Book 20 Volume 1

Witness Statement of Stan Denhoed

14-Apr-16

Index

ONTARIO MUNICIPAL BOARD

Commission des affaires municipals de l’Ontario

PROCEEDING COMMENCED UNDER subsection 34(11) of the *Planning Act*, R.S.O. 1990, c. P. 13, as amended

Applicant and Appellant: James Dick Construction Limited
Subject: Application to amend Zoning By-law No. 57/1999 - Refusal or neglect of Township of Guelph/Eramosa to make a decision
Existing Zoning: Agriculture (A) and Hazard (H) .
Proposed Zoning: Extractive Industrial (M3) and Hazard (H)
Purpose: To permit a quarry
Property Address/Description: Part Lot 1, Concession 6
Municipality: Guelph Eramosa
Municipality File No.: ZBA09/12
OMB Case No.: PL150494
OMB File No.: PL150494
OMB Case Name: James Dick Construction Limited v. Guelph/Eramosa (Township)

PROCEEDING COMMENCED UNDER subsection 11(5) of the *Aggregate Resources Act,* R.S.O. 1990, c. A.8, as amended

Referred by: Jane Ireland
Objector: Shirley Allen
Objector: Ron & Debbie Brennen
Objector: John & Ann Brophy
Objector: Dennis & Laura Campbell; and others
Applicant: James Dick Construction Limited
Subject: Application for a Class A licence for the removal of aggregate
Property Address/Description: Part Lot 1, Concession 6
Municipality: Guelph Eramosa
OMB Case No.: PL150494
OMB File No.: MM150034
OMB Case Name: James Dick Construction Limited v. Guelph/Eramosa (Township)

WITNESS STATEMENT FOR STAN DENHOED

1. The evidence to be presented by Stan Denhoed will consist of a presentation and review of the following reports and documents:

Tab	Document	
1	Level I and II Hydrogeological Investigation Hidden Quarry	September 1, 2012
2	Figures and Appendices	September 1, 2012
3	GRCA Cumulative Effects Analysis	March 13, 2013
4	Groundwater Model Addendum Report Final Model Figures	March 14, 2013
5	Groundwater Model Addendum Report Figures	March 14, 2013
6	M15 Drilling Summary to Burnside	June 7, 2013
7	Harden Response to MOE	July 15, 2013
8	Hidden Quarry Hydrogeology Issues to Burnside	September 5, 2013
9	Flooding Analysis Trib B	September 9, 2013
10	Harden Response to GRCA	November 26, 2013
11	Harden Letter to Burnside (Response to Hydrog Issues)	January 14, 2014
12	Harden Letter to Burnside (Response to M15 Drilling)	January 14, 2014
13	Harden Letter to Burnside	June 10, 2014
14	Response Matrix to Hunter Questionnaire	July 8, 2014
15	Attachments to Response to Hunter Questionnaire	July 8, 2014
16	Harden Letter to Burnside	December 9, 2014
17	Specific Well Contingency Plans	January 8, 2015
18	Harden Letter to Burnside	June 12, 2015
19	Harden Response to Hunter	July 16, 2015
20	Harden Letter to Burnside	August 17, 2015
21	November 11, 2015 Final Monitoring Plan	November 11, 2015
22	Well Complaint Protocol	November 11, 2015
23	Hidden Quarry Wash Plant Analysis	January 11, 2016
24	Harden Thermal and Washplant	April 4, 2016
25	Stan Denhoed C.V.	
26	Executed OMB Experts Duty Form - S Denhoed	

2. In addition, Stan Denhoed, will refer to the Ministry and Agency Review Comments and the Township of Guelph-Eramosa Peer Review Comments set out in the Document Books produced and provided by James Dick Construction Limited.

April 27, 2016

Date

Stan Denhoed

Level I and II
Hydrogeological Investigation
Hidden Quarry
Rockwood, Ontario

HARDEN ENVIRONMENTAL SERVICES LTD.
SEPTEMBER 2012

WWW.HARDENV.COM

Executive Summary

James Dick Construction Ltd. (JDCL) proposes to resume aggregate extraction from Part of Lot 1, Concession 6 in the Township of Guelph Eramosa. Sand and gravel has been extracted from this site on several occasions including for the construction of Provincial Hwy No. 7. The sand and gravel occurs as kame deposits and stony sand till deposits within the Paris Moraine complex. The site also contains well sorted glacial fluvial deposits of sand, gravel and silt. The dolostone bedrock formation beneath the site is the Amabel formation. The intent of James Dick Construction Ltd. is to extract both the sand and gravel and the dolostone from this site. The maximum depth of extraction will be approximately thirty metres below the water table. The extraction will be done without dewatering the excavation; therefore, minimal disturbance of water levels will occur.

The site is located on the Paris Moraine within the Grand River watershed and Blue Springs Creek subwatershed. Blue Springs Creek is located approximately one kilometer southeast of the site. Blue Springs Creek flows westerly and converges with the Eramosa River near Eden Mills. The Eramosa River is located approximately two kilometres northwest of the site, on the north side of the Paris Moraine.

The elevation of the site varies from 354 to 365 m AMSL compared with 382 m AMSL for the crest of the Paris Moraine and 325 m AMSL at Blue Springs Creek. This places the site approximately midway with respect to elevation between the crest of the moraine and Blue Springs Creek.

The overburden thickness in the area ranges from twenty five metres at the crest of the moraine to exposed bedrock outcrop near to the site. Overburden thickness at this site ranges from four to fifteen metres. The thinnest overburden occurs in the northwest area of the site. The overburden is mainly a product of the latest advance of the Lake Ontario ice lobe resulting in the deposition of the sandy Wentworth Till. Melt water sorted some of this till into sand, gravel and silt deposits as found at the site. Earlier glacial advances deposited silt tills that are also encountered at the site.

Drainage in the area is generally poorly developed due to the hummocky topography on the moraine; however, there are three nearby streams in which there is intermittent flow. Drainage is southward from the crest of the moraine towards Blue Springs Creek. Within 500 metres of the site there are no permanent streams between the crest of the moraine and Hwy 7 with the exception of a small stream originating at a spring on the Allen Farm on 6th Line (Tributary A) approximately 450 metres northwest of the site. Although this stream has perennial flow at the 6th Line, there is no permanent flow downstream (i.e. the stream loses water). There are streams with permanent flow between Hwy 7 and Blue Springs Creek located between 4th and 5th Line Nassagaweya and 5th and 6th Line Nassagaweya.

An intermittent stream is found within the site boundaries. The stream originates approximately 650 metres northwest of the site. Groundwater emerges from relatively permeable Wentworth Till deposits on the De Grandis property, enhanced by the construction of a pond. Water discharging from the pond flows through a Provincially Significant Wetland (Allen property) and into the JDCL property (Tributary B). Between the De Grandis property and the JDCL property there is limited loss of water due to silty surficial deposits. On the JDCL property, however, there is a total loss of stream flow for several months of the year. During periods of high flow, a culvert beneath Hwy #7 conveys stream flow onto the Brydson Farm and ultimately the drainage system ends at Blue Springs Creek.

There is a wetland located in the northwest corner of the site and wetlands found north and northeast of the site. The on-site wetland has an area of approximately one hectare and with the exception of a small pocket of open water, is observed to become largely dry during late summer and fall. There are no defined surface water channels associated with this wetland. This wetland occurs in a natural depression and is supported by runoff, direct precipitation and overburden groundwater from the north and west. Water losses from the wetland are evaporation, evapotranspiration, groundwater outflow downwards, southward and eastward.

The site is neither located in the Well Head Protection Area (WHPA) of the nearby Rockwood municipal wells, nor in the WHPA of the City of Guelph wells located in Puslinch Township. The Intake Protection Zone (IPZ-3) of the City of Guelph Eramosa River intake includes the on-site intermittent stream and all tributaries of the Eramosa River. The aggregate development of the site is not expected to contribute any storm water to surface water features as the site will drain internally.

Springs occur from overburden deposits on the southern flank of the Paris Moraine. Northwest of the site, this occurs in Lot 2, on both the Degrandis and Allen properties. These springs occur where the relatively permeable Wentworth Till deposits are underlain by a silt till deposit. The permeability contrast results in preferentially horizontal flow resulting in the discharge.

Horizontal groundwater flow is from the upland Paris Moraine area toward Blue Springs Creek. In general, this results in a northwest to southeast groundwater flow direction along the southern flank of the Paris Moraine. The predominant vertical groundwater flow direction is downwards.

Thirty-four groundwater monitors, eight surface water monitors and eleven surface water flow monitoring stations are included in the environmental monitoring at this site.

In general, groundwater only occurs above the bedrock in association with surface water features at the site, i.e. the northwest wetland and the on-site stream. Groundwater flow direction is generally from northwest to southeast. The on-site stream is not supported by groundwater from the site. The stream loses water along its entire reach within the subject property. Gravel and dolostone extraction will maintain a minimum setback distance of 20 - 30 metres from this feature.

The proposed extraction will remove the sand and gravel overburden at the site and the dolostone bedrock to an elevation of approximately 317 m AMSL. The sand and gravel will be extracted above the water table for the most part. A hydraulic barrier will be installed downgradient of the northwest wetland to minimize the loss of water from the wetland. The hydraulic barrier will retain groundwater levels beneath the wetland.

Extraction of the dolostone bedrock will be conducted with subaqueous methods. The rock will be made available through drill and blast methods and removed with a drag line. There will be no dewatering at this site.

It is estimated that the maximum disturbance of the potentiometric surface of the bedrock groundwater will be a 2.45 metre decrease along the northern edge of the quarry and at least a similar increase along the southern edge of the quarry.

A silt till overlies the bedrock in the vicinity of the northwest wetland. The silt till limits the hydraulic connection between the wetland and the bedrock, however, an increase in downward groundwater flow is likely to occur as a result of the aggregate extraction. The hydraulic barrier is designed to retain water in the wetland, thereby compensating for any potential loss of water via enhanced downward flow through the silt till. A pre and post extraction water balance for the wetland shows that during and after extraction the water balance of the wetland will be maintained. Hydraulic barriers have successfully been used to protect wetlands adjacent to other aggregate sites in Wellington County and elsewhere in Ontario.

The area of influence within the dolostone aquifer will extend beneath the Allen Wetland. Support hydrology for the wetland is neither derived from the bedrock aquifer nor is it reliant upon bedrock groundwater levels.

The area of influence will extend beneath the De Grandis and Allen springs. The springs arise from overburden groundwater originating from permeable sediments within the Paris Moraine to the north of the springs. Changes in the bedrock aquifer water levels in the source areas of these springs will be small and no significant change in spring discharge will occur.

Local water wells rely on the bedrock aquifer for a water supply. The decrease in water levels in bedrock wells will be minor compared to the available drawdown in the wells. The aquifer is productive and the maximum change in water levels is less than the natural seasonal variation and will not affect the yield of any local water wells.

The bedrock aquifer and wells completed in the bedrock aquifer are already subject to direct influence from surface water. All local streams experience a loss and at times a total loss of water as it recharges the aquifer below. In the process of doing so, agricultural nutrients and biological elements are being transported into the aquifer under existing conditions. This has resulted in the water quality of several local wells being impacted. While the quarry itself is not a potential source of contaminants, there is the potential for a transport pathway from the ground surface to the bedrock aquifer to be enhanced. The Region of Halton has already recognized the potential for biological issues in wells in this area and recommends that residences with bedrock wells be diligent with sampling for bacteriological contamination. In both phases of the Halton study it was noted that those wells with a recommended water treatment device (either a chlorinator or UV System) were significantly more likely to have bacteriologically safe drinking water.

Table of Contents Page No.

List of Figures
(Following Text)

List of Figures (Cont'd)

List of Appendices and Tables

1.0 INTRODUCTION

Harden Environmental Services Ltd. has been retained by James Dick Construction Ltd. (JDCL) to evaluate the potential impacts on groundwater and surface water resources from the proposed sand, gravel and dolostone extraction both above and below the water table in Lot 1, Concession 6, Township of Guelph/Eramosa, County of Wellington. Below-water-table extraction is proposed for the bedrock resource without dewatering. This approach minimizes the changes occurring to groundwater levels and results in a significant increase in groundwater storage.

The site is 38.08 ha in size and is located two kilometres east of Rockwood and 4.5 kilometres west of Acton. Figure 1.1 shows the site location within the Blue Springs Creek watershed. The site is located in an upland area of the Blue Springs Creek watershed. Figure 1.2 shows the Lot and Concession fabric local to the site. The site is located north of Provincial Highway No. 7 and east of the 6th Line Eramosa. Highway 7 is a municipal boundary between the Town of Milton and the Township of Guelph Eramosa. The road opposite the site in the Town of Milton is the 5th Line Nassagaweya. Lot numbers north of Highway 7 increase from Lot 1 and Lot numbers south of Hwy 7 decrease from Lot 32 in the Town of Milton (former Township of Nassagaweya). Figure 1.3 shows local topography and the site's location relative to significant features such as the Canadian National rail line, the Eramosa River and Blue Springs Creek.

The property is presently recognized on the County of Wellington's Official Plan as part of the Mineral Aggregate Overlay. The present zoning on the property is agriculture. Several areas of the site have previously been used for gravel extraction. A wetland is located along the western corner of the property boundary and an intermittent stream flows from northwest to southeast across the eastern half of the site.

This report describes in detail the groundwater and surface water resources around the site, the potential effects of the mining process on water resources and recommends actions that will minimize impacts to water resources. Features and properties discussed in this report are shown on Figure 1.4. This report has been written to satisfy the requirements of Level 2 hydrogeological reports as required under the Aggregate Resources Act. This Level 2 hydrogeological report includes a discussion of the following items:

- water wells;
- springs;
- groundwater aquifers;
- surface watercourses and bodies;
- discharge to surface water;
- proposed water diversion, storage and drainage facilities on site;

- methodology;
- description of the physical setting including local geology, hydrogeology, and surface water systems;
- water budget;
- groundwater modelling;
- impact assessment;
- mitigation measures, including trigger mechanisms;
- contingency plan;
- monitoring plan; and
- technical support data in the form of tables, graphs and figures, usually appended to the report.

The site is located in an area of secondary significance with regards to sand and gravel resources and within “Selected Bedrock Resource Area 1" (MNR, 1981). The bedrock resource is the Amabel Formation.

2.0 METHODOLOGY

2.1 DOCUMENT REVIEW

The first phase of this investigation included a review of previously written work related to the groundwater, geology, hydrology and hydrogeology of the area surrounding the site. The following documents and reports were included in the review:

- Hydrogeology and Ground Water Model of the Blue Springs Creek IHD Representative Drainage Basin, 1978, prepared by J.M.H. Coward and M Barouch of the Ontario Ministry of the Environment;
- Beak International Incorporated, 1999, Eramosa Blue Springs Creek Watershed Interim Report;
- Burt, A.K., 2011, Project Unit 08-003; The Orangeville Moraine Project: Preliminary Results of Drilling and Section Work;
- Burt, A.K. and Rainsford, DK.B., 2010, Project Unit 08-003, The Orangeville Moraine Project: Buried Valley Targeted Gravity Study;
- Eramosa River - Blue Springs Creek Linear Corridor Initiative, 1995, prepared by Procter and Redfern Limited for the Grand River Conservation Authority;
- Acton Property Lot 1 Concession 6, Township of Eramosa, County of Wellington Preliminary Report (June 1990) prepared by Ken W. Ingham P. Eng. for James Dick Construction Limited;
- Influence of Vertical Fractures in Horizontally-Stratified Rocks, by Todd M. Reichart, M.Sc. Thesis University of Waterloo;
- Aerial photographs for this site (April 1930, April 1964, June 1972, April 1980, May 1994 and Spring 2006);
- Published geological and hydrogeological maps and reports;
- Environment Canada precipitation data;
- Ministry of the Environment Water Well Records; and
- Gartner Lee Limited, April 2004, Guelph/Eramosa Township Regional Groundwater Characterization and Wellhead Protection Study

The Acton Property Lot 1 Concession 6, Township of Eramosa, County of Wellington Preliminary Report (June 1990) prepared by Ken W. Ingham provides site specific geological data. Portions of this report have been included in the relevant appendices of this report and are discussed throughout. Ken Ingham reported on the borehole completion and monitoring well installation at four locations (M1 to M4, inclusive) which are shown on Figure 2.1. Borehole logs and monitor completion details in Table A1 (Appendix A) have been prepared from this report and from discussions with the author. The Ingham report also indicates that a total of twenty three soil samples were submitted for grain size analysis. The results of these analyses are included in Appendix A.

The on-site project investigation completed by Harden Environmental commenced in April 1995 and has included excavating nine test pits, installation of twelve mini-piezometers, installation of eleven drive point monitors, installation of seven drilled monitors, establishing fifteen surface water monitoring locations, hydraulic testing, monitoring groundwater levels and geochemical sampling. These activities are described in detail in the following subsections.

2.2 SOIL SURVEY

A detailed soil investigation of the site was undertaken in September 1996. Seven test pits were excavated across the site (Figure 2.1). The soil stratigraphy observed in the test pits is shown in Appendix A. Soil samples were collected of representative geological units encountered. Four soil samples were submitted for grain size analyses. The results of these grain size analyses are found in Appendix A. Bedrock was encountered in test pit (TP2) at a depth of six metres below ground surface (mbgs).

Drive points were installed in the three test pits (TP1, TP2, and TP5) where the presence of groundwater was observed or suspected. Water levels measured in these monitors are provided in Appendix B (Table B1). The stand pipe at TP5 was destroyed prior to March 1997.

In February 2012, two additional test pits were excavated, one in the northeast corner of the property (TP8) and one along the eastern property boundary (TP9). The stratigraphy of the test pits is provided in Appendix A. Bedrock was encountered at TP9 at a depth of approximately 4.5 metres below ground surface (mbgs). Stand pipes were installed in test pits TP8 and TP9, water levels are provided in Appendix B (Table B1).

Four 25 mm holes were hand-augered in the northwest wetland. These locations are designated SP1 to SP4 with locations shown on Figure 2.2. A description of the soil profile is found in Table A2 in Appendix A.

Several 50 mm diameter holes were hand-augered with a Dutch Auger in the Allen Wetland. The locations of the holes are shown on Figure 2.3 and the soil descriptions are found in Table A2 Appendix A. Three samples were submitted for grain size analysis and are designated AW7, AW8 and AW11 in Appendix A.

Additional detailed soil testing was conducted for the Lot 1, Concession 6 E½. Eight boreholes were drilled and soils described in detail (England Naylor, 1989).

A summary of all grain size analyses is presented in Table A3.

2.3 GROUNDWATER MONITOR INSTALLATIONS

A summary table of all groundwater monitors is found in Table A1, borehole logs are found in Appendix A.

Four groundwater monitors were installed in the boreholes drilled by Ken Ingham in 1990. These are all of PVC construction and have a diameter of 50 mm. As summarized in Table A1, these monitors, designated as M1 through M4, are bedrock groundwater monitors.

Drive point groundwater monitors were installed at six locations (M5 to M10, inclusive) between April 1995 and April 1998. The purpose of these groundwater monitors is to monitor the shallow water table in the overburden aquifer and to show the interconnection between the on-site surface water in the stream, the pond and the shallow groundwater system. Drive point groundwater monitors placed in test pits (TP1, TP2, TP5, TP8, and TP9) were also installed in September 1996 and February 2012. These drive points were driven into the base of a test pit prior to the test pit being filled in with the native material.

The installation of these groundwater monitors was accomplished by driving a 0.6 metre long screened drive point into the ground. This screened drive point was threaded to 3 cm (1.25 inch) diameter steel pipe. The completion details of these monitors are provided in Table A1 and water level data collected from these monitors is provided in Table B1. M5 was installed through an existing shallow dug well.

In 2010, seven additional boreholes were drilled on Site with a combination auger and coring rig. Installation of two shallow bedrock monitoring wells and five overburden monitoring wells was completed within the drilled boreholes. These wells were labeled M1-S, M11, M12, M13-S, M13-D (bedrock), M14-S, and M14-D (bedrock). Borehole logs for the seven new borehole monitoring wells are present in Appendix A.

TP8 was installed to establish the relationship between groundwater and the northeast wetland. TP9 was installed to determine groundwater levels at the southern edge of the proposed quarry.

In July 2009, six mini-piezometers (MPS1, MPS2, MPN1, MPN2, MPE1, and MPE2) were installed in order to establish groundwater discharge/recharge relationships and calculate gradients along the perimeter of the on Site wetland feature (northwest wetland). The mini-piezometers are constructed of 18 mm steel pipe with a Solinst^{TM} Drive Point Piezometer. Two additional mini-piezometers (MPW1 and MPW2) were installed in January 2011. Figure 2.1 provides the locations of these monitors and Table B1 summarizes the results of monitoring.

In December 2010, four mini-piezometers (MP1, MP2, MP3, and MP4) were installed along Tributary B to establish recharge/discharge relationships between the stream and the surrounding groundwater table. Figure 2.1 provides the locations of these monitors and Table B1 summarizes the results of monitoring.

2.4 SURFACE WATER MONITORING LOCATIONS

Fourteen surface water monitoring locations (RS1 and SW1 to SW12, inclusive) were established within and nearby to the Site (Figure 2.4) during the course of this investigation. The purposes and activities conducted at each of these locations varied. SW1 and SW6 (replaced destroyed SW1) were established in the northwest wetland to monitor the surface water levels in the open water portion of the wetland.

Surface water monitoring stations SW2, SW3, SW4, SW5, and SW7 (replaced destroyed SW2), SW8 and SW9 were established in Tributary B to monitor surface water levels (stage) in the stream. Stage measurements were measured on a staff gauge at each location (Table B2, Appendix B), which have been surveyed relative to the geodetic datum. SW5 was established adjacent to M9 to investigate the interaction between the surface water in the stream and the adjacent shallow groundwater levels. In addition to stage level measurements, in 2007 and 2008 stream flows were measured in the stream at SW7, and since 2009 stream flows have been measured immediately downstream of the small culvert at SW8 where the stream exits the property at the eastern boundary. Additionally, stream flow measurements and observations were recorded where the stream enters the site (SW4) and where it flows under Highway 7 (SW3). All surface water flow monitoring data is included in Table C1 Appendix C.

Stream flows and surface water levels have also been measured where Tributary A crosses under 6th Concession Road at hydrologic monitoring location RS1.

In late 2011 and early 2012, stream flows were measured in Tributary C at hydrologic monitoring station SW10. This represents flow in Tributary C prior to entering Concession 6.

Stream flow measurements were also obtained at SW11 and SW12 to verify the gaining/losing nature of Tributary C.

Stream flows were obtained at SW9 and SW4 to determine loss/gain within the Allen Wetland.

Stream discharge measurements were generally made with a Price 1210A velocity meter prior to and including 2007 and with a Marsh McBirney velocity meter post 2007 at all stream hydrologic monitoring locations. Prior to 1999, stream flows were measured with a pail at SW3.

2.5 HYDRAULIC TESTING

Hydraulic testing was conducted on monitors M6, M9 and M10 in April 1998. Additional testing was conducted in January 2011 at monitors adjacent to the on Site wetland at locations M1S, M6, M13S, M13D, M14S, M14D, MPS1, MPS2, MPW1, MPW2, MPN1, MPN2, MPE1, and MPE2. This testing was conducted using the Falling Head Method. The falling head method involves adding a known volume of water into the monitoring well and measuring the water level as it returns to pre-test or static level. The observed change in the water level with time was converted to a hydraulic conductivity using the Hvorslev method (Freeze and Cherry, 1979). The data obtained in April 1998 from M9 was also analyzed using the Bouwer-Rice method (Kruseman and de Ritter, 1991). The data and analyses of these tests are included in Appendix D and summarized in Table D1.

Falling head testing was conducted at bedrock groundwater monitors M1D, M2, M3 and M4 in November 2011. Results are provided in Table D1.

Monitors M2, M4 and well 6705627 were tested by installing a pump and removing water at a constant rate for a short duration. The pumping test data was graphed and analyzed for transmissivity using a method based on the semi-log graphical analysis method. The graphs are found in Appendix D and the results are summarized in Table D1.

A twenty-four hour pumping test was conducted in a well located in Lot 1, Concession 6 E½ in 1998 and reported in Harden, 1998. This well is 39.32 metres deep and penetrates the dolostone aquifer to a similar depth of the proposed quarry. Several observation wells were monitored during the test and estimates of transmissivity and storativity of the aquifer were obtained. The observations are found in Appendix D.

2.6 GROUNDWATER LEVEL MONITORING

Groundwater levels were obtained from monitoring wells, drive point monitors and staff gauges since April 1995. Groundwater levels were obtained using an electric water level meter. The data from all groundwater monitoring is provided in Appendix B as Table B1 and individual hydrographs are presented in figures B1 through B12. All monitoring points have been level surveyed relative to a NAD 83 geodetic datum allowing groundwater levels to be expressed as groundwater elevation data in metres above mean sea level (m AMSL).

2.7 WATER QUALITY

Water quality analyses were conducted on six groundwater monitors (M1 to M5, inclusive and TP1), four surface water bodies (Allen Farm Stream at RS1, on Site stream at SW3, on Site wetland at SW1, and Blue Springs Creek at 5th Concession Road) on November 21, 1996. The locations of these water quality sampling points are shown on Figure 2.5. The water at these locations was analyzed for general inorganic chemistry (anions and cations). The results of this testing are provided in Appendix E.

A water quality sample was obtained from on-site well No. 6705627 and the results are provided in Appendix E.

2.8 WATER WELL SURVEY

A review of the Ministry of the Environment (MOE) well records (February, 2012) for the area was conducted of all reported wells within a one kilometer radius of the site. This review revealed that a total of fifty-nine wells are reported to be present in this area. The reported MOE water well records within this one kilometre radius of the site are shown on Figure 2.6 and are included in Appendix F as Table F1. The locations of water wells shown on this figure are as reported by the MOE. Adjustments to well locations have been made for some wells following the water well survey and the adjusted well locations were used in the groundwater model, static water level reporting and top of bedrock reporting. Although all readily available MOE well records were collected for this area it is reasonable to assume that not all water wells in the area are identified or located accurately. As a result, a door-to-door water well survey was also conducted (1998 and 2011/12) to identify the neighbouring water wells and springs. The results of this water well survey are shown on Figure 2.7 and Table G1.

Based on the MOE water well records it was found that there are a total of five wells (8.2%) which are reported to be completed into the overburden aquifer. Most of these overburden wells (MOE wells # 6708802, 6708308, 6700542 [observation well drilled by MOE] and 2805656) are situated approximately one kilometre to the southwest of the site, near the bend in Highway No. 7. The fifth overburden well (MOE Well Number 2805499) is situated approximately one kilometre northeast of the site.

MOE well records show that the majority (91.8%) of the water wells within a one kilometre radius of the site obtain their water from the bedrock aquifer. There are no dry wells reported in this area and most of the wells appear to be capable of being pumped at rates of greater than 0.61 L/s (8 IGPM), based on the pumping tests performed during well completion. These MOE well records also indicate that the available drawdown, based on the difference between the reported static level and one metre above the bottom of the well, are generally greater than five metres and the average is greater than nineteen metres.

The door-to-door survey identified twenty-three water wells within a five hundred metre radius of the site. The majority (91%) of these wells obtain their water from the bedrock aquifer. The survey identified two water wells (9%) which are completed into the overburden (No. 2 and 6). Well No. 6 is an unused water well situated in a field approximately 160 metres southwest of the site. This well was discovered through discussions with Mr. Gordon Ball. The depth of Well No. 6 is 3.58 metres below top of casing (m BTOC) and the water level on April 21, 1998 was 3.35 m BTOC. It is unknown whether this well has gone dry in the past.

Well No. 2 is no longer used by the neighbouring mushroom farm for their drinking water supply. It is occasionally used for cleaning purposes. According to the owner, the pumping rate from this dug well is approximately 1.36 L/s (18 IGPM) and the depth of this well is 3.97 metres below top of casing (m BTOC). Well No. 3 is being used seasonally in the cooling system for the mushroom farm at a rate of between 80 and 100 gallons per minute.

2.9 GROUNDWATER MODEL

A groundwater model was prepared from for an area of approximately six kilometers radius of the Site. Available data was input into Viewlog^{TM} and Modflow^{TM} to create a model of groundwater potentials for the bedrock aquifer. Details of the groundwater model and results are found in Appendix H.

The purpose of the model was to estimate the potential change in water levels in the bedrock aquifer.

3.0 PHYSICAL SETTING

The setting is described below in terms of; physiography, surface water features, geology, hydrogeology, climatic setting and hydrology.

3.1 PHYSIOGRAPHY

The site is located in the Horseshoe Moraine Physiographic region (Chapman and Putnam, 1984) (Figure 3.1). The site is located in the upland area of the Blue Springs Creek Watershed on the Paris Moraine (Figure 3.2). The Paris Moraine extends from Cambridge to Caledon. The maximum ground surface elevation of the moraine northwest of the site is approximately 382 m AMSL. At the crest of the moraine, the overburden thickness exceeds twenty five metres, however, at the site, the overburden thickness is generally less than eight metres. The crest of the moraine is the watershed boundary between Blue Springs Creek and the Eramosa River. The Eramosa River is located approximately 2.5 kilometers north of the site at an approximate elevation of 380 m AMSL. The Ontario Geological Survey has investigated a buried valley between the crest of the moraine and the Eramosa River and found that the valley infill is as much as 85 metres (Burt et. al, 2010). This suggests that the bedrock elevation at the bottom of the buried valley is less than 320 m AMSL, thus lower than the present day Blue Springs Creek. Glacial activity resulted in the filling of the bedrock valley north of the site but left the Blue Springs Creek valley open. The influence of the sand and gravel aquifers within the buried valley on regional groundwater flow has not been investigated. It is thought that the buried valley occupies an area of structural weakness in the bedrock, originating from the escarpment near Erin.

Blue Springs Creek is located 1000 m southeast of the site at an elevation of approximately 325 m AMSL. The Blue Springs Creek valley is broad and deeply incised into the surrounding bedrock. Between the site and Blue Springs Creek there are many rock outcrops.

The river valleys of the Eramosa River and Blue Springs Creek predate the most recent glacial advances and thus were not likely formed by meltwater from the glaciers that formed the Paris Moraine.

The elevation of the site ranges from 354 to 365 metres above mean sea level (m AMSL). The site has gently rolling topography with the exception of the southeast corner where higher relief is associated with hummocky terrain (Figure 3.3).

3.2 CLIMATIC SETTING

As part of their study of the Blue Springs Creek Basin Coward and Barouch (1978) conducted a water balance analysis using data from October 1966 to 1972. Using these data they calculated the following average annual values for the entire basin:

Annual Precipitation (P)	= 901 mm/yr
Annual Actual Evapotranspiration (AET)	= 517 mm/yr
Annual Evaporation (Open Water)	= 652 mm/yr

An updated study of climatic data obtained from the Environment Canada weather station at Shand Dam in Fergus, Ontario located twenty two kilometers northwest of the Site was performed. The last forty-six years of data from 1965 to 2011 was analyzed using the Thornthwaite method and the resulting average annual values are as follows:

Annual Precipitation (P) = 954 mm/yr
Annual Actual Evapotranspiration (AET) = 507 mm/yr

The annual variation in precipitation is significant, ranging from 640 mm/year to 1268 mm/year.

The Guelph-Eramosa study (Gartner Lee, 2004) used the Guelph Arboretum station data (1971 – 2000) and found that the annual precipitation was 923 mm/year and the potential evapotranspiration rate was 487 mm/year.

Based on these evaluations, the surplus water (precipitation less evapotranspiration) is between 384 and 436 mm/year. Coward and Barouch (1978) measured stream flow in Blue Springs Creek and estimated that water surplus in the basin was on average 366 mm/year.

3.3 HYDROLOGY

Surplus water (precipitation less evapotranspiration) either infiltrates, runs off the land into a surface water body or as occurs near this site, does both. The hummocky topography on the Paris moraine in general promotes infiltration by capturing surplus water in depressions, resulting in significant infiltration. Some of this water re-emerges as diffuse seepage or discrete springs. Combined with runoff, this emerged groundwater seasonally flows through water courses and depending on the volume of flow, the water course either re-infiltrates entirely or a portion flows overland to Blue Springs Creek. This pattern of infiltration, emergence, surface flow and re-infiltration occurs in Tributary A, Tributary B and Tributary C near to the site and likely other streams east of the site.

This hydrological pattern is due to the underlying geological environment. Conditions such as closed depressions and relatively permeable soils are observed in upland areas on the Paris Moraine to the north of the site. It is expected, therefore, that there is significant infiltration of groundwater. The Guelph Eramosa study (Gartner Lee, 2004) suggests an infiltration rate of between 221 and 442 mm/year for the local sediments. The Paris Moraine overlies older tills and potentially less permeable tills such as the Port Stanley till. This permeability contrast results in the preferential lateral groundwater flow, rather than downwards into the underlying bedrock aquifer. This results in the emergence of groundwater (Source areas of Tributaries A, B and C) on the side slope of the Paris Moraine and also prevents loss of stream flow in Tributaries A, B and C until more permeable sediments are encountered as occurs in Lots 1 and 2 in Concessions 5 and 6, Guelph-Eramosa Township.

The Blue Springs Creek valley is a significant incision into the dolostone aquifer and it is likely that the majority of infiltration in the watershed ultimately discharges to Blue Springs Creek.

The Ministry of the Environment provide a method of estimating infiltration in 'MOEE Hydrogeological Technical Information Requirements for Land Development Applications' (1995). Topography, soil type and land cover are used to estimate infiltration. Based on this method, the infiltration factor applicable to surplus water in this area ranges from 0.5 to 0.8. This results in estimated infiltration of between 192 and 348 mm/year. The calibrated model for the Guelph Eramosa study (Gartner Lee, 2004) suggests the following infiltration rates;

Glacial Till 63 mm/year
Hummocky Till 252 mm/year
Kames/Eskers 378 mm/year
Glacial Gravel 442 mm/year
Glacial Fluvial Sand 221 mm/year

There is a wide range of infiltration but in general the infiltration rates are expected to be relatively high in this area.

3.3.1 ON-SITE HYDROLOGY

The site is hummocky and as previously indicated has been modified in the past by anthropogenic activity. The modifications include:

- draining of the central depression by channeling the stream that passes through the property,
- sand and gravel extraction along 6th Line Eramosa,
- sand and gravel extraction near the northwest wetland and,
- sand and gravel extraction at the eastern corner of the site, along Highway No. 7

Eight micro-drainage areas were identified on-site, these are shown on Figure 3.4. The largest micro-drainage area (D2) is along the stream which flows through the site. Three of these micro-drainage areas (D5, D6 and D7) have internal drainage and thus contain runoff on-site. Micro-drainage areas D5 and D6 get runoff from off-site areas and only D1, D4 and D8 naturally direct runoff off-site. The culvert beneath 6th Line Eramosa at Highway No. 7 drains the small micro-drainage area D8. The runoff volume from all of these micro-drainage basins is believed to be small due to the high hydraulic conductivities of the surface sediments, the lack of any defined runoff channels and the lack of ponded water.

The hydrologic function of this site is therefore one of significant recharge of the bedrock aquifer.

3.4 SURFACE WATER FEATURES

The site is located one kilometre northwest of Blue Springs Creek within the Blue Springs Creek watershed (Figure 1.3). The site is also approximately two kilometres southeast of the Eramosa River (which flows through the town of Rockwood). The Blue Springs Creek watershed boundary is located at the height of land approximately 750 m north and west of the site. Flow in both the Eramosa River and Blue Springs Creek is westward.

A wetland area located along the northwestern corner property boundary is approximately one hectare (10,600 m^2) in size. Other than runoff originating within its catchment area (Area D6, Figure 3.4), there are no surface water inflows or outflows from this wetland. The water level in the pond within this wetland decreases by more than a metre between April and October. During the spring freshet the former gravel pit east of the wetland is also inundated, however at no time is there a connection between the two bodies of standing water. Perennial standing water has been observed in the wetland between 1995 and 2011 and also noted in historical aerial photographs (Appendix I). It has been noted that during periods of drought the wetland surface water area shrinks to approximately 50 m^2 and is principally located in the southern area of the wetland at SW1.

An intermittent stream (Tributary B) flows from the northwest to the southeast through the eastern half of the site (Figure 1.4). Flow has been observed in the stream during the spring freshet and after high intensity rainfall events. The stream is usually dry during the summer months. The headwaters for the stream include an upland wetland located northwest of the site (Allen wetland) and a spring-fed pond on the De Grandis property. Within the site, the stream has a well-defined channel, the southern section of which is man-altered. It appears that from a centrally located depression to the southern property limit, a channel has been dug to allow for the conveyance of water.

The stream flow onto the site (measured at SW4, Figure 2.1) ranges from 154 L/s to being dry. In 2006, Tributary B was dry at SW4 between June 22 and September 15. In 2008, Tributary B flowed all year at SW4. The volume of stream flow where Tributary B leaves the site ranges from 132 L/s to being dry. Measured at SW8, the stream flow in Tributary B ceases every year. The maximum loss of stream flow is approximately 24 L/s.

Two measurements at SW9 and SW4 confirm that Tributary B is losing water through the Allen Wetland. On March 27 and May 11, 2012 Tributary B lost approximately 6 L/s between SW9 and SW4.

Tributary A arises from a spring on the Allen property. The spring is enclosed in a stone crock and water is observed to flow around the stone crock. Flow in Tributary A occurs year-round. Tributary A flows southwesterly through the Ball Farm and if there is sufficient flow will pass beneath Hwy No. 7 and into a pond. There is no indication that this flow proceeds farther than the Eramosa-Milton Townline. The flow rate in Tributary A at 6th Line Eramosa ranges from 1.15 L/s to 69 L/s.

The flow rate in Tributary C at 7th Line Eramosa has been measured since November 2011 and has ranged from being dry to 53.13 L/s. This flow arises from springs and runoff in Lot 3, Concession 7. Similar to Tributary B, Tributary C loses most of, if not all of its flow prior to reaching Hwy No. 7. In March 2012, the flow rate in Tributary C was the same at 7th Line as it was at the northern edge of Lot 1, Concession 6 E½, suggesting no change in flow where the silty till soils are at the ground surface. From the northern edge of Lot 1, Concession 6 E½, to Highway No. 7, however, Tributary C lost 25 L/s on February 2nd and 23rd 2012.

The Brydson Spring, Tributary D and possibly wetland and ponds located between Hwy 7 and Blue Springs Creek have bedrock groundwater as their source.

3.4.1 SURFACE WATER CHEMISTRY

Four surface water samples were collected for water analyses. In general the surface water is fresh (low chloride content). These surface water samples met the PWQO's for parameters tested.

Elevated nitrate concentrations (8.2 and 9.0 mg/L) was observed in two samples (Tributary A and B respectively) which suggests that there is some contamination of these surface water bodies. Considering that Tributary A and B emerge from active farms, it is likely that barnyard wastes or fertilizers are the source of nitrogen in the streams.

3.5 GEOLOGY

A description of the geological units in this area is provided in this section.

3.5.1 BEDROCK GEOLOGY

The site is located on the eastern rim of the Michigan Basin (Telford, 1978). The bedrock stratigraphy has a gentle southwestward dip of approximately 4 to 6 m per km (Livery, 1981). The bedrock surface in the vicinity of the site occurs at an elevation of between 344 and 371 m AMSL with the higher bedrock surface elevations occurring to the north and northeast of the site (Figure 3.5) Several bedrock valleys have been reported in the area including the bedrock valleys occupied by the Eramosa River and Blue Springs Creek (Procter and Redfern, 1995) (Burt, 2010).

The site is underlain by Silurian-aged dolostone. The core for M2 was logged prior to the preliminary assignment of the un-subdivided Amabel Formation into the Goat Island, Gasport, Irondequoit, Rockway and Merritton formations (Brunton, 2010). The overall thickness of the dolostone beneath the site is 43.7 metres as measured at on-site borehole M2. A well (MW-08-T3-06) drilled for the City of Guelph Tier 3 Source Water Protection study is located two kilometers north of the site. The well record identifies the presence of 4.5 metres of the Ancaster and Niagara Falls members of the Goat-Island Formation. The Gasport Formation is 44.5 metres thick at MW-08-T3-06 and the thickness of the Irondequoit, Rockway and Merritton Formations is less than 5 metres. The Vinemount and Reformatory formations are not present beneath this site. These formations occur to the west and can be found in outcrop in Rockwood.

Ingham (1990) describes the topmost part of the rock at M2 as bluish, grey, medium grained, medium to coarse porosity, vuggy and very fossiliferous.

The Cabot Head formation underlies the dolostone formations. The Cabot Head is a shale deposit and is found at an elevation of 308.8 m AMSL at M2.

A number of caves and underground caverns have been reported in the area near Rockwood and Eden Mills (Coward and Barouch, 1978). These caves are created by dissolution of the rock. The caves appear to be oriented at approximately 325 degrees from north (Karrow, 1968) in the direction of the biohermal bodies and are situated near the base of these bioherms. The presence of these caverns and the disappearance of streams in the area suggest some degree of solution enhanced permeability is occurring in the dolostone aquifer.

The bedrock surface elevation ranges from 346.9 to 353.2 m AMSL beneath the site. In general, the top of bedrock elevation decreases from north to south. There is a bedrock low located in the southeast corner of the site. The bedrock surface is found at an elevation of 340.88 m AMSL in MOE Well #2805483. There appears to be a local bedrock surface elevation high point in Lot 2, Concession 6 along 7th Line Eramosa. According to MOE Well #6715237 the bedrock surface has an elevation of approximately 366 m AMSL. There does not appear to be a bedrock high associated with the crest of the Paris Moraine. Bedrock in the Eramosa River valley outcrops at approximately 370 m AMSL and in the Blue Springs Creek valley from an elevation of 346 m AMSL to the river's edge at approximately 330 m AMSL.

3.5.2 OVERBURDEN

The quaternary geology obtained from the Ministry of Natural Resources is presented in Figure 3.6. In general, the immediate vicinity of the site was interpreted to be underlain by kame, esker and outwash deposits. Wentworth till deposits were interpreted to occur in the area as well. The quaternary geology map prepared by Burt (2011) is found in Figure 3.7. This map identifies extensive deposits of the Port Stanley till and Wentworth Till in the near vicinity to the site.

The unconsolidated geological material overlying the bedrock at the site is both morainal and fluvial in nature. This area of Southern Ontario had experienced several advances and retreats of the glacial ice sheets, the most recent occurring approximately 12,000 years ago. This glacial advance from southeast to northwest resulted in the deposition of the stony Wentworth Till including large boulder plucks. A sinuous ridge of glacial till embedded with large boulders occurs in the eastern part of the site, on the neighbouring property to the north and on the De Grandis property. The boulders are mainly of Paleozoic origin (dolostone) however, several large igneous boulders were also observed. The matrix within this till is a sandy to silty sand till with 70% sand and 30% silt and clay (sample from TP4). A similar deposit was found by Naylor (1989) in Lot 1 Concession 6 E½. In TP9, this till was underlain by consolidated olive green coloured silt till of relatively old origin (pers. Comm. Abigail Burt, 2012).

A surficial silt till is found within the site at M3 and northward beneath the Allen wetland (samples AW7, AW8 and AW11). This till has between 45 and 60% silt and at M3 is two metres thick.

Ice-contact stratified sediments are found mainly in the central and western portions of the site. Steep hummocky terrain in the south central portion of the site coincides with former borrow areas from the site and contain deposits of sand and gravel. Boreholes M12 and M11 find thick deposits of fine and medium grained sand and silt deposits in the northwestern portion of the site (borehole M12).

Sand and gravel extraction occurred in the northwestern portion of the site and a small wayside pit is found in the southwestern part of the site.

Geological cross-sections are presented in Figures 3.9 to 3.12 with a key map of cross section locations found on Figure 3.8. Water well record data for wells north of the site indicate a glacial till overlying bedrock (Figure 3.9), up to sixteen metres thick at well # 6706762. The bedrock surface has a relatively gentle downward slope from the Paris Moraine to just northwest of Blue Springs Creek where it suddenly decreases in elevation. Based on testpit and borehole data a silt or silt till layer is found to overly the dolostone bedrock in the western half of the site as observed in M1, M4, MW13, MW14, TP1, TP2 and TP3 (Figures 3.10 and 3.11). This layer is generally less than two metres thick. East of Tributary B, a sandy till is more prevalent above the bedrock although silt is found at TP8 and a dense silt till at TP9. In general, however, the basal silt till is thin or absent above the bedrock near Tributary B (Figure 3.12).

The presence of deposits of gravel, sand and silt indicates a period of fluvial action resulting in the sorting of the geological material. Sand and gravel deposits occur in a relatively high energy environment (e.g. glacial melt) and the silt deposits represent a lower energy (e.g. ice dam) period. The Blue Springs Creek valley was an outlet for glacial melt water. A very high energy environment existed south of the site as evidenced by the absence of overburden despite the Paris Moraine complex sediments deposited on both north and south sides of the valley (Figure 3.2).

The 1965 soil survey of Wellington County (Figure 3.13) identifies the site as being underlain by the Dumfries Sandy Loam with Parkhill Loam and muck to the north. The Parkhill loam is reported to have poor drainage. This coincides where the Allen Wetland is found, and the identification of a silt till in soil samples. The change from surficial silt till to a sand till or sand and gravel deposits coincides with the major loss of stream flow in Tributary B and C.

3.6 HYDROGEOLOGY

3.6.1 REGIONAL HYDROGEOLOGY

The Paris moraine is an area of significant infiltration due to the capture of surplus water in closed depressions and a relatively permeable matrix. Blue Springs Creek is an area of regional groundwater discharge from the bedrock aquifer.

Figure 3.14 provides a regional perspective of groundwater flow. Based on static water levels obtained from water well records, the groundwater with the greatest hydraulic potential is found north of the site co-incident with the crest of the Paris Moraine. Groundwater potentials of 380 m AMSL occur northeast of the site. These high groundwater potentials occur in the overburden sediments within the Paris moraine. The high potentials occur because of significant infiltration on the hummocky moraine and slow migration downward, impeded by silt within the sandy tills or by silt till within or beneath the moraine. Burt (2010) classifies the Paris Moraine/Wentworth till as an aquitard.

In general, at the crest of the Paris Moraine, groundwater has a westerly flow along the axis of the moraine. Along the northern flank of the moraine groundwater is diverted northward towards the Eramosa River. Along the southern flank of the moraine groundwater is diverted towards Blues Springs Creek.

Evidence of silt till layers beneath the moraine or within the moraine is found in several locations on the south slope of the Paris Moraine. Tributaries A, B, C and other streams east of the site arise from a permeability contrast within the moraine sediments. Groundwater infiltrating on the Paris moraine and percolating downwards encounters a layer of lower permeability. Based on soil samples obtained from the Allen wetland, this layer is a sandy silt till comprising greater than 50% silt. Groundwater then preferentially flows laterally in a southerly direction and emerges as surface water. The emergence of groundwater onto the ground surface is a relatively short-lived occurrence as within several hundred metres, the water re-infiltrates. Observations of flow in Tributary A, B and C confirm this. The re-infiltration occurs where sandy Wentworth Till occurs, kame sand and gravel occurs or where thin overburden overlying bedrock occurs. As observed in Tributary B southeast of the site, and Tributary D, a significant volume of groundwater can re-emerge from the bedrock within the Blue Springs Creek valley.

Regionally, groundwater discharges to the Eramosa River and Blue Springs Creek. The site and nearby environs are underlain by the regionally extensive Amabel Formation. The Amabel

Formation is an aquifer capable of supplying large quantities of water (both the City of Guelph and Rockwood rely on water from the Amabel formation).

A convergence of groundwater flow occurs in an area coincident with Tributary B, within Lot 1, Concession 6 and southeast to the Brydson Spring. The static water level in M3 is approximately four metres lower than at M13D and twelve metres lower than water levels along 7th Line Eramosa (Figure 3.15). This trend can be found along the southern edge of the site. A gentler hydraulic gradient between M3 and the Brydson Spring suggests an area of greater hydraulic conductivity in the bedrock.

3.6.1.1 GROUNDWATER SEEPAGE AND SPRINGS

A number of areas of groundwater discharge or springs have been identified in the 1978 MOE document (Coward and Barouch, 1978) and confirmed during the door-to-door water well survey. Three areas of discrete groundwater discharge situated more than 300 metres from the site have been identified to the northwest. One of the northwest areas of groundwater discharge is situated on the Allen Farm (Figure 1.4) at an elevation of approximately 361 m AMSL. This spring has a concrete casing over top with stones inside the casing. The static water level in the bedrock well (Well # 6708039) on the Allen Farm property was measured at 354.8 m AMSL, several metres lower than the spring. The land surface immediately to the north of the spring rises to an elevation of 380 m AMSL in a hummocky moraine feature (Figure 3.9). The static water levels in the bedrock shown on Figure 3.9 show that bedrock water levels decrease from the Paris Moraine southeasterly to Blue Springs Creek and remain below the ground surface. The source area of the spring is therefore interpreted to be the upland area immediately to the north of the spring.

The resulting stream from the spring feeds into two interconnected ponds located near to 6th Line Eramosa which then discharge to Tributary A that flows westerly beneath the 6th Line. Flow in this upper reach of the stream is perennial. South and west of the 6th Line however, the stream loses water and dries up on the Ball farm. Topographic maps indicate that this stream flows under Hwy No. 7, however, flow has only been observed under Hwy No. 7 during the spring thaw.

Groundwater discharge also occurs on the De Grandis property. Observations made at the De Grandis property include;

1) diffuse seepage of groundwater in areas north of the Allen Wetland
2) man-made berms along the southern edge of the man-made ponds

3) outflow of water from the ponds into two streams flowing on the Allen wetland

Groundwater seepage at the De Grandis property occurs from glacial till deposits at an elevation of 364 m AMSL. According to Ms. De Grandis, a pond was dug on the property in the 1980's for aquaculture and she identified several springs within the pond. She recalled that during the excavation much of the pond was dry and dug into 'clay', however, water was encountered along the northern edge of the excavation. The De Grandis house is supplied by water from a shallow dug well. The static water level in the well was measured to be very similar to the elevation of the pond water and was found to have a high yield (after 30 minutes of running a garden hose (approx. 20 L/min) there was no measurable change in the well water level. This indicates highly permeable overburden sediments. Large dolostone boulders are found in the vicinity of the De Grandis pond and this is interpreted to be the Wentworth till.

Overflow from the De Grandis pond flows onto the Allen property in two separate channels (Figure 2.4). These channels join within the Allen wetland and the combined flow carries onto the JDCL site (Tributary B). Outflow from the De Grandis pond is not regulated other than through a small breach in the containment berm. The discharge from the De Grandis pond varies significantly as measured from as much as 154 L/s at SW4 to having no discharge.

The land surface rises gently to the north of the De Grandis pond. Stony fields north of the ponds and extending north of the railway track provide good opportunity for infiltration.

Tributary C also emerges from the south slope of the Paris Moraine. The source of Tributary C in Lot 3 Concession 7 occurs at an elevation of approximately 375 m AMSL.

These springs occur in an upland area identified as significant groundwater recharge areas (GRCA, 2008). The recharge in this upland area is high as a result of permeable surficial sediments and closed drainage. The springs occur in an area identified as a regional groundwater recharge area for the bedrock aquifer and thus downward groundwater flow predominates. The springs are interpreted to arise from permeability contrast within the overburden. Sediments with relatively higher permeability facilitate high infiltration and sediments with relatively lower permeability impede the downward movement of percolating water, resulting in lateral movement and discharge at the ground surface as springs.

The Brydson spring occurs 400 metres southeast of the site at elevation of approximately 345 m AMSL. The Brydson Spring occurs in an area of thin overburden and likely represents discharge directly from the bedrock. This can be considered to be the re-emergence of Tributaries B and C.

3.6.1.2 SOURCE WATER PROTECTION

The site is not located in the well head protection areas (WHPAs) of either the Rockwood municipal wells or the City of Guelph wells.

Tributary B is a tributary to Blue Springs Creek and ultimately to the Eramosa River. The Intake Protection Zone (IPZ-3) of the City of Guelph intake on the Eramosa River includes all upstream areas (tributaries) of the Eramosa River and Blue Springs Creek watershed. Thus the IPZ-3 is assigned to all lands within 120 metres of Tributary B on the site. The IPZ-3 falling within the site boundary has the lowest vulnerability score of 1 (Aqua Resource, 2010) and thus is not a threat to the intake (pers. Communication Sandra Cooke, GRCA, August 15, 2012). The active excavation portions of the site will drain internally and it is not expected to have any storm water flow directed to Tributary B.

3.6.2 ON-SITE HYDROGEOLOGY

The site is located at an intermediate elevation on the southern slope of the Paris Moraine. The site is one of groundwater recharge occurring within many closed depressions and along the permeable corridor of Tributary B. There is the potential for localized groundwater discharge to a wetland occurring in the northwest corner of the site where percolating water encounters a silt layer. Water flowing on top of the silt layer seasonally discharges to the ground surface along the northern property limit where gravel extraction has removed aggregate above the silt layer. Emerging groundwater is observed to flow southerly. There is no other permanent surface water on-site other than in this wetland.

Groundwater potentials are the greatest in the western corner of the site and lowest in the eastern corner of the site. In general the groundwater flow direction is from west to east. The hydraulic potential in the overburden at M13 is recorded as high as 355.49 m AMSL in the spring of 2011.

Hydrographs of water levels obtained from on-site monitors are provided in Appendix B. There are up to seventeen years of records for monitors M1, M2, M3, M4, M5 and M6. The hydrographs show seasonal variation in water levels. The seasonal variation in water levels ranges from 0.8 to 2.5 metres for bedrock monitors and 1.0 to 2.4 metres for overburden monitors. There is no significant long term trend observed in the water levels.

Groundwater potentials in the overburden and bedrock are shown on Figures 3.16 and 3.17 respectively. Groundwater flows west to east across the site. The greatest groundwater potentials are found at M13 in both the bedrock and overburden.

The water table is not present in the overburden throughout the entire site. Saturated conditions within the overburden do not occur at M4, M7, M8, M11 or M12. At these locations the silt till or silt layer is absent or very thin. Groundwater occurring within the overburden does so above the silt till or silt layer generally in the northern portion of the site and percolates into the bedrock within the southern portion of the site. Notably, M11 is located 21 metres from Tributary B at a depth of 349.91 m AMSL (4.49 metres below streambed) and is dry. It is known that Tributary B is a losing stream as can be seen by the difference in hydraulic potentials between MP1, MP2 and SW5 and between MP3, MP4 and SW4. At these locations the hydraulic potentials measured in the mini-piezometers adjacent to the stream is less than that of the surface water feature. The losing nature of Tributary B is also recorded in the stream flow measurements.

Figure B9 is a hydrograph of M13 S/D (shallow and deep). The hydrograph shows that there is a consistent downward hydraulic gradient between the sand and gravel deposits overlying a silt till layer and the dolostone aquifer below. The silt till is 1.98 metres thick at this location. The average water level difference between the monitors is 0.59 metres resulting in a hydraulic gradient of 0.30 m/m across the silt till layer.

Figure B1 is a hydrograph of M1 S/D. MI S is completed in the silt till layer and MI D is completed in the dolostone. On average, there is a 1.6 metre difference in the observed water levels. The silt till is 1.58 metres thick resulting in a downward hydraulic gradient of 1.01 m/m.

3.6.2.1 HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY

The results of the hydraulic conductivity testing are presented in Table D1. The sand and gravel and silty sand layers at the site have relatively high hydraulic conductivity estimated between 1 x 10^{-5} m/s and 5 x 10^{-4} m/s. These layers are relatively efficient at transmitting water and under saturated conditions, will facilitate the movement of groundwater.

The sandy silt and silt till layers have hydraulic conductivity values of between 1 x 10^{-7} and 1 x 10^{-6} m/s. These layers are not impermeable, but transmit groundwater relatively poorly.

The transmissivity testing of the dolostone aquifer suggests that the bedrock has a transmissivity between 7.5 x 10^{-7} and 5 x 10^{-6} m/s (M2, M4 and Well # 6705627).

These results are similar to those obtained from a 24 hour pumping test conducted on the adjacent property. Harden Environmental conducted a test on well TW-2 in Lot 1, Concession 6 E½. TW-2 is 39.32 metres deep, a similar depth to the proposed quarry. The estimated transmissivity from the test data ranges from 20 to 150 m^2/day. The range in transmissivity arises from different responses measured in several monitoring wells during the test. Using an aquifer thickness of 40 metres, the hydraulic conductivity of the bedrock is estimated between 5 x 10^{-6} and 5 x 10^{-5} m/s.

There is no indication from this testing that there are significant zones of relatively high permeability at depth beneath the site. The drawdown in TW2 was 13 metres at a discharge rate of 1.36 L/s. The drawdown at on-site well # 6705627 was 1.8 m at a rate of 0.4 L/s after 100 minutes of pumping without stabilization of the water level. These wells extend to the approximate depth of the proposed quarry. On July 3rd 2012 the owner of the mushroom farm adjacent to the site stated that he was discharging approximately 400 L/min from a 60 metre deep well and that the pump, set at a depth of 50 metres was only operating intermittently because of insufficient water in the well. These observations suggest that a highly productive zone within the Amabel formation does not occur beneath this site.

The Guelph Eramosa Study used hydraulic conductivity values of 5 x 10^{-4} m/s and 1 x 10^{-5} m/s for the dolostone aquifer.

The detailed hydraulic testing conducted by the University of Guelph in nearby Tier 3 well MW-08-T3-06 found that hydraulic conductivity of the dolostone bedrock ranged from 8 x 10^{-7} m/s to 5 x 10^{-5} m/s.

3.6.2.1 RELATIONSHIP BETWEEN TRIBUTARY B AND GROUNDWATER

Tributary B flows along a rocky channel for the first 150 metres downstream from the northern site boundary. In this area Tributary B is underlain by glacial till. In the central portion of the site, Tributary B meanders through sandy sediments. In the southern portion of the site, Tributary B flows through man-made channels.

Two drive point monitors MP1 and MP2 were installed in November 2010 on either side of the stream at the location of SW5 and M9. A cross section depicting the water table in this location is shown in Figure 3.18. Figure 3.18 shows that in this location the stream is clearly recharging groundwater on both the sides of the stream. Similarly, two drive point monitors MP3 and MP4 were installed in November 2010 on either side of the stream at the location of SW4 (upstream property boundary). Each monitor was installed to a depth of four metres below ground surface and MP3 is six metres and MP4 is eight metres horizontal distance from the edge of the stream. Both were found to be dry in November 2010 whereas there was flow in the stream. In May

2011, both contained a water level that was found to be two metres below the stream surface water level at SW4. The water levels in these monitors are consistently below the stream level.

This evidence as well as stream flow measurements confirms that throughout the subject property, the stream is losing water to the underlying sediments.

3.6.2.2 RELATIONSHIP BETWEEN NORTHWEST WETLAND AND GROUNDWATER

The northwest wetland is located along 6th Line Eramosa at the northern property boundary. The wetland has been mapped in the field and has an area of approximately 10,600 m^2. There is an open water portion of the wetland that changes in extent seasonally. In the spring, the open water area is approximately 10,500 m^2 and during the summer and fall periods can shrink to less than 50 m^2 and occurs as a shallow pool in the southern part of the wetland. The total catchment area of the wetland is estimated to be 27,225 m^2 (Figure 3.4) based on topographic surveys and field observations. The western catchment boundary is the hedgerow along 6th Line. There are no culverts beneath the road and water sheeting across the road has not been observed suggesting that the middle of the road can be considered the edge of the surface water catchment area. The northern edge of the catchment extends onto the adjacent property as shown. To the east, the wetland boundary is sharp and found along an elevated hedgerow (natural or created by former aggregate operation). To the south, the ground elevation rises to an elevation of approximately 360 m AMSL in the conifer plantation. The surface water catchment of the wetland is approximately 30 metres south of the wetland within the plantation.

The elevation of the wetland ground surface ranges from 354.28 at SW1 to 354.71 m AMSL along the edge. The lowest elevation of the wetland occurs in the southern part of the wetland and has always been observed to have open water (frozen in the winter). There is a significant seasonal fluctuation in the surface water level in the wetland. A range of 354.2 (December 1997) to 355.73 (April 2000) has been observed. Annually the range in water level is as high as 1.45 metres (2007). In 2008 the surface water level in the pond fell by 1.24 metres between April and May.

During high runoff events such as the spring freshet, water also collects in the former extraction area northeast of the wetland. Even at the highest water level observed, there remains a physical separation between the wetland and water collected in the former extraction area. A water level difference is also maintained.

The surface of the bedrock beneath the wetland can be inferred from known bedrock elevations at boreholes M1 (349.53 m AMSL), M13 (350.2 m AMSL) and M14 (349.78 m AMSL). Therefore, based on the wetland ground surface elevations previously mentioned, the bedrock is found between 4.08 m and 5.18 m below the wetland surface. A silt till layer is found above the bedrock and the top elevations are summarized in Table A4. The thickness of this layer ranges between 1.67 m and 1.98 metres.

Four holes were hand augered through the wetland in order to characterize the underlying soils. Each hand auger hole encountered organic soils, a silty sand layer and a sand and gravel layer. Each hand auger hole was dug to auger refusal. A summary of the findings is presented in Table A2. The organic layer is found to be between 0.2 and 0.7 metres thick. The silty sand layer is between 0.2 and 1.45 metres thick. The thinnest portion of the silty sand occurs along the northern edge of the wetland and the thickest silty sand occurs along the western edge. The silty sand likely represents sediment carried into the wetland depression by runoff water from the surrounding area. The hand auger system did not allow for determining the thickness of the sand and gravel layer, but using the adjacent boreholes as a guide, the sand and gravel layer is between 0.8 and 2.3 metres thick beneath the wetland.

There are no observations of iron precipitates or marl that would signify the discharge of groundwater into the wetland. The relationship between the surface water level in the wetland and adjacent groundwater monitors is shown on Figure 3.19. MPN-1 and MPW-1 are located north and west of the northwest wetland as shown on Figure 2.4. M6 is located south of the wetland. The hydrographs show that in the spring the surface water level is very similar to the groundwater levels measured in MPN-1 MPW-1and M6. As observed in the fall of 2011, the water levels in all three groundwater monitors were more than 0.25 metres below the surface water level in the wetland. This means that the surface water in the wetland is perched above the groundwater system due to the organic layer lining the bottom of the wetland. As observed in the summer of 2012, the water level in M6, located within the wetland, is more than 0.5 metres below the pond level.

MPN-1 installed along the north and MPW-1 installed along the west part of the wetland confirm upward gradients (i.e. potential for groundwater discharge into the wetland) from the sand and gravel unit. MPS-1 installed along the south and MPE-1 installed along the east part of the wetland confirm downward gradients (i.e. potential for groundwater recharge from the wetland). As shown on Figure 3.16, groundwater flow radiates away from the southern and eastern wetland boundaries. The underlying silt till layer beneath the wetland retards movement of groundwater vertically between the overburden and bedrock aquifers. Water levels obtained at M13S and M13D show a downward hydraulic gradient between the overburden and bedrock aquifers at the wetland.

The potentiometric surface in the bedrock measured in M13D upgradient of the wetland has a maximum value of 354.95 m AMSL (May, 2011). At the same time the surface water level in the wetland was measured at 355.38 m AMSL and the piezometric level in the sand and gravel at MW13S was 355.49 m AMSL. The measurement in M13D represents the highest value of bedrock potentiometric surface found on-site. Therefore, with the wetland water level being higher than the bedrock water level, there is no potential for bedrock groundwater to discharge to either the wetland or the sand and gravel unit beneath the wetland. The silt till layer found between the wetland and the bedrock provides hydraulic separation of these hydrostratigraphic units.

3.6.2.3 ALLEN WETLAND

There is a Provincially Significant Wetland (PSW) located north of the Site. The watercourse (Tributary B) flowing through the wetland originates from a spring fed pond (Figure 2.4) north of the PSW. On-site measurements of stream flow at SW4 show that surface water flow from Tributary B will cease in the summer months.

The elevation of the wetland is between 360 and 363 m AMSL. The elevation of a depression in the Allen farm field adjacent to the wetland is 358.19 m AMSL based on a site level survey conducted by Harden Environmental on December 21, 2011 (Figure 3.20). The elevation of Tributary C, east of the wetland is 359 m AMSL (GRCA, 1 metre contours) and is thus also below the wetland elevation. These observations confirm that the only potential source of groundwater for the wetland is from the north. At the southern edge of the wetland (at the JDCL property) groundwater occurs below an elevation of 355 m AMSL (at TP8), several metres below the wetland.

Several holes were hand-augered within the wetland to determine the underlying geological materials (Figure 2.3). The soils found confirm that the wetland is underlain by a silt till containing between 40 and 60% silt. The soil survey map for Wellington County (Figure 3.13) identifies the wetland as being underlain by soils with poor drainage.

Diffuse groundwater seepage was observed along the northern edge of the wetland. This area is also underlain by relatively low permeability till and the seepage is interpreted to be interflow along the contact between the relatively permeable surficial till found on the De Grandis property and the silt till identified beneath the wetland.

The support hydrology for the Allen Wetland is direct precipitation, runoff and interflow from the north. Stream flow measurements of surface water leaving the wetland as measured at SW4 are summarized in Table C1. In general flow from the wetland ceases for one to three months in the summer however in 2008 and 2011 there was continuous flow. The flow rate was measured as high as 158 L/s.

Based on a review of aerial photographs, topographic maps and site visits, the stream flow enters the wetland from the De Grandis pond. Two outlets from the pond were observed resulting in two separate streams. One stream (northern branch) heads south westerly and the southern branch initially heads south easterly but turns sharply south westerly. The streams join at a confluence shown on Figure 2.4. The stream channels are ill defined at times and flow occurs over a broad area. Other times the channel is well defined. Two streamflow measurements obtained in 2012 confirm that from the confluence of the northern and southern branches to the JDCL site, Tributary B loses water. The nearest groundwater monitors to the Allen Wetland are TP8 (overburden) and M3 (bedrock). The ground elevations in the wetland are approximately 361 m AMSL and the groundwater level in TP8 is more than six metres below this elevation and in M3, more than 10 metres below the elevation of the wetland.

3.6.2.4 NORTHEAST WETLAND

A wetland exists off site near the northeastern corner of the property. A test pit excavation with drive point installation (TP8) completed on-site fifty metres from the wetland provides groundwater levels that are approximately 3.5 metres below the surface water in the wetland. The off-site wetland is not an area of groundwater discharge and is determined to be a perched feature. Surface soils in test pit TP8 were mainly comprised of a silty till.

3.6.3 GROUNDWATER CHEMISTRY

Six groundwater samples were obtained and analyzed for general water quality. The results of these analyses are found in Appendix E. In general the groundwater is fresh (low chloride content). These groundwater samples met all of the Ontario drinking water objectives (ODWOs) except for iron (M2, M5 and TP1) and magnesium (M5 and TP1).

Elevated nitrate concentrations (>5 mg/L) observed in two samples (M2 and M3). These elevated levels of nitrate suggest that there is some contamination of the groundwater from surface and near surface sources. Potential sources of nitrate include neighbouring septic systems and nearby farming practices.

The water quality of the bedrock aquifer obtained from on-site well # 6705627 is typical of the dolostone aquifer in this area.

4.0 MINING PLAN AND POTENTIAL HYDROLOGIC CHANGES

Based on the regional and local conditions discussed in Section 3.6.1 and the local conditions stated in Section 3.6.2, this section describes the process through which the mining plan has been developed and the resultant mining plan. The understanding of the groundwater and surface water flow regimes and how they interact has been considered during the development process.

4.1 MINING PROCESS

The mining plan for this pit/quarry will employ a mining technique used to minimize the disturbance of the groundwater flow system. JDCL proposes to remove the aggregate above the water table with traditional excavation equipment. However, below the water table JDCL will drill holes into the dolostone, break the rock with explosives and remove the broken rock with excavators or draglines stationed above the water table without dewatering. The proposed depth of extraction is thirty metres below the water table. Other than the blasting phase, this is a similar approach to traditional below-water-table sand and gravel extraction. The main hydrogeological benefit of this method over dewatering is the minimal disturbance to hydraulic potentials in the bedrock.

This method will not be unique to this site. James Dick Construction Ltd. is currently using this technique in their Guelph Limestone quarry and mining companies use this method almost exclusively for mining limestone in southwest Florida.

The proposed mining area is shown on Figure 4.1 and includes extraction both east and west of Tributary B. Details of the mine phasing are found on the site plans prepared by Stovel and Associates Inc. The mining of the bedrock will commence in the north half of the west pond and will proceed from north to south.

4.2 POTENTIAL IMPACT OF CREATION OF WATER BODY (PASSIVE IMPACT)

4.2.1 OVERBURDEN

There is at least seasonally saturated overburden found along the perimeter of the proposed quarry with the exception for the boundary along Provincial Hwy #7 and a portion bordering 6th Line Eramosa. Unmitigated, the groundwater in the till, sands and gravel will flow into the quarry thus “drawing” water from the overburden. Other than the northwest wetland, there are no environmental features sensitive to changes in the groundwater levels within the overburden. A hydraulic barrier will be constructed in the location shown on Figure 4.2 to prevent the draw of overburden groundwater into the excavation. The barrier, where constructed, will result in the maintenance of groundwater levels outside of the excavation area. The barrier is constructed by digging a trench downgradient of the wetland and replacing the sand and gravel with silt. The silt has a significantly lower hydraulic conductivity than the sand and gravel and thus retards the movement of groundwater. This results in water levels rising on the wetland side of the barrier. Calculations indicate that with the construction of the hydraulic buffer, there will be a slight surplus of water available to the wetland when compared to the current condition. It is recommended that a culvert be included in the buffer design that can be adjusted to prevent water accumulating in the wetland area.

The barrier will be keyed into the silt/silt till layer and will be 2.5 metres wide. The design horizontal hydraulic conductivity of the barrier is 5 x 10^{-8} m/s. Hydraulic barriers constructed of silt and clay have successfully been used elsewhere in Wellington County and in Peel Region. In the Reid’s Heritage Homes pit, located in Puslinch Township, a total length of 1150 m of hydraulic barrier was installed. The barrier is installed between two and fourteen metres depth and has a post installation hydraulic conductivity of 1.8 x 10^{-10} m/s. Another 750 metre long barrier, 11 metres wide is effectively protecting Warnock Lake adjacent to the Caledon Sand and Gravel pit. The hydraulic conductivity of the Caledon Sand and Gravel barrier is estimated to be 1 x 10^{-10} m/s. The Roszell Pit, approved in Puslinch Township, proposes to use a 10 metre wide hydraulic barrier with a design hydraulic conductivity of 1 x 10^{-8} m/s to protect a PSW.

4.2.2 BEDROCK

The creation of a water body results in the same hydraulic potential in the aquifer along the perimeter of the water body. Presently groundwater flows from west to east as a result of an approximate six metre decrease in hydraulic potential in the bedrock aquifer. This general flow pattern will remain post extraction; however the hydraulic potential of the water body will be less than that of the present hydraulic potential in the bedrock in the northern portion of the quarry by approximately two and a half metres. This results in an increase in groundwater flow into the excavation and a decrease of the hydraulic potential in the bedrock aquifer in areas north of the site. This also results in an increase in hydraulic potential south of the site (i.e. groundwater levels will increase). A 3-D groundwater model was prepared to determine the area of influence as shown on Figure 4.3. The maximum drawdown at the northern edge of the West Pond is 2.45 metres. The predicted final water level in the West Pond is 348.6 m AMSL and in the East Pond is 348.4 m AMSL.

The creation of a water body will alter the water storage capacity at the site by creating significantly more water storage than presently exists. The additional storage will have a benefit to downstream wells, springs, ponds or streams during drier conditions.

4.3 IMPACTS ARISING FROM ROCK EXTRACTION BELOW THE WATER TABLE (ACTIVE IMPACT)

The removal of rock from below-the-water-table will lower the water level in the quarry thereby drawing water in from the surrounding rock body. Groundwater will flow into the quarry, replacing the volume of rock removed and thereby creating a significant reservoir of stored water. It is proposed to extract rock from this site at a rate of 700,000 tonnes per year. The approximate density of the dolostone is 2.6 tonnes per cubic metre, resulting in the potential removal of 270,000 cubic metres of rock per year.

Assuming that active mining will occur from April 1 through to December 24th, the annual extraction will occur over 235 working days. The extraction rate on average is therefore 1145 cubic metres per day.

The initial excavation into the rock (sinking cut) is estimated to be 50 metres by 25 metres, an area of 1250 square metres. The removal of 1145 cubic metres from this initial excavation will, assuming no inflow of water during the extraction, have a maximum drawdown of 0.91 metres per day. Groundwater will, however, flow into the excavation and replace the removed aggregate, thus limiting the daily drawdown. Analysis of the impact of a passive 2.45 metre drawdown (see Section 4.3.2) suggests that wells, streams, springs and wetlands will not be affected. Monitoring of the water level in the sinking cut and nearby monitors is recommended to verify that no off-site impacts are occurring. The initial rate of extraction can be moderated to minimize water level changes. The additional drawdown effect caused by the extraction will be muted once a body of water has been established.

The passive and active impacts are not additive since the maximum passive impact will occur when the active impact is negligible. For example, by the time the extraction is completed on the west side of Tributary B (passive impact at a maximum), the potential daily active drawdown will be less than one millimeter.

4.4 SITE HYDROLOGY

In Section 3.3 it was stated that a main hydrological function of this site is recharge. This function will not change. There will be no additional overland flow of water from the site. Micro drainage area D1 presently has the potential to contribute water off-site although this has not been observed, even under frozen ground conditions. Post extraction, this potential will be removed from the 2.57 hectares that will be captured in the quarry. This results in a potential increased contribution of 3600 m^3 of water to the aquifer annually. It is unlikely that the runoff from area D1 would contribute to Tributary C given the loss of water observed in Tributary C in that area. The lands onto which water from D1 could discharge are zoned industrial and have an approved site alteration plan.

The extraction area includes 17,865 m^2 of drainage area D2. Thus there will be a decrease in runoff from area D2 into Tributary B. The entire catchment area of Tributary B is estimated to be 585,156 m^2 upstream of monitoring station SW8 (Figure 4.4). The reduction in catchment area is 3% and thus no significant change in stream flow will occur.

The post extraction evapotranspiration rate will increase as a result of the development of open surface water. It is estimated that the evapotranspiration rate for the site is approximately 517 mm/year and open water evaporation is 652 mm/year. There will be approximately 13.9 hectares of open water resulting in a loss of 18,765 m^3/year compared to existing conditions. This loss of water to the aquifer is insignificant relative to the groundwater recharge occurring as a result of recharge beneath Tributary B[*] and Tributary C.

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[*] The recharge occurring from Tributary B for a nine month period is approximately 500,000 m^3.

5.0 IMPACT ASSESSMENT

This section discusses how the development of the pit will affect the hydrologic and hydrogeological regimes.

Any changes to the groundwater flow system will be very gradual and will be detected with the recommended groundwater monitoring program. Any impact presented herein is based on the full development of the quarry without mitigation in the bedrock aquifer. A monitoring program is recommended to confirm the predictions made herein and contingencies such as cessation of mining below the water table, reducing the area of extraction or changing the configuration of the mining can be implemented to address issues that arise.

5.1 NORTHWEST WETLAND

There is the potential for an indirect change to the hydrology of the northwest wetland as a result of an alteration to the groundwater flow system adjacent to, and beneath the wetland. Figure 5.1 depicts the existing hydrologic conditions at the wetland. Groundwater, originating northwest of the wetland, flows beneath the wetland in the silty sand layer, sand and gravel and the bedrock aquifer. Downgradient of the wetland (southeast of M1), groundwater flow in the silty sand layer and sand and gravel layer ceases and there is only groundwater found in the bedrock. Presently, the wetland contributes water to the shallow groundwater flow system south of the wetland and a portion of the groundwater in the shallow groundwater system flows through the silt layer into the bedrock aquifer. The proposed bedrock extraction will result in an increase in the potential for water to flow from the shallow groundwater system into the bedrock as a result of an increase in the downward hydraulic gradient caused by a lowering of the hydraulic potential in the bedrock. The construction of the hydraulic barrier in the overburden will result in a decrease in shallow groundwater flow towards the south, thus offsetting the downward loss of water. Calculations indicate that with a hydraulic barrier in place there will be a slight surplus of water available to the wetland compared to existing conditions. As such, a culvert will be installed to prevent the wetland from becoming too inundated with water.

The construction of the hydraulic barrier will result in the retention of water in the area shown on Figure 5.1.

5.1.1 NORTHWEST WETLAND WATER BALANCE

A water balance approach has been taken to show that the proposed extraction will not significantly change the hydrological conditions of the wetland. The purpose of preparing a water balance is to show that there is a level of understanding of hydrological contributions to the wetland and predictions of impact to the wetland can be made by applying anticipated changes to the support hydrology of the wetland.

The water balance prepared for the northwest wetland considers the following hydrological components;

Inputs	Outputs
Precipitation (P)	Wetland Evapotranspiration (ET)
Runoff (RO)	Groundwater Out Horizontal (G_{oH})
Groundwater In (G_{in})	Groundwater Out Vertical (G_{oV})

Observations of the wetland suggest that there is no year over year increase or decrease in water stored. Depending on factors such as the snow pack, drought conditions or rainy years, the water stored in the wetland does vary, but in general, there is very little water stored in the wetland by the end of the fall. For the purpose of this water balance, an annual change in water storage is not considered.

The water balance of the wetland can then be presented as follows;

$$P + RO + G_{in} = ET + G_{oH} + G_{oV}$$

5. 1.1.1 NORTHWEST WETLAND WATER BALANCE EXISTING CONDITION

The input values to the water balance are as follows;

Precipitation

As discuss in Section 3.2, the annual rainfall ranges from 640 to 1268 mm/year. For this evaluation we have considered an average annual rainfall of 900 mm/year. An increase or decrease by 100 mm per year affects the overall water balance by approximately 4%, thus the water balance is not particularly sensitive to annual precipitation. Only direct precipitation on the wetland is considered in the precipitation parameter. Precipitation falling within the adjacent catchment area will contribute water to the wetland either as groundwater inflow or runoff. The volume of direct precipitation is estimated to be 9,531 m^3/year.

Runoff

The runoff rate from upland areas around the wetland is estimated to be 140 mm/year based on the overland flow estimate for the Blue Springs Creek (Coward and Barouch, 1978). The water balance is not sensitive to the estimate of runoff as the upland area of the wetland is relatively small. Decreasing the runoff to 70 mm/year changes the water balance by less than 2% and increasing the runoff value to 280 mm/year changes the water balance by less than 4%. The volume of runoff into the wetland is estimated to be 846 m^3/year.

Evapotranspiration

The Actual Evapotranspiration (AET) estimate established by Coward and Barouch is 517 mm/year. A Thornthwaite analysis of precipitation data from the Shand Dam suggests an AET of 507 mm/year. The evapotranspiration rate from the wetland itself is estimated to be 652 mm/year. This reflects the Potential Evapotranspiration considering that there is water available to the aquatic wetland plants for much of the growing season. The volume of evapotranspiration from the wetland is estimated to be 6,905 m^3/year.

Groundwater Inflow

Figure 3.15 depicts the groundwater flow pattern near to the northwest wetland. The shallow groundwater flow is predominantly easterly. The volume of groundwater flowing through the sand layer beneath the wetland is estimated using

$Q = k\ I\ A$ (Equation 1)

Where;

Q = volumetric groundwater discharge (m^3/year)
I = hydraulic gradient (m/m)
K = hydraulic conductivity and
A = cross sectional area through which groundwater passes (m^2).

The hydraulic gradient upgradient of the wetland is estimated using the difference in hydraulic potential between M13S and M14s. There is an average hydraulic gradient of 0.0078 m/m between these stations. The hydraulic conductivity is estimated to be 5 x 10^{-4} m/s based on in-situ testing at MW13S, MPN-1, and MPN-2. The saturated sand thickness is on average 2.5 metres and the length through which flow occurs is 165 metres (see Figure 4.2).

Based on these values, the annual flux of groundwater beneath the wetland from upgradient is 50,408 m^3/year. This estimate of groundwater flux is sensitive to changes in the estimate of hydraulic conductivity.

Groundwater Outflow Horizontal

Equation 1 is used to estimate the volume of groundwater flow downgradient of the wetland. A hydraulic gradient of 0.0078 is used based on the average hydraulic gradient between TP13S and MW14S. The hydraulic conductivity is estimated to be 3 x 10^{-4} m/s based on hydraulic testing at MPE-2. The saturated sand thickness is 3.3 metres and the flow field width is 165 metres.

The estimate of the annual flux of groundwater out of the wetland is 42,343 m^3/year.

Groundwater Outflow Vertical

There is a downward hydraulic gradient observed at both MW13S/D and MW1S/D. The silt till layer retards the downward movement resulting in the development of the wetland in this topographical depression. The silt till thickness is approximately two metres and the difference in hydraulic potential between the bedrock and the sand unit is on average 0.59 m at MW13S/D. The vertical hydraulic gradient across the silt till is 0.30. The vertical hydraulic conductivity is estimated to be 5 x 10^{-8} m/s. This is based on in-situ testing of MW14S (4.3 x 10^{-7} m/s) and MW1S (9 x 10^{-7} m/s) and applying a factor of 0.1[†] to account for the vertical nature of the flow. Thus a vertical hydraulic conductivity of between 4.3 x 10^{-8} and 9 x 10^{-8} m/s can be expected. The area over which this gradient is applied is the maximum size of the wetted perimeter of the wetland or 26,445 m^2 as shown on Figure 4.2. This is the area from the proposed barrier to the upgradient edge of the wetland. The estimated groundwater outflow volume is 12,301 m^3/year.

[†] Vertical hydraulic conductivity is commonly estimated to be 10% that of horizontal hydraulic conductivity.

Pre Extraction Water Balance Summary

Appendix J, Table J1 summarizes the water balance components for the northwest wetland before extraction occurs. The inputs and outputs from the wetland balance within 2% of the total input to the wetland. Thus, although the water balance is sensitive to the estimates of hydraulic conductivity, the balance between inputs and outputs from the wetland suggest that estimated parameters are reasonable.

5. 1.1.2 NORTHWEST WETLAND WATER BALANCE POST EXTRACTION CONDITION

The two areas anticipated to change post extraction are the horizontal and vertical components of groundwater flow out of the wetland. It is recognized that a hydraulic barrier will be needed to minimize the disturbance of groundwater flow in the shallow groundwater system downgradient of the wetland. The hydraulic barrier will be installed along the southern and eastern portions of the wetland as shown on Figure 4.2. The barrier will limit the outflow of groundwater downgradient of the wetland. There is also an expected change in the bedrock water levels beneath the wetland. According to the results of the 3-D Modflow model, the average drawdown beneath the wetland will be 1.53 metres. This was calculated by averaging the drawdown calculated for each model grid cell between the proposed barrier and the upgradient edge of the wetland. This will increase the flux of groundwater through the silt till layer and thus increase the volume of groundwater moving vertically out of the wetland.

The following changes are anticipated for the post extraction water balance

Groundwater Inflow

The hydraulic barrier will be longer than the wetland is wide, thus the volume of groundwater captured and directed into the wetland area will increase. The width of the flow field affected by the barrier is 210 metres in comparison to the width of the wetland of 165 metres. It is also estimated conservatively that the saturated thickness of the sand aquifer upgradient of the wetland will decrease by 0.5 metres in response to the drawdown created in the bedrock aquifer. The average decrease in potentiometric surface in the bedrock upgradient from the wetland is estimated by the groundwater model to be 0.8 metres (from the wetland to Tributary A), thus a decrease of 0.5 metres in the overburden is conservatively high. The volume of groundwater inflow is estimated to be 51,325 m^3/year.

Groundwater Outflow Horizontal

Groundwater outflow will be governed by the hydraulic conductivity of the hydraulic barrier and the width of the hydraulic barrier. The design hydraulic conductivity of the hydraulic barrier is 1 x 10^{-7} m/s. The elevation of the silt till beneath the barrier is approximately 351.5 m AMSL (MW14). The maximum water level on the upgradient side of the hydraulic barrier will be set at 355.73 m AMSL based on the maximum historical water level observed in the northwest wetland. The average water level in the wetland is 354.98 m AMSL resulting in there being 3.5 metres of water on the upgradient side of the hydraulic barrier. Assuming that the downgradient side of the barrier will be dry, the hydraulic gradient across a 2.5 metre wide barrier will be approximately 1.5. Using Equation1, the groundwater flux across the hydraulic barrier and thus out of the wetland via horizontal groundwater flow is estimated to be 6,623 m^3/year, a significant decrease from pre-barrier construction.

Groundwater Outflow Vertical

The vertical groundwater outflow will increase as a result of the expected water level change in the bedrock aquifer. The water level in the bedrock aquifer will, on average decrease by 1.53 metres, below the wetland. This will increase the hydraulic gradient between the wetland and the bedrock aquifer. The flux of groundwater across the silt till is estimated to be 44,647 m^3/year.

Post Extraction Water Balance Summary

Table J1 summarizes the post extraction water balance for the northwest wetland and compares it with the pre-extraction water balance.

There is a net increase in the water available to the wetland post-extraction. This is mainly due to the retention of water on the wetland side of the hydraulic barrier. The calculated 6 % increase in the water volume available to the wetland is not significant. An overflow culvert will be installed at an elevation of 355.8 m AMSL to ensure that the wetland is not flooded above historical high water level mark. The overflow will discharge into the quarry.

Water levels obtained from the northwest wetland and adjacent monitors have shown that the groundwater levels will seasonally be below the surface water level in the wetland. This shows that the wetland retains water in the absence of groundwater contributions and with vertically downward gradients between the open water and underlying groundwater. This suggests that the organic matte beneath the wetland retards the loss of water from the wetland, at least during the latter part of the year. This retention capability of the wetland sediments is additional natural protection not considered in the water balance analysis.

5.2 TRIBUTARY B

There is a minimum setback of 20 - 30 metres from Tributary B and from there a maximum slope of 2:1 in the overburden. It has been established that Tributary B does not get hydrological support from the groundwater system and the loss of water from Tributary B thus depends on the relative permeability of the underlying sediments. The proposed pit/quarry will not change the relationship of the stream to the underlying sediments, thus no change in the function of Tributary B will occur.

5.3 SPRINGS

Several springs emerge from the overburden to the north and northeast of the proposed quarry. These springs emerge from ground elevations of between 361 and 373 m AMSL and according to our observations and personal communications with property owners, have perennial flow. The source areas for each of these springs are both higher in elevation and more distant from the quarry than the springs themselves. In each instance, the flow from the springs travels southerly, away from the crest of the Paris Moraine.

5. 3.1 ALLEN FARM

The groundwater model predicts that the water level in the bedrock aquifer beneath the Allen Farm spring is 355 m AMSL. This is six metres below the ground surface where the spring emerges. The water level in the nearest well (at the Allen Farm) confirms that the water level in the bedrock aquifer is several metres below ground surface.

The Allen Farm spring flow is not derived from the bedrock aquifer. The spring flow is derived from the infiltration of water in the upgradient area into a relatively permeable deposit that upon encountering a lower permeability till layer, preferentially moves laterally towards the south and discharges where the ground surface intersects the lower permeability layer. The flow in the Allen Farm spring is perennial, thus the hydraulic potential of the source area must always exceed the elevation of the spring (approximately 361 m AMSL). Using the Allen Farm well as the closest indicator of hydraulic head in the bedrock, there is insufficient hydraulic potential in the bedrock to be the source of water for the spring. Flowing artesian conditions do not occur in bedrock wells in this area, another indication that the bedrock cannot be the source of water for the springs.

The groundwater model also predicts that the drawdown as a result of the mining will be approximately 0.8 metres in the dolostone aquifer, significantly less than the observed annual variation of 2.4 metres in the dolostone aquifer. This reduction in the water level in the bedrock will not affect the discharge of water from the spring as it is governed by the overburden source water elevation and the position of the confining layer, not bedrock groundwater levels.

5. 3.2 DE GRANDIS FARM

The groundwater discharge at the De Grandis Farm originates north of the spring-fed pond. Testing of the De Grandis dug well indicates very permeable conditions in the overburden, the source area of water for the spring fed pond. A water level change of 0.55 m is predicted for the dolostone aquifer beneath the De Grandis pond at full build-out of quarry. The model-predicted hydraulic potential of the dolostone beneath the De Grandis pond under pre-extractive conditions is approximately 358 m AMSL or three metres below the ground surface. This suggests that the bedrock aquifer is not the source area for the pond. The proposed extractive activities will not change the water supply of the house well or pond.

Extraction at the site will occur such that monitoring will confirm the model predictions well in advance of any significant change in water levels at the De Grandis property. For instance, extraction of the northern half of the west pond is predicted to result in a two centimeter change in the bedrock aquifer water levels beneath the De Grandis pond (Figure 5.2). Any changes that will occur will be gradual and will be detected by the proposed monitoring program.

5. 3.3 BRYDSON FARM

Water levels are predicted to rise along the southern edge of the quarry. The Brydson spring is located approximately 400 metres southeast of the quarry and will not experience any loss of flow.

5. 4 WATER WELLS

5. 4.1 WATER QUANTITY

There are several water wells within 120 metres of the site. An increase in water levels is predicted to occur south of the pit/quarry and no loss of well yield can occur south of the site.

The groundwater model predicts a 1.6 metre water level change in the dolostone aquifer for the nearest Water Well #5 (Figure 2.7). Considering that the aquifer yields are more than adequate for a residence, the small change in water level will not affect the use of the well and the predicted change in the water level is of the same magnitude as natural annual water level fluctuations. Although access to Water Well #5 was denied, it is assumed that the depth of the well is similar to other wells drilled in the area. The nearest well, Water Well #8, is 33.2 metres deep and has 27 metres of available drawdown. This is a significant amount of available drawdown in the dolostone aquifer and the small predicted change in available drawdown will not affect the use of the well.

5. 4.2 WATER QUALITY

There are two areas of water quality that require consideration.

First, the mining process introduces chemical explosives to the sub-aqueous environment to break the rock apart. A water proof emulsion will be used for the explosives. The emulsion is not soluble in water. In addition, the emulsion will be placed in drill holes fitted with tubular linings. The explosives are consumed at detonation. Sub-aqueous mining is being conducted at the Guelph Limestone Quarry in Guelph and in numerous quarries in Florida. Harden Environmental obtained a water quality sample from the Guelph Limestone Quarry four hours after detonation of the explosives. The sample was obtained from the quarry pond above the broken rock pile. The sample was analyzed for metals, polyaromatic hydrocarbons, volatile organic compounds and hydrocarbons. Water quality results are in Appendix E and summarized as follows;

- No detections of PAHs
- No F1 to F4 hydrocarbons
- No exceedence of Ontario Drinking Water Quality Standards for inorganic compounds
- No exceedences of Ontario Drinking Water Quality Standards for organic compounds.

It is our conclusion that sub-aqueous mining does not have a significant impact on water quality.

Secondly, the water body created will be susceptible to biological contamination introduced by wildlife. The bedrock aquifer is already susceptible to contaminants from the ground surface as recognized in several reports including Halton Rural Drinking Water Study, Phase 1 and City of Guelph Final Groundwater and Surface Water Vulnerability Report (Aqua Resources, March 2010). The water quality survey by Halton Region found that the water from 31% of drilled wells in their survey was unsafe for drinking. The Beak International (1999) study states that in the Blue Springs Creek watershed, the rapid movement of surface water into the bedrock leads to high susceptibility of contamination. Therefore, the quarry is being developed in an area already susceptible to contamination from the ground surface.

Several local homeowners already treat their drinking water or choose to purchase bottled water because of water quality concerns.

Surface water samples of Tributary A and Tributary B exhibited evidence of contaminants from upgradient farming activities with elevated nitrate concentrations. Groundwater samples from wells M2, M3 and M4 also have elevated nitrate concentrations indicative of the movement of nitrogen compounds from the ground surface into the bedrock aquifer. The thin or absent overburden is not effective protection for the bedrock aquifer.

Monitoring of the water quality in the ponds and dolostone aquifer will be conducted.

6.0 MONITORING PROGRAM AND CONTINGENCY MEASURES

6.1 ON-SITE MONITORING PROGRAM

Monitoring has been taking place at this site since 1995. An extensive database of background groundwater and surface water elevations and flow measurements has been developed. A detailed monitoring program will continue to ensure that sensitive features and surface water flows are maintained. The monitoring program is designed to identify trends towards unacceptable impacts early on to allow for time to implement contingence measures.

The monitoring program for this proposed pit/quarry involves the following activities:

- measuring groundwater levels,
- obtain water quality samples,
- monitoring water levels in the on-site wetland and stream, and
- stream flow measurements.

We recommend the following monitoring program.

Parameter	Monitoring Locations	Frequency
Groundwater Levels	M1 S/D, M2, M3, M4, M6, M13S/D, M14 S/D M, MPN1, MPN2, MPS1, MPS2, MPE1, MPE2, MPW1, MPW2, TP1, TP8, TP9	Monthly April to November, February
Groundwater Levels	M2, M3, TP1, M13 S/D M14 S/D	Weekly during first 3 months of extraction
Surface Water Levels	SW6	Monthly April to November
Surface Water Flow	SW4, SW8, SW3	Monthly April to November
Groundwater Quality	M2, M4	Annually
Surface Water Quality	West Pond, East Pond	Annually

6.2 PRE-BEDROCK EXTRACTION WATER WELL SURVEY

We recommend that a detailed water well survey be completed prior to the commencement of the extraction of bedrock resources. This survey will as a minimum include all wells in shaded area shown on Figure 6.1. The well survey will include the following;

- construction details of the well (drilled, bored, sandpoint etc..)
- depth of well and depth of pump
- location of well relative to septic system
- static water level
- history of water quantity or quality issues
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals
- one hour flow test.

The purpose of survey is to have a baseline evaluation of both water quality and water quantity in nearby water wells. Should an issue arise with a local water well, the baseline data can be used as a reference against future measurements.

6. 3 CONTINGENCY MEASURES

If the on-site monitoring results suggest that an unacceptable impact may occur to a feature, depending on the nature of the potential impact and the type of receptor one or more of the following contingencies could be considered:

- increase the length and/or width of barrier
- decreased rate (or stopping) subaqueous extraction
- change in configuration of mining or decrease in mining extent
- alter timing of extraction to coincide with high seasonal groundwater levels.

7.0 CONCLUSIONS

1) The proposed extraction will be conducted with conventional methods above the water table. Where the dolostone occurs below the water table, the rock will be removed by dragline after being broken by blasting. This results in a relatively minor disturbance to groundwater levels in the dolostone aquifer. The maximum predicted impact on water levels at the property boundary is 1.8 metres.

2) The on-site wetland is underlain by a layer of silt till. The proposed extraction will ultimately result in additional vertical movement of groundwater beneath the wetland. A hydraulic barrier will be constructed to retain water in the overburden sediments beneath the wetland, thus minimizing any impact to flora and fauna in the wetland. It is predicted that the water balance of the wetland will change by less than 4% of the present hydrologic inputs to the wetland. The groundwater level beneath the wetland naturally falls below the surface water level in the wetland, therefore. the wetland is capable of retaining water in the absence of groundwater support.

3) There is a net increase in the water available to the wetland post-extraction. This is mainly due to the retention of water on the wetland side of the hydraulic barrier. The calculated 6 % increase in the water volume available to the wetland is not significant. An overflow culvert will be installed at an elevation of 355.8 m AMSL to ensure that the wetland is not flooded above historical high water level mark.

4) There will be no negative impacts to off-site wetlands. The ground surface of the Allen wetland located north of the site is at least six metres above the groundwater level measured in nearby on-site monitor TP8. There is a loss of water in Tributary B as it passes through the Allen wetland and the wetland is situated at a higher elevation than lands to the west, south and east thereby eliminating the potential for groundwater contributions from those directions. The Allen wetland is therefore supported by direct precipitation, runoff from the property to the north (De Grandis) and interflow.

5) There will not be any loss of water to wetlands, ponds or streams downgradient of the site. It is predicted that water levels in the bedrock aquifer will increase downgradient of the quarry.

6) The measured surface water levels in the northeast wetland are 3.5 metres above the groundwater elevation measured in TP8 nearby. This wetland is not groundwater dependant and will not be affected by the proposed extractive activities.

7) Local residences obtain water from the dolostone aquifer. The minor disturbance to water levels in the dolostone aquifer will not significantly affect any water well with respect to quantity or quality of water available to the residence. The maximum predicted impact to the nearest water well is a drawdown of 1.6 metres. The aquifer in this area productive over a saturated thickness of more than forty metres, therefore no significant change in the yield in the nearest well, or any other well will occur.

8) Spring discharge on the Allen and De Grandis properties will not be affected by the proposed extraction. These springs occur in areas higher in elevation relative to the site and are sourced from permeable overburden sediments distant from the proposed quarry. Spring discharge on the Brydson Farm will not be negatively impacted by the proposed extraction.

9) The slow extraction process and extraction phasing will allow for monitoring to detect changes in groundwater levels in the overburden and dolostone. Should unexpected water level changes arise, mitigation measures will be implemented.

10) The predicted final water level in the West Quarry pond is 348.6 m AMSL and in the East Quarry Pond is 348.4 m AMSL.

8.0 RECOMMENDATIONS

Based on the findings of this environmental assessment conducted on Part Lot 1, Township of Guelph-Eramosa, County of Wellington, we present the following recommendations.

1. That James Dick Construction Ltd. adopts the monitoring program presented in this report.

2. That the mitigative measures described herein be implemented as described.

3. That the attached spill action plan (Appendix J) be implemented as described.

Respectfully submitted

Harden Environmental Services Ltd.

Stan Denhoed

Stan Denhoed, P.Eng., M.Sc.
Senior Hydrogeologist

9.0 REFERENCES

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Reichart, T.M., 1992, Influence of Vertical Fractures in Horizontally Stratified Rocks, M.Sc. Thesis University of Waterloo, 63 pp

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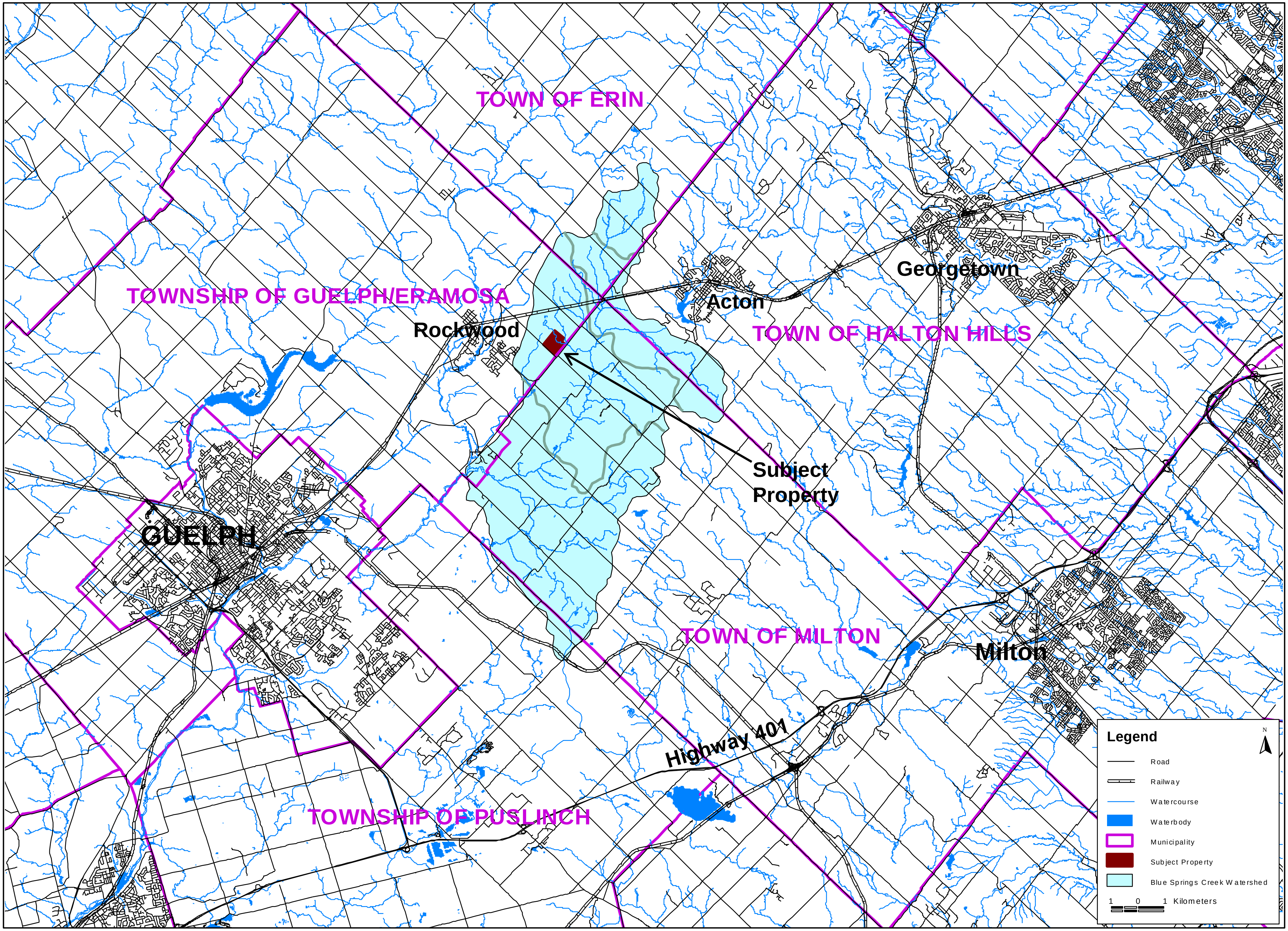
FIGURES



Harden Environmental Services Ltd.

Project No: 9506

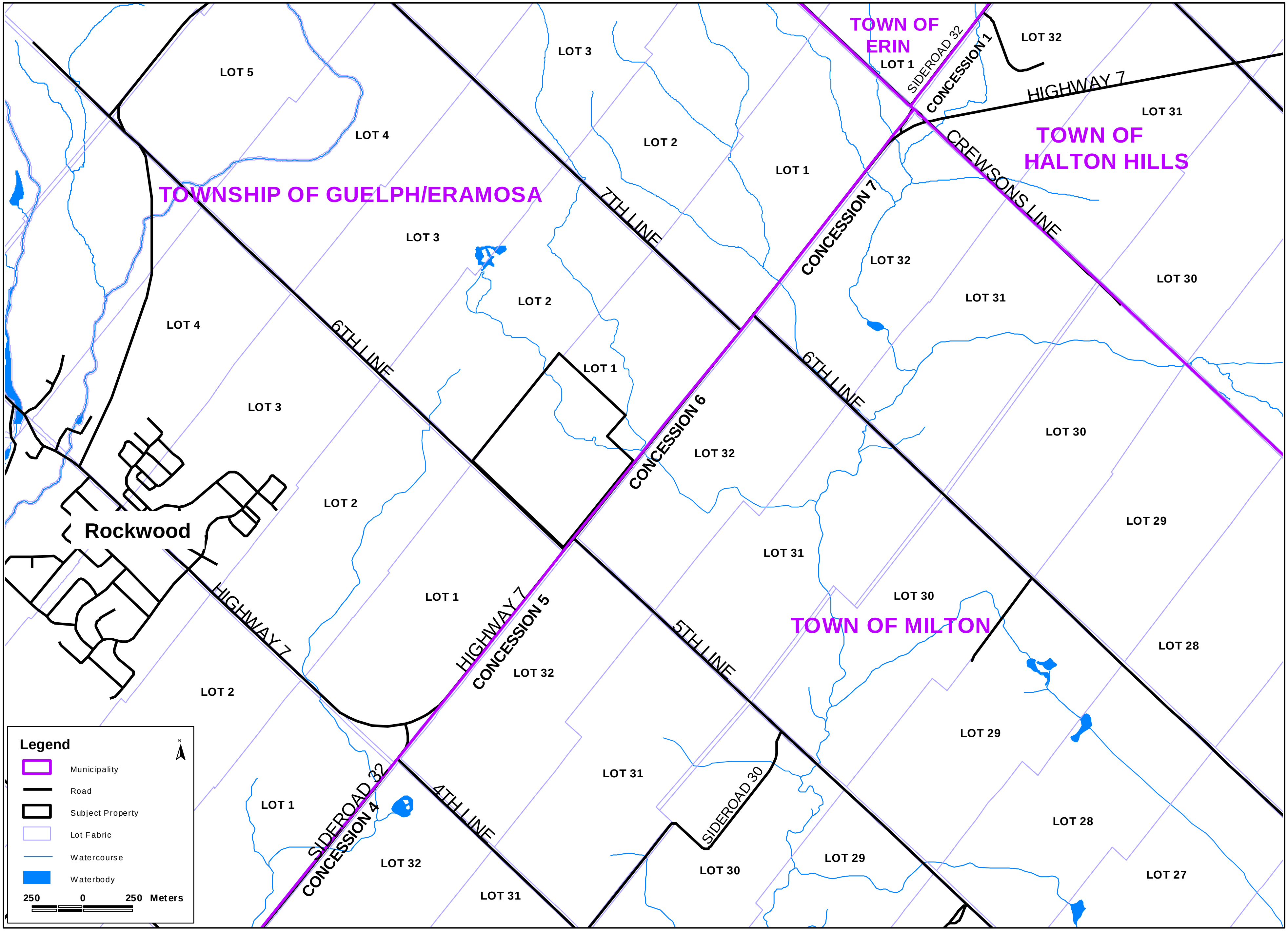
Date: Nov 2011

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1.1: Site Location



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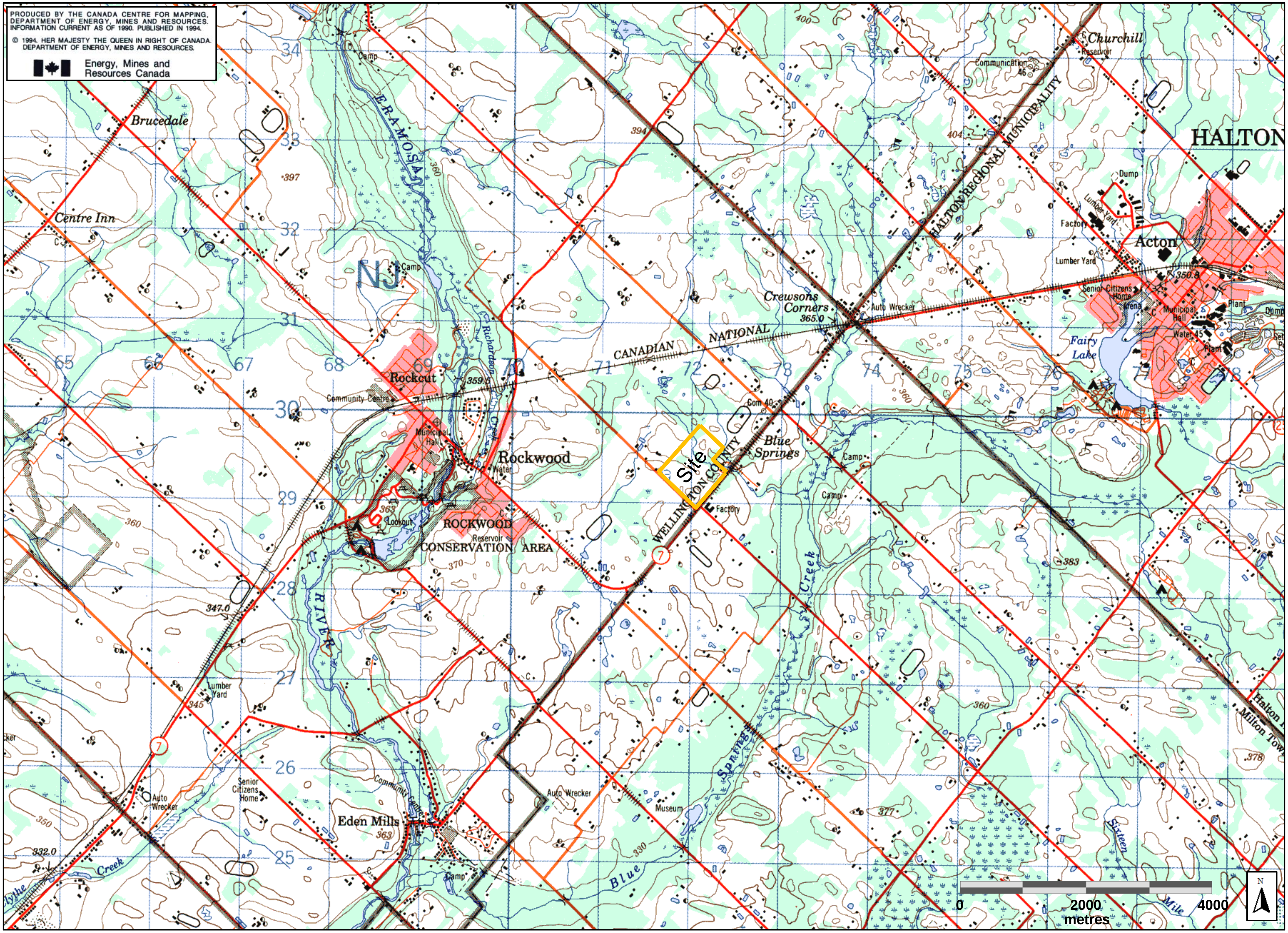
Date: Nov 2011	
Drawn By: AR	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington

Figure 1.2: Lot Fabric



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Proposed Aggregate Extraction

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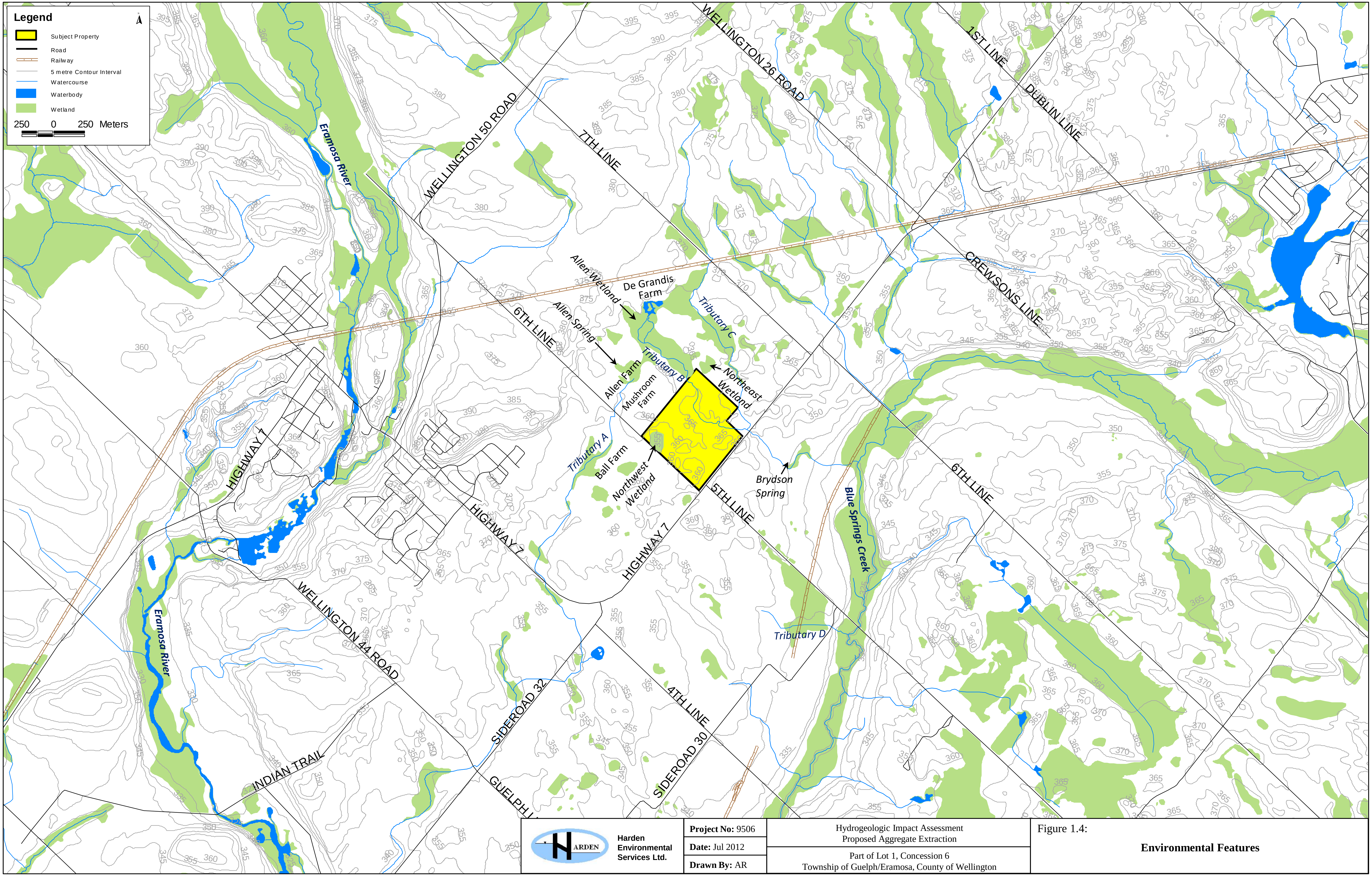
Figure 1.3: Regional Topography

Subject Property (Approximate)



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Part of Lot 1, Concession 6
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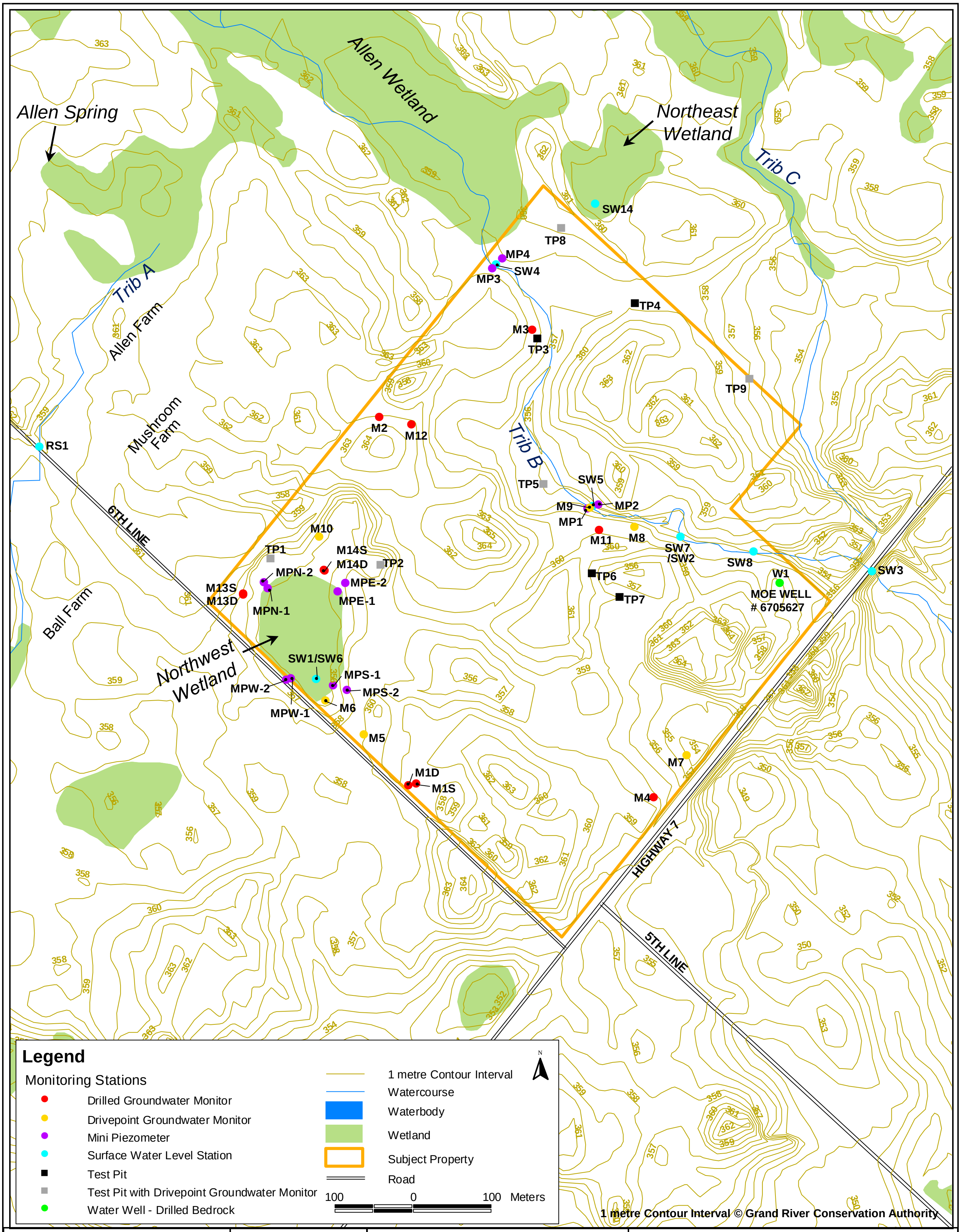
Figure 1.4:

Environmental Features



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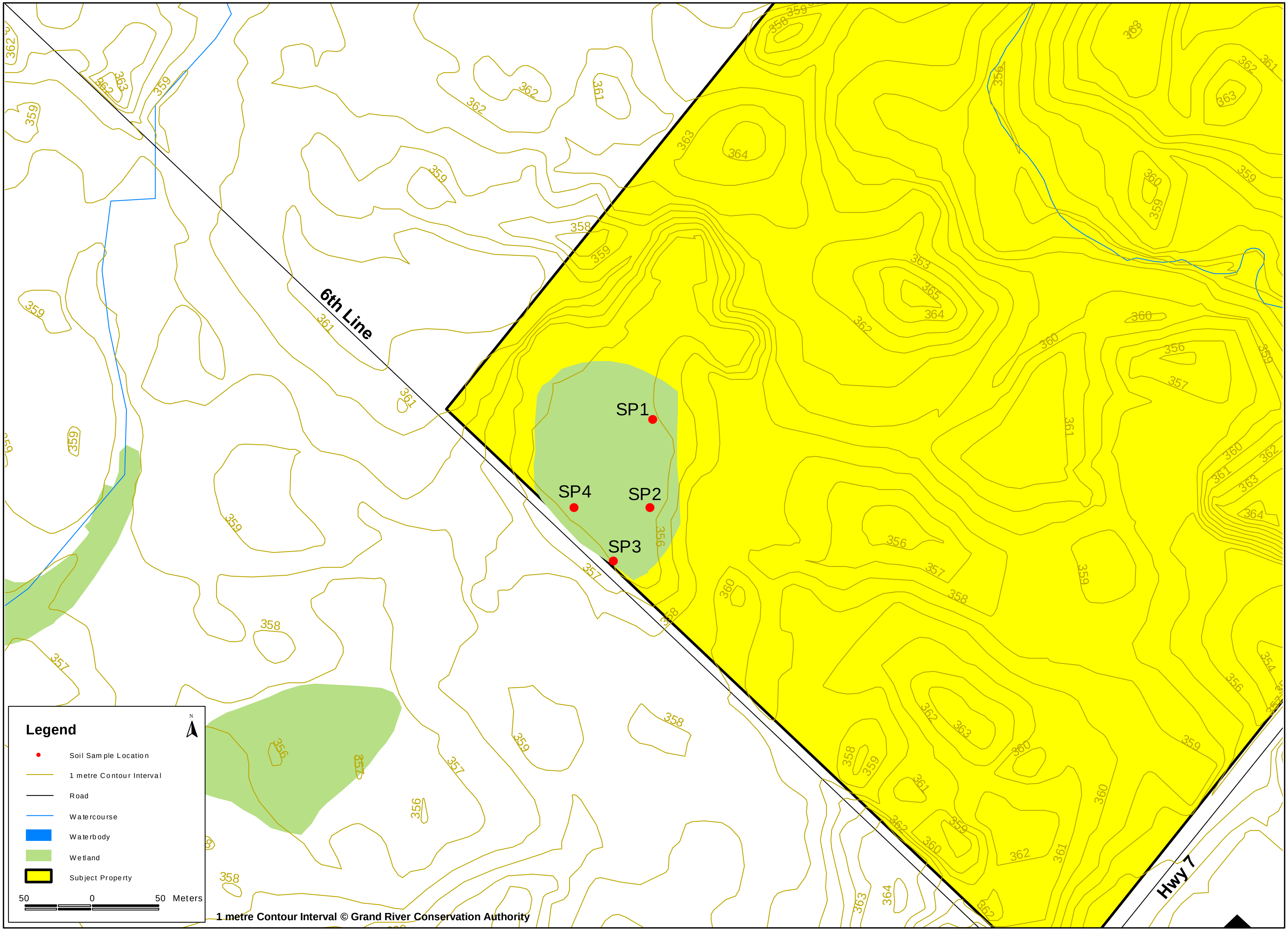
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 2.1:

Water Level Monitoring Locations



1 metre Contour Interval © Grand River Conservation Authority

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Proposed Aggregate Extraction

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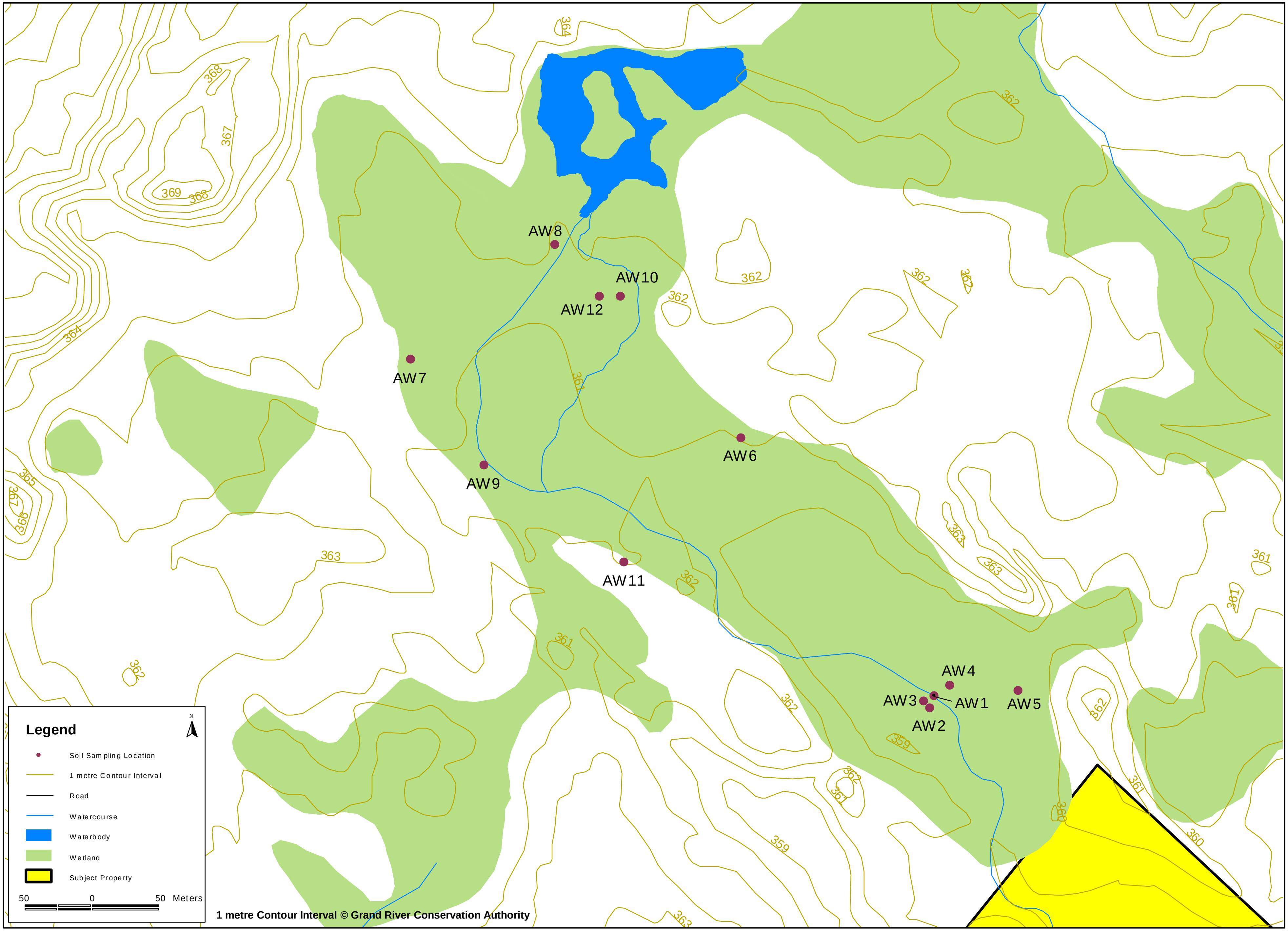
Figure 2.2: Northwest Wetland Soil Sampling Locations



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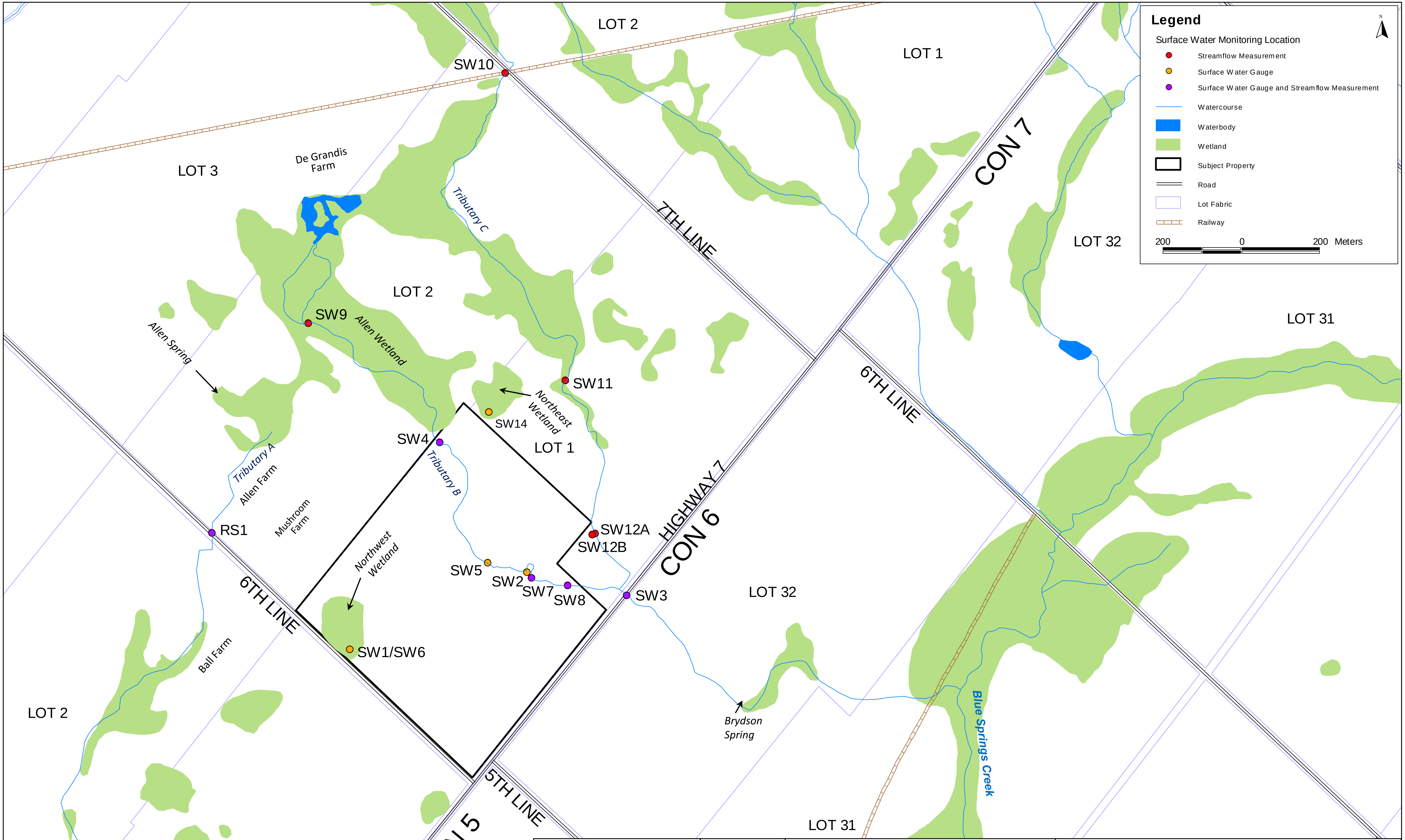
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 2.3: Allen Wetland Soil Sampling Locations



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Project No: 9506

Date: Mar 2012

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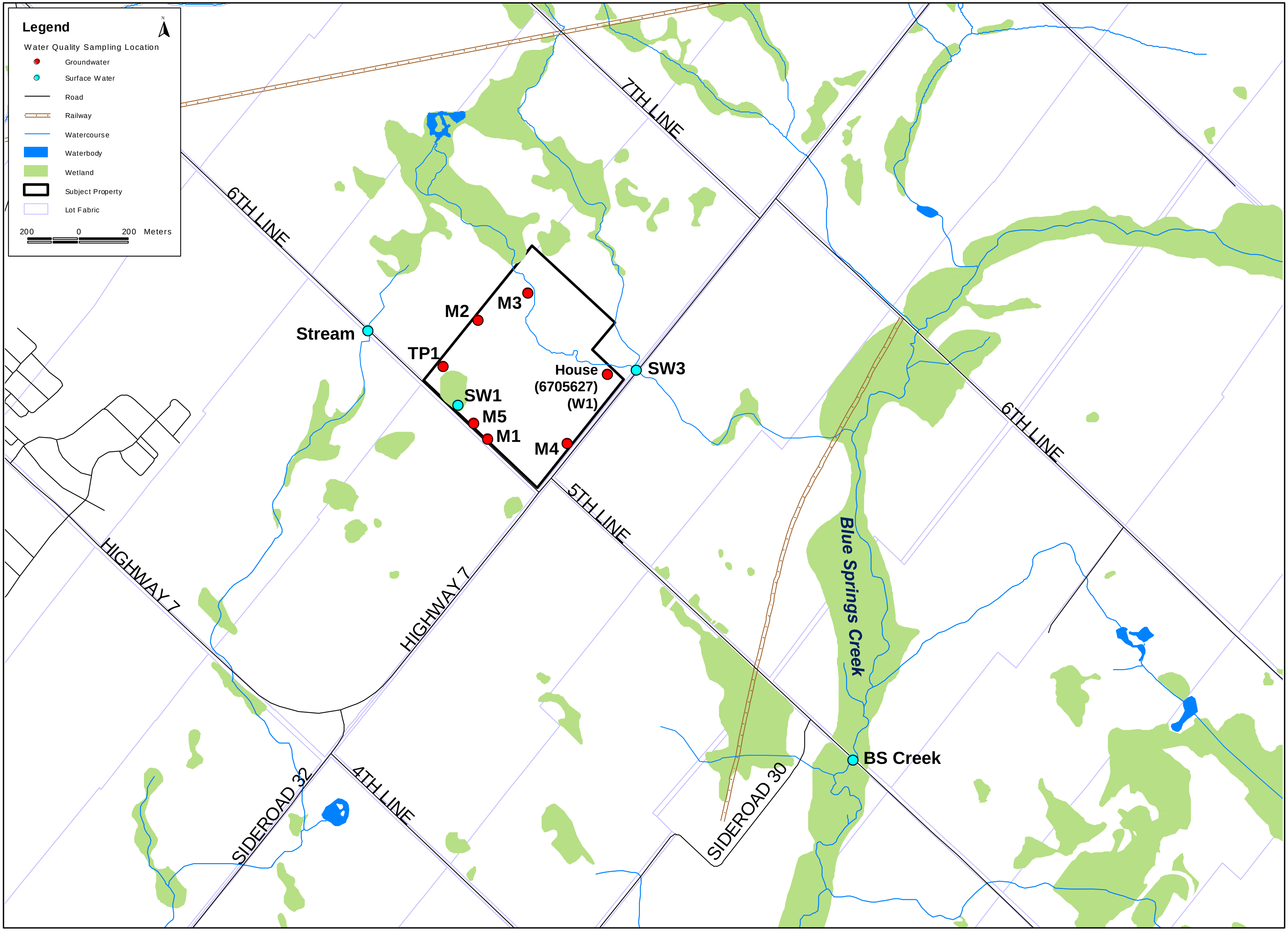
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 2.4:

Surface Water Monitoring Locations



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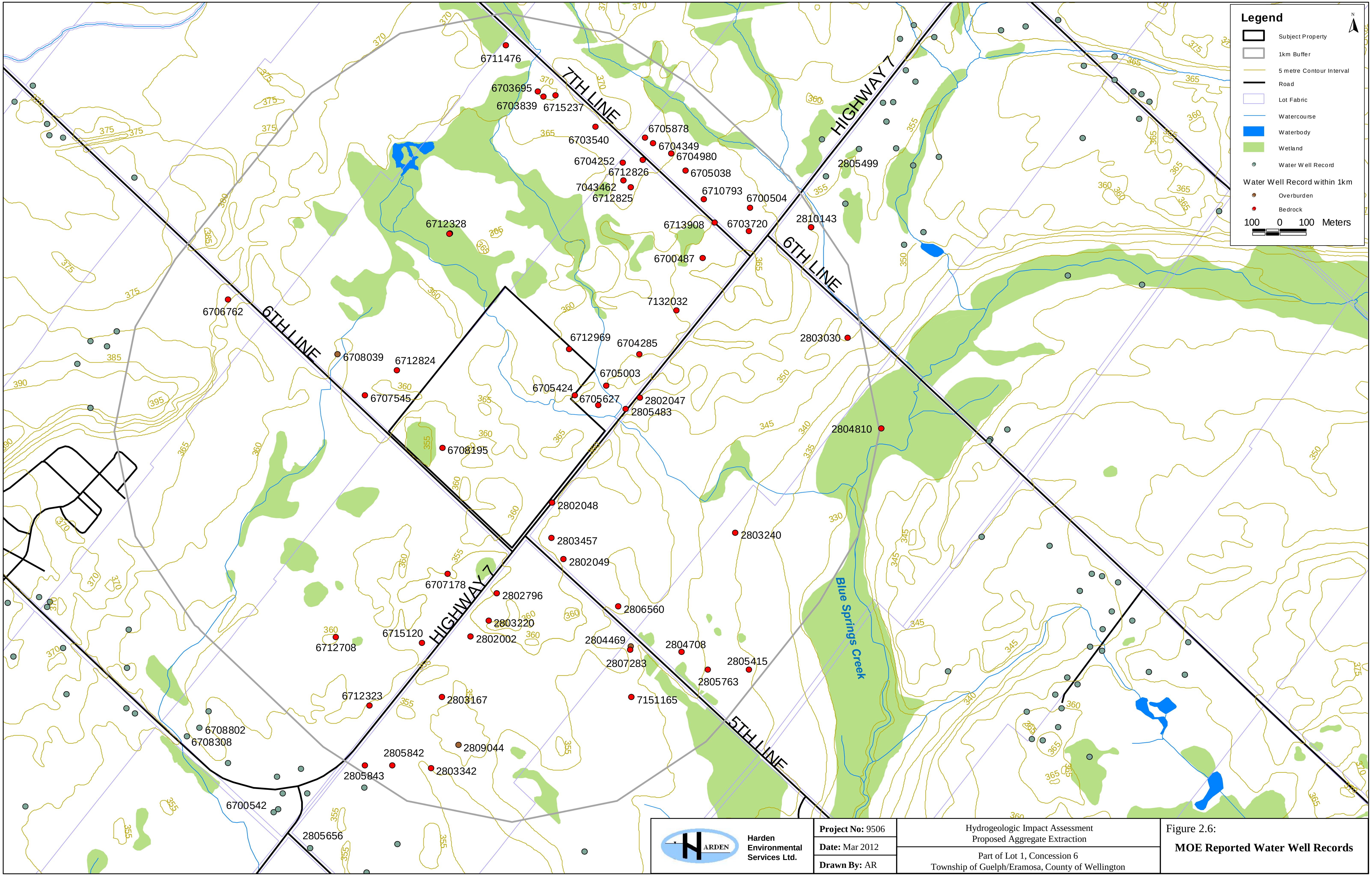
Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 2.5: Water Quality Sampling Locations**
Date: Apr 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		



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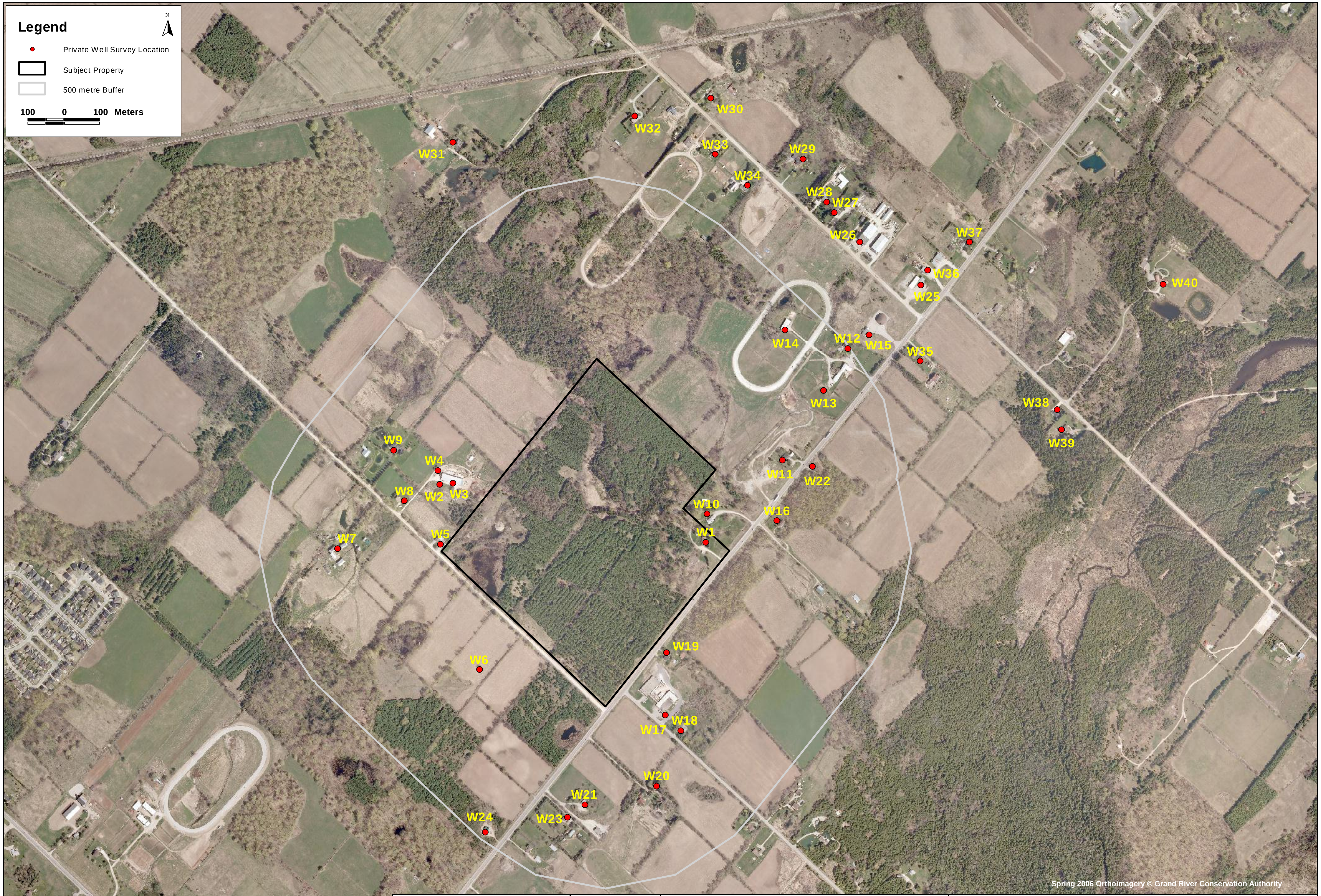
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 2.6:

MOE Reported Water Well Records



Spring 2006 Orthoimagery © Grand River Conservation Authority

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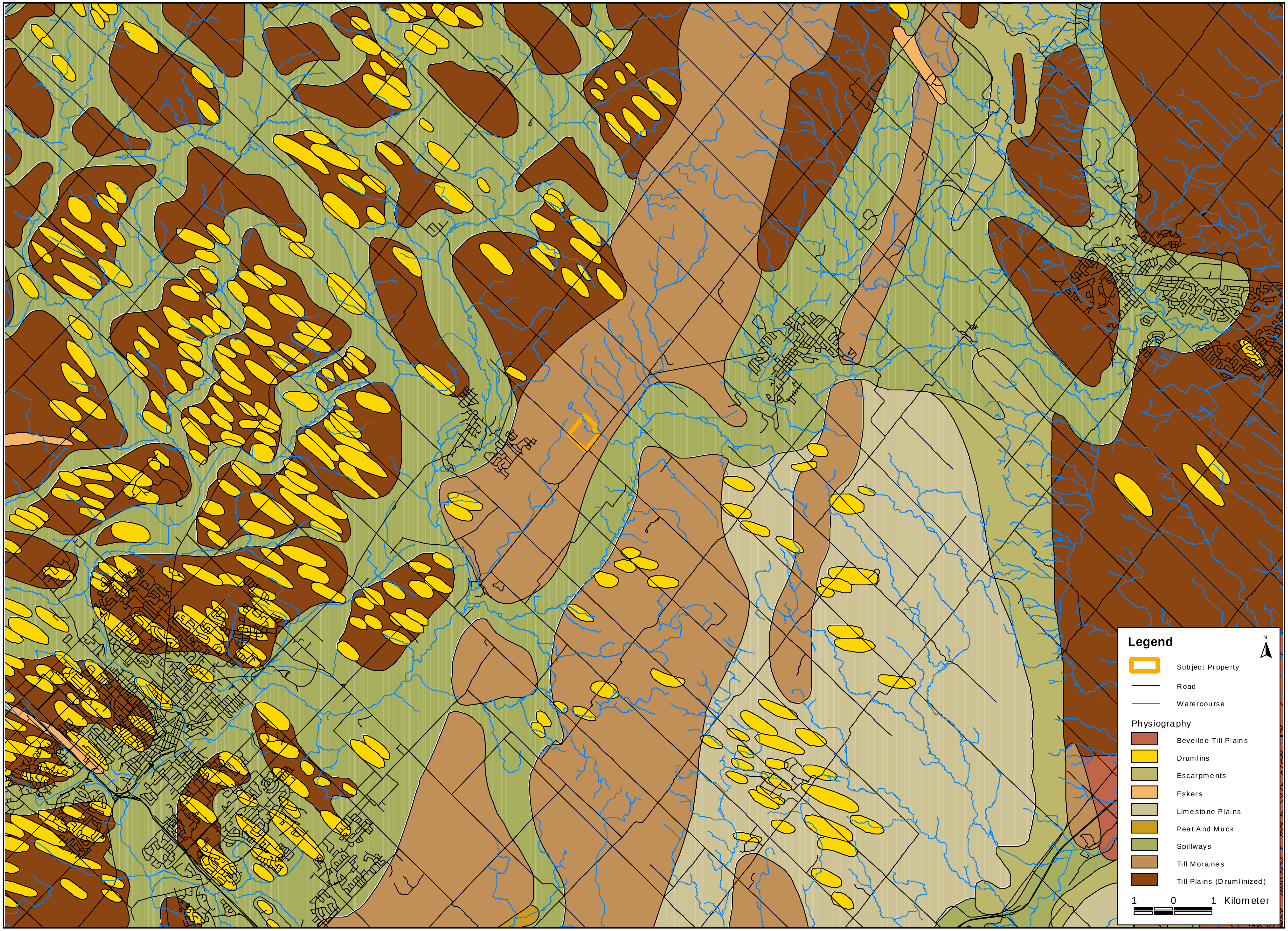
Figure 2.7:

Private Water Well Survey



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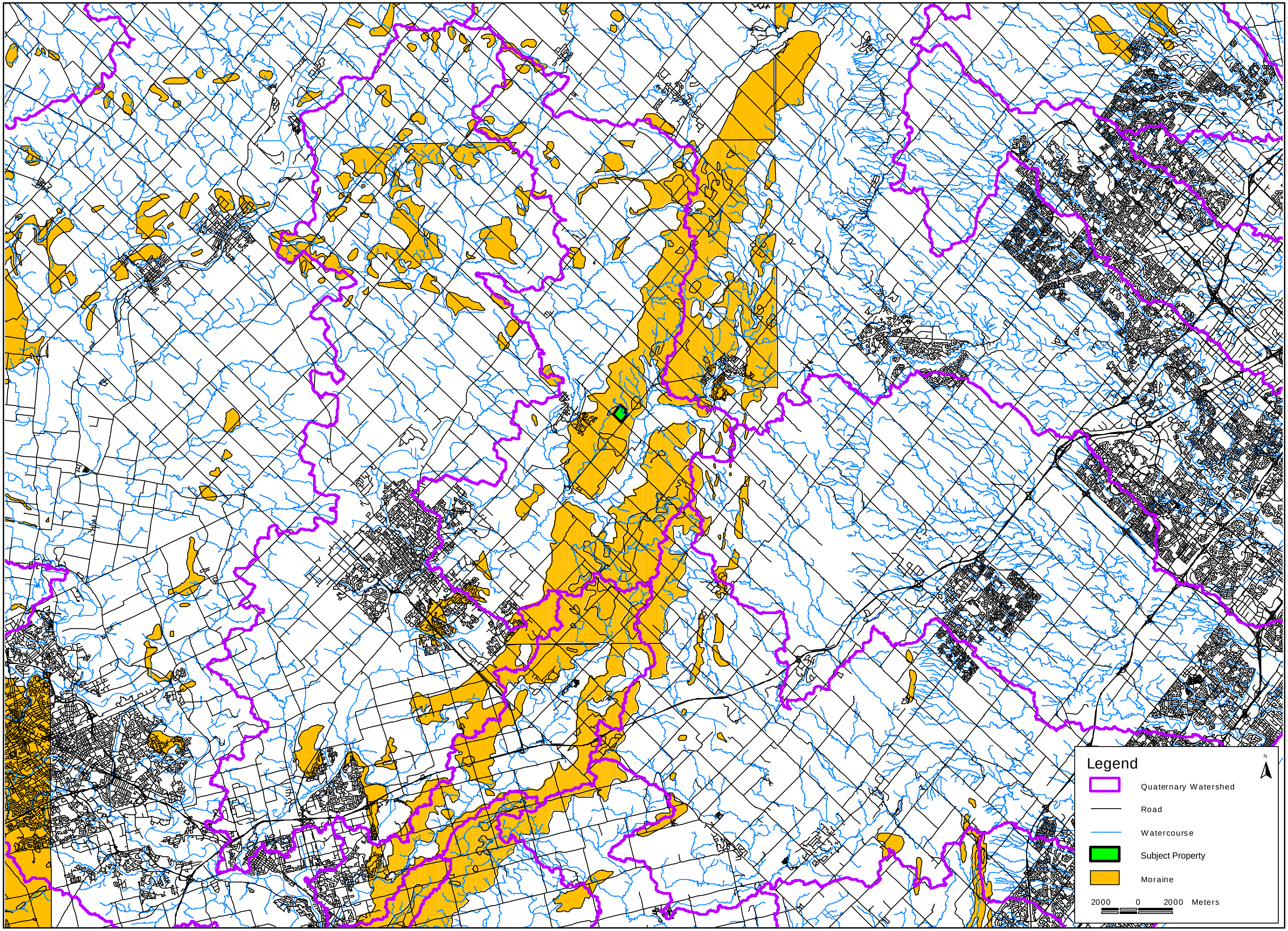
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3.1: Physiography

Source: Chapman, L.J. and Putnam, D.F. 2007. Physiography of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 228. Copyright © Queen's Printer for Ontario



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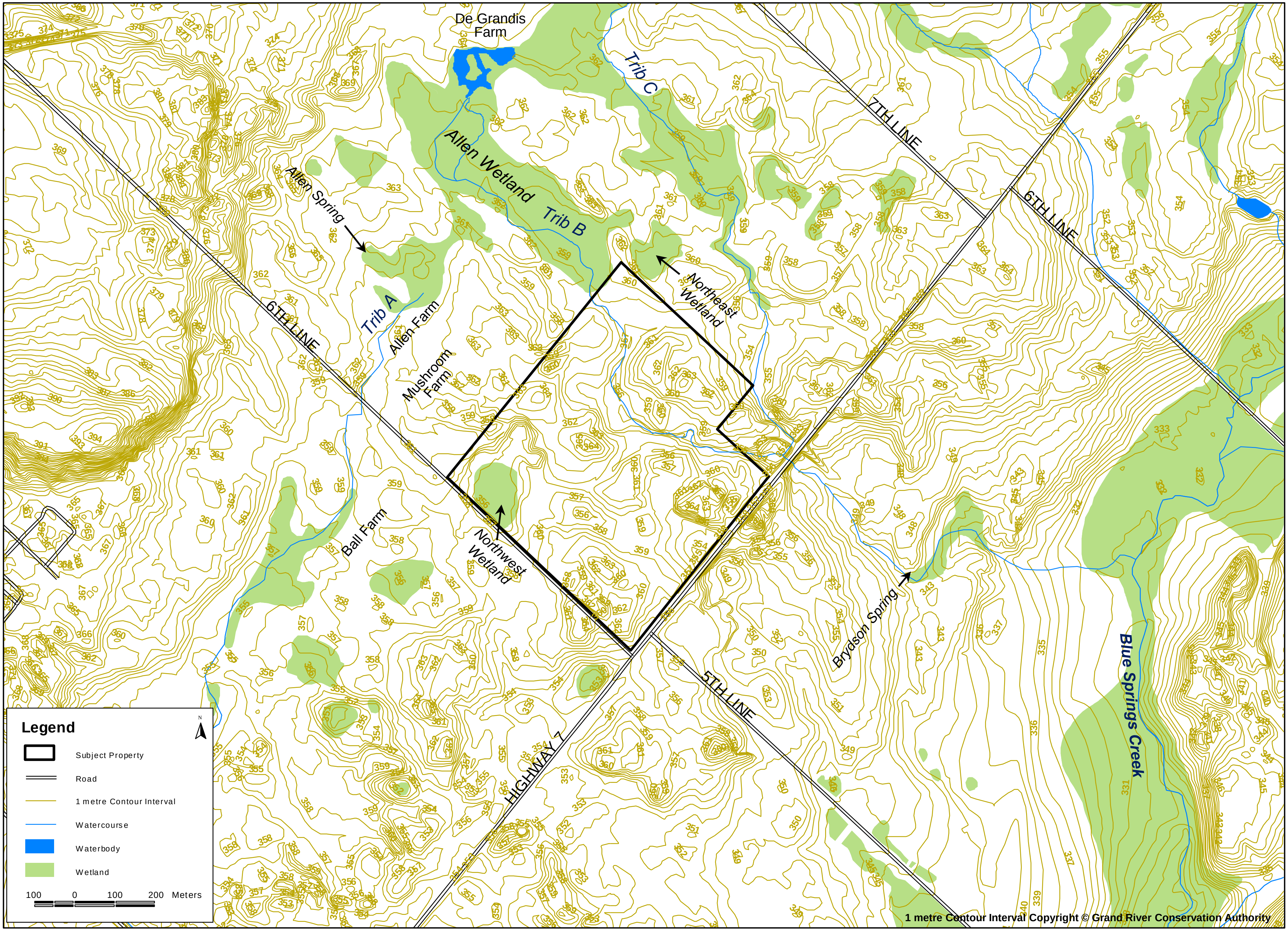
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3.2: MNR Identified Moraine Locations

Source: Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 128 – Revised. Copyright © Queen's Printer for Ontario



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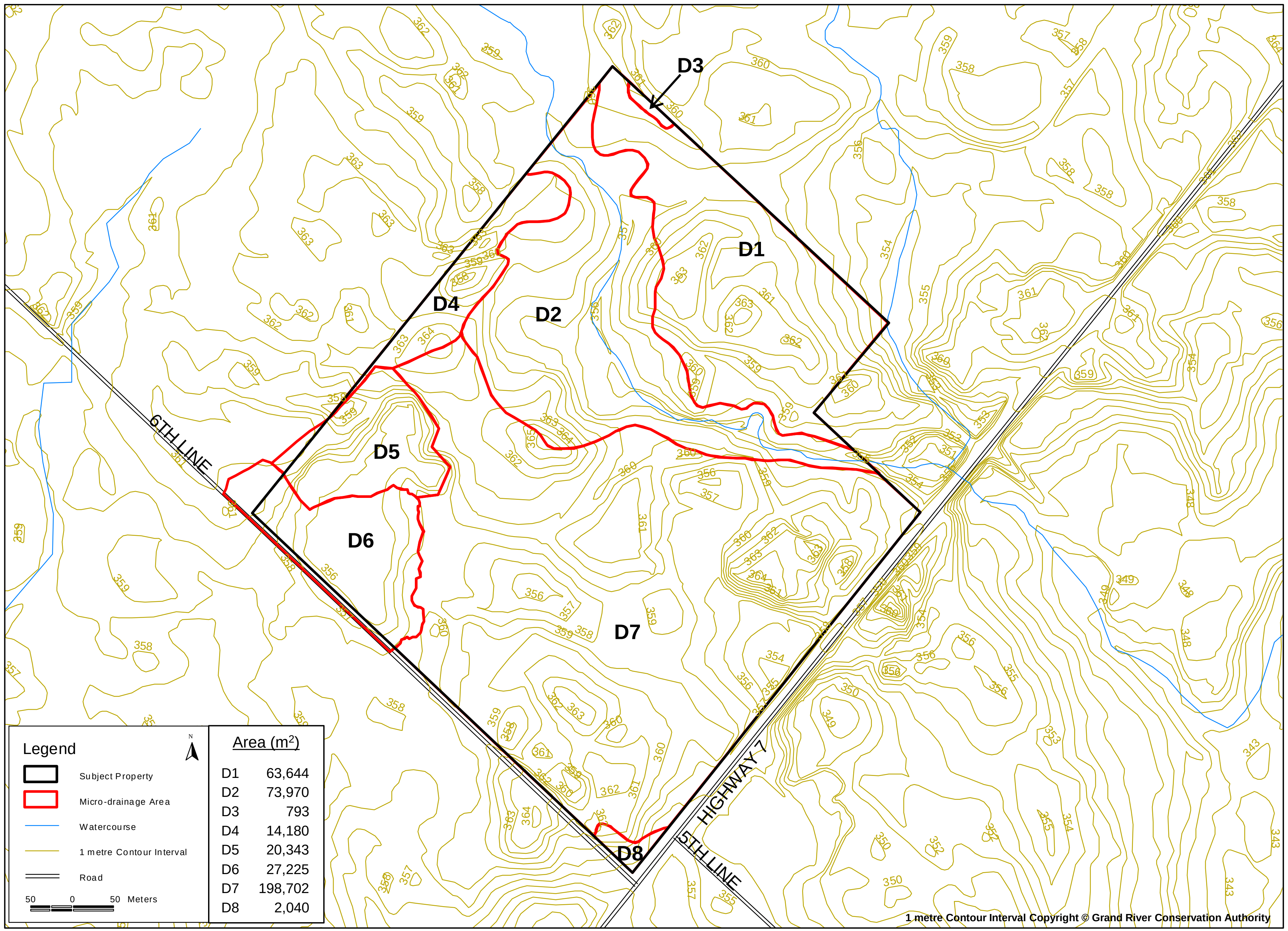
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3.3: Site Topography and Drainage



Area (m^2)	
D1	63,644
D2	73,970
D3	793
D4	14,180
D5	20,343
D6	27,225
D7	198,702
D8	2,040

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Project No: 9506

Date: Jul 2012

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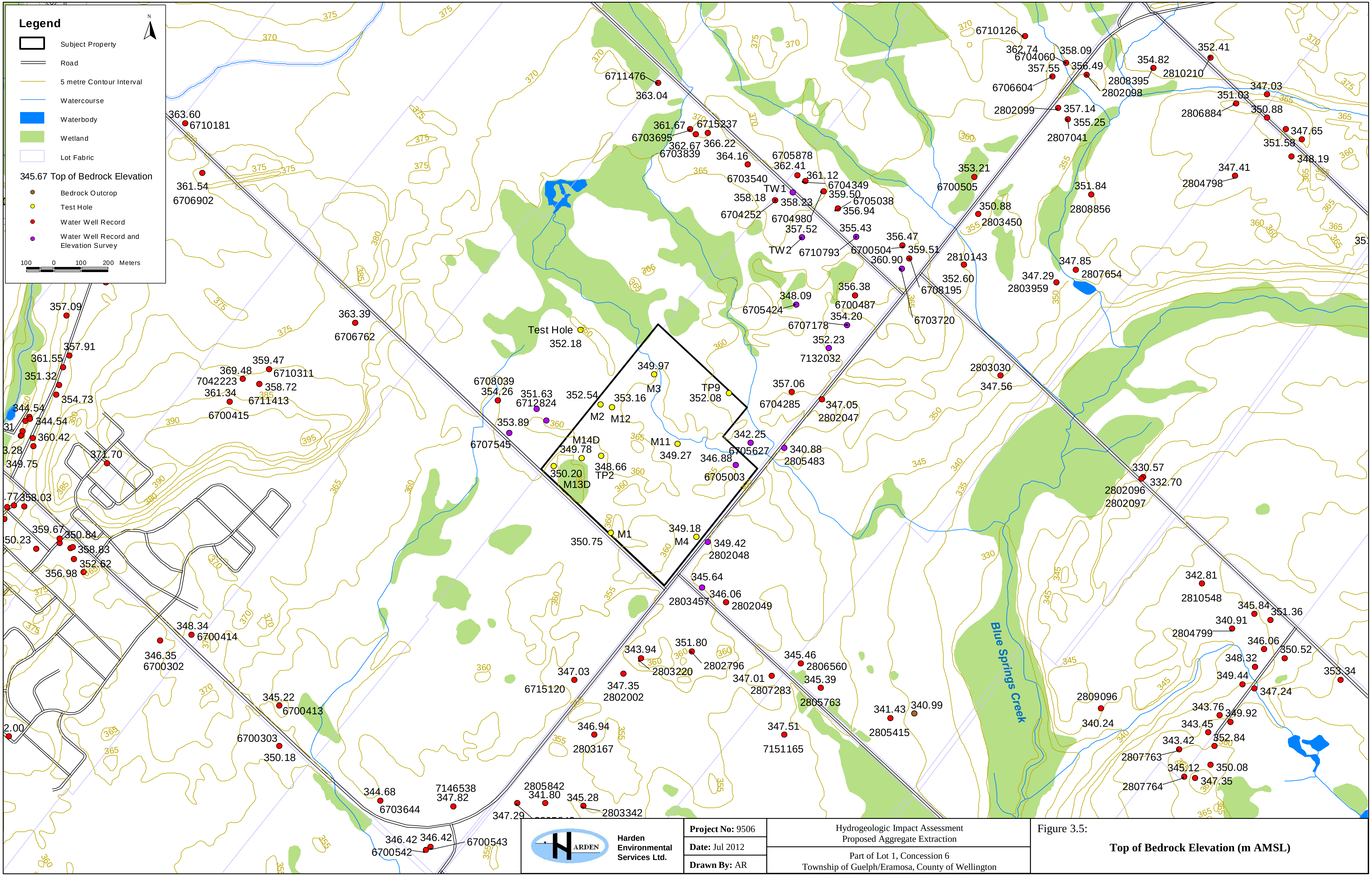
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3.4: Micro-drainage Areas



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Date: Jul 2012

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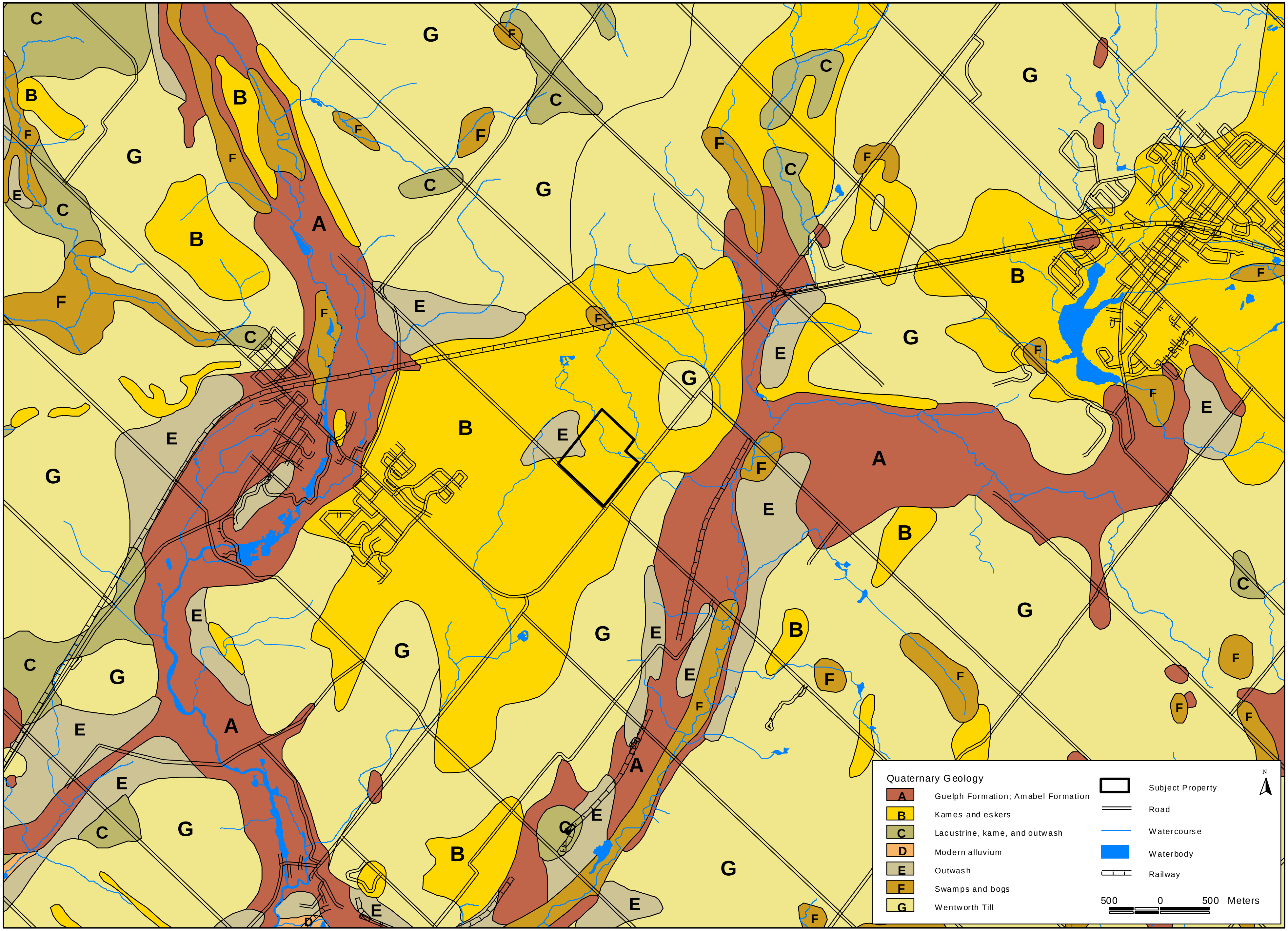
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3.5:

Top of Bedrock Elevation (m AMSL)



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Project No: 9506

Date: Mar 2012

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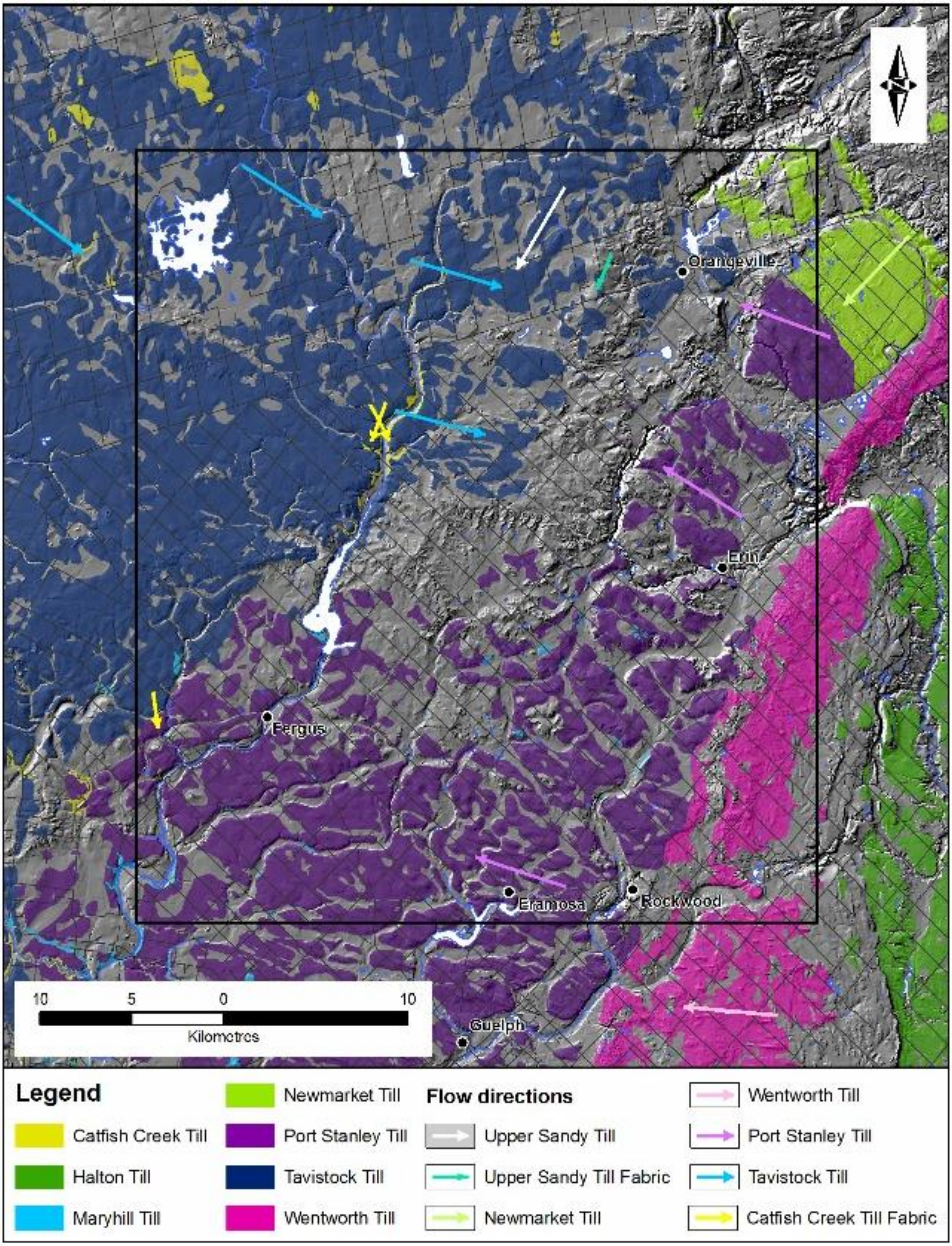
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

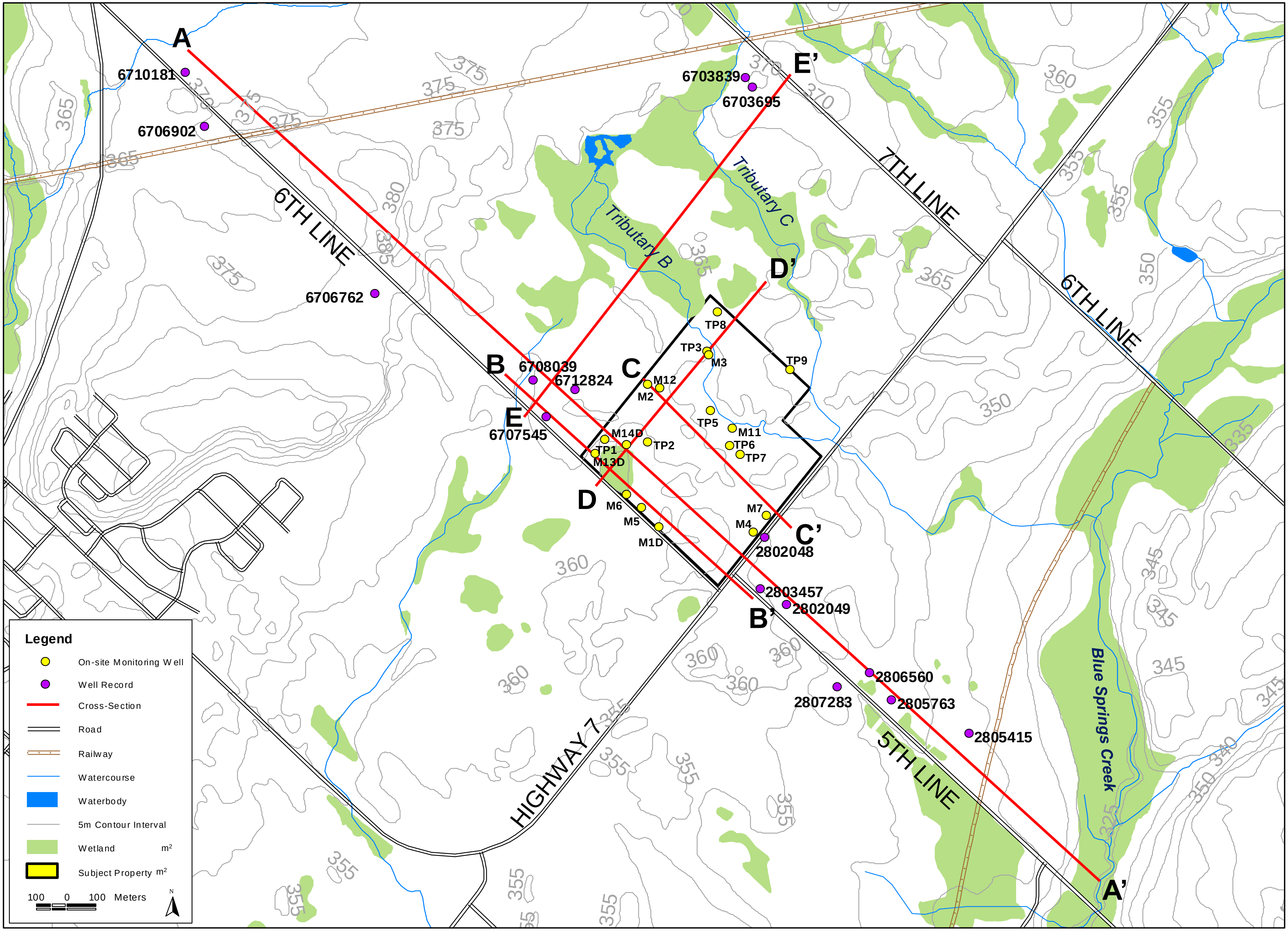
Figure 3.6: Quaternary Geology

Source: Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 128 – Revised. Copyright © Queen's Printer for Ontario



Source: Figure 28.5 Burt, A.K. 2011. The Orangeville moraine project: preliminary results of drilling and section work; in Summary of Field Work and Other Activities 2011, Ontario Geological Survey, Open File Report 6270, p.28-1 to 28-34.

