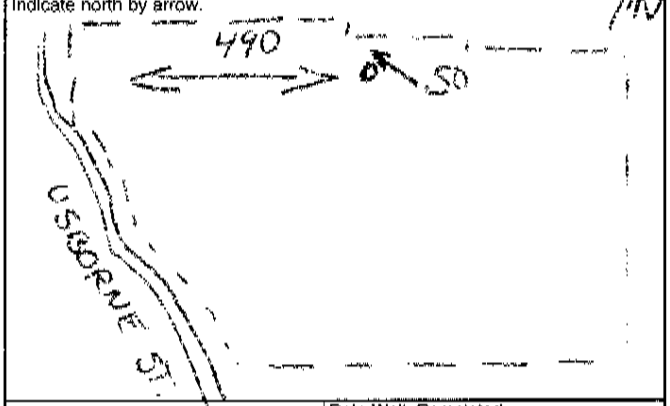
☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☑ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Well Contractor/Technician Information

Name of Well Contractor: T SAUNDERS DRILLING LTD	Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE K0A 1G0	
Name of Well Technician (last name, first name): SAUNDERS, TROY	Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saul	Date Submitted YYYY MM DD: 2007 05 29

Location of Well

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



Audit No. Z 55050	Date Well Completed YYYY MM DD: 2007 05 24
Was the well owner's information package delivered? ☒ Yes ☐ No	Date Delivered YYYY MM DD: 2007 05 24

Ministry Use Only

Data Source	Contractor
Date Received YYYY MM DD	Date of Inspection YYYY MM DD
Remarks	Well Record Number

0506E (08/2006) **Well Owner's Copy** *Cette formule est disponible en français*

Ontario Ministry of the Environment

Well Tag No. **A 054439** A 054439

Well Record

Regulation 903 Ontario Water Resources Act

page ___ of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR, Lot, Concession): 876 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-5144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 83 Zone 18 Easting 386985 Northing 5036832
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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	12.19

GRI # 5-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres / Kind of Water

___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN

___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify WELL PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres) 12.19
Pumping rate - (litres/min) 4.5
Duration of pumping 1 hrs + 0 min
Final water level end of pumping 12.19 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	.62		
1	1.76	1	11.45
2	1.81	2	11.32
3	1.87	3	11.29
4	1.93	4	11.26
5	2.05	5	11.23
10	2.99	10	11.14
15	2.99	15	11.05
20	5.3	20	11.0
25	6.98	25	10.93
30	7.28	30	10.80
40	9.53	40	10.66
50	10.91	50	10.45
60	12.19	60	10.31

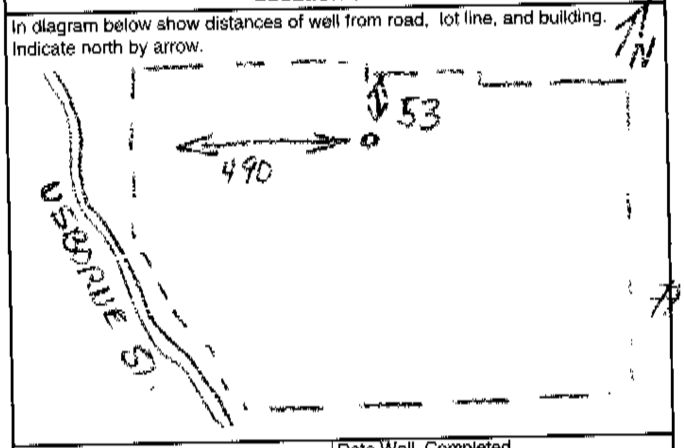
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction

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

Water Use

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

Final Status of Well

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

Audit No. Z 55052
Date Well Completed YYYY MM DD 2007 05 29
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD 2007 05 29

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saud
Date Submitted YYYY MM DD 2007 06 29

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (place sticker and print number below) A 054432
A054432

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 876 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: M'NAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 8 3 Zone 18 Easting 380504 Northing 5037238 Unit Make/Model MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth From	Metres To
BROWN	SHALE			0	.45
BROWN	LIMESTONE	GREY LIMESTONE		.45	24.38

GRI # 6-1

Hole Diameter

Depth From	Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres / Kind of Water
20.7 m ☒ Fresh ☐ Sulphur ☒ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth From	Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB PUMP
Pump intake set at - (metres) 24.38
Pumping rate - (litres/min) 1.7
Duration of pumping ___ hrs + 40 min
Final water level end of pumping 24.81 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WELL PUMPED DRY

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	4.62		
1	5.13	1	23.52
2	6.47	2	23.52
3	6.82	3	23.32
4	7.51	4	23.32
5	9.6	5	23.32
10	12.45	10	23.31
15	15.25	15	23.30
20	17.57	20	23.30
25	18.80	25	23.30
30	24.80	30	23.29
40	24.81	40	23.28
50		50	23.28
60		60	23.27

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	6.04	BENTONITE SLURRY	.192

Method of Construction

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

Water Use

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

Final Status of Well

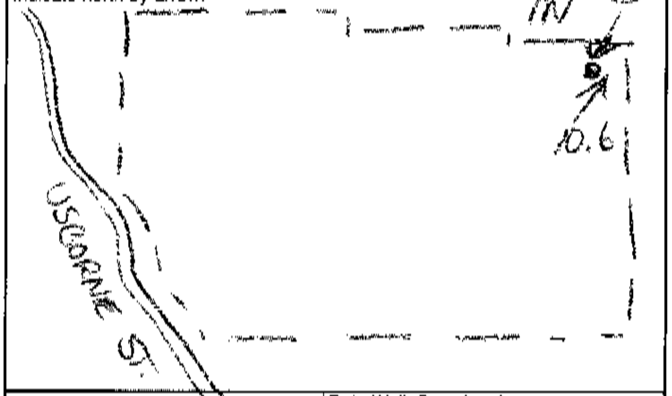
☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☒ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT.
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: x Troy Saunders
Date Submitted YYYY MM DD: 2007 05 28

Location of Well

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



Audit No. Z 55051
Date Well Completed YYYY MM DD: 2007 05 23
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD: 2007 05 28

Ministry Use Only

Data Source | Contractor
Date Received YYYY MM DD | Date of Inspection YYYY MM DD
Remarks | Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (place sticker and print number below)
A 054431
A054431

Well Record
Regulation 903 Ontario Water Resources Act

page ___ of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: MCNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 8 3 Zone 18 Easting 387490 Northing 5037241
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	SHALE			0	.45
BROWN	LIMESTONE	GREY LIMESTONE		.45	12.19

GRI # 6-2

Hole Diameter

Depth Metres From	To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres / Kind of Water
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres) 12.19
Pumping rate - (litres/min) .75
Duration of pumping ___ hrs + 40 min
Final water level end of pumping 12.19 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WELL PUMPED DRY

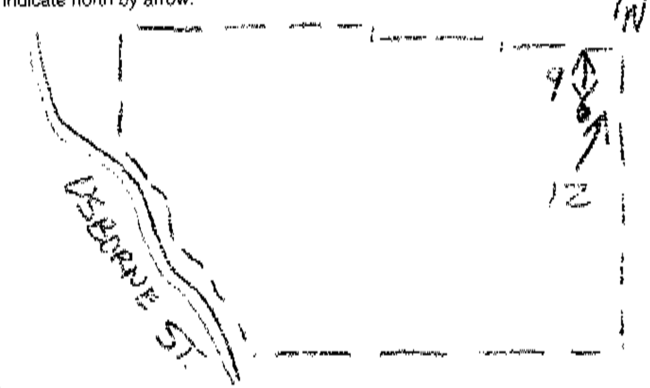
Draw Down Time min	Water Level Metres	Recovery Time min	Water Level Metres
Static Level	5.65		
1	6.20	1	12.05
2	7.05	2	12.03
3	7.76	3	12.03
4	8.12	4	12.03
5	8.50	5	11.71
10	9.50	10	11.70
15	10.10	15	11.70
20	10.60	20	11.69
25	11.10	25	11.69
30	11.60	30	11.68
40	12.19	40	11.67
50		50	11.67
60		60	11.65

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	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction
☐ Cable Tool ☐ Rotary (air) ☐ Diamond ☐ Digging
☐ Rotary (conventional) ☒ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use
☐ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☐ Commercial ☒ Not used
☐ Irrigation ☐ Municipal ☐ Cooling & air conditioning

Final Status of Well
☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☒ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Audit No. Z 55053
Date Well Completed YYYY MM DD 2007 05 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD 2007 05 28

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: x Troy Saunders
Date Submitted YYYY MM DD 2007 06 28

Ministry Use Only
Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006) Well Owner's Copy *Cette formule est disponible en français*

Ontario Ministry of the Environment

Well Tag Number (place sticker and print number below)
A 054433
A 054433

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N8
Telephone Number (include area code): 613-623-5648
Address of Well Location (County/District/Municipality): RENFREW
Township: M'NAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 8 3 Zone 18 Easting 377757 Northing 5030979
Unit Make/Model: MAGELLAN
Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth From	Metres To
BROWN	SHALE			0	.60
BROWN	LIMESTONE	GREY LIMESTONE		.60	24.38
	GRI # 7				

Hole Diameter

Depth Metres From	To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres / Kind of Water
12.80 m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☒ Other, specify PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0? .60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 24.38
Pumping rate - (litres/min): 7.2
Duration of pumping ___ hrs + 60 min
Final water level end of pumping 23.13 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Water Level Metres	Recovery Time min	Water Level Metres
Static Level	7.20		
1	9.33	1	23.13
2	9.94	2	23.12
3	9.97	3	23.08
4	10.0	4	23.07
5	10.4	5	23.05
10	12.0	10	22.87
15	13.5	15	22.58
20	14.0	20	22.44
25	15.9	25	22.2
30	16.7	30	22.13
40	19.4	40	21.83
50	22.1	50	20.87
60	23.13	60	19.87

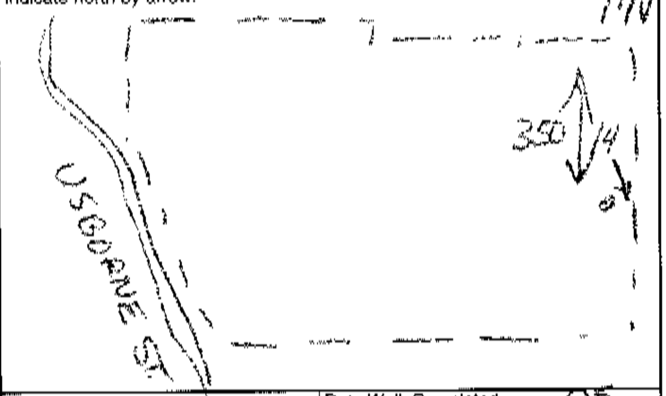
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction

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

Water Use

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

Final Status of Well

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

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): R.R.1 BRAESIDE K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saund
Date Submitted YYYY MM DD: 2007 06 08

Audit No. Z 55058
Date Well Completed YYYY MM DD: 2007 05 23
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD: 2007 05 23

Ministry Use Only
Data Source | Contractor
Date Received YYYY MM DD | Date of Inspection YYYY MM DD
Remarks | Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Wel(l tag number below) **A 054434**
A054434

Well Record

Regulation 903 Ontario Water Resources Act

page 2 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N2
Telephone Number (Include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 83 Zone 18 Easting 338029 Northing 5036588
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	SHALE			0	.91
BROWN	LIMESTONE	GREY LIMESTONE		.91	24.38
	GRI # 8-1				

Hole Diameter

Depth Metres From	To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres / Kind of Water
10.97 m ☑ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
23.16 m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☑ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0 + .60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 24.38
Pumping rate - (litres/min): 15.75
Duration of pumping: 6 hrs + 0 min
Final water level end of pumping: 22.36 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ______ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Water Level Metres	Recovery Time min	Water Level Metres
Static Level	13.32		
1	16.60	1	20.75
2	16.67	2	20.6
3	16.74	3	20.55
4	16.80	4	20.27
5	16.64	5	20.09
10	17.10	10	19.64
15	17.50	15	19.39
20	17.90	20	19.25
25	18.20	25	18.95
30	18.78	30	18.77
40	18.90	40	18.66
50	19.15	50	18.52
60	19.50	60	18.46

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	6.09	BENTONITE SLURRY	.192

Method of Construction

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

Water Use

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

Final Status of Well

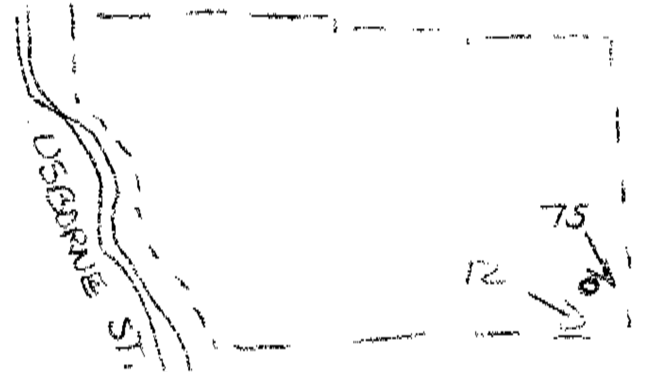
☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☒ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor X
Date Submitted YYYY MM DD 2007 06 30

Location of Well

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



Audit No. **Z 55049**
Date Well Completed YYYY MM DD 2007 05 30
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD 2007 05 30

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well (number below) **A 054435**

A054435

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N2
Telephone Number (include area code): 613 623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 388033 Northing 5036594
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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	12.19

GRI # 8-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres / Kind of Water

☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN

☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 12.0
Pumping rate - (litres/min): 4.55
Duration of pumping: 0 hrs + 40 min
Final water level end of pumping: 11.50 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WATER DRAWDOWN TO WELL BOTTOM

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	5.61		
1	4.05	1	12.17
2	4.18	2	12.03
3	4.30	3	12.01
4	4.56	4	11.97
5	4.70	5	11.95
10	5.80	10	11.84
15	7.10	15	11.80
20	7.85	20	11.74
25	9.00	25	11.68
30	10.00	30	11.66
40	11.50	40	11.63
50	/	50	11.59
60	/	60	11.37

Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Method of Construction

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

Water Use

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

Final Status of Well

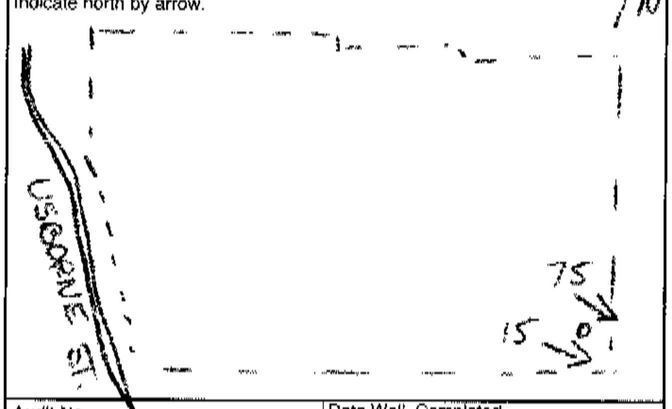
☐ Water Supply ☒ Observation well ☐ Test Hole ☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality ☐ Unfinished ☐ Dewatering ☐ Replacement well ☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-577
Signature of Technician/Contractor: X Troy Saul
Date Submitted YYYY MM DD: 2007 06 30

Location of Well

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



Audit No. Z 55045
Date Well Completed YYYY MM DD: 2007 05 30
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD: 2007 05 30

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

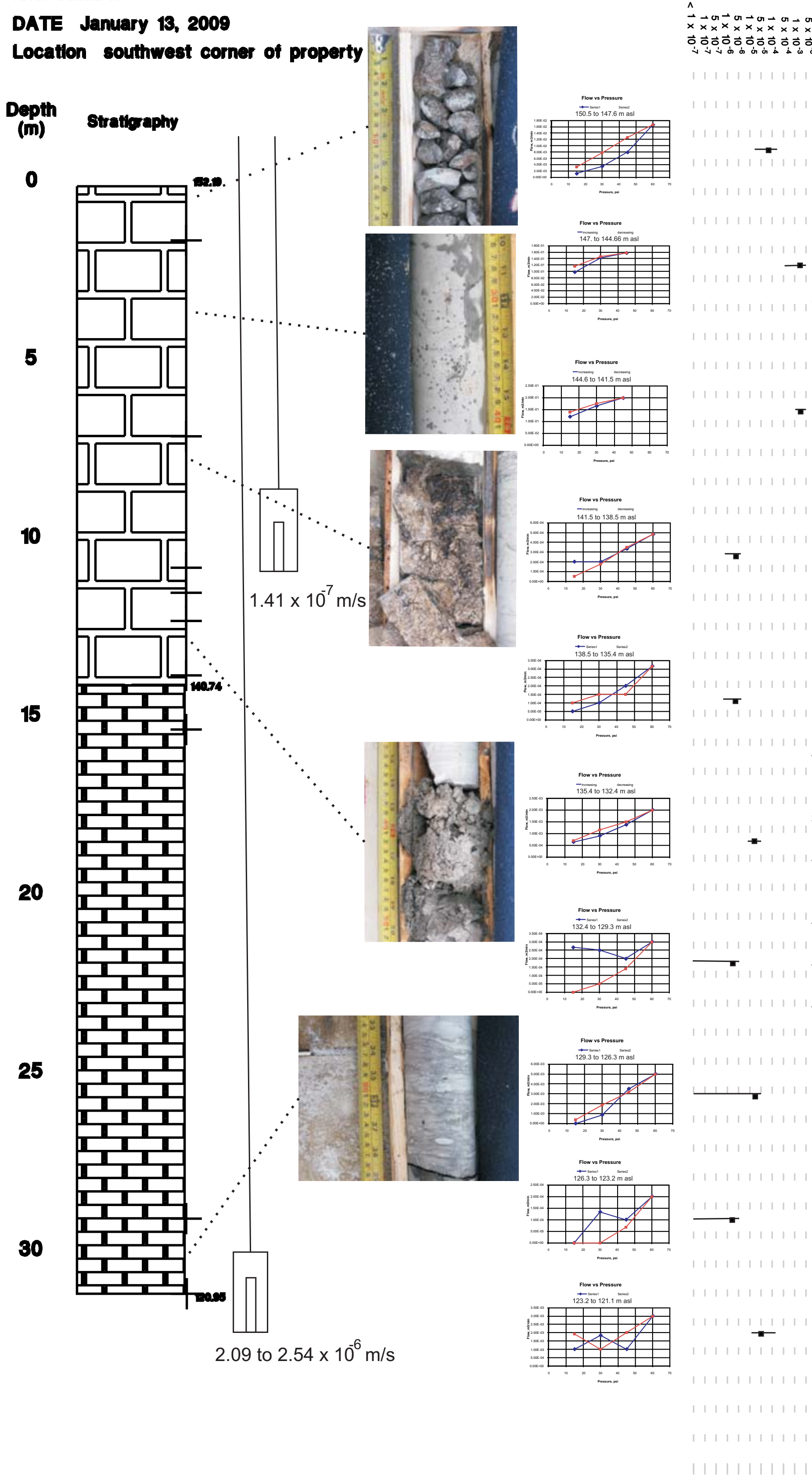
PROJECT 05490

Hole Number 9-1

DATE **January 13, 2009**

Location **southwest corner of property**

DRILL TYPE: diamond drill, CME 75



0 to 11.30 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded,medium to thickly bedded

-very weathered to 3 m bgs

-occasional vug present

-tree roots split core at 7.01 m bgs

-most breaks are mechanical breaks

11.30 to 30.65 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-K-bentonite present from 11.28 to 11.73 m bgs

-rust staining at

-small vugs below 12.0 m bgs

-water bearing zone at 31.09 m

GORRELL RESOURCE INVESTIGATIONS

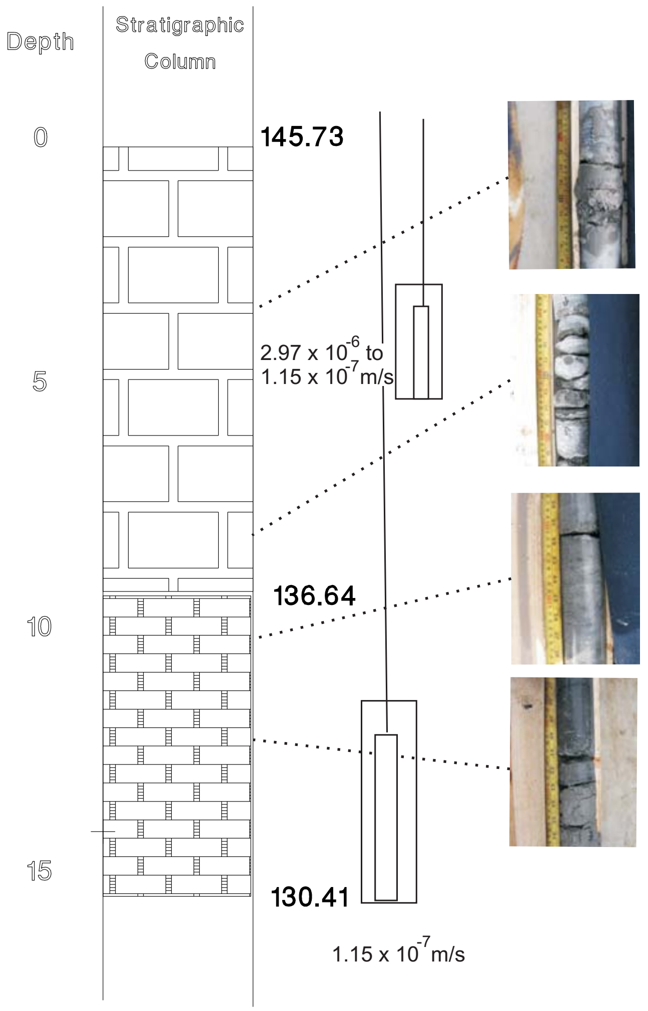
PROJECT 05490

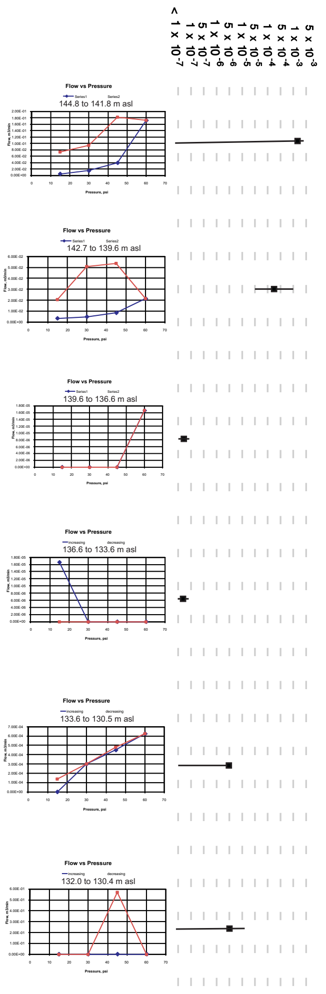
Hole Number 10

DATE February 18, 2009

Location northeast corner of property

DRILL TYPE: diamond drill, CME





0 to 9.09 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly beddeD

-occasional vug present

-possible K-bentonite layer at 3.35 to 3.40 & 8.38 m

-rust staining at 2.16, 2.5,4.88 to 5.18 and 7.75 to 7.80 m bgs,

-most breaks are mechanical breaks

9.09 to 15.32 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-K-bentonite present from 12.50 to 13.11 m bgs

-rust staining at 12.12

·small vugs below 11.49 m bgs

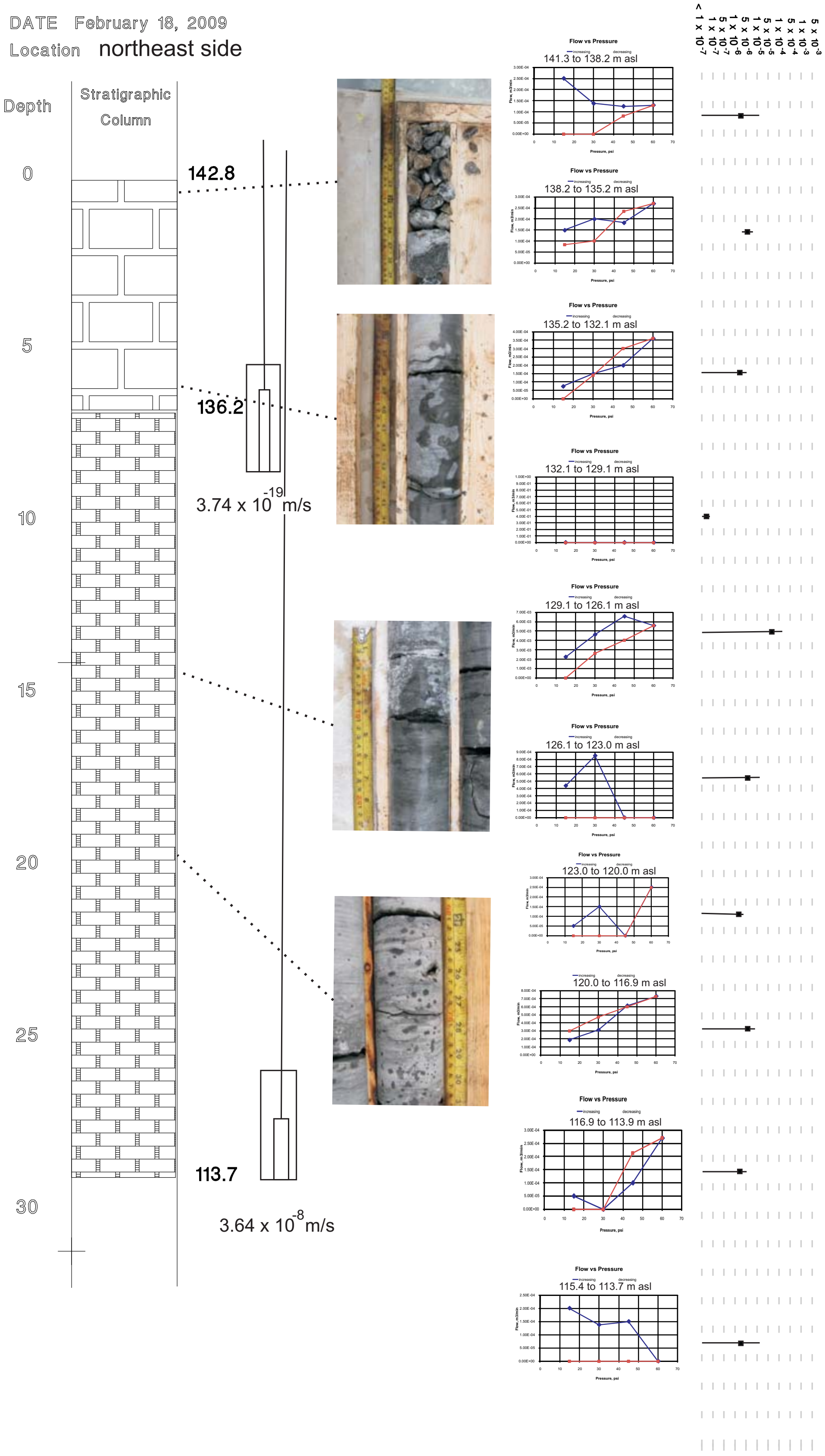
PROJECT 05490

Hole Number 11

DATE February 18, 2009

Location northeast side

DRILL TYPE: diamond drill, CME



0 to 6.65 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded

6.65 to 29.10 m GULL RIVER FORMATION

-6.65 to 15.27 upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-15.27 to 29.10 lower member of formation, consists of interbedded limestone and dolostone, sharp contacts, predominately limestone that is fine to very fine crystalline

-K-bentonite layer at 14.81 to 15.04

GORRELL RESOURCE INVESTIGATIONS gri

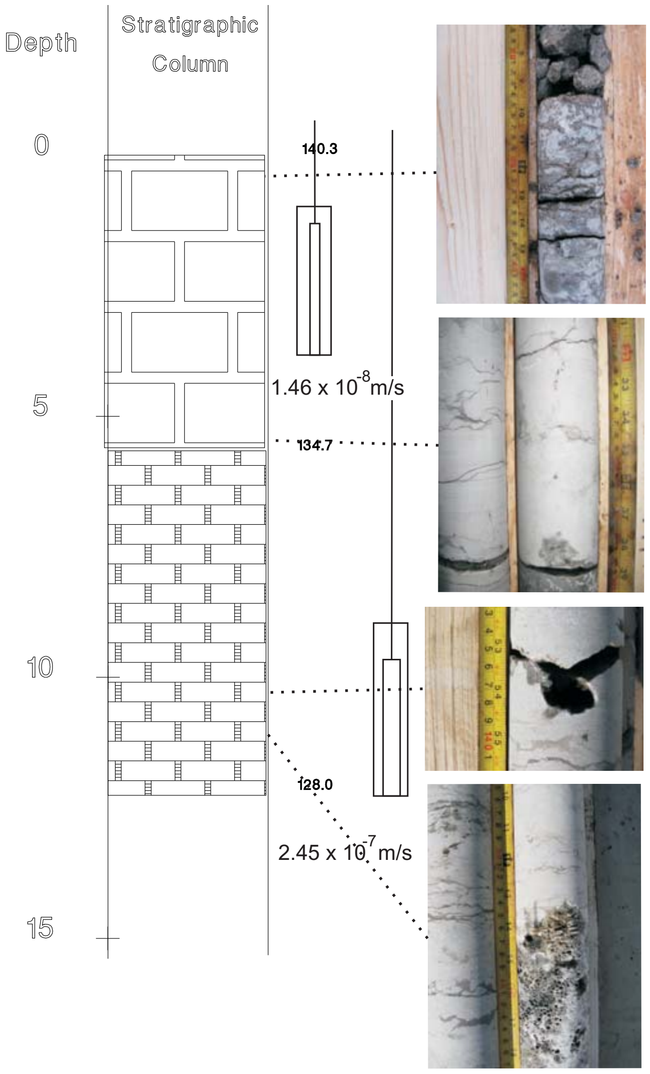
PROJECT 05490

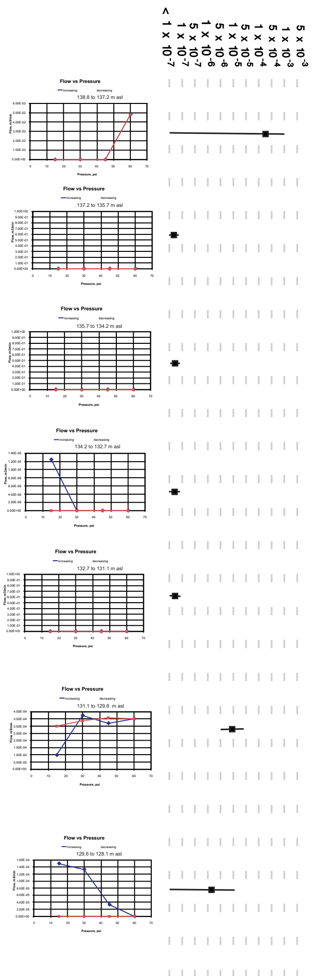
Hole Number 12

DATE February 23, 2009

Location southwest corner of property

DRILL TYPE: diamond drill, CME





0 to 5.6 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown
to grey, fine to occasional medium crystalline, medium to
massive bedded, medium to thickly bedded,

-occasional vug present

5.58 to 12.27 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline
limestone with shale interbeds

-large vug present at 10.5 m, tetradium coral zone from 10.97 to 11.10 m

GORRELL RESOURCE INVESTIGATIONS gri

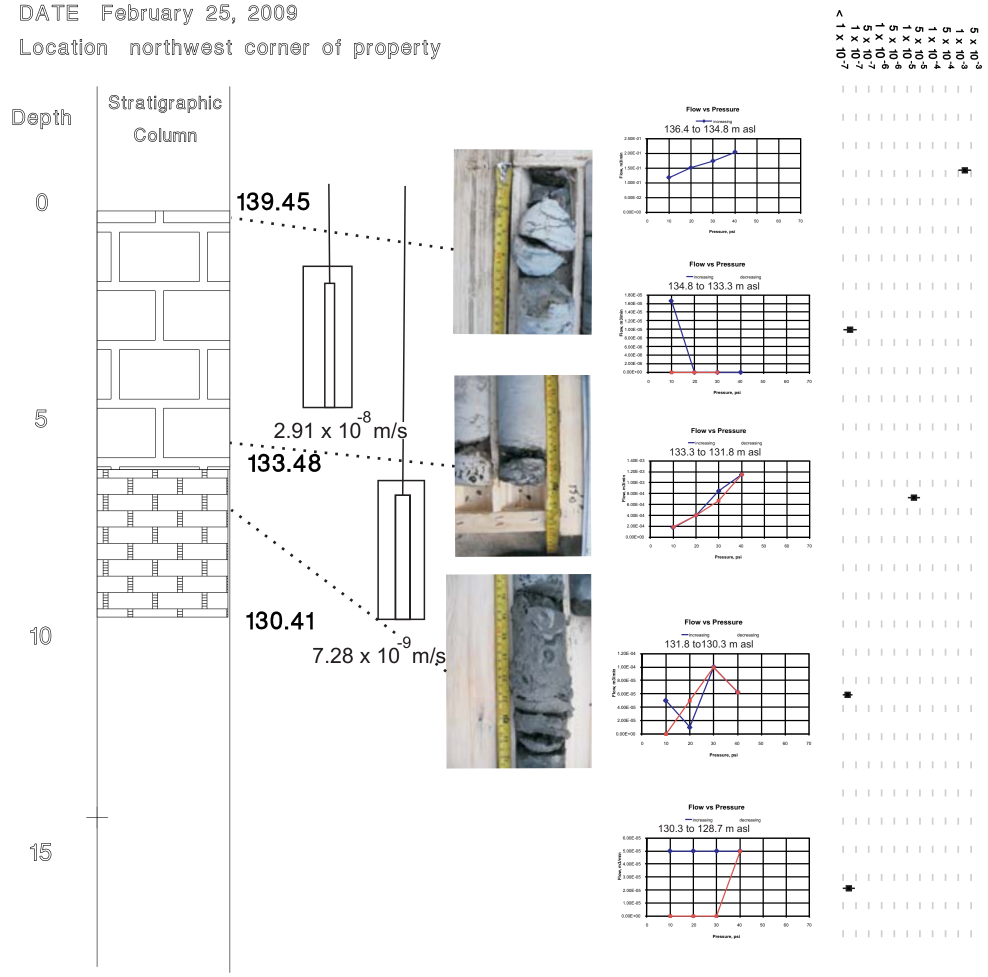
PROJECT 05490

Hole Number 13

DATE February 25, 2009

Location northwest corner of property

DRILL TYPE: diamond drill, CME



0 to 5.97 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded

-highly weathered zone at 1.98 to 2.74

-occasional vug present

-fractures at 3.76, 3.84, 5.33

5.97 to 9.37 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-fracture at 6.02

-K-bentonite present from 6.34 to 6.71 m bgs

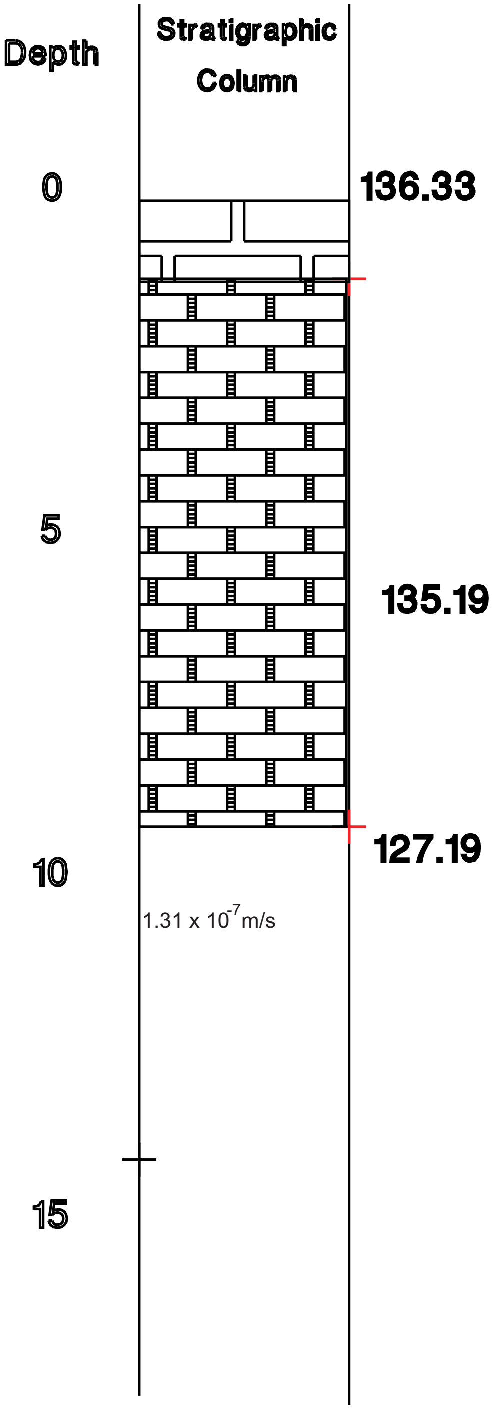
PROJECT 05490

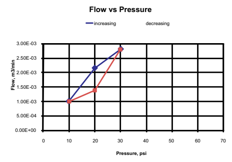
DRILL TYPE: diamond drill, CME 75

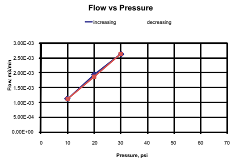
Hole Number F

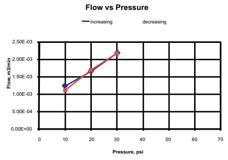
DATE March 4, 2009

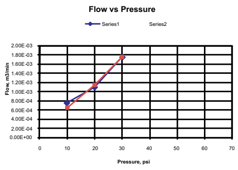
Location quarry floor, just south of sump; drilled for core to be tested

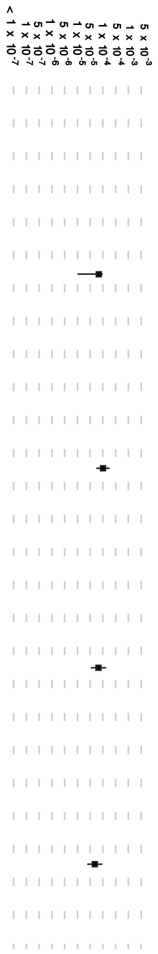












0 to 1.14 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded

-occasional vug present

1.14 to 9.14 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-K-bentonite at 4.47 m (131.9 m asl)

GORRELL RESOURCE INVESTIGATIONS

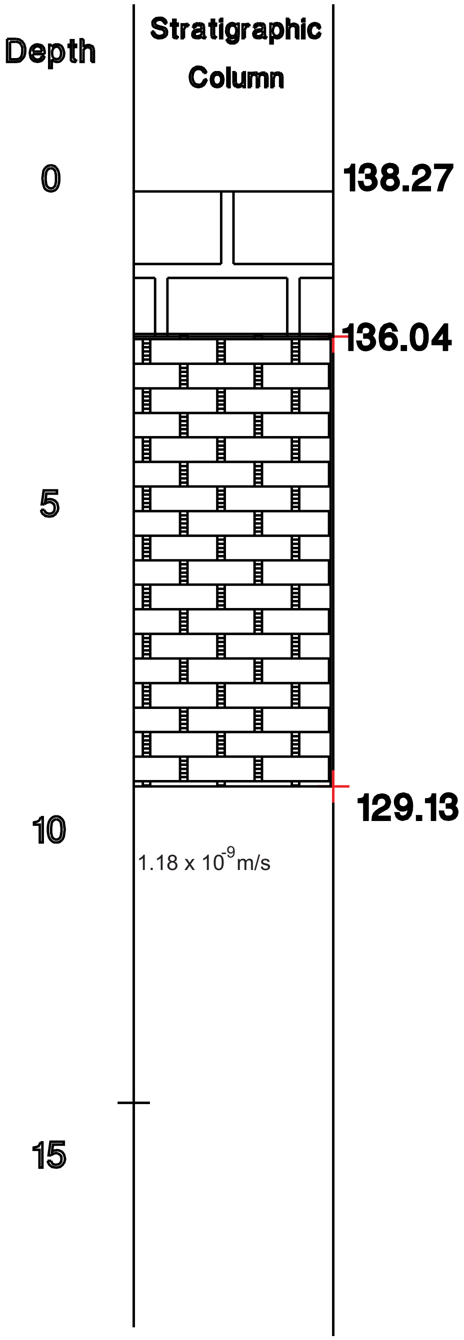
PROJECT 05490

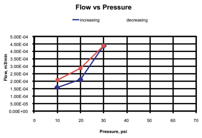
DRILL TYPE: diamond drill, CME 75

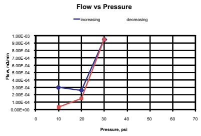
Hole Number G

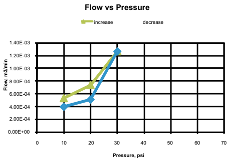
DATE March 5, 2009

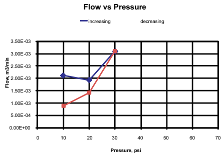
Location quarry floor, south portion of quarry; drilled for core to be tested

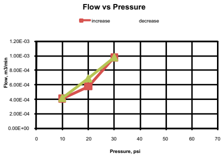


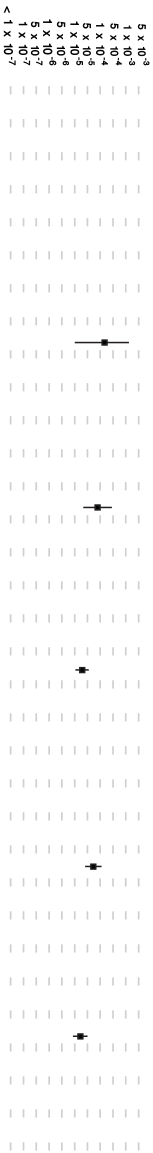












0 to 2.23 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded

-occasional vug present

2.23 to 9.14 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-K-bentonite at 4.11 m (134.16 m asl)

Appendix II

Summary of MOE Well Record Data

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

WELL RECORD SUMMARY

MOE #	Well No.	Conc., Lot	Easting	Northing	Surface Elev. (ft)	Date Drilled	Water Found (ft)	Static Level (ft)	Pumped Level (ft)	Pump Rate (IGPM)	Owner, Log
TW 1	**1**		387620	5035980	492.126	Jul-02	DRY	25.4	56	0.85	SMITHS CONSTRUCTION CO loos fill 0001, grey shly lmsn 0065
TW 2	**2**		387120	5035930	456.037	Jul-02	45	25.8	39.2	0.65	SMITHS CONSTRUCTION CO loos fill 0002, grey shly lmsn 0065
55-08122	**3**	B,15				Feb-86	190	60	175	30	brwn shle 001, brwn lmsn 0200
	4	B, 17				Aug-89	199	30	150	7	sand loam 0060, grey lmsn 0205
55-04898	**5**	A, 15	387930	5035200	425	May-77	80	15	60	10	sand grvl 0010, grey lmsn 0085
55-02998	**6**	A, 15	387693	5035381	400	Feb-73	101	50	70	6	brwn loam 001, brwn lmsn 0105
55-10795	**7**	A, 15				Mar-92	239	98	244	5	fill 01, shle loam 03, grey lmsn 0195, grey lmsn snds lyrd 0245
55-01008	**8**	A, 15	387860	5035240	415	Aug-63	196	63	140	10	brwn shle 0010, grey lmsn 0200
55-03893	**9**	A, 16	387450	5035600	475	Nov-75	130	60	110	0	brwn shle 0013, unkn 0130
55-07769	**10**	A, 16				Apr-85	74	34	70	10	shle 03, red lmsn 0083
55-09461	**11**	A, 17				Apr-89	210	60	200	15	sand stns 004, grey lmsn shle 0165, grey shle snds 0218
55-09178	**12**	A, 17				Aug-88	208	52	215	12	sand stns 001, lmsn shle 0133, grey shle snds 0218
55-01009	**13**	A, 18	387080	5037480	415	Aug-60	90	10	70	6	msnd 005, grey lmsn 0100
55-05882	**14**	B, 15	389000	5036500	350	Jun-79	230	90	200	20	hpan 021, grey lmsn 0234
55-01068	**15**	B, 15	388905	5036660	300	Aug-64	155	80	140	2	lmsn 0160
55-01355	**16**	B, 15	388860	5036700	300	Jan-65	148	28	40	7	lmsn shle 0150

WELL RECORD SUMMARY

MOE #	Well No.	Conc., Lot	Easting	Northing	Surface Elev. (ft)	Date Drilled	Water Found (ft)	Static Level (ft)	Pumped Level (ft)	Pump Rate (IGPM)	Owner, Log
55-06996	**17**	B, 16	388799	5036599	375	Dec-62	162	68	174	10	fill 002, lmsn 0175,
55-10691	**18**	B, 17				Oct-91	252	6	261	10	sand stns 053, brwn lmsn 089, grey lmsn lyrd 0262
55-03621	**19**	B, 17	388000	5037500	350	May-74	150	15		0	fill 005, lmsn 0155
55-12419	**20**	B, 17				Sep-95	71	12	79	7	clay 56, S&G 061, grvl 70, grnt snds 080
55-03292	**21**	B, 18	387853	5037781	325	Oct-73	72	15	60	6	loam grvl 018, brwn lmsn 073
55-01069	**22**	B, 18	387840	5037780	335	Apr-59	60	10	10	10	msnd bldr 015, whit lmsn 0061
55-01070	**23**	B, 18	387825	5037480	365	Aug-60	112	32	50	15	loam 005, grey lmsn 0116
55-01071	**24**	B, 18	387790	5036050	260	Jul-67	84	6	40	15	fill 002, brwn shle 087
55-02159	**25**	B, 18	387730	5037880	350	Aug-68	110	30	90	3	grvl 015, shle 0120
55-03029	**26**	B, 18	387847	5037712	325	Mar-73	165	50	120	10	loam 006, brwn lmsn 0172
55-04969	**27**	B, 18	387650	5038100	250	Feb-76	96	20	70	5	sand grvl 012, brwn lmsn 0100
55-03046	**28**	B, 18	387505	5037820	360	May-73	165	70	140	10	loam 007, brwn lmsn 0172
55-09545	**29**	B, 18				Jul-89	285	50	299	15	grey clay 02, grey lmsn 0190, red lmsn 0202, grey lmsn 0234, whit snds 0244, grey lmsn 0300
55-12653	**30**	B, 18				May-96	65	4	65	50	fsnd 025, grvl 065
55-06374	**31**	B, 18	387799	5037799	350	Sep-81	40	60	90	9	sand 011, brwn lmsn 0120
55-03030	**32**	B, 18	387666	5038167	255	Apr-73	80	14	80	4	grvl sand 0014, brwn lmsn 0090

Study Ref.	TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
	MCNAB TOWNSHIP CON A(016)	18 387480 5035822^{W}	1975/11 4767	06	FR 0130	060 / 110 / 2:0	DO		5503893 () BRWN SHLE 0013 UNKN 0130
	MCNAB TOWNSHIP CON A(016)	18 387462 5036252^{L}	1985/04 4875	06 06	FR 0074	034 / 070 010 / 0:30	DO		5507769 () LOAM SHLE 0003 GREY LMSN 0058 BLUE LMSN 0072 GREY LMSN 0083
	MCNAB TOWNSHIP CON A(017)	18 387066 5036718^{L}	1989/04 4875	06 06	FR 0052 FR 0210	060 / 200 015 / 1:30	DO		5509461 (40980) BRWN SAND STNS 0004 GREY LMSN SHLE 0165 GREY SHLE 0185 GREY SHLE SNDS 0218
	MCNAB TOWNSHIP CON A(017)	18 387066 5036718^{L}	1988/08 4875	06 06	FR 0041 FR 0070 FR 0208	052 / 215 012 / 1:30	DO		5509178 (29545) BRWN SAND STNS 0001 GREY LMSN SHLE 0133 GREY SHLE SILT SNDS 0184 GREY SHLE SNDS 0218
	MCNAB TOWNSHIP CON B(016)	18 388829 5036821^{W}	1982/12 4767	06 06	FR 0140 FR 0162	068 / 174 010 / 1:0	DO		5506996 () BRWN SHLE FILL LOOS 0002 BRWN LMSN SOFT LYRD 0175
33	MCNAB TOWNSHIP CON B(016)	18 388547 5037004^{W}	2004/02 4879	06	0244 UK 0169	102 / 157 010 / 1:0	DO		5515521 (Z04383) A004288 BRWN SHLE 0002 GREY LMSN LYRD 0244 GREY LMSN LYRD 0295
34	MCNAB TOWNSHIP CON B(016)	18 388600 5037150^{W}	2004/11 4879	06	0052 0271	121 / 193 015 / 1:0	DO		5515883 (Z20139) A019955 BRWN SAND FILL 0007 BRWN LOAM SHLE 0009 BRWN SHLE 0015 GREY LMSN 0148 GREY LMSN SHLE LYRD 0286
35	MCNAB TOWNSHIP CON B(017)	18 388303 5037429^{W}	2004/07 4879	06	0065 0161 0223	054 / 127 006 / 1:0	DO		5515704 (Z10623) A010594 BRWN SHLE LOAM FILL 0002 BRWN SHLE LOAM CLAY 0005 BRWN LMSN 0028 GREY LMSN 0167 GREY LMSN SHLE LYRD 0245
36	MCNAB TOWNSHIP CON B(017)	18 388132 5037403^{W}	2004/06 4879	06	0202 0055 0173	057 / 144 012 / 1:0	DO		5515653 (Z10639) A010588 BRWN SHLE LOAM STNS 0002 BRWN SHLE STNS SAND 0005 GREY LMSN LYRD 0191 GREY LMSN SHLE LYRD 0220
37	MCNAB TOWNSHIP CON B(017)	18 387441 5037172^{W}	2004/04 4879	06	0244 UK 0074 0160	058 / 158 010 / 1:0	DO		5515578 (Z10625) A004293 BRWN SHLE LOAM 0000 BRWN LMSN 0028 GREY LMSN 0160 GREY LMSN 0260
38	MCNAB TOWNSHIP CON B(017)	18 388153 5037669^{W}	2005/02 4879	06 05		/ / :0	DO	0056 05	5515953 (Z20169) A018270
39	MCNAB TOWNSHIP CON B(017)	18 387908 5037459^{L}	1995/09 4879	06 06	UK 0071	012 / 079 007 / 1:0	DO		5512449 (165298) BRWN CLAY DNSE 0017 GREY CLAY SOFT 0058 GREY SAND GRVL 0061 GREY GRVL 0070 GREY SAND GRNT QRTZ 0073 GREY GRNT 0080
40	MCNAB TOWNSHIP CON B(017)	18 387908 5037459^{L}	1991/10 4879	06 06	FR 0252	006 / 261 010 / 1:0	DO		5510691 (108251) BRWN SAND STNS 0004 GREY SAND STNS BLDR 0053 BRWN LMSN 0089 GREY LMSN LYRD 0262
41	MCNAB TOWNSHIP CON B(017)	18 388153 5037669^{W}	2004/09 4879	06	0175 0155	073 / 129 005 / 1:0	DO		5515835 (Z18433) A018270 BRWN SAND SHLE 0001 GREY LMSN 0155 GREY LMSN SHLE LYRD 0220

	TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
42	MCNAB TOWNSHIP CON B(017)	18 387764 5037586[W]	2006/03 4879	06	0138 0089 0125	032 / 088 010 / 1:0	DO		5516356 (Z40244) A040271 BRWN SAND STNS 0004 BRWN LMSN LMSN 0013 GREY LMSN 0038 GREY LMSN SHLE 0145
43	MCNAB TOWNSHIP CON B(017)	18 388177 5037588[W]	2004/09 4879	06	0051 0176 0226	046 / 155 010 / 1:0	DO		5515788 (Z18430) A010619 BRWN SAND SHLE 0003 BRWN LMSN FCRD 0008 GREY LMSN LYRD LMSN 0165 GREY LMSN SHLE LYRD 0245
44	MCNAB TOWNSHIP CON B(017)	18 388030 5037722[W]	1974/05 3323	06	FR 0150	015 / / 0:30	DO		5503621 () BRWN FILL 0005 GREY LMSN 0155
45	MCNAB TOWNSHIP B(017)		1989/08 2307	06 06	FR 0199	030 / 150 007 / 1:0	DO		5509660 (68901) BRWN SAND LOAM CMTD 0060 GREY LMSN HARD 0205

Study Ref.	TOWNSHIP CONCESSION (LOT)	UTM^{1}	DATE ^{2} CNTR ^{3}	CASING DIA ^{4}	WATER^{5,6} DETAIL	STAT LVL/PUMP LVL^{7} RATE^{8}/TIME HR:MIN	WATER USE^{9}	SCREEN INFO^{10}	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND^{5,11}
46	MCNAB TOWNSHIP CON 11(015)	18 386917 5034820^{L}	1996/09 3323	06	FR 0088	008 / 092 020 / 1:0	DO		5512761 (153095) GREY CLAY 0045 GREY SHLE LMSN 0092
47	MCNAB TOWNSHIP CON 11(016)	18 386750 5035992^{W}	1965/04 4306	06 06	FR 0065	020 / 040 007 / 1:0	DO		5501323 () SHLE 0065
48	MCNAB TOWNSHIP CON 11(016)	18 386990 5035522^{W}	1967/07 4806	06 06	FR 0112	003 / 010 010 / 1:0	ST DO		5501324 () BLUE CLAY 0094 GREY LMSN 0113
49	MCNAB TOWNSHIP CON 11(016)	18 386660 5035442^{W}	1950/09 1802	04 04	FR 0090	010 / 020 015 / 2:0	DO		5501322 () CLAY 0067 LMSN 0100
50	MCNAB TOWNSHIP CON 11(016)	18 386508 5035298^{L}	1996/11 4879	06 06	UK 0037	008 / 044 010 / 1:0	DO		5512794 (174948) BRWN CLAY DNSE 0012 GREY LMSN FCRD 0013 GREY LMSN LYRD LMSN 0037 GREY LMSN LYRD SHLE 0045
51	MCNAB TOWNSHIP CON 11(016)	18 386505 5035300^{L}	2003/10 4879	06 06	FR 0237	032 / 043 030 / 1:0	DO		5515486 (255355) BRWN SAND ROCK FILL 0004 BRWN LMSN FCRD 0008 BRWN LMSN 0043 GREY LMSN 0172 GREY LMSN SNDS 0238
52	MCNAB TOWNSHIP CON 11(017)	18 386088 5035766^{L}	1990/04 4879	06 06	FR 0080 FR 0095	014 / 099 005 / 1:0	DO		5509932 (69285) GREY LMSN 0100
53	MCNAB TOWNSHIP CON 11(017)	18 386088 5035766^{L}	1988/03 4875	06 06	FR 0062 FR 0089	035 / 090 007 / 1:0	DO		5508968 (21039) GREY LMSN SHLE 0098
54	MCNAB TOWNSHIP CON 11(017)	18 386088 5035766^{L}	1991/08 4879	06 06	FR 0080 FR 0060	039 / 069 014 / 1:0	DO AC		5510607 (108218) BRWN SHLE SNDY 0002 BRWN LMSN SHLE FCRD 0005 GREY LMSN 0089
55	MCNAB TOWNSHIP CON 11(017)	18 386229 5035921^{W}	1976/11 3323	06	FR 0080	010 / 010 010 / 1:0	DO		5504878 () BRWN SAND 0005 GREY LMSN 0085
56	MCNAB TOWNSHIP CON 11(017)	18 386220 5036172^{W}	1961/09 4306	05 05	FR 0050	012 / 100 001 / 1:0	DO ST		5501325 () MSND 0019 GREY LMSN 0100
57	MCNAB TOWNSHIP CON 11(017)	18 386230 5036022^{W}	1979/07 4006	06	FR 0160	085 / 160 005 / 2:0	DO		5505710 () GREY LMSN SHLY MGRD 0160 WHIT FLDS MGRD 0161 GREY LMSN SHLY MGRD 0165
58	MCNAB TOWNSHIP CON 11(017)	18 386088 5035766^{L}	1987/03 4875	06 06	FR 0088	027 / 045 012 / 1:30	DO		5508549 () GREY LMSN SHLE 0097
59	MCNAB TOWNSHIP CON 11(018)	18 386127 5036316^{W}	2002/07 4879	06 06	UK 0115 UK 0133	042 / 194 005 / 1:0	DO		5514810 (240550) BRWN SAND SHLE 0002 BRWN LMSN SHLE FCRD 0008 BRWN LMSN FCRD 0015 BRWN LMSN 0075 GREY LMSN 0195
60	MCNAB TOWNSHIP CON 11(018)	18 385829 5036421^{W}	1981/10 4767	06	FR 0140	020 / 120 010 / 1:0	DO		5506639 () BRWN LOAM 0006 BRWN LMSN 0148
61	MCNAB TOWNSHIP CON 11(018)	18 385830 5036322^{W}	1979/07 3323	06	FR 0190	040 / 150 015 / 1:0	DO		5505811 () BRWN SAND 0001 WHIT LMSN 0197

Study Ref.	TOWNSHIP CONCESSION (LOT)	UTM^{1}	DATE ^{2} CNTR ^{3}	CASING DIA ^{4}	WATER^{5,6} DETAIL	STAT LVL/PUMP LVL^{7} RATE^{8}/TIME HR:MIN	WATER USE^{9}	SCREEN INFO^{10}	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND^{5,11}
62	MCNAB TOWNSHIP CON 11(018)	18 385830 5036422^{W}	1978/06 4767	06	FR 0175 FR 0220	030 / 200 005 / 1:0	DO		5505031 () BRWN LOAM 0001 BRWN LMSN 0225
63	MCNAB TOWNSHIP CON 12(016)	18 387280 5035772^{W}	1975/05 4767	06 06	FR 0102	010 / 065 008 / 2:0	DO		5503679 () BRWN LOAM SHLE 0003 BRWN LMSN 0110
64	MCNAB TOWNSHIP CON 12(018)	18 386913 5037054^{W}	2002/09 4879	06 06	SU 0116 SU 0143	042 / 149 025 / 1:0	DO		5514935 (240516) BRWN SHLE LOAM 0001 BRWN LMSN 0047 GREY LMSN 0150
65	MCNAB TOWNSHIP CON 12(018)	18 386875 5037055^{W}	2002/08 4879	06 06	UK 0120 UK 0235	038 / 244 015 / 1:0	DO		5514936 (240539) BRWN SAND SHLE 0002 BRWN LMSN 0072 GREY LMSN 0245
66	MCNAB TOWNSHIP CON 13()	18 387901 5037451^{W}	2005/05 4879	06	0162 FR 0084	012 / 045 008 / 1:0	DO		5516091 (Z20166) A019965 GREY LMSN LYRD 0170
	MCNAB TOWNSHIP CON A(015)	18 387890 5035462^{W}	1963/08 4806	06 06	FR 0120 FR 0196	063 / 140 010 / 1:0	DO		5501008 () SHLE 0010 GREY LMSN 0200
	MCNAB TOWNSHIP CON A(015)	18 387525 5035603^{W}	1973/02 4767	06 06	FR 0101	050 / 070 006 / 1:0	DO		5502998 () BRWN LOAM 0001 BRWN LMSN 0105
	MCNAB TOWNSHIP CON A(015)	18 387884 5035804^{L}	1992/03 4879	06 06	FR 0195 FR 0239	098 / 244 005 / 1:0	DO		5510795 (108271) GREY CLAY FILL 0001 GREY SHLE LOAM 0003 GREY LMSN 0195 GREY LMSN SNDS LYRD 0245
	MCNAB TOWNSHIP CON A(015)	18 387980 5035422^{W}	1977/05 3323	06	FR 0080	015 / 060 010 / 1:0	DO		5504898 () SAND GRVL LOOS 0010 GREY LMSN SOFT 0085
	MCNAB TOWNSHIP CON A(016)	18 387462 5036252^{L}	1985/04 4875	06 06	FR 0074	034 / 070 010 / 0:30	DO		5507769 () LOAM SHLE 0003 GREY LMSN 0058 BLUE LMSN 0072 GREY LMSN 0083
	MCNAB TOWNSHIP CON A(016)	18 387480 5035822^{W}	1975/11 4767	06	FR 0130	060 / 110 / 2:0	DO		5503893 () BRWN SHLE 0013 UNKN 0130
	MCNAB TOWNSHIP CON A(017)	18 387066 5036718^{L}	1989/04 4875	06 06	FR 0052 FR 0210	060 / 200 015 / 1:30	DO		5509461 (40980) BRWN SAND STNS 0004 GREY LMSN SHLE 0165 GREY SHLE 0185 GREY SHLE SNDS 0218
	MCNAB TOWNSHIP CON A(017)	18 387066 5036718^{L}	1988/08 4875	06 06	FR 0041 FR 0070 FR 0208	052 / 215 012 / 1:30	DO		5509178 (29545) BRWN SAND STNS 0001 GREY LMSN SHLE 0133 GREY SHLE SILT SNDS 0184 GREY SHLE SNDS 0218
	MCNAB TOWNSHIP CON A(018)	18 387110 5037702^{W}	1960/08 4806	05 05	FR 0090	010 / 070 006 / 1:0	PS		5501009 () MSND 0005 GREY LMSN 0100
	MCNAB TOWNSHIP CON B(017)	18 387908 5037459^{L}	1995/09 4879	06 06	UK 0071	012 / 079 007 / 1:0	DO		5512449 (165298) BRWN CLAY DNSE 0017 GREY CLAY SOFT 0058 GREY SAND GRVL 0061 GREY GRVL 0070 GREY SAND GRNT QRTZ 0073 GREY GRNT 0080

Study Ref.	TOWNSHIP CONCESSION (LOT)	UTM^1	DATE ^{2} CNTR ^{3}	CASING DIA ^{4}	WATER^{5,6} DETAIL	STAT LVL/PUMP LVL^7 RATE^8/TIME HR:MIN	WATER USE^9	SCREEN INFO^{10}	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND^{5,11}
	MCNAB TOWNSHIP CON B(017)	18 387764 5037586^W	2006/03 4879	06	0138 0089 0125	032 / 088 010 / 1:0	DO		5516356 (Z40244) A040271 BRWN SAND STNS 0004 BRWN LMSN LMSN 0013 GREY LMSN 0038 GREY LMSN SHLE 0145
	MCNAB TOWNSHIP CON B(017)	18 387441 5037172^W	2004/04 4879	06	0244 UK 0074 0160	058 / 158 010 / 1:0	DO		5515578 (Z10625) A004293 BRWN SHLE LOAM 0000 BRWN LMSN 0028 GREY LMSN 0160 GREY LMSN 0260
	MCNAB TOWNSHIP CON B(017)	18 387908 5037459^L	1991/10 4879	06 06	FR 0252	006 / 261 010 / 1:0	DO		5510691 (108251) BRWN SAND STNS 0004 GREY SAND STNS BLDR 0053 BRWN LMSN 0089 GREY LMSN LYRD 0262
67	MCNAB TOWNSHIP CON B(018)	18 387511 5037900^L	2000/09 4879	06 06	FR 0074 FR 0205 FR 0262	070 / 269 006 / 1:0	DO		5514103 (218384) BRWN SAND 0011 BRWN LMSN 0055 GREY LMSN 0189 GREY LMSN LYRD SHLE 0270
	MCNAB TOWNSHIP CON B(018)	18 387855 5037702^W	1960/08 4806	05 05	SU 0095 SU 0112 SU 0071	032 / 050 015 / 1:0	IR		5501070 () LOAM STNS 0005 GREY LMSN 0116
	MCNAB TOWNSHIP CON B(018)	18 387877 5037934^W	1973/03 4767	06 06	FR 0120 FR 0165 FR 0080	050 / 120 010 / 1:0	DO		5503029 () BRWN LOAM 0006 BRWN LMSN 0172
	MCNAB TOWNSHIP CON B(018)	18 387514 5037899^L	1989/07 4879	06 06	FR 0225 FR 0285	050 / 299 015 / 1:0	DO		5509545 (45157) GREY CLAY 0002 GREY LMSN 0190 RED LMSN 0202 GREY LMSN 0234 WHIT SNDS 0244 GREY LMSN 0300
	MCNAB TOWNSHIP CON B(018)	18 387514 5037899^L	1996/05 3323	06	FR 0065	004 / 065 050 / 1:0	DO		5512653 (153063) BRWN FSND 0025 BRWN CGVL 0065
68	MCNAB TOWNSHIP CON B(025)	18 387966 5037545^W	2005/10 4879	06	0143 0207	096 / 120 010 / 1:0	DO		5516300 (Z29343) A027340 BRWN SAND GRVL 0004 BRWN LMSN 0028 GREY LMSN 0189 GREY LMSN SHLE 0220
69	MCNAB TOWNSHIP CON (027)	18 387840 5037401^W	2007/03 4879	06	0096 0140	017 / 104 012 / 1:0	DO		7046285 (Z44861) A054545 BRWN CLAY 0006 GREY LMSN LYRD SNDS 0170
70	MCNAB TOWNSHIP 10(015)	18 386270 5034459^W	2006/01 4879	05 06	0086 0094	010 / 021 010 / 1:0	DO		5516343 (Z40219) A027306 BRWN SAND 0003 BRWN CLAY 0018 GREY CLAY 0025 BRWN LMSN 0040 GREY LMSN 0052 GREY LMSN 0053 GREY LMSN 0058 GREY LMSN CLAY 0058 GREY LMSN LYRD 0104
71	MCNAB TOWNSHIP 12(015)	18 387854 5035530^W	2006/05 4879	06	0054 0282 0160	131 / 012 / 1:0	DO		5516384 (Z40227) A05036+ BRWN SAND STNS SHLE 0003 BRWN SHLE 0005 BRWN LMSN 0028 GREY LMSN 0160 GREY LMSN SHLE 0295
72	MCNAB TOWNSHIP (035)	18 387561 5037612^W	2008/11 4879	06 06	0060 0149 0198	019 / 067 010 / 1:0	DO		7117142 (Z87354) A073844 BRWN SAND STNS CLAY 0005 GREY LMSN 0187 GREY LMSN 0220

Study Ref.	TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
	MCNAB TOWNSHIP ()	18 387757 5036979^{W}	2007/05 4879	06	0042	024 / 076 002 / :58	NU		7045848 (Z55058) A054433 BRWN SHLE 0002 BRWN LMSN 0080
	MCNAB TOWNSHIP ()	18 386848 5036125^{W}	2007/05 4879	06	0046 0077	017 / 024 005 / 6:0	NU		7045849 (Z55056) A054429 BRWN LMSN 0080
	MCNAB TOWNSHIP ()	18 386845 5036122^{W}	2007/05 4879	06	0023	009 / 040 001 / 1:40	NU		7045850 (Z55057) A054430 BRWN LMSN 0040
	MCNAB TOWNSHIP ()	18 386569 5036502^{W}	2007/05 4879	06	0069	008 / 048 001 / 4:57	NU		7045851 (Z55054) A054436 BRWN CLAY DNSE 0016 GREY CLAY 0019 BRWN LMSN 0080
	MCNAB TOWNSHIP ()	18 386982 5036840^{W}	2007/05 4879	06		005 / 078 003 / :43	NU		7045871 (Z55050) A054438 BRWN LMSN 0080
	MCNAB TOWNSHIP ()	18 387504 5037238^{W}	2007/05 4879	06	0068	015 / 080 / :40	NU		7045853 (Z55051) A054432 BRWN SHLE 0001 BRWN LMSN 0080
	MCNAB TOWNSHIP ()	18 386985 5036832^{W}	2007/05 4879	06		002 / 040 001 / 1:0	NU		7045856 (Z55052) A054439 BRWN LMSN 0040
	MCNAB TOWNSHIP ()	18 387490 5037241^{W}	2007/05 4879	06		019 / 040 / :40	NU		7045858 (Z55053) A054431 BRWN SHLE 0001 BRWN LMSN 0040
	MCNAB TOWNSHIP ()	18 386571 5036496^{W}	2007/05 4879	06		011 / 038 / :30	NU		7045852 (Z55055) A054437 BRWN CLAY DNSE 0016 GREY CLAY SOFT 0019 BRWN LMSN 0040
	BRAESIDE VILLAGE A (016)	18 387020 5036818^{W}	2009/02 7423	04 01					7125075 (Z099061) A077798 GREY DLMT FCRD 0018 GREY DLMT 0040
	BRAESIDE VILLAGE A (016)	18 387502 5035926^{W}	2009/02 7423	04 01					7125072 (Z099058) A073995 GREY DLMT FCRD 0035 GREY CLAY DNSE 0102
	BRAESIDE VILLAGE A (016)	18 387912 5036596^{W}	2009/02 7423	04 01					7125073 (Z099059) A077796 GREY DLMT FCRD 0041 GREY CLAY DNSE 0043 GREY DLMT 0051
	BRAESIDE VILLAGE A (016)	18 387398 5036815^{W}	2009/02 7423	04 01					7125074 (Z099060) A077797 GREY DLMT FCRD 0049 GREY CLAY DNSE 0049 GREY DLMT 0095
	BRAESIDE VILLAGE A (016)	18 386814 5036404^{W}	2009/02 7423	04 01					7125076 (Z099062) A077799 GREY DLMT FCRD 0021 GREY CLAY DNSE 0022 GREY DLMT 0035
73	BRAESIDE VILLAGE (MC (028)	18 387809 5037518^{W}	2007/07 4879	06	0059 0211 0238	093 / 102 011 / 1:0	DO		7047324 (Z55048) A054559 BRWN SAND FILL 0002 BLCK 0003 BRWN LMSN LYRD 0014 GREY LMSN LYRD SHLE 0245

WELL RECORD SUMMARY

MOE #	Well No.	Conc., Lot	Easting	Northing	Surface Elev. (ft)	Date Drilled	Water Found (ft)	Static Level (ft)	Pumped Level (ft)	Pump Rate (IGPM)	Owner, Log
55-10811	**74**	B,17	UTM for wells 74 - 79 not provided on original Well Record, locations were taken from Golder Report		367	May-92	210	70	219	10	Golder TW 1 -ref unclear (Con 13, Lot 5) sand/grvl 2.5 limestone (var colour, condition) 220
55-11646	**75**	B,17			394	Aug-93	199	83	204	9	Golder TW 2 - Street 1, Sublot 23 overburden 001 limestone (var colour, condition) 168, limestone (grey/red/green) 205
55-11645	**76**	B,17			344	Aug-93	43	29.25	69	10	Golder TW 3 - Street 1, Sublot 12 limestone (var colour, condition) 70
N/A	**77**				427	2002					record not found, Golder ref "BH02-1"
A040256	**78**	15,12	387854	5035530		Jun-06	54 160 282	131	138		sand 003, shale 005, limestone 160, red and green limestone 295
55-11992	**79**	11,18			N/A	Sep-94	57 92	26	94	10	shale 001, brown limestone 32, grey limestone 57, brown limestone 63, grey limestone 95