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 3.7:**
	Date: 2011	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Quaternary Geology (Burt, 2011)**
	Drawn By: Burt, 2011		



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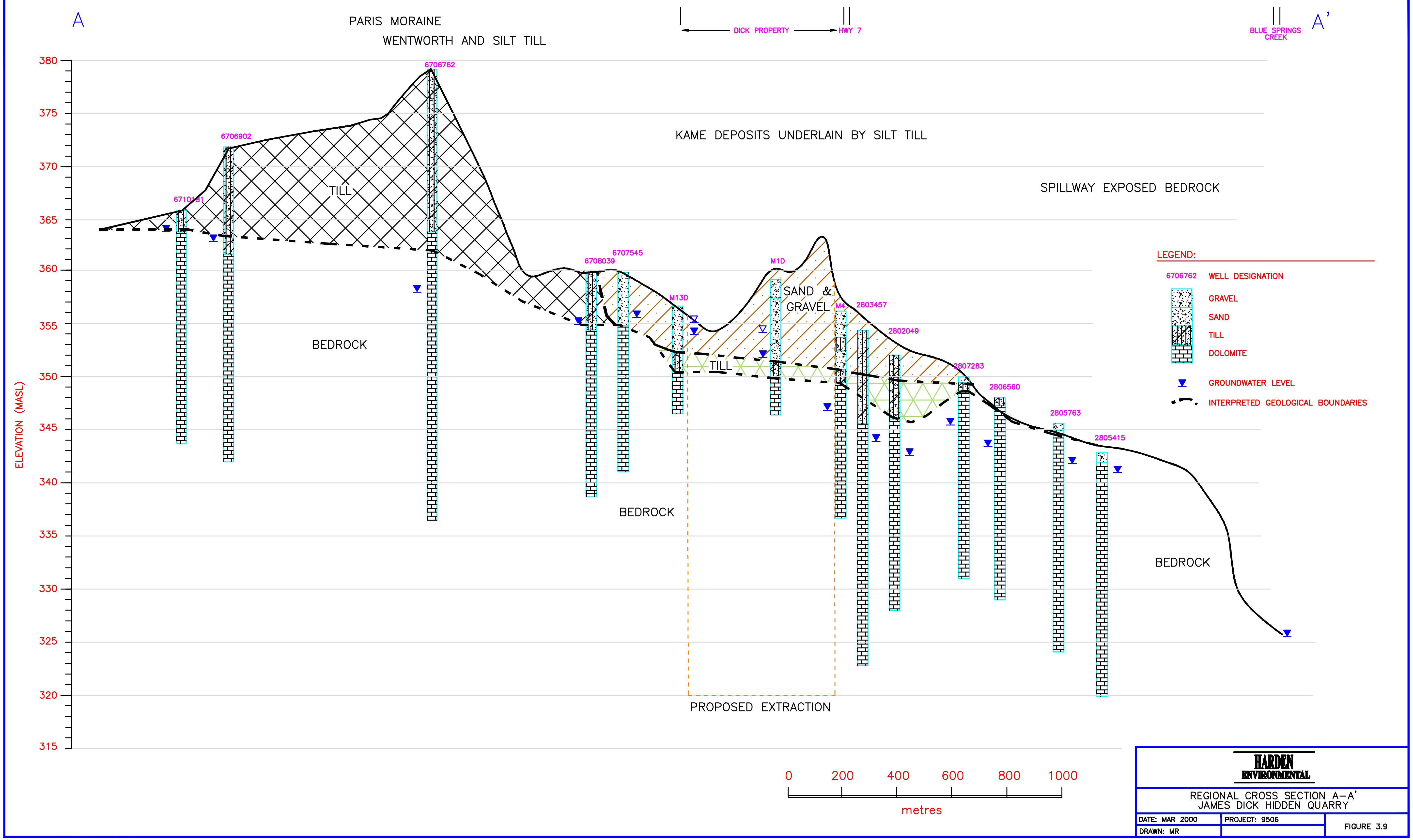
Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction
Date: Aug 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington
Drawn By: AR	

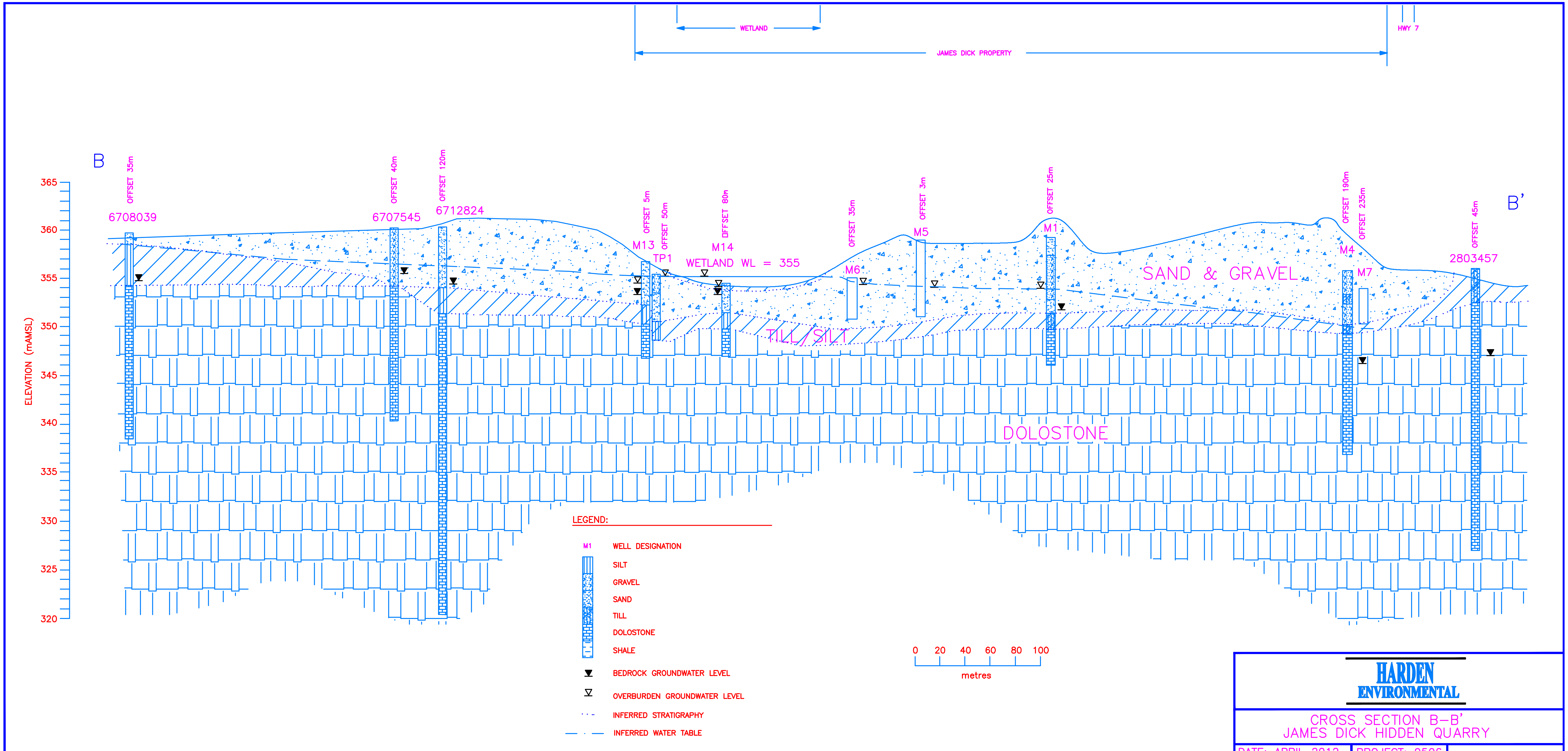
Figure 3.8: Cross-Section Location Map



HARDEN ENVIRONMENTAL

REGIONAL CROSS SECTION A–A'
JAMES DICK HIDDEN QUARRY

DATE: MAR 2000
PROJECT: 9506
DRAWN: MR
FIGURE 3.9

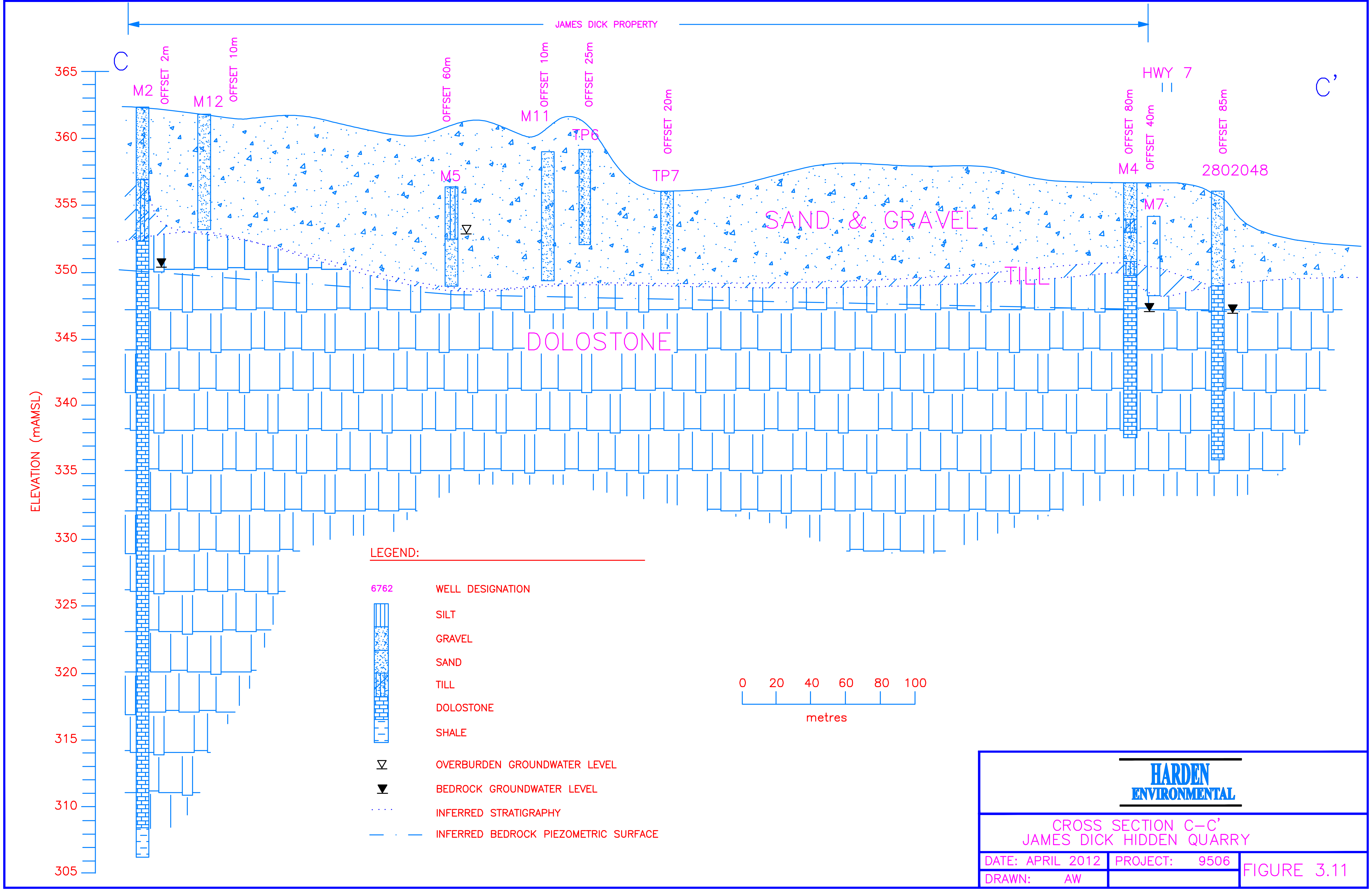


HARDEN ENVIRONMENTAL

CROSS SECTION B–B'
JAMES DICK HIDDEN QUARRY

DATE: APRIL 2012
PROJECT: 9506
DRAWN: AW

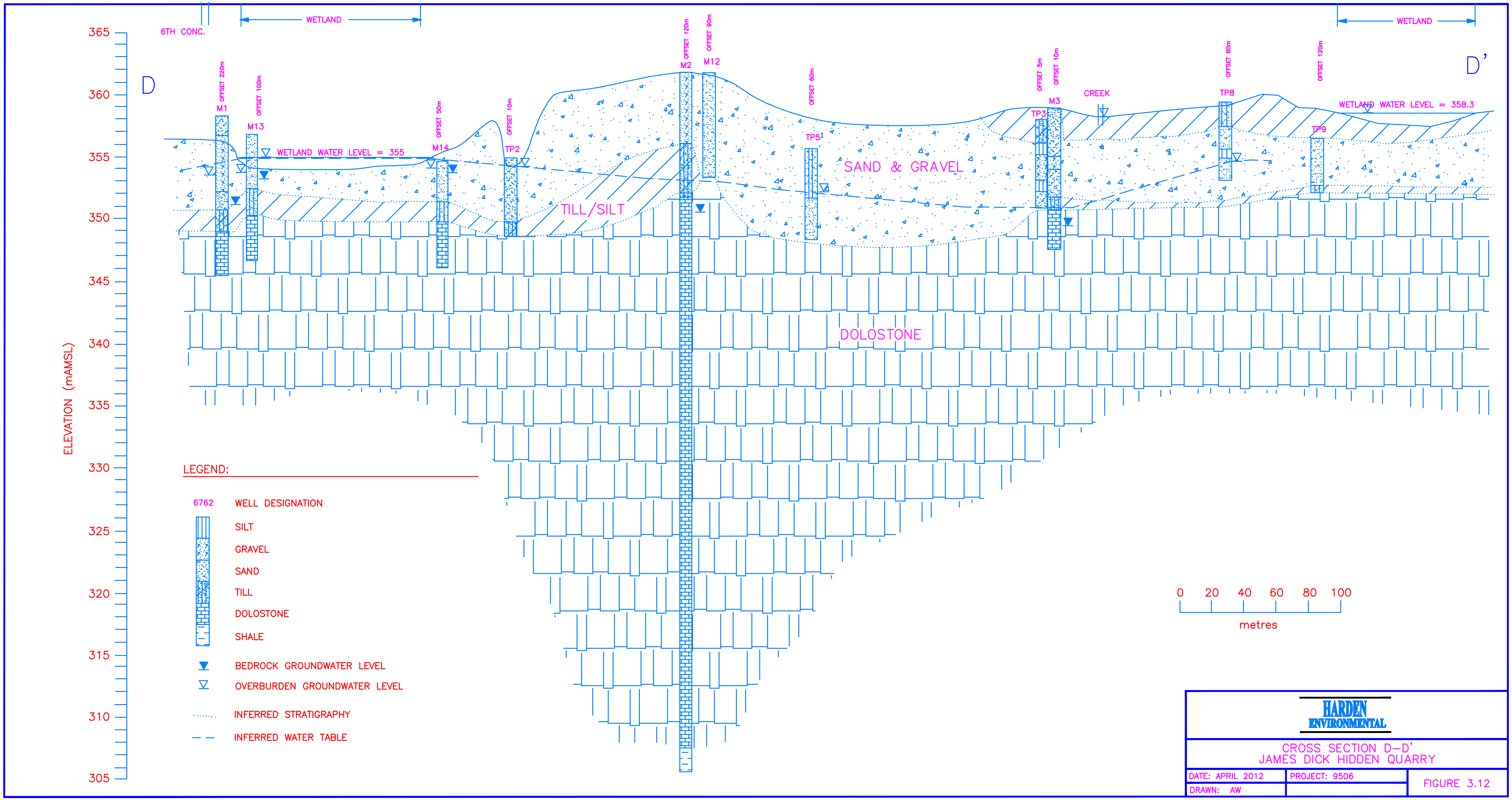
FIGURE 3.10



HARDEN ENVIRONMENTAL

CROSS SECTION C–C'
JAMES DICK HIDDEN QUARRY

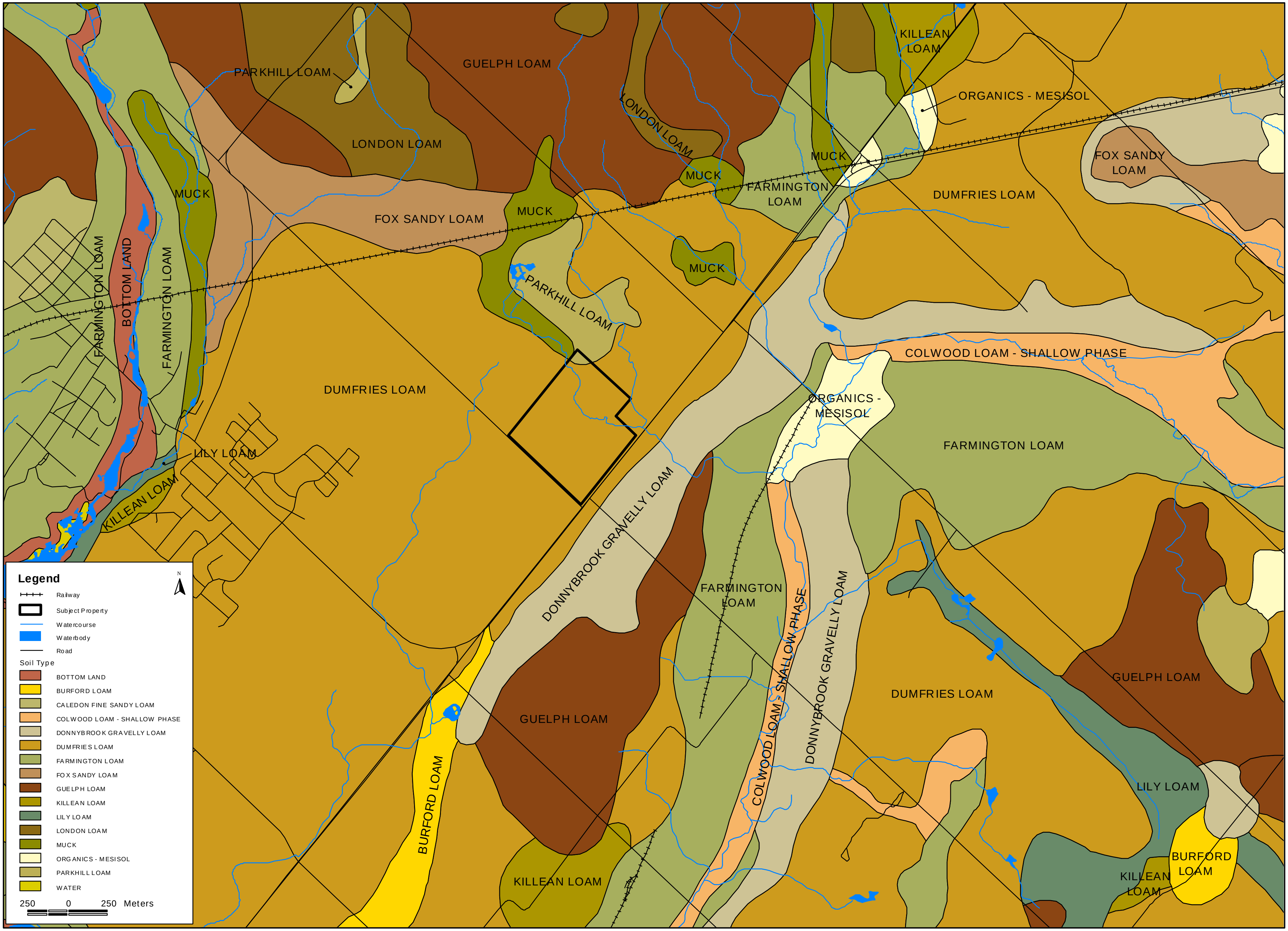
DATE: APRIL 2012	PROJECT: 9506	FIGURE 3.11
DRAWN: AW		



HARDEN ENVIRONMENTAL

CROSS SECTION D–D'
JAMES DICK HIDDEN QUARRY

DATE: APRIL 2012
PROJECT: 9506
DRAWN: AW
FIGURE 3.12



Harden Environmental Services Ltd.

Project No: 9506

Date: Apr 2012

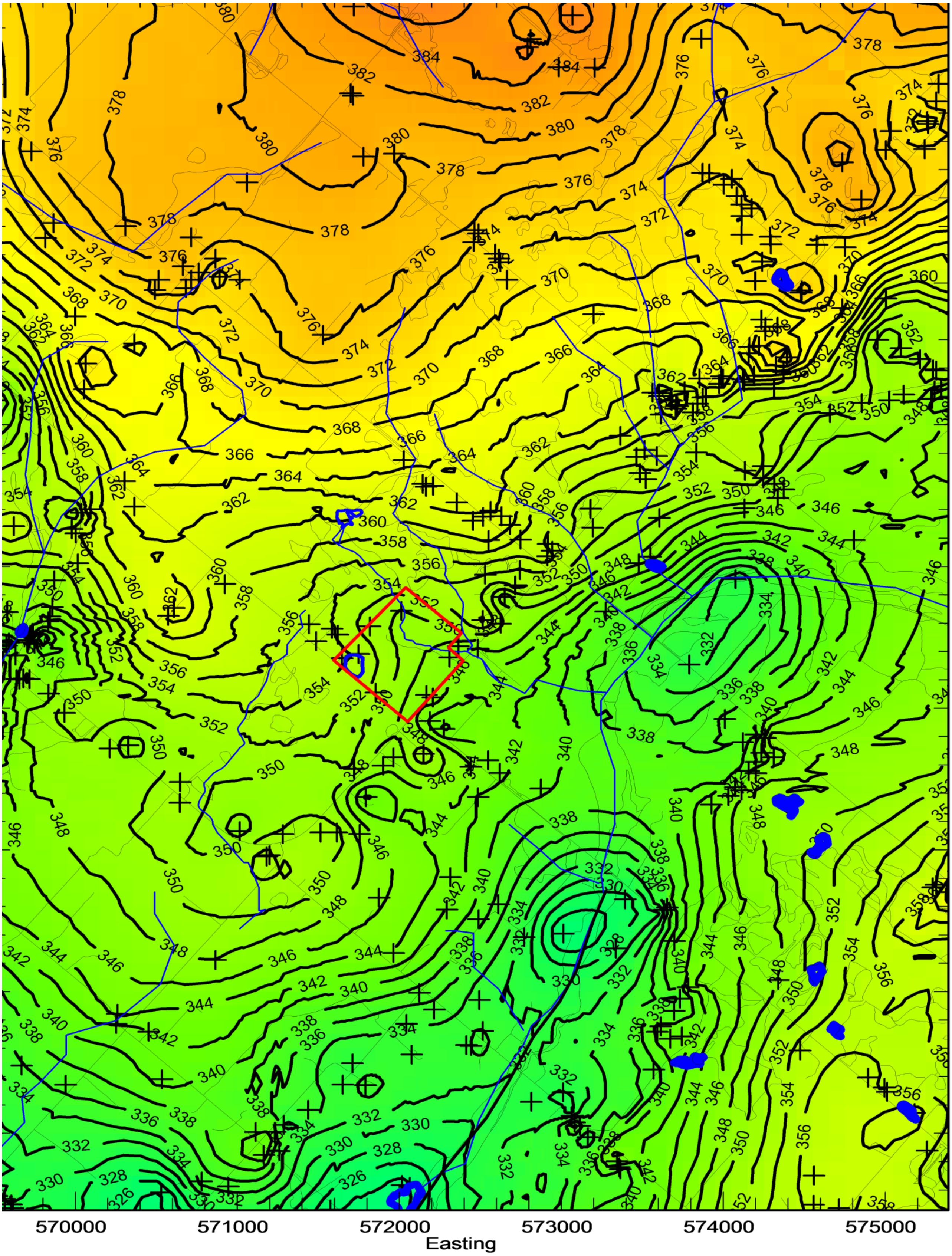
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

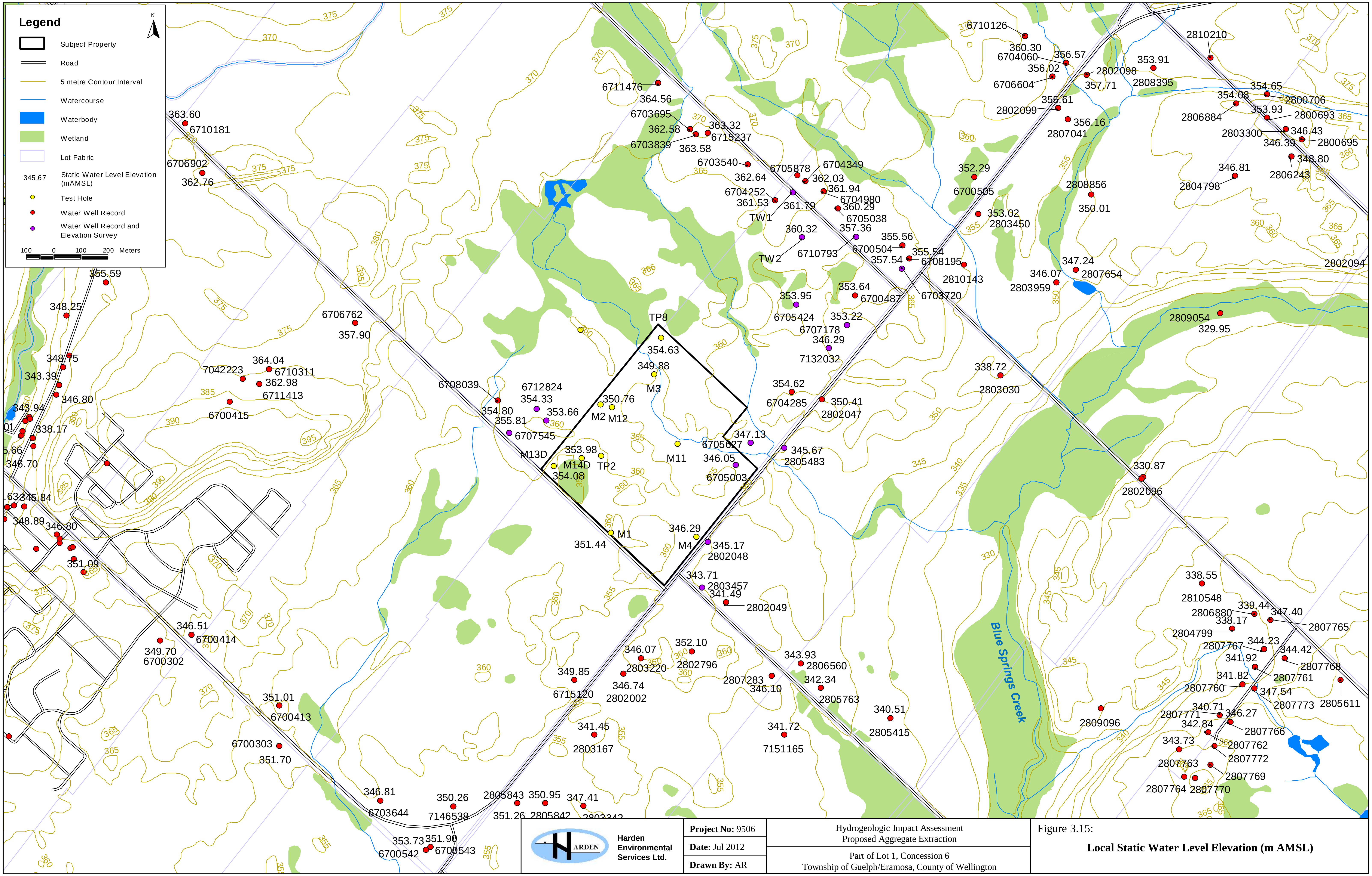
Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3.13: Wellington County Soil Survey

Source: Ontario Ministry of Agriculture, Food and Rural Affairs, Agriculture and Agri-Food Canada, Ministry of Natural Resources, 2011, Soil Survey Complex.



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 3.14:**
	Date: Jul 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Regional Groundwater Flow**
	Drawn By: SD		



Harden Environmental Services Ltd.

Project No: 9506
Date: Jul 2012
Drawn By: AR

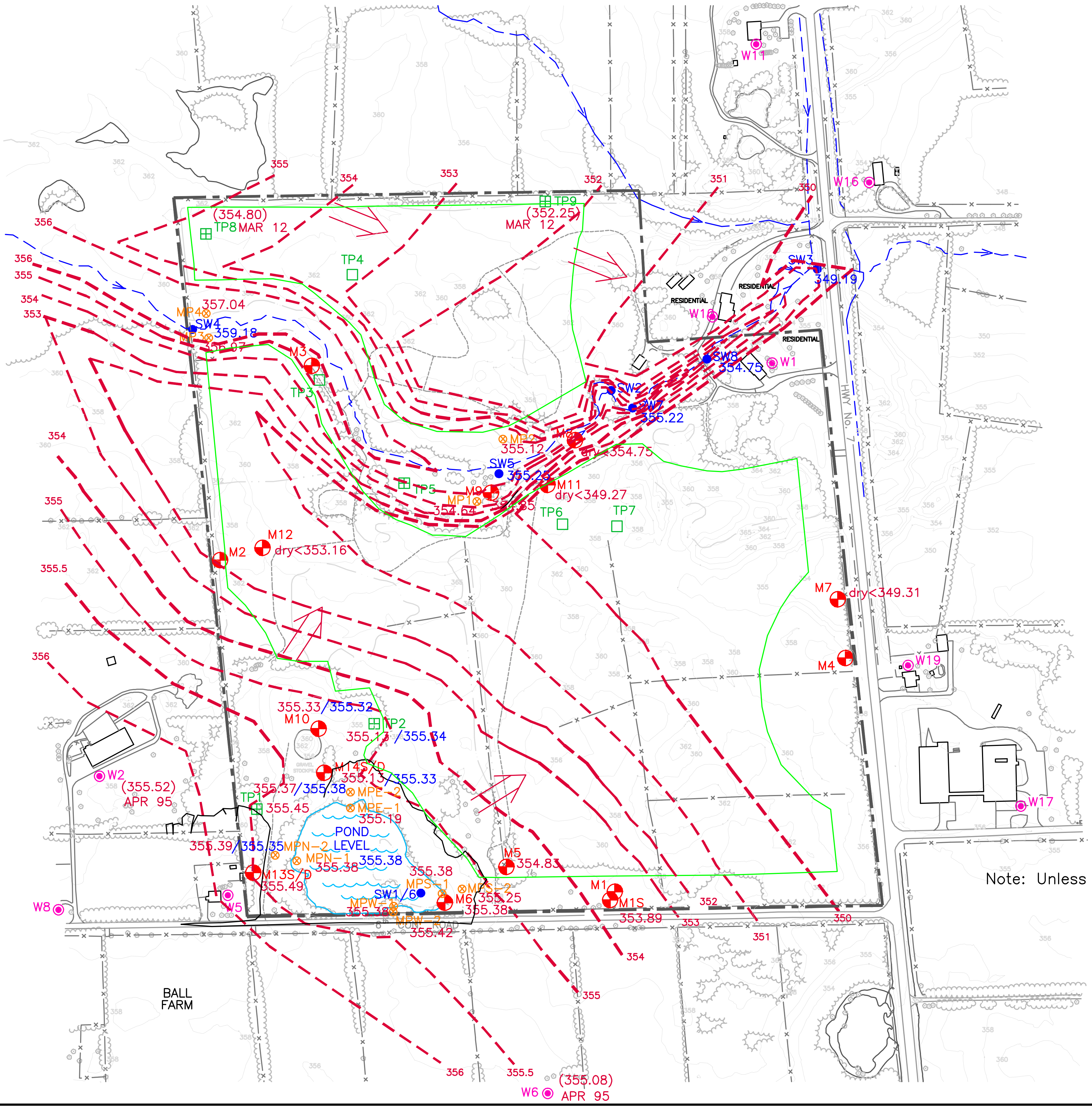
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3.15:

Local Static Water Level Elevation (m AMSL)

DRAFT



LEGEND

━ · ━	PROPERTY BOUNDARY
⌒⌒⌒	FOREST EDGE
- - -	TRAIL
──>	PERMANENT STREAM
– –> – –	INTERMITTENT STREAM
× —— ×	FENCELINE
RESIDENTIAL	BUILDINGS (TYPE)
◐ M1	GROUNDWATER MONITOR LOCATION AND DESIGNATION
⊞ TP1	TEST PIT WITH WATER TABLE MONITOR LOCATION AND DESIGNATION
☐ TP4	TEST PIT LOCATION AND DESIGNATION
● SW1	SURFACE WATER LOCATION AND DESIGNATION
◉ R1	RESIDENTIAL WELL LOCATION AND DESIGNATION
352.05	OBSERVED GROUNDWATER ELEVATION IN OVERBURDEN
352.22	OBSERVED SURFACE WATER ELEVATION
▬ ▬ ▬	INFERRED GROUNDWATER ELEVATION IN OVERBURDEN
⇒	OVERBURDEN GROUNDWATER FLOW DIRECTION

0 100 200 300 400

metres

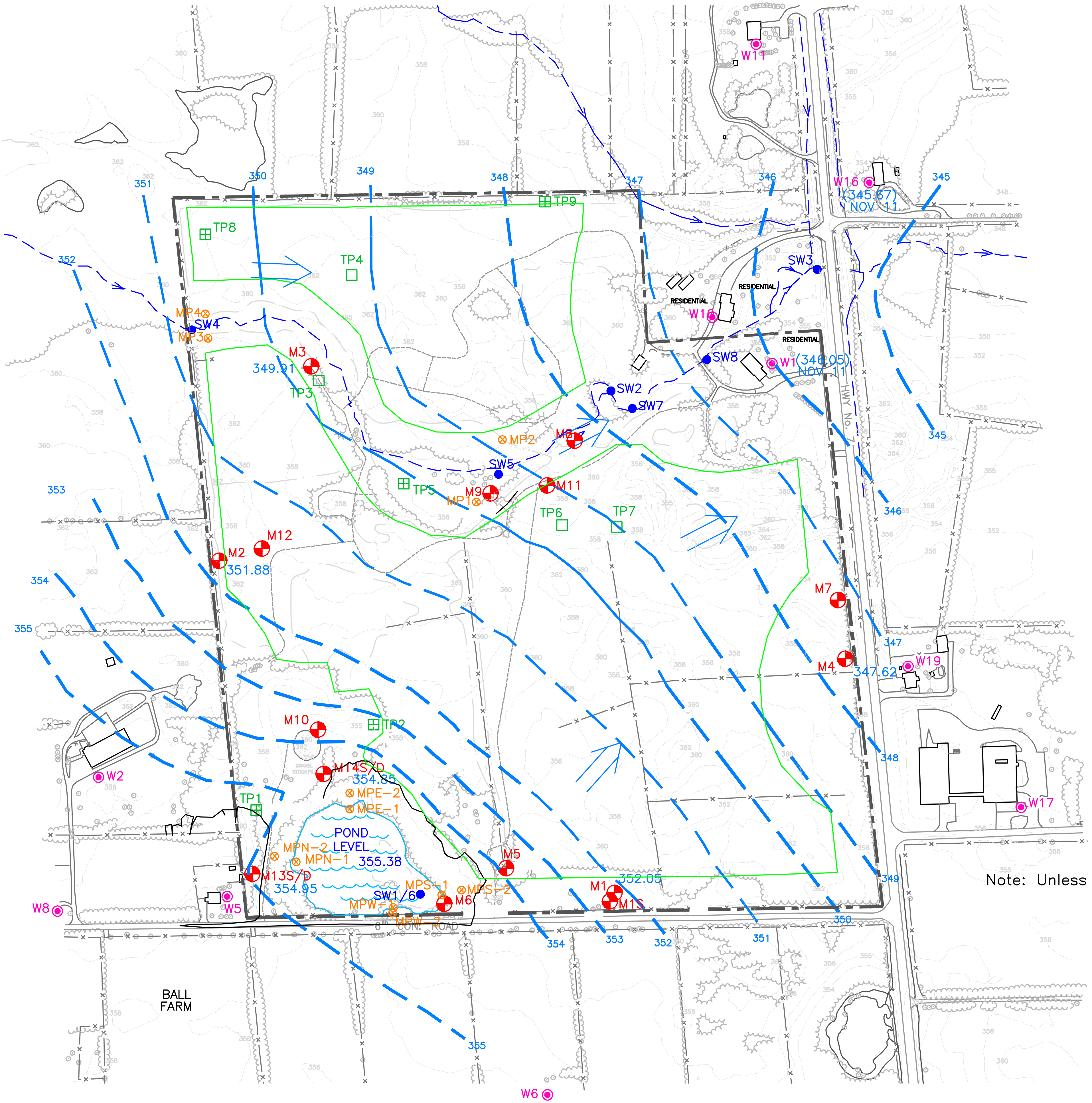
Note: Unless specified GW contours based on May 31, 2011 elevation data.

HARDEN
ENVIRONMENTAL

OVERBURDEN WATER TABLE CONTOURS

DATE: SEPT 2011	PROJECT: 9506	Figure 3.16
DRAWN: AW	SCALE: 1 : 4000	

DRAFT



LEGEND

— · —	PROPERTY BOUNDARY
⌒⌒⌒	FOREST EDGE
- - - -	TRAIL
—→—	PERMANENT STREAM
- -→- -	INTERMITTENT STREAM
×——×	FENCELINE
◇ RESIDENTIAL	BUILDINGS (TYPE)
◐ M1	GROUNDWATER MONITOR LOCATION AND DESIGNATION
⊞ TP1	TEST PIT WITH WATER TABLE MONITOR LOCATION AND DESIGNATION
☐ TP4	TEST PIT LOCATION AND DESIGNATION
● SW1	SURFACE WATER LOCATION AND DESIGNATION
◉ R1	RESIDENTIAL WELL LOCATION AND DESIGNATION
353.89	OBSERVED GROUNDWATER ELEVATION IN BEDROCK
— — —	INFERRED GROUNDWATER ELEVATION IN BEDROCK
⇒	BEDROCK GROUNDWATER FLOW DIRECTION

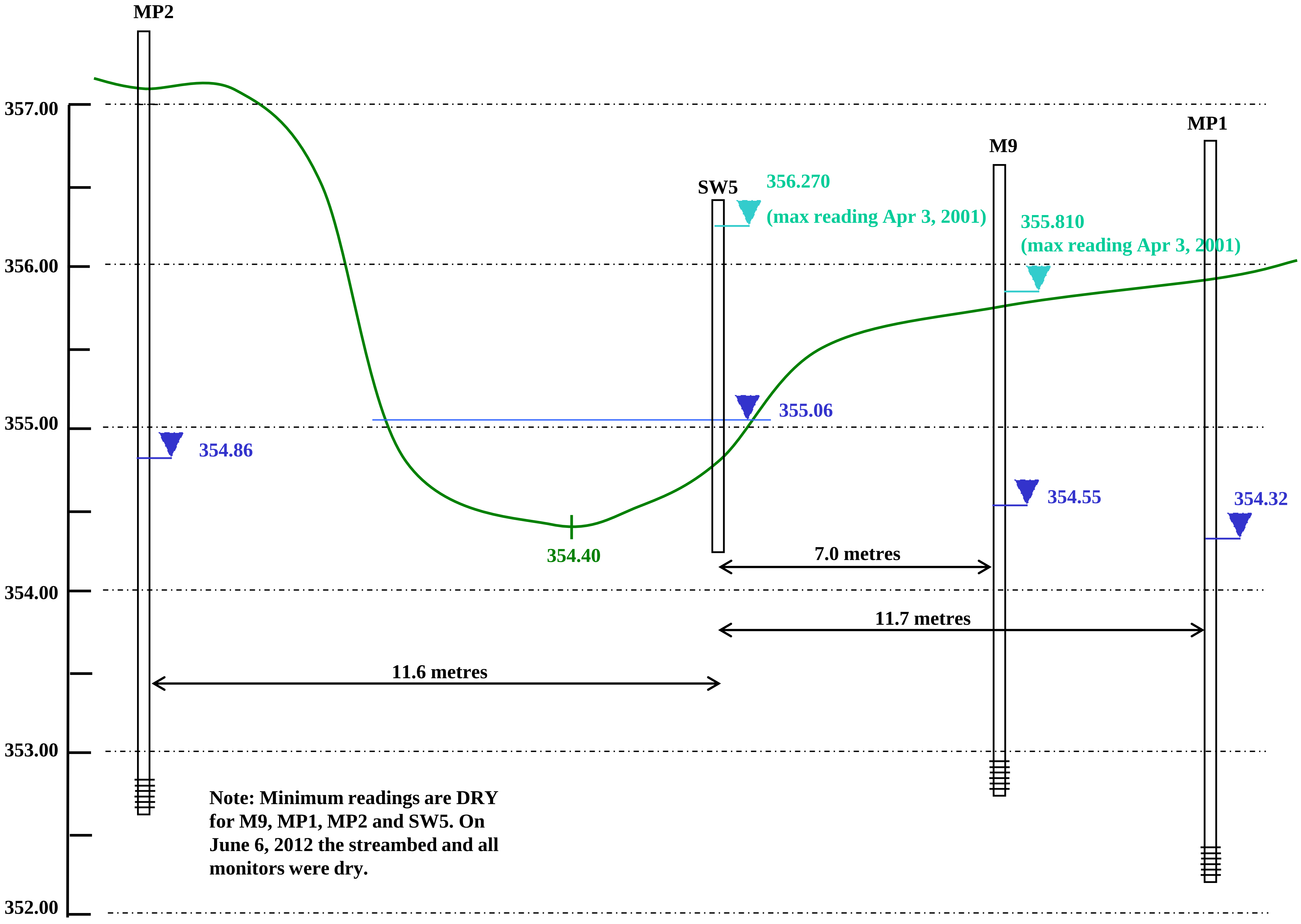
0 100 200 300 400
metres

Note: Unless specified GW contours based on May 31, 2011 elevation data.

HARDEN
ENVIRONMENTAL

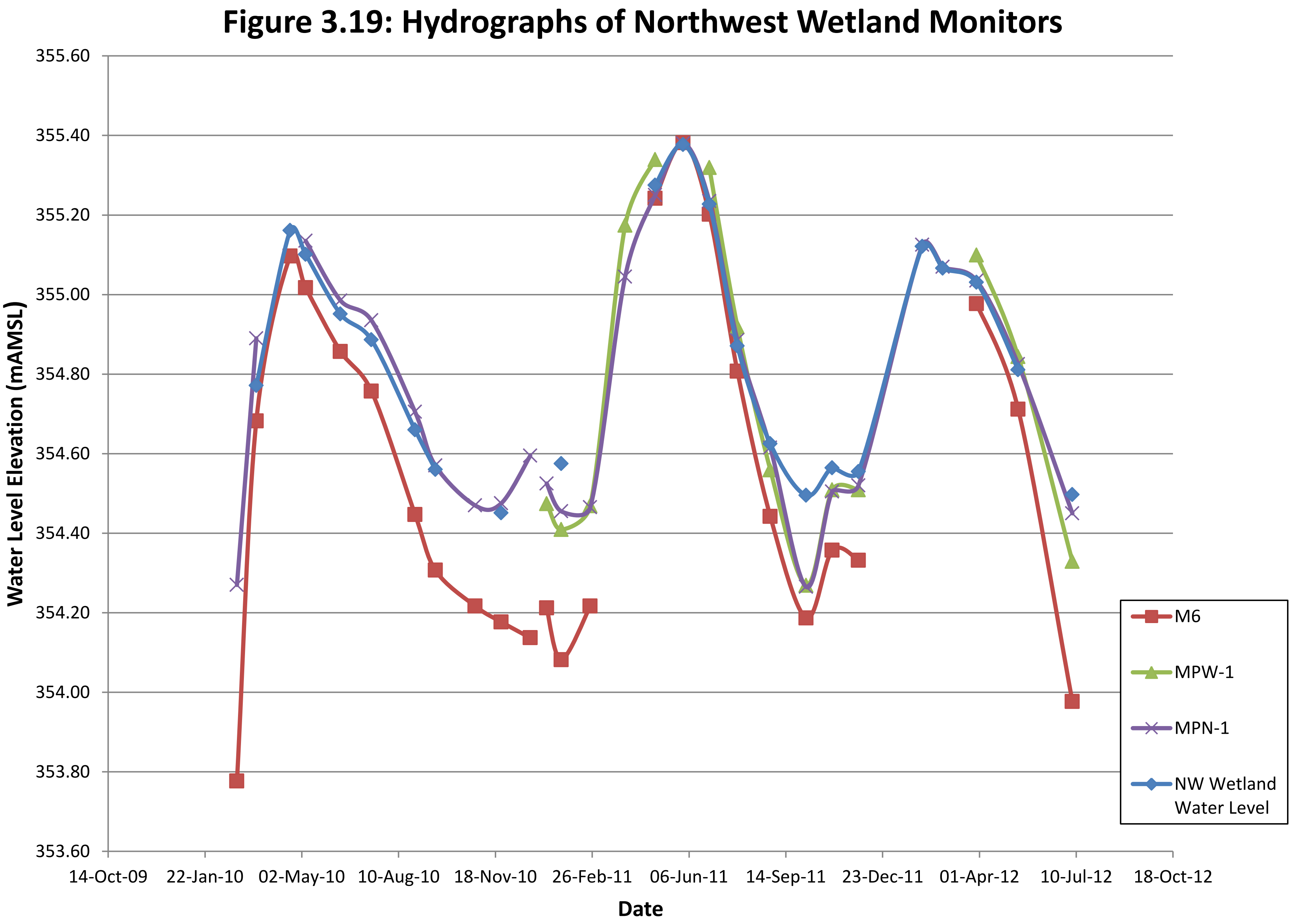
BEDROCK GROUNDWATER CONTOURS

DATE: SEPT 2011	PROJECT: 9506	FIGURE 3.17
DRAWN: AW	SCALE: 1 : 4000	



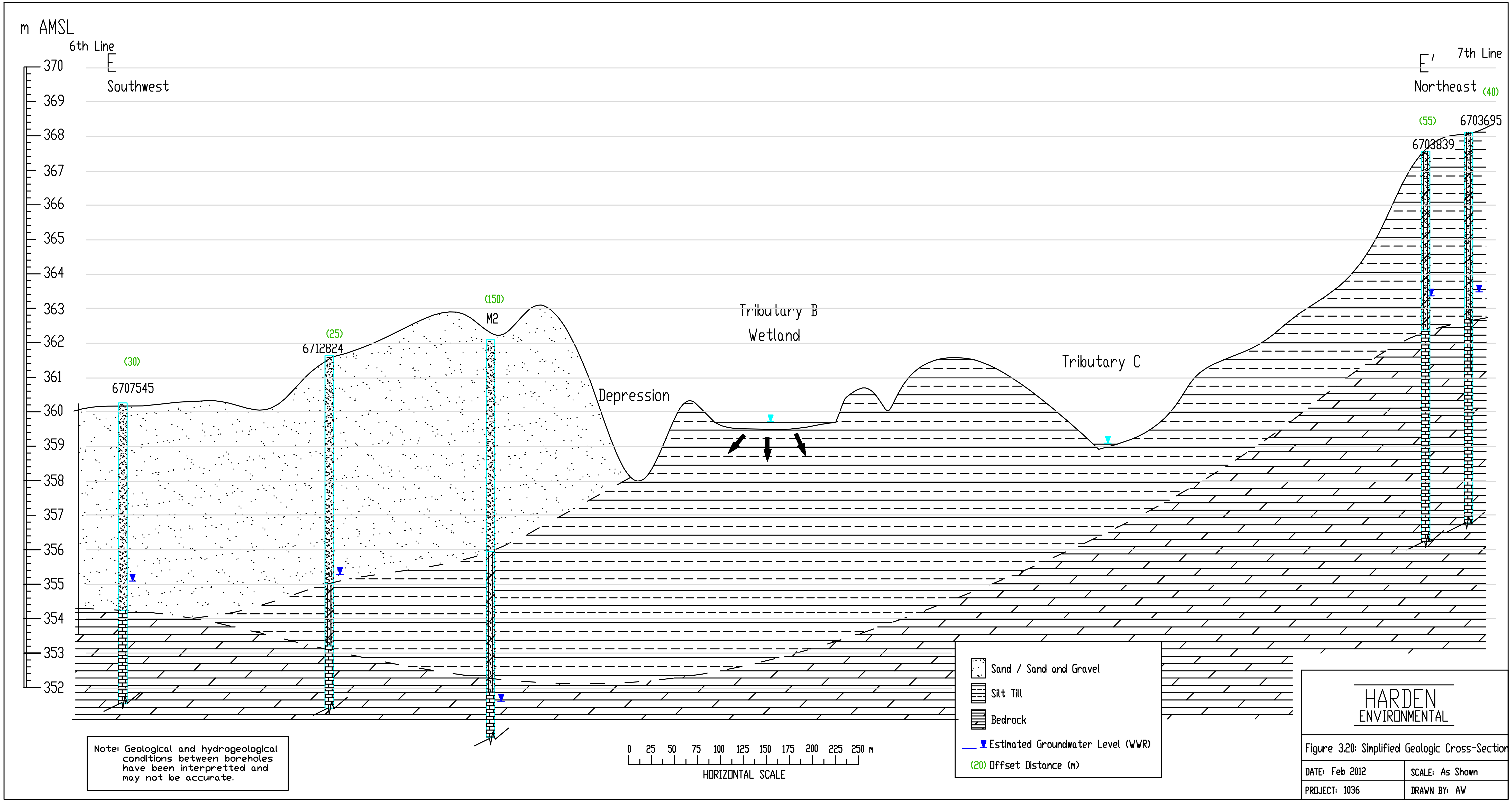
Note: Minimum readings are DRY for M9, MP1, MP2 and SW5. On June 6, 2012 the streambed and all monitors were dry.

Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Jul 2012 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure 3.18: Water Table at SW5 July 26, 2011**



Harden
Environmental
Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 3.19: Hydrographs of Northwest Wetland Monitors**
Date: Jul 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		



Note: Geological and hydrogeological conditions between boreholes have been interpretted and may not be accurate.

HARDEN
ENVIRONMENTAL

Figure 3.20: Simplified Geologic Cross-Sectio

DATE: Feb 2012
SCALE: As Shown
PROJECT: 1036
DRAWN BY: AW

Harden Environmental Services Ltd.

Project No: 9506

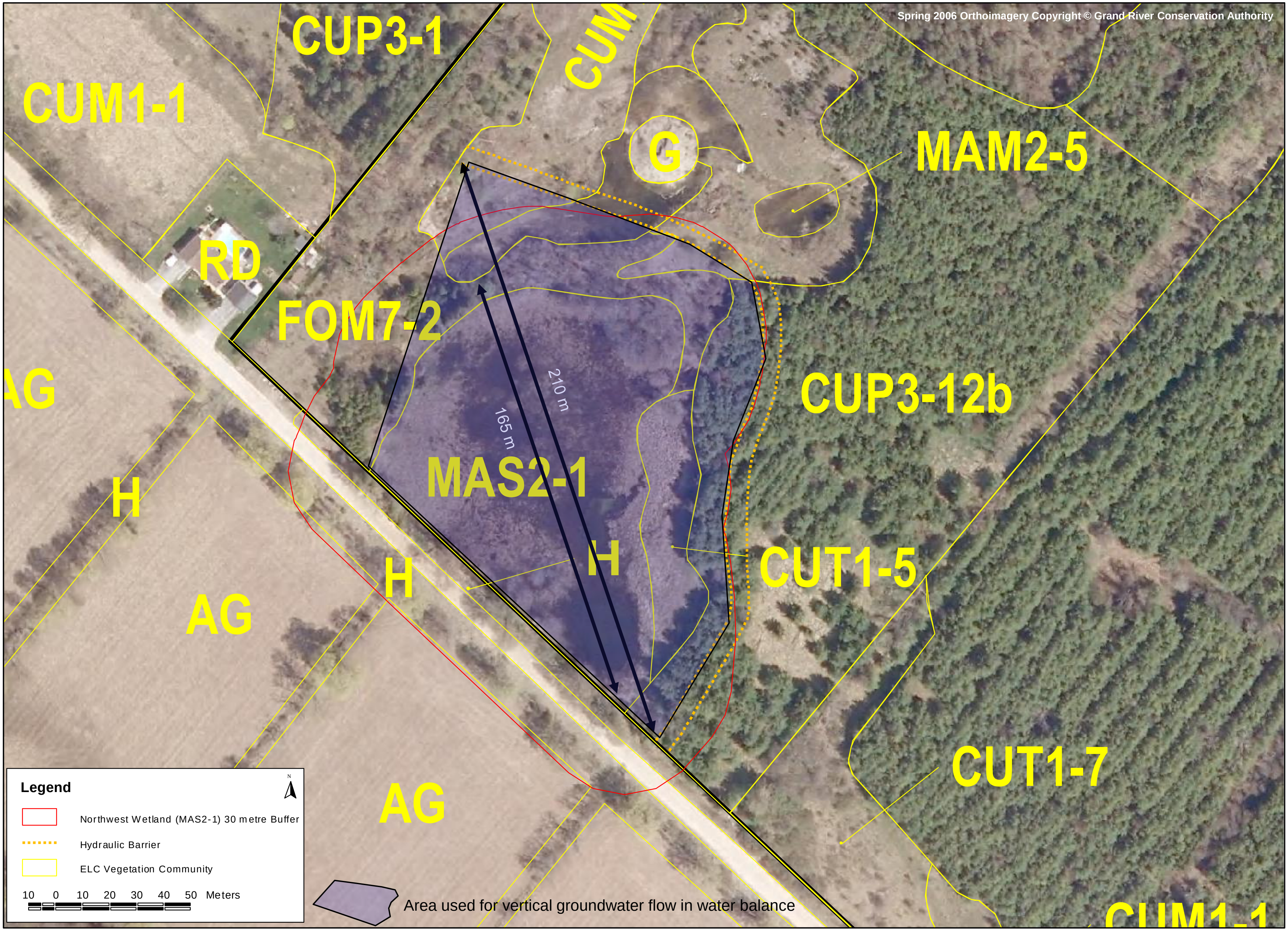
Date: Jun 2012

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 4.1: Extraction Footprint



Spring 2006 Orthoimagery Copyright © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506

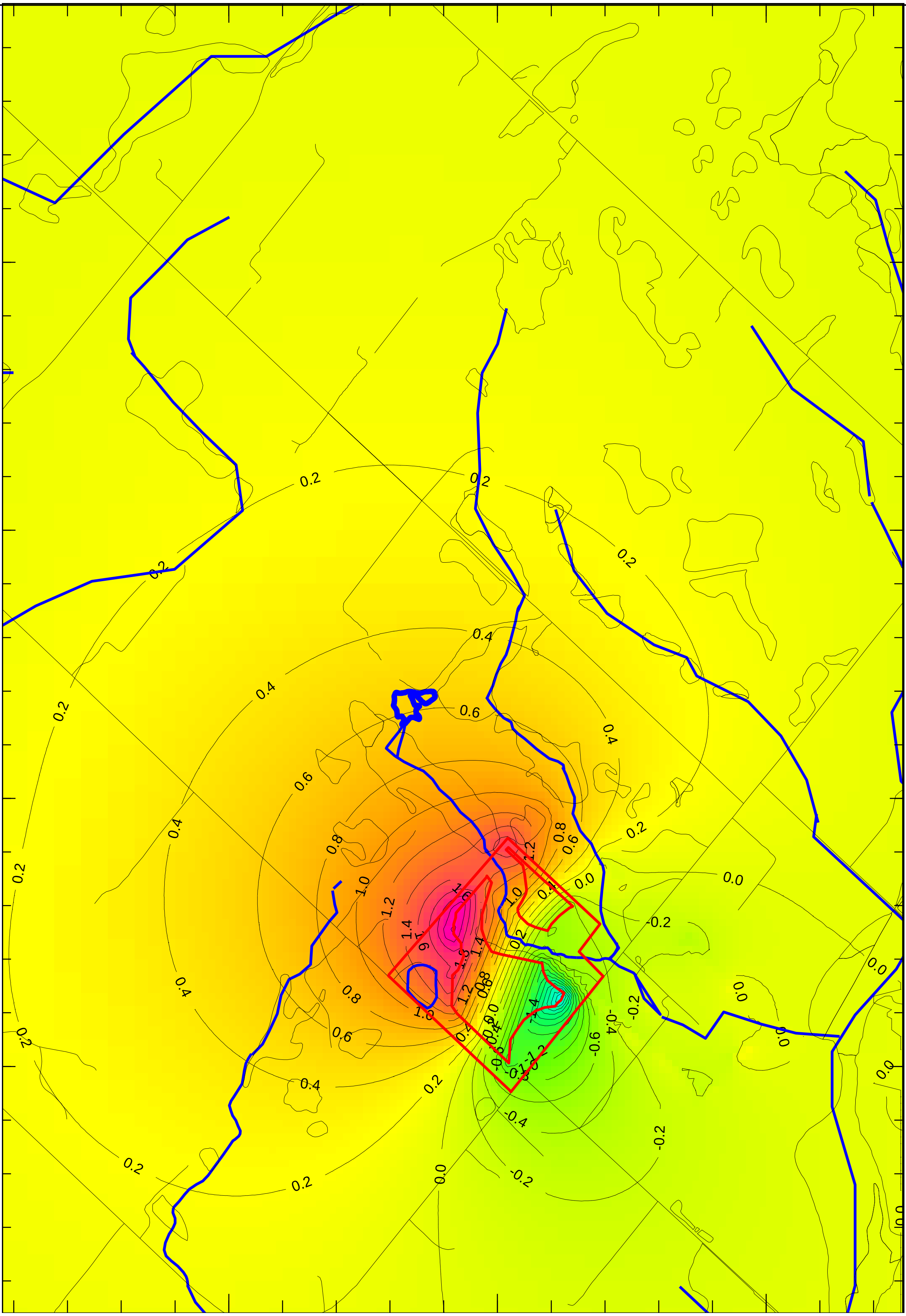
Date: Jul 2012

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 4.2: Northwest Wetland Hydraulic Barrier



Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2012

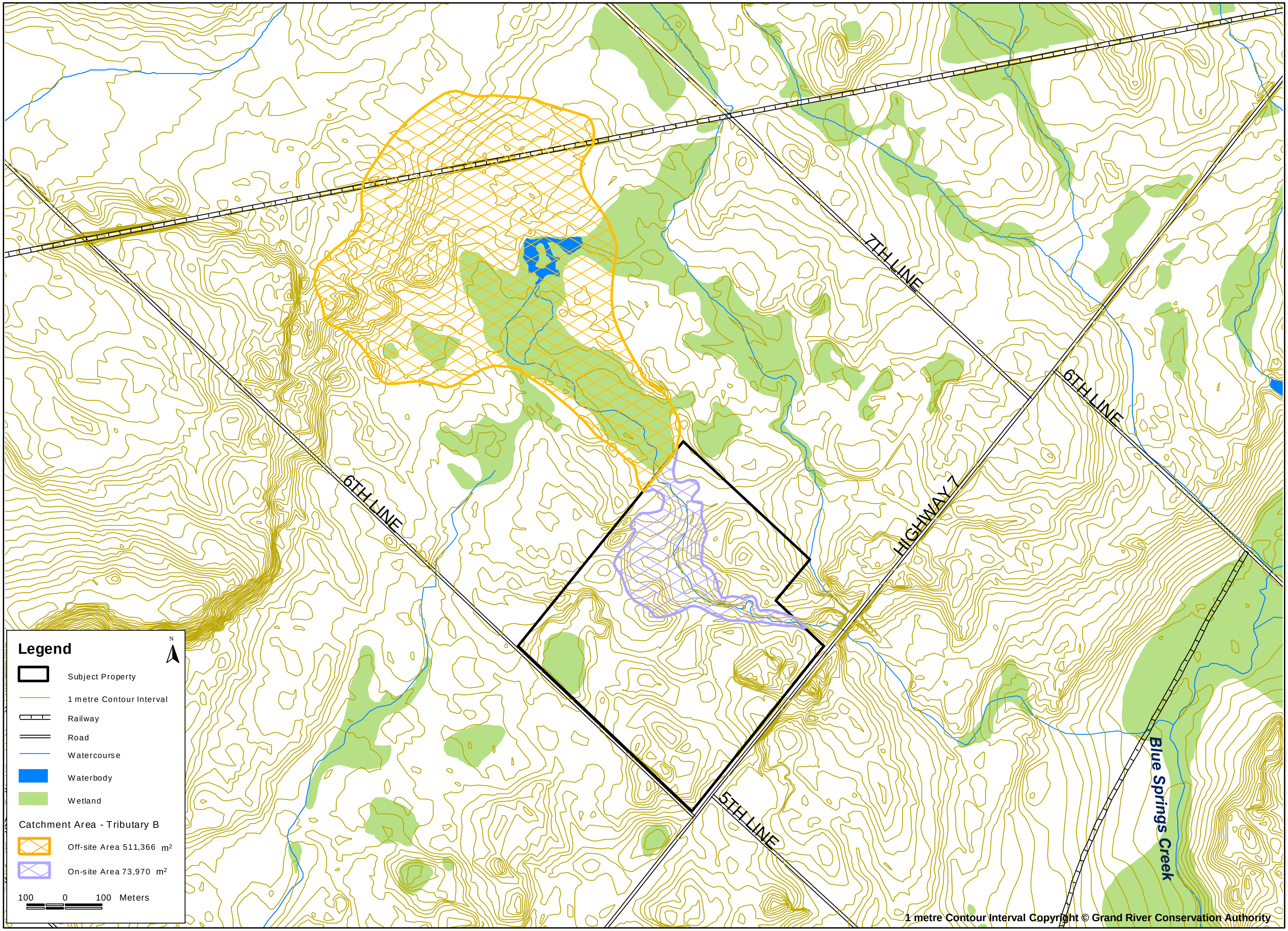
Drawn By: SD

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 4.3

Maximum Predicted Drawdown in Bedrock Aquifer



Harden Environmental Services Ltd.

Project No: 9506

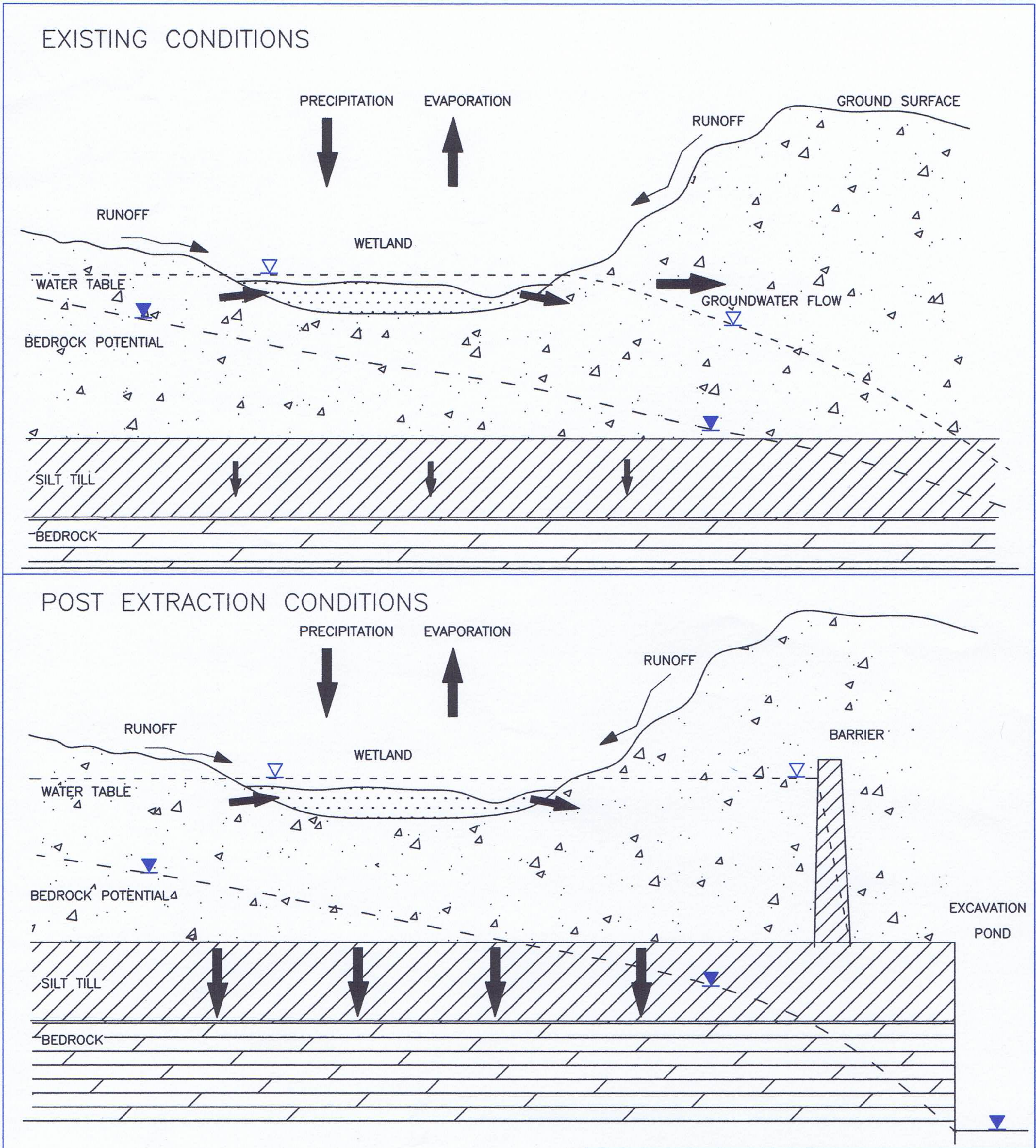
Date: May 2012

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

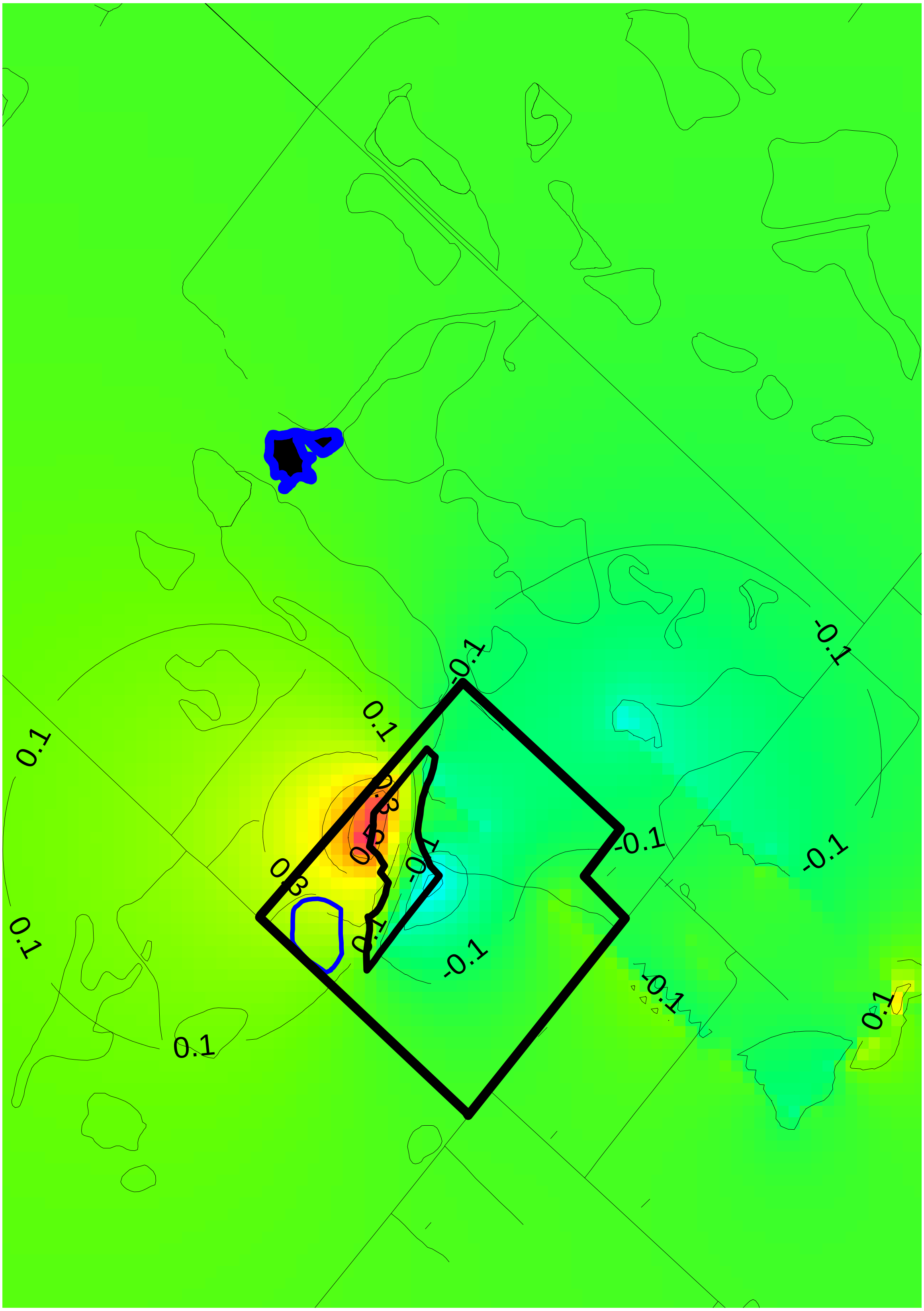
Figure 4.4: Tributary B Catchment Area



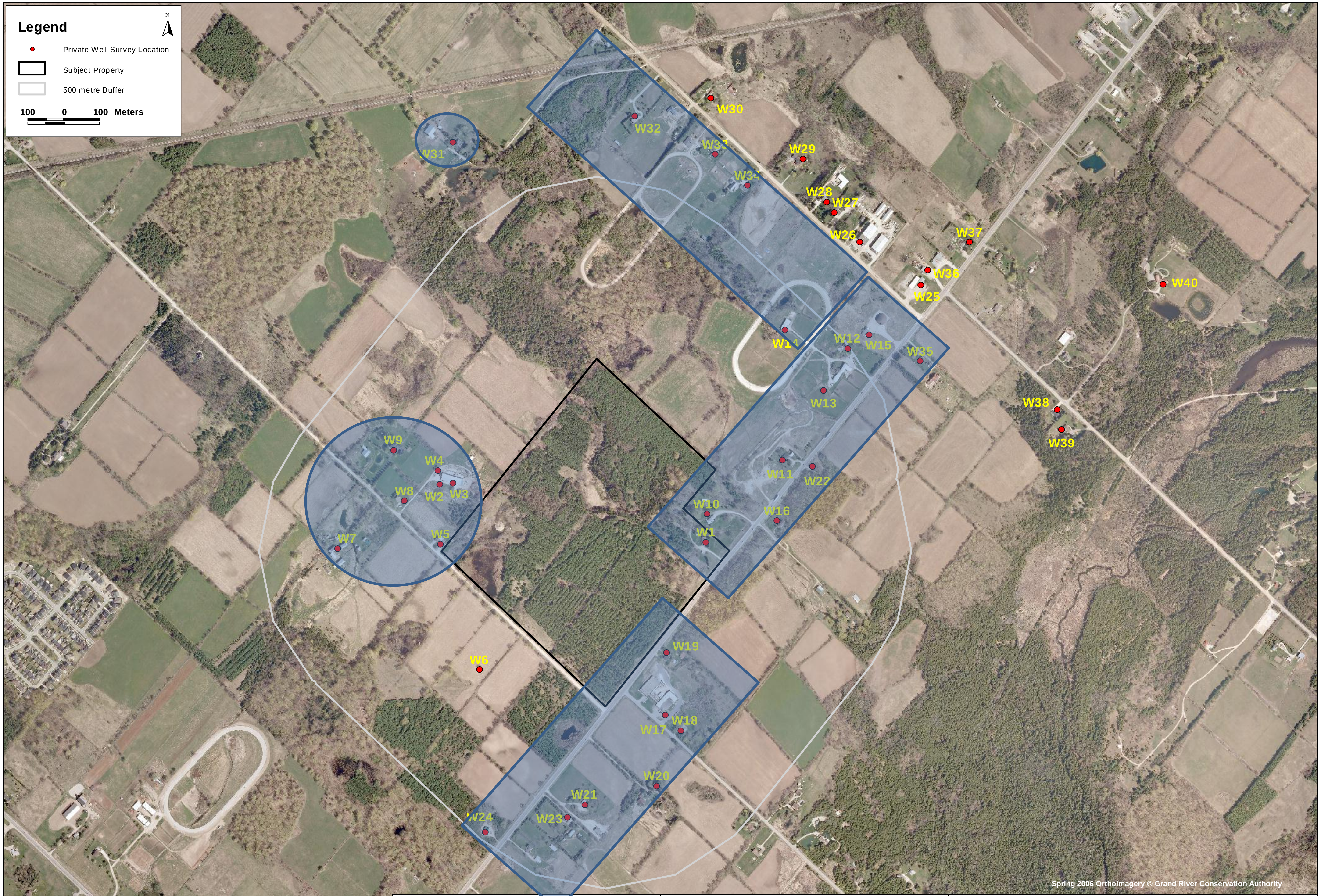
HARDEN ENVIRONMENTAL

WETLAND / BARRIER WATER BALANCE
JAMES DICK HIDDEN QUARRY

DATE: JUN 2012	PROJECT: 9506	FIGURE 5.1
DRAWN: AW		



Harden Environmental Services Ltd.	**Project No:** 9506	Rockwood Groundwater Model Addendum Report	**Figure 5.2:** **Predicted Drawdown in Bedrock Aquifer: North Half of West Pond**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		



Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2012

Drawn By: SD

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 6.1:

Proposed Pre Quarry Well Survey Locations

APPENDICES

Appendix A

Geological Data

Borehole Logs
Grain Size Analysis
Table A1: Monitoring Station Completion Details
Table A2: Soil Descriptions - Allen Wetland and Northwest Wetland
Table A3: Summary of Grain Size Analysis
Table A4: Top of Silt/Silt Till

PROJECT: M1-S

M1-S

LOCATION: Rockwood

BORING DATE: Dec 21, 2010 **DATUM:** GROUND SURFACE **DIP:** 90 **LOGGED:** AW

DEPTH SCALE: METRES / FEET

BORING METHOD: Auger

SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
GS = 358.84 mAMSL					
Dark brown, Sandy organics	0	S1	SS	29	3
Sand, light brown, medium, silty	0.78	S2	SS	79	4
Coarse gravel, silty, bouldery, with coarse to fine sand	1.68	S3	SS	21	-
		S4	SS	58	58
Medium gravel, very silty, coarse to fine sand	2.59	S5	SS	75	48
		S6	SS	75	61
		S7	SS	50	-
Bouldery medium gravel, very silty, coarse and fine sand	5.03	S9	SS	81	48
Brown sand, gravelly, silty, medium to fine sand	6.10	S10	SS	54	29
Till, reddish grey, gravelly, sandy silt till, some clay	7.62	S12	SS	42	26
		S13	SS	58	18
		S14	SS	58	-
END OF HOLE @ 9.35m	9.35				

CONCENTRATION (%)

LEL ◆

MOISTURE CONTENT ●

GAS CONCENTRATION ■

0 20 40 60 80 100

INSTALLATION INFORMATION

DRAWN: AW

Harden Env

CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD QUARRY
BORING DATE: MAY 1990

RECORD OF BOREHOLE M1D

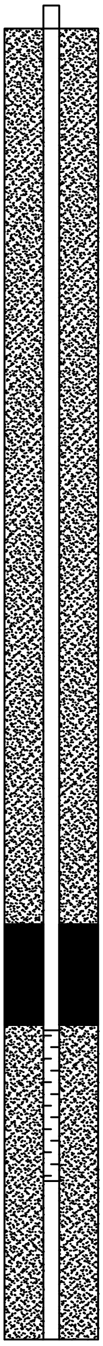
SHEET 1 OF 1

DATUM: GROUND SURFACE
DIP: −90
LOGGED: KI

SOIL PROFILE			SAMPLES				CONCENTRATION (%)
DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	NUMBER	TYPE	RECOVERY	"N" VALUE	LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100
GROUND SURFACE							
Dark brown, SANDY LOAM.		0.00					
SAND, light brown, medium, silty.		0.76					
SAND, light brown, medium.		1.52					
COARSE GRAVEL, silty, bouldery, coarse to fine sand.		1.68					
MEDIUM GRAVEL, very silty, coarse to fine sand. Lens of fine gravel and well graded sand (3.9–4.5m).		2.59					
BOULDERY MEDIUM GRAVEL, very silty, coarse and fine sand.		5.03					
SAND, gravelly, silty, medium to fine sand.		6.10					
TILL, light brown, gravelly, sandy silt till, some clay.		7.62					
DOLOMITE, brown, fine grained, dense.		9.30					
DOLOMITE, light grey to light buff grey, medium grained, fine porosity, medium bedded.		9.45					
DOLOMITE, light to medium blueish grey, medium grained, medium porosity, thick bedded.		11.28					
DOLOMITE, blueish grey, medium grained, coarse porosity, very fossiliferous.		12.19					
END OF HOLE		12.80					

INSTALLATION INFORMATION

MONITOR
M1D



T.O.P. 360.215m
GROUND ELEV. 359.265m

SAND PACK 0.00–8.76m

BENTONITE SEAL 8.76–9.76m

SCREEN 9.76–11.26m

SAND PACK 9.76–12.80m

DRAWN: MR
HARDEN ENVIRONMENTAL SERVICES LTD.
CHECKED: SD

PROJECT: 9506

LOCATION: ROCKWOOD QUARRY

BORING DATE: MAY 1990

RECORD OF BOREHOLE M2

SHEET 1 OF 2

DATUM: GROUND SURFACE

DIP: −90

LOGGED: KI

DEPTH SCALE — METRES: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DEPTH SCALE — FEET: 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64, 68, 72, 76, 80, 84, 88, 92, 96, 100

BORING METHOD

CONCENTRATION (%): LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ — 0 20 40 60 80 100

SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	NUMBER	TYPE	RECOVERY	"N" VALUE
GROUND SURFACE					
GRAVELLY LOAM, light brown.	0.00				
COARSE GRAVEL, silty, coarse and fine sand.	0.76				
MEDIUM GRAVEL, silty, coarse to fine sand. Small dolomite boulders.	2.74				
TILL, light brown, gravelly, sandy silt till, some clay. Thin layers of silty sand and gravel. Occ. large dolomite boulders.	5.79				
DOLOMITE, light grey to light blueish grey, medium grained, medium to coarse porosity with vuggy sections, thick to massive bedded, very fossiliferous. Open fissures with some brown clay at 11.3, 13.0, 13.1, 13.3, and 14.5 m	9.91				
DOLOMITE, light grey mottled with light blueish grey, medium grained, medium porosity, some vuggy sections, thin to thick bedded. open fissures at 16.0, 16.2m	14.94				
DOLOMITE, light buff grey, fine grained, thick to massive bedded, medium to fine porosity. Blueish grey, medium grained with coarse to vuggy porosity at 18.5–19.1 and 20.11–22.40m.	16.61				
DOLOMITE, light buff grey, fine grained, fine porosity, thick to massive bedded, light blueish grey, medium grained with coarse to vuggy porosity 24.2–24.8m.	21.03				
DOLOMITE, light blueish grey, fine grained, fine porosity, thick to massive bedded. Frequent stylolites. Large open fissure at 25.3m.	24.84				
DOLOMITE, light to medium grey, medium grained, thick to massive bedded, coarse to vuggy reefy porosity, large vugs lined with dolomite crystals, fossiliferous.	27.74				

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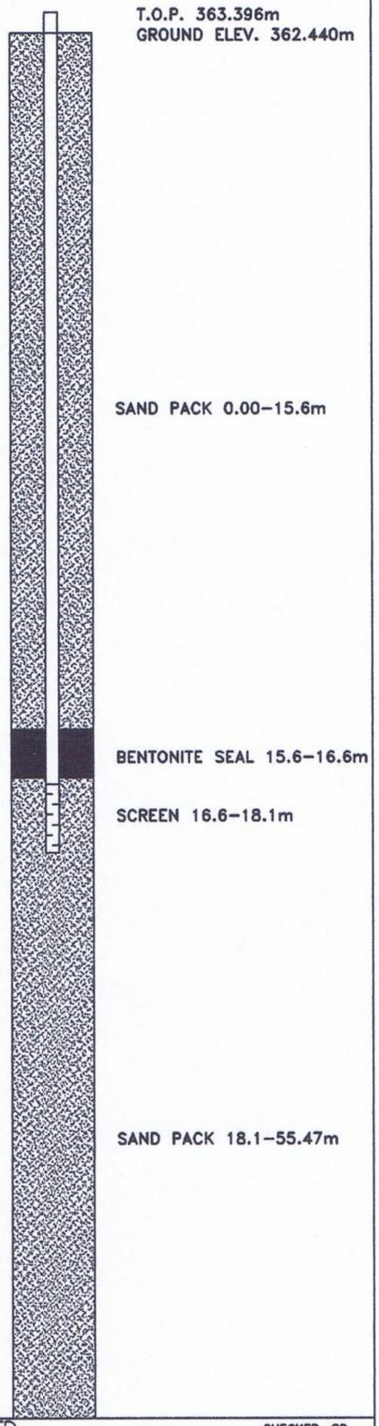
INSTALLATION INFORMATION

MONITOR M2



DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD QUARRY
BORING DATE: MAY 1990

RECORD OF BOREHOLE M2

SHEET 2 OF 2

DATUM: GROUND SURFACE
DIP: -90
LOGGED: KI

DEPTH SCALE — METRES: 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60
FEET: 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140, 144, 148, 152, 156, 160, 164, 168, 172, 176, 180, 184, 188, 192, 196, 200

CONCENTRATION (%): LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ — 0 20 40 60 80 100

SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	NUMBER	TYPE	RECOVERY	"N" VALUE
DOLOMITE, light to medium grey, medium grained, thick to massive bedded, coarse to vuggy reefy porosity, large vugs lined with dolomite crystals, fossiliferous.					
DOLOMITE, light grey, medium grained, fine porosity, medium thin bedded, very fossiliferous.	32.00				
DOLOMITE, light buff grey and light blueish grey banded, fine grained, fine porosity, minor coarse to vuggy porosity, massive bedded, some medium to thick bedded sections.	33.22				
DOLOMITE, light blueish grey mottled with light grey to white fossil debris, fine grained, thick to massive bedded. Inclined open fissure at 42.3–42.8m Greenish grey filmy shale seams between some beds.	42.98				
DOLOMITE, light to medium blueish grey, coarse grained, coarse to medium reefy porosity, frequent vugs and small cavities, thick bedded with some inclined bedding. Thin dark grey shale seams between beds from 47.9m.	46.18				
DOLOMITE, light grey, medium grained, fine porosity, thick bedded thin bedded with thin dark grey shale seams between beds 50.74–51.2m.	48.77				
DOLOMITE, transition beds: inter-bedded light grey, fossiliferous and medium grey, aphanitic dolomite.	51.21				
DOLOMITE, light brownish to med. greenish grey, aphanitic, medium to thin bedded. Bundles of dark grey shale seams with pellets and seams of pyrite.	52.12				
SHALE, green limey with layers of dolomite and thin layers of calcareous sandstone.	53.64				
SHALE, interlayered red and dark grey, thin layers of dolomite.	54.86				
END OF HOLE	55.47				

INSTALLATION INFORMATION

MONITOR
M2

SAND PACK 18.1–55.47m

DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD QUARRY
BORING DATE: MAY 1990

RECORD OF BOREHOLE M3

SHEET 1 OF 1

DATUM: GROUND SURFACE

DIP: −90

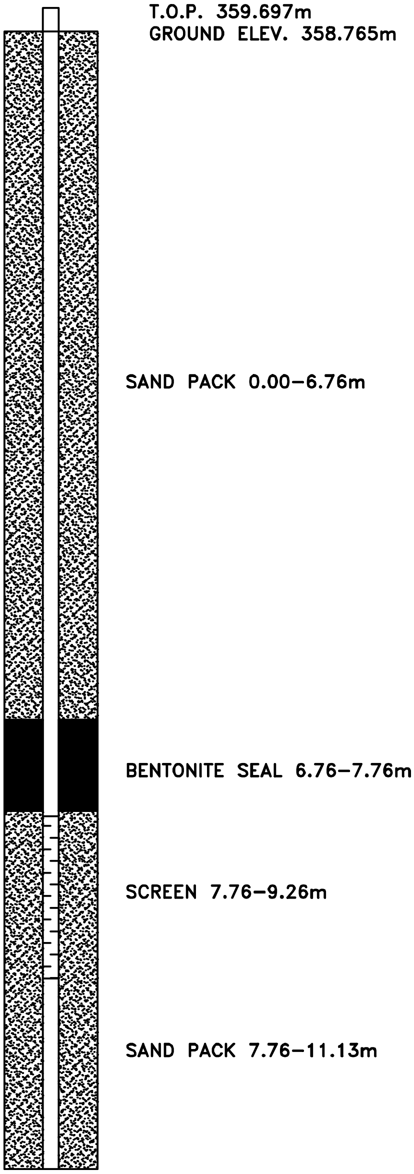
LOGGED: KI

CONCENTRATION (%): LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ (0 20 40 60 80 100)

DESCRIPTION	DEPTH B.G.S. (m)
GROUND SURFACE	0.00
Light brown, SANDY SILT LOAM.	0.00
SAND, light brown, fine, silty.	0.61
SAND, light brown, gravelly, medium to fine sand; thin layers of coarse sand. Occasional boulders.	2.13
SAND, light brown, gravelly, silty, fine sand.	5.03
TILL, light brown, gravelly, silty sand till, trace clay.	7.16
DOLOMITE, light grey, coarse grained, coarse reefy porosity, thin to medium bedded.	8.08
DOLOMITE, light grey mottled with pale green and pink crinoid stems, medium grained, medium porosity, medium to thick bedded. Open weathered fissures at 9.5–10.1m Some brown clay.	8.99
END OF HOLE	11.13

INSTALLATION INFORMATION

MONITOR M3



DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD QUARRY
BORING DATE: MAY 1990

RECORD OF BOREHOLE M4

SHEET 1 OF 2

DATUM: GROUND SURFACE
DIP: -90
LOGGED: KI

DEPTH B.G.S. (m)	SOIL PROFILE – DESCRIPTION
	GROUND SURFACE
0.00	SANDY LOAM.
0.30	FINE GRAVEL, medium to well graded sand.
1.22	MEDIUM GRAVEL, very silty, medium to fine sand.
2.59	TILL, light brown, bouldery, gravelly, silty sand till.
3.51	MEDIUM GRAVEL, very silty, coarse, to fine sand. Small dolomite boulders.
5.33	TILL, light brown, silty sand till. some brown clay. occasional small dolomite boulders.
6.71	DOLOMITE, light buff grey mottled with pale fossil fragments and pink crinoid stems, coarse grained, coarse reefy porosity, medium to thick inclined beds 6.7–7.9m, massive bedded 7.9–8.8m.
9.14	DOLOMITE, light grey banded and mottled with light blueish grey, fine grained, fine porosity, massive bedded.
10.97	DOLOMITE, light grey, mottled with light blueish grey, fine grained, fine to medium porosity, medium to thick bedded, open inclined weathered fractures 12.0–12.3m., large cavity 12.8–13.3m.
13.26	DOLOMITE, blueish grey, dense, patches of green argillaceous dolomite.
14.17	DOLOMITE, light buff grey, fine grained, fine porosity, cavity 14.5–14.8m.
14.78	DOLOMITE

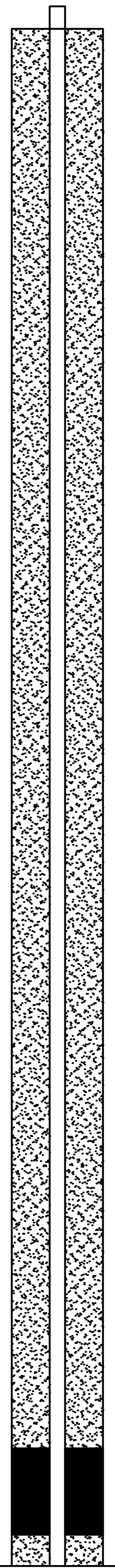
CONTINUED ON NEXT PAGE

SAMPLES: NUMBER, TYPE, RECOVERY, "N" VALUE

CONCENTRATION (%): LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ (0 20 40 60 80 100)

INSTALLATION INFORMATION

MONITOR M4



T.O.P. 356.611m
GROUND ELEV. 355.816m

SAND PACK 0.00–14.3m

BENTONITE SEAL 14.3–15.3m

DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

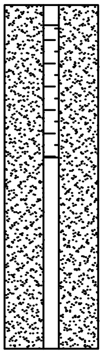
CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD QUARRY
BORING DATE: MAY 1990

RECORD OF BOREHOLE M4

SHEET 2 OF 2

DATUM: GROUND SURFACE
DIP: -90
LOGGED: KI

DEPTH SCALE		BORING METHOD	SOIL PROFILE			SAMPLES				CONCENTRATION (%)	INSTALLATION INFORMATION
METRES	FEET		DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	NUMBER	TYPE	RECOVERY	"N" VALUE	LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100	MONITOR M4
16 17 18	50 52 54 56 58 60		DOLOMITE, light buff grey, with large patches of medium blueish grey dense dolomite, fine grained, coarse reefy porosity, frequent small cavities and fossil moulds, thin inclined bedding 14.8–15.2m. thick bedded 15.2–18.6m, open fracture filled with brown clay 15.8–16.0m. thin dark grey shale seams between beds 16.0–18.6m.								 T.O.P. 356.611m GROUND ELEV. 355.816m SCREEN 15.3–16.8m SAND PACK 16.8–18.59m
19 20 21 22 23 24 25 26 27 28 29 30	62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100		END OF HOLE		18.59						

DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: M11

LOCATION: Rockwood

BORING DATE: Dec 22, 2010 DATUM: GROUND SURFACE DIP: 90 LOGGED: AW

M11

Page 1 OF 1

DEPTH SCALE
METRES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
FEET: 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

BORING METHOD	SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
Auger	GS = 358.57 mAMSL					
	Organic soil, reddish brown	0	S1	SS	37	3
	Fine Sand with gravel, pale brown	0.6	S2	SS	58	13
	Light brown silty sand till, stoney	1.52	S3	SS	42	44
			S4	SS	67	22
			S5	SS	17	-
			S6	SS	58	-
			S7	SS	71	70
			S8	SS	79	51
			S9	SS	79	42
			S10	SS	50	-
	Dark brown, silty sand till, stoney	7.62	S11	SS	50	-
			S12	SS	69	51
		9.14				
	END OF HOLE @ 9.30m	9.30				

CONCENTRATION (%)
LEL ◆
MOISTURE CONTENT ●
GAS CONCENTRATION ■
0 20 40 60 80 100

INSTALLATION INFORMATION

M11

DRAWN: AW Harden Env CHECKED: SD

PROJECT: M12

LOCATION: Rockwood

BORING DATE: Dec 22, 2010 **DATUM:** GROUND SURFACE **DIP:** 90 **LOGGED:** AW

M12

BORING METHOD	DESCRIPTION	DEPTH B.G.S. (m)	ID	TYPE	RECOVERY (%)	"N" VALUE
Auger	GS = 362.00 mAMSL					
	Organic soil	0				
	Brown Fine-Medium Sand with trace silt, uniform, no stones	0.45	S1	SS	62	15
			S2	SS	71	22
			S3	SS	83	20
	Fine to medium sand, with stones, with some silt, brown, dense	6.24	S4	SS	83	19
			S5	SS	42	-
	Silty Fine-Medium Sand with stones, dense	7.62	S6	SS	75	45
			S7	SS	50	-
	END OF HOLE @ 8.84m	8.84				

CONCENTRATION (%)

LEL ◆

MOISTURE CONTENT ●

GAS CONCENTRATION ■

0 20 40 60 80 100

INSTALLATION INFORMATION

M12

DRAWN: AW

Harden Env

CHECKED: SD

PROJECT: M13-S

M13-S

Page 1 OF 1

LOCATION: Rockwood

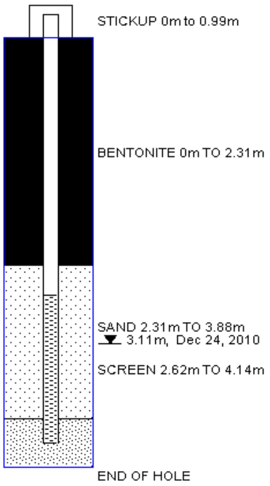
BORING DATE: Dec 23, 2010 **DATUM:** GROUND SURFACE **DIP:** 90 **LOGGED:** AW

DEPTH SCALE METRES	DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	SAMPLES ID	SAMPLES TYPE	RECOVERY (%)	"N" VALUE	CONCENTRATION (%) LEL ◆ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100
			GS = 356.78 mAMSL							
0	0	Auger	Coarse Sand and Gravel with some to little silt, with angular stones, with few cobbles		0					
			END OF HOLE @ 4.37m		4.37					

Depth scale: METRES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15; FEET 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

INSTALLATION INFORMATION

M14-D



DRAWN: AW **Harden Env** **CHECKED:** SD

PROJECT: M13-D

M13-D

Page 1 OF 1

LOCATION: Rockwood

BORING DATE: Dec 23, 2010 **DATUM:** GROUND SURFACE **DIP:** 90 **LOGGED:** AW

BORING METHOD: Auger

SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)
GS = 356.75 mAMSL	
Sand and gravel with some silt, with angular stones, with few cobbles	0
Sandy Silt Till	4.57
Dolostone, grey, weathered, fractured	6.55
END OF HOLE @ 10.06m	10.06

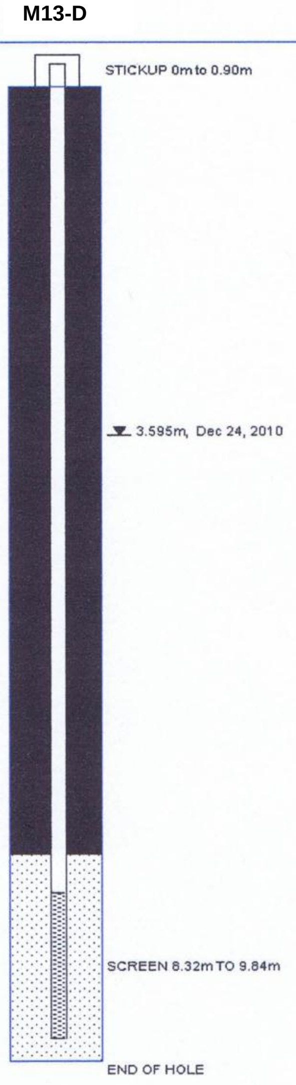
ID	TYPE	RECOVERY (%)	"N" VALUE
S1	SS	67	20
S2	SS	71	20
S3	SS	54	29
S4	SS	50	22
S5	SS	54	26
S6	SS	81	25

CONCENTRATION (%)

LEL ◆
MOISTURE CONTENT ●
GAS CONCENTRATION ■

0 20 40 60 80 100

INSTALLATION INFORMATION



DRAWN: AW

Harden Env

CHECKED: SD

PROJECT: M14-S

M14-S

Page 1 OF 1

LOCATION: Rockwood

BORING DATE: Dec 24, 2010 **DATUM:** GROUND SURFACE **DIP:** 90 **LOGGED:** AW

DEPTH SCALE METRES	DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
			GS = 354.64 mAMSL						
0	0	Auger	Uniform Fine-Medium Sand with Silt, no gravel, no stones	░	0				
3	10		Fine Sandy Silt Till with gravel with some stones, increasing plasticity in fines with depth	▥	3.05				
			END OF HOLE @ 4.27m		4.27				

METRES: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

FEET: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50

CONCENTRATION (%)

LEL ◆

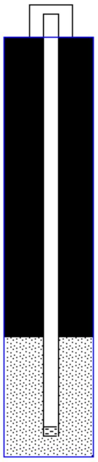
MOISTURE CONTENT ●

GAS CONCENTRATION ■

0 20 40 60 80 100

INSTALLATION INFORMATION

M14-S



STICKUP 0m to 0.98m

CAVED MATERIAL 3.04m TO 4.27m

SCREEN 3.96m TO 4.06m

▼ 3.96m, Dec 24, 2010

END OF HOLE

DRAWN: AW

Harden Env

CHECKED: SD

PROJECT: M14-D

LOCATION: Rockwood

BORING DATE: Dec 24, 2010 **DATUM:** GROUND SURFACE **DIP:** 90 **LOGGED:** AW

M14-D

Page 1 OF 1

BORING METHOD	SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
	GS = 354.50 mAMSL					
Auger	Uniform Fine Sand with Silt, no stones	0	S1	SS	79	21
	Sandy Silt Till, stoney, increasing plasticity in fines with depth	3.05	S2 S3	SS SS	87 75	26 25
	Dolostone, grey, weathered, fractured	4.72	S4	SS	17	-
	END OF HOLE @ 7.62m	7.62				

CONCENTRATION (%)

LEL ◆
MOISTURE CONTENT ●
GAS CONCENTRATION ■
0 20 40 60 80 100

INSTALLATION INFORMATION

* Integrity of bentonite seal unknown due to instability of borehole wall

DRAWN: AW Harden Env CHECKED: SD

PROJECT: 9506

RECORD OF TEST PIT TP1

SHEET 1 OF 1

LOCATION: ROCKWOOD SITE

BORING DATE: SEPT. 1996

DATUM: GROUND SURFACE

DIP: −90

LOGGED: CD

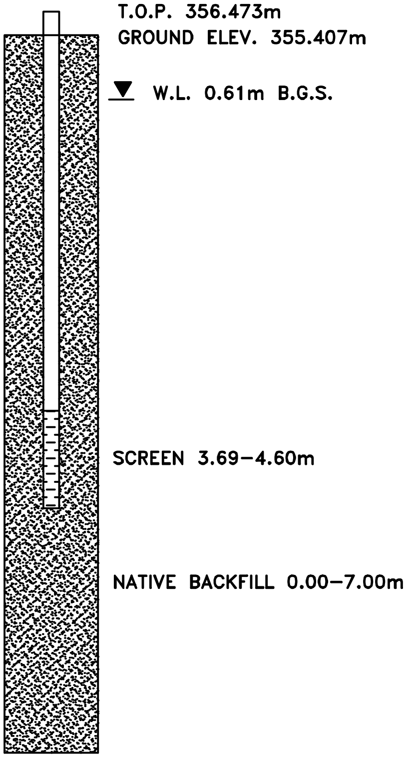
DEPTH SCALE		BORING METHOD	SOIL PROFILE			SAMPLES				CONCENTRATION (%)
METRES	FEET		DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	NUMBER	TYPE	RECOVERY	"N" VALUE	LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100
			GROUND SURFACE							
0	0		Coarse SAND & COBBLES.		0.00	1				
2	6		Fine SAND.		2.00	2				
5	16		SILT, some clay, some stones. Layered.		5.00	3				
7	22		END OF HOLE		7.00					

METRES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

FEET: 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

INSTALLATION INFORMATION

MONITOR TP1



DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: 9506

LOCATION: ROCKWOOD SITE

BORING DATE: SEPT. 1996

RECORD OF TEST PIT TP2

SHEET 1 OF 1

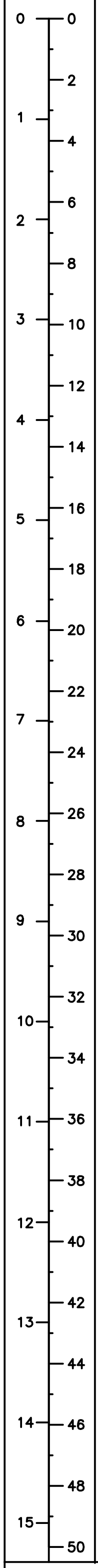
DATUM: GROUND SURFACE

DIP: -90

LOGGED: SD

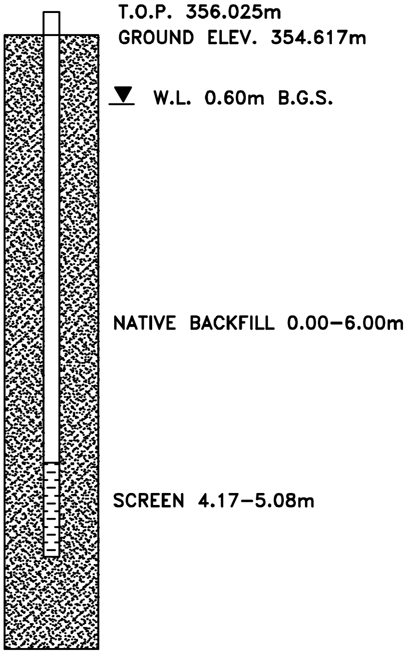
CONCENTRATION (%): LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ (0 20 40 60 80 100)

SOIL PROFILE DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	SAMPLES NUMBER	TYPE	RECOVERY	"N" VALUE	BORING METHOD
GROUND SURFACE							
Fine SAND, light olive brown.	▨	0.00	4				
SILT, layered with stones, some clay.	▥	5.00	5				
DOLOSTONE END OF HOLE		6.00					



INSTALLATION INFORMATION

MONITOR TP2



DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD SITE
BORING DATE: SEPT. 1996

RECORD OF TEST PIT TP3

SHEET 1 OF 1

DATUM: GROUND SURFACE   DIP: −90   LOGGED: SD

DEPTH SCALE: METRES | FEET
BORING METHOD

CONCENTRATION (%)
LEL ♦
MOISTURE CONTENT ●
GAS CONCENTRATION ■
0 20 40 60 80 100

INSTALLATION INFORMATION
NO INSTALLATION

GROUND ELEV. 358.45m

SOIL PROFILE DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	SAMPLES NUMBER	TYPE	RECOVERY	"N" VALUE
GROUND SURFACE						
Sandy TILL.		0.00				
SILT.		2.00				
GRAVEL		3.00				
SILT		5.00				
SAND, well sorted.		6.00				
END OF HOLE DRY AT COMPLETION		8.00				

METRES: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15
FEET: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50

DRAWN: MR   HARDEN ENVIRONMENTAL SERVICES LTD.   CHECKED: SD

PROJECT: 9506

LOCATION: ROCKWOOD SITE

BORING DATE: SEPT. 1996

RECORD OF TEST PIT TP4

SHEET 1 OF 1

DATUM: GROUND SURFACE

DIP: -90

LOGGED: SD

DEPTH SCALE METRES	DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES "N" VALUE	CONCENTRATION (%) LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100	INSTALLATION INFORMATION NO INSTALLATION
			GROUND SURFACE								
0	0		Silty, stoney SAND.	▨	0.00	6					
8	26		END OF HOLE DRY AT COMPLETION		8.00						

METRES	FEET
0	0
	2
1	4
	6
2	8
3	10
	12
4	14
5	16
	18
6	20
	22
7	24
8	26
	28
9	30
	32
10	34
11	36
	38
12	40
	42
13	44
14	46
	48
15	50

DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD SITE
BORING DATE: SEPT. 1996

RECORD OF TEST PIT TP5

SHEET 1 OF 1

DATUM: GROUND SURFACE
DIP: -90
LOGGED: SD

DEPTH SCALE: METRES 0–15; FEET 0–50

BORING METHOD

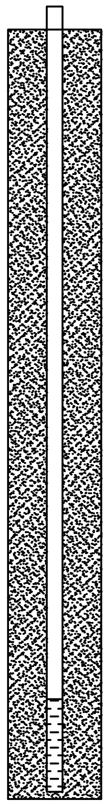
SOIL PROFILE

DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	SAMPLES NUMBER	TYPE	RECOVERY	"N" VALUE
GROUND SURFACE						
Sandy SILT, some oxidized iron staining, grey green.		0.00	7			
Silty SAND.		4.00				
GRAVEL, well sorted.		7.00				
END OF HOLE		7.50				

CONCENTRATION (%)
LEL ♦
MOISTURE CONTENT ●
GAS CONCENTRATION ■
0 20 40 60 80 100

INSTALLATION INFORMATION

MONITOR
TP5



T.O.P. 356.639m
GROUND ELEV. 355.684m

▼ W.L. 3.92m B.G.S.

NATIVE BACKFILL 0.00–7.50m

SCREEN 6.55–7.46m

DRAWN: MR
HARDEN ENVIRONMENTAL SERVICES LTD.
CHECKED: SD

PROJECT: 9506

RECORD OF TEST PIT TP6

SHEET 1 OF 1

LOCATION: ROCKWOOD SITE

BORING DATE: SEPT. 1996

DATUM: GROUND SURFACE

DIP: −90

LOGGED: SD

DEPTH SCALE METRES	DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES "N" VALUE	CONCENTRATION (%) LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100	INSTALLATION INFORMATION NO INSTALLATION
0	0		GROUND SURFACE								GROUND ELEV. 359.298m
			SAND & GRAVEL, lots of cobbles.	▨	0.00						
7			END OF HOLE DRY ON COMPLETION		7.00						

METRES: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

FEET: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50

DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD SITE
BORING DATE: SEPT. 1996

RECORD OF TEST PIT TP7

SHEET 1 OF 1

DATUM: GROUND SURFACE

DIP: -90

LOGGED: SD

DEPTH SCALE		BORING METHOD	SOIL PROFILE			SAMPLES				CONCENTRATION (%)	INSTALLATION INFORMATION
METRES	FEET		DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	NUMBER	TYPE	RECOVERY	"N" VALUE	LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100	NO INSTALLATION
			GROUND SURFACE								GROUND ELEV. 356.245m
0	0		SAND & GRAVEL.		0.00						
7	23		Silty SAND.		7.00						
8	26		END OF HOLE DRY ON COMPLETION		8.00						

METRES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

FEET: 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

DRAWN: MR

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD SITE
BORING DATE: FEB. 2012

RECORD OF TEST PIT TP8

SHEET 1 OF 1

DATUM: GROUND SURFACE
DIP: −90
LOGGED: SD

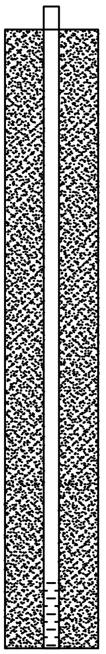
SOIL PROFILE			SAMPLES			
DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	NUMBER	TYPE	RECOVERY	"N" VALUE
GROUND SURFACE						
Stoney, silty sand TILL, brown	▨	0.00				
Fine sand, coarse sand, with silt, some stones. Layered.	░	2.00				
SILT	▥	3.80	1			
Medium SAND	░	4.50	2			
Sand and Gravel	⁘	5.05	3			
END OF HOLE		6.07				

CONCENTRATION (%)
LEL ♦
MOISTURE CONTENT ●
GAS CONCENTRATION ■
0 20 40 60 80 100

DEPTH SCALE: METRES 0–15; FEET 0–50

INSTALLATION INFORMATION

MONITOR
TP8



T.O.P. 360.36m
GROUND ELEV. 359.45m
NATIVE BACKFILL 0.00–6.07m
▼ W.L. 4.82m B.G.S.
SCREEN 5.46–6.07m

DRAWN: AW

HARDEN ENVIRONMENTAL SERVICES LTD.

CHECKED: SD

PROJECT: 9506
LOCATION: ROCKWOOD SITE
BORING DATE: FEB. 2012

RECORD OF TEST PIT TP9

SHEET 1 OF 1

DATUM: GROUND SURFACE
DIP: –90
LOGGED: SD

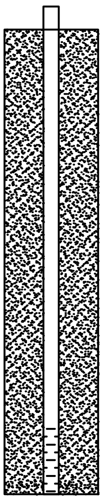
DEPTH SCALE
METRES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
FEET: 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

BORING METHOD

SOIL PROFILE			SAMPLES				CONCENTRATION (%)
DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	NUMBER	TYPE	RECOVERY	"N" VALUE	LEL ♦ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100
GROUND SURFACE							
Topsoil, fine SAND, with stones		0.00					
Fine sand, medium sand, some gravel, some stones. Layered.		1.00	1				
SILT TILL with rounded stones		4.00	2				
DOLOSTONE END OF HOLE		4.57	3				

INSTALLATION INFORMATION

MONITOR
TP9



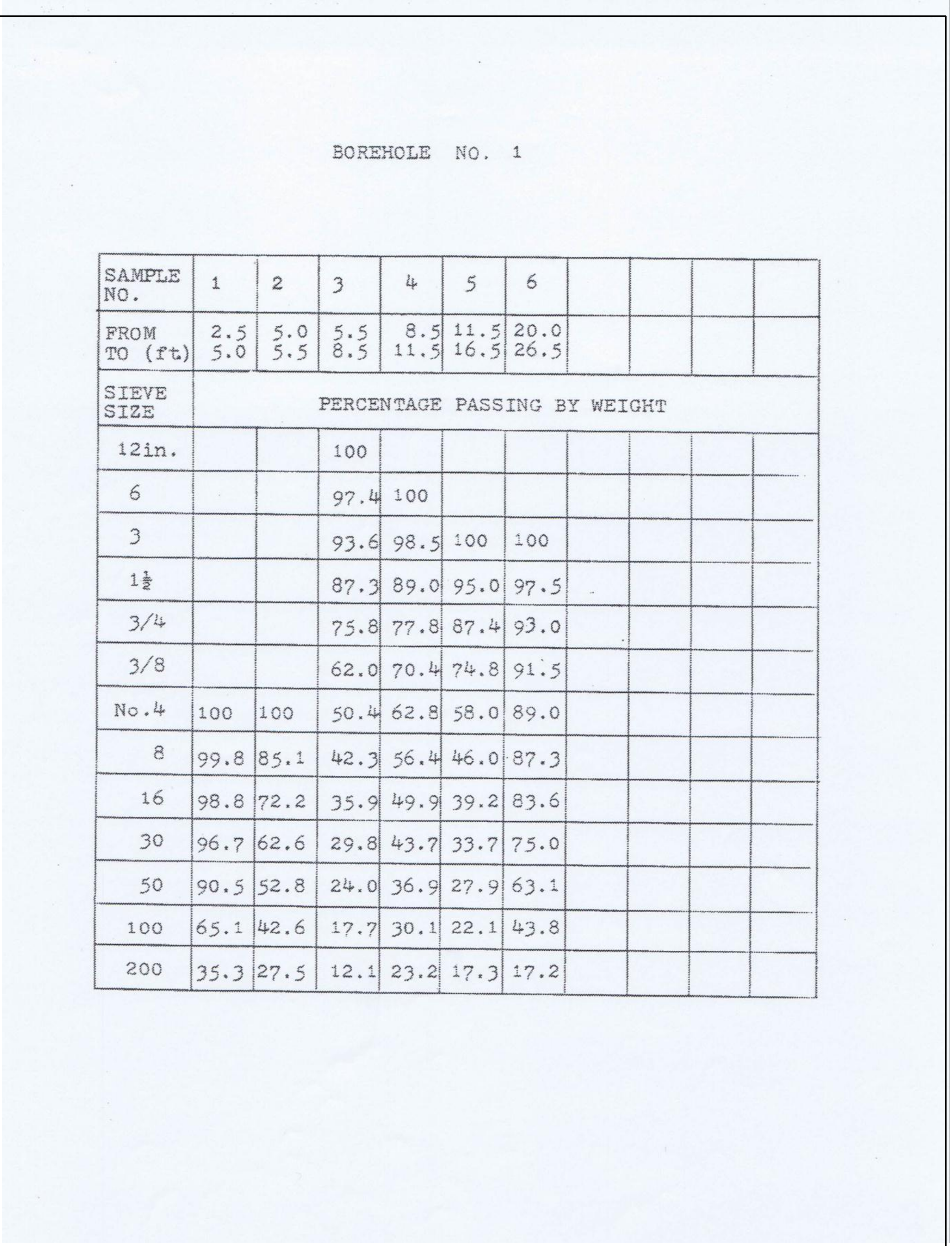
T.O.P. 357.59m
GROUND ELEV. 356.65m

NATIVE BACKFILL 0.00–4.57m

DRY UPON COMPLETION

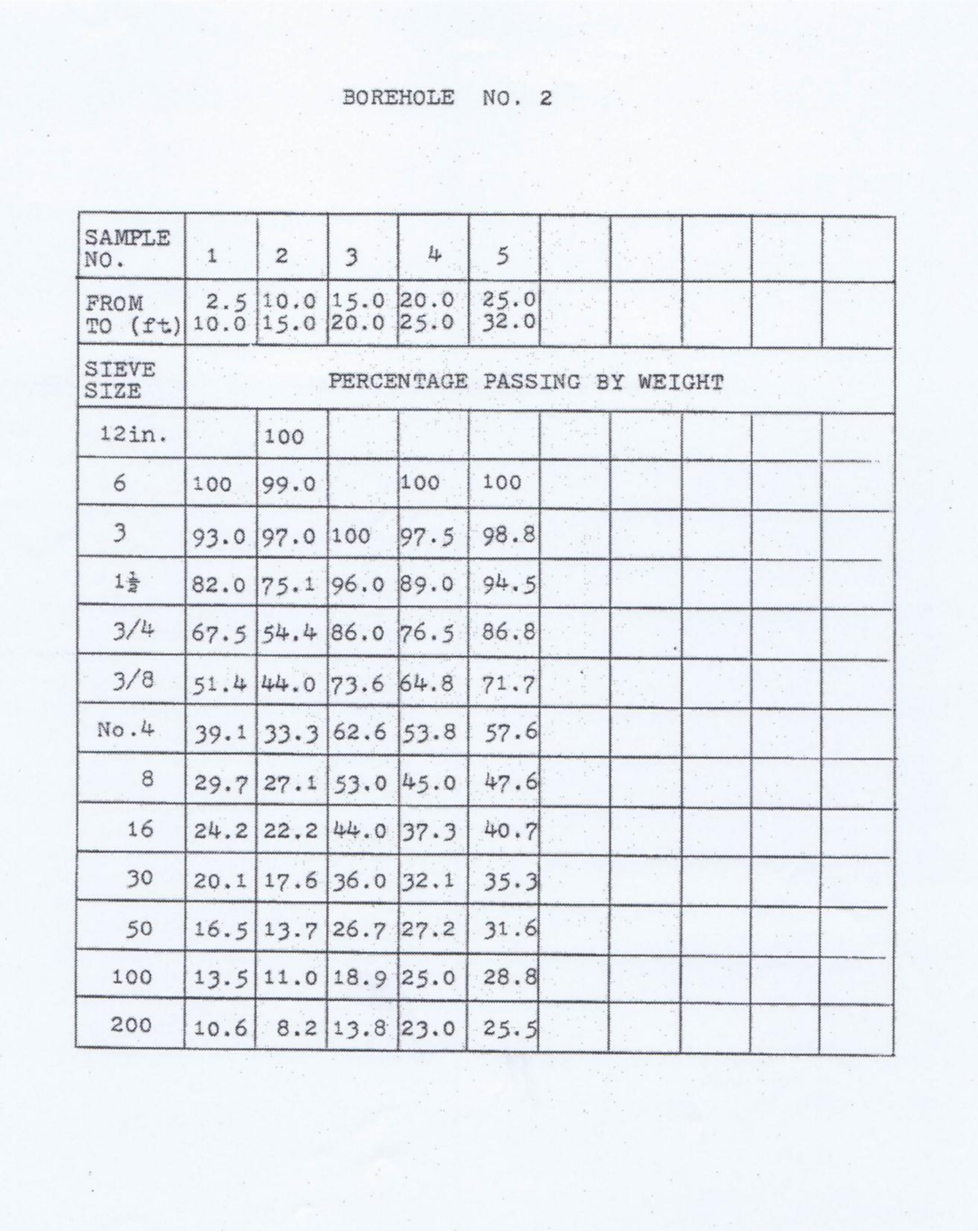
SCREEN 3.96–4.57m

DRAWN: AW
HARDEN ENVIRONMENTAL SERVICES LTD.
CHECKED: SD



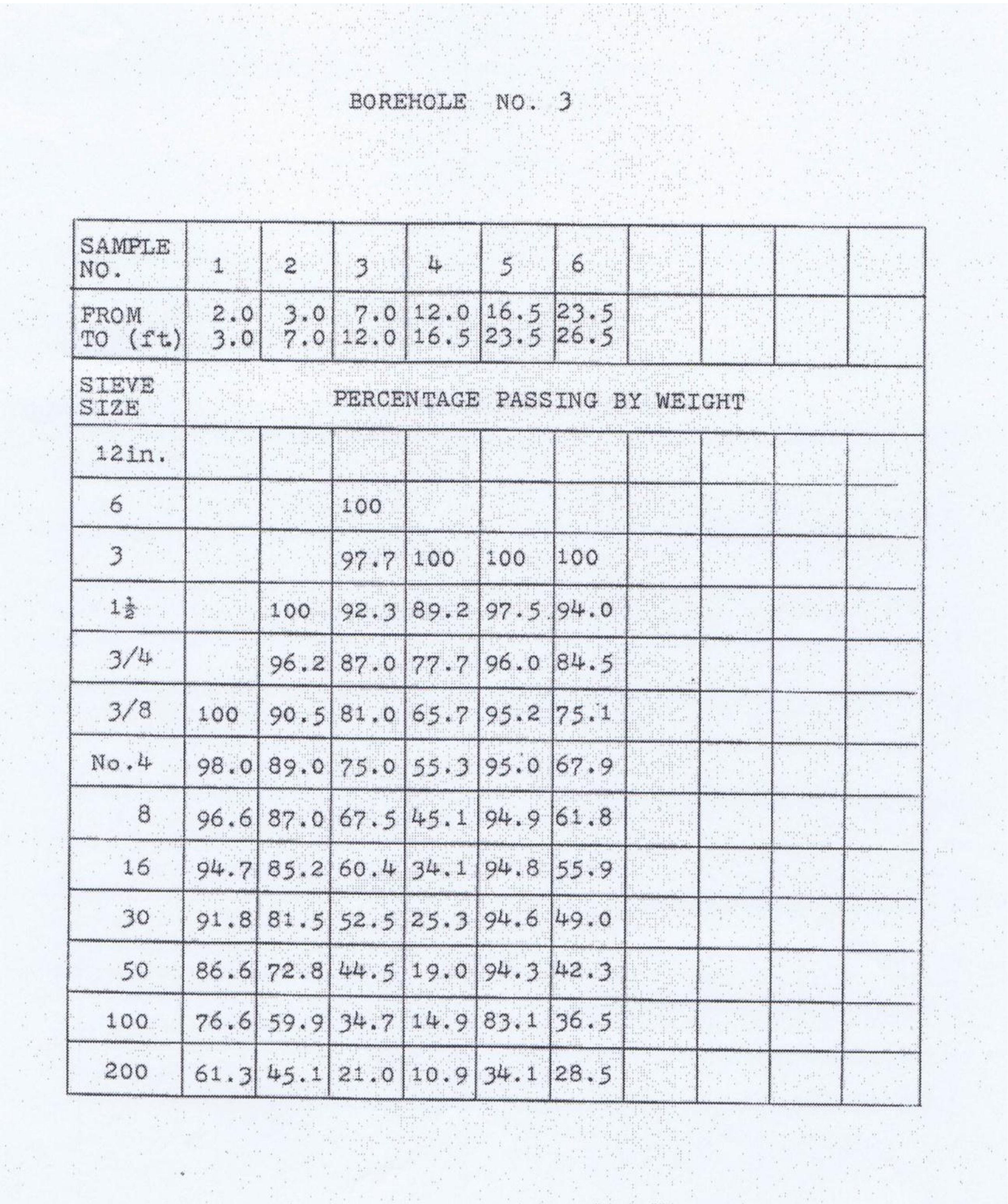
BOREHOLE NO. 1

SAMPLE NO.	1	2	3	4	5	6				
FROM TO (ft)	2.5 5.0	5.0 5.5	5.5 8.5	8.5 11.5	11.5 16.5	20.0 26.5				
SIEVE SIZE	PERCENTAGE PASSING BY WEIGHT									
12in.			100							
6			97.4	100						
3			93.6	98.5	100	100				
1½			87.3	89.0	95.0	97.5				
3/4			75.8	77.8	87.4	93.0				
3/8			62.0	70.4	74.8	91.5				
No.4	100	100	50.4	62.8	58.0	89.0				
8	99.8	85.1	42.3	56.4	46.0	87.3				
16	98.8	72.2	35.9	49.9	39.2	83.6				
30	96.7	62.6	29.8	43.7	33.7	75.0				
50	90.5	52.8	24.0	36.9	27.9	63.1				
100	65.1	42.6	17.7	30.1	22.1	43.8				
200	35.3	27.5	12.1	23.2	17.3	17.2				



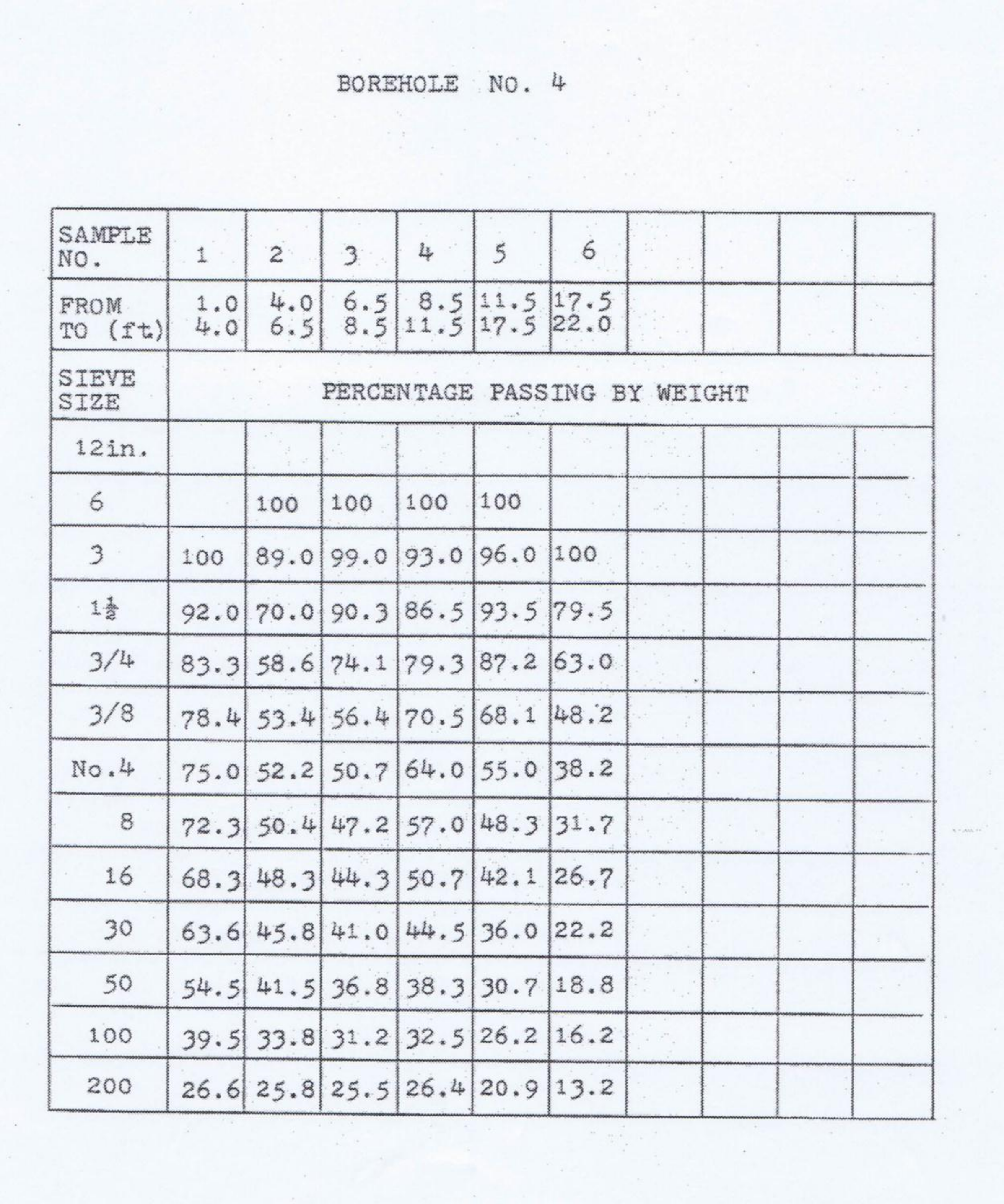
BOREHOLE NO. 2

SAMPLE NO.	1	2	3	4	5					
FROM TO (ft)	2.5 10.0	10.0 15.0	15.0 20.0	20.0 25.0	25.0 32.0					
SIEVE SIZE	PERCENTAGE PASSING BY WEIGHT									
12in.		100								
6	100	99.0		100	100					
3	93.0	97.0	100	97.5	98.8					
1½	82.0	75.1	96.0	89.0	94.5					
3/4	67.5	54.4	86.0	76.5	86.8					
3/8	51.4	44.0	73.6	64.8	71.7					
No.4	39.1	33.3	62.6	53.8	57.6					
8	29.7	27.1	53.0	45.0	47.6					
16	24.2	22.2	44.0	37.3	40.7					
30	20.1	17.6	36.0	32.1	35.3					
50	16.5	13.7	26.7	27.2	31.6					
100	13.5	11.0	18.9	25.0	28.8					
200	10.6	8.2	13.8	23.0	25.5					



BOREHOLE NO. 3

SAMPLE NO.	1	2	3	4	5	6				
FROM TO (ft.)	2.0 3.0	3.0 7.0	7.0 12.0	12.0 16.5	16.5 23.5	23.5 26.5				
SIEVE SIZE	PERCENTAGE PASSING BY WEIGHT									
12in.										
6			100							
3			97.7	100	100	100				
1½		100	92.3	89.2	97.5	94.0				
3/4		96.2	87.0	77.7	96.0	84.5				
3/8	100	90.5	81.0	65.7	95.2	75.1				
No.4	98.0	89.0	75.0	55.3	95.0	67.9				
8	96.6	87.0	67.5	45.1	94.9	61.8				
16	94.7	85.2	60.4	34.1	94.8	55.9				
30	91.8	81.5	52.5	25.3	94.6	49.0				
50	86.6	72.8	44.5	19.0	94.3	42.3				
100	76.6	59.9	34.7	14.9	83.1	36.5				
200	61.3	45.1	21.0	10.9	34.1	28.5				



BOREHOLE NO. 4

SAMPLE NO.	1	2	3	4	5	6				
FROM TO (ft)	1.0 4.0	4.0 6.5	6.5 8.5	8.5 11.5	11.5 17.5	17.5 22.0				
SIEVE SIZE	PERCENTAGE PASSING BY WEIGHT									
12in.										
6		100	100	100	100					
3	100	89.0	99.0	93.0	96.0	100				
1½	92.0	70.0	90.3	86.5	93.5	79.5				
3/4	83.3	58.6	74.1	79.3	87.2	63.0				
3/8	78.4	53.4	56.4	70.5	68.1	48.2				
No.4	75.0	52.2	50.7	64.0	55.0	38.2				
8	72.3	50.4	47.2	57.0	48.3	31.7				
16	68.3	48.3	44.3	50.7	42.1	26.7				
30	63.6	45.8	41.0	44.5	36.0	22.2				
50	54.5	41.5	36.8	38.3	30.7	18.8				
100	39.5	33.8	31.2	32.5	26.2	16.2				
200	26.6	25.8	25.5	26.4	20.9	13.2				

ENGLAND NAYLOR ENGINEERING LTD.

CONSULTING ENGINEERS
353 Bridge Street East
Kitchener, Ontario N2K 2Y5
519-741-1313
FAX 519-741-5422

November 20, 1996 0979L1.R04

FACSIMILE TRANSMISSION

Harden Environmental Services Ltd.
497 Exmoor Street
Waterloo, Ontario
N2K 3T8

Attention: Mr. Stan Denhoed, P.Eng.

Dear Sir:

**Re: Miscellaneous Laboratory Testing
for Harden Environmental Services Ltd.**

Attached are the grain size distribution curves (Figures 1 to 3) for the three soil samples delivered to our laboratory on November 13, 1996.

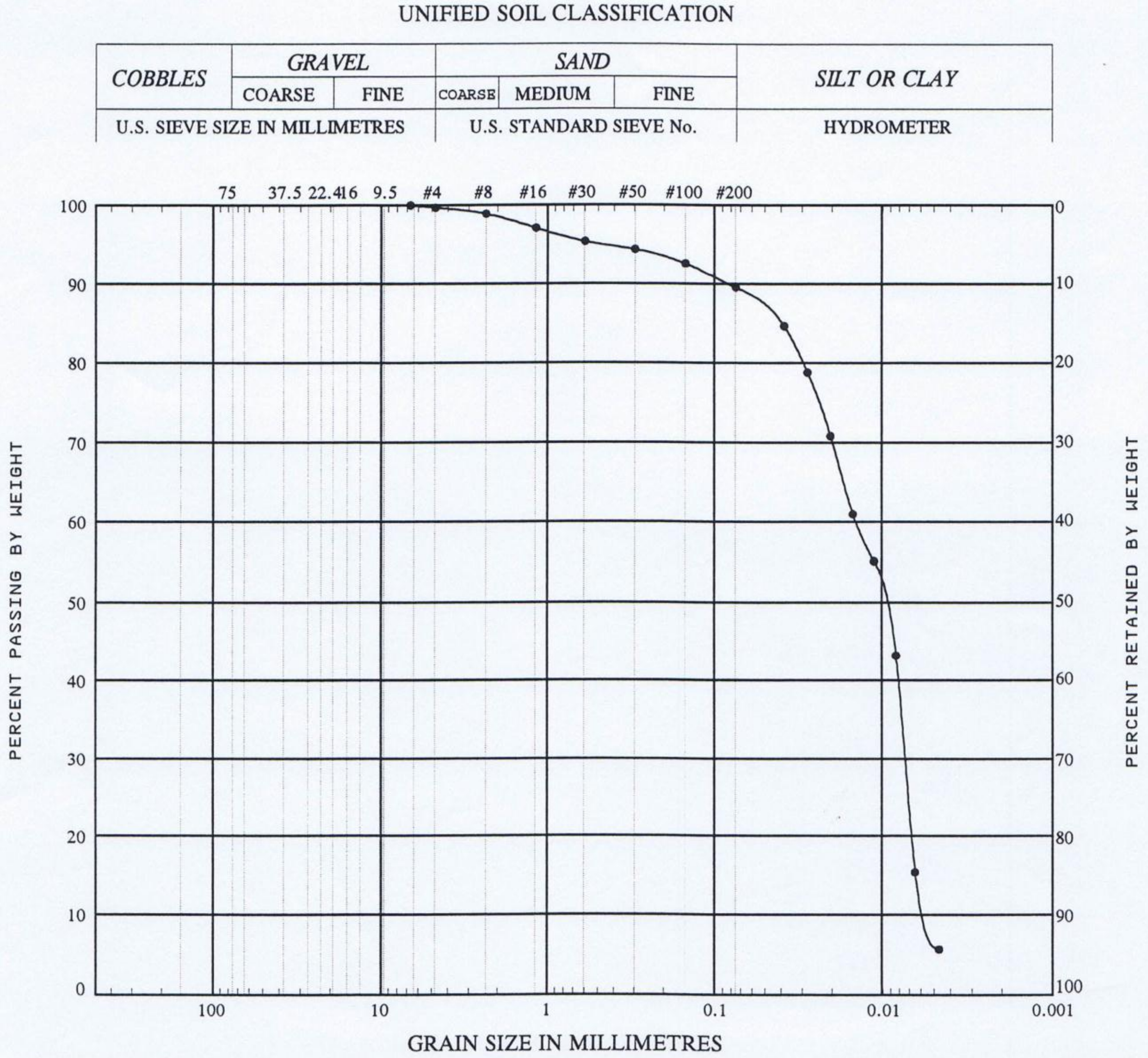
I trust that this information meets your present requirements. Should you have any questions or require additional testing, please do not hesitate to contact our office.

Yours very truly,

T. Salter

Tim Salter, C.E.T.

ta
Att.



PROJECT Miscellaneous Lab Testing for Harden Environmental Services

LOCATION

JOB NO. 0979L01

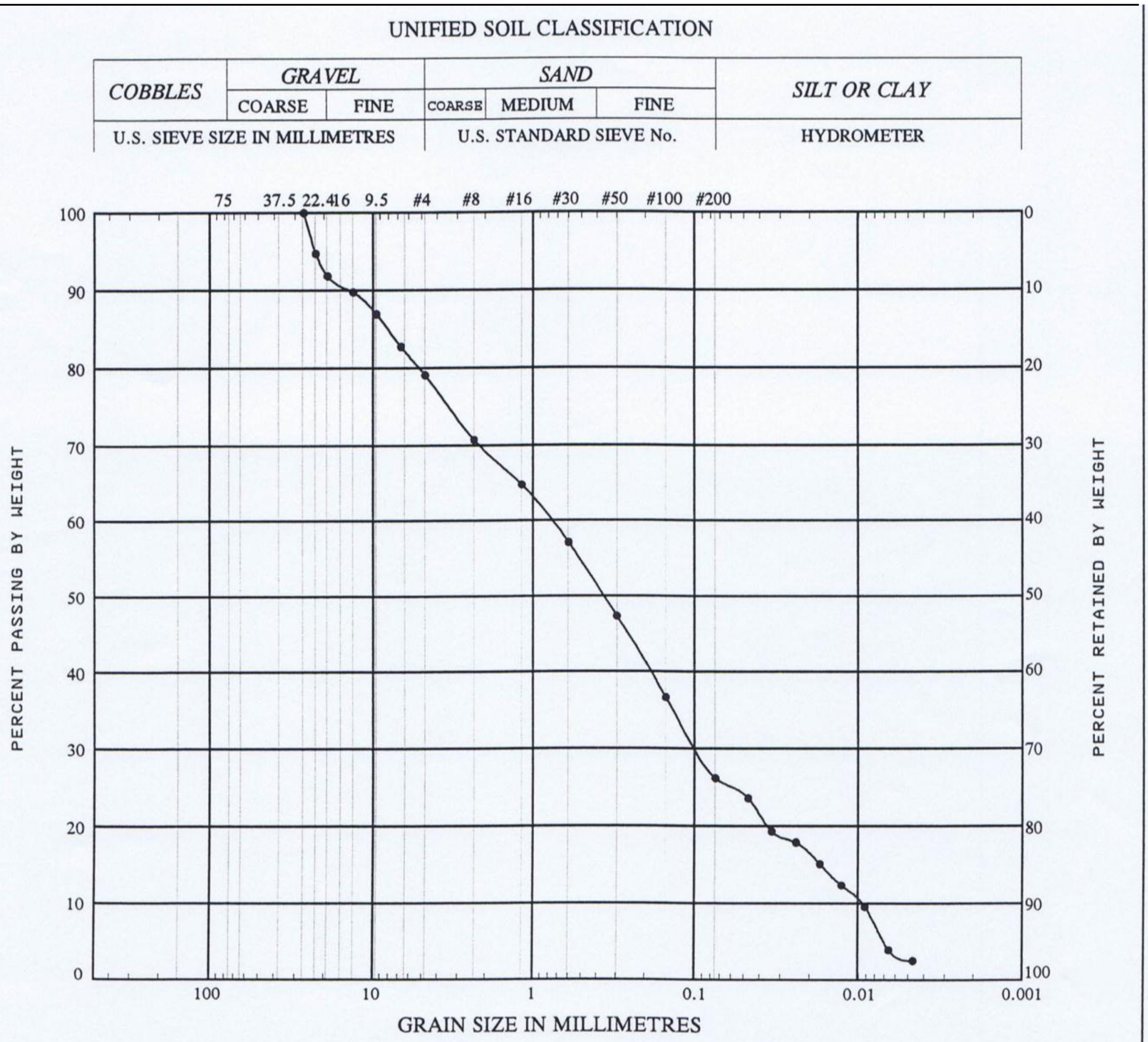
CURVE ID	BOREHOLE/ TEST PIT	SAMPLE NO.	DEPTH (m)	SOIL DESCRIPTION
●	TP1	3	5→7m	Silt, some sand

REMARKS

ENGLAND NAYLOR ENGINEERING LTD.
CONSULTING ENGINEERS

Figure No. 1

Appendix A **Grain Size Analysis**	**TP1 at 5-7 mbgs**



PROJECT Miscellaneous Lab Testing for Harden Environmental Services

LOCATION

JOB NO. 0979L01

CURVE ID	BOREHOLE/ TEST PIT	SAMPLE NO.	DEPTH (m)	SOIL DESCRIPTION
●	TP4	6	8m	Silty sand, some gravel

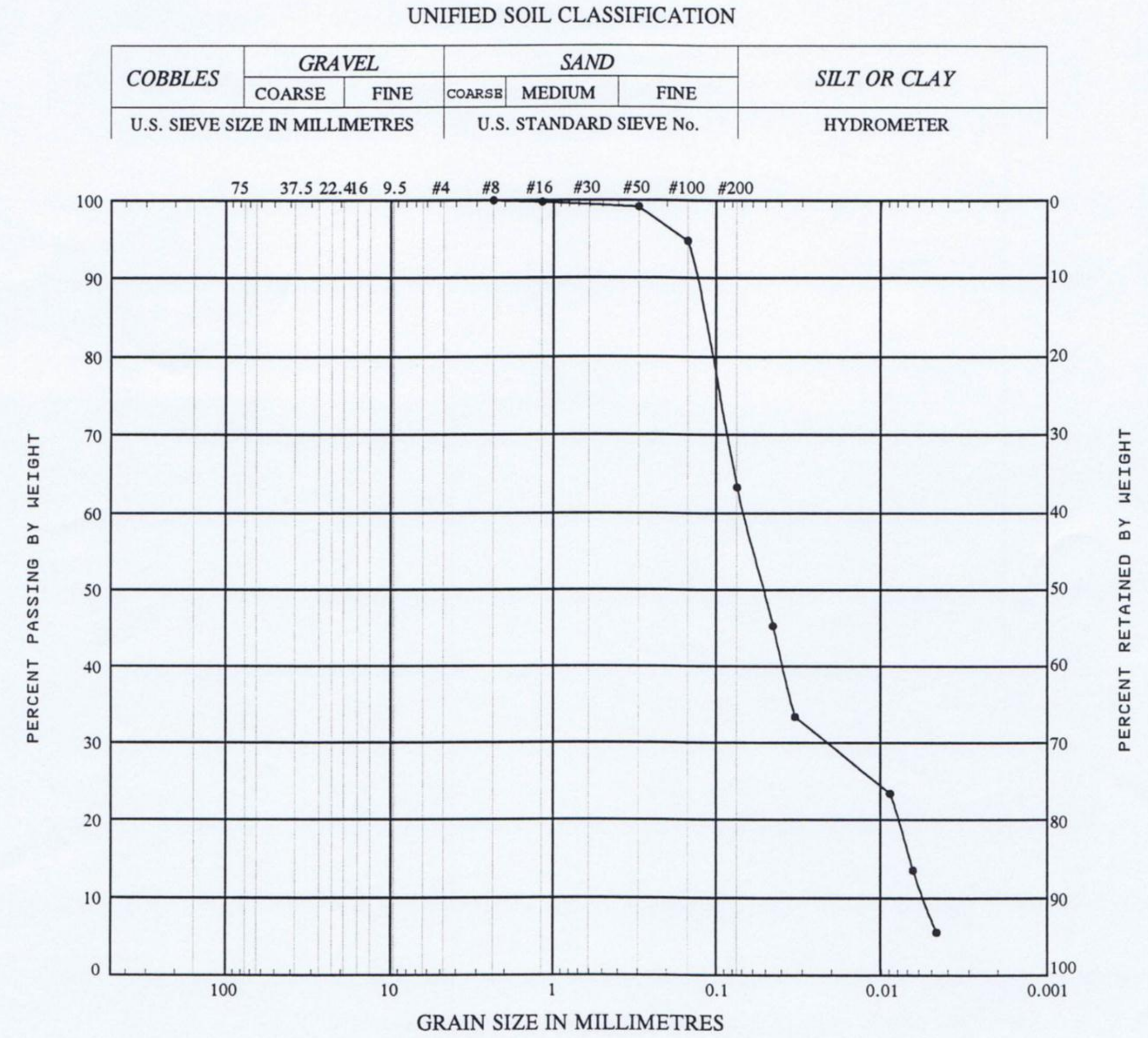
REMARKS

ENGLAND NAYLOR ENGINEERING LTD.
CONSULTING ENGINEERS

Figure No. 2

Appendix A
Grain Size Analysis

TP4 at 8 mbgs



PROJECT Miscellaneous Lab Testing for Harden Environmental Services

LOCATION

JOB NO. 0979L01

CURVE ID	BOREHOLE/ TEST PIT	SAMPLE NO.	DEPTH (m)	SOIL DESCRIPTION
●	Tp5	7	4m	Sand and silt

REMARKS

ENGLAND NAYLOR ENGINEERING LTD.
CONSULTING ENGINEERS

Figure No. 3

Appendix A
Grain Size Analysis

TP5 at 4 mbgs

Courtland

Courtland Engineering Consultants Inc.

260 Courtland Avenue East
Kitchener, Ontario
N2G 2V7

Geotechnical Division
(519) 579-3110
Fax (519) 579-1510

May 15, 1998

Harden Environmental Services Limited
497 Exmoor Street
Waterloo, Ontario
N2K 3T8

Attention: Ian Judd-Henry

Project No. G785

Dear Sir:

Re: Gradation Analysis 9506 SP1

As per your request, we have carried out gradation analysis testing on a soil sample submitted to our laboratory on May 14, 1998. The resulting gradation curve is presented on the attached sheet.

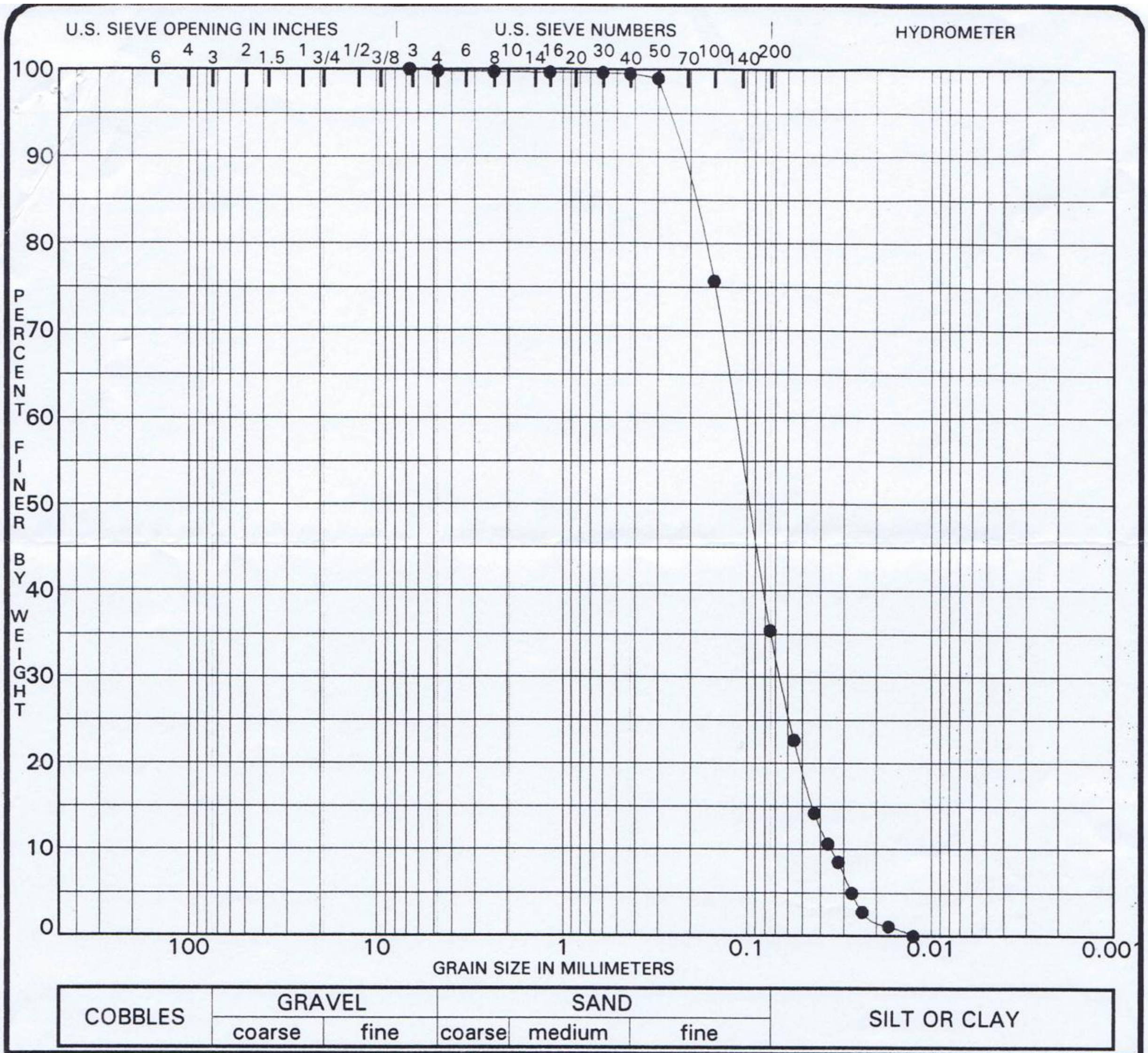
Please note that it is the producer's responsibility to ensure the consistency of the material supplied. Additional testing must be carried out if the gradation of the materials at the source varies from the sample submitted.

We trust that the information provided is sufficient for your present needs. If there are any questions, please contact the undersigned.

Yours truly
COURTLAND ENGINEERING CONSULTANTS INC.

Larry MacArthur

Larry MacArthur, P.Eng.
Designated Consulting Engineer



Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	G785-095 0.0	**FINE SILTY SAND**						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	G785-095 0.0	6.70	0.11	0.066	0.0352	0.2	64.4	35.4	

PROJECT **Harden Environmental Services Ltd. - 9506**
SP1 = TP2

JOB NO. **G785**
DATE **15/05/98**

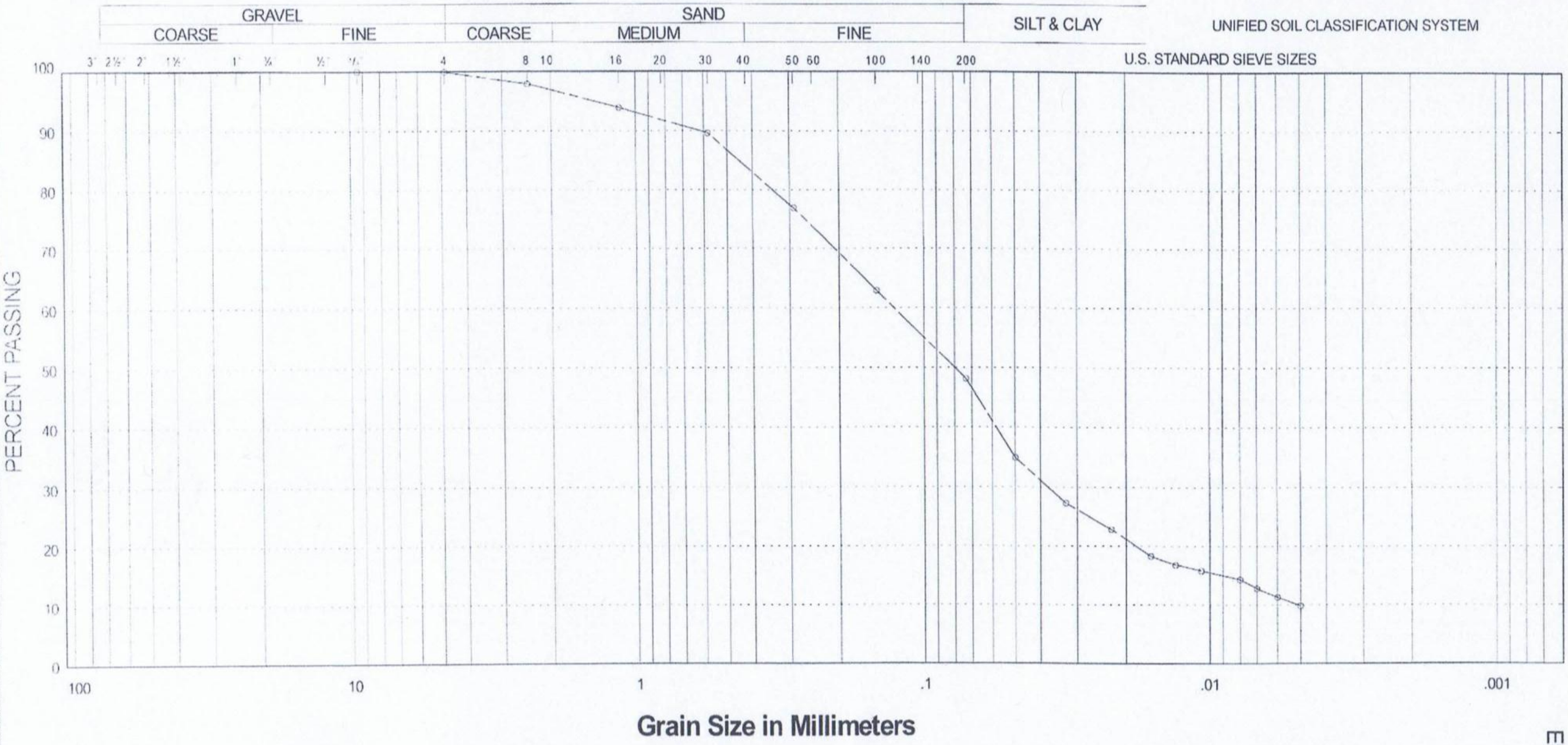
@0.55m.

GRADATION CURVES
Courtland Engineering Consultants Inc.
260 Courtland Ave E. Kitchener, On.