Appendix III

Well Test Data and Analysis (TW 1 – 8)

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

AQUIFER TEST DATA

PROJ. NO: 02180
WELL NO: TW 1
TEST NO: 1

Date: 30-Jul-02
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point: 0.32
Well Depth: 19.3

Depth of Intake: 17.70 m
Pump on: 10:20
Pump off: 11:08
Duration: 0:48 hours:min
Pump Rate: 3.8 L/min
Recovery Time: N/A hours:min

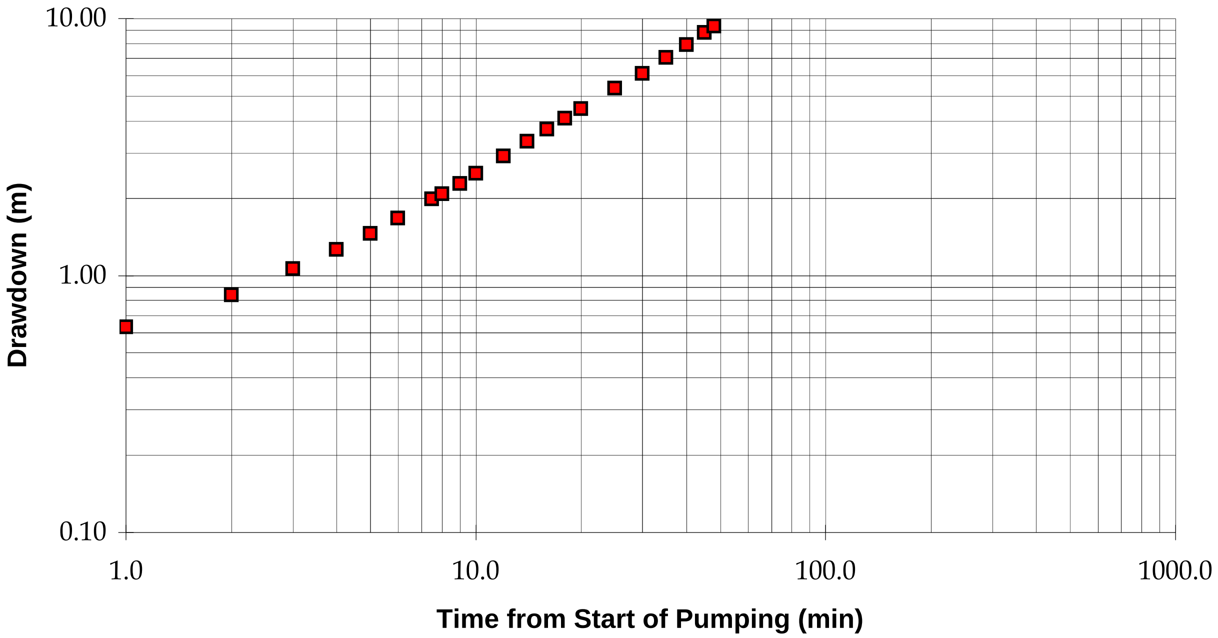
TIME t= 48 at t'=0

WATER LEVEL DATA SWL= 7.74 m

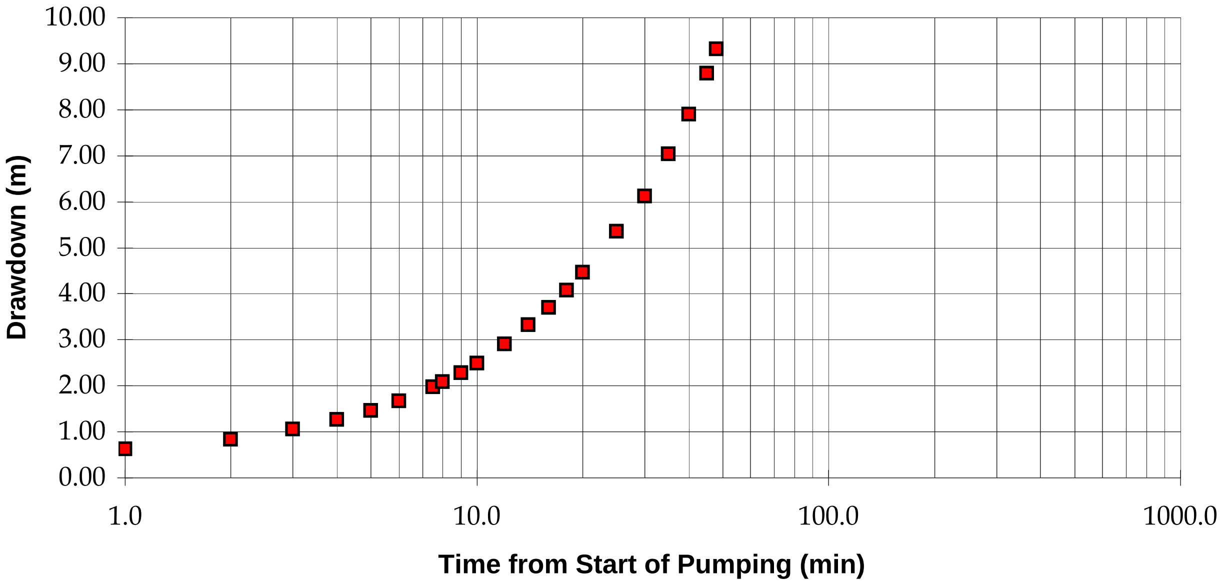
Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	
1.0	8.37	0.63	49.0	1.0	16.62	49.00	8.88	no cascading evident
2.0	8.58	0.84	50.0	2.0	16.58	25.00	8.84	
3.0	8.80	1.06	51.0	3.0	16.56	17.00	8.82	
4.0	9.00	1.26	52.0	4.0	16.55	13.00	8.81	
5.0	9.20	1.46	53.0	5.0	16.54	10.60	8.80	
6.0	9.41	1.67	54.0	6.0	16.53	9.00	8.79	
7.5	9.72	1.98	55.0	7.0	16.52	7.86	8.78	
8.0	9.82	2.08	56.0	8.0	16.51	7.00	8.77	
9.0	10.02	2.28	57.0	9.0	16.50	6.33	8.76	
10.0	10.23	2.49	58.0	10.0	16.50	5.80	8.76	
12.0	10.65	2.91	60.0	12.0	16.48	5.00	8.74	
14.0	11.07	3.33	62.0	14.0	16.47	4.43	8.73	
16.0	11.44	3.70	64.0	16.0	16.46	4.00	8.72	
18.0	11.82	4.08	66.0	18.0	16.45	3.67	8.71	
20.0	12.20	4.46	68.0	20.0	16.43	3.40	8.69	
25.0	13.10	5.36	288.0	240.0	15.27	1.20	7.53	
30.0	13.86	6.12						Water was milky for
35.0	14.78	7.04						duration of pumping
40.0	15.64	7.90						
45.0	16.53	8.79						Soft silty sediment and
48.0	17.06	9.32						cuttings in base of well
								prior to pumping

19.2 **% recovery**
80.62 **% of total available drawdown**

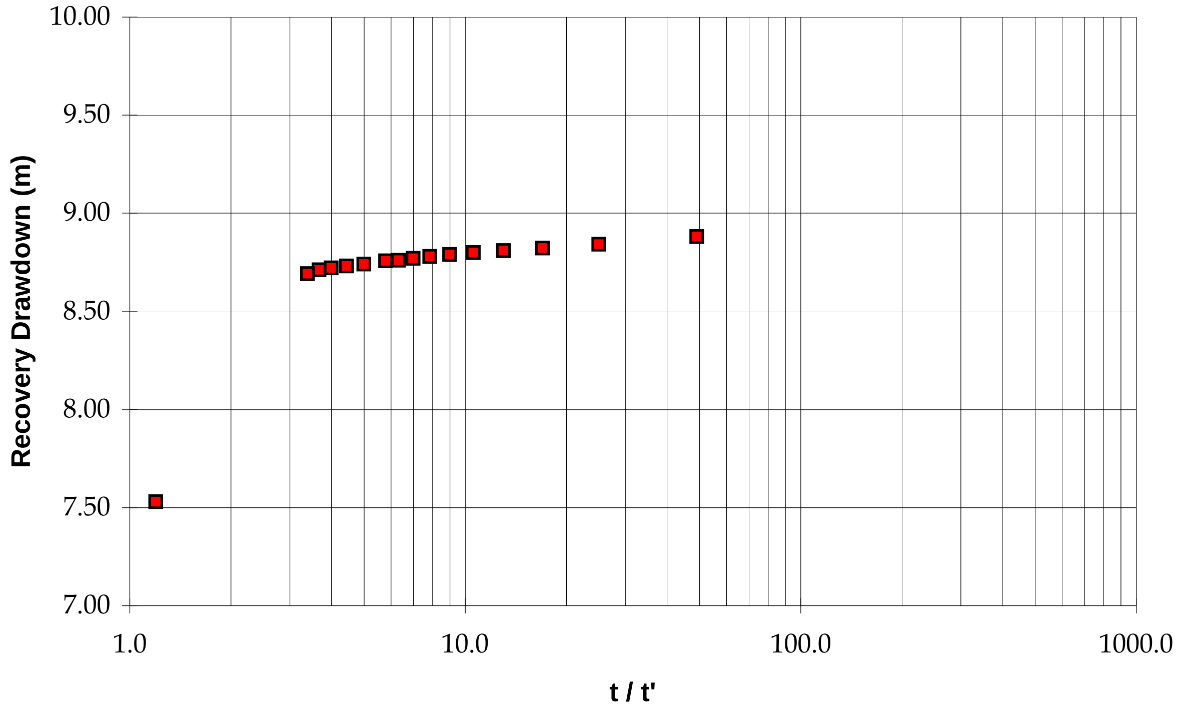
Theis Analysis, TW 1



Jacob Analysis, TW 1



Theis Recovery Analysis, TW 1



Analysis of Aquifer Test Data

TW 1

Q = 5.47 m^3/day

Jacob Analysis

$\Delta s =$ 13 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 5.47}{4\pi * 13.0} = 0.08\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 9.4 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 5.47}{4\pi * 9.4} = 0.11\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 02180
WELL NO: TW 2
TEST NO: 1

Date: 29-Jul-02
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

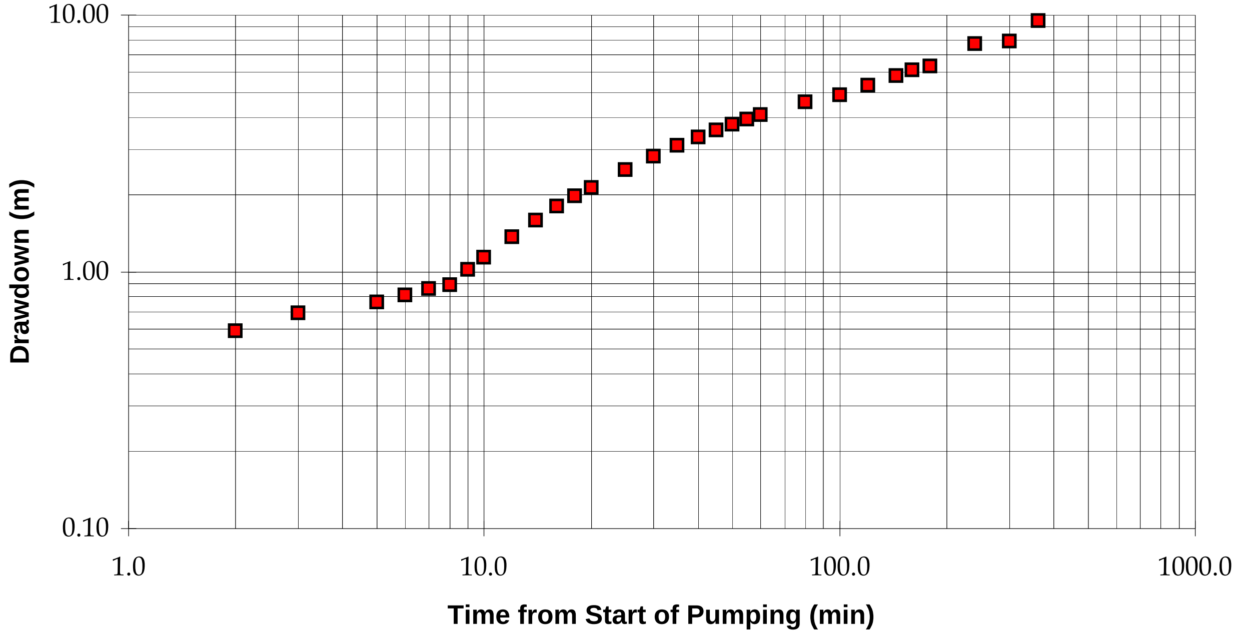
How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point: 0.4
Well Depth: 19.8

Depth of Intake: 18.50 m
Pump on: 11:20
Pump off: 17:22
Duration: 6:02 hours:min
Pump Rate: 2.85 L/min
Recovery Time: N/A hours:min

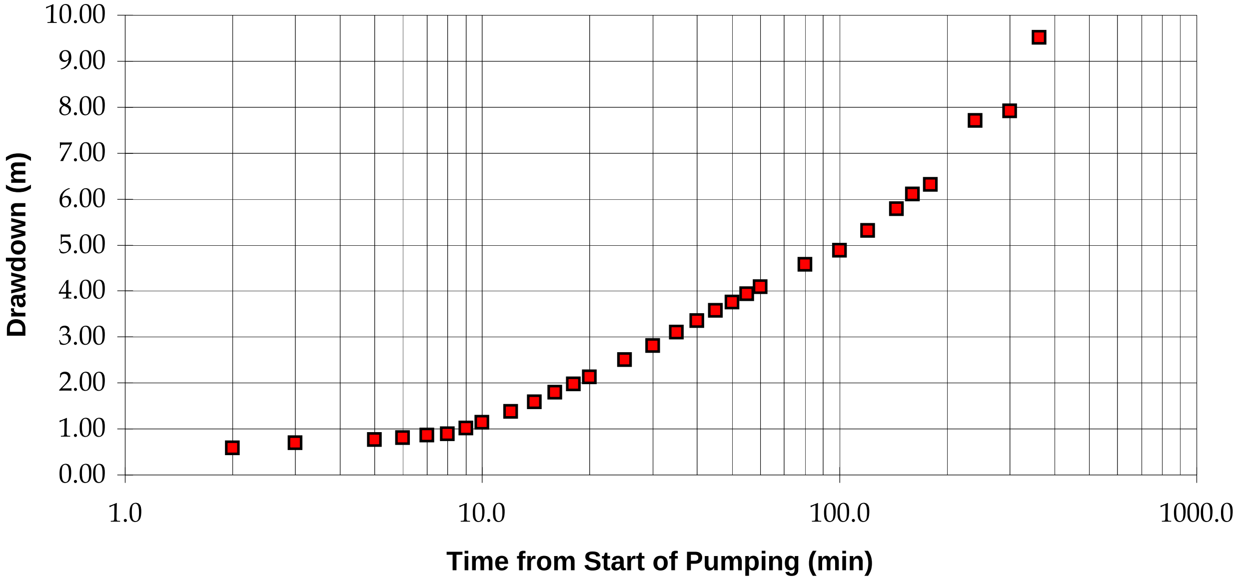
	TIME		WATER LEVEL DATA					
t=	362	at t'=0	SWL=	7.86	m			
	Pumping				Recovery			COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	
1.0	8.30	0.44	363.0	1.0	16.75	363.00	8.89	
2.0	8.45	0.59	364.0	2.0	16.62	182.00	8.76	
3.0	8.55	0.69	365.0	3.0	16.51	121.67	8.65	
4.0	8.58	0.72	366.0	4.0	16.40	91.50	8.54	
5.0	8.62	0.76	367.0	5.0	16.28	73.40	8.42	
6.0	8.67	0.81	368.0	6.0	16.17	61.33	8.31	
7.0	8.72	0.86	369.0	7.0	16.05	52.71	8.19	
8.0	8.75	0.89	370.0	8.0	15.94	46.25	8.08	
9.0	8.88	1.02	371.0	9.0	15.82	41.22	7.96	
10.0	9.00	1.14	372.0	10.0	15.71	37.20	7.85	
12.0	9.23	1.37	374.0	12.0	15.50	31.17	7.64	
14.0	9.45	1.59	376.0	14.0	15.28	26.86	7.42	light cascading from 15.4
16.0	9.66	1.80	378.0	16.0	15.06	23.63	7.20	
18.0	9.83	1.97	380.0	18.0	14.90	21.11	7.04	
20.0	9.99	2.13	382.0	20.0	14.50	19.10	6.64	
25.0	10.36	2.50	387.0	25.0	13.88	15.48	6.02	
30.0	10.67	2.81	392.0	30.0	13.67	13.07	5.81	
35.0	10.96	3.10	397.0	35.0	13.20	11.34	5.34	
40.0	11.21	3.35	402.0	40.0	12.75	10.05	4.89	
45.0	11.43	3.57	407.0	45.0	12.39	9.04	4.53	
50.0	11.62	3.76	412.0	50.0	12.04	8.24	4.18	
55.0	11.79	3.93	417.0	55.0	11.71	7.58	3.85	
60.0	11.95	4.09	422.0	60.0	11.34	7.03	3.48	
80.0	12.44	4.58	443.0	81.0	10.63	5.47	2.77	
100.0	12.74	4.88	462.0	100.0	10.19	4.62	2.33	
120.0	13.17	5.31	482.0	120.0	9.89	4.02	2.03	
144.5	13.65	5.79						
160.0	13.96	6.10						discharge constricted with
180.0	14.17	6.31						sediment around 240 min,
240.0	15.57	7.71			78.7	% recovery		PR dropped significantly
300.0	15.77	7.91			79.65	% of total available		
362.0	17.37	9.51				drawdown		Sampled at 355 min

Gorrell Resource
Investigations

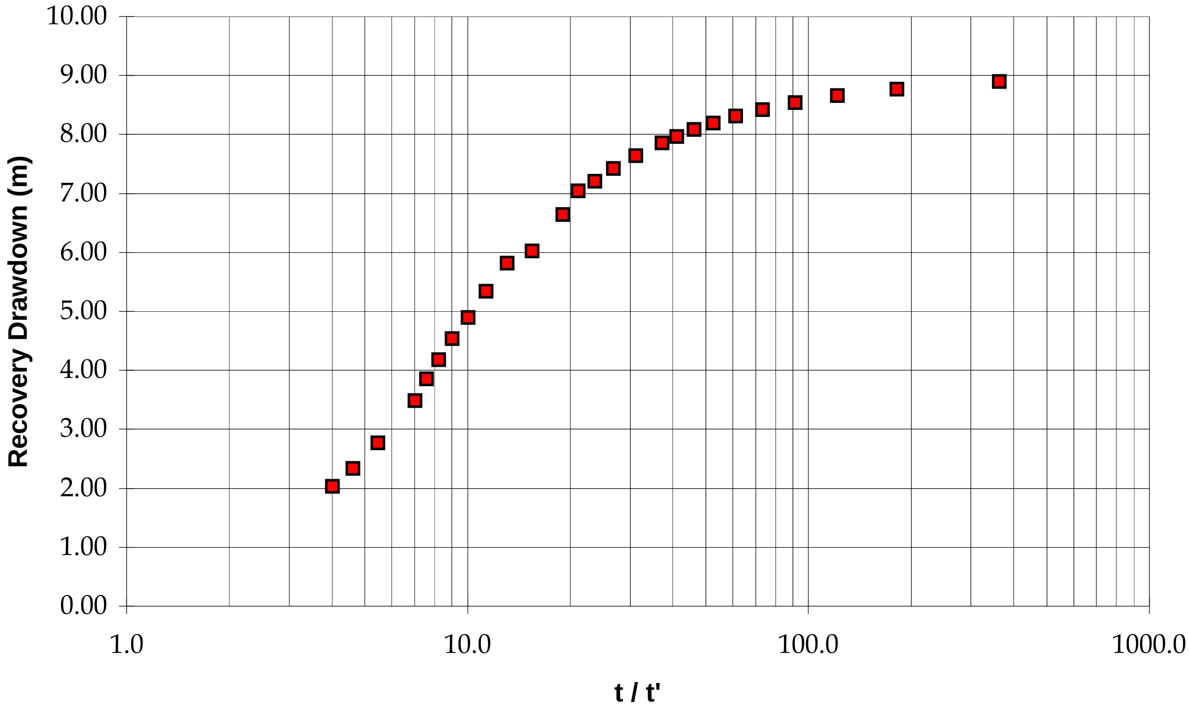
Theis Analysis, TW 2



Jacob Analysis, TW 2



Theis Recovery Analysis, TW 2



Gorrell Resource
Investigations

Analysis of Aquifer Test Data

TW 2

Q = $4.10 m^3/day$

Jacob Analysis

$\Delta s = 4.5 m$

$$T = \frac{2.3 Q}{4\pi \Delta s} = \frac{2.3 * 4.10}{4\pi * 4.5} = 0.17 m^2/day$$

Theis Recovery Analysis

$\Delta s = 8m$

$$T = \frac{2.3 Q}{4\pi \Delta s} = \frac{2.3 * 4.10}{4\pi * 8} = 0.09 m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460

WELL NO: TW 3-1

TEST NO: 2

Date: 01-May-07

TYPE OF WELL: Pumping

TYPE OF DATA: Pumping and Recovery

How Q measured: pail

How WL Measured: tape

Rad./Dist. of Pumping Well: 0.076 m

Measuring Point for WL: top of casing

Elev. Meas. Point: 0.5

Well Depth: 25

Depth of Intake: 24.80 m

Pump on:

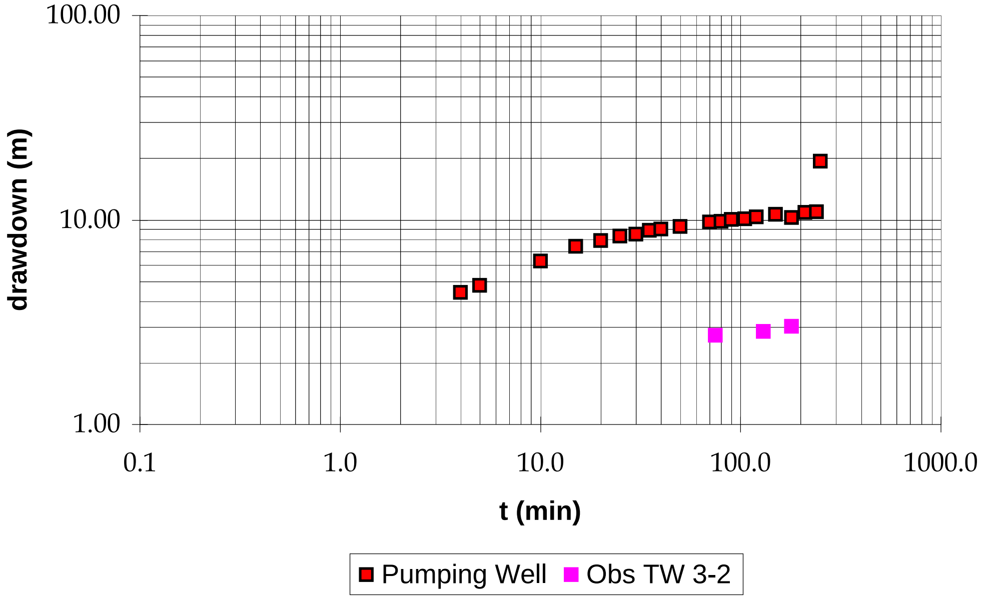
Pump off:

Duration: 4:10 hours:min

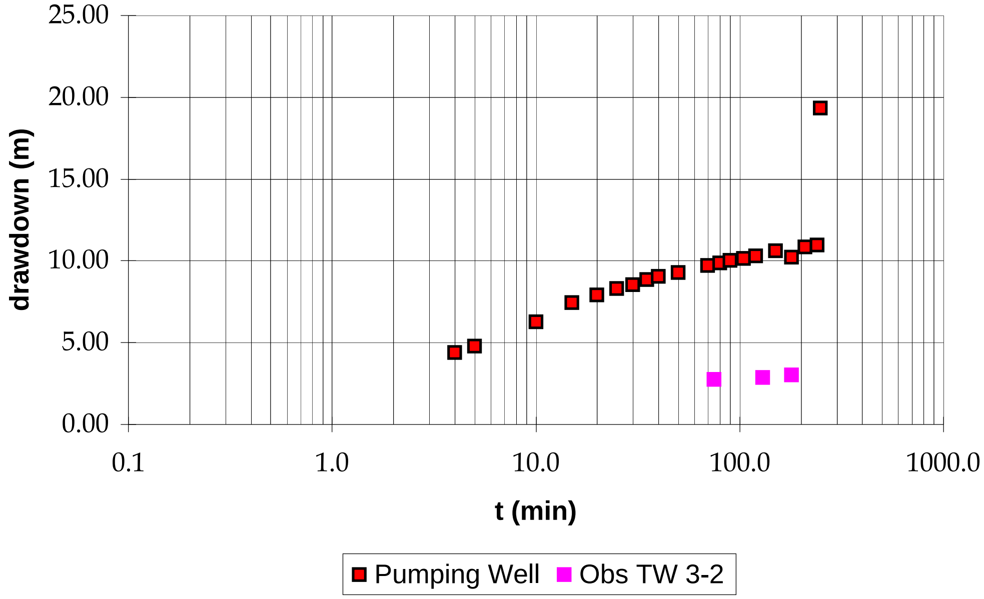
Pump Rate: 49.5 L/min

Recovery Time: hours:min

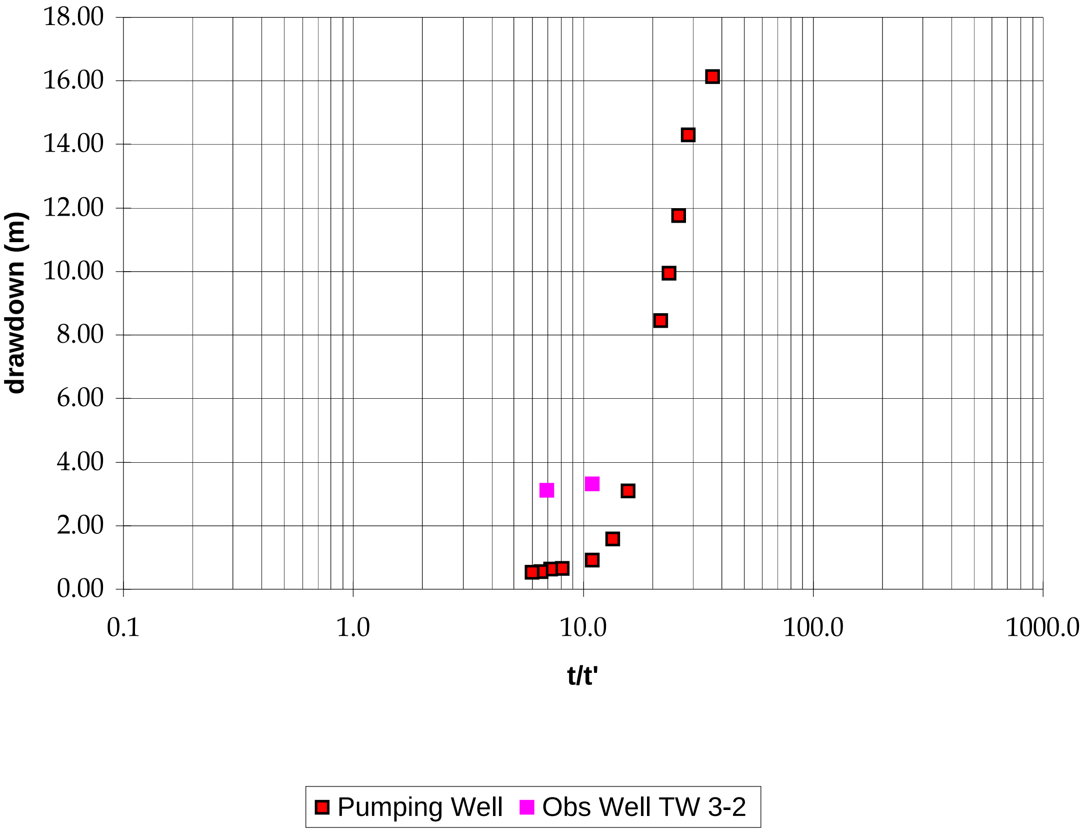
	TIME		WATER LEVEL DATA					
t=	250	at t'=0	SWL=	5.45 m				
	Pumping				Recovery			COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 3-2 = 2.47 m
4.0	9.85	4.40	257.0	7.0	21.57	36.71	16.12	T - 8.8 oC, D.O. = 5.37 mg/L
5.0	10.23	4.78	259.0	9.0	19.75	28.78	14.30	
10.0	11.71	6.26	260.0	10.0	17.20	26.00	11.75	
15.0	12.89	7.44	261.0	11.0	15.38	23.73	9.93	
20.0	13.37	7.92	262.0	12.0	13.89	21.83	8.44	
25.0	13.75	8.30	267.0	17.0	8.53	15.71	3.08	
30.0	13.97	8.52	270.0	20.0	7.02	13.50	1.57	
35.0	14.31	8.86	275.0	25.0	6.35	11.00	0.90	
40.0	14.49	9.04	285.0	35.0	6.09	8.14	0.64	
50.0	14.71	9.26	290.0	40.0	6.07	7.25	0.62	
70.0	15.17	9.72	295.0	45.0	5.99	6.56	0.54	
80.0	15.30	9.85	300.0	50.0	5.97	6.00	0.52	
90.0	15.46	10.01						
105.0	15.58	10.13						
120.0	15.75	10.30						
150.0	16.07	10.62						
180.0	15.67	10.22						
210.0	16.29	10.84						
240.0	16.41	10.96						Q up to 20 IGPM
250.0	24.77	19.32						cascading at +/- 24 m
					97.3	% recovery		
					98.82	% of total available drawdown		



Theis Analysis, TW 3-1
Test 2



Jacob Analysis, TW 3-1
Test 2



Theis Recovery Analysis, TW 3-1
Test 2

AQUIFER TEST DATA
Installed piezometers

Project No. **05460**
Test No. **2**
Location **TW 3-1**

Date: **01/05/2007**
Recovery time: **50 min**
Type of Data: **Pumping and Recovery**

Surface Elevation
Distance from well

Piezometer No. **TW 3-1**
Elevation Meas. Point
Static Water Level 2.47
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	reading	drawdown	reading	drawdown	reading	drawdown	reading	drawdown
75	2.73	0.26						
130	2.85	0.38						
180	3.01	0.54						
275	3.31	0.84						
292	3.1	0.63						

Analysis of Aquifer Test Data

TW 3-1

Q = 71.28 m^3/day

Jacob Analysis

$\Delta s = 11$ m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 71.28}{4\pi * 11.0} = 1.03\ m^2/day$$

Theis Recovery Analysis

$\Delta s = 43.5$ m

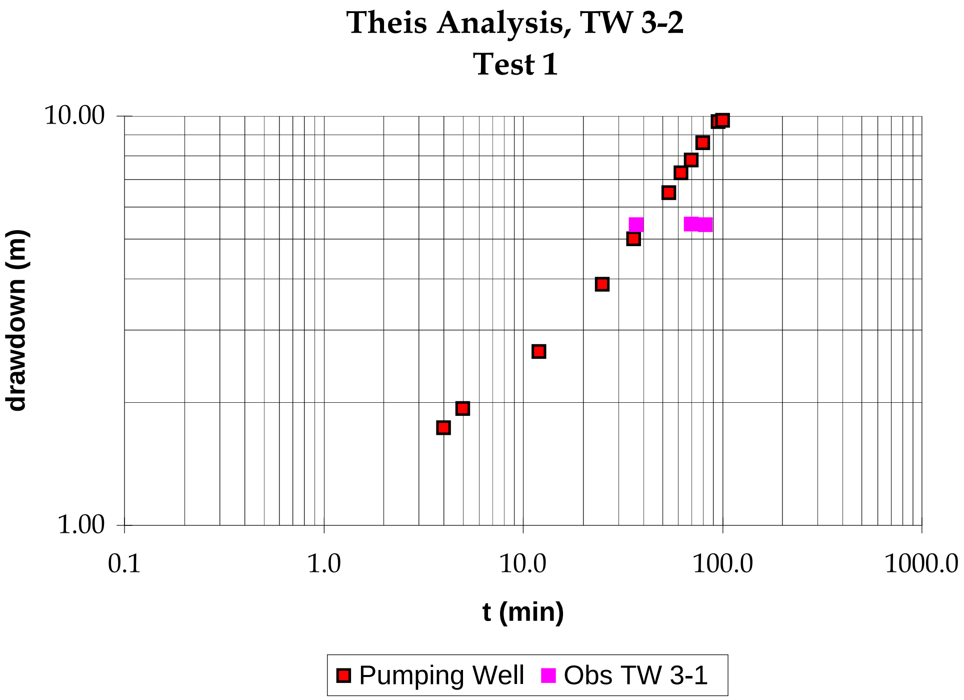
$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 71.28}{4\pi * 43.5} = 0.29\ m^2/day$$

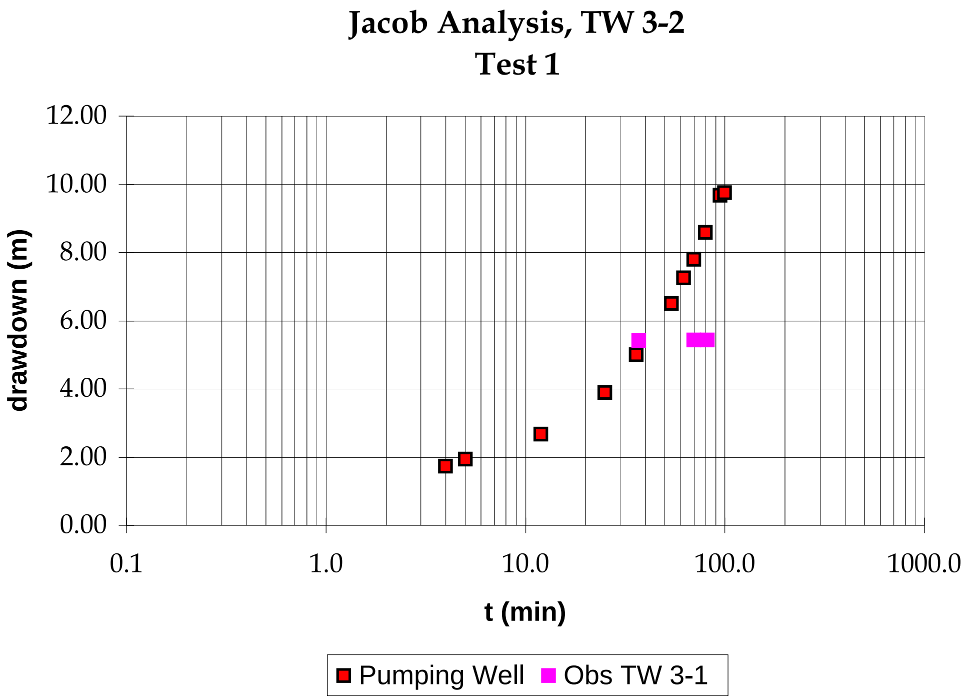
AQUIFER TEST DATA

PROJ. NO:	**05460**	**Date:**	**27-Apr-07**
WELL NO:	**TW 3-2**	**TYPE OF WELL:**	**Pumping**
TEST NO:	**1**	**TYPE OF DATA:**	**Pumping and Recovery**

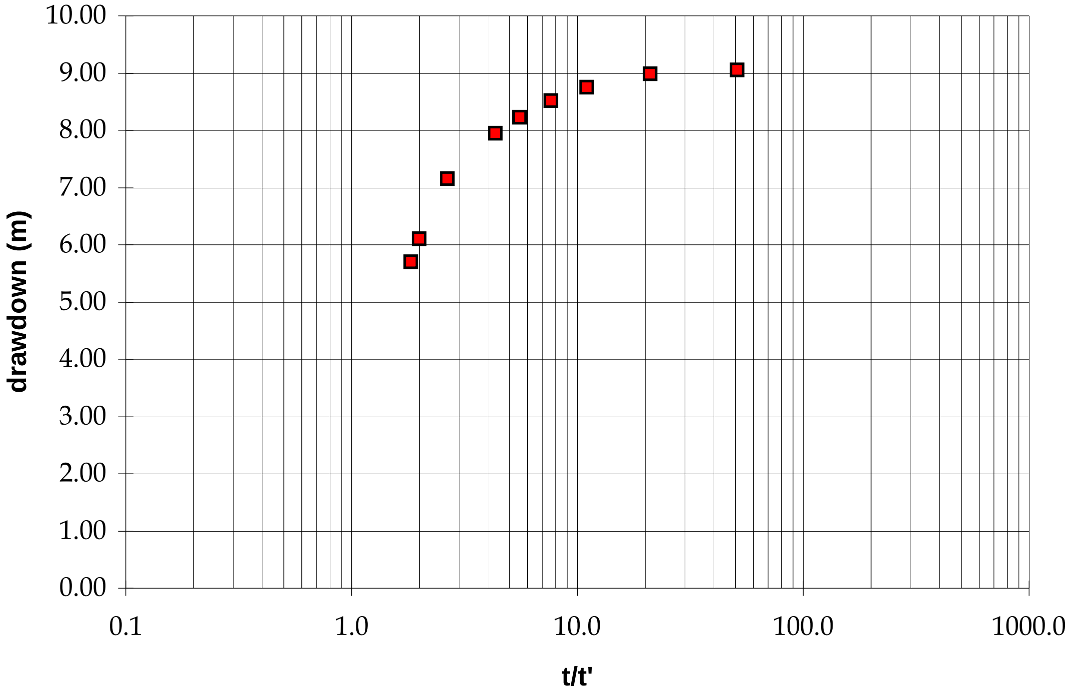
How Q measured:	**pail**	**Depth of Intake:**	**12.40 m**
How WL Measured:	**tape**	**Pump on:**	
Rad./Dist. of Pumping Well:	**0.076 m**	**Pump off:**	
Measuring Point for WL:	**top of casing**	**Duration:**	**1:40 hours:min**
Elev. Meas. Point:		**Pump Rate:**	**3.6 L/min**
Well Depth:	**12.5**	**Recovery Time:**	**2:00 hours:min**

TIME			WATER LEVEL DATA					
t= 100 at t'=0			SWL= 2.67 m					
Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 3-1 = 5.39 m
4.0	4.40	1.73	102.0	2.0	11.72	51.00	9.05	
5.0	4.60	1.93	105.0	5.0	11.65	21.00	8.98	
12.0	5.33	2.66	110.0	10.0	11.42	11.00	8.75	
25.0	6.55	3.88	115.0	15.0	11.18	7.67	8.51	
36.0	7.67	5.00	122.0	22.0	10.89	5.55	8.22	
54.0	9.17	6.50	130.0	30.0	10.61	4.33	7.94	
62.0	9.92	7.25	160.0	60.0	9.82	2.67	7.15	
70.0	10.47	7.80	200.0	100.0	8.77	2.00	6.10	
80.0	11.26	8.59	220.0	120.0	8.37	1.83	5.70	
95.0	12.34	9.67						
100.0	12.42	9.75						
					41.5	% recovery		
					99.19	% of total available drawdown		


Theis Analysis, TW 3-2
Test 1
10.00
1.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 3-1


Jacob Analysis, TW 3-2
Test 1
12.00
10.00
8.00
6.00
4.00
2.00
0.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 3-1

Theis Recovery Analysis, TW 3-2
Test 1



AQUIFER TEST DATA
Installed piezometers

Project No. **05460**
Test No. **1**
Location

Date: **27/04/2007**
Recovery time: **2:00**
Type of Data: **Pumping and Recovery**

Surface Elevation
Distance from well

Piezometer No. **TW 3-2**
Elevation Meas. Point 0.5
Static Water Level 5.39
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	reading	drawdown	reading	drawdown	reading	drawdown	reading	drawdown
37	5.41	0.02						
70	5.43	0.04						
82	5.42	0.03						

Analysis of Aquifer Test Data

TW 3-2

Q = 5.18 m^3/day

Jacob Analysis

$\Delta s =$ 10.5 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 5.18}{4\pi * 10.5} = 0.09\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 9 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 5.18}{4\pi * 9} = 0.11\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 4-1
TEST NO: 2

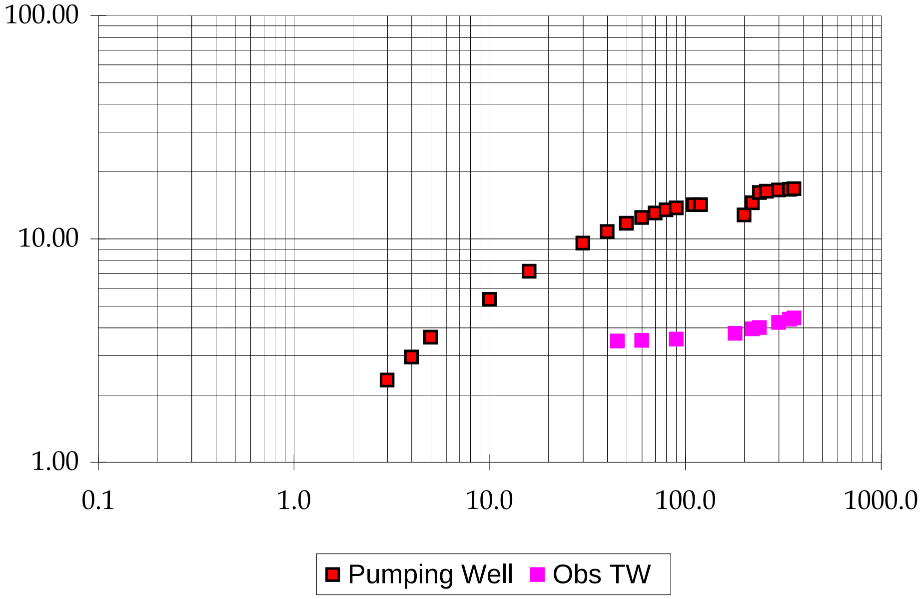
Date: 24-Apr-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point: 0.63
Well Depth: 25

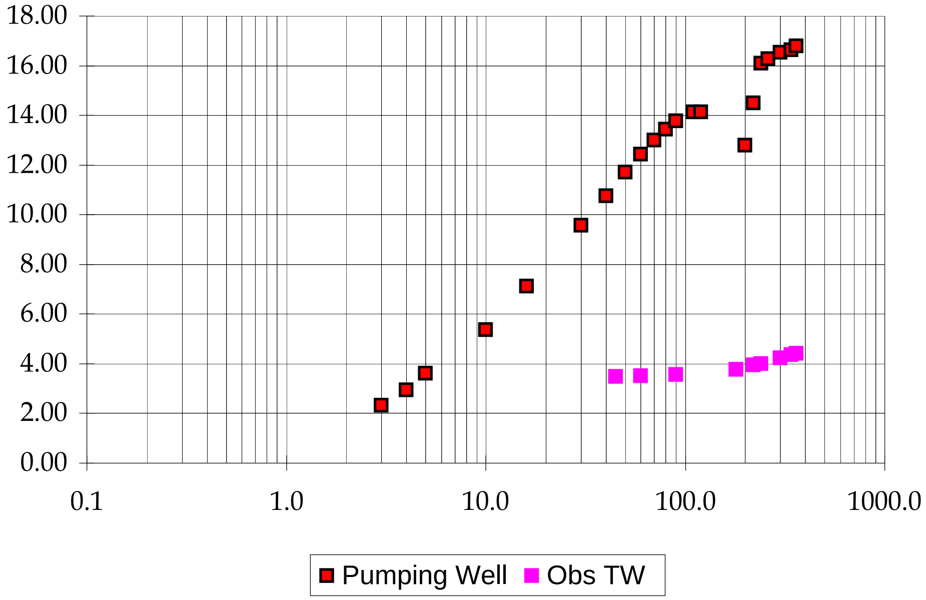
Depth of Intake: 24.00 m
Pump on: 8:20
Pump off: 13:00
Duration: 2:10 hours:min
Pump Rate: 16.65 L/min
Recovery Time: 1:40 hours:min

	TIME		WATER LEVEL DATA					
t=	360 at t'=0		SWL=	3.35 m				
	Pumping				Recovery			COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 4-2 = 3.16 m
1.0			361.0	1.0	17.82	361.00	14.47	
2.0			362.0	2.0	15.87	181.00	12.52	
3.0	5.67	2.32	367.0	7.0	13.56	52.43	10.21	
4.0	6.30	2.95	374.0	14.0	11.87	26.71	8.52	
5.0	6.96	3.61	380.0	20.0	10.97	19.00	7.62	
10.0	8.71	5.36	385.0	25.0	9.91	15.40	6.56	
16.0	10.47	7.12	390.0	30.0	9.05	13.00	5.70	
30.0	12.91	9.56	395.0	35.0	7.38	11.29	4.03	
40.0	14.11	10.76	410.0	50.0	6.55	8.20	3.20	
50.0	15.05	11.70	420.0	60.0	5.94	7.00	2.59	
60.0	15.78	12.43	430.0	70.0	5.64	6.14	2.29	
70.0	16.36	13.01	440.0	80.0	5.29	5.50	1.94	Q checked
80.0	16.79	13.44	450.0	90.0	4.99	5.00	1.64	
90.0	17.11	13.76	460.0	100.0	4.32	4.60	0.97	
110.0	17.49	14.14	611.0	251.0	3.61	2.43	0.26	
120.0	17.49	14.14						
180.0	16.15	12.80						
200.0	17.83	14.48						
220.0	19.44	16.09						
240.0	19.62	16.27						
260.0	19.87	16.52						
300.0	19.98	16.63						
340.0	20.13	16.78						
360.0	20.14	16.79						
					98.5	% recovery		
					77.55	% of total available drawdown		

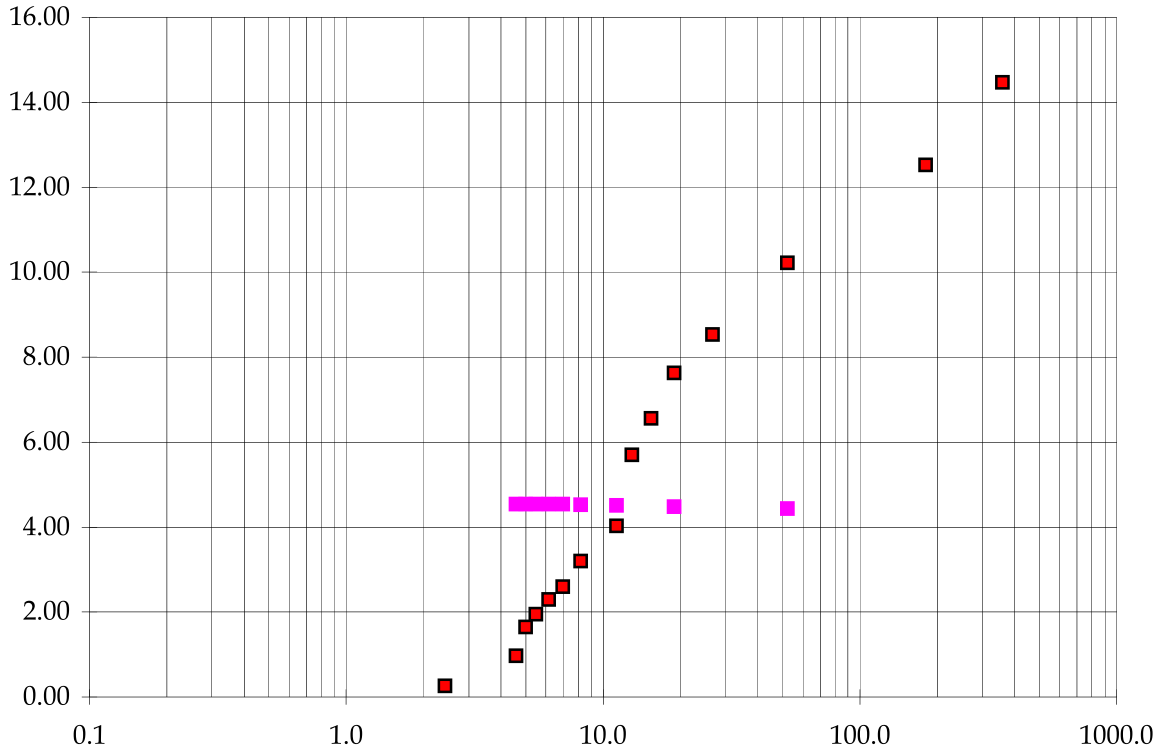
Theis Analysis, TW 4-1
Test 2



Jacob Analysis, TW 4-1,
Test 2



Theis Recovery Analysis, TW 4-1, Test 2



AQUIFER TEST DATA
Installed piezometers

Project No. 05460
Test No. TW 4-1
Location 1

Date: 23/04/2007
Recovery time: 2:57
Type of Data: Pumping and Recovery

Surface Elevation
Distance from well

Piezometer No. TW 4-2
Elevation Meas. Point
Static Water Level 3.47
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	reading	drawdown	reading	drawdown	reading	drawdown	reading	drawdown
45	3.47	0.00						
60	3.51	0.04						
90	3.55	0.08						
180	3.77	0.30						
220	3.95	0.48						
240	4.00	0.53						
300	4.22	0.75						
340	4.35	0.88						
360	4.41	0.94						
367	4.43	0.96						
380	4.47	1.00						
395	4.50	1.03						
410	4.52	1.05						
420	4.53	1.06						
430	4.54	1.07						
440	4.54	1.07						
450	4.54	1.07						
460	4.54	1.07						

Analysis of Aquifer Test Data

TW 4-1

Q = 23.98 m^3/day

Jacob Analysis

$\Delta s =$ 17 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 23.98}{4\pi * 17.0} = 0.26\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 11.0 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 23.98}{4\pi * 11} = 0.40\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 4-2
TEST NO: 1

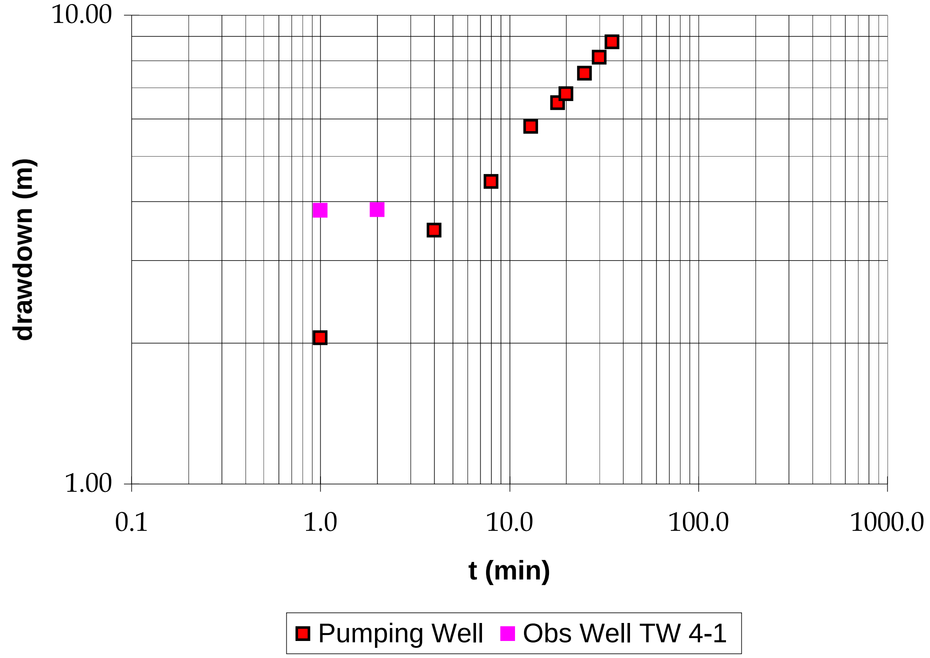
Date: 25-Apr-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point: 0.58
Well Depth: 12.5

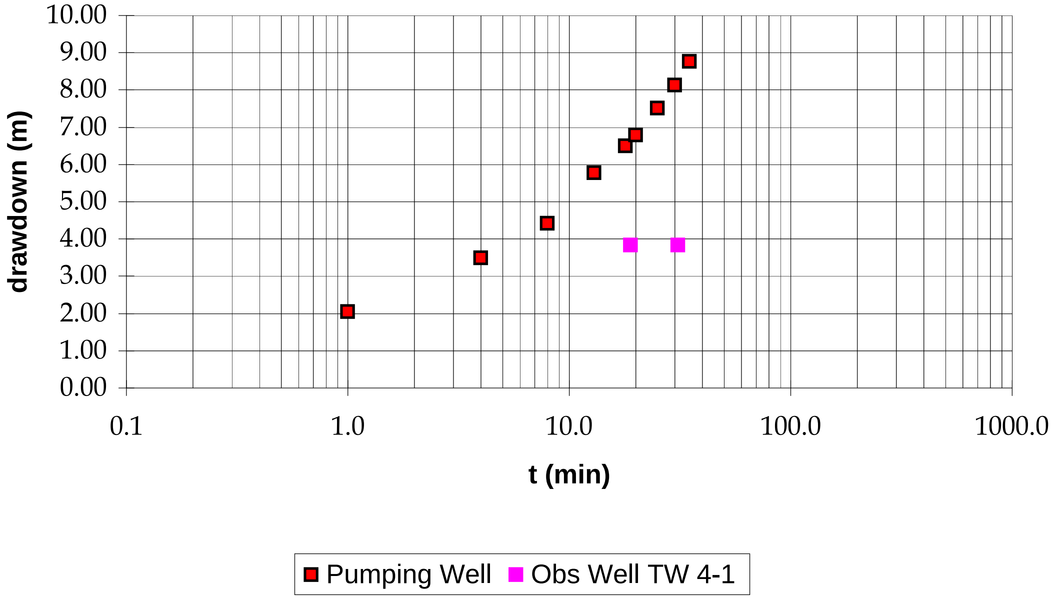
Depth of Intake: 12.18 m
Pump on:
Pump off:
Duration: 0:35 hours:min
Pump Rate: 2.03 L/min
Recovery Time: 2:40 hours:min

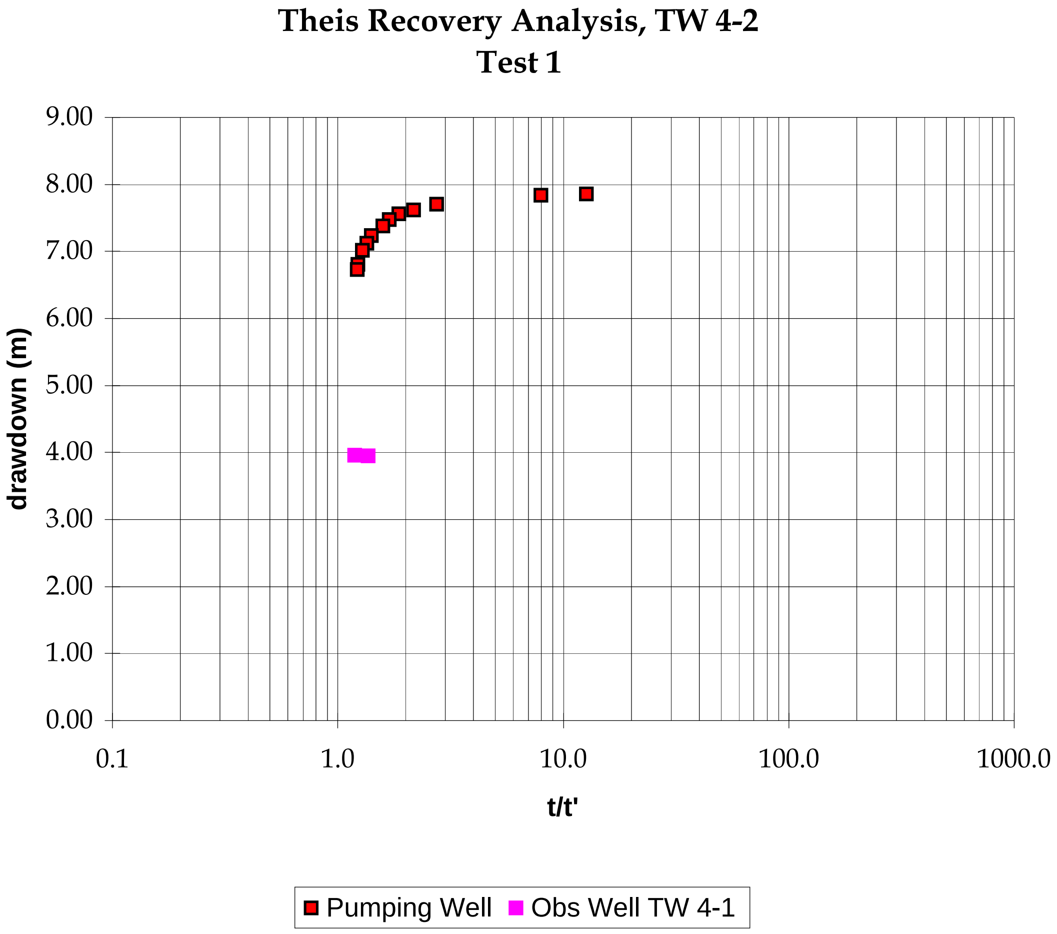
TIME			WATER LEVEL DATA					
t= 35 at t'=0			SWL= 3.42 m					
Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 4-1 = 3.77 m
1.0	5.47	2.05	38.0	3.0	11.27	12.67	7.85	
4.0	6.90	3.48	40.0	5.0	11.25	8.00	7.83	
8.0	7.83	4.41	55.0	20.0	11.12	2.75	7.70	
13.0	9.20	5.78	65.0	30.0	11.03	2.17	7.61	
18.0	9.92	6.50	75.0	40.0	10.98	1.88	7.56	
20.0	10.21	6.79	85.0	50.0	10.89	1.70	7.47	
25.0	10.93	7.51	95.0	60.0	10.80	1.58	7.38	
30.0	11.54	8.12	120.0	85.0	10.65	1.41	7.23	
35.0	12.18	8.76	135.0	100.0	10.54	1.35	7.12	
			155.0	120.0	10.43	1.29	7.01	
			185.0	150.0	10.22	1.23	6.80	
			195.0	160.0	10.15	1.22	6.73	
					23.2	% recovery		
					96.48	% of total available drawdown		

Theis Analysis, TW 4-2
Test 1



Jacob Analysis, TW 4-2
Test 1




Theis Recovery Analysis, TW 4-2
Test 1
drawdown (m)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.1
1.0
10.0
100.0
1000.0
t/t'
Pumping Well
Obs Well TW 4-1

AQUIFER TEST DATA
Installed piezometers

Project No. **05460** **Date:** **23/04/2007**
Test No. **TW 4**-2 **Recovery time:** **2:57**
Location **1** **Type of Data:** **Pumping and Recovery**

Surface Elevation
Distance from well

Piezometer No. **TW 4-1**
Elevation Meas. Point
Static Water Level 3.77
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	reading	drawdown	reading	drawdown	reading	drawdown	reading	drawdown
19	3.83	0.06						
31	3.84	0.07						
95	3.95	0.18						
185	3.96	0.19						

Analysis of Aquifer Test Data

TW 4-2

Q = 2.92 m^3/day

Jacob Analysis

$\Delta s =$ 7 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 2.92}{4\pi * 7.0} = 0.08\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 4.5 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 2.92}{4\pi * 3.3} = 0.12\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 5-1
TEST NO: 2

Date: 09-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

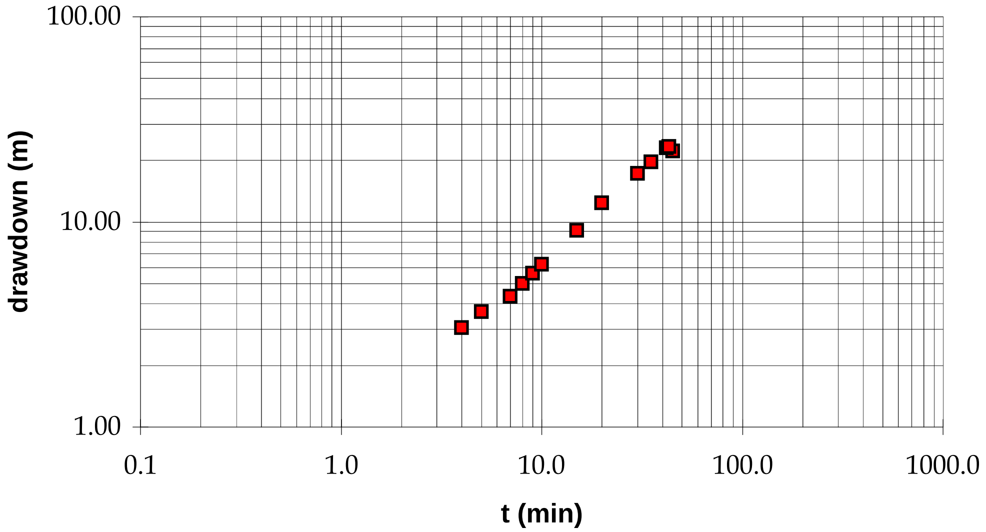
How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 25.0

Depth of Intake: 24.80 m
Pump on:
Pump off:
Duration: 0:43 hours:min
Pump Rate: 12.38 L/min
Recovery Time: 3:17 hours:min

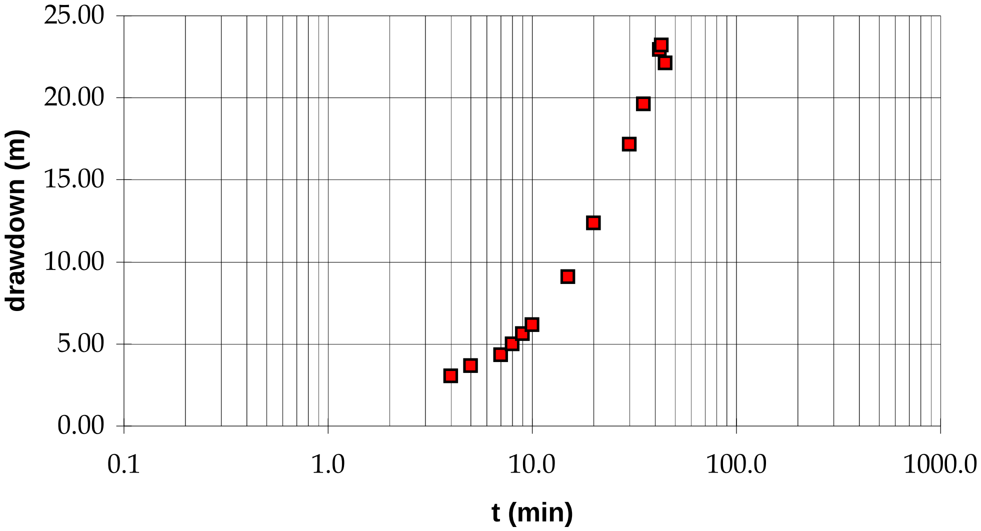
TIME			WATER LEVEL DATA					
t=	43	at t'=0	SWL=	1.43 m				
	Pumping				Recovery			COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 5-2 = 0.62 m
4.0	4.47	3.04	45.0	2.0	23.64	22.50	22.21	
5.0	5.08	3.65	50.0	7.0	23.55	7.14	22.12	
7.0	5.77	4.34	53.0	10.0	23.55	5.30	22.12	
8.0	6.42	4.99	58.0	15.0	23.55	3.87	22.12	
9.0	7.04	5.61	63.0	20.0	23.52	3.15	22.09	
10.0	7.61	6.18	68.0	25.0	23.51	2.72	22.08	
15.0	10.51	9.08	73.0	30.0	23.51	2.43	22.08	
20.0	13.78	12.35	177.0	134.0	23.38	1.32	21.95	
30.0	18.58	17.15	240.0	197.0	23.32	1.22	21.89	
35.0	21.04	19.61						
45.0	23.54	22.11						
42.0	24.38	22.95						
43.0	24.64	23.21						
					5.7	% recovery		
					98.47	% of total available		

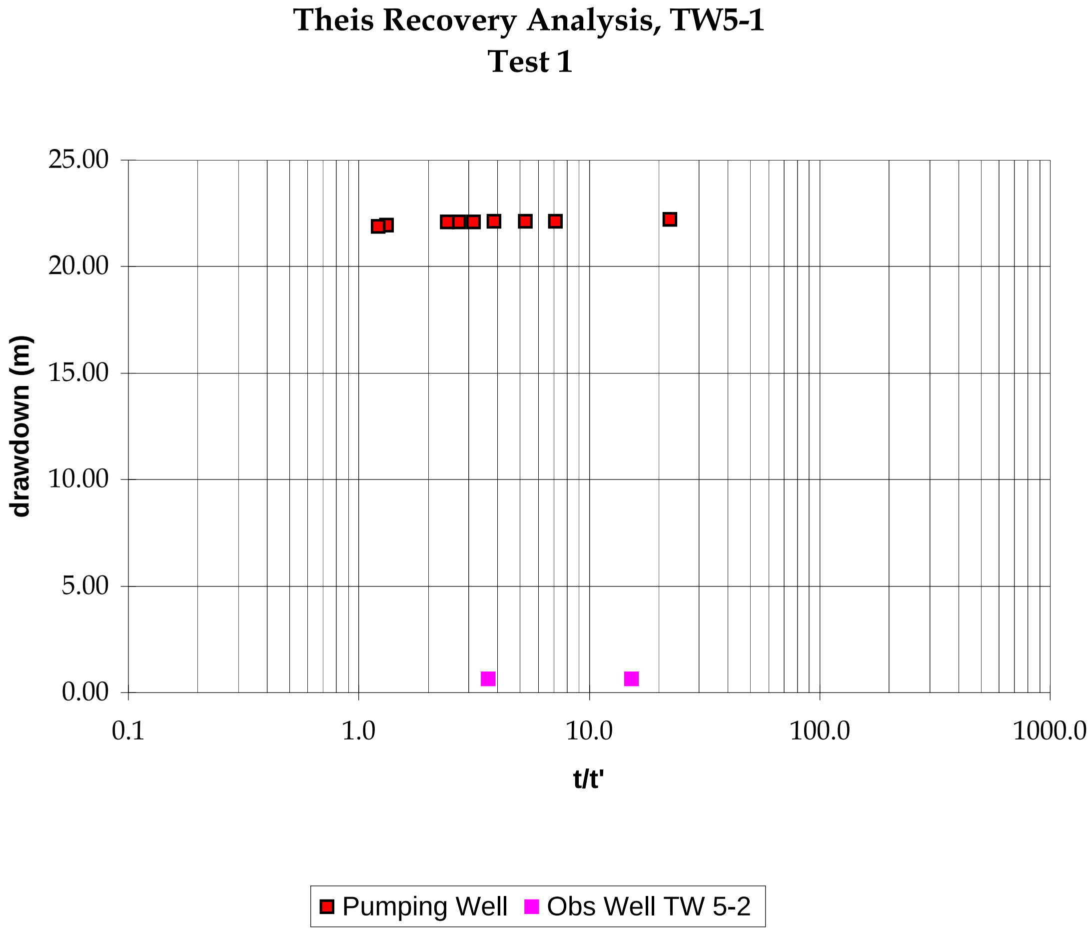
| | | || | | |drawdown | |

Theis Analysis, TW 5-1
Test 1



Jacob Analysis, TW5-1
Test 1





Theis Recovery Analysis, TW5-1
Test 1

AQUIFER TEST DATA
Installed piezometers

Project No. **05460** **Date:** **09/05/2007**
Test No. **TW 5-1** **Recovery time:** **3:17**
Location **Type of Data:** **Pumping and Recovery**

Surface Elevation
Distance from well

Piezometer No.	**TW 5-2**							
Elevation Meas. Point								
Static Water Level	0.62							
Depth of Intake (sur.)								
Depth of Intake (m.a.s.l.)								
t	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**	**reading**	**drawdown**
46	0.63	0.01						
73	0.63	0.01						

Analysis of Aquifer Test Data

TW 5-1

Q = 17.86 m^3/day

Jacob Analysis

Δs = 29 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 17.86}{4\pi * 29} = 0.11\ m^2/\text{day}$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 5-2
TEST NO: 1

Date: 08-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 25

Depth of Intake: 24.80 m
Pump on:
Pump off:
Duration: 0:55 hours:min
Pump Rate: 4.5 L/min
Recovery Time: 2:00 hours:min

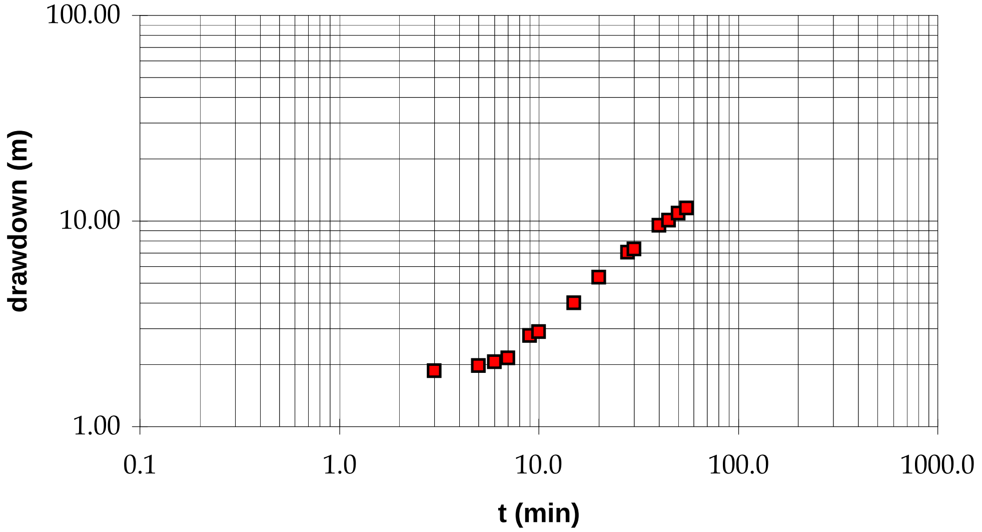
TIME t= 55 at t'=0

WATER LEVEL DATA SWL= 0.62 m

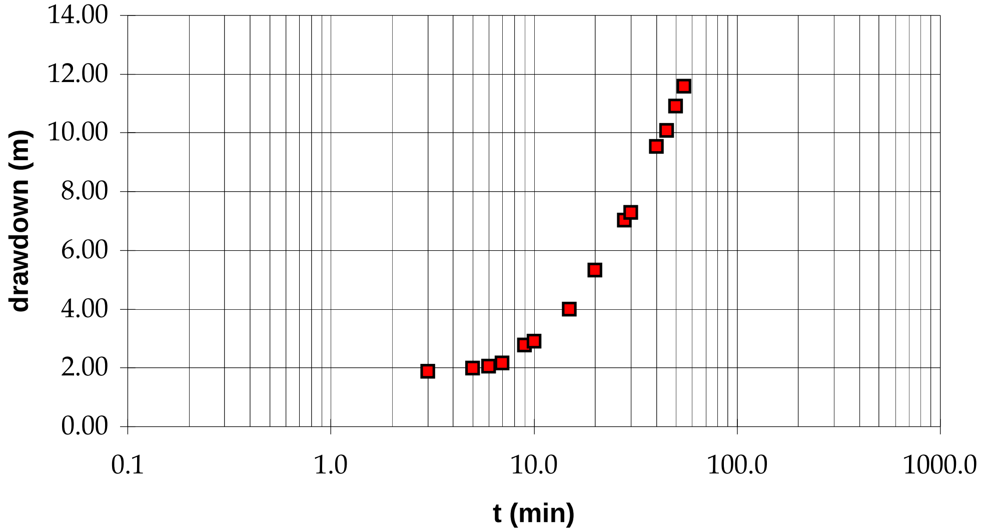
	Pumping				Recovery			COMMENTS
t	**Reading**	**Drawdown**	**t**	**t'**	**Reading**	**t/t'**	**Drawdown**	
3.0	2.49	1.87	56.0	1.0	11.45	56.00	10.83	
5.0	2.60	1.98	58.0	3.0	11.29	19.33	10.67	
6.0	2.68	2.06	60.0	5.0	11.23	12.00	10.61	
7.0	2.77	2.15	65.0	10.0	11.14	6.50	10.52	
9.0	3.38	2.76	70.0	15.0	11.05	4.67	10.43	
10.0	3.51	2.89	85.0	30.0	10.80	2.83	10.18	
15.0	4.61	3.99	90.0	35.0	10.74	2.57	10.12	
20.0	5.93	5.31	95.0	40.0	10.66	2.38	10.04	
28.0	7.65	7.03	100.0	45.0	10.59	2.22	9.97	
30.0	7.90	7.28	105.0	50.0	10.52	2.10	9.90	
40.0	10.15	9.53	110.0	55.0	10.45	2.00	9.83	
45.0	10.70	10.08	120.0	65.0	10.31	1.85	9.69	
50.0	11.53	10.91	145.0	90.0	9.94	1.61	9.32	
55.0	12.19	11.57	175.0	120.0	9.61	1.46	8.99	

22.3 **% recovery**
47.46 **% of total available drawdown**

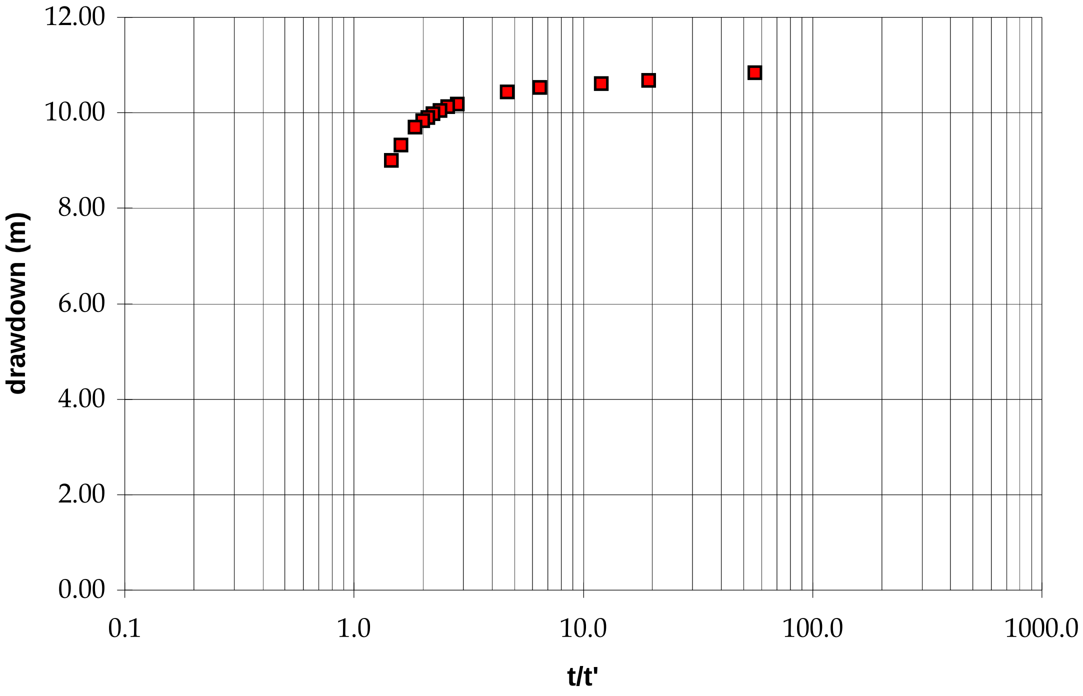
Theis Analysis, TW 5-2



Jacob Analysis, TW 5-2



Theis Recovery Analysis, TW 5-2



Analysis of Aquifer Test Data

TW 5-2

Q = $6.48\ m^3/day$

Jacob Analysis

$\Delta s = 14\ m$

$$T = \frac{2.3\ Q}{4\pi\ \Delta s} = \frac{2.3 * 6.48}{4\pi\ * 14} = 0.08\ m^2/day$$

Theis Recovery Analysis

$\Delta s = 7.3\ m$

$$T = \frac{2.3\ Q}{4\pi\ \Delta s} = \frac{2.3 * 6.48}{4\pi\ * 7.3} = 0.16\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 6-1
TEST NO: 1

Date: 08-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 25

Depth of Intake: 24.80 m
Pump on:
Pump off:
Duration: 0:40 hours:min
Pump Rate: 10.35 L/min
Recovery Time: 2:00 hours:min

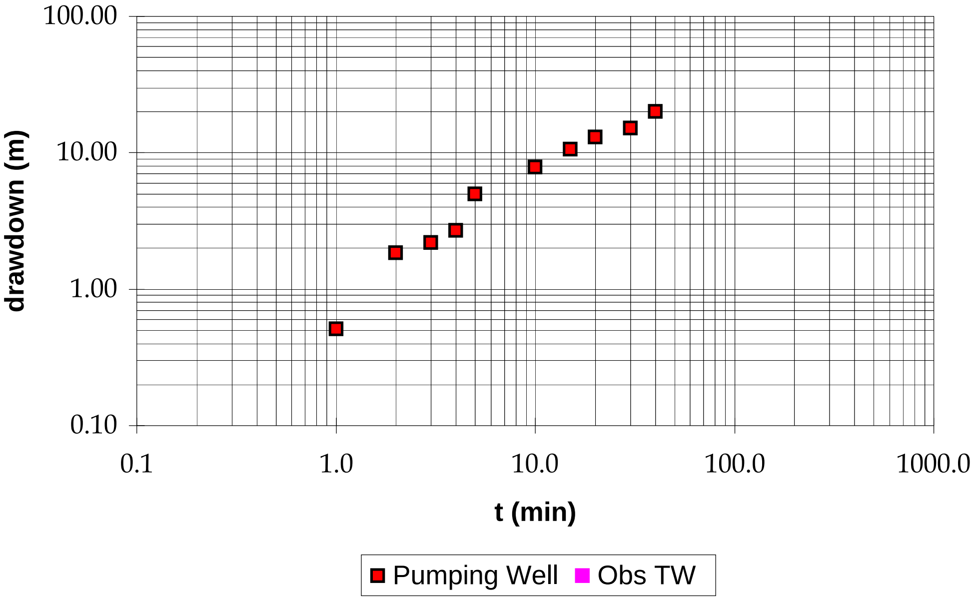
TIME
t= 40 at t'=0

WATER LEVEL DATA
SWL= 4.62 m

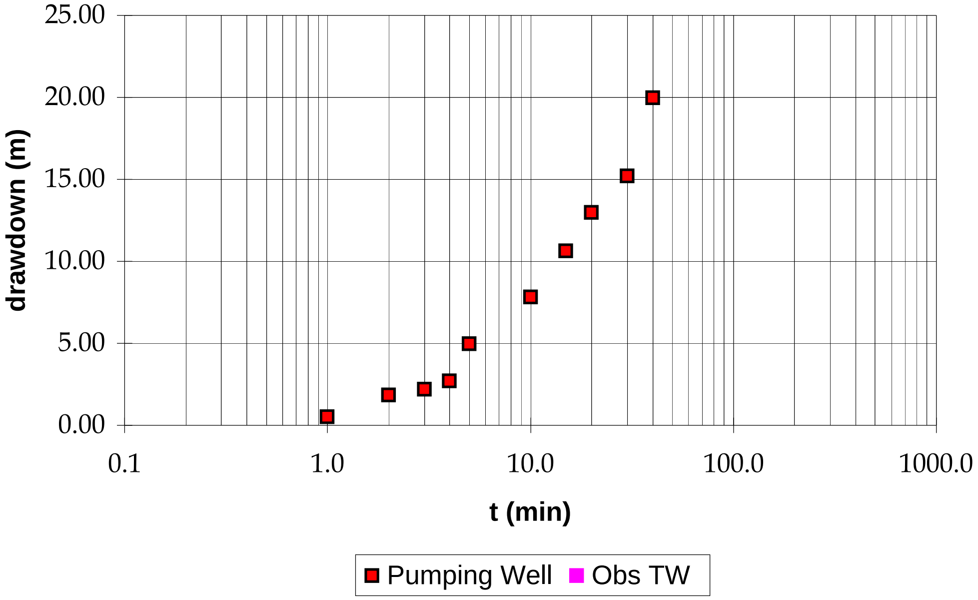
Pumping			Recovery					COMMENTS
t	**Reading**	**Drawdown**	**t**	**t'**	**Reading**	**t/t'**	**Drawdown**	**SWL 6-2 = 11.5 m**
1.0	5.13	0.51	42.0	2.0	23.65	21.00	19.03	
2.0	6.47	1.85	45.0	5.0	23.65	9.00	19.03	
3.0	6.82	2.20	55.0	15.0	23.63	3.67	19.01	
4.0	7.31	2.69	70.0	30.0	23.62	2.33	19.00	
5.0	9.60	4.98	90.0	50.0	23.61	1.80	18.99	
10.0	12.45	7.83	100.0	60.0	23.60	1.67	18.98	
15.0	15.25	10.63	160.0	120.0	23.54	1.33	18.92	
20.0	17.57	12.95						
30.0	19.80	15.18						
40.0	24.60	19.98						

5.3 **% recovery**
98.04 **% of total available drawdown**

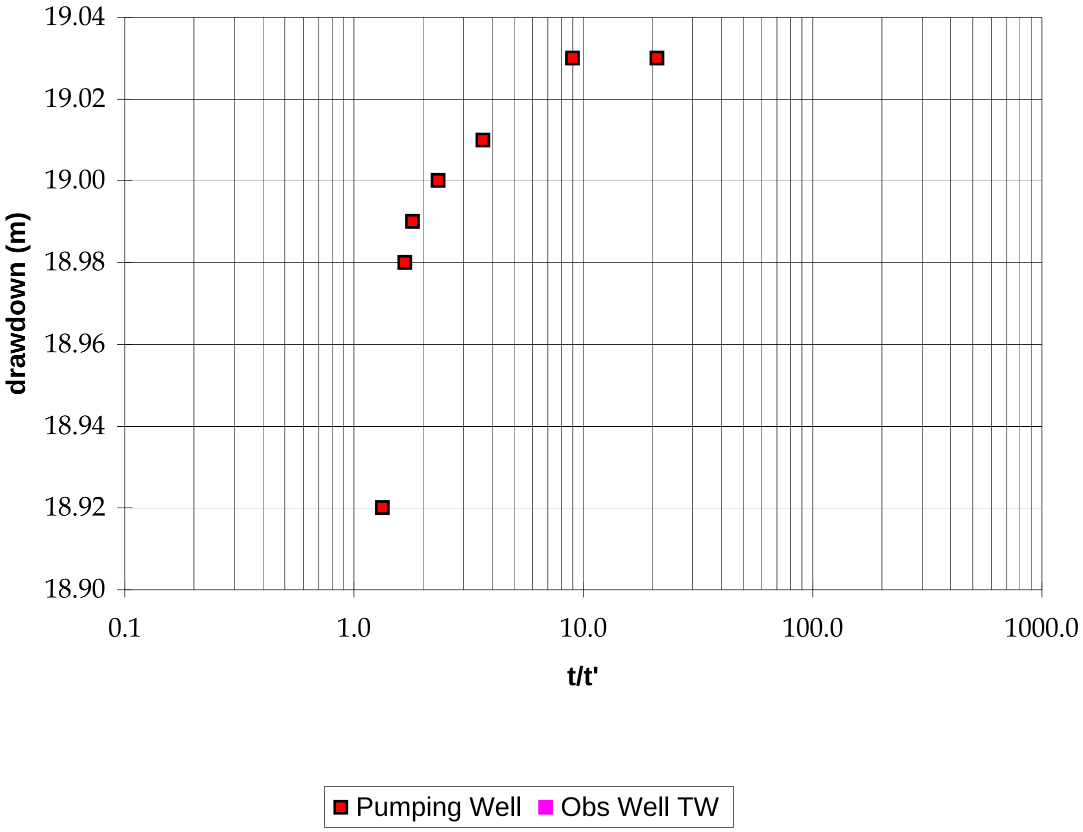
Theis Analysis, TW 6-1



Jacob Analysis, TW 6-1



Theis Recovery Analysis, TW 6-1



Analysis of Aquifer Test Data

TW 6-1

$Q =$ 14.9 m^3/day

Jacob Analysis

$\Delta s =$ 15 m

$$T = \frac{2.3\ Q}{4\pi\ \Delta s} = \frac{2.3 * 14.9}{4\pi\ * 15} = 0.18\ m^2/day$$

AQUIFER TEST DATA

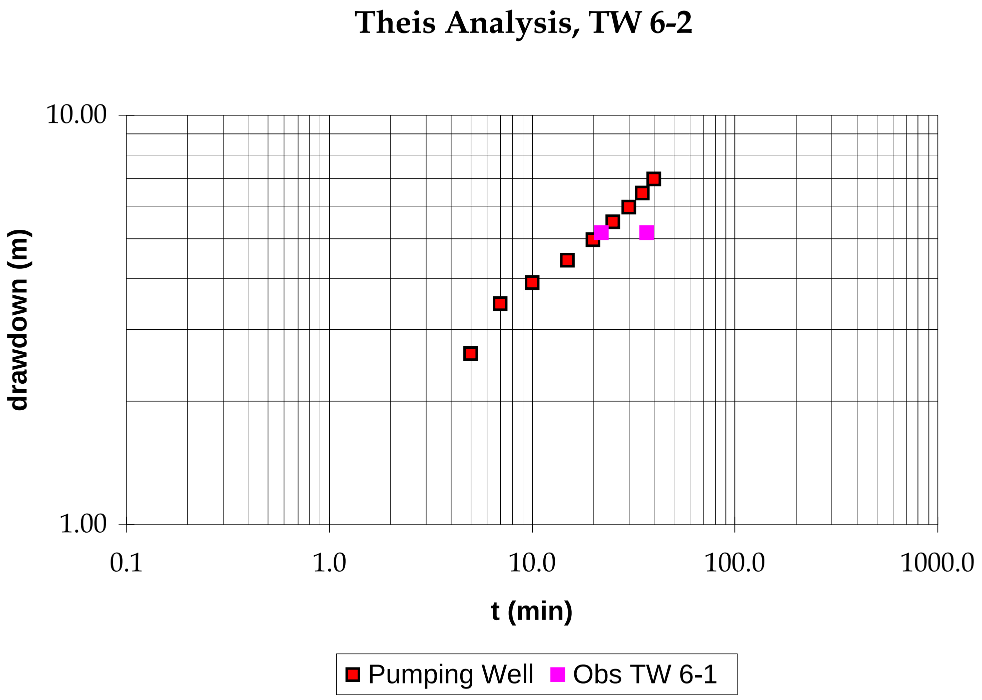
PROJ. NO: 05460
WELL NO: TW 6-2
TEST NO: 1

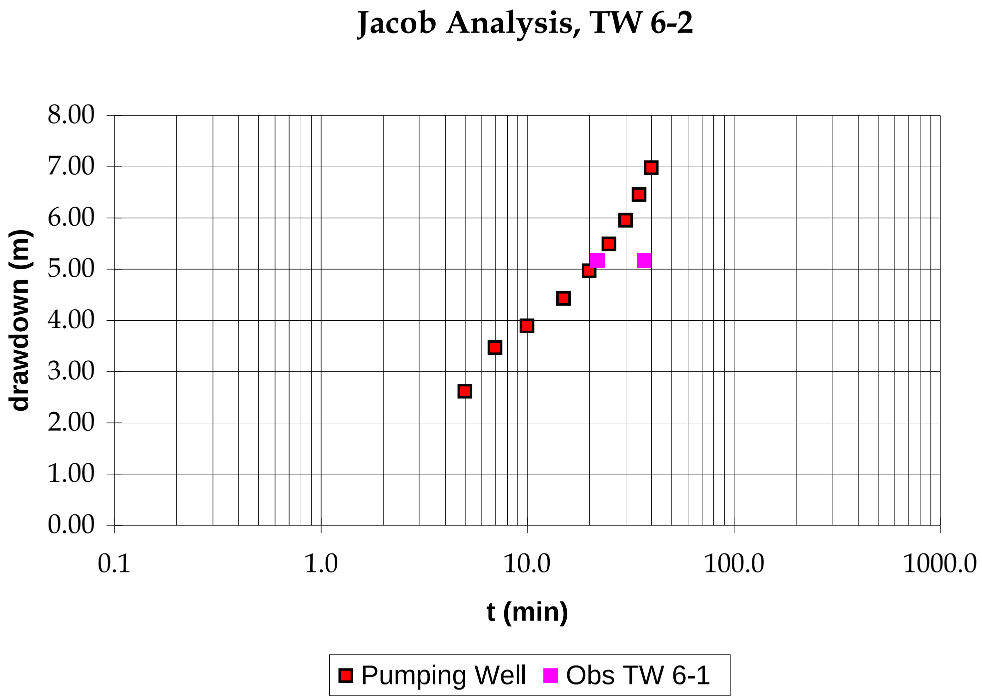
Date: 07-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 12.8

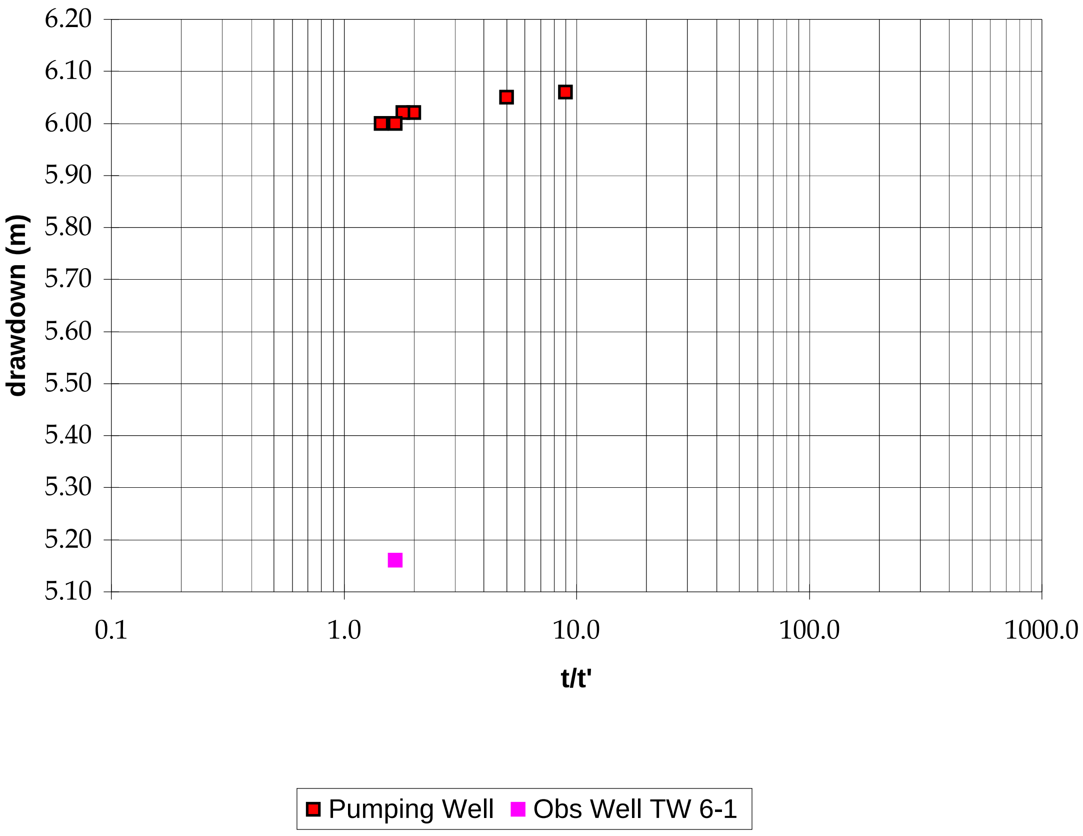
Depth of Intake: 12.70 m
Pump on:
Pump off:
Duration: 0:40 hours:min
Pump Rate: 0.75 L/min
Recovery Time: 2:10 hours:min

TIME			WATER LEVEL DATA					
t=	40	at t'=0	SWL=	5.65 m				
	Pumping				Recovery			COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 6-1 = 5.18 m
5.0	8.26	2.61	45.0	5.0	11.71	9.00	6.06	
7.0	9.11	3.46	50.0	10.0	11.70	5.00	6.05	
10.0	9.54	3.89	80.0	40.0	11.67	2.00	6.02	
15.0	10.07	4.42	90.0	50.0	11.67	1.80	6.02	
20.0	10.61	4.96	100.0	60.0	11.65	1.67	6.00	
25.0	11.14	5.49	130.0	90.0	11.65	1.44	6.00	
30.0	11.60	5.95						
35.0	12.10	6.45						
40.0	12.62	6.97						
					13.9	% recovery		
					97.48	% of total available drawdown		


Theis Analysis, TW 6-2
10.00
1.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 6-1


Jacob Analysis, TW 6-2
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 6-1

Theis Recovery Analysis, TW 6-2



AQUIFER TEST DATA
Installed piezometers

Project No. **05460**
Test No. **TW 6-2**
Location

Date: **07/05/2007**
Recovery time: **1:30**
Type of Data: **Pumping and Recovery**

Surface Elevation
Distance from well

Piezometer No.
Elevation Meas. Point
Static Water Level 5.18
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	reading	drawdown	reading	drawdown	reading	drawdown	reading	drawdown
22	5.16	-0.02						
37	5.16	-0.02						
100	5.16	-0.02						

Analysis of Aquifer Test Data

TW 6-2

Q = 1.08 m^3/day

Jacob Analysis

Δs = 9 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 1.08}{4\pi * 9} = 0.02\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 7
TEST NO: 1

Date: 10-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

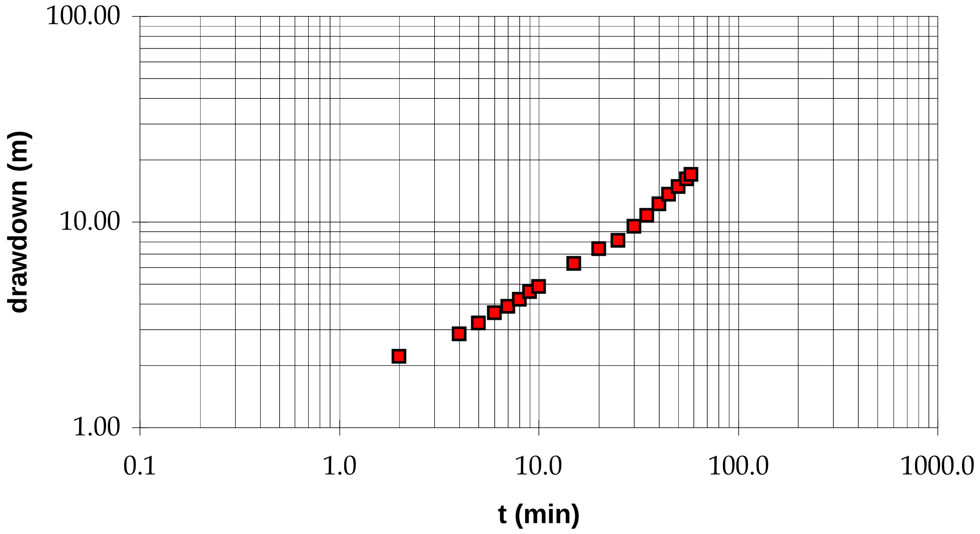
How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 25

Depth of Intake: 24.60 m
Pump on:
Pump off:
Duration: 0:58 hours:min
Pump Rate: 7.2 L/min
Recovery Time: 2:00 hours:min

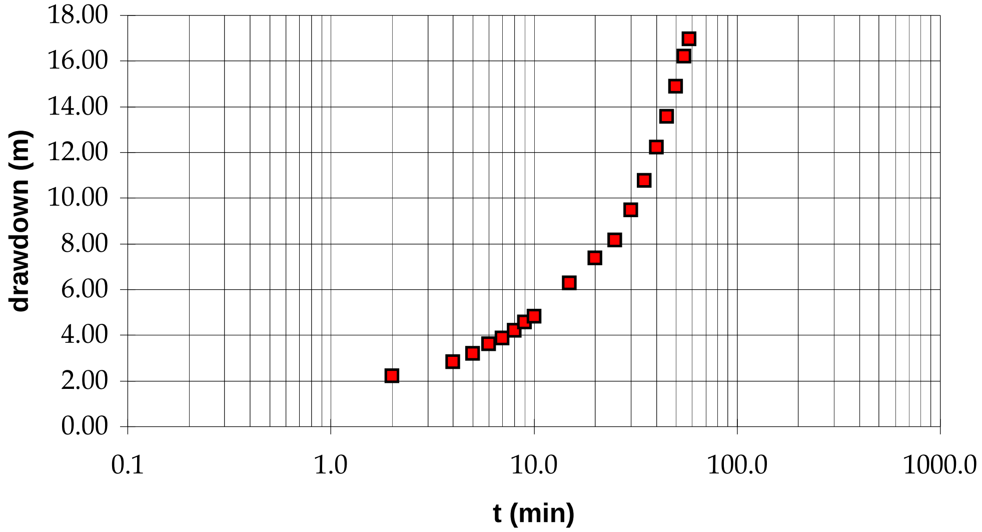
TIME			WATER LEVEL DATA					
t= 58 at t'=0			SWL= 7.20 m					
Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	
2.0	9.42	2.22	60.0	2.0	23.12	30.00	15.92	
4.0	10.04	2.84	63.0	5.0	23.05	12.60	15.85	
5.0	10.41	3.21	64.0	6.0	22.99	10.67	15.79	
6.0	10.81	3.61	65.0	7.0	22.92	9.29	15.72	
7.0	11.08	3.88	66.0	8.0	22.87	8.25	15.67	
8.0	11.40	4.20	67.0	9.0	22.84	7.44	15.64	
9.0	11.76	4.56	68.0	10.0	22.81	6.80	15.61	
10.0	12.03	4.83	73.0	15.0	22.58	4.87	15.38	
15.0	13.48	6.28	78.0	20.0	22.46	3.90	15.26	
20.0	14.58	7.38	98.0	40.0	21.83	2.45	14.63	
25.0	15.35	8.15	136.0	78.0	20.83	1.74	13.63	
30.0	16.69	9.49	178.0	120.0	19.87	1.48	12.67	
35.0	17.98	10.78						
40.0	19.42	12.22						
45.0	20.77	13.57						
50.0	22.09	14.89						
55.0	23.41	16.21						
58.0	24.16	16.96						

25.3 % recovery
95.28 % of total available drawdown

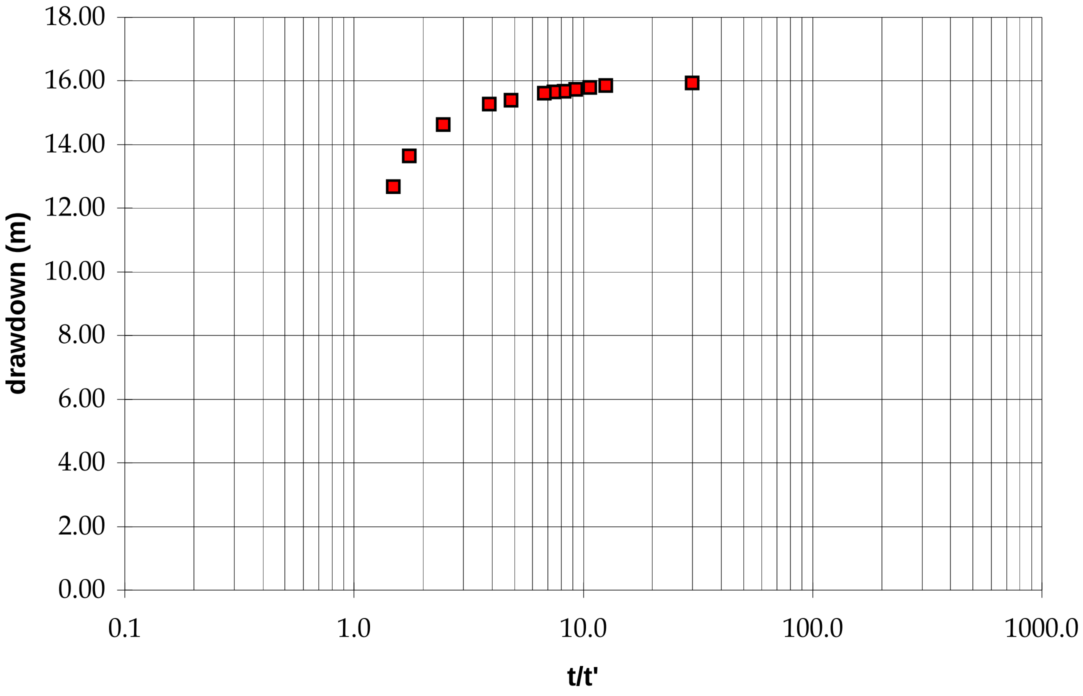
Theis Analysis, TW 7



Jacob Analysis, TW 7



Theis Recovery Analysis, TW 7



Analysis of Aquifer Test Data

TW 7

Q = 10.37 m^3/day

Jacob Analysis

$\Delta s = 9$ m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 10.37}{4\pi * 9} = 0.21\ m^2/day$$

Theis Recovery Analysis

$\Delta s = 5.2$ m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 10.37}{4\pi * 5.2} = 0.37\ m^2/day$$

AQUIFER TEST DATA

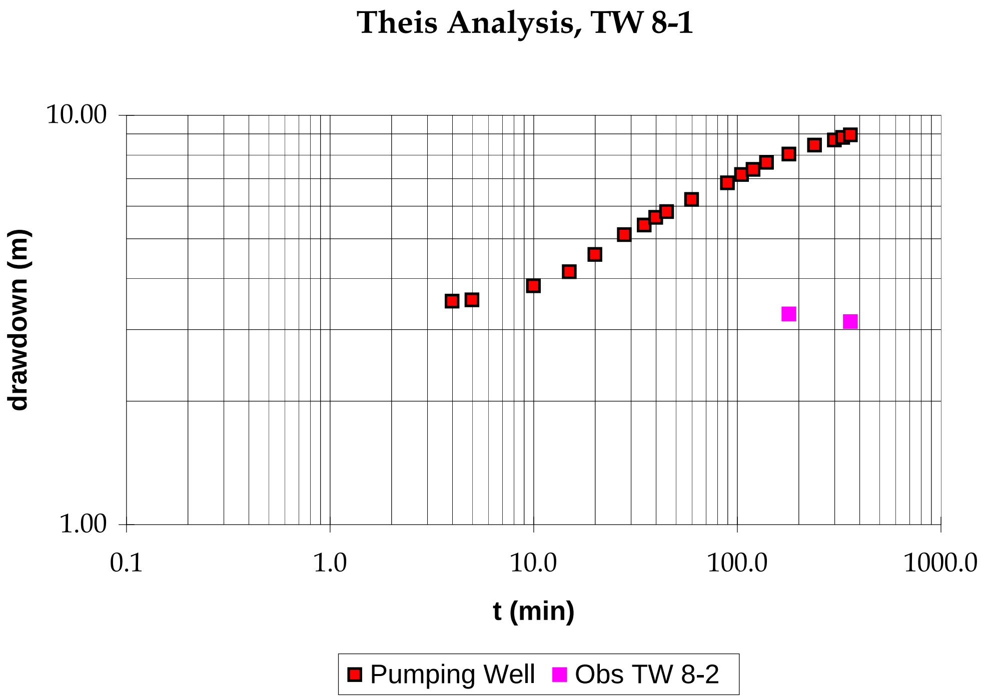
PROJ. NO: 05460
WELL NO: TW 8-1
TEST NO: 1

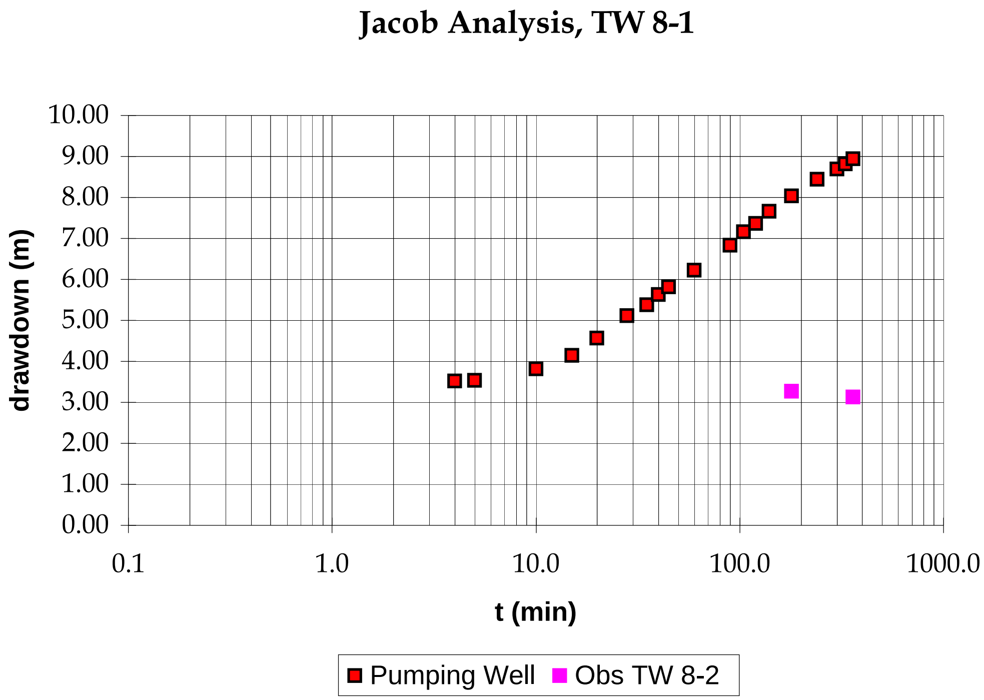
Date: 04-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 25

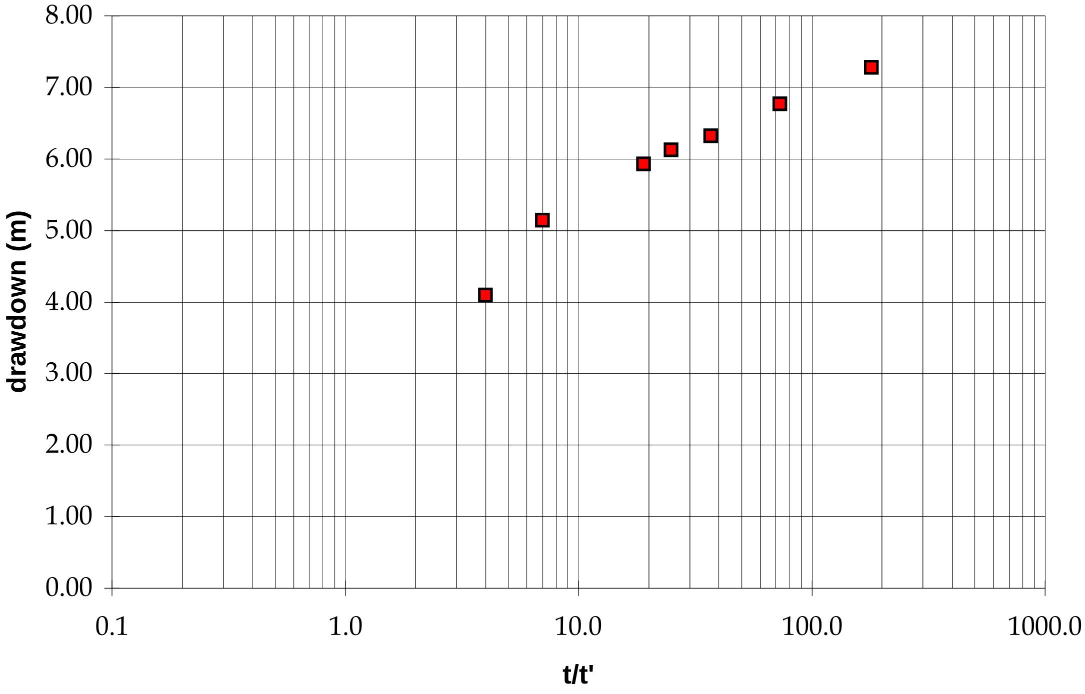
Depth of Intake: 24.80 m
Pump on:
Pump off:
Duration: 6:00 hours:min
Pump Rate: 15.75 L/min
Recovery Time: 2:00 hours:min

	TIME		WATER LEVEL DATA					
t=	360	at t'=0	SWL=	13.32 m				
	Pumping				Recovery			COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 8-2 = 3.35 m
4.0	16.83	3.51	362.0	2.0	20.60	181.00	7.28	
5.0	16.85	3.53	365.0	5.0	20.09	73.00	6.77	
10.0	17.14	3.82	370.0	10.0	19.64	37.00	6.32	
15.0	17.46	4.14	375.0	15.0	19.44	25.00	6.12	
20.0	17.88	4.56	380.0	20.0	19.25	19.00	5.93	
28.0	18.43	5.11	420.0	60.0	18.46	7.00	5.14	
35.0	18.70	5.38	480.0	120.0	17.41	4.00	4.09	
40.0	18.94	5.62						
45.0	19.13	5.81						
60.0	19.54	6.22						
90.0	20.15	6.83						
105.0	20.47	7.15						
120.0	20.68	7.36						
140.0	20.97	7.65						
180.0	21.35	8.03						
240.0	21.75	8.43						
300.0	22.00	8.68						
330.0	22.14	8.82						
360.0	22.26	8.94						
					54.3	**% recovery**		
					76.54	**% of total available drawdown**		


Theis Analysis, TW 8-1
10.00
1.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 8-2


Jacob Analysis, TW 8-1
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
drawdown (m)
0.1
1.0
10.0
100.0
1000.0
t (min)
Pumping Well
Obs TW 8-2

Theis Recovery Analysis, TW 8-1



AQUIFER TEST DATA
Installed piezometers

Project No. 05460
Test No. TW 8-1
Location

Date: 05/04/2007
Recovery time: 0:00
Type of Data: Pumping and Recovery

Surface Elevation
Distance from well

Piezometer No. TW 8-2
Elevation Meas. Point
Static Water Level 3.35
Depth of Intake (sur.)
Depth of Intake (m.a.s.l.)

t	reading	drawdown	reading	drawdown	reading	drawdown	reading	drawdown
180	3.27	-0.08						
360	3.13	-0.22						

Analysis of Aquifer Test Data

TW 8-1

Q = 22.68 m^3/day

Jacob Analysis

$\Delta s =$ 7 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 22.68}{4\pi * 7} = 0.59\ m^2/day$$

Theis Recovery Analysis

$\Delta s =$ 5 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 22.68}{4\pi * 5} = 0.83\ m^2/day$$

AQUIFER TEST DATA

PROJ. NO: 05460
WELL NO: TW 8-2
TEST NO: 1

Date: 02-May-07
TYPE OF WELL: Pumping
TYPE OF DATA: Pumping and Recovery

How Q measured: pail
How WL Measured: tape
Rad./Dist. of Pumping Well: 0.076 m
Measuring Point for WL: top of casing
Elev. Meas. Point:
Well Depth: 13

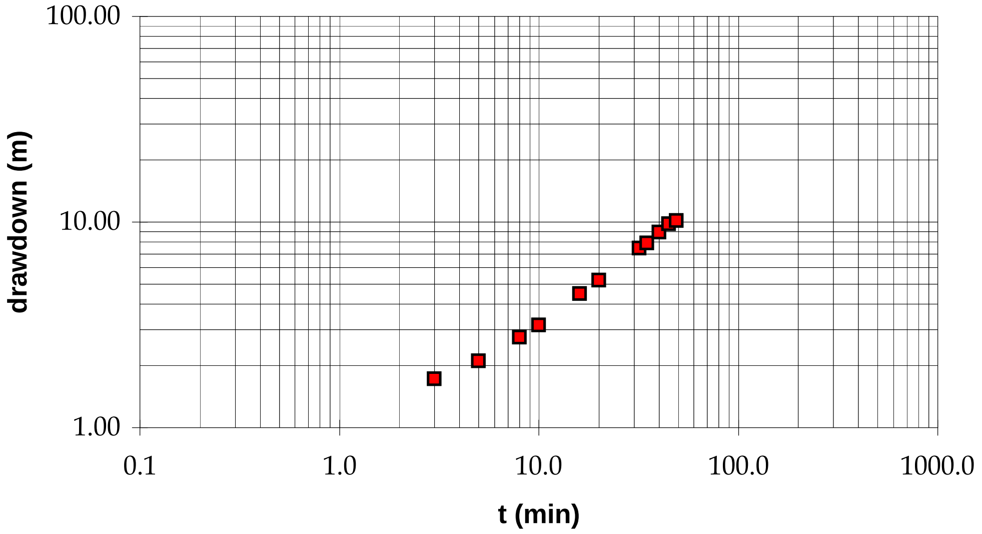
Depth of Intake: 12.90 m
Pump on:
Pump off:
Duration: 0:49 hours:min
Pump Rate: 1 L/min
Recovery Time: 2:00 hours:min

TIME t= 49 at t'=0

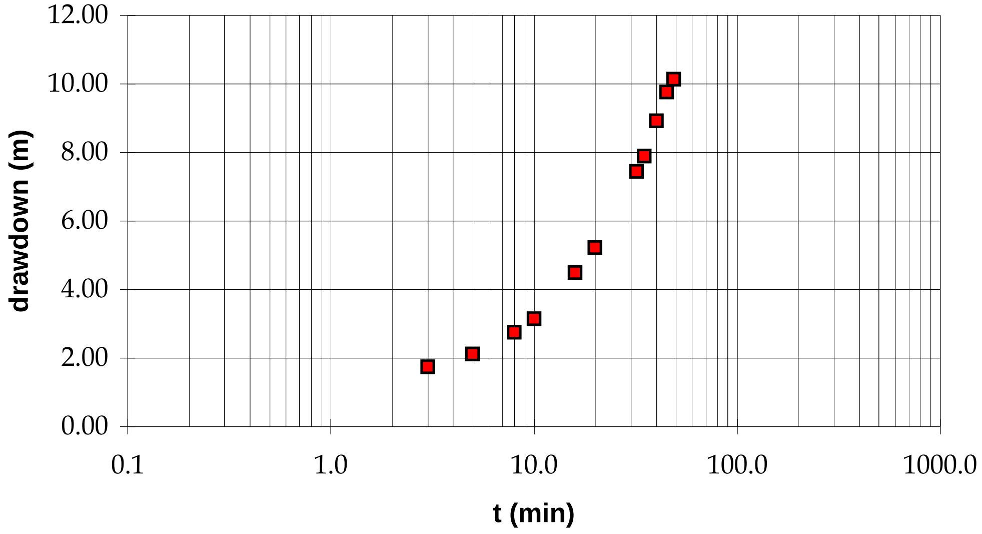
WATER LEVEL DATA SWL= 2.61 m

Pumping			Recovery					COMMENTS
t	Reading	Drawdown	t	t'	Reading	t/t'	Drawdown	SWL 8-1 = 12.14 m
3.0	4.34	1.73	50.0	1.0	12.14	50.00	9.53	T = 14.2 oC, DO = 9.09 mg/L
5.0	4.72	2.11	51.0	2.0	12.03	25.50	9.42	
8.0	5.35	2.74	52.0	3.0	12.01	17.33	9.40	
10.0	5.75	3.14	53.0	4.0	11.97	13.25	9.36	
16.0	7.09	4.48	54.0	5.0	11.95	10.80	9.34	
20.0	7.83	5.22	60.0	11.0	11.84	5.45	9.23	
32.0	10.04	7.43	82.0	33.0	11.66	2.48	9.05	
35.0	10.50	7.89	99.0	50.0	11.54	1.98	8.93	
40.0	11.53	8.92	129.0	80.0	11.39	1.61	8.78	
45.0	12.37	9.76	149.0	100.0	11.26	1.49	8.65	
49.0	12.75	10.14	159.0	110.0	11.20	1.45	8.59	
			169.0	120.0	11.14	1.41	8.53	
					15.9	% recovery		
					97.59	% of total available drawdown		

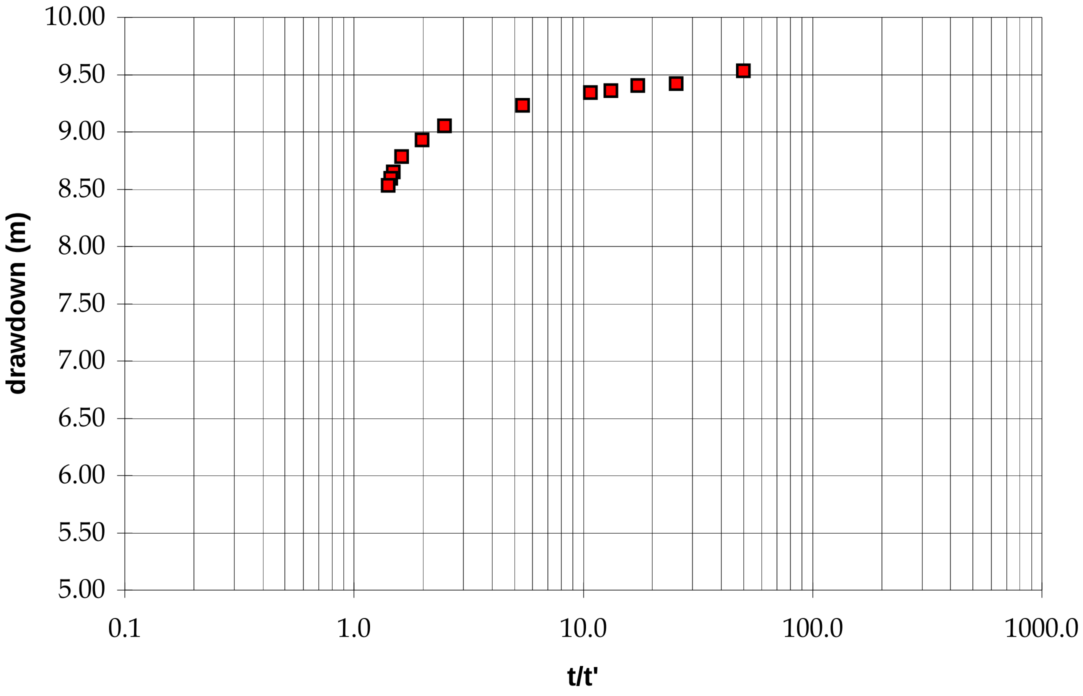
Theis Analysis, TW 8-2



Jacob Analysis, TW 8-2



Theis Recovery Analysis, TW 8-2



Analysis of Aquifer Test Data

TW 8-2

Q = 1.44 m^3/day

Jacob Analysis

Δs = 11 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 1.44}{4\pi * 11} = 0.02\ m^2/\text{day}$$

Theis Recovery Analysis

Δs = 6.5 m

$$T = \frac{2.3\,Q}{4\pi\,\Delta s} = \frac{2.3 * 1.44}{4\pi * 6.5} = 0.04\ m^2/\text{day}$$

Appendix IV

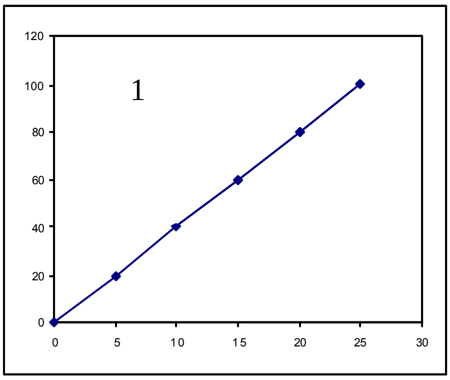
Packer Test Data and Analysis

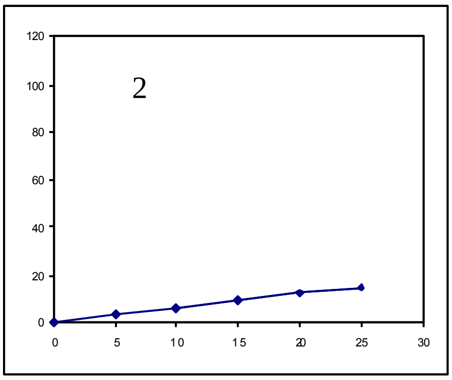
(TW 9 – 13)

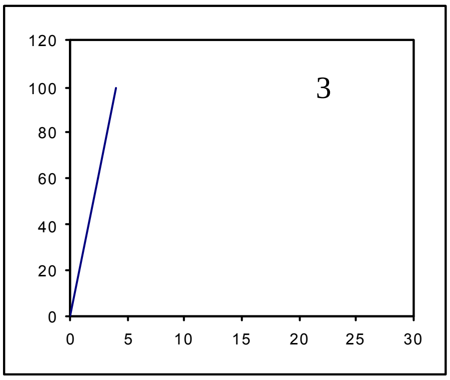
Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

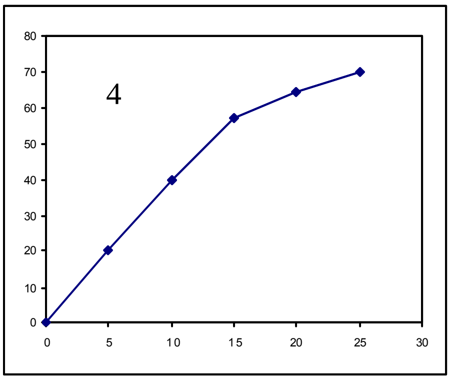
George A. Gorrell M.Sc. P.Geo. F.G.A.C.

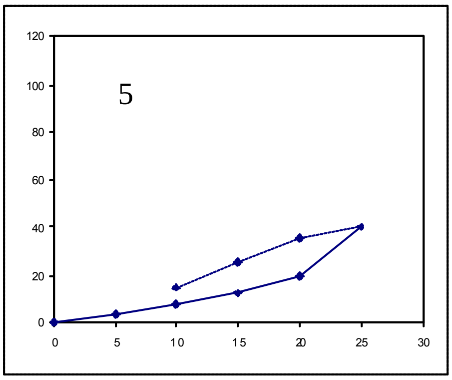
Typical Flow vs. Pressure Curves

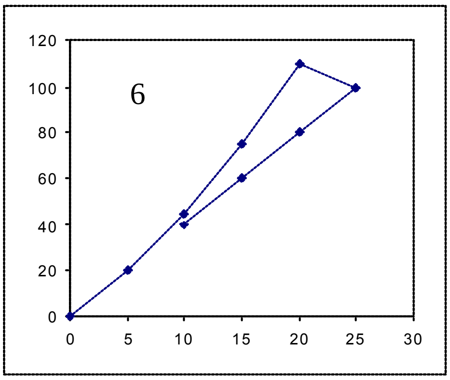


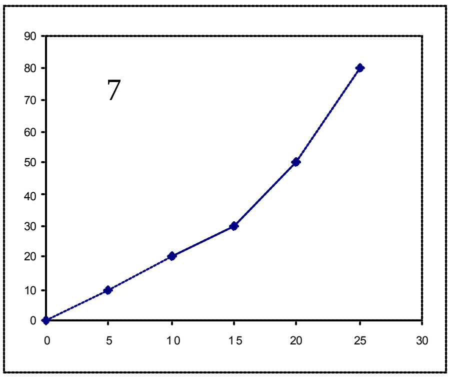


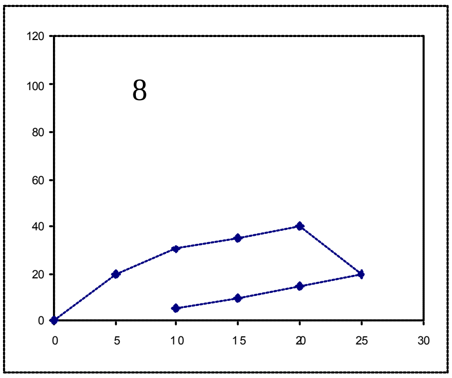


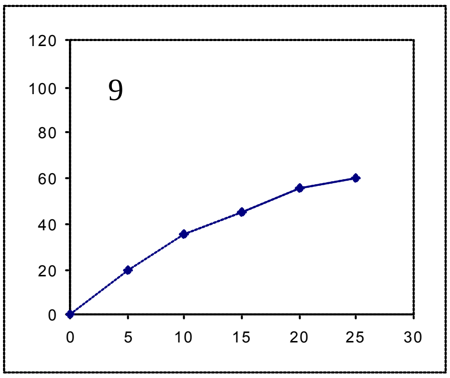












The graphs in Figure 2 illustrate a selection of type curves, which are commonly observed. The following describes each curve. (Note that the recovery curve -reducing pressure curve- is indicated by a dashed line in the plots, otherwise the recovery curve is seen to mimic the ascending pressure curve).

1. Ideal result where flow is laminar, probably on clean fractures, discharge proportional to pressure head.
2. Tight fractures, impermeable material
3. Highly permeable, large open fractures. Water acceptance exceeds capacity of the test system and pressure recorded is due to friction in supply system.
4. Fairly high permeability with a decrease in flow with time due partially to a change from laminar to turbulent flow, as well as partial clogging of fractures with time.
5. Low permeability, but washing out of gouge material from the fractures, increasing the permeability.
6. Laminar flow, moderate permeability but with an increase in flow with pressure. Increasing packer pressure brings the flow back to a linear relationship with pressure, indicating increased flow was previous leakage past the packer.
7. Increase in permeability with increased pressure and the recovery curve follows the same path. This indicates that fractures have been opened up due to excess pressure (hydrofraccing).
8. Progressive decrease in permeability with pressure (and time) indicating incomplete blocking of the fractures by transported material.
9. Moderate permeability and flow rate is not linear. The down turned curve and similar recovery curve indicate that turbulent flow conditions exist beyond 15 bars.

Project No: 08360
Date: 03-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 28.96
Length of Test Section: 2.13

Depth, top of bottom of packer: 31.09
Length of Packer: 2.13

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	6.9710	
1	6.9740	3.00E-03
2	6.9750	1.00E-03
3	6.9760	1.00E-03
4	6.9770	1.00E-03
5	6.9780	1.00E-03
6	6.9790	1.00E-03
7	6.9800	1.00E-03
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	6.6870	
1	6.6890	2.00E-03
2	6.9900	3.01E-01
3	6.9920	2.00E-03
4	6.9930	1.00E-03
5	6.9945	1.50E-03
6	6.9965	2.00E-03
7	6.9985	2.00E-03
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	7.0020	
1	7.0040	2.00E-03
2	7.0050	1.00E-03
3	7.0060	1.00E-03
4	7.0070	1.00E-03
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	7.0150	
1	7.0175	2.50E-03
2	7.0200	2.50E-03
3	7.0230	3.00E-03
4	7.0265	3.50E-03
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	6.0290	
1	6.0310	2.00E-03
2	6.0330	2.00E-03
3	6.0350	2.00E-03
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	7.0350	
1	7.0360	1.00E-03
2	7.0370	1.00E-03
3	7.0380	1.00E-03
4		
5		
6		
7		
8		
9		
10		

Comments

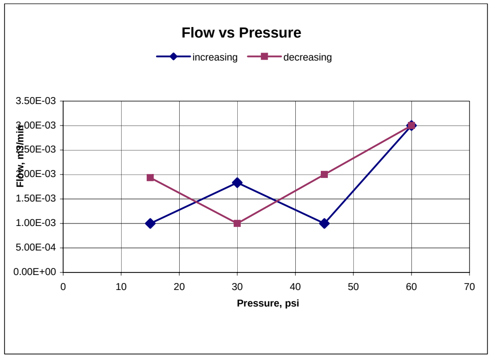
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	7.0358	
1	7.0369	1.10E-03
2	7.0391	2.20E-03
3	7.0410	1.90E-03
4	7.0427	1.70E-03
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 123.23
Bottom (m): 121.10

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.00E-03	4.97E-05
30	1.83E-03	2.90E-05
45	1.00E-03	1.14E-05
60	3.00E-03	2.90E-05
45	2.00E-03	2.38E-05
30	1.00E-03	1.24E-04
15	1.93E-03	4.14E-05



Project No: 08360
Date: 03-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Borehole Depth: 31.09
Test Hole No: 9-1
Radius of Borehole (m): 0.0379
Ht Press. Gauge, above G.S: 0.6
Surface Elevation: 152.19 m ASL
Water Level: 9.62
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 28.96
Length of Test Section: -3.05
Depth, top of bottom of packer: 25.91
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	11.2000	
1	11.2000	0.00E+00
2	11.2000	0.00E+00
3	11.2000	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	11.2020	
1	11.2022	2.00E-04
2	11.2023	1.00E-04
3	11.2024	1.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	11.2043	
1	11.2044	1.00E-04
2	11.2045	1.00E-04
3	11.2046	1.00E-04
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	11.2058	
1	11.2060	2.00E-04
2	11.2062	2.00E-04
3	11.2064	2.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	11.2065	
1	11.2065	0.00E+00
2	11.2066	1.00E-04
3	11.2067	1.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	11.2067	
1	11.2067	0.00E+00
2	11.2067	0.00E+00
3	11.2067	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

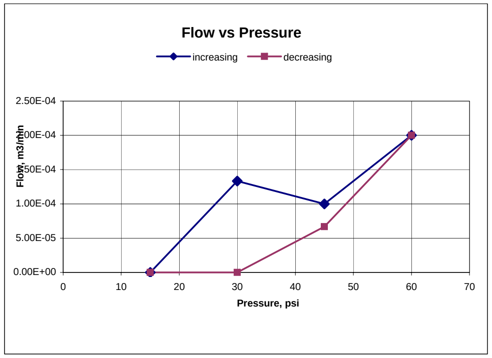
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	11.2067	
1	11.2067	0.00E+00
2	11.2067	0.00E+00
3	11.2067	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 123.23
Bottom (m): 126.28

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	1.33E-04	4.03E-06
45	1.00E-04	2.42E-06
60	2.00E-04	3.02E-06
45	6.67E-05	1.61E-06
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Borehole Depth: 31.09
Test Hole No: 9-1
Radius of Borehole (m): 0.0379
Ht Press. Gauge, above G.S: 0.6
Surface Elevation: 152.19 m ASL
Water Level: 9.62
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 22.86
Length of Test Section: 3.05
Depth, top of bottom of packer: 25.91
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	12.7450	
1	12.7450	0.00E+00
2	12.7420	-3.00E-03
3	12.7415	-5.00E-04
4	12.7415	0.00E+00
5	12.7415	0.00E+00
6	12.7415	0.00E+00
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	12.7475	
1	12.7479	4.00E-04
2	12.7485	6.00E-04
3	12.7495	1.00E-03
4	12.7505	1.00E-03
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	12.7550	
1	12.7579	2.90E-03
2	12.7602	2.30E-03
3	12.7630	2.80E-03
4	12.7665	3.50E-03
5	12.7700	3.50E-03
6	12.7735	3.50E-03
7		
8		
9		
10		

Comments back pressure reversed gauge

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	12.7770	
1	12.7825	5.50E-03
2	12.7874	4.90E-03
3	12.7924	5.00E-03
4	12.7975	5.10E-03
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	12.7990	
1	12.8024	3.40E-03
2	12.8055	3.10E-03
3	12.8090	3.50E-03
4	12.8120	3.00E-03
5	12.8150	3.00E-03
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	12.8170	
1	12.8188	1.80E-03
2	12.8206	1.80E-03
3	12.8225	1.90E-03
4	12.8244	1.90E-03
5		
6		
7		
8		
9		
10		

Comments

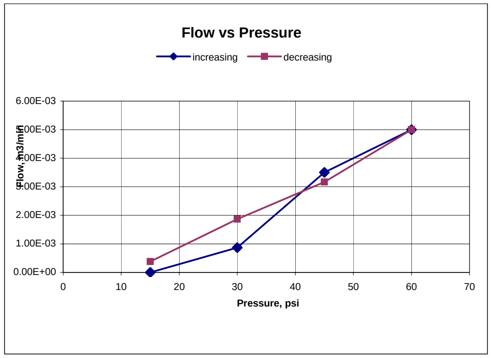
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	12.8225	
1	12.8226	5.00E-05
2	12.8229	3.00E-04
3	12.8232	3.50E-04
4	12.8237	5.00E-04
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 129.33
Bottom (m): 126.28

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	8.67E-04	1.21E-05
45	3.50E-03	3.62E-05
60	5.00E-03	4.03E-05
45	3.17E-03	3.62E-05
30	1.87E-03	3.42E-05
15	3.83E-04	8.45E-06



Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 19.81
Length of Test Section: 3.05

Depth, top of bottom of packer: 22.86
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.1037	
1	13.1038	5.00E-05
2	13.1038	0.00E+00
3	13.1042	4.50E-04
4	13.1045	3.00E-04
5	13.1048	2.50E-04
6	13.1050	2.50E-04
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.1102	
1	0.1105	2.50E-04
2	0.1110	5.00E-04
3	0.1115	5.50E-04
4	0.1119	3.50E-04
5	0.1121	2.50E-04
6	0.1124	2.50E-04
7	0.1126	2.50E-04
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.1154	
1	0.1157	2.50E-04
2	0.1159	2.00E-04
3	0.1161	2.00E-04
4	0.1163	2.00E-04
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.1177	
1	0.1180	3.04E-04
2	0.1185	4.46E-04
3	0.1188	3.00E-04
4	0.1191	3.00E-04
5	0.1194	3.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.1188	
1	0.1188	0.00E+00
2	0.1189	1.30E-04
3	0.1190	1.20E-04
4	0.1192	1.50E-04
5	0.1193	1.50E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.1177	
1	0.1177	0.00E+00
2	0.1177	0.00E+00
3	0.1177	5.00E-05
4	0.1178	5.00E-05
5	0.1178	5.00E-05
6		
7		
8		
9		
10		

Comments note meter unwound due to backpressure between 45 and 30, 30 and 15

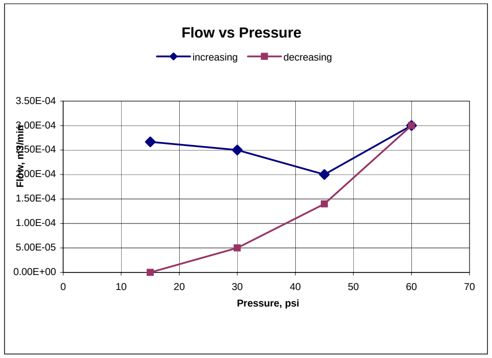
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.1151	
1	0.1151	0.00E+00
2	0.1151	0.00E+00
3	0.1151	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 132.38
Bottom (m): 129.33

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.67E-04	5.43E-06
30	2.50E-04	4.43E-06
45	2.00E-04	2.21E-06
60	3.00E-04	2.82E-06
45	1.40E-04	1.61E-06
30	5.00E-05	5.43E-07
15	0.00E+00	0.00E+00



Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 16.76
Length of Test Section: 3.05

Depth, top of bottom of packer: 19.81
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.2962	
1	13.2968	5.50E-04
2	13.2973	5.00E-04
3	13.2978	5.00E-04
4	13.2983	5.50E-04
5	13.2989	5.50E-04
6	13.2995	6.50E-04
7	13.3000	5.00E-04
8	13.3007	7.00E-04
9	13.3013	6.00E-04
10	13.3019	6.00E-04

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.3042	
1	13.3051	9.50E-04
2	13.3060	8.50E-04
3	13.3069	9.00E-04
4	13.3078	9.00E-04
5	13.3087	9.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.3108	
1	13.3125	1.70E-03
2	13.3139	1.35E-03
3	13.3153	1.45E-03
4	13.3168	1.45E-03
5	13.3182	1.40E-03
6	13.3195	1.35E-03
7	13.3209	1.35E-03
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	13.3225	
1	13.3246	2.10E-03
2	13.3266	2.00E-03
3	13.3286	2.00E-03
4	13.3306	2.00E-03
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.3314	
1	13.3331	1.70E-03
2	13.3347	1.60E-03
3	13.3362	1.45E-03
4	13.3377	1.55E-03
5	13.3392	1.50E-03
6	13.3408	1.55E-03
7	13.3422	1.45E-03
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.3421	
1	13.3431	1.05E-03
2	13.3443	1.15E-03
3	13.3454	1.15E-03
4	13.3466	1.15E-03
5		
6		
7		
8		
9		
10		

Comments

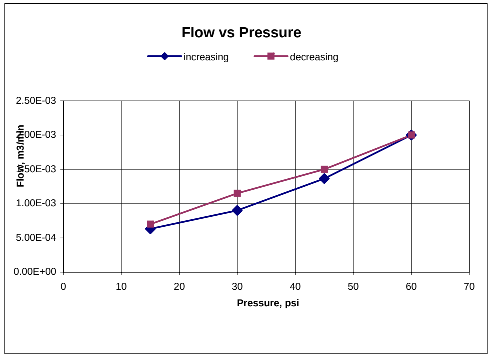
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.3459	
1	13.3463	4.00E-04
2	13.3471	8.50E-04
3	13.3477	6.00E-04
4	13.3484	7.00E-04
5	13.3491	6.50E-04
6	13.3498	7.00E-04
7	13.3505	7.50E-04
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 135.43
Bottom (m): 132.38

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	6.33E-04	1.51E-05
30	9.00E-04	1.21E-05
45	1.37E-03	1.45E-05
60	2.00E-03	1.63E-05
45	1.50E-03	1.57E-05
30	1.15E-03	1.57E-05
15	7.00E-04	1.51E-05



Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 13.72
Length of Test Section: 3.05

Depth, top of bottom of packer: 16.76
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.4234	
1	13.4240	6.50E-04
2	13.4243	3.00E-04
3	13.4247	4.00E-04
4	13.4250	2.50E-04
5	13.4250	5.00E-05
6	13.4251	5.00E-05
7	13.4251	5.00E-05
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.4273	
1	13.4276	2.50E-04
2	13.4277	1.00E-04
3	13.4278	1.00E-04
4	13.4279	1.00E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.4289	
1	13.4292	3.00E-04
2	13.4295	3.00E-04
3	13.4297	2.00E-04
4	13.4299	1.50E-04
5	13.4301	2.50E-04
6	13.4303	2.00E-04
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	13.4311	
1	13.4315	4.00E-04
2	13.4318	2.50E-04
3	13.4321	3.00E-04
4	13.4325	4.00E-04
5	13.4327	2.50E-04
6	13.4330	2.50E-04
7	13.4334	4.00E-04
8	13.4337	3.00E-04
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.4334	
1	13.4334	0.00E+00
2	13.4336	1.50E-04
3	13.4337	1.50E-04
4	13.4339	1.50E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.4332	
1	13.4332	0.00E+00
2	13.4333	5.00E-05
3	13.4334	1.50E-04
4	13.4336	1.50E-04
5	13.4337	1.50E-04
6		
7		
8		
9		
10		

Comments

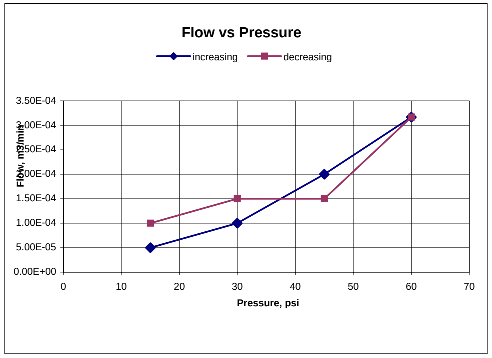
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.4322	
1	13.4322	0.00E+00
2	13.4323	1.00E-04
3	13.4324	1.00E-04
4	13.4325	1.00E-04
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 138.47
Bottom (m): 135.43

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	5.00E-05	9.06E-07
30	1.00E-04	1.71E-06
45	2.00E-04	1.81E-06
60	3.17E-04	2.82E-06
45	1.50E-04	1.51E-06
30	1.50E-04	2.01E-06
15	1.00E-04	2.42E-06



Project No: 08360
Date: 06-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 10.67
Length of Test Section: 3.05