Appendix A **Grain Size Analysis**	**TP2 at 0.55 mbgs**

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3188-2-2



PROJECT: Harden Environmental Proj. No. 9506

LOCATION:

BOREHOLE N°:

SAMPLE N°: 149

DEPTH:

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SAND AND SILT, trace clay

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

ENCLOSURE N° 2

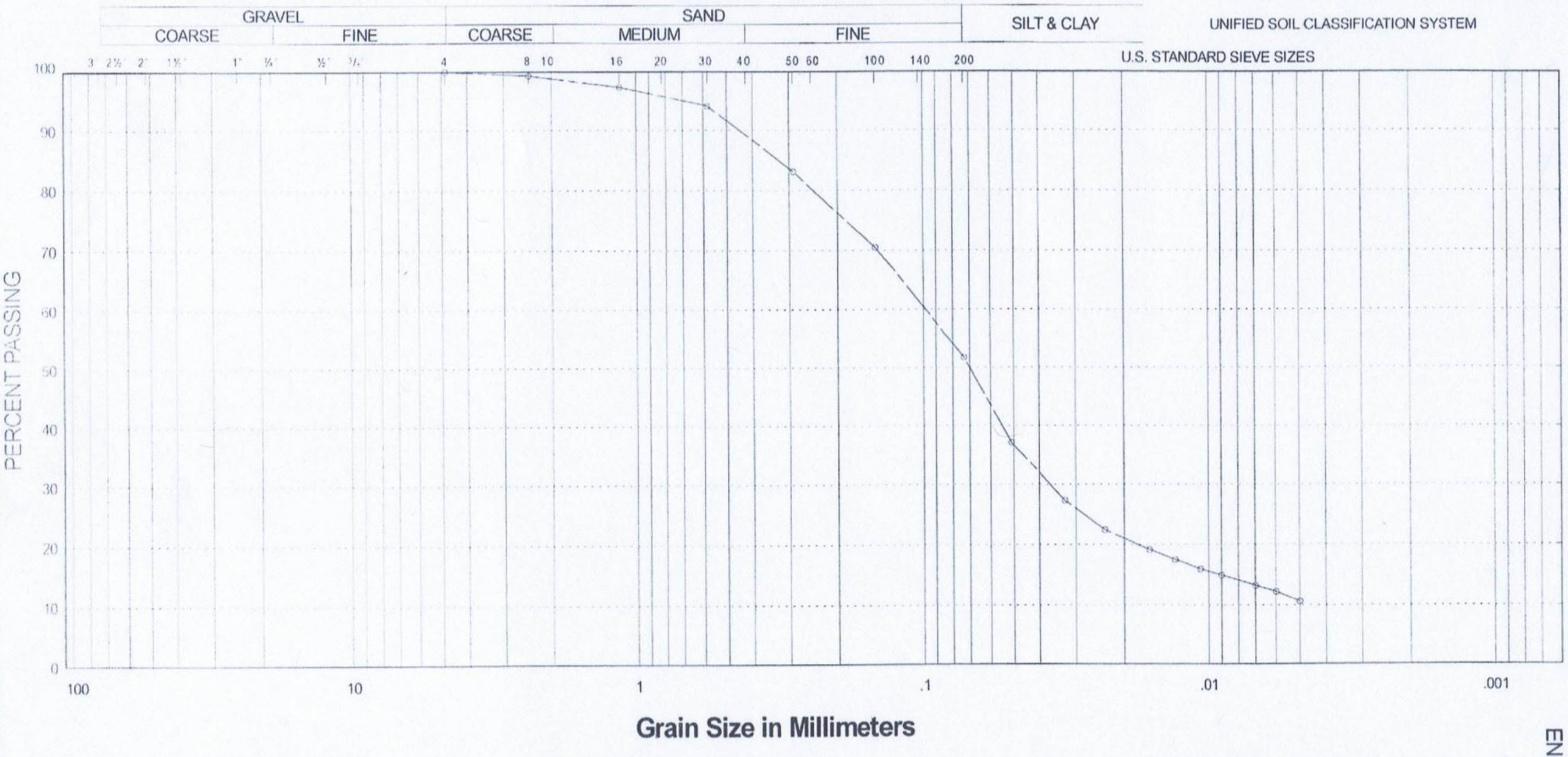
V. A. WOOD (GUELPH) INCORPORATED

Appendix A **Grain Size Analysis**	**Allen Wetland AW7 at 0.2-0.4 mbgs**

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3188-2-2

UNIFIED SOIL CLASSIFICATION SYSTEM



PROJECT: Harden Environmental Proj No. 9506

LOCATION:

BOREHOLE N°:

SAMPLE N°: 148

DEPTH:

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SAND AND SILT, some clay

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

ENCLOSURE N° 1

V. A. **WOOD (GUELPH) INCORPORATED**

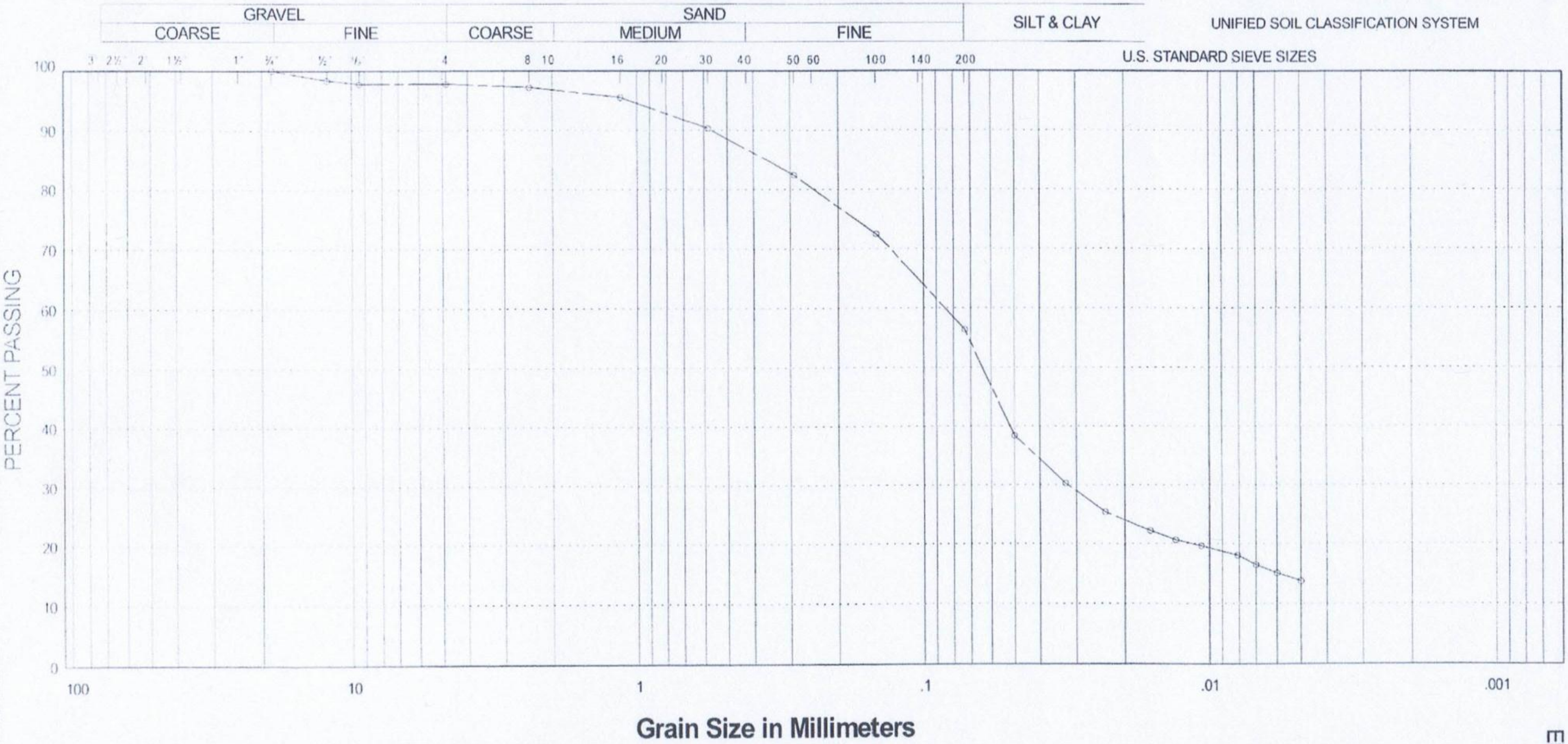
Appendix A
Grain Size Analysis

Allen Wetland AW8 at 0.2-0.4 mbgs

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3188-2-2

UNIFIED SOIL CLASSIFICATION SYSTEM



PROJECT: Harden Environmental Proj. No. 9506

LOCATION:

BOREHOLE N°:

SAMPLE N°: 190

DEPTH:

ELEVATION:

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILT AND SAND, some clay, trace gravel

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

ENCLOSURE N° 3

V. A. WOOD (GUELPH) INCORPORATED

Appendix A **Grain Size Analysis**	**Allen Wetland AW11 at 0.2-0.4 mbgs**

Table A1: Monitoring Station Completion Details

Monitoring Station	Type	Date Installed	Inside Diameter (in)	Stick-up (m)	Ground Elevation (mAMSL)	Reference Point Elevation (mAMSL)	Depth (mbgs)	Base of Screen Elevation (mAMSL)	Top of Screen Elevation (mAMSL)	Screen Length (m)
M1D	Drilled Groundwater Monitor	May-1990	2.00	0.87	358.83	359.70	12.80	347.57	349.07	1.50
M1S	Drilled Groundwater Monitor	Dec-2010	2.00	1.00	358.84	359.84	9.35	350.18	350.74	0.56
M2	Drilled Groundwater Monitor	May-1990	2.00	0.94	362.45	363.39	55.47	344.35	345.85	1.50
M3	Drilled Groundwater Monitor	May-1990	2.00	0.93	359.27	360.20	11.13	350.01	351.51	1.50
M4	Drilled Groundwater Monitor	May-1990	2.00	0.74	355.89	356.63	18.59	339.09	340.59	1.50
M5	Drivepoint Groundwater Monitor	Nov-1996	1.25	1.07	358.64	359.71	5.94	352.70	353.30	0.60
M6	Drivepoint Groundwater Monitor	Nov-1996	1.25	1.13	354.97	356.10	1.98	352.99	353.59	0.60
M7	Drivepoint Groundwater Monitor	Apr-1998	1.25	1.14	352.43	353.57	2.82	349.61	350.21	0.60
M7R	Drivepoint Groundwater Monitor	Nov-2010	1.25	0.82	352.45	353.27	3.14	349.31	349.91	0.60
M8	Drivepoint Groundwater Monitor	Apr-1998	1.25	1.16	356.30	357.46	1.55	354.75	355.35	0.60
M9	Drivepoint Groundwater Monitor	Apr-1998	1.25	1.35	355.67	357.02	2.61	353.07	353.67	0.60
M9R	Drivepoint Groundwater Monitor	Nov-2010	1.25	1.03	355.67	356.70	2.92	352.75	353.35	0.60
M10	Drivepoint Groundwater Monitor	Apr-1998	1.25	1.14	355.13	356.27	0.93	354.20	354.80	0.60
M11	Drilled Groundwater Monitor	Dec-2010	2.00	0.86	358.57	359.43	9.30	349.91	351.43	1.50
M12	Drilled Groundwater Monitor	Dec-2010	2.00	0.89	362.00	362.89	8.84	353.69	355.21	1.50
M13S	Drilled Groundwater Monitor	Dec-2010	2.00	0.99	356.78	357.77	4.37	352.64	354.16	1.50
M13D	Drilled Groundwater Monitor	Dec-2010	2.00	0.90	356.75	357.65	10.06	346.91	348.43	1.50
M14S	Drilled Groundwater Monitor	Dec-2010	2.00	0.98	354.64	355.62	4.27	350.58	350.88	0.30
M14D	Drilled Groundwater Monitor	Dec-2010	2.00	0.78	354.50	355.28	7.62	348.56	348.86	0.30
TP1	Test Pit Location With Drivepoint Groundwater Monitor	Sep-1996	1.25	1.07	355.35	356.41	4.60	350.75	351.66	0.91
TP2	Test Pit Location With Drivepoint Groundwater Monitor	Sep-1996	1.25	1.37	354.66	356.03	5.08	349.58	350.49	0.91
TP3	Test Pit Location	Sep-1996	n/a	n/a	358.45	n/a	8.00	n/a	n/a	n/a
TP4	Test Pit Location	Sep-1996	n/a	n/a	n/a	n/a	8.00	n/a	n/a	n/a
TP5	Test Pit Location With Drivepoint Groundwater Monitor	Sep-1996	1.25	0.96	355.68	356.64	7.46	348.22	349.13	0.91
TP6	Test Pit Location	Sep-1996	n/a	n/a	359.30	n/a	7.00	n/a	n/a	n/a
TP7	Test Pit Location	Sep-1996	n/a	n/a	356.25	n/a	8.00	n/a	n/a	n/a
TP8	Test Pit Location With Drivepoint Groundwater Monitor	Feb-2012	1.25	0.91	359.45	360.36	6.07	353.38	353.99	0.61
TP9	Test Pit Location With Drivepoint Groundwater Monitor	Feb-2012	1.25	0.94	356.65	357.59	4.57	352.08	352.69	0.61
MPN-1	Mini-Piezometer	Jul-2009	0.75	0.84	354.67	355.51	2.07	352.60	352.69	0.09
MPN-2	Mini-Piezometer	Jul-2009	0.75	1.29	355.29	356.58	1.62	353.67	353.76	0.09
MPE-1	Mini-Piezometer	Jul-2009	0.75	0.79	354.71	355.50	2.12	352.59	352.68	0.09
MPE-2	Mini-Piezometer	Jul-2009	0.75	0.79	355.29	356.08	2.12	353.17	353.26	0.09
MPS-1	Mini-Piezometer	Jul-2009	0.75	0.77	354.73	355.50	2.14	352.59	352.68	0.09
MPS-2	Mini-Piezometer	Jul-2009	0.75	0.68	355.54	356.22	2.23	353.31	353.40	0.09
MPW-1	Mini-Piezometer	Jan-2011	0.75	0.38	354.90	355.28	2.26	352.64	352.73	0.09
MPW-2	Mini-Piezometer	Jan-2011	0.75	0.76	355.09	355.85	1.88	353.21	353.30	0.09

HARDEN
ENVIRONMENTAL

Table A1: Monitoring Station Completion Details

Monitoring Station	Type	Date Installed	Inside Diameter (in)	Stick-up (m)	Ground Elevation (mAMSL)	Reference Point Elevation (mAMSL)	Depth (mbgs)	Base of Screen Elevation (mAMSL)	Top of Screen Elevation (mAMSL)	Screen Length (m)
MP1	Mini-Piezometer	Nov-2010	0.75	1.14	355.81	356.95	3.61	352.20	352.29	0.09
MP2	Mini-Piezometer	Nov-2010	0.75	0.44	356.95	357.38	4.32	352.63	352.72	0.09
MP3	Mini-Piezometer	Nov-2010	0.75	0.75	359.80	360.55	4.00	355.80	355.89	0.09
MP4	Mini-Piezometer	Nov-2010	0.75	0.76	359.23	359.99	3.99	355.24	355.33	0.09
SW1	Surface Water Gauge	Aug-1996	n/a	n/a	n/a	355.34	n/a	n/a	n/a	n/a
SW2	Surface Water Gauge	Aug-1996	n/a	n/a	n/a	355.28	n/a	n/a	n/a	n/a
SW3-D	Surface Water Gauge and Streamflow Measurement	Aug-1996	n/a	n/a	349.04	351.02	n/a	n/a	n/a	n/a
SW3-U	Surface Water Gauge and Streamflow Measurement	Aug-1996	n/a	n/a	n/a	351.96	n/a	n/a	n/a	n/a
SW3A/SW8	Streamflow Measurement	Mar-2009	n/a	n/a	n/a	355.33	n/a	n/a	n/a	n/a
SW4	Surface Water Gauge and Streamflow Measurement	Aug-1996	n/a	n/a	358.87	360.52	n/a	n/a	n/a	n/a
SW5	Surface Water Gauge	Aug-1996	n/a	n/a	354.72	355.66	n/a	n/a	n/a	n/a
SW6	Surface Water Gauge	Oct-2001	n/a	n/a	n/a	354.96	n/a	n/a	n/a	n/a
SW7	Surface Water Gauge and Streamflow Measurement	Oct-2001	n/a	n/a	n/a	356.46	n/a	n/a	n/a	n/a

HARDEN
ENVIRONMENTAL

Table A2: Soil Descriptions - Allen Wetland and Northwest Wetland

Location	Sample ID	Depth	Major Munsell Colour	Minor Munsell Colour	Soil Description
Allen Wetland	AW1	0.6 - 1.1 m	HUE 10YR 4/3 - Brown	HUE 10YR 4/3 - Brown	Fine Sand with silt with medium sand, no gravel, no tiny stones, brown, saturated, uniform
Allen Wetland	AW2	1.0 - 1.25 m	HUE 10YR 5/4 - Yellowish Brown	HUE 10YR 4/3 - Brown	Fine Sand with silt with medium sand, no gravel, no tiny stones, yellowish brown, saturated, uniform
Allen Wetland	AW3	1.0 - 1.25 m	HUE 10YR 5/6 - Yellowish Brown	HUE 10YR 3/1 - very dark gray	Fine Sandy Silt, yellowish brown with no tiny stones, no gravel, uniform
Allen Wetland	AW5	0.5 - 1.0 m	HUE 10YR 4/3 - Brown	HUE 10YR 5/6 - yellowish brown	Fine Sandy Silt, brown with few tiny stones, no gravel, uniform
Allen Wetland	AW5	1.0 - 1.25 m	HUE 10YR 3/4 - Dark Yellowish Brown	HUE 10YR 6/6 - brownish yellow	Fine Sandy Silt, brown with few gravel, trace tiny stones, saturated
Allen Wetland	AW6	0.3 - 0.5 m	HUE 10YR 4/3 - Brown	HUE 10YR 3/2 - very dark grayish brown	Silty Fine Sand with some gravel, brown with few tiny rounded stones
Allen Wetland	AW7	0.2 - 0.4 m	HUE 2.5Y 6/4 - Light Yellowish Brown	HUE 2.5Y 3/1 - Very Dark Gray	Silt and Fine Sand, yellowish brown, with some gravel, trace tiny stones
Allen Wetland	AW7	0.4 - 0.5 m	HUE 2.5Y 6/4 - Light Yellowish Brown	HUE 2.5Y 5/1 - Gray	Fine Sandy Silt, yellowish brown with few tiny stones, some gravel, uniform, saturated
Allen Wetland	AW8	0.2 - 0.4 m	HUE 2.5Y 4/1 - Dark Gray	HUE 2.5Y 6/6 - Olive Yellow	Fine Sandy Silt, yellowish gray with gravel, some tiny stones, saturated
Allen Wetland	AW9	0.5 - 1.0 m	HUE 2.5Y 4/1 - Dark Gray	HUE 2.5Y 5/1 - Gray	Fine Sandy Silt, gray with few tiny stones, some gravel, uniform, saturated
Allen Wetland	AW10	0.5 - 1.0 m	HUE 10YR 4/4 - Dark Yellowish Brown	HUE 10YR 4/1 - Dark Gray	Silt and Fine Sand, brown, with some gravel, trace tiny stones, saturated
Allen Wetland	AW11	0.2 - 0.4 m	HUE 7.5YR 4/6 - Strong Brown	HUE 7.5YR 4/1 - Dark Gray	Fine Sandy Silt, brown, with few gravel, trace tiny stones, moderate plasticity
Allen Wetland	AW11	0.4 - 0.6 m	HUE 2.5Y 5/4 - Light Olive Brown	HUE 2.5Y 6/6 - Olive Yellow	Fine Sandy Silt, brown, with gravel, with tiny stones, saturated, moderate plasticity
Allen Wetland	AW12	0.2-0.4 m below streambed	HUE 2.5Y 4/2 - Dark Grayish Brown	HUE 2.5Y 2.5/1 - Black	Fine Sandy Silt, brown, with trace gravel, few stones, low-moderate plasticity
Northwest Wetland	SP1 S1-1	0 - 0.37 m	HUE 10YR 2/1 - Black	HUE 10YR 2/1 - Black	Organics, blackish, silt with very fine sand
Northwest Wetland	SP1 S1-2	0.37 - 0.58 m	HUE 10YR 4/2 - Dark Grayish Brown	HUE 10YR 4/4 - Dark Yellowish Brown	Fine sand brown and silt, uniform, no stones, saturated below 0.3 mbgs
Northwest Wetland	SP1 S2	0.58 - 0.88 m	HUE 10YR 4/4 - Dark Yellowish Brown	HUE 10YR 5/6 - yellowish brown	Fine brown sand and silt, increased plasticity, with few gravel in top 5 cm and no gravel below, saturated
Northwest Wetland	SP1 S3-1	0.88 - 1.02 m	HUE 10YR 5/4 - yellowish brown	HUE 10YR 5/6 - yellowish brown	Silty Fine brown Sand, with trace gravel, no stones, saturated
Northwest Wetland	SP1 S3-2	1.02 - 1.12 m	HUE 10YR 5/3 - brown	HUE 10YR 5/4 - yellowish brown	Silty Fine-medium brown Sand, with few gravel, with trace tiny stones, saturated
Northwest Wetland	SP1 S3-3	1.12 - 1.18 m	HUE 10YR 5/3 - brown	HUE 10YR 3/1 - very dark gray	Silty Medium-fine brown sand, with some coarse sand, with trace gravel, with no stones, saturated
Northwest Wetland	SP1 S4-1	1.12 - 1.32 m	HUE 2.5Y 5/4 - light olive brown	HUE 2.5Y 6/4 - light yellowish brown	Silty Medium-fine brown sand, with some coarse sand, with some gravel, with few stones, saturated
Northwest Wetland	SP1 S4-2	1.32 - 1.54 m	HUE 2.5Y 6/3 - light yellowish brown	HUE 2.5Y 6/2 - light brownish gray	Silty Fine brown Sand, with trace gravel, no stones, saturated

Table A2: Soil Descriptions - Allen Wetland and Northwest Wetland

Location	Sample ID	Depth	Major Munsell Colour	Minor Munsell Colour	Soil Description
Northwest Wetland	SP1 S5-1	1.54 - 1.62 m	HUE 2.5Y 5/4 - light olive brown	HUE 2.5Y 5/2 - grayish brown	Silty Fine brown Sand, with trace gravel, no stones, saturated
Northwest Wetland	SP1 S5-2	1.62 - 2.00 m	HUE 2.5Y 5/3 - light olive brown	HUE 2.5Y 6/4 - light yellowish brown	Silty Medium-fine brown sand, with some coarse sand, with some gravel, with few stones, saturated
Northwest Wetland	SP2 S1-1	0 - 0.44 m	HUE 10YR 2/1 - Black	HUE 10YR 2/1 - Black	Organics, blackish, silt with very fine sand
Northwest Wetland	SP2 S1-2	0.44 - 0.6 m	HUE 10YR 5/2 - Grayish Brown	HUE 10YR 4/1 - Dark Gray	Fine brown sand and silt, no gravel, no stones, uniform
Northwest Wetland	SP2 S2-1	0.6 - 0.75 m	HUE 10YR 4/2 -Dark Grayish Brown	HUE 10YR 4/2 -Dark Grayish Brown	Silty fine brown sand, with no gravel, trace tiny stones, uniform, saturated
Northwest Wetland	SP2 S2-2	0.75 - 0.96 m	HUE 2.5Y 4/2 - Dark Grayish Brown	HUE 2.5Y 5/3 - light olive brown	Silty fine gray sand, with no gravel, trace tiny stones, uniform, saturated
Northwest Wetland	SP2 S3-1	0.96 - 1.05 m	HUE 2.5Y 4/4 - Olive Brown	HUE 2.5Y 6/6 - Olive Yellow	Silty fine brown sand, with few gravel, with trace tiny stones, saturated
Northwest Wetland	SP2 S3-2	1.34 - 1.54 m	HUE 2.5Y 5/6 - Light Olive Brown	HUE 2.5Y 6/6 - Olive Yellow	Fine sandy silt, brown, with few coarse sand, with trace tiny stones, saturated, low-moderate plasticity
Northwest Wetland	SP2 S4	1.54 - 1.62 m	HUE 2.5Y 5/4 - Light Olive Brown	HUE 2.5Y 6/4 - Light Yellowish Brown	Fine sandy silt, brown, with few coarse sand, with trace tiny stones, saturated
Northwest Wetland	SP2 S5	1.62 - 1.67 m	HUE 2.5Y 6/2 - Light Brownish Gray	HUE 2.5Y 6/3 - Light Yellowish Brown	Fine sandy silt, light gray, with some gravel, with trace tiny stones, saturated
Northwest Wetland	SP3 S1	0.3 -0.45 m	HUE 10YR 2/1 - Black	HUE 10YR 3/2 -Very Dark Grayish Brown	Organics, blackish, silt with very fine sand
Northwest Wetland	SP3 S2	0.45 - 0.6 m	HUE 10YR 2/1 - Black	HUE 10YR 3/2 -Very Dark Grayish Brown	Organics, blackish, silt with very fine sand, slight increase in plasticity
Northwest Wetland	SP3 S3	0.6 - 0.7 m	HUE 2.5Y 5/3 - Light Olive Brown	HUE 2.5Y 4/3 - Olive Brown	Fine Sandy Silt, brown, with no gravel, with trace tiny stones, uniform
Northwest Wetland	SP3 S4	0.7 - 0.8 m	HUE 2.5Y 5/3 - Light Olive Brown	HUE 2.5Y 5/4 - Light Olive Brown	Fine Sandy Silt, brown, with no gravel, with some medium sand, with trace tiny stones
Northwest Wetland	SP3 S5	0.8 - 0.9 m	HUE 2.5Y 5/3 - Light Olive Brown	HUE 2.5Y 4/2 - Dark Grayish Brown	Silty fine sand, brown gray, with few gravel, no tiny stones, saturated
Northwest Wetland	SP3 S6	0.9 - 1.3 m	HUE 2.5Y 6/4 - Light Yellowish Brown	HUE 2.5Y 5/4 - Light Olive Brown	Silty fine sand, yellowish brown, with few gravel, no tiny stones, saturated
Northwest Wetland	SP3 S7-1	1.3 - 1.5 m	HUE 2.5Y 5/3 - Light Olive Brown	HUE 2.5Y 5/4 - Light Olive Brown	Fine sand and silt, brown, with few gravel, trace tiny stones, saturated
Northwest Wetland	SP3 S7-2	1.5 - 1.65 m	HUE 2.5Y 6/3 - Light Yellowish Brown	HUE 2.5Y 6/2 - Light Brownish Gray	Fine sandy silt, gray with few gravel, no tiny stones
Northwest Wetland	SP3 S8	1.65 - 2.0 m	HUE 2.5Y 5/3 - Light Olive Brown	HUE 2.5Y 6/4 - Light Yellowish Brown	Silty fine sand, brown, with few tiny stones, no gravel
Northwest Wetland	SP4 S1	0.9 - 1.3 m	HUE 2.5Y 5/3 - Light Olive Brown	HUE 2.5Y 6/2 - Light Brownish Gray	Fine sandy silt, brown, no gravel, trace tiny stones, saturated
Northwest Wetland	SP4 S2	1.3 - 1.55 m	HUE 2.5Y 5/3 - Light Olive Brown	HUE 2.5Y 6/3 - Light Yellowish Brown	Fine silty sand, brown, with some gravel, with some tiny stones, with trace coarse sand, saturated

Table A3: Summary of Grain Size Analysis

BH1 (M1D) % Passing By Weight					BH2 (M2) % Passing By Weight					BH3 (M3) % Passing By Weight					BH4 (M4) % Passing By Weight				
Sample No.	mbgs		Sand and Gravel	Silt or Clay	Sample No.	mbgs		Sand and Gravel	Silt or Clay	Sample No.	mbgs		Sand and Gravel	Silt or Clay	Sample No.	mbgs		Sand and Gravel	Silt or Clay
1	From	0.76	64.7	35.3	1	From	0.76	89.4	10.6	1	From	0.61	38.7	61.3	1	From	0.30	73.4	26.6
	To	1.52				To	3.05				To	0.91				To	1.22		
2	From	1.52	72.5	27.5	2	From	3.05	91.8	8.2	2	From	0.91	54.9	45.1	2	From	1.22	74.2	25.8
	To	1.68				To	4.57				To	2.13				To	1.98		
3	From	1.68	87.9	12.1	3	From	4.57	86.2	13.8	3	From	2.13	79.0	21.0	3	From	1.98	74.5	25.5
	To	2.59				To	6.10				To	3.66				To	2.59		
4	From	2.59	76.8	23.2	4	From	6.10	77.0	23.0	4	From	3.66	89.1	10.9	4	From	2.59	73.6	26.4
	To	3.51				To	7.62				To	5.03				To	3.51		
5	From	3.51	82.7	17.3	5	From	7.62	74.5	25.5	5	From	5.03	65.9	34.1	5	From	3.51	79.1	20.9
	To	5.03				To	9.75				To	7.16				To	5.33		
6	From	6.10	82.8	17.2						6	From	7.16	71.5	28.5	6	From	5.33	86.8	13.2
	To	8.08									To	8.08				To	6.71		

			% Passing By Weight	
Sample	From (mbgs)	To (mbgs)	Sand and Gravel	Silt or Clay
TP1	5	7	10.5	89.5
TP2	0.55	0.55	64.6	35.4
TP4	8	8	74.0	26.0
TP5	4	4	36.5	63.5
AW S1	0.2	0.4	48.8	51.2
AW S2	0.2	0.4	52.2	47.8
AW S3	0.3	0.5	43.8	56.2

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Table A4: Top of Silt/Silt Till

Top of Silt/Silt Till		
Monitor Location	Elevation (mAMSL)	Silt Thickness (Metres)
M13	352.18	1.98
M14	351.45	1.67
TP2	349.61	1.00
M1	351.21	1.68

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Appendix B

Water Level Monitoring Data

Table B1: Groundwater Levels (Metres Below Top of Reference Point)
Table B2: Groundwater Elevations (Metres Above Mean Sea Level)
Table B3: Surface Water Levels (Metres Below Top of Reference Point)
Table B4: Surface Water Elevations (Metres Above Mean Sea Level)
Monitoring Station Hydrographs

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	17-Apr-95	01-May-95	17-May-95	27-Jun-95	11-Jul-95	01-Aug-95	18-Oct-95	04-Dec-95	30-Jan-96	11-Mar-96	20-Jun-96
M1D	**359.70**	8.17	8.11	8.07	8.19	8.27	8.35	8.6	8.23	8	7.9	7.82
M2	**363.39**	12.45	12.37	12.3	12.67	12.72	12.87	13.33	12.64	12.1	12.1	12.08
M3	**360.20**	10.63	10.3	10.29	10.31	10.31	10.3	10.33	10.32	10.28	10.28	10.29
M4	**356.63**	10.2	10.12	9.95	10.3	10.42	10.7	10.83	10.2	9.95	9.98	9.75
M5	**359.71**											
M6 in	**356.10**											
M6 out	**356.10**											
M7	**353.27**											
M8	**357.46**											
M9	**356.70**											
M10 in	**356.27**											
M10 out	**356.27**											
TP1	**356.41**											
TP2 in	**356.03**											
TP2 out	**356.03**											
TP5	**356.64**											
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**											
MPN-1 out	**355.51**											
MPN-2 in	**356.58**											
MPN-2 out	**356.58**											
MPE-1 in	**355.50**											
MPE-1 out	**355.50**											
MPE-2 in	**356.08**											
MPE-2 out	**356.08**											
MPS-1 in	**355.50**											
MPS-1 out	**355.50**											
MPS-2	**356.22**											
MPW-1 in	**355.41**											
MPW-1 out	**355.41**											
MPW-2 in	**355.99**											
MPW-2 out	**355.99**											
MP1	**356.95**											
MP2	**357.38**											
MP3	**360.55**											
MP4	**359.99**											
M1-S	**359.84**											
M11	**359.43**											
M12	**362.89**											
M13-S	**357.77**											
M13-D	**357.65**											
M14-S in	**355.62**											
M14-S out	**355.62**											
M14-D	**355.28**											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	02-Aug-96	04-Sep-96	08-Nov-96	21-Nov-96	14-May-97	26-Jun-97	15-Jul-97	14-Oct-97	17-Dec-97	06-Feb-98	31-Mar-98
M1D	**359.70**	8.14	8.3	8.13	8.12	7.82	8.08	8.21	8.74	8.97	8.57	8.01
M2	**363.39**	12.48	12.85	12.46	12.48	11.97	12.39	12.65	13.25	13.4	13.03	12.03
M3	**360.20**	10.28	10.32	10.31	10.31	10.3	10.29	10.29	10.36	10.78	10.59	10.32
M4	**356.63**	10.26	10.52	10.42	10.22	9.95	10.16	10.39	10.95	11.02	10.69	9.65
M5	**359.71**			5.66	5.67	5.3	5.59	5.71	6.3	6.5	6.08	5.35
M6 in	**356.10**			1.43		0.99	1.28	1.53	2.45	2.63	2.12	1.19
M6 out	**356.10**											
M7	**353.27**											
M8	**357.46**											
M9	**356.70**											
M10 in	**356.27**											
M10 out	**356.27**											
TP1	**356.41**		1.65	1.42		1.125	1.42	1.59	2.31	2.43	1.85	1.12
TP2 in	**356.03**		1.92	1.83		1.46	1.78	1.9	2.53	2.72	2.27	1.53
TP2 out	**356.03**											
TP5	**356.64**		3.92	3.82	3.9	3.45	Des	Des	Des	Des	Des	Des
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**											
MPN-1 out	**355.51**											
MPN-2 in	**356.58**											
MPN-2 out	**356.58**											
MPE-1 in	**355.50**											
MPE-1 out	**355.50**											
MPE-2 in	**356.08**											
MPE-2 out	**356.08**											
MPS-1 in	**355.50**											
MPS-1 out	**355.50**											
MPS-2	**356.22**											
MPW-1 in	**355.41**											
MPW-1 out	**355.41**											
MPW-2 in	**355.99**											
MPW-2 out	**355.99**											
MP1	**356.95**											
MP2	**357.38**											
MP3	**360.55**											
MP4	**359.99**											
M1-S	**359.84**											
M11	**359.43**											
M12	**362.89**											
M13-S	**357.77**											
M13-D	**357.65**											
M14-S in	**355.62**											
M14-S out	**355.62**											
M14-D	**355.28**											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	21-Apr-98	29-Apr-98	31-Aug-98	13-Oct-98	23-Nov-99	18-Jan-00	24-Feb-00	16-Mar-00	25-Apr-00	26-Jun-00	18-Jul-00
M1D	**359.70**	7.965	7.98	8.58	8.87	8.5	8.35	8.465	8.23	8.105	7.86	7.97
M2	**363.39**	12.08	12.13	13.18	13.33	12.955	12.8	12.94	12.55	12.27	11.88	12.14
M3	**360.20**	10.3	10.3	10.33	10.37	10.695	10.33	10.315	10.3	10.29	10.29	10.29
M4	**356.63**		9.9	10.86	10.98	10.64	10.54	10.77	10.36	9.8	9.5	9.95
M5	**359.71**	5.28	5.32	6.11	6.48	6.01	5.78	5.89	5.66	5.43	5.25	5.4
M6 in	**356.10**	1.055	1.1	2.29	2.68	1.9	1.65	1.81	1.355	1.145	0.95	1.08
M6 out	**356.10**											
M7	**353.27**	Dry	4.11	Dry	Dry	Dry	Dry		Dry	Dry	3.49	Dry
M8	**357.46**	Dry	Dry	Dry	Dry							
M9	**356.70**	2.61	2.61	Dry	Dry	3.39	2.93	Dry	3.25	1.455	1.275	1.72
M10 in	**356.27**	1.52	1.43	Dry	Dry	Dry	1.96	1.85	1.67	1.545	1.14	1.57
M10 out	**356.27**											
TP1	**356.41**	1.135		2.14	2.52	1.77	1.62	1.7	1.375	1.19	1.105	1.22
TP2 in	**356.03**	1.455	1.51	2.34	2.73	2.19	1.96	2.02	1.805	1.6	1.385	1.58
TP2 out	**356.03**											
TP5	**356.64**	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**											
MPN-1 out	**355.51**											
MPN-2 in	**356.58**											
MPN-2 out	**356.58**											
MPE-1 in	**355.50**											
MPE-1 out	**355.50**											
MPE-2 in	**356.08**											
MPE-2 out	**356.08**											
MPS-1 in	**355.50**											
MPS-1 out	**355.50**											
MPS-2	**356.22**											
MPW-1 in	**355.41**											
MPW-1 out	**355.41**											
MPW-2 in	**355.99**											
MPW-2 out	**355.99**											
MP1	**356.95**											
MP2	**357.38**											
MP3	**360.55**											
MP4	**359.99**											
M1-S	**359.84**											
M11	**359.43**											
M12	**362.89**											
M13-S	**357.77**											
M13-D	**357.65**											
M14-S in	**355.62**											
M14-S out	**355.62**											
M14-D	**355.28**											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	19-Sep-00	30-Oct-00	30-Jan-01	03-Apr-01	04-Jun-01	17-Jul-01	23-Aug-01	04-Oct-01	06-Dec-01	30-Jan-02	22-Feb-02
M1D	359.70	8.35	8.555	8.87	8.06	8.06	8.31	8.53	8.74	8.38	8.30	8.22
M2	363.39	12.845	13.04	13.3	12.11	12.31	12.77	13.02	13.23	12.87	12.71	12.61
M3	360.20	10.31	10.34	10.45	10.29	10.30	10.30	10.32	10.36	10.40	10.32	10.31
M4	356.63	10.65	10.84	11.02	9.47	9.98	10.53	10.82	10.96	10.40	10.30	10.33
M5	359.71	5.83	6.08	6.39	5.505	5.47	5.71	6.05	6.31	5.95	5.73	5.62
M6 in	356.10	1.67	2.04	2.45	1.15	1.09	1.50	2.06	2.37	1.76	1.42	1.38
M6 out	356.10					1.00						
M7	353.27	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
M8	357.46										2.26	1.80
M9	356.70	3.63	Dry	Dry	1.205	1.53	2.77	Dry	Dry	2.15	2.15	1.78
M10 in	356.27	Dry	Dry	Dry	1.46	1.52	1.96	Dry	Dry	1.96	1.78	1.54
M10 out	356.27											
TP1	356.41	1.76	2.025	2.26	1.14	1.24	1.61	1.99	2.28	1.87	1.54	1.40
TP2 in	356.03	2.02	2.28	2.56	1.62	1.64	1.90	2.23	2.53	2.12	1.89	1.79
TP2 out	356.03											
TP5	356.64	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des
TP8	360.36											
TP9	357.59											
MPN-1 in	355.51											
MPN-1 out	355.51											
MPN-2 in	356.58											
MPN-2 out	356.58											
MPE-1 in	355.50											
MPE-1 out	355.50											
MPE-2 in	356.08											
MPE-2 out	356.08											
MPS-1 in	355.50											
MPS-1 out	355.50											
MPS-2	356.22											
MPW-1 in	355.41											
MPW-1 out	355.41											
MPW-2 in	355.99											
MPW-2 out	355.99											
MP1	356.95											
MP2	357.38											
MP3	360.55											
MP4	359.99											
M1-S	359.84											
M11	359.43											
M12	362.89											
M13-S	357.77											
M13-D	357.65											
M14-S in	355.62											
M14-S out	355.62											
M14-D	355.28											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	01-Apr-02	06-Jun-02	04-Jul-02	08-Aug-02	27-Sep-02	19-Nov-02	31-Dec-02	06-Mar-03	09-May-03	13-Jun-03	18-Jul-03
M1D	**359.70**	8.97	7.92	7.70	8.33		8.91	9.03	9.12	8.16	8.00	8.18
M2	**363.39**		12.04	12.13	13.04	13.11	13.32	13.42	13.51	12.41	12.12	12.53
M3	**360.20**	10.30	10.29	10.31	10.30		10.56	11.01	11.29	10.30	10.29	10.29
M4	**356.63**	9.56	9.77	10.12	10.73		11.00	11.04	11.16	10.10	10.00	10.48
M5	**359.71**	5.40	5.32	5.49	5.80		6.59	6.61	6.69	5.54	5.36	5.60
M6 in	**356.10**	1.02	1.02	1.27	1.63	2.35	2.57	2.75	2.84	1.20	1.04	1.33
M6 out	**356.10**											
M7	**353.27**	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
M8	**357.46**	1.67	2.08	2.35	Dry	Dry	Dry	Dry	Dry	2.67	Dry	Dry @ 2.71
M9	**356.70**	1.20	1.40	2.47	Dry		Dry	Dry	Dry	2.65	2.47	2.72
M10 in	**356.27**	1.39	1.35	1.79	Dry	2.06	Dry	Dry	Dry	1.56	1.40	1.80
M10 out	**356.27**											
TP1	**356.41**	1.15	1.15	1.39	1.74	2.20	2.39	2.49	2.51	1.25	1.14	1.46
TP2 in	**356.03**	1.55	1.52	1.78	2.01	2.38	2.69	2.80	2.93	1.73	1.52	1.82
TP2 out	**356.03**											
TP5	**356.64**	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**											
MPN-1 out	**355.51**											
MPN-2 in	**356.58**											
MPN-2 out	**356.58**											
MPE-1 in	**355.50**											
MPE-1 out	**355.50**											
MPE-2 in	**356.08**											
MPE-2 out	**356.08**											
MPS-1 in	**355.50**											
MPS-1 out	**355.50**											
MPS-2	**356.22**											
MPW-1 in	**355.41**											
MPW-1 out	**355.41**											
MPW-2 in	**355.99**											
MPW-2 out	**355.99**											
MP1	**356.95**											
MP2	**357.38**											
MP3	**360.55**											
MP4	**359.99**											
M1-S	**359.84**											
M11	**359.43**											
M12	**362.89**											
M13-S	**357.77**											
M13-D	**357.65**											
M14-S in	**355.62**											
M14-S out	**355.62**											
M14-D	**355.28**											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	26-Aug-03	02-Sep-03	29-Sep-03	24-Oct-03	28-Nov-03	19-Dec-03	30-Jan-04	12-Mar-04	16-Apr-04	13-May-04	17-Jun-04
M1D	**359.70**	8.81		8.50	8.55	8.24	8.08	8.02	7.92	7.65	8.05	7.86
M2	**363.39**	13.49	13.31	12.89	12.98	12.60	12.24	12.10	11.97	11.38	12.21	12.08
M3	**360.20**	10.33		10.40	10.40	10.39	10.30	10.29	10.30	10.28	10.28	10.28
M4	**356.63**	10.85		10.82	10.89	10.49	10.18	10.06	9.86	9.29	9.39	9.70
M5	**359.71**	5.87		5.88	6.08	5.80	5.58	5.54	5.45	5.06	5.03	5.72
M6 in	**356.10**	1.54		1.78	1.98	1.52	1.26			area flooded	inaccessible	0.90
M6 out	**356.10**											0.87
M7	**353.27**	Dry		Dry @ 4.00	dry	Dry	Dry	Dry	dry @ 3.96	dry @ 3.96	dry @ 3.96	dry @ 3.96
M8	**357.46**	Dry		Dry @ 2.70	dry	Dry	Dry	Dry	dry @ 1.27	dry @ 2.73	dry @ 2.73	dry @ 2.75
M9	**356.70**	3.97		Dry @ 3.98	dry	3.25	2.98	2.74	2.55	2.40	2.28	2.32
M10 in	**356.27**	1.98		1.98	Dry	1.82	1.65	1.65	1.43	1.04	1.03	1.07
M10 out	**356.27**											
TP1	**356.41**	1.68		1.82	1.97	1.51	1.32	1.33	1.17	1.07	1.02	1.06
TP2 in	**356.03**	2.00		2.18	2.27	1.88	1.77	1.74	1.59	area flooded	inaccessible	1.38
TP2 out	**356.03**											
TP5	**356.64**	Des		Des	Des	Des	Des	Des	Des	Des	Des	Des
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**											
MPN-1 out	**355.51**											
MPN-2 in	**356.58**											
MPN-2 out	**356.58**											
MPE-1 in	**355.50**											
MPE-1 out	**355.50**											
MPE-2 in	**356.08**											
MPE-2 out	**356.08**											
MPS-1 in	**355.50**											
MPS-1 out	**355.50**											
MPS-2	**356.22**											
MPW-1 in	**355.41**											
MPW-1 out	**355.41**											
MPW-2 in	**355.99**											
MPW-2 out	**355.99**											
MP1	**356.95**											
MP2	**357.38**											
MP3	**360.55**											
MP4	**359.99**											
M1-S	**359.84**											
M11	**359.43**											
M12	**362.89**											
M13-S	**357.77**											
M13-D	**357.65**											
M14-S in	**355.62**											
M14-S out	**355.62**											
M14-D	**355.28**											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	21-Jul-04	19-Aug-04	24-Sep-04	09-Nov-04	18-Nov-04	17-Dec-04	21-Jan-05	18-Feb-05	17-Mar-05	14-Apr-05	27-May-05
M1D	**359.70**	8.39	8.57	8.69	8.46	8.49	8.45	8.05	8.02	8.06	8.05	8.17
M2	**363.39**	12.69	13.17	13.40	12.87	12.88	12.82	12.11	12.12	12.27	11.99	12.52
M3	**360.20**	10.29	10.30	10.30	10.34	10.36	10.38	10.30	10.31	10.30	10.29	10.31
M4	**356.63**	10.42	10.58	10.72	10.83	10.85	10.67	10.08	10.03	10.15	9.31	9.93
M5	**359.71**	5.83	5.98	5.77	6.01	6.05	6.06	5.62	5.53	5.59	5.06	5.33
M6 in	**356.10**	1.43	1.57	1.52	1.85	1.93	1.94	1.32	frozen @ 1.12	frozen @ 0.97	0.92	0.94
M6 out	**356.10**	1.29	1.38									
M7	**353.27**	dry @ 3.96	dry @ 3.96	dry @ 3.95	dry @ 3.96	dry @ 3.95	dry @ 3.92	dry @ 3.95	frozen @ 1.22	frozen @ 1.07	dry @ 3.97	dry @ 3.96
M8	**357.46**	dry @ 2.70	dry @ 2.74	dry @ 2.72	dry @ 2.71	dry @ 2.72	dry @ 2.68	dry @ 2.70	dry @ 2.72	dry @ 2.73	dry @ 2.73	dry @ 2.73
M9	**356.70**	2.50	2.65	dry @ 3.94	dry @ 3.95	dry @ 3.93	3.51	2.89	2.69	2.70	2.39	2.39
M10 in	**356.27**	1.63	1.82	1.93	2.02	2.03	dry @ 2.05	1.60	1.41	1.64	0.98	1.12
M10 out	**356.27**											
TP1	**356.41**	1.20	1.37	1.54	1.93	1.97	2.11	frozen @ 1.18	frozen @ 1.15	frozen @ 1.10	1.02	1.10
TP2 in	**356.03**	1.72	1.85	1.95	2.21	2.25	2.24	1.79	1.73	frozen @ 1.33	inaccessible	1.46
TP2 out	**356.03**											
TP5	**356.64**	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**											
MPN-1 out	**355.51**											
MPN-2 in	**356.58**											
MPN-2 out	**356.58**											
MPE-1 in	**355.50**											
MPE-1 out	**355.50**											
MPE-2 in	**356.08**											
MPE-2 out	**356.08**											
MPS-1 in	**355.50**											
MPS-1 out	**355.50**											
MPS-2	**356.22**											
MPW-1 in	**355.41**											
MPW-1 out	**355.41**											
MPW-2 in	**355.99**											
MPW-2 out	**355.99**											
MP1	**356.95**											
MP2	**357.38**											
MP3	**360.55**											
MP4	**359.99**											
M1-S	**359.84**											
M11	**359.43**											
M12	**362.89**											
M13-S	**357.77**											
M13-D	**357.65**											
M14-S in	**355.62**											
M14-S out	**355.62**											
M14-D	**355.28**											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	28-Jun-05	13-Jul-05	15-Aug-05	12-Sep-05	24-Oct-05	21-Nov-05	19-Dec-05	16-Jan-06	13-Feb-06	08-Mar-06	22-Jun-06
M1D	359.70	8.42	8.56	8.72	8.83	8.83	8.69	8.15	8.15	8.11	8.15	8.29
M2	363.39	12.76	13.19	13.48	13.51	13.58	13.35	12.34	12.31	12.09	12.33	12.58
M3	360.20	10.33	10.32	10.48	10.53	10.55	10.49	10.34	10.29	10.12	10.24	10.59
M4	356.63	10.18	10.68	10.83	10.93	10.96	10.90	10.31	10.28	10.10	10.18	10.50
M5	359.71	5.57	5.70	5.87	5.93	5.95	5.83	5.65	5.66	5.32	5.30	5.57
M6 in	356.10	1.10	1.46	1.75	1.80	1.84	1.63	frozen @ 1.26	1.35	frozen @ 1.27	fr @ 0.92	1.60
M6 out	356.10											
M7	353.27	dry @ 3.96	dry @ 3.96	dry @ 3.96	dry @ 3.96	dry	dry	dry	dry	dry	dry	dry
M8	357.46	dry @ 2.74	dry @ 2.74	dry @ 2.75	dry @ 2.74	dry	dry	dry	dry	dry	dry	dry
M9	356.70	2.63	3.48	dry @ 3.95	dry @ 3.95	dry	dry	3.33	2.90	2.77	2.65	2.49
M10 in	356.27	1.21	1.90	2.03	1.98	dry	1.80	dry	1.75	1.66	1.14	1.65
M10 out	356.27											
TP1	356.41	1.31	1.40	1.60	1.62	1.67	1.40	1.37	1.43	frozen @ 1.37	fr @ 1.08	1.27
TP2 in	356.03	1.66	1.91	2.08	2.10	2.12	1.97	1.82	1.64	1.73	1.43	1.74
TP2 out	356.03											
TP5	356.64	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des
TP8	360.36											
TP9	357.59											
MPN-1 in	355.51											
MPN-1 out	355.51											
MPN-2 in	356.58											
MPN-2 out	356.58											
MPE-1 in	355.50											
MPE-1 out	355.50											
MPE-2 in	356.08											
MPE-2 out	356.08											
MPS-1 in	355.50											
MPS-1 out	355.50											
MPS-2	356.22											
MPW-1 in	355.41											
MPW-1 out	355.41											
MPW-2 in	355.99											
MPW-2 out	355.99											
MP1	356.95											
MP2	357.38											
MP3	360.55											
MP4	359.99											
M1-S	359.84											
M11	359.43											
M12	362.89											
M13-S	357.77											
M13-D	357.65											
M14-S in	355.62											
M14-S out	355.62											
M14-D	355.28											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	19-Jul-06	21-Aug-06	15-Sep-06	05-Oct-06	28-Dec-06	30-Jan-07	15-Feb-07	12-Mar-07	10-Apr-07	08-May-07	18-Jul-07
M1D	**359.70**	8.43	8.64	8.67	8.54	8.01	7.82	8.05	8.08	7.85	8.08	8.15
M2	**363.39**	12.80	13.30	13.47	13.25	12.31	11.85	11.98	12.08	11.80	11.98	12.12
M3	**360.20**	10.81	10.42	10.52	10.46	10.22	10.20	10.24	10.30	10.12	10.31	10.45
M4	**356.63**	10.72	10.85	10.91	10.94	10.03	10.08	9.96	9.83	9.65	9.80	9.96
M5	**359.71**	5.70	5.80	5.97	5.81	5.35	5.41	5.45	5.49	5.35	5.58	5.69
M6 in	**356.10**	1.71	1.58	1.72	1.55	1.37	1.25	fr @ 1.26	1.28	1.05	1.11	dry
M6 out	**356.10**									0.86		
M7	**353.27**	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
M8	**357.46**	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
M9	**356.70**	2.63	dry	dry	3.31	2.81	2.64	2.68	2.72	2.61	2.76	2.83
M10 in	**356.27**	1.77	1.92	dry	1.65	1.23	1.13	1.22	1.27	1.02	1.17	1.25
M10 out	**356.27**											
TP1	**356.41**	1.39	1.47	1.51	1.42	1.25	1.19	1.25	1.28	1.15	1.32	1.37
TP2 in	**356.03**	1.94	1.99	2.05	1.90	1.59	1.42	1.47	1.50	1.36	1.52	1.58
TP2 out	**356.03**											
TP5	**356.64**	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**											
MPN-1 out	**355.51**											
MPN-2 in	**356.58**											
MPN-2 out	**356.58**											
MPE-1 in	**355.50**											
MPE-1 out	**355.50**											
MPE-2 in	**356.08**											
MPE-2 out	**356.08**											
MPS-1 in	**355.50**											
MPS-1 out	**355.50**											
MPS-2	**356.22**											
MPW-1 in	**355.41**											
MPW-1 out	**355.41**											
MPW-2 in	**355.99**											
MPW-2 out	**355.99**											
MP1	**356.95**											
MP2	**357.38**											
MP3	**360.55**											
MP4	**359.99**											
M1-S	**359.84**											
M11	**359.43**											
M12	**362.89**											
M13-S	**357.77**											
M13-D	**357.65**											
M14-S in	**355.62**											
M14-S out	**355.62**											
M14-D	**355.28**											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	30-Aug-07	26-Sep-07	25-Oct-07	26-Nov-07	21-Dec-07	23-Jan-08	22-Feb-08	18-Mar-08	21-Apr-08	26-May-08	16-Jul-08
M1D	**359.70**	8.75	8.89	8.80	8.68	8.84	8.13	8.00	7.90	7.49	7.92	8.10
M2	**363.39**	13.46	13.56	13.49	13.35	13.51	12.07	11.92	11.90	10.84	12.18	12.05
M3	**360.20**	10.72	10.83	10.78	10.65	10.79	10.42	10.20	10.16	10.02	10.22	10.36
M4	**356.63**	10.05	10.29	11.05	10.98	10.85	10.15	9.92	9.79	8.50	10.00	9.89
M5	**359.71**	6.21	6.32	6.22	6.10	6.22	5.73	5.54	5.46	4.63	5.26	5.63
M6 in	**356.10**	1.95	dry	2.24	2.18	2.46	dry/ice	dry/ice	dry/ice	0.48	0.93	1.24
M6 out	**356.10**									0.51		
M7	**353.27**	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
M8	**357.46**	dry	dry	dry	dry	dry	dry	dry	dry	2.48	dry	dry
M9	**356.70**	dry	dry	dry	dry	dry	2.78	2.65	2.63	2.20	2.61	2.79
M10 in	**356.27**	dry	dry	dry	dry	dry	1.21	1.20	1.20	0.71	1.10	1.21
M10 out	**356.27**											
TP1	**356.41**	1.97	2.08	1.96	1.81	1.96	1.39	1.23	1.18	0.82	1.44	1.36
TP2 in	**356.03**	2.24	2.32	2.30	2.15	2.31	1.55	1.46	1.42	0.51	1.09	1.55
TP2 out	**356.03**											
TP5	**356.64**	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des	Des
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**											
MPN-1 out	**355.51**											
MPN-2 in	**356.58**											
MPN-2 out	**356.58**											
MPE-1 in	**355.50**											
MPE-1 out	**355.50**											
MPE-2 in	**356.08**											
MPE-2 out	**356.08**											
MPS-1 in	**355.50**											
MPS-1 out	**355.50**											
MPS-2	**356.22**											
MPW-1 in	**355.41**											
MPW-1 out	**355.41**											
MPW-2 in	**355.99**											
MPW-2 out	**355.99**											
MP1	**356.95**											
MP2	**357.38**											
MP3	**360.55**											
MP4	**359.99**											
M1-S	**359.84**											
M11	**359.43**											
M12	**362.89**											
M13-S	**357.77**											
M13-D	**357.65**											
M14-S in	**355.62**											
M14-S out	**355.62**											
M14-D	**355.28**											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	18-Aug-08	08-Sep-08	30-Oct-08	12-Nov-08	16-Dec-08	30-Jan-09	13-Feb-09	12-Mar-09	07-Apr-09	08-Jun-09	23-Jun-09
M1D	359.70	8.05	8.12	8.22	8.51	8.18	7.85	7.77	7.54	7.50	7.84	8.16
M2	363.39	12.02	12.11	12.54	13.11	12.19	11.83	11.69	11.21	10.99	12.01	12.43
M3	360.20	10.36	10.43	10.55	10.62	10.49	10.19	10.14	10.17	10.18	10.31	10.50
M4	356.63	9.85	9.93	10.03	10.48	10.24	9.74	9.64	9.12	8.87	9.15	9.45
M5	359.71	5.60	5.68	5.81	5.87	5.79	5.46	5.36	4.93	5.01	5.47	5.77
M6 in	356.10	1.31	1.52	1.69	1.73	1.53	froz	froz	0.79	0.74	0.81	0.98
M6 out	356.10									0.65		
M7	353.27	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
M8	357.46	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
M9	356.70	2.73	2.80	2.91	3.11	2.87	2.40	froz	2.11	2.12	2.43	2.75
M10 in	356.27	1.18	1.24	1.35	dry	1.30	1.20	1.18	0.94	0.83	1.49	1.07
M10 out	356.27											
TP1	356.41	1.33	1.36	1.50	1.62	1.44	1.16	1.08	0.93	0.93	1.22	1.25
TP2 in	356.03	1.51	1.56	1.68	2.06	1.65	1.41	1.39	1.08	0.95	1.45	1.38
TP2 out	356.03											
TP5	356.64	Des	Des	Des	Des	Des	Des	Des	Des	des	des	des
TP8	360.36											
TP9	357.59											
MPN-1 in	355.51											
MPN-1 out	355.51											
MPN-2 in	356.58											
MPN-2 out	356.58											
MPE-1 in	355.50											
MPE-1 out	355.50											
MPE-2 in	356.08											
MPE-2 out	356.08											
MPS-1 in	355.50											
MPS-1 out	355.50											
MPS-2	356.22											
MPW-1 in	355.41											
MPW-1 out	355.41											
MPW-2 in	355.99											
MPW-2 out	355.99											
MP1	356.95											
MP2	357.38											
MP3	360.55											
MP4	359.99											
M1-S	359.84											
M11	359.43											
M12	362.89											
M13-S	357.77											
M13-D	357.65											
M14-S in	355.62											
M14-S out	355.62											
M14-D	355.28											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	21-Jul-09	19-Aug-09	02-Sep-09	06-Oct-09	04-Nov-09	21-Dec-09	27-Jan-10	24-Feb-10	16-Mar-10	20-Apr-10	06-May-10
M1D	**359.70**	8.19	8.28	8.32	8.46	8.51	8.55	8.49	8.53	8.05	7.83	7.95
M2	**363.39**	12.51	12.80	12.83	12.94	12.97	12.99	12.87	12.89	12.19	11.83	12.06
M3	**360.20**	10.28	10.35	10.40	10.46	10.44	10.36	10.33	10.29	10.29	10.29	10.29
M4	**356.63**	9.48	10.54	10.59	10.75	10.81	10.85	10.76	10.78	10.03	9.76	10.00
M5	**359.71**	5.73	5.83	5.86	5.99	6.16	6.19	6.18	6.22	5.67	5.32	5.44
M6 in	**356.10**	1.50	1.66	1.77	2.27	2.07	2.10	2.08	2.32	1.42	1.00	1.08
M6 out	**356.10**										0.94	1.00
M7	**353.27**	dry	dry	dry	dry	dry	dry	dry	dry	3.75	dry	dry
M8	**357.46**	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
M9	**356.70**	2.92	3.73	3.76	3.93	3.98	3.85	3.24	dry	3.19	2.62	2.60
M10 in	**356.27**	1.92	1.94	1.96	dry	dry	dry	dry	dry	1.22	1.09	1.33
M10 out	**356.27**											
TP1	**356.41**	1.52	1.62	1.67	1.86	2.06	2.04	1.98	2.07	1.19	1.11	1.20
TP2 in	**356.03**	1.88	2.02	2.09	2.28	2.38	2.34	2.37	2.43	1.77	1.50	1.63
TP2 out	**356.03**											
TP5	**356.64**	des	des	des	des	des	des	des	des	des	des	des
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**			0.9	1.15	1.22	1.205	1.12	1.235	0.615	-	0.37
MPN-1 out	**355.51**											0.405
MPN-2 in	**356.58**			1.98	2.25	2.31	2.325	2.225	2.33	1.52	1.36	1.45
MPN-2 out	**356.58**											
MPE-1 in	**355.50**			1.29	1.535	1.62	1.61	1.595	1.71	0.94	-	0.69
MPE-1 out	**355.50**											0.4
MPE-2 in	**356.08**			2.065	2.32	2.395	2.41	2.395	2.45	1.76	1.36	1.49
MPE-2 out	**356.08**											
MPS-1 in	**355.50**			1.23	1.45	1.54	1.56	1.555	1.74	0.845	0.485	0.565
MPS-1 out	**355.50**									0.73	0.34	0.4
MPS-2	**356.22**			2.145	2.46	2.525	2.53	2.545	2.595	1.73	1.36	1.45
MPW-1 in	**355.41**											
MPW-1 out	**355.41**											
MPW-2 in	**355.99**											
MPW-2 out	**355.99**											
MP1	**356.95**											
MP2	**357.38**											
MP3	**360.55**											
MP4	**359.99**											
M1-S	**359.84**											
M11	**359.43**											
M12	**362.89**											
M13-S	**357.77**											
M13-D	**357.65**											
M14-S in	**355.62**											
M14-S out	**355.62**											
M14-D	**355.28**											

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	11-Jun-10	13-Jul-10	27-Aug-10	17-Sep-10	28-Oct-10	24-Nov-10	24-Dec-10	30-Dec-10	10-Jan-11	25-Jan-11	24-Feb-11
M1D	**359.70**	8.06	8.29	8.29	8.36	8.42	8.42	8.28		8.29	8.31	8.28
M2	**363.39**	12.27	12.72	12.84	12.73	12.80	12.77	12.65			12.66	12.61
M3	**360.20**	10.29	10.29	10.29	10.32	10.33	10.33	10.32			10.31	10.30
M4	**356.63**	10.16	10.19	10.58	10.71	10.68	10.61	10.49			10.52	10.50
M5	**359.71**	5.58	5.60	5.78	5.92	6.05	6.08	5.92		5.84	5.86	5.89
M6 in	**356.10**	1.24	1.34	1.65	1.79	1.88	1.92	1.96		1.89	2.02	1.88
M6 out	**356.10**						dry					
M7	**353.27**	dry	dry	dry	dry	dry	dry	dry			dry	dry@3.85
M8	**357.46**	dry	dry	dry	dry	dry	dry	dry			dry	dry
M9	**356.70**	2.60	2.47	dry	dry	3.63	2.70	2.51			2.40	2.19
M10 in	**356.27**	1.65	1.72	1.96	1.99	dry	dry@2.07	dry		dry	dry	dry
M10 out	**356.27**											
TP1	**356.41**	1.35	1.30	1.61	1.78	1.90	1.91	1.72		1.78	1.86	1.83
TP2 in	**356.03**	1.77	1.80	1.97	2.11	2.23	2.26	2.13		2.04	2.08	2.10
TP2 out	**356.03**											
TP5	**356.64**	des	des	des	des	des	des	des			des	des
TP8	**360.36**											
TP9	**357.59**											
MPN-1 in	**355.51**	0.52	0.57	0.8	0.935	1.035	1.03	0.91		0.98	1.05	1.04
MPN-1 out	**355.51**	0.555	0.625	0.845	0.945	dry	dry	dry @ 0.87		dry		dry
MPN-2 in	**356.58**	1.585	1.61	1.87	2.09	2.135	2.125	2.01		2.05	2.13	2.12
MPN-2 out	**356.58**											
MPE-1 in	**355.50**	0.835	0.88	1.135	1.31	1.45	1.48	1.47		1.41	1.47	1.44
MPE-1 out	**355.50**	0.56	0.62	dry	dry	dry	dry	dry @ 0.81		dry		dry
MPE-2 in	**356.08**	1.65	1.69	1.92	2.11	2.245	2.28	2.12		2.04	2.08	2.07
MPE-2 out	**356.08**											
MPS-1 in	**355.50**	0.725	0.795	1.1	1.26	1.36	1.4	1.37		1.31	1.40	0.86
MPS-1 out	**355.50**	0.55	0.615	dry	dry	dry	dry	dry		dry		dry
MPS-2	**356.22**	1.62	1.68	1.97	2.21	2.37	2.42	2.28		2.19	2.25	2.26
MPW-1 in	**355.41**							2.09		0.94	1.00	0.94
MPW-1 out	**355.41**							dry		dry		dry
MPW-2 in	**355.99**							1.72		1.50	1.57	1.51
MPW-2 out	**355.99**											
MP1	**356.95**							3.055			2.96	froz@1.16
MP2	**357.38**							2.72			2.62	froz@0.45
MP3	**360.55**							dry			dry	3.24
MP4	**359.99**							dry			dry	2.65
M1-S	**359.84**							6.95		6.93	6.94	6.92
M11	**359.43**							dry @ 9.52			dry	dry
M12	**362.89**							dry @ 9.20			dry	dry@9.19
M13-S	**357.77**							3.11		3.17	3.25	3.21
M13-D	**357.65**							3.595		3.65	3.74	3.62
M14-S in	**355.62**							3.96	2.24	1.50	1.55	1.54
M14-S out	**355.62**											
M14-D	**355.28**							1.32	1.30	1.26	1.30	1.32

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	01-Apr-11	02-May-11	31-May-11	27-Jun-11	26-Jul-11	29-Aug-11	05-Oct-11	01-Nov-11	28-Nov-11
M1D	**359.70**	7.76	7.67	7.65	7.65	8.19	8.27	8.41	8.26	8.31
M2	**363.39**	11.69	11.54	11.51	11.65	12.59	12.65	12.78	12.63	12.64
M3	**360.20**	10.28	10.30	10.29	10.30	10.30	10.31	10.32	10.32	10.32
M4	**356.63**	9.56	9.36	9.01	9.54	10.31	10.54	10.71	10.34	10.40
M5	**359.71**	5.25	5.13	4.88	5.24	5.54	5.75	5.99	5.88	5.84
M6 in	**356.10**	froz at 1.07	0.855	0.715	0.895	1.290	1.655	1.910	1.740	1.765
M6 out	**356.10**		0.855	0.720	0.870	dry	dry	dry	dry	dry
M7	**353.27**	3.76	dry at 3.85	dry	dry	dry	dry	dry	dry	dry
M8	**357.46**	froz at 1.19	dry	dry	dry	dry	dry	dry	dry	dry
M9	**356.70**	2.10	1.905	1.850	1.980	2.150	3.270	3.650	2.820	2.800
M10 in	**356.27**	1.30	1.09	0.94	1.11	1.81	1.97	dry	dry	dry
M10 out	**356.27**			0.95	1.07	dry	dry	dry	dry	dry
TP1	**356.41**	1.18	1.05	0.96	1.07	1.34	1.65	2.01	1.80	1.77
TP2 in	**356.03**	1.54	1.25	0.895	1.440	1.770	1.940	2.190	2.065	2.035
TP2 out	**356.03**			0.690	dry	dry	dry	dry	dry	dry
TP5	**356.64**	des	des	des	des	des	des	des	des	des
TP8	**360.36**									
TP9	**357.59**									
MPN-1 in	**355.51**	0.46	0.26	0.125	0.270	0.620	0.890	1.240	1.000	0.985
MPN-1 out	**355.51**	0.39	0.26	0.125	0.280	0.635	muck	dry	dry	dry
MPN-2 in	**356.58**	1.45	1.31	1.195	1.330	1.680	1.970	2.330	2.080	2.060
MPN-2 out	**356.58**			1.235		dry	dry	dry	dry	dry
MPE-1 in	**355.50**	0.78	0.54	0.315	0.620	0.970	1.240	1.555	1.400	1.360
MPE-1 out	**355.50**	0.39	0.26	0.125	0.280	0.635	dry	dry	dry	dry
MPE-2 in	**356.08**	1.08	0.85	0.71	0.90	1.36	1.78	2.21	2.00	1.91
MPE-2 out	**356.08**		dry	0.695	dry	dry	dry	dry	dry	dry
MPS-1 in	**355.50**	0.60	0.37	-0.12	0.43	0.81	1.13	1.41	1.25	1.26
MPS-1 out	**355.50**	0.40	-	-0.12	0.28	0.63	dry	dry	dry	dry
MPS-2	**356.22**	1.43	1.19	0.97	1.35	1.69	2.01	2.37	2.21	2.20
MPW-1 in	**355.41**	0.24	0.07	UW	0.09	0.49	0.85	1.14	0.90	0.90
MPW-1 out	**355.41**	0.20	0.05	UW	0.07	dry	dry	dry	dry	dry
MPW-2 in	**355.99**	0.80	0.63	0.465	0.660	1.100	1.430	1.710	1.470	1.465
MPW-2 out	**355.99**	0.76	0.625	0.49	0.64	dry	dry	dry	dry	dry
MP1	**356.95**	2.68	2.46	2.31	2.45	2.63	3.62	dry	3.35	3.34
MP2	**357.38**	froz at 0.48	2.31	2.26	2.37	2.52	3.71	3.65	3.03	3.01
MP3	**360.55**	froz at 0.84	3.34	3.58	dry	dry	dry	dry	dry	dry
MP4	**359.99**	froz at 0.82	2.69	2.95	dry	dry	dry	dry	dry	dry
M1-S	**359.84**	6.31	6.22	5.95	6.21	6.54	6.745	6.950	6.900	6.835
M11	**359.43**	dry	dry	dry	dry	dry	dry	dry	dry	dry
M12	**362.89**	dry	dry	dry	dry	dry	dry	dry	dry	dry
M13-S	**357.77**	2.57	2.39	2.28	2.44	2.76	3.08	3.45	3.19	3.17
M13-D	**357.65**	2.96	2.72	2.70	2.85	3.43	3.70	4.02	3.57	3.64
M14-S in	**355.62**	0.94	0.71	0.49	0.82	1.19	1.41	1.68	1.54	1.51
M14-S out	**355.62**	0.45	0.39	0.29	0.40	dry	dry	dry	dry	dry
M14-D	**355.28**	-	0.51	UW		0.96	1.16	1.43	1.30	1.27

HARDEN
ENVIRONMENTAL

Table B1: Groundwater Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	02-Feb-12	23-Feb-12	29-Mar-12	11-May-12	06-Jul-12
M1D	**359.70**	7.91	7.97	7.99	8.34	8.63
M2	**363.39**	11.87	12.02	12.00	12.53	13.12
M3	**360.20**	10.30	10.32	10.32	10.31	10.31
M4	**356.63**	9.80	9.94	9.86	10.24	10.79
M5	**359.71**	5.42	5.47	5.46	5.63	5.90
M6 in	**356.10**	froz @1.045	froz @1.00	1.120	1.385	2.120
M6 out	**356.10**	0.980	froz @0.98	1.070	dry	dry
M7	**353.27**	dry	dry	dry	dry	dry
M8	**357.46**	dry	dry	dry	dry	dry
M9	**356.70**	2.380	2.290	2.080	2.100	dry
M10 in	**356.27**	1.45	1.58	1.61	1.78	dry
M10 out	**356.27**	dry	dry	dry	dry	dry
TP1	**356.41**	1.12	1.22	1.24	1.44	1.79
TP2 in	**356.03**	1.590	1.650	1.640	1.830	2.130
TP2 out	**356.03**	dry	dry	dry	dry	dry
TP5	**356.64**	des	des	des	des	des
TP8	**360.36**			5.56	6.18	6.63
TP9	**357.59**			5.34	5.31	dry
MPN-1 in	**355.51**	0.380	0.435	0.470	0.680	1.055
MPN-1 out	**355.51**	0.385	0.430	0.470	0.695	dry
MPN-2 in	**356.58**	1.425	1.500	1.520	1.740	2.130
MPN-2 out	**356.58**	dry	dry	dry	dry	dry
MPE-1 in	**355.50**	0.800	0.850	0.850	1.050	1.570
MPE-1 out	**355.50**	0.390	0.435	0.475	0.695	dry
MPE-2 in	**356.08**	1.16	1.23	1.25	1.52	2.14
MPE-2 out	**356.08**	dry	dry	dry	dry	dry
MPS-1 in	**355.50**	0.58	0.66	0.66	0.89	1.50
MPS-1 out	**355.50**	0.38	0.44	0.47	0.69	dry
MPS-2	**356.22**	1.38	1.46	1.52	1.77	2.31
MPW-1 in	**355.41**	froz @ 0.195	froz @0.26	0.31	0.57	1.08
MPW-1 out	**355.41**	0.19	froz @0.19	0.27	dry	dry
MPW-2 in	**355.99**	0.785	0.890	0.920	1.175	1.630
MPW-2 out	**355.99**	0.74	dry	dry	dry	dry
MP1	**356.95**	2.88	2.87	2.66	2.58	dry
MP2	**357.38**	2.54	2.52	2.47	2.52	dry
MP3	**360.55**	froz @1.02	froz	dry	dry	dry
MP4	**359.99**	froz @0.98	froz	dry	dry	dry
M1-S	**359.84**	6.470	6.495	6.490	6.660	6.870
M11	**359.43**	dry	dry	dry	dry	dry
M12	**362.89**	dry	dry	dry	dry	dry
M13-S	**357.77**	2.49	2.60	2.62	2.84	3.24
M13-D	**357.65**	2.91	3.06	3.08	3.52	4.13
M14-S in	**355.62**	1.02	1.08	1.07	1.27	1.59
M14-S out	**355.62**	0.68	0.71	0.81	dry	dry
M14-D	**355.28**	0.81	0.86	0.85	1.04	1.34

HARDEN
ENVIRONMENTAL

Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	17-Apr-95	01-May-95	17-May-95	27-Jun-95	11-Jul-95	01-Aug-95	18-Oct-95	04-Dec-95	30-Jan-96	11-Mar-96	20-Jun-96	02-Aug-96	04-Sep-96	08-Nov-96
M1-D	**359.70**	351.53	351.59	351.63	351.51	351.43	351.35	351.10	351.47	351.70	351.80	351.88	351.56	351.40	351.57
M2	**363.39**	350.94	351.02	351.09	350.72	350.67	350.52	350.06	350.75	351.29	351.29	351.31	350.91	350.54	350.93
M3	**360.20**	349.57	349.90	349.91	349.89	349.89	349.90	349.87	349.88	349.92	349.92	349.91	349.92	349.88	349.89
M4	**356.63**	346.43	346.51	346.68	346.33	346.21	345.93	345.80	346.43	346.68	346.65	346.88	346.37	346.11	346.21
M5	**359.71**														354.05
M6 in	**356.10**														354.67
M6 out	**356.10**														
M7	**353.27**														
M8	**357.46**														
M9	**356.70**														
M10 in	**356.27**														
M10 out	**356.27**														
TP1	**356.41**													354.76	354.99
TP2 in	**356.03**													354.11	354.20
TP2 out	**356.03**														
TP5	**356.64**													352.72	352.82
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**														
MPN-1 out	**355.51**														
MPN-2 in	**356.58**														
MPN-2 out	**356.58**														
MPE-1 in	**355.50**														
MPE-1 out	**355.50**														
MPE-2 in	**356.08**														
MPE-2 out	**356.08**														
MPS-1 in	**355.50**														
MPS-1 out	**355.50**														
MPS-2	**356.22**														
MPW-1 in	**355.41**														
MPW-1 out	**355.41**														
MPW-2 in	**355.99**														
MPW-2 out	**355.99**														
MP1	**356.95**														
MP2	**357.38**														
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**														
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**														
M13-D	**357.65**														
M14-S in	**355.62**														
M14-S out	**355.62**														
M14-D	**355.28**														

Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	21-Nov-96	14-May-97	26-Jun-97	15-Jul-97	14-Oct-97	17-Dec-97	06-Feb-98	31-Mar-98	21-Apr-98	29-Apr-98	31-Aug-98	13-Oct-98	23-Nov-99	18-Jan-00
M1-D	**359.70**	351.58	351.88	351.62	351.49	350.96	350.73	351.13	351.69	351.73	351.72	351.12	350.83	351.20	351.35
M2	**363.39**	350.91	351.42	351.00	350.74	350.14	349.99	350.36	351.36	351.31	351.26	350.21	350.06	350.43	350.59
M3	**360.20**	349.89	349.90	349.91	349.91	349.84	349.42	349.61	349.88	349.90	349.90	349.87	349.83	349.51	349.87
M4	**356.63**	346.41	346.68	346.47	346.24	345.68	345.61	345.94	346.98		346.73	345.77	345.65	345.99	346.09
M5	**359.71**	354.04	354.41	354.12	354.00	353.41	353.21	353.63	354.36	354.43	354.39	353.60	353.23	353.70	353.93
M6 in	**356.10**		355.11	354.82	354.57	353.65	353.47	353.98	354.91	355.04	355.00	353.81	353.42	354.20	354.45
M6 out	**356.10**														
M7	**353.27**										349.48				
M8	**357.46**														
M9	**356.70**									354.41	354.41			353.63	354.09
M10 in	**356.27**									354.75	354.84				354.31
M10 out	**356.27**														
TP1	**356.41**		355.29	354.99	354.82	354.10	353.98	354.56	355.29	355.28		354.27	353.89	354.64	354.79
TP2 in	**356.03**		354.57	354.25	354.13	353.50	353.31	353.76	354.50	354.57	354.52	353.69	353.30	353.84	354.07
TP2 out	**356.03**														
TP5	**356.64**	352.74	353.19												
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**														
MPN-1 out	**355.51**														
MPN-2 in	**356.58**														
MPN-2 out	**356.58**														
MPE-1 in	**355.50**														
MPE-1 out	**355.50**														
MPE-2 in	**356.08**														
MPE-2 out	**356.08**														
MPS-1 in	**355.50**														
MPS-1 out	**355.50**														
MPS-2	**356.22**														
MPW-1 in	**355.41**														
MPW-1 out	**355.41**														
MPW-2 in	**355.99**														
MPW-2 out	**355.99**														
MP1	**356.95**														
MP2	**357.38**														
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**														
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**														
M13-D	**357.65**														
M14-S in	**355.62**														
M14-S out	**355.62**														
M14-D	**355.28**														

HARDEN
ENVIRONMENTAL

Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	24-Feb-00	16-Mar-00	25-Apr-00	26-Jun-00	18-Jul-00	19-Sep-00	30-Oct-00	30-Jan-01	03-Apr-01	04-Jun-01	17-Jul-01	23-Aug-01	04-Oct-01	05-Dec-01
M1-D	**359.70**	351.23	351.47	351.59	351.84	351.73	351.35	351.14	350.83	351.64	351.64	351.39	351.17	350.96	351.32
M2	**363.39**	350.45	350.84	351.12	351.51	351.25	350.54	350.35	350.09	351.28	351.08	350.62	350.37	350.16	350.52
M3	**360.20**	349.89	349.90	349.91	349.91	349.91	349.89	349.86	349.75	349.91	349.90	349.90	349.88	349.84	349.80
M4	**356.63**	345.86	346.27	346.83	347.13	346.68	345.98	345.79	345.61	347.16	346.65	346.10	345.81	345.67	346.23
M5	**359.71**	353.82	354.05	354.28	354.46	354.31	353.88	353.63	353.32	354.21	354.24	354.00	353.66	353.40	353.76
M6 in	**356.10**	354.29	354.74	354.95	355.15	355.02	354.43	354.06	353.65	354.95	355.01	354.60	354.04	353.73	354.34
M6 out	**356.10**										355.10				
M7	**353.27**				350.10										
M8	**357.46**														
M9	**356.70**		353.77	355.56	355.74	355.30	353.39			355.81	355.49	354.25			354.87
M10 in	**356.27**	354.42	354.60	354.73	355.13	354.70				354.81	354.75	354.31			354.31
M10 out	**356.27**														
TP1	**356.41**	354.71	355.04	355.22	355.31	355.19	354.65	354.39	354.15	355.27	355.17	354.80	354.43	354.13	354.54
TP2 in	**356.03**	354.01	354.22	354.43	354.64	354.45	354.01	353.75	353.47	354.41	354.39	354.13	353.80	353.50	353.91
TP2 out	**356.03**														
TP5	**356.64**														
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**														
MPN-1 out	**355.51**														
MPN-2 in	**356.58**														
MPN-2 out	**356.58**														
MPE-1 in	**355.50**														
MPE-1 out	**355.50**														
MPE-2 in	**356.08**														
MPE-2 out	**356.08**														
MPS-1 in	**355.50**														
MPS-1 out	**355.50**														
MPS-2	**356.22**														
MPW-1 in	**355.41**														
MPW-1 out	**355.41**														
MPW-2 in	**355.99**														
MPW-2 out	**355.99**														
MP1	**356.95**														
MP2	**357.38**														
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**														
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**														
M13-D	**357.65**														
M14-S in	**355.62**														
M14-S out	**355.62**														
M14-D	**355.28**														

HARDEN
ENVIRONMENTAL

Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	30-Jan-02	22-Feb-02	01-Apr-02	06-Jun-02	04-Jul-02	08-Aug-02	27-Sep-02	19-Nov-02	31-Dec-02	06-Mar-03	09-May-03	13-Jun-03	18-Jul-03	26-Aug-03
M1-D	**359.70**	351.40	351.48	350.73	351.78	352.00	351.37		350.79	350.67	350.58	351.54	351.70	351.52	350.89
M2	**363.39**	350.68	350.78		351.35	351.26	350.35	350.28	350.07	349.97	349.88	350.98	351.27	350.86	349.90
M3	**360.20**	349.88	349.89	349.90	349.92	349.89	349.90		349.64	349.19	348.91	349.90	349.91	349.91	349.87
M4	**356.63**	346.33	346.30	347.07	346.86	346.51	345.90		345.63	345.59	345.47	346.53	346.63	346.15	345.78
M5	**359.71**	353.98	354.09	354.31	354.39	354.22	353.91		353.12	353.10	353.02	354.17	354.35	354.11	353.84
M6 in	**356.10**	354.68	354.72	355.08	355.08	354.83	354.47	353.75	353.53	353.35	353.26	354.90	355.06	354.77	354.56
M6 out	**356.10**														
M7	**353.27**														
M8	**357.46**	355.20	355.66	355.79	355.38	355.11						354.79			
M9	**356.70**	354.87	355.24	355.82	355.62	354.55						354.37	354.55	354.30	353.05
M10 in	**356.27**	354.49	354.73	354.88	354.92	354.48		354.21				354.71	354.87	354.47	354.29
M10 out	**356.27**														
TP1	**356.41**	354.87	355.01	355.26	355.26	355.02	354.67	354.21	354.02	353.92	353.90	355.16	355.27	354.95	354.73
TP2 in	**356.03**	354.14	354.24	354.48	354.51	354.25	354.02	353.65	353.34	353.23	353.10	354.30	354.51	354.21	354.03
TP2 out	**356.03**														
TP5	**356.64**														
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**														
MPN-1 out	**355.51**														
MPN-2 in	**356.58**														
MPN-2 out	**356.58**														
MPE-1 in	**355.50**														
MPE-1 out	**355.50**														
MPE-2 in	**356.08**														
MPE-2 out	**356.08**														
MPS-1 in	**355.50**														
MPS-1 out	**355.50**														
MPS-2	**356.22**														
MPW-1 in	**355.41**														
MPW-1 out	**355.41**														
MPW-2 in	**355.99**														
MPW-2 out	**355.99**														
MP1	**356.95**														
MP2	**357.38**														
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**														
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**														
M13-D	**357.65**														
M14-S in	**355.62**														
M14-S out	**355.62**														
M14-D	**355.28**														

Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	02-Sep-03	29-Sep-03	24-Oct-03	28-Nov-03	19-Dec-03	30-Jan-04	12-Mar-04	16-Apr-04	13-May-04	17-Jun-04	21-Jul-04	19-Aug-04	24-Sep-04	09-Nov-04
M1-D	**359.70**		351.20	351.15	351.46	351.62	351.68	351.78	352.05	351.65	351.84	351.31	351.13	351.01	351.24
M2	**363.39**	350.08	350.50	350.41	350.79	351.15	351.29	351.42	352.01	351.18	351.31	350.70	350.22	349.99	350.52
M3	**360.20**		349.80	349.80	349.81	349.90	349.91	349.90	349.92	349.92	349.92	349.91	349.90	349.90	349.86
M4	**356.63**		345.81	345.74	346.14	346.45	346.57	346.77	347.34	347.24	346.93	346.21	346.05	345.91	345.80
M5	**359.71**		353.83	353.63	353.91	354.13	354.17	354.26	354.65	354.68	353.99	353.88	353.73	353.94	353.70
M6 in	**356.10**		354.32	354.12	354.58	354.84					355.20	354.67	354.53	354.58	354.25
M6 out	**356.10**										355.23	354.81	354.72		
M7	**353.27**														
M8	**357.46**														
M9	**356.70**				353.77	354.04	354.28	354.47	354.62	354.74	354.70	354.52	354.37		
M10 in	**356.27**		354.29		354.45	354.62	354.62	354.84	355.23	355.24	355.20	354.64	354.45	354.34	354.25
M10 out	**356.27**														
TP1	**356.41**		354.59	354.44	354.90	355.09	355.08	355.24	355.34	355.39	355.35	355.21	355.04	354.87	354.48
TP2 in	**356.03**		353.85	353.76	354.15	354.26	354.29	354.44			354.65	354.31	354.18	354.08	353.82
TP2 out	**356.03**														
TP5	**356.64**														
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**														
MPN-1 out	**355.51**														
MPN-2 in	**356.58**														
MPN-2 out	**356.58**														
MPE-1 in	**355.50**														
MPE-1 out	**355.50**														
MPE-2 in	**356.08**														
MPE-2 out	**356.08**														
MPS-1 in	**355.50**														
MPS-1 out	**355.50**														
MPS-2	**356.22**														
MPW-1 in	**355.41**														
MPW-1 out	**355.41**														
MPW-2 in	**355.99**														
MPW-2 out	**355.99**														
MP1	**356.95**														
MP2	**357.38**														
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**														
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**														
M13-D	**357.65**														
M14-S in	**355.62**														
M14-S out	**355.62**														
M14-D	**355.28**														

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Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	18-Nov-04	17-Dec-04	21-Jan-05	18-Feb-05	17-Mar-05	14-Apr-05	27-May-05	28-Jun-05	13-Jul-05	15-Aug-05	12-Sep-05	24-Oct-05	21-Nov-05	19-Dec-05
M1-D	**359.70**	351.21	351.25	351.65	351.68	351.64	351.65	351.53	351.28	351.14	350.98	350.87	350.87	351.01	351.55
M2	**363.39**	350.51	350.57	351.28	351.27	351.12	351.40	350.87	350.63	350.20	349.91	349.88	349.81	350.04	351.05
M3	**360.20**	349.84	349.82	349.90	349.89	349.90	349.91	349.89	349.87	349.88	349.72	349.67	349.65	349.71	349.86
M4	**356.63**	345.78	345.96	346.55	346.60	346.48	347.32	346.70	346.45	345.95	345.80	345.70	345.67	345.73	346.32
M5	**359.71**	353.66	353.65	354.09	354.18	354.12	354.65	354.38	354.14	354.01	353.84	353.78	353.76	353.88	354.06
M6 in	**356.10**	354.17	354.16	354.78			355.18	355.16	355.00	354.64	354.35	354.30	354.26	354.47	
M6 out	**356.10**														
M7	**353.27**														
M8	**357.46**														
M9	**356.70**		353.51	354.13	354.33	354.32	354.63	354.63	354.39	353.54					353.69
M10 in	**356.27**	354.24		354.67	354.86	354.63	355.29	355.15	355.06	354.37	354.24	354.29		354.47	
M10 out	**356.27**														
TP1	**356.41**	354.44	354.30				355.39	355.31	355.10	355.01	354.81	354.79	354.74	355.01	355.04
TP2 in	**356.03**	353.78	353.79	354.24	354.30			354.57	354.37	354.12	353.95	353.93	353.91	354.06	354.21
TP2 out	**356.03**														
TP5	**356.64**														
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**														
MPN-1 out	**355.51**														
MPN-2 in	**356.58**														
MPN-2 out	**356.58**														
MPE-1 in	**355.50**														
MPE-1 out	**355.50**														
MPE-2 in	**356.08**														
MPE-2 out	**356.08**														
MPS-1 in	**355.50**														
MPS-1 out	**355.50**														
MPS-2	**356.22**														
MPW-1 in	**355.41**														
MPW-1 out	**355.41**														
MPW-2 in	**355.99**														
MPW-2 out	**355.99**														
MP1	**356.95**														
MP2	**357.38**														
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**														
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**														
M13-D	**357.65**														
M14-S in	**355.62**														
M14-S out	**355.62**														
M14-D	**355.28**														

Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	16-Jan-06	13-Feb-06	08-Mar-06	22-Jun-06	19-Jul-06	21-Aug-06	15-Sep-06	05-Oct-06	28-Dec-06	30-Jan-07	15-Feb-07	12-Mar-07	10-Apr-07	08-May-07
M1-D	**359.70**	351.55	351.59	351.55	351.41	351.27	351.06	351.03	351.16	351.69	351.88	351.65	351.62	351.85	351.62
M2	**363.39**	351.08	351.30	351.06	350.81	350.59	350.09	349.92	350.14	351.08	351.54	351.41	351.31	351.59	351.41
M3	**360.20**	349.91	350.08	349.96	349.61	349.39	349.78	349.68	349.74	349.98	350.00	349.96	349.90	350.08	349.89
M4	**356.63**	346.35	346.53	346.45	346.13	345.91	345.78	345.72	345.69	346.60	346.55	346.67	346.80	346.98	346.83
M5	**359.71**	354.05	354.39	354.41	354.14	354.01	353.91	353.74	353.90	354.36	354.30	354.26	354.22	354.36	354.13
M6 in	**356.10**	354.75			354.50	354.39	354.52	354.38	354.55	354.73	354.85		354.82	355.05	354.99
M6 out	**356.10**													355.24	
M7	**353.27**														
M8	**357.46**														
M9	**356.70**	354.12	354.25	354.37	354.53	354.39			353.71	354.21	354.38	354.34	354.30	354.41	354.26
M10 in	**356.27**	354.52	354.61	355.13	354.62	354.50	354.35		354.62	355.04	355.14	355.05	355.00	355.25	355.10
M10 out	**356.27**														
TP1	**356.41**	354.98			355.14	355.02	354.94	354.90	354.99	355.16	355.22	355.16	355.13	355.26	355.09
TP2 in	**356.03**	354.39	354.30	354.60	354.29	354.09	354.04	353.98	354.13	354.44	354.61	354.56	354.53	354.67	354.51
TP2 out	**356.03**														
TP5	**356.64**														
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**														
MPN-1 out	**355.51**														
MPN-2 in	**356.58**														
MPN-2 out	**356.58**														
MPE-1 in	**355.50**														
MPE-1 out	**355.50**														
MPE-2 in	**356.08**														
MPE-2 out	**356.08**														
MPS-1 in	**355.50**														
MPS-1 out	**355.50**														
MPS-2	**356.22**														
MPW-1 in	**355.41**														
MPW-1 out	**355.41**														
MPW-2 in	**355.99**														
MPW-2 out	**355.99**														
MP1	**356.95**														
MP2	**357.38**														
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**														
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**														
M13-D	**357.65**														
M14-S in	**355.62**														
M14-S out	**355.62**														
M14-D	**355.28**														

Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	18-Jul-07	30-Aug-07	26-Sep-07	25-Oct-07	26-Nov-07	21-Dec-07	23-Jan-08	22-Feb-08	18-Mar-08	21-Apr-08	26-May-08	16-Jul-08	18-Aug-08	08-Sep-08
M1-D	**359.70**	351.55	350.95	350.81	350.90	351.02	350.86	351.57	351.70	351.80	352.21	351.78	351.60	351.65	351.58
M2	**363.39**	351.27	349.93	349.83	349.90	350.04	349.88	351.32	351.47	351.49	352.55	351.21	351.34	351.37	351.28
M3	**360.20**	349.75	349.48	349.37	349.42	349.55	349.41	349.78	350.00	350.04	350.18	349.98	349.84	349.84	349.77
M4	**356.63**	346.67	346.58	346.34	345.58	345.65	345.78	346.48	346.71	346.84	348.13	346.63	346.74	346.78	346.70
M5	**359.71**	354.02	353.50	353.39	353.49	353.61	353.49	353.98	354.17	354.25	355.08	354.45	354.08	354.11	354.03
M6 in	**356.10**		354.15		353.86	353.92	353.64				355.62	355.17	354.86	354.79	354.58
M6 out	**356.10**										355.59				
M7	**353.27**														
M8	**357.46**										354.98				
M9	**356.70**	354.19						354.24	354.37	354.39	354.82	354.41	354.23	354.29	354.22
M10 in	**356.27**	355.02						355.06	355.07	355.07	355.56	355.17	355.06	355.09	355.03
M10 out	**356.27**														
TP1	**356.41**	355.04	354.44	354.33	354.45	354.60	354.45	355.02	355.18	355.23	355.59	354.97	355.05	355.08	355.05
TP2 in	**356.03**	354.45	353.79	353.71	353.73	353.88	353.72	354.48	354.57	354.61	355.52	354.94	354.48	354.52	354.47
TP2 out	**356.03**														
TP5	**356.64**														
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**														
MPN-1 out	**355.51**														
MPN-2 in	**356.58**														
MPN-2 out	**356.58**														
MPE-1 in	**355.50**														
MPE-1 out	**355.50**														
MPE-2 in	**356.08**														
MPE-2 out	**356.08**														
MPS-1 in	**355.50**														
MPS-1 out	**355.50**														
MPS-2	**356.22**														
MPW-1 in	**355.41**														
MPW-1 out	**355.41**														
MPW-2 in	**355.99**														
MPW-2 out	**355.99**														
MP1	**356.95**														
MP2	**357.38**														
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**														
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**														
M13-D	**357.65**														
M14-S in	**355.62**														
M14-S out	**355.62**														
M14-D	**355.28**														

Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	30-Oct-08	12-Nov-08	16-Dec-08	30-Jan-09	13-Feb-09	12-Mar-09	07-Apr-09	08-Jun-09	23-Jun-09	21-Jul-09	19-Aug-09	02-Sep-09	06-Oct-09	04-Nov-09
M1-D	**359.70**	351.48	351.19	351.52	351.85	351.93	352.16	352.20	351.86	351.54	351.51	351.42	351.38	351.24	351.19
M2	**363.39**	350.85	350.28	351.20	351.56	351.70	352.18	352.40	351.38	350.96	350.88	350.59	350.56	350.45	350.42
M3	**360.20**	349.65	349.58	349.71	350.01	350.06	350.03	350.02	349.89	349.70	349.92	349.85	349.80	349.74	349.76
M4	**356.63**	346.60	346.15	346.39	346.89	346.99	347.51	347.76	347.48	347.18	347.15	346.09	346.04	345.88	345.82
M5	**359.71**	353.90	353.84	353.92	354.25	354.35	354.78	354.70	354.24	353.94	353.98	353.88	353.85	353.72	353.55
M6 in	**356.10**	354.41	354.37	354.57			355.31	355.36	355.29	355.12	354.60	354.44	354.33	353.83	354.03
M6 out	**356.10**							355.45							
M7	**353.27**														
M8	**357.46**														
M9	**356.70**	354.11	353.91	354.15	354.62		354.91	354.90	354.59	354.27	354.10	353.29	353.26	353.09	353.04
M10 in	**356.27**	354.92		354.97	355.07	355.09	355.33	355.44	354.78	355.20	354.35	354.33	354.31		
M10 out	**356.27**														
TP1	**356.41**	354.91	354.79	354.97	355.25	355.33	355.48	355.48	355.19	355.16	354.89	354.79	354.74	354.55	354.35
TP2 in	**356.03**	354.35	353.97	354.38	354.62	354.64	354.95	355.08	354.58	354.65	354.15	354.01	353.94	353.75	353.65
TP2 out	**356.03**														
TP5	**356.64**														
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**												354.61	354.36	354.29
MPN-1 out	**355.51**														
MPN-2 in	**356.58**												354.60	354.33	354.27
MPN-2 out	**356.58**														
MPE-1 in	**355.50**												354.21	353.97	353.88
MPE-1 out	**355.50**														
MPE-2 in	**356.08**												354.01	353.76	353.68
MPE-2 out	**356.08**														
MPS-1 in	**355.50**												354.27	354.05	353.96
MPS-1 out	**355.50**														
MPS-2	**356.22**												354.07	353.76	353.69
MPW-1 in	**355.41**														
MPW-1 out	**355.41**														
MPW-2 in	**355.99**														
MPW-2 out	**355.99**														
MP1	**356.95**														
MP2	**357.38**														
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**														
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**														
M13-D	**357.65**														
M14-S in	**355.62**														
M14-S out	**355.62**														
M14-D	**355.28**														

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Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	21-Dec-09	27-Jan-10	24-Feb-10	16-Mar-10	20-Apr-10	06-May-10	11-Jun-10	13-Jul-10	27-Aug-10	17-Sep-10	28-Oct-10	24-Nov-10	24-Dec-10	30-Dec-10
M1-D	**359.70**	351.15	351.21	351.17	351.65	351.87	351.75	351.64	351.41	351.41	351.34	351.28	351.28	351.42	
M2	**363.39**	350.40	350.52	350.50	351.20	351.56	351.33	351.12	350.67	350.55	350.66	350.59	350.62	350.74	
M3	**360.20**	349.84	349.87	349.91	349.91	349.92	349.91	349.91	349.91	349.91	349.88	349.87	349.87	349.88	
M4	**356.63**	345.78	345.87	345.85	346.60	346.87	346.63	346.47	346.44	346.05	345.92	345.95	346.02	346.14	
M5	**359.71**	353.52	353.53	353.49	354.04	354.39	354.28	354.13	354.11	353.93	353.80	353.66	353.63	353.79	
M6 in	**356.10**	354.00	354.02	353.78	354.68	355.10	355.02	354.86	354.76	354.45	354.31	354.22	354.18	354.14	
M6 out	**356.10**					355.16	355.10								
M7	**353.27**				349.84										
M8	**357.46**														
M9	**356.70**	353.17	353.78		353.83	354.40	354.42	354.42	354.55			353.39	354.00	354.19	
M10 in	**356.27**				355.05	355.19	354.94	354.62	354.55	354.31	354.28				
M10 out	**356.27**														
TP1	**356.41**	354.37	354.43	354.34	355.23	355.30	355.21	355.06	355.11	354.80	354.63	354.51	354.51	354.69	
TP2 in	**356.03**	353.69	353.66	353.60	354.26	354.53	354.40	354.26	354.23	354.06	353.92	353.80	353.77	353.90	
TP2 out	**356.03**														
TP5	**356.64**														
TP8	**360.36**														
TP9	**357.59**														
MPN-1 in	**355.51**	354.30	354.39	354.27	354.89		355.14	354.99	354.94	354.71	354.57	354.47	354.48	354.60	
MPN-1 out	**355.51**						355.10	354.95	354.88	354.66	354.56				
MPN-2 in	**356.58**	354.26	354.36	354.25	355.06	355.22	355.13	355.00	354.97	354.71	354.49	354.45	354.46	354.57	
MPN-2 out	**356.58**														
MPE-1 in	**355.50**	353.89	353.91	353.79	354.56		354.81	354.67	354.62	354.37	354.19	354.05	354.02	354.03	
MPE-1 out	**355.50**						355.10	354.94	354.88						
MPE-2 in	**356.08**	353.67	353.68	353.63	354.32	354.72	354.59	354.43	354.39	354.16	353.97	353.83	353.80	353.96	
MPE-2 out	**356.08**														
MPS-1 in	**355.50**	353.94	353.95	353.76	354.66	355.02	354.94	354.78	354.71	354.40	354.24	354.14	354.10	354.13	
MPS-1 out	**355.50**				354.77	355.16	355.10	354.95	354.89						
MPS-2	**356.22**	353.69	353.67	353.62	354.49	354.86	354.77	354.60	354.54	354.25	354.01	353.85	353.80	353.94	
MPW-1 in	**355.41**													353.32	
MPW-1 out	**355.41**														
MPW-2 in	**355.99**													354.27	
MPW-2 out	**355.99**														
MP1	**356.95**													353.90	
MP2	**357.38**													354.66	
MP3	**360.55**														
MP4	**359.99**														
M1-S	**359.84**													352.89	
M11	**359.43**														
M12	**362.89**														
M13-S	**357.77**													354.66	
M13-D	**357.65**													354.05	
M14-S in	**355.62**													351.66	353.38
M14-S out	**355.62**														
M14-D	**355.28**													353.96	353.98

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Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	10-Jan-11	25-Jan-11	24-Feb-11	01-Apr-11	02-May-11	31-May-11	27-Jun-11	26-Jul-11	29-Aug-11	05-Oct-11	01-Nov-11	28-Nov-11
M1-D	**359.70**	351.41	351.39	351.42	351.94	352.03	352.05	352.05	351.51	351.43	351.29	351.44	351.39
M2	**363.39**		350.73	350.78	351.70	351.85	351.88	351.74	350.80	350.74	350.61	350.76	350.75
M3	**360.20**		349.90	349.90	349.92	349.90	349.91	349.90	349.90	349.89	349.88	349.88	349.89
M4	**356.63**		346.11	346.13	347.07	347.27	347.62	347.09	346.32	346.09	345.92	346.29	346.23
M5	**359.71**	353.87	353.85	353.82	354.46	354.58	354.83	354.47	354.17	353.96	353.73	353.84	353.87
M6 in	**356.10**	354.21	354.08	354.22		355.24	355.38	355.20	354.81	354.44	354.19	354.36	354.33
M6 out	**356.10**					355.24	355.38	355.23					
M7	**353.27**				349.51								
M8	**357.46**												
M9	**356.70**		354.30	354.51	354.60	354.80	354.85	354.72	354.55	353.43	353.05	353.88	353.90
M10 in	**356.27**				354.97	355.18	355.33	355.16	354.47	354.30			
M10 out	**356.27**						355.32	355.20					
TP1	**356.41**	354.63	354.55	354.59	355.23	355.36	355.45	355.34	355.07	354.76	354.40	354.61	354.65
TP2 in	**356.03**	353.99	353.95	353.93	354.49	354.78	355.13	354.59	354.26	354.09	353.84	353.96	353.99
TP2 out	**356.03**						355.34						
TP5	**356.64**												
TP8	**360.36**												
TP9	**357.59**												
MPN-1 in	**355.51**	354.53	354.46	354.47	355.05	355.25	355.38	355.24	354.89	354.62	354.27	354.51	354.52
MPN-1 out	**355.51**				355.12	355.25	355.38	355.23	354.87				
MPN-2 in	**356.58**	354.53	354.45	354.46	355.13	355.27	355.39	355.25	354.90	354.61	354.25	354.50	354.52
MPN-2 out	**356.58**						355.35	356.58					
MPE-1 in	**355.50**	354.09	354.03	354.06	354.72	354.96	355.19	354.88	354.53	354.26	353.95	354.10	354.14
MPE-1 out	**355.50**				355.11	355.24	355.38	355.22	354.87				
MPE-2 in	**356.08**	354.04	354.00	354.01	355.00	355.23	355.37	355.18	354.72	354.30	353.87	354.08	354.17
MPE-2 out	**356.08**						355.38						
MPS-1 in	**355.50**	354.19	354.10	354.64	354.90	355.13	355.62	355.07	354.69	354.37	354.10	354.26	354.24
MPS-1 out	**355.50**				355.11			355.22	354.87				
MPS-2	**356.22**	354.03	353.97	353.96	354.79	355.03	355.25	354.87	354.53	354.21	353.85	354.01	354.02
MPW-1 in	**355.41**	354.47	354.41	354.47	355.17	355.34		355.32	354.92	354.56	354.27	354.51	354.51
MPW-1 out	**355.41**				355.21	355.36		355.34					
MPW-2 in	**355.99**	354.49	354.42	354.48	355.19	355.36	355.52	355.33	354.89	354.56	354.28	354.52	354.52
MPW-2 out	**355.99**				355.23		355.50	355.35					
MP1	**356.95**		353.99		354.27	354.49	354.64	354.50	354.32	353.33		353.61	353.61
MP2	**357.38**		354.76			355.07	355.12	355.02	354.86	353.67	353.73	354.35	354.37
MP3	**360.55**			357.31		357.21	356.97						
MP4	**359.99**			357.34		357.30	357.04						
M1-S	**359.84**	352.91	352.90	352.92	353.53	353.62	353.89	353.63	353.30	353.09	352.89	352.94	353.00
M11	**359.43**												
M12	**362.89**												
M13-S	**357.77**	354.60	354.52	354.56	355.20	355.38	355.49	355.33	355.01	354.69	354.32	354.59	354.60
M13-D	**357.65**	354.00	353.91	354.03	354.69	354.93	354.95	354.80	354.22	353.95	353.63	354.08	354.01
M14-S in	**355.62**	354.12	354.07	354.08	354.68	354.91	355.13	354.80	354.43	354.21	353.94	354.08	354.11
M14-S out	**355.62**				355.17		355.33	355.22					
M14-D	**355.28**	354.02	353.98	353.96		354.77			354.32	354.12	353.85	353.98	354.01

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ENVIRONMENTAL

Table B2: Groundwater Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	02-Feb-12	23-Feb-12	29-Mar-12	11-May-12	06-Jul-12
M1-D	**359.70**	351.79	351.73	351.71	351.36	351.07
M2	**363.39**	351.52	351.37	351.39	350.86	350.27
M3	**360.20**	349.91	349.88	349.89	349.90	349.89
M4	**356.63**	346.83	346.69	346.77	346.39	345.84
M5	**359.71**	354.29	354.24	354.25	354.08	353.81
M6 in	**356.10**			354.98	354.71	353.98
M6 out	**356.10**	355.12		355.03		
M7	**353.27**					
M8	**357.46**					
M9	**356.70**	354.32	354.41	354.62	354.60	
M10 in	**356.27**	354.82	354.69	354.66	354.49	
M10 out	**356.27**					
TP1	**356.41**	355.30	355.19	355.18	354.97	354.62
TP2 in	**356.03**	354.44	354.38	354.39	354.20	353.90
TP2 out	**356.03**					
TP5	**356.64**					
TP8	**360.36**			354.80	354.19	353.73
TP9	**357.59**			352.25	352.29	
MPN-1 in	**355.51**	355.13	355.07	355.04	354.83	354.45
MPN-1 out	**355.51**	355.12	355.08	355.04	354.81	
MPN-2 in	**356.58**	355.16	355.08	355.06	354.84	354.45
MPN-2 out	**356.58**					
MPE-1 in	**355.50**	354.70	354.65	354.65	354.45	353.93
MPE-1 out	**355.50**	355.11	355.07	355.03	354.81	
MPE-2 in	**356.08**	354.92	354.85	354.83	354.56	353.94
MPE-2 out	**356.08**					
MPS-1 in	**355.50**	354.93	354.85	354.84	354.61	354.00
MPS-1 out	**355.50**	355.12	355.07	355.03	354.81	
MPS-2	**356.22**	354.84	354.76	354.70	354.45	353.91
MPW-1 in	**355.41**			355.10	354.84	354.33
MPW-1 out	**355.41**	355.22		355.14		
MPW-2 in	**355.99**	355.20	355.10	355.07	354.81	354.36
MPW-2 out	**355.99**	355.25				
MP1	**356.95**	354.07	354.08	354.29	354.37	
MP2	**357.38**	354.84	354.87	354.91	354.86	
MP3	**360.55**					
MP4	**359.99**					
M1-S	**359.84**	353.37	353.34	353.35	353.18	352.97
M11	**359.43**					
M12	**362.89**					
M13-S	**357.77**	355.28	355.18	355.16	354.93	354.53
M13-D	**357.65**	354.74	354.59	354.57	354.13	353.52
M14-S in	**355.62**	354.60	354.54	354.55	354.35	354.03
M14-S out	**355.62**	354.94	354.91	354.81		
M14-D	**355.28**	354.47	354.42	354.43	354.24	353.94

Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	02-Aug-96	04-Sep-96	08-Nov-96	21-Nov-96	14-May-97	26-Jun-97	15-Jul-97	14-Oct-97	17-Dec-97	06-Feb-98	31-Mar-98	07-Apr-98	21-Apr-98	29-Apr-98	23-Nov-99	18-Jan-99	22-Feb-00
SW1	**355.33**	0.54	0.32	0.52	0.51	0.19	0.44	0.64	1.1	1.13	1.04	1	0.22	0.17	0.2	0.92	0.66	0
SW2	**355.28**	0.648	0.7	0.78	0.71	0.21	0.30	0.75	Dry	Dry	0.23	0.03		0.9		0.78	0	
SW3	**351.02**																	
SW4	**360.52**																	
SW5	**355.66**												0.77	0.765	0.8	0.82	0.73	0.74
SW6 (Replaces SW1)	**355.34**																	
SW7 (Replaces SW2)	**356.46**																	
SW8	**355.33**																	
SW14	**358.64**																	
RS1	**359.78**																	

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Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	16-Mar-00	25-Apr-00	26-Jun-00	18-Jul-00	19-Sep-00	30-Oct-00	30-Jan-01	03-Apr-01	04-Jun-01	17-Jul-01	23-Aug-01	04-Oct-01	05-Dec-01	30-Jan-02
SW1	**355.33**	-0.275	-0.4		Submrgd	-0.02	0.22		Submrgd		0.05		Removed	Removed	Removed
SW2	**355.28**	-0.255			Submrgd	0.52	Dry		Submrgd			Dry	Removed	Removed	Removed
SW3	**351.02**			1.91	No Flow	Dry	Dry	Dry	Flow		Dry	Dry	Dry	Dry	Dry
SW4	**360.52**														
SW5	**355.66**	0.685	-0.015		Submrgd	Dry	Dry	Dry	Submrgd		0.83	Dry	Dry		0.15
SW6 (Replaces SW1)	**355.34**												0.14	0.345	0.57
SW7 (Replaces SW2)	**356.46**												Dry	Dry	Submrgd
SW8	**355.33**														
SW14	**358.64**														
RS1	**359.78**														

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Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	22-Feb-02	01-Apr-02	06-Jun-02	04-Jul-02	08-Aug-02	19-Nov-02	31-Dec-02	06-Mar-03	09-May-03
SW1	**355.33**	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed
SW2	**355.28**	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed
SW3	**351.02**				Dry	Dry			Dry	1.83
SW4	**360.52**									
SW5	**355.66**		Submrgd	Submrgd	0.65	Dry	Dry	Dry	Dry	0.52
SW6 (Replaces SW1)	**355.34**	0.65	Submrgd	Visible		0.68				0.7
SW7 (Replaces SW2)	**356.46**	Submrgd	Submrgd	Submrgd		Dry	Dry	Dry	Dry	Submrgd
SW8	**355.33**									
SW14	**358.64**									
RS1	**359.78**									

***sc denotes snow covered**

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Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	13-Jun-03	18-Jul-03	26-Aug-03	24-Oct-03	28-Nov-03	19-Dec-03	30-Jan-04	12-Mar-04	16-Apr-04
SW1	**355.33**	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed
SW2	**355.28**	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed
SW3	**351.02**	1.84	Dry	Dry	Dry	1.78	1.75	Frozen 1.72	buried	1.78
SW4	**360.52**								buried	1.32
SW5	**355.66**	0.52	0.8	Dry	Dry	0.49	0.43	0.39	frozen @ 0.42	0.51
SW6 (Replaces SW1)	**355.34**	0.83	0.85	0.95	0.95	0.68	0.42	Frozen 0.35	buried	0.5
SW7 (Replaces SW2)	**356.46**	Submrgd	0.85	Dry	Dry	Submrgd	Submrgd	Submrgd	buried	dry
SW8	**355.33**									
SW14	**358.64**									
RS1	**359.78**									1.15

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ENVIRONMENTAL

Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	13-May-04	17-Jun-04	21-Jul-04	19-Aug-04	24-Sep-04	09-Nov-04	18-Nov-04	17-Dec-04	21-Jan-05
SW1	**355.33**	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed
SW2	**355.28**	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed
SW3	**351.02**	1.82	1.88	dry @ 1.86	dry	dry	dry	dry	covered	covered
SW4	**360.52**	1.29	1.48	-	1.5	dry	dry	dry	covered	covered
SW5	**355.66**	0.29	0.61	0.81	0.73	dry	dry	dry	covered	covered
SW6 (Replaces SW1)	**355.34**	0.55	Submrgd	Submrgd	Submrgd	0.75	0.85	0.62	Frozen @0.38	Frozen @0.30
SW7 (Replaces SW2)	**356.46**	dry	Submrgd	Submrgd	0.89	dry	dry	dry	buried	buried
SW8	**355.33**									
SW14	**358.64**									
RS1	**359.78**	1.19	1.22	1.24	1.26	1.27	1.25	1.27	1.24	1.21

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Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	18-Feb-05	17-Mar-05	14-Apr-05	27-May-05	28-Jun-05	13-Jul-05	15-Aug-05	12-Sep-05	24-Oct-05
SW1	**355.33**	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed
SW2	**355.28**	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed	Removed
SW3	**351.02**	covered	covered	1.89	1.83	dry	dry	dry	dry	dry
SW4	**360.52**	covered	covered	1.31	1.46	1.41	1.41	dry	dry	1.49
SW5	**355.66**	covered	covered	0.42	0.52	0.7	dry	dry	dry	dry
SW6 (Replaces SW1)	**355.34**	0.62	snow @ 0.33	0.95	0.72	0.55	0.35	0.79	0.82	0.8
SW7 (Replaces SW2)	**356.46**	buried	buried	Submrgd		dry	dry	dry	dry	dry
SW8	**355.33**									
SW14	**358.64**									
RS1	**359.78**	1.18	1.22	1.16	1.2	1.23	1.26	1.28	1.28	1.25

***sc denotes snow covered**

HARDEN
ENVIRONMENTAL

Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	21-Nov-05	19-Dec-05	16-Jan-06	13-Feb-06	08-Mar-06	24-Apr-06	24-May-06	22-Jun-06	19-Jul-06
SW1	**355.33**	Removed	Removed							
SW2	**355.28**	Removed	Removed							
SW3	**351.02**	dry	sc	sc	sc	sc	1.73	dry	dry	dry
SW4	**360.52**	1.52	sc	sc	sc	sc	1.3	1.42	dry	dry
SW5	**355.66**	dry	sc	sc	sc	sc	0.52	0.54	dry	dry
SW6 (Replaces SW1)	**355.34**	0.95	sc	sc	sc	sc	0.1	0.48	0.81	0.91
SW7 (Replaces SW2)	**356.46**	dry	sc	sc	sc	sc	1.35	1.48	dry	dry
SW8	**355.33**									
SW14	**358.64**									
RS1	**359.78**	1.23	1.25	1.22	1.2	1.22	1.2	1.28	1.32	1.28

***sc denotes snow covered**

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ENVIRONMENTAL

Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	21-Aug-06	15-Sep-06	05-Oct-06	28-Dec-06	30-Jan-07	15-Feb-07	12-Mar-07	10-Apr-07	08-May-07
SW1	355.33									
SW2	355.28									
SW3	351.02	dry	dry	1.93	1.88	sc	sc	sc	1.72	1.81
SW4	360.52	dry	dry	1.58	1.54	sc	sc	sc	1.38	1.47
SW5	355.66	dry	dry	0.65	0.6	sc	sc	sc	0.51	0.63
SW6 (Replaces SW1)	355.34	0.89	1.1	0.88	0.8	sc	sc	sc	Submrgd	Submrgd
SW7 (Replaces SW2)	356.46	dry	dry	1.45	1.35	sc	sc	sc	1.4	1.43
SW8	355.33									
SW14	358.64									
RS1	359.78	1.28	1.3	1.22	1.24	1.3	1.32	1.2	1.22	1.23

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ENVIRONMENTAL

Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	18-Jul-07	30-Aug-07	26-Sep-07	25-Oct-07	26-Nov-07	21-Dec-07	23-Jan-08	22-Feb-08	18-Mar-08
SW1	355.33									
SW2	355.28									
SW3	351.02	dry	dry	dry	dry	dry	sc	sc	sc	sc
SW4	360.52	1.5	1.6	dry	dry	1.62	sc	sc	sc	sc
SW5	355.66	dry	dry	dry	dry	dry	sc	sc	sc	sc
SW6 (Replaces SW1)	355.34	0.87	dry	dry	0.91	0.95	sc	sc	sc	sc
SW7 (Replaces SW2)	356.46	dry	dry	dry	dry	dry	sc	sc	sc	sc
SW8	355.33									
SW14	358.64									
RS1	359.78	1.29	1.29	1.32	1.31	1.28	1.27	1.25	1.21	1.21

*sc denotes snow covered

HARDEN
ENVIRONMENTAL

Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	21-Apr-08	26-May-08	16-Jul-08	18-Aug-08	08-Sep-08	30-Oct-08	12-Nov-08	16-Dec-08	30-Jan-09
SW1	355.33									
SW2	355.28									
SW3	351.02	1.74	1.71	1.88	dry	dry	dry	dry	1.81	sc
SW4	360.52	1.15	1.35	1.35	1.39	1.38	1.59	1.46	1.47	sc
SW5	355.66	0.12	0.46	0.51	0.59	0.6	dry	dry	0.6	sc
SW6 (Replaces SW1)	355.34	Submrgd	0.02	0.5	0.6	0.75	0.81	0.89	frozen0.82	sc
SW7 (Replaces SW2)	356.46	0.27	1.41	1.44	1.47	1.47	dry	dry	1.45	sc
SW8	355.33									
SW14	358.64									
RS1	359.78	1.16	1.21	1.23	1.25	1.27	1.21	1.26	1.25	1.22

*sc denotes snow covered

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Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	13-Feb-09	12-Mar-09	07-Apr-09	08-Jun-09	23-Jun-09	21-Jul-09	19-Aug-09	02-Sep-09	06-Oct-09
SW1	**355.33**									
SW2	**355.28**									
SW3	**351.02**	sc	1.83	1.78	1.83	1.73	dry	dry	dry	dry
SW4	**360.52**	1.25	1.2	1.25	1.31	1.42	1.55	1.59	1.61	muddy
SW5	**355.66**	sc	0.18	0.39	0.45	0.61	dry	dry	dry	dry
SW6 (Replaces SW1)	**355.34**	sc	Submrgd	Submrgd	0.55	0.63	0.73	0.89	0.9	0.9
SW7 (Replaces SW2)	**356.46**	froz@0.98	0.35	1.35	1.38	1.48	dry	dry	dry	dry
SW8	**355.33**									
SW14	**358.64**									
RS1	**359.78**	sc	1.14	1.1	1.14	1.21	1.23	1.24	1.27	1.29
			froz	froz	0.76	0.65	0.73	0.85	dry	dry@1.08

***sc denotes snow covered**

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Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	04-Nov-09	21-Dec-09	27-Jan-10	24-Feb-10	16-Mar-10	20-Apr-10	06-May-10	11-Jun-10	13-Jul-10
SW1	**355.33**									
SW2	**355.28**									
SW3	**351.02**	dry	sc	frozen	frozen	-	-	1.86	1.81	1.74
SW4	**360.52**	muddy	sc	frozen@1.18	frozen@1.14	1.21	1.37	1.43	1.45	1.46
SW5	**355.66**	dry	sc	frozen@0.4	sc	0.22	0.465	0.54	0.493	0.51
SW6 (Replaces SW1)	**355.34**	0.88	sc	frozen@0.895	sc	damg	damg	damg	damg	damg
SW7 (Replaces SW2)	**356.46**	dry	sc	frozen@1.30	sc	0.31	1.33	1.365	1.36	1.38
SW8	**355.33**			-	-	-	-	-	-	0.48
SW14	**358.64**									
RS1	**359.78**	1.28	sc	1.24	1.25	1.155	1.205	1.25	1.2	1.23

***sc denotes snow covered**

dry dry dry frozen sc - 0.94

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Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	27-Aug-10	17-Sep-10	28-Oct-10	24-Nov-10	24-Dec-10	25-Jan-11	24-Feb-11	01-Apr-11	02-May-11
SW1	**355.33**									
SW2	**355.28**									
SW3	**351.02**	dry	dry	dry	1.94	frozen@1.65	frozen	frozen	1.81	1.85
SW4	**360.52**	-	1.58	1.5	1.46	frozen@1.26	frozen@1.20	frozen@1.06	1.295	1.32
SW5	**355.66**	dry	dry	0.59	0.535	frozen@0.48	frozen@0.45	frozen@0.15	0.42	0.42
SW6 (Replaces SW1)	**355.34**	damg	damg	damg	0.884	frozen	0.76	frozen@0.68	frozen	0.06
SW7 (Replaces SW2)	**356.46**	dry	dry	1.46	1.42	frozen@1.34	frozen@1.25	frozen@1.085	1.27	1.26
SW8	**355.33**	dry	dry	0.54	0.52	frozen@0.45	frozen@0.38	frozen	-	-
SW14	**358.64**									
RS1	**359.78**	1.24	1.22	1.215	1.21	1.24	1.24	1.225	1.19	1.2

***sc denotes snow covered**

dry

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Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	31-May-11	27-Jun-11	26-Jul-11	29-Aug-11	05-Oct-11	01-Nov-11	28-Nov-11	02-Feb-12	23-Feb-12
SW1	**355.33**									
SW2	**355.28**									
SW3	**351.02**	1.83	1.88	dry	dry	dry	1.87	1.85	1.81	froz
SW4	**360.52**	1.34	1.4	1.49	1.58	1.555	1.37	1.38	1.325	1.37
SW5	**355.66**	0.41	0.48	0.6	dry	0.8	0.485	0.455	froz @ 0.43	froz @ 0.45
SW6 (Replaces SW1)	**355.34**	UW			0.71	0.84	0.77	0.78	froz	frpz
SW7 (Replaces SW2)	**356.46**	1.245	1.335	1.64	dry	dry	1.38	1.39	froz @1.29	1.37
SW8	**355.33**	-					0.48	0.48	froz	froz
SW14	**358.64**									
RS1	**359.78**	1.18	1.21	1.25	1.28	1.24	1.23	1.215	1.215	1.23

***sc denotes snow covered**

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Table B3: Surface Water Levels (Metres Below Top of Reference Point)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	29-Mar-12	11-May-12	23-May-12	06-Jul-12
SW1	**355.33**				
SW2	**355.28**				
SW3	**351.02**				dry
SW4	**360.52**	1.39	1.48	1.495	dry
SW5	**355.66**	0.51	0.565		dry
SW6 (Replaces SW1)	**355.34**				0.84
SW7 (Replaces SW2)	**356.46**	1.345	1.435	1.595	dry
SW8	**355.33**				dry
SW14	**358.64**	0.32	0.415		dry
RS1	**359.78**	1.21	1.2	1.23	1.25

***sc denotes snow covered**

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	02-Aug-96	04-Sep-96	08-Nov-96	21-Nov-96	14-May-97	26-Jun-97	15-Jul-97	14-Oct-97	17-Dec-97	06-Feb-98	31-Mar-98	07-Apr-98	21-Apr-98
SW1	**355.33**	354.79	355.01	354.82	354.83	355.15	354.89	354.69	354.23	354.20	354.29	354.33	355.11	355.16
SW2	**355.28**	354.63	354.58	354.50	354.57	355.07	354.98	354.54			355.05	355.25		354.38
SW3	**351.02**													
SW4	**360.52**													
SW5	**355.66**												354.89	354.90
SW6 (Replaces SW1)	**355.34**													
SW7 (Replaces SW2)	**356.46**													
SW8	**355.33**													
Northwest Wetland	*****	354.79	355.01	354.82	354.83	355.15	354.89	354.69	354.23	354.20	354.29	354.33	355.11	355.16
SW14	**358.64**													
RS1	**359.78**													

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	29-Apr-98	23-Nov-99	18-Jan-00	22-Feb-00	16-Mar-00	25-Apr-00	26-Jun-00	18-Jul-00	19-Sep-00	30-Oct-00	30-Jan-01	03-Apr-01	04-Jun-01
SW1	**355.33**	355.13	354.41	354.67	355.33	355.61	355.73			355.35	355.11			
SW2	**355.28**		354.50	355.28		355.54				354.76				
SW3	**351.02**							349.11						
SW4	**360.52**													
SW5	**355.66**	354.86	354.84	354.93	354.92	354.98	355.68						356.27	355.91
SW6 (Replaces SW1)	**355.34**													
SW7 (Replaces SW2)	**356.46**													
SW8	**355.33**													
Northwest Wetland	*****	355.13	354.41	354.67	355.33	355.61	355.73			355.35	355.11			355.10
SW14	**358.64**													
RS1	**359.78**													

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	17-Jul-01	23-Aug-01	04-Oct-01	06-Dec-01	30-Jan-02	22-Feb-02	01-Apr-02	06-Jun-02	04-Jul-02	08-Aug-02	19-Nov-02	31-Dec-02	06-Mar-03
SW1	**355.33**	355.28												
SW2	**355.28**													
SW3	**351.02**													
SW4	**360.52**													
SW5	**355.66**	354.83				355.51		356.16	355.92	355.01				
SW6 (Replaces SW1)	**355.34**			354.48	354.68	354.91	354.99	355.15	355.15		355.02			
SW7 (Replaces SW2)	**356.46**													
SW8	**355.33**													
Northwest Wetland	*****	355.28		354.48	354.68	354.91	354.99	355.15	355.15		355.02			
SW14	**358.64**													
RS1	**359.78**													

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	09-May-03	13-Jun-03	18-Jul-03	26-Aug-03	24-Oct-03	28-Nov-03	19-Dec-03	30-Jan-04	12-Mar-04	16-Apr-04	13-May-04	17-Jun-04	21-Jul-04
SW1	**355.33**													
SW2	**355.28**													
SW3	**351.02**	349.19	349.18				349.24	349.27			349.24	349.20	349.14	
SW4	**360.52**										359.20	359.23	359.04	
SW5	**355.66**	355.14	355.14	354.86			355.17	355.23	355.27		355.15	355.37	355.05	354.85
SW6 (Replaces SW1)	**355.34**	355.04	355.17	355.19	355.29	355.29	355.02	354.76			354.84	354.89		
SW7 (Replaces SW2)	**356.46**													
SW8	**355.33**													
Northwest Wetland	*****	355.04	355.17	355.19	355.29	355.29	355.02	354.76			354.84	354.89	355.23	354.81
SW14	**358.64**													
RS1	**359.78**										358.63	358.59	358.56	358.54

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	19-Aug-04	24-Sep-04	09-Nov-04	18-Nov-04	17-Dec-04	21-Jan-05	18-Feb-05	17-Mar-05	14-Apr-05	27-May-05	28-Jun-05	13-Jul-05	15-Aug-05
SW1	**355.33**													
SW2	**355.28**													
SW3	**351.02**									349.13	349.19			
SW4	**360.52**	359.02								359.21	359.06	359.11	359.11	
SW5	**355.66**	354.93								355.24	355.14	354.96		
SW6 (Replaces SW1)	**355.34**		355.09	355.19	354.96			354.96		355.29	355.06	354.89	354.69	355.13
SW7 (Replaces SW2)	**356.46**													
SW8	**355.33**													
Northwest Wetland	*****	354.72	355.09	355.19	354.96			354.96		355.29	355.06	354.89	354.69	355.13
SW14	**358.64**													
RS1	**359.78**	358.52	358.51	358.53	358.51	358.54	358.57	358.60	358.56	358.62	358.58	358.55	358.52	358.50

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	12-Sep-05	24-Oct-05	21-Nov-05	19-Dec-05	16-Jan-06	13-Feb-06	08-Mar-06	24-Apr-06	24-May-06	22-Jun-06	19-Jul-06	21-Aug-06	15-Sep-06
SW1	**355.33**													
SW2	**355.28**													
SW3	**351.02**								349.29					
SW4	**360.52**		359.03	359.00					359.22	359.10				
SW5	**355.66**								355.14	355.12				
SW6 (Replaces SW1)	**355.34**	355.16	355.14	355.29					354.44	354.82	355.15	355.25	355.23	355.44
SW7 (Replaces SW2)	**356.46**								355.11	354.98				
SW8	**355.33**													
Northwest Wetland	*****	355.16	355.14	355.29					354.44	354.82	355.15	355.25	355.23	355.44
SW14	**358.64**													
RS1	**359.78**	358.50	358.53	358.55	358.53	358.56	358.58	358.56	358.58	358.50	358.46	358.50	358.50	358.48

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	05-Oct-06	28-Dec-06	30-Jan-07	15-Feb-07	12-Mar-07	10-Apr-07	08-May-07	18-Jul-07	30-Aug-07	26-Sep-07	25-Oct-07	26-Nov-07	21-Dec-07
SW1	**355.33**													
SW2	**355.28**													
SW3	**351.02**	349.09	349.14				349.30	349.21						
SW4	**360.52**	358.94	358.98				359.14	359.05	359.02	358.92			358.90	
SW5	**355.66**	355.01	355.06				355.15	355.03						
SW6 (Replaces SW1)	**355.34**	355.22	355.14						355.21			355.25	355.29	
SW7 (Replaces SW2)	**356.46**	355.01	355.11				355.06	355.03						
SW8	**355.33**													
Northwest Wetland	*****	355.22	355.14				355.24		355.21	354.30	354.30	355.25	355.29	
SW14	**358.64**													
RS1	**359.78**	358.56	358.54	358.48	358.46	358.58	358.56	358.55	358.49	358.49	358.46	358.47	358.50	358.51

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	23-Jan-08	22-Feb-08	18-Mar-08	21-Apr-08	26-May-08	16-Jul-08	18-Aug-08	08-Sep-08	30-Oct-08	12-Nov-08	16-Dec-08	30-Jan-09	13-Feb-09
SW1	355.33													
SW2	355.28													
SW3	351.02				349.28	349.31	349.14					349.21		
SW4	360.52				359.37	359.17	359.17	359.13	359.14	358.93	359.06	359.05		359.27
SW5	355.66				355.54	355.20	355.15	355.07	355.06			355.06		
SW6 (Replaces SW1)	355.34					354.36	354.84	354.94	355.09	355.15	355.23			
SW7 (Replaces SW2)	356.46				356.19	355.05	355.02	354.99	354.99			355.01		
SW8	355.33													
Northwest Wetland	*				355.59	354.36	354.84	354.94	355.09	355.15	355.23			
SW14	358.64													
RS1	359.78	358.53	358.57	358.57	358.62	358.57	358.55	358.53	358.51	358.57	358.52	358.53	358.56	

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	12-Mar-09	07-Apr-09	08-Jun-09	23-Jun-09	21-Jul-09	19-Aug-09	02-Sep-09	06-Oct-09	04-Nov-09	21-Dec-09	27-Jan-10	24-Feb-10	16-Mar-10
SW1	**355.33**													
SW2	**355.28**													
SW3	**351.02**	349.19	349.24	349.19	349.29									
SW4	**360.52**	359.32	359.27	359.21	359.10	358.97	358.93	358.91						359.31
SW5	**355.66**	355.48	355.27	355.21	355.05									355.44
SW6 (Replaces SW1)	**355.34**			354.89	354.97	355.07	355.23	355.24	355.24	355.22				
SW7 (Replaces SW2)	**356.46**	356.11	355.11	355.08	354.98									356.15
SW8	**355.33**													
Northwest Wetland	*****		355.45	354.89	354.97	355.07	355.23	355.24	355.24	355.22				354.77
SW14	**358.64**													
RS1	**359.78**	358.64	358.68	358.64	358.57	358.55	358.54	358.51	358.49	358.50		358.54	358.53	358.63

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	20-Apr-10	06-May-10	11-Jun-10	13-Jul-10	27-Aug-10	17-Sep-10	28-Oct-10	24-Nov-10	24-Dec-10	25-Jan-11	24-Feb-11	01-Apr-11	02-May-11
SW1	**355.33**													
SW2	**355.28**													
SW3	**351.02**		349.16	349.21	349.28				349.08				349.21	349.17
SW4	**360.52**	359.15	359.09	359.07	359.06		358.94	359.02	359.06				359.23	359.20
SW5	**355.66**	355.20	355.12	355.17	355.15			355.07	355.13				355.24	355.24
SW6 (Replaces SW1)	**355.34**								354.45		354.58			355.28
SW7 (Replaces SW2)	**356.46**	355.13	355.10	355.10	355.08			355.00	355.04				355.19	355.20
SW8	**355.33**													
Northwest Wetland	*****	355.16	355.10	354.95	354.89	354.66	354.56		354.45		354.58			355.28
SW14	**358.64**													
RS1	**359.78**	358.58	358.53	358.58	358.55	358.54	358.56	358.57	358.57	358.54	358.54	358.56	358.59	358.58

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Table B4: Surface Water Elevations (Metres Above Mean Sea Level)

MONITOR / LOCATION	REFERENCE ELEVATION (mAMSL)	31-May-11	27-Jun-11	26-Jul-11	29-Aug-11	05-Oct-11	01-Nov-11	28-Nov-11	02-Feb-12	23-Feb-12	29-Mar-12	11-May-12	23-May-12	06-Jul-12
SW1	355.33													
SW2	355.28													
SW3	351.02	349.19	349.14				349.15	349.17	349.21					
SW4	360.52	359.18	359.12	359.03	358.94	358.97	359.15	359.14	359.20	359.15	359.13	359.04	359.03	
SW5	355.66	355.25	355.18	355.06		354.86	355.18	355.21			355.15	355.10		
SW6 (Replaces SW1)	355.34				354.63	354.50	354.56	354.56						354.50
SW7 (Replaces SW2)	356.46	355.22	355.13	354.82			355.08	355.07		355.09	355.12	355.03	354.87	
SW8	355.33						354.85	354.85						
Northwest Wetland	*	355.38	355.23	354.87	354.63	354.50	354.56	354.56	355.12	355.07	355.03	354.81		354.50
SW14	358.64										358.32	358.22		
RS1	359.78	358.60	358.57	358.53	358.50	358.54	358.55	358.57	358.57	358.55	358.57	358.58	358.55	358.53

* Levels obtained from SW1, SW6, M6 out, MPS-1 out

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Figure B1: M1 S/D Hydrograph

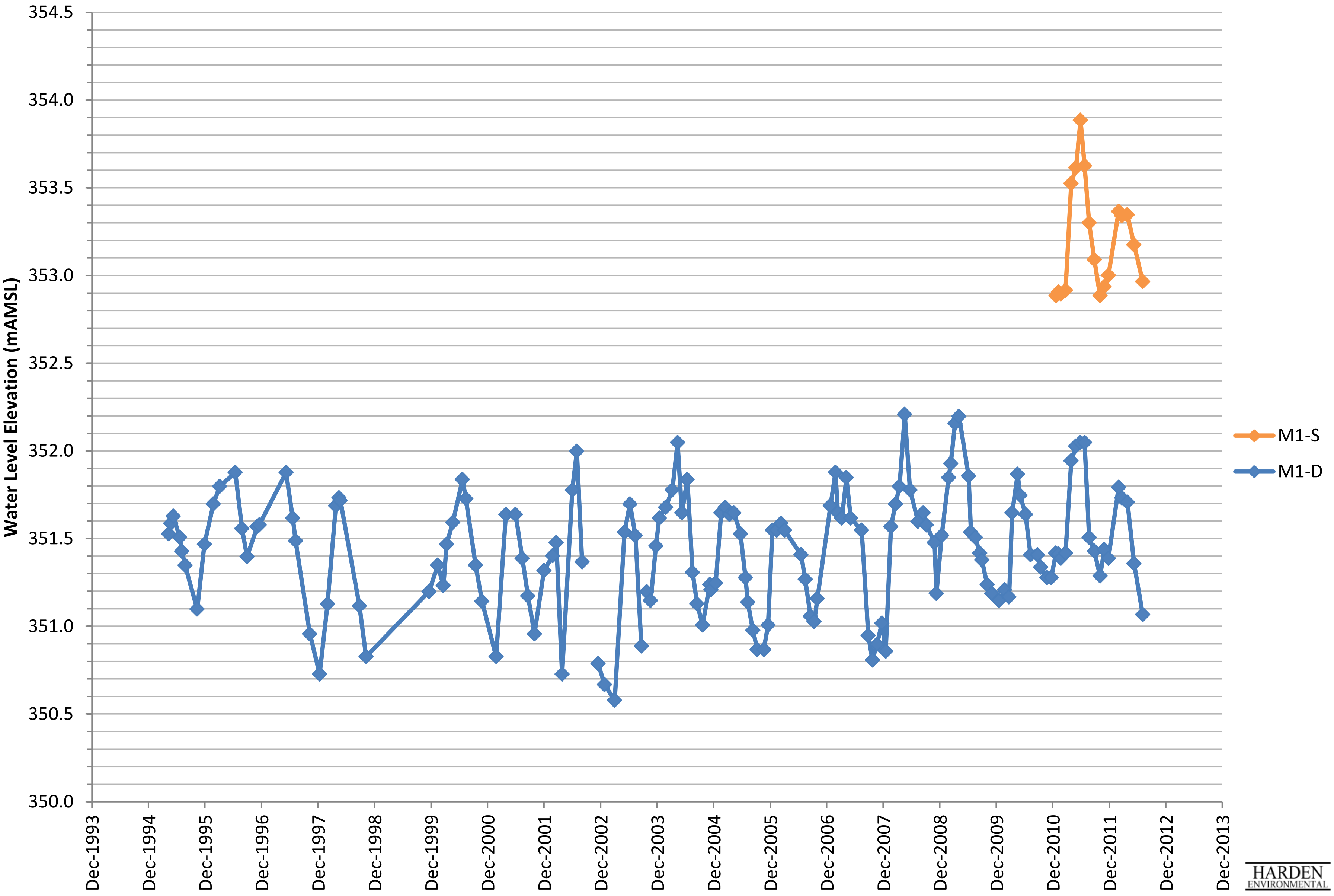

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Figure B2: M2 Hydrograph

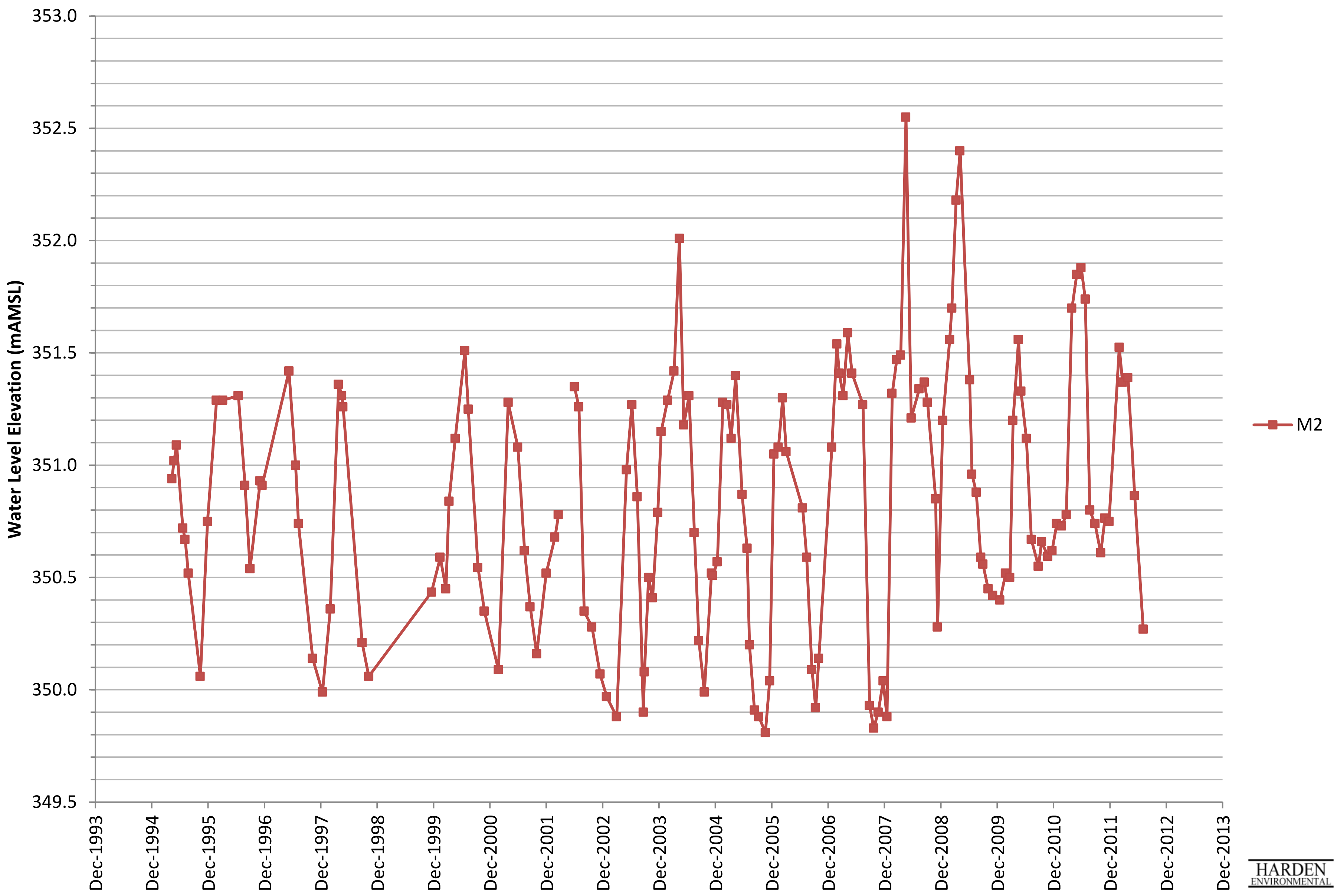

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Figure B3: M3 Hydrograph

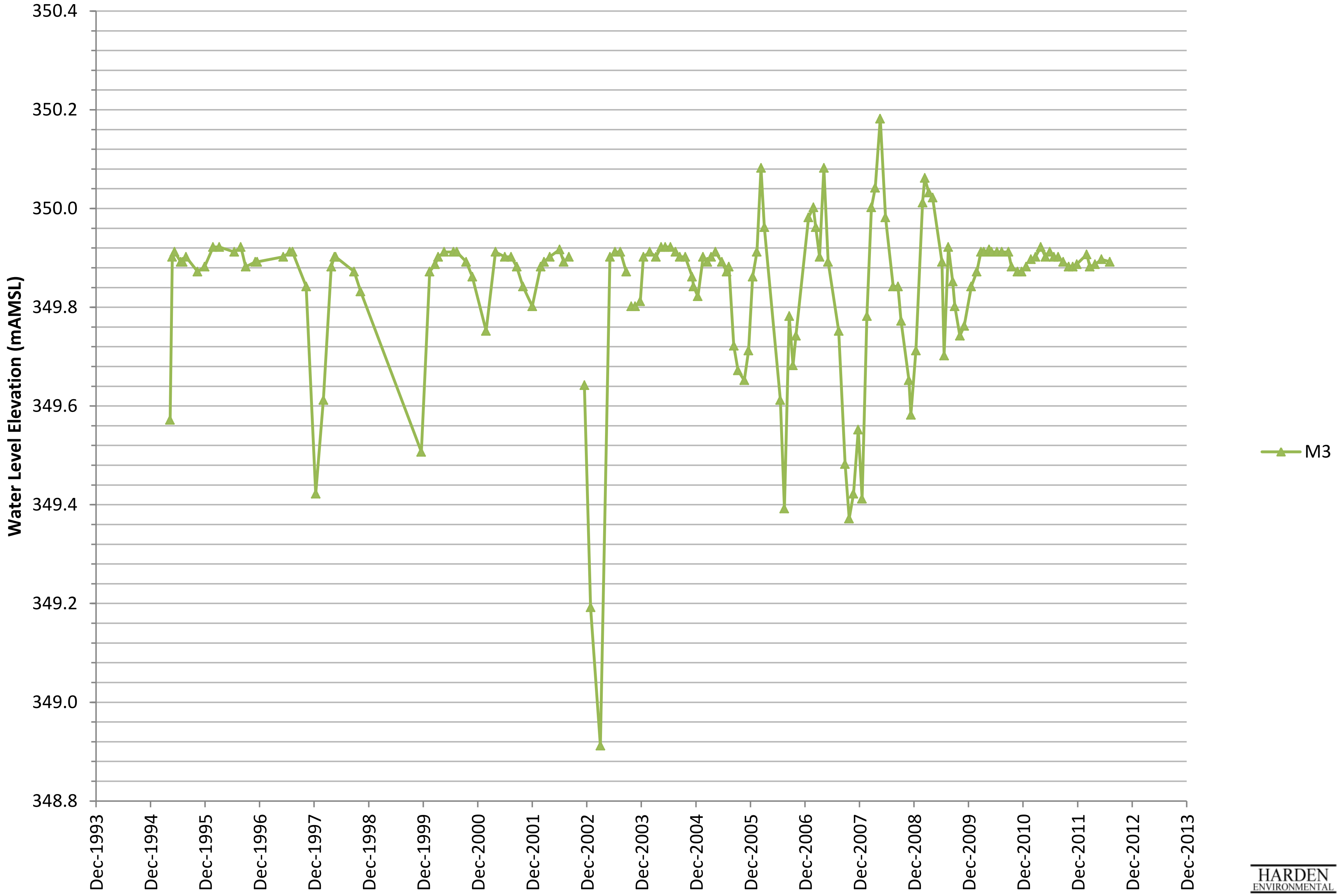

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Figure B4: M4 Hydrograph

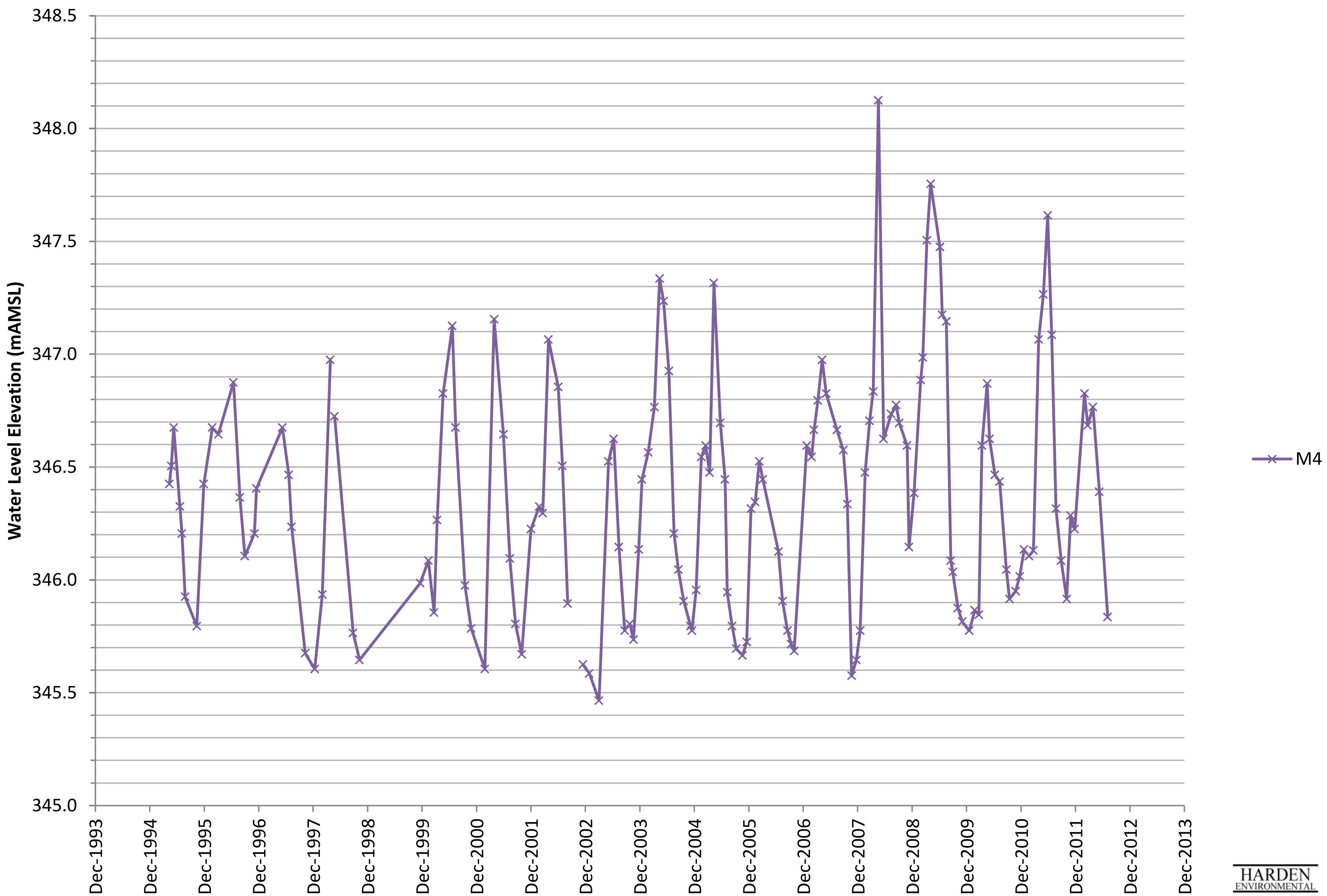

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Figure B5: M5 Hydrograph

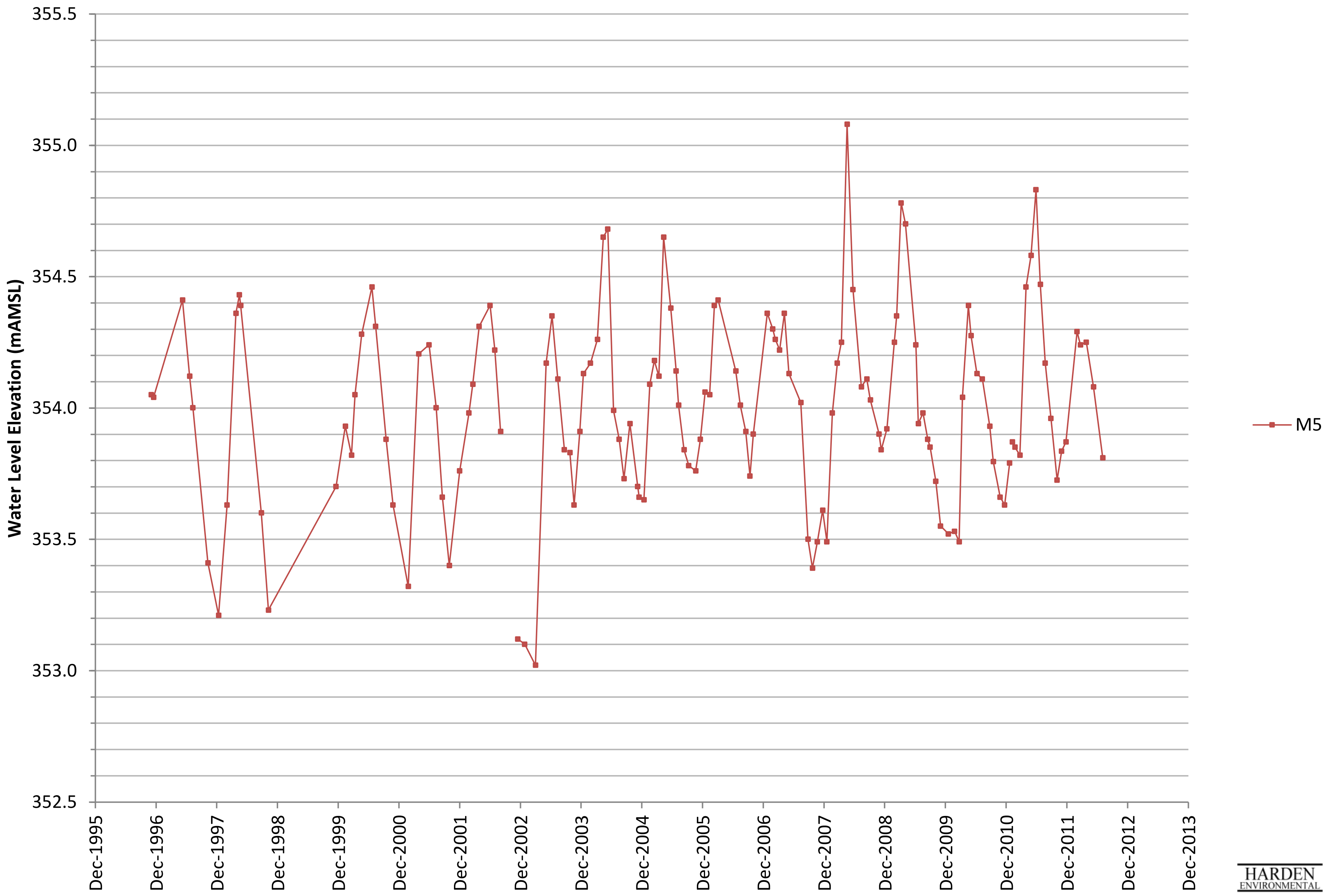

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Figure B6: M6 Hydrograph

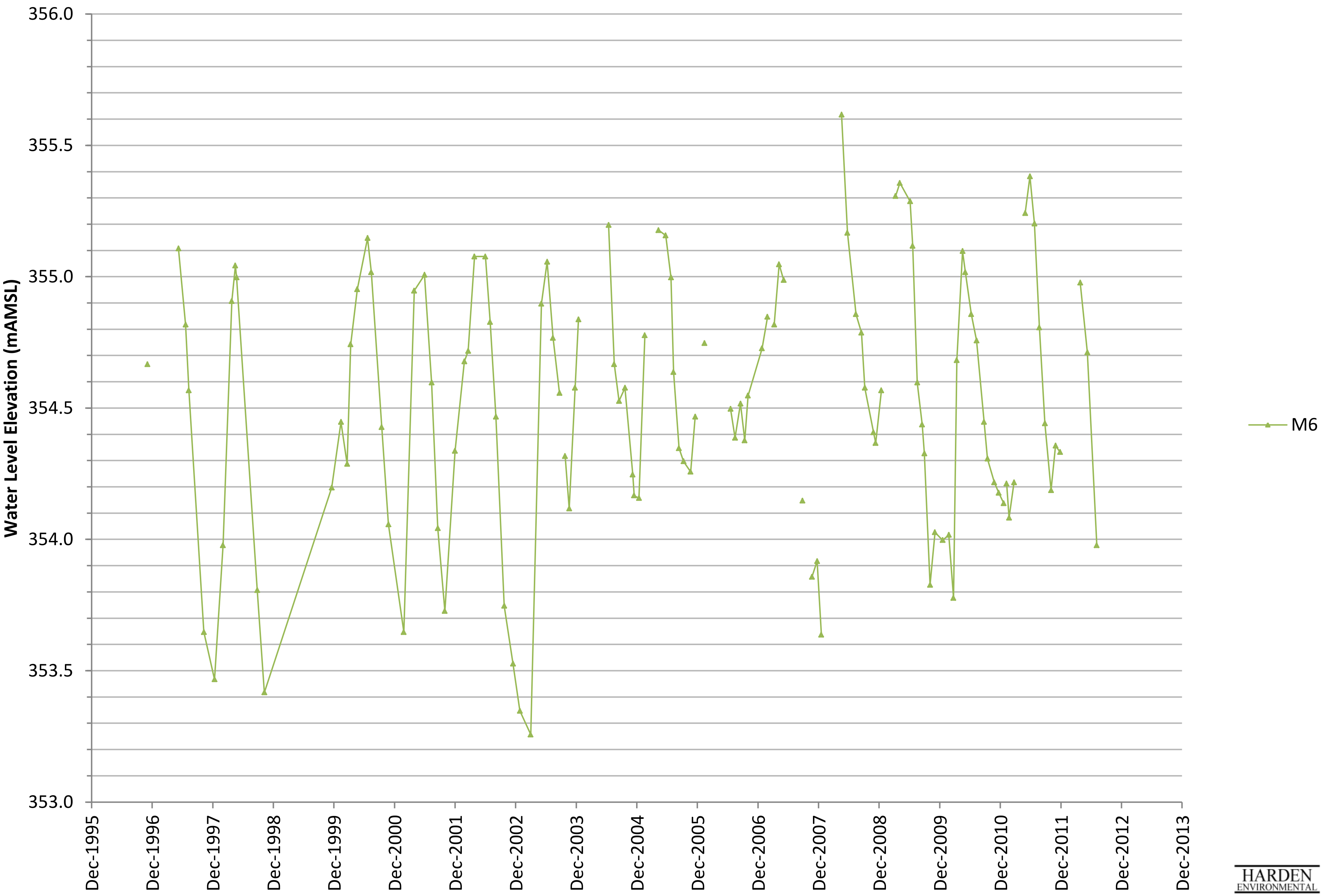

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Figure B7: M9 Hydrograph

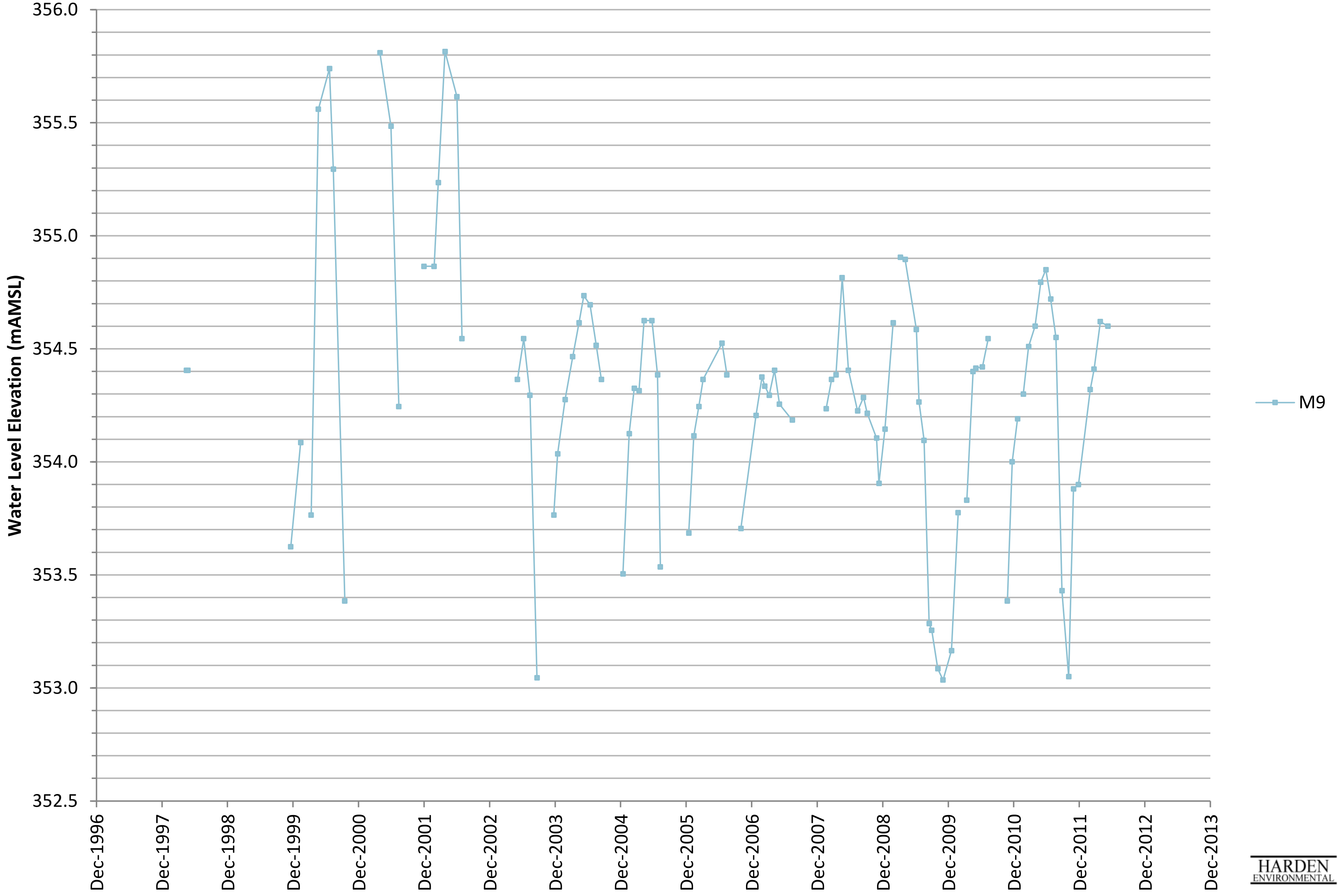

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Figure B8: M10 Hydrograph

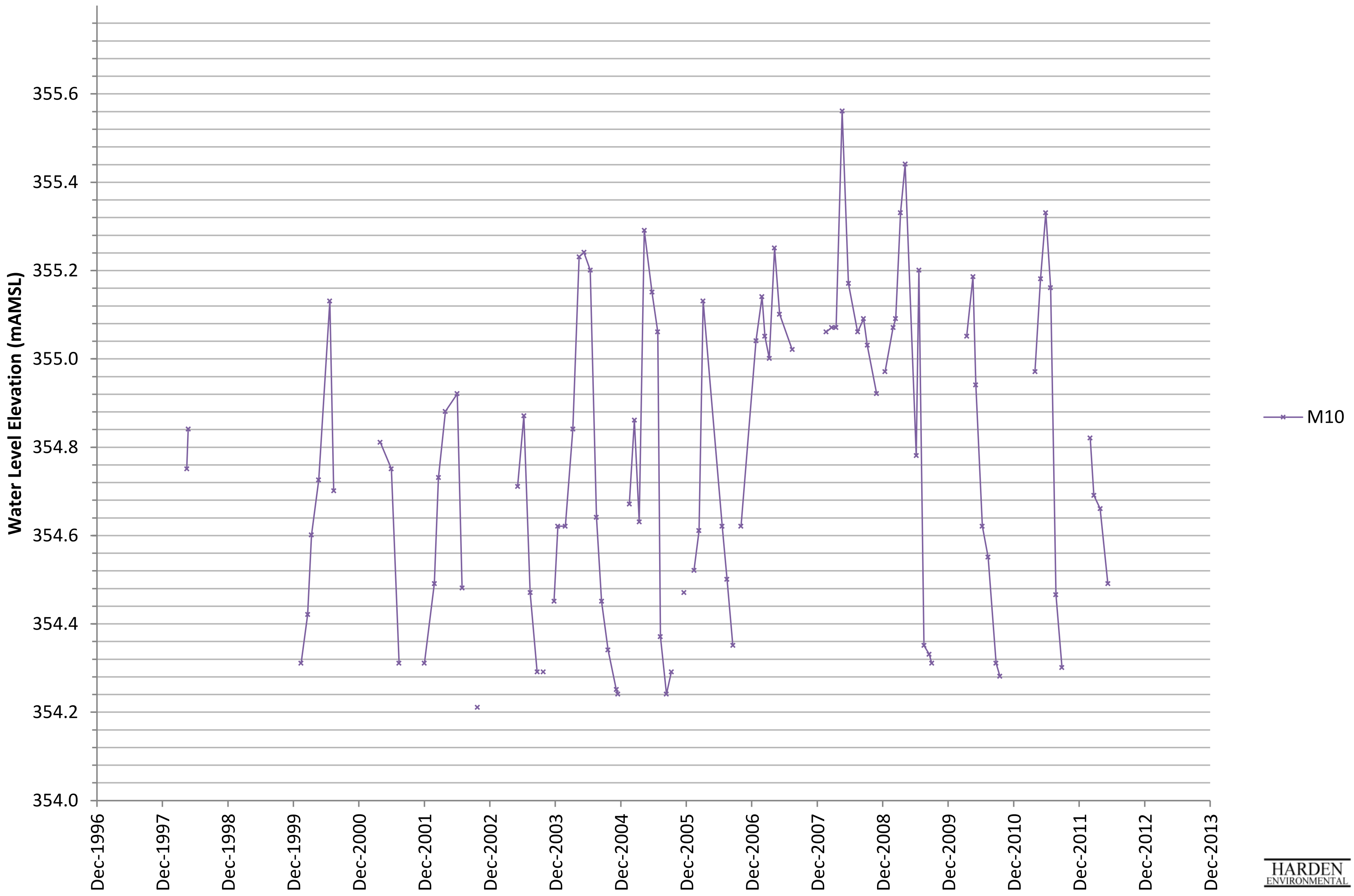

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Figure B9: M13 S/D Hydrograph

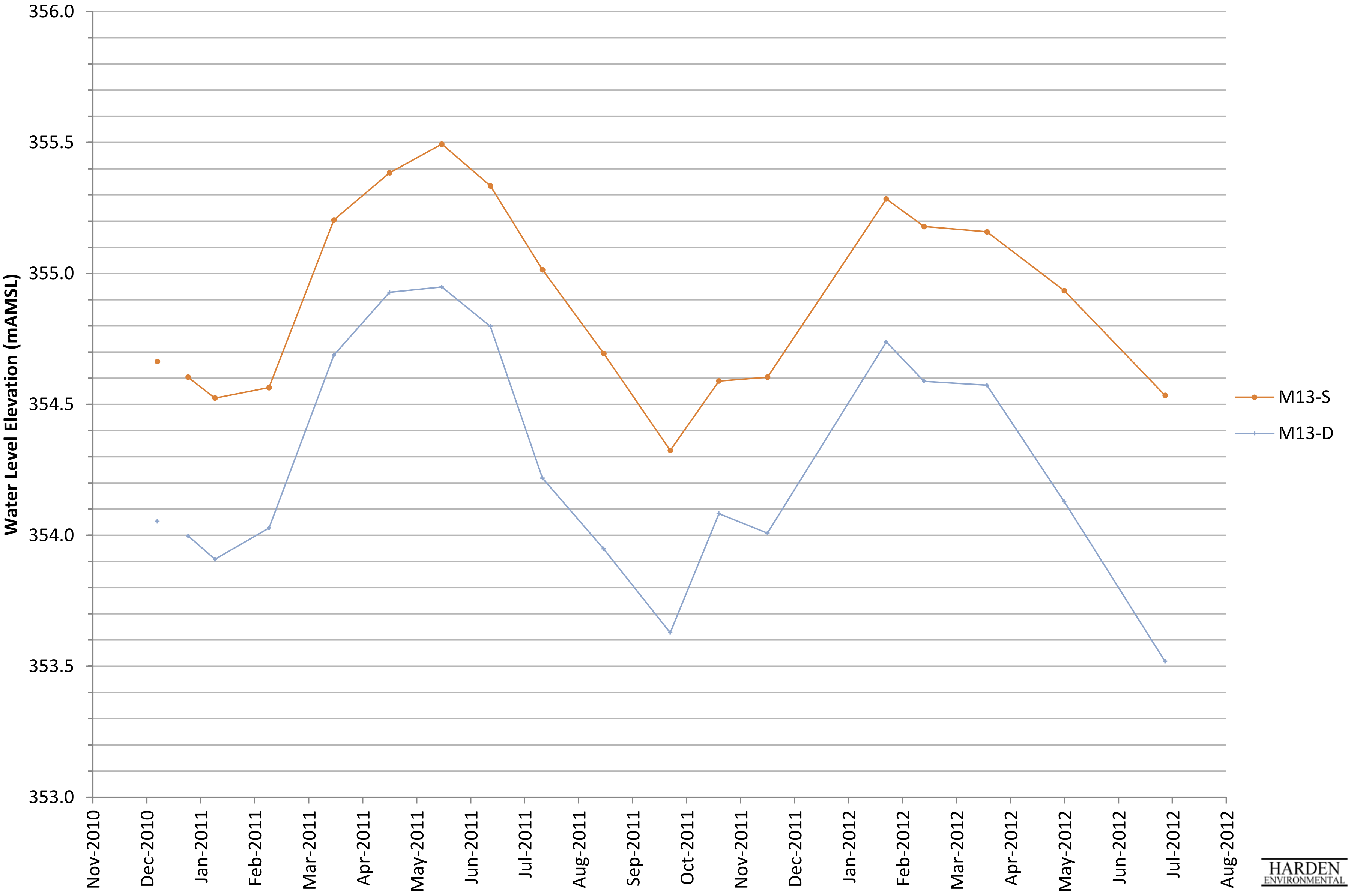

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Figure B10: M14 S/D Hydrograph

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Figure B11: MP1/MP2 Hydrograph