Depth, top of bottom of packer: 13.72
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.5316	
1	13.5306	-9.50E-04
2	13.5313	6.50E-04
3	13.5314	1.50E-04
4	13.5316	2.00E-04
5	13.5318	1.50E-04
6	13.5320	2.50E-04
7	13.5322	2.00E-04
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.5360	
1	13.5362	2.00E-04
2	13.5365	3.00E-04
3	13.5367	2.00E-04
4	13.5369	2.00E-04
5	13.5371	2.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.5388	
1	13.5392	4.00E-04
2	13.5396	4.00E-04
3	13.5398	2.00E-04
4	13.5402	4.00E-04
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	13.5414	
1	13.5418	4.00E-04
2	13.5423	5.50E-04
3	13.5428	4.50E-04
4	13.5433	5.00E-04
5	13.5438	5.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	13.5436	
1	13.5439	2.50E-04
2	13.5443	4.50E-04
3	13.5447	3.50E-04
4	13.5450	3.50E-04
5	13.5454	3.50E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	13.5447	
1	13.5447	2.00E-05
2	13.5458	1.05E-03
3	13.5458	3.00E-05
4	13.5461	2.50E-04
5	13.5463	2.50E-04
6		
7		
8		
9		
10		

Comments

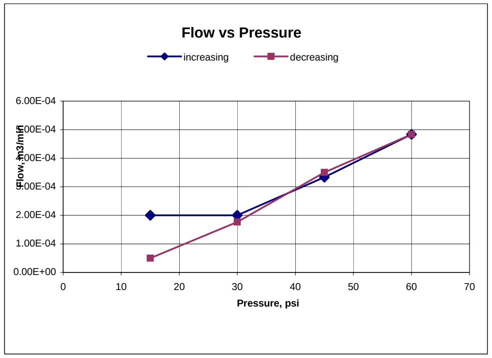
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	13.5453	
1	13.5453	0.00E+00
2	13.5454	5.00E-05
3	13.5454	5.00E-05
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 141.52
Bottom (m): 138.47

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.00E-04	4.03E-06
30	2.00E-04	2.82E-06
45	3.33E-04	3.72E-06
60	4.83E-04	4.23E-06
45	3.50E-04	3.72E-06
30	1.77E-04	2.82E-06
15	5.00E-05	8.25E-07



Project No: 08360
Date: 09-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: **152.19** m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 7.62
Length of Test Section: 3.05

Depth, top of bottom of packer: 10.67
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	14.2080	
1	14.3330	1.25E-01
2	14.4470	1.14E-01
3	14.5680	1.21E-01
4	14.6940	1.26E-01
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	14.9800	
1	15.1430	1.63E-01
2	15.3060	1.63E-01
3	15.4710	1.65E-01
4	15.6390	1.68E-01
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	15.8400	
1	15.0400	-8.00E-01
2	15.2350	1.95E-01
3	15.4350	2.00E-01
4	15.6370	2.02E-01
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0		
1		0.00E+00
2		0.00E+00
3		0.00E+00
4		0.00E+00
5		0.00E+00
6		0.00E+00
7		0.00E+00
8		0.00E+00
9		0.00E+00
10		0.00E+00

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0		
1		0.00E+00
2		0.00E+00
3		0.00E+00
4		0.00E+00
5		0.00E+00
6		0.00E+00
7		0.00E+00
8		0.00E+00
9		0.00E+00
10		0.00E+00

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	16.7100	
1	16.8900	1.80E-01
2	17.0680	1.78E-01
3	17.2420	1.74E-01
4	17.4170	1.75E-01
5		
6		
7		
8		
9		
10		

Comments stopped at 45 as one test takes full tanker of water

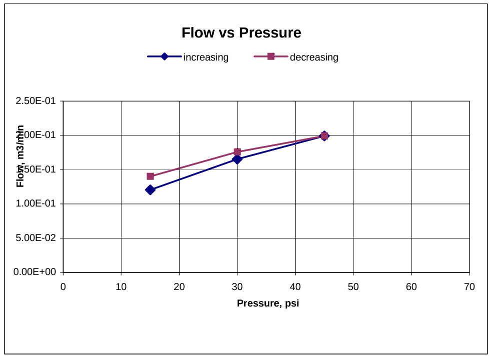
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	17.5500	
1	17.6920	1.42E-01
2	17.8300	1.38E-01
3	17.9700	1.40E-01
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 144.57
Bottom (m): 141.52

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.20E-01	2.62E-03
30	1.65E-01	2.42E-03
45	1.99E-01	2.21E-03
30	1.76E-01	2.62E-03
15	1.40E-01	3.02E-03



Project No: 08360
Date: 09-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19 m ASL

Borehole Depth: 31.09
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 4.57
Length of Test Section: 3.05

Depth, top of bottom of packer: 7.62
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	18.1900	
1	18.3020	0.11
2	18.4040	0.10
3	18.5050	0.10
4	18.6020	0.10
5	18.6970	0.09
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	18.9500	
1	19.0980	0.15
2	19.2430	0.15
3	19.3850	0.14
4	19.5290	0.14
5	19.6710	0.14
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	19.7800	
1	19.9560	0.18
2	20.1120	0.16
3	20.2780	0.17
4	20.4290	0.15
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	20.6000	
1	20.7460	0.15
2	20.8920	0.15
3	21.0380	0.15
4		
5		
6		
7		
8		
9		
10		

Comments stopped at 45 as one test takes full tanker of water

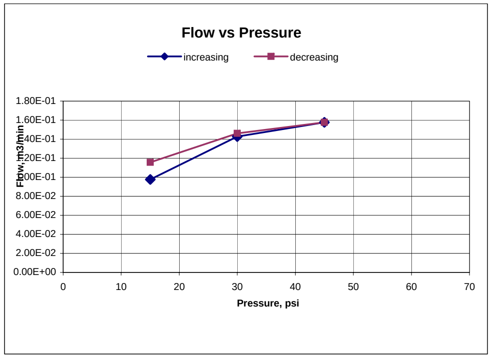
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	21.1200	
1	21.2370	0.12
2	21.3530	0.12
3	21.4670	0.11
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 147.62
Bottom (m): 144.57

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	9.77E-02	5.03E-03
30	1.43E-01	2.01E-03
45	1.58E-01	1.61E-03
30	1.46E-01	2.01E-03
15	1.16E-01	2.52E-03



Project No: 08360
Date: 09-Feb-09

Drillers: All-Terrain Drilling, Darren & Chris
Representing GRI: GAG

Test Hole No: 9-1
Surface Elevation: 152.19

Borehole Depth: **31.09**
Radius of Borehole (m): 0.0379
Water Level: 9.62

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 1.68
Length of Test Section: 2.90

Depth, top of bottom of packer: 4.57
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	21.5492	
1	21.5506	1.40E-03
2	21.5518	1.20E-03
3	21.5530	1.20E-03
4	21.5542	1.20E-03
5		
6		
7		
8		
9		
10		

Test No. Test No.
Pressure: 30

Time (min)	Flow Meter	Diff.
0	21.5588	
1	21.5616	2.80E-03
2	21.5652	3.60E-03
3	21.5688	3.60E-03
4	21.5721	3.25E-03
5		
6		
7		
8		
9		
10		

Test No. Test No.
Pressure: 45

Time (min)	Flow Meter	Diff.
0	21.5796	
1	21.5868	7.20E-03
2	21.5949	8.10E-03
3	21.6027	7.80E-03
4	21.6107	8.00E-03
5		
6		
7		
8		
9		
10		

Comments

Test No. Test No.
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.6190	
1	0.6337	1.47E-02
2	0.6474	1.37E-02
3	0.6637	1.63E-02
4	0.6799	1.62E-02
5	0.6974	1.75E-02
6		
7		
8		
9		
10		

Test No. Test No.
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.7160	
1	0.7291	1.31E-02
2	0.7418	1.27E-02
3	0.7542	1.24E-02
4	0.7668	1.26E-02
5		
6		
7		
8		
9		
10		

Test No. Test No.
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.7730	
1	0.7812	8.20E-03
2	0.7890	7.80E-03
3	0.7968	7.75E-03
4	0.8042	7.45E-03
5		
6		
7		
8		
9		
10		

Comments

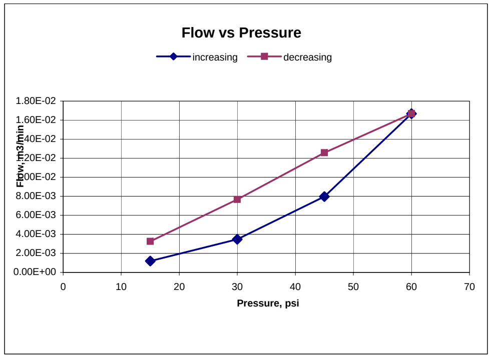
Test No. Test No.
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.8150	
1	0.8187	3.70E-03
2	0.8220	3.30E-03
3	0.8253	3.30E-03
4	0.8285	3.20E-03
5		
6		
7		
8		
9		
10		

Test Hole No: 9-1

Test Interval
Top (m): 150.51
Bottom (m): 147.62

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.20E-03	2.62E-05
30	3.48E-03	4.63E-05
45	7.97E-03	8.05E-05
60	1.67E-02	1.41E-04
45	1.26E-02	1.25E-04
30	7.67E-03	1.01E-04
15	3.27E-03	6.04E-05



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.32
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 13.72
Length of Test Section: 1.60

Depth, top of bottom of packer: 15.32
Length of Packer: 1.60

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	21.83060	
1	21.83095	3.50E-04
2	21.83150	5.50E-04
3	21.83230	8.00E-04
4	21.83230	0.00E+00
5	21.83230	0.00E+00
6	21.83230	0.00E+00
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.83295	
1	0.83335	4.00E-04
2	0.83365	3.00E-04
3	0.83410	4.50E-04
4	0.83445	3.50E-04
5	0.83470	2.50E-04
6	0.83495	2.50E-04
7	0.83520	2.50E-04
8	0.83545	2.50E-04
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.83625	
1	0.83665	4.00E-04
2	0.83710	4.50E-04
3	0.83765	5.50E-04
4	0.83810	4.50E-04
5	0.83865	5.50E-04
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.83860	
1	0.83940	8.00E-04
2	0.84010	7.00E-04
3	0.84080	7.00E-04
4	0.84150	7.00E-04
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.84175	
1	1.44175	6.00E-01
2	1.94175	5.00E-01
3	2.59175	6.50E-01
4	3.14175	5.50E-01
5	3.69175	5.50E-01
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.85515	
1	0.85530	1.50E-04
2	0.85565	3.50E-04
3	0.85595	3.00E-04
4	0.85630	3.50E-04
5	0.85665	3.50E-04
6		
7		
8		
9		
10		

Comments

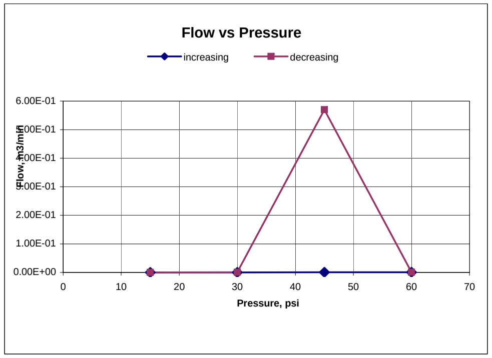
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.85675	
1	0.85695	2.00E-04
2	0.85720	2.50E-04
3	0.85740	2.00E-04
4	0.85755	1.50E-04
5	0.85755	0.00E+00
6	0.85755	0.00E+00
7	0.85755	0.00E+00
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 132.02
Bottom (m): 130.42

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	2.50E-04	1.09E-05
45	5.17E-04	1.25E-05
60	7.00E-04	1.41E-05
45	5.70E-01	data error
30	3.38E-04	1.41E-05
15	0.00E+00	0.00E+00



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Borehole Depth: 15.33

Test Hole No: 10-1
Surface Elevation: 145.74

Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 12.19
Length of Test Section: 3.05

Depth, top of bottom of packer: 15.24
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.04865	
1	0.04865	0.00E+00
2	0.04865	0.00E+00
3	0.04865	0.00E+00
4	0.04865	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.04960	
1	0.04985	2.50E-04
2	0.05025	4.00E-04
3	0.05060	3.50E-04
4	0.05080	2.00E-04
5	0.05115	3.50E-04
6	0.05145	3.00E-04
7	0.05175	3.00E-04
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.05240	
1	0.05285	4.50E-04
2	0.05330	4.50E-04
3	0.05375	4.50E-04
4		
5		
6		
7		
8		
9		
10		

Comments flows higher, meter read to .xxx places

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.05450	
1	0.05510	6.00E-04
2	0.05575	6.50E-04
3	0.05640	6.50E-04
4	0.05695	5.50E-04
5	0.05760	6.50E-04
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.05790	
1	0.05845	5.50E-04
2	0.05885	4.00E-04
3	0.05940	5.50E-04
4	0.05980	4.00E-04
5	0.06030	5.00E-04
6	0.06075	4.50E-04
7	0.06125	5.00E-04
8	0.06175	5.00E-04
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.06175	
1	0.06200	2.50E-04
2	0.06235	3.50E-04
3	0.06265	3.00E-04
4	0.06290	2.50E-04
5	0.06320	3.00E-04
6	0.06355	3.50E-04
7		
8		
9		
10		

Comments

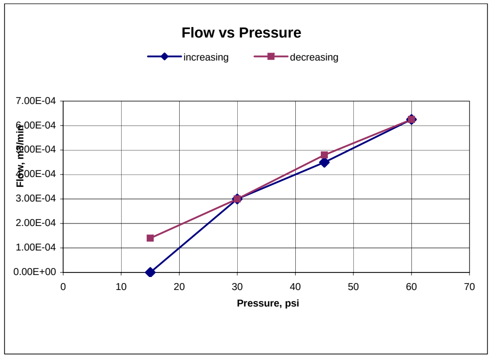
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.06360	
1	0.06365	5.00E-05
2	0.06375	1.00E-04
3	0.06385	1.00E-04
4	0.06410	2.50E-04
5	0.06430	2.00E-04
6		
7		
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 133.55
Bottom (m): 130.50

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	3.00E-04	0.00E+00
45	4.50E-04	6.24E-06
60	6.25E-04	6.04E-06
45	4.80E-04	6.64E-06
30	3.00E-04	6.04E-06
15	1.40E-04	8.05E-06



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.33
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 9.14
Length of Test Section: 3.05

Depth, top of bottom of packer: 12.19
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.06975	
1	0.07040	6.50E-04
2	0.07050	1.00E-04
3	0.07055	5.00E-05
4	0.07060	5.00E-05
5	0.07060	0.00E+00
6	0.07060	0.00E+00
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.87200	
1	0.87245	4.50E-04
2	0.87250	5.00E-05
3	0.87250	0.00E+00
4	0.87250	0.00E+00
5	0.87250	0.00E+00
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.87270	
1	0.87270	0.00E+00
2	0.87270	0.00E+00
3	0.87270	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.87280	
1	0.87285	5.00E-05
2	0.87290	5.00E-05
3	0.87295	5.00E-05
4	0.87295	0.00E+00
5	0.87295	0.00E+00
6	0.87295	0.00E+00
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.87295	
1	0.87295	0.00E+00
2	0.87295	0.00E+00
3	0.87295	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.87295	
1	0.87295	0.00E+00
2	0.87295	0.00E+00
3	0.87295	0.00E+00
4	0.87295	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

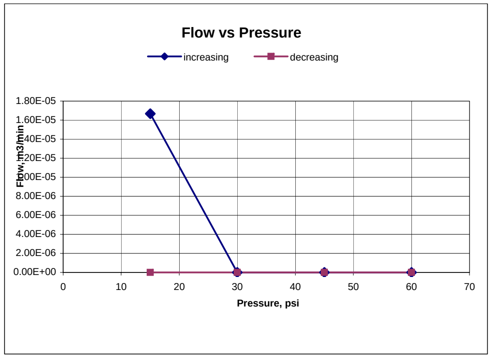
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.87260	
1	0.87260	0.00E+00
2	0.87260	0.00E+00
3	0.87260	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 136.60
Bottom (m): 133.55

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.67E-05	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.33
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 6.10
Length of Test Section: 3.05

Depth, top of bottom of packer: 9.14
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.87510	
1	0.87510	0.00E+00
2	0.87510	0.00E+00
3	0.87510	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.87540	
1	0.87545	5.00E-05
2	0.87545	0.00E+00
3	0.87545	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.87555	
1	0.87555	0.00E+00
2	0.87555	0.00E+00
3	0.87555	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.87560	
1	0.87565	5.00E-05
2	0.87570	5.00E-05
3	0.87570	0.00E+00
4	0.87570	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.87570	
1	0.87570	0.00E+00
2	0.87570	0.00E+00
3	0.87570	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.87570	
1	0.87570	0.00E+00
2	0.87565	-5.00E-05
3	0.87565	0.00E+00
4	0.87565	0.00E+00
5		
6		
7		
8		
9		
10		

Comments flow reversed in test 2r

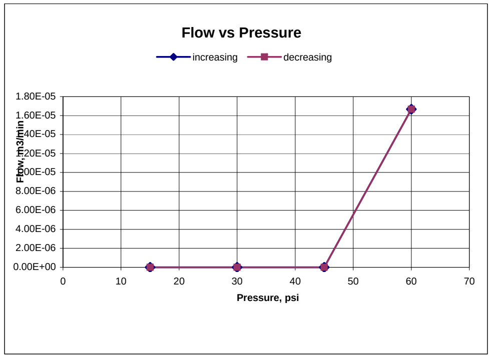
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.87545	
1	0.87545	0.00E+00
2	0.87545	0.00E+00
3	0.87545	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 139.64
Bottom (m): 136.60

Pressure	Flow	K
(psi)	(m^3/min)	(cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	1.67E-05	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.33
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 3.05
Length of Test Section: 3.05

Depth, top of bottom of packer: 6.10
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.09600	
1	0.09950	3.50E-03
2	0.10270	3.20E-03
3	0.10585	3.15E-03
4	0.10895	3.10E-03
5	0.11225	3.30E-03
6	0.11550	3.25E-03
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.11900	
1	0.12390	4.90E-03
2	0.12855	4.65E-03
3	0.13325	4.70E-03
4	0.13780	4.55E-03
5	0.14255	4.75E-03
6	0.14710	4.55E-03
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.15100	
1	0.15870	7.70E-03
2	0.16670	8.00E-03
3	0.17515	8.45E-03
4	0.18445	9.30E-03
5	0.19380	9.35E-03
6	0.20355	9.75E-03
7	0.21315	9.60E-03
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.22300	
1	0.23915	1.62E-02
2	0.25780	1.87E-02
3	0.28200	2.42E-02
flow increase:		
0	0.345	
1	0.404	5.90E-02
2	0.468	6.40E-02
3	0.530	6.20E-02
4	0.588	5.80E-02

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.633	
1	0.680	4.70E-02
2	0.728	4.80E-02
3	0.782	5.40E-02
4	0.840	5.80E-02
5	0.901	6.10E-02
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.947	
1	0.993	4.60E-02
2	1.043	5.00E-02
3	1.095	5.20E-02
4	1.150	5.50E-02
5		
6		
7		
8		
9		
10		

Comments

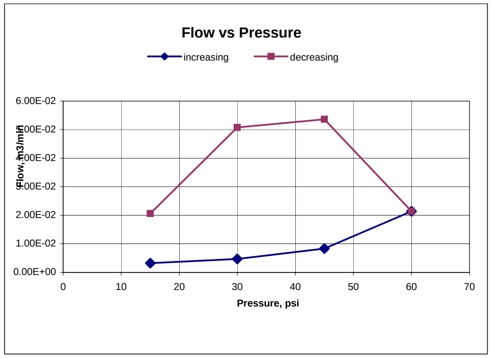
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.1730	
1	0.1948	2.18E-02
2	0.2148	2.00E-02
3	0.2348	2.00E-02
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 142.69
Bottom (m): 139.64

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	3.25E-03	1.23E-04
30	4.70E-03	1.01E-04
45	8.36E-03	1.09E-04
60	2.14E-02	2.01E-04
45	5.36E-02	7.25E-05
30	5.08E-02	1.05E-04
15	2.06E-02	9.86E-04



Project No: 8360
Date: 18-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 10-1
Surface Elevation: 145.74

Borehole Depth: 15.33
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 0.91
Length of Test Section: 3.05

Depth, top of bottom of packer: 3.96
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.6460	
1	0.6513	5.30E-03
2	0.6563	5.00E-03
3	0.6612	4.90E-03
4	0.6659	4.70E-03
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.6740	
1	0.6887	1.47E-02
2	0.7030	1.43E-02
3	0.7179	1.49E-02
4	0.7332	1.53E-02
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.754	
1	0.786	3.20E-02
2	0.822	3.60E-02
3	0.863	4.10E-02
4	0.912	4.90E-02
5	0.968	5.60E-02
6	1.032	6.40E-02
7	1.107	7.50E-02
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	0.225	
1	0.355	1.30E-01
2	0.500	1.45E-01
3	0.675	1.75E-01
4	0.855	1.80E-01
5	1.043	1.88E-01
6	1.230	1.87E-01
7	1.422	1.92E-01
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	0.550	
1	0.734	1.84E-01
2	0.914	1.80E-01
3	1.097	1.83E-01
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	0.213	
1	0.302	8.90E-02
2	0.394	9.20E-02
3	0.488	9.40E-02
4	0.588	1.00E-01
5		
6		
7		
8		
9		
10		

Comments

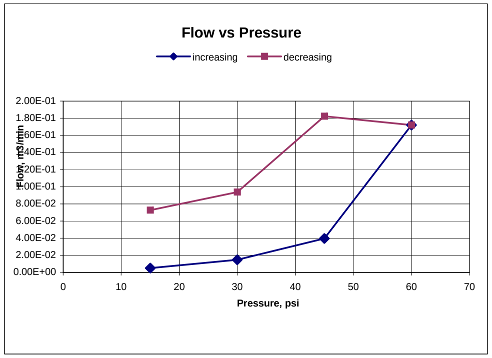
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	0.664	
1	0.737	7.30E-02
2	0.810	7.30E-02
3	0.882	7.20E-02
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 10-1

Test Interval
Top (m): 144.83
Bottom (m): 141.78

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	4.98E-03	2.01E-04
30	1.48E-02	3.02E-04
45	3.95E-02	5.84E-04
60	1.72E-01	1.61E-03
45	1.82E-01	0.00E+00
30	9.38E-02	1.87E-03
15	7.27E-02	3.02E-03



Project No: 8260
Date: 20-Feb-09

Drillers: All Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81

Borehole Depth: 29.08
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0

Depth, bottom of top of packer: 1.52
Length of Test Section: 3.05

Depth, top of bottom of packer: 4.57
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.60585	
1	35.60610	0.00025
2	35.60635	0.00025
3	35.60660	0.00025
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.60715	
1	35.60735	0.00020
2	35.60755	0.00020
3	35.60770	0.00015
4	35.60780	0.00010
5	35.60795	0.00015
6	35.60810	0.00015
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.60825	
1	35.60840	0.00015
2	35.60855	0.00015
3	35.60865	0.00010
4	35.60875	0.00010
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.60890	
1	35.60900	0.00010
2	35.60915	0.00015
3	35.60930	0.00015
4	35.60940	0.00010
5	35.60955	0.00015
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.60955	
1	35.60965	0.00010
2	35.60970	0.00005
3	35.60980	0.00010
4	35.60985	0.00005
5	35.60995	0.00010
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.60995	
1	35.60995	0.00000
2	35.60995	0.00000
3	35.60995	0.00000
4	35.60995	0.00000
5		
6		
7		
8		
9		
10		

Comments

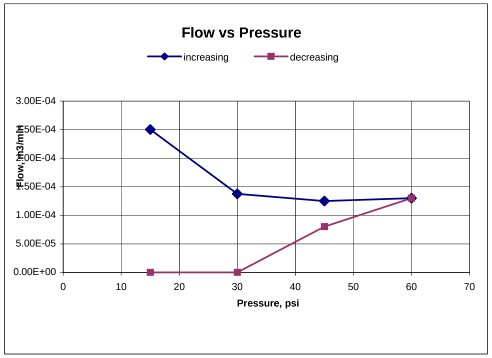
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.60985	
1	35.60985	0.00000
2	35.60985	0.00000
3	35.60985	0.00000
4	35.60985	0.00000
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 141.29
Bottom (m): 138.24

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.50E-04	1.01E-05
30	1.37E-04	3.02E-06
45	1.25E-04	1.61E-06
60	1.30E-04	1.41E-06
45	8.00E-05	9.06E-07
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 4.57
Length of Test Section: 3.05

Depth, top of bottom of packer: 7.62
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.69615	
1	35.69620	5.00E-05
2	35.69625	5.00E-05
3	35.69640	1.50E-04
4	35.69655	1.50E-04
5	35.69670	1.50E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.69715	
1	35.69735	2.00E-04
2	35.69755	2.00E-04
3	35.69775	2.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.69800	
1	35.69830	3.00E-04
2	35.69855	2.50E-04
3	35.69875	2.00E-04
4	35.69890	1.50E-04
5	35.69910	2.00E-04
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.69950	
1	35.69975	2.50E-04
2	35.70000	2.50E-04
3	35.70030	3.00E-04
4	35.70060	3.00E-04
5	35.70085	2.50E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.70085	
1	35.70105	2.00E-04
2	35.70130	2.50E-04
3	35.70155	2.50E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.70160	
1	35.70165	5.00E-05
2	35.70175	1.00E-04
3	35.70185	1.00E-04
4	35.70195	1.00E-04
5		
6		
7		
8		
9		
10		

Comments

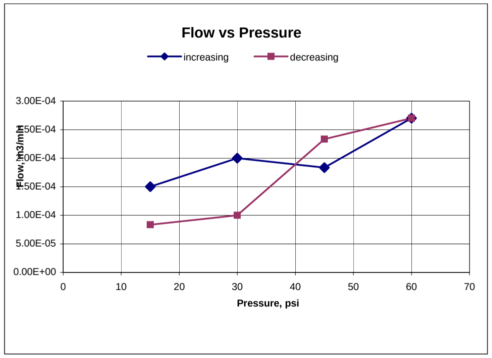
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.70185	
1	35.70190	5.00E-05
2	35.70200	1.00E-04
3	35.70210	1.00E-04
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 138.24
Bottom (m): 135.19

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.50E-04	7.45E-06
30	2.00E-04	4.63E-06
45	1.83E-04	3.22E-06
60	2.70E-04	2.82E-06
45	2.33E-04	3.22E-06
30	1.00E-04	2.42E-06
15	8.33E-05	3.22E-06



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Borehole Depth: 29.08
Test Hole No: 11-1
Radius of Borehole (m): 0.0379
Ht Press. Gauge, above G.S: 0.6
Surface Elevation: 142.81 m ASL
Water Level: 0
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 7.62
Length of Test Section: 3.05
Depth, top of bottom of packer: 10.67
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.25010	
1	35.25015	5.00E-05
2	35.25025	1.00E-04
3	35.25035	1.00E-04
4	35.25040	5.00E-05
5	35.25045	5.00E-05
6	35.25055	1.00E-04
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.25075	
1	35.25090	1.50E-04
2	35.25100	1.00E-04
3	35.25120	2.00E-04
4	35.25135	1.50E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.25160	
1	35.25180	2.00E-04
2	35.25200	2.00E-04
3	35.25220	2.00E-04
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.25250	
1	35.25280	3.00E-04
2	35.25320	4.00E-04
3	35.25360	4.00E-04
4	35.25390	3.00E-04
5	35.25430	4.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.25445	
1	35.25475	3.00E-04
2	35.25500	2.50E-04
3	35.25535	3.50E-04
4	35.25565	3.00E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.25570	
1	35.25580	1.00E-04
2	35.25590	1.00E-04
3	35.25610	2.00E-04
4	35.25625	1.50E-04
5	35.25640	1.50E-04
6		
7		
8		
9		
10		

Comments

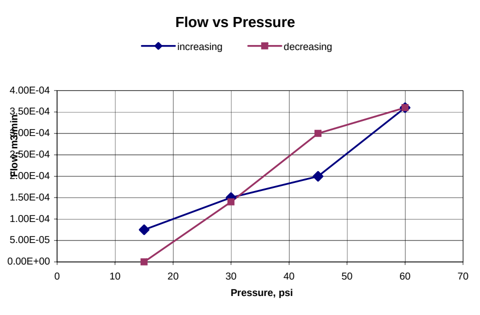
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.25645	
1	35.25645	0.00E+00
2	35.25645	0.00E+00
3	35.25645	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 135.19
Bottom (m): 132.14

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	7.50E-05	3.02E-06
30	1.50E-04	3.02E-06
45	2.00E-04	1.81E-06
60	3.60E-04	4.23E-06
45	3.00E-04	4.23E-06
30	1.40E-04	3.02E-06
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 10.67
Length of Test Section: 3.05

Depth, top of bottom of packer: 13.72
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.60255	
1	35.60255	0.00E+00
2	35.60255	0.00E+00
3	35.60255	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.60275	
1	35.60285	1.00E-04
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5	35.60285	0.00E+00
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

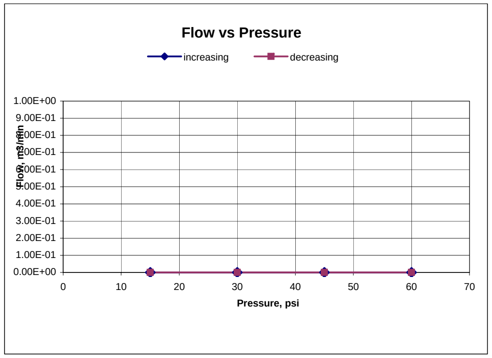
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.60285	
1	35.60285	0.00E+00
2	35.60285	0.00E+00
3	35.60285	0.00E+00
4	35.60285	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 132.14
Bottom (m): 129.09

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 13.72
Length of Test Section: 3.05

Depth, top of bottom of packer: 16.76
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.57650	
1	32.57910	2.60E-03
2	32.58165	2.55E-03
3	32.58380	2.15E-03
4	32.58605	2.25E-03
5	32.58815	2.10E-03
6	32.59045	2.30E-03
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.59550	
1	32.60185	6.35E-03
2	32.60750	5.65E-03
3	32.61275	5.25E-03
4	32.61790	5.15E-03
5	32.62290	5.00E-03
6	32.62780	4.90E-03
7	32.63250	4.70E-03
8	32.63720	4.70E-03
9	32.64170	4.50E-03
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.64800	
1	32.65580	7.80E-03
2	32.66300	7.20E-03
3	32.67000	7.00E-03
4	32.67680	6.80E-03
5	32.68365	6.85E-03
6	32.69005	6.40E-03
7	32.69660	6.55E-03
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	32.73000	
1	32.73560	5.60E-03
2	32.74120	5.60E-03
3	32.74680	5.60E-03
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.75100	
1	32.75500	4.00E-03
2	32.75900	4.00E-03
3	32.76300	4.00E-03
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.76600	
1	32.76865	2.65E-03
2	32.77130	2.65E-03
3	32.77390	2.60E-03
4		
5		
6		
7		
8		
9		
10		

Comments

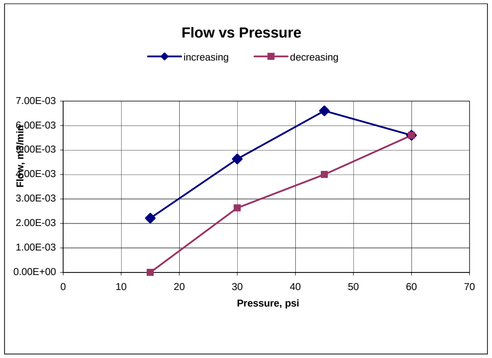
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.77670	
1	32.77770	1.00E-03
2	32.77775	5.00E-05
3	32.77775	0.00E+00
4	32.77775	0.00E+00
5	32.77775	0.00E+00
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 129.09
Bottom (m): 126.05

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.22E-03	8.25E-05
30	4.63E-03	1.05E-04
45	6.60E-03	8.05E-05
60	5.60E-03	5.53E-05
45	4.00E-03	5.64E-05
30	2.63E-03	5.23E-05
15	0.00E+00	0.00E+00



Gorrell Resource Investigations

Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 16.76
Length of Test Section: 3.05

Depth, top of bottom of packer: 19.81
Length of Packer: 3.05

Test No.:
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.32240	
1	32.32275	3.50E-04
2	32.32325	5.00E-04
3	32.32370	4.50E-04
4	32.32410	4.00E-04
5	32.32460	5.00E-04
6	32.32400	
7	32.32445	4.50E-04
8	32.32485	4.00E-04
9		
10		

Test No.: 0
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.32750	
1	32.32850	1.00E-03
2	32.32940	9.00E-04
3	32.33025	8.50E-04
4	32.33110	8.50E-04
5	32.33195	8.50E-04
6		
7		
8		
9		
10		

Test No.: 0
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.33330	
1	32.33460	1.30E-03
2	32.33580	1.20E-03
3	32.33700	1.20E-03
4	32.33725	2.50E-04
5	32.33725	0.00E+00
6	32.33725	0.00E+00
7	32.33725	0.00E+00
8		
9		
10		

Comments

Test No.: 0
Pressure: 60

Time (min)	Flow Meter	Diff.
0	32.33725	
1	32.33725	0.00E+00
2	32.33725	0.00E+00
3	32.33725	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No.: 0
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.33725	
1	32.33725	0.00E+00
2	32.33725	0.00E+00
3	32.33725	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No.: 0
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.33725	
1	32.33725	0.00E+00
2	32.33725	0.00E+00
3	32.33725	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

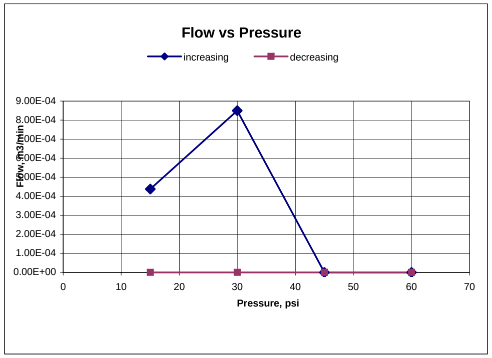
Test No.: 0
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.33720	
1	32.33720	0.00E+00
2	32.33720	0.00E+00
3	32.33720	0.00E+00
4	32.33720	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 126.05
Bottom (m): 123.00

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	4.37E-04	1.61E-05
30	8.50E-04	1.61E-05
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 19.81
Length of Test Section: 3.05

Depth, top of bottom of packer: 22.86
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.18675	
1	32.18680	5.00E-05
2	32.18685	5.00E-05
3	32.18690	5.00E-05
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.18745	
1	32.18760	1.50E-04
2	32.18770	1.00E-04
3	32.18790	2.00E-04
4	32.18805	1.50E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.18835	
1	32.18845	1.00E-04
2	32.18845	0.00E+00
3	32.18845	0.00E+00
4	32.18845	0.00E+00
5	32.18845	0.00E+00
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	32.18865	
1	32.18875	1.00E-04
2	32.18875	0.00E+00
3	32.18895	2.00E-04
4	32.18920	2.50E-04
5	32.18945	2.50E-04
6	32.18970	2.50E-04
7		
8		
9		
610		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	32.18975	
1	32.18990	1.50E-04
2	32.18990	0.00E+00
3	32.18990	0.00E+00
4	32.18990	0.00E+00
5	32.18990	0.00E+00
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	32.18990	
1	32.18990	0.00E+00
2	32.18990	0.00E+00
3	32.18990	0.00E+00
4	32.18990	0.00E+00
5	32.18990	0.00E+00
6		
7		
8		
9		
10		

Comments

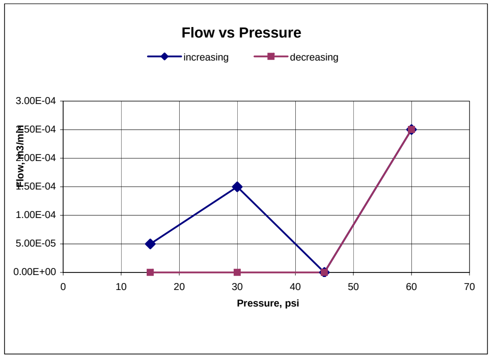
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	32.18990	
1	32.18990	0.00E+00
2	32.18990	0.00E+00
3	32.18990	0.00E+00
4	32.18990	0.00E+00
5	32.18990	0.00E+00
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 123.00
Bottom (m): 119.95

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	5.00E-05	1.61E-06
30	1.50E-04	3.02E-06
45	0.00E+00	0.00E+00
60	2.50E-04	2.82E-06
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 20-Feb-09

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 22.86
Length of Test Section: 3.05

Depth, top of bottom of packer: 25.91
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	30.16545	
1	30.16575	3.00E-04
2	30.16600	2.50E-04
3	30.16630	3.00E-04
4	30.16650	2.00E-04
5	30.16670	2.00E-04
6	30.16685	1.50E-04
7	30.16705	2.00E-04
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	30.16760	
1	30.16790	3.00E-04
2	30.16820	3.00E-04
3	30.16855	3.50E-04
4	30.16885	3.00E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	30.16940	
1	30.17000	6.00E-04
2	30.17065	6.50E-04
3	30.17125	6.00E-04
4	30.17185	6.00E-04
5		
6		
7		
8		
9		
10		

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	30.17250	
1	30.17325	7.50E-04
2	30.17395	7.00E-04
3	30.17475	8.00E-04
4	30.17545	7.00E-04
5	30.17615	7.00E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	30.17670	
1	30.17730	6.00E-04
2	30.17790	6.00E-04
3	30.17850	6.00E-04
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	30.17880	
1	30.17930	5.00E-04
2	30.17975	4.50E-04
3	30.18020	4.50E-04
4	30.18070	5.00E-04
5	30.18115	4.50E-04
6		
7		
8		
9		
10		

Comments

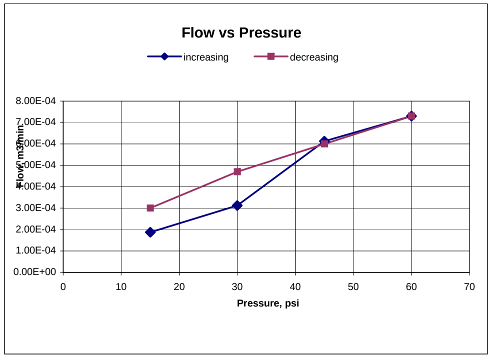
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	30.18130	
1	30.18155	2.50E-04
2	30.18185	3.00E-04
3	30.18220	3.50E-04
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 119.95
Bottom (m): 116.90

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.88E-04	7.25E-06
30	3.12E-04	6.24E-06
45	6.12E-04	7.45E-06
60	7.30E-04	7.04E-06
45	6.00E-04	7.45E-06
30	4.70E-04	0.00E+00
15	3.00E-04	0.00E+00



Project No: 08360
Date: 00-Jan-00

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 25.91
Length of Test Section: 3.05

Depth, top of bottom of packer: 28.96
Length of Packer: 3.05

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	30.16030	
1	30.16045	1.50E-04
2	30.16050	5.00E-05
3	30.16060	1.00E-04
4	30.16060	0.00E+00
5	30.16060	0.00E+00
6	30.16070	1.00E-04
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	30.16085	
1	30.16095	1.00E-04
2	30.16110	1.50E-04
3	30.16120	1.00E-04
4	30.16120	0.00E+00
5	30.16120	0.00E+00
6	30.16120	0.00E+00
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	30.16145	
1	30.16150	5.00E-05
2	30.16150	0.00E+00
3	30.16160	1.00E-04
4	30.16175	1.50E-04
5	30.16190	1.50E-04
6	30.16210	2.00E-04
7	30.16210	0.00E+00
8	30.16210	0.00E+00
9	30.16230	2.00E-04
10	30.16245	1.50E-04

Comments

Test No. 1
Pressure: 60

Time (min)	Flow Meter	Diff.
0	30.16265	
1	30.16290	2.50E-04
2	30.16320	3.00E-04
3	30.16350	3.00E-04
4	30.16375	2.50E-04
5	30.16400	2.50E-04
6		
7		
8		
9		
10		

Test No. 1
Pressure: 45

Time (min)	Flow Meter	Diff.
0	30.16410	
1	30.16430	2.00E-04
2	30.16455	2.50E-04
3	30.16475	2.00E-04
4	30.16495	2.00E-04
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure: 30

Time (min)	Flow Meter	Diff.
0	30.16500	
1	30.16515	1.50E-04
2	30.16515	0.00E+00
3	30.16515	0.00E+00
4	30.16515	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

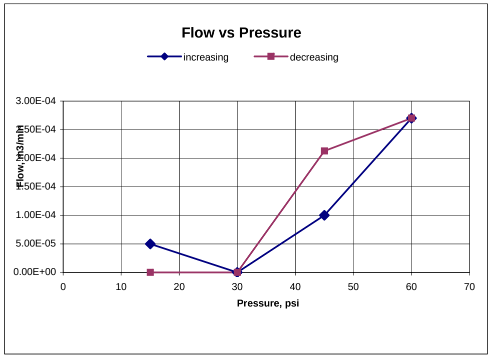
Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	30.16515	
1	30.16515	0.00E+00
2	30.16515	0.00E+00
3	30.16515	0.00E+00
4	30.16515	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 116.90
Bottom (m): 113.85

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	5.00E-05	1.71E-06
30	0.00E+00	0.00E+00
45	1.00E-04	1.51E-06
60	2.70E-04	2.82E-06
45	2.12E-04	3.22E-06
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 08360
Date: 00-Jan-00

Drillers: All-Terrain
Representing GRI: GAG

Test Hole No: 11-1
Surface Elevation: 142.81 m ASL

Borehole Depth: 29.08
Radius of Borehole (m): 0.0379
Water Level: 0

Ht Press. Gauge, above G.S: 0.6
Ht Water Swivel above G.S: 0.6

Depth, bottom of top of packer: 27.43
Length of Test Section: 1.65

Depth, top of bottom of packer: 29.08
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	29.94700	
1	29.94770	7.00E-04
2	29.94790	2.00E-04
3	29.94810	2.00E-04
4	29.94830	2.00E-04
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	29.94935	
1	29.94965	3.00E-04
2	29.94990	2.50E-04
3	29.95015	2.50E-04
4	29.95030	1.50E-04
5	29.95040	1.00E-04
6	29.95055	1.50E-04
7	29.95070	1.50E-04
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	29.95100	
1	29.95115	1.50E-04
2	29.95135	2.00E-04
3	29.95155	2.00E-04
4	29.95170	1.50E-04
5	29.95180	1.00E-04
6	29.95195	1.50E-04
7	29.95215	2.00E-04
8	29.95230	1.50E-04
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	29.95270	
1	29.95295	2.50E-04
2	29.95320	2.50E-04
3	29.95350	3.00E-04
4	29.95370	2.00E-04
5	29.95370	0.00E+00
6	29.95370	0.00E+00
7	29.95370	0.00E+00
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	29.95370	
1	29.95370	0.00E+00
2	29.95370	0.00E+00
3	29.95370	0.00E+00
4	29.95370	0.00E+00
5	29.95370	0.00E+00
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	29.95370	
1	29.95370	0.00E+00
2	29.95370	0.00E+00
3	29.95370	0.00E+00
4	29.95370	0.00E+00
5		
6		
7		
8		
9		
10		

Comments flow reversed between 2r and 1r

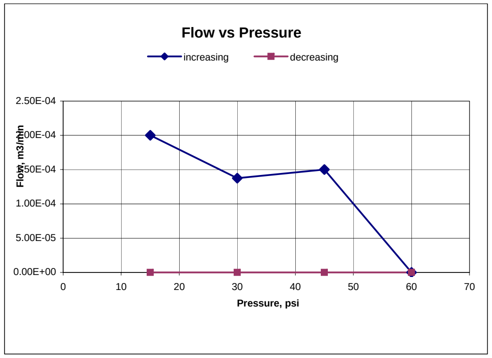
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	29.95350	
1	29.95350	0.00E+00
2	29.95350	0.00E+00
3	29.95350	0.00E+00
4	29.95350	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 11-1

Test Interval
Top (m): 115.38
Bottom (m): 113.73

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	2.00E-04	1.45E-05
30	1.38E-04	6.04E-06
45	1.50E-04	3.82E-06
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09
Drillers: all terrain
Representing GRI: GAG

Borehole Depth: 12.31
Test Hole No: 12-1
Radius of Borehole: 0
Ht Press. Gauge, above G.S: 0.7
Surface Elevation: 140.28
Water Level: 0
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 10.67
Depth, top of bottom of packer: 12.19
Length of Test Section: 1.52
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.6155	
1	35.6157	2.00E-04
2	35.6158	1.00E-04
3	35.6160	2.00E-04
4	35.6162	1.50E-04
5	35.6163	1.50E-04
6	35.6165	1.50E-04
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.61770	
1	35.61785	1.50E-04
2	35.61795	1.00E-04
3	35.61815	2.00E-04
4	35.61825	1.00E-04
5	35.61840	1.50E-04
6	35.61855	1.50E-04
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.61895	
1	35.61915	2.00E-04
2	35.61935	2.00E-04
3	35.61950	1.50E-04
4	35.61950	0.00E+00
5	35.61950	0.00E+00
6	35.61955	5.00E-05
7	35.61970	1.50E-04
8	35.61975	5.00E-05
9	35.61975	0.00E+00
10	35.61980	5.00E-05

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.62015	
1	35.62035	2.00E-04
2	35.62040	5.00E-05
3	35.62040	0.00E+00
4	35.62040	0.00E+00
5	35.62040	0.00E+00
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.62040	
1	35.62040	0.00E+00
2	35.62040	0.00E+00
3	35.62040	0.00E+00
4	35.62040	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.62025	
1	35.62025	0.00E+00
2	35.62025	0.00E+00
3	35.62025	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments flow reversed between 3r and 2r

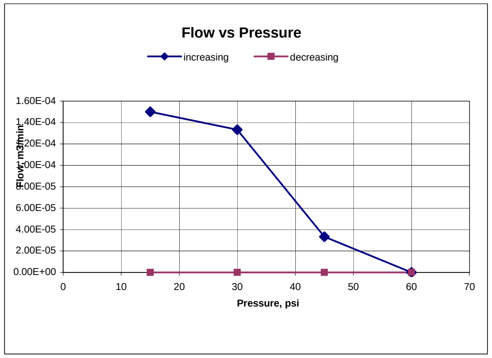
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.61975	
1	35.61975	0.00E+00
2	35.61975	0.00E+00
3	35.61975	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 129.61
Bottom (m): 128.09

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.50E-04	1.21E-05
30	1.33E-04	6.04E-06
45	3.33E-05	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09
Drillers: all terrain
Representing GRI: GAG

Test Hole No: 12-1
Surface Elevation: 140.28
Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0
Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 9.14
Length of Test Section: 1.52
Depth, top of bottom of packer: 10.67
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.6518	
1	35.6518	0.00E+00
2	35.6518	0.00E+00
3	35.6522	4.00E-04
4	35.6529	7.50E-04
5	35.6531	1.50E-04
6	35.6532	1.50E-04
7	35.6533	5.00E-05
8	35.6534	1.00E-04
9	35.6535	1.00E-04
10	35.6536	1.00E-04

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.5543	
1	35.5550	7.00E-04
2	35.5559	9.00E-04
3	35.5568	9.50E-04
4	35.5575	7.00E-04
5	35.5580	4.50E-04
6	35.5589	9.50E-04
7	35.5594	4.50E-04
8	35.5597	3.00E-04
9	35.5600	3.00E-04
10	35.5604	4.50E-04

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.5611	
1	35.5615	3.50E-04
2	35.5618	3.00E-04
3	35.5621	3.00E-04
4	35.5624	3.50E-04
5	35.5627	3.00E-04
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	35.5630	
1	35.5634	4.00E-04
2	35.5637	3.00E-04
3	35.5641	3.50E-04
4	35.5644	3.50E-04
5	35.5648	3.50E-04
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	35.5648	
1	35.5652	3.50E-04
2	35.5656	4.00E-04
3	35.5659	3.00E-04
4	35.5663	4.00E-04
5	35.5666	3.50E-04
6	35.5670	3.50E-04
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	35.5670	
1	35.5673	3.50E-04
2	35.5677	3.50E-04
3	35.5680	3.00E-04
4	35.5683	3.50E-04
5		
6		
7		
8		
9		
10		

Comments

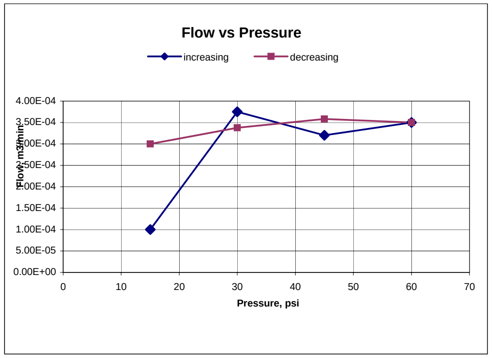
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	35.5684	
1	35.5685	1.00E-04
2	35.5688	2.50E-04
3	35.5691	3.00E-04
4	35.5694	3.00E-04
5	35.5697	3.00E-04
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 131.14
Bottom (m): 129.61

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.00E-04	9.26E-06
30	3.75E-04	1.65E-05
45	3.20E-04	8.05E-06
60	3.50E-04	6.44E-06
45	3.58E-04	9.26E-06
30	3.38E-04	1.49E-05
15	3.00E-04	2.42E-05



Project No: 8360
Date: 24-Feb-09

Drillers: all terrain
Representing GRI: GAG

Borehole Depth: 12.31
Test Hole No: 12-1
Radius of Borehole: 0
Ht Press. Gauge, above G.S: 0.7
Surface Elevation: 140.28
Water Level: 0
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 7.62
Depth, top of bottom of packer: 9.14
Length of Test Section: 1.52
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	37.56965	
1	37.56970	5.00E-05
2	37.56970	0.00E+00
3	37.56970	0.00E+00
4	37.56970	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	37.56995	
1	37.57000	5.00E-05
2	37.57000	0.00E+00
3	37.57000	0.00E+00
4	37.57000	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	37.57020	
1	37.57035	1.50E-04
2	37.57035	0.00E+00
3	37.57035	0.00E+00
4	37.57035	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	37.57050	
1	37.57060	1.00E-04
2	37.57065	5.00E-05
3	37.57065	0.00E+00
4	37.57065	0.00E+00
5	37.57065	0.00E+00
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	37.57065	
1	37.57065	0.00E+00
2	37.57065	0.00E+00
3	37.57065	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	37.57065	
1	37.57065	0.00E+00
2	37.57065	0.00E+00
3	37.57065	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

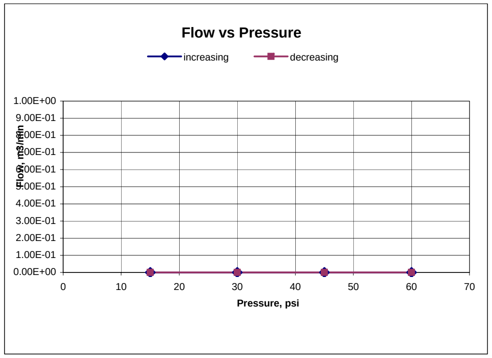
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	37.57065	
1	37.57065	0.00E+00
2	37.57065	0.00E+00
3	37.57065	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 132.66
Bottom (m): 131.14

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09
Drillers: all terrain
Representing GRI: GAG

Test Hole No: 12-1
Surface Elevation: 140.28
Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0
Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 6.10
Length of Test Section: 1.52
Depth, top of bottom of packer: 7.62
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	37.99885	
1	37.99890	5.00E-05
2	37.99890	0.00E+00
3	37.99895	5.00E-05
4	37.99895	0.00E+00
5	37.99895	0.00E+00
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	37.99970	
1	37.99970	0.00E+00
2	37.99970	0.00E+00
3	37.99970	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	37.99980	
1	37.99980	0.00E+00
2	37.99980	0.00E+00
3	37.99980	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	38.00010	
1	38.00015	5.00E-05
2	38.00015	0.00E+00
3	38.00015	0.00E+00
4	38.00015	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.00015	
1	38.00015	0.00E+00
2	38.00015	0.00E+00
3	38.00015	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.00015	
1	38.00015	0.00E+00
2	38.00015	0.00E+00
3	38.00015	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

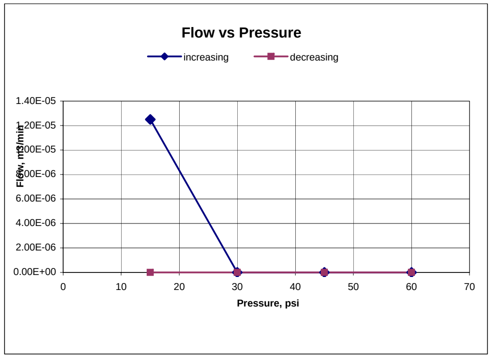
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.00025	
1	38.00025	0.00E+00
2	38.00025	0.00E+00
3	38.00025	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 134.18
Bottom (m): 132.66

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	1.25E-05	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 12-1
Surface Elevation: 140.28

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 1.7

Depth, bottom of top of packer: 4.57
Length of Test Section: 1.52

Depth, top of bottom of packer: 6.10
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.48000	
1	38.48000	0.00E+00
2	38.48000	0.00E+00
3	38.48000	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.48030	
1	38.48035	5.00E-05
2	38.48035	0.00E+00
3	38.48035	0.00E+00
4	38.48035	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.48065	
1	38.48065	0.00E+00
2	38.48065	0.00E+00
3	38.48065	0.00E+00
4	38.48065	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	38.48070	
1	38.48070	0.00E+00
2	38.48070	0.00E+00
3	38.48070	0.00E+00
4	38.48070	0.00E+00
5	38.48070	0.00E+00
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.58070	
1	38.58070	0.00E+00
2	38.58070	0.00E+00
3	38.58070	0.00E+00
4	38.58070	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.58065	
1	38.58065	0.00E+00
2	38.58065	0.00E+00
3	38.58065	0.00E+00
4	38.58065	0.00E+00
5	38.58065	0.00E+00
6	38.58065	0.00E+00
7		
8		
9		
10		

Comments

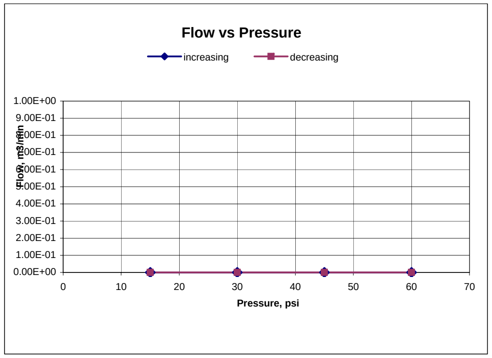
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.48030	
1	38.48030	0.00E+00
2	38.48030	0.00E+00
3	38.48030	0.00E+00
4	38.48030	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 135.71
Bottom (m): 134.18

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 12-1
Surface Elevation: 140.28

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 3.05
Length of Test Section: 1.52

Depth, top of bottom of packer: 4.57
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.48070	
1	38.48070	0.00E+00
2	38.48070	0.00E+00
3	38.48070	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.48020	
1	38.48025	5.00E-05
2	38.48035	1.00E-04
3	38.48035	0.00E+00
4	38.48040	5.00E-05
5	38.48040	0.00E+00
6	38.48040	0.00E+00
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.48165	
1	38.48180	1.50E-04
2	38.48190	1.00E-04
3	38.48195	5.00E-05
4	38.48195	0.00E+00
5	38.48195	0.00E+00
6	38.48195	0.00E+00
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	38.48230	
1	38.48230	0.00E+00
2	38.48230	0.00E+00
3	38.48230	0.00E+00
4	38.48230	0.00E+00
5	38.48230	0.00E+00
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	38.28230	
1	38.28230	0.00E+00
2	38.28230	0.00E+00
3	38.28230	0.00E+00
4	38.28230	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	38.28230	
1	38.28230	0.00E+00
2	38.28230	0.00E+00
3	38.28230	0.00E+00
4	38.28230	0.00E+00
5	38.28230	0.00E+00
6		
7		
8		
9		
10		

Comments

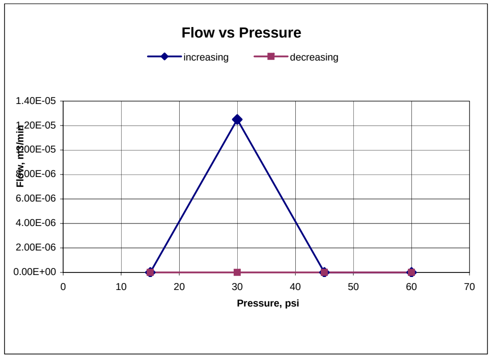
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	38.48215	
1	38.48215	0.00E+00
2	38.48215	0.00E+00
3	38.48215	0.00E+00
4	38.48215	0.00E+00
5	38.48215	0.00E+00
6		
7		
8		
9		
10		

Test Hole No: 12-1

<u>Test Interval</u>
Top (m): 137.23
Bottom (m): 135.71

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	1.25E-05	0.00E+00
45	0.00E+00	0.00E+00
60	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Project No: 8360
Date: 24-Feb-09

Drillers: All terrain
Representing GRI: GAG

Test Hole No: 12-1 T1
Surface Elevation: 140.28

Borehole Depth: 12.31
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0.7

Depth, bottom of top of packer: 1.52
Length of Test Section: 1.52

Depth, top of bottom of packer: 3.05
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	39.18105	
1	39.18105	0.00E+00
2	39.18105	0.00E+00
3	39.18105	0.00E+00
4	39.18105	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	39.18135	
1	39.18135	0.00E+00
2	39.18135	0.00E+00
3	39.18135	0.00E+00
4	39.18135	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	39.18165	
1	39.18165	0.00E+00
2	39.18165	0.00E+00
3	39.18165	0.00E+00
4	39.18165	0.00E+00
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	39.18200	
1	39.18285	8.50E-04
2	39.18360	7.50E-04
3	39.18500	1.40E-03
4	39.19260	7.60E-03
5	39.22700	3.44E-02
6	39.29300	6.60E-02
7	39.37700	8.40E-02
8		
9		
10		

Test No.
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Test No.
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Comments

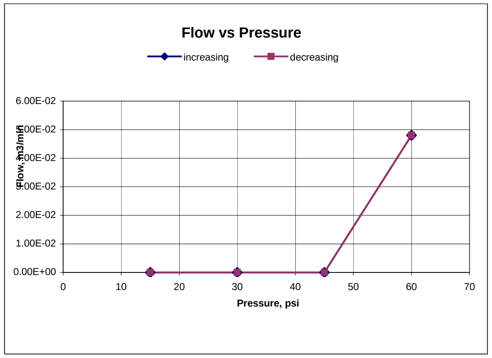
Test No.
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		0.00
2		0.00
3		0.00
4		0.00
5		0.00
6		0.00
7		0.00
8		0.00
9		0.00
10		0.00

Test Hole No: 12-1

Test Interval
Top (m): 138.76
Bottom (m): 137.23

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
45	0.00E+00	0.00E+00
60	4.80E-02	9.26E-04
45	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
15	0.00E+00	0.00E+00



Gorrell Resource Investigations

Project No: 8360
Date: 24-Feb-09

Drillers: All terrain
Representing GRI: GAG

Test Hole No: 12-1 T2
Surface Elevation: 140.28

Borehole Depth: 12.19
Radius of Borehole: 0
Water Level: 0

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 0.7

Depth, bottom of top of packer: 1.52
Length of Test Section: 1.52

Depth, top of bottom of packer: 3.05
Length of Packer: 1.52

Test No. 1
Pressure: 15

Time (min)	Flow Meter	Diff.
0	40.55000	
1	40.60300	5.30E-02
2	40.65600	5.30E-02
3	40.71200	5.60E-02
4		
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 30

Time (min)	Flow Meter	Diff.
0	40.76100	
1	40.87800	1.17E-01
2	40.99500	1.17E-01
3	41.11400	1.19E-01
4		
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 45

Time (min)	Flow Meter	Diff.
0	41.19000	
1	41.35900	1.69E-01
2	41.52900	1.70E-01
3	41.69800	1.69E-01
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 60

Time (min)	Flow Meter	Diff.
0	41.83000	
1	42.04000	2.10E-01
2	42.25800	2.18E-01
3	42.45700	1.99E-01
4		
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 45

Time (min)	Flow Meter	Diff.
0	42.59000	
1	42.71500	1.25E-01
2	42.84000	1.25E-01
3	43.11400	2.74E-01
4	43.28700	1.73E-01
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	43.36000	
1	43.52700	1.67E-01
2	43.66000	1.33E-01
3	43.79600	1.36E-01
4		
5		
6		
7		
8		
9		
10		

Comments

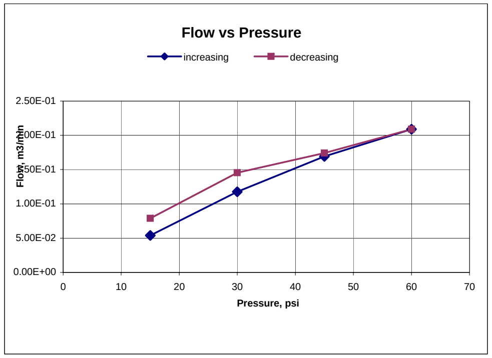
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0	43.88000	
1	43.96900	8.90E-02
2	44.03800	6.90E-02
3		
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 12-1

Test Interval
Top (m): 138.76
Bottom (m): 137.23

Pressure (psi)	Flow (m^3/min)	K (cm/s)
15	5.40E-02	5.23E-03
30	1.18E-01	5.23E-03
45	1.69E-01	4.83E-03
60	2.09E-01	3.82E-03
45	1.74E-01	5.03E-03
30	1.45E-01	6.04E-03
15	7.90E-02	6.84E-03



Project No: 8360
Date: 26-Feb-09

Drillers: all terrain
Representing GRI: GAG

Test Hole No: 13-1
Surface Elevation: 139.41

Borehole Depth: 10.67
Radius of Borehole: 0
Water Level: 1.267968

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 1.8

Depth, bottom of top of packer: 9.14
Length of Test Section: 1.52

Depth, top of bottom of packer: 10.67
Length of Packer: 1.52

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.11460	
1	44.11460	0.00E+00
2	44.11465	5.00E-05
3	44.11465	0.00E+00
4	44.11470	5.00E-05
5	44.11475	5.00E-05
6	44.11480	5.00E-05
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.11535	
1	44.11545	1.00E-04
2	44.11545	0.00E+00
3	44.11545	0.00E+00
4	44.11555	1.00E-04
5	44.11560	5.00E-05
6	44.11565	5.00E-05
7	44.11570	5.00E-05
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.11605	
1	44.11615	1.00E-04
2	44.11630	1.50E-04
3	44.11635	5.00E-05
4	44.11645	1.00E-04
5	44.11650	5.00E-05
6	44.11655	5.00E-05
7	44.11660	5.00E-05
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	44.11680	
1	44.11685	5.00E-05
2	44.11690	5.00E-05
3	44.11690	0.00E+00
4	44.11695	5.00E-05
5	44.11700	5.00E-05
6	44.11705	5.00E-05
7		
8		
9		
10		

Test No. 3r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.11705	
1	44.11705	0.00E+00
2	44.11705	0.00E+00
3	44.11705	0.00E+00
4	44.11705	0.00E+00
5	44.11705	0.00E+00
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.11695	
1	44.11695	0.00E+00
2	44.11695	0.00E+00
3	44.11695	0.00E+00
4	44.11695	0.00E+00
5		
6		
7		
8		
9		
10		

Comments flow reversed between 3r and 2r, 2r and 1r

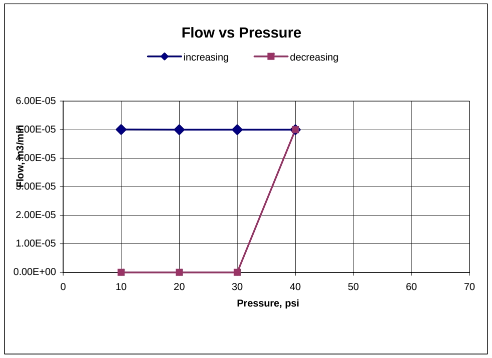
Test No. 1r
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.11685	
1	44.11685	0.00E+00
2	44.11685	0.00E+00
3	44.11685	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 130.27
Bottom (m): 128.74

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	5.00E-05	0.00E+00
20	5.00E-05	0.00E+00
30	5.00E-05	0.00E+00
40	5.00E-05	0.00E+00
30	0.00E+00	0.00E+00
20	0.00E+00	0.00E+00
10	0.00E+00	0.00E+00



Project No: 8360
Date: 26-Feb-09

Drillers: all terrain
Representing GRI: GAG

Borehole Depth: 10.67
Radius of Borehole: 0
Water Level: 1.267968

Test Hole No: 13-1
Surface Elevation: 139.41

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 1.4

Depth, bottom of top of packer: 7.62
Length of Test Section: 1.52

Depth, top of bottom of packer: 9.14
Length of Packer: 0.00

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.11710	
1	44.11720	1.00E-04
2	44.11725	5.00E-05
3	44.11730	5.00E-05
4	44.11735	5.00E-05
5	44.11740	5.00E-05
6		
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.11740	
1	44.11740	0.00E+00
2	44.11740	0.00E+00
3	44.11740	0.00E+00
4	44.11745	5.00E-05
5	44.11745	0.00E+00
6		
7		
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.11755	
1	44.11765	1.00E-04
2	44.11775	1.00E-04
3	44.11785	1.00E-04
4	44.11795	1.00E-04
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	44.11820	
1	44.11830	1.00E-04
2	44.11835	5.00E-05
3	44.11845	1.00E-04
4	44.11850	5.00E-05
5	44.11855	5.00E-05
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.11860	
1	44.11860	0.00E+00
2	44.11860	0.00E+00
3	44.11865	5.00E-05
4	44.11870	5.00E-05
5	44.11875	5.00E-05
6	44.11885	1.00E-04
7	44.11895	1.00E-04
8	44.11905	1.00E-04
9		
10		

Test No. 2r
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.11895	
1	44.11895	0.00E+00
2	44.11900	5.00E-05
3	44.11905	5.00E-05
4	44.11910	5.00E-05
5	44.11915	5.00E-05
6		
7		
8		
9		
10		

Comments reverse flow in 2r and 1r

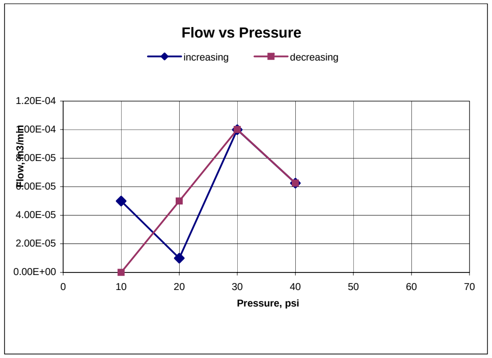
Test No. 1r
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.11905	
1	44.11905	0.00E+00
2	44.11905	0.00E+00
3	44.11905	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 131.79
Bottom (m): 130.27

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	5.00E-05	0.00E+00
20	1.00E-05	0.00E+00
30	1.00E-04	0.00E+00
40	6.25E-05	0.00E+00
30	1.00E-04	0.00E+00
20	5.00E-05	0.00E+00
10	0.00E+00	0.00E+00



Gorrell Resource Investigations

Project No: 8360

Date: 26-Feb-09

Drillers: all terrain

Representing GRI: GAG

Test Hole No: 13-1

Surface Elevation: 139.41

Borehole Depth: 10.67

Radius of Borehole: 0

Water Level: 1.277112

Ht Press. Gauge, above G.S: 0.7

Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 6.10

Length of Test Section: 1.52

Depth, top of bottom of packer: 7.62

Length of Packer: 0.00

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.12065	
1	44.12080	1.50E-04
2	44.12095	1.50E-04
3	44.12115	2.00E-04
4	44.12140	2.50E-04
5	44.12155	1.50E-04
6	44.12170	1.50E-04
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.12280	
1	44.12320	4.00E-04
2	44.12360	4.00E-04
3	44.12400	4.00E-04
4	44.12440	4.00E-04
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.12515	
1	44.12605	9.00E-04
2	44.12685	8.00E-04
3	44.12775	9.00E-04
4	44.12855	8.00E-04
5	44.12940	8.50E-04
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	44.13050	
1	44.13165	1.15E-03
2	44.13280	1.15E-03
3	44.13395	1.15E-03
4	44.13510	1.15E-03
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.13450	
1	44.13510	6.00E-04
2	44.13580	7.00E-04
3	44.13655	7.50E-04
4	44.13715	6.00E-04
5	44.13785	7.00E-04
6	44.13850	6.50E-04
7	44.13910	6.00E-04
8		
9		
10		

Test No. 2r
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.13920	
1	44.13960	4.00E-04
2	44.13995	3.50E-04
3	44.14040	4.50E-04
4	44.14075	3.50E-04
5	44.14120	4.50E-04
6		
7		
8		
9		
10		

Comments

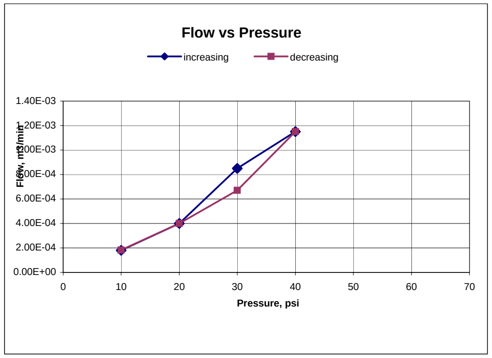
Test No. 1r
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.14125	
1	44.14155	3.00E-04
2	44.14175	2.00E-04
3	44.14190	1.50E-04
4	44.14210	2.00E-04
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 133.31
Bottom (m): 131.79

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	1.80E-04	2.82E-05
20	4.00E-04	1.85E-05
30	8.50E-04	2.82E-05
40	1.15E-03	3.14E-05
30	6.70E-04	2.33E-05
20	4.00E-04	1.93E-05
10	1.83E-04	2.82E-05



Gorrell Resource Investigations

Project No: 8360
Date: 26-Feb-09

Drillers: all terrain
Representing GRI: GAG

Borehole Depth: 10.67
Test Hole No: 13-1
Radius of Borehole: 0
Ht Press. Gauge, above G.S: 0.7
Surface Elevation: 139.41
Water Level: 1.277112
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 4.57
Depth, top of bottom of packer: 6.10
Length of Test Section: 1.52
Length of Packer: 0.00

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.14075	
1	44.14075	0.00E+00
2	44.14080	5.00E-05
3	44.14080	0.00E+00
4	44.14080	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.14155	
1	44.14155	0.00E+00
2	44.14155	0.00E+00
3	44.14155	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.14200	
1	44.14200	0.00E+00
2	44.14200	0.00E+00
3	44.14200	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	44.14240	
1	44.14245	5.00E-05
2	44.14245	0.00E+00
3	44.14245	0.00E+00
4	44.14245	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 3r
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.14230	
1	44.14220	-1.00E-04
2	44.14220	0.00E+00
3	44.14220	0.00E+00
4	44.14220	0.00E+00
5		
6		
7		
8		
9		
10		

Test No. 2r
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.14180	
1	44.14180	0.00E+00
2	44.14180	0.00E+00
3	44.14180	0.00E+00
4		
5		
6		
7		
8		
9		
10		

Comments back pressure in 1r

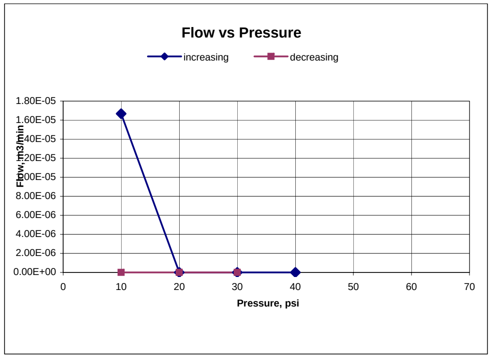
Test No. 1r
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.14130	
1	44.14130	0.00E+00
2	44.14130	0.00E+00
3	44.14125	-5.00E-05
4	44.14125	0.00E+00
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 134.84
Bottom (m): 133.31

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	1.67E-05	0.00E+00
20	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
40	0.00E+00	0.00E+00
30	0.00E+00	0.00E+00
20	0.00E+00	0.00E+00
10	0.00E+00	0.00E+00



Project No: 08360
Date: 26-Feb-09

Drillers: All terrain
Representing GRI: GAG

Test Hole No: 13-1
Surface Elevation: 139.41

Borehole Depth: 9.14
Radius of Borehole: 0
Water Level: 1.267968

Ht Press. Gauge, above G.S: 0.7
Ht Water Swivel above G.S: 2.2

Depth, bottom of top of packer: 3.05
Length of Test Section: 1.52

Depth, top of bottom of packer: 4.57
Length of Packer: 0.00

Test No. 1
Pressure: 10

Time (min)	Flow Meter	Diff.
0	44.25000	
1	44.36900	1.19E-01
2	44.48900	1.20E-01
3	44.60500	1.16E-01
4	44.72300	1.18E-01
5		
6		
7		
8		
9		
10		

Test No. 2
Pressure: 20

Time (min)	Flow Meter	Diff.
0	44.81200	
1	44.97100	1.59E-01
2	45.12300	1.52E-01
3	45.27200	1.49E-01
4	45.42500	1.53E-01
5		
6		
7		
8		
9		
10		

Test No. 3
Pressure: 30

Time (min)	Flow Meter	Diff.
0	44.60000	
1	44.77800	1.78E-01
2	44.95100	1.73E-01
3	45.13400	1.83E-01
4	45.30000	1.66E-01
5		
6		
7		
8		
9		
10		

Comments

Test No. 4
Pressure: 40

Time (min)	Flow Meter	Diff.
0	46.50000	
1	46.70000	2.00E-01
2	46.90800	2.08E-01
3	47.11200	2.04E-01
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Test No. 1
Pressure:

Time (min)	Flow Meter	Diff.
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Comments

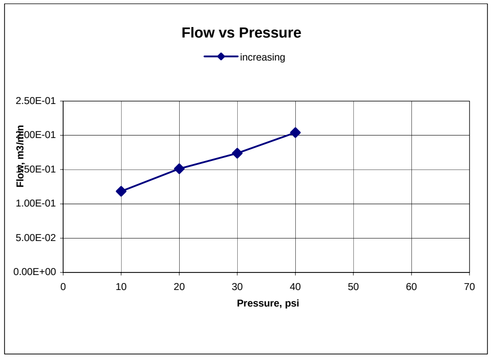
Test No. 1r
Pressure: 15

Time (min)	Flow Meter	Diff.
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Test Hole No: 13-1

Test Interval
Top (m): 136.36
Bottom (m): 134.84

Pressure (psi)	Flow (m^3/min)	K (cm/s)
10	1.18E-01	1.05E-02
20	1.51E-01	6.44E-03
30	1.74E-01	6.04E-03
40	2.04E-01	6.04E-03



Appendix V

Hvorslev Test Data and Analysis

(TW 9 – 13)

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

Hydraulic Conductivity Test Data and Analysis

Job: 08360 **Date:** 04-May-09

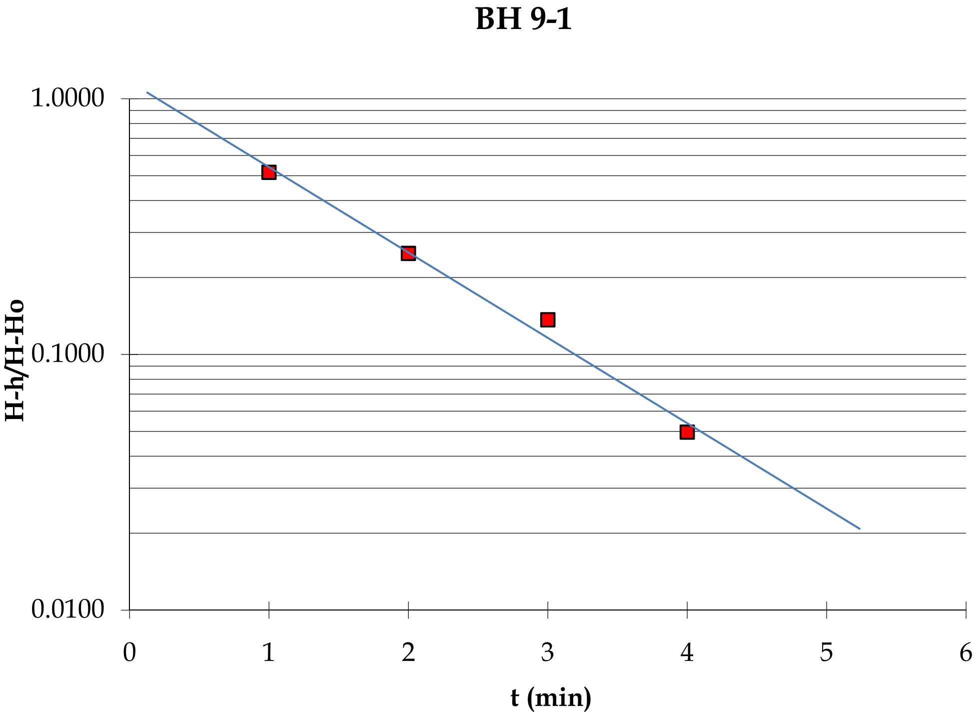
Test Hole No: 09 BH 9-1

H: **23.51** **H - Ho:** -1.61

Ho: **25.12** **To:** 1.50E+00

t	Reading	Correction	h	H - h	H - h/H - Ho
0	25.120		25.12	-1.61	1.0000
1	24.340		24.34	-0.83	0.5155
2	23.910		23.91	-0.40	0.2484
3	23.730		23.73	-0.22	0.1366
4	23.590		23.59	-0.08	0.0497
5	23.520		23.52	-0.01	0.0062

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.50E+00	2.09E-06



Gorrell Resource Investigations

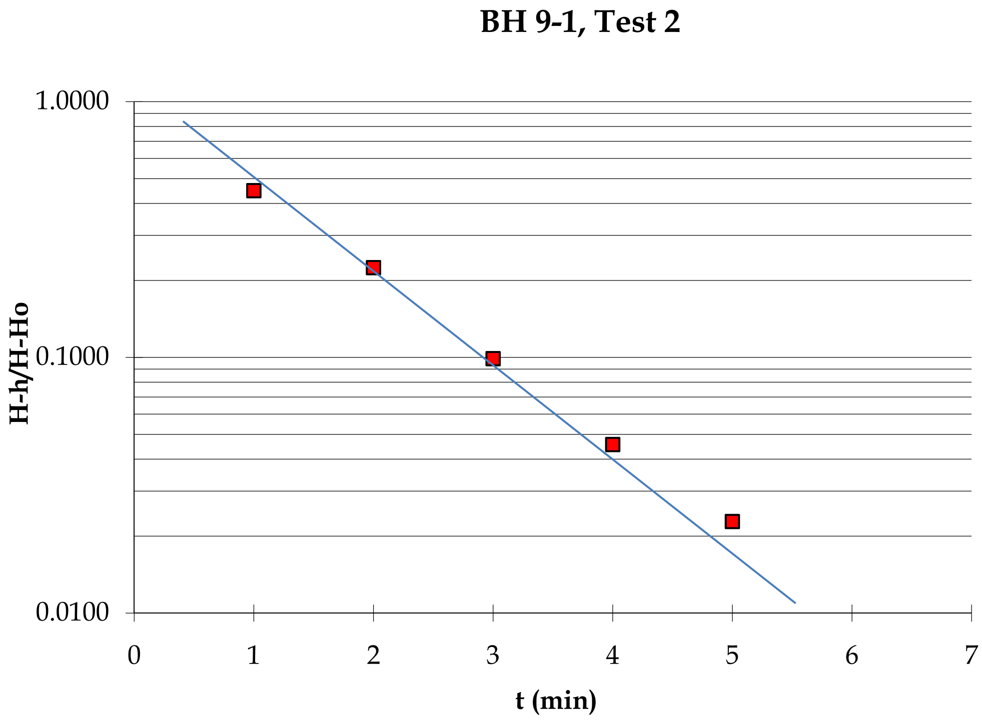
Hydraulic Conductivity Test Data and Analysis

Job: 08360
Date: 04-May-09
Test Hole No: 09 BH 9-1

H: **23.51**
Ho: **26.14**
H - Ho: -2.63
To: 1.23E+00

t	Reading	Correction	h	H - h	H - h/H - Ho
0	26.140		26.14	-2.63	1.0000
1	24.690		24.69	-1.18	0.4487
2	24.100		24.10	-0.59	0.2243
3	23.770		23.77	-0.26	0.0989
4	23.630		23.63	-0.12	0.0456
5	23.570		23.57	-0.06	0.0228
6	23.520		23.52	-0.01	0.0038
7	23.510		23.51	0.00	0.0000

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.23E+00	2.54E-06



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

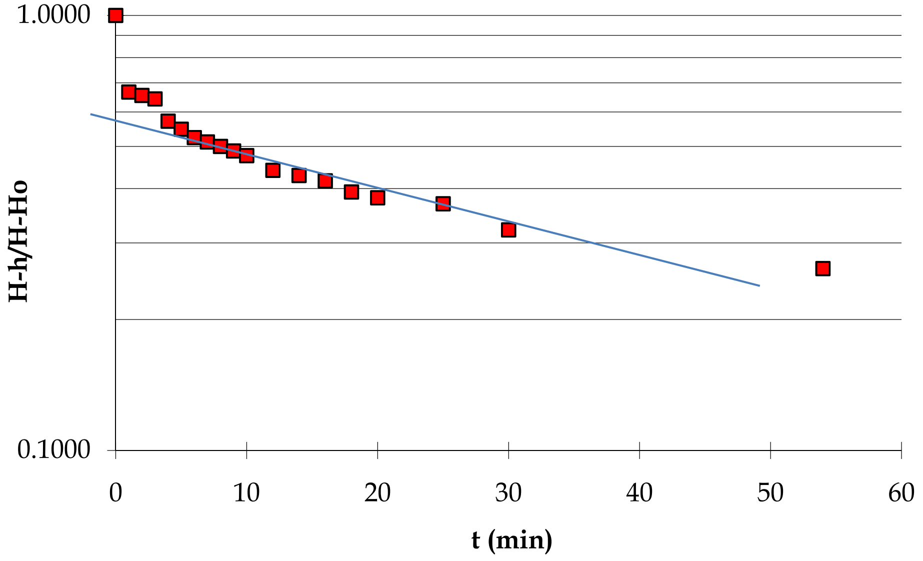
Job: 08360 **Date:** 04-May-09
Test Hole No: 09 BH 9-2

H: **11.56** **H - Ho:** -0.84
Ho: **12.40** **To:** 2.22E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	12.400		12.40	-0.84	1.0000
1	12.120		12.12	-0.56	0.6667
2	12.110		12.11	-0.55	0.6548
3	12.100		12.10	-0.54	0.6429
4	12.040		12.04	-0.48	0.5714
5	12.020		12.02	-0.46	0.5476
6	12.000		12.00	-0.44	0.5238
7	11.990		11.99	-0.43	0.5119
8	11.980		11.98	-0.42	0.5000
9	11.970		11.97	-0.41	0.4881
10	11.960		11.96	-0.40	0.4762
12	11.930		11.93	-0.37	0.4405
14	11.920		11.92	-0.36	0.4286
16	11.910		11.91	-0.35	0.4167
18	11.890		11.89	-0.33	0.3929
20	11.880		11.88	-0.32	0.3810
25	11.870		11.87	-0.31	0.3690
30	11.830		11.83	-0.27	0.3214
54	11.780		11.78	-0.22	0.2619

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.22E+01	1.41E-07

BH 9-2



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

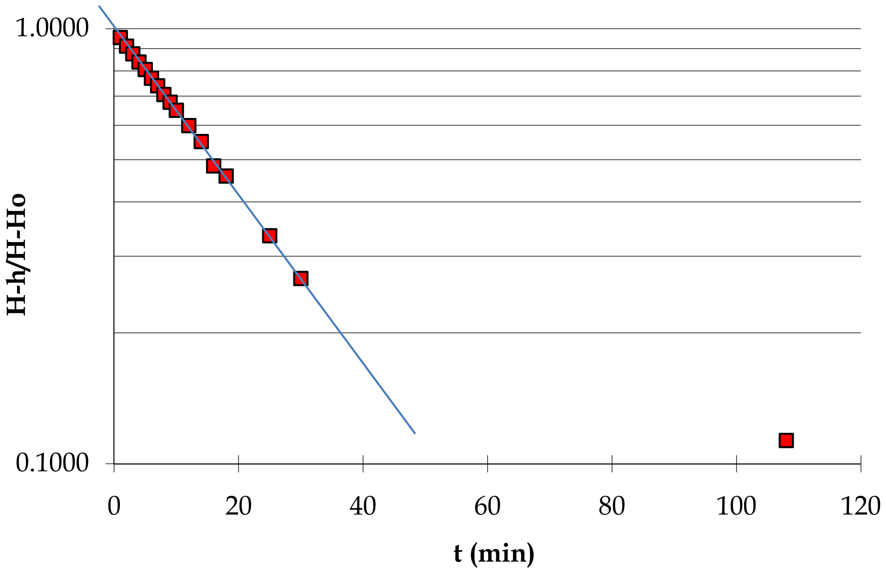
Job: 08360 **Date:**
Test Hole No: 09 BH 10-1

H: **1.40** **H - Ho:** -9.90
Ho: **11.30** **To:** 2.71E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	11.300		11.30	-9.90	1.0000
1	10.850		10.85	-9.45	0.9545
2	10.430		10.43	-9.03	0.9121
3	10.070		10.07	-8.67	0.8758
4	9.700		9.70	-8.30	0.8384
5	9.380		9.38	-7.98	0.8061
6	9.020		9.02	-7.62	0.7697
7	8.720		8.72	-7.32	0.7394
8	8.390		8.39	-6.99	0.7061
9	8.110		8.11	-6.71	0.6778
10	7.830		7.83	-6.43	0.6495
12	7.330		7.33	-5.93	0.5990
14	6.850		6.85	-5.45	0.5505
16	6.190		6.19	-4.79	0.4838
18	5.940		5.94	-4.54	0.4586
25	4.710		4.71	-3.31	0.3343
30	4.040		4.04	-2.64	0.2667
108	2.520		2.52	-1.12	0.1131

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.71E+01	1.15E-07

BH 10-1



Gorrell Resource Investigations

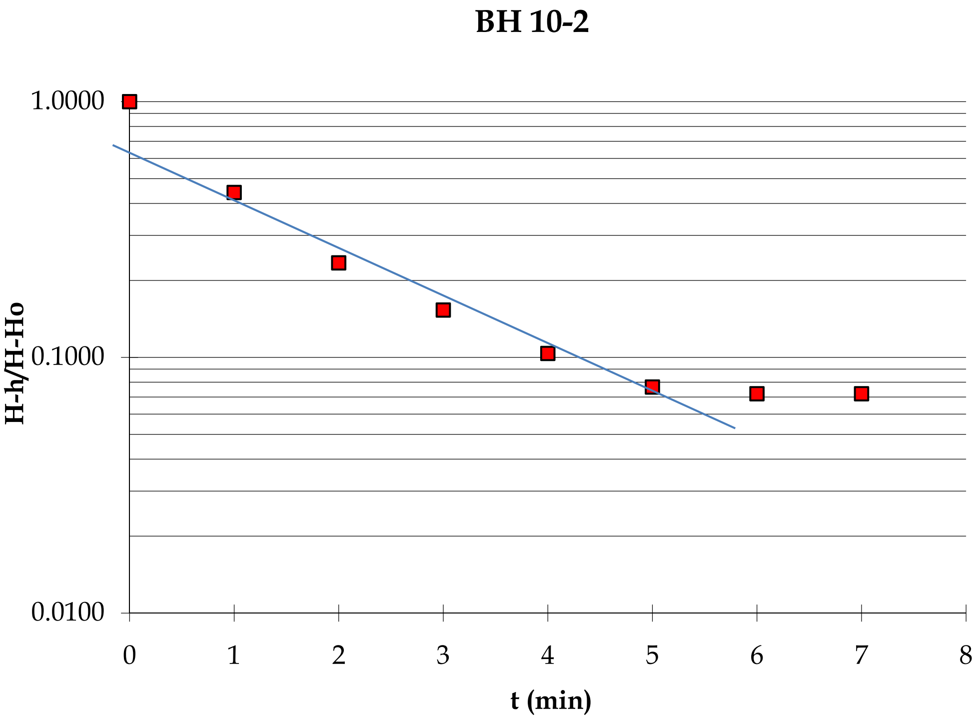
Hydraulic Conductivity Test Data and Analysis

Job:	08360	**Date:**	04-May-09
Test Hole No:	09 BH 10-2	**Test 1**	

H:	**1.38**	**H - Ho:**	-2.22
Ho:	**3.60**	**To:**	1.24E+00

t	Reading	Correction	h	H - h	H - h/H - Ho
0	3.600		3.60	-2.22	1.0000
1	2.360		2.36	-0.98	0.4414
2	1.900		1.90	-0.52	0.2342
3	1.720		1.72	-0.34	0.1532
4	1.610		1.61	-0.23	0.1036
5	1.550		1.55	-0.17	0.0766
6	1.540		1.54	-0.16	0.0721
7	1.540		1.54	-0.16	0.0721

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.24E+00	2.51E-06



Gorrell Resource Investigations

Hydraulic Conductivity Test Data and Analysis

Job: 08360
Test Hole No: 09 BH 10-2

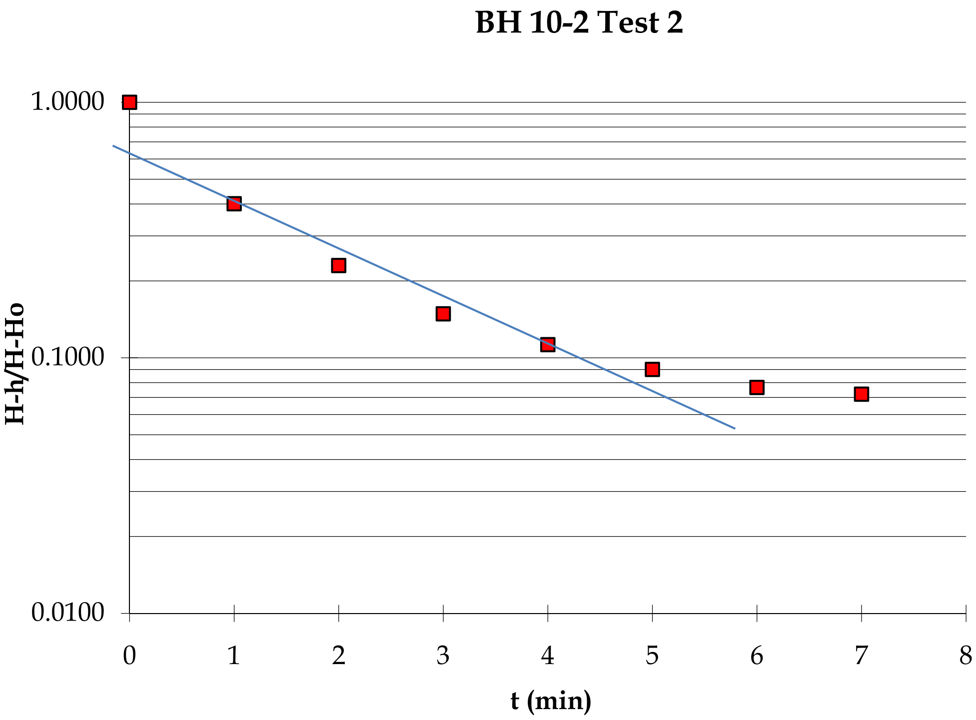
Date: 04-May-09
Test 2

H: **1.38**
Ho: **3.60**

H - Ho: -2.22
To: 1.05E+00

t	Reading	Correction	h	H - h	H - h/H - Ho
0	3.600		3.60	-2.22	1.0000
1	2.270		2.27	-0.89	0.4009
2	1.890		1.89	-0.51	0.2297
3	1.710		1.71	-0.33	0.1486
4	1.630		1.63	-0.25	0.1126
5	1.580		1.58	-0.20	0.0901
6	1.550		1.55	-0.17	0.0766
7	1.540		1.54	-0.16	0.0721

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.05E+00	2.98E-06



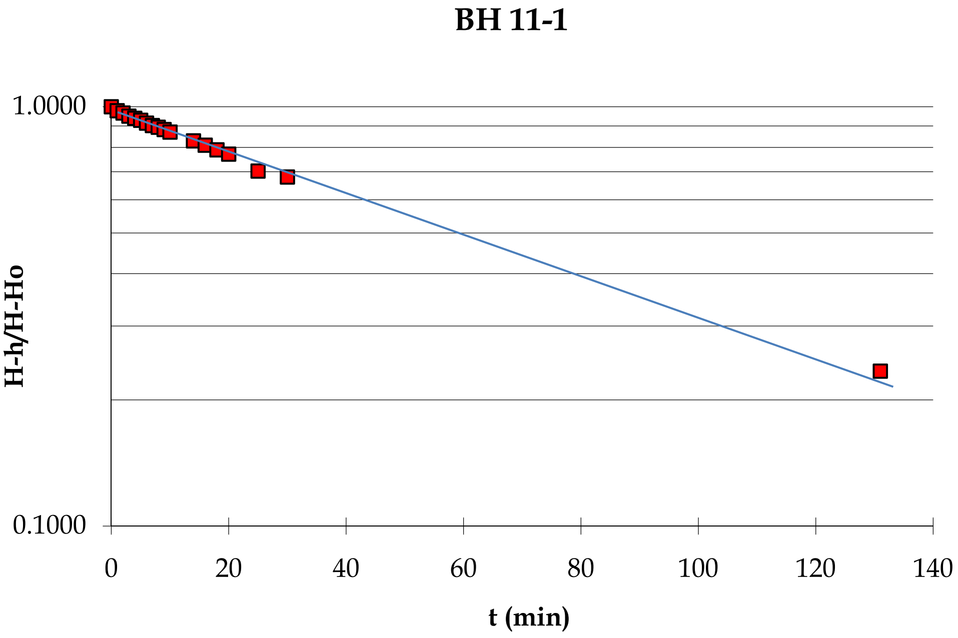
Hydraulic Conductivity Test Data and Analysis

Job: 08360 **Date:**
Test Hole No: 09 BH 11-1

H: **12.19** **H - Ho:** -9.78
Ho: **21.97** **To:** 8.58E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	21.970		21.97	-9.78	1.0000
1	21.760		21.76	-9.57	0.9785
2	21.640		21.64	-9.45	0.9663
3	21.480		21.48	-9.29	0.9499
4	21.370		21.37	-9.18	0.9387
5	21.270		21.27	-9.08	0.9284
6	21.130		21.13	-8.94	0.9141
7	21.010		21.01	-8.82	0.9018
8	20.930		20.93	-8.74	0.8937
9	20.820		20.82	-8.63	0.8824
10	20.700		20.70	-8.51	0.8701
14	20.300		20.30	-8.11	0.8292
16	20.110		20.11	-7.92	0.8098
18	19.910		19.91	-7.72	0.7894
20	19.730		19.73	-7.54	0.7710
25	19.060		19.06	-6.87	0.7025
30	18.840		18.84	-6.65	0.6800
131	14.480		14.48	-2.29	0.2342

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	8.58E+01	3.64E-08



Gorrell Resource Investigations

Hydraulic Conductivity Test Data and Analysis

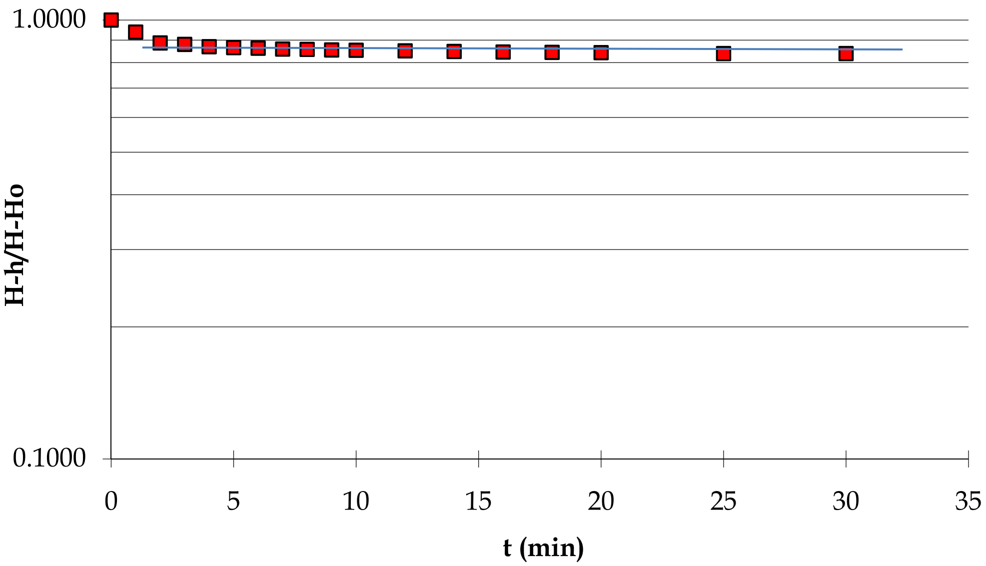
Job: 08360 **Date:** 30-Apr-09
Test Hole No: 09 BH 11-2

H: **1.19** **H - Ho:** -7.51
Ho: **8.70** **To:** 8.34E+12

t	Reading	Correction	h	H - h	H - h/H - Ho
0	8.700		8.70	-7.51	1.0000
1	8.240		8.24	-7.05	0.9387
2	7.850		7.85	-6.66	0.8868
3	7.800		7.80	-6.61	0.8802
4	7.720		7.72	-6.53	0.8695
5	7.690		7.69	-6.50	0.8655
6	7.670		7.67	-6.48	0.8628
7	7.640		7.64	-6.45	0.8589
8	7.630		7.63	-6.44	0.8575
9	7.610		7.61	-6.42	0.8549
10	7.600		7.60	-6.41	0.8535
12	7.580		7.58	-6.39	0.8509
14	7.560		7.56	-6.37	0.8482
16	7.540		7.54	-6.35	0.8455
18	7.530		7.53	-6.34	0.8442
20	7.520		7.52	-6.33	0.8429
25	7.490		7.49	-6.30	0.8389
30	7.490		7.49	-6.30	0.8389

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	8.34E+12	3.74E-19

BH 11-2



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

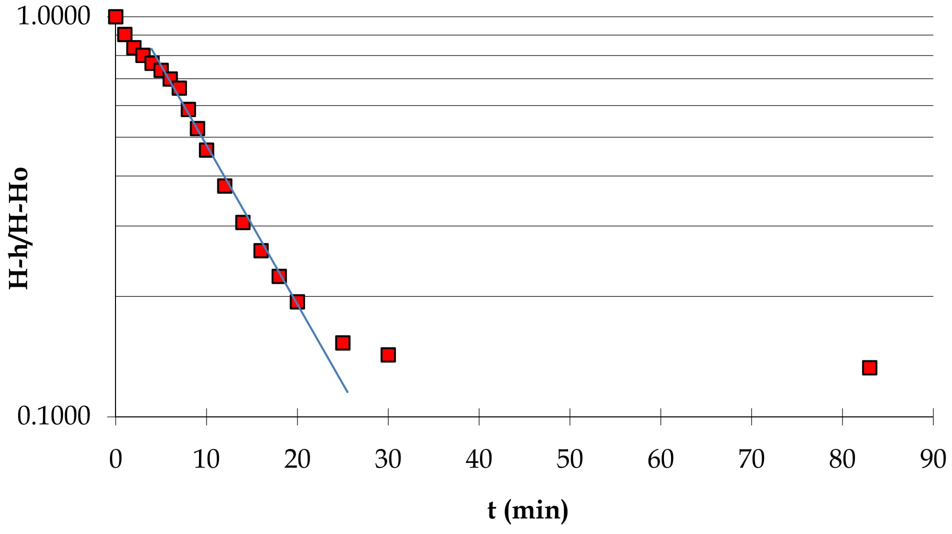
Job: 08360 **Date:** 30-Apr-09
Test Hole No: 09-BH 12-1

H: **1.27** **H - Ho:** -1.96
Ho: **3.23** **To:** 1.27E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	3.230		3.23	-1.96	1.0000
1	3.040		3.04	-1.77	0.9031
2	2.910		2.91	-1.64	0.8367
3	2.840		2.84	-1.57	0.8010
4	2.770		2.77	-1.50	0.7653
5	2.710		2.71	-1.44	0.7347
6	2.640		2.64	-1.37	0.6990
7	2.570		2.57	-1.30	0.6633
8	2.420		2.42	-1.15	0.5867
9	2.300		2.30	-1.03	0.5255
10	2.180		2.18	-0.91	0.4643
12	2.010		2.01	-0.74	0.3776
14	1.870		1.87	-0.60	0.3061
16	1.780		1.78	-0.51	0.2602
18	1.710		1.71	-0.44	0.2245
20	1.650		1.65	-0.38	0.1939
25	1.570		1.57	-0.30	0.1531
30	1.550		1.55	-0.28	0.1429
83	1.53		1.53	-0.26	0.1327

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.27E+01	2.45E-07

BH 12-1



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

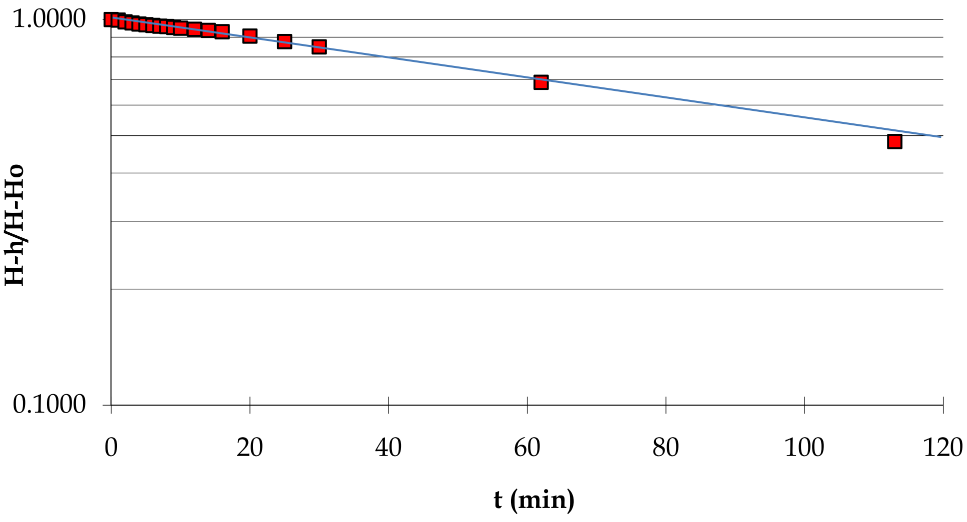
Job:	08360	**Date:**	30-Apr-09
Test Hole No:	09-BH 12-2		

H:	**1.45**	**H - Ho:**	-9.57
Ho:	**11.02**	**To:**	2.14E+02

t	Reading	Correction	h	H - h	H - h/H - Ho
0	11.020		11.02	-9.57	1.0000
1	10.990		10.99	-9.54	0.9969
2	10.890		10.89	-9.44	0.9864
3	10.830		10.83	-9.38	0.9801
4	10.770		10.77	-9.32	0.9739
5	10.730		10.73	-9.28	0.9697
6	10.690		10.69	-9.24	0.9655
7	10.650		10.65	-9.20	0.9613
8	10.630		10.63	-9.18	0.9592
9	10.580		10.58	-9.13	0.9540
10	10.540		10.54	-9.09	0.9498
12	10.480		10.48	-9.03	0.9436
14	10.420		10.42	-8.97	0.9373
16	10.350		10.35	-8.90	0.9300
20	10.120		10.12	-8.67	0.9060
25	9.840		9.84	-8.39	0.8767
30	9.580		9.58	-8.13	0.8495
62	8.030		8.03	-6.58	0.6876
113	6.070		6.07	-4.62	0.4828

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.14E+02	1.46E-08

BH 12-2



Gorrell Resource
Investigations

Hydraulic Conductivity Test Data and Analysis

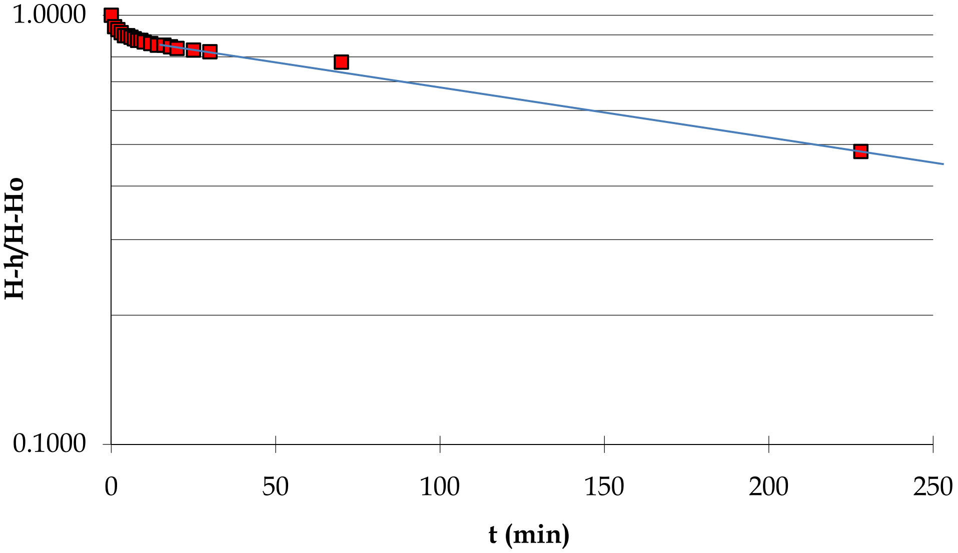
Job: 08360 **Date:** 30-Apr-09
Test Hole No: 09 BH 13-1

H: **3.77** **H - Ho:** -1.35
Ho: **5.12** **To:** 6.62E+02

t	Reading	Correction	h	H - h	H - h/H - Ho
0	5.120		5.12	-1.35	1.0000
1	5.040		5.04	-1.27	0.9407
2	5.020		5.02	-1.25	0.9259
3	5.000		5.00	-1.23	0.9111
4	4.980		4.98	-1.21	0.8963
5	4.980		4.98	-1.21	0.8963
6	4.970		4.97	-1.20	0.8889
7	4.960		4.96	-1.19	0.8815
8	4.950		4.95	-1.18	0.8741
9	4.950		4.95	-1.18	0.8741
10	4.940		4.94	-1.17	0.8667
12	4.930		4.93	-1.16	0.8593
14	4.920		4.92	-1.15	0.8519
16	4.920		4.92	-1.15	0.8519
18	4.910		4.91	-1.14	0.8444
20	4.900		4.90	-1.13	0.8370
25	4.890		4.89	-1.12	0.8296
30	4.880		4.88	-1.11	0.8222
70	4.820		4.82	-1.05	0.7778
228	4.42		4.42	-0.65	0.4815

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
2.13	0.032	2.89E-04	6.62E+02	7.28E-09

BH 13-1



Gorrell Resource
Investigations

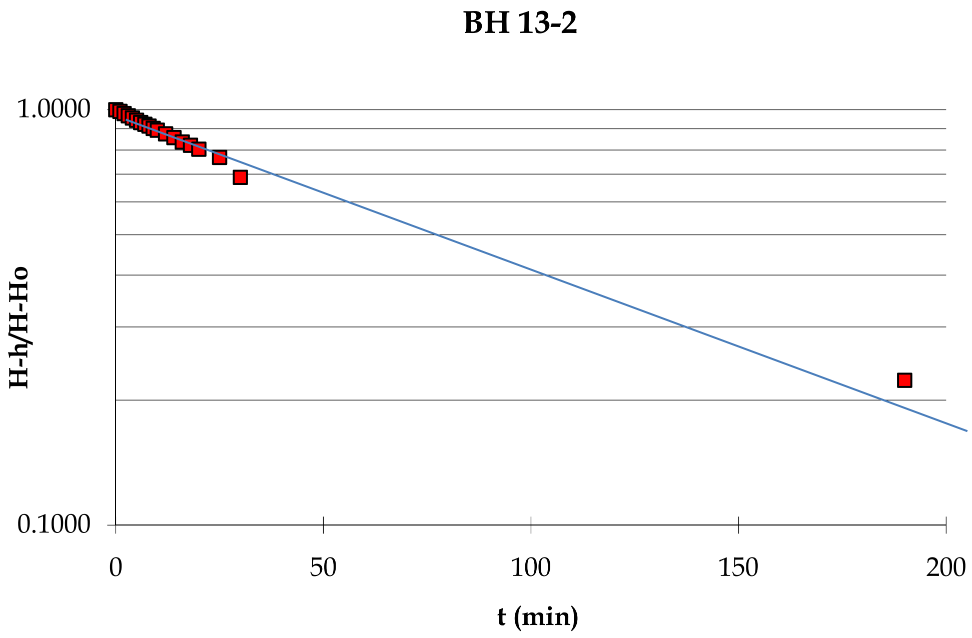
Hydraulic Conductivity Test Data and Analysis

Job: 08360
Date:
Test Hole No: 09 BH 13-2

H: **3.90**
Ho: **7.26**
H - Ho: -3.36
To: 1.07E+02

t	Reading	Correction	h	H - h	H - h/H - Ho
0	7.260		7.26	-3.36	1.0000
1	7.230		7.23	-3.33	0.9911
2	7.190		7.19	-3.29	0.9792
3	7.150		7.15	-3.25	0.9673
4	7.110		7.11	-3.21	0.9554
5	7.070		7.07	-3.17	0.9435
6	7.030		7.03	-3.13	0.9315
7	7.000		7.00	-3.10	0.9226
8	6.970		6.97	-3.07	0.9137
9	6.930		6.93	-3.03	0.9018
10	6.900		6.90	-3.00	0.8929
12	6.840		6.84	-2.94	0.8750
14	6.780		6.78	-2.88	0.8571
16	6.710		6.71	-2.81	0.8363
18	6.660		6.66	-2.76	0.8214
20	6.600		6.60	-2.70	0.8036
25	6.480		6.48	-2.58	0.7679
30	6.210		6.21	-2.31	0.6875
190	4.650		4.65	-0.75	0.2232

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	1.07E+02	2.91E-08



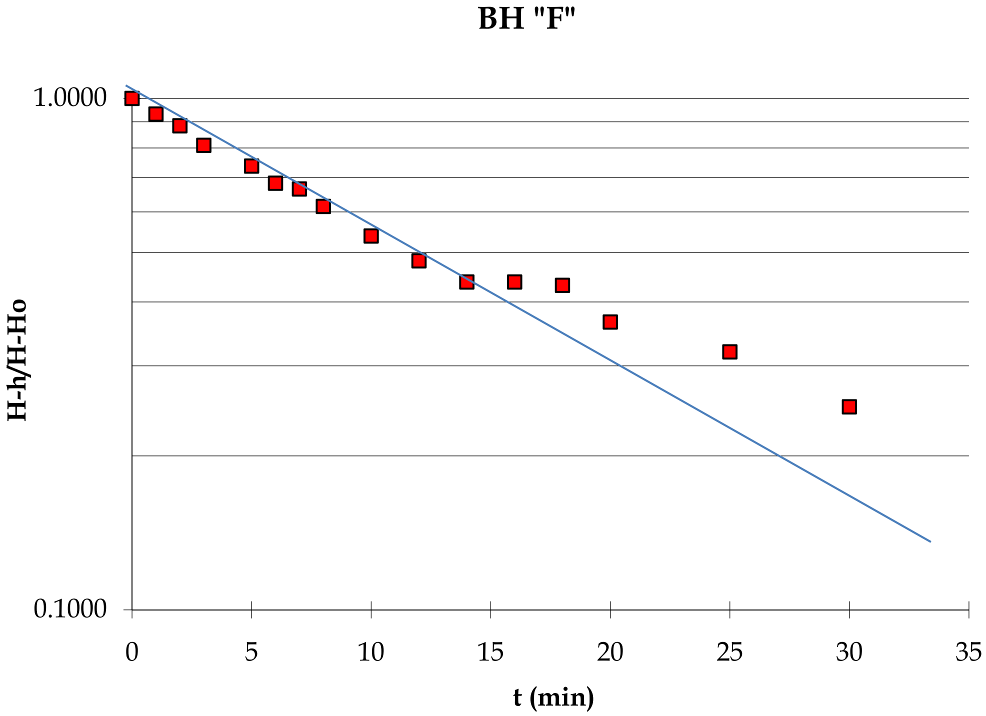
Hydraulic Conductivity Test Data and Analysis

Job:	08360	**Date:**	07-May-09
Test Hole No:	F		

H:	**1.43**	**H - Ho:**	-4.57
Ho:	**6.00**	**To:**	2.39E+01

t	Reading	Correction	h	H - h	H - h/H - Ho
0	6.000		6.00	-4.57	1.0000
1	5.690		5.69	-4.26	0.9322
2	5.470		5.47	-4.04	0.8840
3	5.130		5.13	-3.70	0.8096
5	4.800		4.80	-3.37	0.7374
6	4.550		4.55	-3.12	0.6827
7	4.470		4.47	-3.04	0.6652
8	4.240		4.24	-2.81	0.6149
10	3.890		3.89	-2.46	0.5383
12	3.630		3.63	-2.20	0.4814
14	3.430		3.43	-2.00	0.4376
16	3.430		3.43	-2.00	0.4376
18	3.400		3.40	-1.97	0.4311
20	3.100		3.10	-1.67	0.3654
25	2.890		2.89	-1.46	0.3195
30	2.570		2.57	-1.14	0.2495

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.39E+01	1.31E-07



Gorrell Resource
Investigations

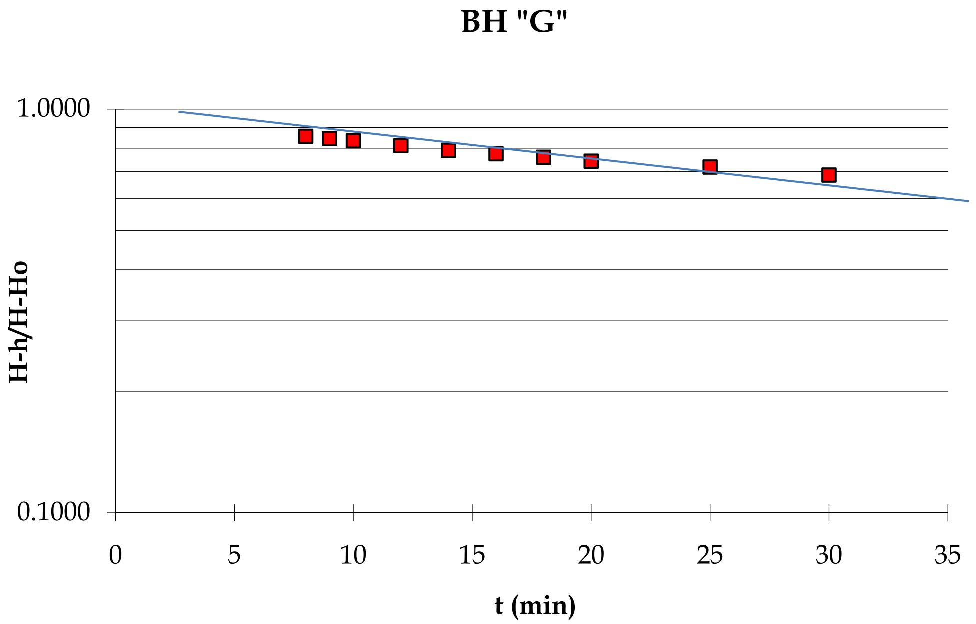
Hydraulic Conductivity Test Data and Analysis

Job: 08360 **Date:** 07-May-09
Test Hole No: G

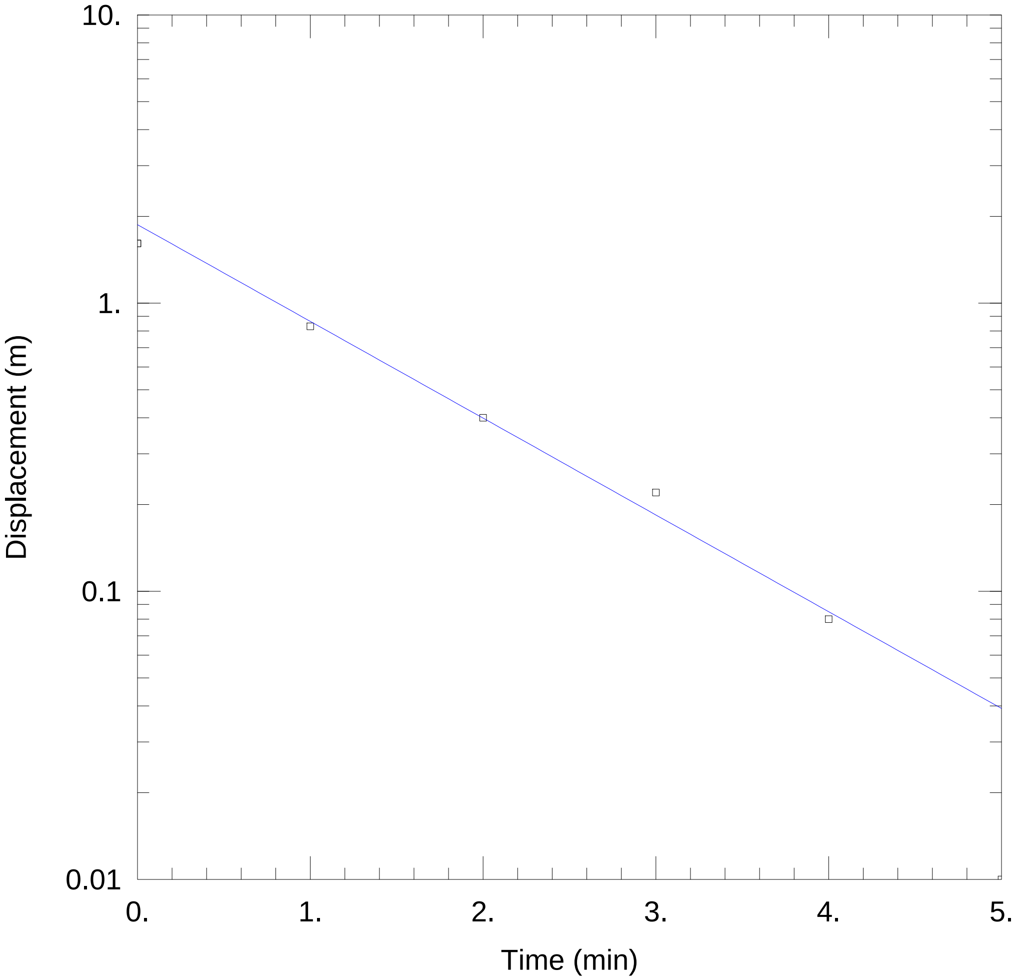
H: **2.38** **H - Ho:** -6.54
Ho: **8.92** **To:** 2.64E+03

t	Reading	Correction	h	H - h	H - h/H - Ho
0	8.920		8.92	-6.54	1.0000
1	8.600		8.60	-6.22	0.9511
2	8.500		8.50	-6.12	0.9358
3	8.410		8.41	-6.03	0.9220
4	8.330		8.33	-5.95	0.9098
5	8.250		8.25	-5.87	0.8976
6	8.160		8.16	-5.78	0.8838
7	8.070		8.07	-5.69	0.8700
8	7.980		7.98	-5.60	0.8563
9	7.910		7.91	-5.53	0.8456
10	7.840		7.84	-5.46	0.8349
12	7.690		7.69	-5.31	0.8119
14	7.550		7.55	-5.17	0.7905
16	7.450		7.45	-5.07	0.7752
18	7.350		7.35	-4.97	0.7599
20	7.240		7.24	-4.86	0.7431
25	7.080		7.08	-4.70	0.7187
30	6.870		6.87	-4.49	0.6865

Piezometer Length [m]	Piezometer Diameter [m]	Shape Factor	To [min]	Hydraulic Conductivity [m/s]
3.66	0.032	1.87E-04	2.64E+03	1.18E-09



Gorrell Resource Investigations



WELL TEST ANALYSIS

Data Set: C:\...\9-1.aqt
Date: 05/02/12 Time: 16:51:27

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 9-1
Test Date: 7/5/2009

AQUIFER DATA

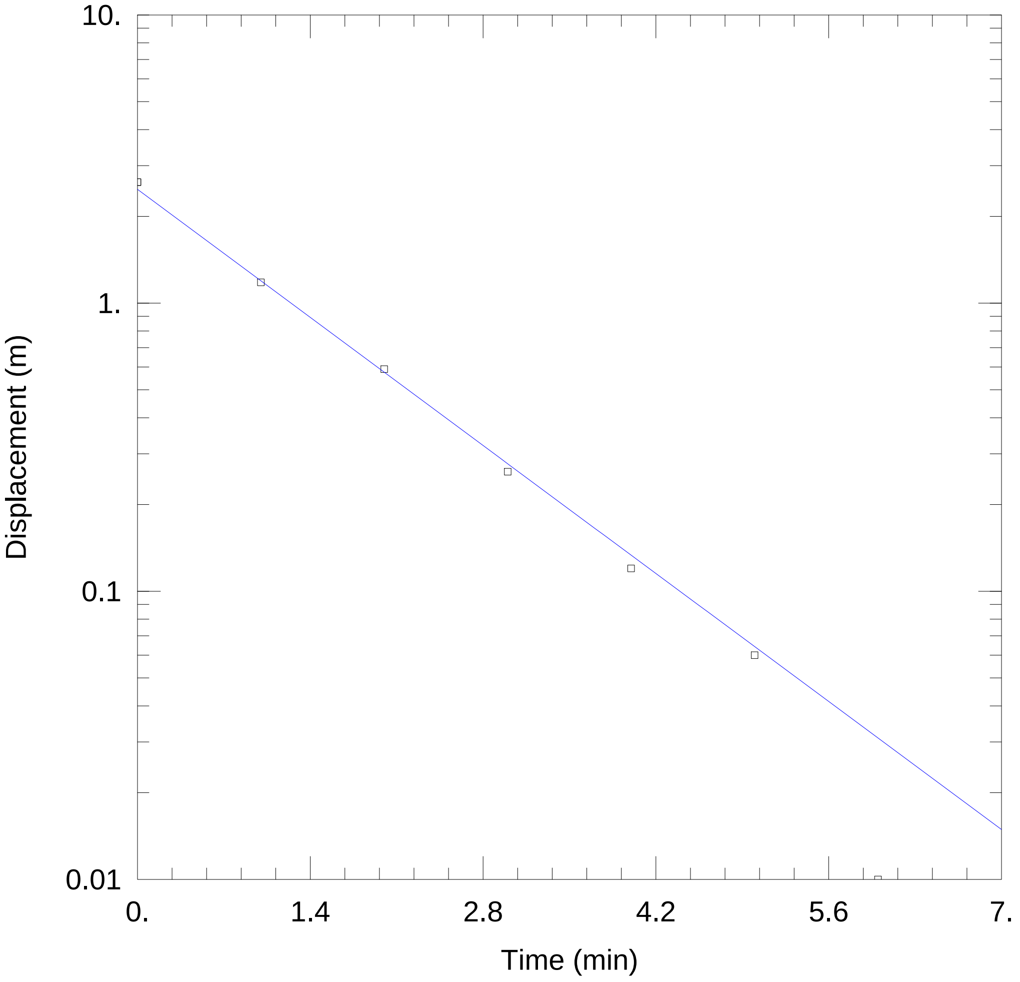
Saturated Thickness: 3.66 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (TW 9-1)

Initial Displacement: 1.61 m
Static Water Column Height: 7.58 m
Total Well Penetration Depth: 31.7 m
Screen Length: 3.66 m
Casing Radius: 0.016 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 2.388E-6 m/sec
y0 = 1.872 m



TEST 2

Data Set: C:\...\9-1T2.aqt
Date: 05/02/12
Time: 16:52:56

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 9-1
Test Date: 7/5/2009

AQUIFER DATA

Saturated Thickness: 3.66 m
Anisotropy Ratio (Kz/Kr): 1.

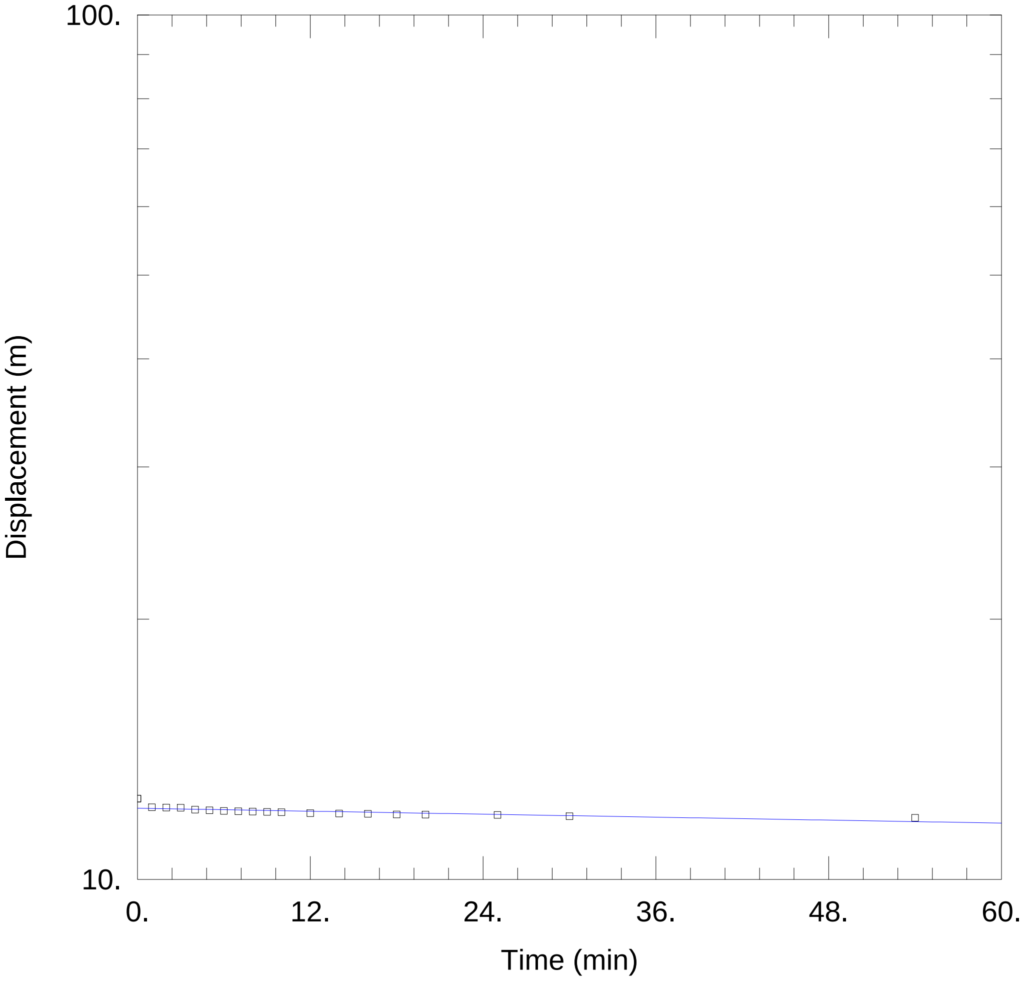
WELL DATA (TW 9-1)

Initial Displacement: 2.63 m
Static Water Column Height: 7.58 m
Total Well Penetration Depth: 31.7 m
Screen Length: 3.66 m
Casing Radius: 0.016 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 2.256E-6 m/sec
y0 = 2.48 m



WELL TEST ANALYSIS

Data Set: C:\...\9-2.aqt
Date: 05/02/12 Time: 16:46:59

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 9-2
Test Date: 4/5/2009

AQUIFER DATA

Saturated Thickness: 1.5 m
Anisotropy Ratio (Kz/Kr): 1.

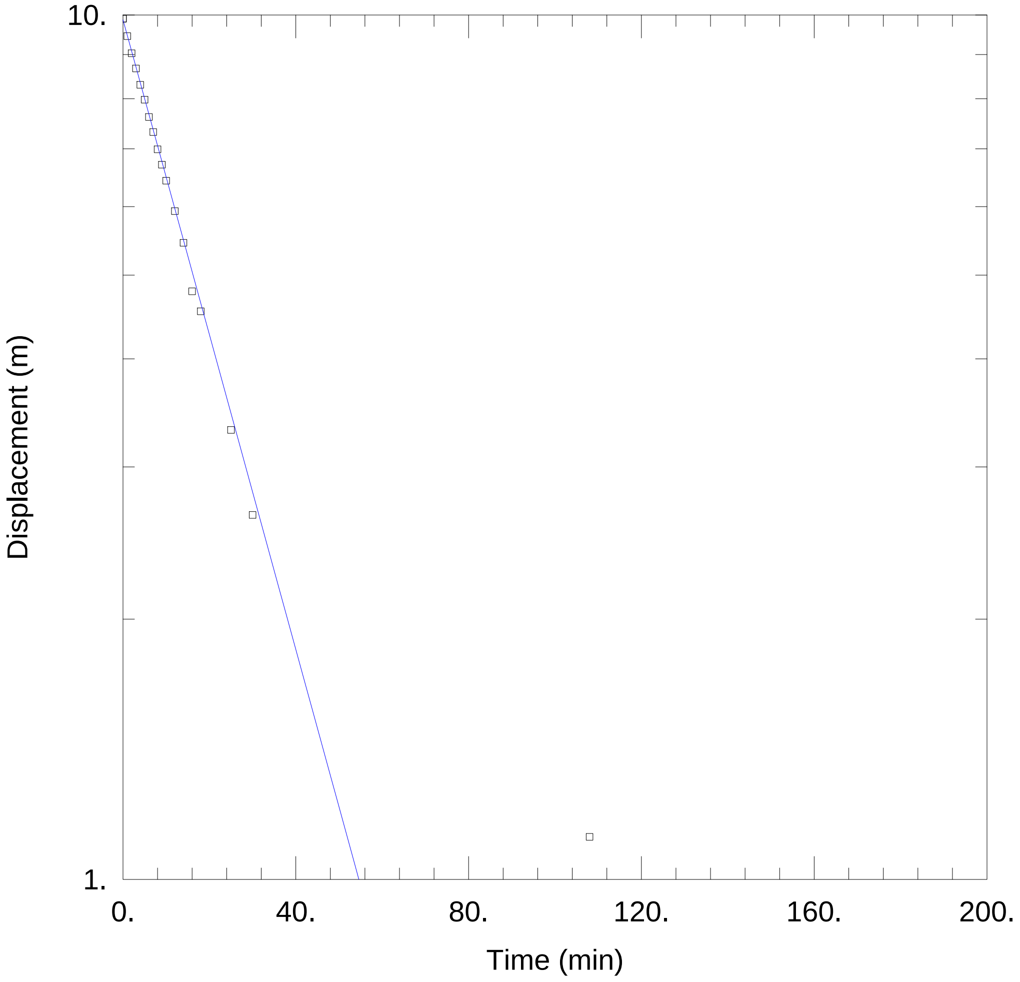
WELL DATA (New Well)

Initial Displacement: 12.4 m
Static Water Column Height: 1.07 m
Total Well Penetration Depth: 12.63 m
Screen Length: 1.5 m
Casing Radius: 0.016 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 4.978E-9 m/sec
y0 = 12.09 m



WELL TEST ANALYSIS

Data Set: C:\...\10-1.aqt
Date: 05/02/12 Time: 18:15:14

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 10-1
Test Date: 4/5/2009

AQUIFER DATA

Saturated Thickness: 3.66 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (TW 10-1)

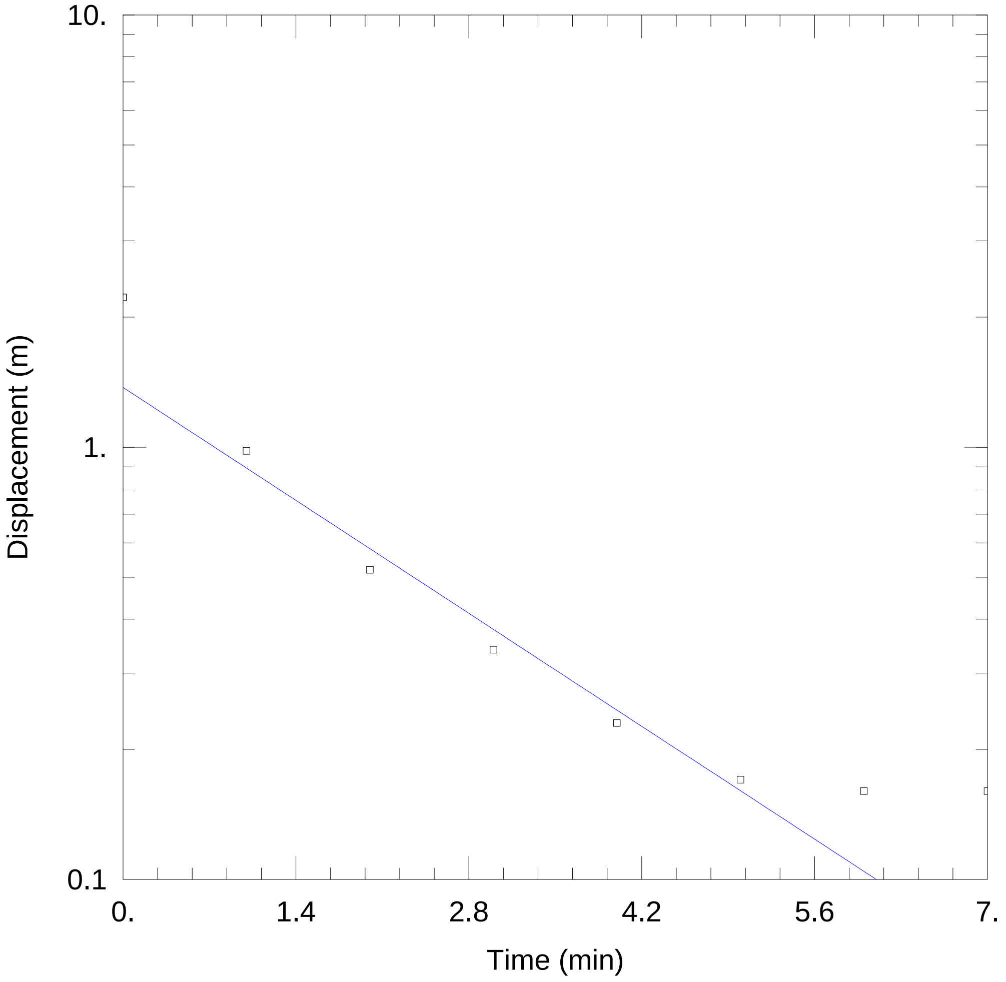
Initial Displacement: 9.9 m
Total Well Penetration Depth: 16.14 m
Casing Radius: 0.016 m

Static Water Column Height: 14.74 m
Screen Length: 3.66 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 1.295E-7 m/sec y0 = 9.873 m



WELL TEST ANALYSIS

Data Set: C:\...\10-2.aqt
Date: 05/02/12 Time: 18:22:58

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 10-2
Test Date: 4/5/2009

AQUIFER DATA

Saturated Thickness: 3.66 m
Anisotropy Ratio (Kz/Kr): 1.

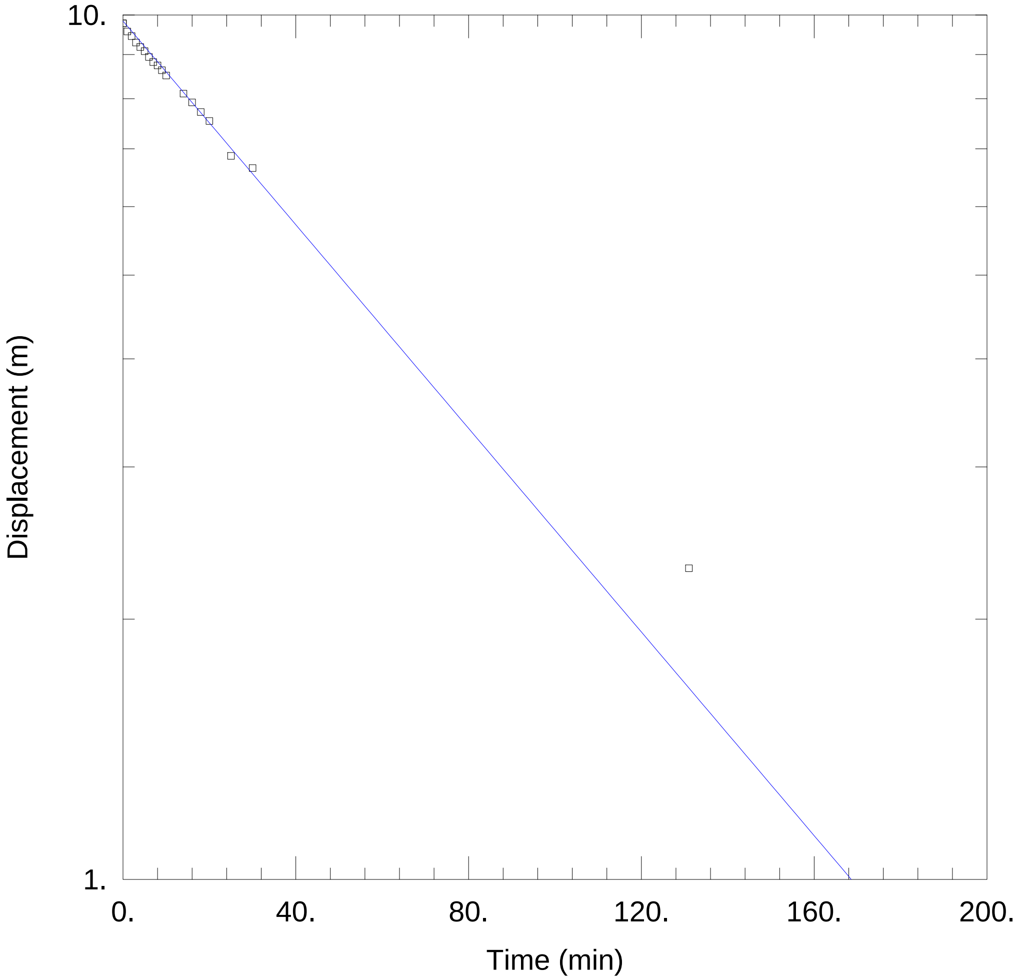
WELL DATA (TW 10-2)

Initial Displacement: 2.22 m
Static Water Column Height: 4.36 m
Total Well Penetration Depth: 5.74 m
Screen Length: 3.66 m
Casing Radius: 0.016 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.327E-6 m/sec
y0 = 1.374 m



WELL TEST ANALYSIS

Data Set: C:\...\11-1.aqt
Date: 05/02/12
Time: 20:05:10

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 11-1
Test Date: 4/5/2009

AQUIFER DATA

Saturated Thickness: 3.66 m
Anisotropy Ratio (Kz/Kr): 1.