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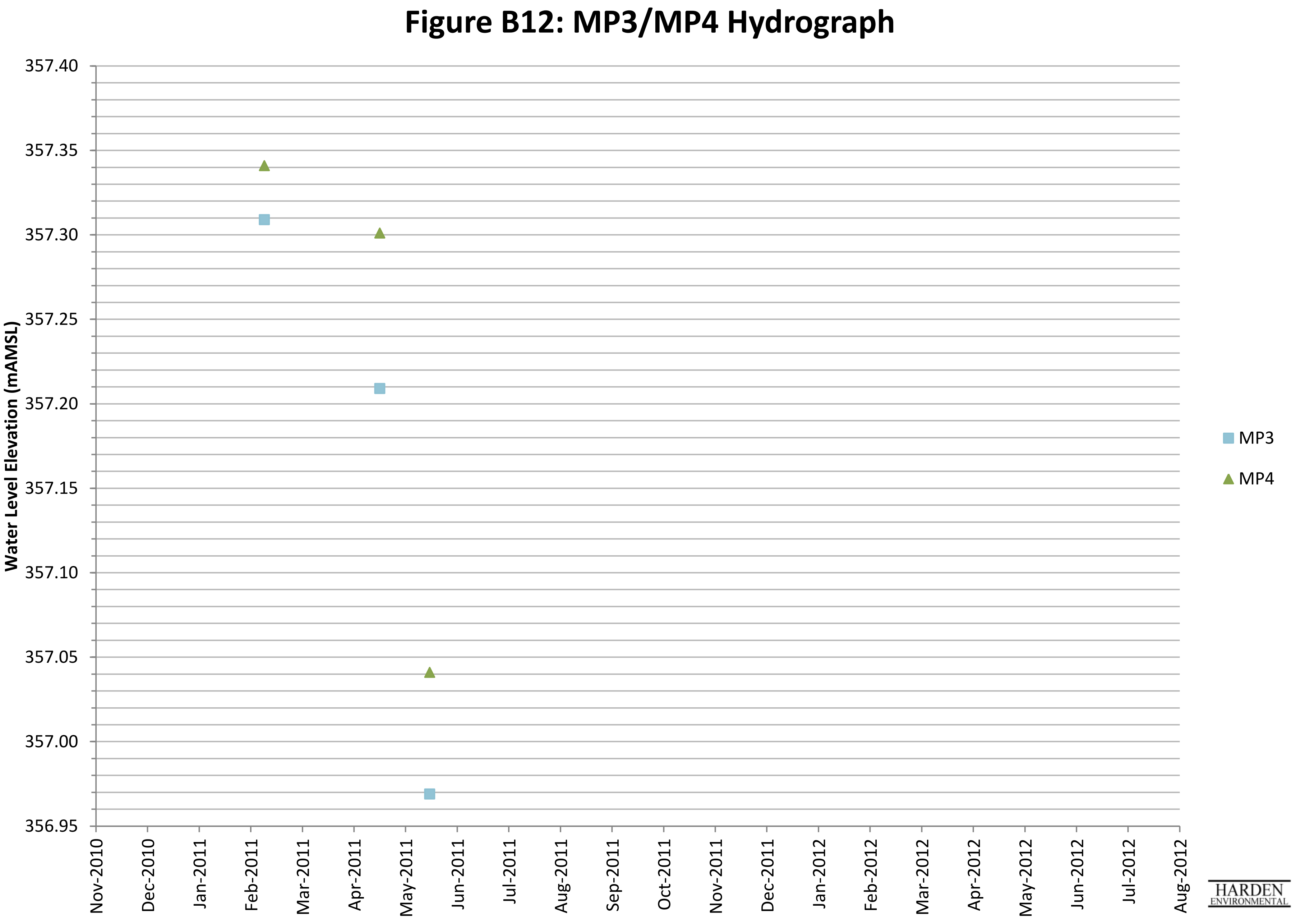
Figure B12: MP3/MP4 Hydrograph
Water Level Elevation (mAMSL)
357.40
357.35
357.30
357.25
357.20
357.15
357.10
357.05
357.00
356.95
Nov-2010
Dec-2010
Jan-2011
Feb-2011
Mar-2011
Apr-2011
May-2011
Jun-2011
Jul-2011
Aug-2011
Sep-2011
Oct-2011
Nov-2011
Dec-2011
Jan-2012
Feb-2012
Mar-2012
Apr-2012
May-2012
Jun-2012
Jul-2012
Aug-2012
MP3
MP4
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Figure B13: MPN-1/MPN-2 Hydrograph

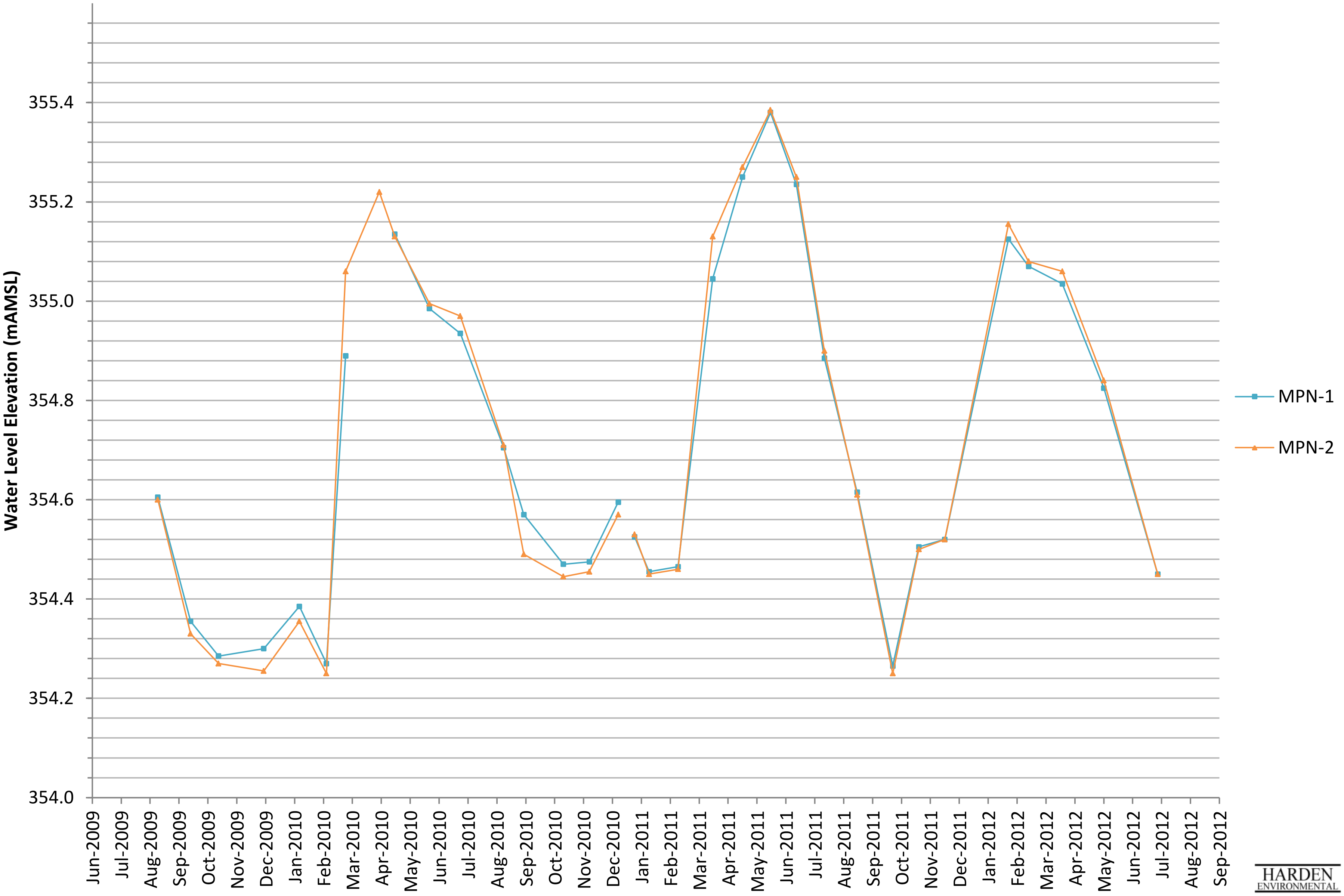

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Figure B14: MPE-1/MPE-2 Hydrograph

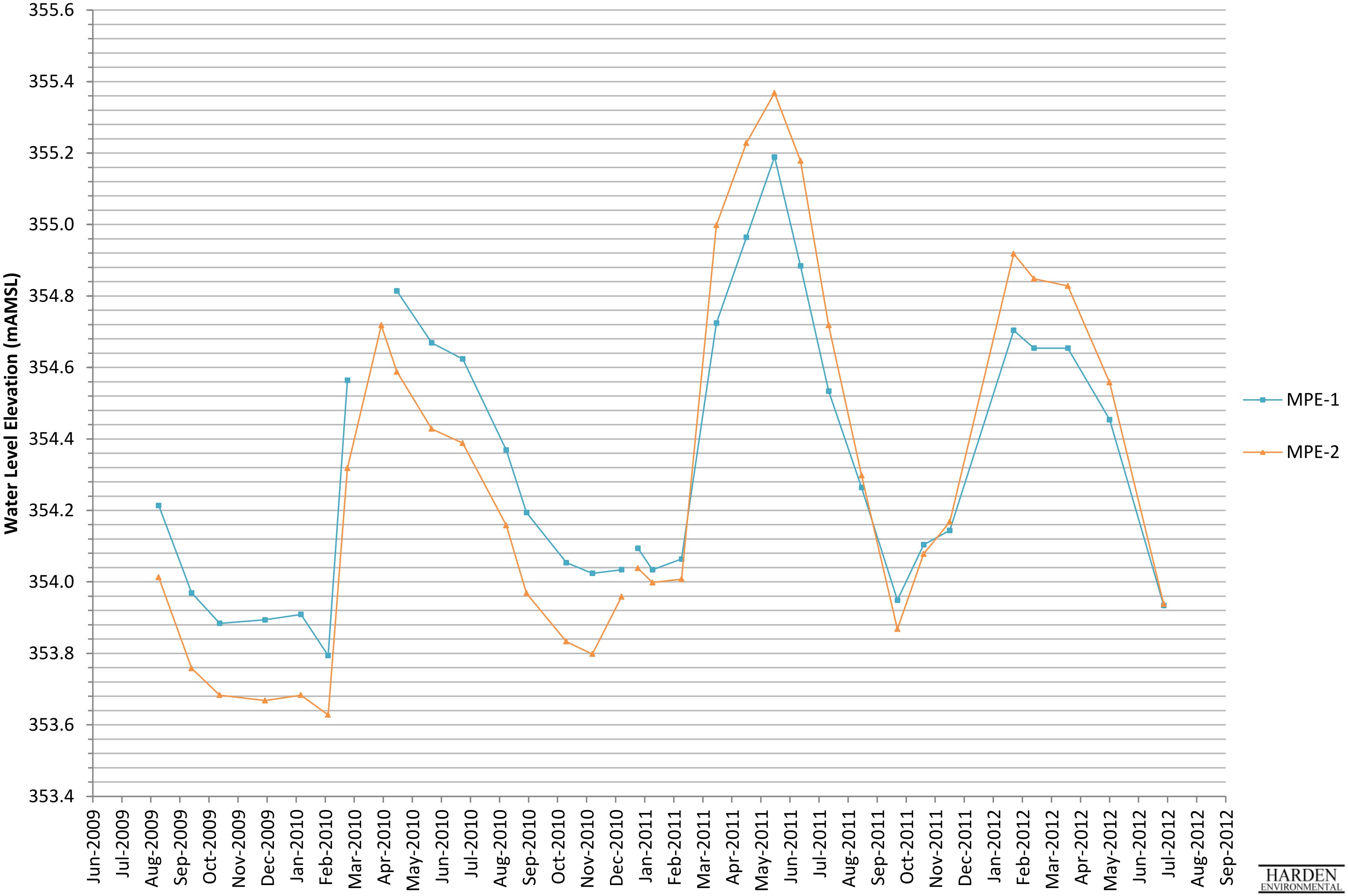

Figure B15: MPS-1/MPS-2 Hydrogaph

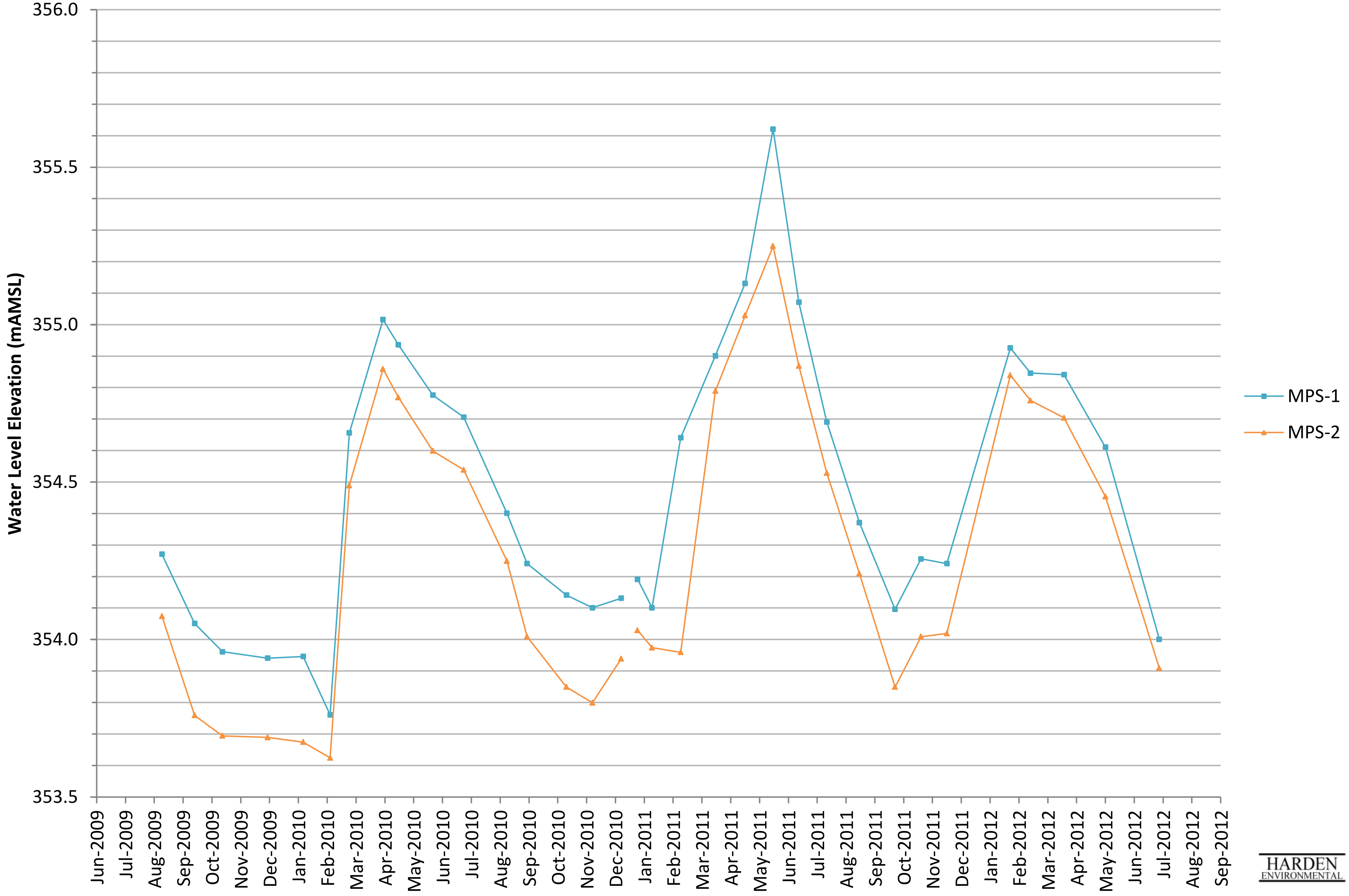

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Figure B16: MPW-1/MPW-2 Hydrograph

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Figure B17: TP1 Hydrograph

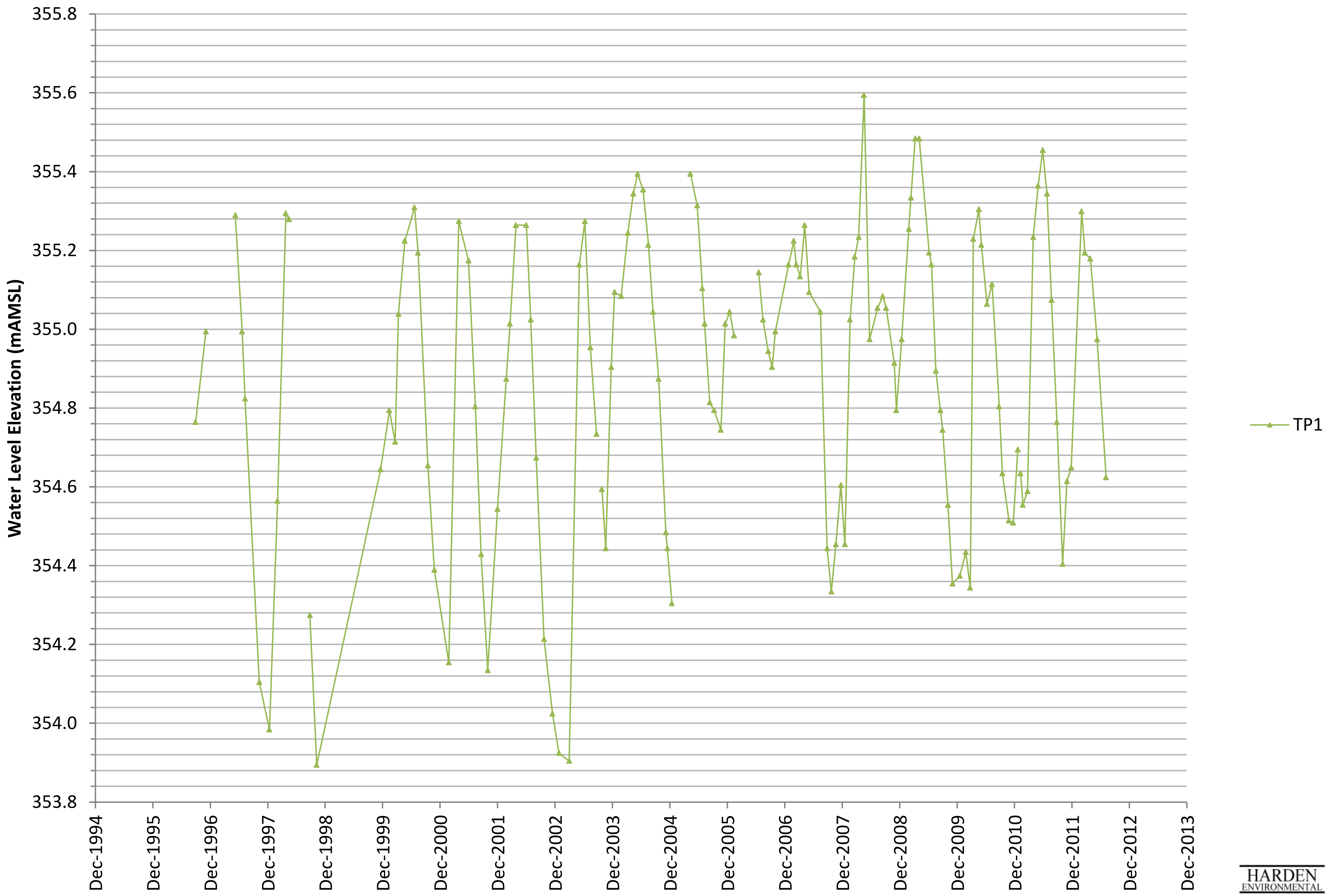

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Figure B18: TP2 Hydrograph

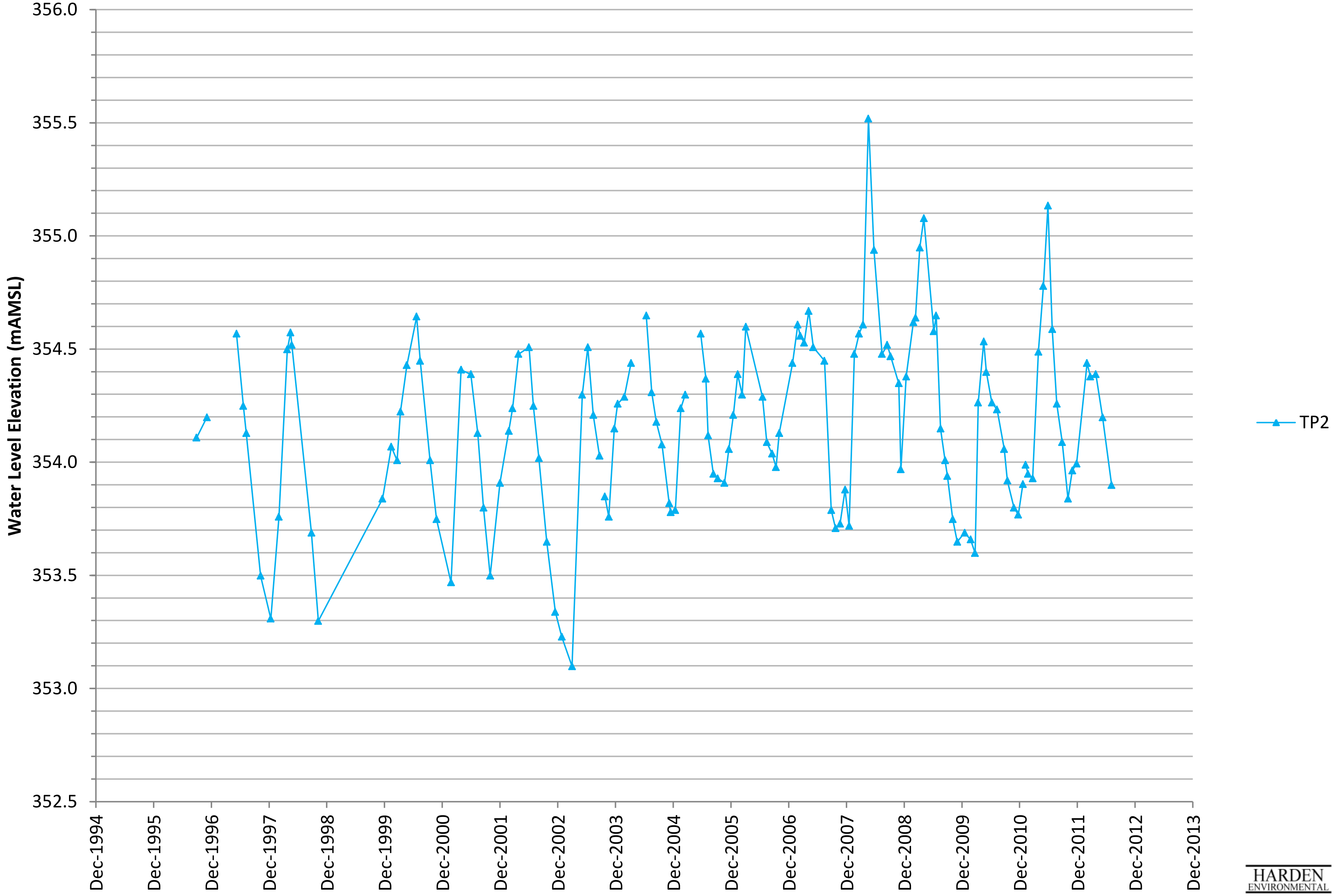

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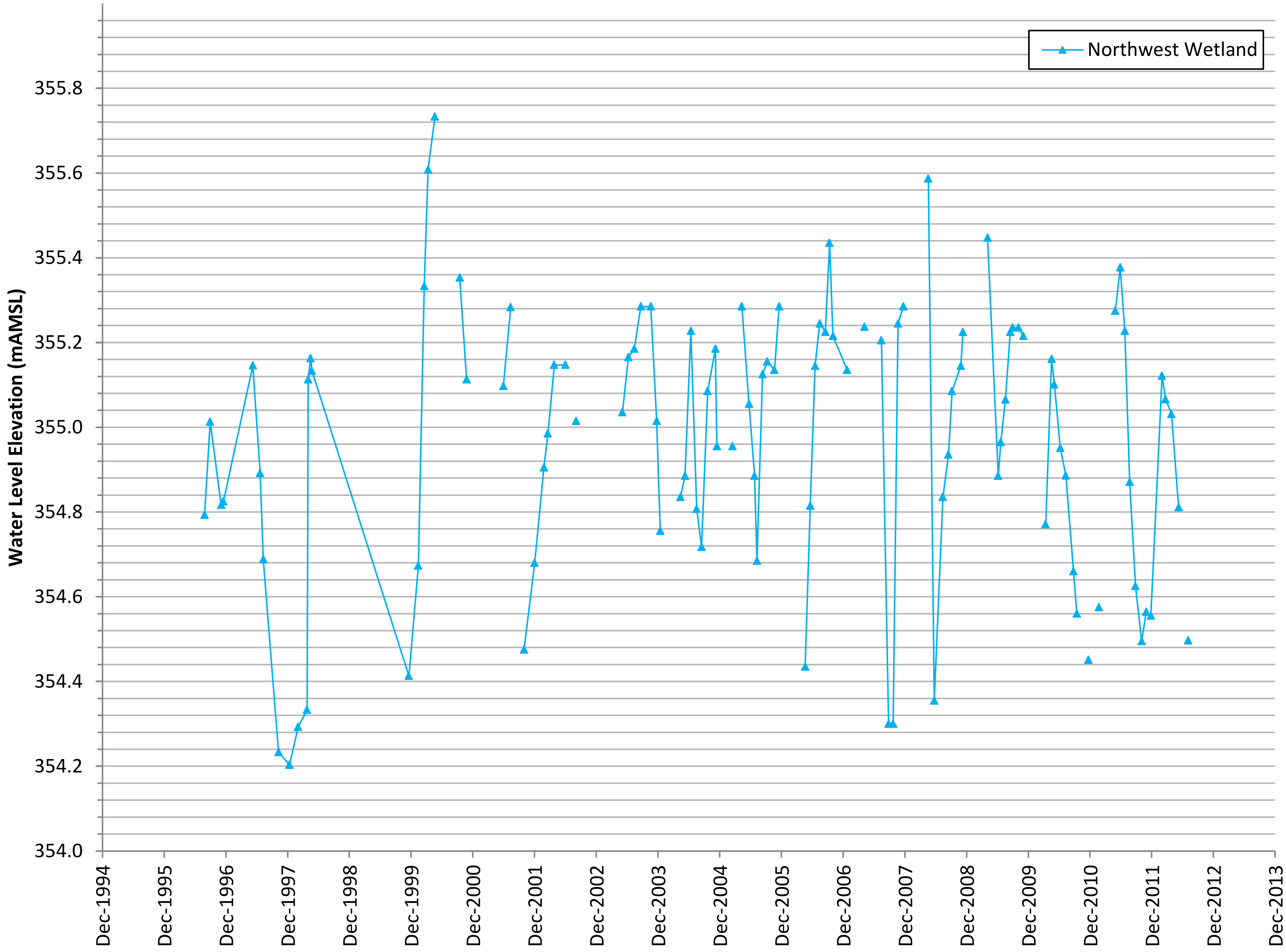
Figure B19: Northwest Wetland Hydrograph



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Appendix C

Surface Water Flow Data

Table C1: Surface Water Flow Data

MONITOR	21-Jan-05	18-Feb-05	18-Mar-05	14-Apr-05	27-May-05	28-Jun-05	13-Jul-05	15-Aug-05	12-Sep-05	24-Oct-05	21-Nov-05	19-Dec-05	16-Jan-06	13-Feb-06	08-Mar-06	24-Apr-06	24-May-06	22-Jun-06	19-Jul-06
SW3 (Downstream of Site)	🟦	🟦	🟦		5.33	0.00	0.00	0.00	0.00	0.00	0.00	🟦	🟦	🟦	🟦	76.88	0.00	0.00	0.00
SW4 (Upstream of Site)	🟦	🟦	🟦		15.34	4.40	1.70	0.00	0.00	7.66	7.08	🟦	🟦	🟦	🟦	91.45	24.08	0.00	0.00
RS1	21.36	32.70	42.70		24.68	10.25	7.90	4.19	9.74	12.22	6.61	19.20	20.37	32.61	47.60	38.50	17.78	8.00	5.22
SW5																			
SW7																			
SW8																			
SW9																			
SW10																			
SW11																			
SW12A																			
SW12B																			

NOTE: All values given in L/s

0.00	**Stream is dry**
🟦	**Denotes frozen conditions no measurement obtained**

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Table C1: Surface Water Flow Data

MONITOR	21-Aug-06	15-Sep-06	05-Oct-06	28-Dec-06	30-Jan-07	15-Feb-07	12-Mar-07	10-Apr-07	08-May-07	18-Jul-07	31-Aug-07	26-Sep-07	25-Oct-07	26-Nov-07	21-Dec-07	23-Jan-08	22-Feb-08	18-Mar-08	21-Apr-08	26-May-08
SW3 (Downstream of Site)	0.00	0.00	0.00	4.94	🟦	🟦	🟦	89.53	14.89	0.00	0.00	0.00	0.00	0.00	🟦	🟦	🟦	🟦	117.15	132.83
SW4 (Upstream of Site)	0.00	0.00	6.83	11.45	🟦	🟦	🟦	100.45	30.87	1.82	0.00	0.00	0.00	0.47	🟦	🟦	🟦	🟦	154.26	152.58
RS1	3.37	4.36	9.73	17.15	14.28	20.27	56.60	44.60	16.71	10.28	5.20	2.95	2.26	3.10	4.00	11.20	9.66	50.18	61.98	59.34
SW5																				
SW7					🟦	🟦	🟦	92.93	16.04	0.00	0.00	0.00	0.00	0.00	🟦	🟦	🟦	🟦	120.40	134.14
SW8																				
SW9																				
SW10																				
SW11																				
SW12A																				
SW12B																				

NOTE: All values given in L/s

0.00	**Stream is dry**
🟦	**Denotes frozen conditions no measurement obtained**

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Table C1: Surface Water Flow Data

MONITOR	16-Jul-08	18-Aug-08	08-Sep-08	30-Oct-08	12-Nov-08	16-Dec-08	30-Jan-09	13-Feb-09	12-Mar-09	07-Apr-09	08-Jun-09	23-Jun-09	21-Jul-09	19-Aug-09	02-Sep-09	06-Oct-09	04-Nov-09	21-Dec-09	27-Jan-10	24-Feb-10
SW3 (Downstream of Site)	35.20	0.00	0.00	0.00	0.00	6.64	🟦	🟦	80.83	98.53	52.62	29.69	0.00	0.00	0.00	0.00	0.00	🟦	🟦	🟦
SW4 (Upstream of Site)	49.47	14.27	18.35	2.85	2.24	12.41	🟦	62.99	92.47	111.02	55.37	33.34	13.79	1.08	0.89	0.00	0.00	🟦	🟦	🟦
RS1	39.82	13.08	15.10	1.54	1.15	5.50	11.17	🟦	65.30	68.93	28.82	12.75	9.13	8.76	5.54	1.49	1.29	🟦	15.76	🟦
SW5								🟦										🟦		🟦
SW7	39.33	4.75	8.39	0.00	0.00	10.75														
SW8							🟦	🟦	83.02	100.20	53.16	30.18	0.00	0.00	0.00	0.00	0.00	🟦	🟦	🟦
SW9																				
SW10																				
SW11																				
SW12A																				
SW12B																				

NOTE: All values given in L/s

0.00 **Stream is dry**

🟦 **Denotes frozen conditions no measurement obtained**

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Table C1: Surface Water Flow Data

MONITOR	16-Mar-10	20-Apr-10	06-May-10	11-Jun-10	13-Jul-10	27-Aug-10	17-Sep-10	28-Oct-10	24-Nov-10	24-Dec-10	25-Jan-11	24-Feb-11
SW3 (Downstream of Site)	133.25	18.72	1.21	12.13	2.74		0.00	0.00	0.00	🟦	🟦	🟦
SW4 (Upstream of Site)	147.33	32.51	19.47	28.38	21.05		0.00	6.36	9.74	🟦	🟦	🟦
RS1	51.94	13.31	12.87	14.48	11.75		7.41	11.33	9.80	7.43	7.06	14.01
SW5												
SW7												
SW8	132.08	18.95	10.98	14.77	9.98		0.00	0.00	3.84	🟦	🟦	🟦
SW9												
SW10												
SW11												
SW12A												
SW12B												

NOTE: All values given in L/s

0.00	**Stream is dry**
🟦	**Denotes frozen conditions no measurement obtained**

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Table C1: Surface Water Flow Data

MONITOR	01-Apr-11	02-May-11	31-May-11	26-Jul-11	29-Aug-11	05-Oct-11	01-Nov-11	28-Nov-11	02-Dec-11	12-Dec-11	21-Dec-11	02-Feb-12	23-Feb-12	27-Mar-12	11-May-12	23-May-12	06-Jul-12
SW3 (Downstream of Site)	39.84	45.89	58.22	0.00	0.00	0.00	10.22	13.21	17.01			47.91	31.13	10.97	0.00	0.00	0.00
SW4 (Upstream of Site)	52.49	60.95	73.59	8.92	0.00	1.04	17.82	21.48	26.79	25.82	26.41	49.50	31.01	25.66	9.54	6.07	0.00
RS1	24.34	23.15	30.15	5.60	7.50	6.32	10.12	15.55	20.70			24.86	13.94	14.09	10.52	7.48	6.22
SW5													29.07				0.00
SW7																	0.00
SW8	43.74	50.27	63.76	0.00	0.00	0.00	10.84	13.47	17.65			47.25	29.61	12.57	2.68	0.00	0.00
SW9														32.57	14.14	10.92	0.00
SW10								23.69	32.69	26.65	28.38	53.13	31.27	16.64	4.74	0.38	0.00
SW11														16.88			0.00
SW12A														3.43			0.00
SW12B														1.32			0.00

NOTE: All values given in L/s

0.00	**Stream is dry**
🟦	**Denotes frozen conditions no measurement obtained**

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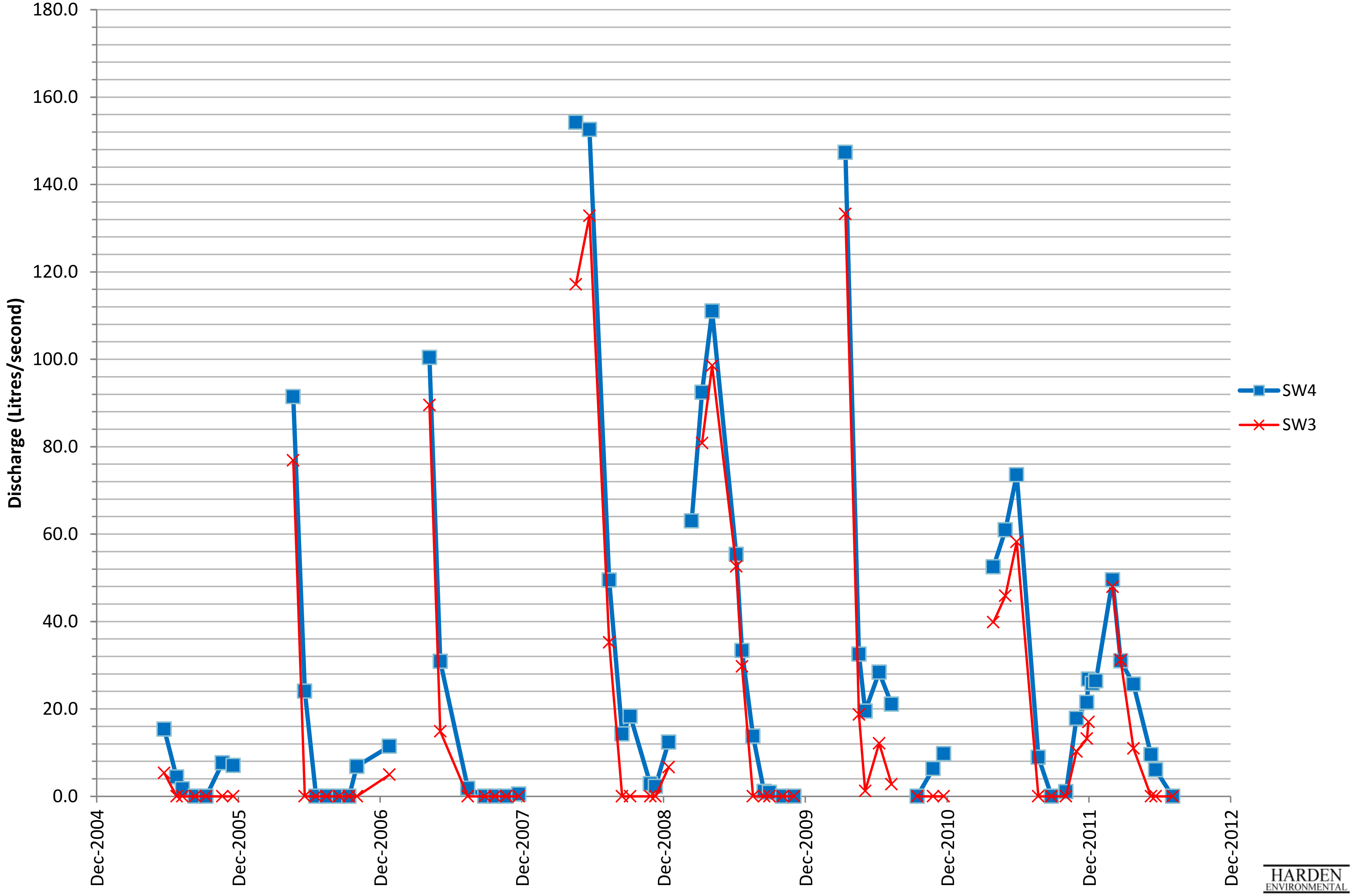
Figure C1: SW3/SW4 Discharge Hydrograph



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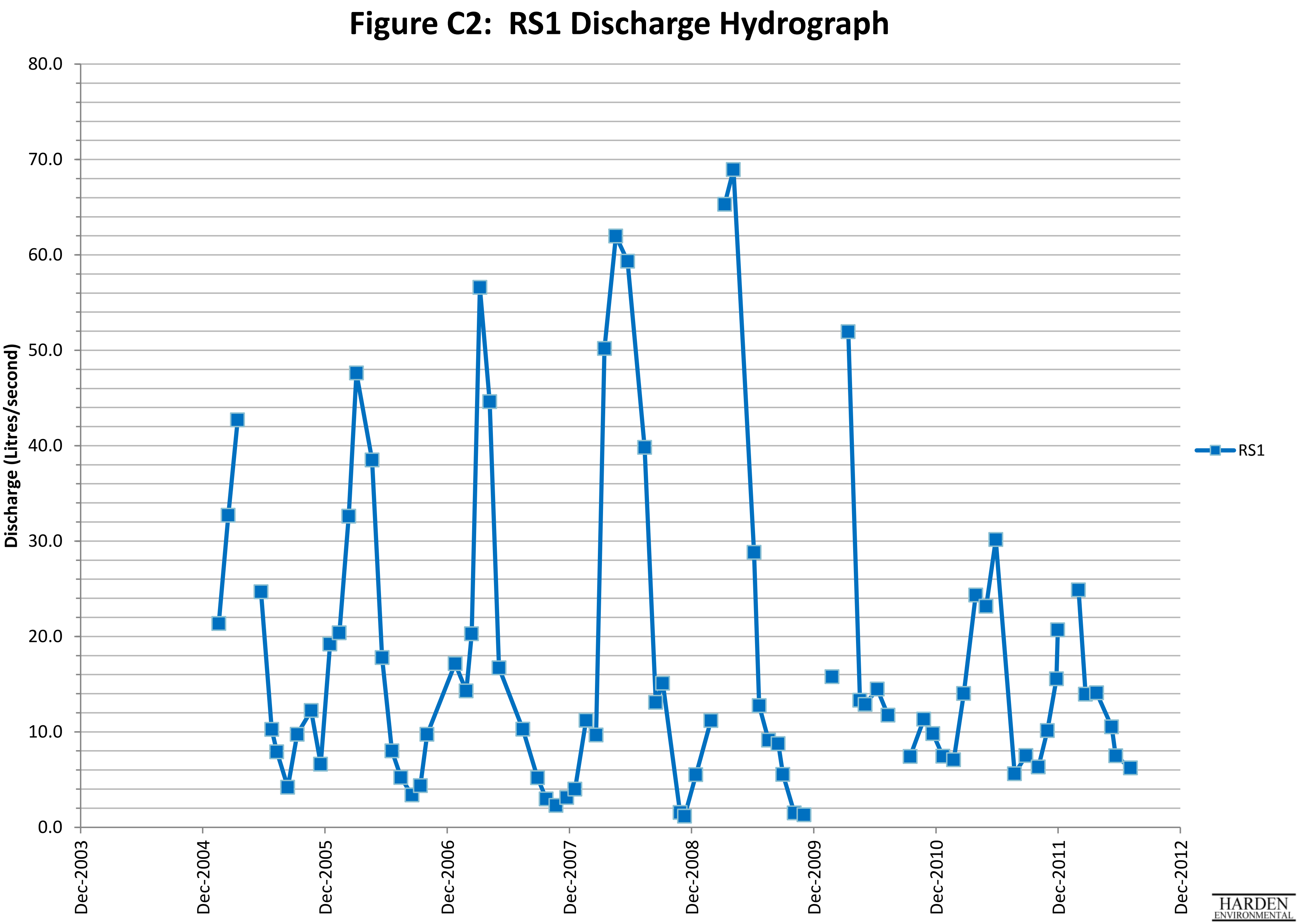

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Appendix D

Hydraulic Testing Data

Table D1: Summary of Hydraulic Testing

Hydraulic Testing Graphs

Table D1: Summary of Hydraulic Testing

Monitor	Completion	Test Method	K (m/sec)	Test Date
MPN-1	Overburden	Hvorslev (falling head test)	2.0 X 10^{-4}	Jan-2011
MPN-2	Overburden	Hvorslev (falling head test)	4.6 X 10^{-5}	Jan-2011
MPE-1	Overburden	Hvorslev (falling head test)	5.3 X 10^{-6}	Jan-2011
MPE-2	Overburden	Hvorslev (falling head test)	8.8 X 10^{-5}	Jan-2011
MPS-1	Overburden	Hvorslev (falling head test)	1.3 X 10^{-6}	Jan-2011
MPS-2	Overburden	Hvorslev (falling head test)	1.1 X 10^{-4}	Jan-2011
MPW-1	Overburden	Hvorslev (falling head test)	3.7 X 10^{-5}	Jan-2011
MPW-2	Overburden	Hvorslev (falling head test)	6.2 X 10^{-6}	Jan-2011
M1S	Overburden	Hvorslev (falling head test)	5.7 X 10^{-7}	Jan-2011
M1D	Bedrock	Hvorslev (falling head test)	5.8 X 10^{-7}	Mar-2012
M2	Bedrock	Hvorslev (falling head test)	1.5 X 10^{-6}	Mar-2012
M4	Bedrock	Short Term Pumping Test	1.3 X 10^{-5}	May-2012
M6	Overburden	Hvorslev (falling head test)	1.3 X 10^{-7}	Apr-1998
M6	Overburden	Hvorslev (falling head test)	9.9 X 10^{-7}	Jan-2011
M9	Overburden	Hvorslev (falling head test)	3.5 X 10^{-5}	Apr-1998
M10	Overburden	Hvorslev (falling head test)	2.0 X 10^{-9}	Apr-1998
M13S	Overburden	Hvorslev (falling head test)	8.0 X 10^{-5}	Jan-2011
M13D	Bedrock	Hvorslev (falling head test)	4.0 X 10^{-7}	Jan-2011
M14S	Overburden	Hvorslev (falling head test)	2.7 X 10^{-7}	Jan-2011
W1	Bedrock	Short Term Pumping Test	9.9 X 10^{-6}	May-2012

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Figure D1: MPN-1 Falling Head Test (Hvorslev Method)
K = 2.0 x 10^{-4} m/sec

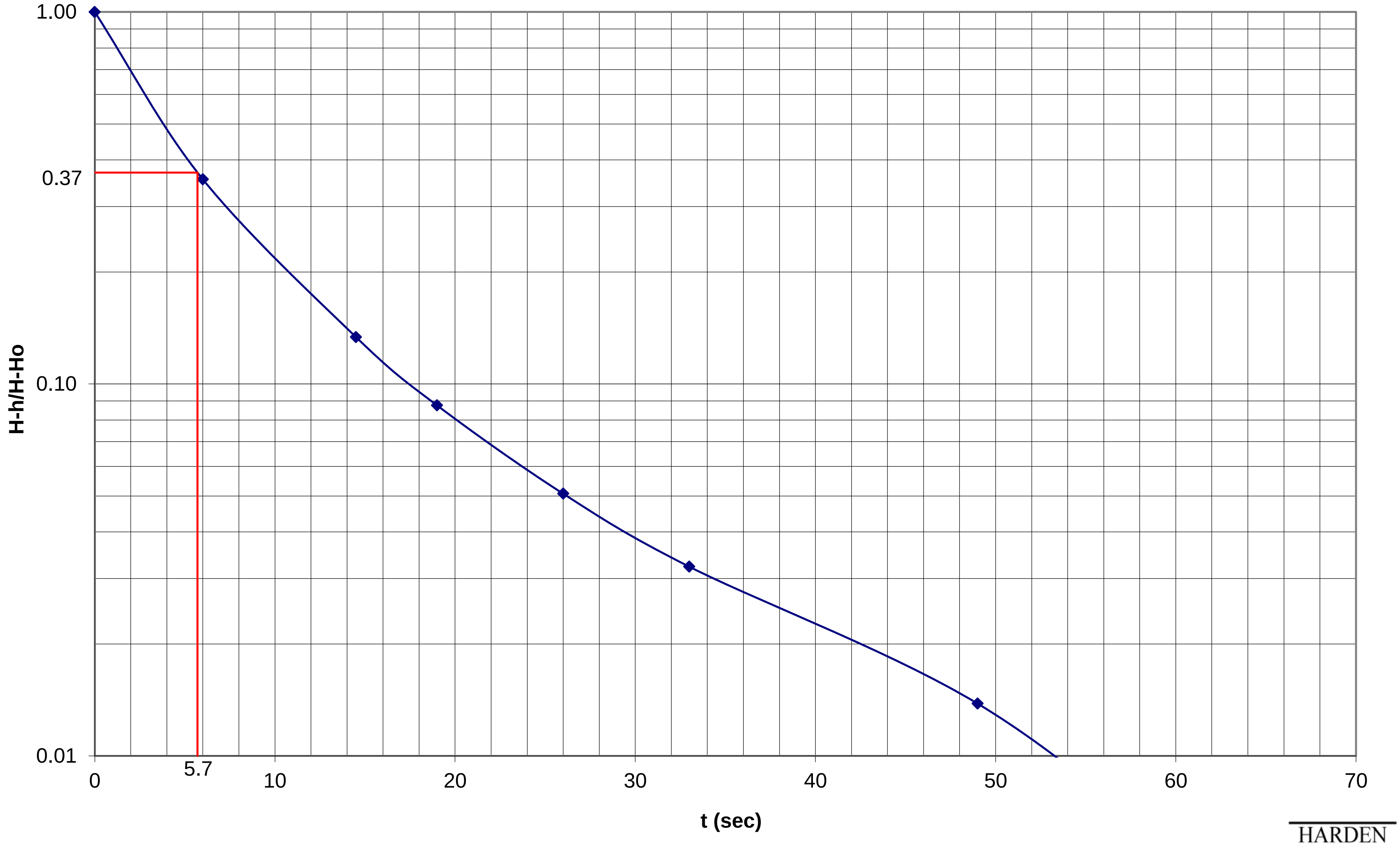

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Figure D2: MPN-2 Falling Head Test (Hvorslev Method)

K = 4.6 x 10^{-5} m/sec

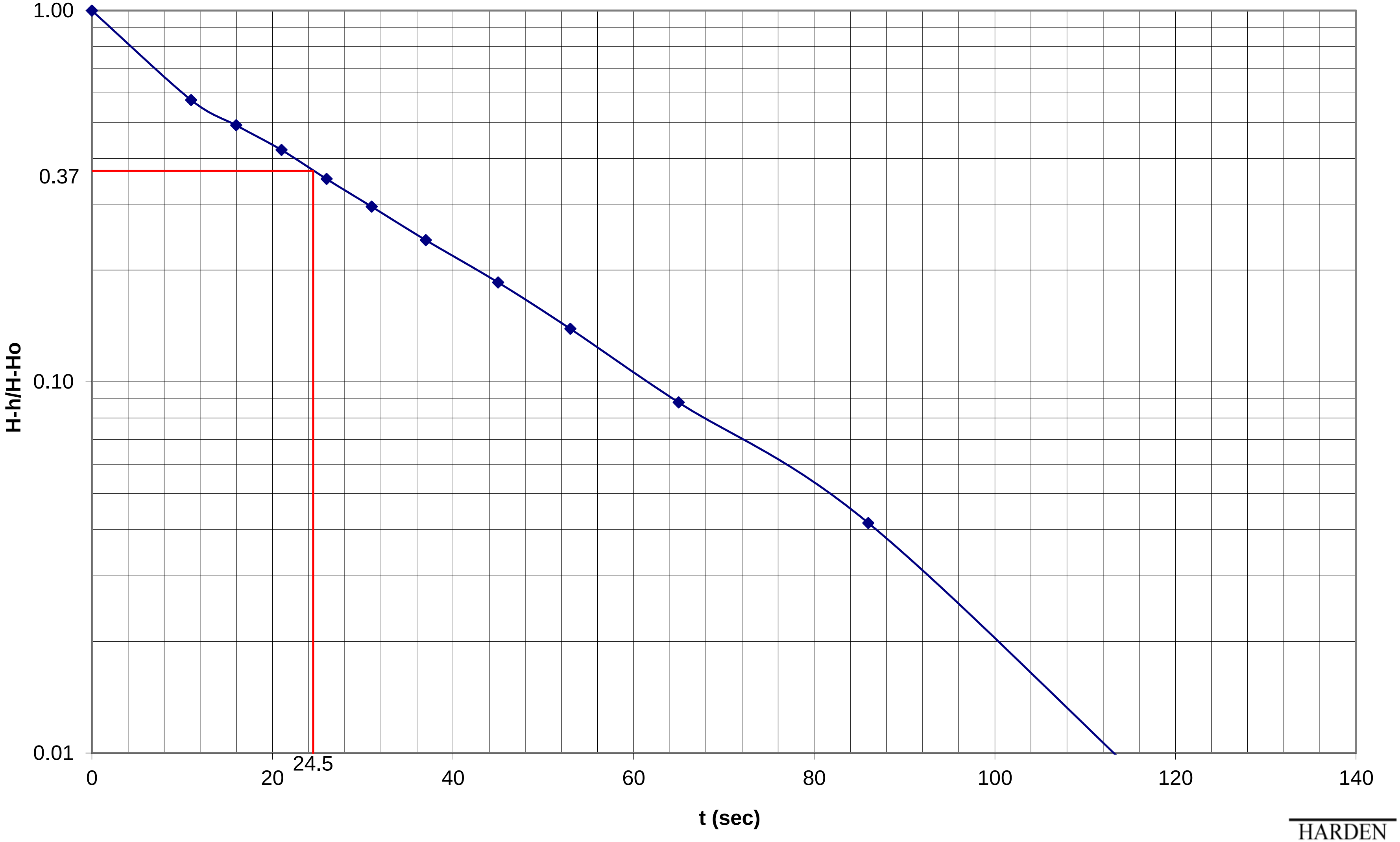

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Figure D3: MPE-1 Falling Head Test (Hvorslev Method)

K = 5.3 x 10^{-6} m/sec

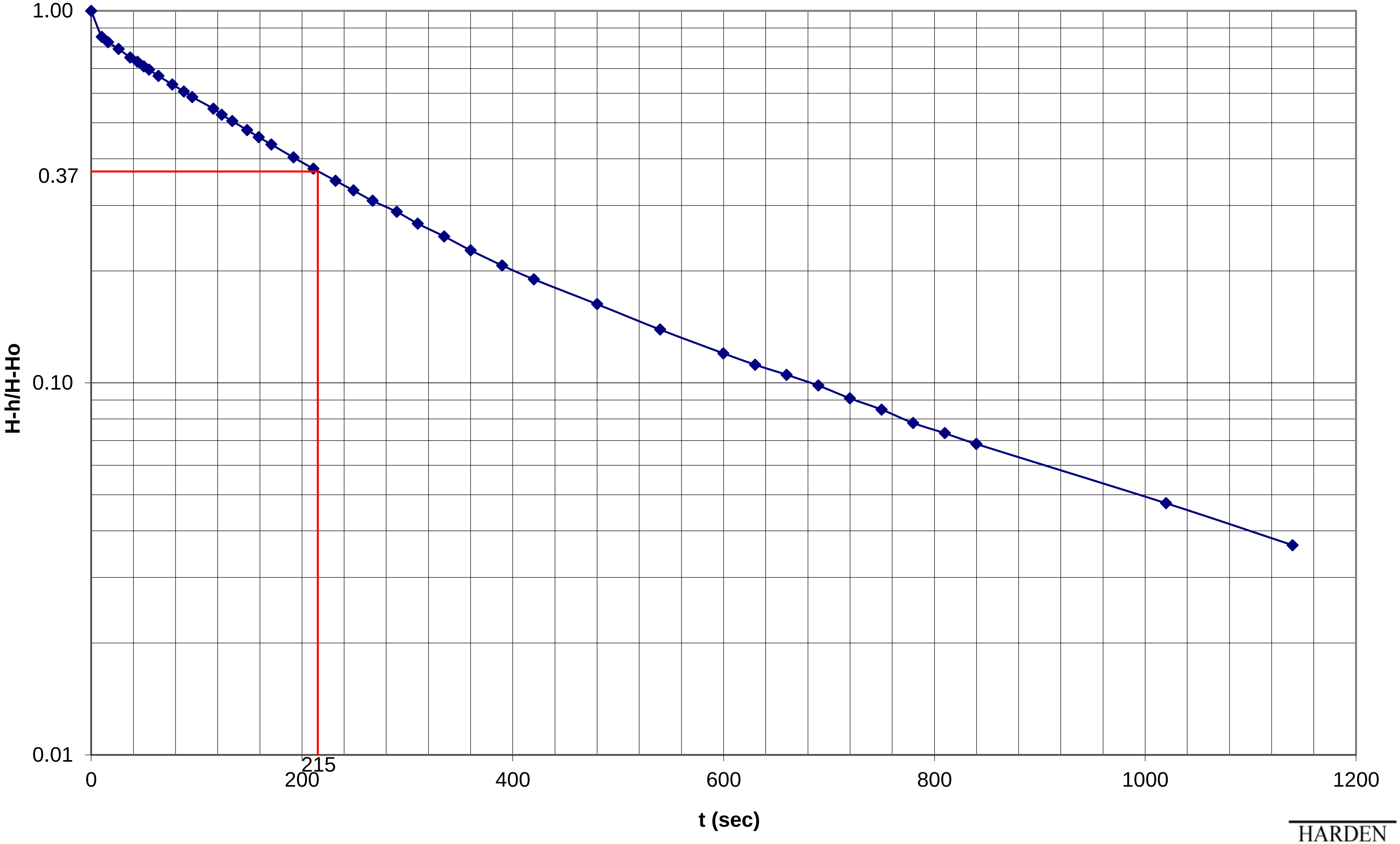

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Figure D4: MPE-2 Falling Head Test (Hvorslev Method)
K = 8.8 x 10^{-5} m/sec

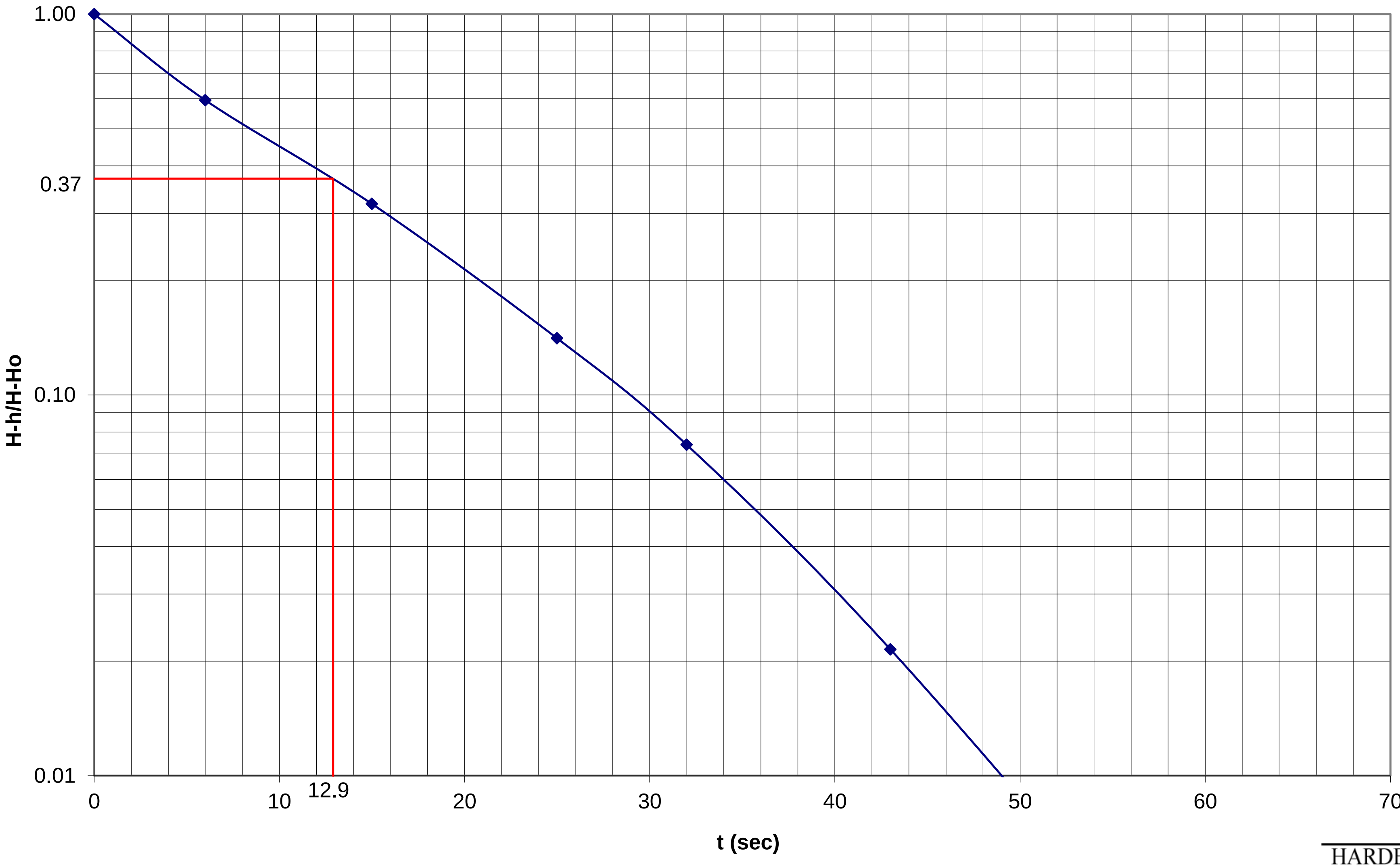

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Figure D5: MPS-1 Falling Head Test (Hvorslev Method)

K = 1.3 x 10^{-6} m/sec

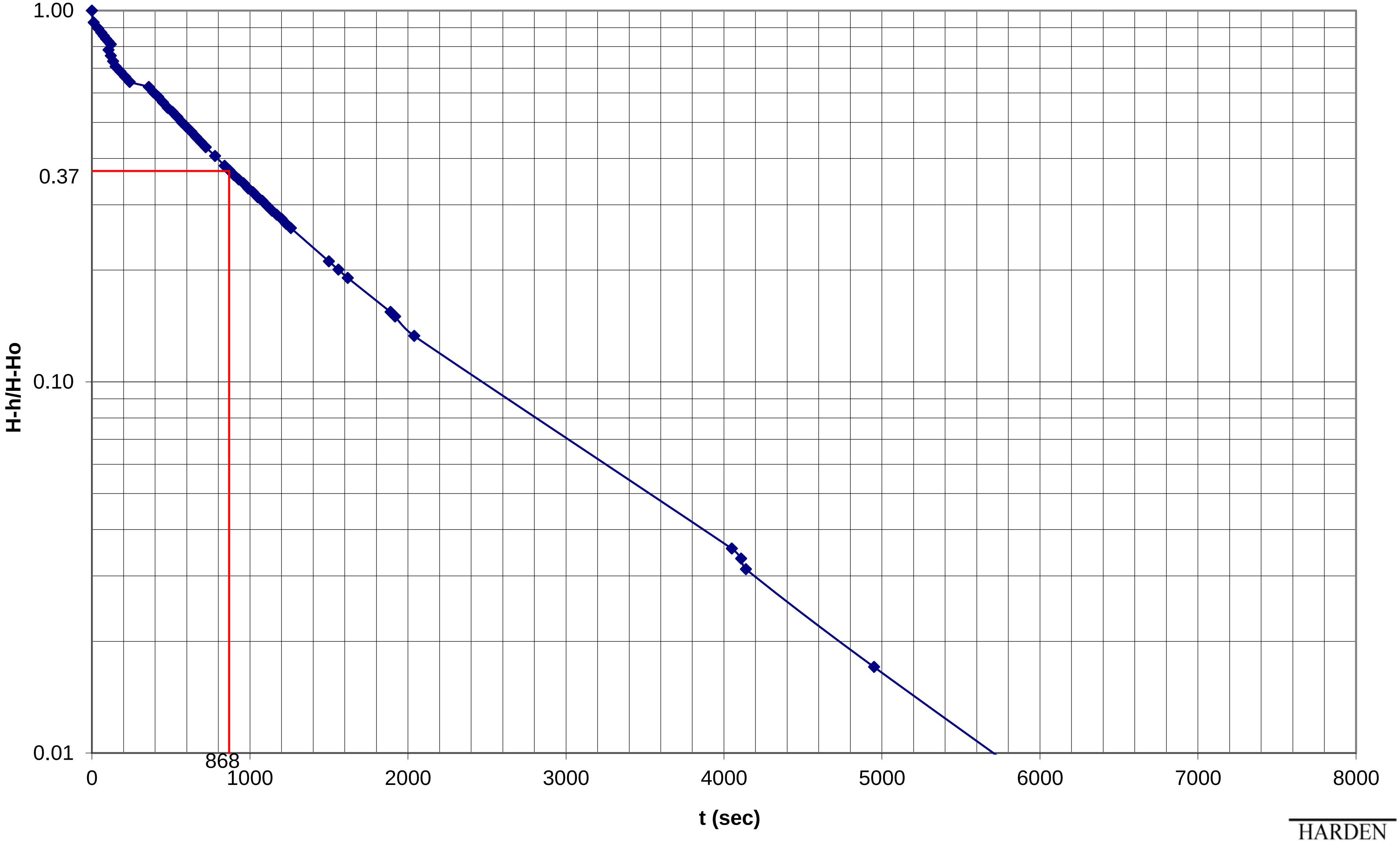

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Figure D6: MPS-2 Falling Head Test (Hvorslev Method)
K = 1.1 x 10^{-4} m/sec

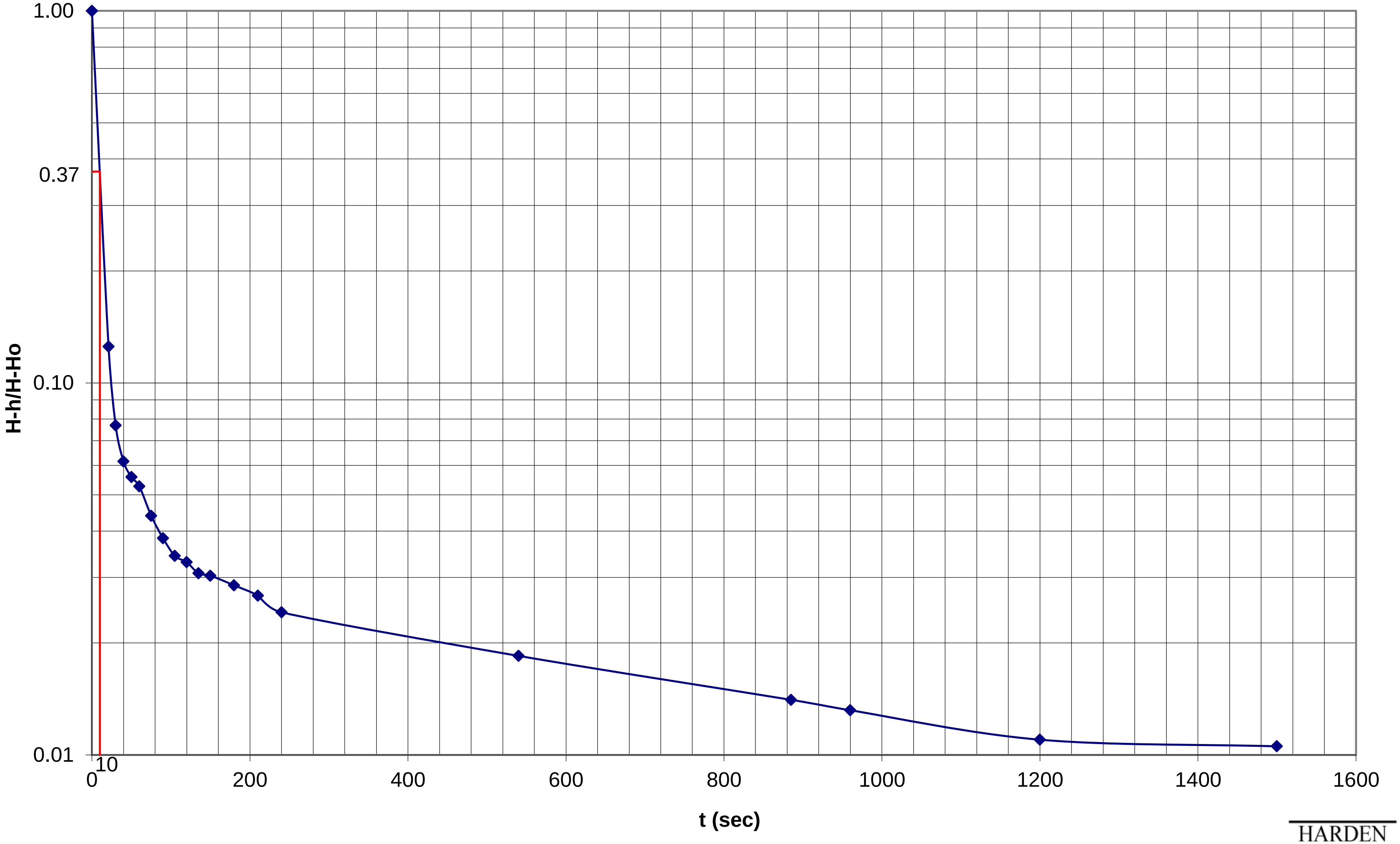

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Figure D7: MPW-1 Falling Head Test (Hvorslev Method)
K = 3.7 x 10^{-5} m/sec

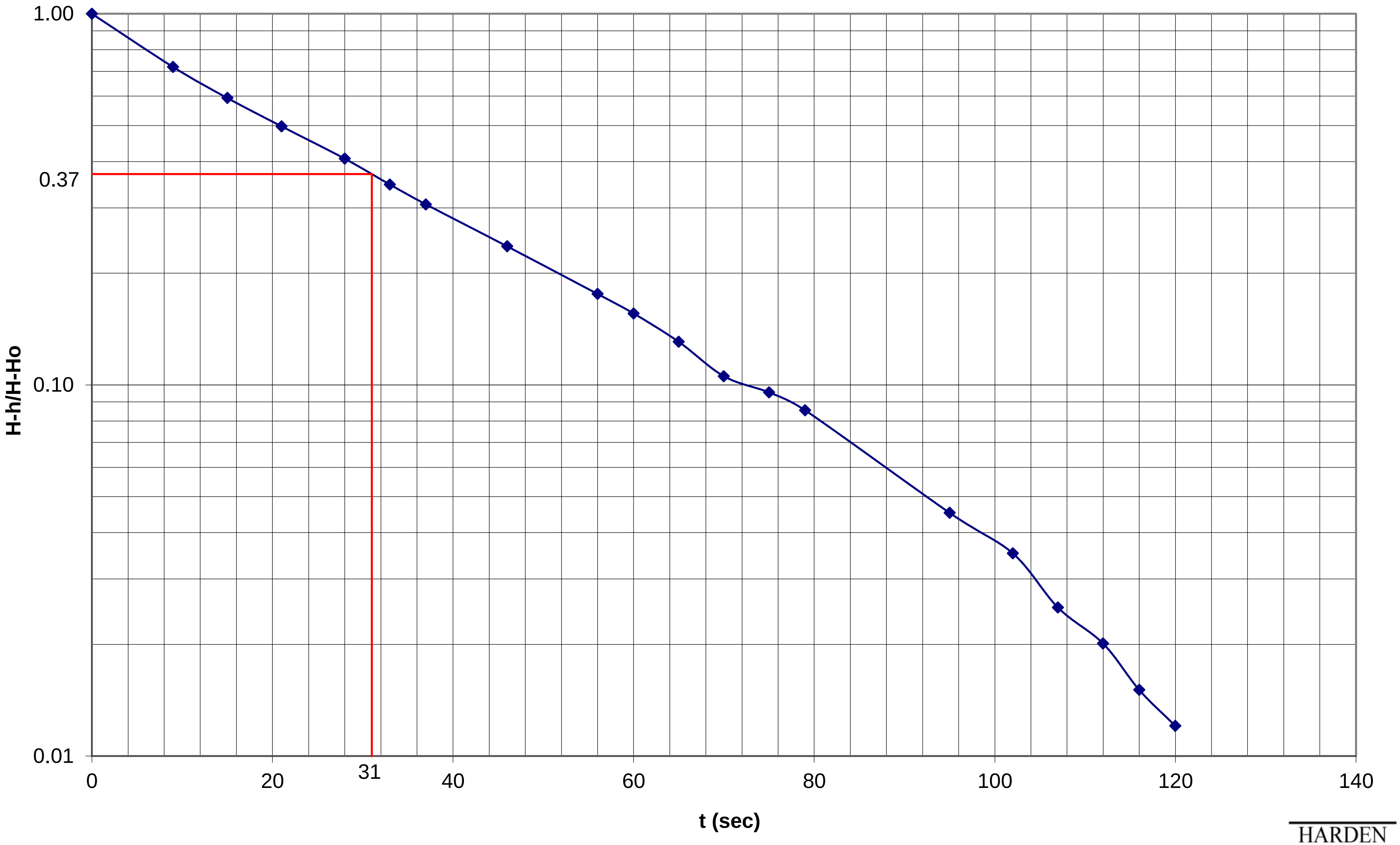

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Figure D8: MPW-2 Falling Head Test (Hvorslev Method)

K = 6.2 x 10^{-6} m/sec

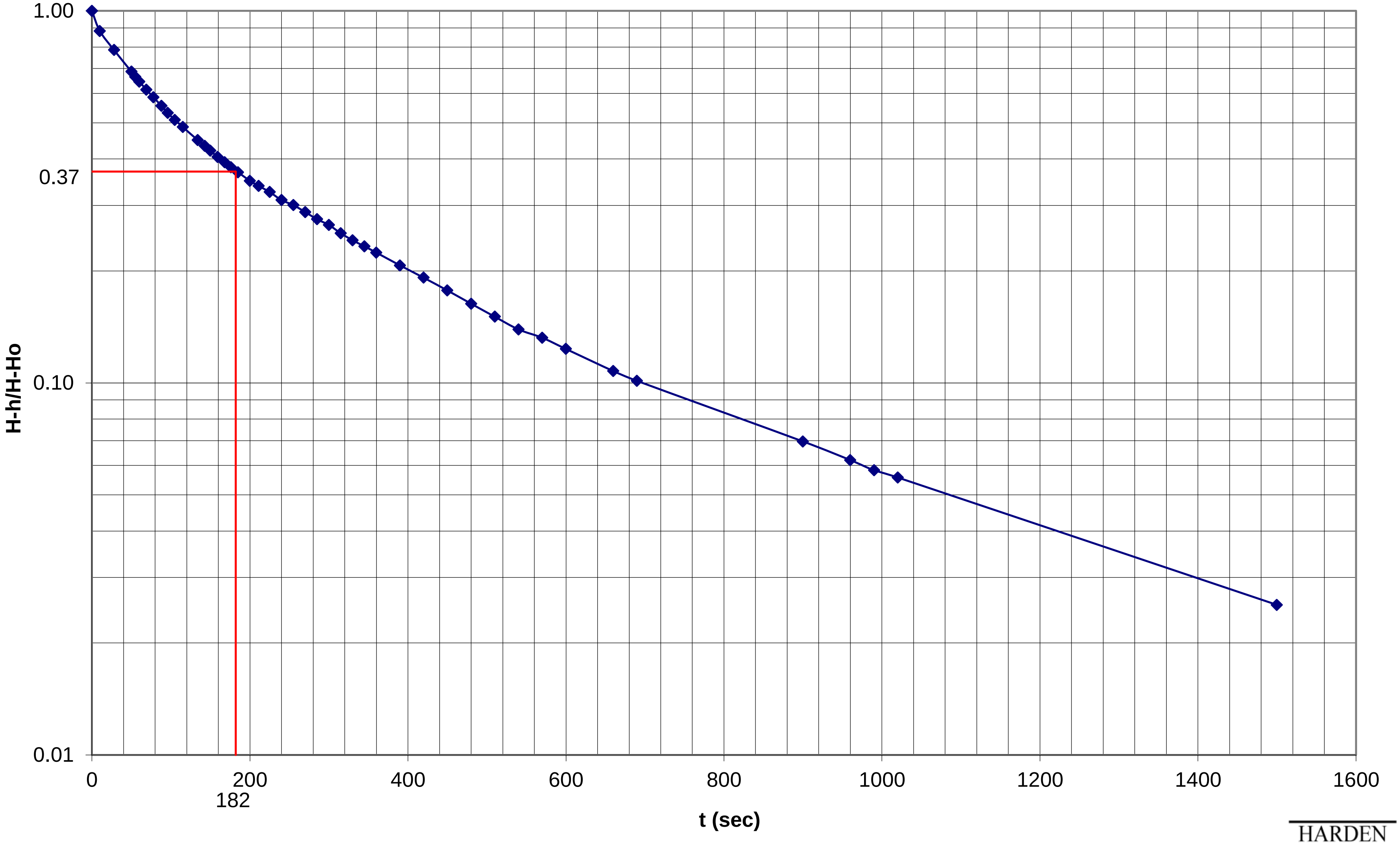

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Figure D9: M1S Falling Head Test (Hvorslev Method)
K = 5.7 x 10^{-7} m/sec

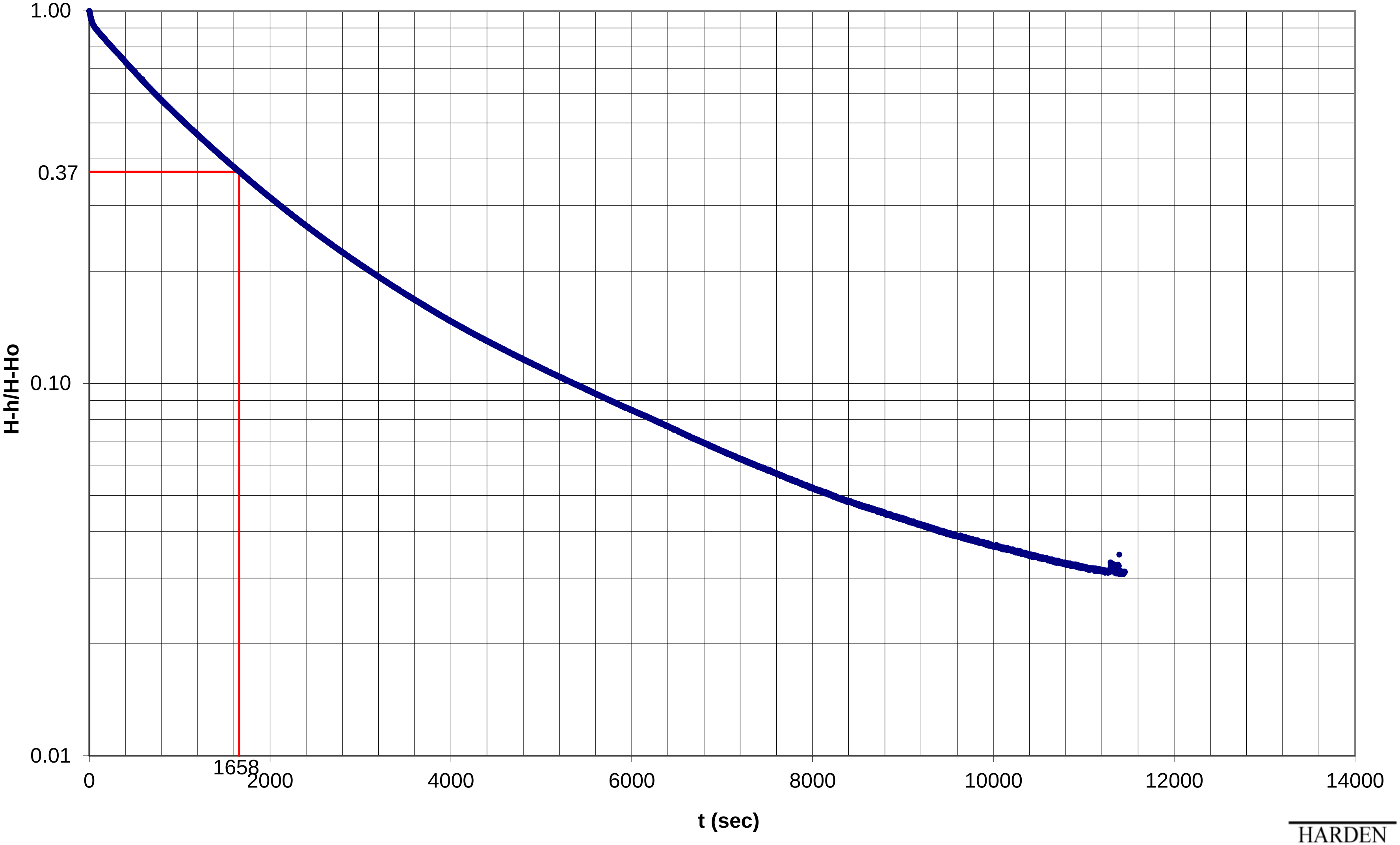

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Figure D10: M1D Falling Head Test (Hvorslev Method)

K = 5.8 x 10^{-7} m/sec

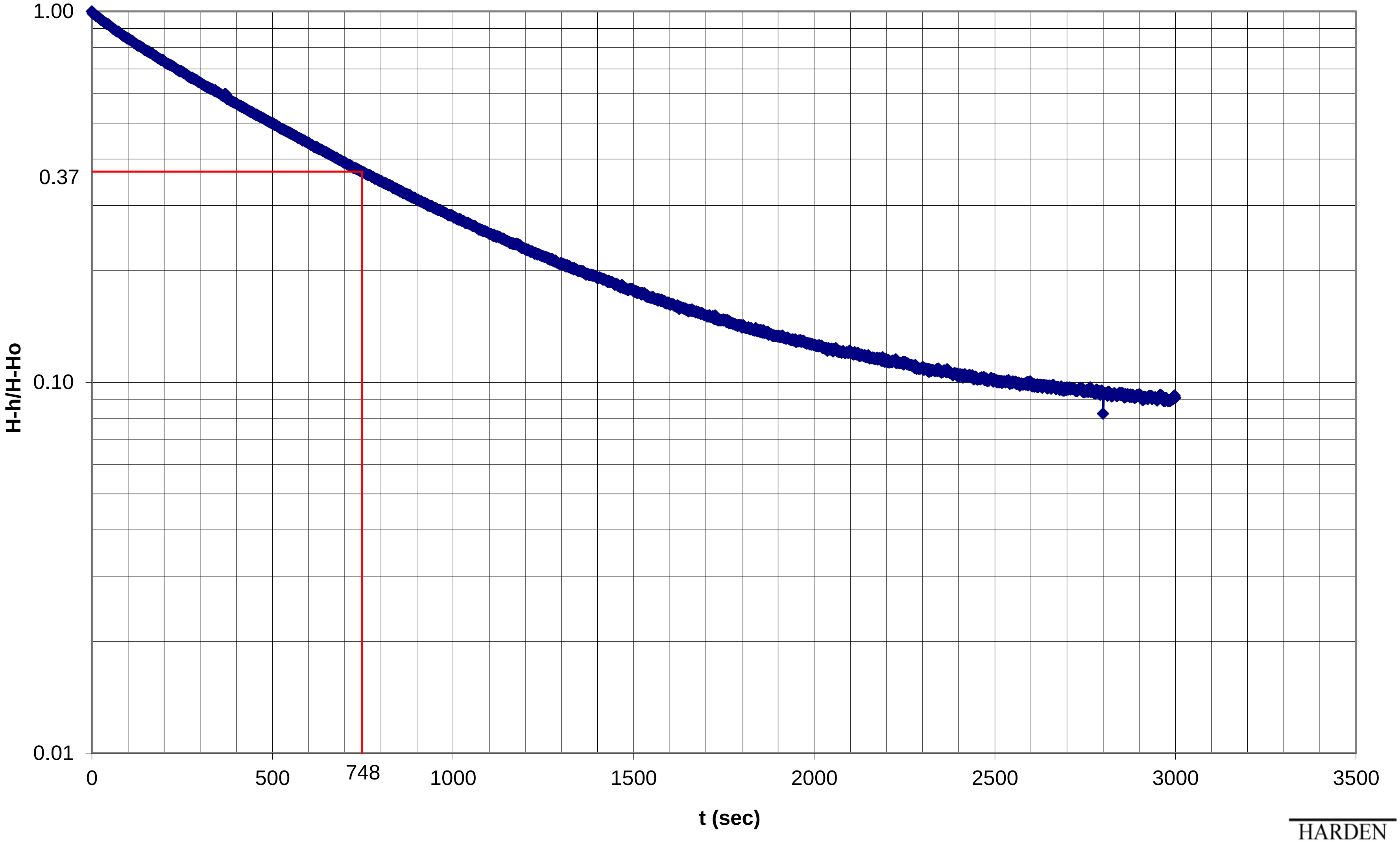

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Figure D11: M2 Falling Head Test (Hvorslev Method)
K = 1.5 x 10^{-6} m/sec

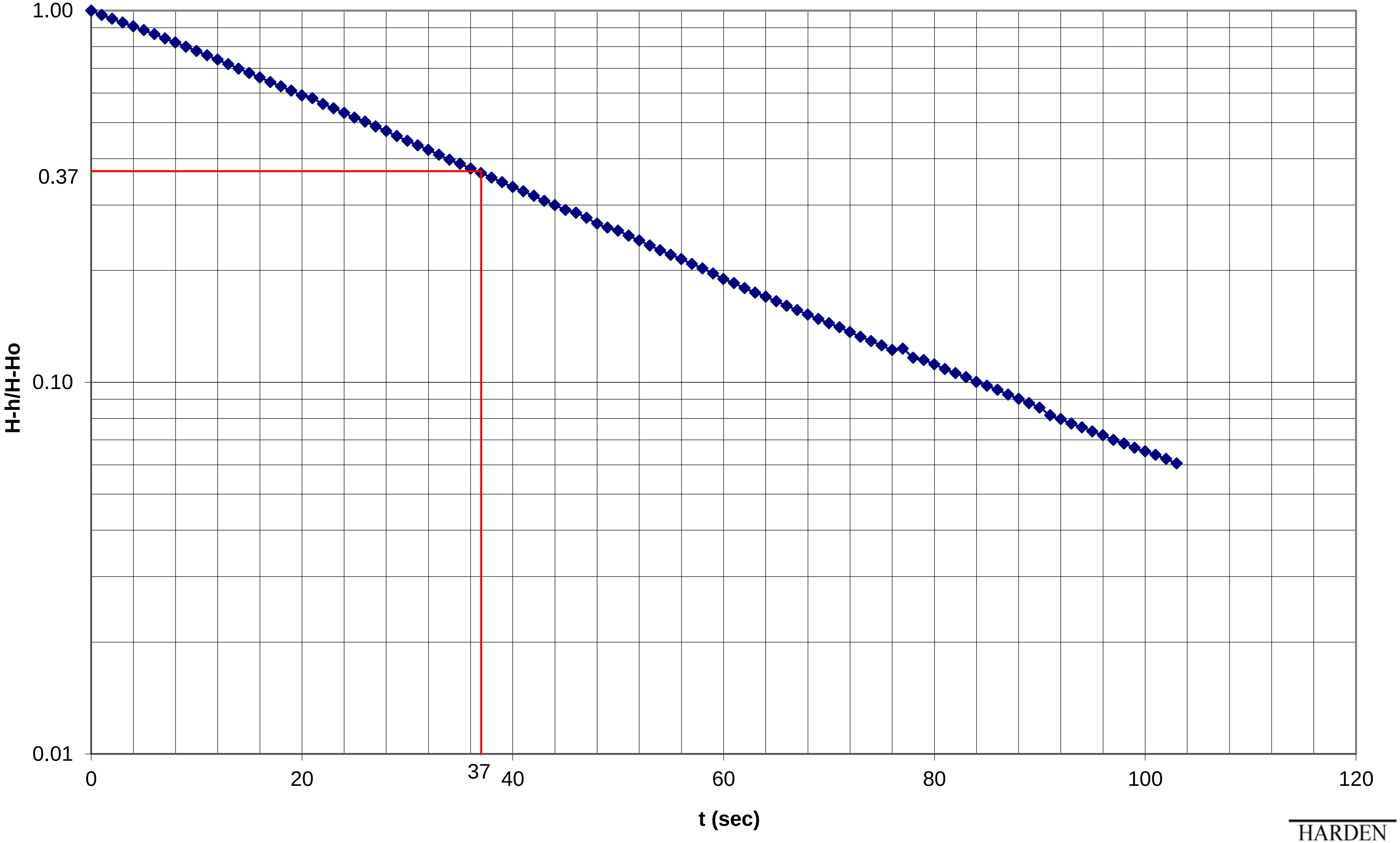

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Figure D12: M4 Drawdown (Pumping Rate 26L/min)

K = 1.3 x 10^{-5} m/sec

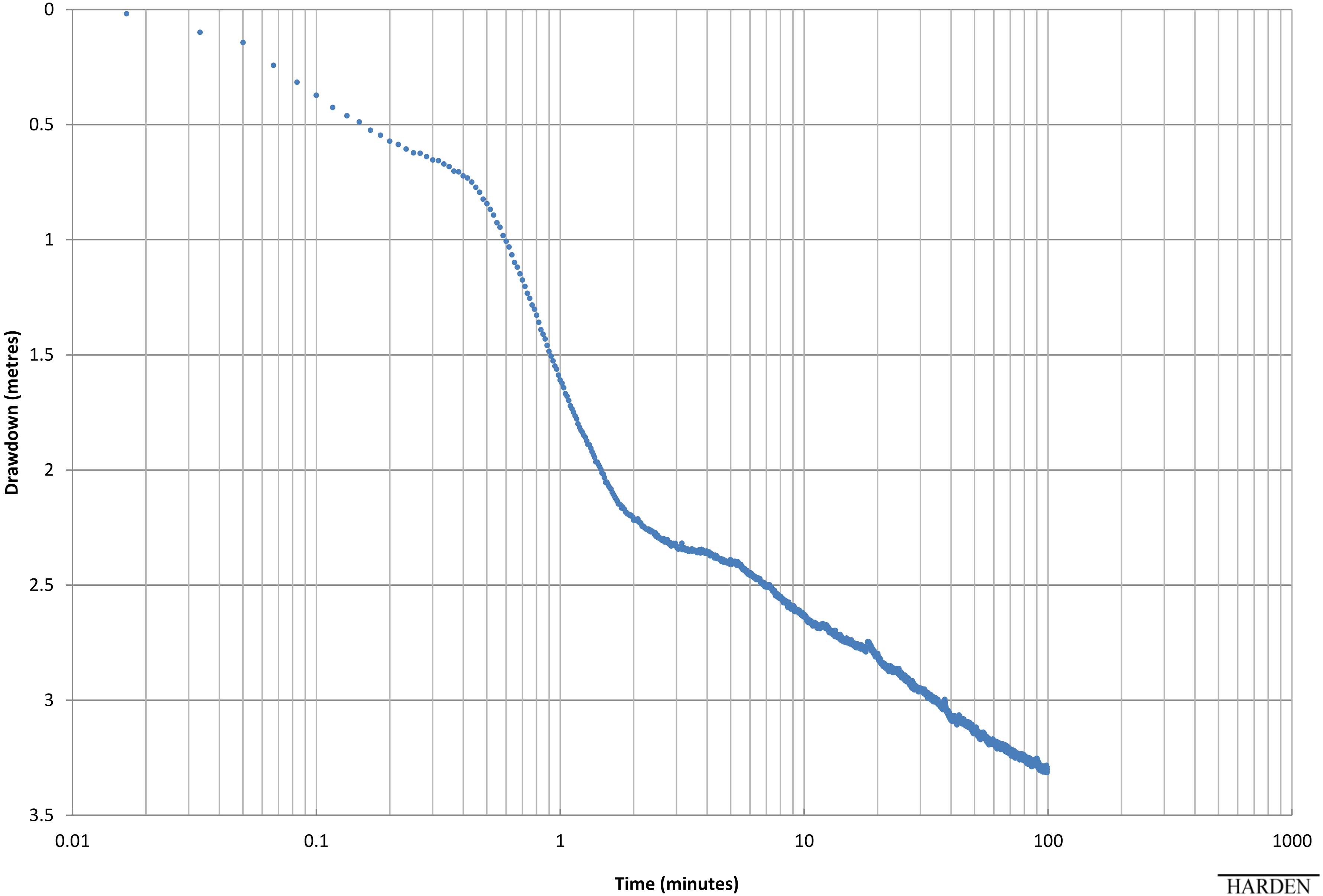

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Figure D13: M6 Falling Head Test (Hvorslev Method)

K = 9.9 x 10^{-7} m/sec

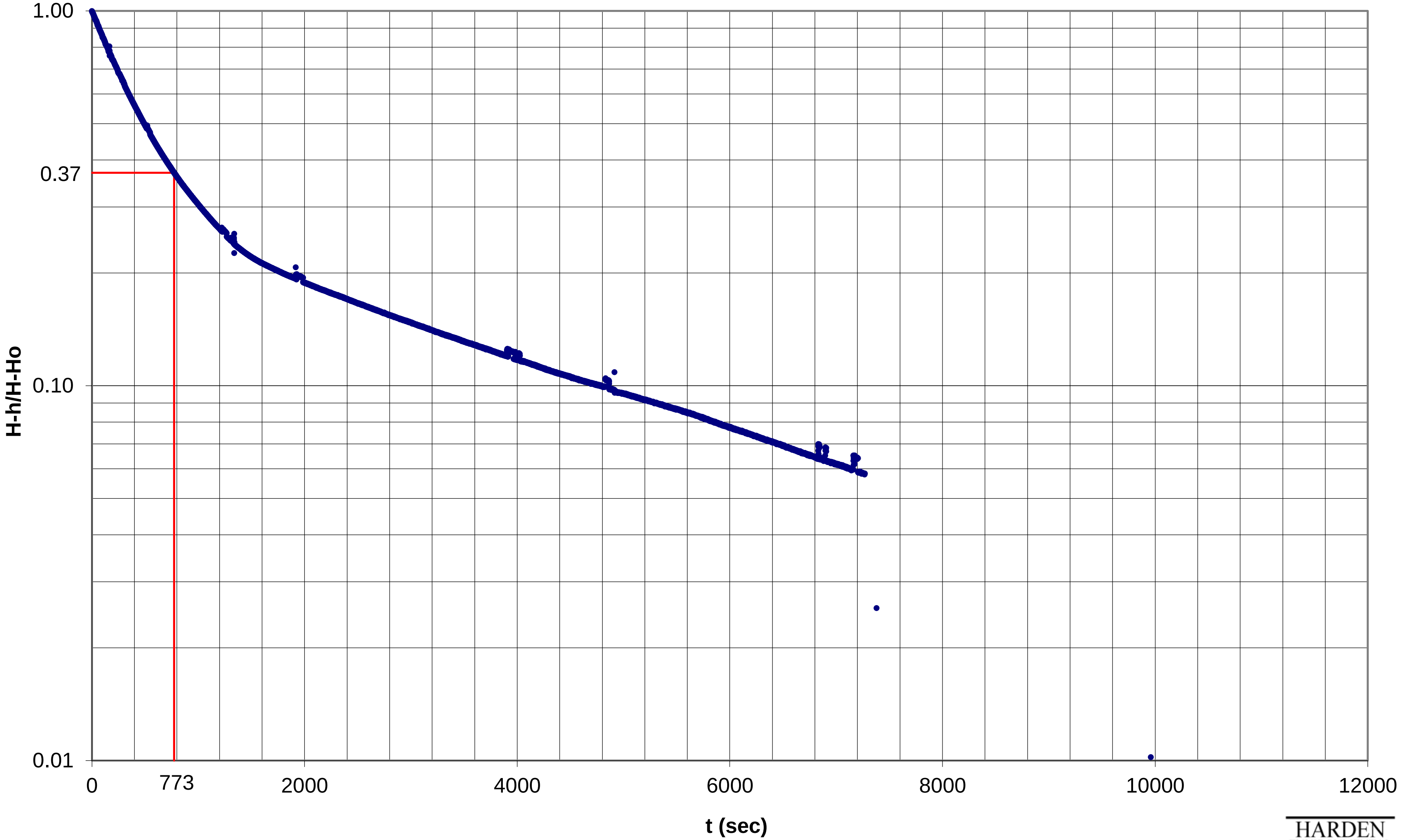

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Figure D14: M13S Falling Head Test (Hvorslev Method)
K = 8.0 x 10^{-5} m/sec

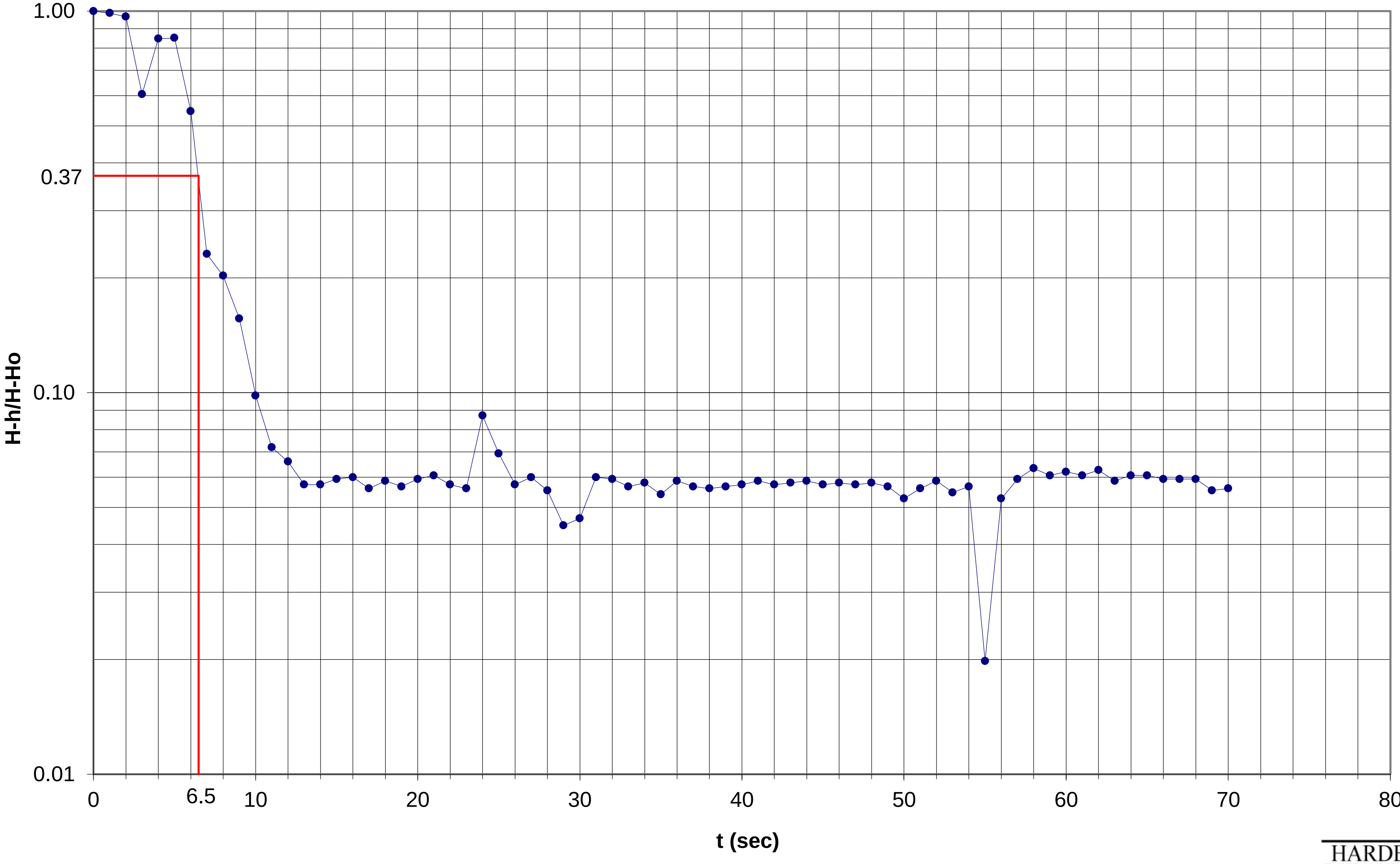

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Figure D15: M13D Falling Head Test (Hvorslev Method)
K = 4.0 x 10^{-7} m/sec

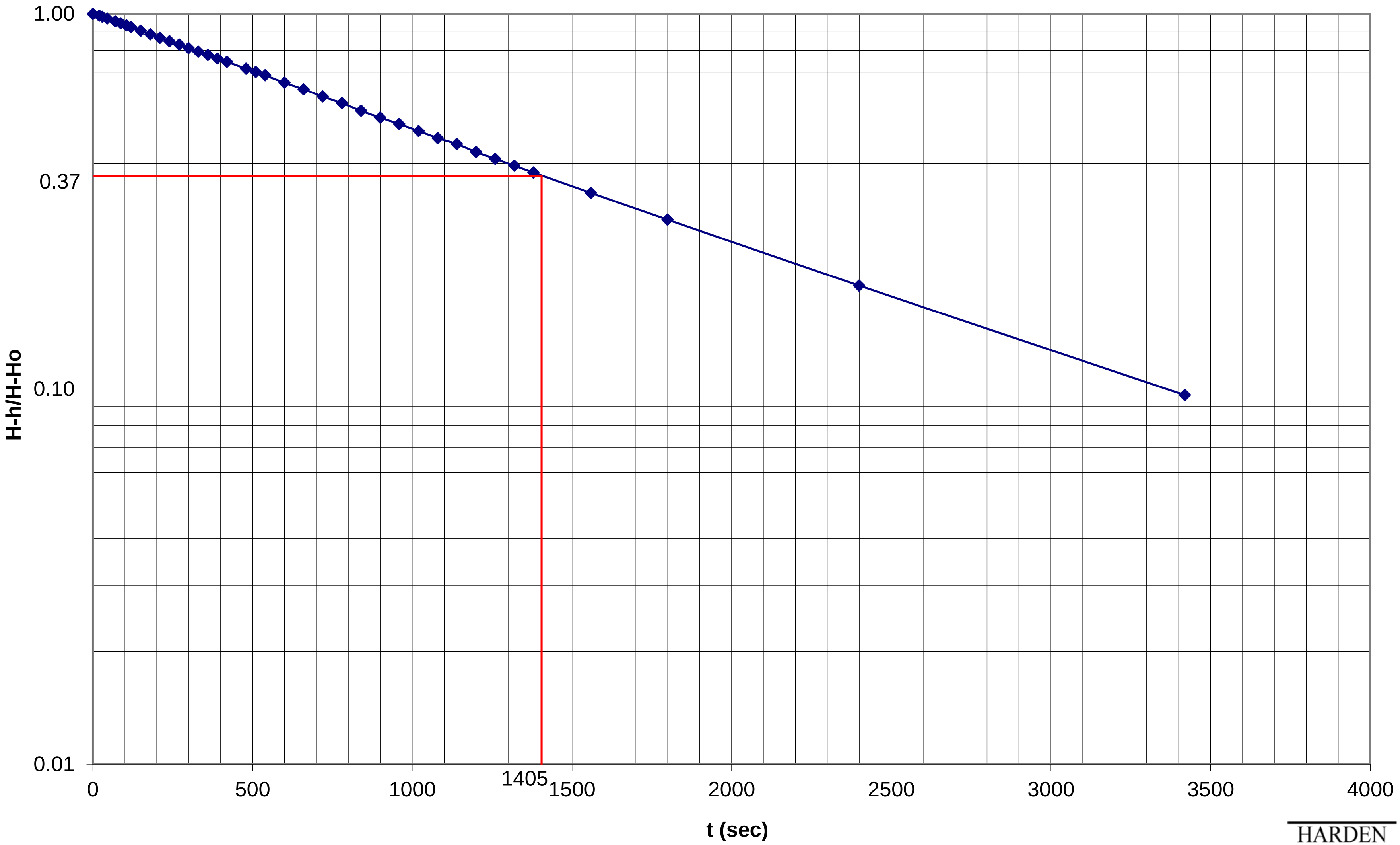

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Figure D16: M14S Falling Head Test (Hvorslev Method)

$K = 2.7 \times 10^{-7}$ m/sec

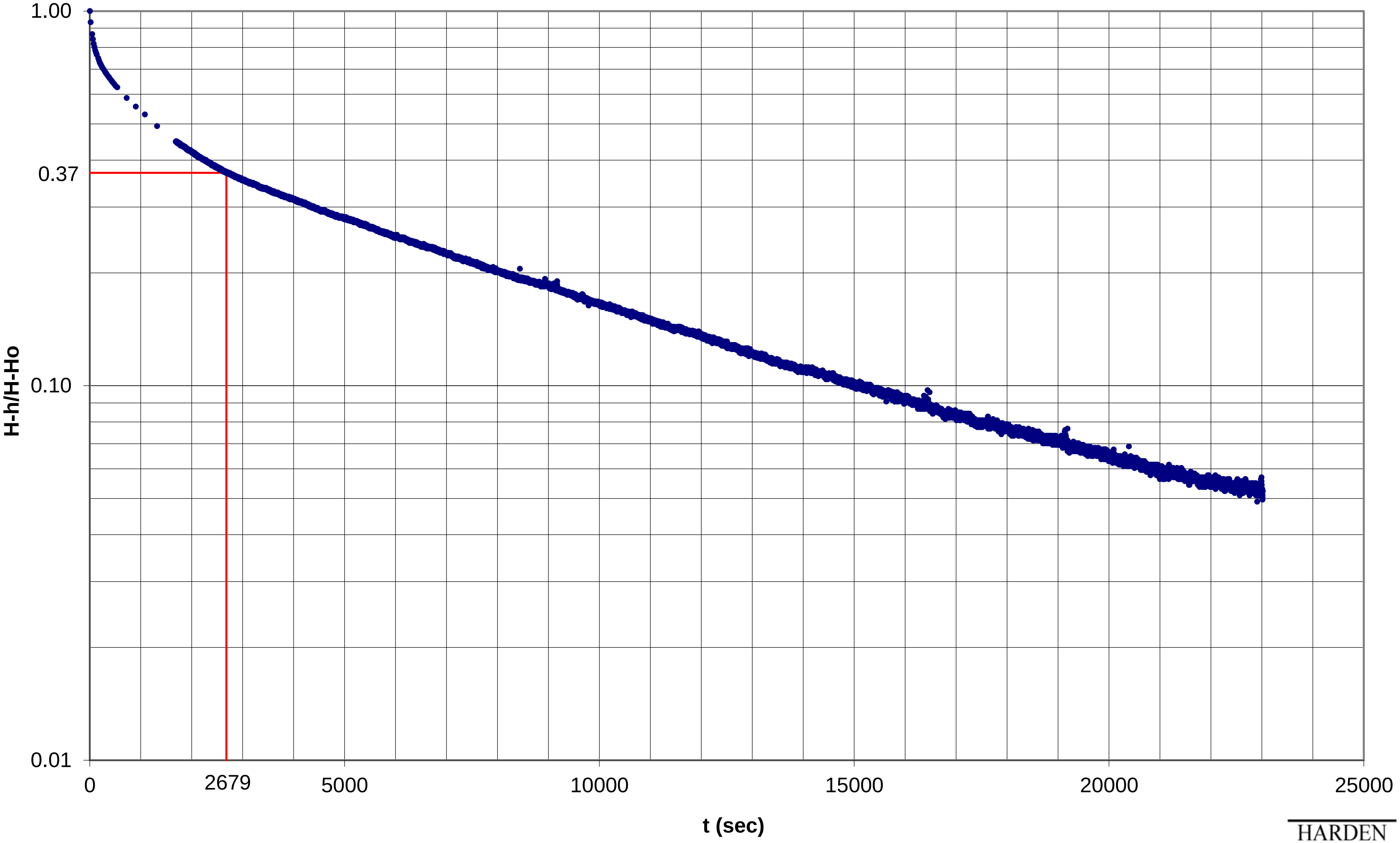

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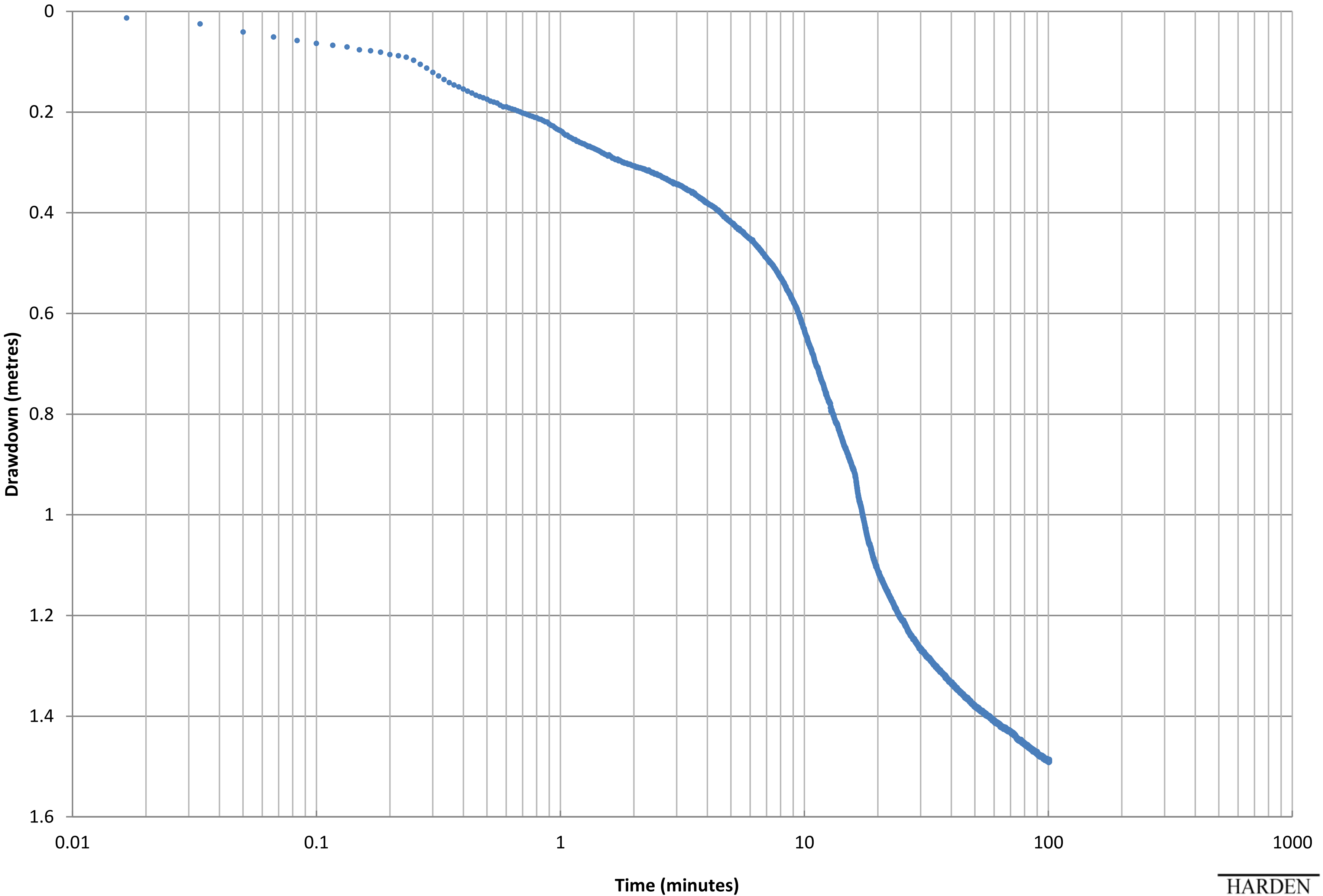
Figure D17: W1 Drawdown (Pumping Rate 26L/min)
K = 9.9 x 10^{-6} m/sec



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Appendix E

Water Quality Results

CANVIRO
Analytical Laboratories Ltd.
50 Bathurst Drive, Unit 12
Waterloo, Ontario N2V 2C5
FAX (519) 747-3806
Phone (519) 747-2575

REPORT OF ANALYSIS

Mr. Stan Denhoed
Harden Environmental Services
497 Exmoore Street
Waterloo, Ontario
N2K 3T8

REPORTED DATE	December 5, 1996
SUBMISSION NO.	96-11438
SAMPLES RECEIVED	November 22, 1996
PROJECT	9506

Dear Mr. Denhoed

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call.

EXPLANATION OF TERMS

RL = Reporting Limit
< = Less than RL unless otherwise stated. RL's are adjusted for dilutions when required.
mg/L = milligrams per litre

Respectfully yours,

Frank Mo
Inorganics
Laboratory Supervisor

CLIENT Harden Environmental Services
PROJECT 9506
SUBMISSION NO. 96-11438

INORGANIC ANALYSIS

MATRIX Aqueous

	Stream	M 3	SW3	M 2	M 4	1
SAMPLE DESCRIPTION	SAMPLE #1	SAMPLE #2	SAMPLE #3	SAMPLE #4	SAMPLE #5	**RL**
SAMPLING DATE	11/21/96	11/21/96	11/21/96	11/21/96	11/21/96	
LAB SAMPLE NO.	11438-01	11438-02	11438-03	11438-04	11438-05	
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Fluoride	0.22	0.25	0.20	0.45	0.40	0.07
Chloride	21	17	19	12	12	0.2
Nitrite-N	<	<	<	<	<	0.1
Bromide	0.10	0.10	0.10	0.10	0.10	0.1
Nitrate-N	8.2	5.3	9.0	6.8	2.8	0.05
Phosphate-P	0.31	0.32	<	0.32	<	0.3
Sulphate	25	18	23	45	74	0.2

	M 1	TP1	M5	SW1	BS Creek	
SAMPLE DESCRIPTION	SAMPLE #6	SAMPLE #7	SAMPLE #8	SAMPLE #9	SAMPLE #10	**RL**
SAMPLING DATE	11/21/96	11/21/96	11/21/96	11/21/96	11/21/96	
LAB SAMPLE NO.	11438-06	11438-07	11438-08	11438-09	11438-10	
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Fluoride	0.31	0.51	0.24	0.22	0.21	0.07
Chloride	11	45	90	26	31	0.2
Nitrite-N	<	<	<	<	<	0.1
Bromide	0.10	0.10	0.11	<	0.10	0.1
Nitrate-N	0.71	0.94	1.6	<	1.8	0.05
Phosphate-P	<	0.31	0.37	0.34	0.32	0.3
Sulphate	49	6.7	13	13	22	0.2

CLIENT Harden Environmental Services
PROJECT 9506
SUBMISSION NO. 96-11438

METAL ANALYSIS

MATRIX Aqueous

Stream M3 SW3 M2 M4

SAMPLE DESCRIPTION	SAMPLE #1	SAMPLE #2	SAMPLE #3	SAMPLE #4	SAMPLE #5	RL
SAMPLING DATE	11/21/96	11/21/96	11/21/96	11/21/96	11/21/96	
LAB SAMPLE NO.	11438-01	11438-02	11438-03	11438-04	11438-05	
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Aluminum	0.08	0.06	0.12	0.24	0.22	0.05
Boron	0.14	0.09	0.23	0.12	0.30	0.05
Barium	0.03	0.07	0.03	0.51	0.25	0.01
Beryllium	<	<	<	<	<	0.001
Cadmium	<	<	<	<	<	0.002
Calcium	88	85	95	95	95	0.1
Chromium	<	<	<	<	<	0.02
Cobalt	<	<	<	<	<	0.05
Copper	<	<	<	<	<	0.02
Iron	<	<	<	0.68	0.14	0.05
Lead	<	<	<	<	<	0.05
Magnesium	25	23	26	28	29	0.1
Manganese	<	<	<	0.05	0.01	0.01
Vanadium	<	<	<	<	<	0.01
Zinc	0.05	0.06	0.03	0.23	0.14	0.01
Nickel	<	<	<	<	<	0.01
Silver	<	<	<	<	<	0.01
Strontium	0.12	0.12	0.13	0.16	0.54	0.01
Sodium	8.0	6.4	7.5	8.0	6.6	0.5
Molybdenum	<	<	<	<	<	0.02
Titanium	<	<	<	<	<	0.01
Potassium	2.7	2.2	2.5	1.3	1.6	1.0
Thallium	<	<	<	<	<	0.1
Zirconium	<	<	<	<	<	0.02

CLIENT Harden Environmental Services
PROJECT 9506
SUBMISSION NO. 96-11438

METAL ANALYSIS

MATRIX Aqueous

	M1	TP1	M5	SW1	BSCreek	
SAMPLE DESCRIPTION	SAMPLE #6	SAMPLE #7	SAMPLE #8	SAMPLE #9	SAMPLE #10	**RL**
SAMPLING DATE	11/21/96	11/21/96	11/21/96	11/21/96	11/21/96	
LAB SAMPLE NO.	11438-06	11438-07	11438-08	11438-09	11438-10	
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Aluminum	0.20	0.17	0.14	0.20	0.13	0.05
Boron	0.28	0.27	0.31	0.27	0.27	0.05
Barium	0.13	0.20	0.15	0.02	0.04	0.01
Beryllium	<	<	<	<	<	0.001
Cadmium	<	<	<	<	<	0.002
Calcium	82	88	98	56	76	0.1
Chromium	<	<	<	<	<	0.02
Cobalt	<	<	<	<	<	0.05
Copper	<	<	<	<	<	0.02
Iron	0.22	0.43	2.1	0.06	0.06	0.05
Lead	<	<	<	<	<	0.05
Magnesium	31	26	25	19	25	0.1
Manganese	0.03	0.81	0.11	<	0.02	0.01
Vanadium	<	<	<	<	<	0.01
Zinc	0.07	0.36	2.9	0.01	0.01	0.01
Nickel	<	<	<	<	<	0.01
Silver	<	<	<	<	<	0.01
Strontium	0.13	0.15	0.14	0.08	0.12	0.01
Sodium	5.6	18	50	11	15	0.5
Molybdenum	<	<	<	<	<	0.02
Titanium	<	<	<	<	<	0.01
Potassium	1.8	1.8	1.2	2.0	1.3	1.0
Thallium	<	<	<	<	<	0.1
Zirconium	<	<	<	<	<	0.02

Water Quality Results - On-site House Well (MOE ID 6705627 / Harden ID W1)

Sample Date: May 18, 2012

	Units	ODWS	RENTAL RES	RDL
Calculated Parameters				
Anion Sum	me/L		10.4	N/A
Bicarb. Alkalinity (calc. as CaCO3)	mg/L		230	1.0
Calculated TDS	mg/L	**500**	613	1.0
Carb. Alkalinity (calc. as CaCO3)	mg/L		1.2	1.0
Cation Sum	me/L		10.3	N/A
Hardness (CaCO3)	mg/L	**80-100**	500	1.0
Ion Balance (% Difference)	%		0.610	N/A
Langelier Index (@ 20C)	N/A		0.774	
Langelier Index (@ 4C)	N/A		0.526	
Saturation pH (@ 20C)	N/A	**6.5-8.5**	6.97	
Saturation pH (@ 4C)	N/A		7.21	
Inorganics				
Total Ammonia-N	mg/L		ND	0.050
Conductivity	umho/cm		910	1.0
Dissolved Organic Carbon	mg/L	**5**	0.57	0.20
Orthophosphate (P)	mg/L		ND	0.010
pH	pH	**6.5-8.5**	7.74	
Dissolved Sulphate (SO4)	mg/L	**500**	270	1
Alkalinity (Total as CaCO3)	mg/L		230	1.0
Dissolved Chloride (Cl)	mg/L	**250**	7	1
Nitrite (N)	mg/L	**1**	ND	0.010
Nitrate (N)	mg/L	**10**	0.13	0.10
Nitrate + Nitrite	mg/L		0.13	0.10
Metals				
Dissolved Aluminum (Al)	mg/L	**0.1**	ND	0.0050
Dissolved Antimony (Sb)	mg/L		ND	0.00050
Dissolved Arsenic (As)	mg/L	**0.025**	ND	0.0010
Dissolved Barium (Ba)	mg/L	**1**	0.029	0.0020
Dissolved Beryllium (Be)	mg/L		ND	0.00050
Dissolved Bismuth (Bi)	mg/L		ND	0.0010
Dissolved Boron (B)	mg/L	**5**	0.017	0.010
Dissolved Cadmium (Cd)	mg/L	**0.005**	ND	0.00010
Dissolved Calcium (Ca)	mg/L		150	0.20
Dissolved Chromium (Cr)	mg/L	**0.05**	ND	0.0050
Dissolved Cobalt (Co)	mg/L		ND	0.00050
Dissolved Copper (Cu)	mg/L	**1**	ND	0.0010
Dissolved Iron (Fe)	mg/L	**0.3**	0.14	0.10
Dissolved Lead (Pb)	mg/L	**0.01**	ND	0.00050
Dissolved Magnesium (Mg)	mg/L		33	0.050
Dissolved Manganese (Mn)	mg/L	**0.05**	0.020	0.0020
Dissolved Molybdenum (Mo)	mg/L		0.0019	0.00050
Dissolved Nickel (Ni)	mg/L		ND	0.0010
Dissolved Phosphorus (P)	mg/L		ND	0.10
Dissolved Potassium (K)	mg/L		1.0	0.20
Dissolved Selenium (Se)	mg/L	**0.01**	ND	0.0020
Dissolved Silicon (Si)	mg/L		4.1	0.050
Dissolved Silver (Ag)	mg/L		ND	0.00010
Dissolved Sodium (Na)	mg/L	**20**	5.9	0.10
Dissolved Strontium (Sr)	mg/L		3.1	0.0010
Dissolved Thallium (Tl)	mg/L		ND	0.000050
Dissolved Titanium (Ti)	mg/L		ND	0.0050
Dissolved Uranium (U)	mg/L		0.00021	0.00010
Dissolved Vanadium (V)	mg/L		ND	0.00050
Dissolved Zinc (Zn)	mg/L	**5**	0.020	0.0050

ND = Not detected

RDL = Reportable Detection Limit

HARDEN
ENVIRONMENTAL

RR#1
MOFFAT, ON
L0P 1J0
(519) 826-0099

Project No: 0508	**FIGURE 1**	**Sample Location – Guelph Limestone Quarry**
Date: February 2012	**Drawn By:** AW	

Table 1: Sump Water Quality Following Blast February 15, 2012
Dolime Quarry, Guelph, ON

Sampling Date			15/02/2012 16:00	
	Units	**Criteria**	**SUMP**	**RDL**
Metals				
Total Aluminum (Al)	mg/L	**-**	0.016	0.0050
Total Antimony (Sb)	mg/L	**0.02**	0.00090	0.00050
Total Arsenic (As)	mg/L	**0.1**	0.0016	0.0010
Total Barium (Ba)	mg/L	**-**	0.051	0.0020
Total Beryllium (Be)	mg/L	**0.011**	ND	0.00050
Total Bismuth (Bi)	mg/L	**-**	ND	0.0010
Total Boron (B)	mg/L	**0.2**	0.056	0.010
Total Cadmium (Cd)	mg/L	**0.0002**	ND	0.00010
Total Calcium (Ca)	mg/L	**-**	120	0.20
Total Chromium (Cr)	mg/L	**-**	ND	0.0050
Total Cobalt (Co)	mg/L	**0.0009**	**0.0013**	0.00050
Total Copper (Cu)	mg/L	**0.005**	0.0019	0.0010
Total Iron (Fe)	mg/L	**0.3**	ND	0.10
Total Lead (Pb)	mg/L	**0.005**	**0.0055**	0.00050
Total Lithium (Li)	mg/L	**-**	ND	0.0050
Total Magnesium (Mg)	mg/L	**-**	32	0.050
Total Manganese (Mn)	mg/L	**-**	0.026	0.0020
Total Molybdenum (Mo)	mg/L	**0.04**	0.0069	0.00050
Total Nickel (Ni)	mg/L	**0.025**	0.014	0.0010
Total Potassium (K)	mg/L	**-**	3.5	0.20
Total Silicon (Si)	mg/L	**-**	3.6	0.050
Total Selenium (Se)	mg/L	**0.1**	ND	0.0020
Total Silver (Ag)	mg/L	**0.0001**	ND	0.00010
Total Sodium (Na)	mg/L	**-**	80	0.10
Total Strontium (Sr)	mg/L	**-**	1.1	0.0010
Total Tellurium (Te)	mg/L	**-**	ND	0.0010
Total Thallium (Tl)	mg/L	**0.0003**	0.000056	0.000050
Total Tin (Sn)	mg/L	**-**	ND	0.0010
Total Titanium (Ti)	mg/L	**-**	ND	0.0050
Total Tungsten (W)	mg/L	**0.030**	ND	0.0010
Total Uranium (U)	mg/L	**0.005**	0.0020	0.00010
Total Vanadium (V)	mg/L	**0.006**	ND	0.00050
Total Zinc (Zn)	mg/L	**0.03**	**0.057**	0.0050
Total Zirconium (Zr)	mg/L	**0.004**	ND	0.0010
Inorganics				
Total Ammonia-N	mg/L	**0.5**	0.39	0.05
Total Kjeldahl Nitrogen (TKN)	mg/L		0.7	0.1
Nitrite (N)	mg/L		0.05	0.01
Nitrate (N)	mg/L	**10**	1.2	0.1
Nitrate + Nitrite	mg/L		1.2	0.1
Unionized Ammonia	mg/L	**0.02**	0.0050	
Miscellaneous Parameters				
Perchlorate (CLO4)	ug/L		ND	0.05
Calculated Parameters				
Methylnaphthalene, 2-(1-)	ug/L	**-**	ND	0.071

ND = Not detected
RDL = Reportable Detection Limit
EDL = Estimated Detection Limit
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

Table 1: Sump Water Quality Following Blast February 15, 2012
Dolime Quarry, Guelph, ON

	Units	Criteria	SUMP	RDL
Polyaromatic Hydrocarbons				
Biphenyl	ug/L	**0.2**	ND	0.050
Acenaphthene	ug/L	**-**	ND	0.050
Acenaphthylene	ug/L	**-**	ND	0.050
Anthracene	ug/L	**0.0008**	ND	0.050
Benzo(a)anthracene	ug/L	**0.0004**	ND	0.050
Benzo(a)pyrene	ug/L	**-**	ND	0.010
Benzo(b/j)fluoranthene	ug/L	**-**	ND	0.050
Benzo(g,h,i)perylene	ug/L	**0.00002**	ND	0.050
Benzo(k)fluoranthene	ug/L	**0.0002**	ND	0.050
Chrysene	ug/L	**0.0001**	ND	0.050
Dibenz(a,h)anthracene	ug/L	**0.002**	ND	0.050
Fluoranthene	ug/L	**0.0008**	ND	0.050
Fluorene	ug/L	**0.2**	ND	0.050
Indeno(1,2,3-cd)pyrene	ug/L	**-**	ND	0.050
1-Methylnaphthalene	ug/L	**2**	ND	0.050
2-Methylnaphthalene	ug/L	**2**	ND	0.050
Naphthalene	ug/L	**7**	ND	0.050
Phenanthrene	ug/L	**0.03**	ND	0.030
Pyrene	ug/L	**-**	ND	0.050
Surrogate Recovery (%)				
D10-Anthracene	%	-	89	
D14-Terphenyl (FS)	%	-	96	
D8-Acenaphthylene	%	-	86	
Volatile Organics				
Acetone (2-Propanone)	ug/L	**-**	ND	10
Benzene	ug/L	**100**	0.11	0.10
Bromodichloromethane	ug/L	**200**	ND	0.10
Bromoform	ug/L	**60**	ND	0.20
Bromomethane	ug/L	**0.9**	ND	0.50
Carbon Tetrachloride	ug/L	**-**	ND	0.10
Chlorobenzene	ug/L	**15**	ND	0.10
Chloroform	ug/L	**-**	ND	0.10
Dibromochloromethane	ug/L	**40**	ND	0.20
1,2-Dichlorobenzene	ug/L	**2.5**	ND	0.20
1,3-Dichlorobenzene	ug/L	**2.5**	ND	0.20
1,4-Dichlorobenzene	ug/L	**4**	ND	0.20
Dichlorodifluoromethane (FREON 12)	ug/L	**-**	ND	0.50
1,1-Dichloroethane	ug/L	**200**	ND	0.10
1,2-Dichloroethane	ug/L	**100**	ND	0.20
1,1-Dichloroethylene	ug/L	**40**	ND	0.10
cis-1,2-Dichloroethylene	ug/L	**200**	ND	0.10
trans-1,2-Dichloroethylene	ug/L	**200**	ND	0.10
1,2-Dichloropropane	ug/L	**0.7**	ND	0.10
cis-1,3-Dichloropropene	ug/L	**-**	ND	0.20
trans-1,3-Dichloropropene	ug/L	**7**	ND	0.20
Ethylbenzene	ug/L	**8**	ND	0.10
Ethylene Dibromide	ug/L	**5**	ND	0.20

ND = Not detected
RDL = Reportable Detection Limit
EDL = Estimated Detection Limit
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

Table 1: Sump Water Quality Following Blast February 15, 2012
Dolime Quarry, Guelph, ON

	Units	Criteria	SUMP	RDL
Hexane	ug/L	**-**	ND	0.50
Methylene Chloride(Dichloromethane)	ug/L	**100**	ND	0.50
Methyl Isobutyl Ketone	ug/L	**-**	ND	5.0
Methyl Ethyl Ketone (2-Butanone)	ug/L	**400**	ND	5.0
Methyl t-butyl ether (MTBE)	ug/L	**200**	ND	0.20
Styrene	ug/L	**4**	ND	0.20
1,1,1,2-Tetrachloroethane	ug/L	**20**	ND	0.10
1,1,2,2-Tetrachloroethane	ug/L	**70**	ND	0.20
Tetrachloroethylene	ug/L	**50**	ND	0.10
Toluene	ug/L	**0.8**	ND	0.20
1,1,1-Trichloroethane	ug/L	**10**	ND	0.10
1,1,2-Trichloroethane	ug/L	**800**	ND	0.20
Trichloroethylene	ug/L	**20**	ND	0.10
Vinyl Chloride	ug/L	**600**	ND	0.20
p+m-Xylene	ug/L	**-**	ND	0.10
o-Xylene	ug/L	**40**	ND	0.10
Xylene (Total)	ug/L	**-**	ND	0.10
Trichlorofluoromethane (FREON 11)	ug/L	**-**	ND	0.20
Surrogate Recovery (%)				
4-Bromofluorobenzene	%	-	94	
D4-1,2-Dichloroethane	%	-	106	
D8-Toluene	%	-	103	
BTEX & F1 Hydrocarbons				
F1 (C6-C10)	ug/L		ND	25
F1 (C6-C10) - BTEX	ug/L		ND	25
F2-F4 Hydrocarbons				
F2 (C10-C16 Hydrocarbons)	ug/L		ND	100
F3 (C16-C34 Hydrocarbons)	ug/L		ND	100
F4 (C34-C50 Hydrocarbons)	ug/L		ND	100
Reached Baseline at C50	ug/L		Yes	
Surrogate Recovery (%)				
1,4-Difluorobenzene	%		99	
4-Bromofluorobenzene	%		100	
D10-Ethylbenzene	%		105	
D4-1,2-Dichloroethane	%		103	
o-Terphenyl	%		107	

ND = Not detected
RDL = Reportable Detection Limit
EDL = Estimated Detection Limit
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

Appendix F

MOE Water Well Records

Table F1: MOE Water Well Records within 1km of Subject Property

Well ID	Well Type	Date Completed	Ground Elevation (mAMSL)	Well Depth (mbgs)	Static Water Level (mbgs)	Static Water Level Elevation (mbgs)	UTM Location Reliability	Material Colour	Material	Material 2	Material 3	Bottom Depth of Material (mbgs)
2802002	Bedrock	21/11/1959	352.69	17.07	6.71	345.98	100 m - 300 m		TOPSOIL			0.61
									GRAVEL			6.10
								GREY	LIMESTONE			17.07
2802047	Bedrock	01/06/1953	354.91	18.59	9.14	345.76	unknown UTM		GRAVEL	BOULDERS		12.50
									LIMESTONE			18.59
2802048	Bedrock	14/07/1959	355.41	20.12	8.53	346.87	100 m - 300 m		TOPSOIL			0.61
									BOULDERS			1.22
									GRAVEL			3.05
									BOULDERS			3.66
									GRAVEL	STONES		6.10
								GREY	LIMESTONE			20.12
2802049	Bedrock	06/09/1966	354.58	23.77	10.67	343.91	100 m - 300 m		GRAVEL	CLAY		6.10
								GREY	LIMESTONE			23.77
2802796	Bedrock	09/10/1968	356.34	23.16	6.10	350.24	30 m - 100 m		MEDIUM SAND			2.44
									GRAVEL	CLAY	STONES	6.40
								GREY	LIMESTONE			23.16
2803030	Bedrock	31/03/1969	350.26	27.43	10.67	339.60	30 m - 100 m		GRAVEL	CLAY		1.83
								GREY	LIMESTONE			27.43
2803167	Bedrock	29/07/1969	354.75	25.91	12.19	342.56	30 m - 100 m	BROWN	GRAVEL	STONES		6.71
								GREY	LIMESTONE			25.91
2803220	Bedrock	19/09/1969	359.72	21.03	13.72	346.00	30 m - 100 m		STONES	GRAVEL		15.85
								BLUE	LIMESTONE			21.03
2803240	Bedrock	01/10/1969	340.94	25.91	4.57	336.37	30 m - 100 m		GRAVEL			5.79
								GREY	LIMESTONE			25.91
2803342	Bedrock	14/04/1970	349.97	37.19	5.49	344.48	30 m - 100 m		GRAVEL			7.62
								GREY	LIMESTONE			37.19
2803457	Bedrock	21/08/1970	354.27	31.70	9.14	345.12	30 m - 100 m	BROWN	BOULDERS	CLAY		8.53
								GREY	LIMESTONE			31.70
2804469	Overburden	28/05/1974	348.15	6.10	2.13	346.02	30 m - 100 m	BROWN	SAND	GRAVEL	BOULDERS	6.10
2804708	Bedrock	20/12/1974	346.30	18.29	5.49	340.81	30 m - 100 m		PREVIOUSLY DUG			1.83
									SAND	STONES		4.27
									CLAY			5.18
								GREY	ROCK			18.29
2804810	Bedrock	20/11/1975	331.17	25.91	7.92	323.24	100 m - 300 m	BROWN	TOPSOIL			1.22
								BROWN	ROCK			16.76
								GREY	ROCK			25.91
2805415	Bedrock	22/10/1979	340.38	18.59	1.83	338.55	100 m - 300 m	BROWN	TOPSOIL	STONES	SOFT	0.91
								BROWN	LIMESTONE	PACKED		3.66
								GREY	LIMESTONE	HARD		18.59
2805483	Bedrock	17/12/1979	355.34	14.63	8.23	347.11	100 m - 300 m	BROWN	SAND	GRAVEL	BOULDERS	12.50
								GREY	LIMESTONE			14.63
2805763	Bedrock	13/05/1981	344.78	21.34	3.66	341.13	100 m - 300 m	BROWN	SAND	SOFT		0.61
								GREY	LIMESTONE	HARD		21.34
2805842	Bedrock	26/06/1982	351.26	30.48	2.74	348.52	100 m - 300 m	BROWN	SAND	GRAVEL	BOULDERS	11.89
								GREY	LIMESTONE	HARD		30.48
2805843	Bedrock	25/06/1982	352.79	24.38	2.74	350.05	100 m - 300 m	BROWN	SAND	GRAVEL	STONES	6.71
								GREY	LIMESTONE	HARD		24.38
2806560	Bedrock	05/11/1986	350.61	21.95	3.05	347.56	100 m - 300 m		FILL	CLAY		1.52
								GREY	LIMESTONE			21.95

mbgs - metres below ground surface | mAMSL - metres above mean sea level

Table F1: MOE Water Well Records within 1km of Subject Property

Well ID	Well Type	Date Completed	Ground Elevation (mAMSL)	Well Depth (mbgs)	Static Water Level (mbgs)	Static Water Level Elevation (mbgs)	UTM Location Reliability	Material Colour	Material	Material 2	Material 3	Bottom Depth of Material (mbgs)
2807283	Bedrock	11/04/1989	348.48	14.94	3.66	344.82	10 - 30 m		TOPSOIL			0.30
								RED	SAND			1.22
									CLAY	GRAVEL	STONES	2.74
									LIMESTONE	SHALE		3.35
								GREY	LIMESTONE	HARD		14.94
2809044	Overburden	28/05/1999	355.63	4.57	3.05	352.58	unknown UTM: Lot Centroid	BROWN	TOPSOIL			0.30
								BROWN	CLAY	SANDY	STONES	2.13
								BROWN	SAND	CLAY	GRAVEL	3.35
								BROWN	SAND	STONES		4.57
2810143	Bedrock	02/11/2004	354.75	44.20	17.00	337.75	unknown UTM: On Water Well Record	BLACK	TOPSOIL			0.61
								BROWN	CLAY	STONES		1.83
								GREY	LIMESTONE			39.02
								BLUE	SHALE			43.59
								RED	SHALE			44.20
6700487	Bedrock	29/07/1963	363.39	46.63	9.14	354.24	100 m - 300 m		BOULDERS	GRAVEL		6.40
								WHITE	LIMESTONE			39.62
								BLUE	LIMESTONE			46.63
6700504	Bedrock	02/05/1949	360.57	12.19	4.57	356.00	unknown UTM		GRAVEL	CLAY		3.66
									LIMESTONE			12.19
6703540	Bedrock	04/08/1969	368.65	24.38	4.57	364.08	30 m - 100 m	BROWN	CLAY	STONES		3.05
								GREY	LIMESTONE			24.38
6703695	Bedrock	13/05/1970	369.76	48.16	4.27	365.49	30 m - 100 m		CLAY	STONES		5.18
								GREY	LIMESTONE			48.16
6703720	Bedrock	09/04/1970	362.81	30.48	5.49	357.33	30 m - 100 m		TOPSOIL			1.22
									LIMESTONE			30.48
6703839	Bedrock	13/05/1970	369.98	48.16	4.27	365.71	30 m - 100 m		CLAY	STONES		5.18
								GREY	LIMESTONE			48.16
6704252	Bedrock	14/06/1972	365.82	16.76	3.66	362.16	30 m - 100 m	BROWN	CLAY	STONES		7.01
								GREY	ROCK			16.76
6704285	Bedrock	19/07/1972	359.81	14.63	5.49	354.33	30 m - 100 m		GRAVEL	STONES		3.05
								GREY	LIMESTONE			14.63
6704349	Bedrock	23/08/1972	366.79	26.21	3.66	363.13	30 m - 100 m	BROWN	CLAY	GRAVEL		4.57
								GREY	LIMESTONE			26.21
6704980	Bedrock	02/01/1974	365.18	22.25	2.13	363.04	30 m - 100 m		PREVIOUSLY DUG			1.52
								BROWN	CLAY	STONES	GRAVEL	4.57
								GREY	ROCK			10.06
								BROWN	ROCK			16.15
								WHITE	ROCK			22.25
6705003	Bedrock	27/03/1974	355.46	30.48	13.72	341.74	30 m - 100 m		GRAVEL			6.71
									CLAY	GRAVEL		11.58
								WHITE	ROCK			18.29
								BROWN	LIMESTONE			30.48
6705038	Bedrock	10/05/1974	363.63	24.38	1.22	362.41	30 m - 100 m		TOPSOIL			0.30
								BROWN	CLAY	STONES		4.57
								GREY	ROCK			24.38
6705424	Bedrock	11/02/1975	360.35	30.48	13.11	347.24	100 m - 300 m	BROWN	CLAY	SAND	STONES	7.62
								BROWN	CLAY	SAND	GRAVEL	10.67
								BROWN	ROCK	LIGHT-COLOURED		12.50
								GREY	ROCK			30.48
6705627	Bedrock	24/07/1974	355.53	28.96	8.84	346.70	100 m - 300 m		CLAY	STONES		13.72
								GREY	LIMESTONE			28.96

mbgs - metres below ground surface | mAMSL - metres above mean sea level

Table F1: MOE Water Well Records within 1km of Subject Property

Well ID	Well Type	Date Completed	Ground Elevation (mAMSL)	Well Depth (mbgs)	Static Water Level (mbgs)	Static Water Level Elevation (mbgs)	UTM Location Reliability	Material Colour	Material	Material 2	Material 3	Bottom Depth of Material (mbgs)
6705878	Bedrock	07/08/1975	367.77	24.38	2.44	365.33	100 m - 300 m	BROWN	SAND			3.66
								GREY	LIMESTONE			24.38
6706762	Bedrock	30/06/1978	370.68	42.67	21.34	349.34	100 m - 300 m		STONES	CLAY		15.85
									LIMESTONE	STONES		32.00
								BLUE	STONES			42.67
6707178	Bedrock	21/09/1979	354.99	38.10	10.67	344.32	100 m - 300 m		CLAY	STONES		6.10
									STONES			8.53
									LIMESTONE			38.10
6707545	Bedrock	13/08/1981	359.94	18.90	4.57	355.37	100 m - 300 m		GRAVEL	BOULDERS		6.10
								GREY	LIMESTONE			18.90
6708039	Overburden	17/08/1983	359.79	21.34	5.49	354.31	100 m - 300 m		TOPSOIL			0.30
								BROWN	CLAY	GRAVEL	STONES	5.49
								GREY	STONES			21.34
6708195	Bedrock	10/06/1985	356.29	27.74	5.79	350.50	100 m - 300 m	BROWN	SAND	STONES	SOFT	1.83
								GREY	LIMESTONE	STONES	HARD	11.89
								BLACK	LIMESTONE	STONES	VERY	16.46
								GREY	LIMESTONE	STONES	HARD	27.74
6710793	Bedrock	15/10/1991	361.07	44.50	3.66	357.41	100 m - 300 m	BROWN	CLAY	STONES		4.57
								GREY	LIMESTONE			44.50
6711476	Bedrock	04/04/1994	367.85	31.39	2.44	365.41	100 m - 300 m		TOPSOIL			0.30
								BROWN	CLAY	GRAVEL		3.96
								GREY	LIMESTONE			7.92
								GREY	LIMESTONE	FRACTURED		8.53
								GREY	LIMESTONE			31.39
6712323	Bedrock	14/08/1997	354.86	30.48	9.14	345.72	10 - 30 m	BROWN	CLAY	GRAVEL		9.75
								BROWN	ROCK			16.76
								GREY	ROCK			30.48
6712328	Bedrock	02/09/1997	361.71	43.59	7.62	354.09	unknown UTM: Lot Centroid		TOPSOIL			0.61
								GREY	CLAY	STONES		9.45
								BROWN	LIMESTONE	LIGHT-COLOURED		12.19
								BROWN	LIMESTONE			30.48
								BROWN	LIMESTONE	DARK-COLOURED		36.58
								BROWN	LIMESTONE			43.59
6712708	Bedrock	23/10/1998	360.04	18.90	6.10	353.94	unknown UTM: Lot Centroid		PREV. DRILLED			7.32
								GREY	LIMESTONE			18.90
6712824	Bedrock	23/11/1998	360.47	39.62	7.92	352.54	10 - 30 m		GRAVEL	BOULDERS		6.10
									CLAY	STONES	SAND	8.84
								GREY	LIMESTONE			36.58
								GREY	LIMESTONE			39.62
6712825	Bedrock	05/05/1998	365.20	39.32	7.62	357.58	10 - 30 m		TOPSOIL			0.61
									SAND	CLAY		2.74
									CLAY	STONES	GRAVEL	5.79
								GREY	LIMESTONE			21.34
								GREY	LIMESTONE			39.32
6712826	Bedrock	04/05/1998	366.09	28.96	3.35	362.74	10 - 30 m		TOPSOIL			0.30
								BROWN	CLAY	STONES		0.61
								BROWN	GRAVEL	CLAY		6.71
								GREY	LIMESTONE			17.98
								BROWN	LIMESTONE			19.81
								GREY	LIMESTONE			28.96

mbgs - metres below ground surface | mAMSL - metres above mean sea level

Table F1: MOE Water Well Records within 1km of Subject Property

Well ID	Well Type	Date Completed	Ground Elevation (mAMSL)	Well Depth (mbgs)	Static Water Level (mbgs)	Static Water Level Elevation (mbgs)	UTM Location Reliability	Material Colour	Material	Material 2	Material 3	Bottom Depth of Material (mbgs)
6712969	Bedrock	31/03/1999	358.77	31.39	6.40	352.37	unknown UTM: Lot Centroid		TOPSOIL			0.30
								BROWN	CLAY	SAND	STONES	9.14
								BROWN	LIMESTONE			12.19
								BROWN	LIMESTONE			16.76
								GREY	LIMESTONE			22.86
								BROWN	LIMESTONE			28.96
								GREY	LIMESTONE			31.39
6713908	Bedrock	22/10/2001	360.18	42.67	4.88	355.31	10 - 30 m	BROWN	CLAY	STONES		4.27
								GREY	ROCK			42.67
6714491	Bedrock	06/06/2003	361.59	54.86	7.01	354.58	unknown UTM: Lot Centroid	BROWN	CLAY	STONES		5.49
								BROWN	GRAVEL	SAND		7.62
								BROWN	CLAY	SAND	GRAVEL	9.45
								GREY	ROCK			51.82
								BLUE	SHALE			54.25
								RED	SHALE			54.86
6715120	Bedrock	15/08/2004	354.18	8.84	5.10	349.08	10 - 30 m	BROWN	SAND	GRAVEL	STONES	7.92
								GREY	LIMESTONE			8.84
6715237	Bedrock	21/10/2004	369.90	11.15	4.57	365.33	unknown UTM: On Water Well Record	BROWN	CLAY	STONES		1.67
								GREY	LIMESTONE			11.15
7043462	Bedrock	17/04/2007	365.35	25.30	12.00	353.35	10 - 30 m	BROWN	CLAY	STONES		7.01
								GREY	LIMESTONE			12.19
									LIMESTONE			22.62
								GREY	LIMESTONE			25.30
7132032	Bedrock	18/09/2009	360.25	31.09	14.63	345.62	10 - 30 m	BROWN	CLAY	STONES	SILTY	7.62
								BROWN	LIMESTONE			22.86
								GREY	LIMESTONE			31.09
7151165	Bedrock	27/08/2010	346.12	18.29	7.32	338.81	10 - 30 m	BROWN	CLAY	STONES		1.52
								BROWN	LIMESTONE			6.10
								GREY	ROCK			18.29

HARDEN
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mbgs - metres below ground surface | mAMSL - metres above mean sea level

Appendix G

Private Well Survey

Table G1: Private Well Survey Results

Well Identifier	Inferred MOE Well Record Number	Address	Con	Lot	Type of Well	Water Usage	Accessible	Well Depth	Static Water Level	Water Quality Issues	Water Quantity Issues	Comments	Date Surveyed
W1	6705627	8532 Hwy 7	6	1	Drilled Bedrock	Domestic	Yes	30.48 mbgs	12.41 mbgs	no	no	In well pit 1.73 mbgs	Mar 2012
W2	none	4949 6th Line	6	2	Dug Overburden	Cleaning	Yes	3.97 mbtoc	2.41 mbtoc	no	yes	Has occasionally gone dry in very dry summers, currently not in use for drinking, occasional use for cleaning	Apr 1998 and Nov 2011
W3	none	4949 6th Line	6	2	Drilled Bedrock	Agricultural	Yes	approx 61 mbgs	6.94 mbtoc	no	no	Pumping rate from well estimated by owner to be 89 gallons per minute used seasonally for cooling system.	Nov 2011
W4	6712824	4949 6th Line	6	2	Drilled Bedrock	Domestic	Yes	39.62 mbgs	7.71 mbtoc	no	no		Nov 2011
W5		4943 6th Line	6	2	Drilled Bedrock	Domestic	Yes, access not granted	n/a	n/a	no	no	New septic bed put in approx 2006, in well pit.	Apr 1998 and Nov 2011
W6	none	4958 6th Line	5	1	Overburden	Abandoned	Yes	3.58 mbtoc	3.35 mbtoc	unknown	unknown	There is a spring north of house which eventually infiltrates to the south	Apr 1998
W7	none	4958 6th Line	5	2	Bedrock	Domestic	Yes, access not granted	6m into rock	reportedly approx 1 mbtoc	no	no	There is a spring north of house which eventually infiltrates to the south	Apr 1998
W8	6707545	4953 6th Line	6	2	Drilled Bedrock	Domestic	Yes	33.20 mbtoc	4.18 mbtoc	Yes	no	Water issues with hardness, in well pit.	Apr 1998 and Nov 2011
W9	6708039	4963 6th Line	6	2	Drilled Bedrock	Domestic	Yes	n/a	4.94 mbtoc	no	no	Artesian well source of spring on property northeast of house	Apr 1998 and Nov 2011
W10	none	8540 Hwy 7	6	1	Drilled Bedrock	Domestic	No	reportedly approx 28 mbtoc	n/a	yes	no	Water quality issue is with iron	Apr 1998 and Nov 2011
W11	none	8554 Hwy 7	6	1	Bedrock	Domestic	No	reportedly approx 33mbtoc	n/a	no	no	Well is buried, no access	Apr 1998
W12	none	8572 Hwy 7	6	1	Drilled Bedrock	Domestic	Yes	n/a	9.79 mbtoc	yes	no	Hardness, some iron staining	Apr 1998 and Nov 2011
W13	7132032	8572 Hwy 7	6	1	Drilled Bedrock	Fire Safety Reservoir	Yes	31.09 mbgs	14.47 mbtoc	no	no		Nov 2011
W14	6705424	8572 Hwy 7	6	1	Drilled Bedrock	Equine	Yes	n/a	5.19 mbtoc	no	no	Drinking and washing water for horses	Nov 2011
W15	6700487	MTO Hwy 7 & 7th Line	6	1	Bedrock	Industrial	Could not locate	46.6 mbtoc	n/a	unknown	unknown	Location of well unknown	Oct 1995
W16	2805483	5134 Hwy 7	6	32	Drilled Bedrock	Domestic	Yes	13.72 mbtoc	7.71 mbtoc	no	no		Apr 1998 and Nov 2011
W17	2803457	14321 5th Line	6	32	Drilled Bedrock	Industrial	No	reportedly approx 34 mbgs	n/a	no	no	In well pit, water tested OK in 2001, some sediment	Apr 1998 and Nov 2011

mbtoc - metres below top of casing | mbgs - metres below ground surface | n/a - not available

Table G1: Private Well Survey Results

Well Identifier	Inferred MOE Well Record Number	Address	Con	Lot	Type of Well	Water Usage	Accessible	Well Depth	Static Water Level	Water Quality Issues	Water Quantity Issues	Comments	Date Surveyed
W18	2802049	14297 5th Line	6	32	Drilled Bedrock	Domestic	No	n/a	n/a	no	no	Inaccessible, buried	Apr 1998 and Nov 2011
W19	2802048	5036 Hwy 7	6	32	Drilled Bedrock	Domestic	Yes	20.12 mbgs	10.35 mbgs	yes	no	Issues with bacteria in 1996, salt flushed fixed problem temporarily, now use UV and reverse osmosis treatment, in well pit	Apr 1998 and Apr 2012
W20	none	4300 Hwy 7	5	32	Drilled Bedrock	Domestic	Yes	20.9 mbtoc	9.20 mbtoc	unknown	unknown	In well pit	Apr 1998
W21	2803220	4264 Hwy 7	5	32	Drilled (Unknown material)	Domestic	No	21 mbtoc	n/a	no	no	In well pit	Apr 1998 and Nov 2011
W22	2802047	5198 Hwy 7	6	32	Drilled (Unknown material)	Domestic	No	approx 20 mbtoc	n/a	no	no	In well pit	Oct 1995 and Nov 2011
W23	2802002	4248 Hwy 7	5	32	Unknown	Domestic	No	n/a	n/a	no	no		Apr 1998 and Nov 2011
W24	6715120	8470 Hwy 7	5	1	Drilled Bedrock	Unknown	Unknown	8.84 mbgs	5.1 mbgs	Unknown	Unknown	Property gated/locked, survey information based on MOE well record.	Nov 2011
W25		Northeast corner Hwy 7 & 7th Line	7	1	Drilled	Unknown	Yes	23.40 mbtoc	4.78 mbtoc	Unknown	Unknown	Well location south side of office	Oct 1995
W26		Northeast corner Hwy 7 & 7th Line	7	1	Drilled	Unknown	Yes	22.00 mbtoc	3.15 mbtoc	Unknown	Unknown	Well location in front of office	Oct 1995
W27		Northeast corner Hwy 7 & 7th Line	7	1	Drilled	Unknown	No	Unknown	Unknown	Unknown	Unknown	Well location in front of house	Oct 1995
W28		4925 7th Line	7	1	Drilled	Domestic	No	Approx 50 mbtoc	n/a	no	no	Well location south side of house	Oct 1995
W29		4935 7th Line	7	1	Drilled	Domestic	No	Approx 25 mbtoc	n/a	no	no	Well location behind house	Oct 1995
W30		4961 7th Line	7	2	Drilled	Domestic	Yes	12.5 mbtoc	5.00 mbtoc	no	no	Well location southeast corner of house	Oct 1995
W31		4970 7th Line	6	3	Drilled	Domestic/Livestock	No	Unknown	Unknown	no	no	Well location in front of house	Oct 1995 and Mar 2012
W32		4964 7th Line	6	2	Drilled	Domestic	No	Unknown	approx 5 mbtoc	no	no	Well location in front of house	Oct 1995
W33		4952 7th Line	6	2	Drilled	Domestic	Yes	Unknown	Unknown	no	no	Well location south side of house	Oct 1995
W34		4944 7th Line	6	2	Drilled	Domestic	No	Unknown	Unknown	no	no		Oct 1995
W35		Hwy 7 South Side first house west of 7th Line	6	32	Drilled	Unknown	Yes	22.3 mbtoc	10.9 mbtoc	Unknown	no	Well location behind barn	Oct 1995
W36		Hwy 7 North side East of Well ID 25	7	1	Drilled	Unknown	No	Unknown	Unknown	no	no	Well location inside auto body shop	Oct 1995
W37		Hwy 7 North side East of Well ID 36	7	1	Drilled	Domestic	No	Approx 20 mbtoc	Unknown	no	no	Well location east corner of house	Oct 1995
W38		RR1 Acton	6	32	Drilled	Domestic	No	Unknown	Unknown	unknown	unknown	Well location in front of house	Oct 1995
W39		RR1 Acton	6	32	Drilled	Domestic	No	Approx 30 mbtoc	Unknown	no	no	Well location in behind house	Oct 1995
W40		RR1 Acton	7	32	Drilled	Unknown	No	Approx 35 mbtoc	near top	Yes	Yes	Hardness, occasionally goes dry in long droughts	Oct 1995

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mbtoc - metres below top of casing | mbgs - metres below ground surface | n/a - not available

Appendix H

Groundwater Model

Groundwater Model Report
Hidden Quarry
Rockwood, Ontario

James Dick Construction Ltd.

Prepared By: Harden Environmental Services Ltd.
September 2012

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Table of Contents

Tables

Rockwood List of Figures

1.0 Introduction

This report describes the groundwater model prepared for the James Dick Construction Ltd. proposed pit/quarry. The Site is located in Lot 1, Concession 6, Township of Eramosa (Figure H1). The model inputs consider groundwater modeling completed in the area for both the Guelph-Eramosa Township (Gartner-Lee Limited, April 2004) and for the City of Guelph (Aqua Resources Incorporated, March 2010) regional groundwater characterization and well head protection studies. Information gathered from MOE water well records (WWRs) and on-site wells were used in the creation and calibration of the model.

The purpose of the model is to provide an estimate of the drawdown that will occur in the bedrock aquifer as a result of the quarry development.

2.0 Numerical Model Development

In constructing this detailed steady-state groundwater flow model, data (such as water levels, stream flows, hydro stratigraphic, topographic and lithographic properties), described in the main section of the report were incorporated into the numerical model.

The model was calibrated to water levels measured from over three hundred wells in the surrounding area.

The calibrated model is used to predict changes to the groundwater flow systems due to below water table bedrock extraction at the Rockwood Pit/Quarry Site. As shown in Figure H2 the extraction footprint will occur in two main areas at the Site. These areas are referred to as the West and East Pond extraction areas.

3.0 Numerical Modeling Software

The United States Geological Survey (USGS) model MODFLOW was used for the groundwater flow simulations. Viewlog™ was used as the graphical interface for the model runs. Microsoft Access^{TM} was used to create and manipulate the database input files obtained from the Water Well Records Database.

4.0 Model Extent and Discretization

The location and extent of the model domain for this modeling project is presented in Figure H3. The model domain is approximately 12 x 14 kilometers (W-E x N-S). As shown in Figure H3, the model domain was designed to encompass an active model area of approximately 112 square kilometres, located between and encompassing the Eramosa River and Blue Springs Creek where the Site is located. A grid spacing of 100 m x 100 m was used for the overall model domain with a refined grid spacing of 25 m x 25 m within an area of five square kilometres centered at the Site.

5.0 Model Layers and Hydrogeological Properties

The groundwater model consists of three layers necessitated by the need for vertical control in representing the depth of the quarry and the depth of a relatively high permeability zone near the bedrock surface. All three layers represent the Amabel dolostone. Model Layer 1 is the topmost layer with a thickness of approximately 30 metres. The bottom of Layer 1 is used to represent the bottom of the quarry during model runs. Model Layer 2 is a relatively thin layer used during the model development stage to test the effect of a ‘production zone’ within the Amabel formation. Model layer 3 represents the lower Amabel formation.

The ground surface is derived from a combination of digital Ontario Base Mapping (Lands Inventory Ontario database) providing five metre contouring and mapping completed for the Grand River Conservation Authority (GRCA) providing one metre contouring. The top of the bedrock layer was determined from the MOE Water Well Database, and on-site boreholes and testpits. The top of the Cabot Head Shale Formation was determined from contact information obtained from the MOE Water Well Database and one on-site borehole (M2).

Layer 1 hydraulic conductivity was based on input data obtained from on-site hydraulic testing, the Guelph-Eramosa Township groundwater model (Gartner Lee Limited, April 2004) and hydraulic testing completed for the City of Guelph (University of Guelph, 2011). The distribution of hydraulic conductivity in Layer 1 is shown on Figure H4. In general, the hydraulic conductivity of 2.0 x 10^{-5} m/s was assigned to Layer 1. A zone of increased hydraulic conductivity is interpreted to occur beneath the eastern half of the quarry. This zone is warranted by the following observations;

a) West to east groundwater flow at the site,

b) Relatively high hydraulic conductivity in M3
c) Relatively low hydraulic gradient from M3 to Brydson Spring.

The hydraulic conductivity in this area was assigned a value of 1.8 x 10^{-4} m/s.

Constant hydraulic conductivities of 2.0 x 10^{-5} and 1.0 x 10^{-5} m/s were assigned to Layers 2 and 3, respectively. The addition of a ‘production’ zone within the Gasport Formation was found to have little influence on the model and on-site testing does not indicate the presence of a ‘production’ zone, thus Model Layer 2 is assigned a moderate hydraulic conductivity the same as Layer 1.

The porosity of the bedrock is assigned to be 0.05.

Model input parameters for the three layers are summarized in Table 1.

Table 1: Summary of Hydrogeological Properties

Layer	Hydraulic Conductivity	Porosity
Layer 1	2.0 x 10^{-5}	0.05
Layer 1 High Conductivity Zone	1.8 x 10^{-4}	0.05
Layer 2	2.0 x 10^{-5}	0.05
Layer 3	1.0 x 10^{-5}	0.05

6.0 Boundary Conditions

Boundary conditions set for the groundwater model are shown on Figure H5. No-flow boundaries were used at the perimeter of the model with the exception of the north-east model area. A constant head boundary condition is assigned in this area. A hydraulic potential estimated from static water levels from water well records was assigned as the constant head value.

7.0 Drains

Drains were assigned to major waterways within the model space (Figure H6). This included the Eramosa River and Blue Springs Creek. In addition, several small tributaries of the Eramosa River and Blue Springs Creek were identified as drains based on perennial flow observed in the stream. The elevation of the drains occurring within the overburden, were assigned to be 0.5 metres below the ground surface. The elevation of drains occurring within the bedrock, were assigned an elevation of 0.5 metres below the top of rock in Layer 1. The elevation of the Bryson Farm creek drain was assigned to be two metres below the top of the bedrock.

The conductance value assigned to the drains is 43.2 m/day.

7.0 Recharge

The modeled recharge values are presented in Figure H7. In general, a recharge value of 130 mm per year was assigned to the upper bedrock Layer 1. This represents groundwater movement occurring from the overburden to the bedrock. It is recognized that recharge rates at the ground surface are generally higher than 130 mm/year; however, the presence of till at depth and observation of several springs suggests a limitation to groundwater movement into the bedrock aquifer.

As shown in Figure H7, an area of higher recharge was assigned to areas east and south of the Site that have relatively thin deposits of coarse grained outwash above the bedrock and known spring discharge locations. The recharge value of 150 mm per year was assigned to this area for the upper bedrock Layer 1.

Streamflow measurements of the on-site ephemeral stream, (Tributary B, Figure H6) provide evidence that the creek is a losing stream across the Site. A zone of increased recharge therefore created along the creek. A recharge value of 0.0154 m/day was assigned to the model along the length of the creek running through the Site. In addition, studies of the creek (Tributary C, Figure H6) located on the property immediately east of the Site suggest that the creek is also an area of groundwater recharge. A recharge value of 0.0392 m/day was assigned to creek where infiltration is known to occur. Tributary A is also a known area of enhanced groundwater recharge and assigned a value of 0.0196 m/day.

9.0 Model Calibration

A total of 330 bedrock water wells were used in the model domain to calibrate the model. Table 2 summarizes the relevant calibration statistics for wells involved in the field survey.

Table 2: Summary of Calibration Statistics

	Number of Wells	ME	MAE	RMS	Normalized RMS
Calibration Statistics	330	1.68	3.49	4.35	4.7 %

ME: Mean Error, MAE: Mean Absolute Error, RMS: Root Mean Squared Error, NRMS: Normalized Root Mean Squared Error

The graph of the predicted vs. measured water levels for the calibration targets is shown on Figure H8. The normalized Root Mean Square is often used in the industry to evaluate the "validity" of a model. In the case of model calibration with 330 water wells, there is a total difference of 92 metres of hydraulic potential in the model and a Root Mean Squared Error of 4.35 m, or 4.7% of the total difference. A normalized RMS of less than 10% is often considered acceptable and a normalized RMS of less than 5% is desirable. Using these numbers as a guide, the model results are acceptable.

The model-predicted water levels are shown on Figure H9 and static water levels recorded in the MOE Water Well database are shown on Figure H10.

10.0 Impacts Due To Bedrock Extraction

The removal of the dolostone aquifer is simulated in the groundwater model by modifying the hydraulic conductivity to 10,000 m/d. This high hydraulic conductivity allows water within the quarry to 'level out' as occurs in lakes and ponds.

The porosity was also modified from 0.05 to 1 in the extraction area.

Two scenarios were simulated with the model as follows:

Scenario 1: Maximum Extraction

The maximum potential impact of the quarry was modeled by simulating the removal of the dolostone aquifer within the entire proposed quarry footprint.

Scenario 2: North Half of West Pond

The potential impact of extracting the north half of the west pond was simulated. This provides an indication of the potential change in bedrock groundwater potential in the area adjacent to the northwest wetland and also the potential impact from the initial phase of the quarry.

10.1 Scenario 1: Maximum Site Extraction

Figure H11 depicts areas and magnitude of impact to the groundwater system predicted to occur following maximum bedrock extraction at the site. The maximum drawdown will occur in the northern most portion of the west pond. The maximum drawdown is predicted to be 2.45 m. The drawdown in the bedrock aquifer will decrease exponentially from the edge of the quarry and as shown in Figure H11 the maximum drawdown to the northern Site boundary is 1.8 metres. Similar, the maximum predicted rise in water levels at the southern edge of the quarry is 2.81 m. The maximum rise in the water table downgradient of the Site at the southern Site boundary is 1.5 metres.

The change in bedrock water levels beneath the northwest wetland[1] range from 1.1 to 1.9 metres. On average, the change in water level is 1.53 metres.

Springs have been identified along the northern edge and west of the Allan wetland and are referred to as the Degrandis Spring and Allan Spring, respectively (Figure H7). Based on modeled results the maximum potential impacts to the bedrock aquifer beneath these spring sources are 0.5 and 07 metres, respectively.

10.3 Scenario 2: Extraction North Half of West Pond

Figure H12 depicts areas and magnitude of impact to the groundwater following bedrock extraction in the north half of the west pond only. As shown in Figure H12 the maximum drawdown at the northern Site boundary is 0.4 metres. Maximum rise in the water table downgradient of the Site at the southern Site boundary is 0.02 metres.

Potential impacts to the bedrock aquifer based on modeled results for the northwest wetland range from 0.2 to 0.35 metres. Based on modeled results the maximum potential impacts to the bedrock aquifer beneath the Rockwood Farm spring and the Degrandis pond is less than five centimeters.

11.0 Conclusions and Recommendations

1. The 3-Dimensional groundwater model presented in this report is a reasonable representation of groundwater flow conditions in the area of the Site.

---

[1] From proposed hydraulic barrier to upgradient edge of wetland

2. Based on modeled results, the maximum magnitude of water level change in the bedrock aquifer is a decline of 1.8 metres at the northern Site boundary and a rise of 1.5 metres at the southern Site boundary.