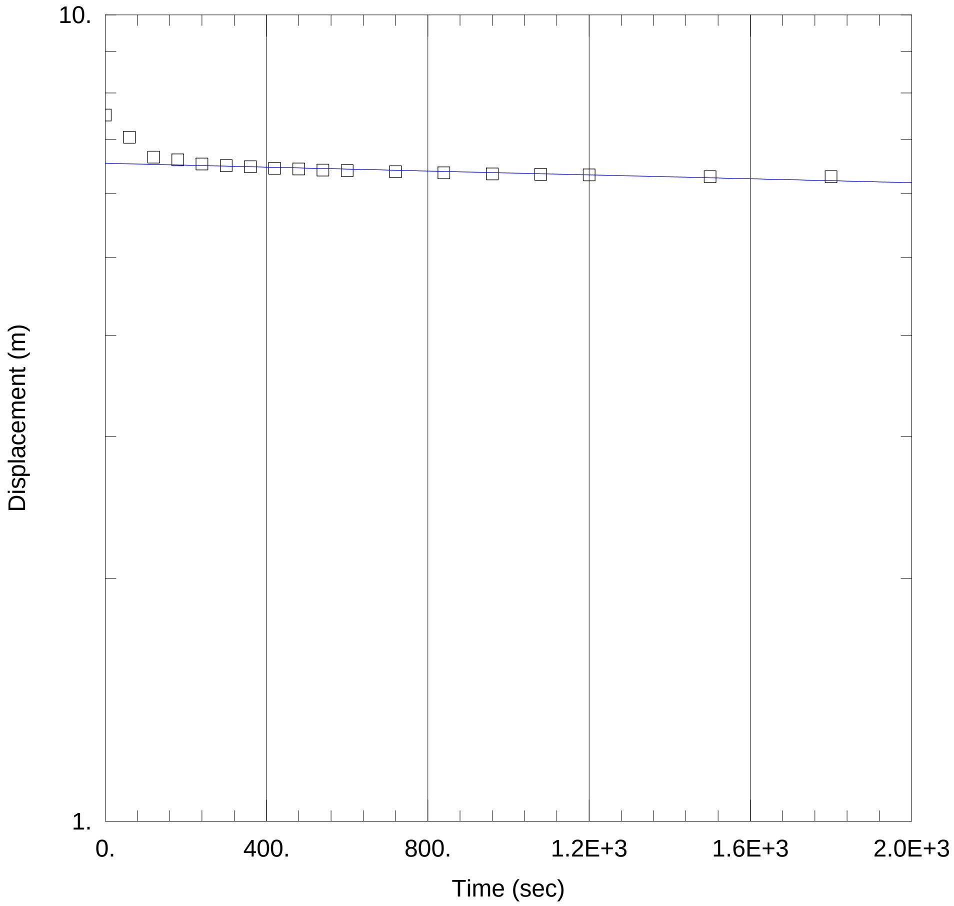
WELL DATA (TW 11-1)

Initial Displacement: 9.78 m
Static Water Column Height: 16.77 m
Total Well Penetration Depth: 28.96 m
Screen Length: 3.66 m
Casing Radius: 0.016 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 4.188E-8 m/sec
y0 = 9.838 m



MILLER BRAESIDE QUARRY MONITORING WELL 11-2 SLUG TEST DATA ANALYSIS RESULTS

Data Set: c:\...\11-2.aqt
Date: 06/17/10
Time: 15:35:29

PROJECT INFORMATION

Company: GRI and AECOM
Client: Miller Paving
Location: Braeside, Ontario
Test Well: BH11-2
Test Date: April 30, 2009

AQUIFER DATA

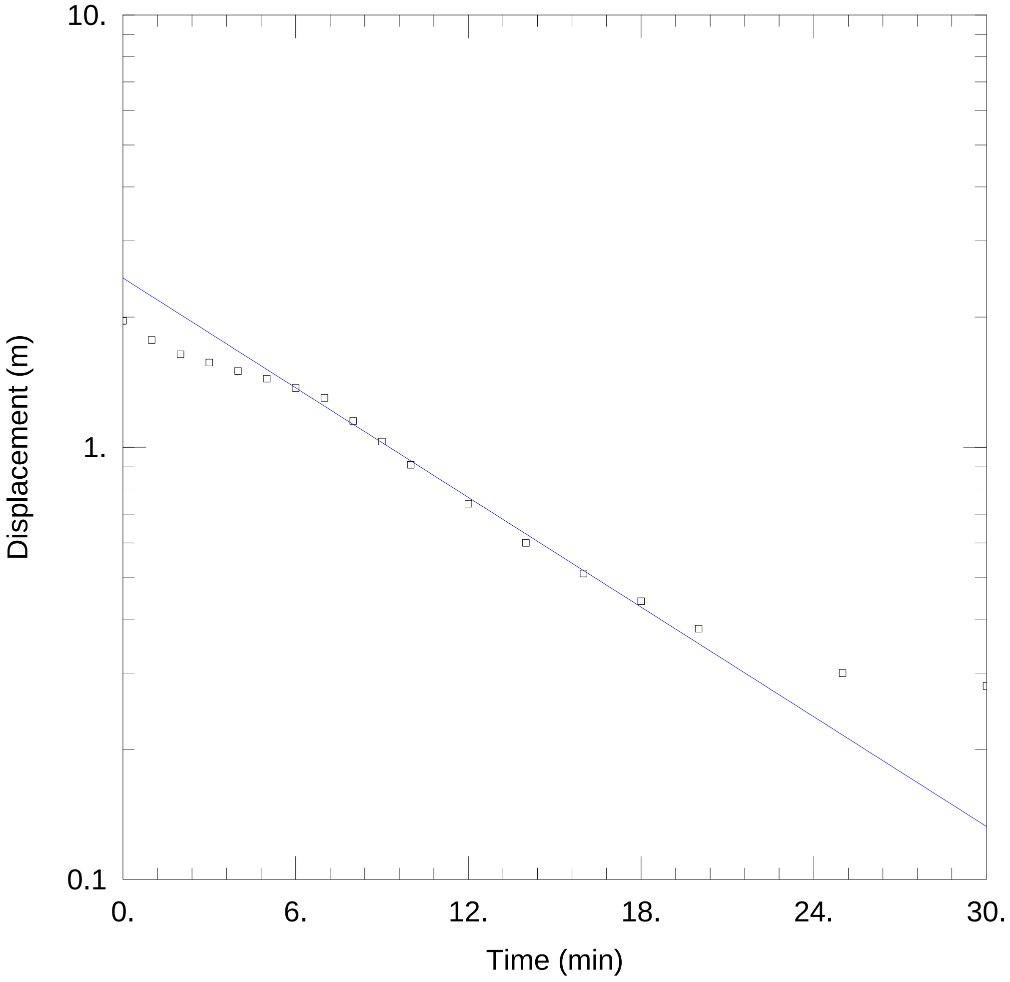
Saturated Thickness: 7.51 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (11-2)

Initial Displacement: 7.51 m
Total Well Penetration Depth: 7.51 m
Casing Radius: 0.016 m
Static Water Column Height: 7.51 m
Screen Length: 3.6 m
Well Radius: 0.016 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 6.009E-9 m/sec
y0 = 6.545 m



WELL TEST ANALYSIS

Data Set: C:\...\12-1.aqt

Date: 05/02/12 | Time: 20:10:40

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 12-1
Test Date: 4/5/2009

AQUIFER DATA

Saturated Thickness: 3.66 m | Anisotropy Ratio (Kz/Kr): 1.

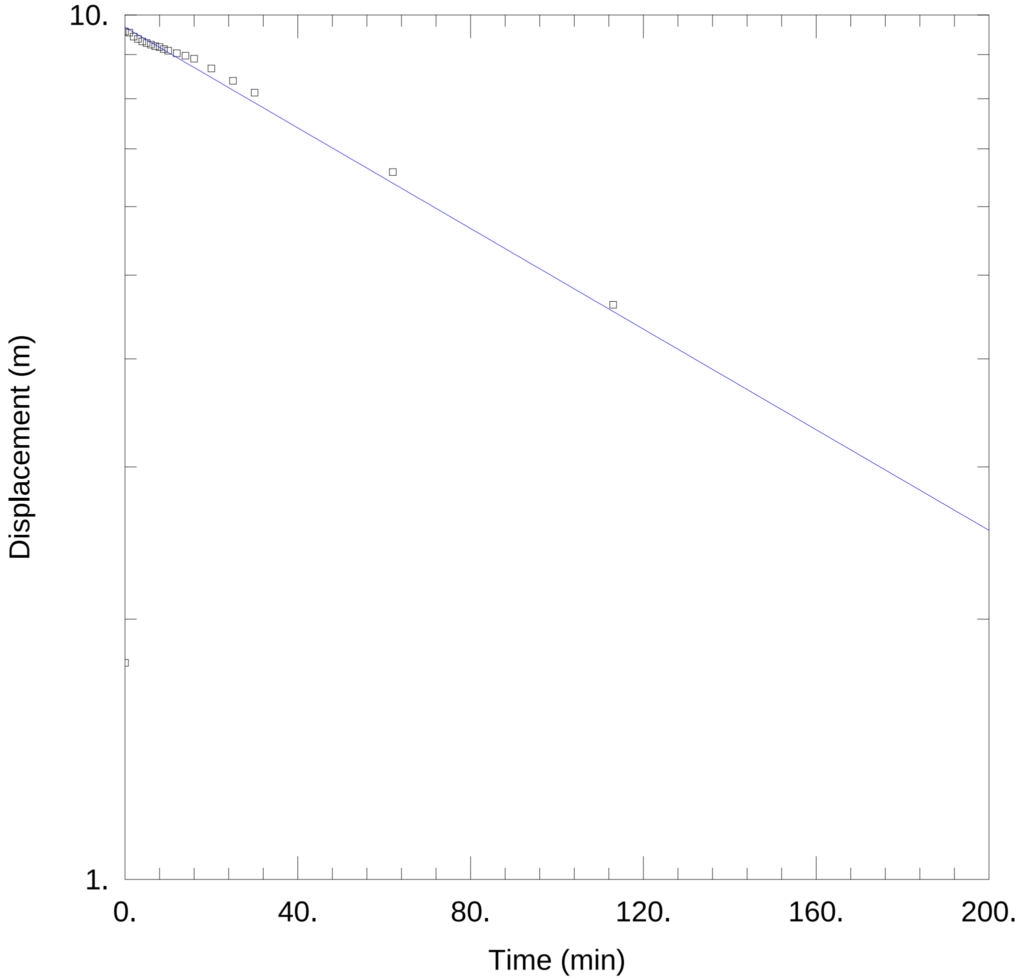
WELL DATA (TW 12-1)

Initial Displacement: 1.96 m
Total Well Penetration Depth: 12.19 m
Casing Radius: 0.016 m
Static Water Column Height: 10.92 m
Screen Length: 3.66 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.008E-7 m/sec
y0 = 2.462 m



WELL TEST ANALYSIS

Data Set: C:\...\12-2.aqt
Date: 05/02/12 Time: 20:16:19

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 12-2
Test Date: 4/5/2009

AQUIFER DATA

Saturated Thickness: 2.1 m
Anisotropy Ratio (Kz/Kr): 1.

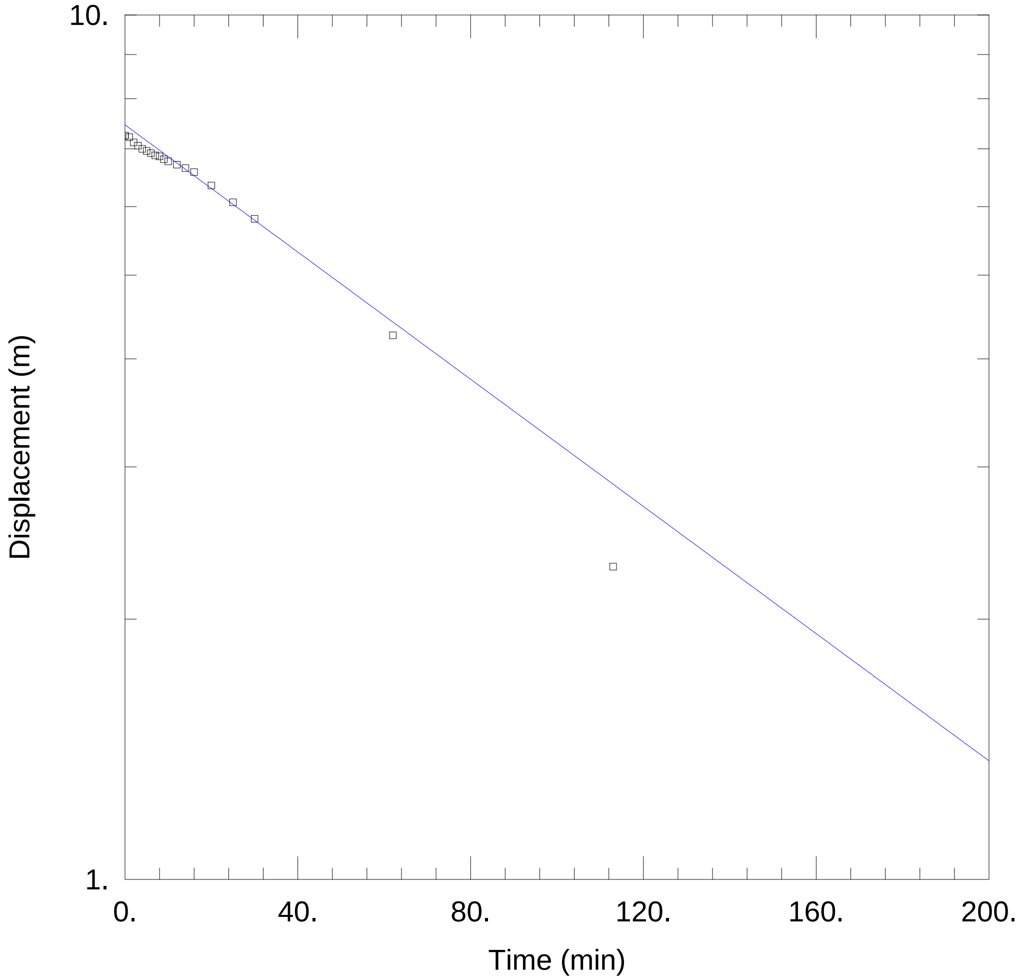
WELL DATA (TW 12-2)

Initial Displacement: 1.78 m
Static Water Column Height: 1.65 m
Total Well Penetration Depth: 3.1 m
Screen Length: 2.1 m
Casing Radius: 0.016 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.606E-8 m/sec
y0 = 9.677 m



WELL TEST ANALYSIS

Data Set: C:\...\13-1.aqt
Date: 05/02/12 Time: 20:23:03

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 13-1
Test Date: 30/4/2009

AQUIFER DATA

Saturated Thickness: 1.5 m
Anisotropy Ratio (Kz/Kr): 1.

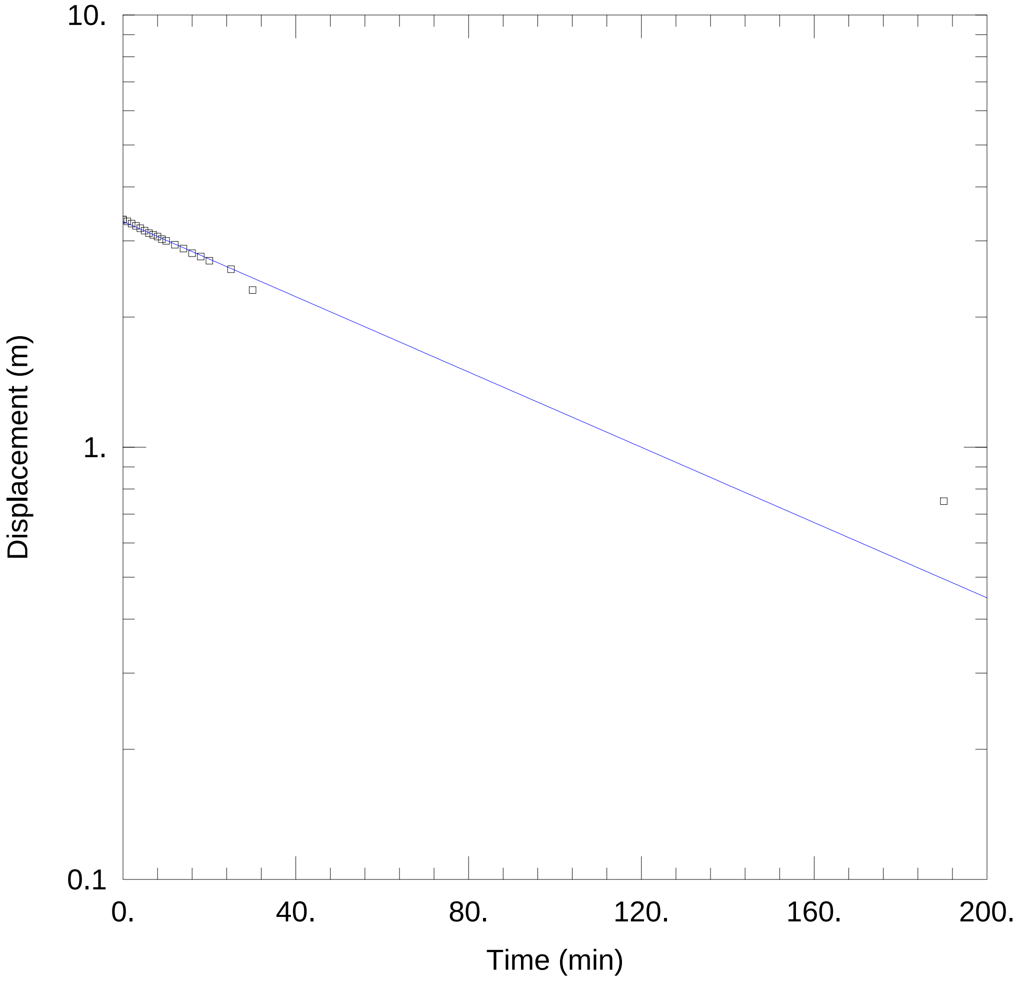
WELL DATA (TW 13-1)

Initial Displacement: 7.25 m
Static Water Column Height: 5.6 m
Total Well Penetration Depth: 9.37 m
Screen Length: 1.5 m
Casing Radius: 0.016 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 6.383E-8 m/sec
y0 = 7.462 m



WELL TEST ANALYSIS

Data Set: C:\...\13-2.aqt
Date: 05/02/12 Time: 20:29:01

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: TW 13-2
Test Date: 30/4/2009

AQUIFER DATA

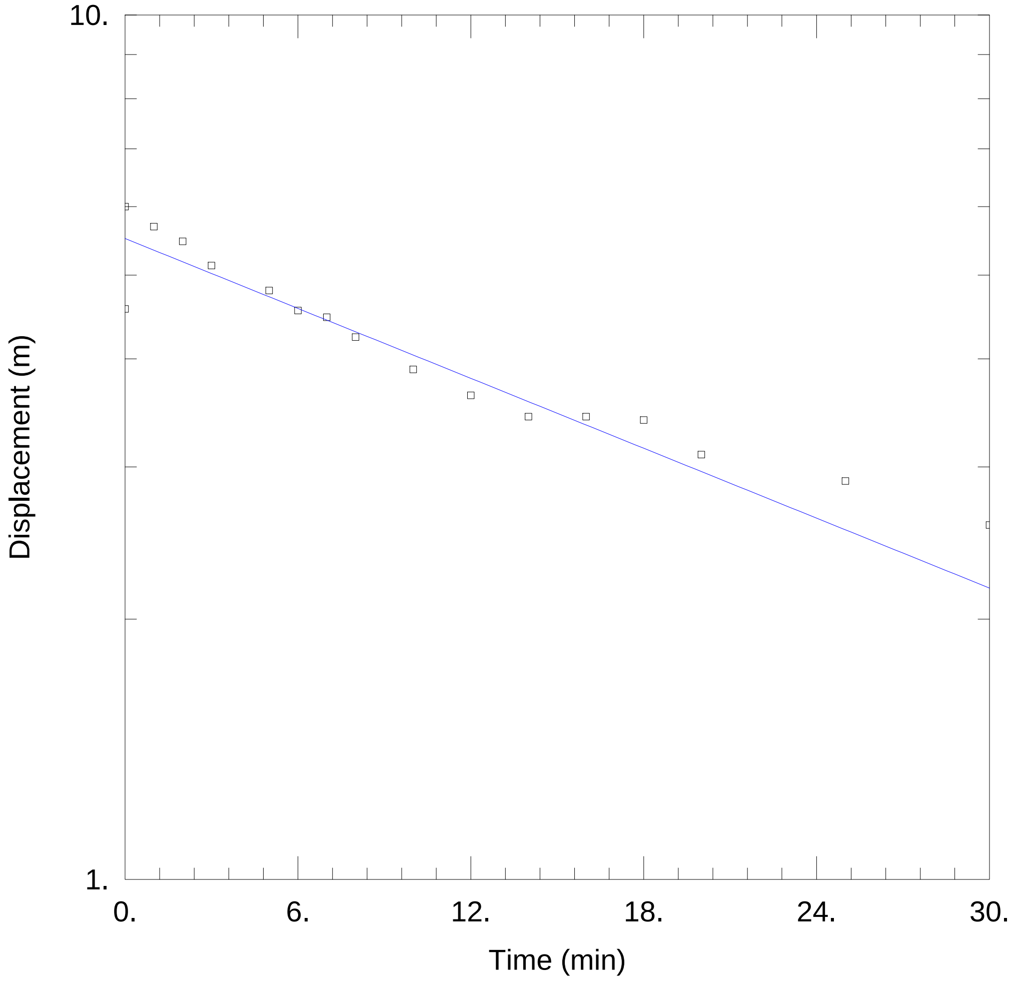
Saturated Thickness: 1.5 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (TW 13-2)

Initial Displacement: 3.36 m
Static Water Column Height: 0.7 m
Total Well Penetration Depth: 4.6 m
Screen Length: 1.5 m
Casing Radius: 0.016 m
Well Radius: 0.016 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 7.464E-8 m/sec
y0 = 3.328 m



WELL TEST ANALYSIS

Data Set: C:\...\Floor Hole F.aqt
Date: 05/03/12 Time: 10:27:09

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: Miller Hole F
Test Date: 7/5/2009

AQUIFER DATA

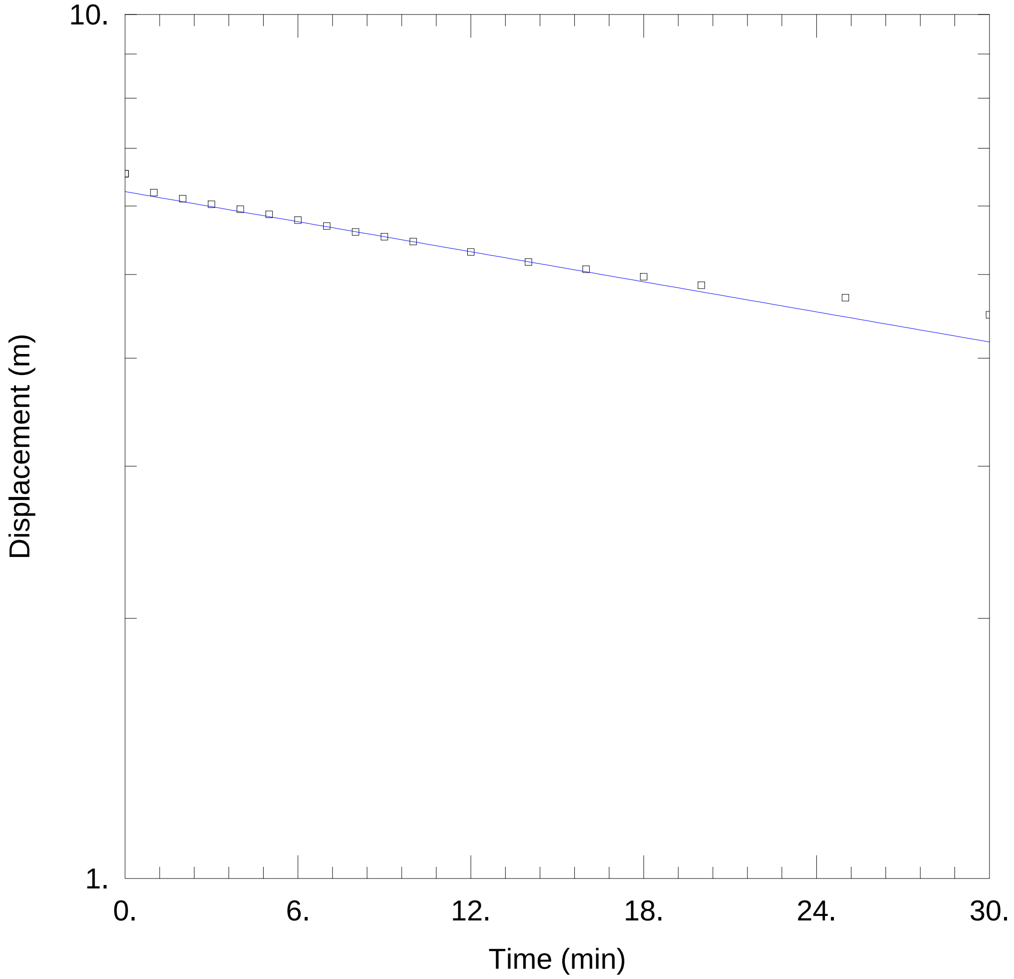
Saturated Thickness: 9.14 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Miller Hole F)

Initial Displacement: 4.57 m
Static Water Column Height: 7.71 m
Total Well Penetration Depth: 9.14 m
Screen Length: 9.14 m
Casing Radius: 0.051 m
Well Radius: 0.051 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 3.899E-7 m/sec
y0 = 5.512 m



WELL TEST ANALYSIS

Data Set: C:\...\Floor Hole G.aqt
Date: 05/03/12
Time: 10:30:36

PROJECT INFORMATION

Company: J/G Gorrell
Client: Miller Paving Ltd.
Project: 08360
Location: Braeside Quarry
Test Well: Miller Hole G
Test Date: 7/5/2009

AQUIFER DATA

Saturated Thickness: 9.14 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Floor Hole G)

Initial Displacement: 6.54 m
Static Water Column Height: 6.76 m
Total Well Penetration Depth: 9.14 m
Screen Length: 9.14 m
Casing Radius: 0.051 m
Well Radius: 0.051 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.678E-7 m/sec
y0 = 6.236 m

Appendix VI

Groundwater Elevation Data

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

Potentiometric Elevations 2006 - 2009
Miller Group Inc. Braeside Quarry

Station	Surface Elev (m)	Cased to Elev (m)	Base Hole Elev (m)	21-Dec-06	20-Apr-07	09-May-07	10-May-07	31-Jul-07	02-Oct-07
Weathered Bedrock Aquifer									
TW 9-2	152.19		140.76						
TW 10-1	145.72		130.36						
TW 10-2	145.74		139.64						
TW 13-1	139.41		130.04						
TW 13-2	139.52		134.95						
Upper Bedrock, Central Part of Plateau									
TW 1	148.98	147.78	128.87	146.83	140.31	140.99		140.00	140.41
TW 11-2	142.91		133.51						
TW 12-1	140.33		128.14						
TW 12-2	140.28		137.23						
Competent Bedrock - Significant Water Bearing Zone Intercepted									
TW 2	139.60	138.10	119.80	136.39	138.54		134.62	133.77	133.02
TW 3-1	133.90	128.41	108.90	129.96	131.46	130.87	128.80	128.24	125.64
TW 4-1	132.92	127.43	107.92	132.18	131.13	130.25	129.11	128.83	127.10
TW 4-2	133.09	127.60	120.59	132.38	131.40	130.23	129.21	128.89	127.36
TW 5-1	139.26	133.77	114.26	141.17	138.43	138.45		138.19	138.09
TW 6-1	137.95	133.28	112.95	127.33	132.43	133.86		128.56	131.87
TW 7	141.79	136.30	116.79	137.45	136.16	135.08	136.30	131.22	127.36
TW 8-1	144.97	139.48	119.97	135.09	134.55	132.32	131.52	131.12	127.72
TW 9-1	152.04		120.95						
TW 11-1	142.81		113.85						
Competent Bedrock - No Significant Water Bearing Zone Intercepted									
TW 3-2	133.88	128.39	121.38	131.27	132.65	131.84	131.36	130.97	129.90
TW 5-2	139.27	133.78	126.77	142.11	139.42	139.27	138.70	139.19	138.96
TW 6-2	138.23	132.46	125.73	132.16	133.13	133.13	127.35	130.85	131.92
TW 8-2	145.05	139.56	132.55	145.94	143.11	142.99	142.72	142.62	142.33

Potentiometric Elevations 2006 - 2009
Miller Group Inc. Braeside Quarry

Station	Surface Elev (m)	Cased to Elev (m)	Base Hole Elev (m)	30-Oct-07	14-Apr-08	05-May-08	13-Jun-08	10-Oct-08	03-Mar-09
Weathered Bedrock Aquifer									
TW 9-2	152.19		140.76						142.26
TW 10-1	145.72		130.36						
TW 10-2	145.74		139.64						
TW 13-1	139.41		130.04						136.24
TW 13-2	139.52		134.95						137.48
Upper Bedrock, Central Part of Plateau									
TW 1	148.98	147.78	128.87	140.71	140.14	142.14	140.78	140.86	
TW 11-2	142.91		133.51						
TW 12-1	140.33		128.14						
TW 12-2	140.28		137.23						
Competent Bedrock - Significant Water Bearing Zo									
TW 2	139.60	138.10	119.80	134.00	138.80	135.58		145.18	
TW 3-1	133.90	128.41	108.90	127.11	135.04	129.74	128.65	128.73	
TW 4-1	132.92	127.43	107.92	127.91	132.72	129.53	129.25	126.49	
TW 4-2	133.09	127.60	120.59	128.03	132.65	129.58	129.30	126.75	
TW 5-1	139.26	133.77	114.26	138.04	138.40	138.45	138.23	135.43	
TW 6-1	137.95	133.28	112.95	132.22	134.33	134.43	133.97	132.60	
TW 7	141.79	136.30	116.79	129.03	135.90	131.82		129.06	
TW 8-1	144.97	139.48	119.97	128.61	135.41	131.74	130.97	128.70	
TW 9-1	152.04		120.95						129.82
TW 11-1	142.81		113.85						130.82
Competent Bedrock - No Significant Water Bearing									
TW 3-2	133.88	128.39	121.38	130.34	133.40	131.78	131.30	131.94	
TW 5-2	139.27	133.78	126.77	139.28	139.45	139.33	139.33	136.58	
TW 6-2	138.23	132.46	125.73	132.16	133.25	133.36	133.36	132.68	
TW 8-2	145.05	139.56	132.55	142.84	143.33	143.10	142.94	141.25	

Potentiometric Elevations 2006 - 2009
Miller Group Inc. Braeside Quarry

Station	Surface Elev (m)	Cased to Elev (m)	Base Hole Elev (m)	30-Apr-09	04-May-09	06-May-09	20-May-09	22-Jul-09	24-Sep-09	23-Nov-09
Weathered Bedrock Aquifer										
TW 9-2	152.19		140.76		141.63		141.81	141.60	141.13	141.64
TW 10-1	145.72		130.36		145.31		144.90	145.12	144.71	145.37
TW 10-2	145.74		139.64		145.38		144.98	145.19	144.78	145.45
TW 13-1	139.41		130.04	136.56	136.22		134.98	136.06	135.86	136.27
TW 13-2	139.52		134.95	136.55	136.53		135.98	136.33	136.11	136.63
Upper Bedrock, Central Part of Plateau										
TW 1	148.98	147.78	128.87			142.67	143.24	141.05	141.48	142.57
TW 11-2	142.91		133.51	142.77	137.40		140.60	142.34	142.44	142.64
TW 12-1	140.33		128.14	140.11	139.94		139.77	139.89	139.65	140.06
TW 12-2	140.28		137.23	139.91	139.77		139.65	139.73	139.48	139.88
Competent Bedrock - Significant Water Bearing Zc										
TW 2	139.60	138.10	119.80			134.66	132.36	133.14	132.54	134.57
TW 3-1	133.90	128.41	108.90			128.70	127.42	126.39	125.60	127.35
TW 4-1	132.92	127.43	107.92			129.58	128.81	128.38	127.77	128.56
TW 4-2	133.09	127.60	120.59			129.65	128.84	128.47	127.88	128.70
TW 5-1	139.26	133.77	114.26			138.42	138.31	138.14	138.00	138.20
TW 6-1	137.95	133.28	112.95			133.75	133.69	133.41	133.30	133.32
TW 7	141.79	136.30	116.79			131.96	131.07	130.56	127.70	131.00
TW 8-1	144.97	139.48	119.97			132.26	130.83	130.41	127.83	129.91
TW 9-1	152.04		120.95		129.56		127.19	125.93	125.05	127.20
TW 11-1	142.81		113.85		131.62		129.98	129.74	127.80	128.79
Competent Bedrock - No Significant Water Bearing										
TW 3-2	133.88	128.39	121.38			131.80	131.05	130.91	130.63	131.47
TW 5-2	139.27	133.78	126.77			139.33	139.18	139.17	138.93	139.34
TW 6-2	138.23	132.46	125.73			133.57	133.46	133.38	133.32	133.37
TW 8-2	145.05	139.56	132.55			143.24	142.90	143.16	142.80	143.37

Appendix VII

Laboratory Reports –

General Groundwater and Surface Water Quality

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

ACCUTEST LABORATORIES - A New Bodycote Company

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Mr. George Gorrell**

Report Number: 2908063
Date: 2009-04-27
Date Submitted: 2009-04-20

Project: 07100

P.O. Number:
Matrix: Surfacewater

Chain of Custody Number: **94630**

		LAB ID:	706486	706487	706488	706489	706490	**GUIDELINE**		
		Sample Date:	2009-04-17	2009-04-17	2009-04-17	2009-04-17	2009-04-17	Provincial Water Quality Objectives - MOE 1999		
		Sample ID:	SP1-T	SP1-M	SP1-B	SP2-T	SP2-M			
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Alkalinity as CaCO3	mg/L	5	164	168	168	175	179			
Chloride	mg/L	1	2	3	2	2	2			
Conductivity	uS/cm	5	312	322	321	329	337			
Fluoride	mg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10			
N-NO3 (Nitrate)	mg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10			
pH			7.97	8.11	8.09	8.11	8.04		6.5-8.5	
Sulphate	mg/L	1	2	5	5	4	4			
CO3 as CaCO3	mg/L	2	N/A-PH	N/A-PH	N/A-PH	N/A-PH	N/A-PH			
Hardness as CaCO3	mg/L	1	156	170	160	173	171			
HCO3 as CaCO3	mg/L	5	164	168	168	175	179			
Ion Balance		0.01	0.93	0.96	0.91	0.95	0.92			
Calcium	mg/L	1	61	63	59	66	65			
Magnesium	mg/L	1	1	3	3	2	2			
Potassium	mg/L	1	<1	<1	<1	<1	<1			
Sodium	mg/L	2	<2	<2	<2	<2	<2			
Iron	mg/L	0.03	<0.03	<0.03	<0.03	0.07	<0.03	PWQO	0.30	mg/L
Manganese	mg/L	0.01	0.01	<0.01	<0.01	0.03	<0.01			

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

N/A-PH = Not Available - pH < 8.3 calculations not available.

APPROVAL: ____________________
Ewan McRobbie
Inorganic Lab Supervisor

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Mr. George Gorrell**

Report Number: 2908063
Date: 2009-04-27
Date Submitted: 2009-04-20
Project: 07100
P.O. Number:
Matrix: Surfacewater

Chain of Custody Number: **94630**

LAB ID:			706491	706492	706493	706494		**GUIDELINE**		
Sample Date:			2009-04-17	2009-04-20	2009-04-20	2009-04-20		Provincial Water Quality Objectives - MOE 1999		
Sample ID:			SP2-B	SP3-T	SP3-M	SP3-B				
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Alkalinity as CaCO3	mg/L	5	203	181	175	261				
Chloride	mg/L	1	3	<1	1	104				
Conductivity	uS/cm	5	384	341	353	856				
Fluoride	mg/L	0.10	<0.10	<0.10	<0.10	<0.10				
N-NO3 (Nitrate)	mg/L	0.10	<0.10	<0.10	0.12	<0.10				
pH			8.22	8.13	8.04	8.03			6.5-8.5	
Sulphate	mg/L	1	6	2	14	17				
CO3 as CaCO3	mg/L	2	N/A-PH	N/A-PH	N/A-PH	N/A-PH				
Hardness as CaCO3	mg/L	1	194	176	178	326				
HCO3 as CaCO3	mg/L	5	203	181	175	261				
Ion Balance		0.01	0.91	0.98	0.93	0.96				
Calcium	mg/L	1	71	67	63	109				
Magnesium	mg/L	1	4	2	5	13				
Potassium	mg/L	1	<1	<1	<1	1				
Sodium	mg/L	2	<2	2	<2	38				
Iron	mg/L	0.03	0.07	0.08	<0.03	0.20		PWQO	0.30	mg/L
Manganese	mg/L	0.01	0.22	0.05	<0.01	0.23				

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: ____________________
Ewan McRobbie
Inorganic Lab Supervisor

ACCUTEST LABORATORIES - A New Bodycote Company

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Mr. George Gorrell**

Report Number: 2908064
Date: 2009-04-28
Date Submitted: 2009-04-20
Project: 07100

P.O. Number:
Matrix: Surfacewater

Chain of Custody Number: **10777**

		LAB ID:	706495	706496	706497	706498		**GUIDELINE**		
		Sample Date:	2009-04-20	2009-04-20	2009-04-20	2009-04-20		Provincial Water Quality Objectives - MOE 1999		
		Sample ID:	SW2	SW4	SW5	SW6				
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Alkalinity as CaCO3	mg/L	5	187	188	259	188				
Chloride	mg/L	1	64	64	95	67				
Conductivity	uS/cm	5	659	587	920	588				
Fluoride	mg/L	0.10	0.13	0.16	<0.10	0.16				
N-NH3 (Ammonia)	mg/L	0.02	<0.02	<0.02	<0.02	<0.02				
N-NO2 (Nitrite)	mg/L	0.10	<0.10	<0.10	<0.10	<0.10				
N-NO3 (Nitrate)	mg/L	0.10	<0.10	0.15	0.20	0.14				
pH			8.08	8.27	8.27	8.28			6.5-8.5	
Sulphate	mg/L	1	54	12	88	13				
Total Dissolved Solids (COND - CALC)	mg/L	5	428	382	598	382				
Total Kjeldahl Nitrogen	mg/L	0.10	0.12	0.41	0.16	0.43				
Total Phosphorus	mg/L	0.01	0.01	0.04	<0.01	0.03		IPWQO	0.02	mg/L
Total Suspended Solids	mg/L	2	3	4	3	5				
CO3 as CaCO3	mg/L	2	N/A-PH	N/A-PH	N/A-PH	N/A-PH				
Hardness as CaCO3	mg/L	1	232	189	371	197				
HCO3 as CaCO3	mg/L	5	187	188	259	188				
Ion Balance		0.01	0.92	0.92	0.97	0.96				
Calcium	mg/L	1	78	51	127	56				
Magnesium	mg/L	1	9	15	13	14				
Potassium	mg/L	1	1	3	1	3				
Sodium	mg/L	2	34	35	45	39				
Aluminum	mg/L	0.01	0.02	0.20	0.02	0.19		IPWQO	0.075	mg/L
Barium	mg/L	0.01	0.03	0.02	0.05	0.02				
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001		PWQO	0.011	mg/L
Boron	mg/L	0.01	0.01	0.02	0.04	0.02		IPWQO	0.200	mg/L
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001		PWQO	0.0002	mg/L
Chromium	mg/L	0.001	0.002	0.002	0.003	0.002				
Cobalt	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002		PWQO	0.0009	mg/L
Copper	mg/L	0.001	<0.001	0.002	<0.001	<0.001		PWQO	0.005	mg/L
Iron	mg/L	0.03	<0.03	0.16	<0.03	0.15		PWQO	0.30	mg/L

MRL = Method Reporting Limit   INC = Incomplete   AO = Aesthetic Objective   OG = Operational Guideline   MAC = Maximum Allowable Concentration   IMAC = Interim Maximum Allowable Concentration

Comment:

N/A-PH = Not Available - pH < 8.3 calculations not available.

APPROVAL:
Ewan McRobbie
Inorganic Lab Supervisor

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Mr. George Gorrell**

Report Number: 2908064
Date: 2009-04-28
Date Submitted: 2009-04-20

Project: 07100

P.O. Number:
Matrix: Surfacewater

Chain of Custody Number: **10777**

		LAB ID:	706495	706496	706497	706498		**GUIDELINE**		
		Sample Date:	2009-04-20	2009-04-20	2009-04-20	2009-04-20		Provincial Water Quality Objectives - MOE 1999		
		Sample ID:	SW2	SW4	SW5	SW6				
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001		PWQO	0.005	mg/L
Manganese	mg/L	0.01	<0.01	0.03	<0.01	0.02				
Molybdenum	mg/L	0.005	<0.005	<0.005	<0.005	<0.005		IPWQO	0.040	mg/L
Nickel	mg/L	0.005	<0.005	<0.005	<0.005	<0.005		PWQO	0.025	mg/L
Silicon	mg/L	0.1	2.9	2.0	3.2	1.9				
Silver	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001		PWQO	0.0001	mg/L
Strontium	mg/L	0.001	0.345	0.298	1.90	0.302				
Thallium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001		IPWQO	0.0003	mg/L
Titanium	mg/L	0.01	<0.01	0.01	<0.01	0.01				
Vanadium	mg/L	0.001	0.004	0.005	0.006	0.005		IPWQO	0.006	mg/L
Zinc	mg/L	0.01	<0.01	<0.01	<0.01	<0.01		PWQO	0.030	mg/L

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: ____________________
Ewan McRobbie
Inorganic Lab Supervisor

ACCUTEST LABORATORIES - A New Bodycote Company

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Mr. George Gorrell**

Report Number: 2908064
Date: 2009-04-28
Date Submitted: 2009-04-20
Project: 07100
P.O. Number:
Matrix: Surfacewater

Chain of Custody Number: **10777**

		LAB ID:	706495	706496	706497	706498		**GUIDELINE**		
		Sample Date:	2009-04-20	2009-04-20	2009-04-20	2009-04-20		Provincial Water Quality Objectives - MOE 1999		
		Sample ID:	SW2	SW4	SW5	SW6				
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
2,4-dinitrotoluene	ug/L	0.3	<0.3	<0.3	<0.3	<0.3		IPWQO	4	ug/L
2,6-dinitrotoluene	ug/L	0.3	<0.3	<0.3	<0.3	<0.3		IPWQO	6	ug/L

MRL = Method Reporting Limit   INC = Incomplete   AO = Aesthetic Objective   OG = Operational Guideline   MAC = Maximum Allowable Concentration   IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL:
Mina Nasirai
Organic Lab Supervisor

ACCUTEST LABORATORIES - A New Bodycote Company

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Ms. Jennifer Gorrell**

Report Number: 2915792
Date: 2009-07-07
Date Submitted: 2009-07-03

Project: 08160

P.O. Number:
Matrix: Water

Chain of Custody Number: **98448**

LAB ID:			727038	727039	727041			**GUIDELINE**		
Sample Date:			2009-07-03	2009-07-03	2009-07-03					
Sample ID:			9-2	10-1	13-1					
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Alkalinity as CaCO3	mg/L	5	228	262	221					
Chloride	mg/L	1	13	7	2					
Conductivity	uS/cm	5	1020	538	455					
Fluoride	mg/L	0.10	0.16	0.58	0.26					
N-NH3 (Ammonia)	mg/L	0.02	<0.02	0.11	0.07					
N-NO2 (Nitrite)	mg/L	0.10	<0.10	<0.10	<0.10					
N-NO3 (Nitrate)	mg/L	0.10	<0.10	<0.10	<0.10					
pH			7.78	7.93	8.02					
Sulphate	mg/L	1	322	24	28					
Total Dissolved Solids (COND - CALC)	mg/L	5	714	350	296					
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10	0.41	0.34					
Total Suspended Solids	mg/L	2	6280	22	6130					
CO3 as CaCO3	mg/L	2	N/A-PH	N/A-PH	N/A-PH					
Hardness as CaCO3	mg/L	1	558	263	224					
HCO3 as CaCO3	mg/L	5	228	262	221					
Ion Balance		0.01	1.01	1.02	1.04					
Calcium	mg/L	1	189	64	70					
Magnesium	mg/L	1	21	25	12					
Potassium	mg/L	1	4	7	3					
Sodium	mg/L	2	11	15	16					
Aluminum	mg/L	0.01	0.04	<0.01	0.06					
Antimony	mg/L	0.0001	0.0009	0.0002	0.0008					
Arsenic	mg/L	0.001	0.001	0.001	0.001					
Barium	mg/L	0.01	0.04	0.02	0.05					
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001					
Boron	mg/L	0.01	0.03	0.18	0.05					
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001					
Chromium	mg/L	0.001	0.003	0.003	0.002					
Cobalt	mg/L	0.0002	0.0010	0.0003	0.0002					
Copper	mg/L	0.001	<0.001	<0.001	0.002					

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

727038: N/A-PH = Not Available - pH < 8.3 calculations not available.
727039: N/A-PH = Not Available - pH < 8.3 calculations not available.

727041: Sample was filtered prior to analysis for Metals. N/A-PH = Not Available - pH < 8.3 calculations not available.

APPROVAL: ____________
Ewan McRobbie
Inorganic Lab Supervisor

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Ms. Jennifer Gorrell**

Report Number: 2915792
Date: 2009-07-07
Date Submitted: 2009-07-03
Project: 08160
P.O. Number:
Matrix: Water

Chain of Custody Number: **98448**

LAB ID:			727038	727039	727041			**GUIDELINE**		
Sample Date:			2009-07-03	2009-07-03	2009-07-03					
Sample ID:			9-2	10-1	13-1					
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Iron	mg/L	0.03	<0.03	0.03	0.06					
Lead	mg/L	0.001	<0.001	<0.001	<0.001					
Manganese	mg/L	0.01	0.03	0.02	0.01					
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001					
Molybdenum	mg/L	0.005	<0.005	0.009	0.007					
Nickel	mg/L	0.005	<0.005	<0.005	<0.005					
Selenium	mg/L	0.001	<0.001	<0.001	<0.001					
Silicon	mg/L	0.1	2.8	4.3	3.4					
Silver	mg/L	0.0001	<0.0001	<0.0001	<0.0001					
Strontium	mg/L	0.001	0.932	3.11	0.487					
Thallium	mg/L	0.0001	0.0002	<0.0001	<0.0001					
Titanium	mg/L	0.01	<0.01	<0.01	<0.01					
Vanadium	mg/L	0.001	0.007	0.006	0.004					
Zinc	mg/L	0.01	0.02	0.01	<0.01					

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL:
Ewan McRobbie
Inorganic Lab Supervisor

ACCUTEST LABORATORIES - A New Bodycote Company

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Ms. Jennifer Gorrell**

Report Number: 2915793
Date: 2009-07-07
Date Submitted: 2009-07-03

Project: 08160

P.O. Number:
Matrix: Water

Chain of Custody Number: 98448

LAB ID:			727042	727043				**GUIDELINE**		
Sample Date:			2009-07-03	2009-07-03						
Sample ID:			9-1	10-2						
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Calcium	mg/L	1	143	64						
Magnesium	mg/L	1	18	26						
Potassium	mg/L	1	2	5						
Sodium	mg/L	2	5	3						
Aluminum	mg/L	0.01	0.54	0.19						
Antimony	mg/L	0.0001	<0.0001	<0.0001						
Arsenic	mg/L	0.001	0.004	<0.001						
Barium	mg/L	0.01	0.08	0.13						
Beryllium	mg/L	0.001	<0.001	<0.001						
Boron	mg/L	0.01	0.12	0.06						
Cadmium	mg/L	0.0001	0.0002	<0.0001						
Chromium	mg/L	0.001	0.006	0.002						
Cobalt	mg/L	0.0002	0.0073	<0.0002						
Copper	mg/L	0.001	0.007	<0.001						
Iron	mg/L	0.03	3.82	0.22						
Lead	mg/L	0.001	0.005	0.002						
Manganese	mg/L	0.01	0.16	<0.01						
Mercury	mg/L	0.0001	<0.0001	<0.0001						
Molybdenum	mg/L	0.005	<0.005	<0.005						
Nickel	mg/L	0.005	0.008	<0.005						
Selenium	mg/L	0.001	<0.001	0.003						
Silicon	mg/L	0.1	4.5	5.0						
Silver	mg/L	0.0001	<0.0001	<0.0001						
Strontium	mg/L	0.001	29.1	2.89						
Thallium	mg/L	0.0001	0.0001	<0.0001						
Titanium	mg/L	0.01	<0.01	0.01						
Vanadium	mg/L	0.001	0.009	0.006						
Zinc	mg/L	0.01	0.24	<0.01						

MRL = Method Reporting Limit   INC = Incomplete   AO = Aesthetic Objective   OG = Operational Guideline   MAC = Maximum Allowable Concentration   IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: ____________________
Ewan McRobbie
Inorganic Lab Supervisor

REPORT OF ANALYSIS

Client: **Gorrell Resource Investigations**
R.R. #1
Oxford Mills, ON
K0G 1S0
Attention: **Ms. Jennifer Gorrell**

Report Number: 2916040
Date: 2009-07-09
Date Submitted: 2009-07-07
Project: 08160
P.O. Number:
Matrix: Water

Chain of Custody Number: **98713**

		LAB ID:	727577	727578				**GUIDELINE**		
		Sample Date:	2009-07-06	2009-07-06				ODWSOG		
		Sample ID:	9-1	10-2						
PARAMETER	**UNITS**	**MRL**						**TYPE**	**LIMIT**	**UNITS**
Alkalinity as CaCO3	mg/L	5	250	250				OG	500	mg/L
Chloride	mg/L	1	2	2				AO	250	mg/L
Conductivity	uS/cm	5	480	479						
Fluoride	mg/L	0.10	0.46	0.46				MAC	1.5	mg/L
N-NH3 (Ammonia)	mg/L	0.02	0.11	0.07						
N-NO2 (Nitrite)	mg/L	0.10	<0.10	<0.10				MAC	1.0	mg/L
N-NO3 (Nitrate)	mg/L	0.10	<0.10	<0.10				MAC	10.0	mg/L
pH			8.07	8.08					6.5-8.5	
Sulphate	mg/L	1	78	14				AO	500	mg/L
Total Dissolved Solids (COND - CALC)	mg/L	5	312	311				AO	500	mg/L
Total Kjeldahl Nitrogen	mg/L	0.10	0.34	0.16						
Total Suspended Solids	mg/L	2	306	133						
CO3 as CaCO3	mg/L	2	N/A-PH	N/A-PH						
Hardness as CaCO3	mg/L	1	315	235				OG	100	mg/L
HCO3 as CaCO3	mg/L	5	250	250						
Ion Balance		0.01	0.97	0.92						
Calcium	mg/L	1	93	56						
Magnesium	mg/L	1	20	23						
Potassium	mg/L	1	2	5						
Sodium	mg/L	2	4	3				MAC	20	mg/L
Iron	mg/L	0.03	0.23	0.24				AO	0.3	mg/L
Manganese	mg/L	0.01	0.09	<0.01				AO	0.05	mg/L

MRL = Method Reporting Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:
N/A-PH = Not Available - pH < 8.3 calculations not available.

APPROVAL: ____________
Ewan McRobbie
Inorganic Lab Supervisor

Appendix VIII

Qualifications

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

George A. Gorrell M.Sc. P.Geo. F.G.A.C.

GEORGE A. GORRELL M.SC. P.GEO. F.G.A.C.

Education

1979: B.A.(Hon), University of Waterloo, Geography (Terrain Evaluation).
1986: M.Sc., Queen's University, Kingston.

Affiliations

Geological Association of Canada, Fellow, 1990
Association of Professional Geoscientists of Ontario - 2003
Canadian Sedimentology Research Group, 1989
Ontario Water Well Technician

Work Experience

July 2010 to present:	BGC Engineering Inc.; Senior Geoscientist
March 1989 to present[1]:	Gorrell Resource Investigations; Partner, Senior Project Manager, Geologist and Hydrogeologist.
November, 1987 - March 1989:	Ministry of Northern Development and Mines; working out of Ministry of Natural Resources office, Kemptville; Geologist.
August 1987 - November 1987:	Consulting geologist for the Multi-disciplinary Agency investigating Neo-tectonics in Eastern Canada (MAGNEC).
June, 1986 - August 1987,	Ministry of Northern Development and Mines; working out of Ministry of Natural Resources office, Kemptville; Geologist;
September, 1984 - June 1986:	Queen's University, Kingston, Teaching Assistant.
May, 1984 - September, 1984:	Consultant for the South Nation Conservation Authority, Berwick, Ontario.
May, 1979 - May, 1984:	Ministry of Natural Resources, Kemptville; Geologist and Senior Party Chief.

---

[1] Intermittent since July 2010

Project History

Gorrell Resource Investigations has completed over 1200 projects in the fields of geology, hydrogeology and related engineering services since its inception in late 1988, and I have had input into every project. Specifically, the projects I have worked on are in the following areas of expertise.

Resource and Source Water Protection Mapping

- Review of Areas of Natural and Scientific Interest – Earth Science ANSIs. Projects completed for Ministry of Natural Resources in Oak Ridges Moraine Study Area, Champlain Sea, Lake Ontario and Kemptville District. Also have conducted development-related site-specific reviews for clients to address requests for assessment to determine how sites may best be protected under development pressures as a liaison between clients and MNR.
- Assessment of granular deposits for their aggregate potential on the Oak Ridges Moraine, in Eastern Ontario (for Northern Development and Mines) and in parts of the Provinces of Nova Scotia, New Brunswick and Quebec
- Sedimentological mapping of buried granular deposits within Eastern Ontario with assessment of their use for blending sand and as communal aquifers. Emphasis was placed on bedform structure and sequences, which was applied to the usability of the sediment.
- Geological Survey of Canada; Hydrogeology of the Oak Ridges Moraine, Rice Lak, Van Dorf, Nobleton, Aurora, King City, Caledon, Credit River, Schomberg, and Pontypool Holes – deep hole logging.
- Geological Survey of Canada; geological mapping, Rice Lake map sheet.
- Geological Survey of Canada; Potential Neotectonic Earth Quakes in Ottawa Valley; Deep Surficial Drilling, Alfred Ontario, 2002
- South Nation Conservation Authority, Geological Survey of Canada, Ontario Geological Survey, Source Water Protection, Kars to Chesterville - Supervised drilling project

Sedimentology Studies

- Micro-scale sedimentological mapping of deep boreholes from various locations on the Oak Ridges Moraine for Natural Resources Canada
- Detailed analysis of the surficial materials and features of parts of Prince Edward County, Ontario to determine whether any of the features are due to neo-tectonic movement.
- Detailed sedimentological investigation of portions of the Mattagami River, Moose River Basin, Parts of Gardiner and Morrow Townships, District of Cochrane
- Detailed geological investigation of portions of the South Nation River to delineate areas susceptible to earthflow based on depositional history.
- Geological investigation of the Groveton Bog, County of Grenville as a possible reservoir of water for the South Nation River. The study examined the surficial materials, hydrological regime and ramifications of the project.

- Investigation of sedimentological causes of earthflows and other types of slope failure in Champlain Sea deposits of Eastern Ontario (for South Nation River Conservation Authority, Mississippi River Conservation Authority).
- Investigation of possible neo-tectonic movement in Prince Edward County, Ontario.

Hydrogeologic Testing

- Design and installation of groundwater monitoring systems in stratified and fractured deposits for various applications;
- Design and supervision of test well construction.
- Hydrogeological evaluation of the Groveton Bog, County of Grenville (South Nation River Conservation Authority).

Quarry Investigations

- Analysis of proposed quarry sites to evaluate potential impacts on hydrogeological regime.

Waste Management Studies

- Hydrogeological and geological site investigations, development of waste management plans, operation plans and contingency plans for municipal and industrial waste disposal sites.

Environmental Planning and Management

- Development feasibility studies for residential, commercial and industrial projects.

Terrain Analysis

- Aerial photograph interpretation and field mapping for geological, hydrogeological and engineering features;
- Planning and supervision of soil testing programs.

Presentations

- Ontario Geoscience Seminar (1986, 1987)
- Canadian Sedimentology Research Group (1987)
- Geological Association of Canada, (1989)
- Field Trip Leader, INQUA XII Congress
- Field Trip Leader, Canadian Sedimentology Research Group, 1989

Oak Ridges Moraine field trip, 2003

- Oak Ridges Moraine field trip, 2004
- Field trip, INQUA 2007
- Field trip, IAH CGS 2007
- Field Trip Leader, 60th Canadian Geotechnical Conference and 8th Joint, 2007
- Field Trip Leader, Canqua, Ottawa 2007

Publications

Barnett, P.J., Sharpe, D.R., Russell, H., Brennand, T.A., Gorrell, G., Pullan, S. and Kenny, F.M. 1997. On the origin of the Oak Ridges Moraine; Geological Association of Canada, Program with Abstracts, Ottawa'97

Barnett, P.J., Sharpe, D.R., Brennand, T.A., Russell. H.A.J., Gorrell, G., Kenny, F. in press. On the Origin of the Oak Ridges Moraine, Canadian Journal of Earth Sciences, submitted.

Geological Survey of Canada; Oak Ridges Moraine, NTS map C/4 Surficial Geology of the Trenton Area, Open File 3333

Geological Survey of Canada; Oak Ridges Moraine, NTS map D/1 Surficial Geology of the Rice lake Area, Open File 3332

Gorrell, G.A. and J. Shaw. 1991. *Development of an esker, bead and fan complex, Lanark, Ontario,* Sedimentary Geology 72, 285-314

Gorrell, G., and Brennand, T.A. 1997. Surficial Geology of the Rice Lake (31 D/1) 1:50 000 NTS map sheet, southern Ontario; Geological Survey of Canada Open File 3332.

Gorrell, G. and McCrae, M. 1992. Aggregate Resource Inventory of Haldimand and Alnwick Townships, Northumberland County. Ontario Geological Survey, Aggregate Resource Inventory Paper 143, 73 p.

Gorrell, G., 1997. Surficial Geology of the Trenton Area, NTS 31C/4, southern Ontario; Geological Survey of Canada, Open File 3333, scale 1:50,000

Gorrell, G. and Sharpe, D.R. 1994. Stop 20, Oak Ridges Moraine. *In* R. Gilbert (compiler), A Field Guide to the Glacial and Postglacial Landscape of Southeastern Ontario and Part of Quebec. Geological Survey of Canada, Bulletin 453, pp. 42-43.

Gorrell, G.A. 1991a. *Buried sand and Gravel Features and blending sands in Eastern Ontario.* Open File report 5801, Ontario Geological Survey

Gorrell, G.A. 1991b. *Buried sand and gravel in the Stirling, Trenton and Campbellford areas*, Open file report 5815, Ontario Geological Survey

Gorrell, G.A.; *Investigation and Documentation of the Neotectonic Record of Prince Edward County, Ontario*; GSC Open File Report 2062, 1988.

Gorrell, G.A. and J. Shaw. 1991. *Deposition in an esker, bead and fan complex, Lanark, Ontario,* Sedimentary Geology 72, 285-314

Gorrell, G.A., S. Van Haaften and T.W. Fletcher. *Aggregate Assessment for the County of Lanark, Southern Ontario*. Ontario Geological Survey Open File Report 5550, Part 1, 67p., Part 2 27p., 19 tables, 4 appendices, 2 figures, 4 maps. 1985.

Gorrell, G.A., A. F.Young and T. W. Fletcher and M. A. Klugman. *Sand and Gravel Assessment for the United Counties of Leeds and Grenville*, Ontario Geological Survey, Open File Report 5432, 61p., 1 fig., 21 tables and 3 maps. 1983.

Gorrell, G. A. and T. W. Fletcher. *Sand and Gravel Assessment for the United Counties of Prescott and Russell*, Ontario Geological Survey, Open File Report 5433, 38p., 1 fig., 11 tables and 2 maps. 1983.

Gorrell, G. A. and T. W. Fletcher. *Sand and Gravel Assessment for the United Counties of Stormont, Dundas, and Glengarry*, Ontario Geological Survey, Open File Report 5434, 54p., 1 fig., 16 tables and 3 maps. 1983.

Gorrell, G. A., T.W. Fletcher and S. Van Haaften; *Aggregate Assessment for the County of Lanark, Southern Ontario*, Ontario Geological Survey, Open File Report 5550, Part 1, 67p., part 2 27p., 19 tables, 4 appendices, 2 figures and 4 maps, 1985.

Gorrell, G. A. and T. W. Fletcher; *Mineral Aggregate Resource Inventory of the County of Lennox and Addington; Southern Ontario*. Ontario Geological Survey, Open File Report 5580, 72pp., 2 figures, 19 tables, 4 appendices, and Maps P.2973 to P.2976, scale 1:50,000. 1987.

Gorrell, G. A. and T. W. Fletcher; *Mineral Aggregate Resources Inventory of the County of Hastings; Southern Ontario.* Ontario Geological Survey, Open File Report 5582, 120pp., 2 figures, 31 tables, 4 appendices and Maps P.2977 to P.2982, scale 1:50,000. 1987.

Gorrell Resource Investigations, *Areas of Natural and Scientific Interest, South Central Region*; 1999.

Gorrell Resource Investigations, *Reconnaissance Earth Science Inventory of Representative Quaternary Sites, Kemptville Administrative District*; March 2001.

Gorrell Resource Investigations, *Earth Science Areas of Natural and Scientific Interest, Oak Ridges Moraine*; 2002.

Gorrell Resource Investigations, *Re-Evaluation of Earth Science Areas of Natural and Scientific Interest, Kemptville Administrative District*; March 2009.

Pugin, Pullan, Sharpe and Gorrell. In prep. Seismic stratigraphy and sedimentology within a glacial basin, and their applications to groundwater prospecting, Oak Ridges Moraine, southern Ontario, Canada

Sharpe, D.R., Barnett, P. J., Brennand T. A., Finley, D., Gorrell, G., and Russell, H. A., 1997: Surficial Geology of the Greater Toronto and Oak Ridges Moraine areas , southern Ontario; Geological Survey of Canada Open File 3026, scale 1:200,000

Russell, H.A.J., Sharpe, D.R., Barnett, P.J., Brennand, T.A., Gorrell, G., and Finley, D., 1997: New regional mapping of the Oak Ridges Moraine, GSC-OGS NATMAP initiative; Geological Survey of Canada Forum 1997, January 1997

Sharpe, D.R., Barnett, P.J., Brennand, T.A., Gorrell, G., Russell, H.A.J, 1997. Surficial Geology of the Oak

Ridges Moraine –NATMAP Area. Ontario, Geological Survey of Canada. Open File 3456. 1:200,000

Sharpe, D.R., L. Dyke, R. L. Good, G. Gorrell, M. J. Hinton, J. A. Hunter, H. A. J. Russell, *GSE High-Quality borehole, "Golden Spike" data, Oak Ridges Morain, southern Ontario,* Geological Survey of Canada Open File 1670, 21p, 2003.

Sharpe, D. R., A. Pugin, S. E. Pullan and G. Gorrell; *Application of seismic stratigraphy and sedimentology to regional hydrogeological investigations: an example from Oak Ridges Morain, southern Ontario, Canada*, Can. Geotech. J., vol 40, 2003.

Shaw J. and G.A. Gorrell. 1991. *Subglacially formed dunes with bimodal and graded gravel in the Trenton drumlin field, Ontario, Canada.* Geographie physique et Quaternaire, vol. 45 pp. 21-34

Ontario Geological Survey Reports

Aggregate Resource Inventory of Haldimand and Alnwick Townships, Northumberland County. Ontario Geological Survey, Aggregate Resource Inventory Paper 143. 1992

Identification of Provincially and Regionally Significant Glacial Landforms in the Lake Ontario Portion of the Eastern Region, Ministry of Natural Resources, GRI Report No. 906000

Buried sand and Gravel Features and blending sands in Eastern Ontario. Open File report 5801, Ontario Geological Survey. 1991.

Buried sand and gravel in the Stirling, Trenton and Campbellford areas, Open file report 5815, Ontario Geological Survey. 1991

Investigation and Documentation of the Neotechtonic Record of Prince Edward County, Ontario; Geological Survey of Canada Open File Report 2062, 1988.

Sand and Gravel Assessment for the United Counties of Leeds and Grenville, Ontario Geological Survey, Open File Report 5432, 61p., 1 fig., 21 tables and 3 maps 1983.

Sand and Gravel Assessment for the United Counties of Prescott and Russell, Ontario Geological Survey, Open File Report 5433, 38p., 1 fig., 11 tables and 2 maps 1983

Sand and Gravel Assessment for the United Counties of Stormont, Dundas, and Glengarry, Ontario Geological Survey, Open File Report 5434, 54p., 1 fig., 16 tables and 3 maps. 1983

Aggregate Assessment for the County of Lanark, Southern Ontario, Ontario Geological Survey, Open File Report 5550, Part 1, 67p., part 2 27p., 19 tables, 4 appendices, 2 figures and 4 maps, 1985.

Mineral Aggregate Resource Inventory of the County of Lennox and Addington; Southern Ontario. Ontario Geological Survey, Open File Report 5580, 72pp., 2 figures, 19 tables, 4 appendices, and Maps P.2973 to P.2976, scale 1:50,000 1987

Mineral Aggregate Resources Inventory of the County of Hastings; Southern Ontario. Ontario Geological Survey, Open File Report 5582, 120pp., 2 figures, 31 tables, 4 appendices and Maps P.2977 to P.2982, scale 1:50,000 1987

End of Sub Appendices I - VIII

Appendix B

Background Hydrogeology Explanation

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

Interpretation of Groundwater Setting

The definition of aquifer is precise – *"a saturated permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients"*[1]. The application of the definition is relative, depending on the local setting. For example, in some areas, till would not be considered an aquifer if there are higher producing alternatives, but in areas where the till is the best possible source of groundwater, it will be used for water supply in the absence of other alternatives. The combination of the availability of the groundwater and the ability of it to flow through the medium in a given locale is what characterizes an aquifer. In summary, to be an aquifer, there has to be groundwater present, and the medium has to have some ability to transmit it.

The ability of the medium to transmit the water determines how quickly the groundwater flows and also determines from what distance the groundwater can be captured from. Transmissivity can be visualized as a resistance. The less able to transmit (low transmissivity), the "harder" it is for the groundwater to move.

An aquifer may be unconfined or confined or somewhere in between. The degree of confinement depends how closely the groundwater system is connected to the surface or atmosphere. An unconfined aquifer is directly connected to the surface; a completely confined aquifer has no direct connection. The connection to the surface affects a number of factors including the reliability of a water supply and its susceptibility to contamination.

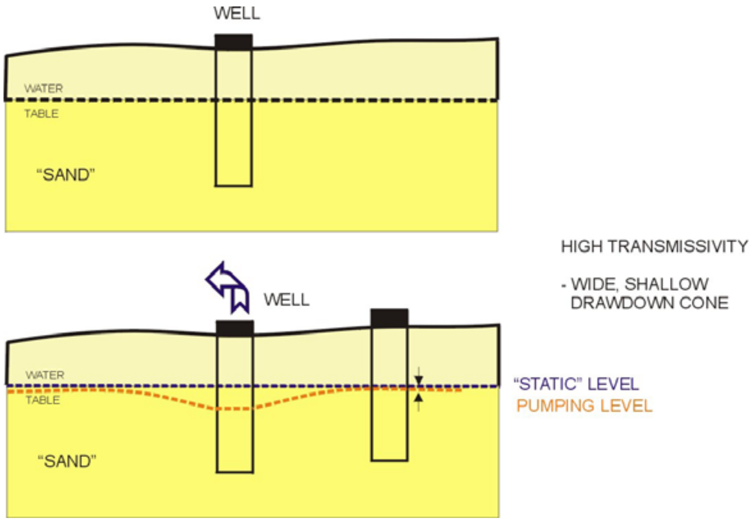
In an unconfined aquifer (such as in soil), the water table approximately coincides with the level that the groundwater is intercepted and is the point in the stratigraphic profile that the medium becomes saturated. This water table is visible in a hole dug in the medium. In sand, the water table stabilizes rapidly because the medium, sand, has a high transmissivity – it is "easy" for the groundwater to move through it. In contrast, in clay or till, the medium has a low transmissivity. The groundwater is present – evident by the dampness or saturation of the soil – but it moves slowly into the hole or well. It can take many orders of magnitude (100 to 10,000 times) longer a time to fill a hole in a fine grained (clay or till), low transmissivity aquifer than a high transmissivity one. If the time taken is too slow, the medium is not considered to be an aquifer but an aquitard or aquiclude. A simple illustration of the behaviour of a pumped well in a permeable medium such as sand (Figure G-1) compared to a low permeability medium such as till is shown in Figure G-2. No distances have been shown in the example; actual distances depend on the aquifer characteristics.

The diagram shows that in a highly permeable medium, groundwater may be captured from a large area, the distance depending on the withdrawal rate. When pumped, the drawdown in the well itself is relatively shallow, and the shape of the water table returns rapidly to near the original static level (undisturbed level), but may remain slightly depressed for a large distance. Drawdown cones (used to describe the shape of the water table in profile) in a highly transmissive aquifer are typically shallow and wide, although at a short distance the water table will have returned almost to the static level.

---

[1] R. A. Freeze and Cherry, J.A.; *Groundwater*, Prentice-Hall Inc, 1979

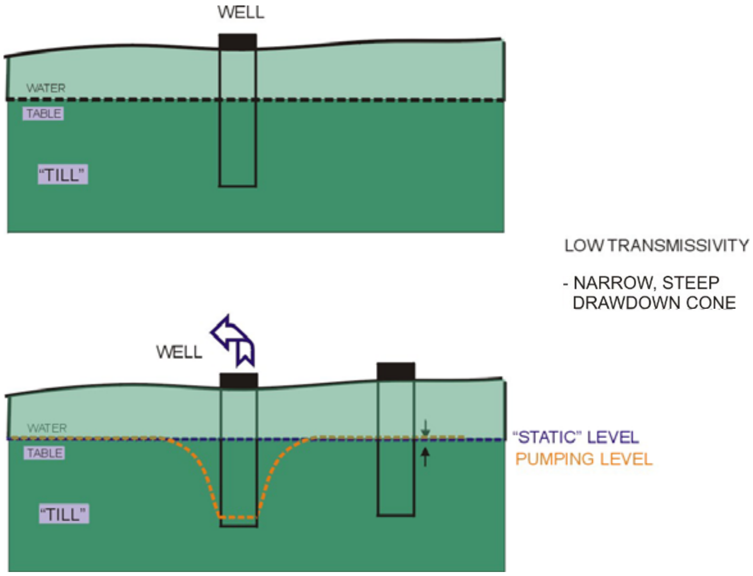
Figure A-1: Theoretical Water Table in High Transmissivity Medium



In contrast, a well in a low transmissivity aquifer, such as till, will see a greater drawdown in the well, but only has the ability to draw from a much smaller capture area, so the water table is restored to it's static level at a much shorter distance. Drawdown cones in a low transmissivity aquifer are deep (the water stored in the well is removed but not instantly recharged as in a high transmissivity well) and typically narrow. The water table is restored to the original static level within a comparatively short distance because the aquifer will not transmit groundwater from a long distance. A neighbouring well in the high transmissivity aquifer would not be impacted by the taking, as the result would be a very small depression in the water table. The same neighbouring well in the low transmissivity aquifer would not be impacted because it is beyond the distance from which the pumping well is drawing.