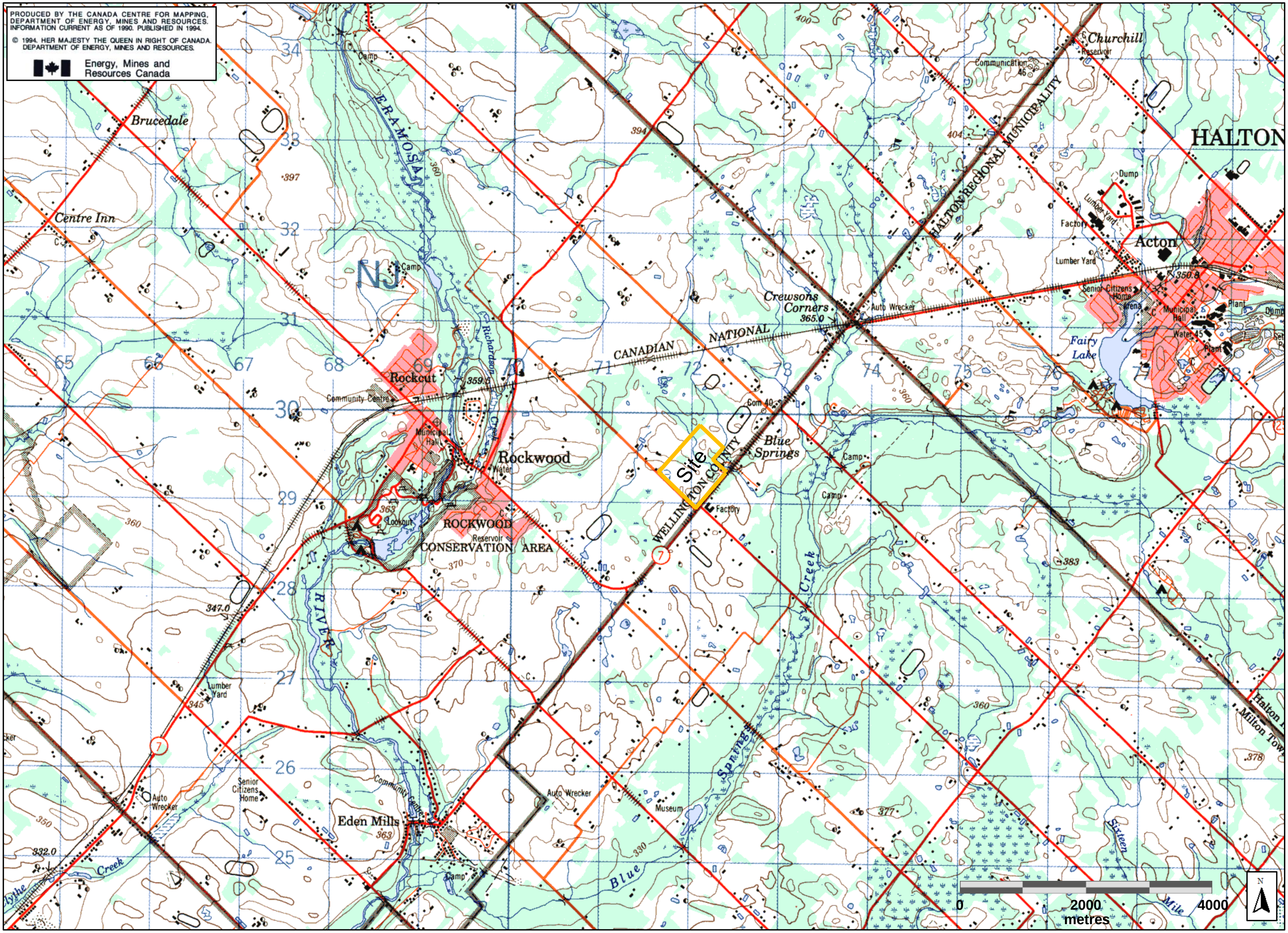
3. The magnitude of groundwater drawdown at the northwest wetland ranges from 1.1 to 1.9 metres for the maximum extraction scenario. The average drawdown value of 1.53 metres should be used to estimate the increase in groundwater flux beneath the wetland and area upgradient of the proposed hydraulic barrier.

4. The extraction of the north half of the west pond will result in a maximum predicted change of 0.7 metres at the northern property line, a maximum change of 0.35 metres below the northwest wetland and less than five centimeter change beneath the Rockwood Farm or Degrandis springs. The commencement of extraction in the north half of the west pond will allow for several years of monitoring to verify predicted impacts prior to extracting the south half of the west pond.

Respectfully Submitted
Harden Environmental Services Ltd.

Stan Denhoed

Stan Denhoed, P.Eng., M.Sc.
Senior Hydrogeologist



PRODUCED BY THE CANADA CENTRE FOR MAPPING, DEPARTMENT OF ENERGY, MINES AND RESOURCES. INFORMATION CURRENT AS OF 1990. PUBLISHED IN 1994.

Energy, Mines and Resources Canada

Harden Environmental Services Ltd.

Project No: 9506

Date: Nov 2011

Drawn By: AR

Hidden Quarry Site
Groundwater Model Addendum Report

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure H1: Study Area

◇ Subject Property (Approximate)

Spring 2006 Orthoimagery Copyright © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506

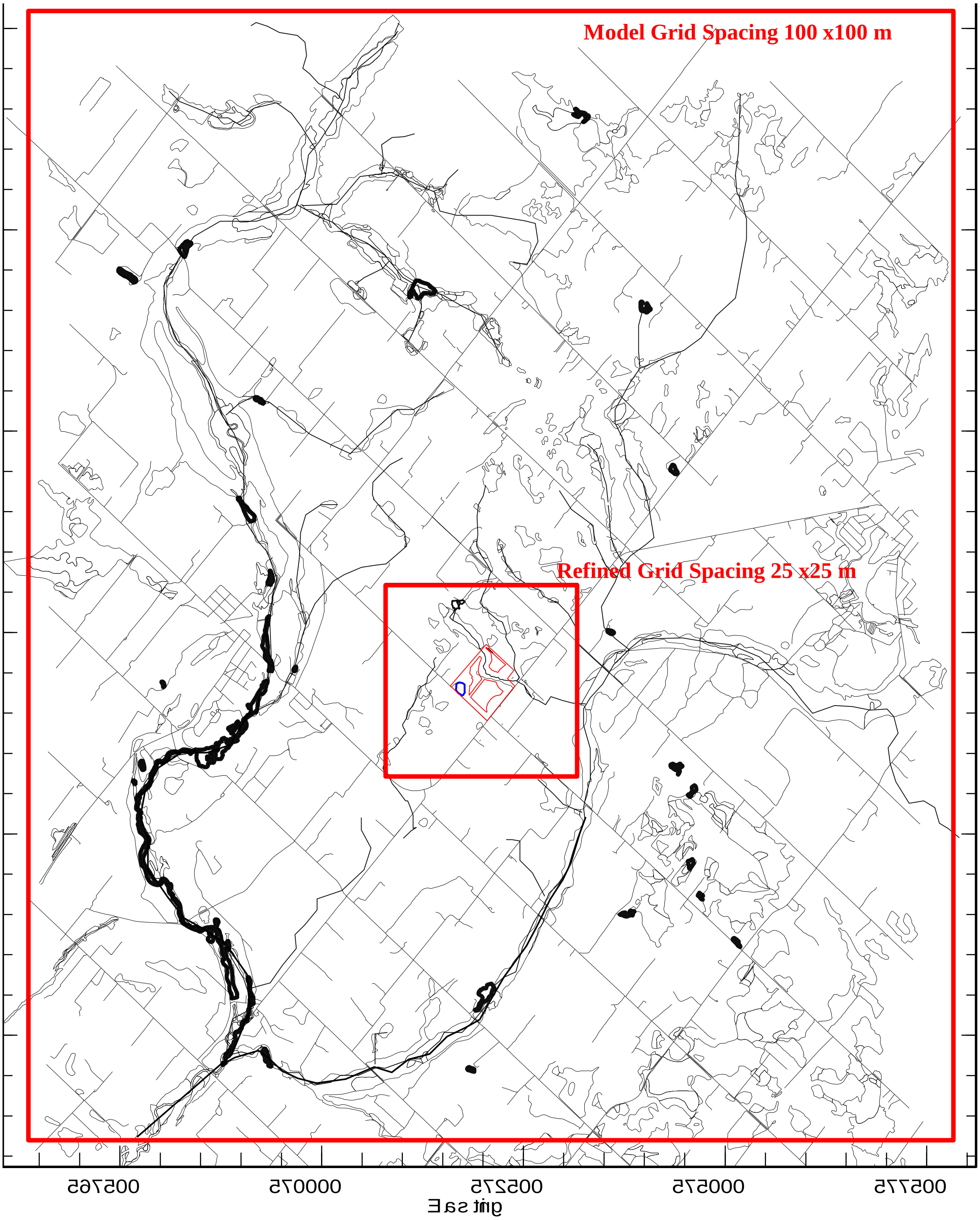
Date: Jun 2012

Drawn By: AR

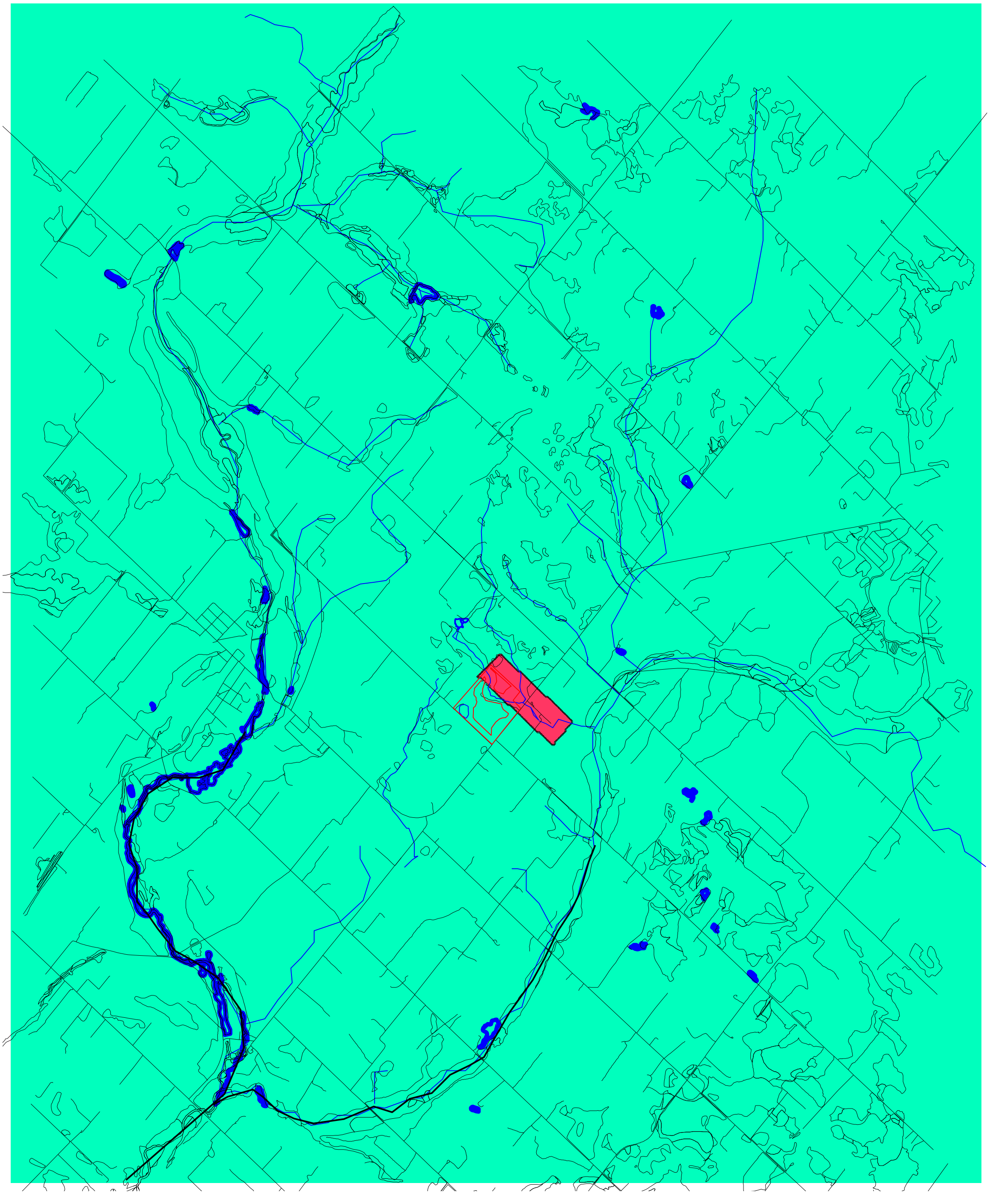
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

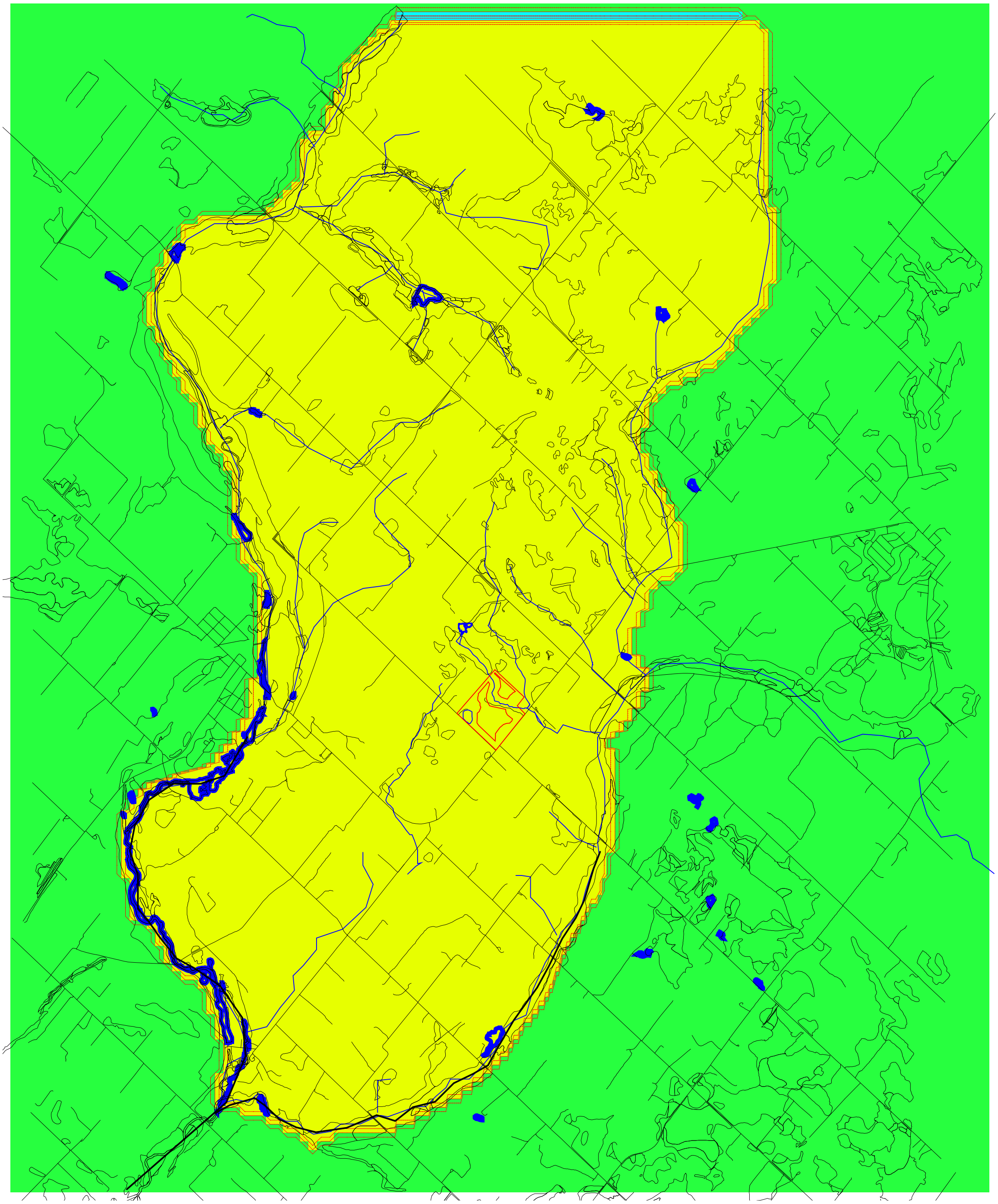
Figure H2: Extraction Footprint



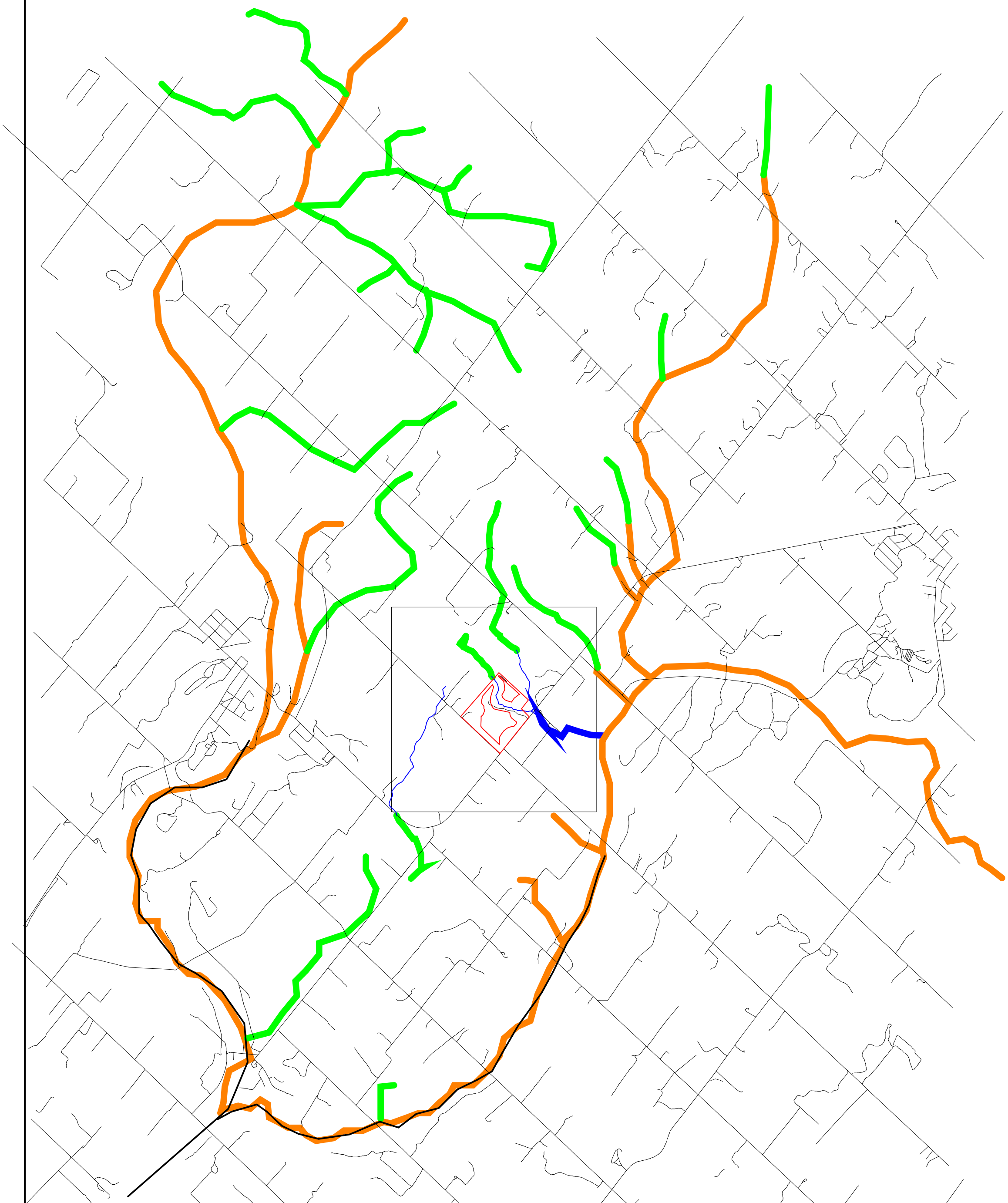
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Groundwater Model Addendum Report	**Figure H3:** **Model Domain**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		



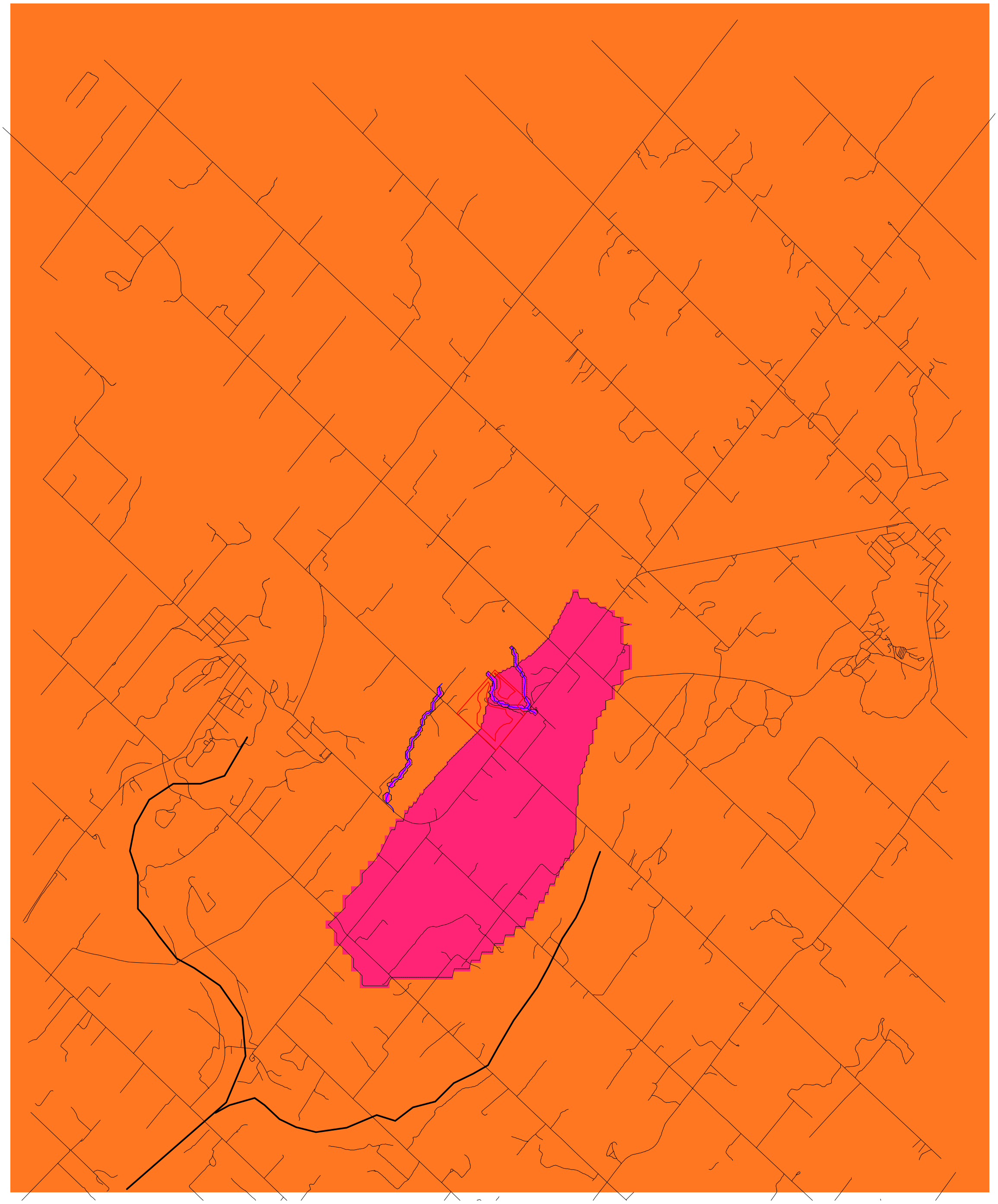
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Groundwater Model Addendum Report	**Figure H4:** **Hydraulic Conductivity Layer 1**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Groundwater Model Addendum Report	**Figure H5:** **Boundary Conditions**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		



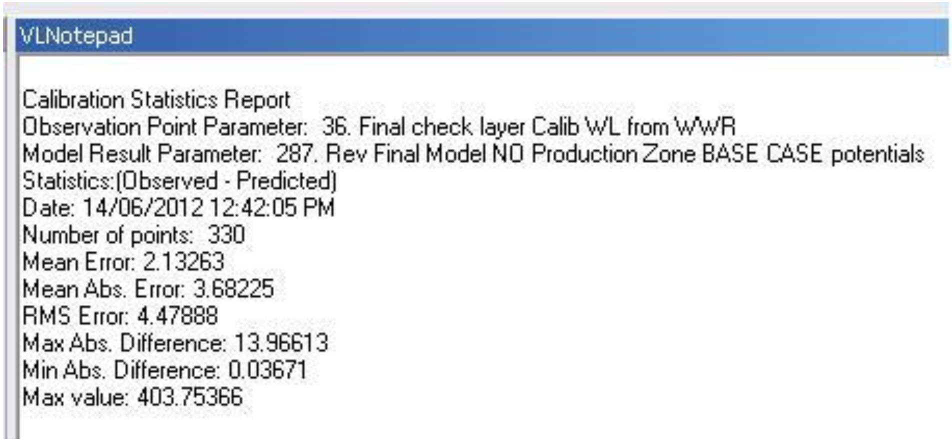
Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Mar 2012 **Drawn By:** SD	Hidden Quarry Groundwater Model Addendum Report Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure H6: Drains**



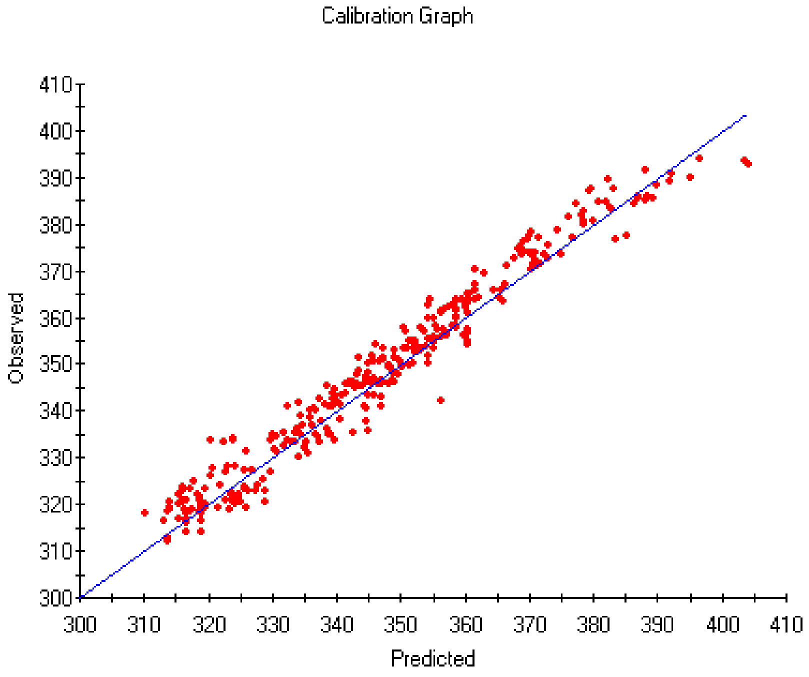
Harden Environmental Services Ltd.

Project No: 9506	Hidden Quarry Groundwater Model Addendum Report
Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington
Drawn By: SD	

Figure H7:
Model Recharge



Calibration Statistics Report
Observation Point Parameter: 36. Final check layer Calib WL from WWR
Model Result Parameter: 287. Rev Final Model NO Production Zone BASE CASE potentials
Statistics:(Observed - Predicted)
Date: 14/06/2012 12:42:05 PM
Number of points: 330
Mean Error: 2.13263
Mean Abs. Error: 3.68225
RMS Error: 4.47888
Max Abs. Difference: 13.96613
Min Abs. Difference: 0.03671
Max value: 403.75366



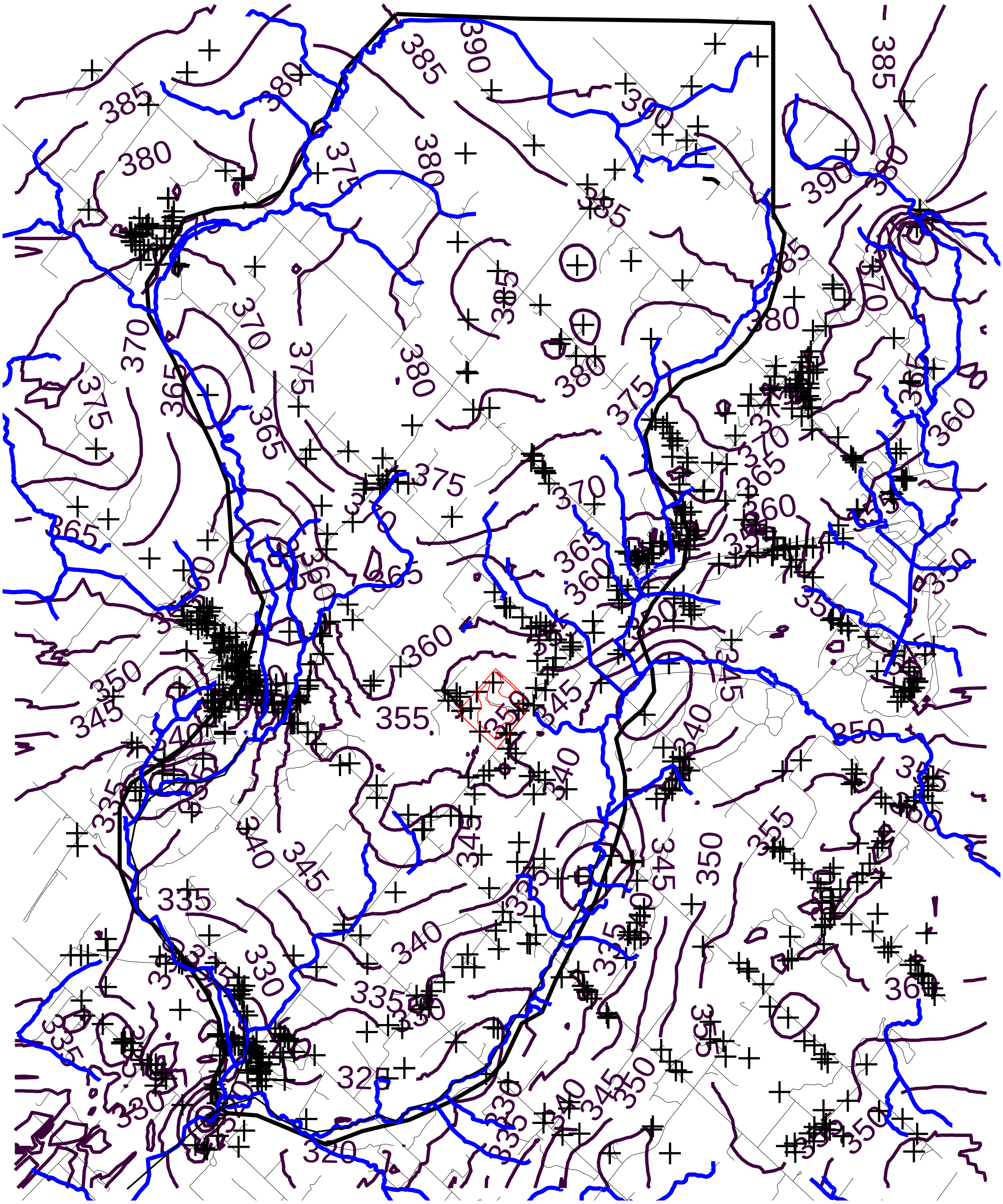
Harden Environmental Services Ltd.

Project No: 9506
Date: Mar 2012
Drawn By: SD

Hidden Quarry Groundwater Model
Addendum Report

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure H8:
Calibration Statistics



Harden Environmental Services Ltd.

Project No: 9506

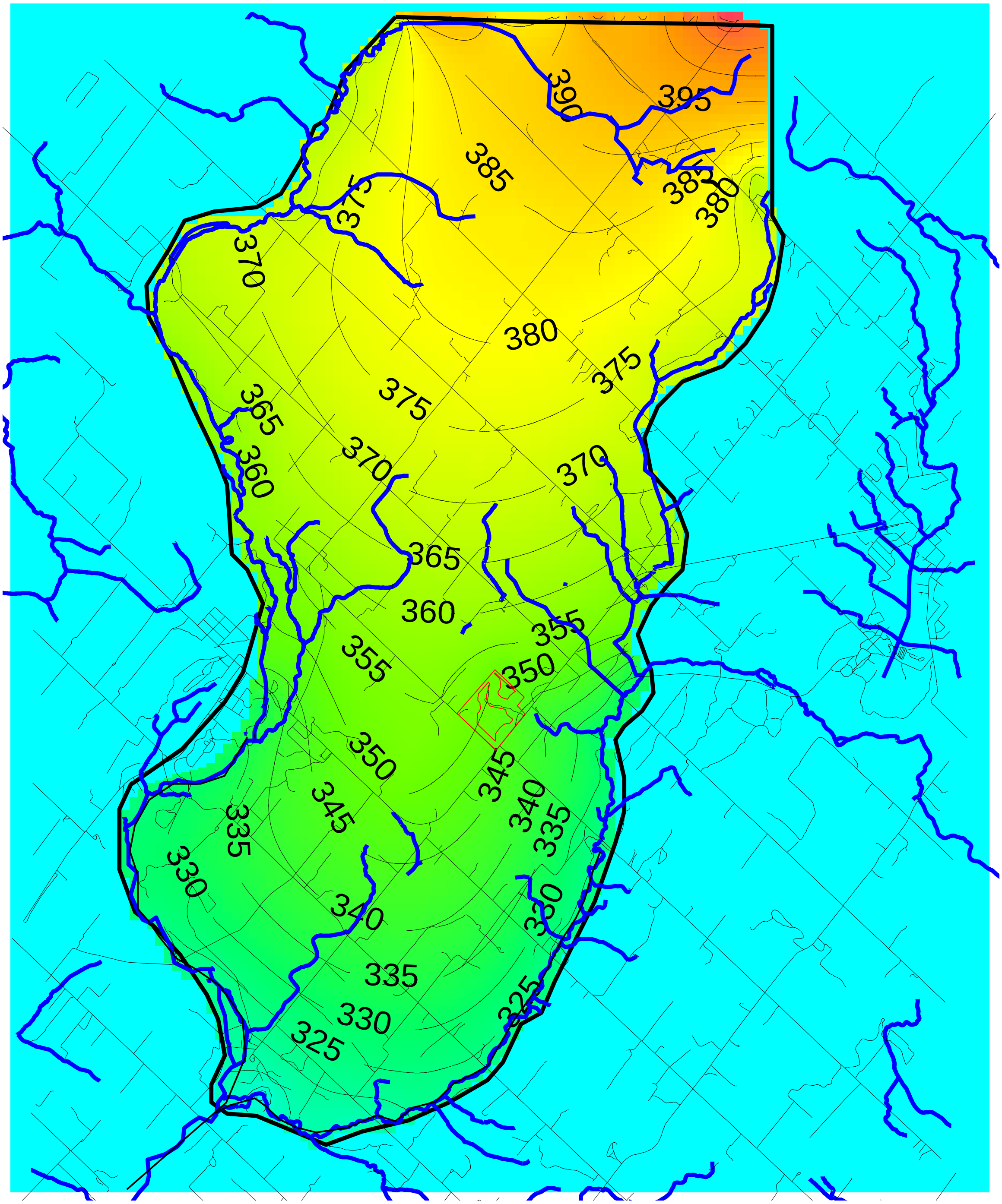
Date: Mar 2012

Drawn By: SD

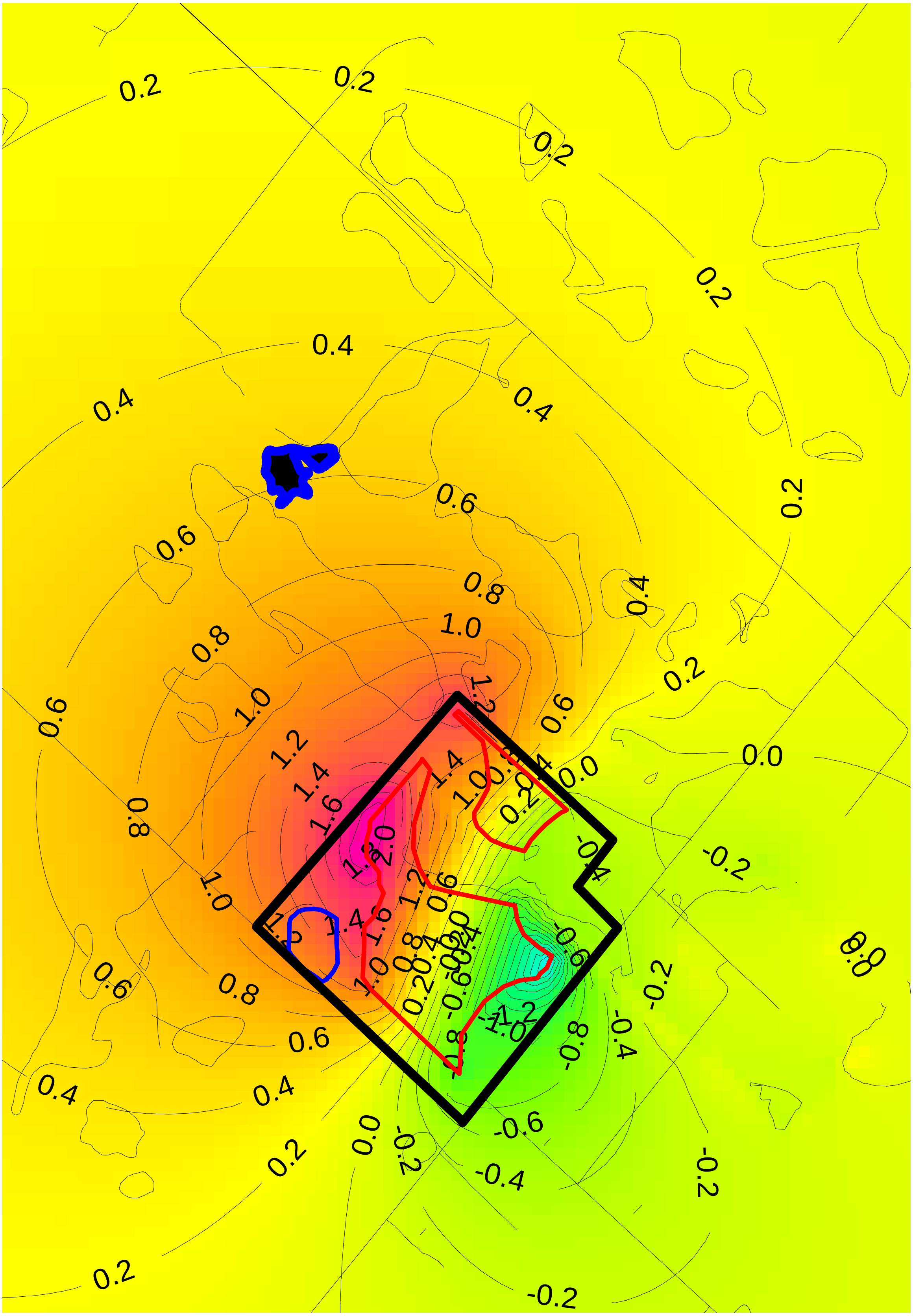
Hidden Quarry Groundwater Model
Addendum Report

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure H9:
Static Water Levels WWR



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Groundwater Model Addendum Report	**Figure H10:** **Predicted Water Levels Layer 1**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		



Harden Environmental Services Ltd.

Project No: 9506

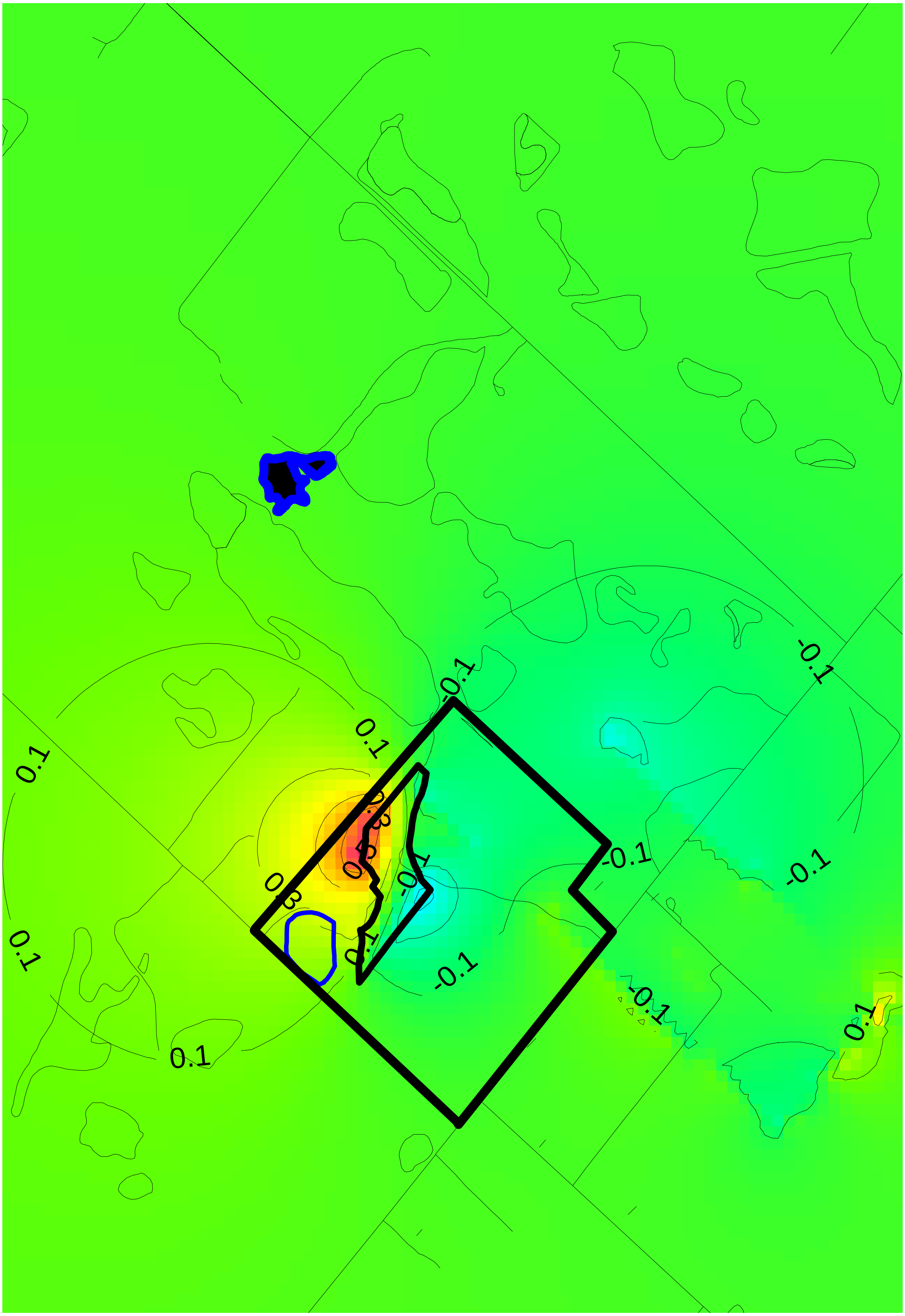
Date: Mar 2012

Drawn By: SD

Hidden Quarry Groundwater Model
Addendum Report

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 11:
Maximum Predicted Water Level Change



Harden Environmental Services Ltd.

Project No: 9506	Hidden Quarry Groundwater Model Addendum Report
Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington
Drawn By: SD	

Figure H12:
North Half of West Pond Predicted Water Level Change

Appendix I

Historical Aerial Photographs

Harden Environmental Services Ltd.

Project No: 9506

Date: Dec 2011

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Aerial Imagery April 29, 1930

Harden
Environmental
Services Ltd.

Project No: 9506
Date: Dec 2011
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Aerial Imagery April 9, 1964

Harden Environmental Services Ltd.

Project No: 9506

Date: Dec 2011

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Aerial Imagery June 7, 1972

Harden
Environmental
Services Ltd.

Project No: 9506
Date: Dec 2011
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Aerial Imagery April 19, 1980

Harden Environmental Services Ltd.

Project No: 9506

Date: Dec 2011

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Aerial Imagery
May 1994

Harden Environmental Services Ltd.

Project No: 9506

Date: Dec 2011

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Aerial Imagery Spring 2006

Appendix J

Water Balance

Table J1: Northwest Wetland Water Balance

Parameter	Units	Pre Extraction	Post Extraction
Wetland Area	**m^2**	10,590	10,590
Catchment Area	**m^2**	16,635	16,635
Area Upgradient of Barrier	**m^2**	26,445	26,445
Direct Precipitation	**m^3**	9,531	9,531
Groundwater Flow In	**m^3**	50,408	51,325
Runoff	**m^3**	846	846
Total In	**m^3**	60,786	61,702
Evapotranspiration	**m^3**	6,905	6,905
GW out Horizontal	**m^3**	42,343	6,623
GW out Vertical	**m^3**	12,301	44,647
Total out	**m^3**	61,549	58,174
Annual Imbalance	**m^3**	- 763	3,528
Annual Imbalance	**%**	-1.26%	6%

Appendix K

Spills Action Plan

RECOMMENDED PROCEDURES FOR THE PREVENTION AND MITIGATION OF CONTAMINANT SPILLS AT THE HIDDEN QUARRY

Emergency Response Numbers:

Fire, Ambulance, Police	**911**
Ministry of the Environment	**1-800-268-6060**
James Dick Construction Ltd.	**1-905-857-3500**
County of Wellington	**519-846-8058**

Harden Environmental Services Ltd.
R.R. 1, Moffat, Ontario L0P 1J0
1-877-336-4633

TABLE OF CONTENTS

ATTACHMENTS

1.0 Introduction

The majority of spills can be minimized through the adoption of good housekeeping policies. Cleanliness, readiness to respond to problems and correct waste management techniques will go a long way to creating a better working environment and prevention of spills. The following list identifies the more common contaminants which could be present on a regular basis on the site.

Vehicular Operating Fuels	Gasoline, diesel fuel
Lubricants	Motor oil, grease, lubricants, coolants, brake fluids, transmission fluids and other liquids used in the normal operation of a vehicle.
Explosives	
Miscellaneous Liquids	degreasing agents, solvents

The site foreman and all employees on site shall be familiar with procedures as set out in the attached document - “Plan of Action - Contaminant Spills".

2.0 Objective

The objective of this brief is to describe the procedures which will be undertaken to prevent and ameliorate spills of contaminant materials and to minimize the adverse effects if a spill does occur. A spill can be defined as a discharge of a pollutant:

a) into the natural environment,
b) from or out of a structure, vehicle or any other container and
c) which will have an adverse impact on the natural environment.

3.0 Prevention

The majority of products listed in the Introduction are used in the operation and maintenance of vehicles. One of the various methods, as outlined in this section will be used by the site operators to service vehicles and machinery, depending on the level of activity at the site or on the stage at which the pit/quarry is operating. Delivery vehicles (haul trucks) will not be maintained on the site.

3.1 Vehicular Maintenance

3.1.1 Outdoor Maintenance Pad

A pad will be constructed of concrete or another relatively impervious material resistant to solvents. Mobile vehicles will be maintained on the pad by a mobile maintenance vehicle. All fluids removed from the vehicle will be hauled off-site. Any spill occurring during maintenance will be collected with absorbent materials and removed from the site.

A mobile maintenance vehicle will service vehicles on the site. If possible, the vehicles will be driven out of the active pit area. All fluids removed from the vehicle for the purpose of replacement or disposal will be collected and removed from the site for disposal in a manner acceptable to the Ontario Ministry of the Environment (MOE). Any spilled fluids will be collected with absorbent material and any contaminated soil will be collected.

3.2 Immobile Equipment

Crushers, screens, conveyers, generators etc. require regular maintenance. This often entails lubrication, cleaning and/or replacement of oils. All fluids removed from this machinery will be collected and removed from the site. All spillage of fuels, liquids, lubricants etc. will be cleaned up immediately. The use of degreasers on immobile machinery will be kept to a minimum.

4.0 Mitigation

Due to unforeseeable circumstances and/or catastrophic events, spills of larger quantities of materials may occur. In the event of this occurring the following procedure will be followed:

4.1 The following information regarding the spill will be reported immediately to the site foreman:

- Type of substance spilled
- Quantity of substance spilled
- Location of spill
- Time that spill occurred

4.2 If the spill is over 80 litres of oils or 40 litres of fuel, degreasing agents, coolants or solvents, the MOE and the County of Wellington will be informed immediately. The current telephone number for the MOE Spills Action Centre is 1-800-268-6060 (24 hrs) and the County of Wellington is (519) 846-8058.

4.3 Regardless of the quantity of the spill, mitigative measures will commence immediately in accordance with the attached plan of action. Initial measures will involve excavation of the contaminated soil. The soil removed from the spill area will be stored onsite in a manner acceptable to the MOE until the MOE has had an opportunity to assess the situation. If required by the MOE, the site operator will remove the contaminated material from the site by an approved waste hauler to an approved waste receiver.

4.4 If it is reasonable to suspect that the contamination will ultimately reach the groundwater the following procedures will be followed.

4.4.1 The excavation will be extended to the water table and a pump, suitable for the type of contamination, will be installed and operated to collect the contaminated groundwater. The collected groundwater will be stored, treated and discharged or removed from the site as recommended by the MOE.

4.4.2 Where the thickness of soil above the water table makes it impossible to excavate to the water table, a withdrawal well will be drilled and a pumping system installed and operated to collect the contaminated ground water. The collected ground water will be stored on site, treated and discharged or removed from the site.

4.5 If required, additional ground water monitors will be installed to verify that the contamination has been mitigated.

4.6 If there is a potential for domestic wells being impacted by the spill, the users of those wells will be notified.

5.0 Employee Training

The site employees are required to have the following training.

5.1 All employees shall be familiar with "Recommended Procedures for the Prevention and Mitigation of Contaminant Spills" cleanup, the associated plan of action report form, any and all materials and equipment that would be used and their location in the event of a contaminant spill.

5.2 Employees shall receive training in respect to the use of materials and equipment required in a contaminant spill cleanup.

6.0 Reporting Requirements

A copy of each written contaminant spill report will be stored on-site for future reference and will be made available to the MOE and/or the County of Wellington upon request.

JAMES DICK CONSTRUCTION LTD

PLAN OF ACTION

CONTAMINANT SPILLS

---

1. Contact the foreman.

2. Appraise the situation and take immediate action to stop further spillage.
    a) Stop the source.
    b) Confine or contain the spill.
    c) Appropriate service vehicles in the area to proceed immediately to the spill site when advised that a spill has occurred.
    d) Use kit materials to start removing spill product.
    Kit material to be located in scale house or maintenance building.

Spill Kit contains:	1 - 27 litre (7 gallon) polyethylene pail
	1- Gasket seal lid,
	6- 'Eliminator ' E-2 socks and
	1 - Polyethylene disposal bag.

    e) Use 45 gallon containers to contain smaller spills. Put any absorbed oils into containers for disposal

3. The dispatcher/scale operator/foreman is to confirm that the Ministry of the Environment and the County of Wellington has been contacted, where necessary. The phone numbers are 1-800-268-6060 (MOE) and (519) 837-2600 (County of Wellington).

4. The spill site supervisor is to contact the Fire and Police departments, where deemed necessary.

5. The site supervisor and person finding the spill will make out a full written report immediately after the spill is taken care of. The following shall be documented in the report:

   a) location in pit (shown on reduced site plan photocopy)
   b) time of spill
   c) type of spill
   d) estimated quantity
   e) cause of spill
   f) property damage
   g) response time and number of people involved
   h) clean up measures taken
   i) assessment of area affected after clean up
   j) an assessment of how spill could have been prevented
   k) a diagram of the spill area
   l) signature of site supervisor and personnel involved in cleanup

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CONTAMINANT SPILL
CLEAN UP REPORT FORM

Location:

Time of Spill:

Type of Spill:

Estimated Quantity of Spill:

Cause of Spill:

Property Damage:

Response Times and Names of People involved in Cleanup:

Clean up measures Taken:

Assessment of area affected after clean up:

____

____

____

How could this spill have been prevented?

____

____

____

Diagrams:

Signature of Site Supervisor and personnel involved in clean-up:

____

____

HARDEN

R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies

Geochemistry

Phase I / II

Regional Flow Studies

Contaminant Investigations

OMB Hearings

Water Quality Sampling

Monitoring

Groundwater Protection Studies

Groundwater Modelling

Groundwater Mapping

Our File: 9506

Date: March 13, 2013

Grand River Conservation Authority,
400 Clyde Road
PO Box 729
Cambridge ON, N1R 5W6

Attention: Heather Ireland, Resource Planner

Dear Ms. Ireland:

Re: Response to GRCA comments regarding Hidden Quarry
Guelph-Eramosa File ZBA09/2012
Cumulative Effects Assessment Issues

We are pleased to respond to the comment made by the GRCA in your letter of January 31, 2012 in regards to the applicability of the document: *Cumulative Effects Assessment (Water Quantity and Quality) Best Practices Paper for Below Water Table Sand and Gravel Extraction Operations in Priority Subwatersheds in the Grand River Watershed- September 2010*.

Our comments on the pertinent aspects of this paper are as follows:

Section 2.1: Initial Assessment

1) Proximity to other licenced pits and quarries, evaporation, surface water drainage and water balance.

The proposed Hidden Quarry is several kilometers from the nearest licenced pit or quarry and there are no other licensed pits or quarries in the Blue Springs Creek subwatershed (Figure 1). There is no potential for the overlapping of areas of influence between the proposed Hidden Quarry and the nearest licenced pit or quarry.

The development of two lakes at the Hidden Quarry site will result in an increase in evaporation from the Blue Springs Creek subwatershed. The estimated increase in evaporation is estimated to be 18,765 m^3/year. The Blue Springs Creek subwatershed has an approximate area of 44 km^2. The estimated evapotranspiration rate from this watershed is 517 mm/y resulting in a total evapotranspiration volume of 22,800,000 m^3. Thus the increase in evapotranspiration expected to occur at the quarry represents a 0.08% increase in loss of water from the watershed annually. This is an insignificant increase being neither measureable nor problematic to flora and fauna in the watershed.

As discussed in Section 4.4 of the Hydrogeology Report, runoff from small portions of micro-drainage areas D1 and D2 will be reduced. Drainage from micro-drainage area D1 reports to Tributary C, an intermittent stream and drainage from micro-drainage area D2 reports to Tributary B. There are no other pits or quarries on these streams thus cumulative impacts cannot occur.

2) Proximity to other proposed pits and quarries

There are no other proposed pits or quarries in the Blue Springs Creek subwatershed and thus cumulative impacts cannot arise.

3) Level of Existing Environmental Degradation

According to the Eramosa River Blue Springs Creek Watershed Study (Beak, 1999) the watershed has high quality aquatic communities and there is no indication that the water quality is deteriorating. The report identifies four main areas of potential stress to the watershed being;

- Species introductions,
- Ponds and weirs (interpreted as on-line features),
- Channel alterations and
- Riparian vegetation loss.

The proposed Hidden Quarry will not have any effect on any of these stress factors. Thus, the proposed quarry will not exacerbate the condition of any existing degraded environment in the watershed. Although the site development will result in two large ponds, there is a significant distance between the ponds and Blue Springs Creek or its tributaries to negate any thermal impact.

4) Potential Impact on "Stress" Assessment of Eramosa River/Blue Springs Creek

The most current stress assessment for the Blue Springs Creek Subwatershed is *moderate*. The moderate stress assessment is mainly due to the surface water taking by the City of Guelph at their Arkell facility. The stress level is determined by the **demand** for water-calculated from Permitted water takings (from PTTW's), **water supply**-calculated from the median flow in the Eramosa River at Watson Road and the **water reserve**-calculated as the 90th percentile of monthly median flow (i.e. flow which is exceeded 90% of the time) in the Eramosa River at Watson Road.

The proposed Hidden Quarry will neither require a Permit to Take Water (therefore no increase in demand) nor diminish flow in the Eramosa River as measured at Watson Road (therefore no change in supply or reserve). Thus, the quarry will not affect the stress level of the Eramosa River.

5) Proximity to Municipal Water Wells

The nearest active municipal well is TW3/02 located 2.2 km from the site. Municipal Well TW2/02 is located approximately 1000 m from the site and is presently inactive. The wells are shown on Figure 2 of this response. The proposed quarry is not within the well head protection area of either well and will not affect the vulnerability of either well. Neither well obtains water from the bedrock aquifer beneath the quarry.

6) Vulnerability of Groundwater Resources

Figure 3 is obtained from the Guelph Eramosa Regional Groundwater Characterization and Well Head Protection Study (2004) and Figures 4 and 5 are sourced from the Aqua Resources 2010 Final Groundwater and Surface Water Vulnerability Report prepared for the City of Guelph. The bedrock aquifer on the proposed Hidden Quarry site and surrounding areas are overwhelmingly classified as having a high vulnerability. The quarry will not increase the vulnerability status of the aquifer.

7) Local Scale Cumulative Effects

The local scale cumulative effects are clearly described in the Level 1 and Level II Hydrogeology Report prepared by Harden Environmental. There are no other nearby extractive operations and therefore there will be no local scale cumulative effects.

8) Section 2.3 Watershed / Subwatershed Scale Cumulative Effects

Figure 1 clearly shows that there are no other extractive operations within the Blue Springs Creek subwatershed and therefore, cumulative effects need not be considered at this time.

Section 3.1 Data Collection

Quantity

James Dick Construction Ltd. is committed to detailed data collection around the quarry and will be able to detect potential interference with private wells, alteration of the position of the water table, quantity of water discharging to or recharging from ponds, streams, wetlands and springs. The monitoring program will allow for the evaluation of the effect of below-water-table extraction, creation of ponds and the effect of permanent surface ponds on surface water and groundwater quantity.

The monitoring program described in Section 6.1 of the Hydrogeology Report will be used to determine if there are any changes to water levels and stream flows in the area of influence of the quarry.

Quality

An annual water quality testing program has been recommended. It will take several years for the removal of the sand and gravel resources and several more years for the quarry to grow to an appreciable size. The below water table extraction will commence in the northern portion of the quarry, the farthest away from downgradient wells. Thus there will be several years of water quality testing prior to the quarry approaching the southern property boundary.

We trust that this letter adequately confirms that the proposed Hidden Quarry complies with all aspects of the document: *Cumulative Effects Assessment (Water Quantity and Quality) Best Practices Paper for Below Water Table Sand and Gravel Extraction Operations in Priority Subwatersheds in the Grand River Watershed- September 2010.*

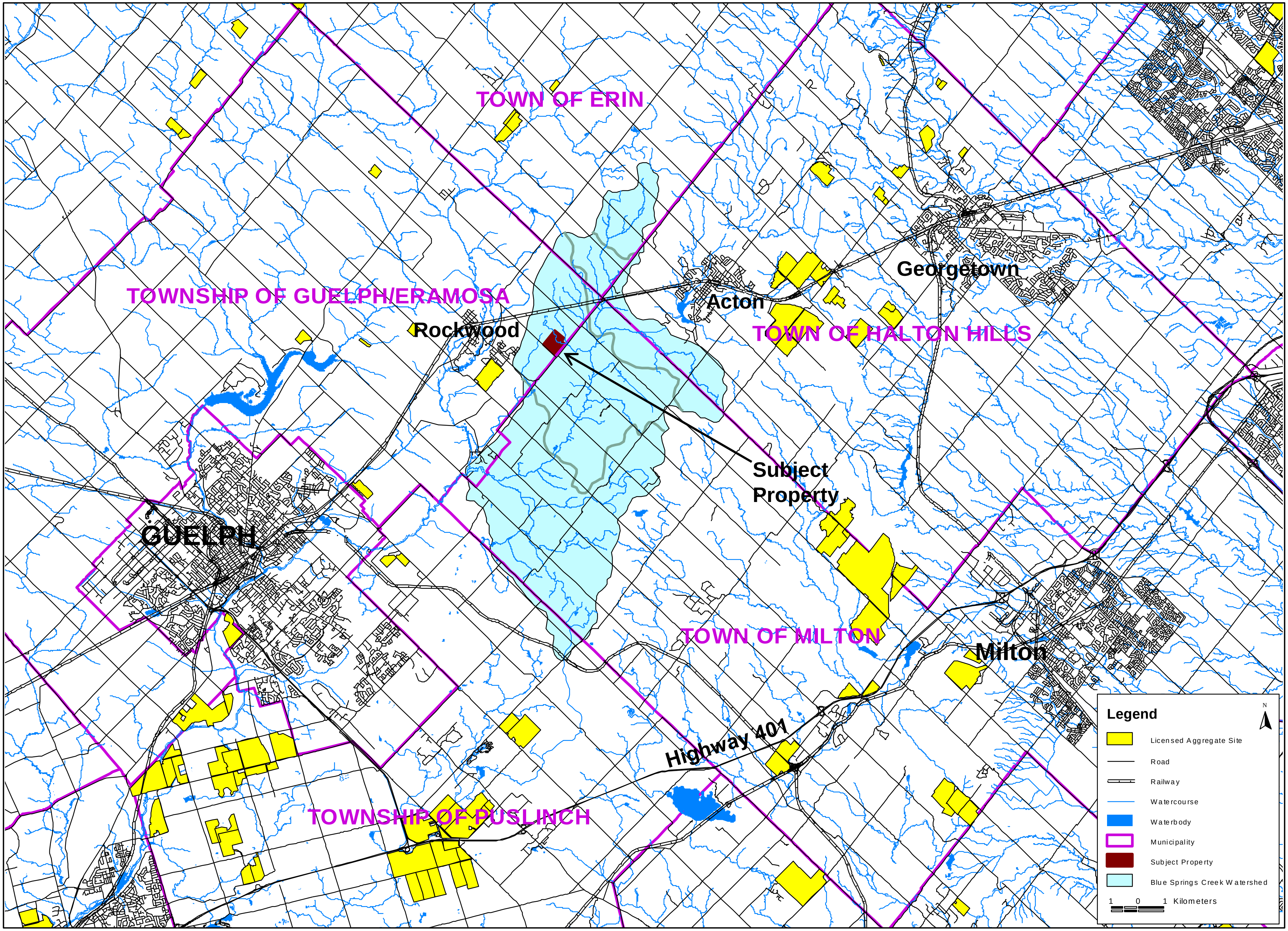
Please do not hesitate to contact Stan Denhoed (519) 826-0099 or Greg Sweetnam (905) 857-3500 if any additional information regarding cumulative effects assessment is required.

Sincerely,

Harden Environmental Services Ltd.

Stan Denhoed

Stan Denhoed, P.Eng.,M.Sc.
Senior Hydrogeologist



Harden Environmental Services Ltd.

Project No: 9506

Date: Mar 2013

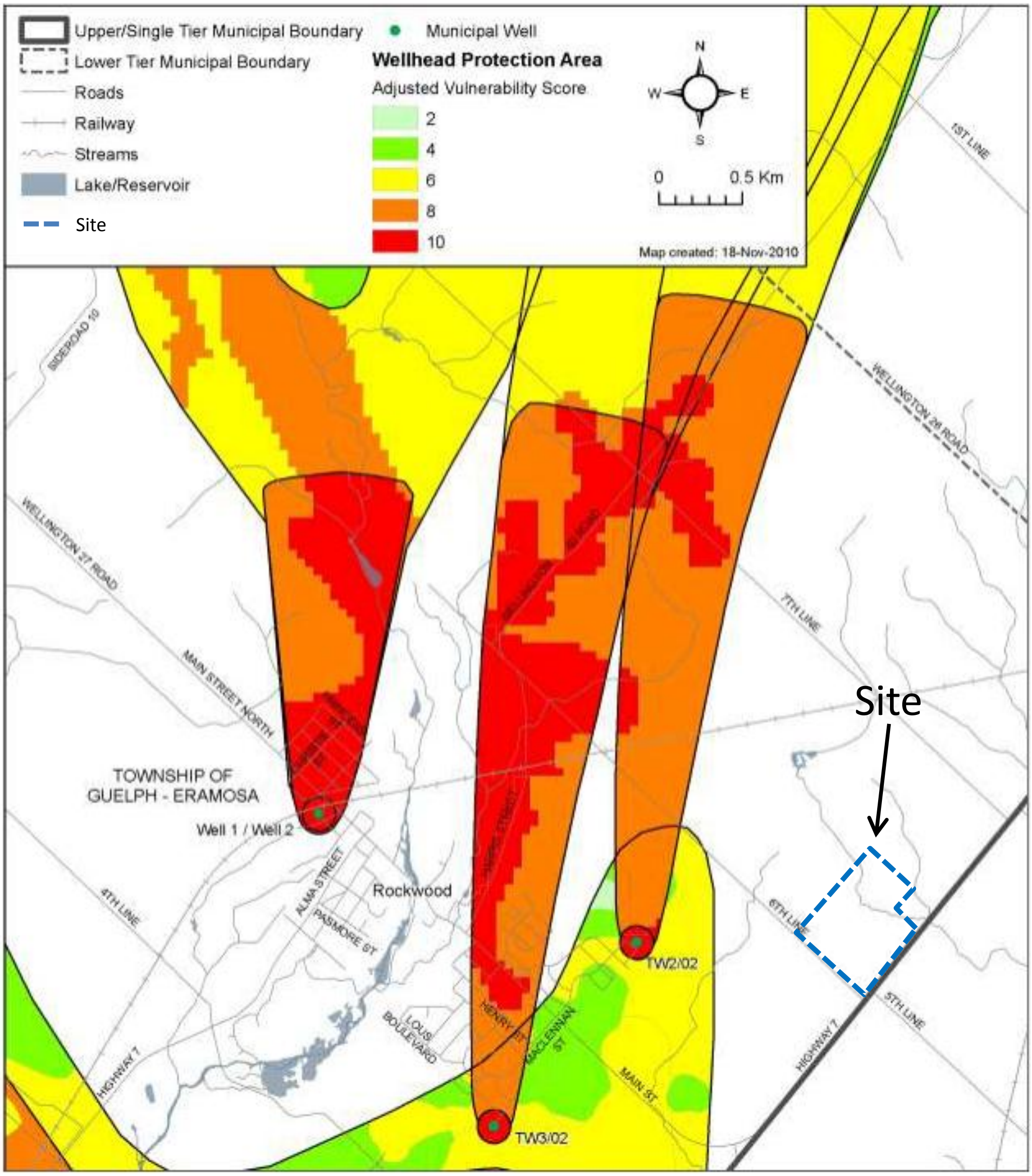
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1: Aggregate Sites

Map 7-49: Rockwood Water Supply Wellhead Protection Area Final Vulnerability



Source: Grand River Source Protection Area, Approved Assessment Report, August 16th, 2012

Harden Environmental Services Ltd.

Project No: 9506

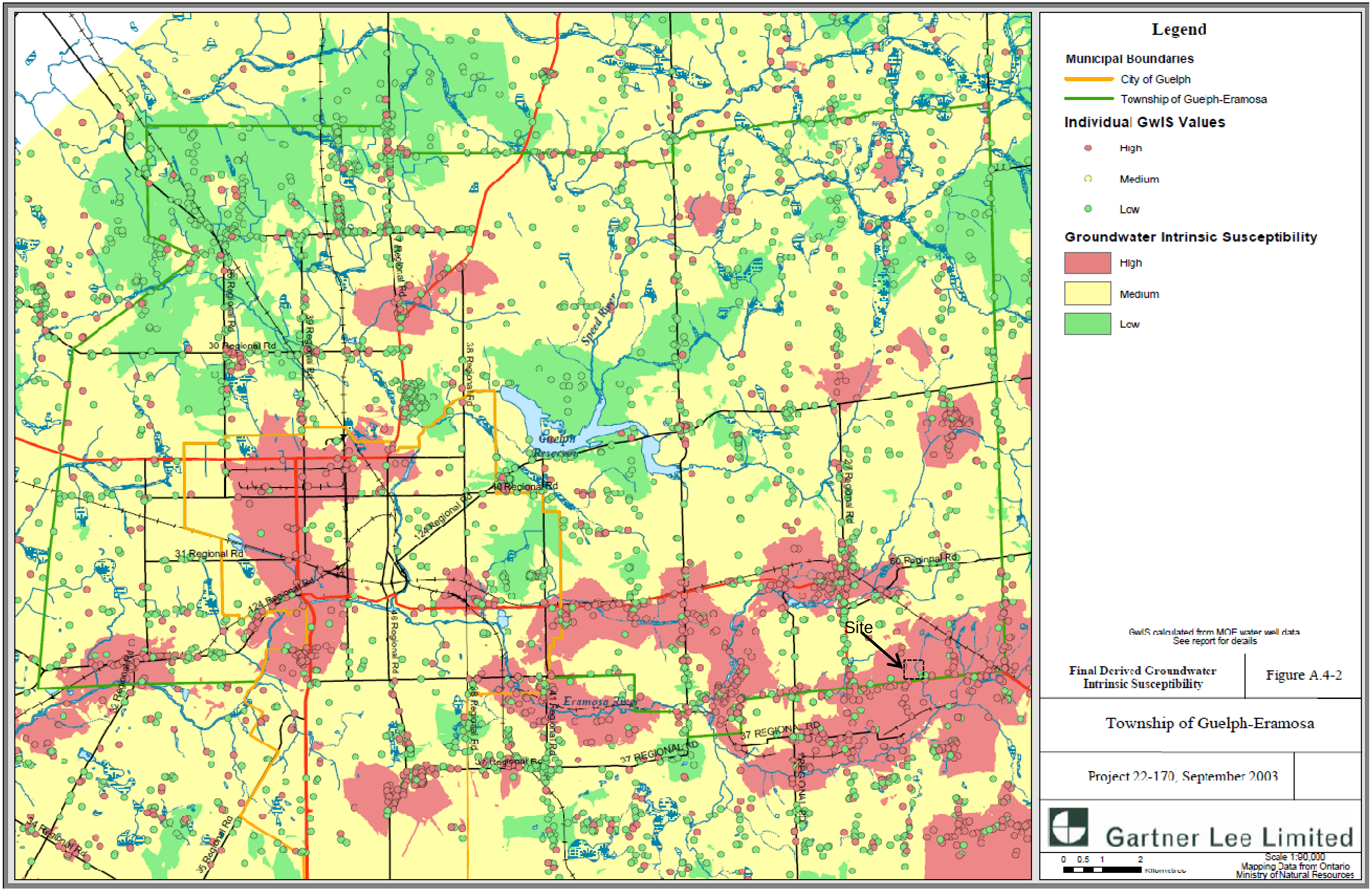
Date: March 2013

Drawn By: JD

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 2: Rockwood Wells



Source: Guelph Eramosa Regional Groundwater Characterization and Well Head Protection Study, 2004

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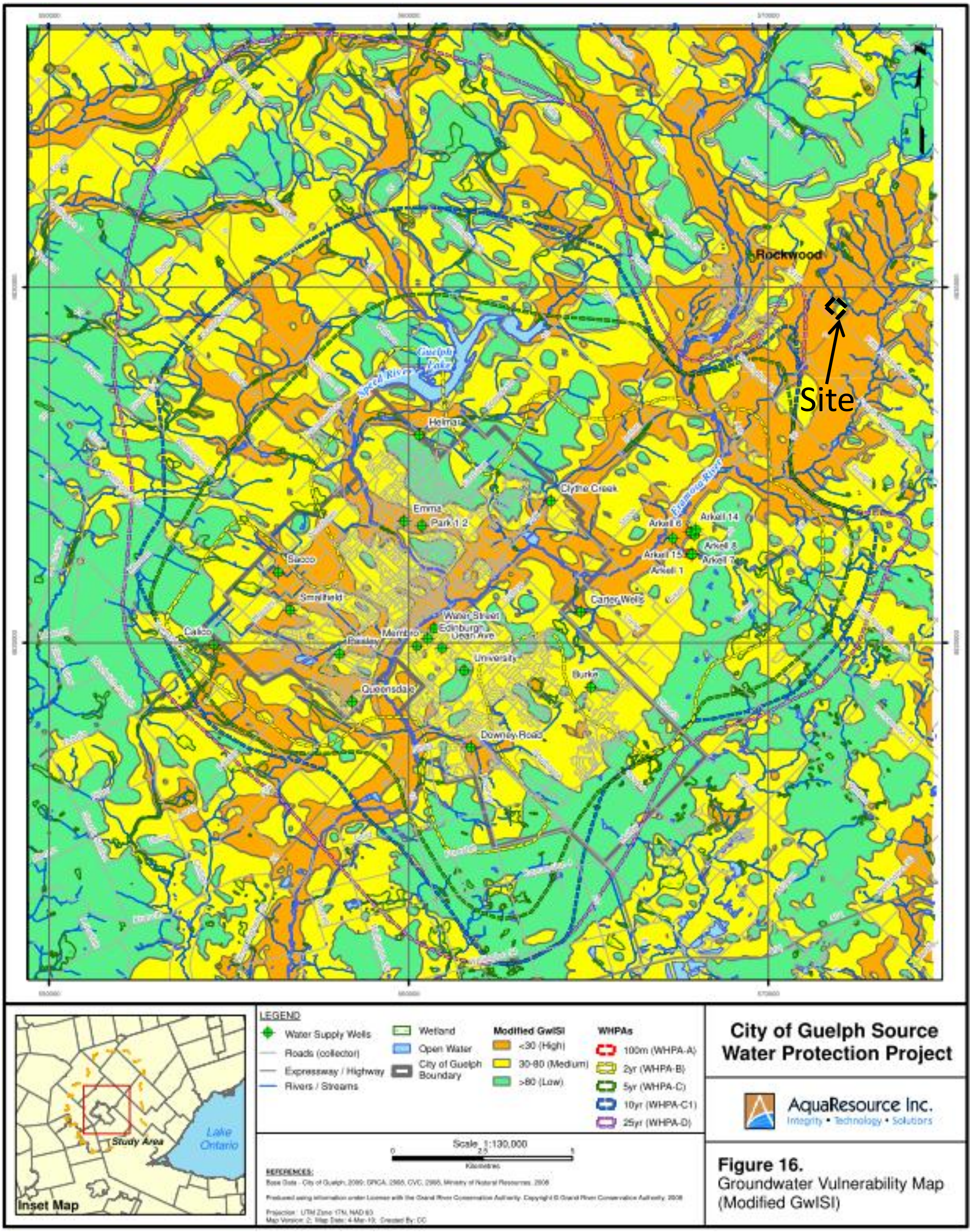
Date: Mar 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3: Guelph-Eramosa Study: Susceptibility



AquaResources 2010 Final Groundwater and Surface Water Vulnerability Report

Harden Environmental Services Ltd.

Project No: 9506

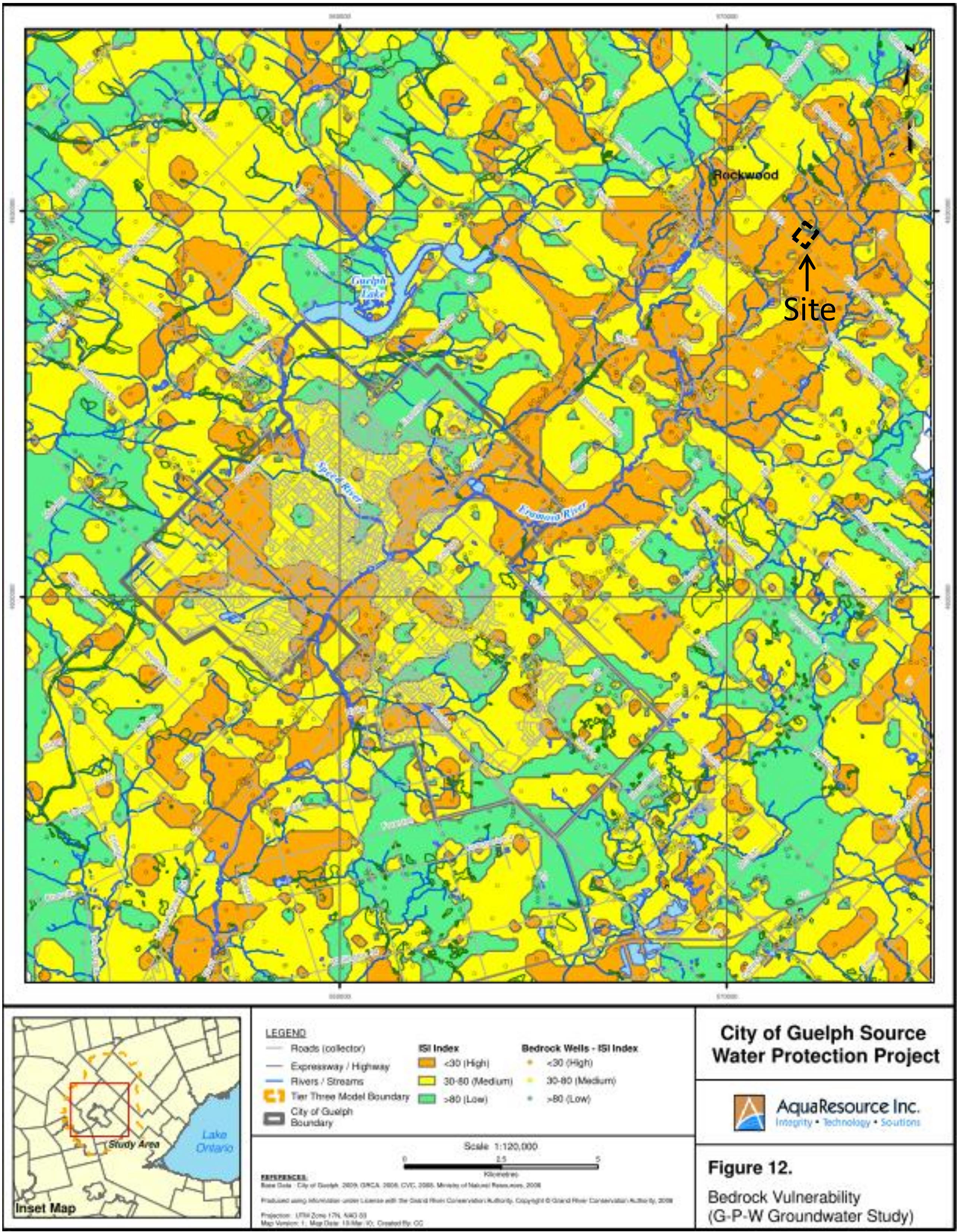
Date: March 2013

Drawn By: JD

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

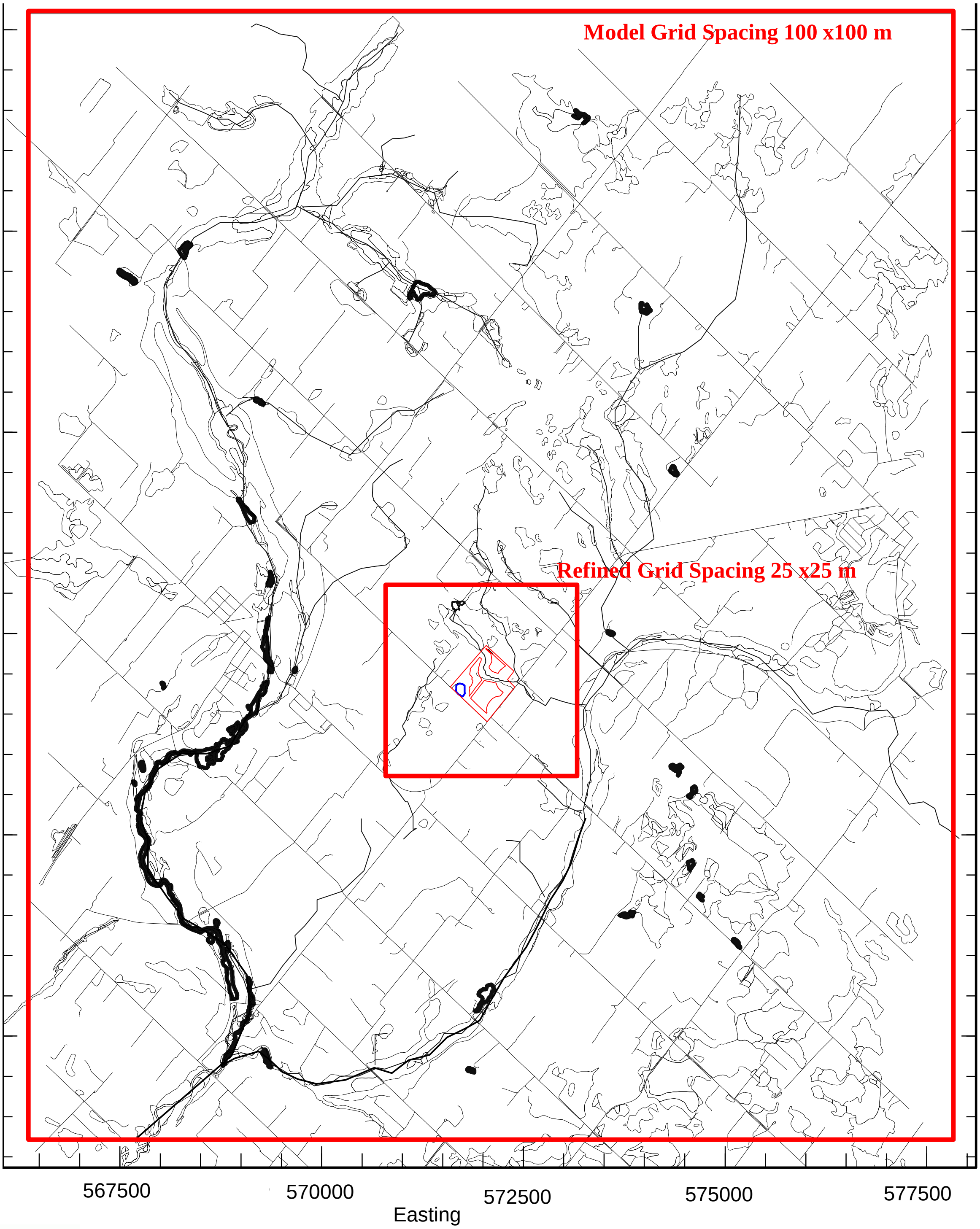
Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

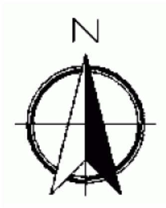
Figure 4: City of Guelph Study: Vulnerability



AquaResources 2010 Final Groundwater and Surface Water Vulnerability Report

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 5: Guelph-Puslinch Study Vulnerability**
	Date: March 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		





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Project No: 9506

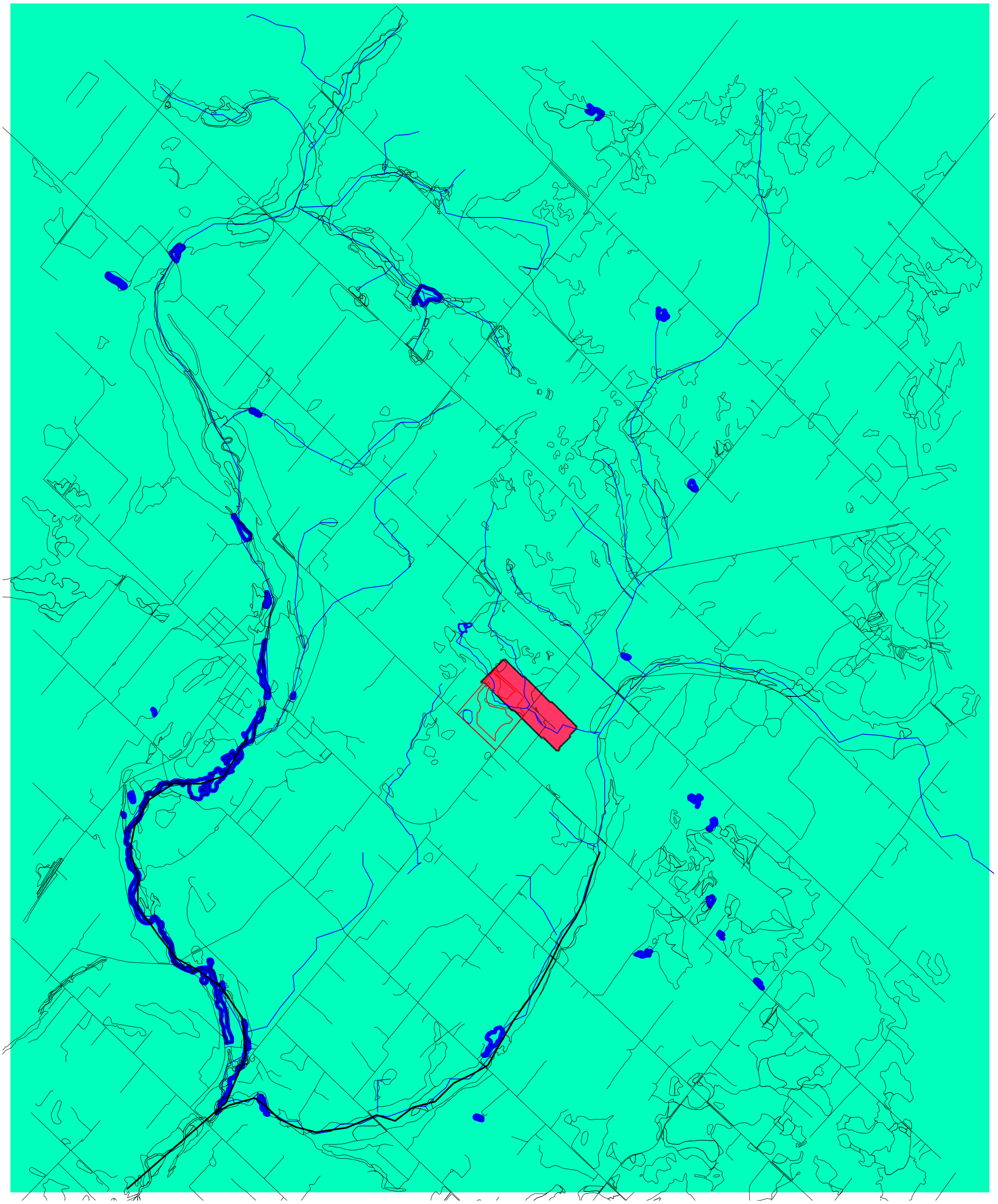
Date: Mar 2012

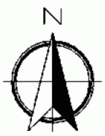
Drawn By: SD

Rockwood Groundwater Model
Addendum Report

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure H3:
Model Domain

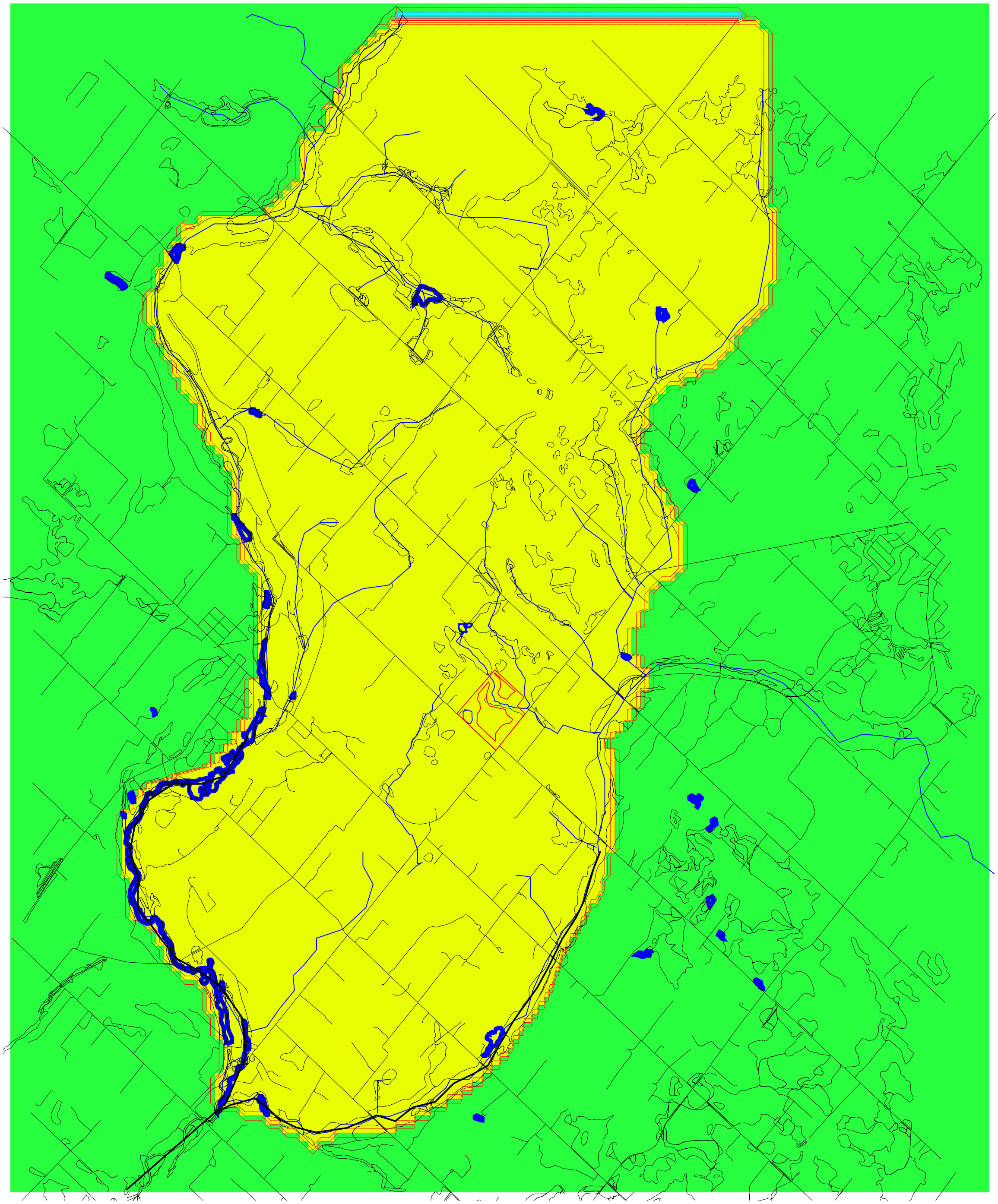




🟩 2 x 10^{-5} m/s

🟥 1.8 x 10^{-4} m/s

ARDEN Harden Environmental Services Ltd.	**Project No:** 9506	Rockwood Groundwater Model Addendum Report	**Figure H4:** **Hydraulic Conductivity Layer 1**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		



🟩 Inactive

🟨 Active

🟥 Constant Head

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Project No: 9506

Date: Mar 2012

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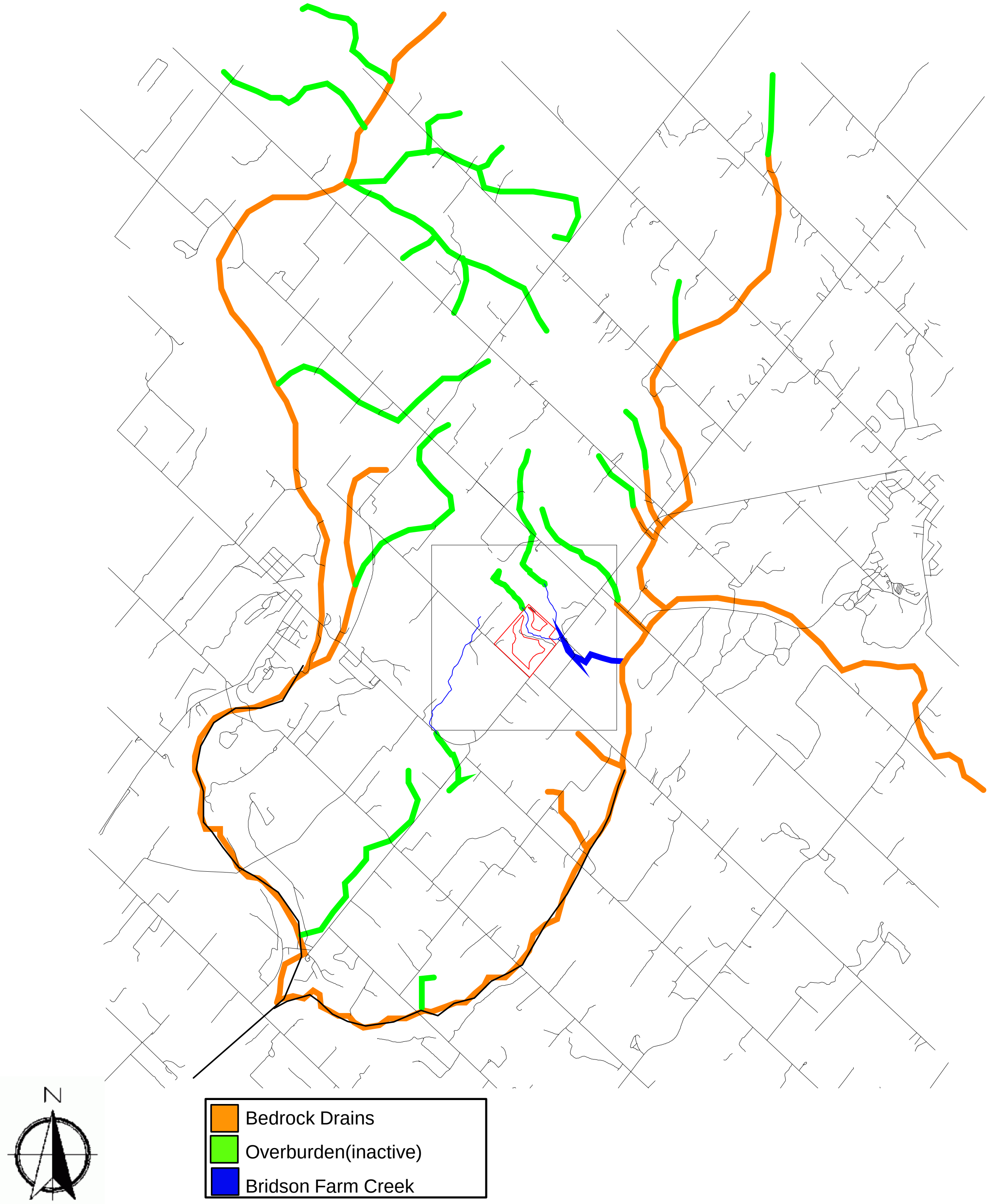
Rockwood Groundwater Model
Addendum Report

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure H5:
Boundary Conditions



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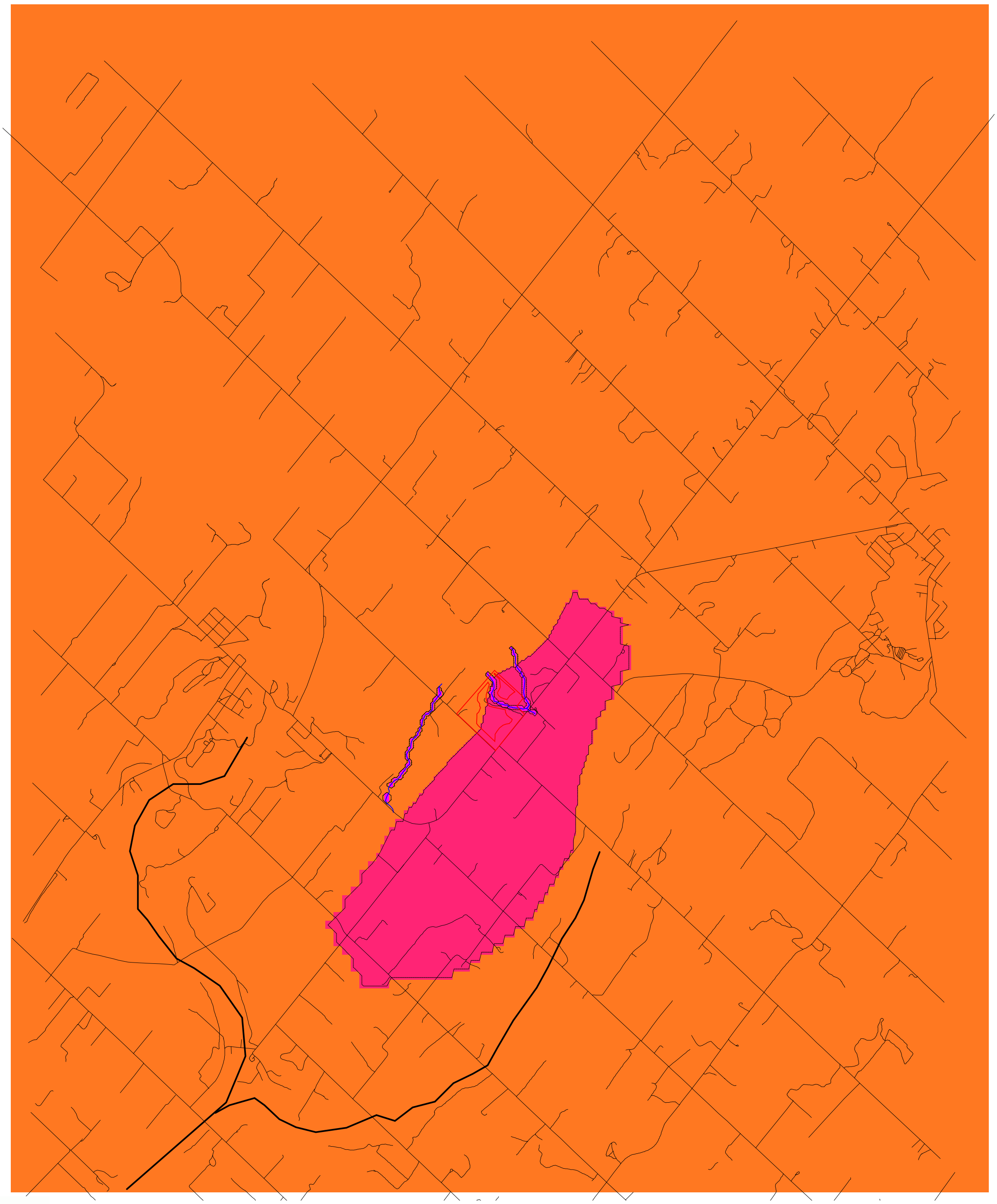
Project No: 9506
Date: Mar 2012
Drawn By: SD

Rockwood Groundwater Model
Addendum Report

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

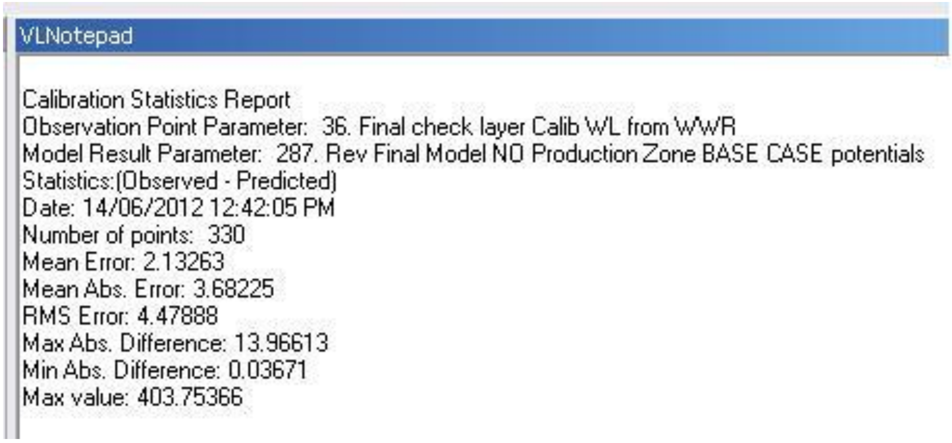
Figure H6:
Drains



🟧 130 mm/year

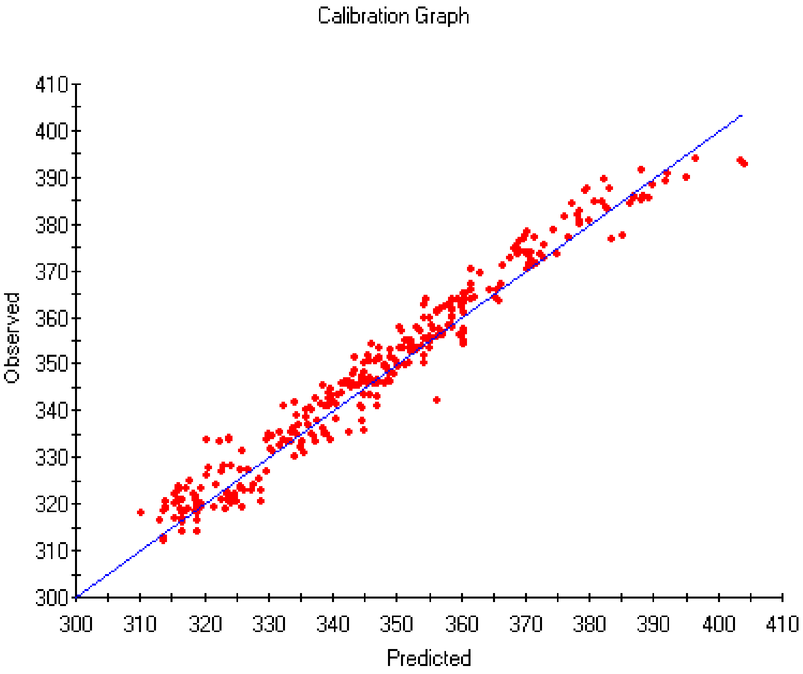
🟥 150 mm/year

Harden Environmental Services Ltd.	**Project No:** 9506	Rockwood Groundwater Model Addendum Report	**Figure H7:** **Model Recharge**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		

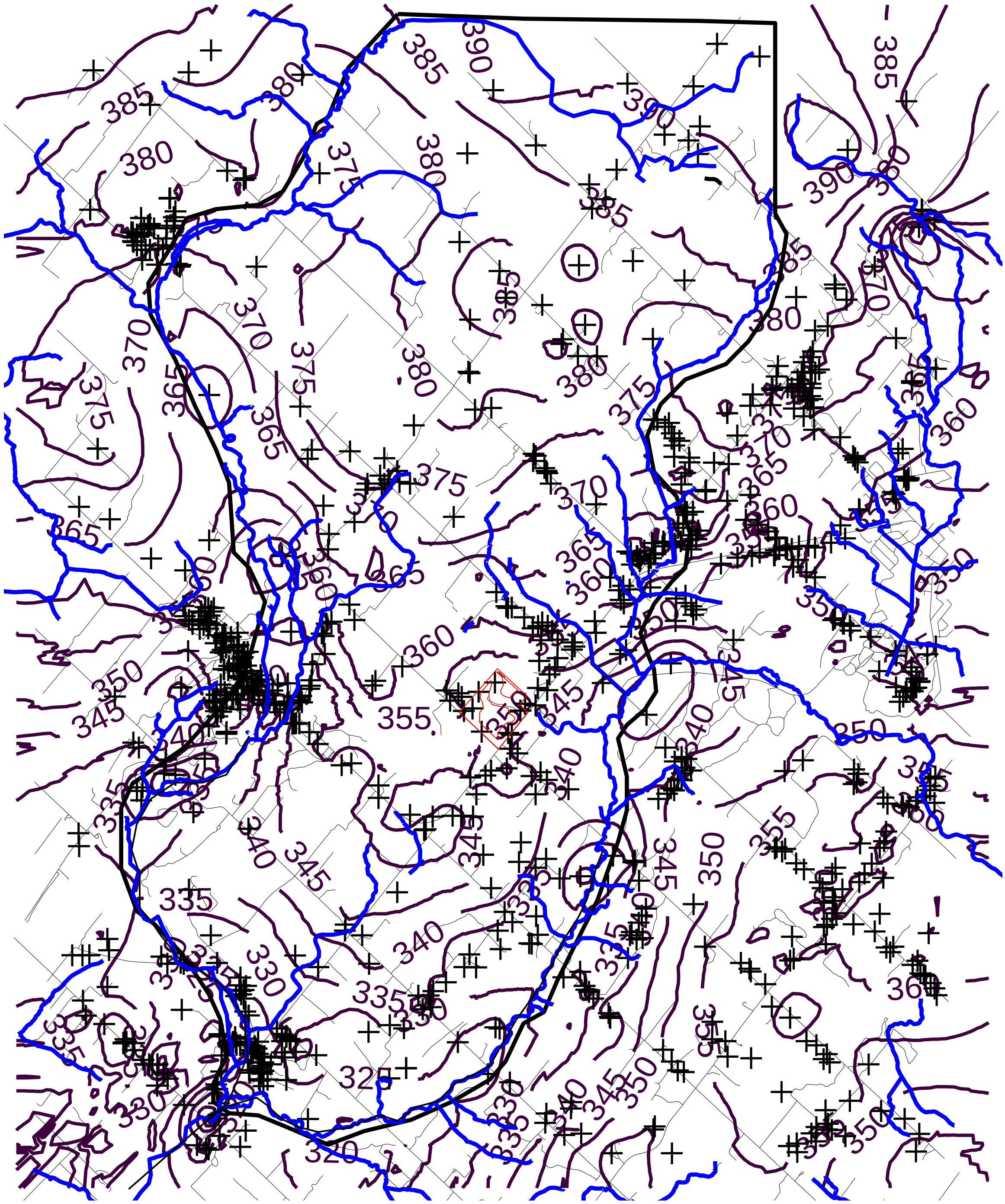


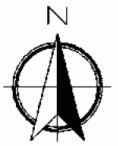
VLNotepad

```
Calibration Statistics Report
Observation Point Parameter:  36. Final check layer Calib WL from WWR
Model Result Parameter:  287. Rev Final Model NO Production Zone BASE CASE potentials
Statistics:(Observed - Predicted)
Date: 14/06/2012 12:42:05 PM
Number of points:  330
Mean Error: 2.13263
Mean Abs. Error: 3.68225
RMS Error: 4.47888
Max Abs. Difference: 13.96613
Min Abs. Difference: 0.03671
Max value: 403.75366
```



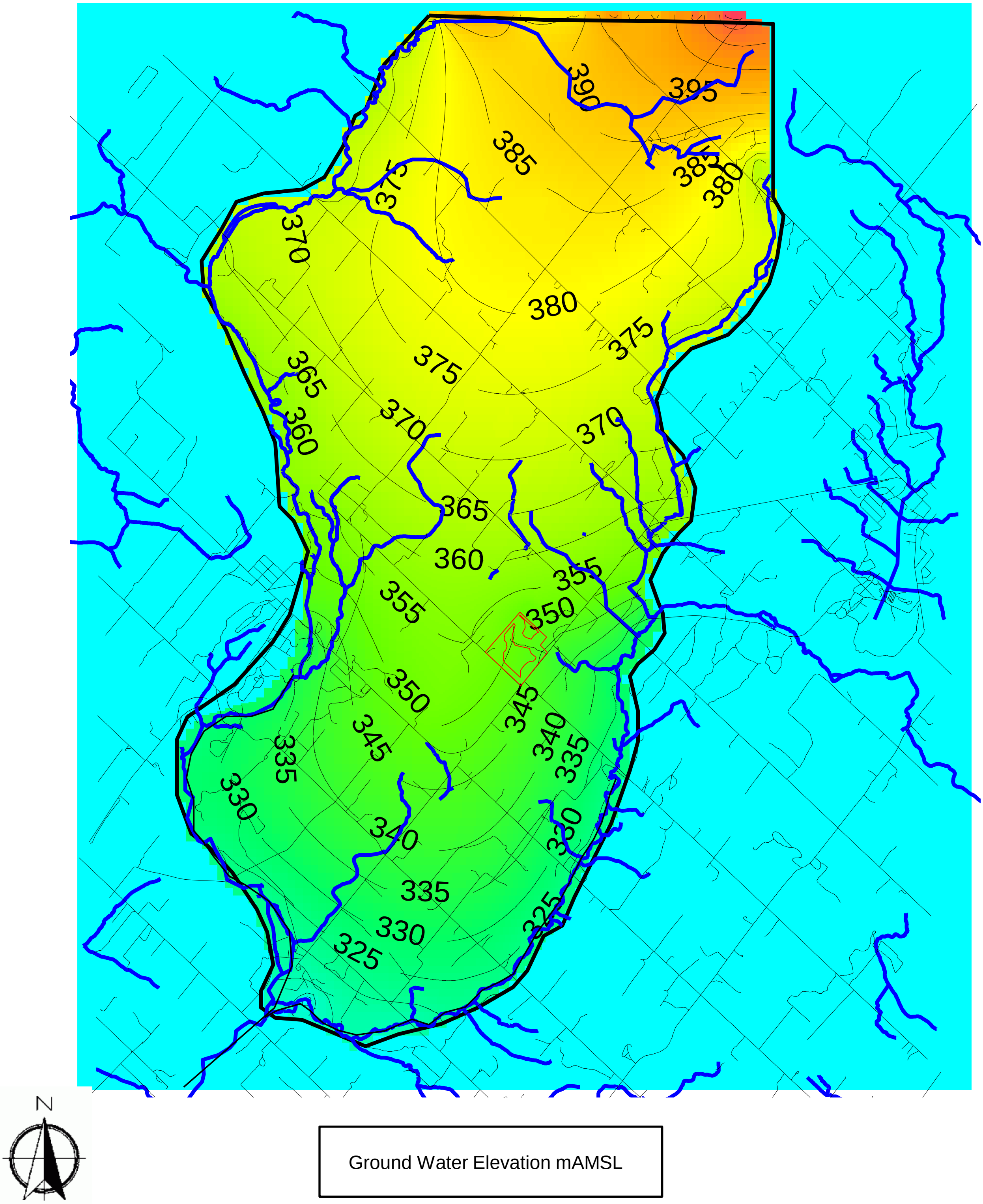
Harden Environmental Services Ltd.	**Project No:** 9506	Rockwood Groundwater Model Addendum Report	**Figure H8:** **Calibration Statistics**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		





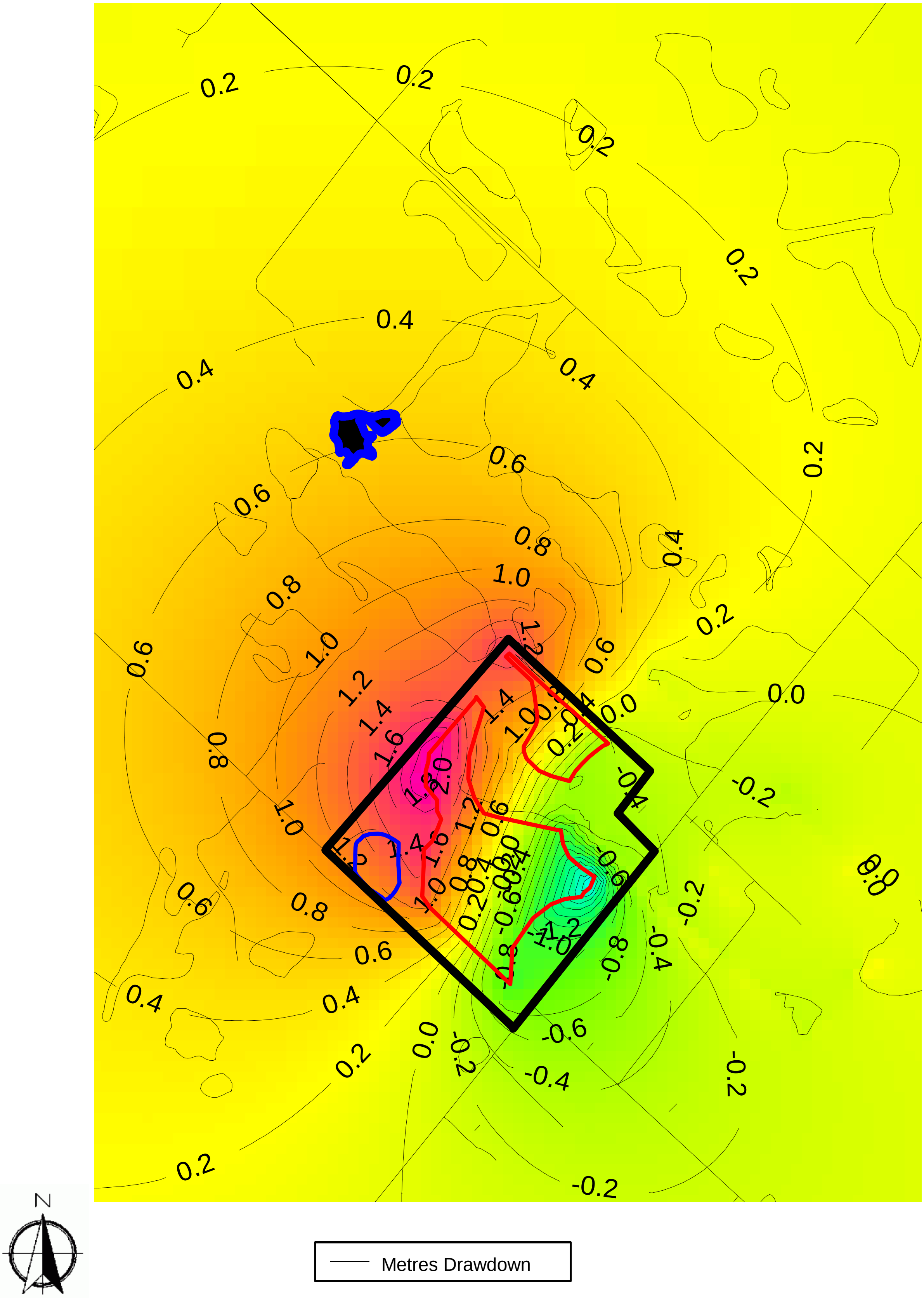
Ground Water Elevation mAMSL

Harden Environmental Services Ltd.	**Project No:** 9506	Rockwood Groundwater Model Addendum Report	**Figure H9:** **Static Water Levels WWR**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		



Ground Water Elevation mAMSL

Harden Environmental Services Ltd.	**Project No:** 9506	Rockwood Groundwater Model Addendum Report	**Figure H10:** **Predicted Water Levels Layer 1**
	Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: SD		



Harden Environmental Services Ltd.

Project No: 9506

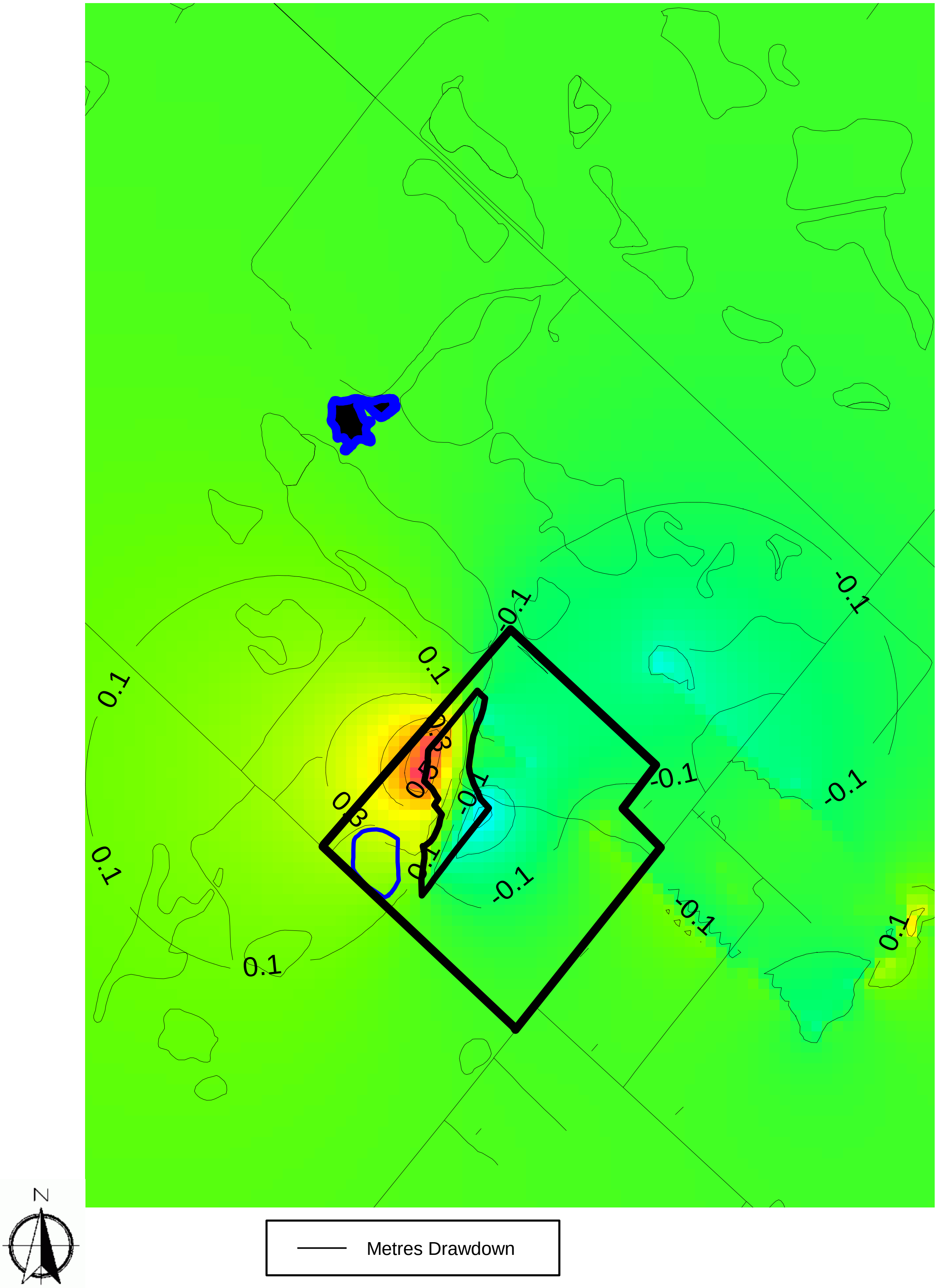
Date: Mar 2012

Drawn By: SD

Rockwood Groundwater Model
Addendum Report

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure H11:
Maximum Predicted Water Level Change

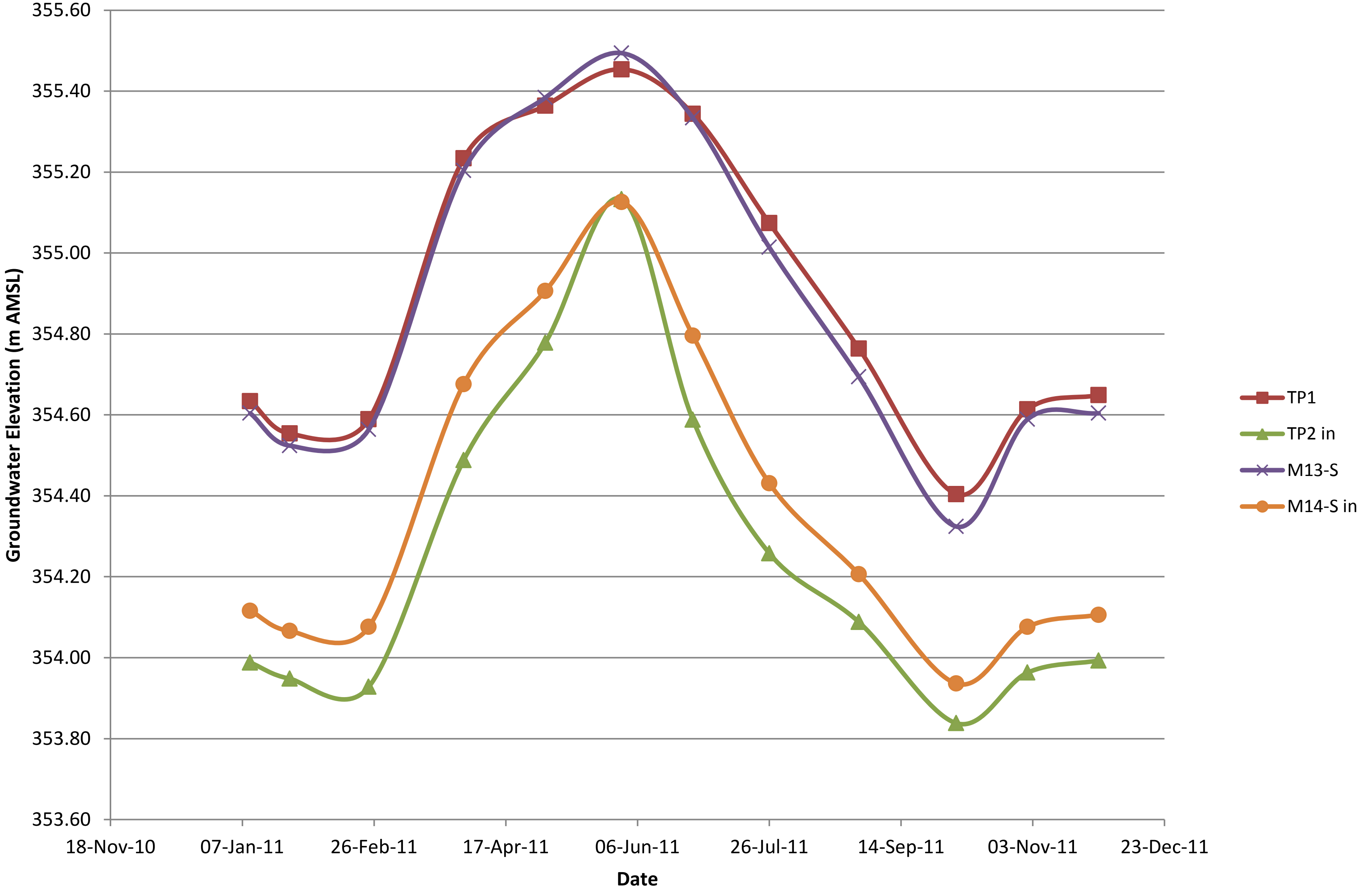


Harden Environmental Services Ltd.

Project No: 9506	Rockwood Groundwater Model Addendum Report
Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington
Drawn By: SD	

Figure H12:
North Half of West Pond
Predicted Water Level Change

Figure R1: Test Pit Monitor Comparison



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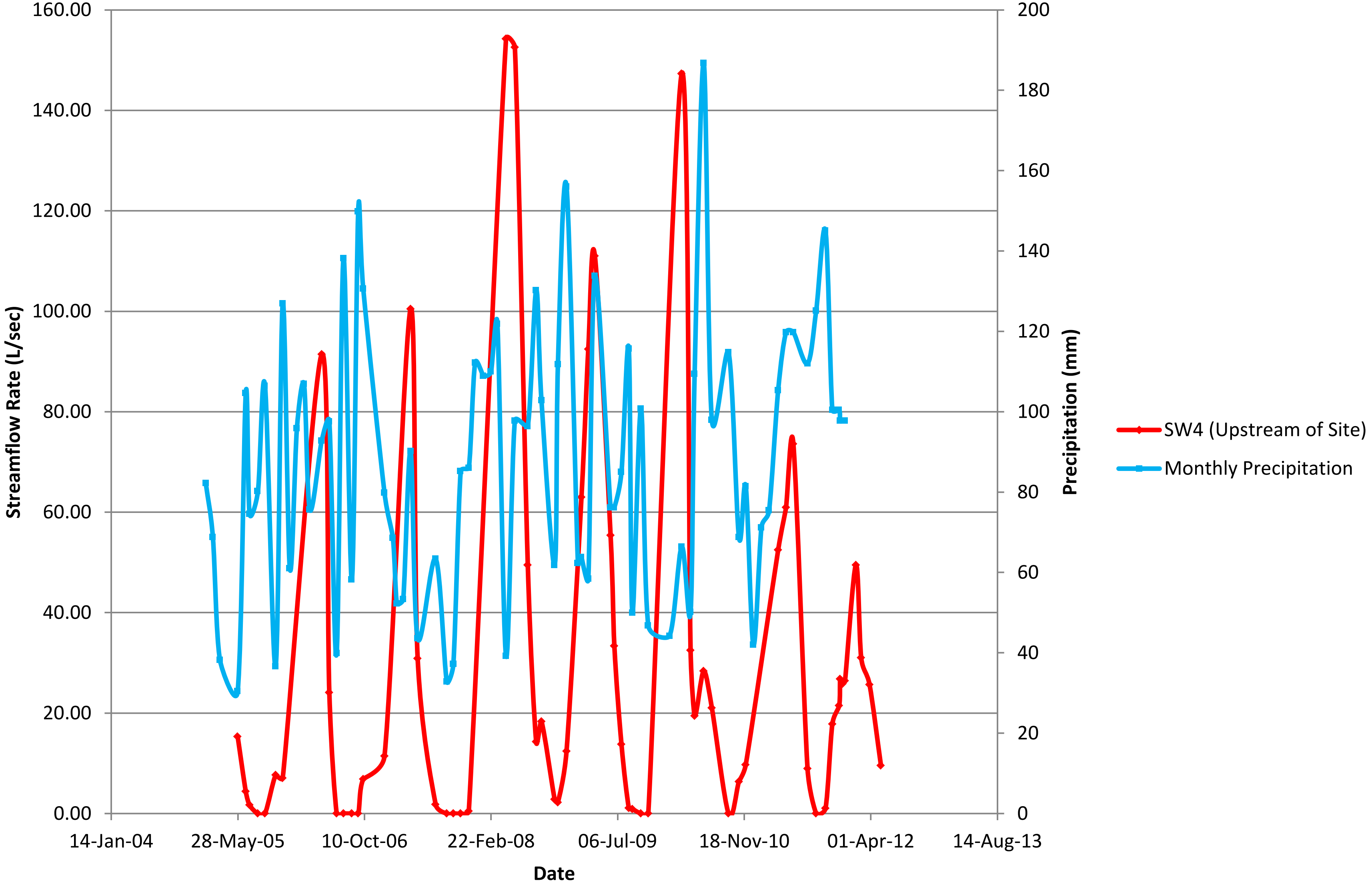
Project No: 9506
Date: Jan 2013
Drawn By: JD

Rockwood Groundwater Model Addendum Report

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure R1:
Test Pit Monitor Comparison

Figure R2: Monthly Precipitation Comparison with Streamflow



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Project No: 9506

Date: Jan 2013

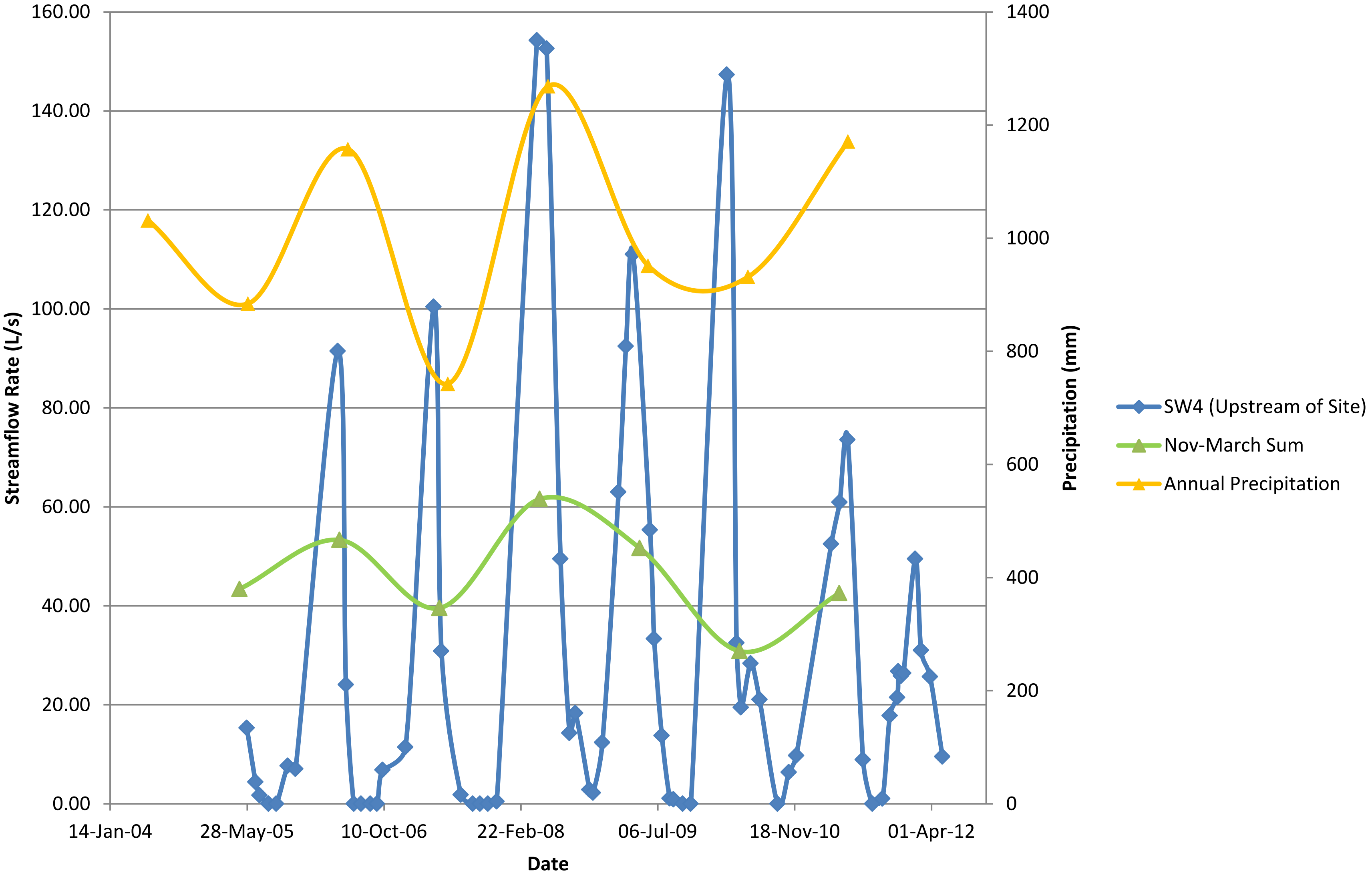
Drawn By: JD

Hidden Quarry

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

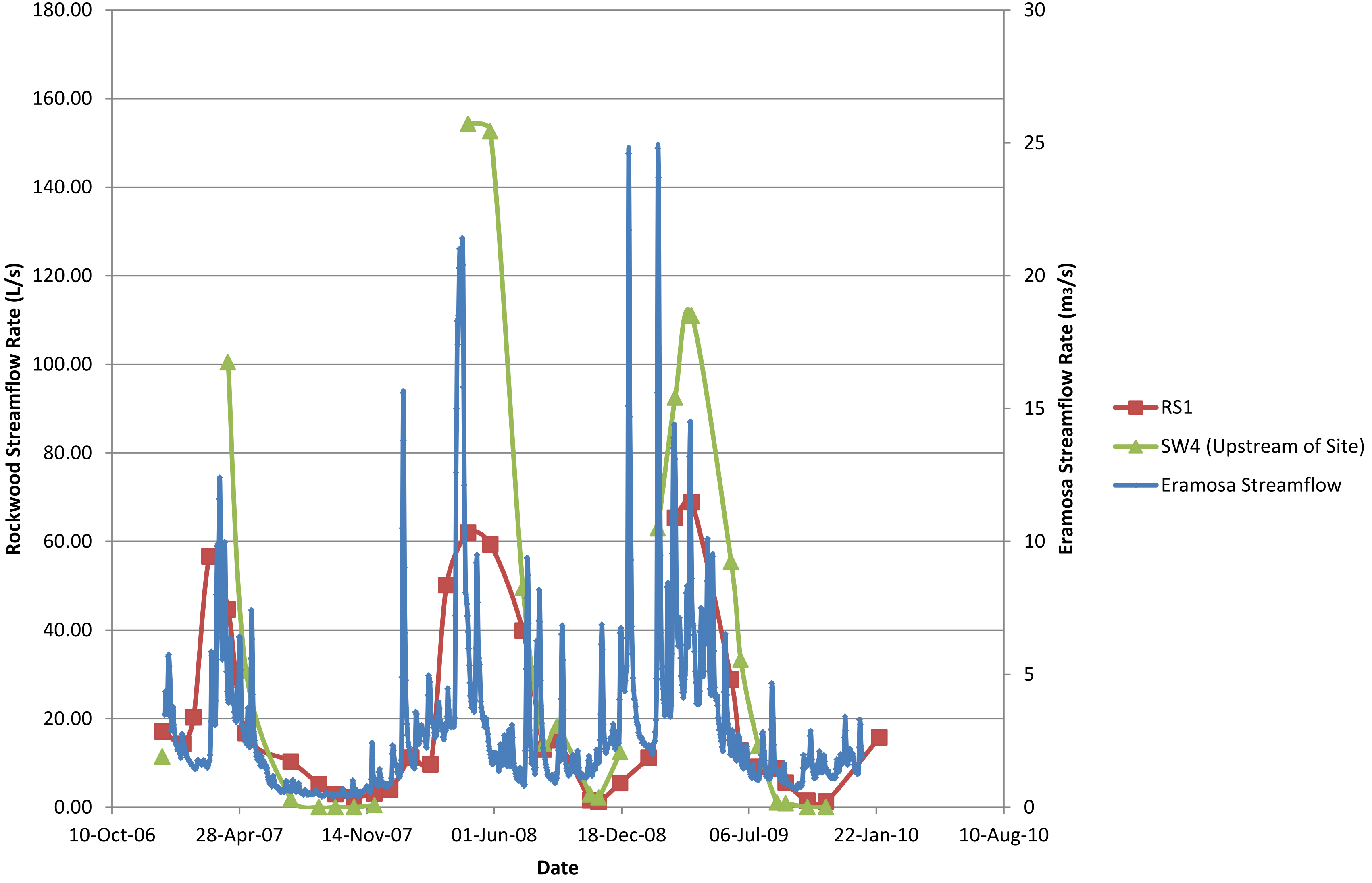
Figure R2:
Monthly Precipitation Comparison with Stream Flow

Figure R3: Precipitation Totals Comparison with Streamflows



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry	**Figure R3:** **Precipitation Totals Comparison with Streamflows**
	Date: Jan 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		

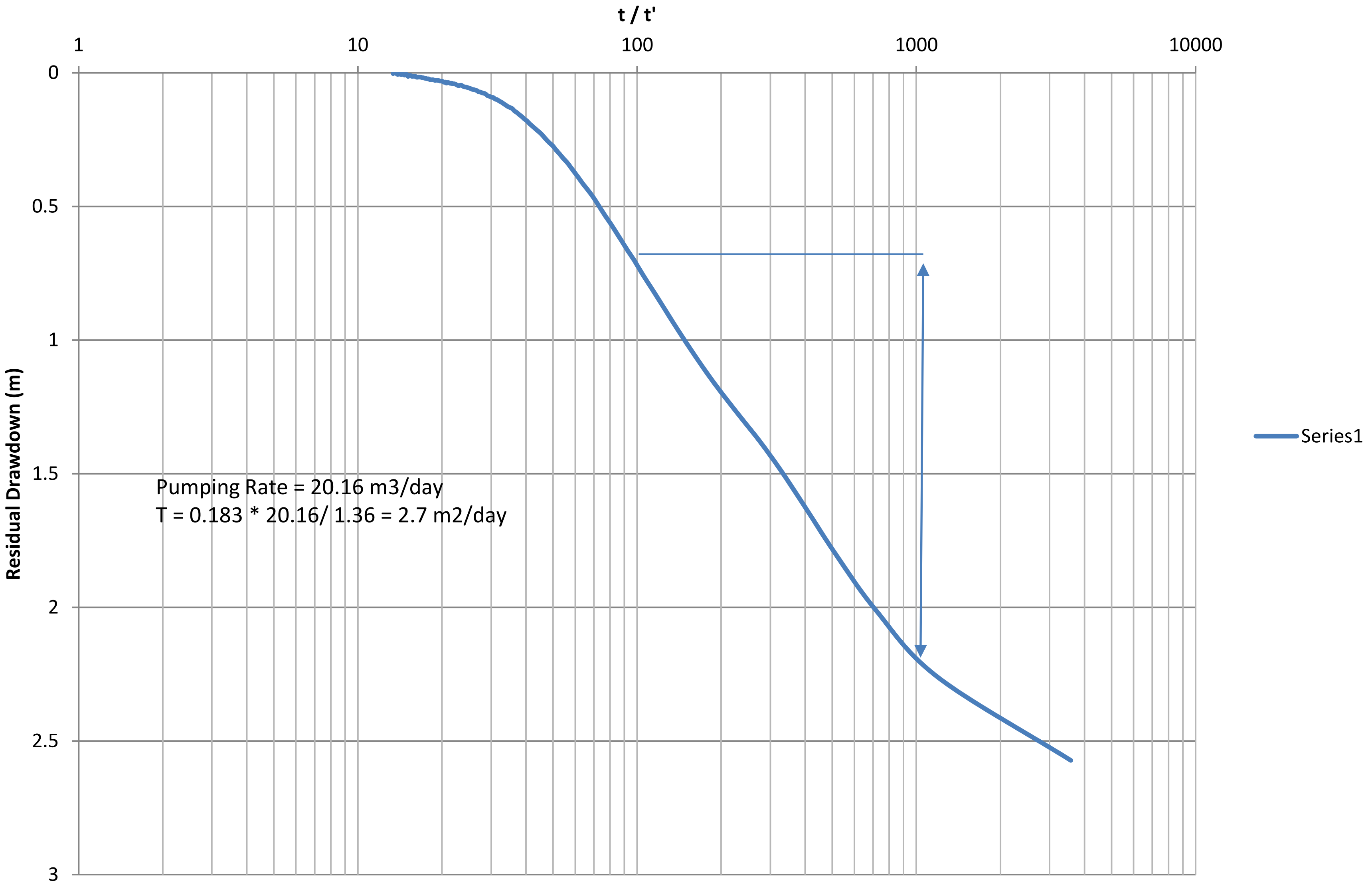
Figure R4: Eramosa and Rockwood Site Streamflows



Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Jan 2013 **Drawn By:** JD	Hidden Quarry Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington

Figure R4: Eramosa and Rockwood Site Streamflows

Figure R5: M2 Recovery Data



Pumping Rate = 20.16 m3/day
T = 0.183 * 20.16/ 1.36 = 2.7 m2/day

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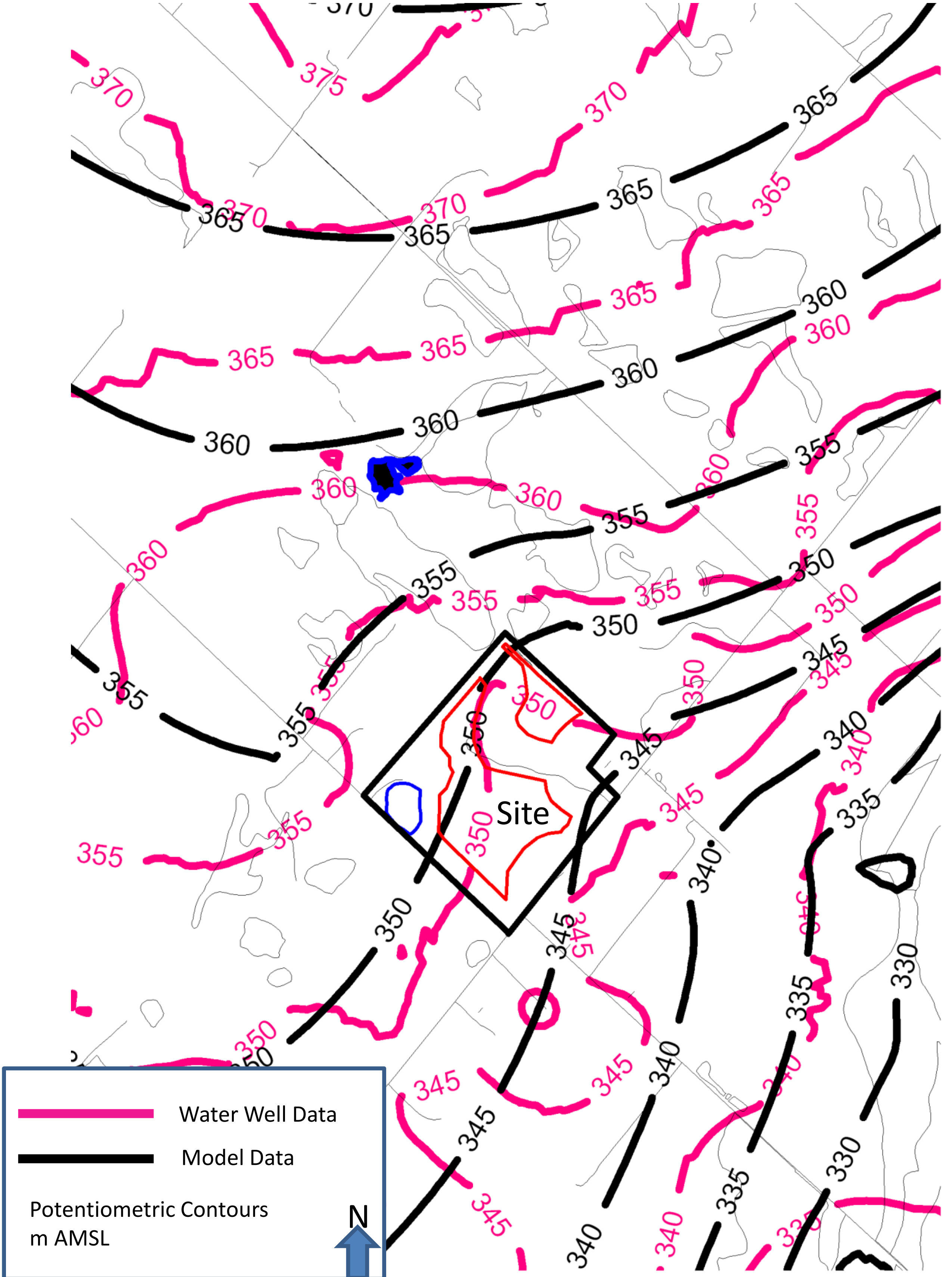
Project No: 9506
Date: Jan 2013
Drawn By: JD

Hidden Quarry

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure R5: M2 Recovery Data



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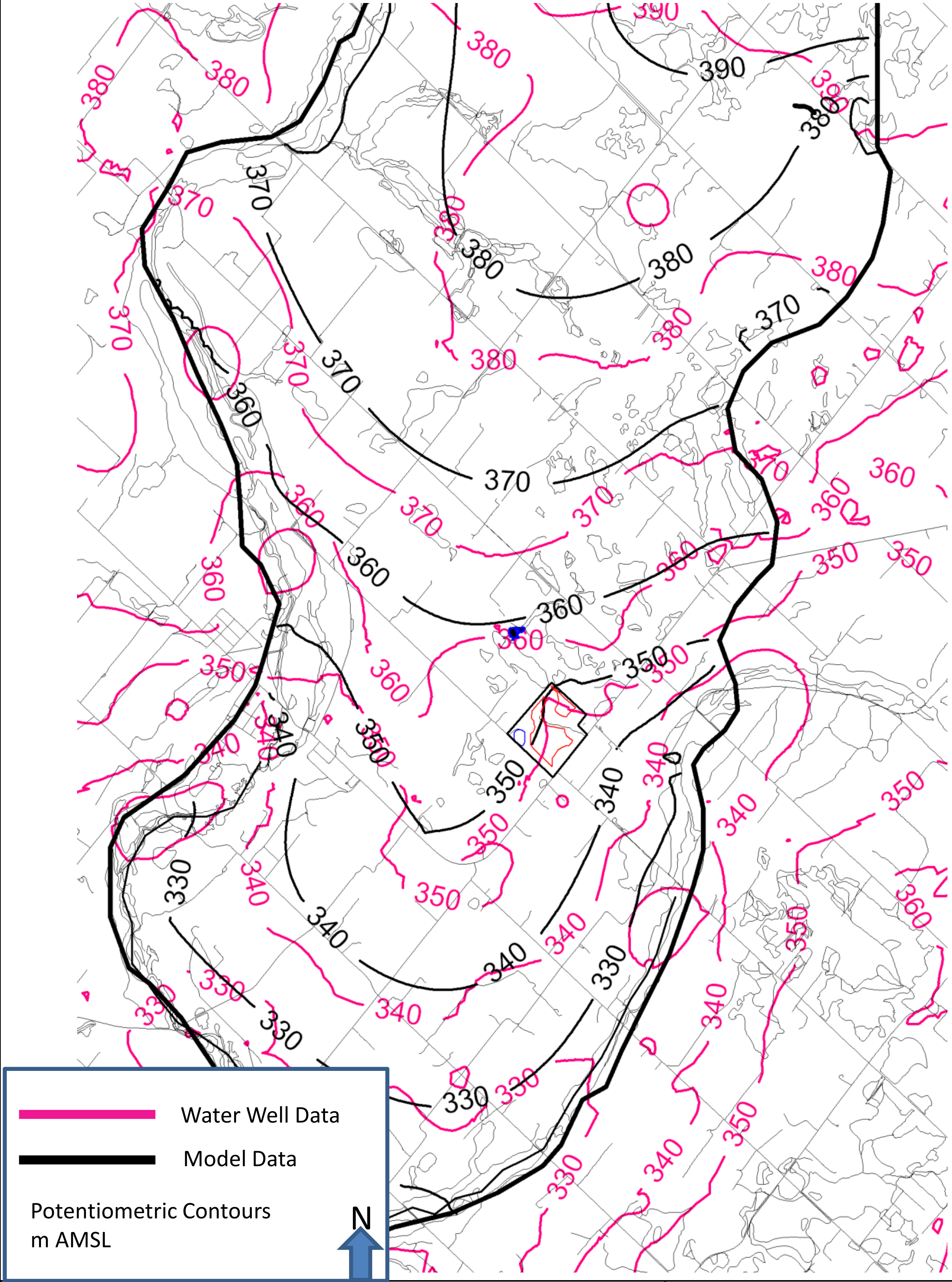
Project No: 9506	Hidden Quarry	**Figure R6: Comparison of Model Results and Water Well Record Data**
Date: JAN 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: SD		



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Project No: 9506

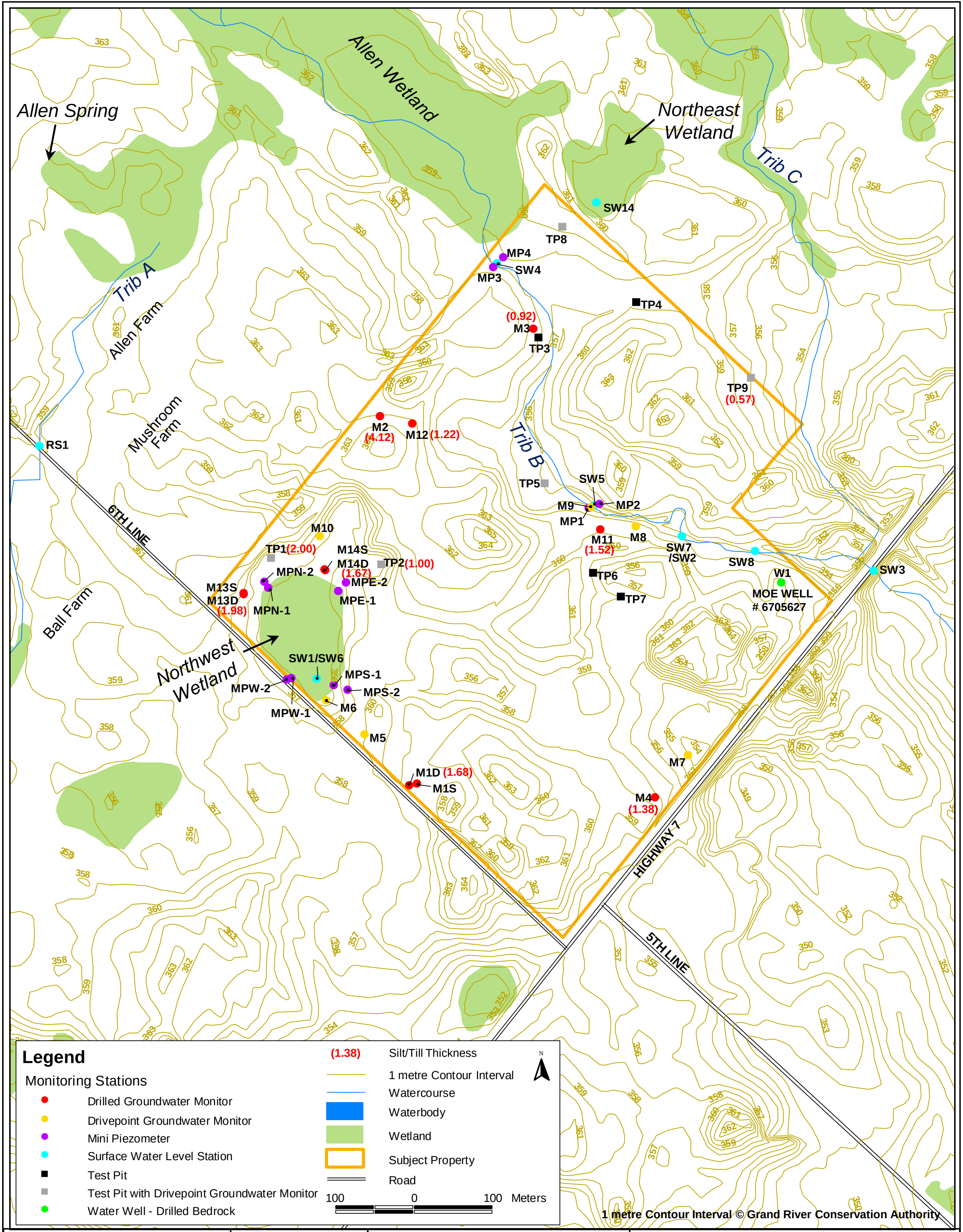
Date: JAN 2013

Drawn By: SD

Hidden Quarry

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure R7: Regional Comparison of Model Results and Water Well Record Data



Harden Environmental Services Ltd.

Project No: 9506

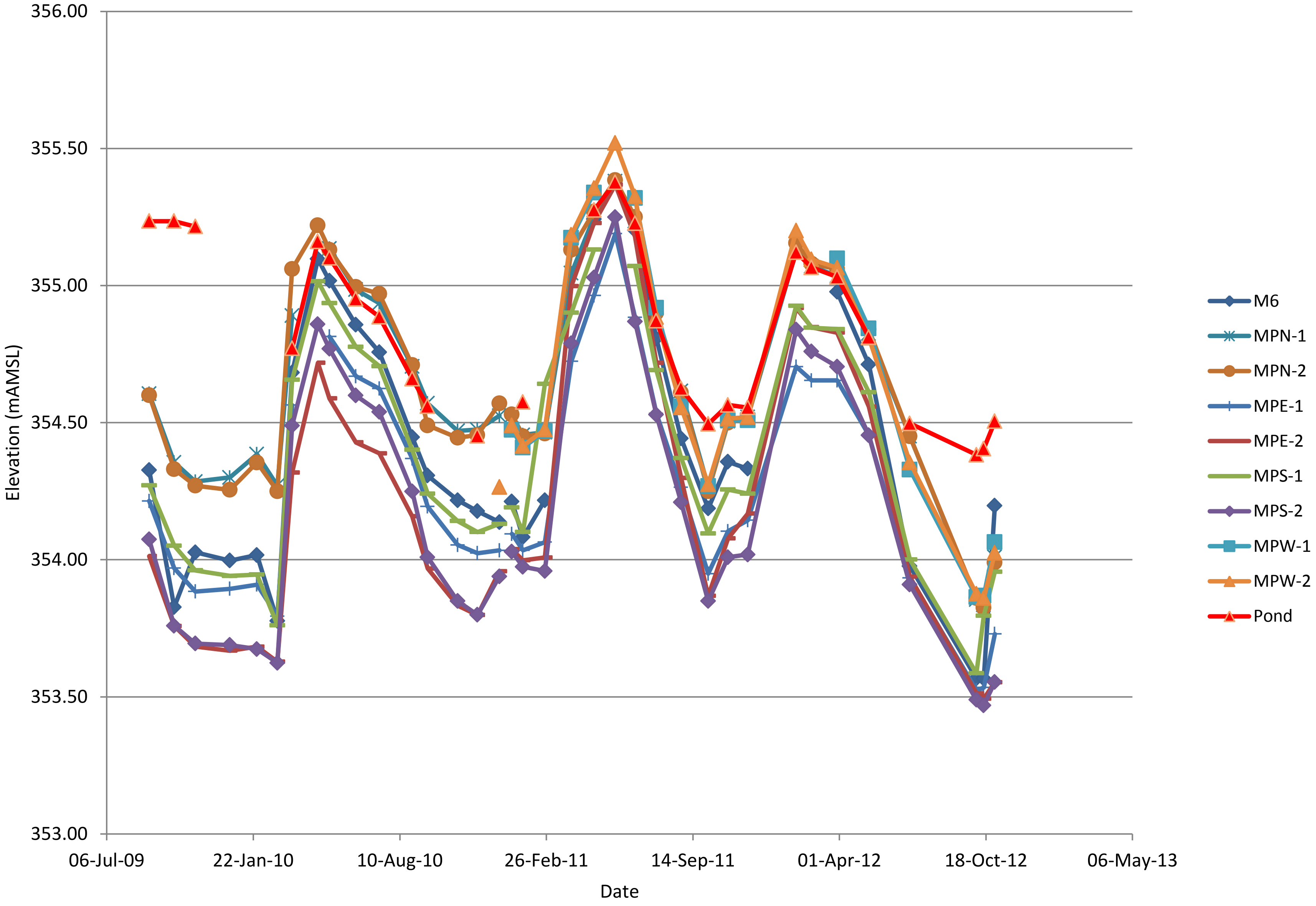
Date: Mar 2012

Drawn By: AR

Hidden Quarry

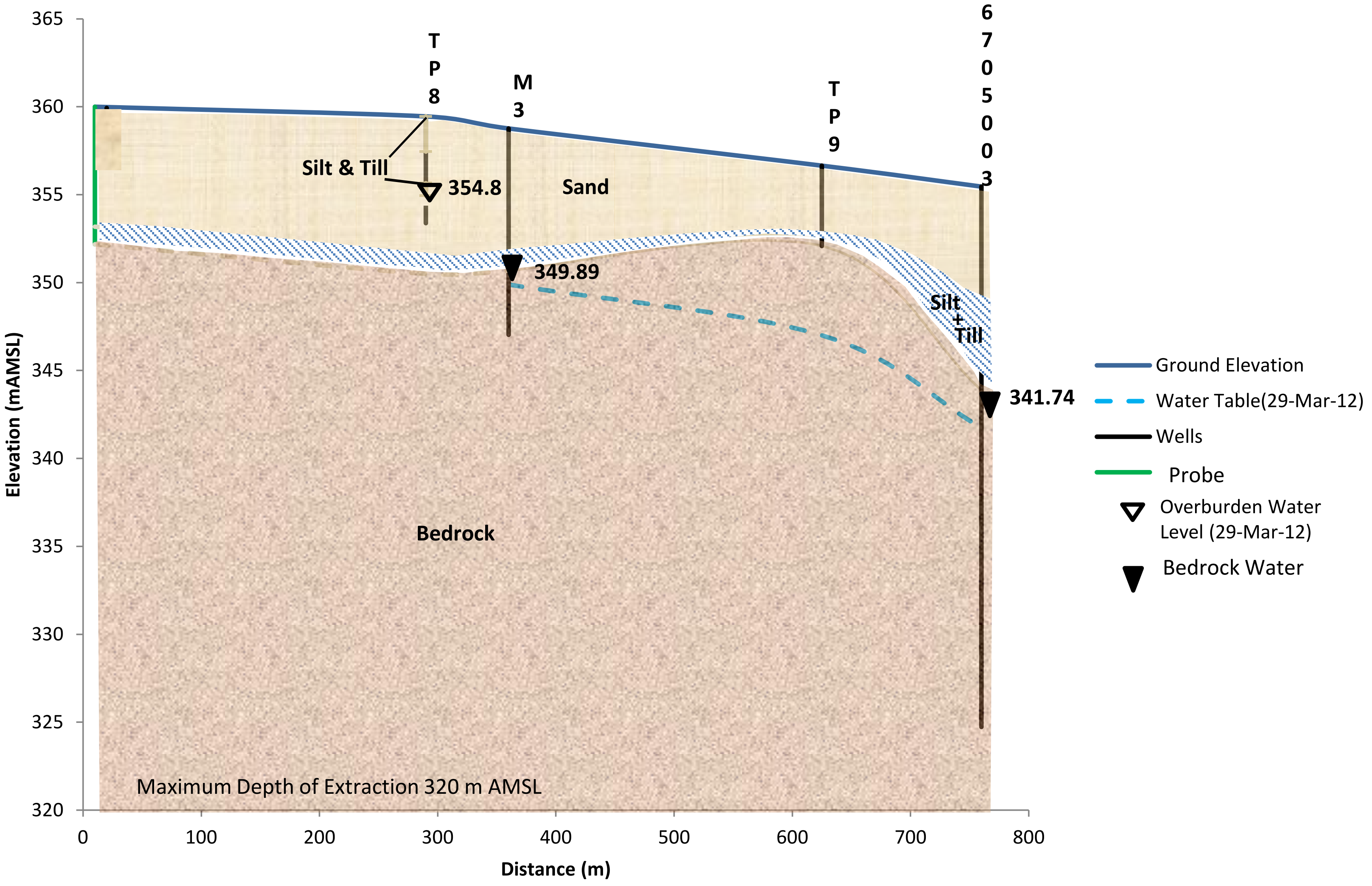
Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure R8: Basal Silt/Till Thickness



Harden **Environmental** **Services Ltd.**	**Project No:** 9506 **Date:** Jan 2013 **Drawn By:** JD	Hidden Quarry Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure R9:** **North-West Wetland Water Levels**

Figure R10 : North-West to South-East Cross Section



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry	**Figure R10:** **North-West to South-East Cross Section**
	Date: Jan 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

Date: June 7, 2013

James Dick Construction Ltd.
Box 470
Bolton, Ontario
L7E 5T4

Attn: Mr. Greg Sweetnam

Dear Mr. Sweetnam:

Re: Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site

1.0 Introduction

We are pleased to provide additional information in regards to geological and hydrogeological characterization of the bedrock underlying the proposed Hidden Quarry. The purpose of this exercise is twofold. Firstly the drilling and testing was conducted in order to satisfy comments made by R.J. Burnside and Associates Ltd. on the Level I and II Hydrogeology Report for the Hidden Quarry and secondly to facilitate monitoring of the site during a proposed pumping test by the Township of Guelph Eramosa in their Well No. 2.

This report details the following field efforts conducted at the site;

1) Drilling of a 140 mm (5.5”) cored borehole by Keith Lang Water Well Drilling,

2) Retrieval and storage of 44.35 metres of core, noted the presence of fractures and breaks in the core,

3) Photographing of the core in both metric and imperial depths below ground surface,

4) Pumping of the well at approximately 2.1 and 4.2 L/s for one hour,

5) Flow profiling of the well and

6) Video logging of the well.

2.0 Drilling Summary

On May 13th and 14th, Keith Lang Water Well Drilling drilled Monitor 15 (M15) at co-ordinates 4829516 N, 571926 E and shown on Figure 1. Keith Lang used a Speedstar 30K drill rig and used mud rotary in the overburden and air rotary in the bedrock. Bedrock was encountered at a depth of 9.55 metres below ground surface (m bgs). The final depth of the borehole was 54.33 m bgs. The diameter of the borehole in the bedrock is 140 mm (5.5"). 150 mm (6") casing was installed to a depth of 10.46 m bgs. There is a stick-up of fifty-one centimetres above ground surface. Bentonite grout was used in the mud circulation to seal the annulus between the overburden and the steel casing. The ground elevation of the borehole is 360.03 metres above mean sea level (m AMSL) and the top of steel casing has an elevation of 360.54 m AMSL.

2.1 Overburden

Wash samples of the overburden were obtained at 1.5 metre intervals. The wash samples only allow for general descriptions of the overburden and in general overburden comprises a very stony sand deposit. Detailed descriptions of the overburden are available from M11 and M12 drilled nearby. The borehole logs for M11 and M12 indicate that the overburden is mainly a stony silty sand.

2.2 Bedrock

The top of bedrock was encountered at a depth of 9.55 m bgs. Coring of the borehole commenced at a depth of 9.98 mbgs. Detailed descriptions of the core are found in the borehole record (Appendix A) and a photo log of the entire core is found in Appendix B. In regards to bedrock nomenclature, all of the dolostone geological units encountered belong to the formerly un-subdivided Amabel Formation. We have attempted to assign individual formation names based on recent work by the Ontario Geological Survey (OGS, 2008)[1] .

Goat Island Formation – Niagara Falls Member

A dark grey non bituminous fine grained dolostone is found in the core between 9.98 m bgs and 10.03 m bgs. This is interpreted to be the Niagara Falls Member of the Goat

---

[1] Summary of Field Work and Other Activities, 2008, OFR 6226, Frank Brunton

Island Formation. Based on a comparison of this core with core of the Eramosa Formation obtained from the Dolime Quarry in Guelph, this core is not representative of the Eramosa Formation.

Gasport Formation

The Gasport Formation is found between 10.03 m bgs and 48.50 m bgs. The Gasport comprises of white to blue grey coarse grained dolostone. The porosity of the Gasport Formation varies from openly porous to tightly packed. There are numerous stylolites within this formation. The formation has visible fossilization of which crinoid stems and brachiopod shell castings were found. Portions of the Gasport Formation are vuggy. No significant loss of core occurred. The driller noted two water bearing fractures at 16 and 18.5 metres depth during the drilling.

Irondequoit Formation

The Irondequoit Formation is found between 48.50 m bgs and 49.93 m bgs. This formation is found to be blue grey dolostone, pyritiferous.

Rockway Formation

The Rockway Formation is found between 49.93 and 50.72 m bgs. The Rockway Formation is a finely crystalline green dolostone. The formation is pyritiferous.

Merriton Formation

The Merriton Formation is found between 50.72 m and 51.51 m bgs. The Merriton Formation is a buff brown finely crystalline dolostone.

Cabot Head Formation

The Cabot Head formation was found below 51.51 m bgs. The Cabot Head formation comprised red and green shale beds.

A summary of the depths and elevations of the geological units is provided in Table 1.

Table 1: Geological Summary

Geological Unit	Depth (m bgs)		Elevation (m AMSL)	
	From	To	From	To
Overburden	0	9.55	360.03	350.48
Goat Island: Niagara Member	9.55*	10.03	350.48	350.00
Gasport Formation	10.03	48.50	350.00	311.53
Irondequoit Formation	48.50	49.93	311.53	310.10
Rockway Formation	49.93	50.72	310.10	309.31
Merriton Formation	50.72	51.51	309.31	308.52
Cabot Head Formation	51.51		308.52	

* Geological unit between top of rock and beginning of core is assumed to be Goat Island Formation

2.3 Description of Core Breaks

Each core break was looked at in the field and at our office and recorded as a machine break, closed fracture or open fracture. The record of core breaks will only include naturally occurring core breaks. The distinction between an open and closed fracture is made where there is evidence of water movement through the break (discolouration, mineral oxidation etc..), imperfect fit of the core and infilling or mineralization along the fracture wall. Where possible, any material found within the fracture was noted, however, the water circulation around the core during the drilling process, likely removed this material, if any was present.

Table 2 (located following the text of this report) is a summary of the core breaks. A total of ninety three natural core breaks are recorded over the 44.35 metres of core. Eighty five percent of core breaks occurred at 90 degree angle relative to the axial length of the core. Two vertical fractures were identified in the core.

The frequency of open fractures is summarized in Table 3.

Table 3: Frequency of Open Fractures

Depth (m bgs)		Number of Open Fractures
From	To	
10	15	7
15	20	3
20	25	9
25	30	8
30	35	10

Depth (m bgs)		Number of Open Fractures
From	To	
35	40	9
40	45	2
45	50	1
50	55	5

The greatest concentration of open fractures occurs between the depth of 20 and 40 metres below ground surface.

2.4 Photo Log of Core

A photo log of the core is found in Appendix B. The photo log is provided in both metric and imperial units. Open and closed fractures are noted on the photo log as well as the interpreted geological contacts. Significant water bearing zones as identified from the downhole flow test and video log are also identified on the photo log.

3.0 Pumping Tests

Monitoring well M15 was pumped prior to and during the flow testing and video logging procedures. Prior to flow testing, the well was pumped at 2.1 and 4.2 litres per second for approximately 60 minutes and 30 minutes respectively. The drawdown curves for these pumping rates are shown on Figure 2. The drawdown after 60 minutes of pumping at 2.1 L/s was 1.21 m. The drawdown after 34 minutes at the 4.2 L/s rate was 2.24 m. Semi-log graphs of the 2.1 L/s and 4.2 L/s test are shown on Figures 3 and 4 respectively. Straight line analysis (Jacob semi log method) suggests that the transmissivity of the aquifer is between 50 and 70 m^2/day. This translates to an estimated hydraulic conductivity of 2 x 10^{-5} m/s (using relationship of T = k/b where b = aquifer thickness of 38.5 metres). The maximum drawdown in M15 was observed at the end of the flow testing at 2.67 metres.

Manual measurements and an automatic logger installed in M2 recorded the effects of pumping. The hydrograph for M2 is shown on Figure 5. M2 also penetrates the entire thickness of the aquifer. The maximum response in M2 was approximately 1.23 metres. The semi-log graph of the drawdown of M2 from the pumping at 4.2 L/s is shown on Figure 6. The straight-line analysis of the data results in an estimated transmissivity of 83 m^2/day in the aquifer.

As shown in Table 3, no response was measured in M1D, M3 or M13D.

Table 3: Water Levels in Shallow Bedrock Monitors on May 24, 2013

Time	M1D (mbct)	Time	M3 (mbct)	Time	M13D (mbct)
10:43	7.875	10:15	10.295	10:48	2.95
10:59	7.875	11:39	10.295	10:55	2.95
11:09	7.875	12:27	10.295	11:14	2.95
11:25	7.875	14:22	10.28	11:22	2.95
14:48	7.88	15:03	10.28	14:43	2.95

3.1 Flow Test

The velocity of water moving through the borehole was measured with a down-hole flow meter. The flow meter was installed in the well and the pump was installed above the flow meter. The pump was operated with a flow rate of approximately 4.2 L/s during the flow measurements. Flow measurements were obtained every 0.30 metres. The results of the flow test are provided in Table 4 following this report and shown graphically on Figure 7. The flow velocity steadily declines between 15 and 36 m bgs. At 36 metres depth, the flow velocity decreases by 0.1 m/s followed by another significant drop in velocity at 42 m bgs. Below 42 mbgs there is negligible flow in the well.

The flow test shows that approximately one third of the yield of the well is derived from various fractures between 10 m and 36 m bgs (350 to 324 m AMSL), one third of the well yield is obtained from a single set of fractures at 36 m bgs (324 m AMSL) and a third of the well yield is obtained from a fracture at 42 m bgs (318 m AMSL) (Table 5).

The maximum flow measured by the flow meter was approximately 0.27 m/s. The area of the borehole is 0.0153 m^2. Thus the volume of water flowing through the well beneath the pump was approximately 4.1 L/s. This is similar to the pumping rate of 4.2 L/s and thus the majority of water removed by the pump was derived from below the pump.

Table 5: Flow Test Summary

Interval (m AMSL)	Interval (m bgs)	Approximate % Yield
324 to 350	10 to 36	33
324	36	33
318	42	33

4.0 Video Log

A video camera was introduced to the well both above and below the pump. The video log is another method that can be used to identify discrete zones of water movement. Two videos were taken by Geokamp Ltd.

4.1 Video 1 – Above Pump Video

Video 1 was taken above the pump before and after pumping occurred. This video shows the bottom of the casing where contact with the rock is made. When the pump is turned on at 5:58 (minutes:seconds) of the video, the water can be observed to recede below the casing/bedrock contact. There is no observable movement of water at that contact. Turbid water can be observed to flow into the wellbore at time 8:46 of the video at a depth of 42’ (12.80 m).

4.2 Video 2 – Below Pump Video

The pump was installed at a depth of approximately 12 metres below the top of casing. The video log identifies that below a depth of 45 metres (148’), the water is stagnant despite the continual operation of the pump. This confirms that the lower portion of the aquifer is not an active part of the flow system. This includes the Irondequoit, Merriton, Rockway and Cabot Head formations.

The video identifies water movement into the well at 52’ (15.8 m).

5.0 Water Levels

Water levels were obtained from M15 on several occasions as summarized in Table 6. The stabilized groundwater elevation in M15 was measured to be 350.69 m AMSL on May 24, 2013. This value correlates to the contoured bedrock water levels as shown on Figure 3.17 of the Level I and Level II hydrogeology report.

Table 7: Water Level Monitoring M15

Date	Water Level (m bgs)	Water Level (m AMSL)
May 14, 2013	9.26	350.77
May 15, 2013	9.12	350.91
May 16, 2013	9.28	350.75
May 24, 2013	9.34	350.69

6.0 Water Quality Results

The water quality results for a sample obtained during the pumping are presented in Appendix C. The water has a nitrate value of 2.0 mg/L and chloride value of 16 mg/L. The low nitrate and chloride concentration indicates relatively low impact from anthropogenic activity. The water quality is typical for the dolostone aquifer in this area.

7.0 Recommended Multi-Level Installation Details

Monitoring Well M15 will be converted into a multi-level monitoring station using 40 mm PVC pipe. The main water bearing zones will be targeted for the discrete monitoring zones. We recommend the following zones for monitoring.

Monitoring Level	Interval (m bgs)		Interval (m AMSL)	
	From	To	From	To
Shallow	10	28	350.03	332.03
Intermediate	33	38	327.03	322.03
Deep	40	55	320.03	305.03

The shallow monitoring level represents the upper water bearing zone and is the zone where the majority of local wells obtain their water. The intermediate zone covers the major water bearing fracture located at a depth of 36 metres. The deep monitoring interval covers the major water bearing fracture at 42 metres. The majority of water movement through the quarry will occur between the elevation of 332 and 350 m AMSL. The maximum proposed depth of the quarry is 30 metres to an elevation of 320 m AMSL. It is more likely that the quarry will be limited to a depth of 25 metres or an elevation of 325 m AMSL. Thus the shallow and intermediate monitoring intervals will monitor water level changes and water quality changes occurring downgradient of the quarry and the deep monitoring zone will be able to monitor water level changes in the water bearing zone beneath the quarry. The intervals will be separated by a bentonite seal. A coarse sand will be used to fill the annulus between the screen and the borehole wall.

8.0 Discussion

The installation of M15 was a useful exercise as it confirmed the following about hydrogeological conditions within the proposed Hidden Quarry site;

1) There are no significant karst features identified in the geological profile. This is in keeping with the observations at M1, M2, M3, M4, M13D and M14D. The core obtained from M15 contains fractures, however, none suggest karstification of the dolostone aquifer.

2) Water bearing zones occur throughout the geological profile. The Gasport Formation is well known for its water bearing ability and this characteristic was confirmed at M15. Water bearing zones occur from the top of bedrock at an elevation of 350 m AMSL to an elevation of 318 m AMSL. There was no indication of preferential flow through the upper three metres of the geological profile.

3) Lateral hydraulic connectivity within the aquifer occurs at depth. There was a hydraulic response noted in monitor M2 to the pumping of M15. M2 and M15 fully penetrate the dolostone aquifer and the response in M2 verifies that water transmission will occur through the aquifer. This proves that M2 will be a useful monitor during the quarry operation to observe changes in the aquifer during extraction.

4) Hydraulic responses were not observed within the shallow bedrock at M1D, M13D or M3 whose completion elevations are all above 346 m AMSL. These wells are completed in the upper three metres of the bedrock. The lack of immediate hydraulic response is due to a relatively poor hydraulic connectivity between the shallow bedrock and deeper fractures; and poor lateral connectivity in the shallow zone. It is anticipated that the shallow bedrock zone will ultimately experience a hydraulic response after a prolonged water level change.

5) Although pumping periods were short, the response in the pumping well and in M2 were used to estimate transmissivity of the aquifer. The near-well transmissivity is estimated to range from 50 m^2/day to 80 m^2/day. This correlates well to the bulk hydraulic conductivity used in the model for the dolostone aquifer. These values also correlate well to the hydraulic testing conducted on the adjacent Mudge property where transmissivity of the aquifer was found to range from 20 to 150 m^2/day.

9.0 Response to Burnside Comments

We provide the following for inclusion in the response matrix for issues raised by Burnside.

Matrix #	Burnside Comment	Harden Response
72	There is not sufficient information on the bedrock in the extraction areas to allow for a reliable prediction of drawdown to be made. The vertical spacing and contribution of the water bearing fractures is not known and as a result, inflow into the pit may result in temporary dewatering of shallow fractures. The length of time for water levels to stabilize is not estimated. There is also a potential that bedrock water quality will be affected if cascading occurs within the extraction area.	The drilling of M15 along with the drill core, video log and down-hole flow monitoring provides confirmation that hydrogeological conditions beneath the quarry are satisfactorily understood. Open fractures and thus water yield for residential wells comes from a wide depth range and the concern regarding dewatering of shallow fractures is not a significant impact as there are numerous water sources at depth in the aquifer. There is not an indication from water well records that nearby wells only obtain water from the portion of the aquifer predicted to be impacted. The maximum off-site impact is predicted to be in the order of 1.5 metres. This is insufficient to significantly change the yield in any bedrock well. The mining process is relatively slow and occurs only for the working portion of the day allowing for daily recovery (at least, partial recovery) of water levels. Thus stabilization of water levels will occur relatively rapidly (days to months) following cessation of mining. The maximum water level change within the quarry is predicted to be 2.45 m at the northern edge of the west pond. This penultimate drawdown will only occur at the end of the quarry life and there will be many years of monitoring to verify that the slow change in water levels is not having an impact on the environment and local wells. It is unlikely that there will be water cascading into the quarry. Our observations of several dolostone quarries in southern Ontario suggest that there is more likely to be water movement behind the rock face. Even so, this cascading can only occur in the upper three metres of the bedrock along the

Matrix #	Burnside Comment	Harden Response
		northern most quarry edge. It is our prediction that at the edge, these three metres will be dewatered and no cascading will occur. The quarry will allow water from various zones within the bedrock to mix but no more than a water well mixes water from the full length of aquifer intersected by the well.
60	The Guelph Eramosa Study used significantly higher hydraulic conductivity values. Since the bedrock is heterogeneous significant variations in hydraulic conductivity can be expected. Additional data from within the extraction area is needed to confirm on-site conditions.	Based on the short term tests conducted in M15, the transmissivity of the aquifer is 50 to 80 m^2/day and within the range as originally predicted. The hydraulic conductivity of the aquifer based on this transmissivity is estimated to be 2×10^{-5} m/s, the same value used in the groundwater model. The data from M15 confirms that there are no unexpected onsite geological or hydrogeological conditions.
54	The bedrock surface is shown in Figure 3.5. The proposed extraction area should be added to this map. It appears that there are few (if any) bedrock monitoring wells within the two extraction areas. Given the heterogeneity of the bedrock, it is recommended that monitoring wells be installed within the extraction areas.	M15 was drilled to satisfy this comment. M15 will be instrumented on several different levels. The testing of M15 confirms that as with all bedrock aquifers, there is vertical heterogeneity with water being produced both diffusely from broad areas and discretely from single fractures. M15 is located centrally to the site between the proposed extraction areas and provides confirmation of hydrogeological conditions already anticipated in the Level I and Level II Hydrogeology Report.
56	It is noted in the report that the Brydson Spring likely represents discharge directly from the bedrock and can be considered to be the re-emergence of Tributaries B and C. There are	The water levels obtained from M2, M12, M3, M15 and M11 confirm that geological conditions are such that groundwater does not occur in the overburden in the eastern two

Matrix #	Burnside Comment	Harden Response
	limited bedrock wells on the proposed quarry site and there is no data that confirms that the tributary loses water to the bedrock. Tracer testing should be considered to confirm this statement.	thirds of this site despite the loss of water from Tributary B. The static water level at the on-site home (MOE Well # 6705627) is below the top of rock. This well is situated very close to Tributary B and downstream of the losing portion of the stream. There is no evidence to suggest that water lost from Tributary B does anything but contribute to the bedrock aquifer. The Brydson Spring is the nearest discharge point and thus a likely destination for water infiltrating local to the quarry. There is no appreciable thickness of overburden at the Brydson Spring or in the Blue Springs Creek valley, thus all infiltrating waters at the site and nearby must contribute to the bedrock. It is our opinion that a tracer test will not yield any meaningful information.

Respectully submitted,
Harden Environmental Services Ltd.

Stan Denhoed

Stan Denhoed, M.Sc., P. Eng.
Senior Hydrogeologist

Table 2: Log of Core Breaks

Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
32.83	10.01	open	90	
33.08	10.08	open	90	
33.17	10.11	open	90	
34.00	10.36	closed	90	
35.29	10.76	open	90	
36.25	11.05	open	90	calcite mineralization
37.83	11.53	closed	90	
41.17	12.55	open	90	iron staining
41.50	12.65	open	90	
48.71	14.85	open	90	clay infilling
50.96	15.53	open	30	brown staining
51.67	15.75	closed	90	
53.67	16.36	open	90	
60.83	18.54	open	90	
61.33	18.69	closed	10	
65.75	20.04	open	90	discolouration along fracture
67.33	20.52	open	90	
68.33	20.83	open	90	
68.83	20.98	open	90	
71.54	21.81	closed	0-90	
72.58	22.12	closed	90	
73.50 - 74.25	22.40 - 22.63	closed	vertical	
74.67	22.76	closed	90	
77.00	23.47	closed	45	
77.21	23.53	open	90	iron staining
77.38	23.58	open	90	iron staining
79.71	24.30	open	90	
79.79	24.32	open	90	
80.63	24.57	open	90	
81.00	24.69	open	90	
83.25	25.37	open	45	
84.17	25.65	open	30	
85.17	25.96	open	90	
86.54	26.38	open	90	
86.92	26.49	open	90	
88.42	26.95	closed	impact fract from driller	
90.75	27.66	open	90	
95.33	29.06	open	20	
98.25	29.95	open	45	
98.63	30.06	open	90	
99.25	30.25	open	45	
99.50	30.33	open	90	
100.83	30.73	closed	90	

Table 2: Log of Core Breaks

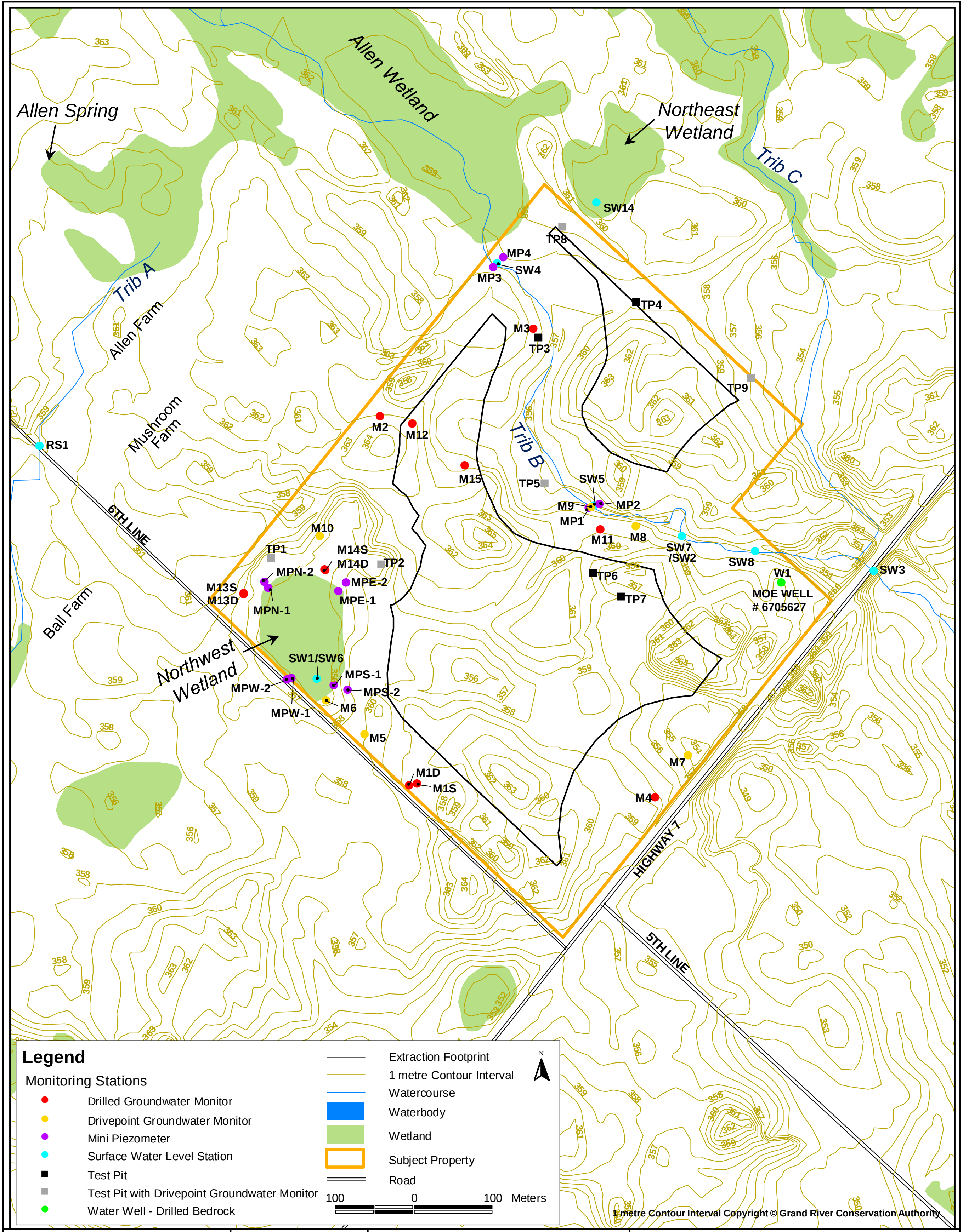
Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
101.25	30.86	closed	90	
102.00	31.09	open	90	vuggy
102.50	31.24	open	90	
102.83	31.34	closed	90	
103.42	31.52	open	90	
106.33	32.41	open	90	
108.42	33.05	closed	90	
109.25	33.30	open	90	drill stem dropped 2-3"
110.17	33.58	closed	90	
112.33	34.24	open	90	
112.83	34.39	closed	vertical	
114.17	34.80	closed	90	
114.50	34.90	open	90	discoloured
117.08	35.69	closed	90	
117.33	35.76	open	90	
119.50	36.42	open	90	
120.25	36.65	closed	90	
120.71	36.79	open	90	
120.79	36.82	open	90	
121.00	36.88	open	90	
124.33	37.90	open	90	
126.83	38.66	open	90	
128.00	39.01	closed	90	
128.75	39.24	open	90	
131.17	39.98	open	90	discolouration around fract-whiter
131.92	40.21	closed	90	
136.08	41.48	open	90	
142.08	43.31	closed	90	
144.50	44.04	open	90	white discolouration around fracture
147.83	45.06	closed	10	
148.00	45.11	closed	90	
152.42	46.46	closed	90	
152.75	46.56	closed	90	
156.50	47.70	open	90	
157.50	48.01	closed	30	
157.96	48.15	closed	30	
161.42	49.20	closed	90	
161.67	49.28	closed	90	
163.92	49.96	closed	90	
164.17	50.04	closed	90	
164.58	50.17	closed	90	
165.50	50.44	closed	90	
165.67	50.50	closed	90	

Table 2: Log of Core Breaks

Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
165.75	50.52	closed	90	
166.00	50.60	open	90	
166.42	50.72	open	90	
167.83	51.16	open	90	
168.17	51.26	open	90	
168.50	51.36	closed	90	
168.92	51.49	open	90	

Table 4: M15 Flow Test Results

Depth (Feet b.c.t.)	Velocity (ft/sec)	Depth m bgs	Velocity (m/s)
50	0.89	14.73	0.27
51	0.88	15.03	0.27
52	0.88	15.34	0.27
53	0.87	15.64	0.27
54	0.87	15.95	0.27
55	0.87	16.25	0.27
56	0.86	16.56	0.26
57	0.83	16.86	0.25
58	0.85	17.17	0.26
59	0.83	17.47	0.25
60	0.82	17.78	0.25
61	0.82	18.08	0.25
62	0.85	18.39	0.26
63	0.8	18.69	0.24
64	0.75	19.00	0.23
65	0.74	19.30	0.23
66	0.74	19.61	0.23
67	0.74	19.91	0.23
68	0.77	20.22	0.23
69	0.78	20.52	0.24
70	0.76	20.83	0.23
71	0.76	21.13	0.23
72	0.77	21.44	0.23
73	0.75	21.74	0.23
74	0.75	22.05	0.23
75	0.75	22.35	0.23
76	0.75	22.65	0.23
77	0.74	22.96	0.23
78	0.74	23.26	0.23
79	0.78	23.57	0.24
80	0.75	23.87	0.23
81	0.74	24.18	0.23
82	0.75	24.48	0.23
83	0.77	24.79	0.23
84	0.75	25.09	0.23
85	0.76	25.40	0.23
86	0.75	25.70	0.23
87	0.78	26.01	0.24
88	0.73	26.31	0.22
89	0.7	26.62	0.21
90	0.7	26.92	0.21
91	0.71	27.23	0.22
92	0.71	27.53	0.22
93	0.71	27.84	0.22
94	0.71	28.14	0.22
95	0.7	28.45	0.21
96	0.71	28.75	0.22
97	0.69	29.06	0.21
98	0.68	29.36	0.21
99	0.64	29.67	0.20
100	0.69	29.97	0.21
101	0.65	30.27	0.20
102	0.68	30.58	0.21
103	0.68	30.88	0.21
104	0.68	31.19	0.21
105	0.67	31.49	0.20
106	0.67	31.80	0.20
107	0.69	32.10	0.21
108	0.68	32.41	0.21
109	0.68	32.71	0.21
110	0.66	33.02	0.20
111	0.63	33.32	0.19
112	0.62	33.63	0.19
113	0.63	33.93	0.19
114	0.66	34.24	0.20
115	0.64	34.54	0.20
116	0.64	34.85	0.20
117	0.67	35.15	0.20
118	0.61	35.46	0.19
119	0.6	35.76	0.18
120	0.6	36.07	0.18
121	0.7	36.37	0.21
122	0.33	36.68	0.10
123	0.33	36.98	0.10
124	0.35	37.29	0.11
125	0.38	37.59	0.12
126	0.36	37.89	0.11
127	0.32	38.20	0.10
128	0.26	38.50	0.08
129	0.3	38.81	0.09
130	0.33	39.11	0.10
131	0.34	39.42	0.10
132	0.3	39.72	0.09
133	0.32	40.03	0.10
134	0.28	40.33	0.09
135	0.33	40.64	0.10
136	0.3	40.94	0.09
137	0.09	41.25	0.03
138	0.32	41.55	0.10
139	0.31	41.86	0.09
140	0	42.16	0.00



Harden Environmental Services Ltd.

Project No: 9506

Date: June 2013

Drawn By: AR

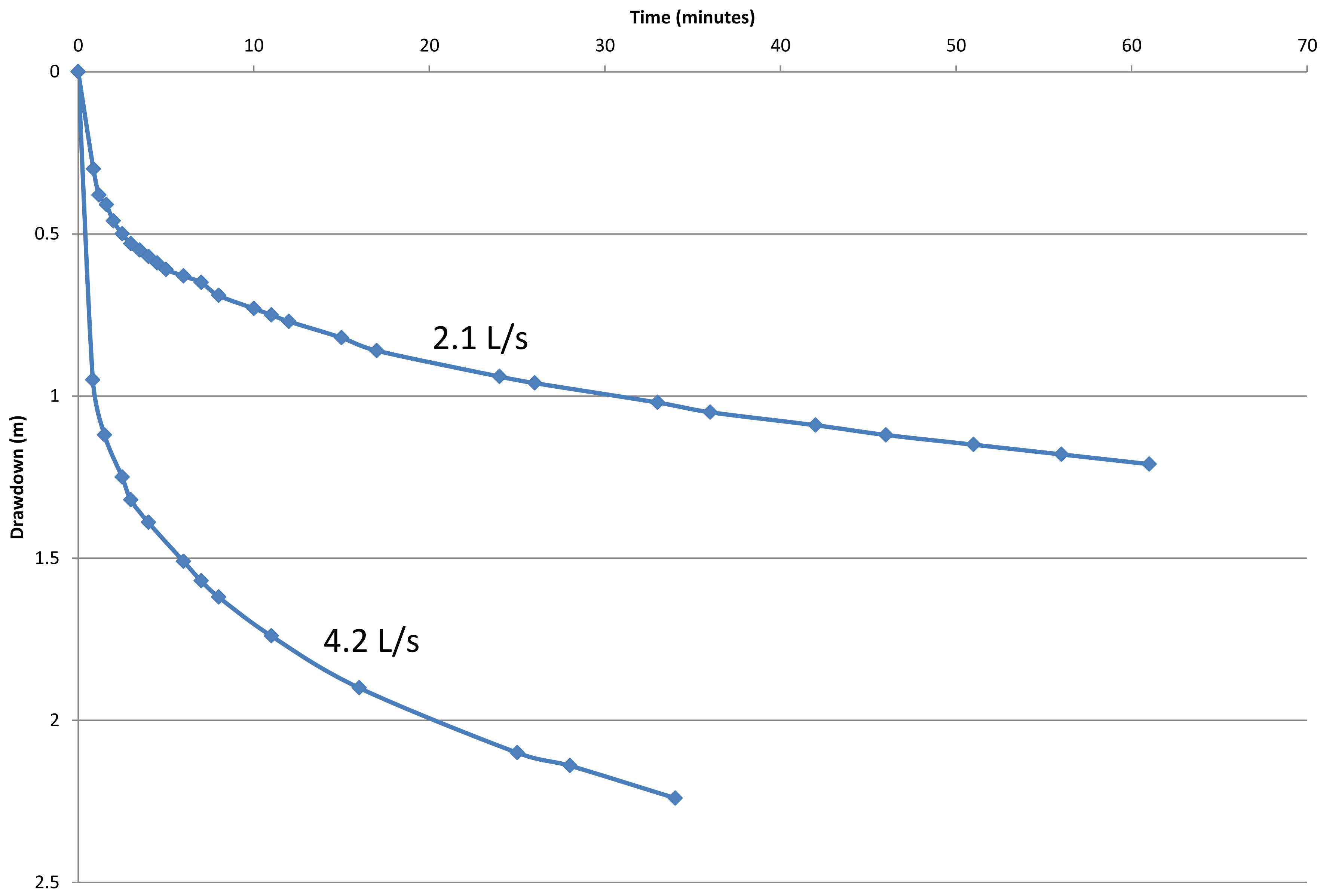
Hidden Quarry Summary of Drilling and Testing
New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1:

Monitoring Locations

Figure 2: M15 Step Test



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Hidden Quarry Summary of Drilling and Testing New Well M15

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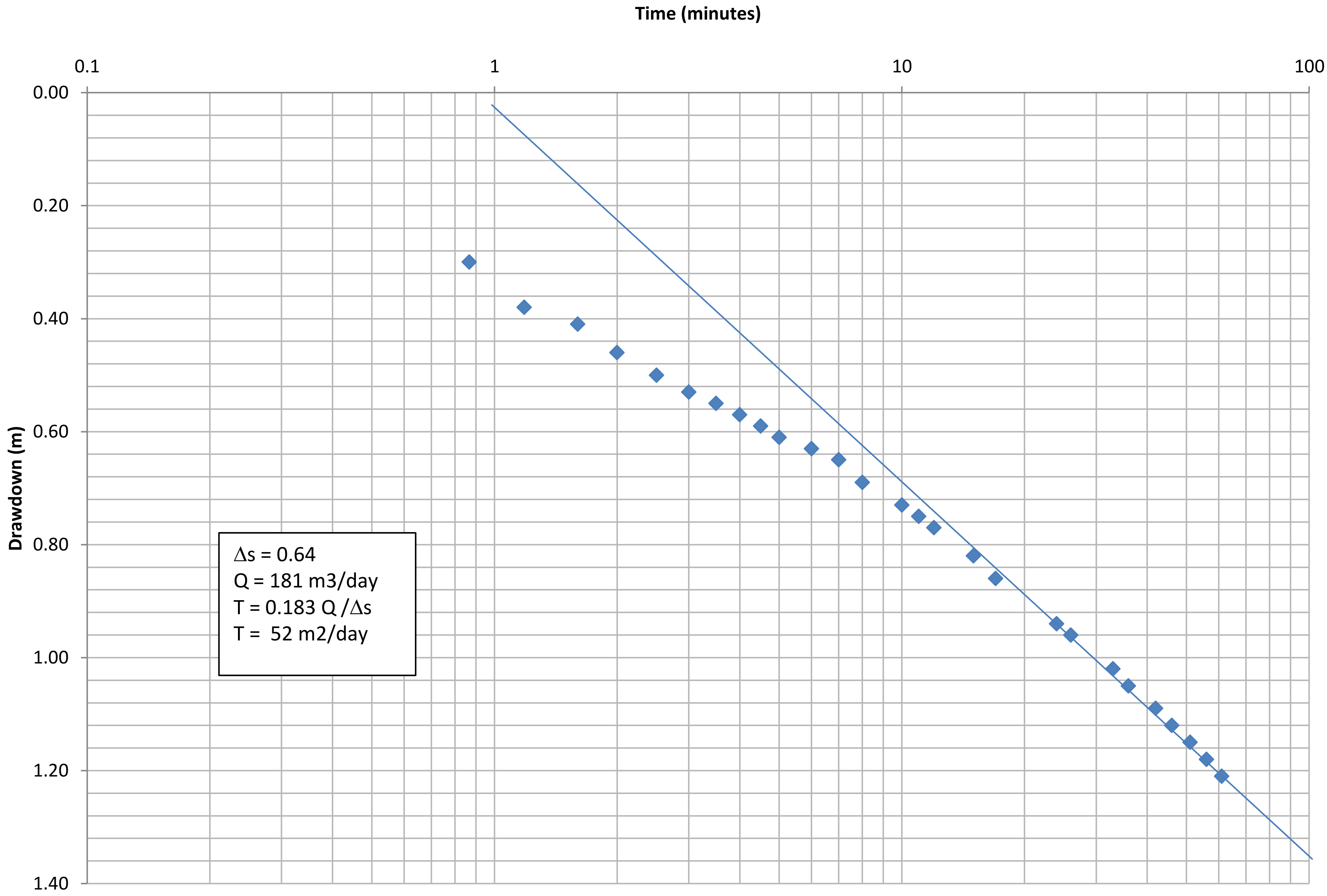
Figure 2: M15 Step Test

Figure 3: M15 2.1 L/s Step Test



Δs = 0.64
Q = 181 m3/day
T = 0.183 Q /Δs
T = 52 m2/day

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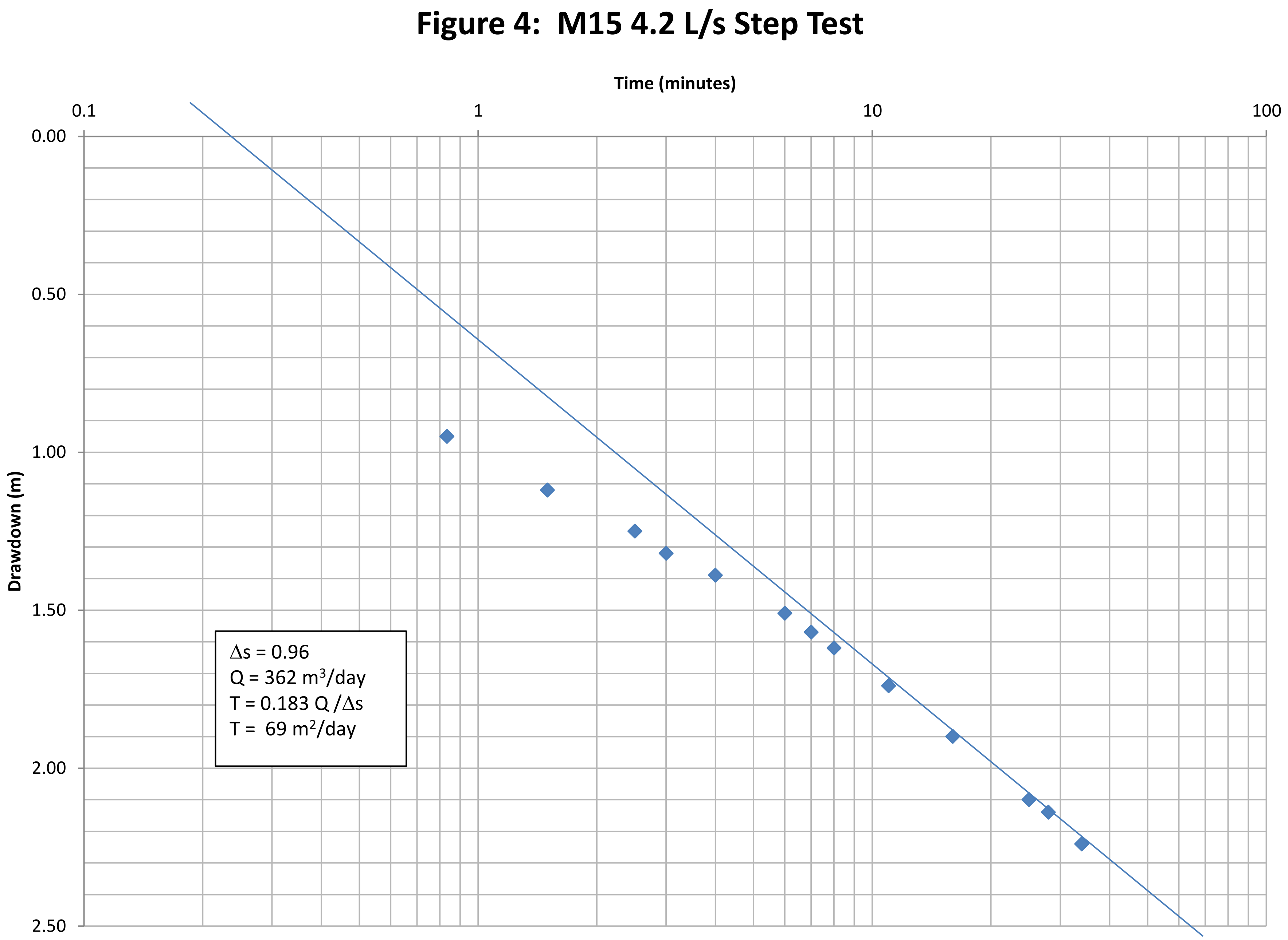
Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3: M15 2.1 L/s Step Test Semi-log Plot



$\Delta s = 0.96$
$Q = 362\ m^3/day$
$T = 0.183\ Q / \Delta s$
$T = 69\ m^2/day$

Harden Environmental Services Ltd.

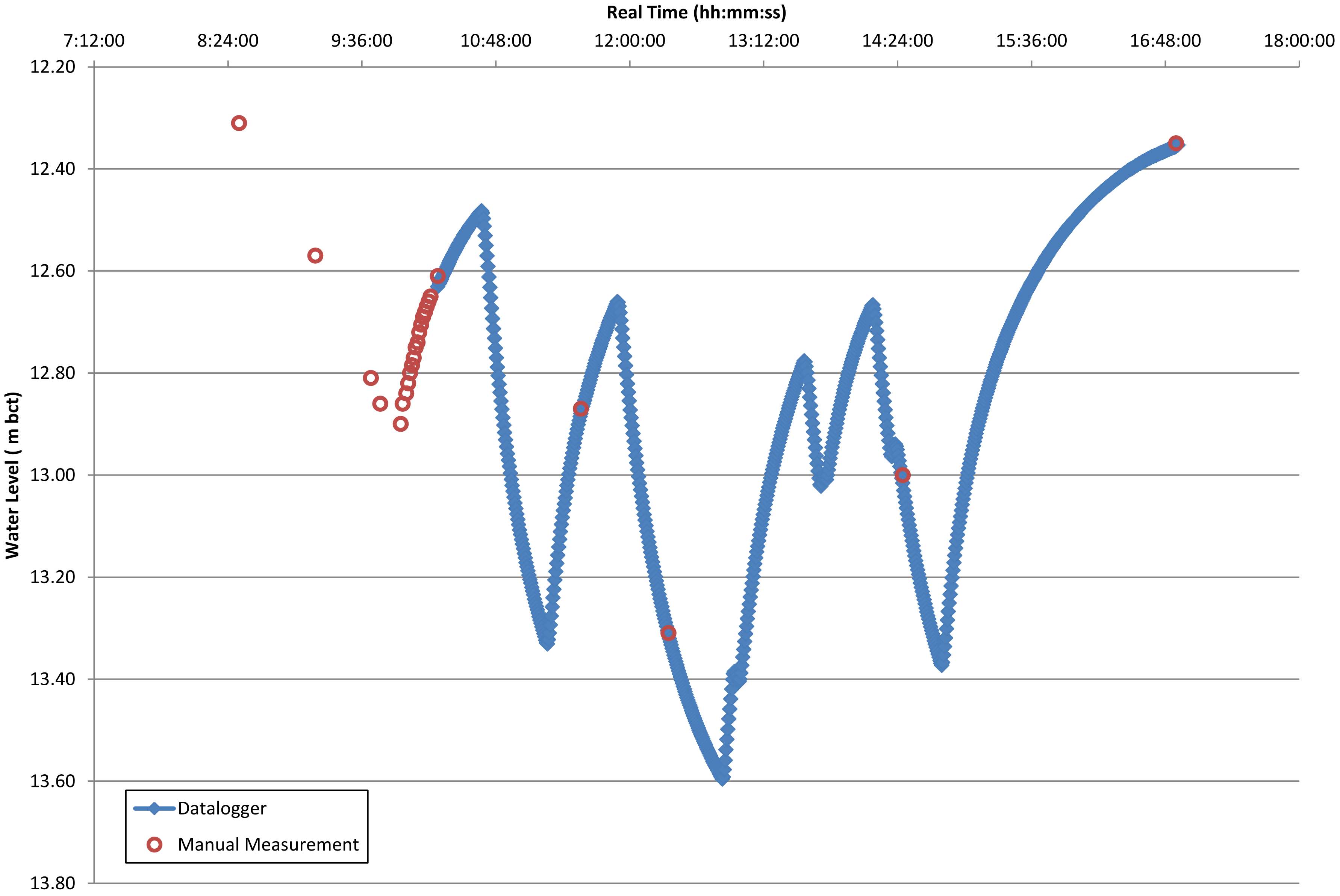
Project No: 9506
Date: June 2013
Drawn By: AR

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

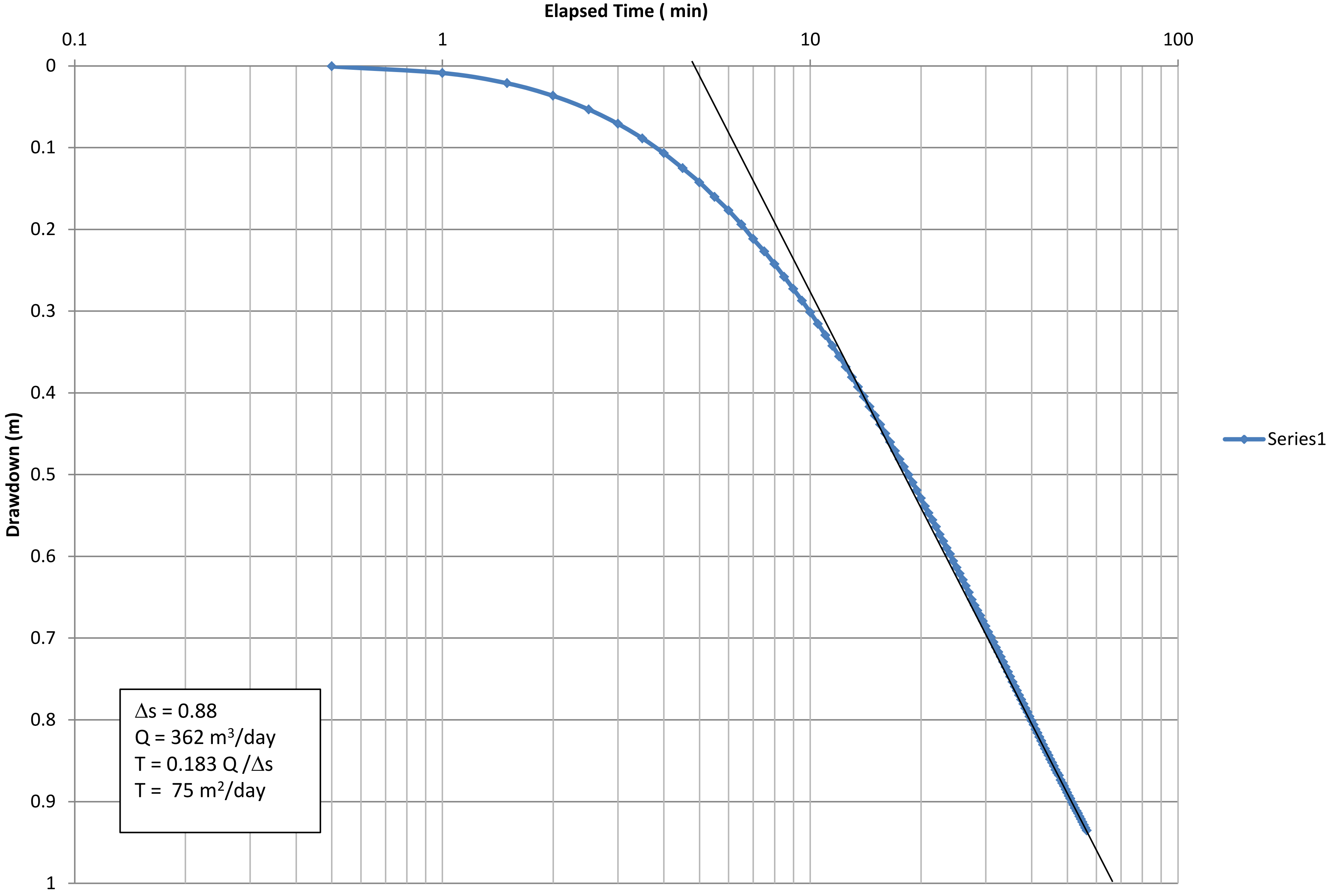
Figure 4: M15 4.2 L/s Step Test Semi-log Plot

Figure 5: M2 Response During M15 Testing



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 5: M2 Response During M15 Testing**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Figure 6: M2 Response to 4.2 L/s Pumping in M15



Δs = 0.88
Q = 362 m³/day
T = 0.183 Q /Δs
T = 75 m²/day

Harden Environmental Services Ltd.

Project No: 9506

Date: June 2013

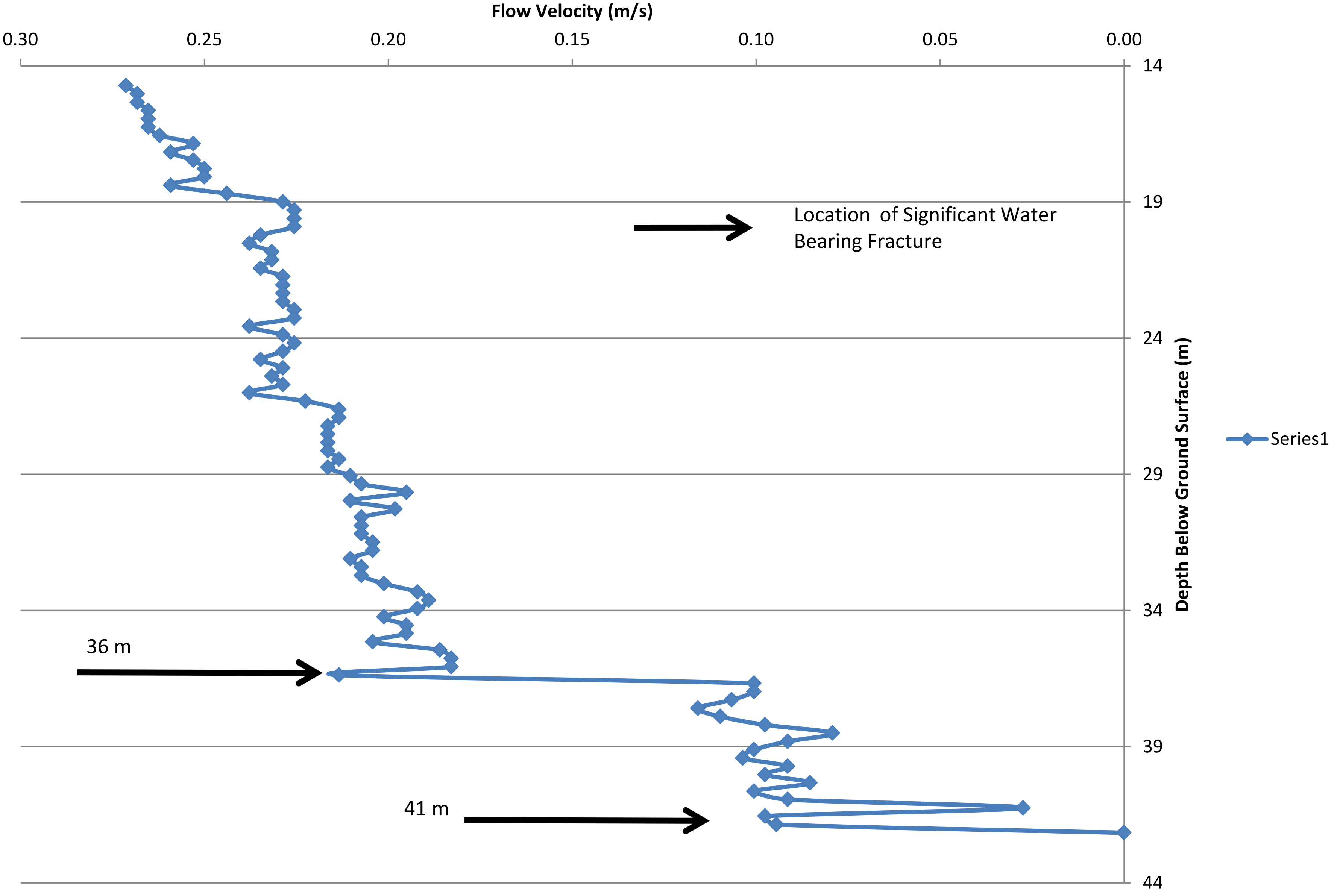
Drawn By: AR

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 6: M2 Response to 4.2 L/s Pumping in M15

Figure 7: Results of Flow Test



Harden Environmental Services Ltd.

Project No: 9506	Hidden Quarry Summary of Drilling and Testing New Well M15
Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington
Drawn By: AR	

Figure 7: Results of Flow Test

APPENDIX A

M15 Borehole Log

PROJECT: 9506

M15

LOCATION: Hidden Quarry

BORING DATE: 15-05-2013 **DATUM:** GROUND SURFACE **DIP:** **LOGGED:** SD

BORING METHOD: Rotary Drilling

CONCENTRATION (%)

LEL ◆
MOISTURE CONTENT ●
GAS CONCENTRATION ■
0 20 40 60 80 100

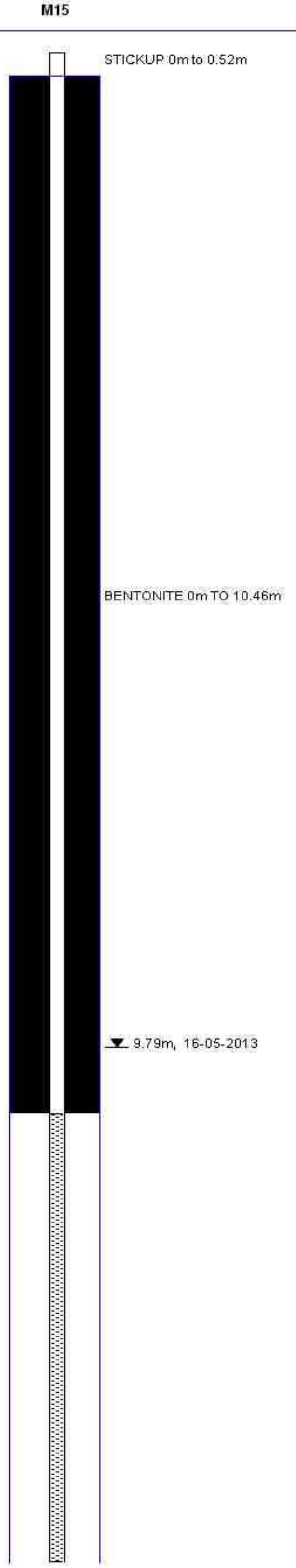
SOIL PROFILE

DESCRIPTION	DEPTH B.G.S. (m)
Stony Silty Sand Paleozoic-stone rich silty sand	0
Goat Island Formation - Niagara Falls Member Dark grey non bituminous fine grained dolostone.	9.55
Gasport Formation. 0.2 to 0.3 metres thick beds of white dolostone and blue grey dolostone. Iron staining at 12.54 metres. Open fractures at 10.08 m, 10.11 m, 10.76 m, 11.05 m, 12.55 m, 12.65 m	10.03
Gasport Formation. White to blue grey dolostone. Numerous stylolites. Clay filled fracture at 14.85m. Open fracture at 14.85 m.	13.11

SAMPLES

ID	TYPE	RECOVERY (%)	"N" VALUE
S1	Wash		
S2	Wash		
S3	Wash		
S4	Wash		
S5	Wash		
S6	Wash		
S7	Wash		
C1	Core		
C2	Core		

INSTALLATION INFORMATION



Continued on next page

DRAWN: JD

CHECKED: SD

PROJECT: 9506

LOCATION: Hidden Quarry

M15

BORING DATE: 15-05-2013 DATUM: GROUND SURFACE DIP: LOGGED: SD

DEPTH SCALE: METRES 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30; FEET 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98

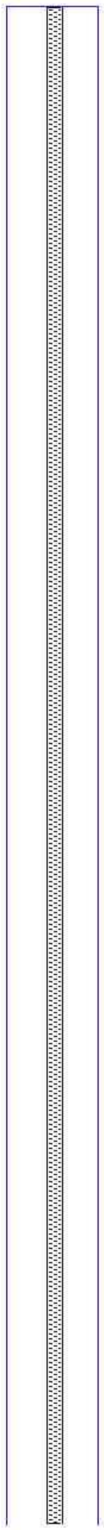
CONCENTRATION (%): LEL ◆ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100

BORING METHOD	SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
Rotary Drilling	Gasport Formation. 0.2 to 2.0 metre thick beds of white and blue grey dolostone. Fossiliferous. Openly porous below 16.24 m. Open fractures at: 15.53 m, 16.36 m. Water bearing fracture at 16.36 m.	15.11	C3	Core		
	Gasport Formation. White and blue grey beds of dolostone. Vuggy below 18.54 m. Fossiliferous. Brachiopod castings and crinoid stems. Open fractures at: 18.54 m, 20.04 m, 20.52 m, 20.83 m, 20.98 m. Water bearing fracture at 18.54 m.	18.14	C4	Core		
	Gasport Formation. White and blue grey dolostone. Thick zones of crinoid stems. More openly porous below 22.80 m. Open fractures at: 23.53 m, 23.58.	21.26	C5	Core		
	Gasport Formation. Blue grey dolostone. Large visible fossils. Openly porous. Open fractures at: 24.30 m, 24.32 m, 24.57 m, 24.69 m, 25.37 m, 25.65 m, 25.96 m, 26.38 m, 26.49 m. Water bearing fracture at 25.96 m.	24.18	C6	Core		
	Gasport Formation. White and blue grey dolostone. Large visible fossils. Openly porous. Large crinoid stems from 26.50 to 26.90 metres. Open fractures at: 27.66 m, 29.06 m, 29.95 m, 30.06 m, 30.25 m, 30.33 m.	27.38	C7	Core		

Continued on next page

INSTALLATION INFORMATION

M15



PROJECT: 9506

LOCATION: Hidden Quarry

M15

BORING DATE: 15-05-2013 **DATUM:** GROUND SURFACE **DIP:** **LOGGED:** SD

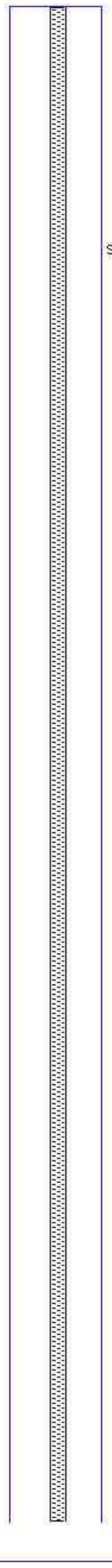
BORING METHOD: Rotary Drilling

CONCENTRATION (%): LEL ◆ MOISTURE CONTENT ● GAS CONCENTRATION ■ (0 20 40 60 80 100)

DEPTH SCALE METRES	DEPTH SCALE FEET	DESCRIPTION	DEPTH B.G.S. (m)	ID	TYPE	RECOVERY (%)	"N" VALUE
30	100	Gasport Formation. White and blue grey dolostone. Large visible fossils. Openly porous.		C7	Core		
31–33	102–108	Gasport Formation. Blue grey dolostone. Large visible fossils. Openly porous. Grey vuggy section from 31.30 to 31.60 metres. Open fractures at: 31.09 m, 31.24 m, 31.52 m, 32.41 m, 33.30 m.	30.38	C8	Core		
34–36	110–118	Gasport Formation. Blue grey dolostone. Vuggy. Large Fossil grains. Openly porous. Open fractures at: 34.24 m, 34.90 m, 35.76 m.	33.38	C9	Core		
37–39	120–128	Gasport Formation. Beds of white and blue grey dolostone. Vuggy. Large fossil grains. Open fractures at: 36.42 m, 36.79 m, 36.82 m, 36.88 m, 37.90 m, 39.24 m. Water bearing fracture at 36.42 m.	36.37	C10	Core		
40–42	130–138	Gasport Formation. Mottled blue grey dolostone. Not vuggy. Openly porous. Large fossil grains. Open fractures at: 39.98 m, 41.48 m. Water bearing fracture at 41.48 m.	39.37	C11	Core		
43–45	140–148	Gasport Formation. Grey dolostone. Fossiliferous. Large crinoid stems. Open fracture at: 44.04 m.	42.42	C12	Core		

Continued on next page

INSTALLATION INFORMATION



SCREEN 10.46m TO 54.33m

DRAWN: JD **CHECKED:** SD

PROJECT: 9506

LOCATION: Hidden Quarry

M15

BORING DATE: 15-05-2013 **DATUM:** GROUND SURFACE **DIP:** **LOGGED:** SD

DEPTH SCALE

METRES: 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60

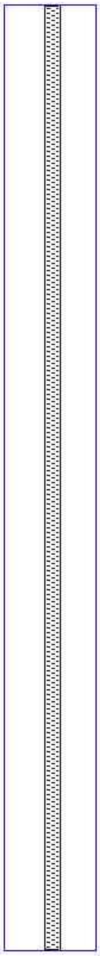
FEET: 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196

BORING METHOD: Rotary Drilling

SOIL PROFILE			SAMPLES				CONCENTRATION (%)
DESCRIPTION	STRATA PLOT	DEPTH B.G.S. (m)	ID	TYPE	RECOVERY (%)	"N" VALUE	LEL ◆ MOISTURE CONTENT ● GAS CONCENTRATION ■ 0 20 40 60 80 100
Gasport Formation. Grey dolostone. Fossiliferous. Large crinoid stems. Open fracture at: 44.04 m.			C12	Core			
Gasport Formation. Grey dolostone. Not vuggy. Minor open porosity. Open fracture at: 47.70 m.		45.57	C13	Core			
Irondequoit Formation. Blue grey dolostone. Pyritic.		48.50					
Rockway Formation. Green dolostone. Finely crystalline. Pyritic. Open fractures at: 50.60 m, 50.72 m.		49.93	C14	Core			
Merriton Formation. Buff brown finely crystalline dolostone. Open fractures at: 51.16 m, 51.26 m, 51.49 m.		50.72					
Cabot Head Formation. Red and green shale.		51.51	C15	Core			
END OF HOLE @ 54.33m		54.33					

INSTALLATION INFORMATION

M15



END OF HOLE

DRAWN: JD

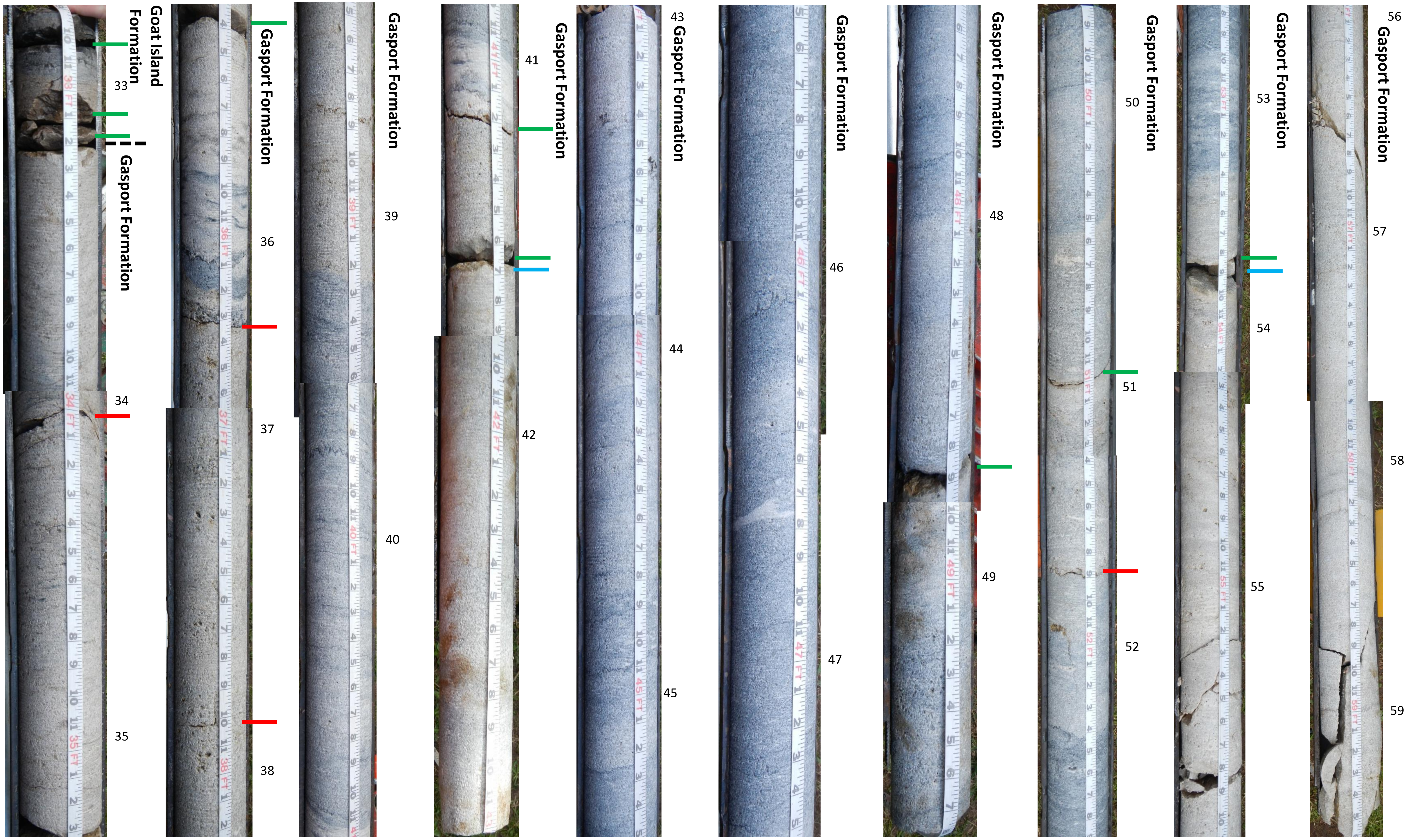
Harden Environmental Services LTD.

CHECKED: SD

APPENDIX B

Core Photo Log

Pages 1-5 in Feet
Pages 6-10 in Metres



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.

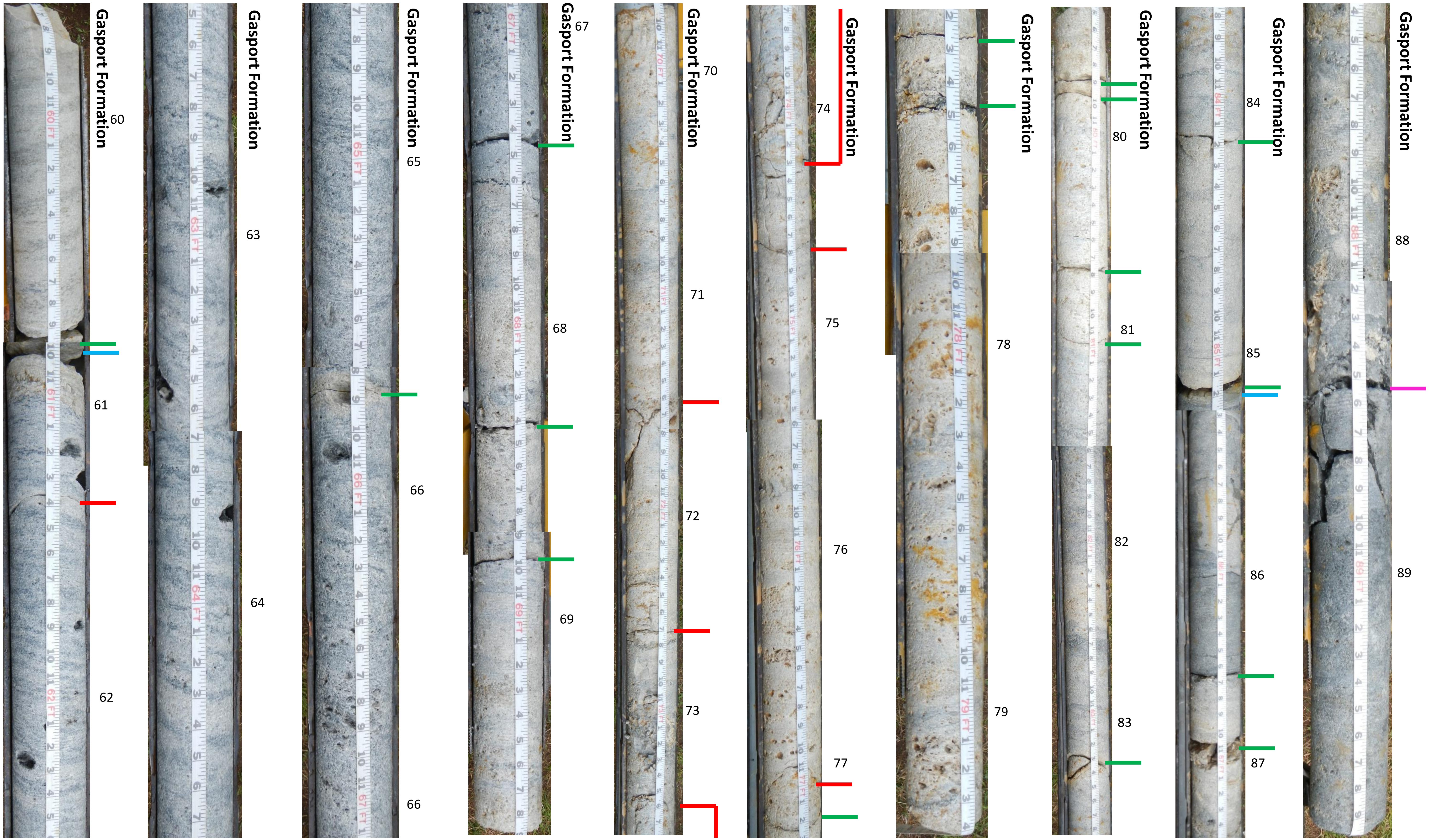
Project No: 9506
Date: May 2013
Drawn By: JD

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Appendix B:

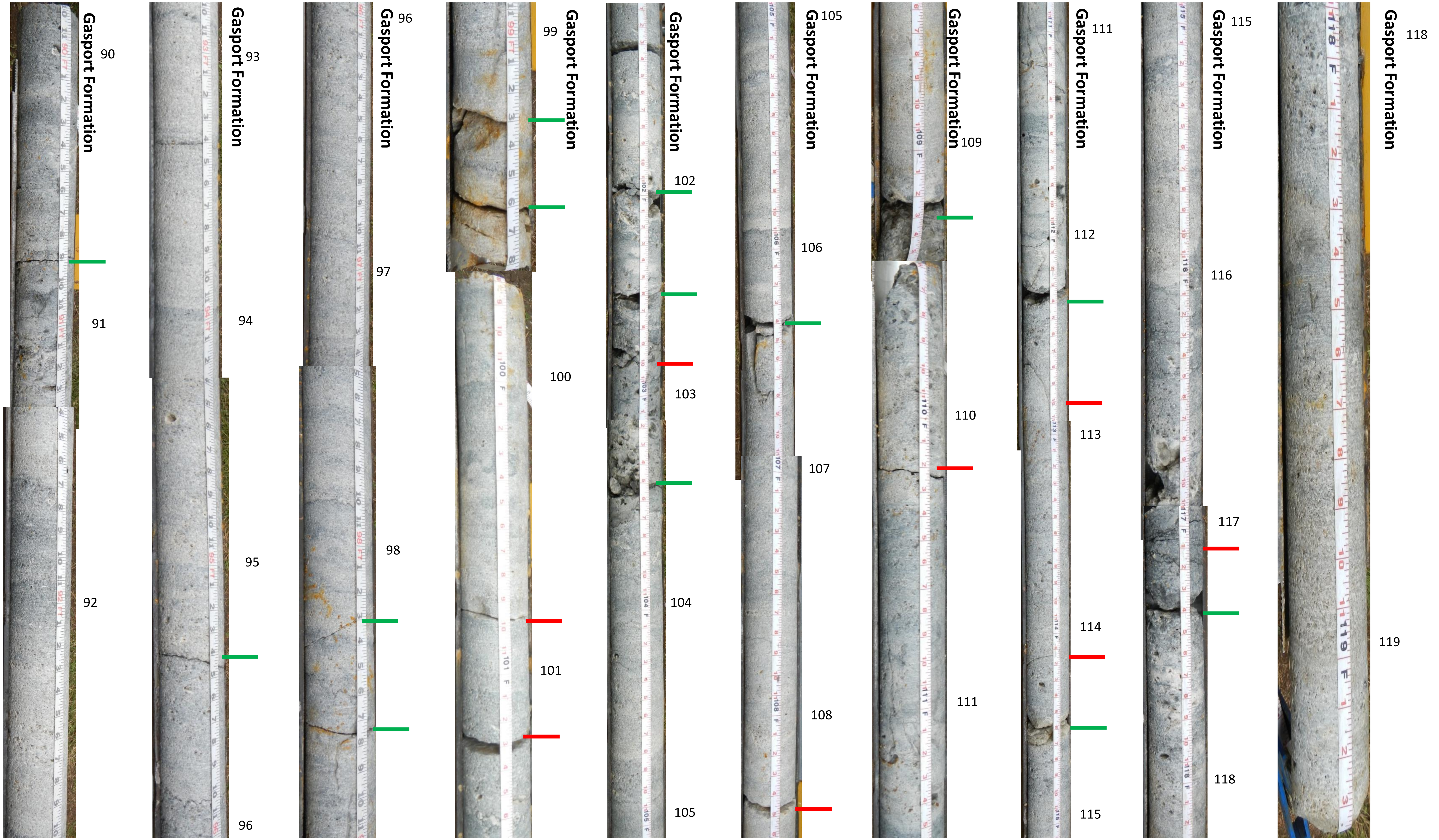
Core Log Photos (32'9"- 59'6")



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B:
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Core Log Photos (59'6"- 89'10")**
	Drawn By: JD		



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.

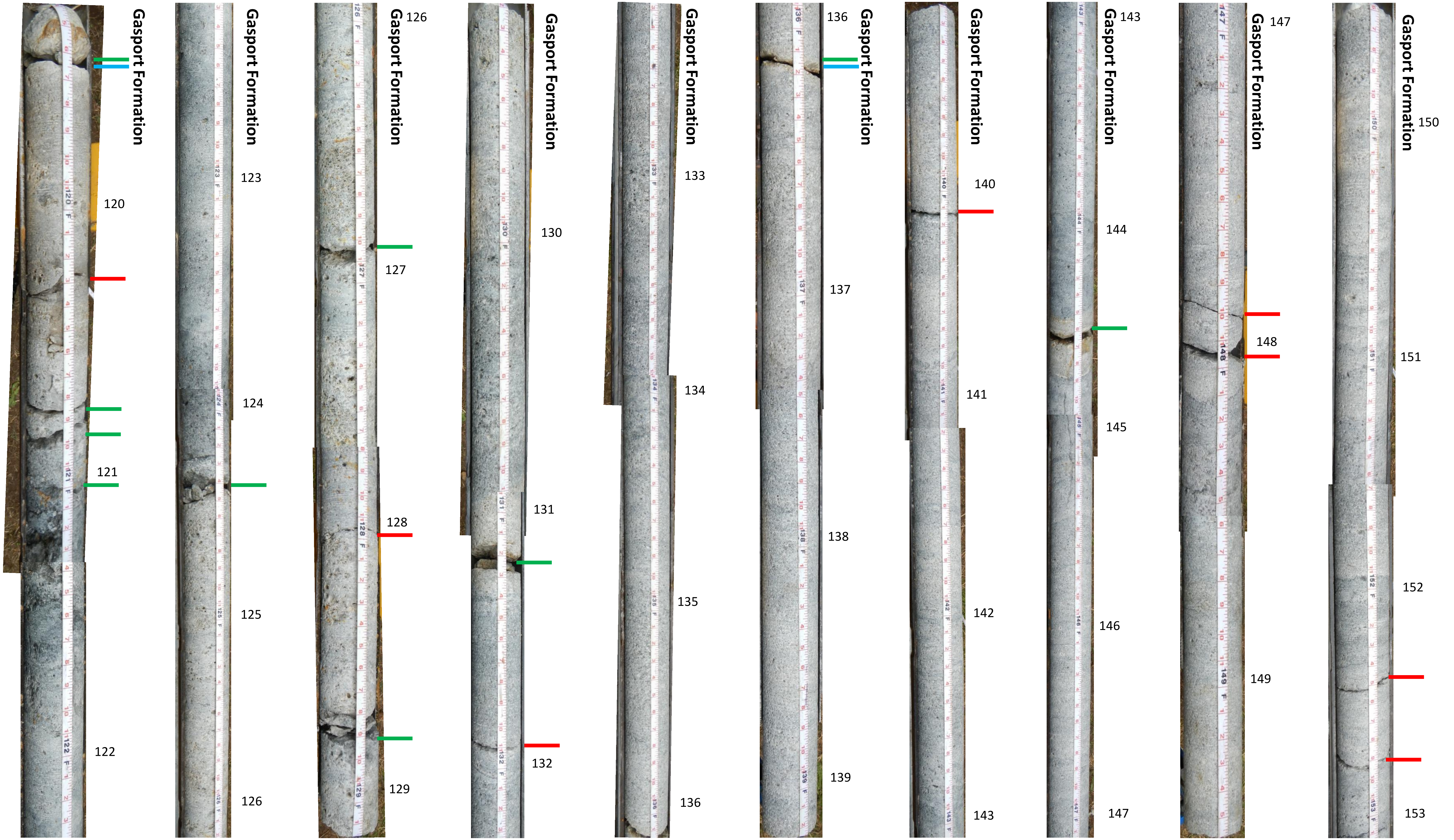
Project No: 9506
Date: May 2013
Drawn By: JD

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Appendix B:

Core Log Photos (89'10"- 119'3.5")



Legend

🟩	Open Fracture
🟥	Closed Fracture
🟪	Impact Fracture From Drillers
🟦	Significant Water Bearing Fracture

Harden Environmental Services Ltd.

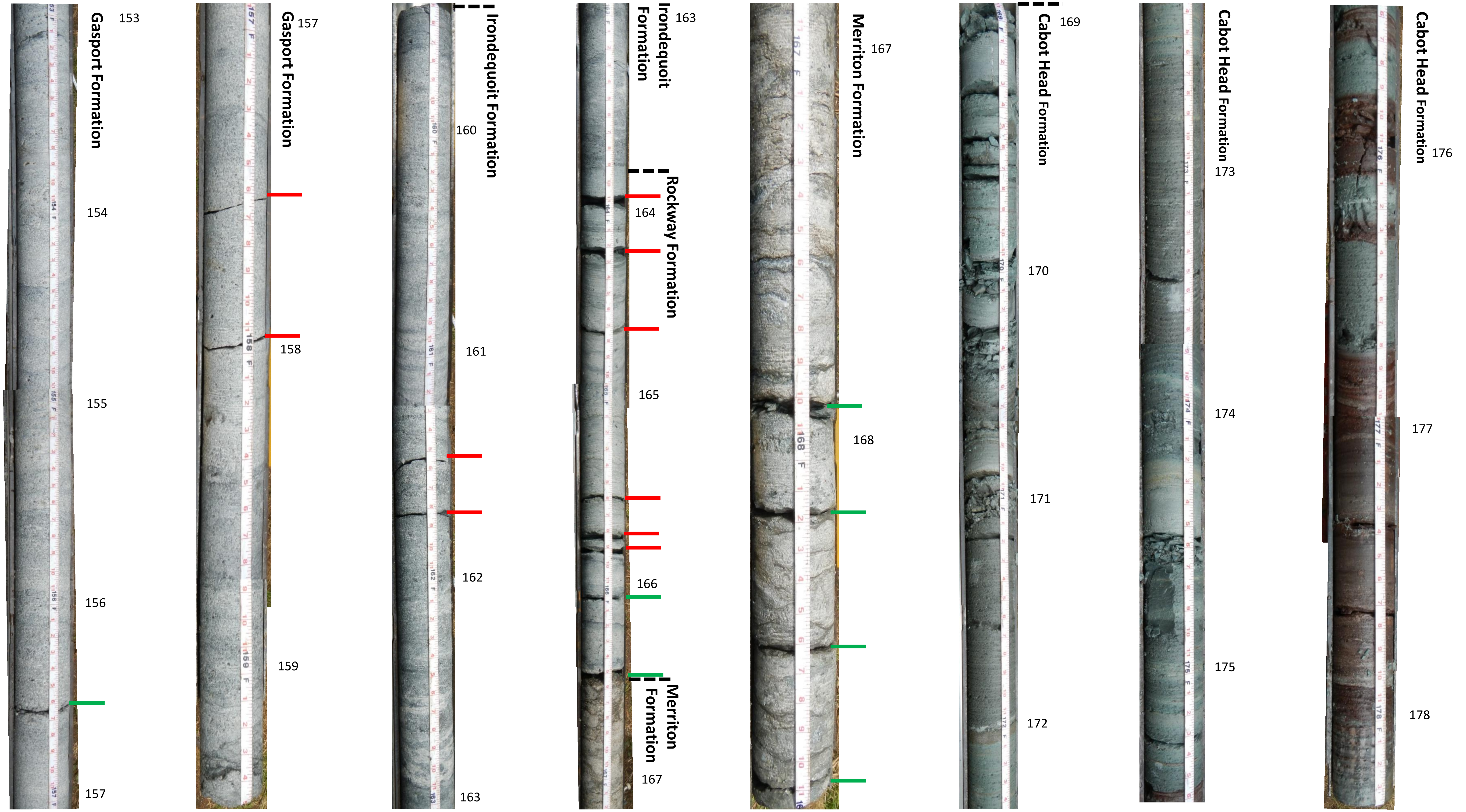
Project No: 9506
Date: May 2013
Drawn By: JD

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Appendix B:

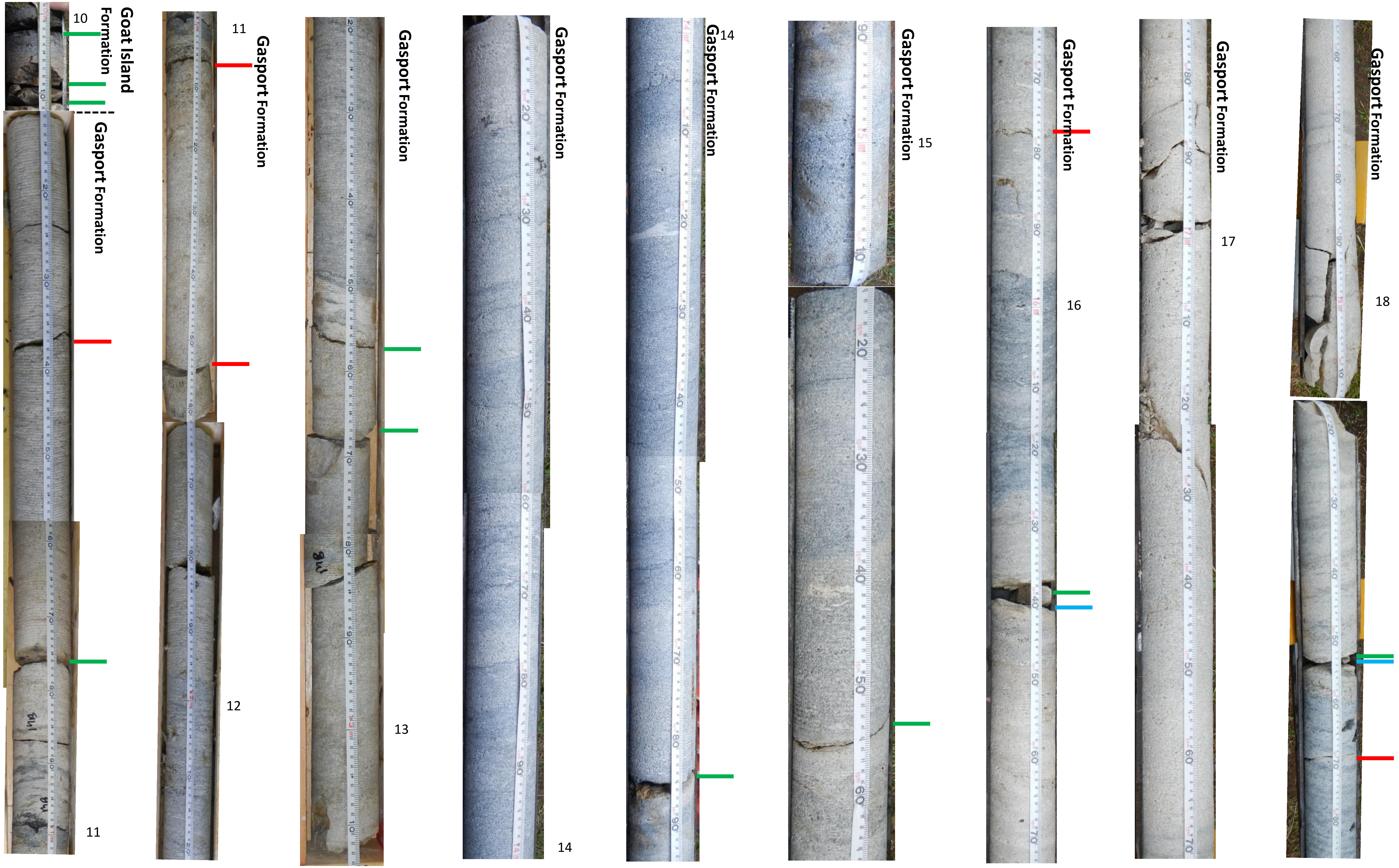
Core Log Photos (119’3.5”-153’1”)



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B:	**Core Log Photos (153’1”-178’4”)**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington		
	Drawn By: JD			



Legend

- 🟩 Open Fracture
- 🟥 Closed Fracture
- 🟪 Impact Fracture From Drillers
- 🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.

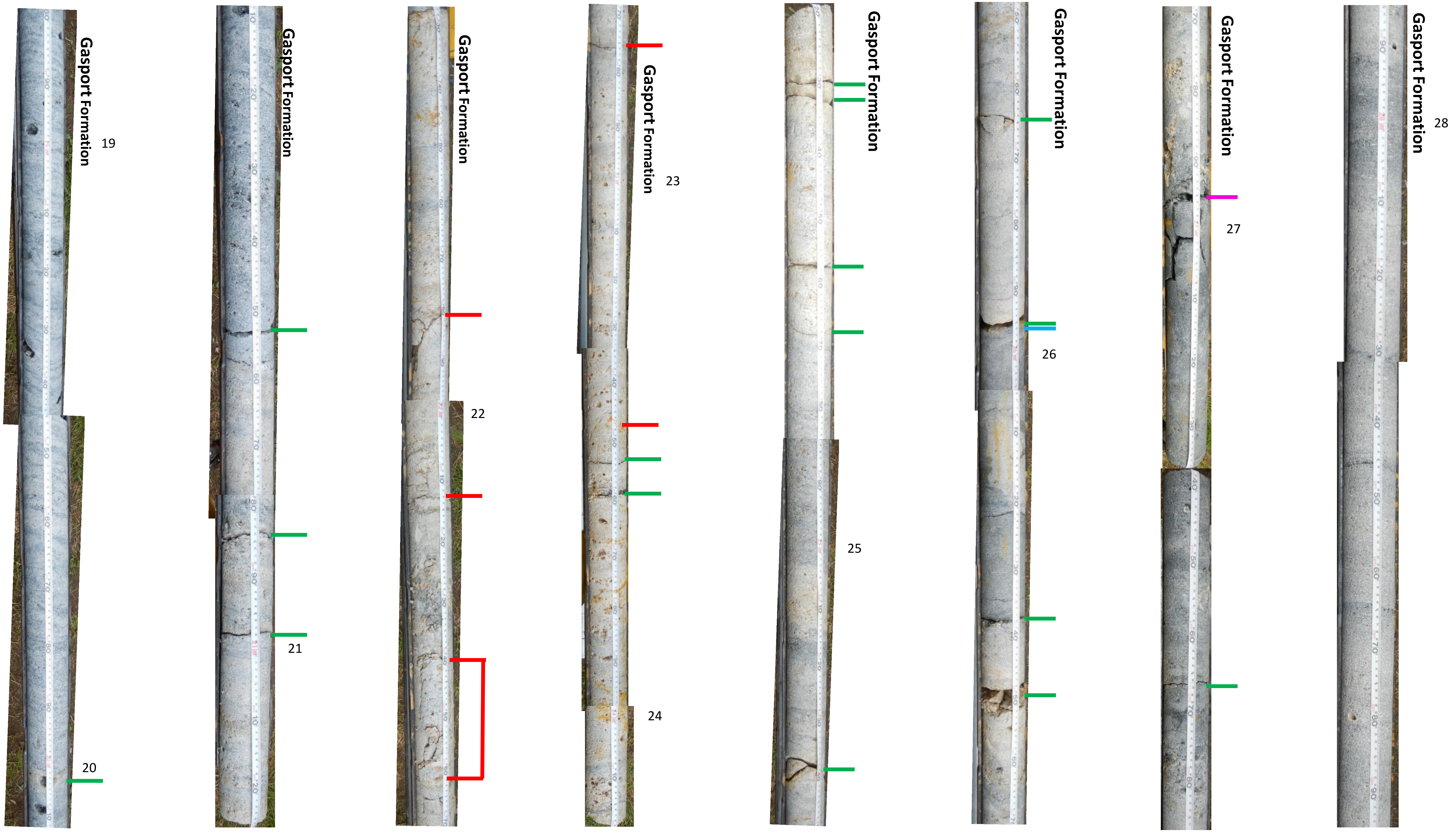
Project No: 9506
Date: May 2013
Drawn By: JD

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Appendix B:

Core Log Photo's (10m – 18.84m)



Legend

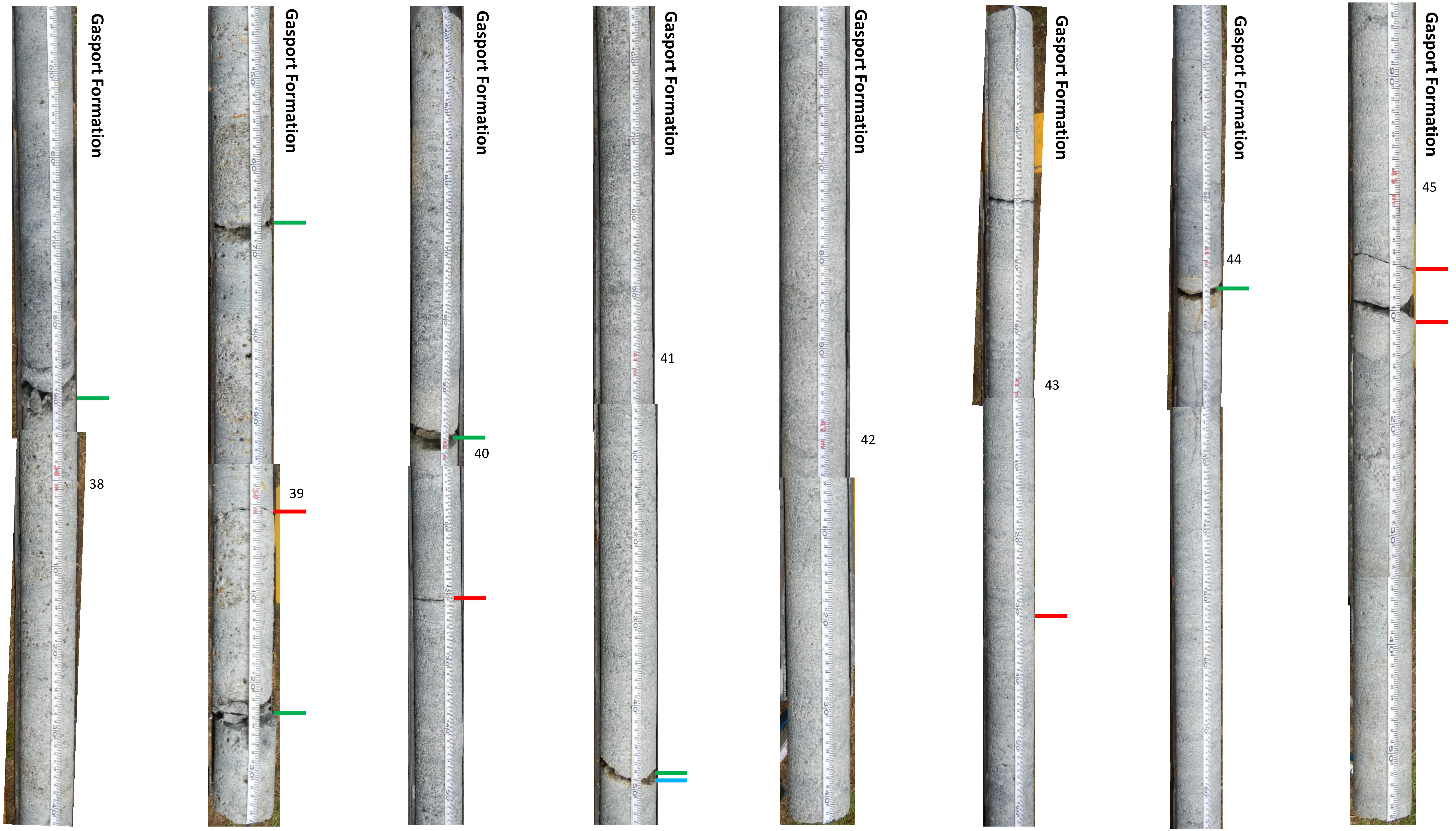
🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photos (18.84m-28.94m)**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		

Legend

- 🟩 Open Fracture
- 🟥 Closed Fracture
- 🟪 Impact Fracture From Drillers
- 🟦 Significant Water Bearing Fracture

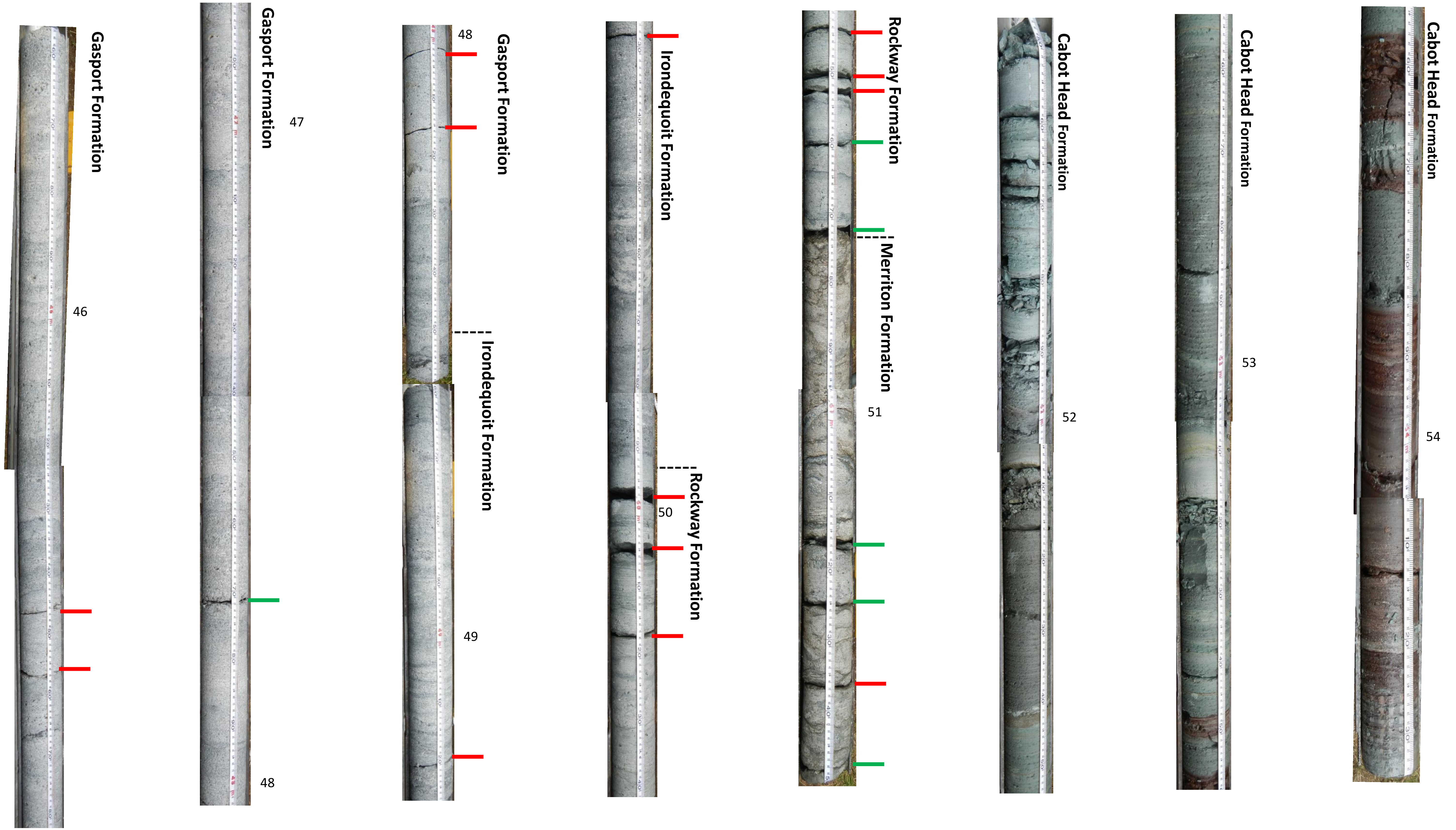
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B: **Core Log Photos (28.94m-37.44m)**
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		



Legend

🟩 Open Fracture
🟥 Closed Fracture
🟪 Impact Fracture From Drillers
🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	Appendix B:
	Date: May 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Core Log Photos (37.44m-45.56m)**
	Drawn By: JD		



Legend

- 🟩 Open Fracture
- 🟥 Closed Fracture
- 🟪 Impact Fracture From Drillers
- 🟦 Significant Water Bearing Fracture

Harden Environmental Services Ltd.

Project No: 9506

Date: May 2013

Drawn By: JD

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Appendix B:

Core Log Photos (45.56m-54.35m)

APPENDIX C

M15 Water Quality Results

RESULTS OF ANALYSES OF WATER

Maxxam ID				RS1829		
Sampling Date				2013/05/24 12:30		
COC Number				na		
	Units	**Criteria A**	**A/O**	**PW1**	**RDL**	**QC Batch**
Calculated Parameters						
Anion Sum	me/L	**-**	-	7.87	N/A	3229791
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	**-**	-	250	1.0	3230462
Calculated TDS	mg/L	**-**	500	439	1.0	3229794
Carb. Alkalinity (calc. as CaCO3)	mg/L	**-**	-	2.4	1.0	3230462
Cation Sum	me/L	**-**	-	8.30	N/A	3229791
Hardness (CaCO3)	mg/L	**-**	80:100	390	1.0	3229982
Ion Balance (% Difference)	%	**-**	-	2.68	N/A	3229790
Langelier Index (@ 20C)	N/A	**-**	-	0.995		3229792
Langelier Index (@ 4C)	N/A	**-**	-	0.747		3229793
Saturation pH (@ 20C)	N/A	**-**	-	7.01		3229792
Saturation pH (@ 4C)	N/A	**-**	-	7.26		3229793
Inorganics						
Total Ammonia-N	mg/L	**-**	-	0.060	0.050	3232665
Conductivity	umho/cm	**-**	-	750	1.0	3232541
Total Kjeldahl Nitrogen (TKN)	mg/L	**-**	-	0.20	0.10	3235497
Dissolved Organic Carbon	mg/L	**-**	5	1.0	0.20	3232526
Orthophosphate (P)	mg/L	**-**	-	ND	0.010	3232548
pH	pH	**-**	6.5:8.5	8.01		3232543
Dissolved Sulphate (SO4)	mg/L	**-**	500	100	1	3232547
Alkalinity (Total as CaCO3)	mg/L	**-**	30:500	260	1.0	3232539
Dissolved Chloride (Cl)	mg/L	**-**	250	16	1	3232546
Nitrite (N)	mg/L	**1**	-	ND	0.010	3232529
Nitrate (N)	mg/L	**10**	-	2.0	0.10	3232529
Nitrate + Nitrite	mg/L	**10**	-	2.0	0.10	3232529

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID					RS1829		
Sampling Date					2013/05/24 12:30		
COC Number					na		
	Units	**Criteria A**	**IMC**	**A/O**	**PW1**	**RDL**	**QC Batch**
Metals							
Dissolved Aluminum (Al)	mg/L	**-**	-	0.1	ND	0.0050	3236227
Dissolved Antimony (Sb)	mg/L	**-**	0.006	-	0.00067	0.00050	3236227
Dissolved Arsenic (As)	mg/L	**-**	0.025	-	ND	0.0010	3236227
Dissolved Barium (Ba)	mg/L	**1**	-	-	0.067	0.0020	3236227
Dissolved Beryllium (Be)	mg/L	**-**	-	-	ND	0.00050	3236227
Dissolved Bismuth (Bi)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Boron (B)	mg/L	**-**	5	-	0.013	0.010	3236227
Dissolved Cadmium (Cd)	mg/L	**0.005**	-	-	ND	0.00010	3236227
Dissolved Calcium (Ca)	mg/L	**-**	-	-	110	0.20	3236227
Dissolved Chromium (Cr)	mg/L	**0.05**	-	-	ND	0.0050	3236227
Dissolved Cobalt (Co)	mg/L	**-**	-	-	ND	0.00050	3236227
Dissolved Copper (Cu)	mg/L	**-**	-	1	ND	0.0010	3236227
Dissolved Iron (Fe)	mg/L	**-**	-	0.3	ND	0.10	3236227
Dissolved Lead (Pb)	mg/L	**0.01**	-	-	ND	0.00050	3236227
Dissolved Lithium (Li)	mg/L	**-**	-	-	ND	0.0050	3236227
Dissolved Magnesium (Mg)	mg/L	**-**	-	-	30	0.050	3236227
Dissolved Manganese (Mn)	mg/L	**-**	-	0.05	0.0022	0.0020	3236227
Dissolved Molybdenum (Mo)	mg/L	**-**	-	-	0.0020	0.00050	3236227
Dissolved Nickel (Ni)	mg/L	**-**	-	-	0.0035	0.0010	3236227
Dissolved Phosphorus (P)	mg/L	**-**	-	-	ND	0.10	3236227
Dissolved Potassium (K)	mg/L	**-**	-	-	4.5	0.20	3236227
Dissolved Selenium (Se)	mg/L	**0.01**	-	-	ND	0.0020	3236227
Dissolved Silicon (Si)	mg/L	**-**	-	-	3.6	0.050	3236227
Dissolved Silver (Ag)	mg/L	**-**	-	-	ND	0.00010	3236227
Dissolved Sodium (Na)	mg/L	**20**	-	200	6.9	0.10	3236227

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A,IMC,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID					RS1829		
Sampling Date					2013/05/24 12:30		
COC Number					na		
	Units	**Criteria A**	**IMC**	**A/O**	**PW1**	**RDL**	**QC Batch**
Dissolved Strontium (Sr)	mg/L	**-**	-	-	1.0	0.0010	3236227
Dissolved Tellurium (Te)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Thallium (Tl)	mg/L	**-**	-	-	0.000077	0.000050	3236227
Dissolved Tin (Sn)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Titanium (Ti)	mg/L	**-**	-	-	ND	0.0050	3236227
Dissolved Tungsten (W)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Uranium (U)	mg/L	**0.02**	-	-	0.00052	0.00010	3236227
Dissolved Vanadium (V)	mg/L	**-**	-	-	ND	0.00050	3236227
Dissolved Zinc (Zn)	mg/L	**-**	-	5	0.062	0.0050	3236227
Dissolved Zirconium (Zr)	mg/L	**-**	-	-	ND	0.0010	3236227

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A,IMC,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

July 15, 2013

James Dick Construction Ltd.
Box 470, Bolton
Ontario, L7E 5T4

Attention: Mr. Greg Sweetnam,
Property Manager

Dear Mr. Sweetnam:

Re: MOE Comments Hidden Quarry

We are pleased to respond to the comments provided by the Ministry of the Environment. We have attached the original MOE comments in Appendix A and have not duplicated the comments in the text of this report.

The comments were separated into surface water comments provided by Craig Fowler and groundwater comments provided by Rosa Stewart and we respond by first addressing surface water comments followed by groundwater comments.

All groundwater and surface water monitoring stations referenced in this report are shown on Figure 1.

Surface Water Comments (SWC)

SWC1) Hydraulic Gradient Analysis related to Streamflow Loss in Tributary B

We have considered two ways that the streamflow loss from Tributary B could be influenced by quarry activities. First, if the excavation physically encounters the 'mound' of infiltrating water beneath Tributary B and thus increases the hydraulic gradient; and secondly if the water table is lowered thereby resulting in a greater streamflow loss from Tributary B before the groundwater mound rises to intersect the bottom of Tributary B.

Physical Interference Analysis

Figure 2 shows a hydraulic gradient analysis between Tributary B monitoring station SW5 and groundwater monitor M9. For the purpose of this analysis we assume that the creek flow is channelized and the distance from the edge of water to groundwater monitor M9 does not change. The hydraulic gradient ranges from 0.016 m/m to 0.259 m/m. The highest gradients are observed in October/November when the sediments beneath the creek are unsaturated. The lowest gradients occur in the spring after the underlying sediments have been saturated for several months.

The data displayed in Figure 2 shows us that where unsaturated conditions occur, the slope of the infiltrating water from Tributary B is approximately 1V:4H. This is a steep slope and considering that the bedrock aquifer is approximately five metres beneath the creek at SW5, the zone of infiltration will not extend beyond a distance of 20 metres from the creek edge. This condition is confirmed at M11 which is located 23 metres from Tributary B. Standing water has never occurred in groundwater M11 indicating that all infiltrating water intersects the water table in the bedrock aquifer within 23 metres of the creek. No layers of significant permeability contrast are revealed in the drilling log of M11.

Figure 3 is a cross-section of the area at SW5. Near SW5 there is a setback distance of 30 metres from Tributary B to the edge of extraction. In addition, a 2:1 horizontal: vertical slope will be maintained in the overburden resulting in a distance of approximately 50 metres between the creek and where the extraction will encounter the water table in the bedrock. Where there is a 20 metre setback, there will be a minimum distance of 40 metres between Tributary B and active below-water-table extraction. This provides ample separation distance between extractive activities and the water infiltrating beneath and adjacent to Tributary B. Based on this analysis, there will be no disturbance of infiltrating waters and no increase in loss from Tributary B arising from physical interference with the infiltrating waters.

Additional confirmation of near tributary infiltration beneath Tributary B is provided in data obtained from groundwater monitors MP3 and MP4. The monitors are four metres deep and are located six and eight metres from Tributary B respectively. The water levels obtained from MP3 and MP4 have always been at least 1.5 metres lower in elevation than Tributary B. The lowest measured hydraulic gradient between Tributary B and groundwater monitors MP3 and MP4 is 0.26 m/m and the highest gradient is 0.37 m/m. This data confirms that a) there is no groundwater discharge to Tributary B and b) infiltration follows a very steep pathway adjacent to Tributary B and that the extraction face at a distance of no less than 20 metres will not intersect infiltrating water and thus increase loss from Tributary B.

Lower Water Table Analysis

The creation of a pond on either side of Tributary B will result in a change in the position of the water table. The position of the water table will rise in the southern half of the quarry site and fall in the northern half. The relative magnitude of the change is the same for the northern and southern portions of the quarry. Thus although a greater amount of infiltrating water from Tributary B is required to create a groundwater mound in the northern half of the quarry, less infiltrating water is required to create a groundwater mound in the southern half of the quarry. It is thus anticipated that there will be no net change in surface water loss from Tributary B. In addition, a silt till is identified in the northern 100 metres of the site (above the ‘waterfalls’) and thus further limiting the potential for a change in streamflow loss in the northern half of the site.

Monitoring of Streamflow Loss from Tributary B

In order to evaluate the loss of streamflow from Tributary B, the flow measured at SW3 will be subtracted from the flow measured at SW4 and compared to historical rates of loss. The rate of streamflow loss is highly variable and decreases to zero during the summer months. The attached Figure 4 is a summary of monthly streamflow loss from Tributary B across the site. Included in the annual report will be an analysis of the streamflow loss and a continuation of this graph (between stations SW3 and SW4). If anomalous streamflow loss occurs, the cause will be evaluated and contingency measures invoked. Groundwater levels are more accurate than streamflow measurements and monitors MP1, MP2, MP3 and MP4 have been added to the groundwater monitoring program. An interpretation of results will be presented in the annual monitoring program and the results will be evaluated for anomalous or trending data. Should a change be noted, contingency measures as presented in Appendix C will be initiated.

SWC2) Allen Wetland and Northeast Wetland

We concur that Northeast Wetland and Allen Wetland are not connected to the bedrock water table and thus will not be affected by the proposed quarry.

SWC3) Recommended changes to the Surface Water Monitoring Program

The monitoring program will be amended as follows;

a) Surface water stations SW4 and SW8 will be added to the monitoring program.

b) The frequency of flow measurements will increase to semi-monthly between April and November (inclusive) and coincide with groundwater measurements. With this frequency of monitoring required it may be beneficial to install a weir and establish a stage-discharge rating curve.

c) MP1, MP2, MP3 and MP4 will be added to the monitoring program and measurements will be obtained at the same time as groundwater measurements.

The revised monitoring program is found in Appendix C.

SWC4) Detailed analysis of Streamflow in Tributary B and water levels in Northwest Wetland

Tributary B

Figures R2 and R3 were submitted to Burnside and Associates in response to a similar question of the relationship between precipitation and flow in Tributary B. Figure R2 compares monthly precipitation from the Shand Dam in Fergus to streamflow at SW4. The monthly precipitation data does not have an annual pattern whereas flow in Tributary B has a pattern of no flow in the late summer months, increasing flow in the fall, winter, early spring and declining flow in the late spring/early summer months. Flow in Tributary B is not responding to monthly precipitation.

Figure R3 compares both annual precipitation rates and November to March cumulative precipitation rates to streamflow measured at SW4. There is no apparent correlation between annual precipitation rates and flow in Tributary B. There is no apparent correlation between November to March cumulative precipitation rate and flow measured at SW4. Thus, although precipitation is the ultimate source of water in Tributary B, there is no readily identifiable correlation between monthly flow and monthly precipitation. A comparison of streamflow in the Eramosa River measured at Watson Road and streamflow in Tributary B is shown on Figure R4. The graph shows that Tributary B has a similar flow profile as the Eramosa River. The Eramosa River responds to runoff events and thus peaks in the spring and has low flows late summer/early fall. This is also the pattern in Tributary B except that flow ceases in the summer. This confirms that flow in Tributary B relies on runoff from its catchment area and does not rely on local groundwater input.

There is no trend in the precipitation vs. streamflow graph and we discussed streamflow in general with Dwight Boyd at the Grand River Conservation Authority. Dwight suggested that spring flows depended on several factors including amount of snow pack, winter thaw events, precipitation and daily temperature range. The variability in these factors alone result in a wide range of possible flow volumes making flow prediction extremely difficult. The history of streamflow does provide a basis for comparison with post-development streamflow and there will be several years of data collection prior to aggregate extraction from below the water table.

The historical data provides a range of spring flows between 50 and 150 L/s and informs us that in some years the stream is dry for several months and other years there is continuous flow. The data shows that the magnitude of flow in the spring is not consistent, but provides a range of expected spring flow that can be used for comparison during and post development of the quarry.

Streamflow measurements are included in the monitoring program at upgradient and downgradient stations. Streamflow will be compared to historical values and additional study will be initiated if anomalous readings are found.

Northwest Wetland

Figure 5 compares surface water levels in the northwest wetland to precipitation. The water level has historically ranged from 354.2 to 355.68 m AMSL. Other than seasonal fluctuations (spring highs - fall lows) there is no season over season trend to the data. These seventeen years of historical data will be used to compare water levels during and post quarry development.

We are recommending an annual trigger value of 354.20 m AMSL. The warning level is established at fifteen centimeters above the trigger level or 354.35 m AMSL. The water level in the wetland falls about fifteen centimeters per month during summer months. This would provide approximately four weeks of enhanced monitoring to determine if there are quarry related impacts. Manual water level measurements will increase to bi-weekly if the warning level is exceeded.

The following wording has been added to the monitoring program.

Monthly surface water levels obtained from station SW6 in the northwest wetland will be compared to historical data. An elevation of 354.20 m AMSL will be used as a level to trigger the following contingencies.

1) Confirmation of water level within 24 hours.

2) Evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed.

3) If quarry activities are found to be responsible, the following actions will be considered and a response presented to the GRCA and the Township of Guelph-Eramosa.

- increase the length and/or width of barrier
- decreased rate (or stopping) subaqueous extraction
- change in configuration of mining or decrease in mining extent
- alter timing of extraction to coincide with high seasonal groundwater levels.

Groundwater Comments (GC)

GC1) Impact to Private Wells

We concur that private wells will not be impacted by the proposed quarry. The pre bedrock extraction survey will be conducted and will be detailed enough to evaluate any water quality or quantity concerns that arise during the bedrock extraction phase.

GC2) Water Quality Impact

We concur with the MOE's finding that there is a low potential for water quality impacts. Two newly installed dedicated groundwater monitors (M15 and M16) along with M2 and M4 will be used to monitor groundwater quality. The parameters that will be included in the semi-annual monitoring (summer) will be general chemistry, bacteria, TKN, ammonia, DOC, pH, temperature, anions and metals. In the event that there is an increasing trend in the concentration of one or more elements or compounds, a study will be conducted to determine the source of the water quality change. If the quarry is found to be responsible and if there is a potential for impact to downgradient wells, James Dick Construction Ltd. will commence with the following actions;

1) Semi-annual testing of the water quality of private wells that could potentially be impacted by the quarry.

2) In the event that a water quality issue related to the quarry occurs, James Dick Construction Ltd. will remedy the issue by either providing the appropriate treatment in the home or drilling a new well and isolating the water supply to the deeper aquifer.

GC3) Thermal effect on Brydson Spring and Blue Springs creek

The spring on the Brydson Farm (Figure 2.4 of Level I/II report) emerges approximately 400 metres southeast of the site property boundary and 600 metres southeast of the bedrock extraction. Blue Springs Creek occurs some 1200 metres from the extraction area. Our experience with thermal impact from pit ponds includes thermal data collected for Mill Creek Aggregates in Puslinch Township (Genevar, 2013) and Roszell Pit in Puslinch Township (Pentney, 2013). Each of these sites have data showing that the during the summer, the temperature of the surface of the pit ponds approaches 25 C and in the winter the temperature of the unfrozen water is 4 C. Each of these pit ponds recharges the downgradient groundwater system and a cyclical thermal impact has been recorded within downgradient groundwater monitors. Mill Creek is located 100 m from the Mill Creek Aggregates pond and springs emerge within 120 metres of the Roszell Pit Pond. In the data presented to-date, a thermal impact occurs within 30 m of each of the pit ponds. However, at both the Mill Creek Aggregates pit and the Roszell Pit, a thermal impact in a second groundwater monitor located less than 100 metres from the pit pond is not found. Therefore, the thermal impact is attenuated within 100 metres of the pit pond. Scientific work conducted by Rob Shincarol and Jeff Markle (2007) suggests that the thermal plume will be attenuated within 250 metres of a site.

Although the thermal plume at the Hidden Quarry will occur within a fractured bedrock setting, the observations of thermal attenuation at gravel pits suggests that the six hundred metre travel distance to the Brydson Spring will be more than sufficient to attenuate thermal changes in the groundwater. Blue Springs Creek is an additional 600 metres, for a total of 1200 metres, from the edge of bedrock extraction and therefore will not be affected by thermal changes at the site.

GC4) Presence of karst

There are six groundwater monitors and one water well at the site that have been drilled into the bedrock. Detailed borehole records are available for boreholes drilled for M1D, M2, M3, M4, M13D, M14D and M15. There is also a water well record for the well servicing the rental house at the site (MOE Well # 6705627). None of the geological observations suggest significant solution enhanced karst features. The presence of vugs and fossiliferous zones (reefal zones) within the bedrock are not necessarily indicative of karst conditions. Open fissures are well documented in the video log of M15, however, large cavities indicative of karst were not found.

We have attached a recent report summarizing the drilling, flow testing and video logging of monitor M15 (Appendix B). There are no observations that suggest significant physical karst features at that location.

Groundwater flow in the bedrock is controlled by fractures and the recent pumping of M15 with a response in M2 confirms that fractures at depth in the dolostone aquifer are persistent. The maximum drawdown in the quarry will be no greater than 2.45 metres and the greatest impact to the nearest private well will be approximately 1.6 metres. We concur with the MOE that this magnitude of water level change will not significantly affect the yield of the private well.

The net result of the quarrying activity will be the creation of a large reservoir of water. This reservoir will be a positive boundary condition for nearby water takers and thus limit the drawdown in nearby wells. Therefore, the presence of fissures in the bedrock does not result in there being any greater potential impact to wells than already predicted.

GC5) Changes to Proposed Groundwater Monitoring Program

GC5a) In our response to water quality concerns raised by the GRCA, we confirmed that James Dick Construction Ltd. was willing to install groundwater monitors M15 and M16. These locations are shown on Figure 1.

GC5b) In response to the MOE recommendation that daily water levels be obtained prior to below-water-table extraction, we suggest installing continuous water level measuring devices in groundwater monitors M1D, M2, M3, M13D, M4, M15 and M16.

GC5c) The greatest water level change in the bedrock aquifer is expected to occur to the north and northwest of the site. Water levels obtained from bedrock monitors M1D, M13D, M14D and M2 will be used to verify that actual water level changes do not exceed the predicted water level change. The trigger level is set at the historic low less the predicted water level change. A warning level of 75% of the predicted change will be used to initiate bi-weekly manual measurements from the groundwater monitors.

Monitor	**Historical Low m AMSL**	**Predicted Change (m)**	**Warning Level m AMSL**	**Trigger Level m AMSL**
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	348.08
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98

GC5d) We recommend that an annual report be prepared and submitted by March 31 of the following year. The report will include all historical data and an interpretation of trends and anomalous observations.

GC5e) Continuous groundwater monitoring devices will be installed in M1D, M2, M3, M13D, M4, M15 and M16. The devices will provide both water level and water temperature information. This information will be evaluated and interpreted in the annual monitoring report.

GC5f) Increase groundwater quality monitoring frequency to semi-annually

The revised groundwater monitoring program is found in Appendix C and reflects all recommendations made by the Ministry of the Environment.

We trust that this additional analysis will satisfy the MOE comments made on the Hidden Quarry. If there are any questions regarding this submission, please do not hesitate to contact Stan Denhoed at (519) 826-0099.

References

Genevar Inc., 2013, 2012 Monitoring Report, Mill Creek Aggregates, Hydrogeology

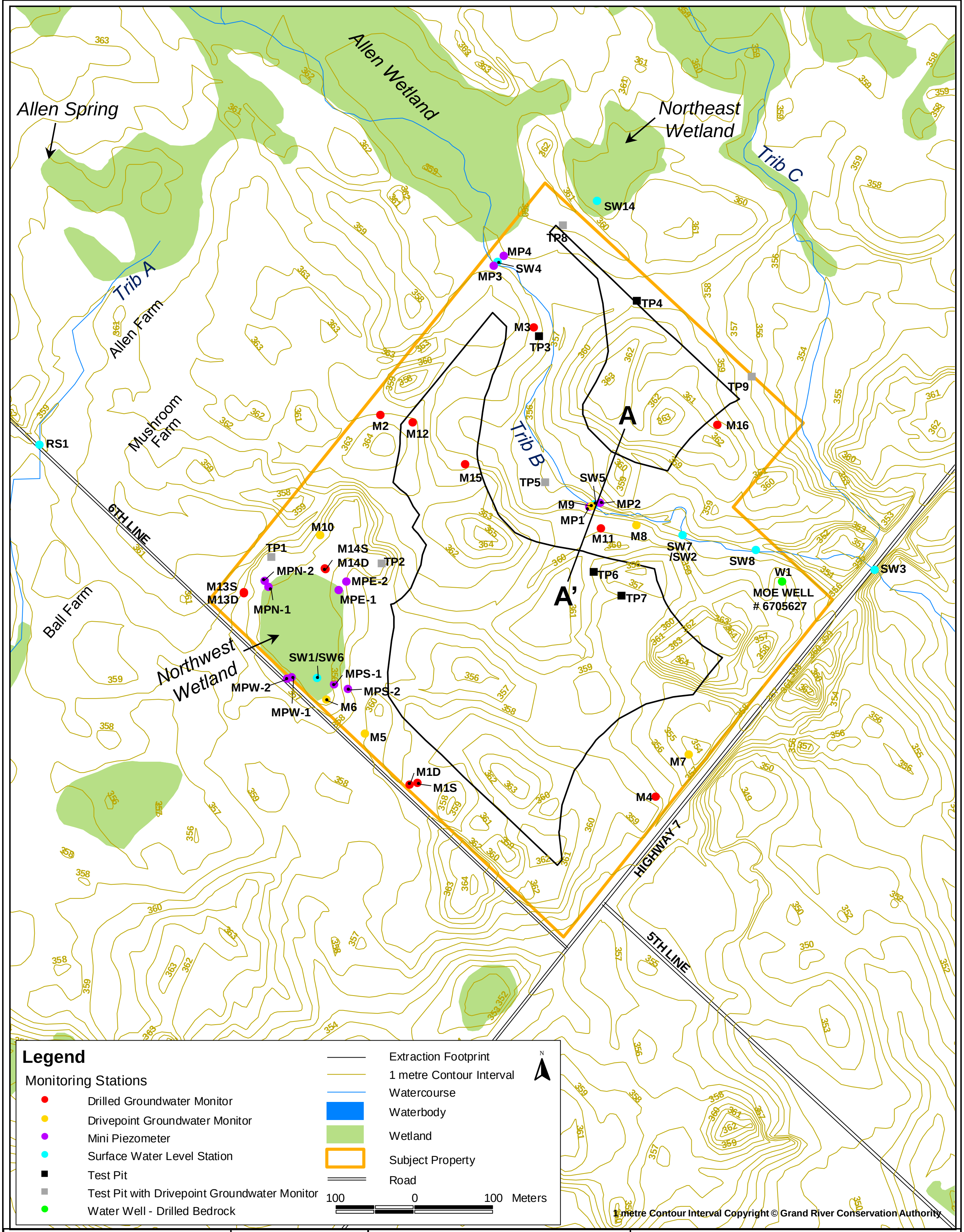
Pentney, A, 2013, Roszell Road Pit, License No. 625189, 2012 Groundwater Monitoring Report

Shincarol and Markle, 2007, Thermal Plume Transport from Sand and Gravel Pits, Potential Thermal Impacts to Cool Water Streams, Journal of Hydrology, (338) p 174-195

Sincerely,
Harden Environmental Services Ltd.

Stan Denhoed

Stan Denhoed, M.Sc., P. Eng.
Senior Hydrogeologist



Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2013

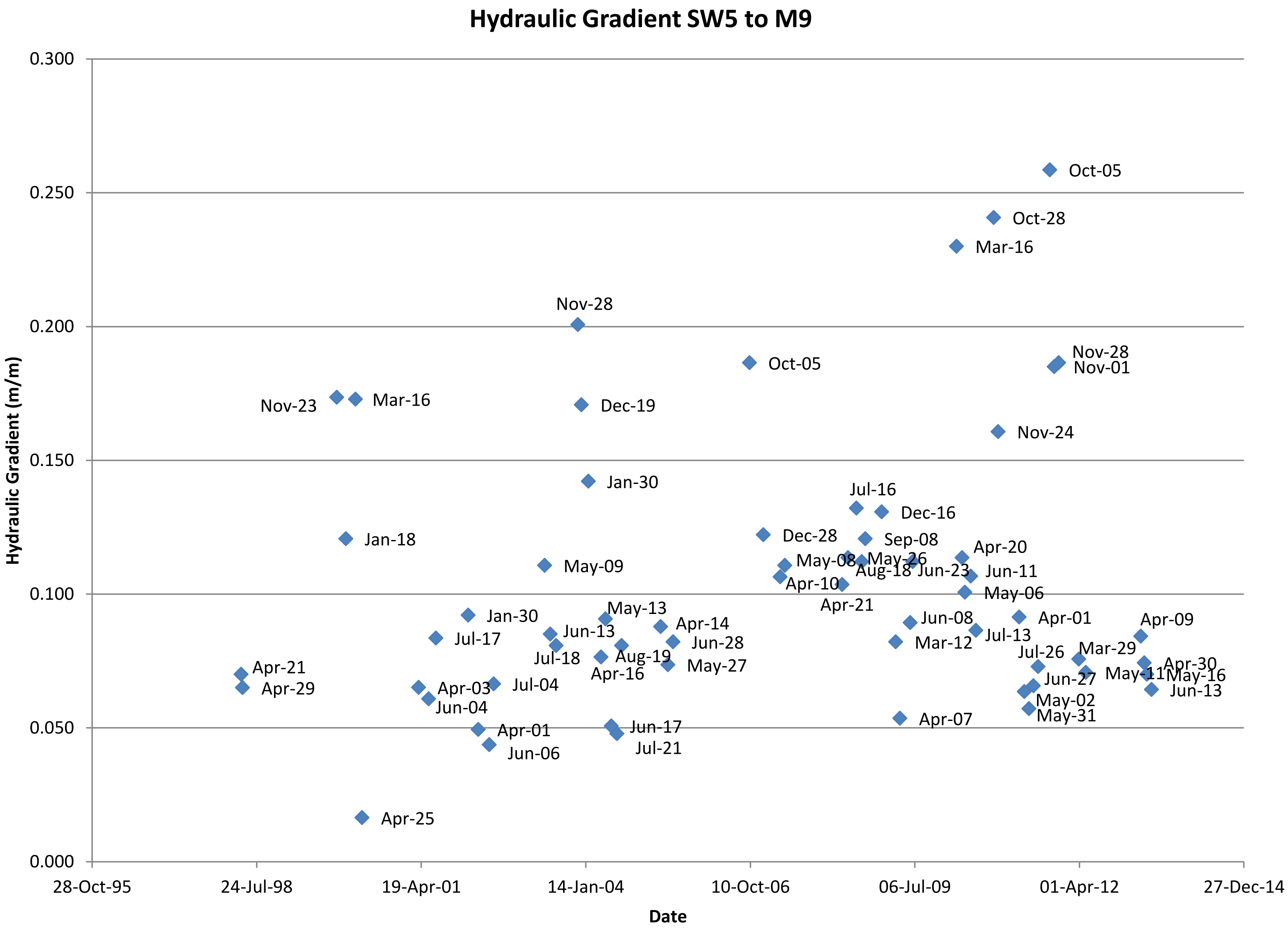
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1:

Monitoring Locations



Harden Environmental Services Ltd.

Project No: 9506

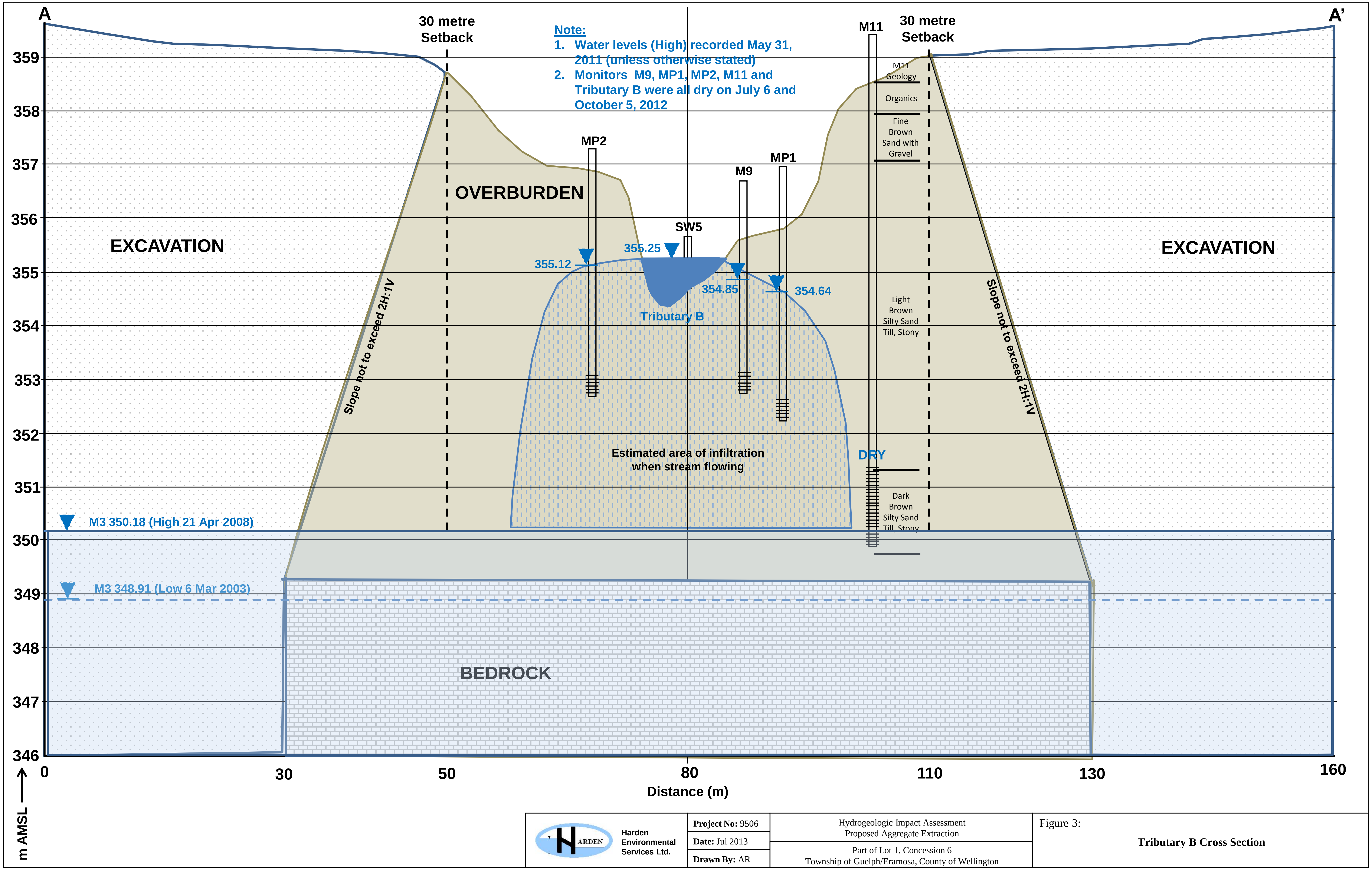
Date: Jul 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

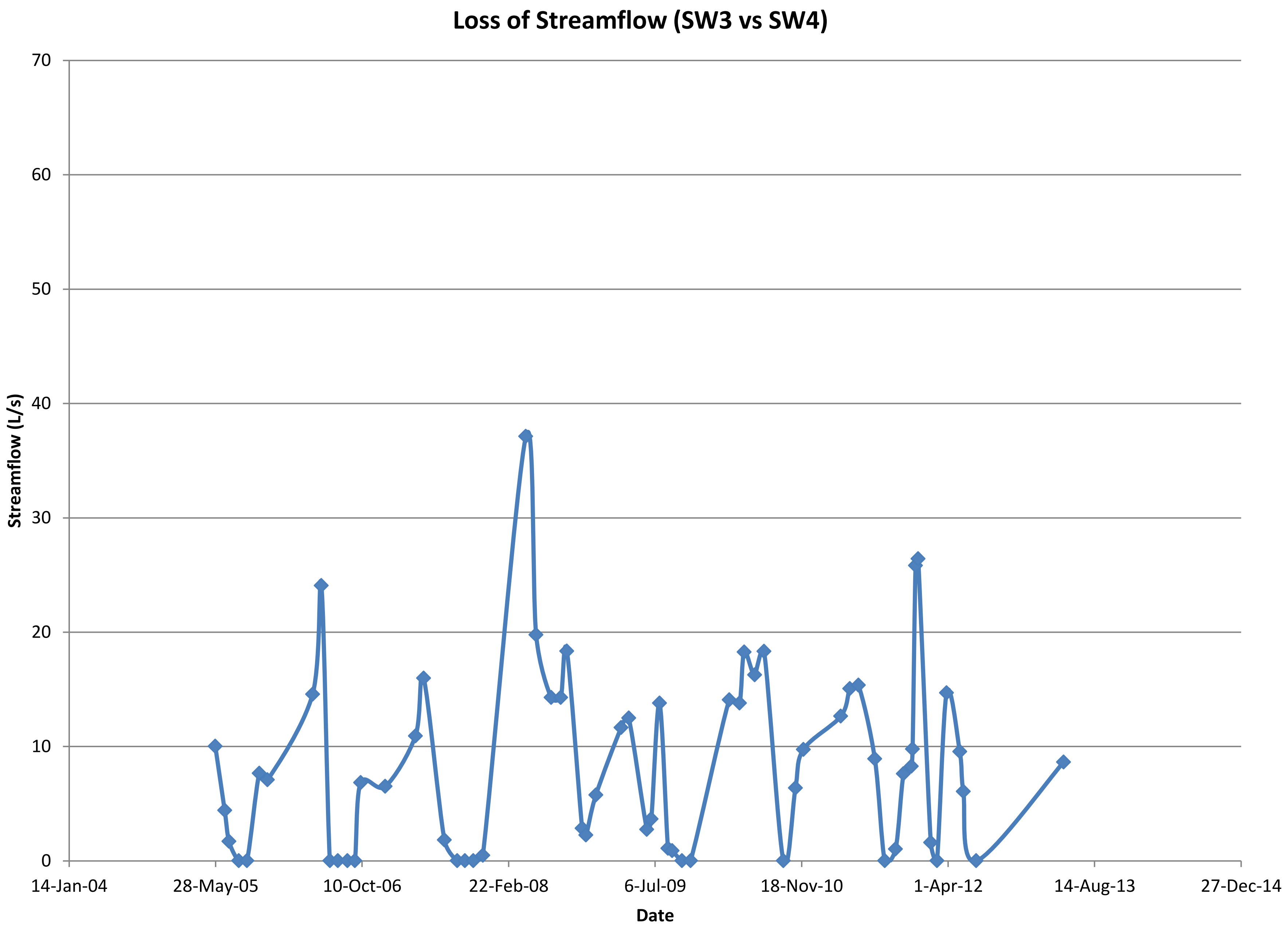
Figure 2: Hydraulic Gradient Analysis



Note:

1. Water levels (High) recorded May 31, 2011 (unless otherwise stated)
2. Monitors M9, MP1, MP2, M11 and Tributary B were all dry on July 6 and October 5, 2012

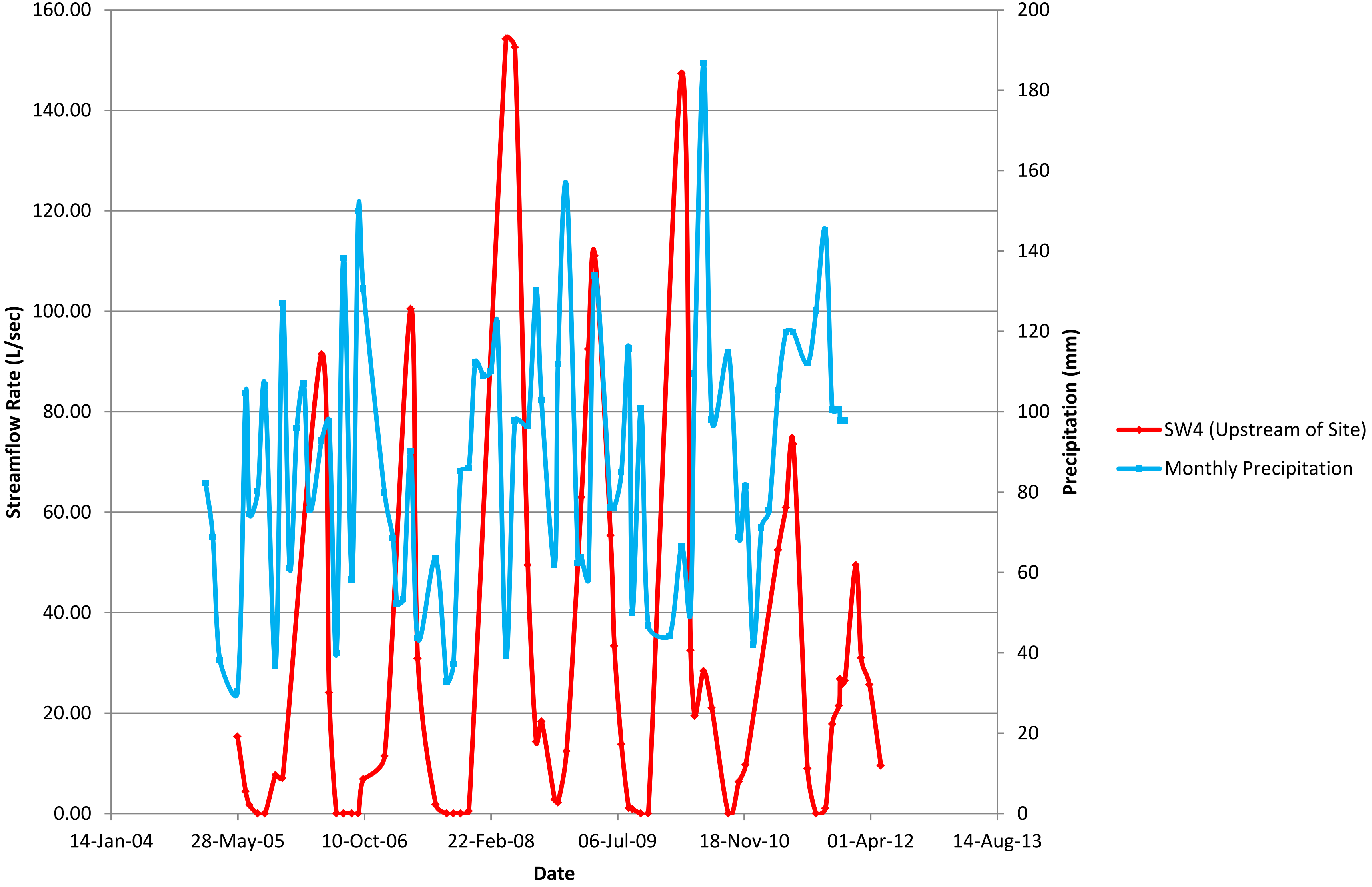
Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	Figure 3: **Tributary B Cross Section**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.

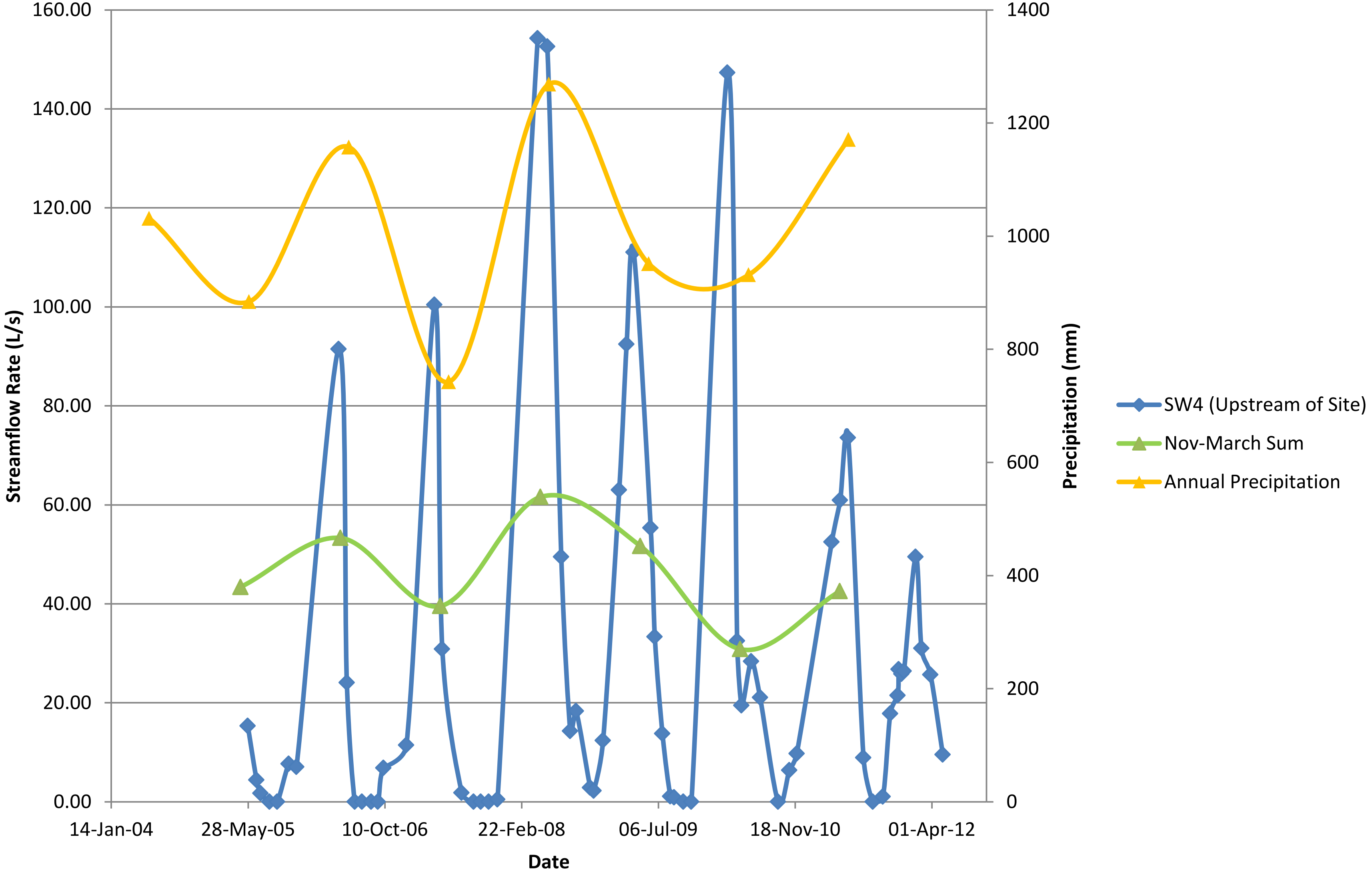
Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 4: Loss of Streamflow Tributary B**
Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		

Figure R2: Monthly Precipitation Comparison with Streamflow



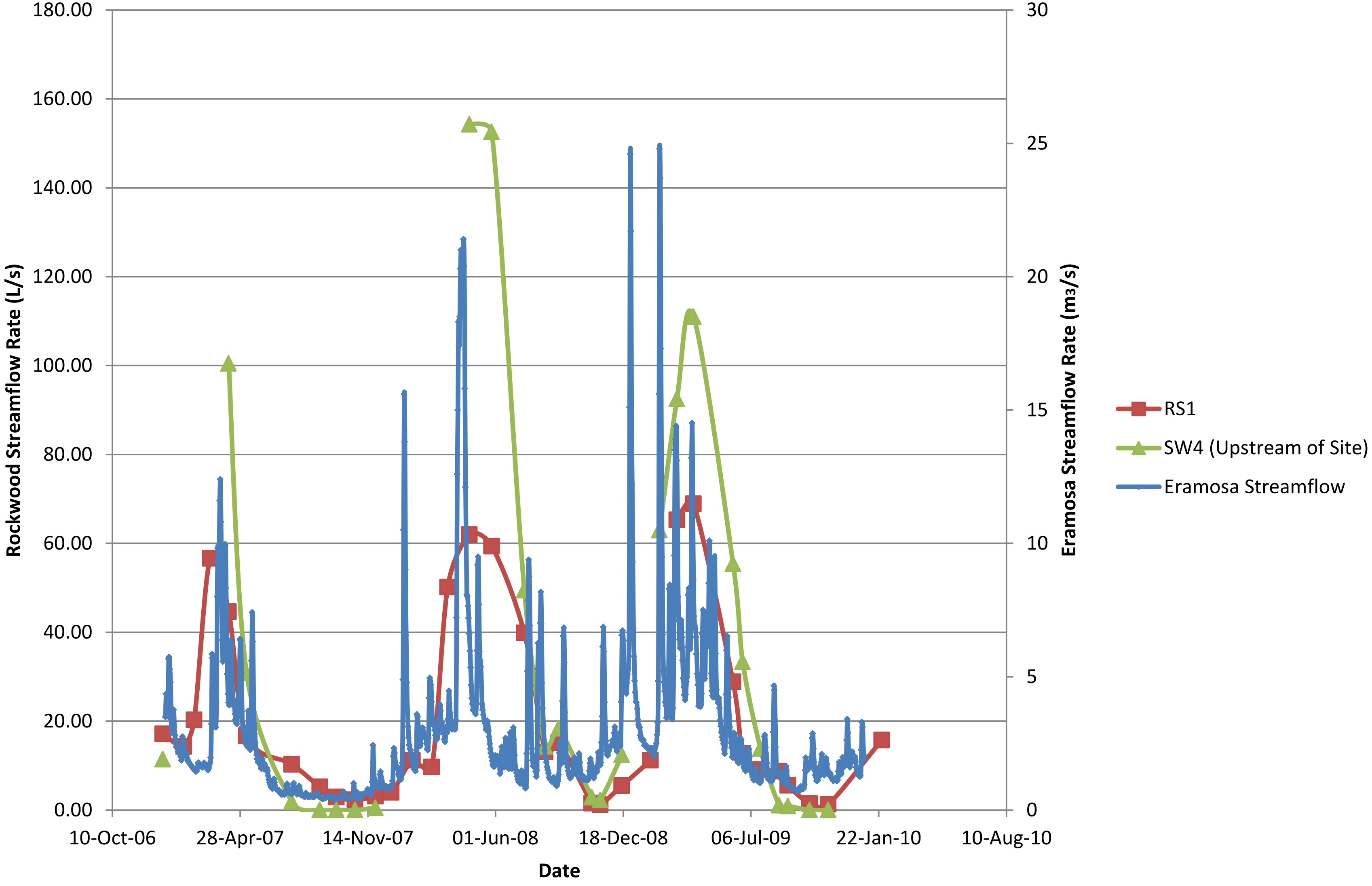
Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Jan 2013 **Drawn By:** JD	Hidden Quarry Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure R2:** **Monthly Precipitation Comparison with Stream Flow**

Figure R3: Precipitation Totals Comparison with Streamflows



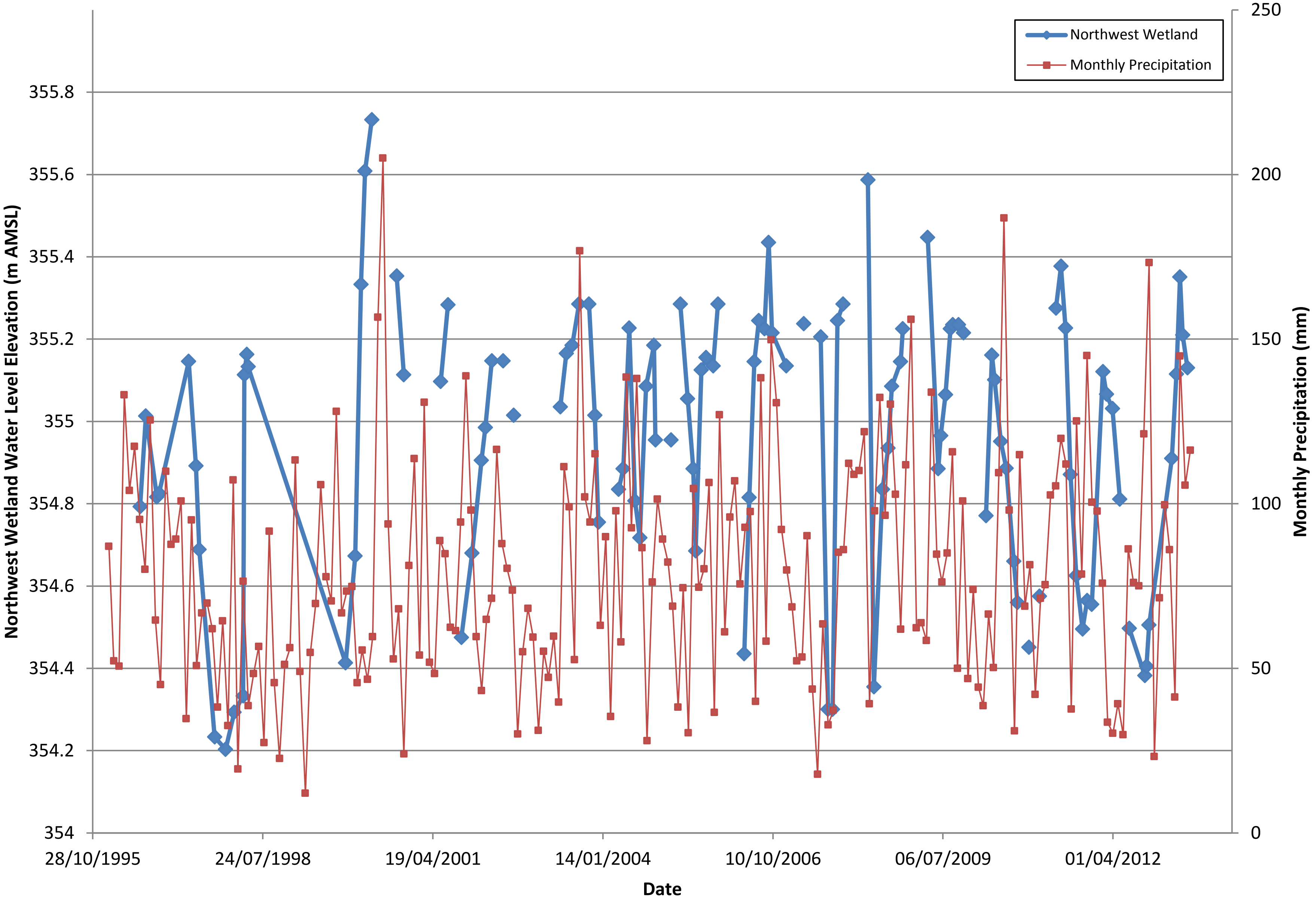
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry	**Figure R3:** **Precipitation Totals Comparison with Streamflows**
	Date: Jan 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		

Figure R4: Eramosa and Rockwood Site Streamflows



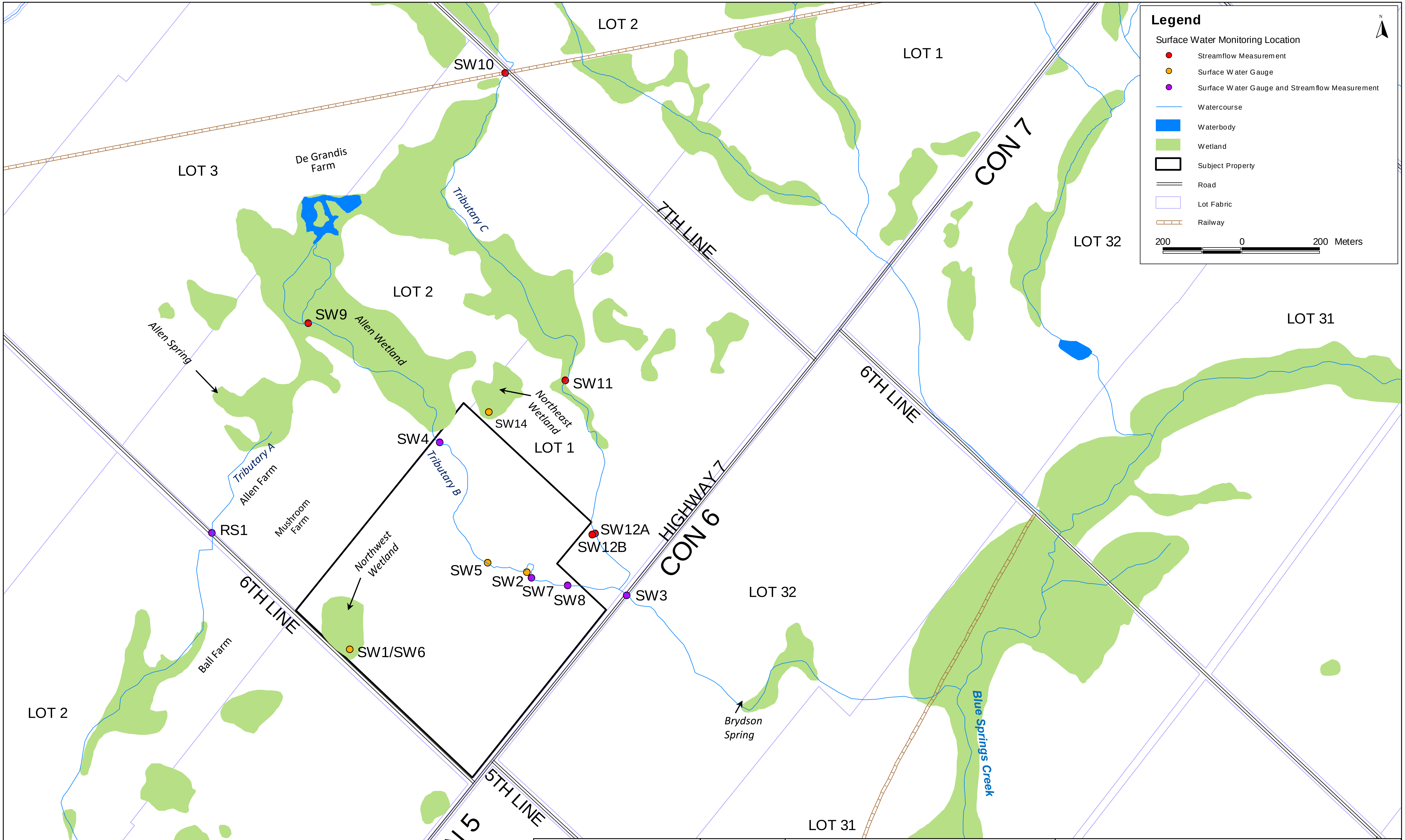
Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry	**Figure R4: Eramosa and Rockwood Site Streamflows**
	Date: Jan 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: JD		

Monthly Precipitation versus Northwest Wetland



Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 5: Precipitation Versus Northwest Wetland**
Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		



Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	Figure 2.4: **Surface Water Monitoring Locations**
Date: Mar 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		

APPENDIX A

MOE Comments Dated July 3, 2013

Ministry of the Environment
West Central Region

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12th Floor
Hamilton, Ontario L8P 4Y7
Tel.: 905 521-7640
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Ministère de l'Environnement
Direction regionale du Centre-Quest

119 rue King ouest
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Téléc. : 905 521-7820

Ontario

July 3, 2013

Mr. G. Sweetnam
Vice President, Resources
James Dick Construction Limited
Box 470
Bolton, Ontario.
L7E 5T4

Dear Mr. Sweetnam:

Re: Application for an Aggregate Resources Act Class A, Category 2 below water table Licence
Part lot 1, Concession 6, Guelph/Eramosa, County of Wellington
James Dick Construction Limited, Hidden Quarry

This is to follow up to my letter dated April 15, 2013 to Mr. S. May, Aggregate Resources Officer, Ministry of Natural Resources regarding the above referenced application. That letter indicated that Ministry of the Environment staff would undertake a more detailed review of the supporting documentation to the application to provide specific comment or concerns in the context of the Aggregate Resources Act approval process. I apologize for the delay in this response.

Ministry of the Environment staff have reviewed the following documents:

- Report titled: "*Level I and II Hydrogeological Investigation, Hidden Quarry, Rockwood, Ontario*", dated September 2012, prepared by Harden Environmental Services Ltd. (Harden)
- Site Plans plotted September 21, 2012, prepared by Stovel and Associates Inc. for James Dick Construction Ltd.

Background

James Dick Construction Ltd. (JDCL) is proposing to extract sand, gravel, and dolostone that will extend below the water table. The site is located on Lot 1, Concession 6, County of Wellington and is approximately 38 hectares. The site is in an agricultural setting and is bound by 6th Line on the southwest side of the property and Highway 7 on the southeast side of the property.

The site is located within the Blue Springs Creek watershed. In terms of local hydrological features, Tributary A is located to the west of the property and flows towards the southwest. Tributary B enters the property from the north and flows in a southerly direction and exits the property on the east side. Tributary C is located to the east of the site and flows in a southerly direction where it converges with Tributary B downstream of the site. The Northwest Wetland is fully contained within the subject property and is approximately 1 hectare during non-drought conditions. Tributary B flows through a provincially significant wetland (Allen Wetland) which is located to the north and is adjacent to the site. There is also the Northeast Wetland which is located to the north outside of the property boundary. Groundwater flow direction is stated to be towards the southeast.

It is proposed that material will be removed to a depth of 30 metres below the water table. The rock will be removed using subaqueous methods without the need for dewatering.

Surface Water Review and Comments:

1. Surface water monitoring including water quantity and water quality has been conducted at different sampling locations within the tributaries and wetlands on and adjacent to the property. Based on the proposed extraction areas, material will be extracted on either side of Tributary B and a buffer of 20-30 metres will be maintained. Two ponds (West and East) will be created on either side of Tributary B. Given that Tributary B and the Northwest Wetland are the closest receptors to the proposed extraction areas, these features have the highest likelihood to be impacted if an impact were to occur.

   The period between when local groundwater levels will be influenced from extraction activities and the stabilization of local hydraulic conditions will represent the time when changes to hydraulic gradients would be the most pronounced. Based on the data presented Tributary B is a "losing" stream which indicates groundwater is not discharging to the part of the reach that flows through the subject property. Subsequently, decreasing the water table has the potential to increase the magnitude of the downward vertical hydraulic gradient. The report has not provided an analysis of hydraulic gradients for the data that has been collected to date or the anticipated changes during extraction activities and the potential change in the flux of water leaving the stream. More specifically, it is unclear if the rate and quantity of water lost to the underlying sediments will significantly increase as a result of lowering the water table which could cause the tributary to experience extended periods of little to no flow.

   The consultant has recommended that a hydraulic barrier be constructed along the southern and eastern perimeter of the Northwest Wetland to mitigate potential changes in hydraulic gradient that would result in loss of water from the wetland into the open space created by the excavation. The proposed approach seems reasonable to address potential impacts and will be evaluated by the proposed monitoring plan.

2. The Northeast Wetland is considered to be a perched hydrologic feature and is not an area of groundwater discharge. As such, the risk for impact associated with the wetland is low. Potential impacts to the Allen Wetland and pond that supplies flow to Tributary B are not anticipated given it is cross-gradient from the site.

3. The proposed monitoring program is presented in Section 6.1 of the subject report. Staff recommend the monitoring program be revised to reflect the following changes:

    a. Collect surface water level measurements at SW4 and SW8 in addition to SW6. This data has been collected historically and should continue to be monitored to assess potential impacts in Tributary B.

    b. Frequency of surface water level and flow measurements increase from monthly to semi-monthly between April and November (inclusive) and coincide with groundwater sampling events.

    c. Add MP1, MP2, MP3, and MP4 to the monitoring program to measure water levels and calculate vertical hydraulic gradients to address issues raised in Point#1. These monitors are useful for evaluating surface/groundwater interactions. The monitoring frequency should coincide with the groundwater monitoring program.

4. There needs to be further synthesis of the monitoring data that has been collected to date to describe pre-extraction conditions. Although the hydrogeological investigation provided the tables of surface water level and flow data, limited information was provided in terms of trends, the natural variation between years and within years (i.e. seasonal differences), and surface/groundwater interactions particularly in the Northwest Wetland and Tributary B. This information can be used to have a clearer understanding of baseline conditions prior to extraction, which is similar to what is being proposed in Section 6.2 to summarize baseline groundwater conditions. Also, it will allow to better define conditions that are outside of the natural variation measured prior to extraction and to establish when potential impacts may be occurring. More specifically, it is not clear how the monitoring program will identify potential impacts or what environmental condition will trigger contingency measures identified in Section 6.3.

<u>**Groundwater Review and Comments:**</u>

1. One of the potential impacts of the proposed quarry to the bedrock aquifer is the change of groundwater levels resulting from the groundwater flow into the quarry to replace the volume of rock removed. The proposed rate of extraction is 700,000 tonnes per year which is equivalent to 270,000 m^3 of rock per year.

   Based on the field work data and published data for the area, a computer modeling was used to predict the water level changes in the bedrock aquifer. The results indicate that the maximum decline of 1.8 m is predicted at the northern Site boundary; and a rise of 1.5 m at the southern Site boundary.

   The predicted water level changes in the groundwater should not significantly affect the private water wells in the area since the expected water level change is less than the measured seasonal water level variation (0.8 to 2.5 m in the bedrock and 1.0 to 2.4 in the overburden) and small compared to the available drawdown in the surveyed area wells (generally greater than 5 m with an average of approx 19 m). The pre-bedrock extraction water survey proposed in Section 6.2 of the report should provide an updated baseline conditions for the local water wells in the area.

2. The report asserts that the bedrock aquifer and wells completed in the aquifer are already subject to direct influence from surface water. This is based on the observation that the local streams recharge the aquifer in the dolostone at times, transporting agricultural nutrients and biological elements to the aquifer below. In addition, the susceptibility of the bedrock aquifer to contaminants from the ground surface has been recognized in several reports of studies done for the area. Harden collected samples from on-Site groundwater monitoring wells and an on-Site private well for water quality analyses. The results indicate that there are elevated nitrates (above 5mg/L) in two wells – one screened in the bedrock and the other in the contact zone between the overburden and the bedrock. Staff agree with Harden that the potential sources of nitrate are septic systems and farming practices existing in the area. In addition, the quarry pond to be created by the aggregate extraction activities will be susceptible to biological contamination introduced by wildlife.

   The proposed mining process – extraction below the groundwater without dewatering – also has the potential to have a detrimental effect on the groundwater quality since chemical explosives, in a water proof emulsion form, are brought in the sub-aqueous environment to break the rock. This type of mining is presently conducted at the Dolime Quarry in Guelph. Harden collected a water sample from the Dolime Quarry pond above the broken rock pile four hours after detonation; the sample was analyzed for metals, inorganic compounds, polycyclic aromatic hydrocarbons (PAH), volatile organic compounds (VOC) and hydrocarbons . The results indicate absence of PAH and VOC (except for benzene found at a concentration of 0.11 ug/L); absence of hydrocarbons; and concentration of inorganics and metals below the Ontario Drinking Water Standards (ODWS). This data indicate a low potential for negative water quality impacts.

3. Another potential impact of the quarry on groundwater is the thermal effects of the creation of the quarry ponds on the temperature of groundwater in the surrounding areas; particularly on the Brydson Spring south of the Site. This potential effect has not been addressed.

4. Based on the bedrock descriptions in the record of boreholes for M2 and M4, the presence of vuggy and reefy porosity, open fissures and large cavities suggest the presence of karst in the bedrock. This issue needs to be addressed.

5. The proposed monitoring and contingency plans are presented in Section 6 of the report. These should be revised to consider the following comments and recommendations:

   a. There is a lack of bedrock monitoring points in the area to the east of the stream crossing the Site; thus, at least a monitoring well should be drilled on the area; water levels should be monitored before bedrock extraction begins, and the well should be added to the monitoring plan.

b. The water level data presented was collected at an approximate monthly frequency; so, the data show the natural seasonal variation of the groundwater water levels in the area. However, during the active rock extraction, specially at the outset, the water levels are expected to fluctuate much more quickly; consequently, it is recommended that, before the commencement of bedrock extraction, bedrock water level data be collected at a frequency of at least once a day for at least one year to generate a baseline dataset. Future water levels fluctuation during the bedrock extraction phases can be compared to the baseline dataset. These future water levels fluctuations should also be measured at a daily frequency as a minimum for a minimum of year, at that point in time the data collected should be assess to establish the frequency of measurements for the life of the quarry.

c. Using the baseline dataset noted in Point b. above, the data from the pre-bedrock extraction water survey proposed in Section 6.2, and the existing data, establish preliminary triggers for the Contingencies Measures presented in Section 6.3 of the report. The preliminary triggers should be re-assessed at the same time of the assessment recommended in Point b. above.

d. Propose a method for reporting and interpretation of the collected data.

e. Consider the outcome of addressing the issues raised above in Points 3. and 4. to modify or enhance the monitoring plan.

f. Increase the groundwater quality frequency to semi-annually.

Ministry staff would be pleased to meet or discuss these comments. The groundwater reviewer is Ms. Rosa Stewart who can be contacted at (905)521-7592 or at Rosa.Stewart@Ontario.ca. The surface water reviewer is Mr. Craig Fowler who can be contacted at (905)521-7823 or at Craig.Fowler@Ontario.ca.

Yours truly,

Carl Slater

Carl Slater
Technical Support Manager
West Central Region

C: Mr. S. May, Ministry of Natural Resources
Ms. J. Glassco, District Manager, Guelph District Office, MOE
Ms. L. Armour, Environmental Officer, Guelph District Office, MOE

APPENDIX B

Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

Date: June 7, 2013

James Dick Construction Ltd.
Box 470
Bolton, Ontario
L7E 5T4

Attn: Mr. Greg Sweetnam

Dear Mr. Sweetnam:

Re: Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site

1.0 Introduction

We are pleased to provide additional information in regards to geological and hydrogeological characterization of the bedrock underlying the proposed Hidden Quarry. The purpose of this exercise is twofold. Firstly the drilling and testing was conducted in order to satisfy comments made by R.J. Burnside and Associates Ltd. on the Level I and II Hydrogeology Report for the Hidden Quarry and secondly to facilitate monitoring of the site during a proposed pumping test by the Township of Guelph Eramosa in their Well No. 2.

This report details the following field efforts conducted at the site;

1) Drilling of a 140 mm (5.5”) cored borehole by Keith Lang Water Well Drilling,

2) Retrieval and storage of 44.35 metres of core, noted the presence of fractures and breaks in the core,

3) Photographing of the core in both metric and imperial depths below ground surface,

4) Pumping of the well at approximately 2.1 and 4.2 L/s for one hour,

5) Flow profiling of the well and

6) Video logging of the well.

2.0 Drilling Summary

On May 13th and 14th, Keith Lang Water Well Drilling drilled Monitor 15 (M15) at co-ordinates 4829516 N, 571926 E and shown on Figure 1. Keith Lang used a Speedstar 30K drill rig and used mud rotary in the overburden and air rotary in the bedrock. Bedrock was encountered at a depth of 9.55 metres below ground surface (m bgs). The final depth of the borehole was 54.33 m bgs. The diameter of the borehole in the bedrock is 140 mm (5.5”). 150 mm (6”) casing was installed to a depth of 10.46 m bgs. There is a stick-up of fifty-one centimetres above ground surface. Bentonite grout was used in the mud circulation to seal the annulus between the overburden and the steel casing. The ground elevation of the borehole is 360.03 metres above mean sea level (m AMSL) and the top of steel casing has an elevation of 360.54 m AMSL.

2.1 Overburden

Wash samples of the overburden were obtained at 1.5 metre intervals. The wash samples only allow for general descriptions of the overburden and in general overburden comprises a very stony sand deposit. Detailed descriptions of the overburden are available from M11 and M12 drilled nearby. The borehole logs for M11 and M12 indicate that the overburden is mainly a stony silty sand.

2.2 Bedrock

The top of bedrock was encountered at a depth of 9.55 m bgs. Coring of the borehole commenced at a depth of 9.98 mbgs. Detailed descriptions of the core are found in the borehole record (Appendix A) and a photo log of the entire core is found in Appendix B. In regards to bedrock nomenclature, all of the dolostone geological units encountered belong to the formerly un-subdivided Amabel Formation. We have attempted to assign individual formation names based on recent work by the Ontario Geological Survey (OGS, 2008)[1] .

Goat Island Formation – Niagara Falls Member

A dark grey non bituminous fine grained dolostone is found in the core between 9.98 m bgs and 10.03 m bgs. This is interpreted to be the Niagara Falls Member of the Goat

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[1] Summary of Field Work and Other Activities, 2008, OFR 6226, Frank Brunton

Island Formation. Based on a comparison of this core with core of the Eramosa Formation obtained from the Dolime Quarry in Guelph, this core is not representative of the Eramosa Formation.

Gasport Formation

The Gasport Formation is found between 10.03 m bgs and 48.50 m bgs. The Gasport comprises of white to blue grey coarse grained dolostone. The porosity of the Gasport Formation varies from openly porous to tightly packed. There are numerous stylolites within this formation. The formation has visible fossilization of which crinoid stems and brachiopod shell castings were found. Portions of the Gasport Formation are vuggy. No significant loss of core occurred. The driller noted two water bearing fractures at 16 and 18.5 metres depth during the drilling.

Irondequoit Formation

The Irondequoit Formation is found between 48.50 m bgs and 49.93 m bgs. This formation is found to be blue grey dolostone, pyritiferous.

Rockway Formation

The Rockway Formation is found between 49.93 and 50.72 m bgs. The Rockway Formation is a finely crystalline green dolostone. The formation is pyritiferous.

Merriton Formation

The Merriton Formation is found between 50.72 m and 51.51 m bgs. The Merriton Formation is a buff brown finely crystalline dolostone.

Cabot Head Formation

The Cabot Head formation was found below 51.51 m bgs. The Cabot Head formation comprised red and green shale beds.

A summary of the depths and elevations of the geological units is provided in Table 1.

Table 1: Geological Summary

Geological Unit	Depth (m bgs)		Elevation (m AMSL)	
	From	To	From	To
Overburden	0	9.55	360.03	350.48
Goat Island: Niagara Member	9.55*	10.03	350.48	350.00
Gasport Formation	10.03	48.50	350.00	311.53
Irondequoit Formation	48.50	49.93	311.53	310.10
Rockway Formation	49.93	50.72	310.10	309.31
Merriton Formation	50.72	51.51	309.31	308.52
Cabot Head Formation	51.51		308.52	

* Geological unit between top of rock and beginning of core is assumed to be Goat Island Formation

2.3 Description of Core Breaks

Each core break was looked at in the field and at our office and recorded as a machine break, closed fracture or open fracture. The record of core breaks will only include naturally occurring core breaks. The distinction between an open and closed fracture is made where there is evidence of water movement through the break (discolouration, mineral oxidation etc..), imperfect fit of the core and infilling or mineralization along the fracture wall. Where possible, any material found within the fracture was noted, however, the water circulation around the core during the drilling process, likely removed this material, if any was present.