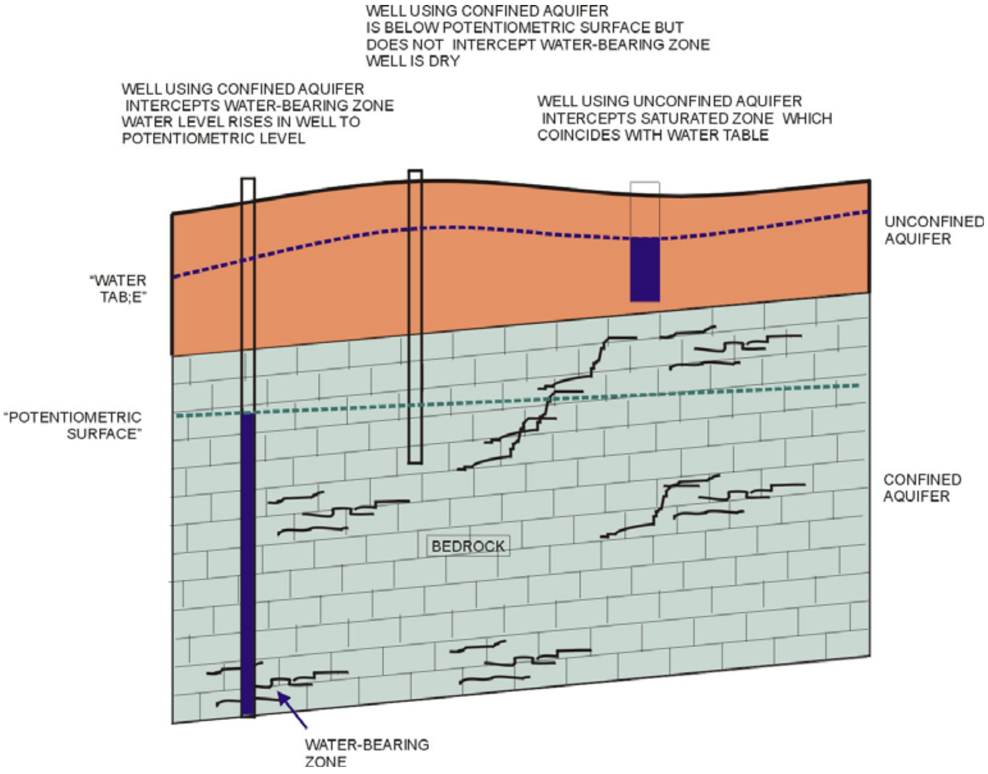
The situation in a confined aquifer is different than an unconfined. The groundwater in a confined aquifer is under pressure due to the mass of the overlying formation. The water table in a confined aquifer is called the "potentiometric surface", and the position of the potentiometric surface will be somewhere above the top of the aquifer. An aquifer in bedrock is an example of a confined aquifer. In the bedrock aquifer, unlike the granular aquifers described above, the groundwater is found only in discrete layers or fractures known as water-bearing zones. A well in bedrock may only encounter one or two distinct water bearing zones. The amount of interconnection between fractures influences the transmissivity of the bedrock aquifer.

Figure A-2 Theoretical Water Table in Low Transmissivity Medium



Unlike the water table of the unconfined aquifer, the potentiometric surface is not a real, visible feature in the aquifer. To "see" the potentiometric surface, i.e. the static level in a well, the water-bearing zone has to be intercepted. Simple excavating to the potentiometric level without penetrating the source (i.e. water bearing zone) would reveal nothing. If the source of the groundwater is not intercepted, there will be no water table (Figure G-3).

Figure A-3: Water Table vs. Potentiometric Surface in a Theoretical Cross-Section



Potentiometric pressures do provide equalization in such a way that if water was to be introduced into the setting in some other way (i.e. from runoff), the system will attempt to stabilize according to the potentiometric pressures. This means that in the situation of an excavation into bedrock, such as a quarry, even if a water-bearing zone in the formation was not intercepted by the excavation, accumulation of runoff in the excavation would endeavour to match the same potentiometric elevation, i.e the excavation would eventually fill to that stable level. A related factor that has to be addressed even if the water bearing zone is not directly intercepted is whether there is a sufficient connection and hydraulic connectivity that will induce vertical seepage from a water bearing zone through the floor of the excavation.

Appendix C
Drill Holes;
MOE Well Records and Borehole Logs

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

Ontario Ministry of the Environment

The Ontario Water Resources Act

WATER WELL RECORD

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

County or District	Township/Borough/City/Town/Village	Con block tract survey, etc.	Lot
Renfrew	McNab	Con 4	16

Owner's surname	First Name	Address	Date completed (day month year)
Smith's Construction Company		Po Box 218 276 Madawaska Blvd. Arnprior, Ont	10 07 2002

Zone ☐☐ Easting ☐☐☐☐☐☐☐ Northing ☐☐☐☐☐☐☐☐

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth - feet From	Depth - feet To
brown	loose fill			0	1'
gray	Shaile limestone			1'	65'

GRI TW 1

WATER RECORD

Water found at - feet	Kind of water
NO water	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas

CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth - feet From	Depth - feet To
6¼	☒ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	.188	0	4'
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			

SCREEN

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

PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at - feet From	Depth set at - feet To	Material and type (Cement grout, bentonite, etc.)
4'	0	Cement Grout

PUMPING TEST

Pumping test method ☐ Pump ☐ Bailer
Pumping rate GPM
Duration of pumping Hours Mins
Static level feet
Water level end of pumping feet
Water levels during ☐ Pumping ☐ Recovery
15 minutes feet 30 minutes feet 45 minutes feet 60 minutes feet
If flowing give rate GPM
Pump intake set at feet
Water at end of test ☐ Clear ☐ Cloudy
Recommended pump type ☐ Shallow ☐ Deep
Recommended pump setting feet
Recommended pump rate GPM

FINAL STATUS OF WELL

☐ Water supply
☐ Observation well
☑ Test hole
☐ Recharge well
☐ Abandoned, insufficient supply
☐ Abandoned, poor quality
☐ Abandoned (Other)
☐ Dewatering
☐ Unfinished
☐ Replacement well

WATER USE

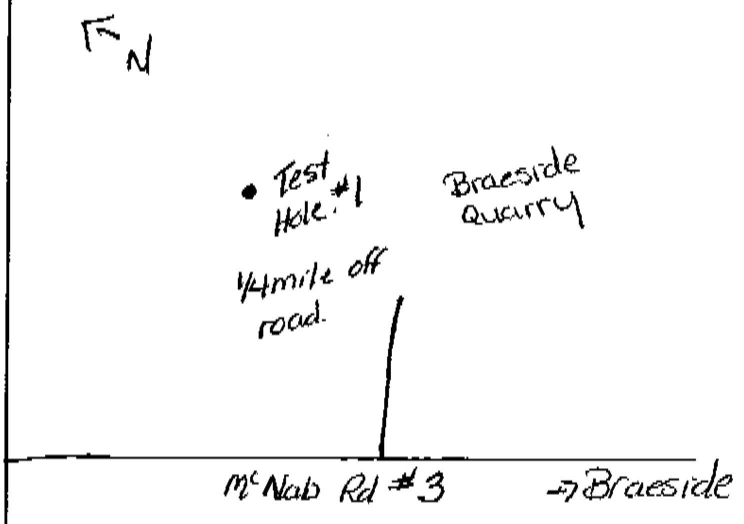
☐ Domestic
☐ Stock
☐ Irrigation
☐ Industrial
☐ Commercial
☐ Municipal
☐ Public supply
☐ Cooling & air conditioning
☐ Not use
☐ Other Reading

METHOD OF CONSTRUCTION

☐ Cable tool
☐ Rotary (conventional)
☐ Rotary (reverse)
☐ Rotary (air)
☒ Air percussion
☐ Boring
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging
☐ Other

LOCATION OF WELL

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



248451

Name of Well Contractor: George H. Law + Son Ltd
Well Contractor's Licence No.: 3323
Address: Box 155 Calabogie, Ont K0J-1H0
Name of Well Technician: Allan Fougere
Well Technician's Licence No.: T-0432
Signature of Technician/Contractor:
Submission date: 10 07 2002 (day mo yr)

MINISTRY USE ONLY

1 - CONTRACTOR'S COPY

0506 (07/00) Front Form 9

Ontario Ministry of the Environment

The Ontario Water Resources Act

WATER WELL RECORD

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

County or District: Renfrew	Township/Borough/City/Town/Village: McNab	Con block tract survey, etc.: Con4	Lot: 16
Owner's surname / First Name: Smiths Construction Company	Address: Po Box 218, 276 Madawaska Blvd. Arnprior, Ont K7S-3H4	Date completed: 10 07 2002 (day month year)	

Zone Easting Northing

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth - feet From	Depth - feet To
brown	loose fill			0	2'
gray	Shaile limestone			2'	65'
	GRI TW 2				

WATER RECORD

Water found at - feet	Kind of water	
unknown	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty	☐ Sulphur ☐ Minerals ☐ Gas

CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth - feet From	Depth - feet To
6 1/4	☑ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	.188	0	5
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic			

SCREEN

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

PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at - feet From	To	Material and type (Cement grout, bentonite, etc.)
5'	0	Cement Grout

PUMPING TEST

Pumping test method ☐ Pump ☐ Bailer	Pumping rate GPM	Duration of pumping ...... Hours ...... Mins		
Static level feet	Water level end of pumping feet	Water levels during ☐ Pumping ☐ Recovery: 15 minutes feet, 30 minutes feet	45 minutes feet	60 minutes feet
If flowing give rate GPM	Pump intake set at feet	Water at end of test ☐ Clear ☐ Cloudy		
Recommended pump type ☐ Shallow ☐ Deep	Recommended pump setting feet	Recommended pump rate GPM		

FINAL STATUS OF WELL

☐ Water supply
☐ Observation well
☑ Test hole
☐ Recharge well
☐ Abandoned, insufficient supply
☐ Abandoned, poor quality
☐ Abandoned (Other)
☐ Dewatering
☐ Unfinished
☐ Replacement well

WATER USE

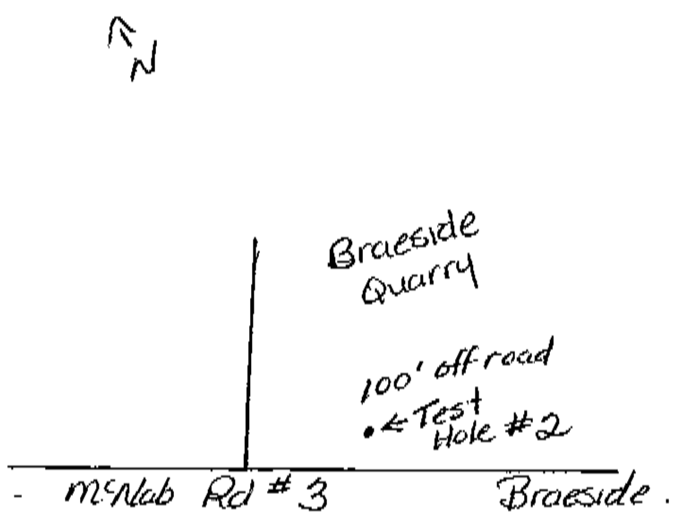
☐ Domestic
☐ Stock
☐ Irrigation
☐ Industrial
☐ Commercial
☐ Municipal
☐ Public supply
☐ Cooling & air conditioning
☐ Not use
☐ Other

METHOD OF CONSTRUCTION

☐ Cable tool
☐ Rotary (conventional)
☐ Rotary (reverse)
☐ Rotary (air)
☑ Air percussion
☐ Boring
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging
☐ Other

LOCATION OF WELL

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



234770

Name of Well Contractor: George H. Law + Son Ltd	Well Contractor's Licence No.: 3323
Address: Box 155 Calabogie, Ont K0J-1H0	
Name of Well Technician: Allan Faugere	Well Technician's Licence No.: T-0432
Signature of Technician/Contractor: Alfred Law	Submission date: 10 07 2002 (day mo yr)

MINISTRY USE ONLY

1 - CONTRACTOR'S COPY

0506 (07/00) Front Form 9

Ontario Ministry of the Environment

Well Tag Number (Place tag here and print number below) A 054429

A054429

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: MNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 386848 Northing 5036125
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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	24.38

GRI # 3-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres	Kind of Water		
7.02 m	☐ Fresh	☐ Sulphur	
	☐ Gas	☐ Salty	☐ Minerals
	☐ Other: UNTESTED		
23.46 m	☐ Fresh	☐ Sulphur	
	☐ Gas	☐ Salty	☐ Minerals
	☐ Other: UNTESTED		
m	☐ Fresh	☐ Sulphur	
	☐ Gas	☐ Salty	☐ Minerals
	☐ Other:		

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0 + .60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at (metres): 24.0
Pumping rate - (litres/min): 22.5
Duration of pumping: 6 hrs + 0 min
Final water level end of pumping: 7.24 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	5.08		
1	6.2	1	6.99
2	6.4	2	6.48
3	6.45	3	6.08
4	6.5	4	6.45
5	6.5	5	5.82
10	6.8	10	5.53
15	6.8	15	5.59
20	6.85	20	5.64
25	6.97	25	5.69
30	7.0	30	5.44
40	7.0	40	5.52
50	7.05	50	5.37
60	7.01	60	5.34

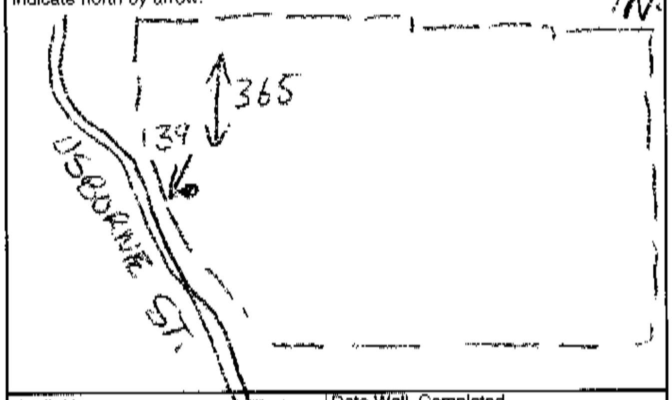
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction

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

Water Use

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

Final Status of Well

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

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saul
Date Submitted: YYYY 2007 MM 06 DD 25

Audit No. Z 55056
Date Well Completed: YYYY 2007 MM 05 DD 25
Was the well owner's information package delivered? ☐ Yes ☐ No
Date Delivered: YYYY 2007 MM 05 DD 25

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag (number below) **A 054430**

A 054430

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 8 3 Zone 18 Easting 386845 Northing 5036122
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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	12.19
	GRI # 3-2				

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres / Kind of Water

7.01 m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED

___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+ .60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 12.19
Pumping rate - (litres/min): 3.6
Duration of pumping 1 hrs + 40 min
Final water level end of pumping 12.29 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

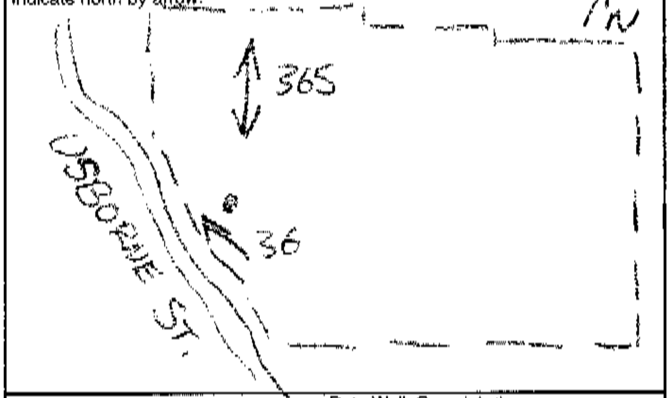
Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	2.67		
1	3.68	1	11.72
2	4.70	2	11.71
3	5.71	3	11.69
4	6.72	4	11.67
5	7.74	5	11.65
10	5.27	10	11.42
15	5.67	15	11.18
20	6.17	20	10.97
25	6.55	25	10.87
30	6.97	30	10.61
40	7.97	40	10.27
50	8.77	50	9.94
60	8.25	60	9.82

Plugging and Sealing Record ☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction

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

Water Use

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

Final Status of Well

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

Audit No. Z 55057

Date Well Completed YYYY MM DD 2007 05 23

Was the well owner's information package delivered? ☒ Yes ☐ No

Date Delivered YYYY MM DD 2007 05 25

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saul
Date Submitted YYYY MM DD 2007 06 25

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006) **Well Owner's Copy** *Cette formule est disponible en français*

Ontario Ministry of the Environment

Well Tag (number below): **A 054436**
A 054436

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: MCNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 83 Zone 18 Easting 386569 Northing 5036502
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	CLAY		DENSE	0	4.87
GREY	CLAY			4.87	5.79
BROWN	LIMESTONE	GREY LIMESTONE		5.79	24.38

GRI # 4-1

Hole Diameter

Depth Metres From	To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres	Kind of Water		
21.03 m	☐ Fresh	☐ Sulphur	☐ Gas
	☐ Salty	☐ Minerals	☐ Other: UNTESTED
m	☐ Fresh	☐ Sulphur	☐ Gas
	☐ Salty	☐ Minerals	☐ Other:
m	☐ Fresh	☐ Sulphur	☐ Gas
	☐ Salty	☐ Minerals	☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.50	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres) 24.38
Pumping rate - (litres/min) 5.63
Duration of pumping 4 hrs + 57 min
Final water level end of pumping 14.78 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Water Level Metres	Recovery Time min	Water Level Metres
Static Level	3.21		
1	3.85	1	14.78
2	3.98	2	14.78
3	4.00	3	
4	4.16	4	
5	4.20	5	
10	4.34	10	
15	4.56	15	
20	5.10	20	
25	5.22	25	
30	5.42	30	
40	5.95	40	
50	6.03	50	
60	6.26	60	

WELL DID NOT RECOVER

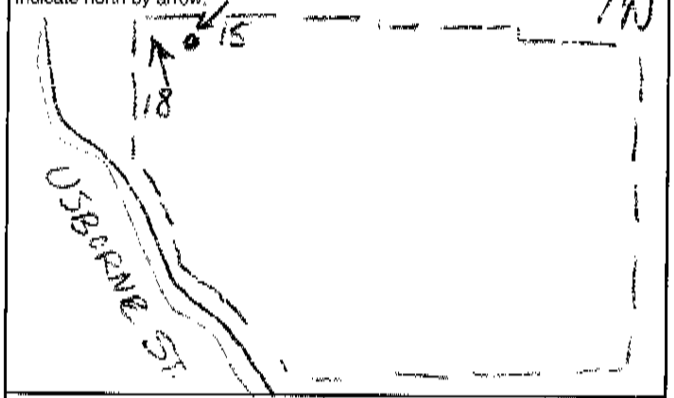
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction

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

Water Use

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

Final Status of Well

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

Audit No. Z 55054
Date Well Completed (YYYY MM DD): 2007 05 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered (YYYY MM DD): 2007 05 28

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saul
Date Submitted (YYYY MM DD): 2007 06 28

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well T[...]mber below)
A 054437
A054437

Well Record

Regulation 903 Ontario Water Resources Act

page ___ of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3141
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 388571 Northing 5036496
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	Depth Metres To
BROWN	CLAY		DENSE	0	4.87
GREY	CLAY		SOFT	4.87	5.79
BROWN	LIMESTONE	GREY LIMESTONE		5.79	12.19

GRI # 4-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres / Kind of Water
☐ ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN
☐ ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
☐ ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Casing

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			

Screen

Outside diam	Material	Slot No.		
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			

No Casing or Screen

☒ Open hole	6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres) 12.19
Pumping rate - (litres/min) 2.03
Duration of pumping ___ hrs + 30 min
Final water level end of pumping 11.50 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WELL PUMPED DRY

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	3.42		
1	5.5	1	11.29
2	6.10	2	11.28
3	6.65	3	11.27
4	6.90	4	11.25
5	7.15	5	11.25
10	8.51	10	11.20
15	9.49	15	11.19
20	10.20	20	11.13
25	10.90	25	11.08
30	11.50	30	11.03
40		40	10.98
50		50	10.87
60		60	10.80

Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Method of Construction

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

Water Use

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

Final Status of Well

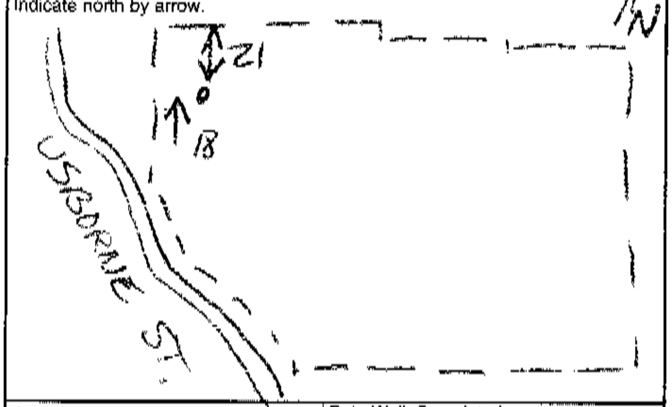
☐ Water Supply ☐ Observation well ☒ Test Hole
☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality
☐ Unfinished ☐ Dewatering ☐ Replacement well
☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT, K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: x Troy Saul
Date Submitted: YYYY 2007 MM 06 DD 28

Location of Well

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



Audit No. **Z 55055**
Date Well Completed: YYYY 2007 MM 05 DD 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered: YYYY 2007 MM 05 DD 28

Ministry Use Only

Data Source:
Contractor:
Date Received: YYYY MM DD
Date of Inspection: YYYY MM DD
Remarks:
Well Record Number:

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well T… …mber below)
A 054438
A054438

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: M'NAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 83 Zone 18 Easting 386988 Northing 5036840
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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	24.38

GRI # 5-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres / Kind of Water
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify WELL PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 21.38
Pumping rate - (litres/min): 12.74
Duration of pumping ___ hrs + 45 min
Final water level end of pumping: 23.64 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. (WELL PUMPED DRY

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	1.43		
1	3.05	1	23.64
2	3.96	2	23.64
3	4.25	3	23.61
4	4.47	4	23.57
5	5.08	5	23.55
10	7.61	10	23.50
15	10.51	15	23.49
20	13.28	20	23.48
25	15.51	25	23.48
30	18.58	30	23.47
40	23.64	40	23.47
50		50	23.47
60		60	23.23

Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Method of Construction

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

Water Use

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

Final Status of Well

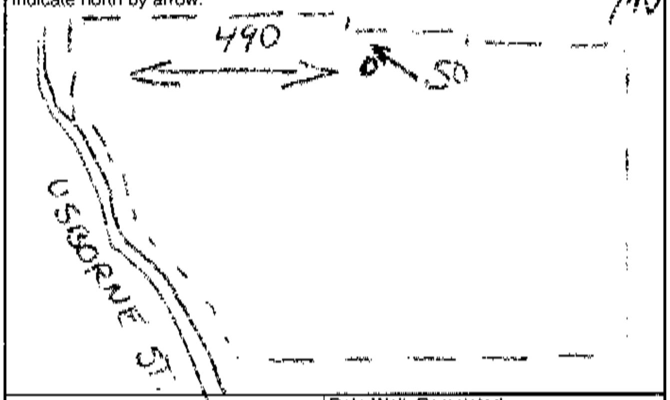
☐ Water Supply ☒ Observation well ☐ Test Hole
☐ Recharge well ☐ Abandoned, insufficient supply ☐ Abandoned, poor quality
☐ Unfinished ☐ Dewatering ☐ Replacement well
☐ Abandoned, (Other)

Well Contractor/Technician Information

Name of Well Contractor: T SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saul
Date Submitted YYYY MM DD: 2007 05 29

Location of Well

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



Audit No. Z 55050
Date Well Completed YYYY MM DD: 2007 05 24
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD: 2007 05 24

Ministry Use Only
Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Ta[...] mber below)
A 054439
A 054439

Well Record

Regulation 903 Ontario Water Resources Act

page ___ of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S3N2
Telephone Number (include area code): 613-623-5144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 83 Zone 18 Easting 386983 Northing 5036832
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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	12.19

GRI # 5-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Water Record

Water found at ___ Metres	Kind of Water
___ m ☐ Gas ☐ Other: UNKNOWN	☐ Fresh ☐ Sulphur ☐ Salty ☐ Minerals
___ m ☐ Gas ☐ Other:	☐ Fresh ☐ Sulphur ☐ Salty ☐ Minerals
___ m ☐ Gas ☐ Other:	☐ Fresh ☐ Sulphur ☐ Salty ☐ Minerals

After test of well yield, water was
☐ Clear and sediment free
☐ Other, specify WELL PUMPED DRY
Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres) 12.19
Pumping rate - (litres/min) 4.5
Duration of pumping 1 hrs + 0 min
Final water level end of pumping 12.19 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	.62		
1	1.76	1	11.45
2	1.81	2	11.32
3	1.87	3	11.29
4	1.93	4	11.26
5	2.05	5	11.23
10	2.99	10	11.14
15	2.99	15	11.05
20	5.3	20	11.0
25	6.72	25	10.93
30	7.28	30	10.80
40	9.53	40	10.66
50	10.91	50	10.45
60	12.19	60	10.31

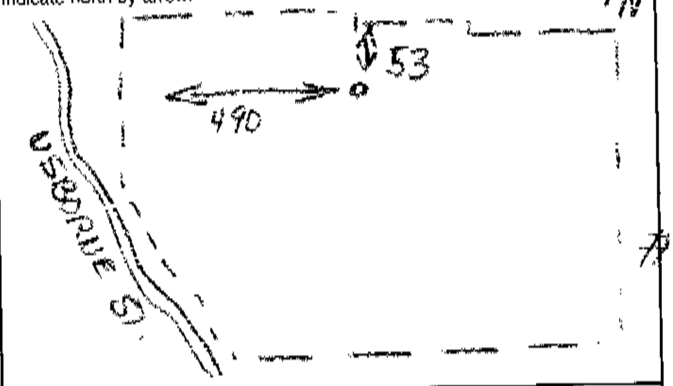
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction

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

Water Use

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

Final Status of Well

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

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X Troy Saul
Date Submitted YYYY MM DD: 2007 05 29

Audit No. Z 55052
Date Well Completed YYYY MM DD: 2007 05 29
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD: 2007 05 29

Ministry Use Only
Data Source:
Contractor:
Date Received YYYY MM DD:
Date of Inspection YYYY MM DD:
Remarks:
Well Record Number:

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (place sticker and/or print number below)
A 054432
A054432

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 876 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 83 Zone 18 Easting 380504 Northing 5037238
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	Depth Metres To
BROWN	SHALE			0	.45
BROWN	LIMESTONE	GREY LIMESTONE		.45	24.38

GRI # 6-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres / Kind of Water
20.7 m ☒ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Casing

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			

Screen

Outside diam	Material	Slot No.	Depth Metres From	Depth Metres To
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			

No Casing or Screen

☒ Open hole 6.09 24.38

Test of Well Yield

Pumping test method: SUB PUMP
Pump intake set at - (metres): 24.38
Pumping rate - (litres/min): 1.7
Duration of pumping ___ hrs + 40 min
Final water level end of pumping: 24.81 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WELL PUMPED DRY

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	4.62		
1	5.13	1	23.52
2	6.47	2	23.52
3	6.82	3	23.32
4	7.51	4	23.32
5	9.6	5	23.32
10	12.45	10	23.31
15	15.25	15	23.30
20	17.57	20	23.30
25	18.80	25	23.30
30	24.80	30	23.29
40	24.81	40	23.28
50		50	23.28
60		60	23.27

Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.04	BENTONITE SLURRY	.192

Method of Construction

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

Water Use

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

Final Status of Well

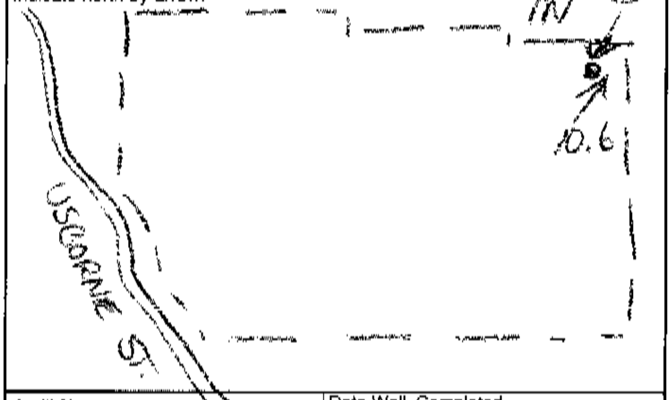
☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☒ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT.
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T 517
Signature of Technician/Contractor: X Troy Saul
Date Submitted: 2007 05 28

Location of Well

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



Audit No. Z 55051
Date Well Completed: 2007 05 23
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered: 2007 05 28

Ministry Use Only

Data Source:
Contractor:
Date Received: YYYY MM DD
Date of Inspection: YYYY MM DD
Remarks:
Well Record Number:

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (place sticker and print number below)
A 054431
A054431

Well Record

Regulation 903 Ontario Water Resources Act

page ___ of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 8 3 Zone 18 Easting 387490 Northing 5037241
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	Depth Metres To
BROWN	SHALE			0	.45
BROWN	LIMESTONE	GREY LIMESTONE		.45	12.19

GRI # 6-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres / Kind of Water
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 12.19
Pumping rate - (litres/min): .75
Duration of pumping ___ hrs + 40 min
Final water level end of pumping 12.19 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WELL PUMPED DRY

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	5.65		
1	6.20	1	12.05
2	7.05	2	12.03
3	7.76	3	12.03
4	8.12	4	12.03
5	8.50	5	11.71
10	9.50	10	11.70
15	10.10	15	11.70
20	10.60	20	11.69
25	11.10	25	11.69
30	11.60	30	11.68
40	12.19	40	11.67
50		50	11.67
60		60	11.65

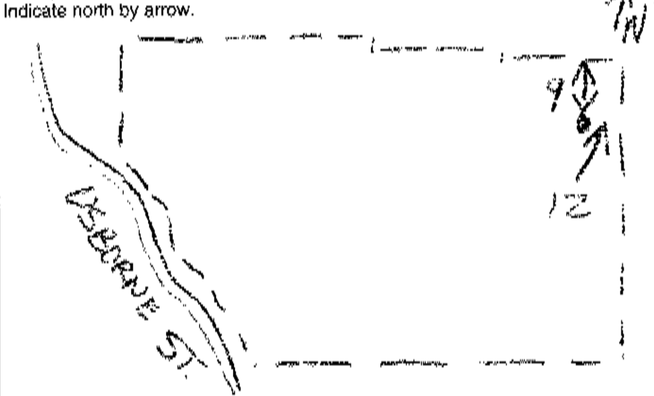
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Method of Construction

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

Water Use

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

Final Status of Well

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

Audit No. Z 55053
Date Well Completed (YYYY MM DD): 2007 05 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered (YYYY MM DD): 2007 05 28

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X
Date Submitted (YYYY MM DD): 2007 06 28

Ministry Use Only

Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

W... (print number below)
A 054433
A 054433

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR,Lot,Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: **Ontario**
Postal Code: K7S 3N8
Telephone Number (include area code): 613-623-5648
Address of Well Location (County/District/Municipality): RENFREW
Township: M'NAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading NAD 8 3 Zone 18 Easting 377757 Northing 5030979
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	Depth Metres To
BROWN	SHALE			0	.60
BROWN	LIMESTONE	GREY LIMESTONE		.60	24.38

GRI # 7

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at ___ Metres / Kind of Water
12.80 m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
☐ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was
☐ Clear and sediment free
☒ Other, specify PUMPED DRY

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0? .60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres) 24.38
Pumping rate - (litres/min) 7.2
Duration of pumping ___ hrs + 60 min
Final water level end of pumping 23.13 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	7.70		
1	9.33	1	23.13
2	9.94	2	23.12
3	9.97	3	23.08
4	10.0	4	23.07
5	10.4	5	23.05
10	12.0	10	22.87
15	13.5	15	22.58
20	14.0	20	22.4
25	15.9	25	22.2
30	16.7	30	22.13
40	19.4	40	21.83
50	22.1	50	20.87
60	23.13	60	19.87

Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Method of Construction

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

Water Use

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

Final Status of Well

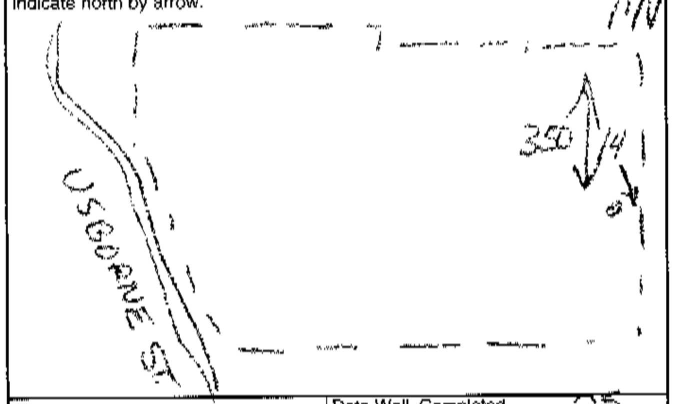
☐ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☒ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☒ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): R.R.#1 BRAESIDE K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor X Troy Saul
Date Submitted YYYY MM DD 2007 06 08

Location of Well

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



Audit No. **Z 55058**
Date Well Completed YYYY MM DD 2007 05 28
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered YYYY MM DD 2007 05 28

Ministry Use Only
Data Source
Contractor
Date Received YYYY MM DD
Date of Inspection YYYY MM DD
Remarks
Well Record Number

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (Place Sticker and/or Print number below): **A 054434**

A054434

Well Record

Regulation 903 Ontario Water Resources Act

page 2 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR, Lot, Concession): 276 MADAWASKA BLVD.
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613-623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 8 3 Zone 18 Easting 388029 Northing 5036588
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	Depth Metres To
BROWN	SHALE			0	.91
BROWN	LIMESTONE	GREY LIMESTONE		.91	24.38

GRI # 8-1

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	24.38	15.23

Water Record

Water found at Metres / Kind of Water
10.97 m ☒ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
23.16 m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED
___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0 +.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	24.38

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 24.38
Pumping rate - (litres/min): 15.75
Duration of pumping: 6 hrs + 0 min
Final water level end of pumping: 22.25 metres
Recommended pump type: ☐ Shallow ☐ Deep
Recommended pump depth. ____ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason.

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	13.32		
1	16.60	1	20.75
2	16.67	2	20.6
3	16.74	3	20.55
4	16.80	4	20.27
5	16.64	5	20.09
10	17.10	10	19.64
15	17.50	15	18.89
20	17.90	20	19.25
25	18.20	25	18.93
30	18.70	30	18.77
40	18.90	40	18.66
50	19.15	50	18.57
60	19.50	60	18.46

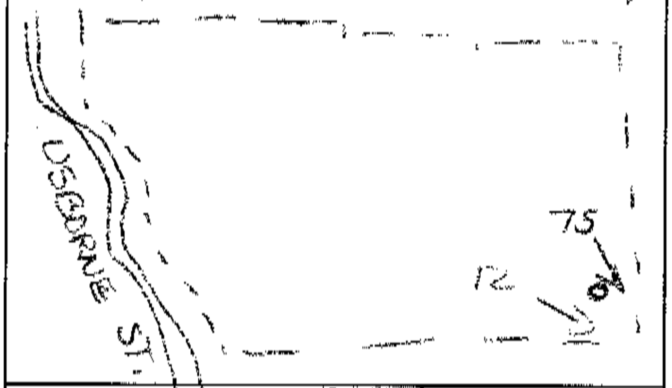
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Audit No. Z 55049
Date Well Completed: YYYY 2007 MM 05 DD 30
Was the well owner's information package delivered? ☒ Yes ☐ No
Date Delivered: YYYY 2007 MM 05 DD 30

Method of Construction

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

Water Use

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

Final Status of Well

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

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT. K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS, TROY
Well Technician's Licence No.: T-517
Signature of Technician/Contractor: X
Date Submitted: YYYY 2007 MM 06 DD 30

Ministry Use Only

Data Source:
Contractor:
Date Received: YYYY MM DD
Date of Inspection: YYYY MM DD
Remarks:
Well Record Number:

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (Place Sticker and/or Print number below): **A 054435**

A054435

Well Record

Regulation 903 Ontario Water Resources Act

page 3 of 3

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 1/10th 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

First Name:
Last Name: MILLER CONSTRUCTION
Mailing Address (Street Number/Name, RR, Lot, Concession): 276 MADAWASKA BLVD
County/District/Municipality: RENFREW
Township/City/Town/Village: ARNPRIOR
Province: Ontario
Postal Code: K7S 3N2
Telephone Number (include area code): 613 623-3144
Address of Well Location (County/District/Municipality): RENFREW
Township: McNAB/BRAESIDE
Lot:
Concession:
RR#/Street Number/Name: 1498 USBORNE ST.
City/Town/Village: BRAESIDE
Site/Compartment/Block/Tract etc.:
GPS Reading: NAD 8 3 Zone 18 Easting 388033 Northing 5036594
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	Depth Metres To
BROWN	LIMESTONE	GREY LIMESTONE		0	12.19

GRI # 8-2

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres
0	6.09	24.77
6.09	12.19	15.23

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
15.87	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0+.60	6.09
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		6.09	12.19

Water Record

Water found at ___ Metres / Kind of Water

- ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNKNOWN
- ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
- ___ m ☐ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

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

Chlorinated ☒ Yes ☐ No

Test of Well Yield

Pumping test method: SUB. PUMP
Pump intake set at - (metres): 12.0
Pumping rate - (litres/min): 4.55
Duration of pumping: 0 hrs + 40 min
Final water level end of pumping: 11.50 metres
Recommended pump type. ☐ Shallow ☐ Deep
Recommended pump depth. ___ metres
Recommended pump rate. (litres/min)
If flowing give rate - (litres/min)
If pumping discontinued, give reason. WATER DRAWDOWN TO WELL BOTTOM

Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Static Level	3.61		
1	4.05	1	12.17
2	4.18	2	12.03
3	4.30	3	12.01
4	4.56	4	11.97
5	4.70	5	11.95
10	5.80	10	11.84
15	7.10	15	11.80
20	7.85	20	11.74
25	9.00	25	11.68
30	10.00	30	11.66
40	11.50	40	11.63
50	/	50	11.59
60	/	60	11.57

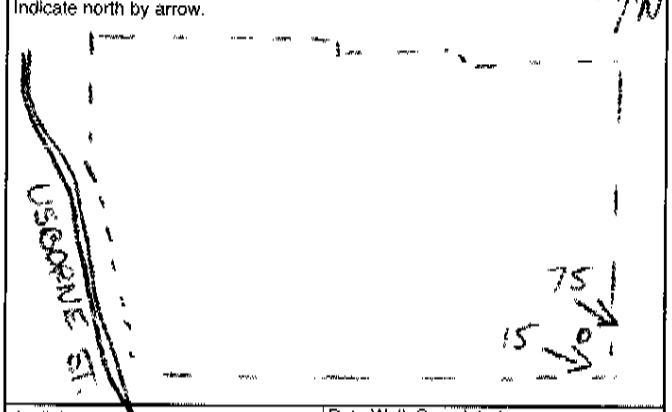
Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	Depth set at - Metres To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6.09	BENTONITE SLURRY	.192

Location of Well

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



Audit No. Z 55045

Date Well Completed: YYYY 2007 MM 05 DD 30

Was the well owner's information package delivered? ☒ Yes ☐ No

Date Delivered: YYYY 2007 MM 05 DD 30

Method of Construction

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

Water Use

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

Final Status of Well

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

Well Contractor/Technician Information

Name of Well Contractor: T. SAUNDERS DRILLING LTD
Well Contractor's Licence No.: 4879
Business Address (street name, number, city etc.): RR#1 BRAESIDE ONT K0A 1G0
Name of Well Technician (last name, first name): SAUNDERS TROY
Well Technician's Licence No.: T-577
Signature of Technician/Contractor: X Troy Saul
Date Submitted: YYYY 2007 MM 06 DD 30

Ministry Use Only

Data Source:
Contractor:
Date Received: YYYY MM DD
Date of Inspection: YYYY MM DD
Remarks:
Well Record Number:

0506E (08/2006)

Well Owner's Copy

Cette formule est disponible en français

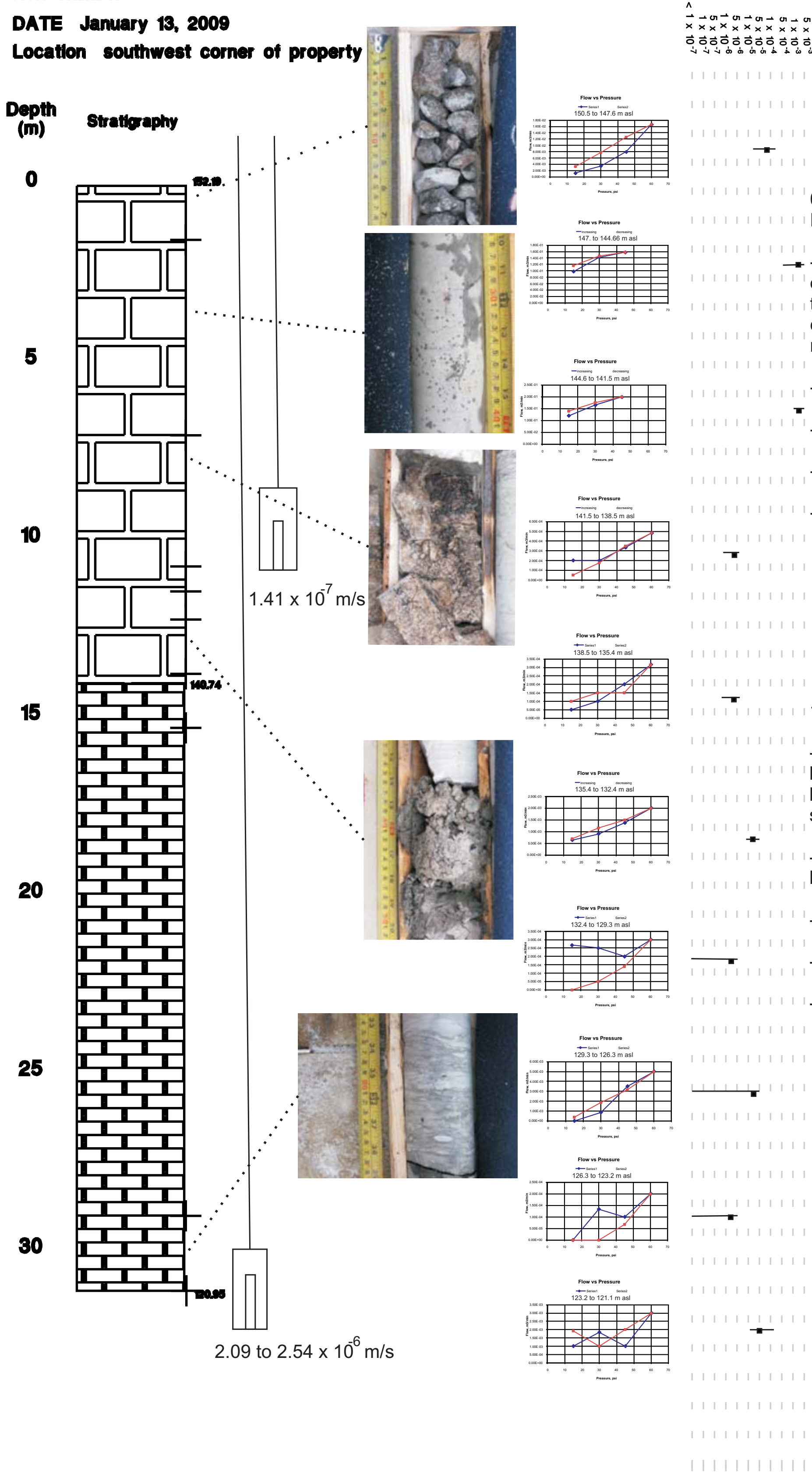
PROJECT 05490

Hole Number 9-1

DATE January 13, 2009

Location southwest corner of property

DRILL TYPE: diamond drill, CME 75



0 to 11.30 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown
to grey, fine to occasional medium crystalline, medium to
massive bedded,medium to thickly bedded

-very weathered to 3 m bgs

-occasional vug present

-tree roots split core at 7.01 m bgs

-most breaks are mechanical breaks

11.30 to 30.65 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with
shale interbeds

-K-bentonite present from 11.28 to 11.73 m bgs

-rust staining at

-small vugs below 12.0 m bgs

-water bearing zone at 31.09 m

GORRELL RESOURCE INVESTIGATIONS gri

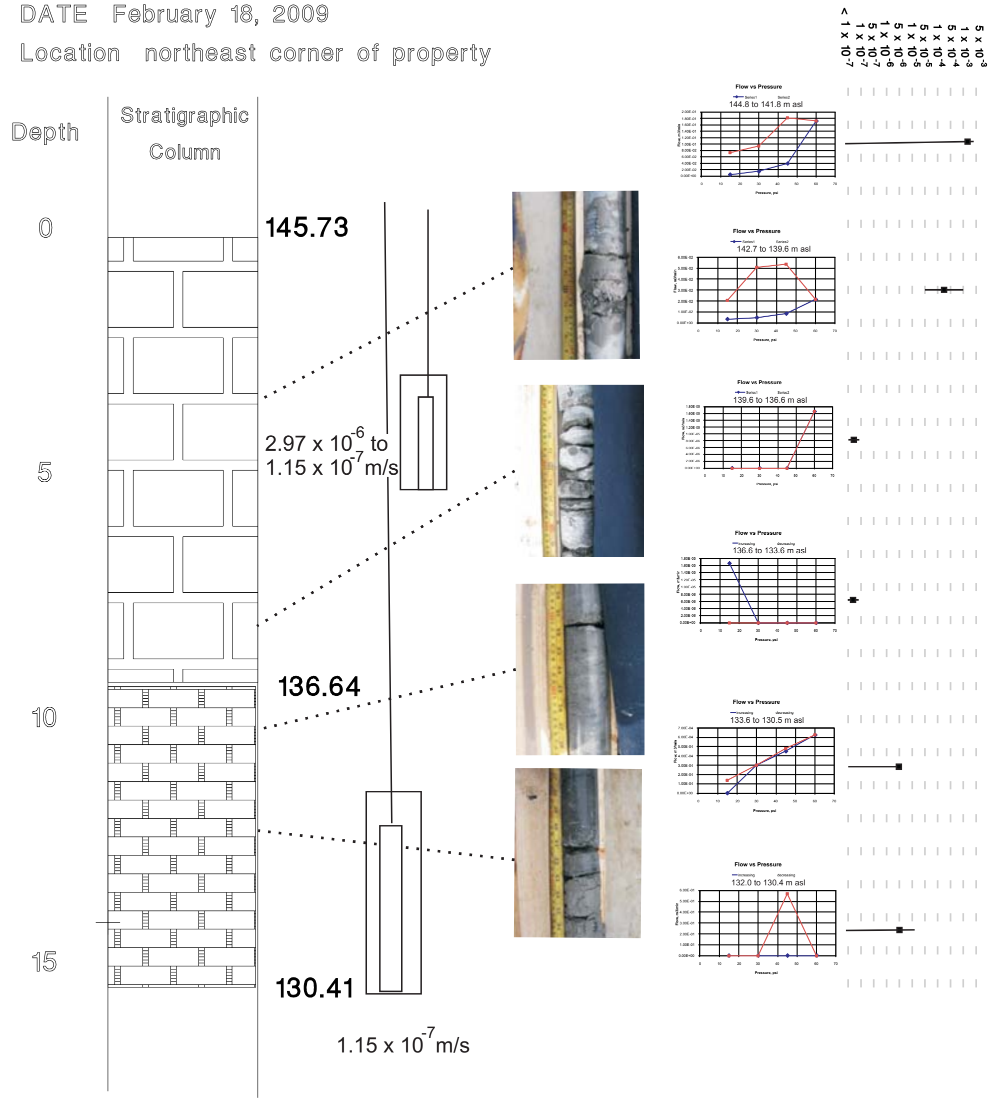
PROJECT 05490

Hole Number 10

DATE February 18, 2009

Location northeast corner of property

DRILL TYPE: diamond drill, CME



0 to 9.09 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly beddeD

-occasional vug present

-possible K-bentonite layer at 3.35 to 3.40 & 8.38 m

-rust staining at 2.16, 2.5,4.88 to 5.18 and 7.75 to 7.80 m bgs,

-most breaks are mechanical breaks

9.09 to 15.32 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-K-bentonite present from 12.50 to 13.11 m bgs

-rust staining at 12.12

·small vugs below 11.49 m bgs

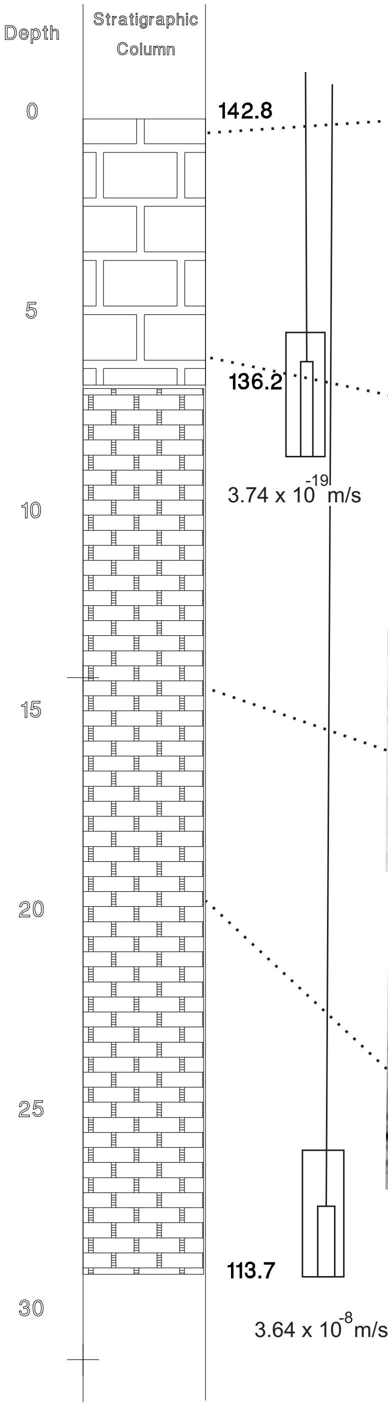
PROJECT 05490

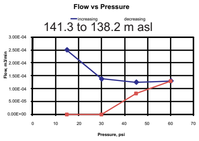
Hole Number 11

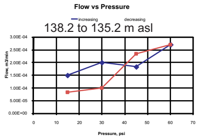
DATE February 18, 2009

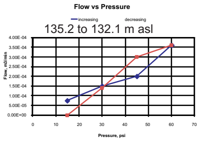
Location northeast side

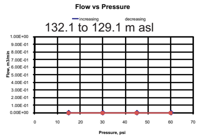
DRILL TYPE: diamond drill, CME

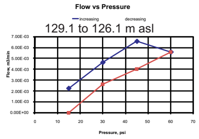


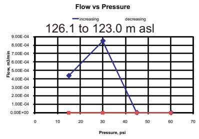


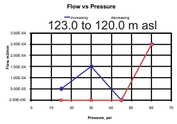


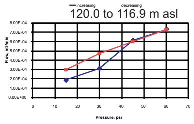


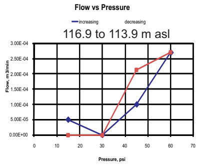


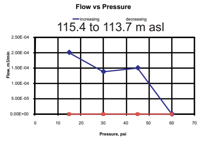


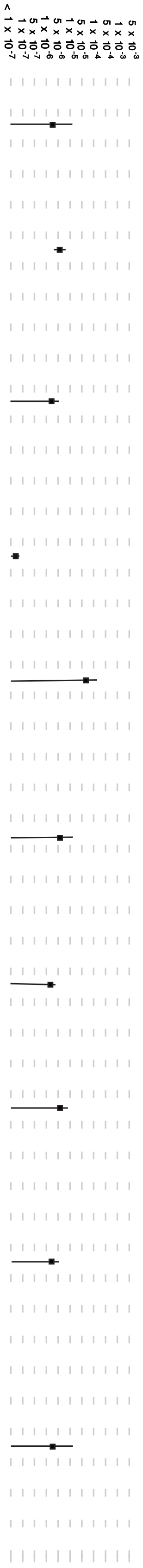












0 to 6.65 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded

6.65 to 29.10 m GULL RIVER FORMATION

-6.65 to 15.27 upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-15.27 to 29.10 lower member of formation, consists of interbedded limestone and dolostone, sharp contacts, predominately limestone that is fine to very fine crystalline

-K-bentonite layer at 14.81 to 15.04

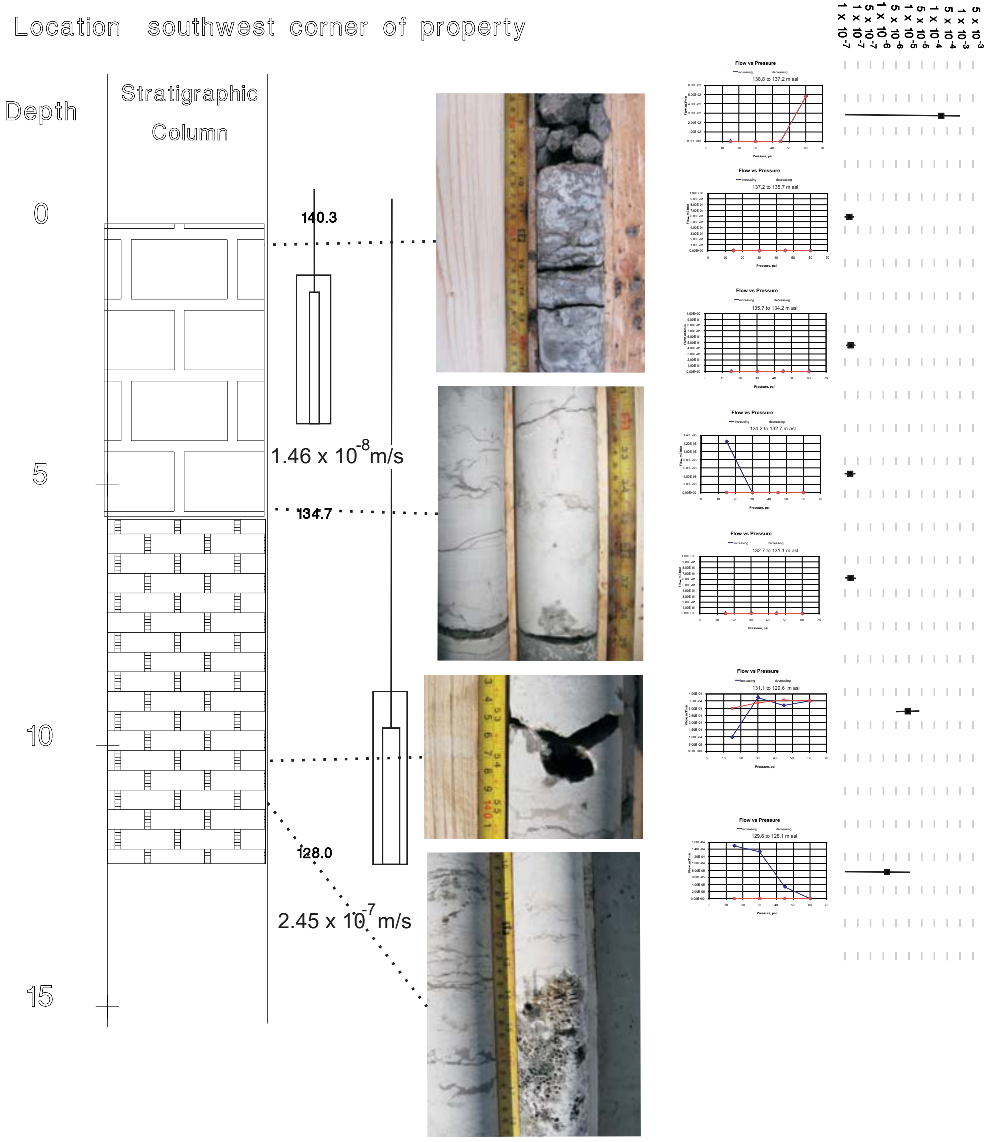
PROJECT 05490

Hole Number 12

DATE February 23, 2009

Location southwest corner of property

DRILL TYPE: diamond drill, CME



0 to 5.6 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown
to grey, fine to occasional medium crystalline, medium to
massive bedded, medium to thickly bedded,

-occasional vug present

5.58 to 12.27 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-large vug present at 10.5 m, tetradium coral zone from 10.97 to 11.10 m

GORRELL RESOURCE INVESTIGATIONS gri

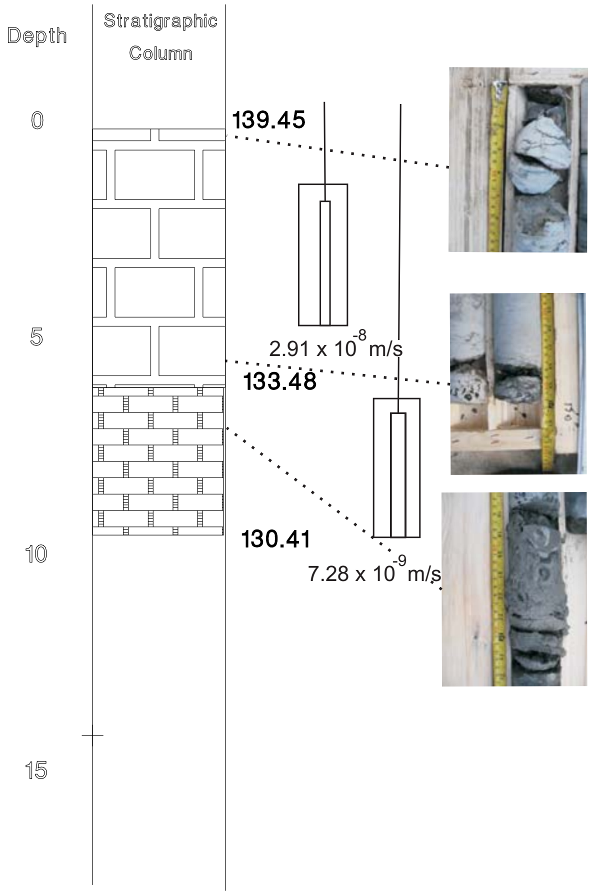
PROJECT 05490

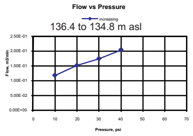
Hole Number 13

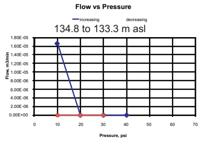
DATE February 25, 2009

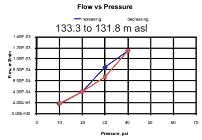
Location northwest corner of property

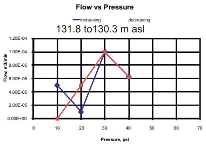
DRILL TYPE: diamond drill, CME

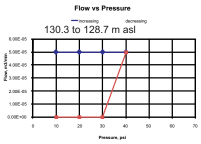


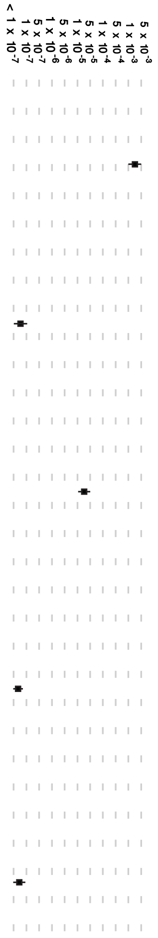












0 to 5.97 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown
to grey, fine to occasional medium crystalline, medium to
massive bedded, medium to thickly bedded

-highly weathered zone at 1.98 to 2.74

-occasional vug present

-fractures at 3.76, 3.84, 5.33

5.97 to 9.37 m GULL RIVER FORMATION

-upper portion of formation, consists of
light grey fine to very fine crystalline limestone with
shale interbeds

-fracture at 6.02

-K-bentonite present from 6.34 to 6.71 m bgs

GORRELL RESOURCE INVESTIGATIONS gri

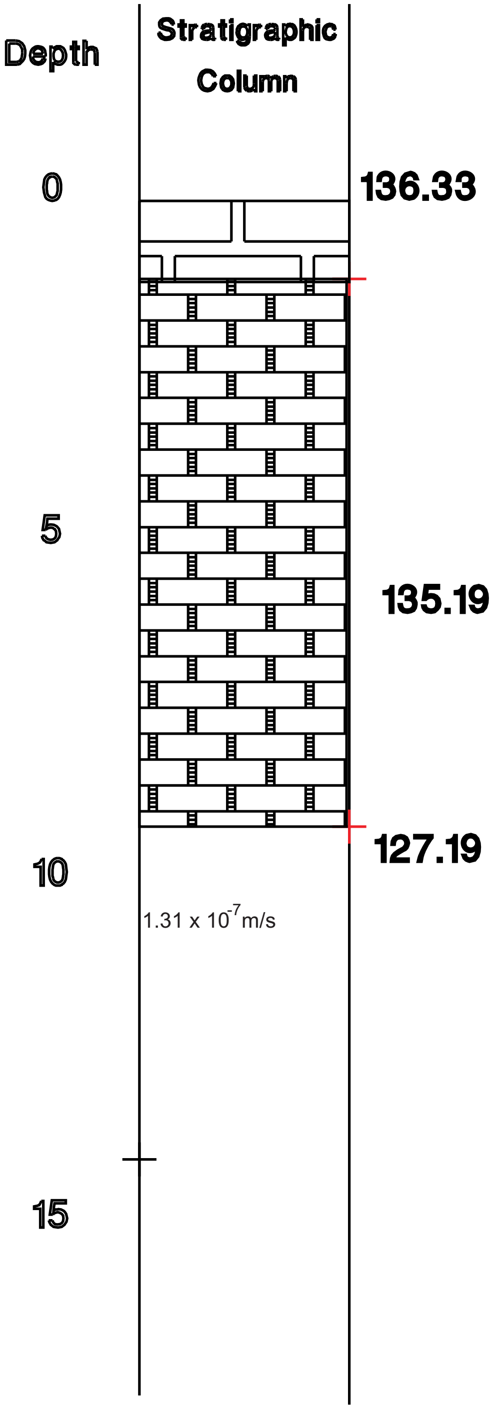
PROJECT 05490

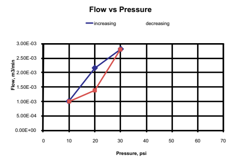
DRILL TYPE: diamond drill, CME 75

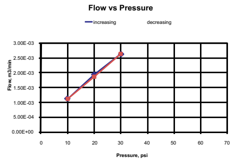
Hole Number F

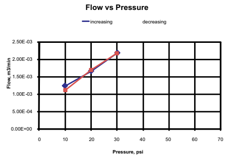
DATE March 4, 2009

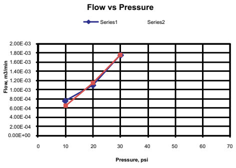
Location quarry floor, just south of sump; drilled for core to be tested

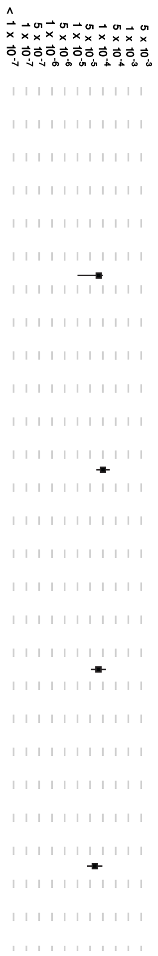












0 to 1.14 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown to grey, fine to occasional medium crystalline, medium to massive bedded, medium to thickly bedded

-occasional vug present

1.14 to 9.14 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with shale interbeds

-K-bentonite at 4.47 m (131.9 m asl)

GORRELL RESOURCE INVESTIGATIONS gri

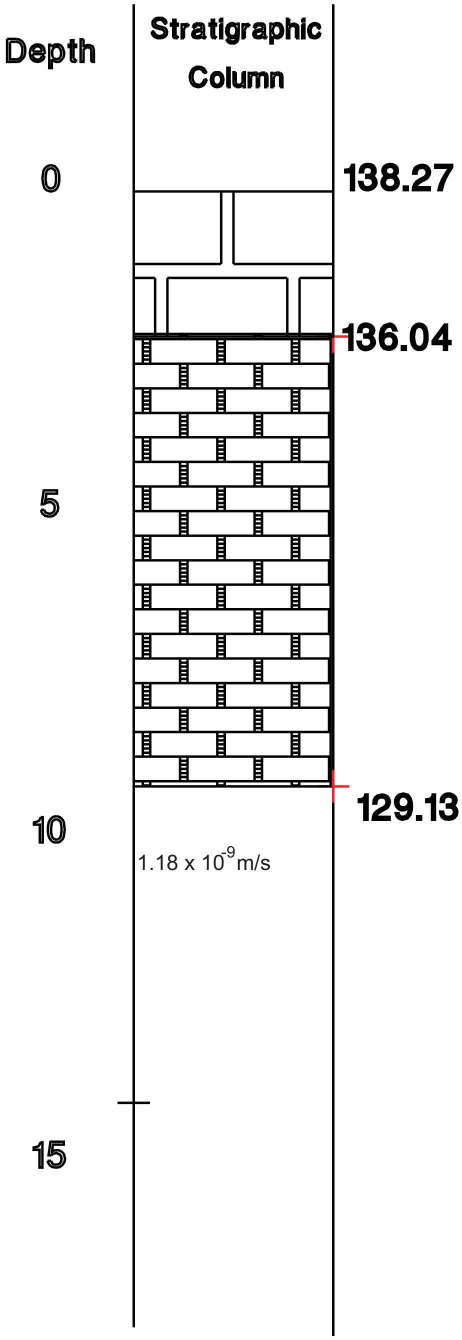
PROJECT 05490

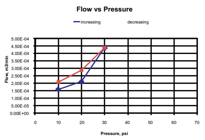
Hole Number G

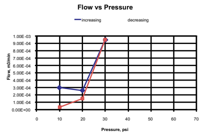
DATE March 5, 2009

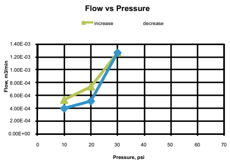
Location quarry floor, south portion of quarry; drilled for core to be tested

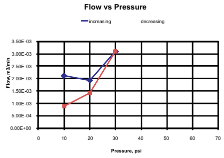
DRILL TYPE: diamond drill, CME 75

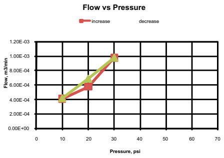


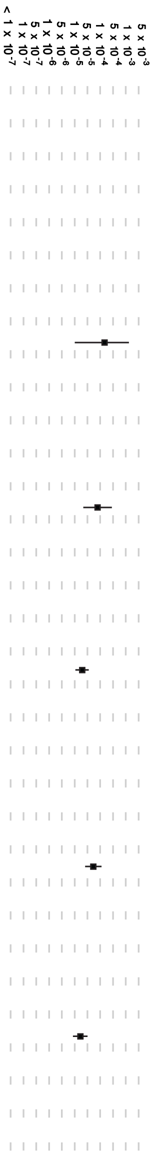












0 to 2.23 m BOBCAYGEON FORMATION

-lower member of Formation, medium to dark brown
to grey, fine to occasional medium crystalline, medium to
massive bedded, medium to thickly bedded

-occasional vug present

2.23 to 9.14 m GULL RIVER FORMATION

-upper portion of formation, consists of light grey fine to very fine crystalline limestone with
shale interbeds

-K-bentonite at 4.11 m (134.16 m asl)

Appendix D
Supplemental Assessment on Radius of Influence
AECOM June 2012

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

Miller Paving Limited

Supplemental Assessment – Radius of Influence From Quarry Dewatering – Proposed Braeside Quarry Expansion

Prepared by:

AECOM
300 – 300 Town Centre Boulevard 905 477 8400 tel
Markham, ON, Canada L3R 5Z6 905 477 1456 fax
www.aecom.com

Project Number:

60117237

Date:

May, 2012

Statement of Qualifications and Limitations

The attached Report (the “Report”) has been prepared by AECOM Canada Ltd. (“Consultant”) for the benefit of the client (“Client”) in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the “Agreement”).

The information, data, recommendations and conclusions contained in the Report (collectively, the “Information”):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the “Limitations”)
- represents Consultant’s professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- was prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

Consultant agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but Consultant makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed in writing by Consultant and Client
- as required by-law
- for use by governmental reviewing agencies.

Consultant accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information (“improper use of the Report”), except to the extent those parties have obtained the prior written consent of Consultant to use and rely upon the Report and the Information. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

Table of Contents

List of Attachments

1. Introduction

This supplemental assessment is intended to address Golder's specific comments dated September 11, 2008, and subsequently, March 9, 2010, on the GRI's earlier hydrogeological assessment reports (November 2007 and November 2009, respectively) with regard to the potential radius of influence in groundwater due to quarry dewatering and upward leakage to the final quarry floor at the site.

Information on the bedrock setting and hydrogeologic characteristics of the site as well as specific water bearing zones/fractures identified during field testing programs have been presented in detail in the hydrogeological assessment final report (Gorrell, May 2012). Representative testing results for bedrock hydraulic conductivity presented in the reports are used in this assessment. Some field testing data from Appendix A of the final report were further analyzed in this assessment using software (Aqtesolv) for aquifer testing to refine and confirm representative hydraulic parameters. Finally, the representative aquifer parameters are used to estimate the potential radius of influence due to quarry dewatering using appropriate analytical solutions with the software.

2. Hydraulic Test Data Review

2.1 Well Response Tests and Pumping Tests

We have reviewed the pumping test data from wells TW1 to TW8 and well response test (slug test) data from the monitoring wells at boreholes TW9 to TW13 presented in Appendices III and V, found in Appendix A of the final report (Gorrell, May 2012). In general, the field test methods and data analysis using the Jacob and Theis equations for the pumping test data and the Hvorslev solution for the slug test data are acceptable. The transmissivity from the pumping test data and the hydraulic conductivity from the slug test data, presented in Tables 1 and 2 of the final report, are considered to be representative hydraulic parameters and have been used for general groundwater impact assessment as presented in Sections 4.2 and 4.3 of this submission.