Table 2 (located following the text of this report) is a summary of the core breaks. A total of ninety three natural core breaks are recorded over the 44.35 metres of core. Eighty five percent of core breaks occurred at 90 degree angle relative to the axial length of the core. Two vertical fractures were identified in the core.

The frequency of open fractures is summarized in Table 3.

Table 3: Frequency of Open Fractures

Depth (m bgs)		Number of Open Fractures
From	To	
10	15	7
15	20	3
20	25	9
25	30	8
30	35	10

Depth (m bgs)		Number of Open Fractures
From	To	
35	40	9
40	45	2
45	50	1
50	55	5

The greatest concentration of open fractures occurs between the depth of 20 and 40 metres below ground surface.

2.4 Photo Log of Core

A photo log of the core is found in Appendix B. The photo log is provided in both metric and imperial units. Open and closed fractures are noted on the photo log as well as the interpreted geological contacts. Significant water bearing zones as identified from the downhole flow test and video log are also identified on the photo log.

3.0 Pumping Tests

Monitoring well M15 was pumped prior to and during the flow testing and video logging procedures. Prior to flow testing, the well was pumped at 2.1 and 4.2 litres per second for approximately 60 minutes and 30 minutes respectively. The drawdown curves for these pumping rates are shown on Figure 2. The drawdown after 60 minutes of pumping at 2.1 L/s was 1.21 m. The drawdown after 34 minutes at the 4.2 L/s rate was 2.24 m. Semi-log graphs of the 2.1 L/s and 4.2 L/s test are shown on Figures 3 and 4 respectively. Straight line analysis (Jacob semi log method) suggests that the transmissivity of the aquifer is between 50 and 70 m^2/day. This translates to an estimated hydraulic conductivity of 2 x 10^{-5} m/s (using relationship of T = k/b where b = aquifer thickness of 38.5 metres). The maximum drawdown in M15 was observed at the end of the flow testing at 2.67 metres.

Manual measurements and an automatic logger installed in M2 recorded the effects of pumping. The hydrograph for M2 is shown on Figure 5. M2 also penetrates the entire thickness of the aquifer. The maximum response in M2 was approximately 1.23 metres. The semi-log graph of the drawdown of M2 from the pumping at 4.2 L/s is shown on Figure 6. The straight-line analysis of the data results in an estimated transmissivity of 83 m^2/day in the aquifer.

As shown in Table 3, no response was measured in M1D, M3 or M13D.

Table 3: Water Levels in Shallow Bedrock Monitors on May 24, 2013

Time	M1D (mbct)	Time	M3 (mbct)	Time	M13D (mbct)
10:43	7.875	10:15	10.295	10:48	2.95
10:59	7.875	11:39	10.295	10:55	2.95
11:09	7.875	12:27	10.295	11:14	2.95
11:25	7.875	14:22	10.28	11:22	2.95
14:48	7.88	15:03	10.28	14:43	2.95

3.1 Flow Test

The velocity of water moving through the borehole was measured with a down-hole flow meter. The flow meter was installed in the well and the pump was installed above the flow meter. The pump was operated with a flow rate of approximately 4.2 L/s during the flow measurements. Flow measurements were obtained every 0.30 metres. The results of the flow test are provided in Table 4 following this report and shown graphically on Figure 7. The flow velocity steadily declines between 15 and 36 m bgs. At 36 metres depth, the flow velocity decreases by 0.1 m/s followed by another significant drop in velocity at 42 m bgs. Below 42 mbgs there is negligible flow in the well.

The flow test shows that approximately one third of the yield of the well is derived from various fractures between 10 m and 36 m bgs (350 to 324 m AMSL), one third of the well yield is obtained from a single set of fractures at 36 m bgs (324 m AMSL) and a third of the well yield is obtained from a fracture at 42 m bgs (318 m AMSL) (Table 5).

The maximum flow measured by the flow meter was approximately 0.27 m/s. The area of the borehole is 0.0153 m^2. Thus the volume of water flowing through the well beneath the pump was approximately 4.1 L/s. This is similar to the pumping rate of 4.2 L/s and thus the majority of water removed by the pump was derived from below the pump.

Table 5: Flow Test Summary

Interval (m AMSL)	Interval (m bgs)	Approximate % Yield
324 to 350	10 to 36	33
324	36	33
318	42	33

4.0 Video Log

A video camera was introduced to the well both above and below the pump. The video log is another method that can be used to identify discrete zones of water movement. Two videos were taken by Geokamp Ltd.

4.1 Video 1 – Above Pump Video

Video 1 was taken above the pump before and after pumping occurred. This video shows the bottom of the casing where contact with the rock is made. When the pump is turned on at 5:58 (minutes:seconds) of the video, the water can be observed to recede below the casing/bedrock contact. There is no observable movement of water at that contact. Turbid water can be observed to flow into the wellbore at time 8:46 of the video at a depth of 42' (12.80 m).

4.2 Video 2 – Below Pump Video

The pump was installed at a depth of approximately 12 metres below the top of casing. The video log identifies that below a depth of 45 metres (148'), the water is stagnant despite the continual operation of the pump. This confirms that the lower portion of the aquifer is not an active part of the flow system. This includes the Irondequoit, Merriton, Rockway and Cabot Head formations.

The video identifies water movement into the well at 52' (15.8 m).

5.0 Water Levels

Water levels were obtained from M15 on several occasions as summarized in Table 6. The stabilized groundwater elevation in M15 was measured to be 350.69 m AMSL on May 24, 2013. This value correlates to the contoured bedrock water levels as shown on Figure 3.17 of the Level I and Level II hydrogeology report.

Table 7: Water Level Monitoring M15

Date	Water Level (m bgs)	Water Level (m AMSL)
May 14, 2013	9.26	350.77
May 15, 2013	9.12	350.91
May 16, 2013	9.28	350.75
May 24, 2013	9.34	350.69

6.0 Water Quality Results

The water quality results for a sample obtained during the pumping are presented in Appendix C. The water has a nitrate value of 2.0 mg/L and chloride value of 16 mg/L. The low nitrate and chloride concentration indicates relatively low impact from anthropogenic activity. The water quality is typical for the dolostone aquifer in this area.

7.0 Recommended Multi-Level Installation Details

Monitoring Well M15 will be converted into a multi-level monitoring station using 40 mm PVC pipe. The main water bearing zones will be targeted for the discrete monitoring zones. We recommend the following zones for monitoring.

Monitoring Level	Interval (m bgs)		Interval (m AMSL)	
	From	To	From	To
Shallow	10	28	350.03	332.03
Intermediate	33	38	327.03	322.03
Deep	40	55	320.03	305.03

The shallow monitoring level represents the upper water bearing zone and is the zone where the majority of local wells obtain their water. The intermediate zone covers the major water bearing fracture located at a depth of 36 metres. The deep monitoring interval covers the major water bearing fracture at 42 metres. The majority of water movement through the quarry will occur between the elevation of 332 and 350 m AMSL. The maximum proposed depth of the quarry is 30 metres to an elevation of 320 m AMSL. It is more likely that the quarry will be limited to a depth of 25 metres or an elevation of 325 m AMSL. Thus the shallow and intermediate monitoring intervals will monitor water level changes and water quality changes occurring downgradient of the quarry and the deep monitoring zone will be able to monitor water level changes in the water bearing zone beneath the quarry. The intervals will be separated by a bentonite seal. A coarse sand will be used to fill the annulus between the screen and the borehole wall.

8.0 Discussion

The installation of M15 was a useful exercise as it confirmed the following about hydrogeological conditions within the proposed Hidden Quarry site;

1) There are no significant karst features identified in the geological profile. This is in keeping with the observations at M1, M2, M3, M4, M13D and M14D. The core obtained from M15 contains fractures, however, none suggest karstification of the dolostone aquifer.

2) Water bearing zones occur throughout the geological profile. The Gasport Formation is well known for its water bearing ability and this characteristic was confirmed at M15. Water bearing zones occur from the top of bedrock at an elevation of 350 m AMSL to an elevation of 318 m AMSL. There was no indication of preferential flow through the upper three metres of the geological profile.

3) Lateral hydraulic connectivity within the aquifer occurs at depth. There was a hydraulic response noted in monitor M2 to the pumping of M15. M2 and M15 fully penetrate the dolostone aquifer and the response in M2 verifies that water transmission will occur through the aquifer. This proves that M2 will be a useful monitor during the quarry operation to observe changes in the aquifer during extraction.

4) Hydraulic responses were not observed within the shallow bedrock at M1D, M13D or M3 whose completion elevations are all above 346 m AMSL. These wells are completed in the upper three metres of the bedrock. The lack of immediate hydraulic response is due to a relatively poor hydraulic connectivity between the shallow bedrock and deeper fractures; and poor lateral connectivity in the shallow zone. It is anticipated that the shallow bedrock zone will ultimately experience a hydraulic response after a prolonged water level change.

5) Although pumping periods were short, the response in the pumping well and in M2 were used to estimate transmissivity of the aquifer. The near-well transmissivity is estimated to range from 50 m^2/day to 80 m^2/day. This correlates well to the bulk hydraulic conductivity used in the model for the dolostone aquifer. These values also correlate well to the hydraulic testing conducted on the adjacent Mudge property where transmissivity of the aquifer was found to range from 20 to 150 m^2/day.

9.0 Response to Burnside Comments

We provide the following for inclusion in the response matrix for issues raised by Burnside.

Matrix #	Burnside Comment	Harden Response
72	There is not sufficient information on the bedrock in the extraction areas to allow for a reliable prediction of drawdown to be made. The vertical spacing and contribution of the water bearing fractures is not known and as a result, inflow into the pit may result in temporary dewatering of shallow fractures. The length of time for water levels to stabilize is not estimated. There is also a potential that bedrock water quality will be affected if cascading occurs within the extraction area.	The drilling of M15 along with the drill core, video log and down-hole flow monitoring provides confirmation that hydrogeological conditions beneath the quarry are satisfactorily understood. Open fractures and thus water yield for residential wells comes from a wide depth range and the concern regarding dewatering of shallow fractures is not a significant impact as there are numerous water sources at depth in the aquifer. There is not an indication from water well records that nearby wells only obtain water from the portion of the aquifer predicted to be impacted. The maximum off-site impact is predicted to be in the order of 1.5 metres. This is insufficient to significantly change the yield in any bedrock well. The mining process is relatively slow and occurs only for the working portion of the day allowing for daily recovery (at least, partial recovery) of water levels. Thus stabilization of water levels will occur relatively rapidly (days to months) following cessation of mining. The maximum water level change within the quarry is predicted to be 2.45 m at the northern edge of the west pond. This penultimate drawdown will only occur at the end of the quarry life and there will be many years of monitoring to verify that the slow change in water levels is not having an impact on the environment and local wells. It is unlikely that there will be water cascading into the quarry. Our observations of several dolostone quarries in southern Ontario suggest that there is more likely to be water movement behind the rock face. Even so, this cascading can only occur in the upper three metres of the bedrock along the

Matrix #	Burnside Comment	Harden Response
		northern most quarry edge. It is our prediction that at the edge, these three metres will be dewatered and no cascading will occur. The quarry will allow water from various zones within the bedrock to mix but no more than a water well mixes water from the full length of aquifer intersected by the well.
60	The Guelph Eramosa Study used significantly higher hydraulic conductivity values. Since the bedrock is heterogeneous significant variations in hydraulic conductivity can be expected. Additional data from within the extraction area is needed to confirm on-site conditions.	Based on the short term tests conducted in M15, the transmissivity of the aquifer is 50 to 80 m^2/day and within the range as originally predicted. The hydraulic conductivity of the aquifer based on this transmissivity is estimated to be 2 x 10^{-5} m/s, the same value used in the groundwater model. The data from M15 confirms that there are no unexpected onsite geological or hydrogeological conditions.
54	The bedrock surface is shown in Figure 3.5. The proposed extraction area should be added to this map. It appears that there are few (if any) bedrock monitoring wells within the two extraction areas. Given the heterogeneity of the bedrock, it is recommended that monitoring wells be installed within the extraction areas.	M15 was drilled to satisfy this comment. M15 will be instrumented on several different levels. The testing of M15 confirms that as with all bedrock aquifers, there is vertical heterogeneity with water being produced both diffusely from broad areas and discretely from single fractures. M15 is located centrally to the site between the proposed extraction areas and provides confirmation of hydrogeological conditions already anticipated in the Level I and Level II Hydrogeology Report.
56	It is noted in the report that the Brydson Spring likely represents discharge directly from the bedrock and can be considered to be the re-emergence of Tributaries B and C. There are	The water levels obtained from M2, M12, M3, M15 and M11 confirm that geological conditions are such that groundwater does not occur in the overburden in the eastern two

Matrix #	Burnside Comment	Harden Response
	limited bedrock wells on the proposed quarry site and there is no data that confirms that the tributary loses water to the bedrock. Tracer testing should be considered to confirm this statement.	thirds of this site despite the loss of water from Tributary B. The static water level at the on-site home (MOE Well # 6705627) is below the top of rock. This well is situated very close to Tributary B and downstream of the losing portion of the stream. There is no evidence to suggest that water lost from Tributary B does anything but contribute to the bedrock aquifer. The Brydson Spring is the nearest discharge point and thus a likely destination for water infiltrating local to the quarry. There is no appreciable thickness of overburden at the Brydson Spring or in the Blue Springs Creek valley, thus all infiltrating waters at the site and nearby must contribute to the bedrock. It is our opinion that a tracer test will not yield any meaningful information.

Respectully submitted,
Harden Environmental Services Ltd.

Stan Denhoed

Stan Denhoed, M.Sc., P. Eng.
Senior Hydrogeologist

Table 2: Log of Core Breaks

Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
32.83	10.01	open	90	
33.08	10.08	open	90	
33.17	10.11	open	90	
34.00	10.36	closed	90	
35.29	10.76	open	90	
36.25	11.05	open	90	calcite mineralization
37.83	11.53	closed	90	
41.17	12.55	open	90	iron staining
41.50	12.65	open	90	
48.71	14.85	open	90	clay infilling
50.96	15.53	open	30	brown staining
51.67	15.75	closed	90	
53.67	16.36	open	90	
60.83	18.54	open	90	
61.33	18.69	closed	10	
65.75	20.04	open	90	discolouration along fracture
67.33	20.52	open	90	
68.33	20.83	open	90	
68.83	20.98	open	90	
71.54	21.81	closed	0-90	
72.58	22.12	closed	90	
73.50 - 74.25	22.40 - 22.63	closed	vertical	
74.67	22.76	closed	90	
77.00	23.47	closed	45	
77.21	23.53	open	90	iron staining
77.38	23.58	open	90	iron staining
79.71	24.30	open	90	
79.79	24.32	open	90	
80.63	24.57	open	90	
81.00	24.69	open	90	
83.25	25.37	open	45	
84.17	25.65	open	30	
85.17	25.96	open	90	
86.54	26.38	open	90	
86.92	26.49	open	90	
88.42	26.95	closed	impact fract from driller	
90.75	27.66	open	90	
95.33	29.06	open	20	
98.25	29.95	open	45	
98.63	30.06	open	90	
99.25	30.25	open	45	
99.50	30.33	open	90	
100.83	30.73	closed	90	

Table 2: Log of Core Breaks

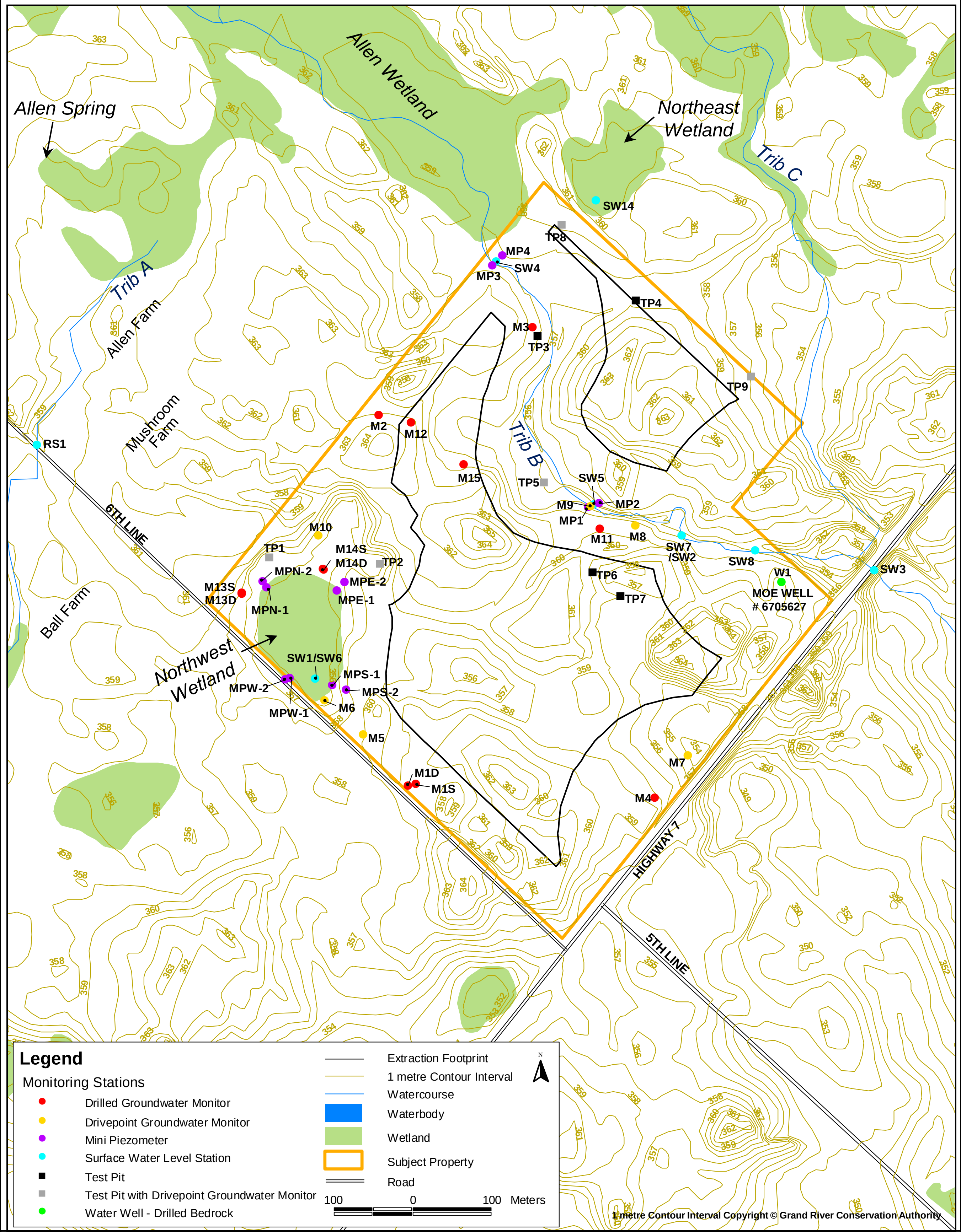
Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
101.25	30.86	closed	90	
102.00	31.09	open	90	vuggy
102.50	31.24	open	90	
102.83	31.34	closed	90	
103.42	31.52	open	90	
106.33	32.41	open	90	
108.42	33.05	closed	90	
109.25	33.30	open	90	drill stem dropped 2-3"
110.17	33.58	closed	90	
112.33	34.24	open	90	
112.83	34.39	closed	vertical	
114.17	34.80	closed	90	
114.50	34.90	open	90	discoloured
117.08	35.69	closed	90	
117.33	35.76	open	90	
119.50	36.42	open	90	
120.25	36.65	closed	90	
120.71	36.79	open	90	
120.79	36.82	open	90	
121.00	36.88	open	90	
124.33	37.90	open	90	
126.83	38.66	open	90	
128.00	39.01	closed	90	
128.75	39.24	open	90	
131.17	39.98	open	90	discolouration around fract-whiter
131.92	40.21	closed	90	
136.08	41.48	open	90	
142.08	43.31	closed	90	
144.50	44.04	open	90	white discolouration around fracture
147.83	45.06	closed	10	
148.00	45.11	closed	90	
152.42	46.46	closed	90	
152.75	46.56	closed	90	
156.50	47.70	open	90	
157.50	48.01	closed	30	
157.96	48.15	closed	30	
161.42	49.20	closed	90	
161.67	49.28	closed	90	
163.92	49.96	closed	90	
164.17	50.04	closed	90	
164.58	50.17	closed	90	
165.50	50.44	closed	90	
165.67	50.50	closed	90	

Table 2: Log of Core Breaks

Depth (Feet bgs)	Depth (metres bgs)	Type	Orientation (degrees)	Additional Comments
165.75	50.52	closed	90	
166.00	50.60	open	90	
166.42	50.72	open	90	
167.83	51.16	open	90	
168.17	51.26	open	90	
168.50	51.36	closed	90	
168.92	51.49	open	90	

Table 4: M15 Flow Test Results

Depth (Feet b.c.t.)	Velocity (ft/sec)	Depth m bgs	Velocity (m/s)
50	0.89	14.73	0.27
51	0.88	15.03	0.27
52	0.88	15.34	0.27
53	0.87	15.64	0.27
54	0.87	15.95	0.27
55	0.87	16.25	0.27
56	0.86	16.56	0.26
57	0.83	16.86	0.25
58	0.85	17.17	0.26
59	0.83	17.47	0.25
60	0.82	17.78	0.25
61	0.82	18.08	0.25
62	0.85	18.39	0.26
63	0.8	18.69	0.24
64	0.75	19.00	0.23
65	0.74	19.30	0.23
66	0.74	19.61	0.23
67	0.74	19.91	0.23
68	0.77	20.22	0.23
69	0.78	20.52	0.24
70	0.76	20.83	0.23
71	0.76	21.13	0.23
72	0.77	21.44	0.23
73	0.75	21.74	0.23
74	0.75	22.05	0.23
75	0.75	22.35	0.23
76	0.75	22.65	0.23
77	0.74	22.96	0.23
78	0.74	23.26	0.23
79	0.78	23.57	0.24
80	0.75	23.87	0.23
81	0.74	24.18	0.23
82	0.75	24.48	0.23
83	0.77	24.79	0.23
84	0.75	25.09	0.23
85	0.76	25.40	0.23
86	0.75	25.70	0.23
87	0.78	26.01	0.24
88	0.73	26.31	0.22
89	0.7	26.62	0.21
90	0.7	26.92	0.21
91	0.71	27.23	0.22
92	0.71	27.53	0.22
93	0.71	27.84	0.22
94	0.71	28.14	0.22
95	0.7	28.45	0.21
96	0.71	28.75	0.22
97	0.69	29.06	0.21
98	0.68	29.36	0.21
99	0.64	29.67	0.20
100	0.69	29.97	0.21
101	0.65	30.27	0.20
102	0.68	30.58	0.21
103	0.68	30.88	0.21
104	0.68	31.19	0.21
105	0.67	31.49	0.20
106	0.67	31.80	0.20
107	0.69	32.10	0.21
108	0.68	32.41	0.21
109	0.68	32.71	0.21
110	0.66	33.02	0.20
111	0.63	33.32	0.19
112	0.62	33.63	0.19
113	0.63	33.93	0.19
114	0.66	34.24	0.20
115	0.64	34.54	0.20
116	0.64	34.85	0.20
117	0.67	35.15	0.20
118	0.61	35.46	0.19
119	0.6	35.76	0.18
120	0.6	36.07	0.18
121	0.7	36.37	0.21
122	0.33	36.68	0.10
123	0.33	36.98	0.10
124	0.35	37.29	0.11
125	0.38	37.59	0.12
126	0.36	37.89	0.11
127	0.32	38.20	0.10
128	0.26	38.50	0.08
129	0.3	38.81	0.09
130	0.33	39.11	0.10
131	0.34	39.42	0.10
132	0.3	39.72	0.09
133	0.32	40.03	0.10
134	0.28	40.33	0.09
135	0.33	40.64	0.10
136	0.3	40.94	0.09
137	0.09	41.25	0.03
138	0.32	41.55	0.10
139	0.31	41.86	0.09
140	0	42.16	0.00



Harden Environmental Services Ltd.

Project No: 9506

Date: June 2013

Drawn By: AR

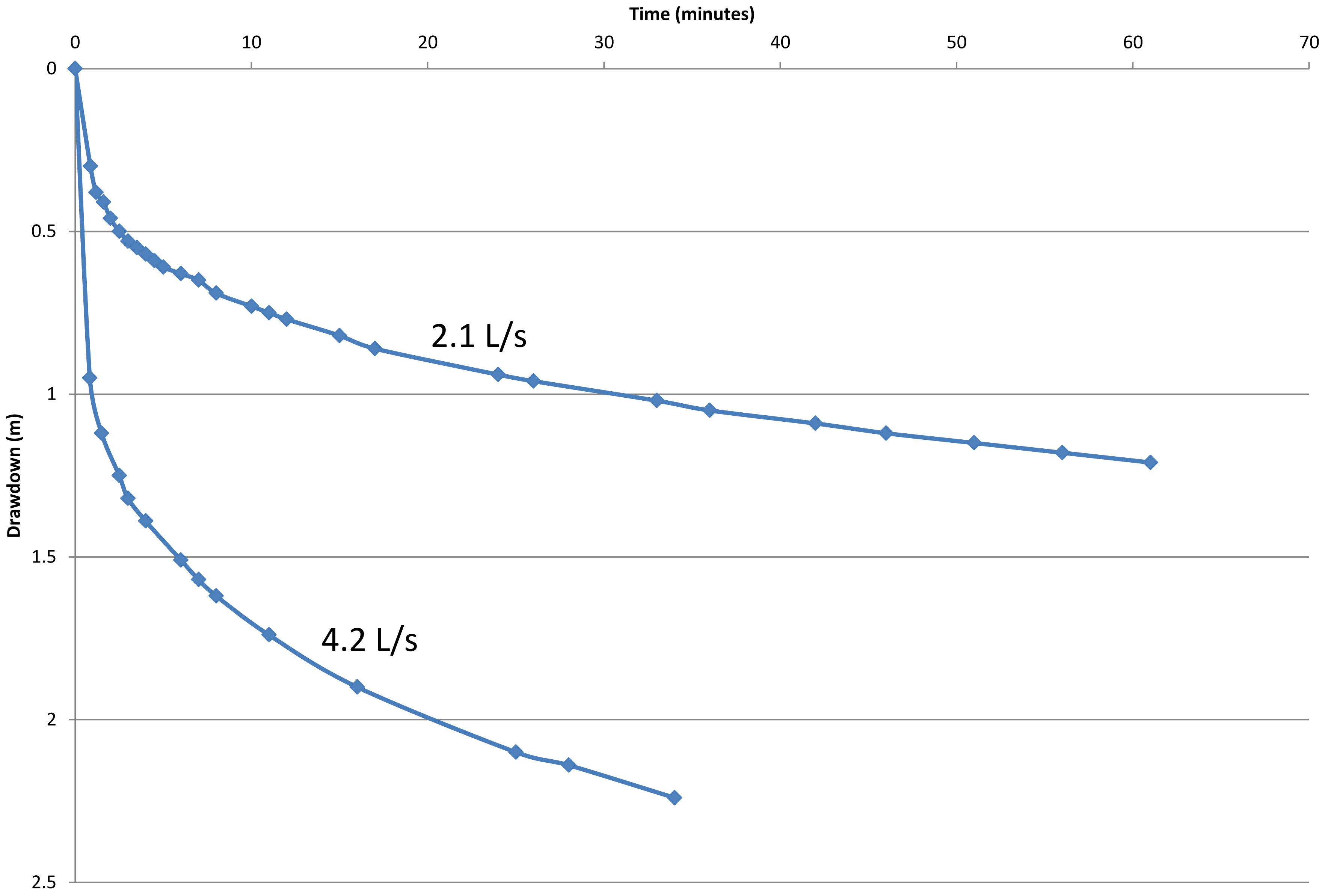
Hidden Quarry Summary of Drilling and Testing
New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1:

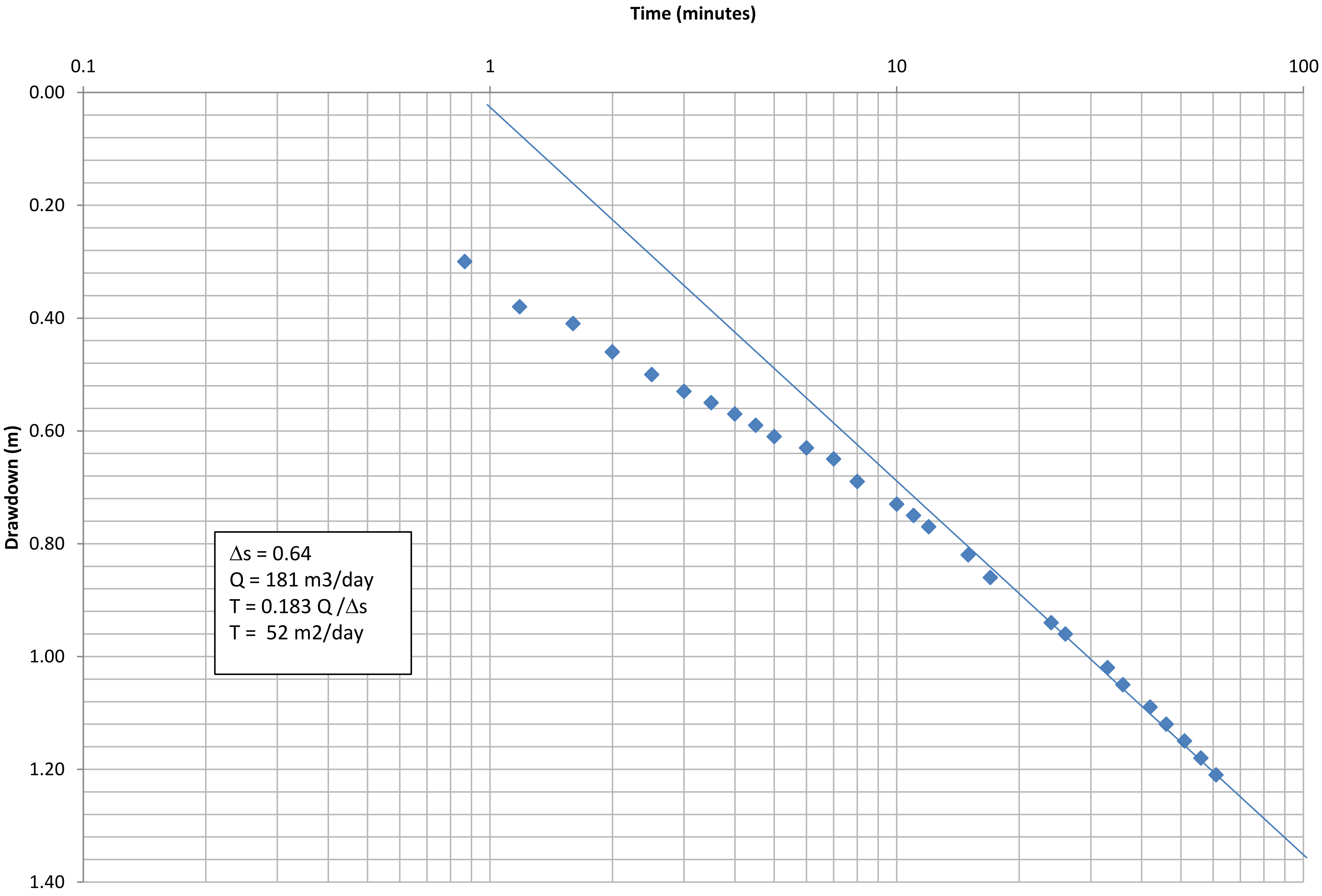
Monitoring Locations

Figure 2: M15 Step Test



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 2: M15 Step Test**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Figure 3: M15 2.1 L/s Step Test



Δs = 0.64
Q = 181 m3/day
T = 0.183 Q /Δs
T = 52 m2/day

Harden Environmental Services Ltd.

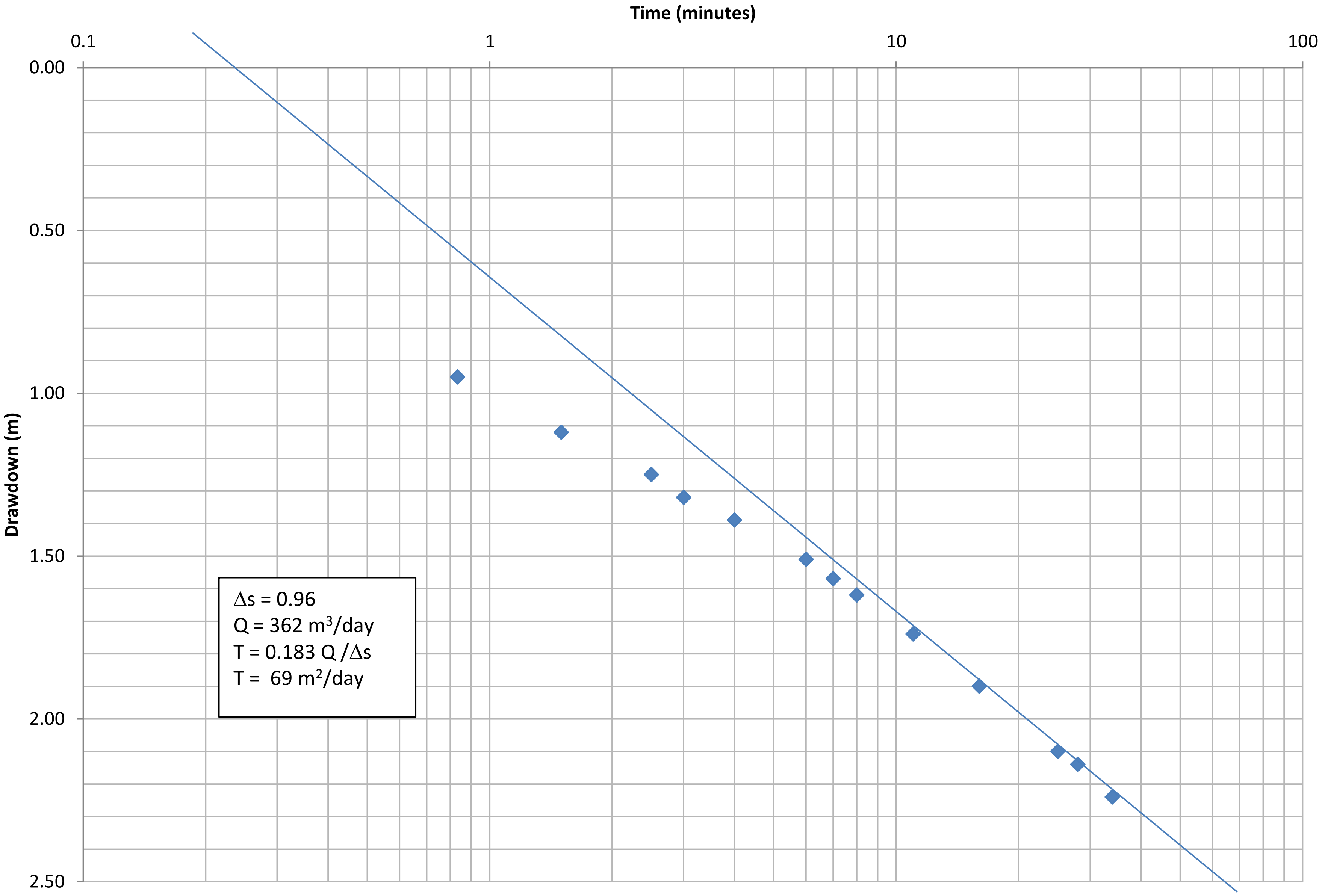
Project No: 9506
Date: June 2013
Drawn By: AR

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3: M15 2.1 L/s Step Test Semi-log Plot

Figure 4: M15 4.2 L/s Step Test

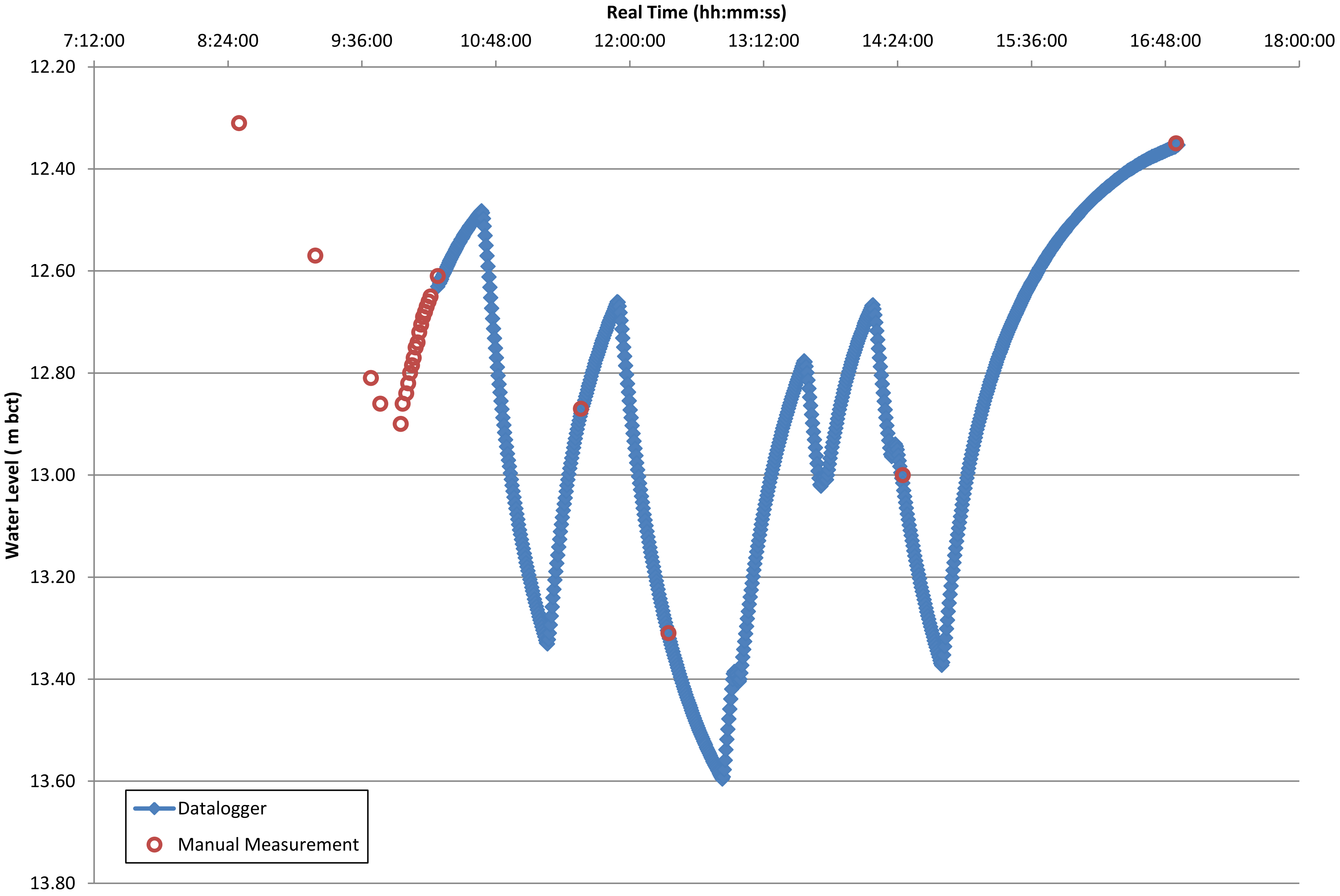


Δs = 0.96
Q = 362 m^3/day
T = 0.183 Q /Δs
T = 69 m^2/day

Harden Environmental Services Ltd.

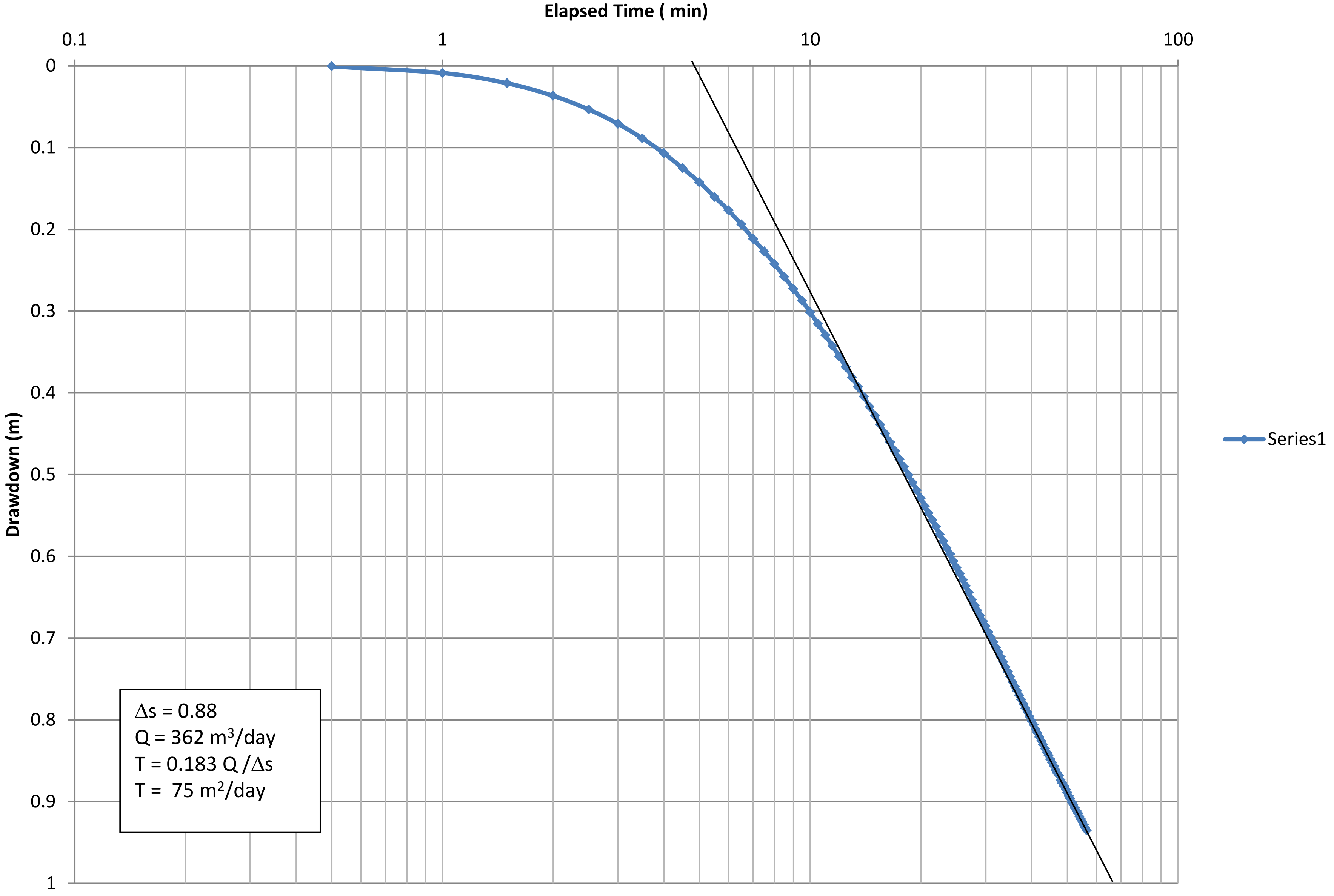
Project No: 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 4: M15 4.2 L/s Step Test Semi-log Plot**
Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		

Figure 5: M2 Response During M15 Testing



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 5: M2 Response During M15 Testing**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Figure 6: M2 Response to 4.2 L/s Pumping in M15



Δs = 0.88
Q = 362 m^3/day
T = 0.183 Q /Δs
T = 75 m^2/day

Harden Environmental Services Ltd.

Project No: 9506

Date: June 2013

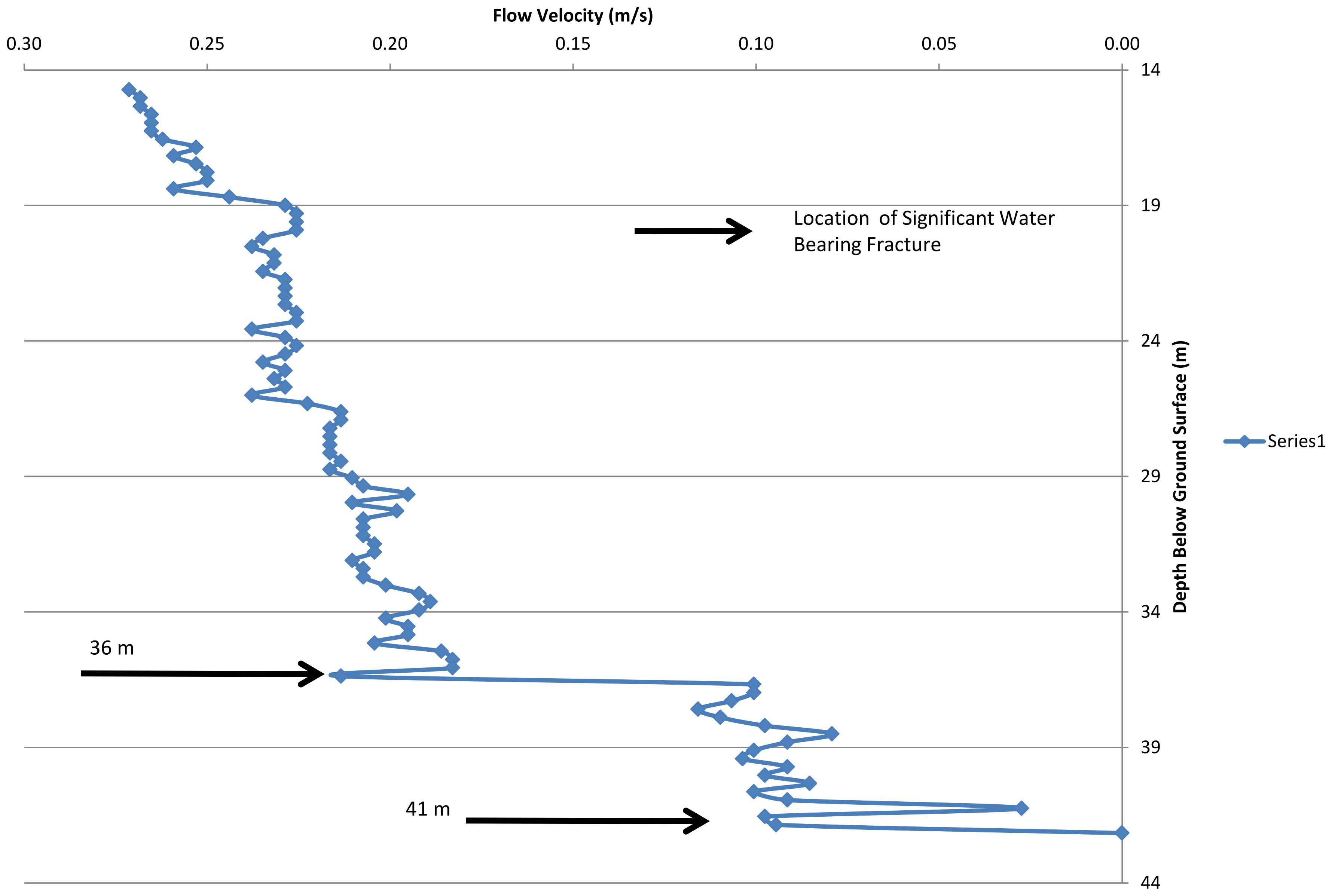
Drawn By: AR

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 6: M2 Response to 4.2 L/s Pumping in M15

Figure 7: Results of Flow Test



Harden Environmental Services Ltd.

Project No: 9506
Date: June 2013
Drawn By: AR

Hidden Quarry Summary of Drilling and Testing New Well M15

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 7: Results of Flow Test

APPENDIX A

M15 Borehole Log

PROJECT: 9506

M15

Page 1 OF 4

LOCATION: Hidden Quarry

BORING DATE: 15-05-2013 **DATUM:** GROUND SURFACE **DIP:** **LOGGED:** SD

BORING METHOD	SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
Rotary Drilling	Stony Silty Sand Paleozoic-stone rich silty sand	0	S1	Wash		
			S2	Wash		
			S3	Wash		
			S4	Wash		
			S5	Wash		
			S6	Wash		
	Goat Island Formation - Niagara Falls Member Dark grey non bituminous fine grained dolostone.	9.55	S7	Wash		
	Gasport Formation. 0.2 to 0.3 metres thick beds of white dolostone and blue grey dolostone. Iron staining at 12.54 metres. Open fractures at 10.08 m, 10.11 m, 10.76 m, 11.05 m, 12.55 m, 12.65 m	10.03	C1	Core		
	Gasport Formation. White to blue grey dolostone. Numerous stylolites. Clay filled fracture at 14.85m. Open fracture at 14.85 m.	13.11	C2	Core		

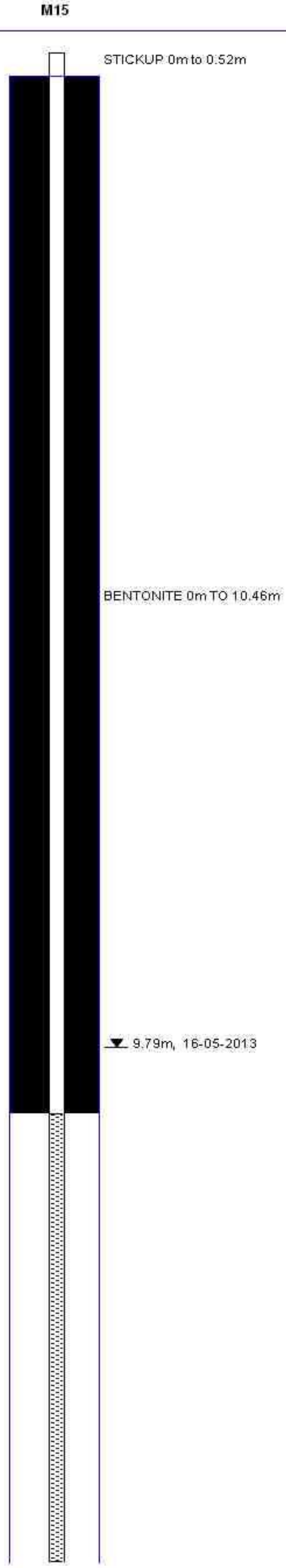
CONCENTRATION (%)

LEL ◆
MOISTURE CONTENT ●
GAS CONCENTRATION ■

0 20 40 60 80 100

Continued on next page

INSTALLATION INFORMATION



DRAWN: JD

Harden Environmental Services LTD.

CHECKED: SD

PROJECT: 9506

LOCATION: Hidden Quarry

BORING DATE: 15-05-2013 **DATUM:** GROUND SURFACE **DIP:** **LOGGED:** SD

M15

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
15	Rotary Drilling	Gasport Formation. 0.2 to 2.0 metre thick beds of white and blue grey dolostone. Fossiliferous. Openly porous below 16.24 m. Open fractures at: 15.53 m, 16.36 m. Water bearing fracture at 16.36 m.	15.11	C3	Core		
18		Gasport Formation. White and blue grey beds of dolostone. Vuggy below 18.54 m. Fossiliferous. Brachiopod castings and crinoid stems. Open fractures at: 18.54 m, 20.04 m, 20.52 m, 20.83 m, 20.98 m. Water bearing fracture at 18.54 m.	18.14	C4	Core		
21		Gasport Formation. White and blue grey dolostone. Thick zones of crinoid stems. More openly porous below 22.80 m. Open fractures at: 23.53 m, 23.58.	21.26	C5	Core		
24		Gasport Formation. Blue grey dolostone. Large visible fossils. Openly porous. Open fractures at: 24.30 m, 24.32 m, 24.57 m, 24.69 m, 25.37 m, 25.65 m, 25.96 m, 26.38 m, 26.49 m. Water bearing fracture at 25.96 m.	24.18	C6	Core		
27		Gasport Formation. White and blue grey dolostone. Large visible fossils. Openly porous. Large crinoid stems from 26.50 to 26.90 metres. Open fractures at: 27.66 m, 29.06 m, 29.95 m, 30.06 m, 30.25 m, 30.33 m.	27.38	C7	Core		

CONCENTRATION (%)

LEL ◆

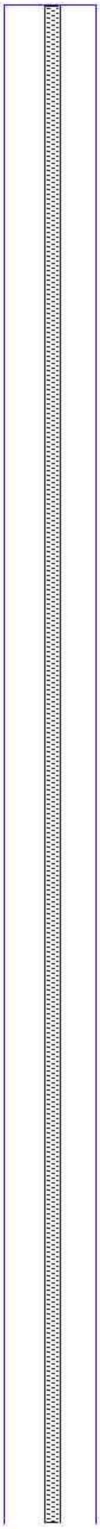
MOISTURE CONTENT ●

GAS CONCENTRATION ■

0 20 40 60 80 100

INSTALLATION INFORMATION

M15



Continued on next page

PROJECT: 9506

LOCATION: Hidden Quarry

M15

BORING DATE: 15-05-2013 **DATUM:** GROUND SURFACE **DIP:** **LOGGED:** SD

DEPTH SCALE METRES: 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45

DEPTH SCALE FEET: 100 102 104 106 108 110 112 114 116 118 120 122 124 126 128 130 132 134 136 138 140 142 144 146 148

BORING METHOD: Rotary Drilling

SOIL PROFILE DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES ID	TYPE	RECOVERY (%)	"N" VALUE
Gasport Formation. White and blue grey dolostone. Large visible fossils. Openly porous.		C7	Core		
Gasport Formation. Blue grey dolostone. Large visible fossils. Openly porous. Grey vuggy section from 31.30 to 31.60 metres. Open fractures at: 31.09 m, 31.24 m, 31.52 m, 32.41 m, 33.30 m.	30.38	C8	Core		
Gasport Formation. Blue grey dolostone. Vuggy. Large Fossil grains. Openly porous. Open fractures at: 34.24 m, 34.90 m, 35.76 m.	33.38	C9	Core		
Gasport Formation. Beds of white and blue grey dolostone. Vuggy. Large fossil grains. Open fractures at: 36.42 m, 36.79 m, 36.82 m, 36.88 m, 37.90 m, 39.24 m. Water bearing fracture at 36.42 m.	36.37	C10	Core		
Gasport Formation. Mottled blue grey dolostone. Not vuggy. Openly porous. Large fossil grains. Open fractures at: 39.98 m, 41.48 m. Water bearing fracture at 41.48 m.	39.37	C11	Core		
Gasport Formation. Grey dolostone. Fossiliferous. Large crinoid stems. Open fracture at: 44.04 m.	42.42	C12	Core		

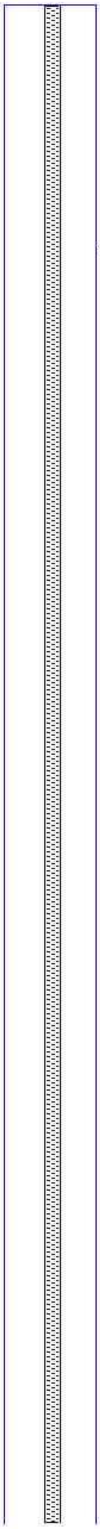
CONCENTRATION (%)

- LEL ◆
- MOISTURE CONTENT ●
- GAS CONCENTRATION ■

0 20 40 60 80 100

INSTALLATION INFORMATION

M15



SCREEN 10.46m TO 54.33m

Continued on next page

PROJECT: 9506

LOCATION: Hidden Quarry

BORING DATE: 15-05-2013 **DATUM:** GROUND SURFACE **DIP:** **LOGGED:** SD

M15

DEPTH SCALE – METRES: 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60

DEPTH SCALE – FEET: 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196

BORING METHOD	SOIL PROFILE – DESCRIPTION	DEPTH B.G.S. (m)	SAMPLES – ID	TYPE	RECOVERY (%)	"N" VALUE
Rotary Drilling	Gasport Formation. Grey dolostone. Fossiliferous. Large crinoid stems. Open fracture at: 44.04 m.		C12	Core		
	Gasport Formation. Grey dolostone. Not vuggy. Minor open porosity. Open fracture at: 47.70 m.	45.57	C13	Core		
	Irondequoit Formation. Blue grey dolostone. Pyritic.	48.50				
	Rockway Formation. Green dolostone. Finely crystalline. Pyritic. Open fractures at: 50.60 m, 50.72 m.	49.93	C14	Core		
	Merriton Formation. Buff brown finely crystalline dolostone. Open fractures at: 51.16 m, 51.26 m, 51.49 m.	50.72				
	Cabot Head Formation. Red and green shale.	51.51	C15	Core		
	END OF HOLE @ 54.33m	54.33				

CONCENTRATION (%)

LEL ◆

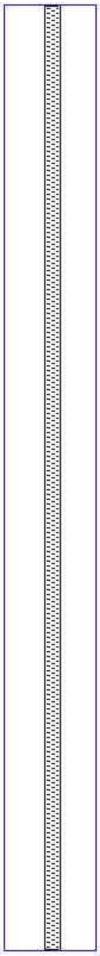
MOISTURE CONTENT ●

GAS CONCENTRATION ■

0 20 40 60 80 100

INSTALLATION INFORMATION

M15



END OF HOLE

DRAWN: JD

Harden Environmental Services LTD.

CHECKED: SD

APPENDIX B

Core Photo Log

Pages 1-5 in Feet
Pages 6-10 in Metres

APPENDIX C

M15 Water Quality Results

RESULTS OF ANALYSES OF WATER

Maxxam ID				RS1829		
Sampling Date				2013/05/24 12:30		
COC Number				na		
	Units	**Criteria A**	**A/O**	**PW1**	**RDL**	**QC Batch**
Calculated Parameters						
Anion Sum	me/L	**-**	-	7.87	N/A	3229791
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	**-**	-	250	1.0	3230462
Calculated TDS	mg/L	**-**	500	439	1.0	3229794
Carb. Alkalinity (calc. as CaCO3)	mg/L	**-**	-	2.4	1.0	3230462
Cation Sum	me/L	**-**	-	8.30	N/A	3229791
Hardness (CaCO3)	mg/L	**-**	80:100	390	1.0	3229982
Ion Balance (% Difference)	%	**-**	-	2.68	N/A	3229790
Langelier Index (@ 20C)	N/A	**-**	-	0.995		3229792
Langelier Index (@ 4C)	N/A	**-**	-	0.747		3229793
Saturation pH (@ 20C)	N/A	**-**	-	7.01		3229792
Saturation pH (@ 4C)	N/A	**-**	-	7.26		3229793
Inorganics						
Total Ammonia-N	mg/L	**-**	-	0.060	0.050	3232665
Conductivity	umho/cm	**-**	-	750	1.0	3232541
Total Kjeldahl Nitrogen (TKN)	mg/L	**-**	-	0.20	0.10	3235497
Dissolved Organic Carbon	mg/L	**-**	5	1.0	0.20	3232526
Orthophosphate (P)	mg/L	**-**	-	ND	0.010	3232548
pH	pH	**-**	6.5:8.5	8.01		3232543
Dissolved Sulphate (SO4)	mg/L	**-**	500	100	1	3232547
Alkalinity (Total as CaCO3)	mg/L	**-**	30:500	260	1.0	3232539
Dissolved Chloride (Cl)	mg/L	**-**	250	16	1	3232546
Nitrite (N)	mg/L	**1**	-	ND	0.010	3232529
Nitrate (N)	mg/L	**10**	-	2.0	0.10	3232529
Nitrate + Nitrite	mg/L	**10**	-	2.0	0.10	3232529

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

Harden Environmental
Maxxam Job #: B383273
Client Project #: 9506
Report Date: 2013/06/06
Site Location: ROCKWOOD

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID					RS1829		
Sampling Date					2013/05/24 12:30		
COC Number					na		
	Units	**Criteria A**	**IMC**	**A/O**	**PW1**	**RDL**	**QC Batch**
Metals							
Dissolved Aluminum (Al)	mg/L	**-**	-	0.1	ND	0.0050	3236227
Dissolved Antimony (Sb)	mg/L	**-**	0.006	-	0.00067	0.00050	3236227
Dissolved Arsenic (As)	mg/L	**-**	0.025	-	ND	0.0010	3236227
Dissolved Barium (Ba)	mg/L	**1**	-	-	0.067	0.0020	3236227
Dissolved Beryllium (Be)	mg/L	**-**	-	-	ND	0.00050	3236227
Dissolved Bismuth (Bi)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Boron (B)	mg/L	**-**	5	-	0.013	0.010	3236227
Dissolved Cadmium (Cd)	mg/L	**0.005**	-	-	ND	0.00010	3236227
Dissolved Calcium (Ca)	mg/L	**-**	-	-	110	0.20	3236227
Dissolved Chromium (Cr)	mg/L	**0.05**	-	-	ND	0.0050	3236227
Dissolved Cobalt (Co)	mg/L	**-**	-	-	ND	0.00050	3236227
Dissolved Copper (Cu)	mg/L	**-**	-	1	ND	0.0010	3236227
Dissolved Iron (Fe)	mg/L	**-**	-	0.3	ND	0.10	3236227
Dissolved Lead (Pb)	mg/L	**0.01**	-	-	ND	0.00050	3236227
Dissolved Lithium (Li)	mg/L	**-**	-	-	ND	0.0050	3236227
Dissolved Magnesium (Mg)	mg/L	**-**	-	-	30	0.050	3236227
Dissolved Manganese (Mn)	mg/L	**-**	-	0.05	0.0022	0.0020	3236227
Dissolved Molybdenum (Mo)	mg/L	**-**	-	-	0.0020	0.00050	3236227
Dissolved Nickel (Ni)	mg/L	**-**	-	-	0.0035	0.0010	3236227
Dissolved Phosphorus (P)	mg/L	**-**	-	-	ND	0.10	3236227
Dissolved Potassium (K)	mg/L	**-**	-	-	4.5	0.20	3236227
Dissolved Selenium (Se)	mg/L	**0.01**	-	-	ND	0.0020	3236227
Dissolved Silicon (Si)	mg/L	**-**	-	-	3.6	0.050	3236227
Dissolved Silver (Ag)	mg/L	**-**	-	-	ND	0.00010	3236227
Dissolved Sodium (Na)	mg/L	**20**	-	200	6.9	0.10	3236227

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A,IMC,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID					RS1829		
Sampling Date					2013/05/24 12:30		
COC Number					na		
	Units	**Criteria A**	**IMC**	**A/O**	**PW1**	**RDL**	**QC Batch**
Dissolved Strontium (Sr)	mg/L	**-**	-	-	1.0	0.0010	3236227
Dissolved Tellurium (Te)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Thallium (Tl)	mg/L	**-**	-	-	0.000077	0.000050	3236227
Dissolved Tin (Sn)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Titanium (Ti)	mg/L	**-**	-	-	ND	0.0050	3236227
Dissolved Tungsten (W)	mg/L	**-**	-	-	ND	0.0010	3236227
Dissolved Uranium (U)	mg/L	**0.02**	-	-	0.00052	0.00010	3236227
Dissolved Vanadium (V)	mg/L	**-**	-	-	ND	0.00050	3236227
Dissolved Zinc (Zn)	mg/L	**-**	-	5	0.062	0.0050	3236227
Dissolved Zirconium (Zr)	mg/L	**-**	-	-	ND	0.0010	3236227

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria A,IMC,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

APPENDIX C

Revised Monitoring Program

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

HIDDEN QUARRY

REVISED MONITORING PROGRAM AND CONTINGENCY MEASURES

1.0 ON-SITE MONITORING PROGRAM

Monitoring has been taking place at this site since 1995. An extensive database of background groundwater and surface water elevations and flow measurements has been developed. A detailed monitoring program will continue to ensure that sensitive features and surface water flows are maintained. The monitoring program is designed to identify trends towards unacceptable impacts early on to allow for time to implement contingence measures.

The monitoring program for this proposed pit/quarry involves the following activities:

- measuring groundwater levels,
- obtaining water quality samples,
- monitoring water levels in the on-site wetland and stream, and
- stream flow measurements.

We recommend the following monitoring program.

Parameter	Monitoring Locations	Frequency
Groundwater Levels	M1S/D, M2, M3, M4, M6, M13S/D, M14S/D, MPN1, MPN2, MPS1, MPS2, MPE1, MPE2, MPW1, MPW2, TP1, TP8, TP9 MP1, MP2, MP3, MP4, M15, M16	Manually Monthly April to November, February Automatic Daily Measurement in M1D, M2, M3, M4, M15, M16 for year prior to and year following bedrock extraction

Parameter	Monitoring Locations	Frequency
		with re-evaluation of monitoring frequency after 1st year of bedrock extraction.
Groundwater Levels	M2, M3, TP1, M13S/D, M14S/D, M15, M16	Weekly during first 3 months of extraction
Surface Water Levels	SW6, SW4, SW8	Monthly April to November *coincident with groundwater monitoring
Surface Water Flow	SW4, SW8, SW3	Semi-Monthly April to November *coincident with groundwater monitoring
Groundwater Quality	M2, M4, M15, M16	Semi-Annually
Surface Water Quality	West Pond, East Pond	Annually

Monitoring locations are shown on Figure C1.

1.1 TRIGGER LEVELS

Groundwater and surface water monitoring will be used at this site to a) verify that predictions of water level change in the bedrock aquifer do not exceed those predicted and b) verify that the hydro-period of the northwest wetland does not change. The water level measurements obtained as part of the monitoring program will be used to trigger contingency measures that may be necessary for the mitigation of a low water level in the northwest wetland, a lower than expected water level in the bedrock aquifer or an anomalous low flow level in Tributary B.

1.1.1 Trigger Levels for the Bedrock Aquifer

The greatest water level change in the bedrock aquifer is expected to occur to the north and northwest of the site. Water levels obtained from bedrock monitors M1D, M13D, M14D and M2 will be used to verify that actual water level changes do not exceed the predicted water level change. A warning level of 75% of the predicted change will be used to initiate bi-weekly manual measurements from the groundwater monitors.

Table 1: Trigger Levels for the Bedrock Aquifer

Monitor	Historical Low	Predicted Change	Warning Level	Trigger Level
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	348.08
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98

The historical water levels, warning level and trigger level are presented in Figures C2, C3, C4 and C5.

1.1.2 Trigger Level for Northwest Wetland

Water levels from Station SW6 will be used to trigger contingency measures for the northwest wetland. Historical monitoring has shown that the water level in the wetland is somewhat independent from adjacent groundwater levels and therefore any potential change in the hydro-period is best determined by the surface water level in the wetland.

A seasonal analysis of the data reveals that low water levels in the wetland can occur at any time of the year. The historical low value in the wetland is 354.20 m AMSL and this is the recommended trigger value. The warning value is recommended to be 354.35 m AMSL. Manual water level measurements will increase to bi-weekly if the warning level is exceeded. As shown on Figure C6, this would result in escalated monitoring three times in the past fifteen years.

1. 2 CONTINGENCY MEASURES

Groundwater Levels

If any trigger level is breached, the following measures will be taken;

1) Confirmation of water level within 24 hours.

2) Evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed.

3) If quarry activities are found to be responsible, the following actions will be considered and a response presented to the GRCA and the Township of Guelph-Eramosa.

- increase the length and/or width of barrier
- decreased rate (or stopping) subaqueous extraction
- change in configuration of mining or decrease in mining extent
- alter timing of extraction to coincide with high seasonal groundwater levels.

Groundwater Quality

The parameters that will be included in the semi-annual monitoring (summer) will be general chemistry, bacteria, TKN, ammonia, DOC, pH, temperature, anions and metals. In the event that there is an increasing trend in the concentration of one or more elements or compounds, a study will be conducted to determine the source of the water quality change. If the quarry is found to be responsible and if there is a potential for impact to downgradient wells, James Dick Construction Ltd. will commence with the following actions;

1) Semi-annual testing of the water quality of private wells that could potentially be impacted by the quarry.

2) In the event that a water quality issue related to the quarry occurs, James Dick Construction Ltd. will remedy the issue by either providing the appropriate treatment in the home or drilling a new well and isolating the water supply to the deeper aquifer

1.3 PRE-BEDROCK EXTRACTION WATER WELL SURVEY

We recommend that a detailed water well survey be completed prior to the commencement of the extraction of bedrock resources. This survey will as a minimum include all wells in the shaded area shown on Figure C7. The well survey will include the following;

- construction details of the well (drilled, bored, sand point etc..)
- depth of well and depth of pump
- location of well relative to septic system
- static water level
- history of water quantity or quality issues

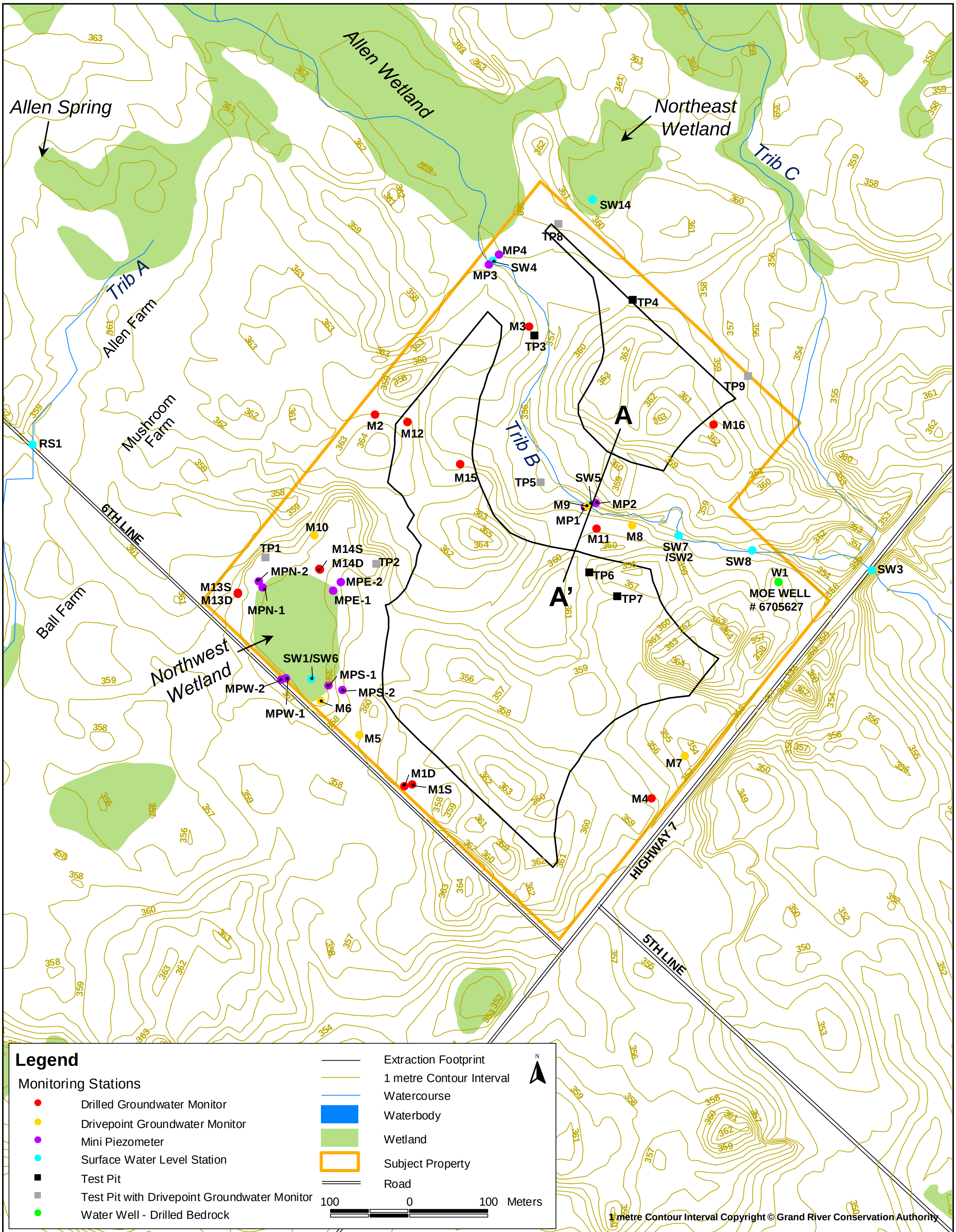
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals
- one hour flow test

The purpose of the survey is to have a baseline evaluation of both water quality and water quantity in nearby water wells. Should an issue arise with a local water well, the baseline data can be used as a reference against future measurements.

1.4 ANNUAL MONITORING REPORT AND INTERPRETATION

An annual report will be prepared and submitted to the Ministry of the Environment and the Ministry of Natural Resources on or before March 31st of the following calendar year. The report will be prepared by a qualified professional, either a professional engineer or a professional geoscientist.

The monitoring report will include all historical monitoring data and an interpretation of the results with respect to potential impact to the quality and quantity of bedrock groundwater, hydro-period of the northwest wetland and flux from Tributary B.



1 metre Contour Interval Copyright © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2013

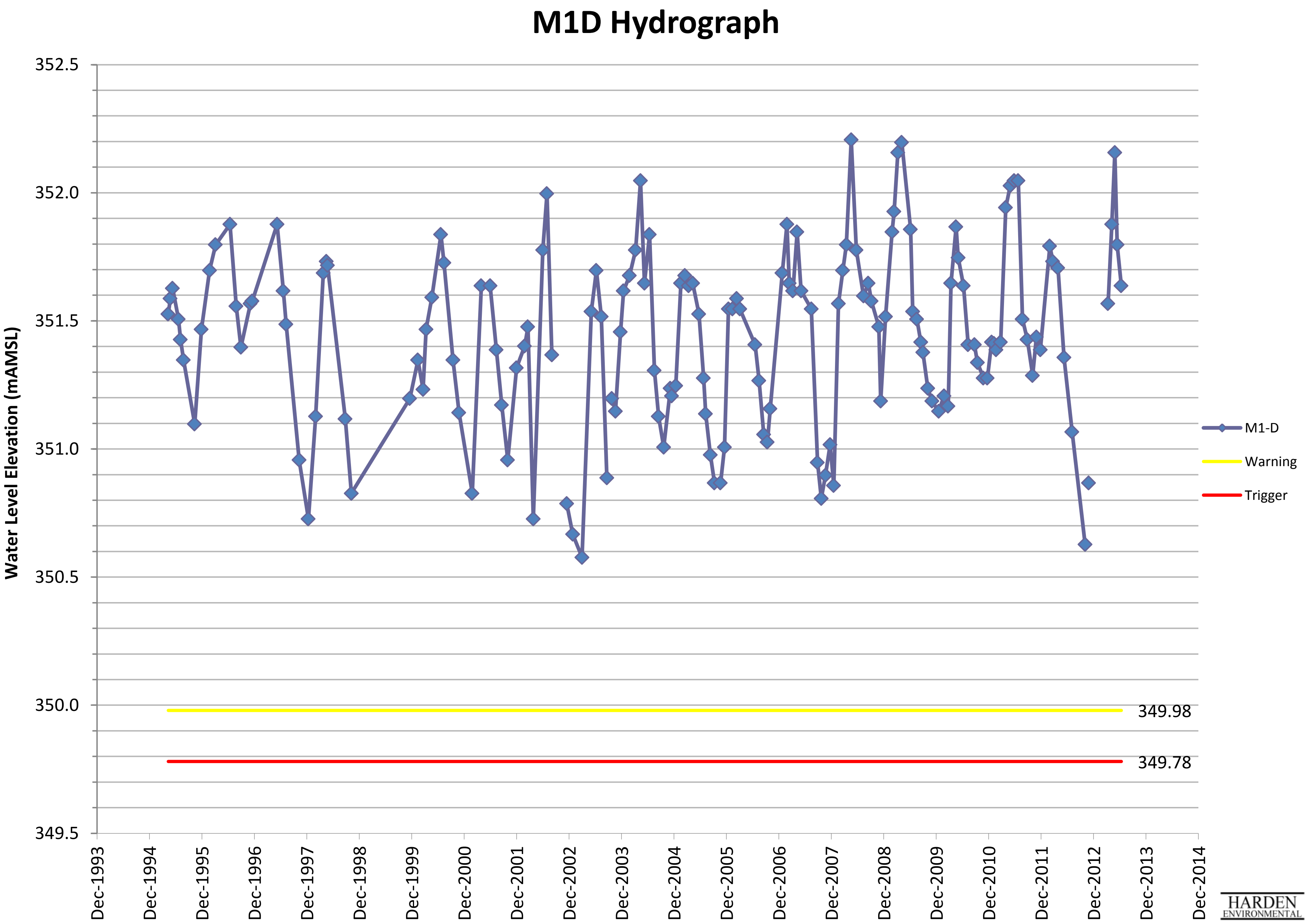
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

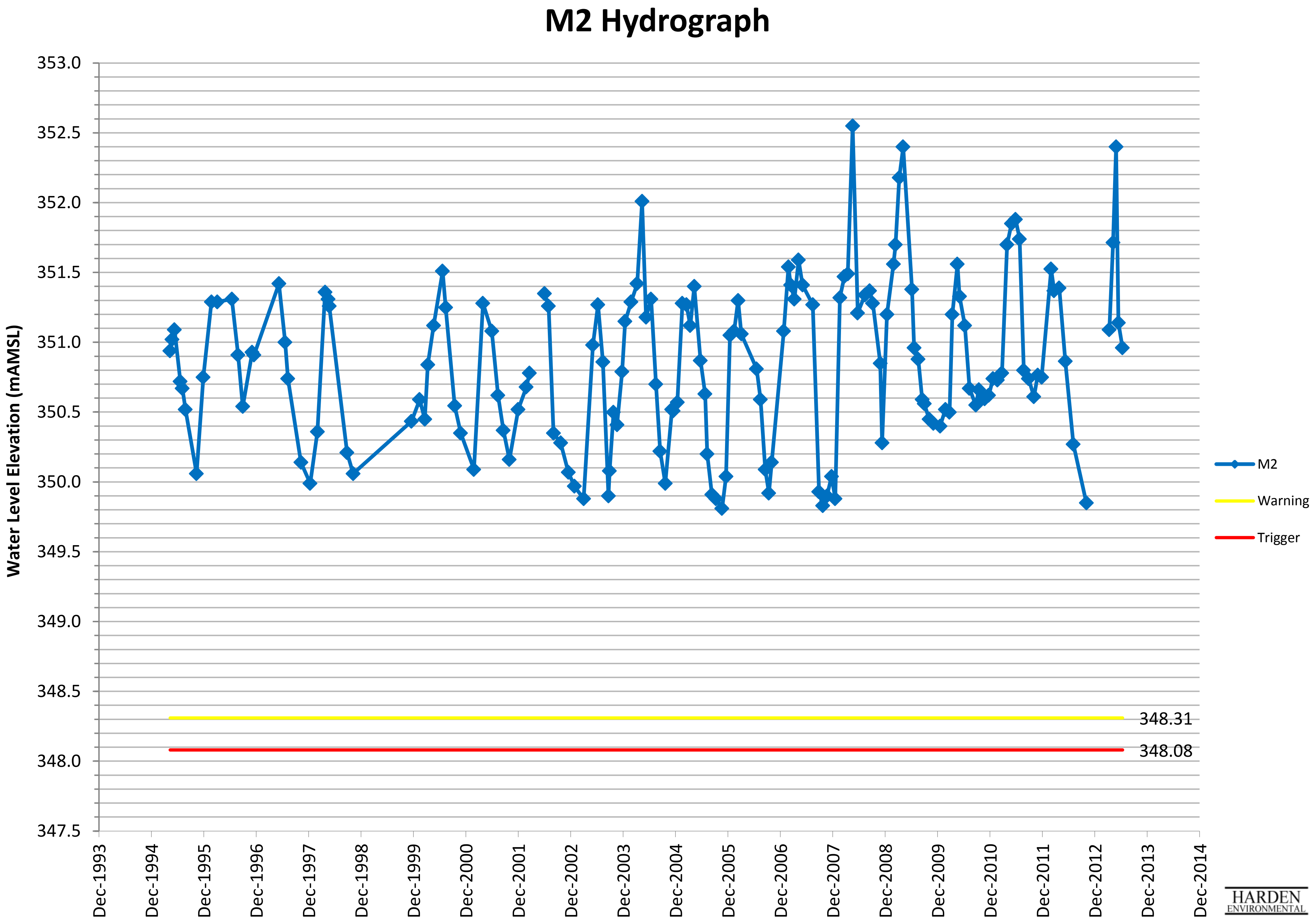
Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C1:

Monitoring Locations

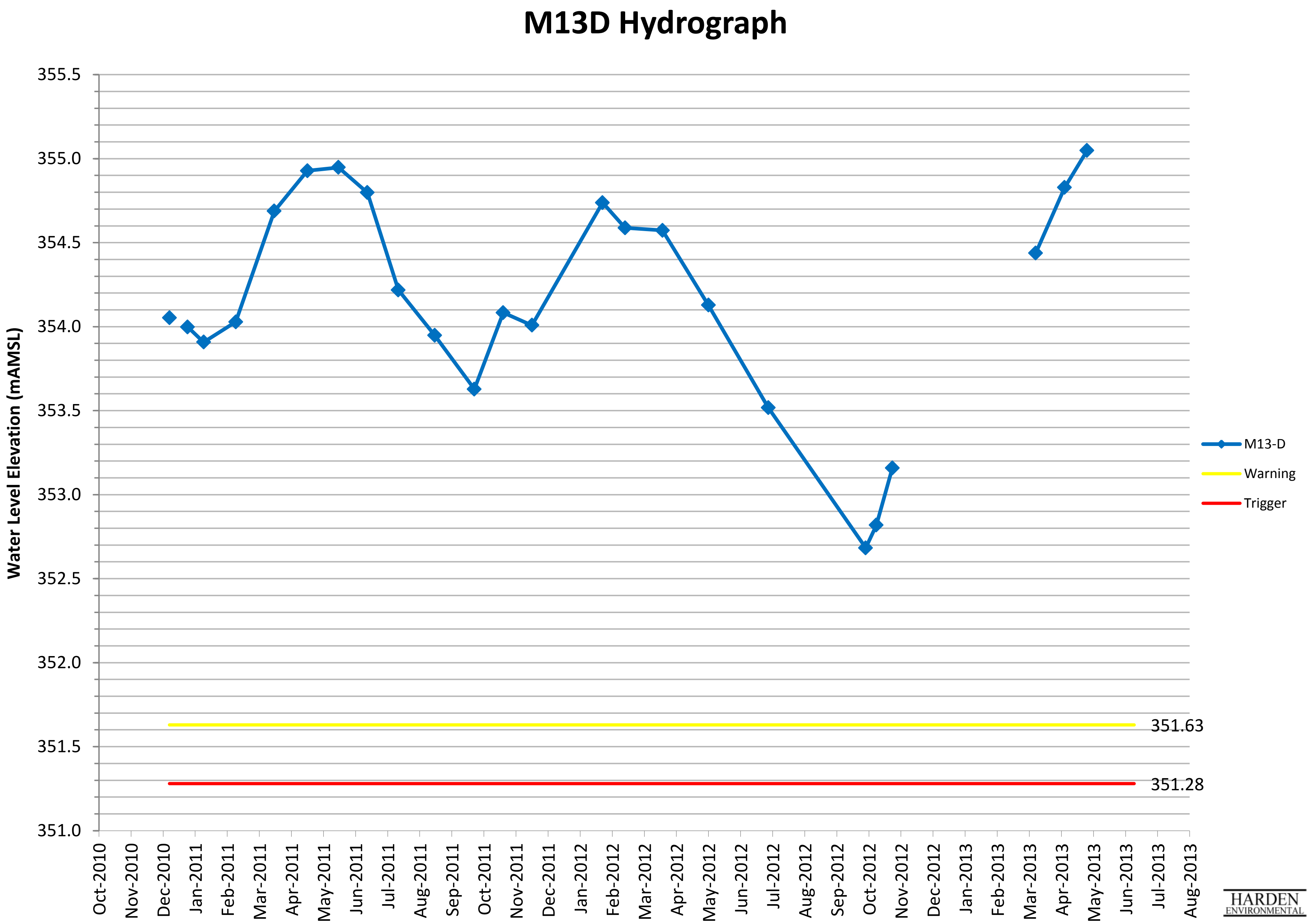


Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C2: M1D Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



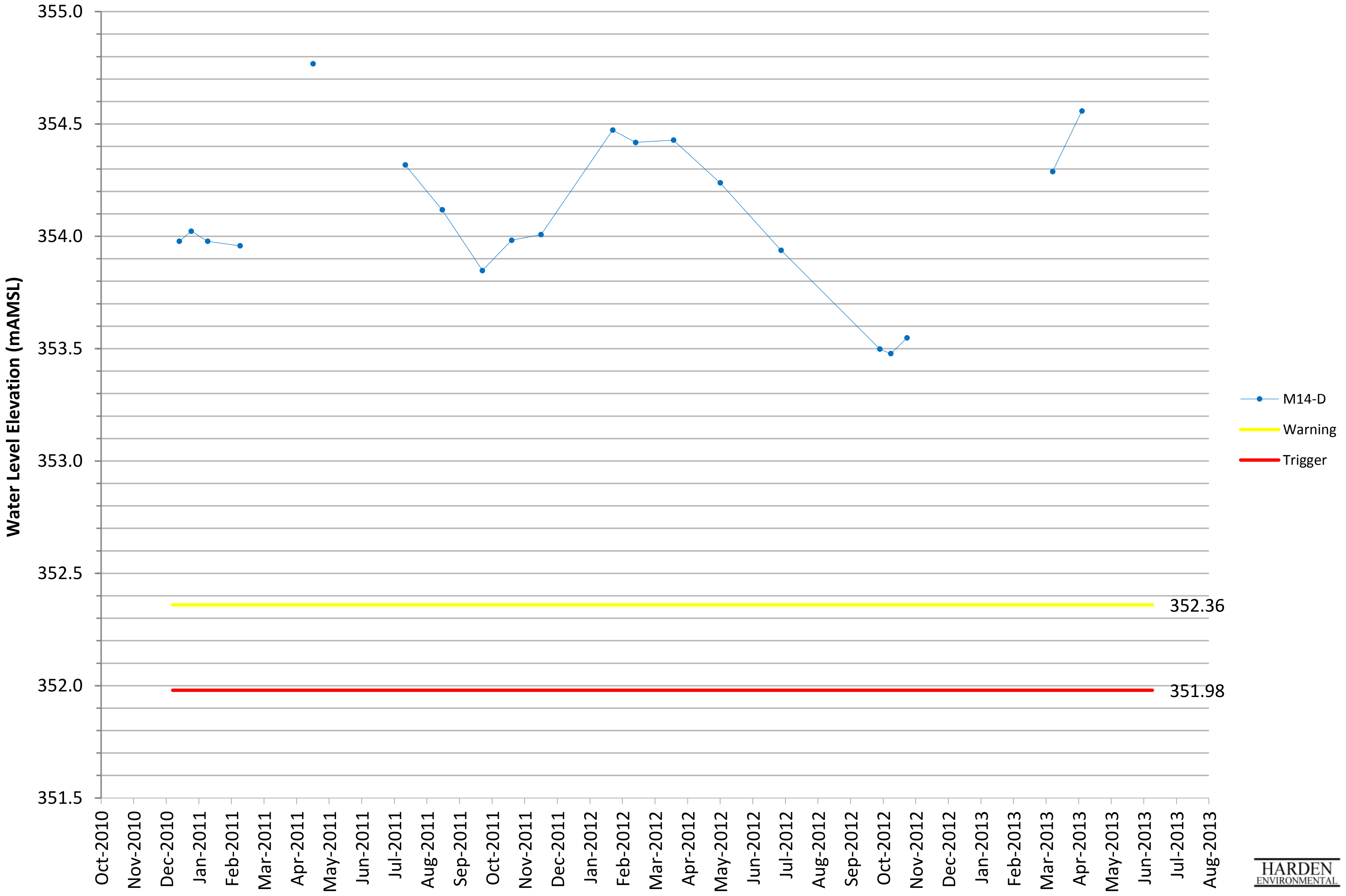
HARDEN ENVIRONMENTAL

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C3: M2 Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Jul 2013 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure C4: M13D Trigger Level**

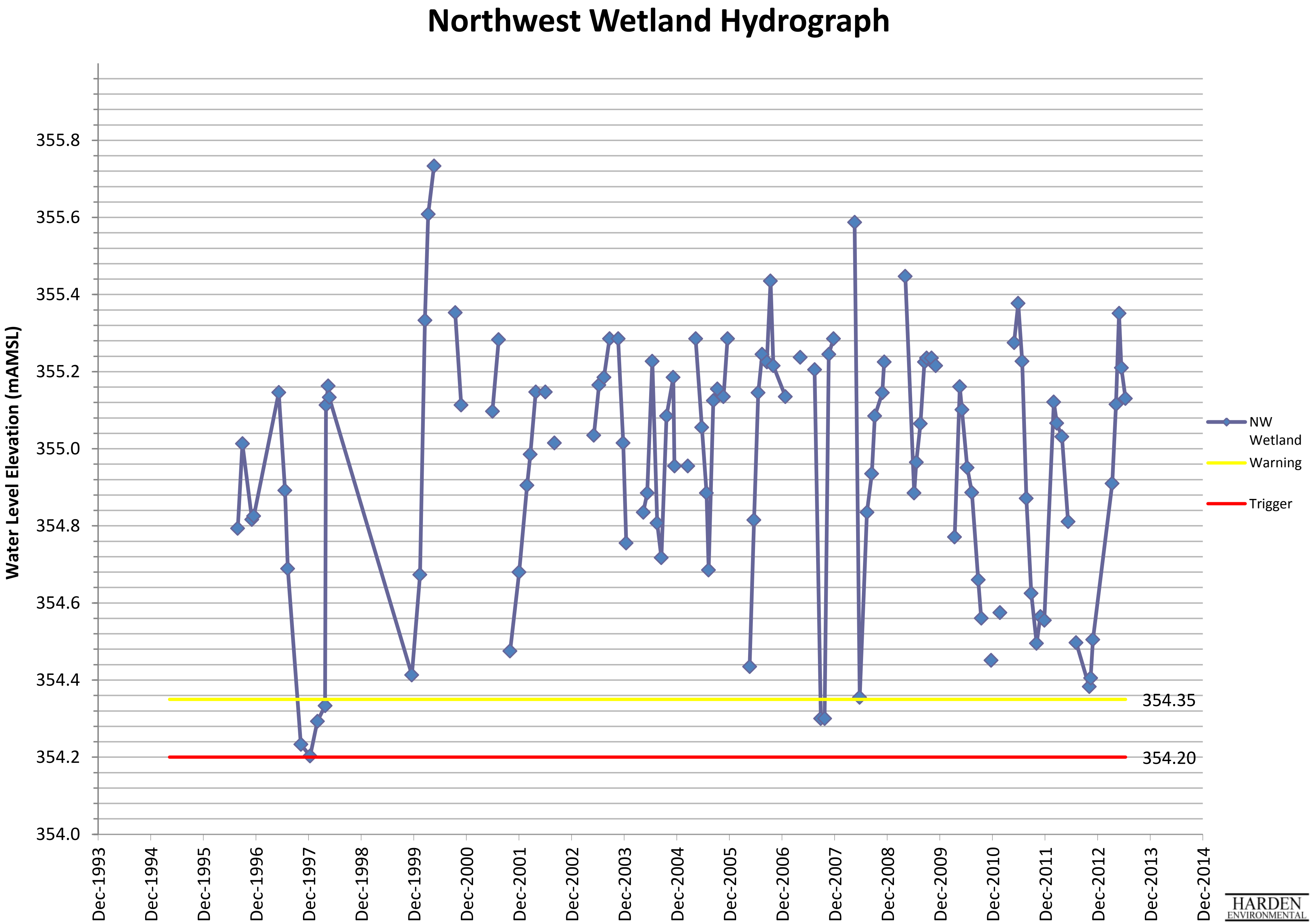
M14D Hydrograph



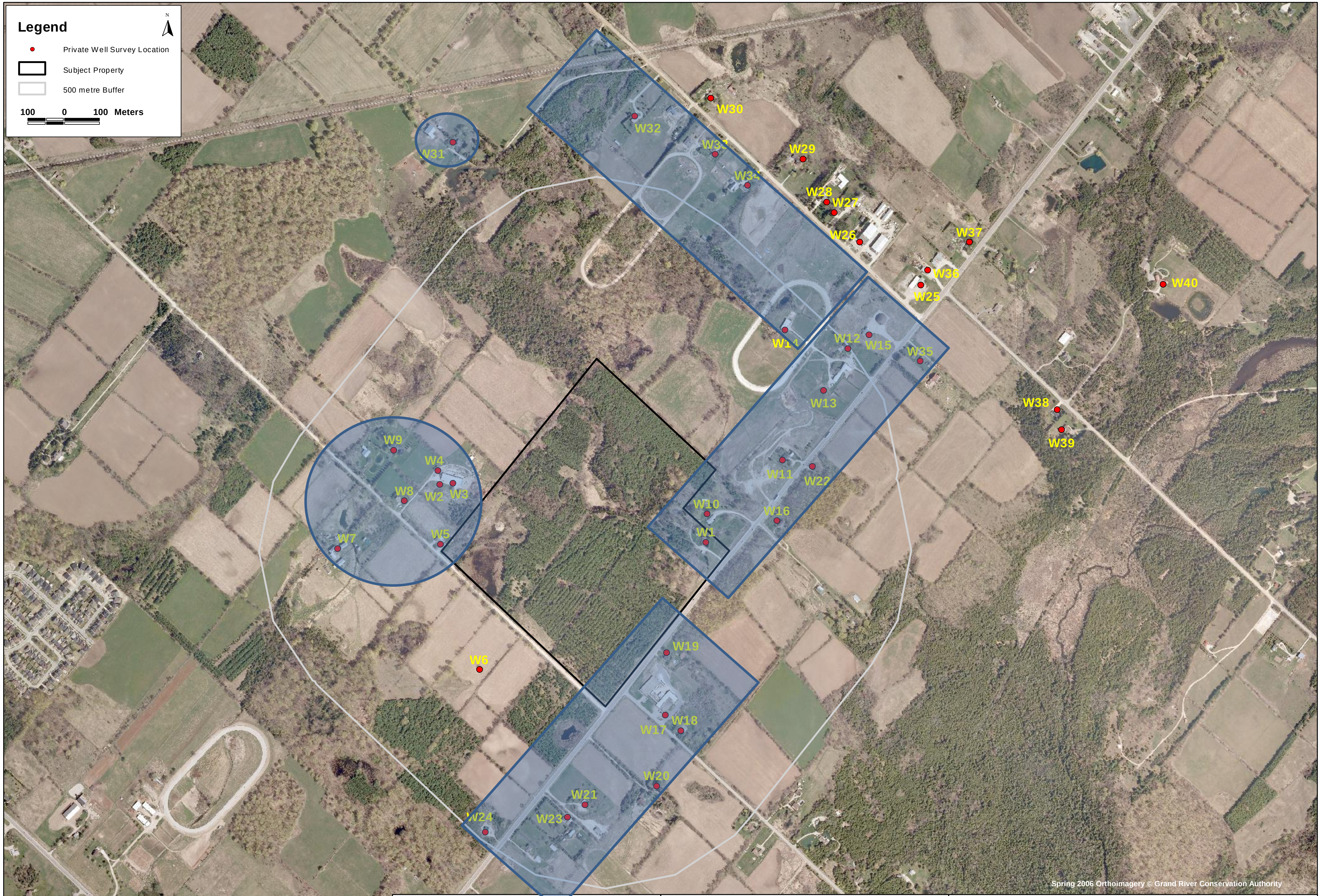
HARDEN
ENVIRONMENTAL

Harden
Environmental
Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C5: M14D Trigger Level**
Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C6: Northwest Wetland Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



HARDEN

Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction
Date: Jul 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington
Drawn By: SD	

Figure C7:

Proposed Pre Quarry Well Survey Locations

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies

Geochemistry

Phase I / II

Regional Flow Studies

Contaminant Investigations

OMB Hearings

Water Quality Sampling

Monitoring

Groundwater Protection Studies

Groundwater Modelling

Groundwater Mapping

Our File: 9506

September 5, 2013

James Dick Construction Ltd.

Box 470, Bolton

Ontario, L7E 5T4

Attention: Mr. Greg Sweetnam

Dear Mr. Sweetnam:

Re: Hydrogeological Summary Report For Township of Guelph Eramosa

We are pleased to provide this list of main issues and our conclusions regarding these issues as discussed at the July 31, 2013 meeting with Burnside and Associates.

1.0 Karst

The presence of karst features in this area, namely the caves at the Rockwood Conservation area, raises the question of potential karst features within the bedrock beneath Hidden Quarry. Karst is the name for the rock environment that occurs when sedimentary rock dissolves in water over millennia eventually resulting in spectacular features such as the Mammoth Caves in Kentucky. Seven boreholes penetrating the bedrock have been drilled at this site in the course of investigating the bedrock and hydrogeological resources. None of the boreholes encountered karst environments. The bedrock is fractured and water filled fractures were identified, however, solution enhanced cavities, fractures or caverns were not found at the site.

The latest geological investigation took place in June 2013. A 150 mm borehole was drilled at the site and investigated with down-the-hole camera and down-the-hole water velocity meter. Karst features were neither identified in the video log of the well, nor does the velocity profile suggest a karst environment.

Since this site is not being dewatered, the presence or absence of karst features has less significance. During and post aggregate extraction, the quarry will be a large reservoir of water available to mute the effects that drought or other water taking in the area has on the water table.

Conclusion

A karst environment is not present in the area proposed to be mined by the Hidden Quarry.

2.0 Water Quality

The main aquifer in this area is the dolostone bedrock aquifer. Groundwater mainly flows through discrete fractures in the bedrock. Water wells drilled into the bedrock access these fractures as their source of water. Pumping water from the well results in the mixing of water from each discrete fracture. Similarly, when the quarry is extracted, groundwater will flow into the quarry from discrete fractures and mix with groundwater from other fractures and with the water already in the quarry. Groundwater sampling conducted at the site in 1995 found that the shallow groundwater contained elevated nitrate concentrations from upgradient farming practices. The nitrate concentrations obtained from two monitors (M2 and M3) were above 5 mg/L but below the Ontario Drinking Water Standard of 10 mg/L. Recently, groundwater samples obtained from M15 and the on-site house well contained nitrate concentrations of 2 mg/L and 0.13 mg/L respectively. These recent samples represent a mixing of deep and shallow groundwater.

It is likely that shallow groundwater entering the quarry will continue to contain elevated nitrate concentrations from upgradient farm practices and the mixing with deeper water and with water already in the quarry will result in a decrease in nitrate concentrations. It is expected that plant growth in the quarry pond will further attenuate nitrate levels.

As reported in the Level I and II Hydrogeology Report for Hidden Quarry (Harden, 2012) quarry water samples were obtained from the Dolime quarry shortly after a blasting event. The nitrate concentration was 1.2 mg/L and there were no exceedence of Ontario Drinking Water Standards for either organic or inorganic compounds.

Conclusion

The proposed Hidden Quarry will result in the mixing of groundwater from various discrete fracture sources in the bedrock aquifer thereby decreasing the overall nitrate concentration already found in the shallow groundwater.

The proposed sub-aqueous mining method will not result in the chemical degradation of groundwater quality.

3.0 Private Wells with Shallow Fracture Sources of Water

The extraction of dolostone at this site will ultimately result in the creation of a pond. There is presently a five metre difference in groundwater elevation from northwest to southeast across this site. The water levelling effect of the pond will result in groundwater levels being approximately 2.5 metres lower along the northern quarry edge and 2.5 metres higher along the southern quarry edge. This effect decreases exponentially with distance from the quarry. This results in a lower water level in private wells north of the Hidden Quarry. Harden Environmental predicts that the water level in the nearest water well will decrease by 1.6 metres. It has been suggested that this could be a significant impact to the yield of a well, should the well obtain all of its water from the upper two metres of rock.

We have prepared Figure 1 showing the bottom depth of nearby wells relative to the top of rock. The range in well depths below top of rock is 0.92 to 42.98 m. There are no wells with less than eight metres of depth below top of rock in the predicted area of groundwater drawdown.

A groundwater flow profile was determined in the newly completed well M15. The profile determined that there were numerous water sources to a depth of 26 metres below top of rock and significant water sources at 26 and 31 metres below top of rock. The significant water bearing zones are shown on Figure 2 along with the frequency analysis of well depths below top of rock. The majority of wells terminate in the upper twenty six metres of rock.

There are no wells within the predicted area of drawdown that obtain water only from the upper two metres of the bedrock aquifer.

Monitor M15 was pumped during the video logging and flow testing procedures. A response was observed in monitor M2 but not in nearby M3 or more distant monitors M1 or M13. M2 fully penetrates the aquifer and M1, M3 and M13 only penetrate the upper three metres of the aquifer. The lack of response in the shallow aquifer suggests poor lateral shallow connectivity and poor connectivity to fractures at depth. This suggests that the anticipated drawdown may not occur to the same extent in the upper portion of the bedrock.

Conclusion

The anticipated drawdown effect of the quarry will not significantly affect the yield of any private water well.

4.0 Groundwater Model Parameter – Hydraulic Conductivity

The 3-D Modflow groundwater model that was prepared for this site used an iterative process to calibrate the model to observed hydrogeological conditions (i.e. groundwater levels). The purpose of the model is to predict the magnitude of water level change and areal distribution of that water level change arising from the lake levelling effect of creating a pond at the Hidden Quarry site.

The iterative process led to estimating the bulk hydraulic conductivity of the bedrock aquifer as 2.0 x 10^{-5} m/s.

Short term pumping tests were conducted in monitor M15 during the video logging and flow profiling. A continuous water level monitoring device was installed in groundwater monitors M2 and M3 during the testing period. The hydraulic conductivity estimated from the testing ranges from 1.4 x 10^{-5} to 1.98 x 10^{-5} m/s.

Conclusion

The on-site testing verifies that the hydraulic conductivity value used in the model is reasonable.

5.0 Brydson Spring and Blue Springs Creek

The Brydson Spring is located 600 metres from the southern edge of the proposed quarry at an elevation of approximately 347 m AMSL. Figure 3 is a cross section depicting the topographical and hydrogeological relationship between the spring and the southern edge of the quarry. A water level rise of 2.54 metres along the southern edge of the quarry is predicted to result in approximately a 0.1 metre water level change at the Brydson Spring. A greater volume of water may flow from the Brydson Spring, however, as no water is being introduced in the quarry or removed from the quarry, there is no overall change in groundwater flow in a regional perspective.

Evidence gathered from literature and experience in gravel pits in Puslinch Township show that the thermal impact downgradient of a pit pond is attenuated within 250 metres of the pond. There are no temperature sensitive features within 250 metres of the southern edge of the quarry, therefore, any localized thermal impact to groundwater is inconsequential.

Blue Springs Creek is located approximately 1200 metres from the proposed quarry. There will be no thermal change in groundwater discharging to Blue Springs Creek nor will there be any reduction in groundwater discharge to the creek.

Conclusion

There will be neither a significant quantity nor quality impact to waters discharging from the Brydson Spring. There will be no change to groundwater quantity or groundwater quality discharging to Blue Springs Creek located 1200 metres away.

6.0 Rock Extraction Water Level Change

The removal of rock from below the water table will simulate a pumping effect on the surrounding aquifer. Groundwater from the aquifer will flow into the quarry to fill the space previously occupied by the rock. The daily volume of rock removed from the quarry is estimated to be 1145 m^3/day.

The greatest water level change will occur at the beginning of the quarry. The initial rock extraction will occur in a sinking cut with the dimensions of 25 x 50 metres (1250 m^2). The removal of 1145 m^3 of rock from below the water table will cause the water level in the quarry to decrease by 0.91 metres per day. At the same time, groundwater will flow into the quarry creating a reservoir of water, thereby decreasing the effect of the following day's rock extraction.

James Dick Construction commits to a maximum drawdown of 2.54 metres in the sinking cut to be monitored daily. Continuous water level recording devices will also be installed in monitors M2 and M3 for verification that this value is not exceeded. The rate of rock extraction will be moderated in the event that drawdown in the sinking cut approaches 2.54 m.

The effect of rock removal from below the water table diminishes as the quarry pond increases in size. The effect of rock removal from below the water table will cause the pond level to decrease by less than 1 mm near the end of the quarry activities.

Conclusion

There will be no off-site impact to any wetland, water well, spring or stream from the active removal of rock from beneath the water table.

7.0 Aquitard

The Eramosa Formation is a natural aquitard protecting the Goat Island and Gasport formation aquifers west of Rockwood. Figure 4 (from 2012 Annual Monitoring Report Arkell Adaptive Management Plan, City of Guelph) shows that the Eramosa Formation does not extend east of Rockwood in this area. Harden Environmental has observed the drilling of M1S, M13d, M14D and M15. The Eramosa Formation is not present in any of those on-site locations.

Conclusion

There is no bedrock aquitard overlying the Goat Island and Gasport Formations at the Hidden Quarry.

8.0 Alteration of Hydraulic Barrier Location

The location of the hydraulic barrier will be altered slightly in order to minimize disturbance of a wetland that is evolving in the former gravel extraction area. The proposed alteration does not affect the water balance in a significant way. The barrier will be approximately 40 metres longer but will terminate at the same location. There will be no greater capture of groundwater upgradient of the barrier but the longer barrier results in a greater flux of water across the barrier. The original water balance calculated a 6% increase in water retention behind the barrier. With the proposed modification, there is a 4% increase in water retention behind the barrier compared to the natural condition.

Conclusion

The modification in the placement of the barrier will not lessen the effectiveness of the barrier.

9.0 Monitoring Plan, Trigger Levels and Contingency Plan

We have attached the revised monitoring report provided to the Ministry of the Environment (Appendix A).

Conclusion

The revised monitoring plan will adequately identify any groundwater issue arising from the proposed quarry operation and the associated trigger levels and contingency plan will prevent any harm from occuring to wetlands, springs, stream, ponds and local water wells.

10.0 Well Complaint

James Dick Construction has committed to remedying any and all issues arising as a result of quarry activities. The following complaint protocol will be followed;

1) Complaints about water well issues will be received any time at (905) 857-3500.

2) James Dick Construction Ltd. has a Water Well Drilling Company and Harden Environmental Services Ltd. on stand-by to address any water quantity or quality issue that arises.

3) In the event of a water shortage a supply of bottled water for drinking/cooking will be delivered within 12 hours of the complaint and an alternative water supply will be delivered within 24 hours of the complaint being received.

4) Within 48 hours, JDCL will initiate a hydrogeological investigation conducted by an independent hydrogeologist to determine the cause of the water issue. The investigation will include but not be limited to the following actions;

- Confirmation of water levels in on-site groundwater monitoring wells
- Review of historical trends in groundwater levels and groundwater quality obtained in on-site groundwater monitoring wells.
- Review of historical measured precipitation rates
- Interview with resident regarding well complaint
- Investigation of subject well including flow testing, water level measurements and water quality testing if necessary
- Written report summarizing the findings.

5) In the event that quarry activities are likely to be the cause of the complaint, James Dick Construction will undertake appropriate mitigative measures such as;

- Lowering the level of the pump within the well
- Extending the cased portion of the well
- Deepening the well
- Well replacement
- Water Treatment
- Modification of quarry activities.

Conclusion

The proposed well complaint protocol proposed by James Dick Construction Ltd. adequately safeguards local residence concerns in the unlikely event that a water well is impacted by quarry activities.

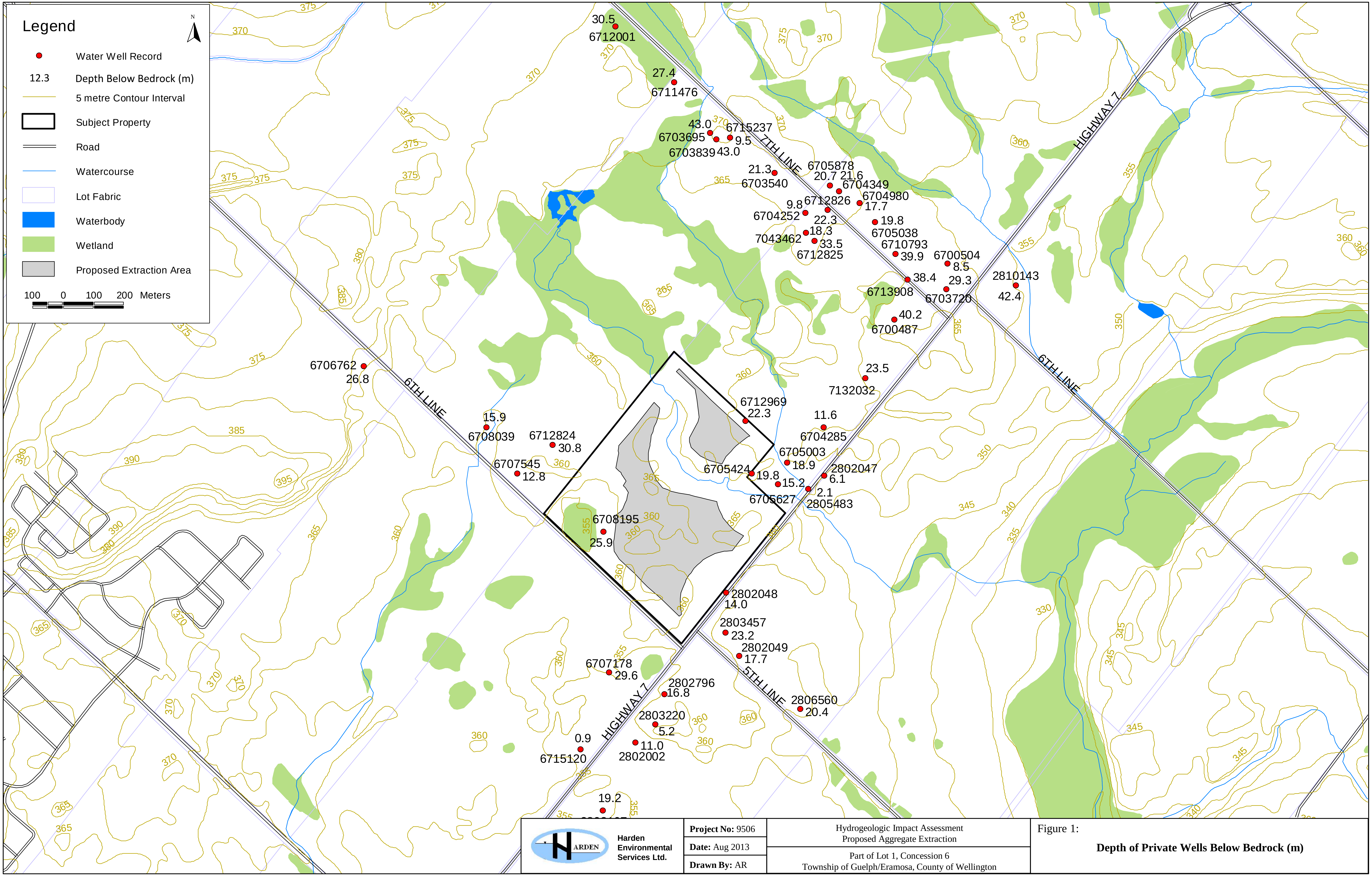
Respectfully Submitted;

Harden Environmental Services Ltd.

Stan Denhoed, M.Sc., P.Eng.

Senior Hydrogeologist

LICENSED PROFESSIONAL ENGINEER
S. E. DENHOED
Sept 5/13
PROVINCE OF ONTARIO



Harden Environmental Services Ltd.

Project No: 9506
Date: Aug 2013
Drawn By: AR

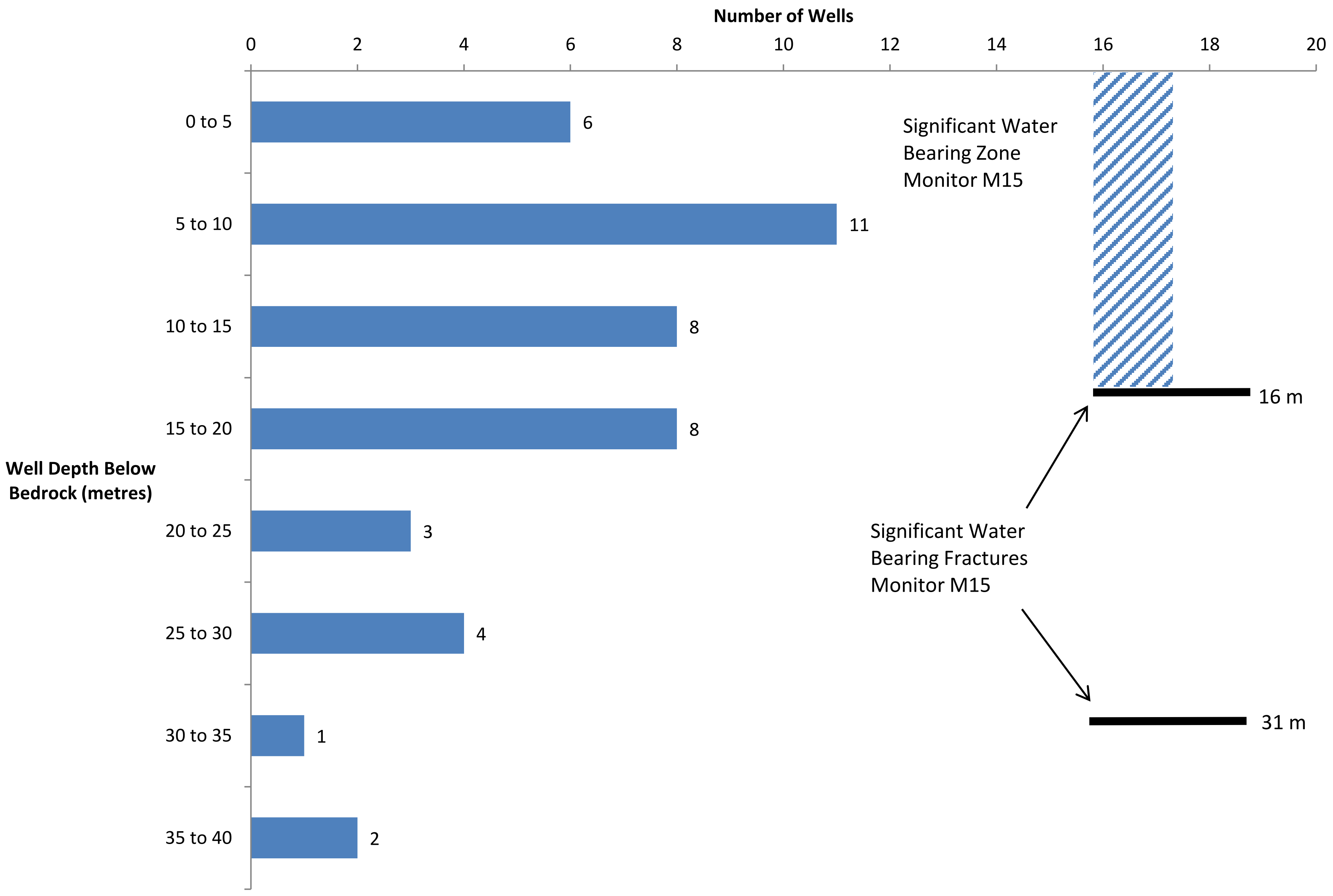
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1:

Depth of Private Wells Below Bedrock (m)

Figure 2: Well Depths and Water Bearing Zones



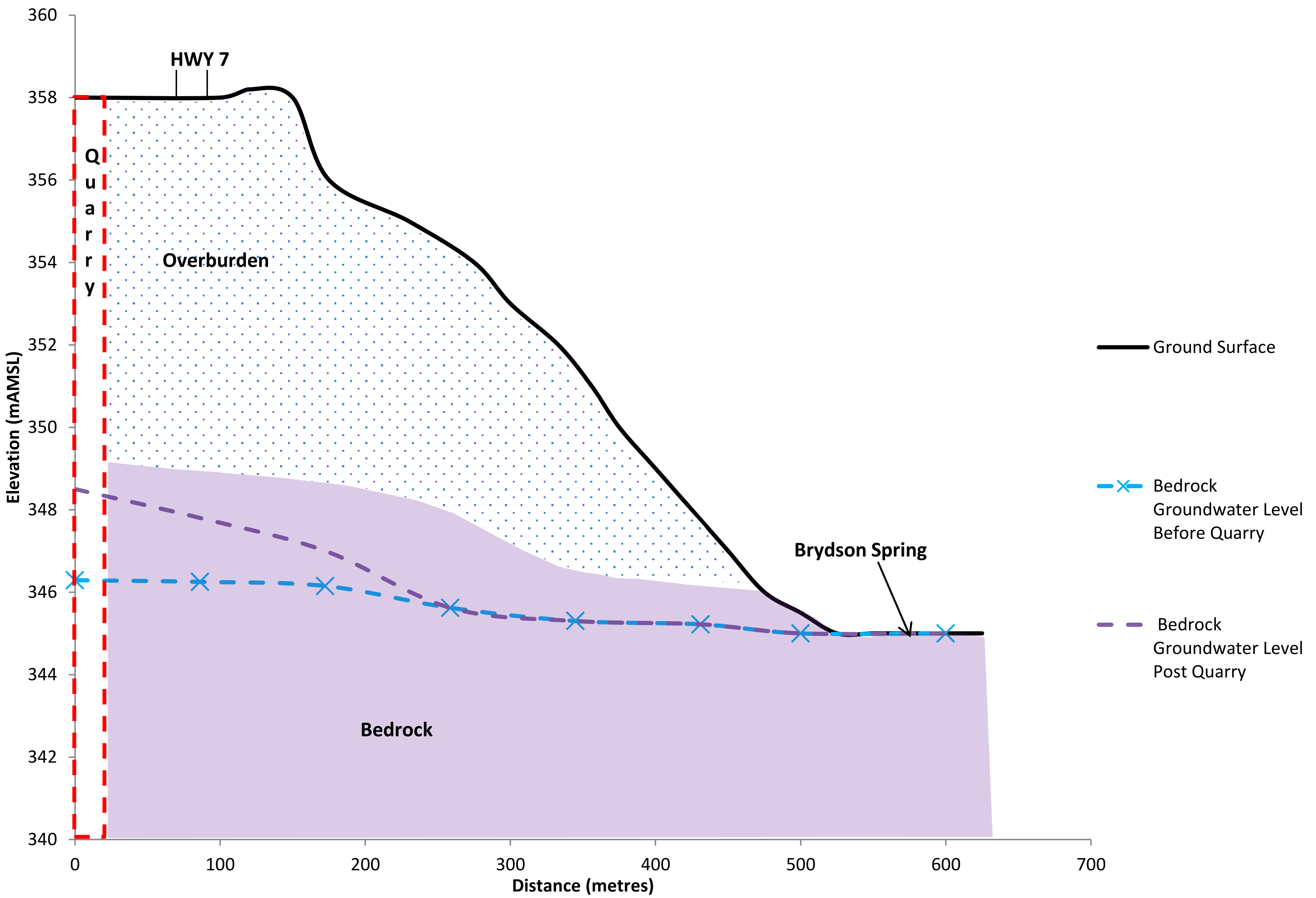
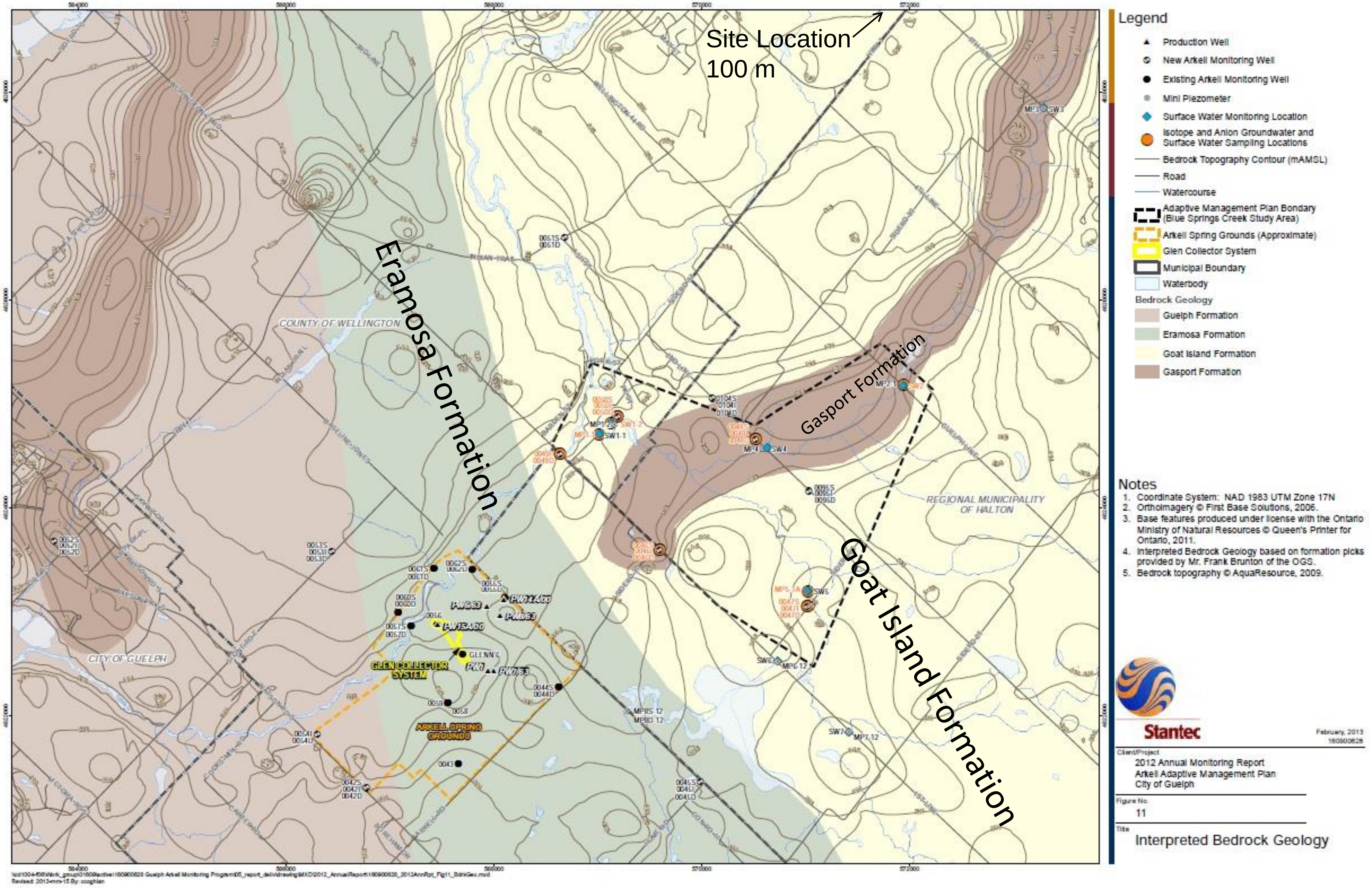


Figure 3: Conceptual Cross Section Hidden Quarry - Brydson Spring



Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Ortholmagery © First Base Solutions, 2006.
3. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2011.
4. Interpreted Bedrock Geology based on formation picks provided by Mr. Frank Brunton of the OGS.
5. Bedrock topography © AquaResource, 2009.

Stantec

February, 2013
160900628

Client/Project
2012 Annual Monitoring Report
Arkell Adaptive Management Plan
City of Guelph

Figure No.
11

Title
Interpreted Bedrock Geology

Harden Environmental Services Ltd.

Project No: 9506
Date: Aug 2013
Drawn By: Source

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 4:

Interpreted Bedrock Geology

Source: Stantec 2012 Annual Monitoring Report – Arkell Adaptive Management Plan

APPENDIX A

REVISED MONITORING PLAN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

HIDDEN QUARRY

REVISED MONITORING PROGRAM AND CONTINGENCY MEASURES

1.0 ON-SITE MONITORING PROGRAM

Monitoring has been taking place at this site since 1995. An extensive database of background groundwater and surface water elevations and flow measurements has been developed. A detailed monitoring program will continue to ensure that sensitive features and surface water flows are maintained. The monitoring program is designed to identify trends towards unacceptable impacts early on to allow for time to implement contingence measures.

The monitoring program for this proposed pit/quarry involves the following activities:

- measuring groundwater levels,
- obtaining water quality samples,
- monitoring water levels in the on-site wetland and stream, and
- stream flow measurements.

We recommend the following monitoring program.

Parameter	**Monitoring Locations**	**Frequency**
Groundwater Levels	M1S/D, M2, M3, M4, M6, M13S/D, M14S/D, MPN1, MPN2, MPS1, MPS2, MPE1, MPE2, MPW1, MPW2, TP1, TP8, TP9 MP1, MP2, MP3, MP4, M15,	Manually Monthly April to November, February Automatic Daily Measurement in M1D, M2, M3, M4, M15, M16 for year prior to and year following

Parameter	**Monitoring Locations**	**Frequency**
	M16	bedrock extraction with re-evaluation of monitoring frequency after 1st year of bedrock extraction.
Groundwater Levels	M2, M3, TP1, M13S/D, M14S/D, M15, M16	Weekly during first 3 months of extraction
Surface Water Levels	SW6, SW4, SW8	Monthly April to November *coincident with groundwater monitoring
Surface Water Flow	SW4, SW8, SW3	Semi-Monthly April to November *coincident with groundwater monitoring
Groundwater Quality	M2, M4, M15, M16	Semi-Annually
Surface Water Quality	West Pond, East Pond	Annually

Monitoring locations are shown on Figure C1.

2.0 TRIGGER LEVELS

Groundwater and surface water monitoring will be used at this site to a) verify that predictions of water level change in the bedrock aquifer do not exceed those predicted and b) verify that the hydro-period of the northwest wetland does not change. The water level measurements obtained as part of the monitoring program will be used to trigger contingency measures that may be necessary for the mitigation of a low water level in the northwest wetland, a lower than expected water level in the bedrock aquifer or an anomalous low flow level in Tributary B.

2.1 Trigger Levels for the Bedrock Aquifer

The greatest water level change in the bedrock aquifer is expected to occur to the north and northwest of the site. Water levels obtained from bedrock monitors M1D, M13D, M14D and M2 will be used to verify that actual water level changes do not exceed the predicted water level change. A warning level of 75% of the predicted change will be used to initiate bi-weekly manual measurements from the groundwater monitors.

Table 1: Trigger Levels for the Bedrock Aquifer

Monitor	Historical Low	Predicted Change	Warning Level	Trigger Level
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	348.08
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98

The historical water levels, warning level and trigger level are presented in Figures C2, C3, C4 and C5.

2.2 Trigger Level for Northwest Wetland

Water levels from Station SW6 will be used to trigger contingency measures for the northwest wetland. Historical monitoring has shown that the water level in the wetland is somewhat independent from adjacent groundwater levels and therefore any potential change in the hydro-period is best determined by the surface water level in the wetland.

A seasonal analysis of the data reveals that low water levels in the wetland can occur at any time of the year. The historical low value in the wetland is 354.20 m AMSL and this is the recommended trigger value. The warning value is recommended to be 354.35 m AMSL. Manual water level measurements will increase to bi-weekly if the warning level is exceeded. As shown on Figure C6, this would result in escalated monitoring three times in the past fifteen years.

3.0 CONTINGENCY MEASURES

3.1 Groundwater Levels and Northwest Wetland

If any trigger level is breached, the following measures will be taken;

1) Confirmation of water level within 24 hours.

2) Evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed.

3) If quarry activities are found to be responsible, the following actions will be considered and a response presented to the GRCA and the Township of Guelph-Eramosa.

- increase the length and/or width of barrier
- decreased rate (or stopping) subaqueous extraction
- change in configuration of mining or decrease in mining extent
- alter timing of extraction to coincide with high seasonal groundwater levels.

3.2 Groundwater Quality

The parameters that will be included in the semi-annual monitoring (summer) will be general chemistry, bacteria, TKN, ammonia, DOC, pH, temperature, anions and metals. In the event that there is an increasing trend in the concentration of one or more elements or compounds, a study will be conducted to determine the source of the water quality change. If the quarry is found to be responsible and if there is a potential for impact to downgradient wells, James Dick Construction Ltd. will commence with the following actions;

1) Semi-annual testing of the water quality of private wells that could potentially be impacted by the quarry.

2) In the event that a water quality issue related to the quarry occurs, James Dick Construction Ltd. will remedy the issue by either providing the appropriate treatment in the home or drilling a new well and isolating the water supply to the deeper aquifer

4.0 PRE-BEDROCK EXTRACTION WATER WELL SURVEY

We recommend that a detailed water well survey be completed prior to the commencement of the extraction of bedrock resources. This survey will as a minimum include all wells in the shaded area shown on Figure C7. The well survey will include the following;

- construction details of the well (drilled, bored, sand point etc..)
- depth of well and depth of pump
- location of well relative to septic system

- static water level
- history of water quantity or quality issues
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals
- one hour flow test

The purpose of the survey is to have a baseline evaluation of both water quality and water quantity in nearby water wells. Should an issue arise with a local water well, the baseline data can be used as a reference against future measurements.

5.0 ANNUAL MONITORING REPORT AND INTERPRETATION

An annual report will be prepared and submitted to the Ministry of the Environment and the Ministry of Natural Resources on or before March 31st of the following calendar year. The report will be prepared by a qualified professional, either a professional engineer or a professional geoscientist.

The monitoring report will include all historical monitoring data and an interpretation of the results with respect to potential impact to the quality and quantity of bedrock groundwater, hydro-period of the northwest wetland and streamflow loss from Tributary B.

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

September 9, 2013

James Dick Construction Ltd.
Box 470
Bolton, Ontario, L7E 5T4

Attention: Mr. Greg Sweetnam
Vice President – Resources

Dear Mr. Sweetnam:

Re: Flooding Issues within Buffer around Tributary B – Hidden Quarry

We are pleased to provide an analysis of historical flood levels in Tributary B at the Hidden Quarry. We have been monitoring the surface water levels in Tributary B since 1998 and therefore have a reasonably long record of the naturally occurring water levels. In addition, tenants at the site have periodically dammed the tributary resulting in unnaturally high water levels. Nonetheless, we have used the highest recorded water levels in the tributary for this analysis.

The values used in this analysis are as follows;

Station	High Water Level (m AMSL)	Date
SW4	359.37	April 2008
SW5	356.37	April 2001
SW7	356.2	April 2008

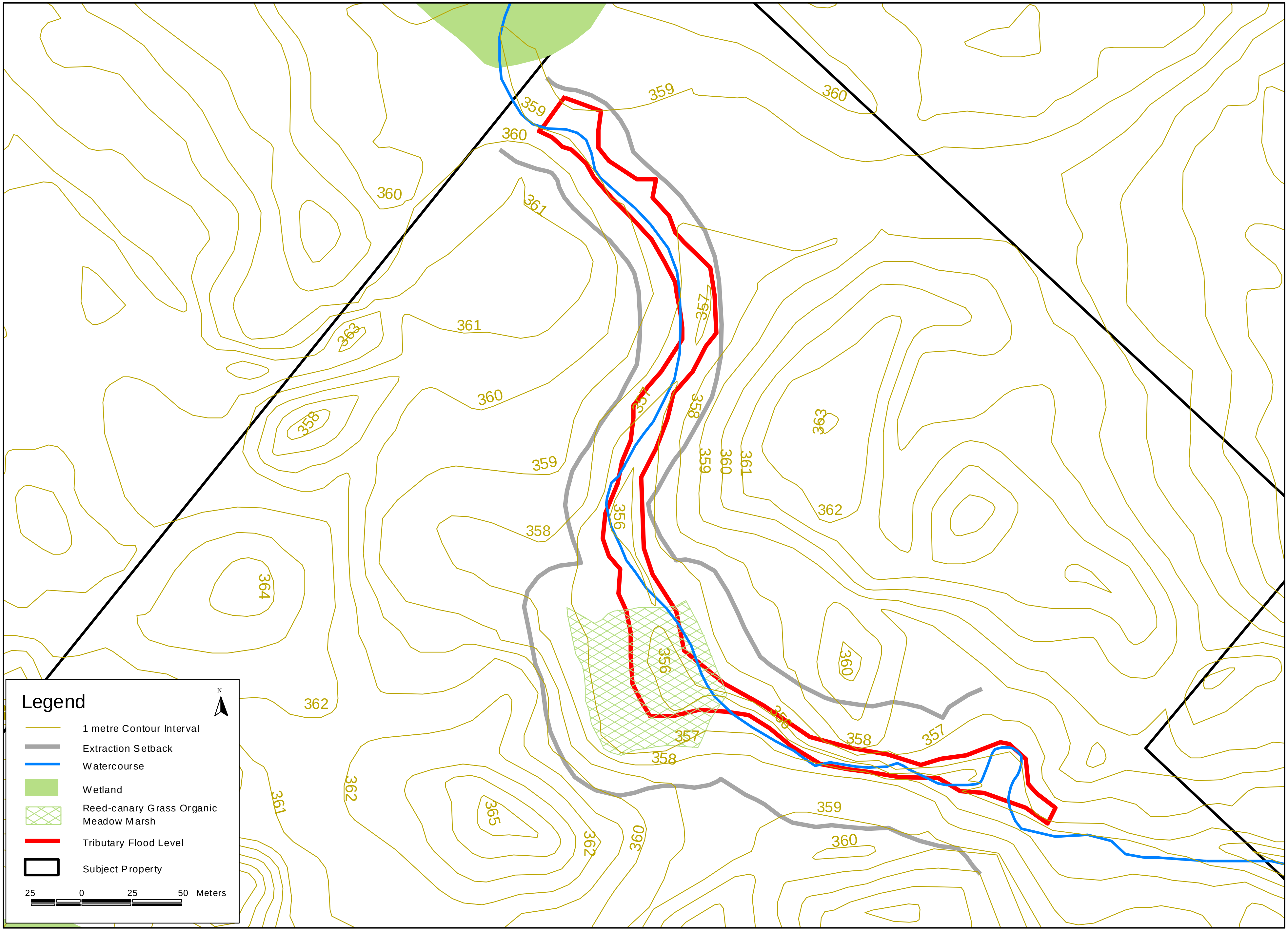
Elevations along the 20 metre and 30 metre buffer along Tributary B were determined from the 1 m contour data set available from the Grand River Conservation Authority and spot elevations determined by Harden Environmental Services Ltd.

Comparing flood levels in Tributary B to ground elevations results in the flooding of areas shown on Figure 1. It can be seen that when at historical flood levels, Tributary B will remain confined within the proposed buffer. This analysis was done by comparing kriged ground elevation data and kriged surface water level data within the Viewlog™ geospatial data analytical software package.

Sincerely,

Harden Environmental Services Ltd.

Stan Denhoed, M.Sc., P.Eng.
Senior Hydrogeologist



Harden Environmental Services Ltd.

Project No: 9506

Date: Aug 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1: Tributary B Flood Level

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

November 26, 2013

Grand River Conservation Authority
400 Clyde Road
PO Box 729
Cambridge ON N1R 5W6

Attention: Fred Natalochny
Supervisor of Resource Planning

Dear Mr. Natalochny:

Re: Review of Revised Materials and Response to Site Meeting Guelph-Eramosa File ZBA09/2012

This letter concerns the eight comments from the GRCA as addressed by Harden Environmental Services, Stovel and Associates or GWS Ecological and Forestry Services.

We are pleased to provide a response to the comments as follows;

GRCA Comment 1a

a) A key conclusion of the hydrogeology assessment is that "there will be no off-site impact to any wetland, water well, spring or stream from the active removal of rock beneath the water table." It is further noted that the proposed revised location of the hydraulic barrier will not lessen its effectiveness. GRCA staff note that the assessment of potential hydrologic impacts has focused on groundwater contributions to wetlands and tributaries on and off the subject property. It is our understanding that a portion of the wetland surface catchment will be removed during extraction. The impact of a reduced surface catchment area on surface water flow toward the riparian wetland and intermittent watercourse needs to be assessed.

Harden Response to Comment 1a

Riparian Wetland

The riparian wetland adjacent to Tributary B presently has a catchment area that includes a portion of the proposed excavation area. Thus, if approved, the quarry will decrease the size of the surface water catchment area of the riparian wetland. Groundwater monitoring confirms that there is no groundwater contribution from the proposed quarry to the riparian wetland, thus the only potential hydrological impact that can arise is through the reduction of the surface water catchment area.

The present day surface water catchment area of the riparian wetland is shown on Figure 1. The catchment area is 570,917 m^2. The potential reduction in surface water catchment area from the proposed quarry is 19,095 m^2. The reduction in area represents 3.3% of the total catchment area of the riparian wetland. It is our opinion that this reduction is insignificant relative to the remaining contributing area. In addition, annual variability in precipitation rate is much greater than 3.3% and therefore the wetland is already accustomed to significant variability in support hydrology. Also, we have been on the site over one hundred and fifty times since 1995 and other than possibly in the spring, we have not observed overland flow from the upland forest into the wetland. This is due to the relatively low slope, heavy tree cover and relatively high permeability of surficial soils.

Tributary B (Intermittent Stream)

The total catchment area of Tributary B upstream from the southern edge of the proposed quarry is 585,156 m^2 (Figure 2). The catchment area reduction of 19,095 m^2 represents 3.3 percent of the total catchment area and will not significantly affect the hydrological function of the stream.

GRCA Comment 1b

b) Please assess whether the 20 to 30 m setback is sufficient to maintain surface flows to the riparian wetland and creek.

Harden Response to Comment 1b

Based on the analysis that there will be a maximum loss of 3.3% of the surface water catchment area of the riparian wetland and stream, the proposed buffer varying from 20 to 30 metres in width along Tributary B is adequate to safeguard the hydrological functions of the stream and the wetland.

There is no groundwater discharge component of support hydrology for either the wetland or the stream, therefore, the 20/30 metre setback will not affect groundwater support for the wetland or stream. In addition to the 20/30 metre setback, there will be a 2:1 slope in the excavation providing an additional 40 to 60 metres separation between below-water-table extraction and the riparian wetland or the stream. Our observations of groundwater conditions along the stream (M3 and M11) clearly show that there is no groundwater above the bedrock and therefore hydrologic conditions in the wetland or the stream cannot be affected.

GRCA Comment 1c

c) Also, the revised location of the hydraulic barrier should be illustrated in a cross section through the PSW and smaller, man-made wetland since the latter is expected to undergo some changes as a result of the construction of the hydraulic barrier. The proposed changes to the man-made wetland should be noted on Drawings 4 and 5.

Stovel and Associates Response to Comment 1c

A cross-section through the PSW and smaller man-made wetland has been prepared and attached to this submission. The proposed changes to the man-made wetland are noted on revised site plan Drawings 4 and 5 also attached.

GRCA Comment 2a

a) The proposed monitoring plan for surface water bodies (i.e., wetlands and intermittent creek) lacks detail. It is generally recommended that wetland hydrology be monitored continuously and concurrently using data loggers and that the sampling frequency be increased in order to be able to detect seasonal variations in surface water levels, Nitrate concentration, temperature, pH, and dissolved oxygen, and conductivity.

Harden Response to Comment 2a

Note: A revised monitoring program is provided in Appendix A.

Monitoring of the Northwest Wetland

As suggested by the GRCA, JDCL has agreed to continuous water level monitoring in the Northwest Wetland. A data logger will be installed at SW6 within the wetland to measure and record the surface water level of the open water portion of the wetland. Water levels will be recorded every four hours. We feel that measurements at SW6 are appropriate because in the eighteen years of monitoring this site, other than a two month period in 2007, there has always been a small open water area within the wetland at station SW6. Monthly water level monitoring has already been recommended and included in the monitoring plan for all eight mini piezometers located within and adjacent to the wetland. This will provide sufficient data to observe seasonal variations and detect potential anthropogenic influences on water levels.

The chemical water quality of the Northwest Wetland will be determined on an annual basis for nitrate, pH, dissolved oxygen, temperature and conductivity. There is little risk of chemical change in the wetland as there will be no quarrying activity within the catchment area of the wetland. Initially there will be berm construction at the edge of the catchment area, however this activity is unlikely to affect the chemical quality of the wetland water as the source area is mainly northwest of the site. Once construction activities have ceased, it is our opinion that provided that water levels do not change, the water quality will not change. We therefore recommend that the water quality testing be limited to the first three years following the approval of the quarry or to the completion of construction activities within the wetland catchment area whichever is the longer. The water quality samples will be obtained in September when water levels are lowest in the wetland.

Monitoring of Tributary B

The flow in Tributary B is almost entirely (97%) from upgradient sources. Harden has recommended monthly streamflow monitoring and water level monitoring in Tributary B. In addition, based on comments made by the GRCA, James Dick Construction Ltd. will install continuous water level monitoring devices in Tributary B at the northern and southern property boundary. These will be located at the SW4 and SW8 locations as shown on Figure 3. Water levels will be obtained every four hours as well as temperature.

Water quality testing in Tributary B has not been recommended as quarry activities will remain outside of the catchment area of the stream.

Monitoring of the Allen Wetland

The Allen Wetland receives no support hydrology from the proposed quarry site. As seen on Figure 1, the upgradient watershed is quite large. We have observed significant flow originating on the De Grandis farm entering the wetland and Tributary B loses water throughout the southern two thirds of the wetland. The lands within and around the wetland have formerly been drained to facilitate farming, indicative of surface water drainage issues (i.e. poor drainage with water retention at the ground surface). The soils we tested beneath the wetland are a silty till resulting in the poor drainage. Based on our observations, the wetland is supported from surface water inflow from the north, shallow overburden groundwater flowing into the wetland along the northern wetland boundary and direct precipitation. The wetland is not supported by groundwater from the bedrock or groundwater from south of the wetland.

With respect to potential groundwater contributions, we have attached Figure 3.20 from our original December 2012 report. This is a cross section through the Allen Wetland (location shown on Figure 2). It can be seen that it is not possible for groundwater to contribute to the wetland given the superior elevation of the wetland compared to low ground elevations to the east and west. Ground elevations to the south also decrease. In addition, the nearest groundwater monitors being M2 (bedrock) and TP8 (overburden) on the Hidden Quarry site have groundwater elevations of approximately 352 and 354 m AMSL respectively. The wetland elevation is approximately 360 m AMSL. This six to eight metre difference clearly shows that the wetland is not groundwater dependent.

It is our opinion that the bedrock groundwater levels are not associated with the hydro-period of the wetland. Figure 5 shows the date that Tributary B was first observed to be dry (on an annual basis) compared to the bedrock groundwater level on that date as observed in groundwater monitor M2. If bedrock groundwater levels were a significant influence on wetland conditions, one would find that the creek would dry up when groundwater was below a certain elevation. Figure 5 shows that Tributary B becomes dry over a wide range of bedrock ground water levels, suggesting other factors determine streamflow (e.g. antecedent rainfall, storage in the De Grandis ponds).

The technical justifications for why the Allen Wetland is not dependent on groundwater from the site are;

1) The site is downgradient and there is a four to six meter elevation difference between groundwater levels along the northern site boundary and the elevation of the Allen Wetland.

2) The Allen Wetland has an elevation superior to elevations found east, west and south, therefore only groundwater from the north can potentially contribute to the wetland. The proposed quarry is to the south.

3) There is no correlation between the date of Tributary B becoming dry and bedrock groundwater levels. This indicates that other factors determine flow in Tributary B and by association, the hydro period of the Allen Wetland.

Therefore, monitoring groundwater levels directly beneath the Allen Wetland will not necessarily be indicative of the saturation conditions at the ground surface that create the wetland environment. It is our opinion that the passage of surface water through the wetland is a better measure of surface water conditions in the wetland.

Therefore, we recommend improving streamflow measurements of Tributary B at the north end of the proposed Hidden Quarry site. This is coincident with the southern edge of the Allen Wetland.

We recommend installing a weir in Tributary B along with a continuous water level recording device. The weir will be installed at location SW4 on Figure 3. A rating curve for the weir will be developed and outflow from the Allen Wetland will be determined accurately. The flow volume and observed groundwater conditions at M2 as an indication of whether or not groundwater levels have changed will be used to determine if surface water level changes in the wetland have occurred as a result of quarry activities.

In regards to a threshold value for the streamflow measurements, the earliest historical observed date of Tributary B being dry at the southern edge of the Allen Wetland in a given year is June 22. Other observed dates of flow cessation are July 6, August 15, August 29, August 31, September 17 and October 5. There has also been at least one year in which flow did not cease in Tributary B. We suggest using the cessation of flow by June 22 as a trigger mechanism to invoke contingency measures.

We also suggest that a warning flow rate of less than 25 L/s in the month of May be used to initiate the evaluation of causes of the low flow occurrence prior to the threshold level being breached. Based on past experience, this will provide approximately 30 days of review before the threshold value is breached.

Monitoring of the Northeast Wetland

A review of surface water levels in the Northeast Wetland (SW14) and groundwater levels in groundwater monitor TP8 located 25 metres away show that there is approximately four metres of elevation difference. This proves that the Northeast Wetland is not associated with the water table and is a perched wetland. The catchment area of the Northeast Wetland within the JDCL property boundary has been determined and is shown as D3 on the attached Figure 3.4 of the Harden 2012 report. The entire catchment area of the Northeast Wetland is outside of the proposed extraction area and will not be affected. Therefore, it is our opinion that monitoring of the Northeast Wetland is not warranted with continuous monitoring or to have associated warning and trigger levels. JDCL has agreed to monitoring the water level at station SW14, located in the Northeast Wetland, at the same frequency as groundwater levels which are monthly between April and November and once in February.

GRCA Comment 2b

b) We recognize that there will be continuous monitoring of the bedrock aquifer. Under bullet 2 of Section 3.0 - Contingency Measures within the revised monitoring plan there is no mention of a time frame for evaluating data to determine whether quarry impacts are responsible for changes to water levels/quality. It would be useful to state a suitable time frame for data review.

Harden Response to Comment 2b

We recommend a seven day period to evaluate the data and follow up with agencies.

GRCA Comment 2c

c) Section 3.1 of the revised monitoring plan states that manual measurements will be taken on a monthly basis for most of the monitors; consideration is warranted as to whether this is frequent enough given the susceptibility of groundwater levels to more significant *fluctuations in the initial extraction phase. Daily measurements may be more appropriate prior to extraction and during the initial extraction phases.*

Harden Response to Comment 2c

The monitoring program presently states the following:

Automatic Daily Measurement in M1D, M2, M3, M4, M15, M16 for year prior to and year following bedrock extraction with re-evaluation of monitoring frequency after 1st year of bedrock extraction.

We have also recommended weekly water levels for the first three months of below-water-table extraction for the monitoring wells nearest to the initial sinking cut. However, we agree that daily water level observations are appropriate and propose to add a staff gauge in the sinking cut that will be monitored on a daily basis with surrounding groundwater levels monitored weekly. This visual aid will be installed such that the operator can monitor the water level in the sinking cut as it is being excavated and a benchmark will clearly show the minimum allowable water level. JDCL has committed to a maximum water level change of 2.54 metres in the sinking cut.

GRCA Comment 3a

a) Seasonal trigger levels should be established for the Northwest Wetland. GRCA staff had indicated previously that additional monitors were necessary in order to understand and assess impacts on other portions of the Provincially Significant Wetland. Therefore, trigger levels should be established for the Northeast Wetland and the Allen Wetland as well. Contingency measures should also be established and tied to the trigger levels.

Harden Response to Comment 3a

We have attached a hydrograph with proposed seasonal trigger levels (Figure 7) for the Northwest Wetland. We are recommending three trigger levels, winter, spring and summer/fall. The trigger levels have been assigned as follows;

Winter Trigger Level - lowest water level observed between December 1 and March 1
Spring Trigger Level - lowest water level observed between March 2 and June 15
Summer/Fall Trigger Level - lowest water level observed between June 16 and November 30.

The trigger levels and warning levels for the Northwest Wetland have been established based on historical monitoring. These values are summarized in Table 2 of the monitoring program as copied below.

Table 2: Trigger Levels for the Surface Water Features

Station	Winter		Spring		Fall	
	Warning	Trigger	Warning	Trigger	Warning	Trigger
Northwest Wetland (SW6)	354.35	354.20	354.48	354.33	354.38	354.23
Allen Wetland (SW4)	The warning level will be a flow rate of less than 25 L/s occurring in May and the trigger level will be cessation of flow prior to June 22.					

The warning level has been established as 0.15 m above the trigger level and represents at least a two week period of time before the trigger level will be reached.

In regards to trigger values for the Northeast Wetland, please see Harden Response to Comment 2a.

GRCA Comment 3b

b) With regard to the trigger levels for the bedrock aquifer, it would be useful to establish the warning level such that there is sufficient time to invoke contingency measures if the trigger level is exceeded.

Harden Response to Comment 3b

We agree that there should be sufficient time between the warning level and trigger level. Under proposed warning and trigger levels, the time between warning level and trigger level is at least four weeks.

GRCA Comment 3c

c) Section 3.1 of the revised monitoring plan states "If any trigger level is breached ..." This should clarify the warning level or trigger level as stated in Table 1.

Harden Response to Comment 3c

Section 3.1 is referring to the trigger level. In the event that a warning level is breached there is a period of increased frequency of monitoring.

GRCA Comment 4

All wetlands verified by the GRCA and extraction setbacks from these features should be plotted and clearly labelled on all site plans.

Stovel and Associates Response to Comment 4

The requested wetlands and setbacks have been plotted and labelled on the attached revised site plans.

GRCA Comment 5

Drawing 4 (Progressive and Final Rehabilitation Plan) includes the following wording under the section "Created Wetlands": "The site plans illustrate areas on the property where wetlands can be created." We recommend a slight revision to the wording to ensure that wetlands "will be created".

Stovel and Associates Response to Comment 5

The requested wording change has been made to Drawing 4. The revised site plan is attached.

GRCA Comment 6

Vegetation species that area considered appropriate for the created wetland communities are not currently listed on the site plan. Please revise the site plan to include species appropriate for the wetland communities.

Stovel and Associates and GWS Ecological and Forestry response to Comment 6

The site plan has been revised to include species appropriate list. The revised site plan is attached.

GRCA Comment 7

GRCA comment #90 from the comment matrix previously provided by Cuesta Planning Consultants Inc. in March 2013 has been addressed by the proponent proposing to install 2 additional groundwater monitoring wells. During a recent site visit, Harden Environmental Services Ltd. indicated that only 1 monitor had been installed. The Revised Monitoring Plan indicates that two monitors had been installed: M15 and M16; however this is contradictory to the site visit and should be clarified.

Harden Response to Comment 7

James Dick Construction Ltd. has committed to the installation of two long term groundwater quality monitoring wells as recommended by the GRCA. M15 has been installed and was also used to address issues raised by the MOE and the consultants for the Township of Guelph Eramosa. M16 will be installed in the location shown on Figure 3 as a condition of the license approval.

GRCA Comment 8

From review of the Revised Monitoring Plan, the well that was installed (M15) appears to be located within the extraction footprint of the West Pond. It would be useful to clarify this location.

Harden Response to Comment 8

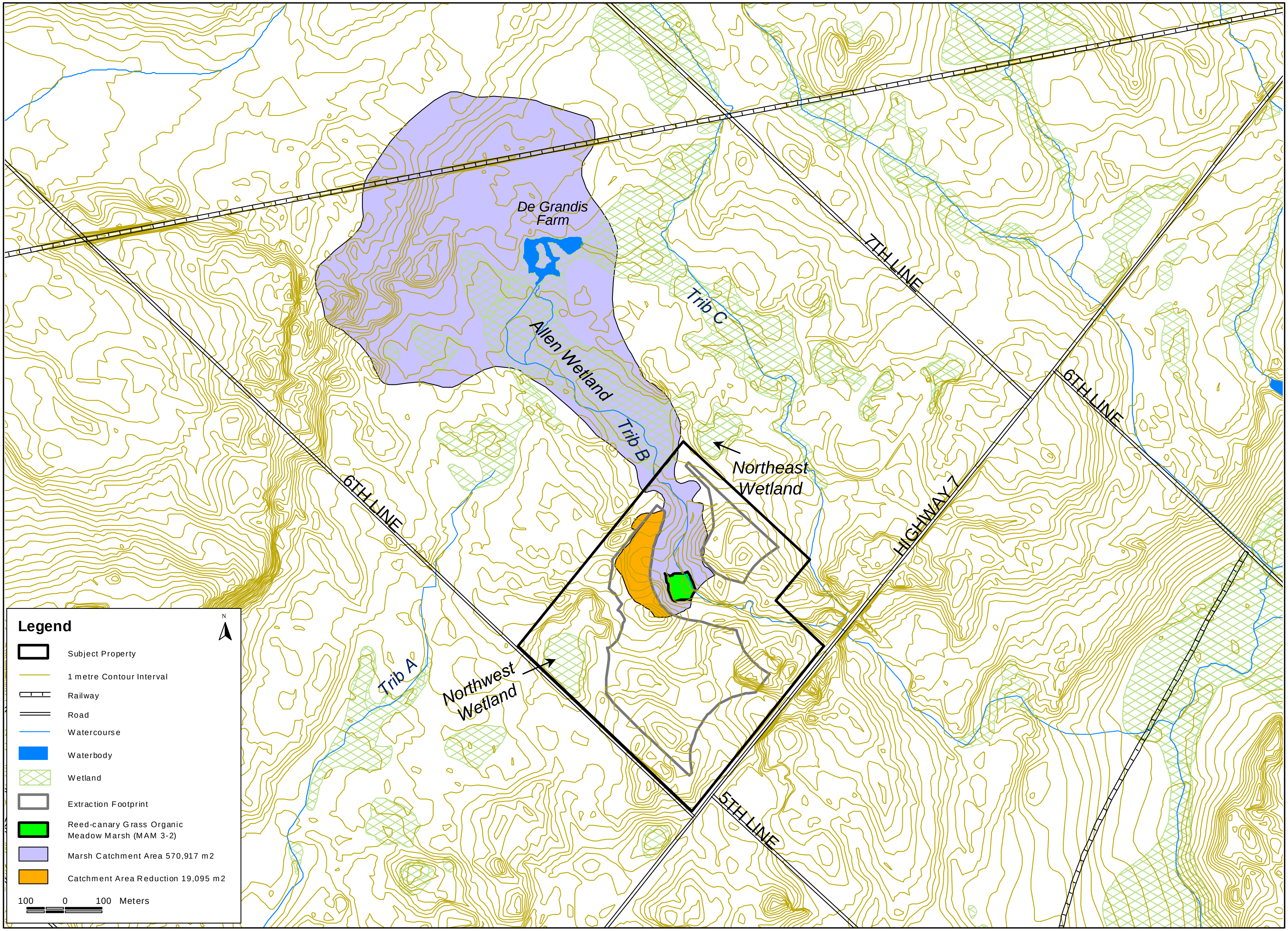
M15 is located in the footprint of the proposed extraction area. There was criticism from private groups and the consultants of the township of Guelph Eramosa that little data was available from within the footprint of the proposed extraction area. M15 serves this purpose and was used for verification of geology, fracture density, vertical water sources and water quality. M15 will be converted to a multi-level monitor and used to monitor the effects of a proposed pumping test in the Rockwood Municipal Well TW2. M15 will be used to monitor water levels and water quality until such time as it is necessary to remove the bedrock at that location. A replacement well will be drilled within 10 metres of M15 and outside of the extraction area.

Sincerely,

Harden Environmental Services Ltd.

Stan Denhoed

Stan Denhoed, P.Eng., M.Sc.
Senior Hydrogeologist



Harden Environmental Services Ltd.

Project No: 9506

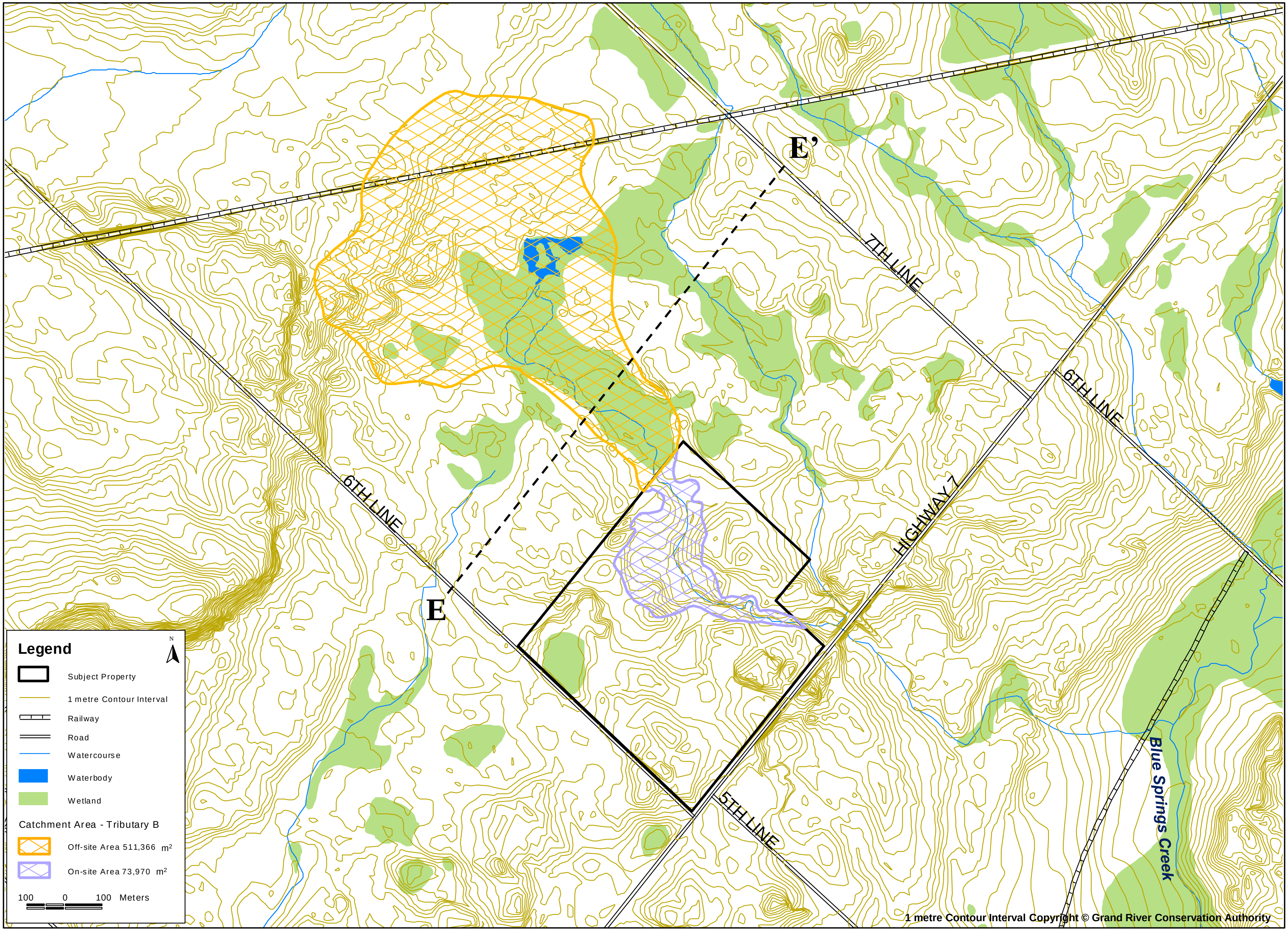
Date: Nov 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1: Marsh Catchment Area Reduction Zone



1 metre Contour Interval Copyright © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506

Date: Nov 2013

Drawn By: AR

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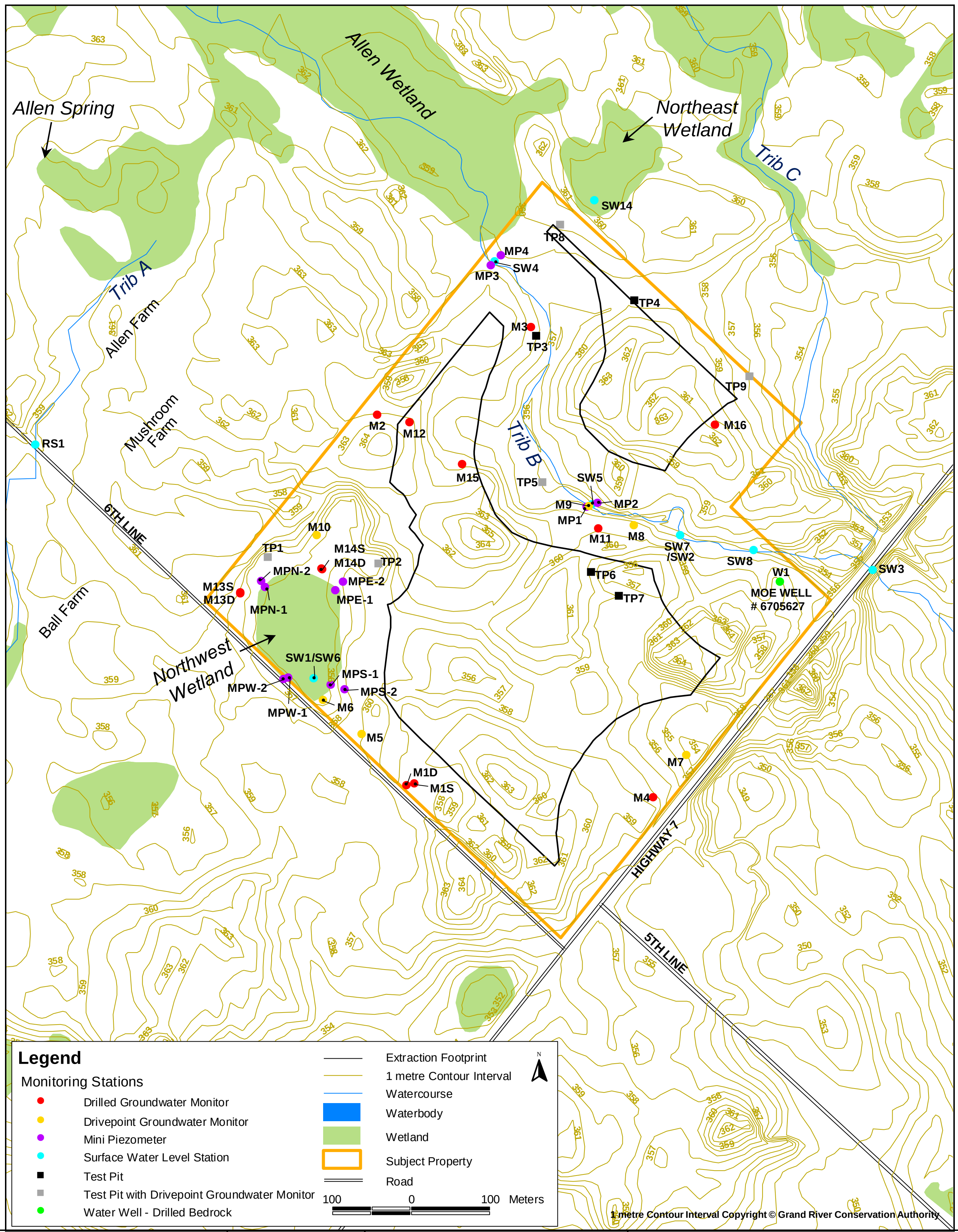
Township of Guelph/Eramosa, County of Wellington

Figure 2: Tributary B Catchment Area



Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2013

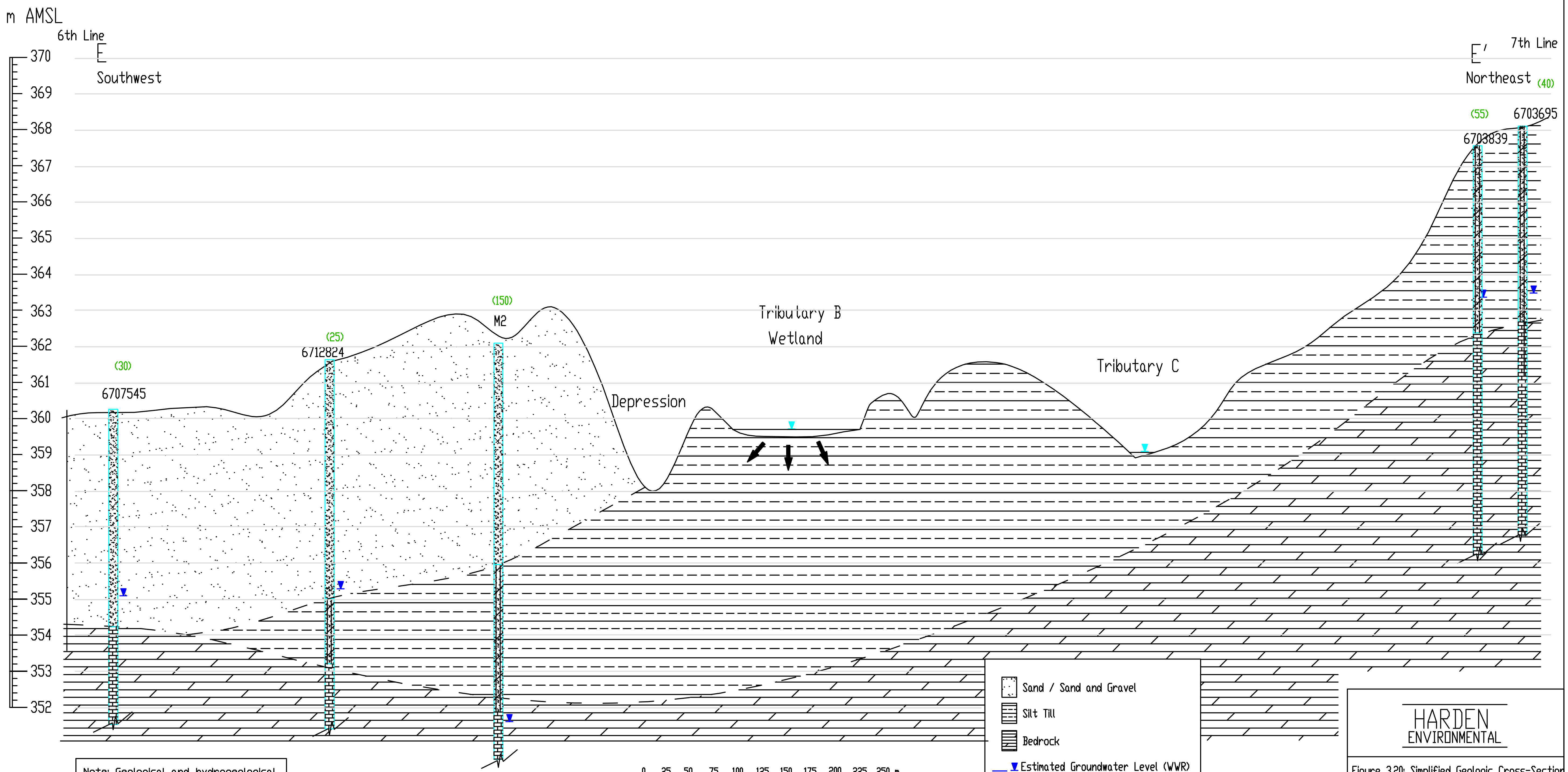
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3:

Monitoring Locations



Note: Geological and hydrogeological conditions between boreholes have been interpretted and may not be accurate.