2.2 Packer Tests

We have reviewed the pump-in (injection) packer testing data presented in Appendix IV, found in Appendix A of the final report. The field test method is described in Sections 2 and 7.2 in Appendix A of the final report. The references for the field test protocol and data analysis include Standard Operating Procedures for Borehole Packer Testing (Michael Royle, SRK North America). The references for these data review also include Earth Manual, Part 2 - A Water Resource Technical Publication by US Bureau of Reclamation, 1990, USBR 7310-89: Procedure for Constant Head Hydraulic Conductivity Tests in Single Drill Holes.

Due to injection of water into test intervals under increasing pressures, the interference from potential fracture washout or clogging, hydrofracturing or turbulent flow might occur and as a result, only representative packer test results are included in Table 1 showing the linear relationship due to laminar flow conditions between the system pressure and measured flow. The reasons for excluding some individual tests from each test interval due to the non-linear effects are briefed in the last column (Comment) of Table 1. Although the individual tests, showing non-linear effects due to either potential fracture washout, fracture clogging, hydrofracturing or turbulent flow conditions were not included, but the initial tests under lower water pressures before these effects took place are included. It is noted that test results from descending pressure steps are not included in Table 1 if non-linear effects had taken place during ascending pressure steps for the same depth interval. If the linear relationship existed due to consistent laminar flow conditions, the test results from the ascending pressure steps were considered representative of the test interval and therefore, the results from the descending pressure steps are also not included.

It should be noted that possible natural boundary conditions of fractures (such as fractures close or open up, or fractures in connection with localized unsaturated rock openings such as significant joints/voids) could have made the system tested more complex and the test data more difficult to interpret. Due to limitations of the pump-in test method and multiple factors potentially affecting the flow data, we generally agree with GRI to consider the hydraulic conductivity estimated from the pump-in tests as the potential hydraulic conductivity. Therefore, the hydraulic conductivity from the packer tests was not used and instead, we have used representative hydraulic conductivity or transmissivity derived from the more reliable well response tests or pumping tests for this groundwater impact assessment (such as radius of influence). It is noted however, that for more conservative assessment, the highest range of potential hydraulic conductivity in the order of 10^{-5} m/s from the packer tests on the shallow bedrock has been used to assess general radius of influence in the weathered bedrock aquifer as shown in the attached Calculation Sheet 1 of this report.

Discussion

Pump-in packer tests are very efficient and effective in identifying discrete permeable fracture zones within competent bedrock so that dedicated monitoring wells can be installed and further tested to characterize the permeable zones using the well response tests (slug test) or pumping tests. In many cases, however, the potential hydraulic conductivity from pump-in packer tests may have to be used for general groundwater impact assessment if well response test data are not available, or insufficient, or less representative. Although properly performed pump-in packer tests with carefully selected water pressure steps may produce representative hydraulic conductivity, the optimal packer test method is to conduct well response tests (slug test) on isolated depth intervals with packers, to minimize the possible non-linear effects and boundary conditions due to water injection with the pump-in method as discussed above.

3. Summary of Bedrock Aquifers

We generally agree with the site hydrogeological model described in detail in Section 6.1 of the hydrogeological assessment final report (Gorrell, May 2012), based on information from on-site boreholes and monitoring wells, as well as local water well records. As summarized in the final report, there are two identified bedrock aquifers which are more permeable and extensive in the local area. These include the shallow weathered bedrock within the Bobcaygeon Formation and the first significant water bearing zone (SWBZ) within the competent bedrock of the Lower Gull River Formation.

The surficial weathered bedrock zone is unconfined with hydraulic conductivity varying from about $2x10^{-7}$ to $5x10^{-5}$ m/s and saturated thickness varying from about 0.5 m to 5.5 m across the site. The first SWBZ is a deep, confined aquifer identified to be moderately permeable with hydraulic conductivity varying from about $2x10^{-6}$ to $2x10^{-5}$ m/s. Based on both local MOE well records and on-site borehole information, the SWBZ occurs at elevations approximately between 120 and 117 mASL about 5 m below the proposed final quarry floor (125 mASL).

Between the weathered bedrock and underlying SWBZ, there are discrete water bearing fractures found within the competent bedrock of the Upper Gull River Formation. The borehole information and hydraulic testing data suggest that these water bearing fractures are localized, discontinuous and of low yields and therefore, considered to be insignificant from a water supply point of view.

4. Potential Effects from Quarry Dewatering

4.1 Radius of Influence Due to Drainage from Weathered Bedrock

It is apparent that dewatering of the weathered bedrock due to quarry operations takes the form of drainage under unconfined conditions from the surrounding weathered bedrock to rock faces of the quarry excavation throughout the entire quarry development phases. As the recharge from precipitation directly effects the drawdown cone in the shallow weathered bedrock around the quarry, recharge should be taken into account in the equation to estimate the radius of influence.

We feel that the drainage equation, Hooghoudt (1936), used for determining the trench spacing based on hydraulic conductivity and infiltration from precipitation is appropriate in estimating the radius of influence from quarry dewatering in the surrounding unconfined, weathered bedrock. The attached Calculation Sheet 1 presents the references and formula as well as the source of input parameters for the equation. Chart 1 attached illustrates the conceptual model of the Hooghoudt Equation.

The normal infiltration rate (190.5 mm/a) is estimated based on the water budget derived from the long term meteorological data at the local weather station (Claybank Station, Ottawa) and the MOE infiltration factors for land development applications. The average saturated thickness of the weathered bedrock is assumed to be about 2.5 m in total with the more permeable upper 2 m and less permeable lower 0.5 m. The radius of influence is then calculated to be in the range of about 90 m for hydraulic conductivity $K_a = 1x10^{-5}$ m/s to about 190 m for $K_a = 5x10^{-5}$ m/s, with $K_b = 5x10^{-6}$ m/s unchanged (K_a refers to the upper 2 m and K_b the lower 0.5 m). The sources of the parameters used for the calculation are described in the calculation sheet. It is noted that to be conservative, the highest potential hydraulic conductivity values ($1x10^{-5}$ to $5x10^{-5}$ m/s) estimated from pump-in packer tests are used in this assessment.

4.2 Radius of Influence Due to Lower Lift Sump Pumping

The purpose of this assignment is to assess potential impacts from long-term operations of the lower lift sump in case the sump intercepts the first significant water bearing zone (SWBZ) below the final quarry floor. An analytical solution with Aqtesolv and the refined aquifer parameters based on results of our data review are used in the assessment.

4.2.1 Setting of Lower Lift Sump

It is understood that this water bearing zone (SWBZ) below the final quarry floor is situated within the Lower Gull River Formation at elevations found typically between 120 and 117 mASL as stated in Section 1.4 of the final report (Gorrell May 2012). It is noted from the attached Table 2 that this SWBZ has been encountered on-site at 119.9 mASL (TW3-1) and 117.3 mASL (TW6-1) to the north, and 121.0 mASL (TW9-1) and 121.8 mASL (TW8-1) to the south, suggesting the SWBZ generally dips to the northeast across the site. As shown in Figure 6 (Gorrell, May 2012), the proposed lower lift sump will be located at the northeast corner of the existing quarry excavation, suggesting the SWBZ is likely present at an elevation between 120 and 119 mASL below the sump.

The final report in Section 12 recommends that the base of the pump chamber in the lower lift sump be set at 123 mASL or 2 m below the final quarry floor (125 mASL) to maintain a minimum separation (3 m) from the underlying SWBZ. The pump chamber, therefore, should not intercept the SWBZ and no adverse effect will be expected as a result of the pump operation. The purpose of this assessment is then to evaluate potential long term offsite effects in case the SWBZ is intercepted by or in hydraulic connection with the pump chamber. This indicates that a very conservative approach has been taken for this assessment to ensure that the proposed groundwater monitoring program for the site is sufficient to provide early warning for the offsite wells and the mitigation/contingency plan to be executed is also adequate to deal with any potential adverse effect.

4.2.2 Hydraulic Parameters of Underlying SWBZ

Wells TW3-1, TW6-1 and TW8-1 were tested by well pumping in 2007 and well TW9-1 was tested in 2009 by a well response test (slug test). The detailed field test data and results of data analysis are presented in Appendix III and V, found in Appendix A of the final report (Gorrrell, May 2012). The attached Table 2 shows the transmissivity of the SWBZs estimated through our independent analysis of the drawdown data (residual drawdown included) from TW3-1, TW6-1 and TW8-1. The drawdown data were analyzed with Aqtesolv, Professional Version 4.5 using the analytical solution for confined aquifers (Papadopulos-Cooper, 1967) that deals with wellbore storage. The graphs showing the results of data analysis with Aqtesolv are also attached.

The attached Table 2 shows that the transmissivity of this SWBZ varies from about 0.6 m^2/day at TW9-1 to 4.3 m^2/day at TW3-1. TW6-1 is not accounted for due to significant well loss during the test. The wide range of transmissivity suggests heterogeneity of the SWBZ across the site, consistent with field observations during borehole drilling and logging. Therefore, the geometric mean of transmissivity (1.6 m^2/day) is assumed to be representative of the SWBZ for the aquifer as a whole, for purposes of general assessment using appropriate analytical solutions.

4.2.3 Methodology and Assumptions

This section provides brief information of the analytical solution and model parameters used and the main assumptions made, as well as the assumed operational conditions of the sump, to assess the potential radius of influence due to partial penetration of the underlying SWBZ.

Commercial Software	Aqtesolv for Window, 2007, Professional Version 4.5.
Analytical Solution.........	Dougherty-Babu, 1984, a transient solution for confined aquifers taking into account the storage of the sump and partial penetration of the sump into the aquifer.
Partial Penetration	The sump base is assumed to be cut about 0.5 m into the underlying SWBZ which is about 3 m thick.
Sump Size......................	The equivalent radius of the sump is about 22.4 m based on the area (1,575 m^2) required for a 2 m deep sump for the sump base set at 123 mASL.
Aquifer Parameters........	The transmissivity (T) of the WBZ equals 1.6 m^2/day which is the geometric mean of T values estimated from TW3-1, TW8-1 and TW9-1 as presented in attached Table 2. The transmissivity (1.6 m^2/day) and calculated hydraulic conductivity ($6.2x10^{-6}$ m/s) represent the average hydraulic parameters of the SWBZ.
Required Drawdown	The required drawdown at the lower lift sump for quarry dewatering operations is about 2.5 to 3 m estimated from the difference between the static level in the SWBZ (127 mASL on long term average estimated from piezometer TW9-1) and the sump level to be maintained (124 to 124.5 mASL or 1 to 1.5 m above the base of the sump).
Pumping Conditions......	The pumping rate starts initially at about 310 m^3/day (about 47 igpm) and decreases over time to about 7.1 m^3/day (about 1.1 igpm) after one year of

operations. The decreasing pumping rates selected are required to maintain the sump level within the maximum drawdown of 3 m over the entire operational period. As shown in the attached drawdown vs. time graph (Appendix B), the sump operational cycles on an annual basis include eight months of continuous pumping to control sump levels followed by four months of winter shutdown for recovery (due to frozen conditions), as specified in the attached data sheet following the graph.

Groundwater Recharge . Groundwater recharge on the SWBZ is not taken into account by the analytical solution used with Aqtesolv.

4.2.4 Analytical Results and Discussions

The cumulated drawdown over time and distance from the sump are calculated using the Forward Solution for the given aquifer parameters and operational conditions of the sump as described above. The results of theoretical calculations, shown in the attached Table 3, suggest that in case the sump base intercepts the top 0.5 m of the SWBZ, the radius of influence for 1 m drawdown may extend to about 500 m from the sump after one year of the sump operation, about 800 m after five years of operation and about 1,000 m after 10 years of operation. Table 3 also shows that the drawdown would increase over time and distance but at extremely slow rates. The relatively small drawdown and very slow increase rates are largely attributed to the lower pumping rates required to maintain the sump level at 124 to 124.5 mASL or to a maximum drawdown of 3 m at the sump and the annual recovery periods due to winter shutdown as shown in the attached time-drawdown plot for the lower lift sump.

As shown in Figure 6 (Gorrell, May 2012), the pump chamber in the lower lift sump will be located at the northeast corner of the existing quarry excavation. The local wells are located along Usborne Street to the west about 600 to 900 m from the sump and Golf Club Road to the north about 700 to 1000 m from the sump. The results in Table 3 suggest that the wells may experience a drawdown of 1.1 to 1.3 m along both Usborne Street and Golf Club Road, over a period of 10 to 20 years of operation at the lower lift sump. It should be indicated that if the sump is located near the boundaries of the future excavation, more drawdown may be experienced in these wells as the future excavation boundaries are located much closer to the wells, about 250 to 400 m to Usborne Street and 300 to 500 m to Golf Club Road. This suggests that the northeast corner of the existing excavation, where a lower lift cut has been constructed, is the preferred location for the future lower lift sump to maximize the distance to the local wells thus minimizing potential impacts on local water supply.

The predicted potential small drawdown at the local wells will unlikely cause adverse effects on water supply due to the large available drawdown in these deep supply wells. Furthermore, it should be noted that the analytical solution used in this assessment does not account for natural groundwater recharge to the pumped SWBZ. In reality, recharge from infiltration onto the regional and local SWBZ always takes place and will significantly reduce the predictive drawdown and radius of influence within the SWBZ shown in the attached Table 3. Finally, the existing monitoring well network established along the perimeter of the property will be used to provide early warning and recommendation to investigate and/or implement the proposed mitigation/contingency measures, if required, to deal with any potential significant off-site well interference complaints. In this way, any adverse effects on the local supply wells due to quarry dewatering will be detected at an early stage and will be mitigated accordingly.

4.3 Estimated Upward Leakage To Final Quarry Floor

This assignment is intended to confirm and update the assessment presented in the GRI's earlier reports listed in Section 1 with regard to upward seepage from the confined aquifer (the SWBZ) to the final quarry floor as well as to the lower lift sump. The existing data of vertical seepage calculation presented in the earlier report were reviewed. The available hydraulic testing data from piezometers in the upper Gull River Formation and seasonal water level data of the SWBZ were reviewed and used in this assessment to calculate yearly average upward gradients and flow from the SWBZ. Potential long term effects on the SWBZ, as a result of upward leakage from the aquifer, are also discussed.

4.3.1 Area Hydrogeological Setting

In the limestone/dolostone setting of Southeastern Ontario, horizontal groundwater flow occurs primarily along bedding plane fractures/openings. The competent bedrock between the bedding planes generally has very low hydraulic conductivity (K) values. Therefore, vertical flow takes place mainly in the form of seepage along discrete vertical fractures cutting through competent rock beds and in connection with the horizontal flow paths. The horizontal hydraulic conductivity (K) for competent bedrock of the Gull River Formation in Southeastern Ontario generally falls in the range of 10^{-8} to 10^{-10} m/s based on our previous experiences from similar quarry sites. Due to discrete distribution and a small number of vertical fractures, potentially present in a local area, the vertical K is usually assumed to be 10 to 100 times lower than the horizontal K for general assessment and as a result, the vertical K is assumed to range from 10^{-9} to 10^{-12} m/s.

4.3.2 Site Average Upward Hydraulic Gradient

We have revisited all borehole logs, monitor installations and groundwater elevations in the report. As previously noted, the significant water bearing zone (SWBZ), occurring at elevations from 117 to 120 mASL in the study area, is observed at elevations from 117.3 to 121.8 mASL at the site. The deep wells at TW2 to TW8 installed earlier are all open boreholes to depth likely intercepting the SWBZ. The static levels in these wells, however, represent the average head of various water bearing zones encountered in the open holes including saturated bedding plane fractures/openings within the competent bedrock and shallow groundwater within the unconfined weathered bedrock and therefore, are not representative of the true hydraulic head of the SWBZ.

TW11-1 is a piezometer installed between 113.9 and 116 mASL about 1 m below the SWBZ. It seems the SWBZ was just missed at TW11-1 as both well response test and packer test results suggest that the piezometer is installed in competent bedrock of low permeability with K values in the order of 10^{-8} m/s.

TW9-1 installed between 121.0 and 123.1 mASL was the only piezometer at the site that intercepts a significant water bearing zone. The water levels from monitor TW9-1, therefore, are most representative of the hydraulic head of the SWBZ at the site. To assess yearly average conditions of upward gradient, all available groundwater elevation data from TW9-1 measured from March to November of 2009 were presented in the Calculation Sheet 2 attached with this submission. With the average hydraulic head of 127.46 mASL at TW9-1, the yearly average upward gradient to the final quarry floor (125 mASL) is estimated to be in the order of 0.49, shown in Calculation Sheet 2 attached. As the base of the lower lift sump will not be lower than 123 mASL, the upward gradient to the sump base is conservatively calculated to be in the order of 1.49 shown in the attached Calculation Sheet 3.

4.3.3 Site Representative Hydraulic Conductivity

We have reviewed all well response test data for piezometers installed in the Gull River Formation bedrock above the SWBZ (117 to 120 mASL). Piezometers 10-1, 11-2, 12-1 and 13-1 installed within the upper Gull River Formation under confined conditions give a range of horizontal K from $1x10^{-7}$ to $6x10^{-9}$ m/s with a geometric mean of $2.5x10^{-8}$ m/s, better representative of the more competent bedrock within the formation, shown in the attached Calculation Sheet 2. It is noted that the vertical K is assumed in the range of $2.5x10^{-9}$ to $2.5x10^{-10}$ m/s, which is 10 times to 100 times lower than the horizontal K. These vertical K values, estimated from the site data, generally fall in the upper portion of the assumed vertical K range (10^{-9} to 10^{-12} m/s) discussed in the above Section 4.3.1 for the competent bedrock of the Gull River Formation in southeastern Ontario. This suggests that the vertical K values, estimated from the site data and used in this assessment, are very conservative estimates.

4.3.4 Calculation Results and Discussions

The licensed final quarry floor will be set at an elevation of 125 mASL about 5.1 to 7.7 m above the SWBZ near TW3 and TW6 in the north part of the site and about 3.2 to 4.1 m above the SWBZ at TW8 and TW9 in the south part of the site. The calculations for the potential upward seepage from the SWBZ to the final quarry floor are presented in the Calculation Sheet 2 attached. The results show that under the assumed yearly average conditions of hydraulic gradient, the upward Darcy flux would be very small ranging from 0.01 mm/day to 0.1 mm/day. This small flux suggests a very small upward leakage to the quarry floor from 0.01 to 0.1 Litre/day per square metre or 0.1 to 1 m^3/day per hectare, shown in Calculation Sheet 2. The potential upward leakage to the lower lift sump is estimated to be minor from 0.05 to 0.5 m^3/day in total due to the small sump area (1575 m^2), shown in Calculation Sheet 3.

The actual long-term effect on the SWBZ due to the above-estimated small upward seepage to the final quarry floor, should take into account the following aspects.

The upward leakage, calculated in the attached Calculation Sheet 2, only applies to three quarters of the year (spring, summer and fall) and no upward seepage is expected through the quarry floor under winter frozen ground conditions.

The amount of upward flow is largely affected by the upward gradient estimated based on water level data. Year 2009 was a very wet year likely representing higher than normal groundwater conditions resulting in the higher upward gradient and flow. Much lower upward gradient and flow, therefore, are expected to occur under long-term average or normal groundwater conditions.

The very small upward leakage may slightly depressurize the SWBZ in the immediate area of the quarry floor. The slowly depressurized SWBZ in turn decreases upward gradients to the quarry floor and therefore, a declining upward leakage is expected over the long-term.

The upward leakage to the final quarry floor would take place only at times the hydraulic head of the SWBZ is higher than the final quarry floor at 125 mASL. No upward seepage into the quarry is expected at times the hydraulic head of the SWBZ is lower than 125 mASL during dry seasons or has declined to below 125 mASL due to the SWBZ depressurization caused by the upward leakage.

The hydraulic head of the SWBZ was measured from 125.05 to 129.56 mASL at TW9-1 from March to November 2009 with an average hydraulic head of 127.5 mASL. As 2009 was a very wet year, it is reasonable to assume that 127 mASL represents the average hydraulic head of the SWBZ under normal year conditions. These suggest that the SWBZ below the quarry may be depressurized by a maximum 2 m on an average and long-term basis. The maximum 2 m head loss in the SWBZ below the quarry floor will not pose significant effects on local supply wells located 300 to 500 metres away to the west and north of the quarry.

It is apparent that potential effects on the local supply wells due to the upward leakage would be insignificant. This is attributed to the very small upward flow which would decrease over time, only up to 2 m drawdown to occur in the SWBZ below the quarry floor, the greater distances of the local wells from the quarry, the large available drawdown in these deep supply wells as well as the natural recharge from precipitation to the aquifer.

The existing monitoring well network established along the perimeter of the property will be used to provide early warning and recommendation to investigate or implement the mitigation/contingency plan, if required, to deal with any potential significant off-site effects.

5. Limitations

It should be indicated that in addition to the assumptions for calculations specified in the above sections, a number of other assumptions also apply to the simple theoretical equations (Hooghoudt, 1936 and Darcy, 1856) and the analytical solutions rendered with the software (Papadopulos-Cooper, 1967 and Dougherty-Babu, 1984). The actual radius of influence from quarry dewatering may vary from what is predicted with the theoretical calculations.

As the radius of influence derived in the above sections is based on theoretical calculations and assumptions given, the actual extent of influence in reality should be confirmed by field monitoring and further investigation/testing as required. Therefore, the results of radius of influence presented above should be used only for planning purposes, to determine monitoring requirements and develop mitigation and contingency plans.

Attachments

- Tables
- Calculations
- Chart
- Graphs

Table 1: Summary of Representative Borehole Packer Testing Results

Borehole No	Test Interval (masl)	Water Pressure (psi)	Potential Hydraulic Conductivity **K** (m/s)	Geometric Mean of Potential **K** (m/s)	Comment
9-1 (Ground at 152.19 mASL)	121.1 - 123.2	15	4.97E-07	3.79E-07	Turbulent flow conditions beyond 30 psi
		30	2.90E-07		
	123.2 - 126.3	30	4.03E-08	4.03E-08	Turbulent flow conditions beyond 30 psi
	126.3 - 129.3	30	1.21E-07	1.21E-07	Fracture partial washout beyond 30 psi
	129.3 - 132.4	15	5.43E-08	5.43E-08	Fracture partial clogging beyond 15 psi
	132.4 - 135.4	15	1.51E-07	1.44E-07	General Laminar flow conditions, slight fracture washout beyond 30 psi
		30	1.21E-07		
		45	1.45E-07		
		60	1.63E-07		
	135.4 - 138.5	15	9.06E-09	1.24E-08	Fracture partial washout beyond 30 psi
		30	1.71E-08		
	138.5 - 141.5	15	4.03E-08	4.03E-08	Fracture partial clogging beyond 15 psi and washed out beyond 30 psi
	141.5 - 144.6	15	2.62E-05	2.41E-05	General consistent laminar flow conditions
		30	2.42E-05		
		45	2.21E-05		
	144.6 - 147.6	15	5.03E-05	3.18E-05	Fracture partial clogging beyond 30 psi
		30	2.01E-05		
	147.6 - 150.5	15	2.62E-07	3.48E-07	Fracture partial washout beyond 30 psi and possible hydrofracturing beyond 45 psi
		30	4.63E-07		
10-1 (Ground at 145.74 mASL)	130.4 - 132.0	30	1.09E-07	1.17E-07	Fracture partial clogging beyond 45 psi
		45	1.25E-07		
	130.5 - 133.5	45	6.24E-08	6.14E-08	Laminar flow conditions beyond 30 psi
		60	6.04E-08		
	133.5 - 136.6	up to 60	0.00E+00	0.00E+00	Water pressure (up to 60 psi) likely not enough for low K bedrock at these depths
	136.6 -139.6	up to 60	0.00E+00		
	139.6 -142.7	15	1.23E-06	1.10E-06	Laminar flow condition from 15 to 45 psi with fracture partially washed out beyond 45 psi
		30	1.01E-06		
		45	1.09E-06		
	141.8 - 144.8	15	2.01E-06	2.46E-06	Fracture partially washed out beyond 30 psi and possible hydrofracturing beyond 45 psi
		30	3.02E-06		
11-1 (Ground at 142.81 mASL)	113.7 - 115.4	15	1.45E-07	1.45E-07	Fracture partial clogging beyond 15 psi and clogged up beyond 45 psi
	113.8 - 116.9	15	1.71E-08	1.71E-08	Fracture clogged up beyond 15 psi and washed out beyond 30 psi
	116.9 - 119.9	15	7.25E-08	6.72E-08	Fracture parially washed out beyond 30 psi
		30	6.24E-08		
	119.9 - 123.0	15	1.61E-08	2.21E-08	Fracture clogging up beyond 30 psi and patially washed out beyond 45 psi
		30	3.02E-08		
	123.0 - 126.0	15	1.61E-07	1.61E-07	Fracture clogged up beyond 30 psi
		30	1.61E-07		
	126.0 - 129.1	15	8.25E-07	8.86E-07	Lamilar flow from 15 to 45 psi and Fracture partial clogging beyond 45 psi
		30	1.05E-06		
		45	8.05E-07		
	129.1 - 132.1	up to 60	0.00E+00	0.00E+00	Water pressure (60 psi) likely not enough for low K bedrock at this depth
	132.1 - 135.2	15	3.02E-08	2.55E-08	General lamilar flow conditions from 15 to 45 psi and fracture partially washed out beyond 45 psi
		30	3.02E-08		
		45	1.81E-08		
	135.2 - 138.2	15	7.45E-08	5.87E-08	Turbulent flow conditions beyond 30 psi
		30	4.63E-08		
	138.2 - 141.3	15	1.01E-07	1.01E-07	Fracture partial clogging beyond 15 psi

Table 1: Summary of Representative Borehole Packer Testing Results

Borehole No	Test Interval (masl)	Water Pressure (psi)	Potential Hydraulic Conductivity **K** (m/s)	Geometric Mean of Potential **K** (m/s)	Comment
12-I (Ground at 140.28 mASL)	128.1 - 129.6	15	1.21E-07	1.21E-07	Fracture clogging up with time beyond 15 psi
	129.6 - 131.1	15 30	9.26E-08 1.65E-07	1.24E-07	Pressure partial clogging beyond 30 psi
	131.1 - 132.7	up to 60	0.00E+00	0.00E+00	Water pressure (up to 60 psi) likely not enough for low K bedrock at these depths
	132.7 - 134.2	up to 60	0.00E+00		
	134.2 - 135.7	up to 60	0.00E+00		
	135.7 - 137.2	up to 60	0.00E+00		
	137.2 - 138.8	15 30 45 60	5.23E-05 5.23E-05 4.83E-05 3.82E-05	4.74E-05	Consistent laminar flow conditions from 15 psi to 60 psi
13-I (Ground at 139.52 mASL)	128.7 - 130.3	up to 40	0.00E+00	0.00E+00	Water pressure (40 psi) too low for low K bedrock at these depths
	130.3 - 131.8	up to 40	0.00E+00		
	131.8 - 133.3	10 20	2.82E-07 1.85E-07	2.28E-07	Fracture partially washed out beyond 20 psi
	133.3 - 134.8	up to 40	0.00E+00	0.00E+00	Water pressure (40 psi) too low for low K bedrock at this depth
	134.8 - 136.4	10 20 30 40	1.05E-04 6.44E-05 6.04E-05 6.04E-05	7.04E-05	Consistent laminar flow conditions

Notes:

1) Complete test data and graphs for test intervals in each borehole found in Appendix iV, Appendix A of the final report (Gorrell, May 2012)
4) Packer tests were performed by All Terrain Drilling with packer pressure maintained at 400 psi throughout the tests
2) Data interpretation referenced to Standard Operating Procedures for Borehole Packer Testing, Michael Royle, SRK North America
6) The two highest depth intervals tested at borehole 9-1 was unsaturated during the test

Table 2: Hydraulic Parameters of the First Significant Water Bearing Zone (SWBZ)

Borehole/Well	SWBZ Found mASL	**Transmissivity (T)** m2/day	Source of Testing Data	Analytical Solution	Comment
TW3-1	119.9	4.340	2007 Pumping test data	Papadopulos-Cooper (1967)	
TW6-1	117.3	0.071	2007 Pumping test data	Papadopulos-Cooper (1967)	Well loss significant
TW8-1	121.8	1.370	2007 Pumping test data	Papadopulos-Cooper (1967)	
TW9-1	120.95	0.597	2009 Slug test data	Hvorslev (1951)	Calculated from K assuming WBZ 3 m thick
Geometric Mean*		1.53			

Notes:
- the licensed final quarry floor is at 125 mASL and the base of the lower lift sump is to be set at 123 mASL
- The first significant water bearing zone (WBZ) below the final quarry floor is reportedly between 120 and 117 mASL
- SWBZ Elevations at wells TW3-1, TW6-1 and TW8-1 refer to Table 1 of the final eport (Gorrell, May 2012)
- SWBZ elevation at TW9-1 refers to Table 3 and core photos in Appendix A of the final report (Gorrell, May 2012)
- Slug test (well response test) data analysis for TW9-1 can be found in Appendix A of the final report (Gorrell, May 2012)
- Data analysis for other wells are independent and can be found in the attachment to this submision
- The analytical solution (Papadopulos-Cooper, 1967) deals with confined aquifers and well storage

* -Calculated geometric mean of T does not include TW6-1 due to significant well loss in the well during pumping test

Table 3: Potential Long Term Drawdown over Distance in the SWBZ Due to Lower Lift Sump Operation

Distance to Sump	Duration of Lower Lift Sump Operation				
	1 Year	5 Years	10 Years	15 Years	20 Years
100 m	1.83	1.87	1.95	1.96	1.98
200 m	1.50	1.60	1.68	1.71	1.73
300 m	1.31	1.44	1.53	1.56	1.58
400 m	1.17	1.32	1.42	1.45	1.48
500 m	1.06	1.23	1.33	1.37	1.40
600 m	0.98	1.16	1.26	1.30	1.33
700 m	0.90	1.10	1.20	1.24	1.28
800 m	0.84	1.05	1.15	1.19	1.23
900 m	0.78	1.00	1.10	1.15	1.18
1000 m	0.73	0.95	1.06	1.11	1.14

Notes: Aqtesolv Pro Version 4.5 - Forward Solution (Dougherty-Babu, 1984) used for calculation

Main Assumptions:

The transmissivity of the first significant WBZ is 1.6 m^2/day (geometric mean)
The thickness of the SWBZ is 3 m and the sump base cut 0.5 m into the SWBZ
Drawdown in the sump will be maintained 2.5 to 3 m from the static over quarry dewatering operations
Sump annual operational cycles: 8 months of continuous pumping and 4 months of winter shutdown

Calculation Sheet 1
Radius of Influence Due to Quarry Dewatering
In Shallow, Unconfined Weathered Bedrock

Reference Book:
Drainage Principles and Applications
by International Institute for Land Reclamation and Improvement (1973)
Theories of Field Drainage and Watershed Runoff
8. Subsurface Flow Into Drains

Hooghoudt Equation (1936)

$$R = q = \frac{8K_b dh + 4K_a h^2}{L^2}$$

see attached chart for concept model

Under steady state conditions, trench discharge rate equals infiltration rate

R	recharge/infiltration rate per unit surface area	m/day
q	trench discharge rate per unit surface area	m/day
K_a	hydraulic conductivity of the layer above drain level	m/day
K_b	hydraulic conductivity of the layer below drain level	m/day
d	trench level height above impervious base of trench	m
h	water table height above trench level at midway between two trenches	m
L	trench spacing	m
0.5 L	radius of influence where no drawdown occurs	m

Modified Equation

$$L^2 = \frac{8K_b dh + 4K_a h^2}{q}$$

Parameters

q	190.5	mm/a	190.5	mm/a	
K_a	5.0E-05	m/s*****	1.0E-05	m/s******	
K_b	5.0E-06	m/s	5.0E-06	m/s	
h	2	m	2	m	
d	0.5	m	0.5	m	
L^2 =	139093	m^2	33117	m^2	
L =	373.0	m	182.0	m	
0.5 L =	**186**	**m**	**91**	**m**	**Radius of Influence**

Source of Data

Infiltration rate derived from local meteorological data as presented below
* -K values from boreholes 9, 12 and 13; ** -K values from boreholes 9 to 13
(all K values from borehole packer test results for shallow weathered bedrock)
Avearge saturated thickness estimated from boreholes 9, 10, 12 and 13 with water levels measured in shallow wells on May 4 and Sep 24, 2009

Water Budget

Long-term meteorological data at Claybank Station, Ottawa, Ontario

Average Anuual Precipitation	814	mm/a
Average Annual Evapotranspiration	521	mm/a
Average Annual Water Surplus	293	mm/a

Infiltration Factor

- based on MOE Hydrogeological Technical Information Requirements For Land Development Applications (April 1995)

		Factors
MOE Factors	Topography	0.2
	Soil Type	0.3
	Land Cover	0.15
	Total	0.65

Normal Infiltration = 190.5 mm/a

Reference: Hydrological Investigation (Skelton, Brumwell and Associates, October 2007)

Calculation Sheet 2

Upward Leakage from the SWBZ To Final Quarry Floor

Final Quarry Floor Area =	68.4	ha
=	684000	m2

Hydraulic Gradient

Average Head of SWBZ at TW9-1	127.46	mASL
SWBZ Elevation =	120	mASL
Final Quarry Floor Elevation =	125	mASL
Average Upward Gradient =	0.492	

Static Level at TW9-1[1]

Date	Elevation	
03-Mar-09	129.82	mASL
04-May-09	129.56	mASL
20-May-09	127.19	mASL
22-Jul-09	125.93	mASL
24-Sep-09	125.05	mASL
23-Nov-09	127.2	mASL
Average	127.46	mASL

Hydraulic Conductivity[2]

Horizontal Kh =	6.01E-09	m/s	from 11-2	Test Interval 133.8 - 137.4 mASL within Gull River Formation above SWBZ
	7.28E-09	m/s	from 13-1	Test Interval 128.9 - 131.0 mASL within Gull River Formation above SWBZ
	1.15E-07	m/s	from 10-1	Test interval 130.4 - 134.0 mASL within Gull River Formation above SWBZ
	7.68E-08	m/s	from 12-1	Test interval 128.1 - 131.7 mASL within Gull River Formation above SWBZ
	2.49E-08	m/s (geometric mean)		
Range of Vertical Kv =	2.49E-10 - 2.49E-9	m/s		assuming vertical K range from 100 times to 10 times lower than geometric mean of horizontal K

Upward Leakage

Vertical Kv =	2.49E-10	m/s	assuming vertical K is 100 times lower than horizontal K
=	2.15E-05	m/day	
Darcy Upward Flow =	7.25	m3/day	Total flow through the entire quarry floor
Flow per ha =	0.106	m3/day	Flow through one hectare of the quarry floor
Flow per m2 =	0.011	L/day	Flow through one m2 of the quarry floor
Upward Flux	0.011	mm/day	
Vertical Kv =	2.49E-09	m/s	assuming vertical K is 10 times lower than horizontal K
=	2.15E-04	m/day	
Darcy Upward Flow =	72.5	m3/day	Total flow through the entire quarry floor
Flow per ha =	1.06	m3/day	Flow through one hectare of the quarry floor
Flow per m2 =	0.106	L/day	Flow through one m2 of the quarry floor
Upward Flux	0.106	mm/day	

Notes: [1]-water level data from Appendix VI in Appendix A; [2]-data for hydraulic ocnducitivity and test interval elevation from Table 2, (Gorrell, May 2012)

Calculation Sheet 3

Upward Leakage from SWBZ To Proposed Lower Lift Sump

Required Sump Capacity = 3150 m3
Proposed Sump Depth = 2 m
Sump Base Area = 1575 m2

Static Level at TW9-1[1]		
Date	Elevation	
03-Mar-09	129.82	mASL
04-May-09	129.56	mASL
20-May-09	127.19	mASL
22-Jul-09	125.93	mASL
24-Sep-09	125.05	mASL
23-Nov-09	127.2	mASL
Average	127.46	mASL

Hydraulic Gradient

Average Head of SWBZ at TW9-1 127.46 mASL
SWBZ Elevation = 120 mASL
Final Sump Base Elevation = 123 mASL
Average Upward Gradient = 1.487

Hydraulic Conductivity[2]

Horizontal Kh = 6.01E-09 m/s from 11-2 Test Interval 133.8 - 137.4 mASL within Gull River Formation above SWBZ
7.28E-09 m/s from 13-1 Test Interval 128.9 - 131.0 mASL within Gull River Formation above SWBZ
1.15E-07 m/s from 10-1 Test interval 130.4 - 134.0 mASL within Gull River Formation above SWBZ
7.68E-08 m/s from 12-1 Test interval 128.1 - 131.7 mASL within Gull River Formation above SWBZ
2.49E-08 m/s (geometric mean)
Range of Vertical Kv = 2.49E-10 - 2.49E-9 m/s assuming vertical K range from 100 times to 10 times lower than geometric mean of horizontal K

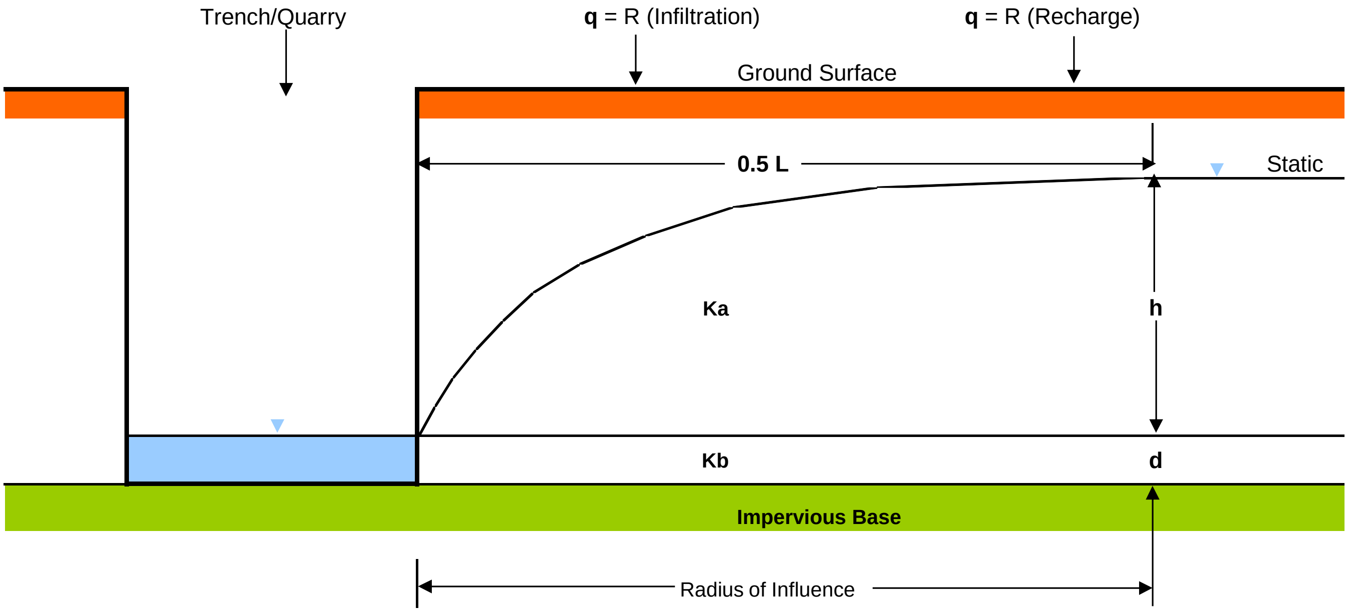
Upward Leakage

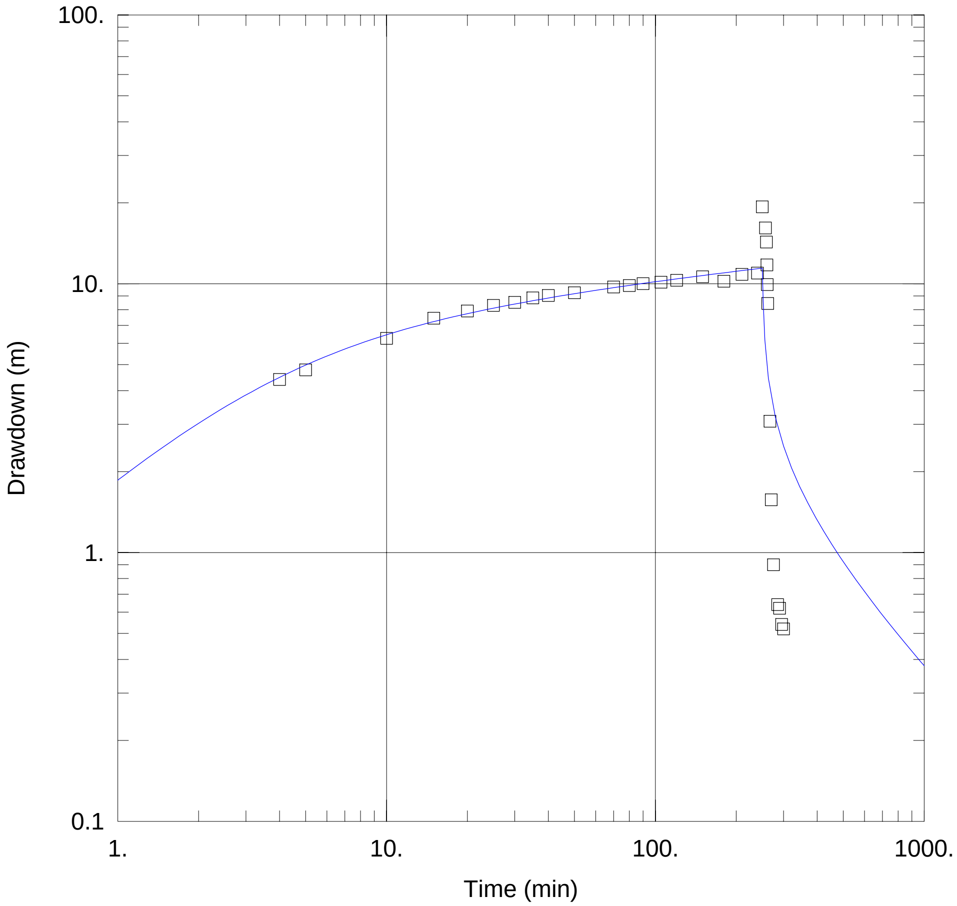
Vertical Kv = 2.49E-10 m/s assuming vertical K is 100 times lower than horizontal K
= 2.15E-05 m/day
Darcy Upward Flow = 0.0504 m3/day Total flow through the entire sump base
Flow per m2 = 0.032 L/day Flow through one m2 of the sump base
Upward Flux 0.032 mm/day

Vertical Kv = 2.49E-09 m/s assuming vertical K is 10 times lower than horizontal K
= 2.15E-04 m/day
Darcy Upward Flow = 0.504 m3/day Total flow through the entire sump base
Flow per m2 = 0.320 L/day Flow through one m2 of the sump base
Upward Flux 0.320 mm/day

Notes: [1]-water level data from Appedix VI in Appendix A; [2]-data for hydraulic ocnducitivity and test interval elevation from Table 2 (Gorrell, May 2012)

Chart 1: Conceptual Model for Hooghoudt Drainage Equation (1936)





BOREHOLE TW3-1 DRAWDOWN DATA ANALYSIS RESULTS

Data Set: D:\...\TW3-1 Drawdown data.aqt
Date: 05/26/10 Time: 13:02:01

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Well: TW3-1
Test Date: May 1, 2007

AQUIFER DATA

Saturated Thickness: 3. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW3-1	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ TW3-1	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

T = 4.343 m^2/day
S = 0.0452
r(w) = 0.076 m
r(c) = 0.076 m

Data Set: D:\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\TW3-1 Drawdown dat
Title: Borehole TW3-1 Drawdown Data Analysis Results
Date: 05/26/10
Time: 13:06:49

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Date: May 1, 2007
Test Well: TW3-1

AQUIFER DATA

Saturated Thickness: 3. m
Anisotropy Ratio (Kz/Kr): 0.1

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: TW3-1

X Location: 0. m
Y Location: 0. m

Casing Radius: 0.076 m
Well Radius: 0.076 m

Fully Penetrating Well

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (L/min)	Time (min)	Rate (L/min)
0.	49.5	250.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: TW3-1

X Location: 0. m
Y Location: 0. m

Radial distance from TW3-1: 0. m

Fully Penetrating Well

No. of Observations: 32

Observation Data

Time (min)	Displacement (m)	Time (min)	Displacement (m)
4.	4.4	180.	10.22
5.	4.78	210.	10.84
10.	6.26	240.	10.96
15.	7.44	250.	19.32
20.	7.92	257.	16.12
25.	8.3	259.	14.3
30.	8.52	260.	11.75
35.	8.86	261.	9.93
40.	9.04	262.	8.44
50.	9.26	267.	3.08

Time (min)	Displacement (m)	Time (min)	Displacement (m)
70.	9.72	270.	1.57
80.	9.85	275.	0.9
90.	10.01	285.	0.64
105.	10.13	290.	0.62
120.	10.3	295.	0.54
150.	10.62	300.	0.52

SOLUTION

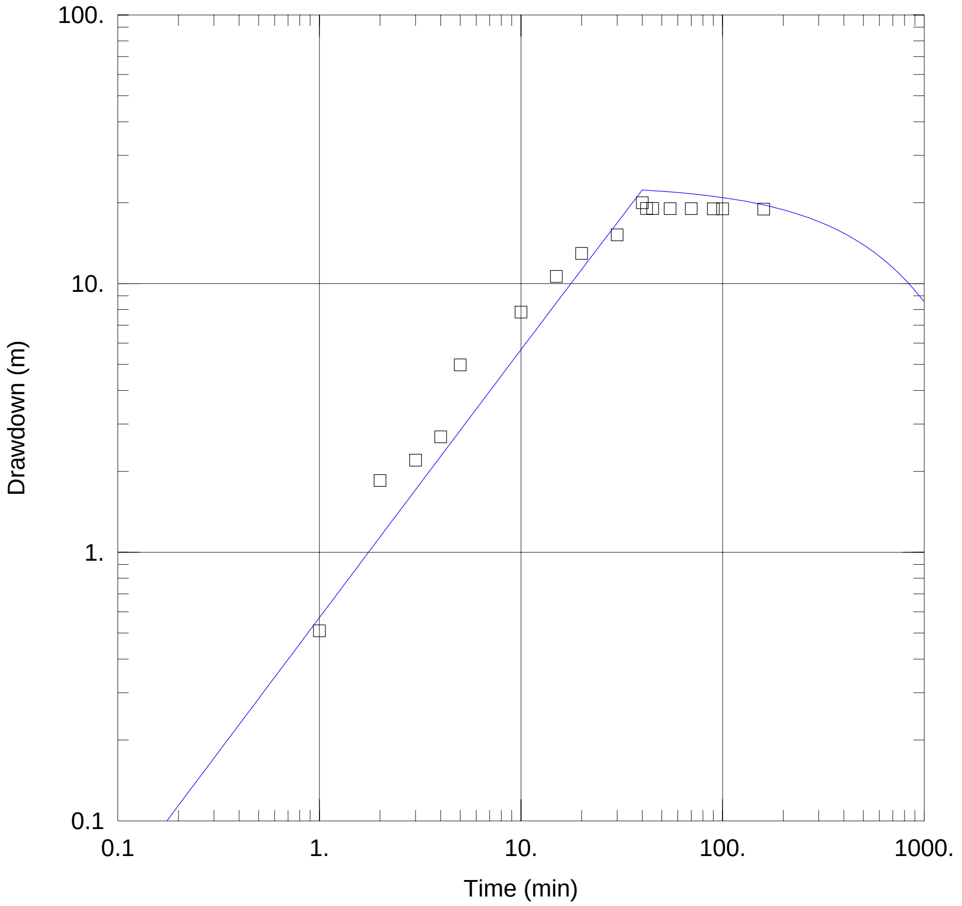
Pumping Test
Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	4.343	m^2/day
S	0.0452	
r(w)	0.076	m
r(c)	0.076	m

K = T/b = 1.448 m/day (0.001676 cm/sec)
Ss = S/b = 0.01507 1/m



BOREHOLE TW6-1 DRAWDOWN DATA ANALYSIS RESULTS

Data Set: D:\...\TW6-1 Drawdown data.aqt
Date: 05/26/10 Time: 13:00:25

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Well: TW6-1
Test Date: May 8, 2007

AQUIFER DATA

Saturated Thickness: 3. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW6-1	0	0

Observation Wells

Well Name	X (m)	Y (m)
☐ TW6-1	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

T = 0.07068 m^2/day
S = 2.16E-14
r(w) = 0.076 m
r(c) = 0.076 m

Data Set: D:\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\TW6-1 Drawdown dat
Title: Borehole TW6-1 Drawdown Data Analysis Results
Date: 05/26/10
Time: 13:05:57

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Date: May 8, 2007
Test Well: TW6-1

AQUIFER DATA

Saturated Thickness: 3. m
Anisotropy Ratio (Kz/Kr): 0.1

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: TW6-1

X Location: 0. m
Y Location: 0. m

Casing Radius: 0.076 m
Well Radius: 0.076 m

Fully Penetrating Well

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (L/min)	Time (min)	Rate (L/min)
0.	10.35	40.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: TW6-1

X Location: 0. m
Y Location: 0. m

Radial distance from TW6-1: 0. m

Fully Penetrating Well

No. of Observations: 17

Observation Data

Time (min)	Displacement (m)	Time (min)	Displacement (m)
1.	0.51	40.	19.98
2.	1.85	42.	19.03
3.	2.2	45.	19.03
4.	2.69	55.	19.01
5.	4.98	70.	19.
10.	7.83	90.	18.99
15.	10.63	100.	18.98
20.	12.95	160.	18.92
30.	15.18		

SOLUTION

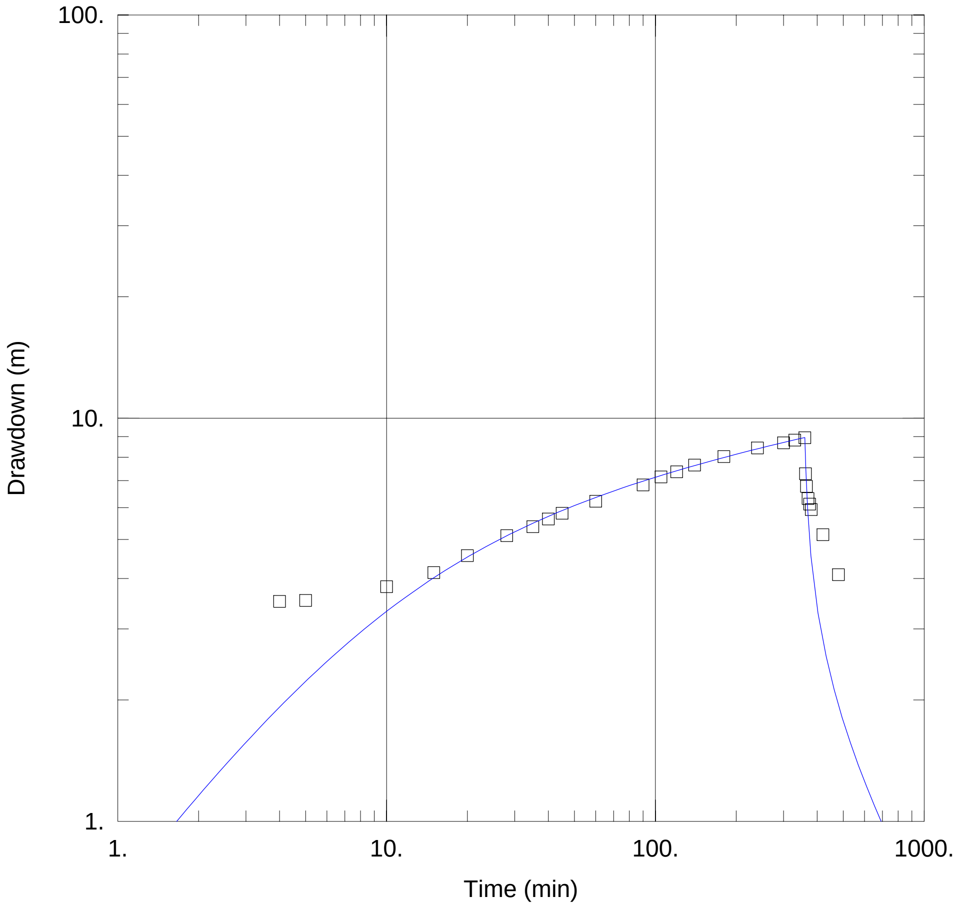
Pumping Test
Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	0.07068	m^2/day
S	2.16E-14	
r(w)	0.076	m
r(c)	0.076	m

K = T/b = 0.02356 m/day (2.727E-5 cm/sec)
Ss = S/b = 7.2E-15 1/m



BOREHOLE TW8-1 DRAWDOWN DATA ANALYSIS RESULTS

Data Set: D:\...\TW8-1 Drawdown data.aqt
Date: 05/26/10
Time: 13:04:32

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Well: TW8-1
Test Date: May 4, 2007

AQUIFER DATA

Saturated Thickness: 3. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW8-1	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ TW8-1	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

T = 1.37 m^2/day
S = 0.1416
r(w) = 0.076 m
r(c) = 0.076 m

Data Set: D:\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\TW8-1 Drawdown dat
Title: Borehole TW8-1 Drawdown Data Analysis Results
Date: 05/26/10
Time: 13:05:12

PROJECT INFORMATION

Company: AECOM Canada on Behalf of GRI
Client: Miller Paving
Project: 60142504
Location: Braeside Quarry, ON
Test Date: May 4, 2007
Test Well: TW8-1

AQUIFER DATA

Saturated Thickness: 3. m
Anisotropy Ratio (Kz/Kr): 0.1

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: TW8-1

X Location: 0. m
Y Location: 0. m

Casing Radius: 0.076 m
Well Radius: 0.076 m

Fully Penetrating Well

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (L/min)	Time (min)	Rate (L/min)
0.	15.75	360.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: TW8-1

X Location: 0. m
Y Location: 0. m

Radial distance from TW8-1: 0. m

Fully Penetrating Well

No. of Observations: 26

Observation Data

Time (min)	Displacement (m)	Time (min)	Displacement (m)
4.	3.51	140.	7.65
5.	3.53	180.	8.03
10.	3.82	240.	8.43
15.	4.14	300.	8.68
20.	4.56	330.	8.82
28.	5.11	360.	8.94
35.	5.38	362.	7.28
40.	5.62	365.	6.77
45.	5.81	370.	6.32
60.	6.22	375.	6.12

Time (min)	Displacement (m)	Time (min)	Displacement (m)
90.	6.83	380.	5.93
105.	7.15	420.	5.14
120.	7.36	480.	4.09

SOLUTION

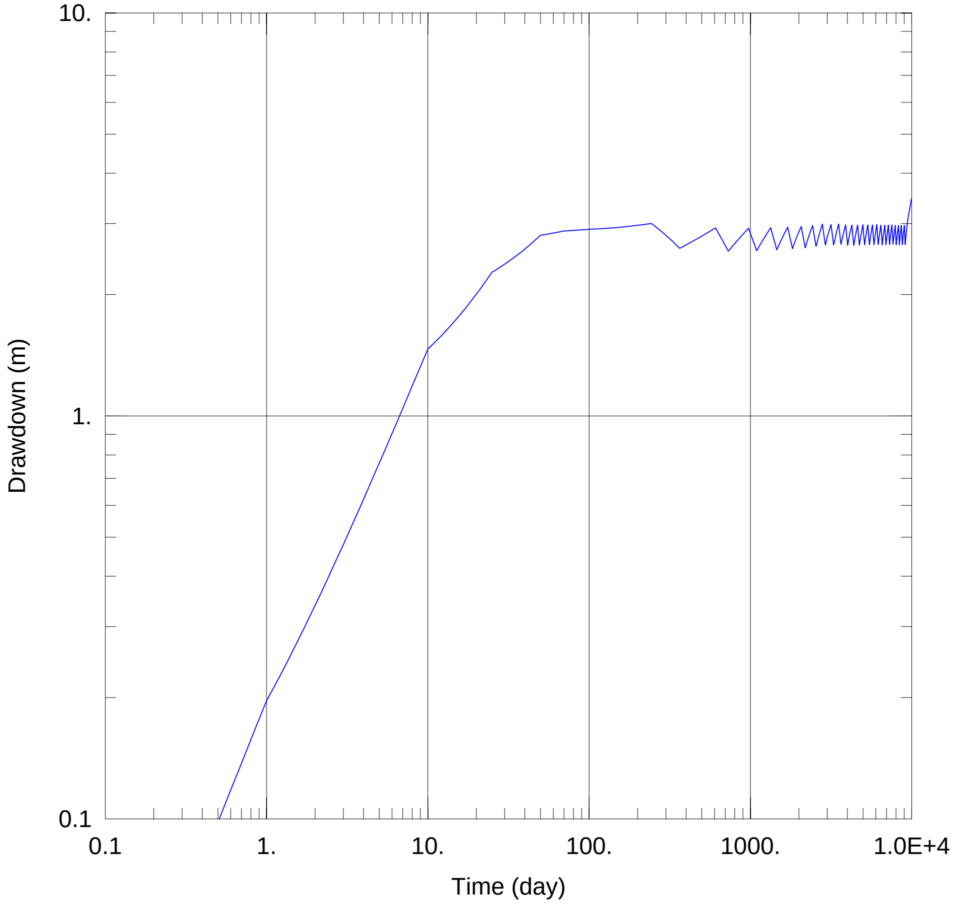
Pumping Test
Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	1.37	m^2/day
S	0.1416	
r(w)	0.076	m
r(c)	0.076	m

K = T/b = 0.4567 m/day (0.0005286 cm/sec)
Ss = S/b = 0.04721 1/m



PREDICTED LONG TERM DRAWDOWN CURVE IN LOWER LIFT SUMP DUE TO SUMP OPERATIONS

Data Set: D:\...\Lower Lift Sump5.aqt
Date: 05/27/10
Time: 09:57:35

PROJECT INFORMATION

Company: AECOM Canada Limited
Client: Miller Paving Limited
Location: Braeside, ON
Test Well: Lower Lift Sump

AQUIFER DATA

Saturated Thickness: 3. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Lower Lift Sump	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ Lower Lift Sump	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Dougherty-Babu

T = 1.63 m^2/day
Kz/Kr = 0.1
r(w) = 22.4 m

S = 0.0001
Sw = 0.
r(c) = 22.4 m

Data Set: D:\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\Lower Lift Sump5.aqt
Title: Predicted Long Term Drawdown Curve in Lower Lift Sump Due to Sump Operations
Date: 05/27/10
Time: 09:59:36

PROJECT INFORMATION

Company: AECOM Canada Limited
Client: Miller Paving Limited
Location: Braeside, ON
Test Well: Lower Lift Sump

AQUIFER DATA

Saturated Thickness: 3. m
Anisotropy Ratio (Kz/Kr): 0.1

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: Lower Lift Sump

X Location: 0. m
Y Location: 0. m

Casing Radius: 22.4 m
Well Radius: 22.4 m

Partially Penetrating Well
Depth to Top of Screen: 0. m
Depth to Bottom of Screen: 0.5 m

No. of pumping periods: 57

Pumping Period Data

Time (day)	Rate (cu. m/day)	Time (day)	Rate (cu. m/day)
0.	310.	4258.	0.
1.	225.	4380.	6.4
10.	90.	4623.	0.
25.	40.	4745.	6.4
50.	12.	4988.	0.
70.	7.8	5110.	6.3
100.	7.	5353.	0.
243.	0.	5475.	6.3
365.	7.1	5718.	0.
608.	0.	5840.	6.3
730.	7.1	6083.	0.
973.	0.	6205.	6.2
1095.	7.	6448.	0.
1338.	0.	6570.	6.2
1460.	6.9	6813.	0.
1703.	0.	6935.	6.2
1825.	6.8	7178.	0.
2068.	0.	7300.	6.2
2190.	6.8	7543.	0.
2433.	0.	7665.	6.1
2555.	6.8	7908.	0.
2798.	0.	8030.	6.1
2920.	6.6	8273.	0.
3163.	0.	8395.	6.1
3285.	6.6	8638.	0.
3528.	0.	8760.	6.1
3650.	6.4	9003.	0.
3893.	0.	9125.	6.1
4015.	6.4		

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: Lower Lift Sump

X Location: 0. m
Y Location: 0. m

Radial distance from Lower Lift Sump: 0. m

Partially Penetrating Well
Depth to Top of Screen: 0. m
Depth to Bottom of Screen: 0.5 m

No. of Observations: 0

SOLUTION

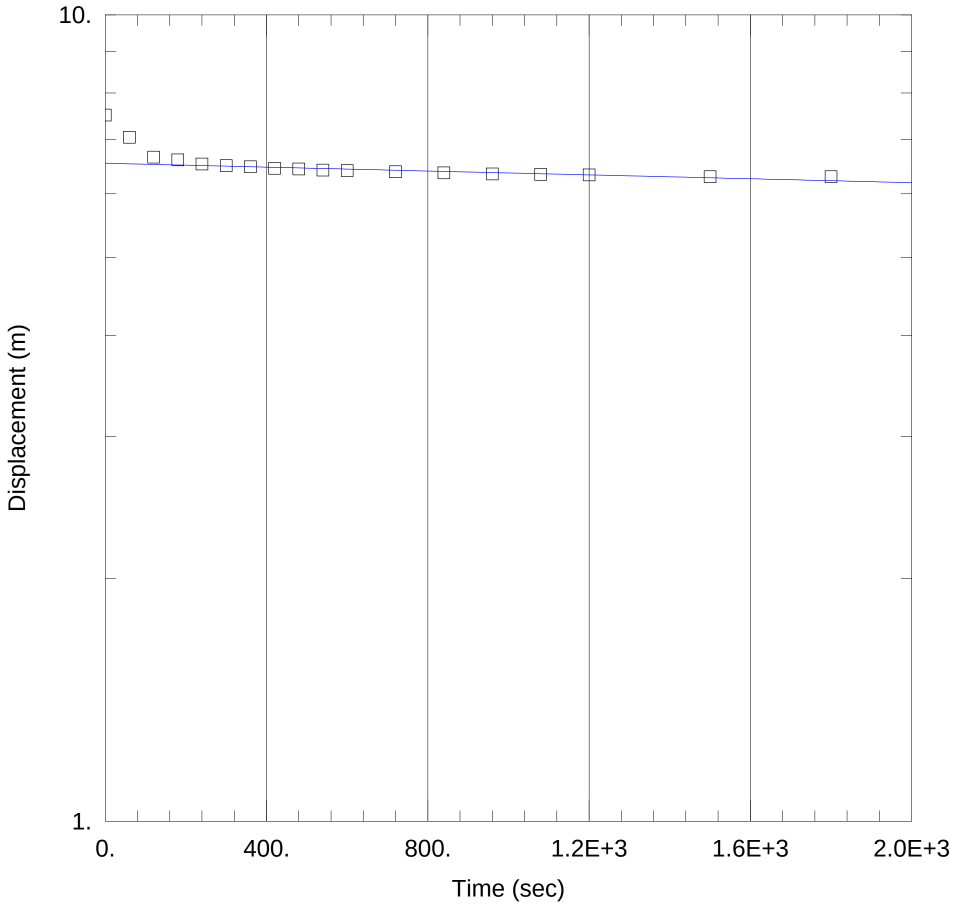
Pumping Test
Aquifer Model: Confined
Solution Method: Dougherty-Babu

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	1.63	m^2/day
S	0.0001	
Kz/Kr	0.1	
Sw	0.	
r(w)	22.4	m
r(c)	22.4	m

K = T/b = 0.5433 m/day (0.0006289 cm/sec)
Ss = S/b = 3.333E-5 1/m



MILLER BRAESIDE QUARRY MONITORING WELL 11-2 SLUG TEST DATA ANALYSIS RESULTS

Data Set: c:\...\11-2.aqt
Date: 06/17/10
Time: 15:35:29

PROJECT INFORMATION

Company: GRI and AECOM
Client: Miller Paving
Location: Braeside, Ontario
Test Well: BH11-2
Test Date: April 30, 2009

AQUIFER DATA

Saturated Thickness: 7.51 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (11-2)

Initial Displacement: 7.51 m
Total Well Penetration Depth: 7.51 m
Casing Radius: 0.016 m
Static Water Column Height: 7.51 m
Screen Length: 3.6 m
Well Radius: 0.016 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 6.009E-9 m/sec
y0 = 6.545 m

Data Set: c:\D\data\Miller Pavings\Braeside Quarry Expansion\Review Comment or Assessment\May 2010 Submission\11-2.aqt
Title: Miller Braeside Quarry Monitoring Well 11-2 Slug Test Data Analysis Results
Date: 06/17/10
Time: 15:33:42

PROJECT INFORMATION

Company: GRI and AECOM
Client: Miller Paving
Location: Braeside, Ontario
Test Date: April 30, 2009
Test Well: BH11-2

AQUIFER DATA

Saturated Thickness: 7.51 m
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: 11-2

X Location: 0. m
Y Location: 0. m

Initial Displacement: 7.51 m
Static Water Column Height: 7.51 m
Casing Radius: 0.016 m
Well Radius: 0.016 m
Well Skin Radius: 0.05 m
Screen Length: 3.6 m
Total Well Penetration Depth: 7.51 m
Corrected Casing Radius (Bouwer-Rice Method): 0.016 m
Gravel Pack Porosity: 0.3

No. of Observations: 17

Observation Data

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
60.	7.05	600.	6.41
120.	6.66	720.	6.39
180.	6.61	840.	6.37
240.	6.53	960.	6.35
300.	6.5	1080.	6.34
360.	6.48	1200.	6.33
420.	6.45	1500.	6.3
480.	6.44	1800.	6.3
540.	6.42		

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: Hvorslev
Log Factor: 0.1637

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	6.009E-9	m/sec
y0	6.545	m

K = 6.009E-7 cm/sec
T = K*b = 4.513E-8 m²/sec (0.0004513 sq. cm/sec)

Appendix E
Qualifications

Proposed Braeside Quarry Expansion
Part Lots 16 and 17, Conc. A,
Municipality of McNab-Braeside

Jennifer B. Gorrell M.Sc. P.Geo. P.Eng.

JENNIFER B. GORRELL M.SC. P. GEO.

Education:

1981: B.Sc. (Eng.), Queen's University, Kingston, Geological Engineering (Geotechnical)
1986: M.Sc. (Eng.), Queen's University, Kingston, Civil Engineering (Geotechnical)

Professional Affiliations:

Association of Professional Engineers of Ontario, Member 1984.
Association of Geoscientists of Ontario, Member 2002.

Work Experience:

October 1988 - present:	BGC Engineering Inc., Senior Hydrogeologist.
April 2010 – November 2010:	Coffey Geotechnics Inc., Toronto, ON; Associate Engineer/Senior Hydrogeologist.
January 2008 – August 2008:	Municipality of North Grenville; Engineer; contract position to expedite licensing of Municipal Waste Transfer Station and manage other waste management project tasks.
October 1988 - present[1]:	Gorrell Resource Investigations; Owner/Partner, Senior Project Manager, Hydrogeologist and Engineer.
May 1984 - June 1988:	Water and Earth Science Associates Ltd., Carp, Ontario; Senior Project Manager and Intermediate Engineer.
Sept 1983 - May 1984:	Department of Civil Engineering, Queen's University; Graduate Student, Teaching Assistant.
May 1982 - Sept 1983:	Water and Earth Science Associates Ltd., Carp, Ontario; Project Hydrogeologist.
May 1981 - May 1982:	Department of Mines, Ministry of Natural Resources, Kemptville, Ontario; Junior Geotechnical Engineer.

---

[1] Intermittent since April 2010

Project History

Gorrell Resource Investigations completed over 1200 projects in the fields of geology, hydrogeology and related engineering services since its inception in 1988, and I have had input into every one. The projects I have worked on are in the following areas of expertise.

Aggregate Resource Investigations

- Site investigation of proposed pit and quarry sites to evaluate suitability and design criteria with respect to geological and hydrogeological conditions;
- Conduct investigations to support applications for aggregate licensing, Permit to Take Water and Certificate of Approval for Industrial Wastewater Systems (Section 53, OWRA);
- Professional management of Site Plan applications through the ARA process and municipal planning changes.

Hydrogeologic Testing

- Design and installation of groundwater monitoring systems in stratified and fractured deposits for various applications;
- Design and supervision of test well construction.

Groundwater Modelling

- Design and completion of field testing programs to provide site information for conceptual model;
- Design of hydrostratigraphic conceptual models;
- Completion of numerical models for a variety of hydrostratigraphic settings.

Waste Management Studies

- Hydrogeological and geological site investigations, development of waste management plans, operation plans and contingency plans for municipal and industrial waste disposal sites throughout Eastern Ontario;
- Annual monitoring, impact analysis and assessment of site requirements for select waste management sites in Eastern Ontario.

Environmental Assessment and Rehabilitation

- Project management of Private Services Grant Program studies;
- Environmental Audits;
- Site Decommissioning studies.

Environmental Planning and Management

- Environmental Assessment of solid waste management plans;
- Regional hydrogeological investigations for management and planning purposes;
- Development feasibility studies for residential, commercial and industrial projects.

Reasonable Use Analysis

- Investigation of proposed or existing contaminant sources for conformity to Ministry of the Environment Guideline B-7 at sites across Eastern Ontario.

On-Site Wastewater Systems

- Site suitability studies for disposal of biosolids and hauled sewage;
- Design of on-site waste wastewater systems of various scales and technologies across Eastern Ontario

Terrain Analysis

- Field mapping for geologic, hydrogeologic and engineering features;
- Planning and supervision of subsurface testing programs.

Geotechnical Engineering

- Evaluation of slope stability along Ottawa River from City of Ottawa to Hawkesbury;
- Calculation of Setback Distances for slopes of Factor of Safety less than 1.5 in the South Nation River Basin;
- Design of shoreline protection for various clients;
- Erosion Study and Shoreline Management Plan along the Lake St. Lawrence-St. Lawrence River-Lake St. Francis (Raisin Region Conservation Authority).

Expert Witness

- Provision of expert testimony before the Ontario Municipal Board since 1989.
- Provision of expert testimony before the Environmental Appeal Board since 1993
- Provision of expert testimony before the Ontario Provincial Court since 1994.

Presentations

- Presentation on Geology and Hydrogeology of Westbrook Quarry to Aggregate Producers of Ontario, 2004.