HARDEN
ENVIRONMENTAL

Figure 3.20: Simplified Geologic Cross-Section

DATE: Feb 2012
SCALE: As Shown
PROJECT: 1036
DRAWN BY: AW

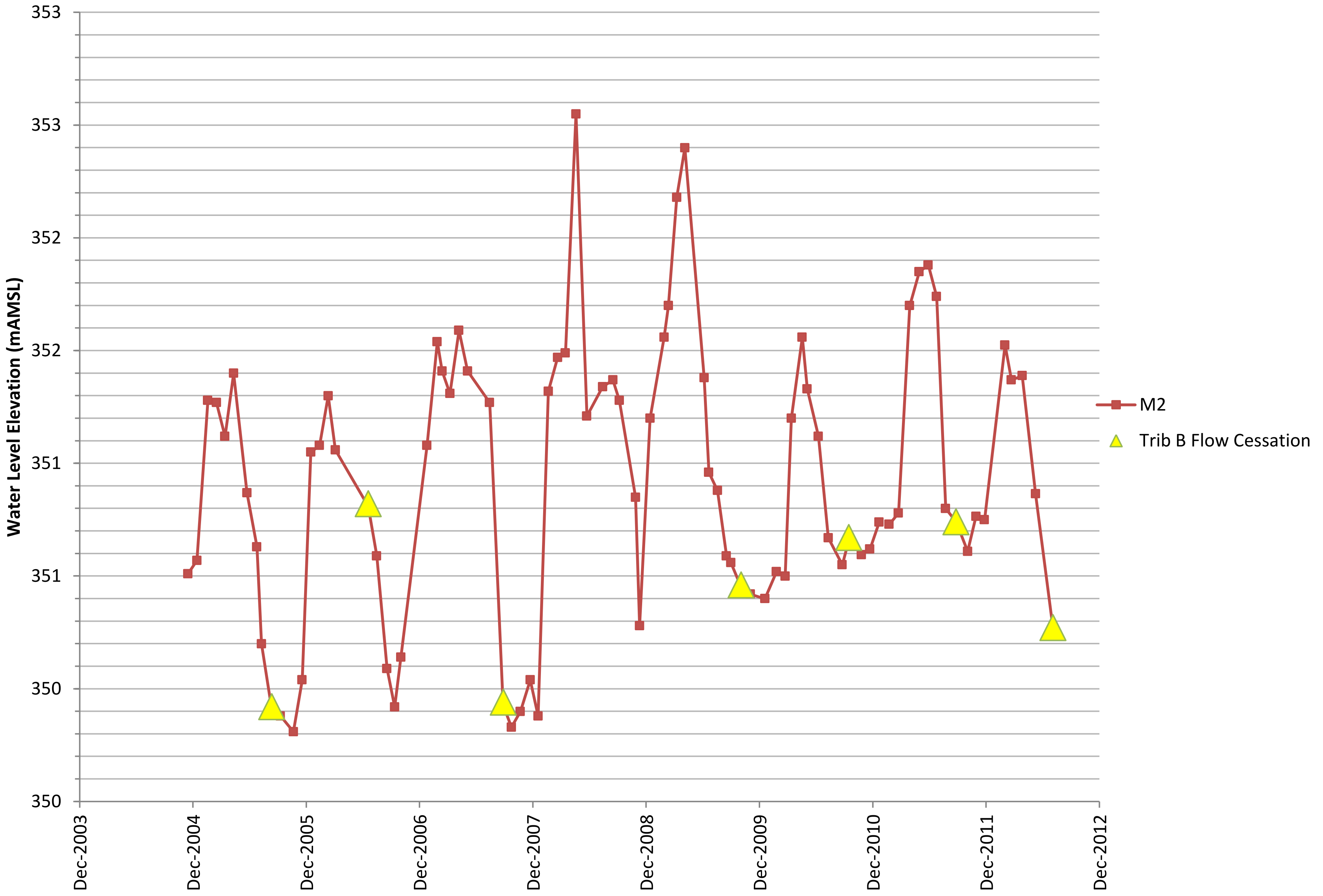
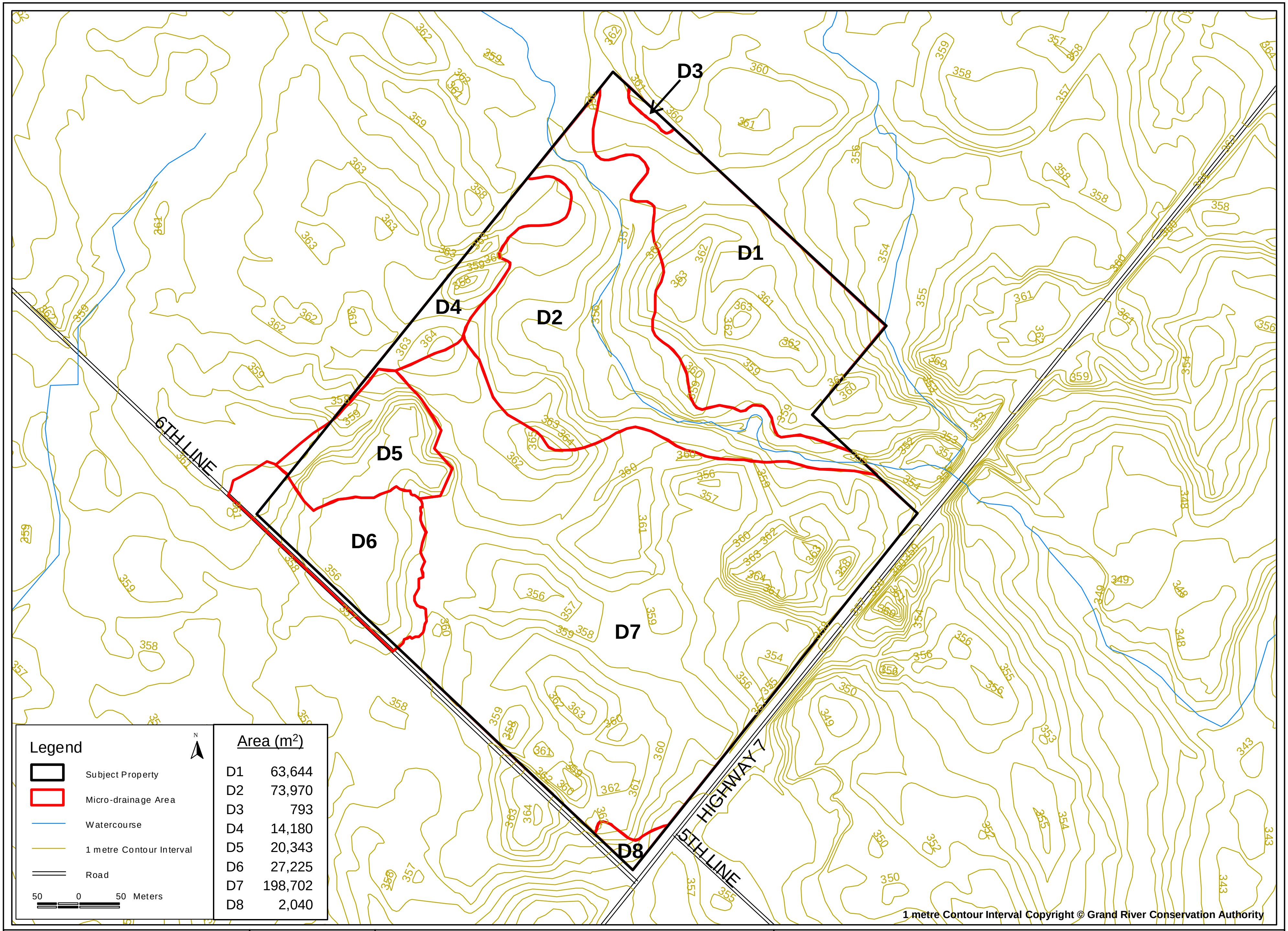


Figure 5: Trib B Flow Cessation and M2 Groundwater Levels



	Area (m^2)
D1	63,644
D2	73,970
D3	793
D4	14,180
D5	20,343
D6	27,225
D7	198,702
D8	2,040

1 metre Contour Interval Copyright © Grand River Conservation Authority

Harden Environmental Services Ltd.

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Date: Jul 2012

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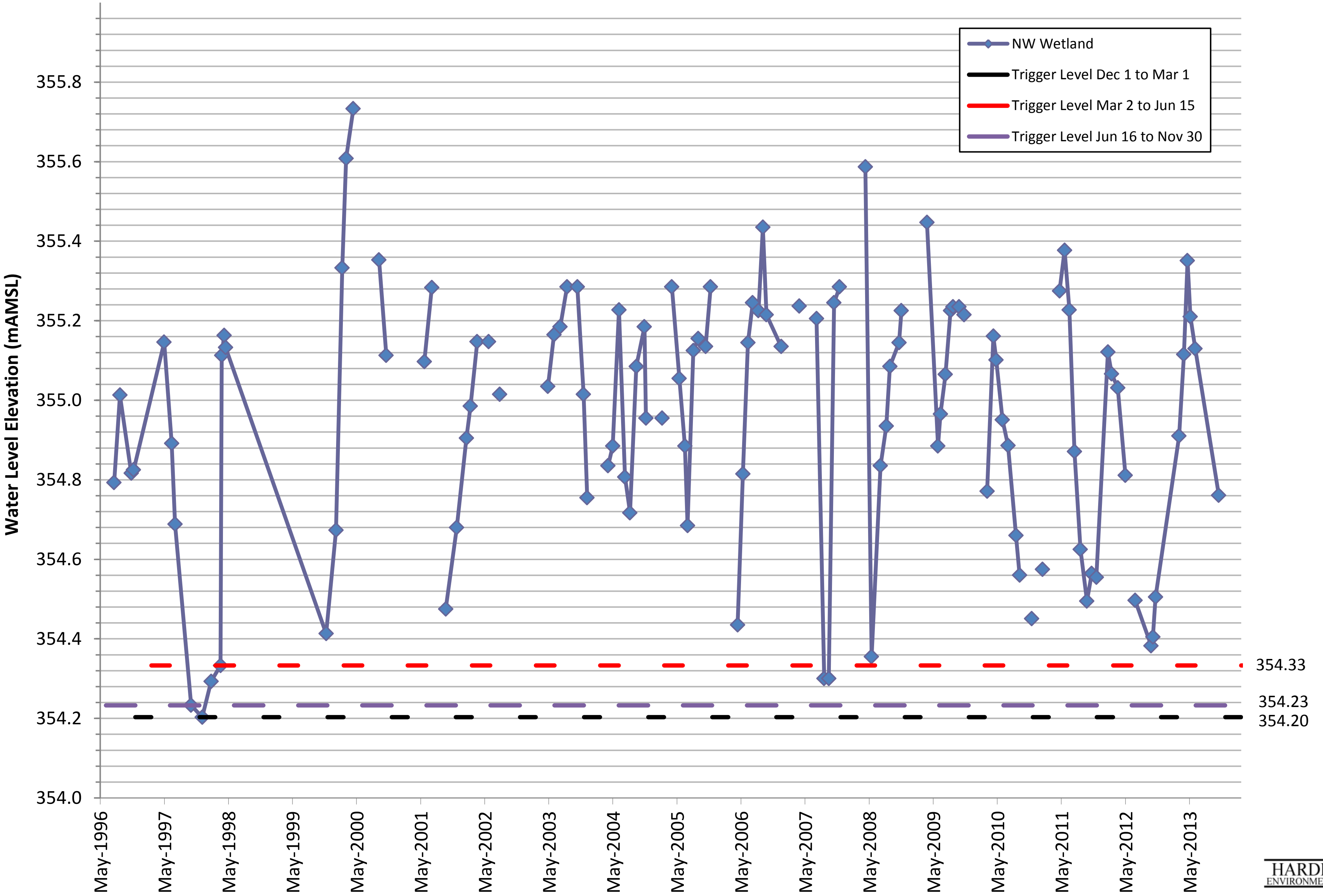
Figure 3.4: Micro-drainage Areas

Figure 7: Northwest Wetland Hydrograph



HARDEN ENVIRONMENTAL

Appendix A

Revised Monitoring Program And Contingency Measures

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
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Groundwater Modelling
Groundwater Mapping

HIDDEN QUARRY

REVISED MONITORING PROGRAM AND CONTINGENCY MEASURES (NOV 26, 2013)

1.0 ON-SITE MONITORING PROGRAM

Monitoring has been taking place at this site since 1995. An extensive database of background groundwater and surface water elevations and flow measurements has been developed. A detailed monitoring program will continue to ensure that sensitive features and surface water flows are maintained. The monitoring program is designed to identify trends towards unacceptable impacts early on to allow for time to implement contingency measures.

The monitoring program for this proposed pit/quarry involves the following activities:

- measuring groundwater levels,
- obtaining water quality samples,
- monitoring water levels in the on-site wetland and stream, and
- stream flow measurements.

We recommend the following monitoring program.

Parameter	**Monitoring Locations**	**Frequency**
Groundwater Levels	M1S/D, M2, M3, M4, M6, M13S/D, M14S/D, MPN1, MPN2, MPS1, MPS2, MPE1, MPE2, MPW1, MPW2, TP1, TP8, TP9, MP1, MP2, MP3, MP4, M15,	Manually Monthly April to November, February Automatic Daily Measurement in M1D, M2, M3, M4, M15, M16 for year prior to and year following

Parameter	Monitoring Locations	Frequency
	M16	bedrock extraction with re-evaluation of monitoring frequency after 1st year of bedrock extraction.
Groundwater Levels	M2, M3, TP1, M13S/D, M14S/D, M15, M16	Weekly during first 3 months of extraction
Surface Water Level	Sinking Cut	Daily
Surface Water Level	SW14	Manually Monthly April to November, February Coincident with groundwater monitoring
Surface Water Levels	SW6, SW4, SW8	Automated Water Level Readings (4 hour interval)
Surface Water Flow	SW4, SW8, SW3	Monthly April to November *coincident with groundwater monitoring
Groundwater Quality	M2, M4, M15, M16	Semi-Annually
Surface Water Quality	West Pond, East Pond, Northwest Wetland	Annually

Monitoring locations are shown on Figure C1.

2.0 TRIGGER LEVELS

Groundwater and surface water monitoring will be used at this site to a) verify that predictions of water level change in the bedrock aquifer do not exceed those predicted and b) verify that the hydro-period of the Northwest Wetland does not change. The water level measurements obtained as part of the monitoring program will be used to trigger contingency measures that may be necessary for the mitigation of a low water level in the Northwest Wetland, a lower than expected water level in the bedrock aquifer or an anomalous low flow level in Tributary B.

2.1 Trigger Levels for the Bedrock Aquifer

The greatest water level change in the bedrock aquifer is expected to occur to the north and northwest of the site. Water levels obtained from bedrock monitors M1D, M13D, M14D and M2 will be used to verify that actual water level changes do not exceed the predicted water level change. A warning level of 75% of the predicted change will be used to initiate bi-weekly manual measurements from the groundwater monitors.

Table 1: Trigger Levels for the Bedrock Aquifer

Monitor	Historical Low	Predicted Change	Warning Level	Trigger Level
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	348.08
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98

The historical water levels, warning level and trigger level are presented in Figures C2, C3, C4 and C5.

2.2 Trigger Level for Northwest Wetland and Allen Wetland

Water levels from Station SW6 will be used to trigger contingency measures for the Northwest Wetland. Historical monitoring has shown that the water level in the wetland is somewhat independent from adjacent groundwater levels and therefore any potential change in the hydro-period is best determined by the surface water level in the wetland.

Trigger levels and warning levels have been determined for three periods as follows:

Winter Trigger Level - lowest water level observed between December 1 and March 1

Spring Trigger Level - lowest water level observed between March 2 and June 15

Summer/Fall Trigger Level - lowest water level observed between June 16 and November 30.

A warning level is established 0.15 metres higher than the trigger level. The warning and trigger levels relative to historical water levels are shown on Figure C6.

Table 2: Trigger Levels for the Surface Water Features

Station	Winter		Spring		Fall	
	Warning	Trigger	Warning	Trigger	Warning	Trigger
Northwest Wetland (SW6)	354.35	354.20	354.48	354.33	354.38	354.23
Allen Wetland (SW4)	The warning level will be a flow rate of less than 25 L/s occurring in May and the trigger level will be cessation of flow prior to June 22.					

Manual water level measurements will increase to bi-weekly if the warning level is exceeded.

3.0 CONTINGENCY MEASURES

3.1 Groundwater Levels and Northwest Wetland

If any trigger level is breached, the following measures will be taken;

1) Confirmation of water level within 24 hours.

2) Evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed.

3) If quarry activities are found to be responsible, the following actions will be considered and a response presented to the GRCA and the Township of Guelph-Eramosa.

- increase the length and/or width of barrier
- decreased rate (or stopping) subaqueous extraction
- change in configuration of mining or decrease in mining extent
- alter timing of extraction to coincide with high seasonal groundwater levels.

3.2 Groundwater Quality

Groundwater Monitors and the East and West Pond

The parameters that will be included in the semi-annual monitoring (summer) will be general chemistry, bacteria, TKN, ammonia, DOC, pH, temperature, anions and metals. In the event that there is an increasing trend in the concentration of one or more elements or compounds, a study will be conducted to determine the source of the water quality change. If the quarry is found to be responsible and if there is a potential for impact to downgradient wells, James Dick Construction Ltd. will commence with the following actions;

1) Semi-annual testing of the water quality of private wells that could potentially be impacted by the quarry.

2) In the event that a water quality issue related to the quarry occurs, James Dick Construction Ltd. will remedy the issue by either providing the appropriate treatment in the home or drilling a new well and isolating the water supply to the deeper aquifer

Northwest Wetland

The Northwest Wetland water will be analyzed annually in September for nitrate, dissolved oxygen, temperature, conductivity and pH for a period of three years or upon completion of construction activities in the surface water catchment area of the northwest wetland whichever is longer.

4.0 PRE-BEDROCK EXTRACTION WATER WELL SURVEY

We recommend that a detailed water well survey be completed prior to the commencement of the extraction of bedrock resources. This survey will as a minimum include all wells in the shaded area shown on Figure C7. The well survey will include the following;

- construction details of the well (drilled, bored, sand point etc..)
- depth of well and depth of pump
- location of well relative to septic system
- static water level

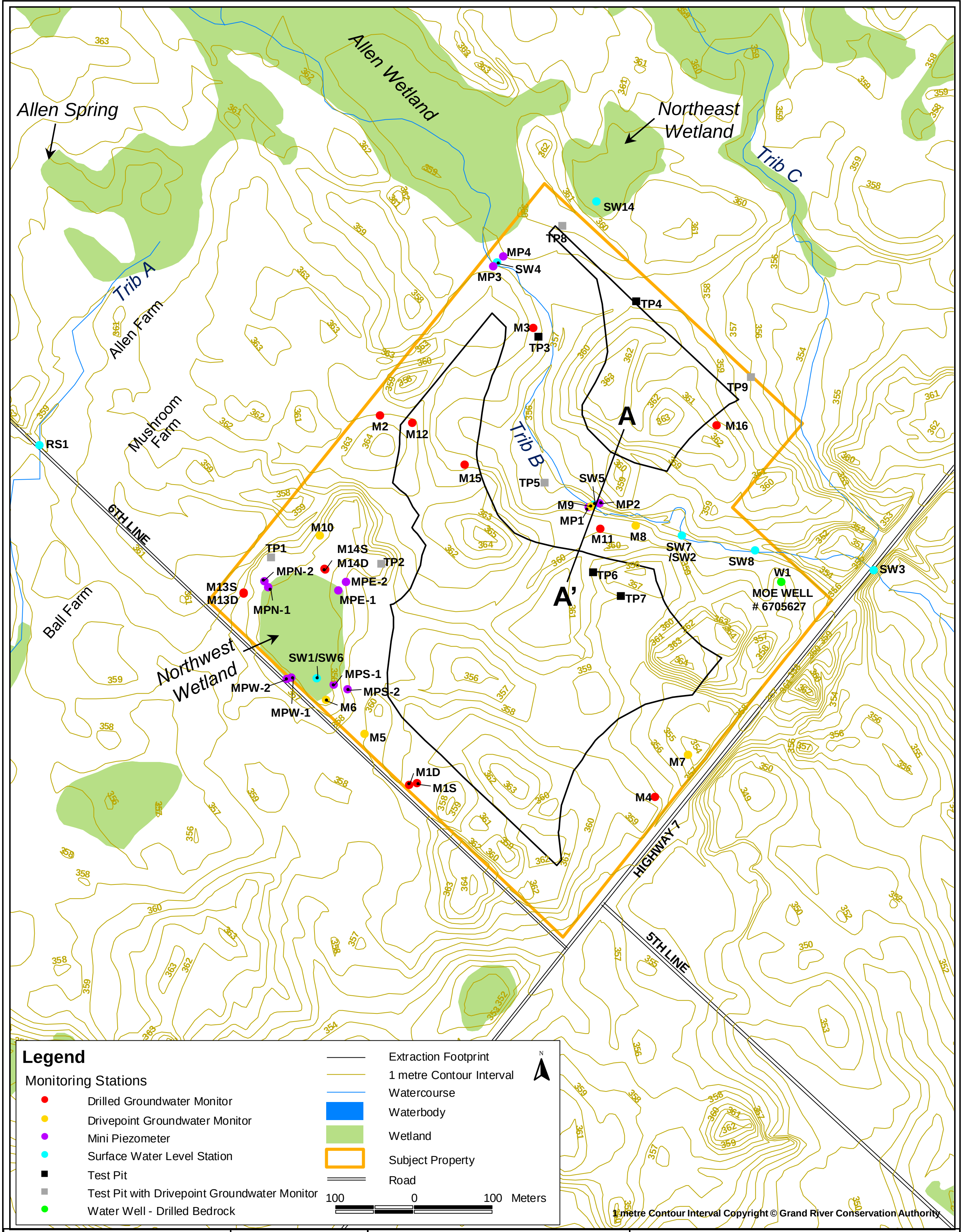
- history of water quantity or quality issues
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals
- one hour flow test

The purpose of the survey is to have a baseline evaluation of both water quality and water quantity in nearby water wells. Should an issue arise with a local water well, the baseline data can be used as a reference against future measurements.

5.0 ANNUAL MONITORING REPORT AND INTERPRETATION

An annual report will be prepared and submitted to the Ministry of the Environment and the Ministry of Natural Resources on or before March 31st of the following calendar year. The report will be prepared by a qualified professional, either a professional engineer or a professional geoscientist.

The monitoring report will include all historical monitoring data and an interpretation of the results with respect to potential impact to the quality and quantity of bedrock groundwater, hydro-period of the Northwest Wetland and streamflow loss from Tributary B.



Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2013

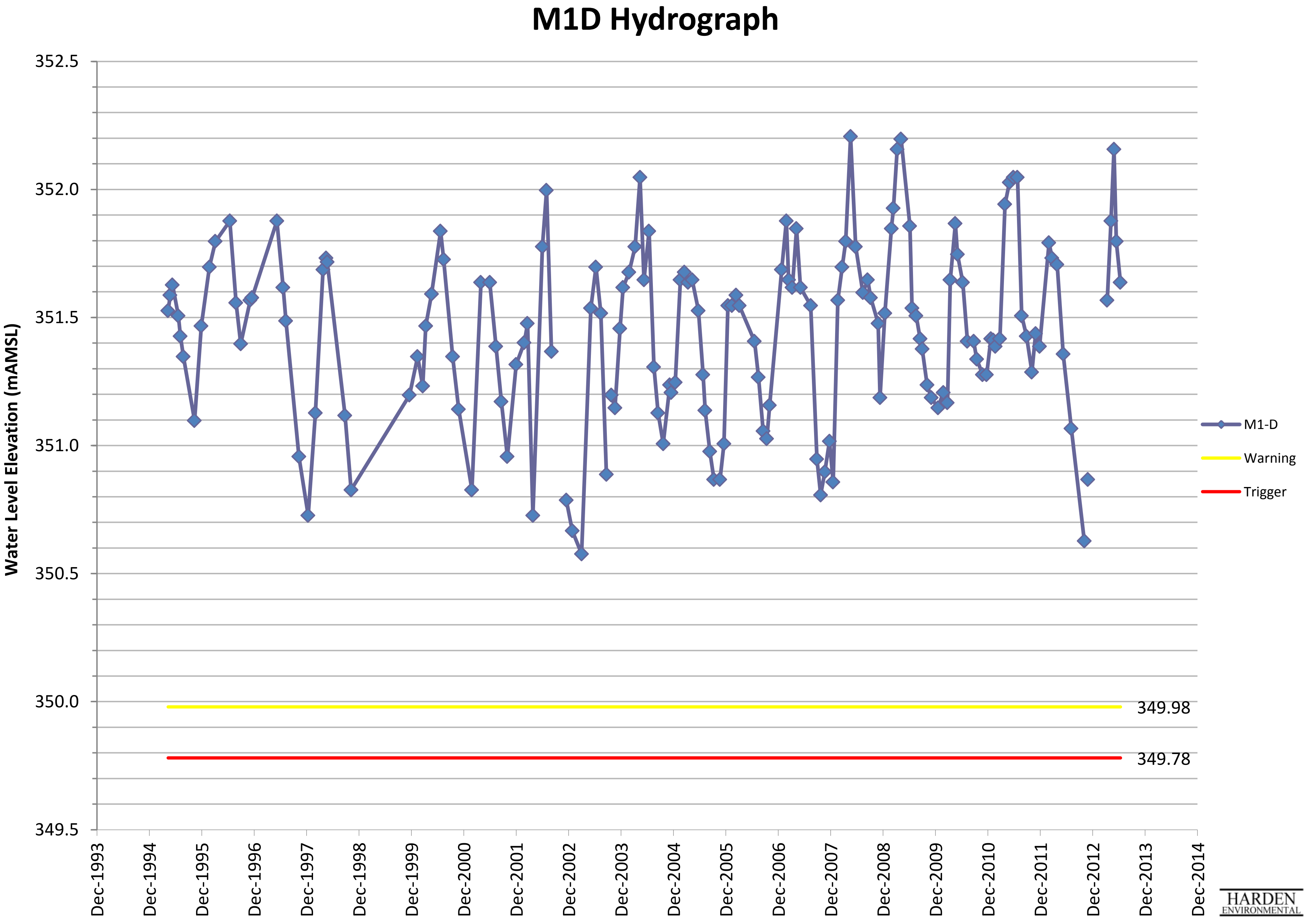
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

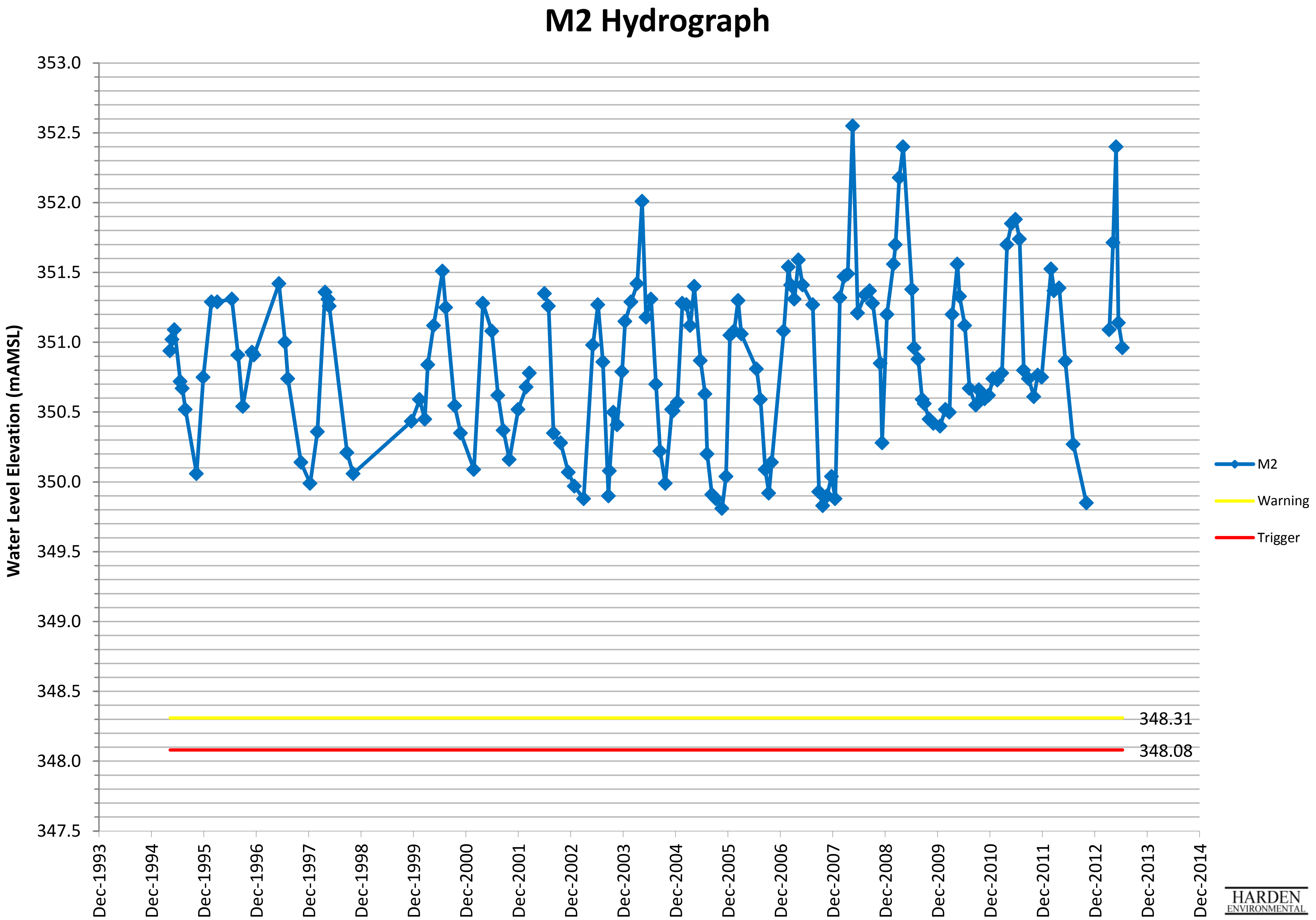
Figure C1:

Monitoring Locations



HARDEN ENVIRONMENTAL

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C2: M1D Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



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Environmental
Services Ltd.

Project No: 9506

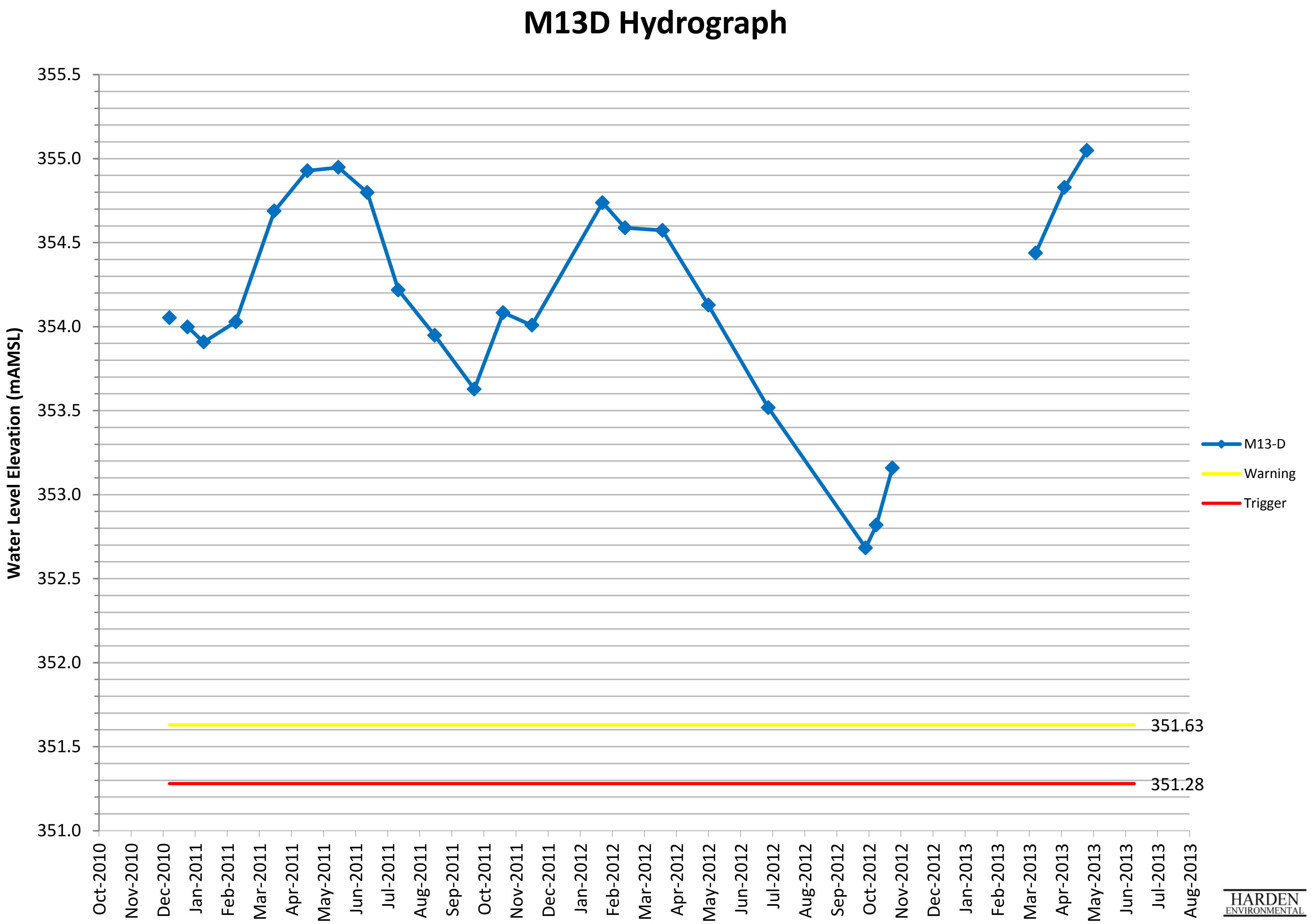
Date: Jul 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C3: M2 Trigger Level



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Project No: 9506

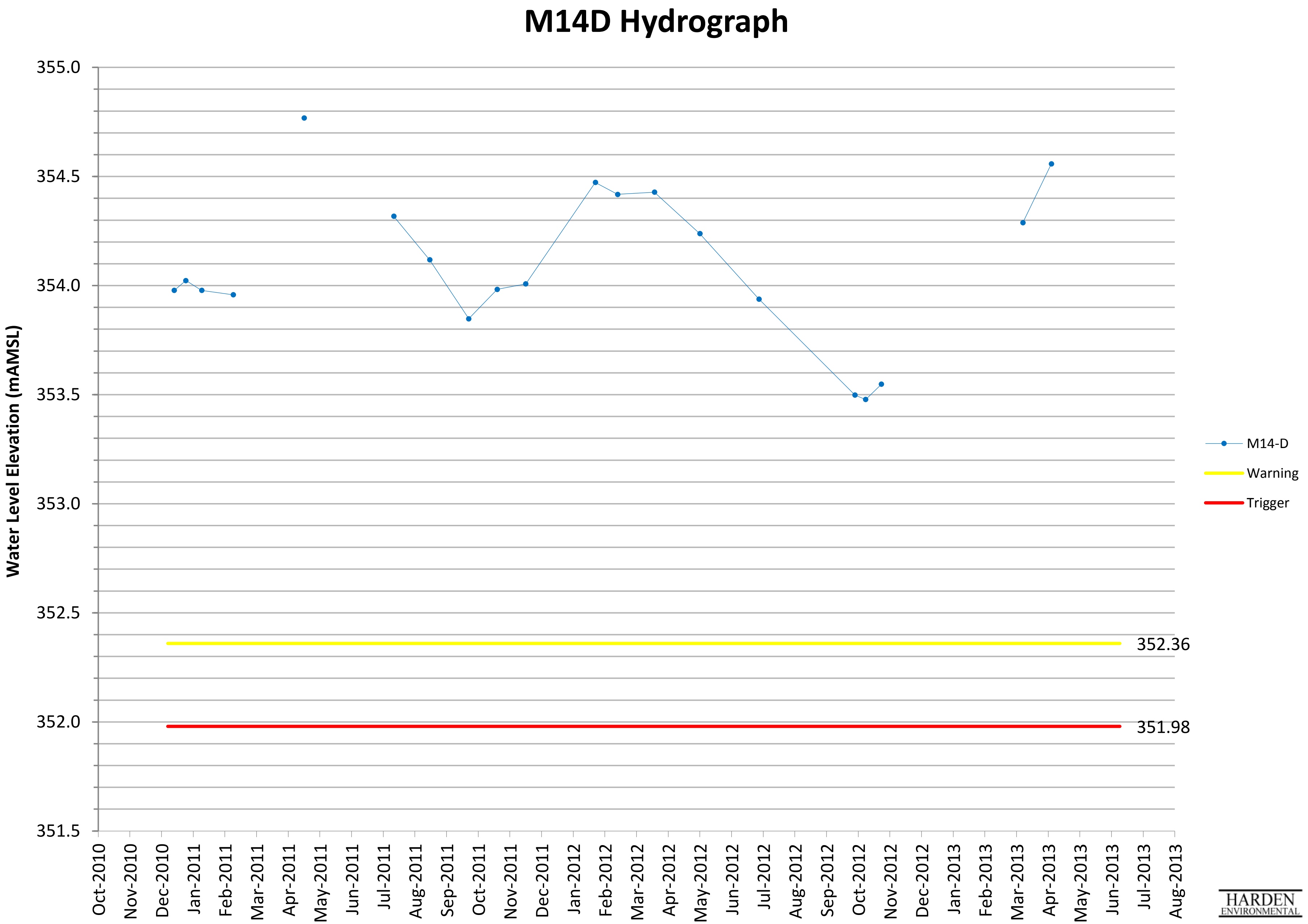
Date: Jul 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

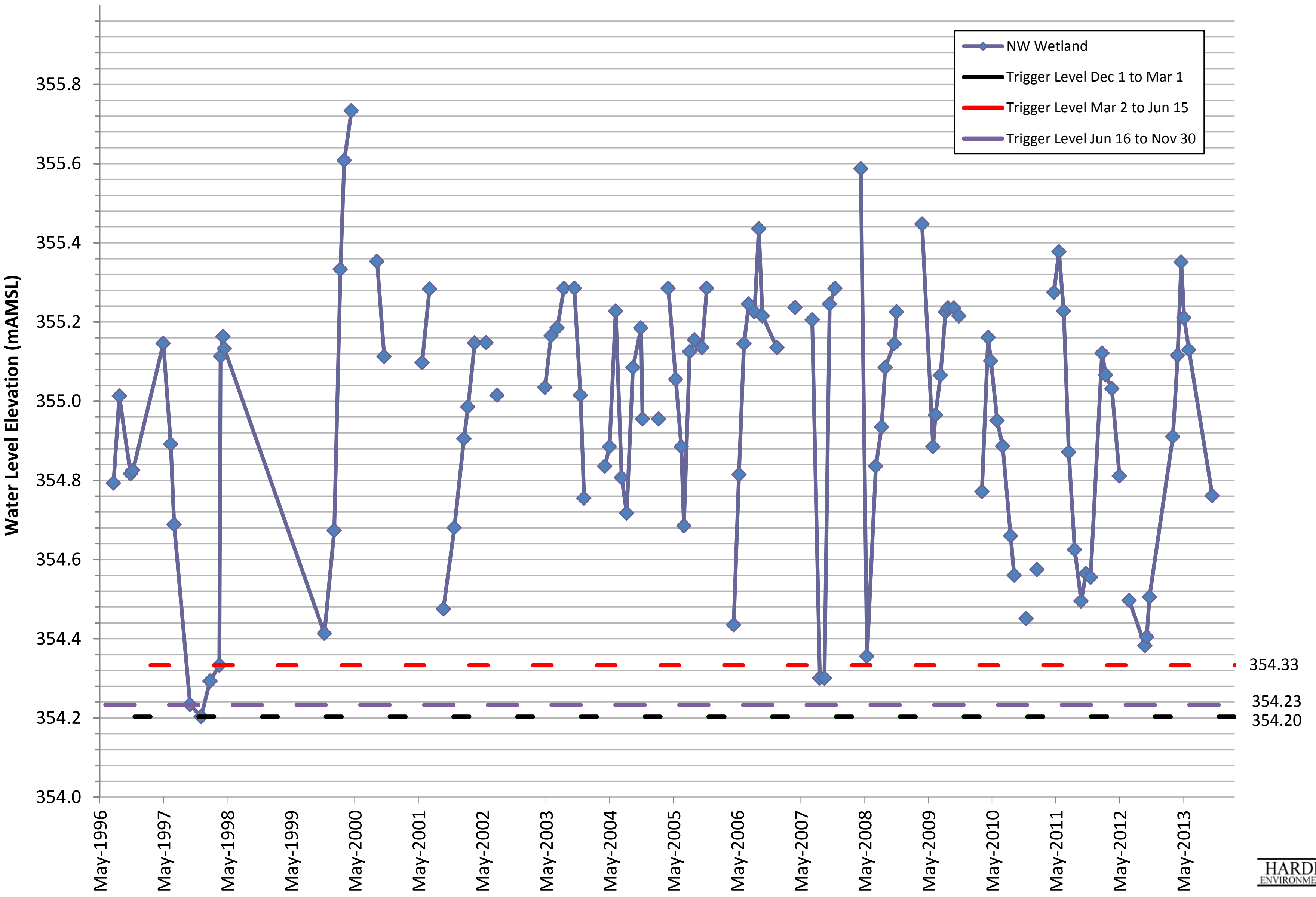
Figure C4: M13D Trigger Level



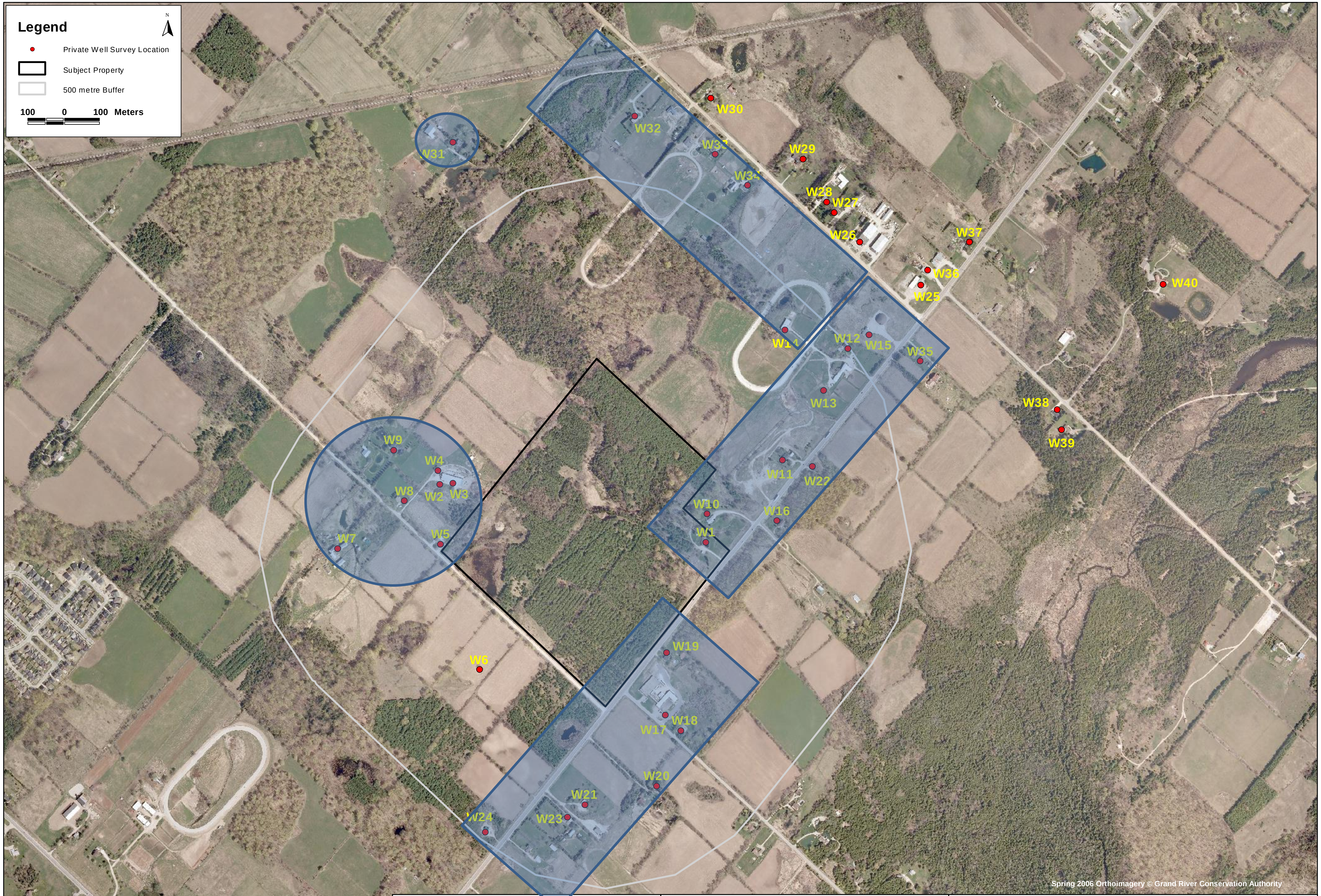
HARDEN ENVIRONMENTAL

Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Jul 2013 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure C5: M14D Trigger Level**

Figure C6: Northwest Wetland Hydrograph



HARDEN ENVIRONMENTAL



Spring 2006 Orthoimagery © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction
Date: Jul 2012	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington
Drawn By: SD	

Figure C7:

Proposed Pre Quarry Well Survey Locations

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

January 14, 2014

R.J. Burnside and Associates Limited
292 Speedvale Avenue West, Unit 20
Guelph, Ontario, N1H 1C4

Attention: Mr. David Hopkins, P.Geo.
Hydrogeologist

Dear Mr. Hopkins:

Re: Response to Burnside Review of Hydrogeological Summary Report Hidden Quarry Site for Township of Guelph/Eramosa Burnside File No.: 300032475.0000

We are pleased to respond to the November 12, 2013 comments provided by R.J. Burnside and Associates Limited (attached Appendix A). It appears that we were able to address several issues and that there are some outstanding. It is our intention to provide sufficient technical analysis in this letter to satisfy the outstanding concerns raised by Burnside and Associates.

1.0 Karst

We agree that cavernous karst features do not exist at this site.

2.0 Water Quality

We agree that throughout the forty-one metres of aquifer encountered in monitoring well M15, groundwater mainly enters the well from two discrete zones and one diffuse zone. There is little inflow to the well from the 19 to 26 metre depth but some 20% of inflow occurs between 26 and 36 metres depth below ground surface.

We agree that nitrate in groundwater originating from upgradient sources likely occurs mainly in fractures within the upper ten metres of the bedrock.

We agree that if the quarry does not extend to the full depth of 41 metres below ground surface and the deeper 33% of inflow is not encountered, there will be less inflow to the quarry and less water for dilution. We have recalculated the nitrogen mass balance (presented in accompanying letter) under these conditions as discussed below.

Nitrate Balance without Full Through Flow

Assuming that a third of the groundwater through flow from lower fractures is not available for dilution the overall nitrogen balance of the site will not change significantly. The net concentration of nitrogen in groundwater entering and leaving the site will increase somewhat owing to the decrease in available dilution. In this analysis we assume that the lower third of the active aquifer does not contribute to dilution. Dilution is only derived from flow through for the remaining two thirds of overall flow. Of this, half is assumed to be derived from the shallow source and half is derived from the intermediate depth fractures.

The volume of groundwater input to this site is calculated as inflow occurring a) under existing gradients and b) flow induced by the lower hydraulic head in the quarry pond.

The volume of flow under natural gradients is estimated using the average hydraulic gradient upgradient of the site and is estimated to be 2 m over 175 m or 0.011 m/m. The width of the flow field is 700 m and the transmissivity is estimated to be 50 m^2/day (this value is a third lower than the value of 75m^2/day estimated by Burnside).

Using

$Q = T \times i \times W$

Where
T – transmissivity (m^2/day)
i – gradient (m/m)
W – width of flow field (m)

the estimated flow through the site under a natural gradient is 385.3 m^3/day or 140,646 m^3/year. Of this, 70,323 m^3 is assumed to flow through the shallow fracture set and 70,323 m^3 in the intermediate fracture set observed in monitoring well M15.

The observed concentrations of nitrogen compounds in the groundwater entering the northern boundary of the site average 4.38 mg/L. Assuming that this value applies to the upper 50% of flow, the mass of nitrogen compounds entering the site from natural flow is

308 kg. It is estimated that the lower flow system has a nitrogen concentration of 0.2 mg/L resulting in an additional 14 kg of nitrogen annually.

Table 1: Nitrogen Balance

Zone	**Nitrogen Concentration (mg/L)**	**Groundwater Flow Volume (m^3)**	**Mass of Nitrogen (kg)**	**Total Nitrogen (kg)**
Upper	4.38	70,323	308	
Middle	0.2	70,323	14	
Induced Flow				
Upper	4.38	128,250	562	
Middle	0.2	128,250	26	
Total from Groundwater			910	
Total from Explosives			894	1,804
Total Dilution		397,146		
Final Nitrogen Concentration	4.54			

The active quarrying will result in 256,500 m^3 of additional groundwater inflow annually assuming that there is no year over year deficit in water balance. This is our experience with below-water-table extraction in similar and less permeable conditions. Assuming that the upper 50% of flow already has a concentration of 4.38 mg/L from upgradient sources, the mass of nitrogen brought into the site by shallow groundwater flow induced by extraction processes is 562 kg and by flow in the middle portion of the aquifer another 26 kg of nitrogen.

The total nitrogen input to the site is estimated to be 910 kg from upgradient groundwater and 894 kg[1] from explosives residue for a total of 1,804 kg.

The water input from upgradient is 140,646 m^3 + 256,500 m^3 = 397,146 m^3.

As shown in Table 1, the expected downgradient nitrogen value is therefore expected to be 4.54 mg/L at the downgradient property line in the absence of any denitrification.

Using the relative absence of nitrogen compounds in water obtained from the Rental House well (W1) as an example, the aquifer has the capability of naturally reducing

---

[1] For detailed assumptions used to calculate the nitrogen residue from explosives please refer to accompanying response to “Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site”

nitrogen concentrations. In addition, nitrogen will be sequestered in any organic mat created in the pond.

It is our conclusion that the total nitrogen concentration in the groundwater leaving the site will have a lower concentration of total nitrogen than shallow groundwater entering the site and will be well below the Ontario Drinking Water Quality standards.

Deeper Water Sources

We agree that quarry activities will result in the mixing of groundwater from various depths. The testing results from monitoring well M15 indicate that confining conditions occur at depth. This generally suggests that the water sources at depth are somewhat isolated from shallower groundwater sources and less exposed to anthropogenic contamination. The vast majority of wells, however, obtain water from the upper and middle portions of the aquifer exposing most wells to contamination from anthropogenic activities and possibly surface water already. This is particularly true for wells located downgradient of the quarry in the Blues Springs Creek valley where overburden is thin or absent. The bedrock aquifer is already susceptible to contaminants from the ground surface as recognized in several reports including Halton Rural Drinking Water Study, Phase 1 and City of Guelph Final Groundwater and Surface Water Vulnerability Report (Aqua Resources, March 2010). The water quality survey by Halton Region found that the water from 31% of drilled wells in their survey was unsafe for drinking. The Beak International (1999) study states that in the Blue Springs Creek watershed, the rapid movement of surface water into the bedrock leads to high susceptibility of contamination. Therefore, the quarry is being developed in an area already susceptible to contamination from the ground surface.

Groundwater on the quarry property does not flow northward. The exception to this is when the production well at the Mushroom Farm (W3) is operating, there may be sufficient drawdown in the well to draw water from the quarry property. If this is the case, the production well will benefit from the body of water developed on the quarry property.

We agree that the mixing of water in the quarry will occur. We note that this mixing already occurs in each bedrock well drilled in this area, including the deep well servicing the Mushroom Farm. The aquifer is also exposed to surface contaminants in the Eramosa River valley and the Blue Springs Creek valley.

GUDI Condition in proposed Well No. 4

We disagree that the quarry may result in the classification of the future Well No. 4 as Groundwater Under the Direct Influence of Surface Water (GUDI).

We have reviewed the definition of GUDI wells as presented in Ontario Regulation 170/03. We understand that Rockwood Wells No. 1 and 2 were deemed GUDI by Burnside and Associates Limited based on the proximity of the exposed bedrock aquifer nearby (GRCA Approved Assessment Report, 2012). We understand that Well No. 3 is not GUDI and obtains water from deep fractures (45 to 48 metres below ground surface).

The following are excerpts from Ontario Regulation 170/03 (italics) and our interpretation relative to future Well No. 4.

> ***2.*** *(1) A drinking water system that obtains water from a raw water supply that is ground water under the direct influence of surface water is deemed, for the purposes of this Regulation, to be a drinking water system that obtains water from a raw water supply that is surface water. O. Reg. 170/03, s. 2 (1).*
>
> *(2) The following drinking water systems are deemed, for the purposes of this Regulation, to be drinking water systems that obtain water from a raw water supply that is ground water under the direct influence of surface water:*
>
> *1. A drinking water system that obtains water from a well that is not a drilled well or from a well that does not have a watertight casing that extends to a depth of six metres below ground level.*

This rule does not apply.

> *2. A drinking water system that obtains water from an infiltration gallery.*

This rule does not apply.

> *3. A drinking water system that is not capable of supplying water at a rate greater than 0.58 litres per second and that obtains water from a well, any part of which is within 15 metres of surface water.*

This rule does not apply.

> *4. A drinking water system that is capable of supplying water at a rate greater than 0.58 litres per second and that obtains water from an overburden well, any part of which is within 100 metres of surface water.*

This rule does not apply.

> *5. A drinking water system that is capable of supplying water at a rate greater than 0.58 litres per second and that obtains water from a bedrock well, any part of which is within 500 metres of surface water.*

This rule already applies given that Tributary A and associated wetlands are within 500 metres of Well No. 4 (Figure 1). Tributary A is a perennial stream that loses water between Eramosa Line 6 and Hwy 7 part of which falls within 500 metres of Well No. 4. This will flag the well as potentially GUDI and appropriate chemical and physical testing will be required to determine if the well is indeed GUDI or not.

> *6. A drinking water system that exhibits evidence of contamination by surface water.*

This will only be known after extensive testing of Well No. 4. There are numerous sources of surface water contamination including the Eramosa River, Tributary A and poorly constructed/abandoned water wells.

> *7. A drinking water system in respect of which a written report has been prepared by a licensed engineering practitioner or professional hydrogeologist that concludes that the system's raw water supply is ground water under the direct influence of surface water and that includes a statement of his or her reasons for reaching that conclusion. O. Reg. 170/03, s. 2 (2); O. Reg. 418/09, s. 1 (5).*

Source water protection analysis has been undertaken by Golder and Associates, Gartner Lee Limited and AquaResources. The approach taken by each of the consultants is to use an equivalent porous media model rather than a discrete fracture model. This approach is justified by the assumption that over a macro scale there is sufficient vertical interconnection between fractures over a large area and thus the aquifer behaves as a continuum. Figure 2 identifies the "water found at" (i.e. fracture) elevations from the water well records. Figure 1 shows the wells used in this analysis. Figure 2 shows that fractures are found at various depths throughout the aquifer and are common enough to allow for the equivalent porous media concept to apply. Figure 3 shows a frequency of occurrence of 'water found at' elevations. It is recognized that individual fractures control groundwater flow on a local scale as observed at the Hidden Quarry site (M15 to M2) and between Rockwood Well No. 3 and observation well OW3D, however, for single fractures to persist in a confined manner between proposed Well No. 4 and the Hidden Quarry is unlikely. For example, although the Rockwood Well No. 3 is sealed to a depth of 36.5 metres, there was a significant response to pumping in observation well OW5D which is only 15.6 metres deep.

It is our conclusion that the proposed Well No. 4 will be flagged as potentially GUDI even in the absence of the proposed quarry, there are other potential sources of surface water contamination closer than the proposed quarry and it is unlikely that fractures are isolated to the extent that interconnections to the bedrock surface will not occur between proposed Well No. 4 and the proposed quarry.

Pathogen Movement

Figure 4 shows the wells that are downgradient of the quarry. These are the only wells that have any risk of water quality impacts. It is our opinion that the detailed monitoring program will identify chemical and bacteriological movement from the quarry and contingency measures are in place in the event that a local well is impacted. Recent testing of the Guelph Limestone quarry during blasting found that the water met all Ontario Drinking Water Quality Standards for comprehensive suite of parameters.

Quarry Depth Limitation

The flow profiling at M15 indicates that there are significant fractures at elevations of 318 m and 324 m AMSL (42 and 36 metres below ground surface respectively). The proposed quarry will extend to an elevation of 320 m AMSL. It is our opinion that limiting the depth of the quarry to an elevation greater than 324 m AMSL will not guarantee the protection of the lower fracture set. The pumping test in Rockwood Well No. 3 shows that at that location there is a hydraulic connection between fractures located more than forty metres below the ground surface and fractures found less than fifteen metres below the ground surface. Therefore, limiting the quarry depth may reduce the volume of water moving through the lower fracture set but will not necessarily eliminate it. Therefore, monitoring and contingency plans are required in any event. The treatment of well water for biological agents is simple, effective and in-expensive. Therefore, we recommend mitigating water quality issues at the few downgradient wells, if they arise, using proven, effective methods designed specifically to address such problems.

3.0 Private Wells with Shallow Fracture Sources of Water

We agree that the bulk transmissivity of the aquifer is approximately 75 m^2/day and that a storativity of 0.00004 is suggested by the limited pumping test in M15 with response in M2.

We agree that flow profiling identified fractures at 36 metres below ground surface and 41 metres below ground surface that accounted for two thirds of the flow entering Well M15.

We agree that testing of local wells by Burnside (and others) suggest that the bulk transmissivity of the full aquifer thickness is typically in the range of 50 to 100 m^2/day and lower fractures account for 25 to 50 m^2/day of that transmissivity.

We agree that fracture flow through a single fracture is much faster than predicted by an equivalent porous media model.

We disagree that groundwater with elevated nitrate may move rapidly away from the quarry before dilution with deeper aquifer water can occur. Our reasons for this disagreement are;

1) Nitrogen compounds that are already in groundwater flowing beneath the quarry property from upgradient sources will likely continue. This water captured in the active quarry will be mixed via extractive processes (i.e. plunging of drag line, blasting) with deep water in the quarry pond. These processes will dilute the concentration of nitrogen compounds by mixing with rainwater and intermediate depth groundwater.

2) Nitrogen loading from the blasting process will occur under turbulent conditions, resulting in significant mixing within the pond and without a significant increase in total nitrogen concentration.

We agree that upon leaving the pond, nitrate can move with greater velocity within discrete fractures than in a porous media situation.

We agree to install individual monitors in M15 and assess hydraulic properties of individual fractures.

We agree that the short term testing in M15 was insufficient for water levels to stabilize, however, the immediate response in M2 suggests that significant local confining conditions exist and the response in M2 is a true response with minimal lag. The minimal lagtime in the response means that the drawdown observed in M2 even for short periods is a good indication of the expected long term response. The level of response observed in M2 is similar to that anticipated in the groundwater model.

We agree that the extrapolation of testing results to 12 hours would result in an approximate drawdown of 1.9 metres in M2, and corresponds to an approximate drawdown in M15 of 3.4 metres which is greater than the proposed maximum allowable water level change in the quarry. A drawdown of 2.5 metres in M15 would occur after 75 minutes resulting in a drawdown at M2 of approximately 1.1 metres. The maximum drawdown predicted to occur in the quarry is 2.54 metres resulting in a 1.6 metre drawdown in the nearest private well. The pumping test in M15 corroborates the model simulations thereby validating the model results.

We agree that shallow wells have the greatest potential to be impacted. We have identified the shallow wells on Figure 5 and none of the shallow wells are located upgradient of the quarry. These wells are located downgradient where water levels will rise. In regards to wells that are upgradient of the quarry, it is our opinion that the magnitude of change will not affect the functioning of the domestic wells. This opinion will be verified upon completion of a detailed pre-bedrock extraction water well survey. If an upgradient well is found, during a flow test, to have a drawdown near to the location of the pump, then the pump will be set to a deeper depth.

We disagree that pro-actively modifying all nearby wells is a necessary step. The predicted maximum impact of 1.6 metres will not affect the yield of any well upgradient of the quarry. James Dick Construction Ltd. has committed to resolving all water well issues related to the quarry activities.

4.0 Groundwater Model Parameter – Hydraulic Conductivity

We agree that a reconstructed M15 will provide improved characterization of individual fracture sets. It is our opinion that this knowledge will not materially affect the predictions of drawdown in neighbouring wells.

We agree that when M15 is reconstructed as a multi-level well additional testing will assist in refining the hydraulic conductivity of individual fracture sets.

Verification of Model Results Using Analytical Approach

In order to corroborate the model results using traditional well hydraulic methods, we have simulated the extraction process by using a series of dewatering wells. Figure 6 shows the location of the dewatering wells used in the simulation. The theory of superposition is that the impact of each dewatering well is additive. Therefore, as depicted in Figure 7, the anticipated drawdown at private well W3 is determined as follows;

$$s_{W3} = s_{DW1} + s_{DW2} + s_{DW3} + s_{DW4} + s_{DW5} + s_{DW6}$$

where s_{W3} is used to signify the total drawdown at private well W3 and s_{DWi} (i = 1 to 6) are the drawdown values from each dewatering well.

We have designed the dewatering wells to drawdown the aquifer by approximately 2.5 metres, thereby mimicking the maximum allowable water level change in the quarry.

The aquifer characteristics calculated by Burnside and Associates based on the short term pumping in M15 are as follows;

Transmissivity = 75 m^2/day

Storativity = 0.00004

These results are similar to the aquifer characteristics found by Burnside in Well No. 3 being T = 37 m^2/day (113 m^2/day at OW3D) and a storativity of 0.000024.

In order to estimate the magnitude of impact at the nearest five private wells shown on Figure 6, we have calculated the cumulative drawdown from each of the six dewatering wells (DW1-DW6) at each private well. The drawdown is estimated using the modified equilibrium equation (Cooper and Jacob, 1946);

Equation (1)

$$s = \frac{0.183Q}{T} \log \frac{2.25Tt}{r^2S}$$

Where

s = drawdown

Q = pumping rate in dewatering well (m3/day)

T = transmissivity (m2/day)

t = time (days)

r = distance to pumping well (m)

S – storativity (dimensionless)

This equation provides a reasonable estimate of drawdown for an equivalent porous media for the following conditions;

1) the water bearing formation is uniform in nature and hydraulic conductivity is the same in all directions,

2) the formation is uniform and infinite in areal extent,

3) the pumped well penetrates and receives water from the full thickness of the water bearing formation,

4) the water removed from storage is discharged instantaneously when the head is lowered,

5) the pumping well is 100% efficient,

6) all water removed from the well comes from aquifer storage,

7) laminar flow exists throughout the well and aquifer,

8) the water table or potentiometric surface has no slope, and

9) the formation receives no recharge from any source.

It is recognized that all of these conditions are not met for this application, however, it is widely accepted that the non equilibrium equation is a reasonable approach to evaluating drawdown. Burnside and Associates used the same method to estimate drawdown around Well No. 3.

Two scenarios were simulated in this analysis.

Scenario 1

The quarry penetrates all of the major water bearing fractures and the transmissivity of 75 m^2/day is applied.

Scenario 2

The quarry penetrates the upper two thirds of the water bearing zone and a transmissivity of 50 m^2/day is applied.

Table 2 summarizes the cumulative impact from the dewatering wells on the nearest five wells and compares the results to the 3-D Modflow model presented in the Harden 2012 report.

Table 2: Estimated Drawdown Using Dewatering Wells to Simulate Quarry Drawdown

	Scenario 1	Scenario 2	Model
	T = 75 Q = 47	T = 50 Q =33	
Private Well	Drawdown (m)	Drawdown (m)	Drawdown (m)
W3	1.50	1.45	1.37
W4	1.42	1.37	1.22
W5	1.44	1.39	1.12
W8	1.30	1.24	1.02
W9	1.23	1.17	0.972

The results are very comparable and confirm less than a 1.5 metre water level change expected in the worst case scenario at the nearest private water well. The dewatering well analysis suggests slightly higher drawdown than the model due to the analytical method not accounting for recharge.

The analysis of Scenario 2 results in less impact to local wells. This results because drawdown cones developed in lower transmissivity aquifers are steeper and have less area of influence than wells in higher transmissivity aquifers (Freeze and Cherry, 1979, Figure 8.6).

This analytical analysis confirms that;

a) the results obtained from the model are reasonable,

b) if the lower fracture set does not contribute water to the quarry, the quarry will fill slower but the impact on local wells is similar to the full depth scenario, and

c) the maximum drawdown in the nearest wells is always less than will occur in the quarry.

This analysis allows us to restate that local wells will not be significantly impacted by the proposed quarry and that a shallower quarry will not result in significantly less impact.

5.0 Brydson Spring and Blue Springs Creek

We agree that there should be no long term impacts to Brydson Spring.

We disagree that there will be short term impacts to Brydson Spring. The quarry will be developed in the northern portion of the site with a maximum water level change of 2.5 meters. This is insufficient to change the water level along the southern property boundary being approximately five metres lower than along the northern property boundary. As the quarry proceeds southward, water levels along the southern property boundary will rise.

There will not be any decrease in flow to Brydson Spring. Blue Springs Creek located 1200 metres from the site will not be impacted in any way.

6.0 Rock Extraction Water Level Change

In order to confirm the model results regarding potential impacts to local wells during the initial rock excavation from the sinking cut, we used four pumping wells to simulate maximum drawdown scenario in the sinking cut. Figure 6 shows the proposed location of the sinking cut and the location of the four simulation wells (DW7-DW10).

The maximum drawdown in the sinking cut is approximately 2.5 metres, therefore the maximum drawdown in the four dewatering wells is adjusted to 2.5 metres by modifying extraction rates from each well. The potential impact occurring in private wells can be estimated by summing the drawdown from each dewatering well at the residential well. The drawdown at the residential wells is estimated using equation (1) introduced previously in section 4.0.

The drawdown in the nearest private wells during the sinking cut extraction is summarized in Table 3. The maximum drawdown in the nearest well is estimated to be 0.87 m.

Table 3: Estimated Drawdown Using Dewatering Wells to Simulate Drawdown in Sinking Cut

	T = 50 Q =33	T = 520 Q = 286
Private Well	Drawdown (m)	Drawdown (m)
W3	0.87	1.13
W4	0.84	1.11
W5	0.75	1.03
W8	0.73	1.02
W9	0.74	1.03

This analysis confirms that the potential water level change at the nearest private wells is not significant relative to their available drawdown. This analysis also shows that under the unlikely scenario of full daily recovery of water levels in the quarry pond, there will not be a significant impact to any local well.

Combined Impact from Rockwood Well No. 4 and Hidden Quarry

We agree that there is a potential for a combined impact of the proposed municipal well and the quarry on wells located between them. It is our opinion that the combined impact will be small relative to the available drawdown in the private wells. We base this opinion on two factors;

a) In their hydrogeological analysis of Rockwood Well No. 3, Burnside suggests that wells between 500 and 3000 metres of Well No. 3 may have a drawdown of up to three metres and conclude that domestic wells will not experience adverse effects and

b) When I visited the mushroom farm in 2012, the owner explained that he was pumping 89 gallons per minute from his 60 m deep well and we could hear the pump cavitating. I understood that the pump was located at a depth of 45 metres. It is also our understanding that none of the neighbours wells were being impacted by this taking and there does not appear to be any impact on bedrock water levels at the Hidden Quarry site. Therefore, it is our opinion that the impacts from the proposed pumping Well No. 4 at a distance of more than one kilometre will not be significant.

We agree that at the maximum rate of extraction and if the quarry water level stabilized on a daily basis, the flow of water into the excavation would be 13.3 L/s. James Dick Construction Ltd. is committing to a maximum water level change of 2.54 m resulting in a maximum water level change of 1.6 m in the nearest domestic water well. We disagree that the flow of 13.3 L/s may be sustainable upon quarrying to the maximum depth. This rate of inflow when the maximum drawdown is 2.54 metres would require a very high transmissivity that has not been measured at the site or anywhere nearby.

However, it is possible to simulate the impact to local wells if this hydrogeological condition occurred. Assuming that the aquifer is capable of refilling the quarry on a daily basis at the maximum rate of rock extraction (1145 m^3 /day), the aquifer transmissivity would have to be approximately 520 m^2/day. Under these conditions, the maximum impact to the local wells is summarized in the third column in Table 3. The maximum drawdown is estimated to be 1.13 metres in the nearest well.

For clarification, the mining process is that the maximum depth of the quarry is achieved in the first blast of the sinking cut, therefore all fractures to the bottom of the quarry will be exposed in the quarry.

It is our conclusion that local wells will not be impacted by this level of water level change.

Burnside Recommendations

1.0 We disagree that the maximum allowable drawdown in the initial sinking cut needs to be restricted to 0.9 m. There are no shallow wells upgradient of the quarry that can be affected by a water level change of 2.54 m in the sinking cut. Figure 6 shows the approximate location of the sinking cut. The cut will be 349 m from the nearest well (W3). Figure 8 is a scaled cross section showing the magnitude of the maximum allowable water level change in the sinking cut relative to the depth of the nearest up-gradient wells. It is our opinion that the magnitude of water level change will not affect the yield of any nearby private water well. As the quarry increases in size, the influence of the extraction will decrease. When the quarry has reached the extent shown on Figure 9, the daily drawdown during maximum extraction is approximately eight centimetres.

2.0 A decrease in water levels can only occur upgradient of the proposed quarry. Modifying the pump setting on every well is unnecessary, particularly where water levels are predicted to increase. The maximum predicted water level change of 2.54 metres and as the response in M2 to pumping in M15 confirms, the maximum drawdown decreases with distance from the quarry.

3.0 According to information available from our water well survey and the MOE database, none of the downgradient wells obtain water exclusively from the lower fracture set. It is possible that if any of the downgradient wells are found to be affected by biological agents (e.g. Cryptosporidium, giardia) that the wells can be deepened or liners installed to access water from deeper fractures where the likelihood of encountering these agents is diminished. The more effective method of managing this issue, should it arise, is by providing simple, effective treatment at the well head.

The introduction of these biological agents to the quarry pond is not a foregone conclusion and these agents may not survive in the aquifer or may undergo natural filtration. Thus, it is our recommendation that this issue be addressed through on-site water quality monitoring with the contingency for off-site water quality monitoring, well modifications and water treatment.

7.0 Aquitard

We agree that there is no natural aquitard overlying the site.

9.0 Monitoring Plans, Trigger Levels and Contingency Plan

A revised monitoring program (January 2014) is provided in Appendix B.

1.0 On-site Monitoring Program

We agree to modify the monitoring program to include monthly year round water levels and daily water levels in wells with data loggers.

We agree to hourly measurements with data loggers in monitoring wells M2, M3, TP1, M13S/D, M15 and M16. We cannot commit to including M14S/D until construction of acoustic and hydraulic berm is complete.

We agree to add SW5 and SW7 to the surface water level list.

We have already agreed with the Grand River Conservation Authority to monitor flow at SW4 and SW7 including a data logger installation. Therefore the inclusion of flow measurements at SW5 and SW7 is not necessary.

We agree to include W1 in the water quality program.

We agree to increase surface water quality monitoring to spring and fall samples corresponding to groundwater sampling. We agree to include the Northwest Wetland and Tributary B (at SW4 and SW3) in the sampling program and to add cryptosporidium and giardia to the list of parameters.

2.0 Trigger Levels

2.1 Trigger Levels for the Bedrock Aquifer

We agree to establish trigger levels for M15 and M16 after monitoring begins. The trigger levels correspond to the maximum water level change expected to occur at the site. We predict the maximum water level change will occur near the end of the quarry life, as the southern portion of the quarry is extracted.

2.2 Trigger Level for Northwest Wetland

We concur with the Burnside recommendation of daily water levels in the Northwest Wetland. We have agreed with the GRCA to install a data logger at SW6 to obtain daily water levels.

3.0 Contingency Measures

3.1 Groundwater Levels and Northwest Wetland

1) We agree to install an onsite weather station when the scale house is established.

2) We agree to limit the time for evaluation of data to 7 days.

3) We agree to changing the contingency measures such that either decreasing the rate of extraction or cessation of extraction is the initial response to a trigger threshold being breached.

4) We agree to increase monitoring to weekly until the source of the trigger level exceedence is identified.

3.2 Groundwater Quality

We agree to commence the groundwater quality program at least one year prior to bedrock extraction.

We agree to initiate contingency measures when any quarry related water quality result is above the ODWQS or above the 95th percentile.

We agree to include the following surface water pathogens to the list of quality parameters; cryptosporidium, giardia, e-coli.

4.0 Pre-Bedrock Extraction Water Well Survey

Contingent upon accessibility, we agree to include a number of domestic wells in the water level monitoring program.

10.0 Well Complaint

We agree to advise the Township of Guelph Eramosa and the Ministry of the Environment upon the receipt of a complaint and the findings of the investigation.

11.0 Next Steps

We agree to construct M15 as a multi-level installation as per the zones identified by Burnside and Associates.

We agree to completing a pre-quarrying water well survey in order to identify needed modifications to residential wells.

The potential impacts from surface water pathogens have been discussed herein. Mitigation measures include on-site and off-site groundwater monitoring, well modifications and water quality treatment.

The final depth of the quarry remains at 320 m AMSL.

The comments provided by Burnside and Associates have been addressed herein.

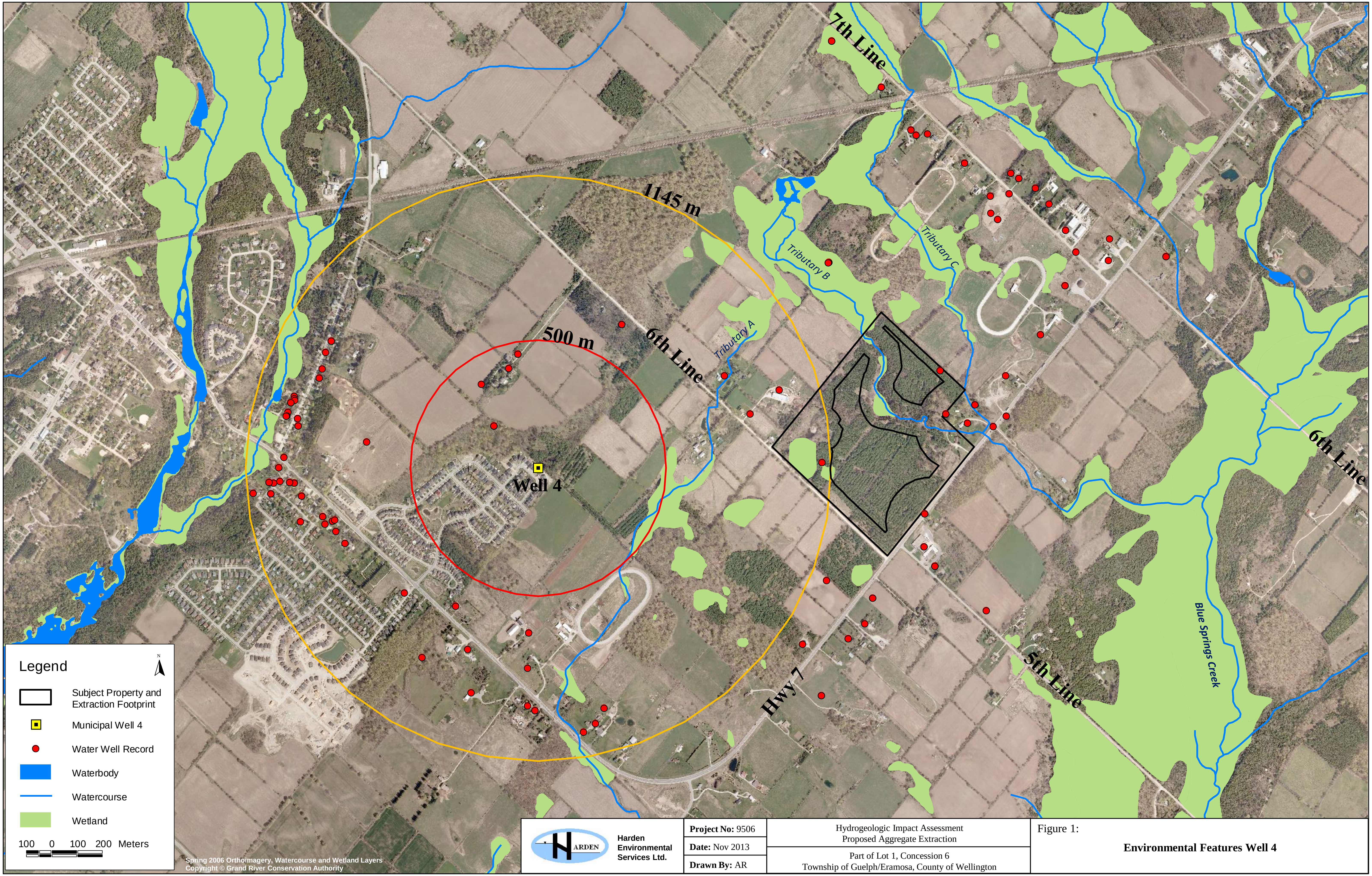
Respectully submitted,
Harden Environmental Services Ltd.

Stan Denhoed

Stan Denhoed, M.Sc., P. Eng.
Senior Hydrogeologist

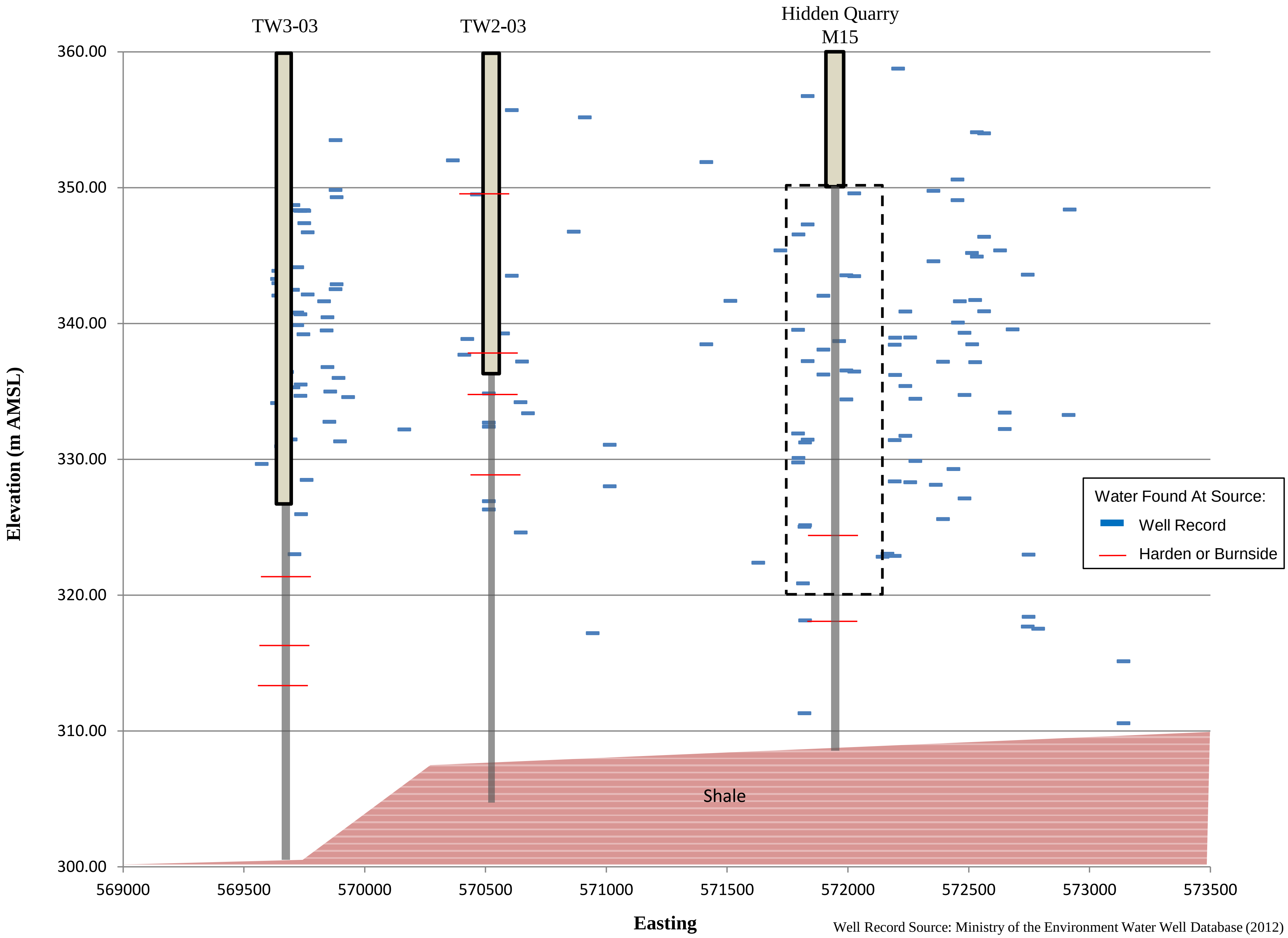
S. E. DENHOED
Jan 14/14

cc: Greg Sweetnam, James Dick Construction Limited



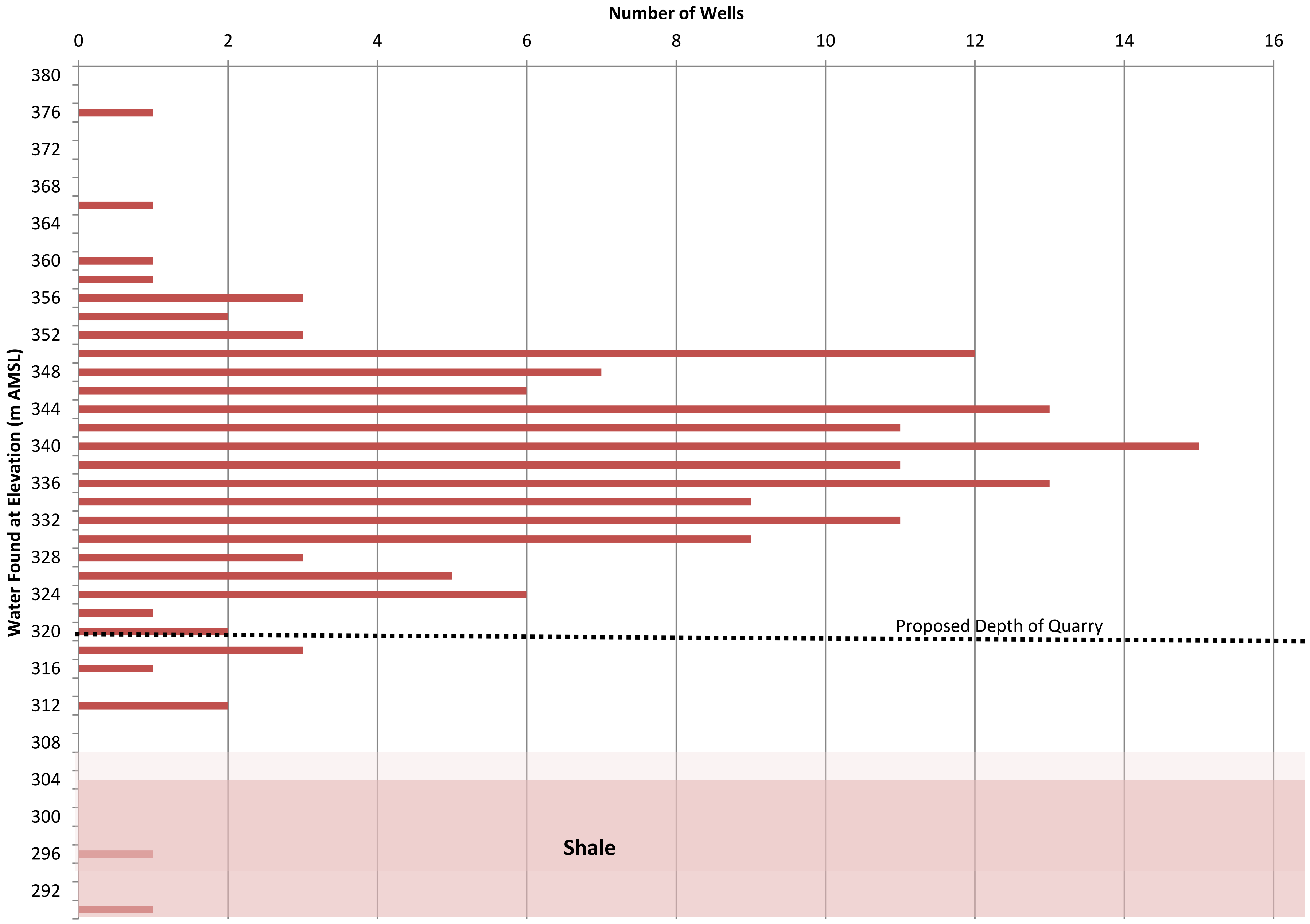
Spring 2006 Orthoimagery, Watercourse and Wetland Layers
Copyright © Grand River Conservation Authority

Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Nov 2013 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	Figure 1: **Environmental Features Well 4**



Well Record Source: Ministry of the Environment Water Well Database (2012)

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 2: Water Found At Fracture Elevations**
	Date: Nov 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Source: Ministry of the Environment Water Well Database (2012)

Harden
Environmental
Services Ltd.

Project No: 9506

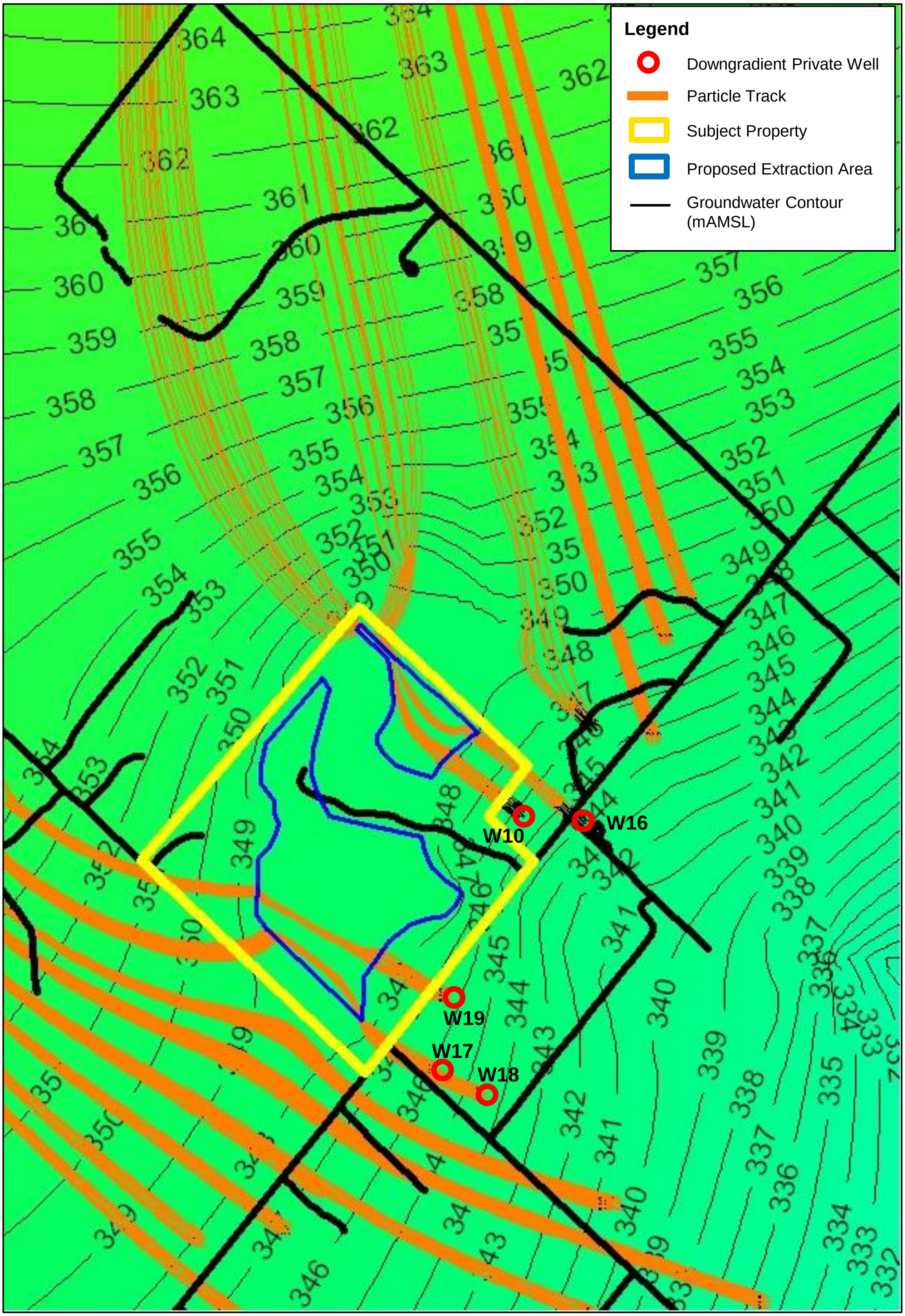
Date: Dec 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3: Water Found At Frequency of Occurrence



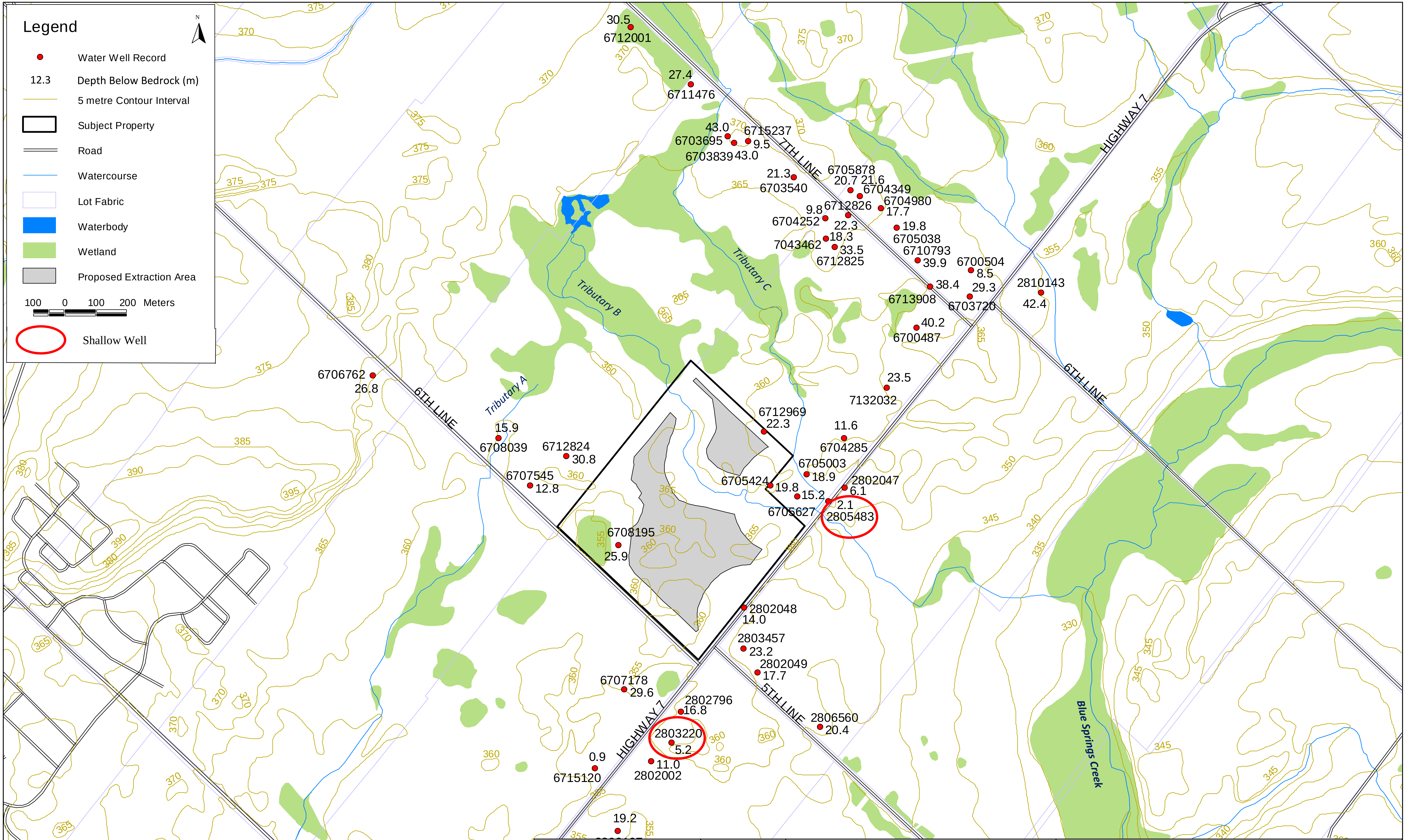
Harden Environmental Services Ltd.

Project No: 9506
Date: Dec 2013
Drawn By: SD

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 4:
Downgradient Private Wells



Harden Environmental Services Ltd.

Project No: 9506
Date: Aug 2013
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 5:

Depth of Private Wells Below Bedrock (m)

Harden Environmental Services Ltd.

Project No: 9506

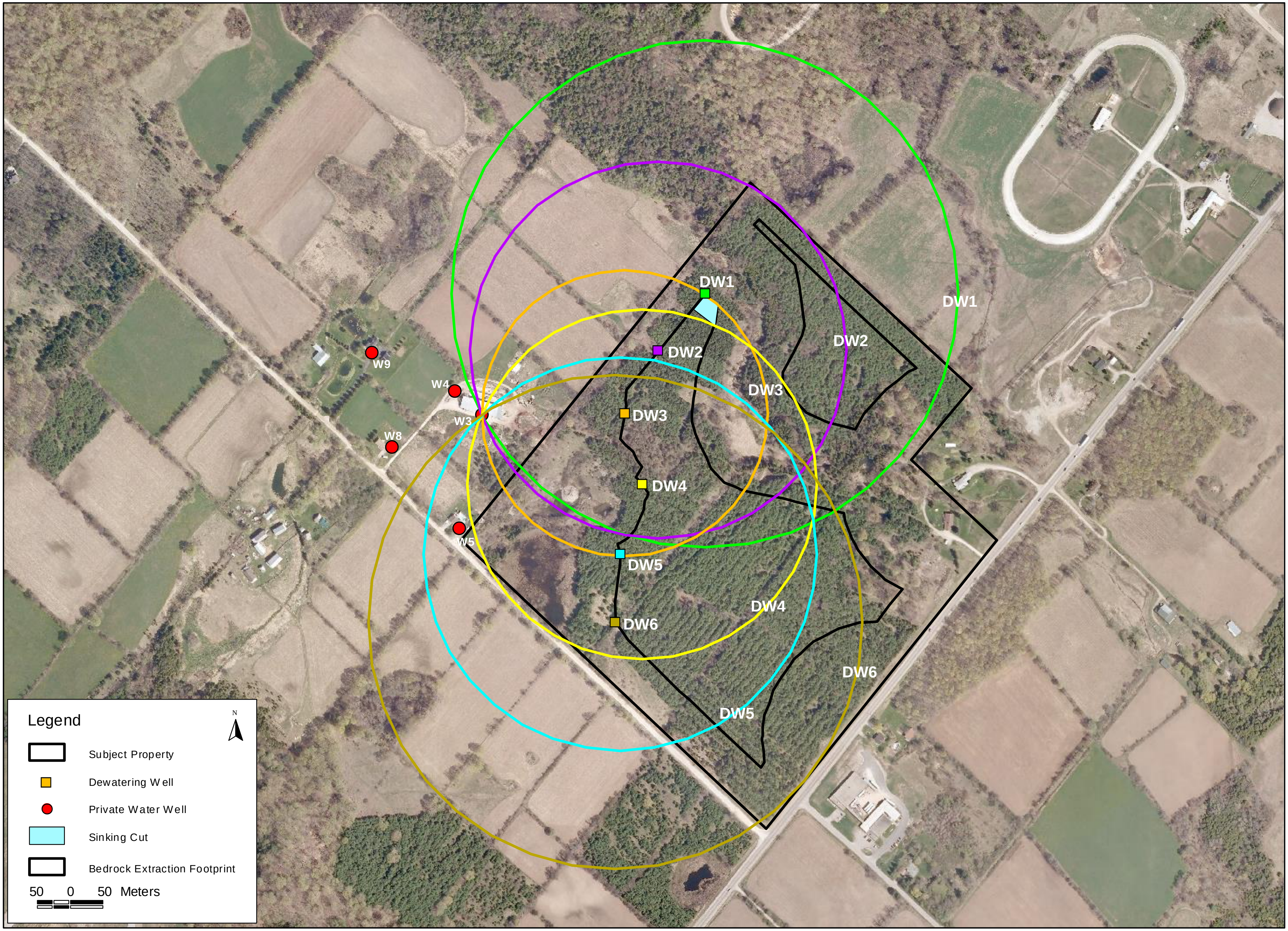
Date: Dec 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

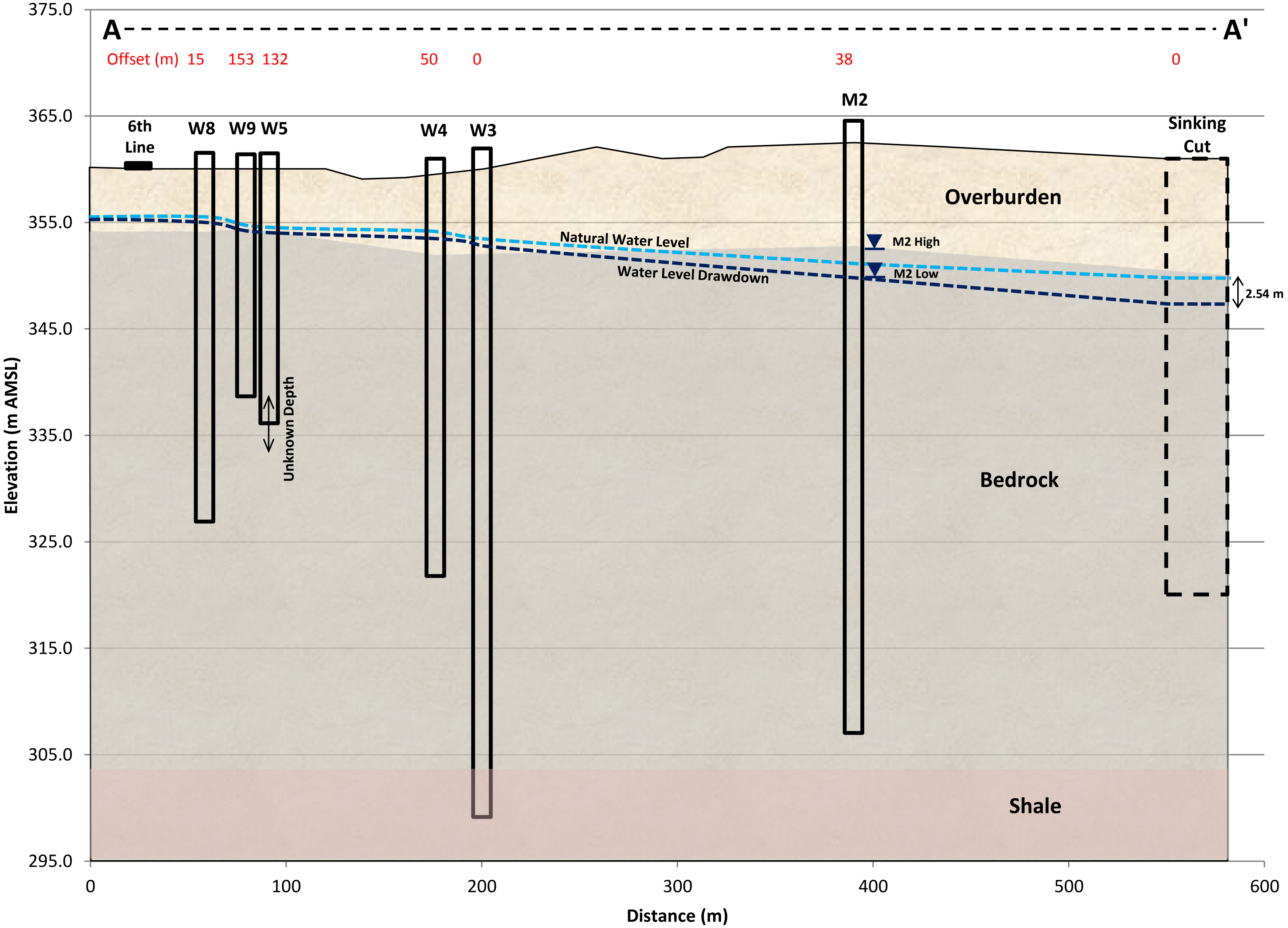
Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 6: Cross Section A-A' Key Map

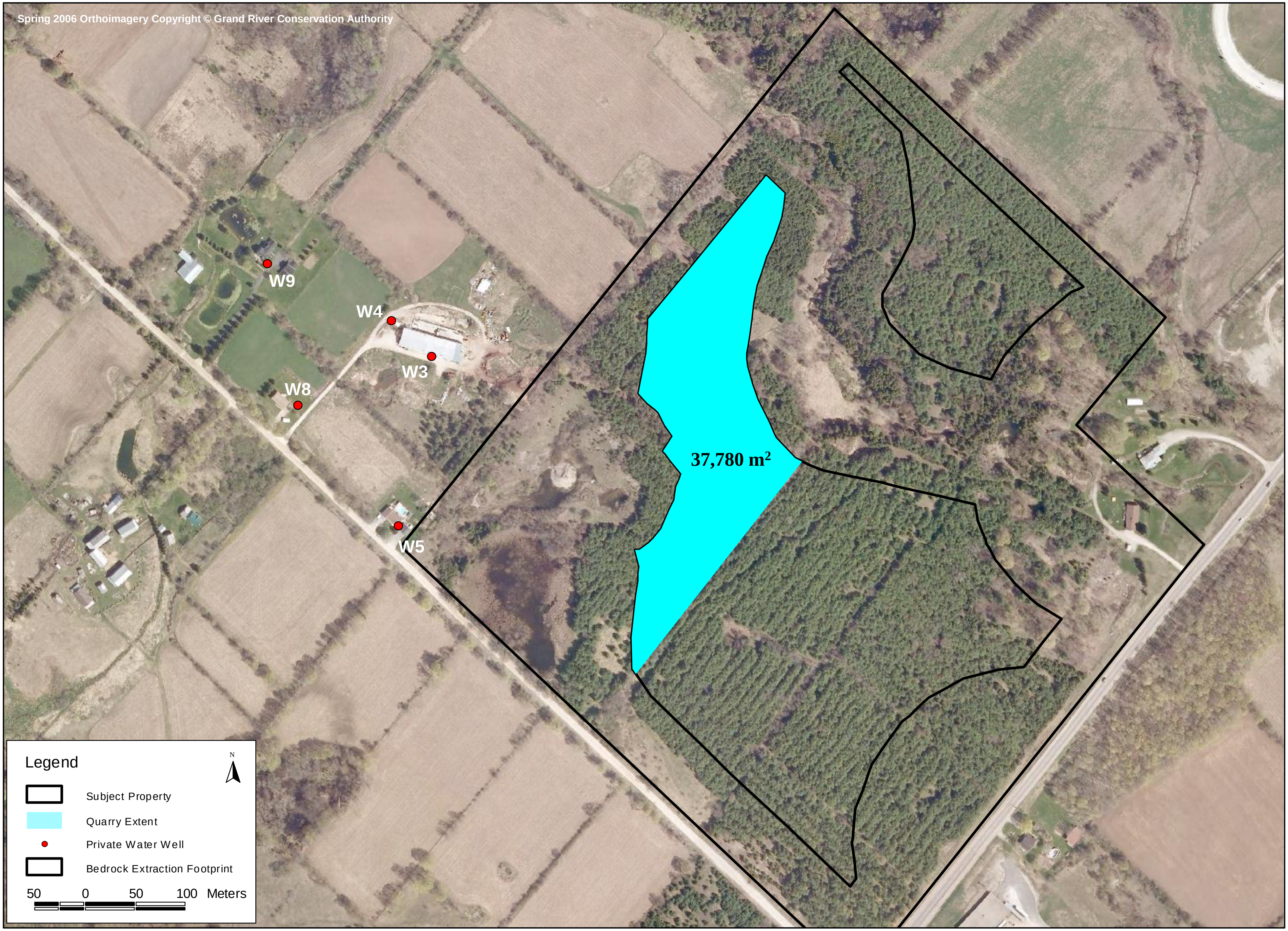


Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	
Date: Dec 2013		**Figure 7: Cumulative Drawdown from Dewatering Wells for W3**
Drawn By: AR	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 8: Cross Section A-A'**
	Date: Dec 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.

Project No: 9506

Date: Dec 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 9: Quarry Extent Daily Drawdown 8cm

Appendix A

Burnside & Associates Comments

November 12, 2013

R.J. Burnside & Associates Limited 292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4 Canada
telephone (519) 823-4995 **fax** (519) 836-5477 **web** www.rjburnside.com

BURNSIDE
[THE DIFFERENCE IS OUR PEOPLE]

November 12, 2013

Via: Email/Mail

Mr. Stan Denhoed, M.Sc., P.Eng.
Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
RR #1
Moffatt, ON L0P 1J0

Dear Mr. Denhoed:

Re: Hydrogeological Summary Report for Township of Guelph/Eramosa
File No.: 300032475.0000

Thank you for providing R.J. Burnside & Associates Limited (Burnside) with a copy of the Harden Environmental Services Ltd. (Harden) September 5, 2013 letter to review. The Burnside comments are provided below under the same headings used in the letter.

1.0 Karst

Harden indicates that a karst environment is not present in the area proposed to be mined by Hidden Quarry.

Burnside Comment

Burnside reviewed GIS mapping generated by the OGS as part of “Brunton, F.R. and Dodge, J.E.-P, 2008. Karst of Southern Ontario and Mantoulin Island, Ontario Geological Survey, Groundwater Resources, Study 5.”

The mapping indicates the presense of karst features along the Eramosa River in Rockwood and near Blue Springs Creek to the south of the proposed quarry. There is no evidence to suggest that the site is in an area of karst terrain. Some scientists now refer to the water producing fractures in the bedrock as micro-karst but this is much different that the large cavernous conditions typically associated with karst.

2.0 Water Quality

Harden indicates that the proposed Hidden Quarry will result in the mixing of groundwater from various discrete fracture sources with an overall decrease in nitrate concentrations already found in the shallow groundwater. The proposed subaqueous mining method will not result in the chemical degradation of groundwater quality.

Burnside Comment

Flow profiling indicated water in the upper 35 m of bedrock comes from three discrete zones with little flow between 19 and 36 mbgs. It appears that most of the nitrate is contributed from fractures in the upper 10 m of the bedrock. If the quarry does not encounter the deepest zone at 41 mbgs then about 30% of the water may not contribute to dilution. Although the depths and water production from fractures in the rock is heterogeneous, the water quality impacts should be calculated using the available information. Once M15 is equipped as a multi-level well, it should be purged and water quality samples collected to see if there are variations with depth. The nitrate contributed by the blasting materials should be quantified and included in the mass balance.

We concur with harden that water wells drilled in the bedrock access multiple fractures, however it is important to note that the Ontario Water Resources Act through the well Regulation 903 (Last amendment: O.Reg. 468/10) states in Section 14 that:

> "any annular space, other than annular space surrounding a well screen, is sealed to prevent any movement of water, natural gas, contaminants or other material between subsurface formations or between a subsurface formation and the ground surface"

The purpose of this section of the well regulation is to protect the good quality groundwater in the subsurface for use as potable sources. The fractures found at 36 and 41 m are currently secure sources of groundwater that are recharged over time by water moving into those formations. These deeper fractures are also the future water source for Rockwood Well 4 that will be constructed this year.

The excavation of the quarry into these fractures will cause the water in the deep fracture system to be under the influence of surface water and the associated bacteria and viruses such as Cryptospiridium and Giardia. Quarrying activities will result in constant mixing of the water in the quarry. The existing secure water quality in deep bedrock aquifer will therefore be changed to a surface water source for an unknown distance surrounding the quarry. This could result in the classification of Rockwood Well 4 as a GUDI water source.

Once the quarry is finished, there will be a large surface body directly in contact with the bedrock fracture system which may allow rapid movement of pathogens towards bedrock wells downgradient of the site.

As a result, there may be some benefit to restricting the extraction to the bedrock above 36 m in order to protect the lower fractures system.

3.0 Private Wells with Shallow Fracture Source of Water

Harden predicts a 1.6 m decline in the closest domestic well due to the quarry and indicates that testing of M15 suggests that the lack of water level response in M1, M3 and M13 is due to poor lateral shallow connectivity and poor connectivity to fractures at depth.

Burnside Comment

Analysis of the response observed at M2 indicates a total Transmissivity of 75 m^2/day. Further analysis of the data indicates a Storativity of only 0.00004. This relatively low Storativity results in the rapid (5 minutes) response at a relatively distant (125 m) location. Depressurization of the deep formation at M15 will result in rapid response over a large area. This Storativity is indicative of a confined aquifer system and is likely caused by response in the deeper fractures at 34 and 41 m.

Testing completed by Burnside on existing wells in Rockwood indicates that a well that penetrates the entire carbonate formation typically exhibits a Transmissivity in the range of 50 to 100 m^2/day. Wells that only access the fracture systems below 35 m exhibit Transmissivity of 25 to 50 m^2/day. M15 is consistent with these historical tests. It is important to note that the Transmissivity of an individual fracture or group of fractures cannot directly be converted into a hydraulic conductivity based on the entire bedrock thickness. The groundwater flow is much faster and can reach much further distances within an individual fracture than in a bulk porous media as predicted by a model. As a result, groundwater with elevated nitrate may move rapidly away from the quarry before dilution with deeper water can occur.

Currently, the total transmissivity of the fractures encountered by M15 has been estimated. Once individual monitors are installed opposite the fractures testing should be completed to assess the hydraulic properties of the individual fractures. Monitoring of water levels in this monitor well and the quarry itself can be used to predict off site impacts.

The pumping test did not continue for a period long enough for water levels to stabilize. Nearby wells (Rockwood Well 3) typically stabilize after approximately 12 hours of pumping in the deep bedrock fractures. Extrapolation of existing data to at least 12 hours allows an estimate of the actual response that will occur during quarrying activities. For example, extrapolation of the test of M15 to 12 hours would result in approximately 1.9 m of drawdown in M2. This data indicates that water levels in domestic well close to the site will be measurably impacted by onsite activities. As a result, wells with pumps set at shallow depths may experience water quantity issues. The six wells indicated on Figure 2 to be completed from 0 to 5 m below bedrock have the greatest potential to be impacted. The proposed domestic well survey plan should be combined with proactive well upgrades to ensure that no domestic water supplies are adversely impacted by the quarrying activities. Upgrades of nearby wells to include pitless adaptors and water level conduits should be included as part of the program to ease the monitoring process.

4.0 Groundwater Model Parameter – Hydraulic Conductivity

Harden indicates that the bulk hydraulic conductivity of the bedrock aquifer used by the groundwater model is 2.0 x 10^{-5} m/s.

Testing of M15 resulted in estimated hydraulic values ranging from 1.4 x 10^{-5} to 1.98 x 10^{-5} m/s.

Burnside Comment

Although a bulk value for hydraulic conductivity is useful in predicting the long term behaviour of water in the quarry, video flow profiling suggests that there are many metres of rock that are competent and contribute little in the way of groundwater flow. As a result, groundwater flow into the quarry may be highly variable with depth.

In-situ hydraulic conductivity of M15 when it is re-constructed as a multi-level well will help to refine the hydraulic conductivity estimates.

5.0 Brydson Spring and Blue Springs Creek

Harden indicates that there will be neither a significant quantity nor quality impact to waters discharging from the Brydson Spring and no change to groundwater quantity or groundwater quality discharging to Blue Springs Creek.

Burnside Comment

In the long term, there should be no impacts to Byrdson Spring. There may be some short term reductions in flow as the quarry fills with water following rock extraction.

6.0 Rock Extraction Water Level Change

Harden indicates that removal of rock from below the water table will simulate a pumping effect on the surrounding aquifer. Groundwater will flow into the quarry to fill the space previously occupied by rock.

The initial rock extraction will occur in a sinking cut with the dimensions of 25 x 50 m (1,250 m^2). Harden indicates the removal of this material from below the water table will cause the water levels in the quarry to decrease by 0.91 m/day. James Dick has committed to a maximum drawdown of 2.54 m in the sinking cut to be monitored daily with the rate of rock extraction moderated in the event that drawdown approaches 2.54 m.

Burnside Comment

There is significant potential for impacts from the proposed quarry activities on the groundwater resources in the surrounding area. There are several existing domestic water wells with unconfirmed pump installation depths and a municipal well that will be pumping 10 to 16 L/s when it is constructed. The combined impact of the quarry and the municipal well on the existing wells between the sites is difficult to assess in a heterogeneous carbonate aquifer.

Testing completed on M15 in 2013 showed that a pumping rate of 4.2 L/s resulted in drawdown of just under 1 m at a distance of 125 m in less than 100 minutes. This water level response was used to calculate a Transmissivity of 75 m^2/day. It was also determined that only 30% or only 1.3 L/s was derived from the bedrock above 35 m.

The description of how rock will be quarried indicates that a 25 m by 50 m strip will be mined vertically at a rate of 0.9 m/day. The daily volume of rock removed will be 1,145 m^3. If the area mined is below the water table, then removal of 1.145 m^3 of rock will require 1,145 m^3 of water to flow into the strip on a daily basis. This will necessitate a continuous flow of 13.3 L/s from the shallow bedrock fracture system 24 hours/day in order to maintain the pre-extraction water level. This will cause a measureable impact to existing domestic wells in the surrounding area during the initial days of the quarrying activities when all of the "make up" water is derived from the shallow fractures which may not be able to sustain the rate of flow into the excavation to keep if full of water. Once the first strip is quarried to the maximum depth and all of the water producing intervals are encountered, then the flow of 13.3 L/s may be sustainable. This will depend on the size and extent of the fracture system encountered.

Burnside recommends that in order to ensure that offsite impacts are minimized that:

1. The initial stages of excavation are completed at a rate that allows the water level to be maintained within 0.9 m of static conditions as predicted in the report. This would mean that at the beginning of the day removal of rock could only occur if water levels had returned to static levels. This would prevent a cumulative dewatering of the bedrock adjacent to the site.
2. All domestic wells within 500 m of the quarry site be inspected and tested to evaluate how susceptible they are to water level variations. Submersible pumps should then be set as deep as possible in the wells to ensure that they are not impacted by the quarry activities. The proposed monitoring program (Appendix A of your letter) for onsite wells and surface water stations is comprehensive, but should be expanded to include representative domestic wells.
3. Flow profiling at M15 indicated that a deeper fracture system provided about 66% of the flow. These fractures are separated from a shallow fracture system by several metres of rock which produces minimal water. If the deeper fracture set is providing water to a number of nearby domestic wells, James Dick may wish to maintain the base of the quarry above this level to ensure that an alternate water supply is available in the event that the shallow zone has water quality/quantity impacts due to quarry activities.

7.0 Aquitard

Harden indicates that the Eramosa Formation (a natural aquitard protecting the Goat Island and Gasport formation) is not present at the Hidden Quarry site.

Burnside Comment

Burnside concurs with Harden that the Eramosa Formation is not present at the Hidden Quarry site.

9.0 Monitoring Plans, Trigger Levels and Contingency Plan

Appendix A contains a revised monitoring program that was submitted to the MOE by Harden. The Burnside comments will follow the same headings as contained in the monitoring plan.

Burnside Comment

1.0 Onsite Monitoring Program

Groundwater Levels – These should be measured monthly year round (with exception of well listed below) in wells with manual levels and daily year round in wells with dataloggers.

Groundwater Levels – M2, M3, TP1, M13S10, M14SID, M15, M16. As a minimum, these should be measured hourly with the data logger during the first three months of extraction in order to ensure the maximum daily drawdown of 0.91 m is not exceeded and that any exceedance of the trigger levels can be quickly mitigated.

Surface Water Levels – SW5 and SW7 should be added to the list.

Surface Water Flow – SW5 and SW7 should be added to see if the extraction has any effect on when flow ceases in Tributary B.

Groundwater Quality – W1 should be added along with the most vulnerable wells identified in the pre-bedrock extraction water well survey (Section 4.0).

Surface Water Quality – Increase to semi-annual (spring and fall) at some time as groundwater sampling. Add northwest wetland and Tributary B (at SW4 and SW3) to confirm east and west ponds are not impacting surface water/groundwater. Add cryptosporidium and giardia to the list of parameters

2.0 Trigger Levels

The trigger levels proposed by Harden are designed to verify that water levels in the bedrock aquifer do not exceed predicted values and that the hydro-period of the northwest wetland does not change.

2.1 Trigger Levels for the Bedrock Aquifer

Harden uses the historical low levels in M1D, M2, M13D and M14D and the predicted water level change to establish conservative trigger levels.

Burnside Comment

Trigger levels should be established for M15 and M16 after monitoring begins. It is not clear how the trigger levels relate to the drawdown trigger of 2.54 m in the sinking cut. It is also not clear if the predicted change is following completion of extraction or is the maximum expected change.

2.2 Trigger Level for Northwest Wetland

The historical low value of 344.20 m AMSL at SW6 is the recommended trigger value with a warning level of 354.35 m AMSL. Harden recommends an increase in manual water level measurements to bi-weekly if the warning level is exceeded.

Burnside Comment

Burnside recommends daily water level monitoring begin 3 weeks prior to the initial overburden/bedrock extraction so pre-extraction trends can be established. Daily water level measurements should continue as long as weather conditions permit.

3.0 Contingency Measures

3.1 Groundwater Levels and Northwest Wetland

If a trigger level is breached Harden recommends the following measures be undertaken:

1. Confirmation of water levels with 24 hours.
2. Evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed.
3. If quarry activities are found to be responsible, the following actions will be considered and a response presented to the GRCA and the Township of Guelph/Eramosa:

- increase the length and/or width of barrier;
- decreased rate (or stopping) subaqueous extraction;
- change in configuration of mining or decrease in mining extent; and
- after timing of extraction to coincide with high seasonal groundwater levels.

Burnside Comment

Burnside recommends the following:

1. An onsite weather station be established as it can take significant time to obtain data from GRCA/Environment Canada.
2. A timeline be provided for the evaluation of data.
3. A decreased rate (or stopping) of subaqueous extraction be the initial response.
4. Increased monitoring be undertaken at other locations until the source of the trigger level exceedance is identified.

3.2 Groundwater Quality

Harden recommends semi-annual (summer) sampling for a variety of parameters. An increasing trend in the concentration of one or more elements will result in a study to determine the source of the water quality change. If the quarry is found to be responsible or there is a potential for impact to downgradient wells, James Dick Construction Ltd. will commence with the following actions:

1. Semi-annual testing of the water quality of private wells that could potentially be impacted by the quarry.
2. In the event that a water quality issue related to the quarry occurs, James Dick Construction Ltd. will remedy the issue by either providing the appropriate treatment in the home or drilling a new well and isolating the water supply to the deeper aquifer.

Burnside Comment

Burnside concurs with the proposed water quality monitoring program. It is recommended that the program begin at least a year prior to extraction so that existing conditions can be established. When a sufficient data set is available, Burnside recommends that any result above the ODWQS or above the 95th percentile result in actions 1 and 2 above. Surface water pathogens should be included in the list of quality parameters.

4.0 Pre-Bedrock Extraction Water Well Survey

Harden recommends that a detailed water well survey be completed prior to the extraction of bedrock resources.

Burnside Comment

The Harden plan is comprehensive and will provide valuable baseline information. Burnside recommends the results of the survey be used to select a number of domestic wells for inclusion in the water level monitoring program.

10.0 Well Complaint

Harden provided a proposed protocol for dealing with complaints about water well issues.

Burnside Comment

Burnside concurs with the proposed protocol. The Township of Guelph/Eramosa and the Ministry of the Environment should be advised when a complaint has been received and should be provided with the results of the independent investigation.

11.0 Next Steps (Next included in the Harden Report)

The following are the outstanding issues that need to be addressed:

- M15 should be constructed as a multilevel monitor with appropriate hydraulic conductivity and water quality testing completed. The groundwater model should be modified as necessary to incorporate the test results.
- Burnside will provide information on the construction and testing of Rockwood Well 4 to James Dick once it is available.
- The detailed domestic well survey should be completed so that pre quarrying improvements can be established.
- The potential for impacts from surface water pathogens should be quantified along with mitigation methods.
- The final depth of the quarry should be confirmed.
- Burnside comments should be addressed.

Should you have any question regarding the above, please contact the undersigned.

Yours truly,

R.J. Burnside & Associates Limited

Dave Hopkins, P.Geo.
Hydrogeologist
DH:sd

cc: Ms. J. Sheppard, Township of Guleph/Eramosa (Hand Delivery)
Mr. D. McNalty, R.J. Burnside & Associates Limited (Email)
Cuesta Planning Consultants Inc. (Mail)
Mr. Greg Sweetnam, James Dick Construction Ltd. (Mail)

Appendix B

Revised Monitoring Program and Contingency Measures

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
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Groundwater Studies
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Groundwater Mapping

HIDDEN QUARRY

REVISED MONITORING PROGRAM AND CONTINGENCY MEASURES (JANUARY 2014)

1.0 ON-SITE MONITORING PROGRAM

Monitoring has been taking place at this site since 1995. An extensive database of background groundwater and surface water elevations and flow measurements has been developed. A detailed monitoring program will continue to ensure that sensitive features and surface water flows are maintained. The monitoring program is designed to identify trends towards unacceptable impacts early on to allow for time to implement contingence measures.

The monitoring program for this proposed pit/quarry involves the following activities:

- measuring groundwater levels,
- obtaining water quality samples,
- monitoring water levels in the on-site wetland and stream, and
- stream flow measurements.

We recommend the following monitoring program.

Parameter	**Monitoring Locations**	**Frequency**
Groundwater Levels	M1S/D, M2, M3, M4, M6, M13S/D, M14S/D, MPN1, MPN2, MPS1, MPS2, MPE1, MPE2, MPW1, MPW2, TP1, TP8, TP9 MP1, MP2, MP3, MP4, M15, M16	Manually Monthly Automatic Daily Measurement in M1D, M2, M3, M4, M15, M16 for year prior to and year following bedrock extraction with re-evaluation of monitoring frequency after 1st year of

Parameter	Monitoring Locations	Frequency
		bedrock extraction.
Groundwater Levels	M2, M3, TP1, M13S/D, M14S/D, M15, M16	Hourly during first 3 months of extraction
Surface Water Level	Sinking Cut	Daily
Surface Water Level	SW14, SW5, SW7	Manually Monthly Coincident with groundwater monitoring
Surface Water Levels	SW6, SW4, SW8	Automated Water Level Readings (4 hour interval)
Surface Water Flow	SW4, SW8, SW3	Semi-Monthly April to November *coincident with groundwater monitoring
Groundwater Quality	W1,M2, M4, M15, M16	Semi-Annually
Surface Water Quality	West Pond, East Pond, Northwest Wetland, Tributary B (SW4, SW3)	Semi –Annually (Spring and Fall)
Climate	On-Site Weather Station at Scale House to include precipitation and temperature	Daily

Monitoring locations are shown on Figure C1.

2.0 TRIGGER LEVELS

Groundwater and surface water monitoring will be used at this site to a) verify that predictions of water level change in the bedrock aquifer do not exceed those predicted and b) verify that the hydro-period of the northwest wetland does not change. The water level measurements obtained as part of the monitoring program will be used to trigger contingency measures that may be necessary for the mitigation of a low water level in the northwest wetland, a lower than expected water level in the bedrock aquifer or an anomalous low flow level in Tributary B.

2.1 Trigger Levels for the Bedrock Aquifer

The greatest water level change in the bedrock aquifer is expected to occur to the north and northwest of the site. Water levels obtained from bedrock monitors M1D, M13D, M14D and M2 will be used to verify that actual water level changes do not exceed the predicted water level change. A warning level of 75% of the predicted change will be used to initiate bi-weekly manual measurements from the groundwater monitors.

Table 1: Trigger Levels for the Bedrock Aquifer

Monitor	Historical Low	Predicted Change	Warning Level	Trigger Level
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	348.08
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98
M15	TBD			
M16	TBD			

TBD – to be determined

The historical water levels, warning level and trigger level are presented in Figures C2, C3, C4 and C5.

2.2 Trigger Level for Northwest Wetland and Allen Wetland

Water levels from Station SW6 will be used to trigger contingency measures for the northwest wetland. Historical monitoring has shown that the water level in the wetland is somewhat independent from adjacent groundwater levels and therefore any potential change in the hydro-period is best determined by the surface water level in the wetland.

Trigger levels and warning levels have been determined for three periods as follows:

Winter Trigger Level - lowest water level observed between December 1 and March 1

Spring Trigger Level - lowest water level observed between March 2 and June 15

Summer/Fall Trigger Level - lowest water level observed between June 16 and November 30.

A warning level is established 0.15 metres higher than the trigger level. The warning and trigger levels relative to historical water levels are shown on Figure C6.

Table 2: Trigger Levels for the Surface Water Features

Station	Winter		Spring		Fall	
	Warning	Trigger	Warning	Trigger	Warning	Trigger
Northwest Wetland (SW6)	354.35	354.20	354.48	354.33	354.38	354.23
Allen Wetland (SW4)	The warning level will be a flow rate of less than 25 L/s occurring in May and the trigger level will be cessation of flow prior to June 22.					

Manual water level measurements will increase to bi-weekly if the warning level is exceeded.

3.0 CONTINGENCY MEASURES

3.1 Groundwater Levels and Northwest Wetland

If any trigger level is breached, the following measures will be taken;

1) Confirmation of water level within 24 hours. Increase monitoring to weekly until source of the trigger level exceedence is identified.

2) Within seven days conduct an evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed.

3) If quarry activities are found to be responsible, the following actions will be considered and a response presented to the GRCA and the Township of Guelph-Eramosa.

- decreased rate (or stopping) subaqueous extraction
- increase the length and/or width of barrier
- change in configuration of mining or decrease in mining extent
- alter timing of extraction to coincide with high seasonal groundwater levels.

3.2 Water Quality

The water quality program will commence at least one year prior to bedrock extraction.

Groundwater Monitors and the East and West Pond

The parameters that will be included in the semi-annual monitoring (summer) will be general chemistry, cryptosporidium, giardia, e-coli, TKN, ammonia, DOC, pH, temperature, anions and metals.

In the event that there is an increasing trend in the concentration of one or more elements or compound or if any quarry related contaminant is found above the Ontario Drinking Water Quality Standard or above the 95% percentile of results obtained, a study will be conducted to determine the source of the water quality change. If the quarry is found to be responsible and if there is a potential for impact to downgradient wells, James Dick Construction Ltd. will commence with the following actions;

1) Semi-annual testing of the water quality of private wells that could potentially be impacted by the quarry.

2) In the event that a water quality issue related to the quarry occurs, James Dick Construction Ltd. will remedy the issue by either providing the appropriate treatment in the home or drilling a new well and isolating the water supply to the deeper aquifer.

Northwest Wetland

The northwest wetland water will be analyzed for nitrate, dissolved oxygen, temperature, conductivity and pH for a period of three years or upon completion of construction activities in the surface water catchment area of the northwest wetland whichever is longer.

4.0 PRE-BEDROCK EXTRACTION WATER WELL SURVEY

We recommend that a detailed water well survey be completed prior to the commencement of the extraction of bedrock resources. This survey will as a minimum include all wells in the shaded area shown on Figure C7. The well survey will include the following;

- construction details of the well (drilled, bored, sand point etc..)
- depth of well and depth of pump
- location of well relative to septic system
- static water level

- history of water quantity or quality issues
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals
- one hour flow test

The purpose of the survey is to have a baseline evaluation of both water quality and water quantity in nearby water wells. Should an issue arise with a local water well, the baseline data can be used as a reference against future measurements.

If there are domestic wells suitable for water level monitoring identified in the survey, they will be included in the water level monitoring program and monitored on a semi-annual basis.

If the survey indicates that modification(s) to the well are necessary either for continued monitoring or to minimize the potential for impact, the modifications will be made to the well at the expense of James Dick Construction Ltd.

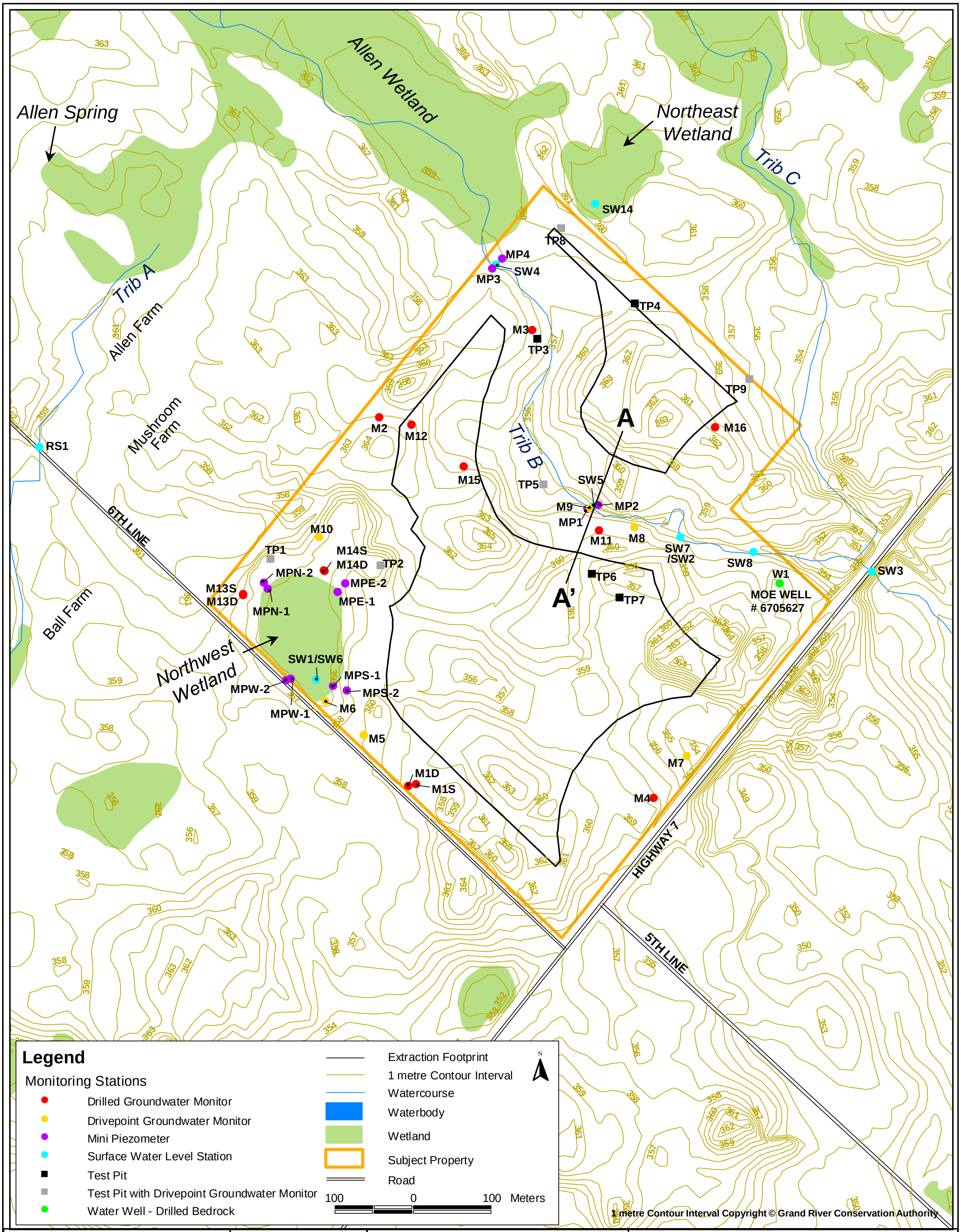
5.0 ANNUAL MONITORING REPORT AND INTERPRETATION

An annual report will be prepared and submitted to the Ministry of the Environment and the Ministry of Natural Resources on or before March 31st of the following calendar year. The report will be prepared by a qualified professional, either a professional engineer or a professional geoscientist.

The monitoring report will include all historical monitoring data and an interpretation of the results with respect to potential impact to the quality and quantity of bedrock groundwater, hydro-period of the northwest wetland and streamflow loss from Tributary B.

6.0 Water Well Complaints

James Dick Construction Ltd. agrees to inform the Township of Guelph Eramosa and the Ministry of the Environment upon the receipt of a water well complaint and the results of any related investigation.



Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2013

Drawn By: AR

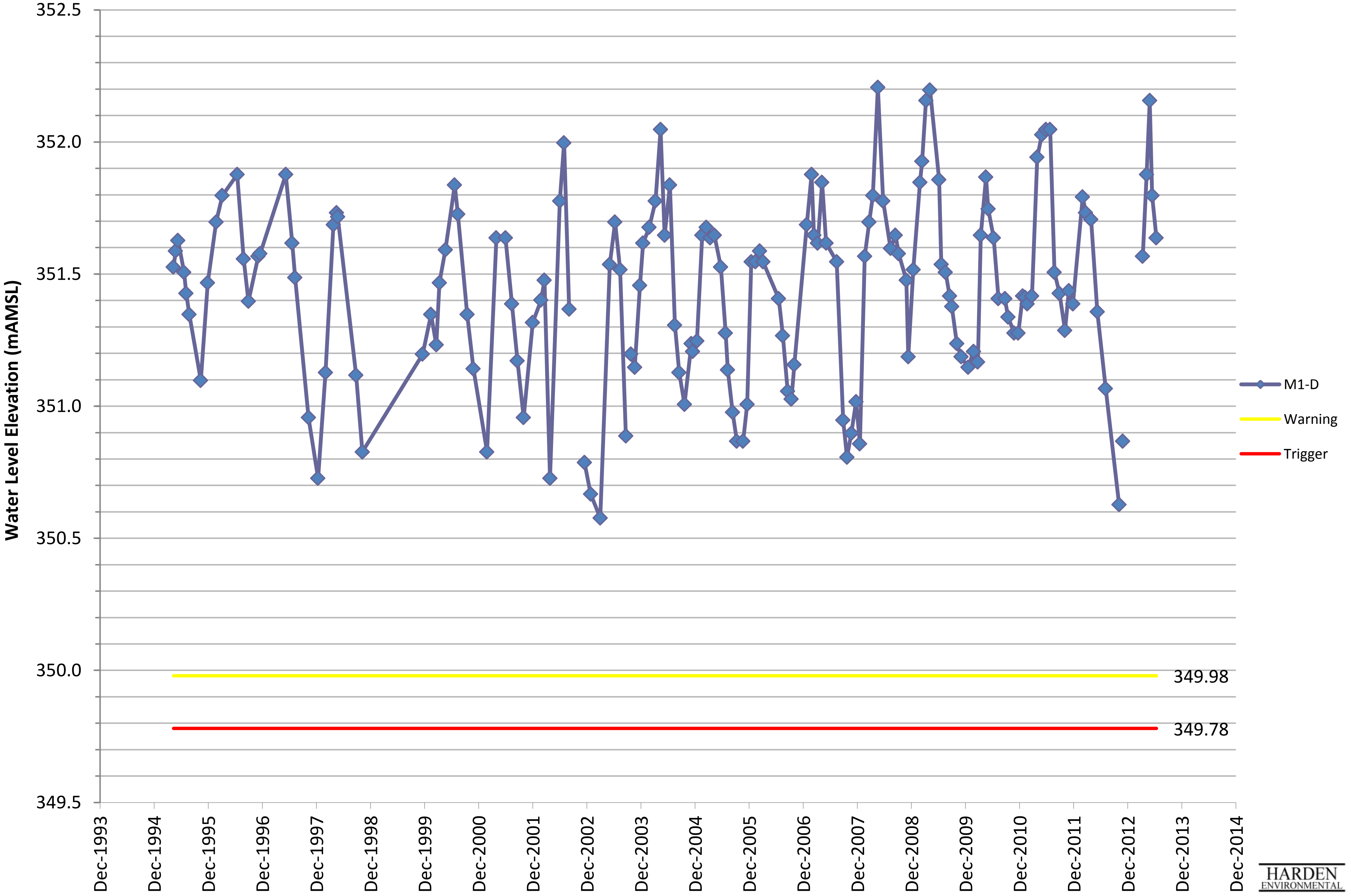
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C1:

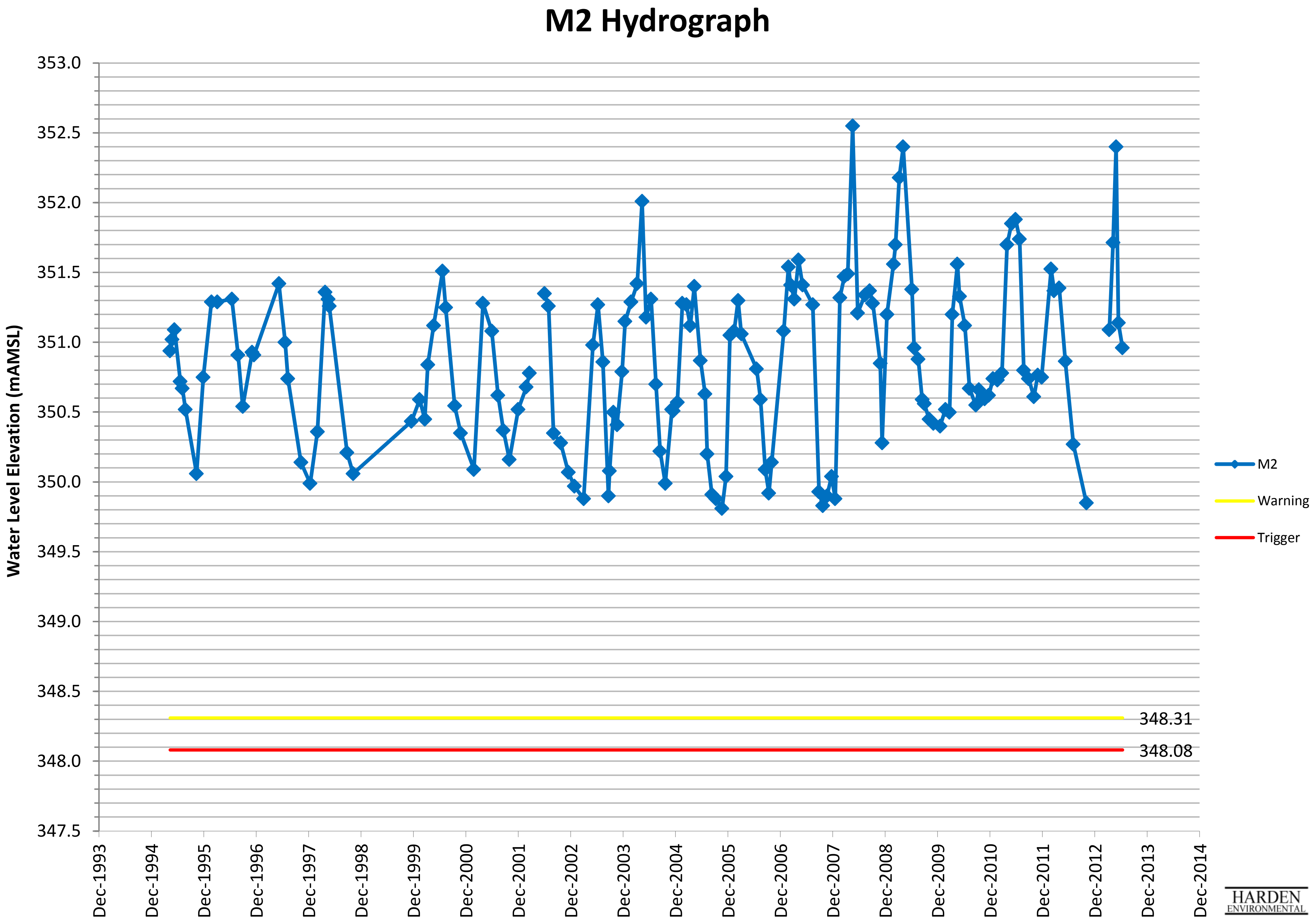
Monitoring Locations

M1D Hydrograph



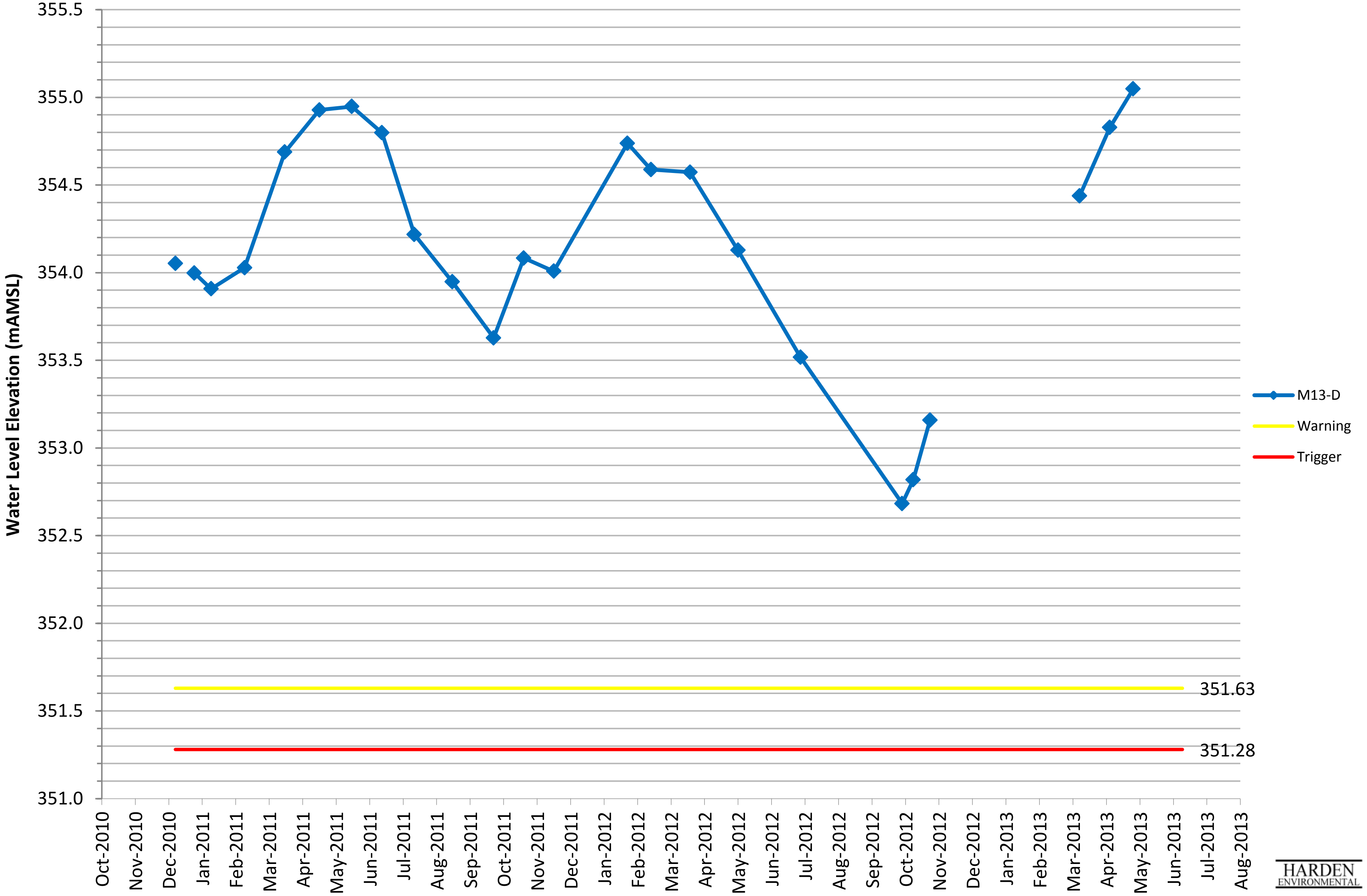
HARDEN ENVIRONMENTAL

Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Jul 2013 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure C2: M1D Trigger Level**



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C3: M2 Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

M13D Hydrograph



Harden Environmental Services Ltd.

Project No: 9506

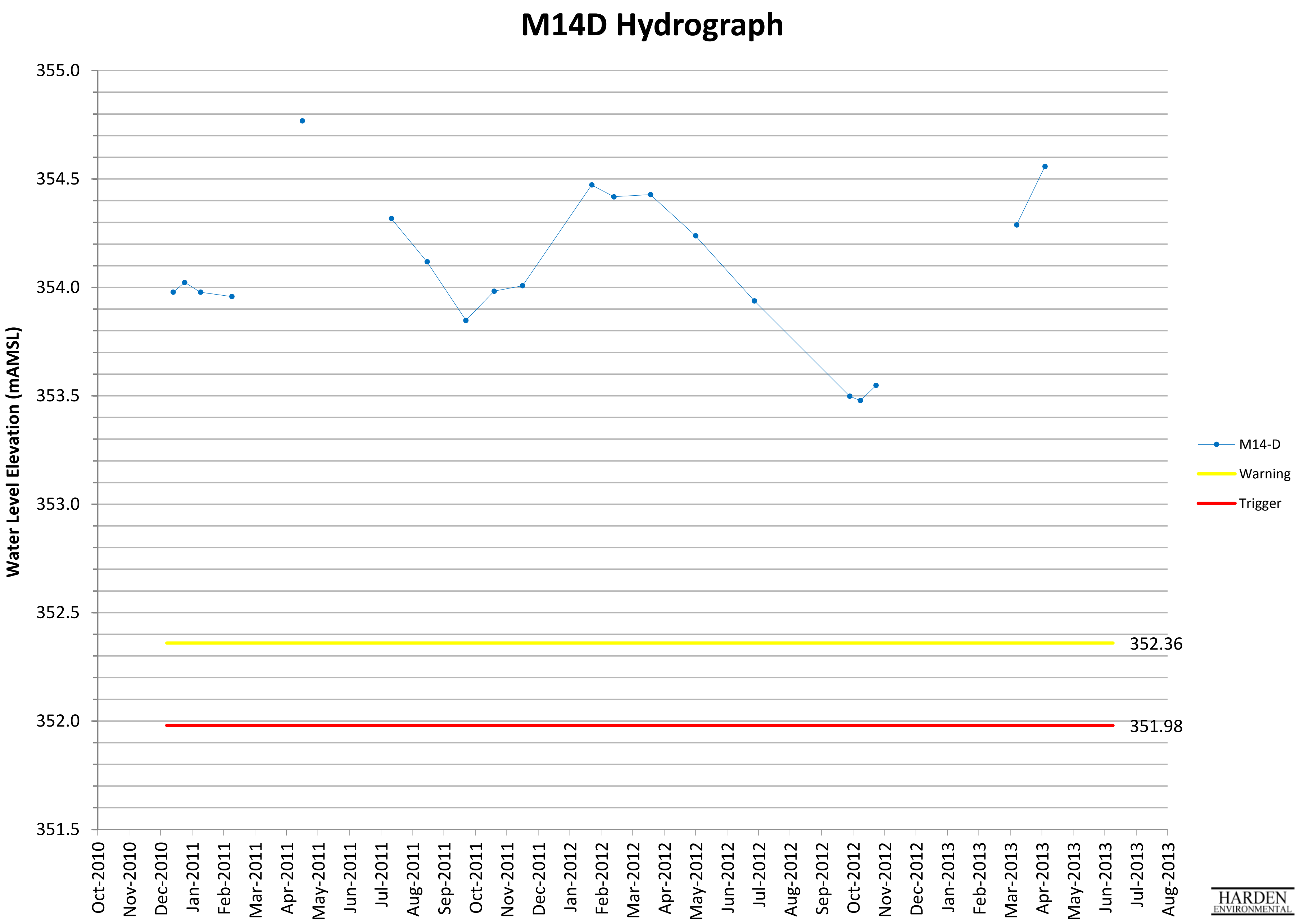
Date: Jul 2013

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C4: M13D Trigger Level



Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2013

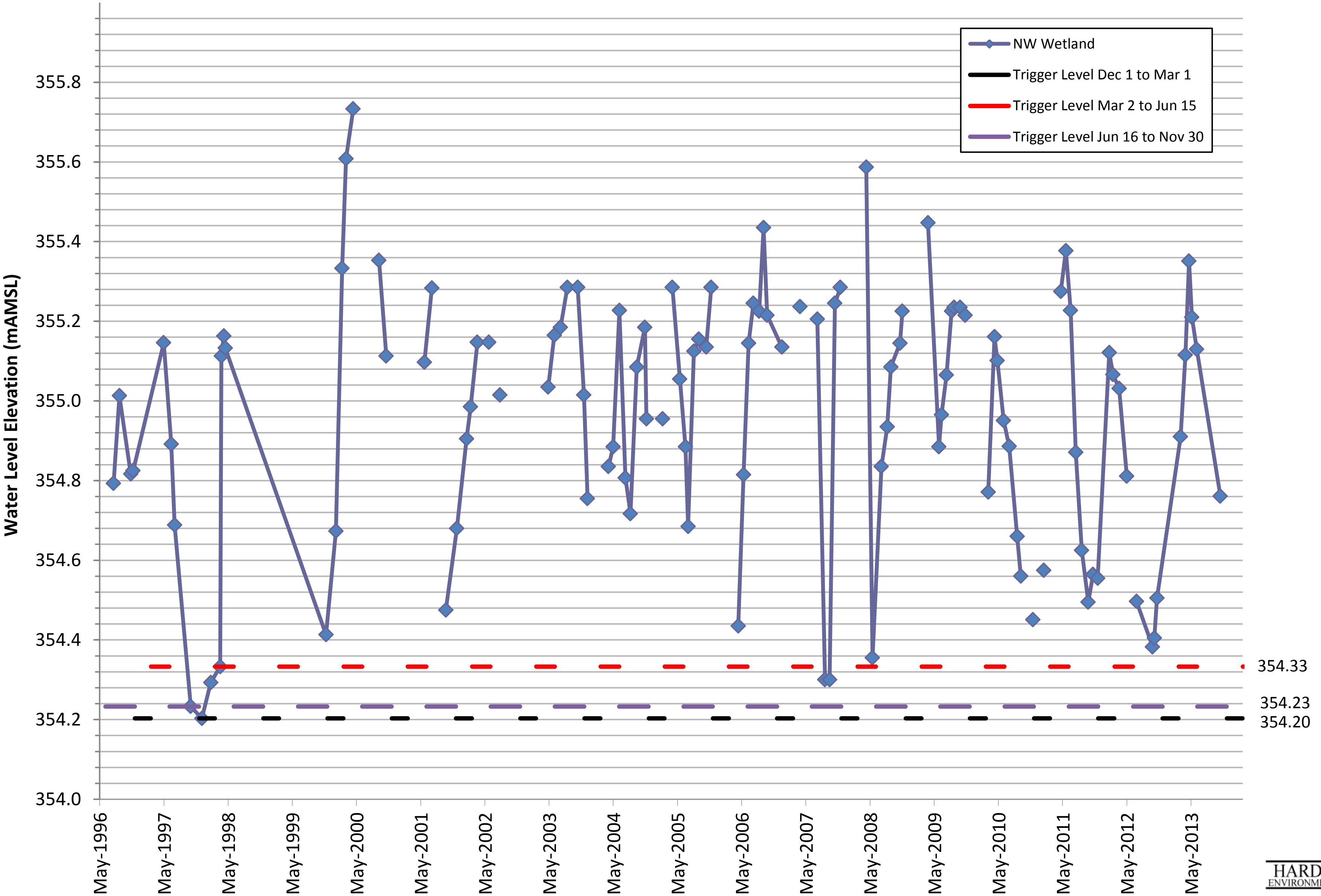
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

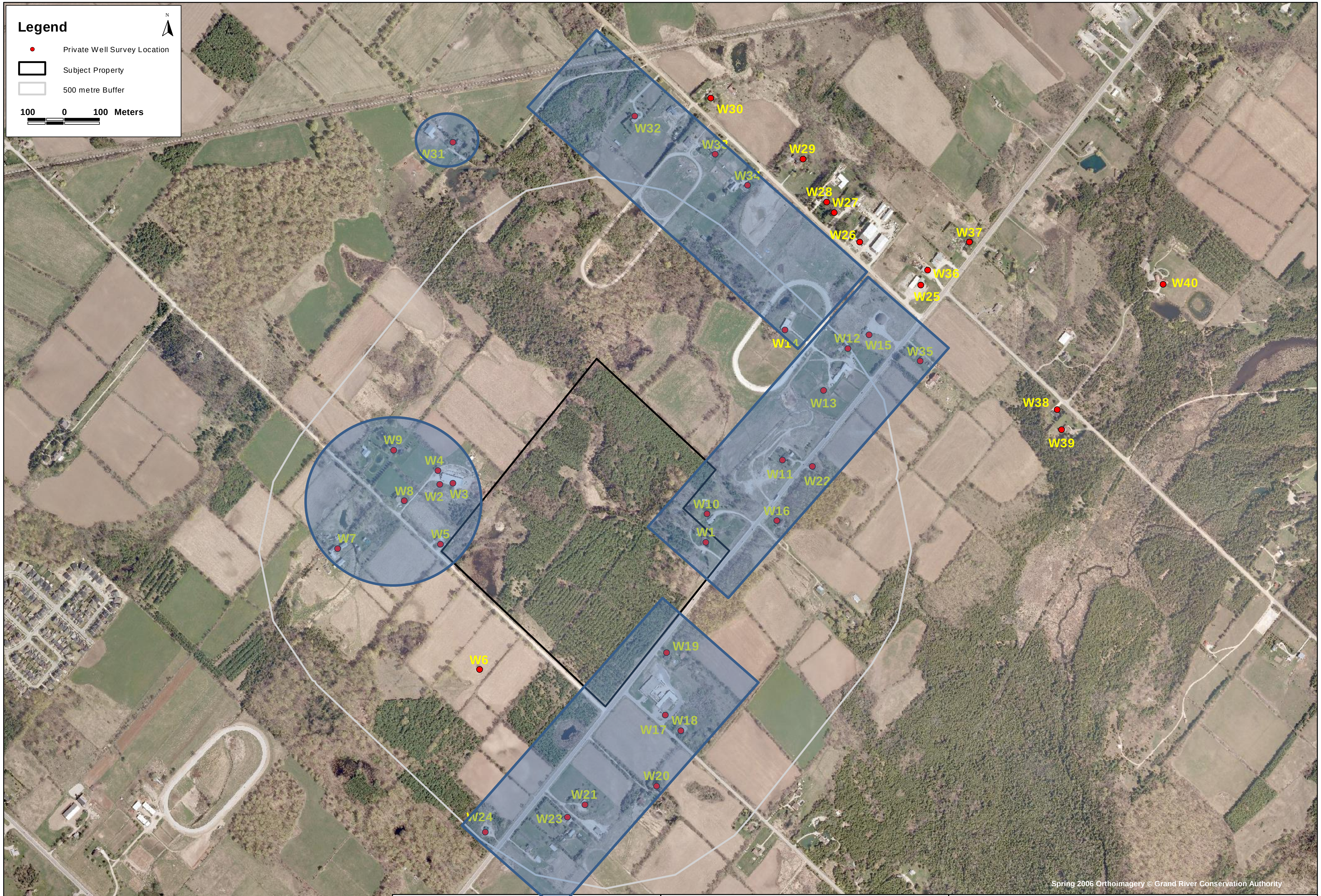
Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C5: M14D Trigger Level

Figure C6: Northwest Wetland Hydrograph



HARDEN ENVIRONMENTAL



Spring 2006 Orthoimagery © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2012

Drawn By: SD

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C7:

Proposed Pre Quarry Well Survey Locations

HARDEN

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Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

January 14, 2014

R.J. Burnside and Associates Limited
292 Speedvale Avenue West, Unit 20
Guelph, Ontario, N1H 1C4

Attention: Mr. David Hopkins, P.Geo
Hydrogeologist

Dear Mr. Hopkins:

Re: Response to Burnside Review of Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site
Burnside File No.: 300032475.0000

We are pleased to respond to the November 12, 2013 comments provided by R.J. Burnside and Associates Limited (attached Appendix A). It appears that we are able to find agreement on many issues. Burnside has requested additional information or clarification on other issues as reported herein. It is our intention to provide sufficient technical analysis in this letter to satisfy the outstanding concerns raised by Burnside and Associates.

2.2 Bedrock

We are in agreement that the Eramosa confining layer is not present at the site.

We are in agreement that the extraction will occur in the Niagara Falls Member and the Gasport Formation.

2.3 Description of Core Breaks

We are in agreement that bedrock extraction will occur from 10 to 40 metres below ground surface and the portions of the upper 10 m of rock that has fewer fractures, will respond slower to both dewatering and filling conditions of the quarry.

3.0 Pumping Tests

We are in agreement that the bulk hydraulic conductivity is approximately 2 x 10^{-5} m/s.

We agree that there is a system of interconnected fractures at depth as indicated by the response observed in M2 from the pumping in M15.

We agree, based on the observations, that it is possible that there is an anisotropic response with preferential flow from the northwest direction. Additional deep monitoring locations may prove otherwise. The rapid response observed suggests that the fracture(s) is/are under confined conditions. The persistence of this fracture network is unknown, however, the conventional wisdom by local practitioners (AquaResources, Golder Associates and Gartner Lee) suggests that the use of an equivalent porous media (EPM) model is a reasonable approach to evaluating groundwater flow and response to withdrawals from the aquifer. Recent discussions with Dr. Beth Parker at the University of Guelph suggest that the EPM method is reasonable over a macro scale.

We agree that the lack of response on shallow bedrock wells can be attributed to limited pumping duration and/or poor local fracture network connecting deep and shallow fractures.

We have added notation to Figure 5 (attached) indicating which portions of the drawdown correlate to pumping, flow profiling and video logging.

3.1 Flow Test

We agree that between the depths of 19 and 26 metres below ground surface there is a zone of lower permeability as indicated by a relatively stable flow velocity in that zone.

We agree that there will be dewatering of fractures in the upper portion of the bedrock aquifer along the northern boundary of the quarry; however, the maximum allowable "dewatering" of the bedrock is 2.54 metres. It has been agreed by James Dick Construction Ltd. that this will be visually monitored daily in the extraction area and recorded automatically every hour in nearby monitoring wells.

6.0 Water Quality Results

Nitrate

We agree that the presence of nitrate in the Dolime Quarry sample indicates that nitrate will be present in the quarry water and may result in an increase in nitrate levels in groundwater passing through the quarry. The recent water sample from monitoring well M15 and the Rental House well (W1) at the Hidden Quarry site found that nitrate concentrations in the bedrock aquifer were 2.0 and 0.13 mg/L respectively. The Ontario Drinking Water Quality Standard for nitrate is 10 mg/L. The Dolime example suggests that nitrate could increase by 1.2 mg/L. This would still result in a nitrate concentration well below the ODWQS.

Existing examples within the Township of Guelph Eramosa, Milton, Ontario and Florida, U.S.A., suggest that nitrogen concentrations in the quarry water will be lower than that predicted.

Township of Guelph Eramosa

The Guelph Limestone Quarry (formerly Dolime Quarry) is being mined with both subaqueous and dry-bench methods. The discharge water from the quarry was measured in October 2013 and November 2013 with total nitrogen concentrations of 0.24 mg/L and 0.65 mg/L respectively. This data confirms that nitrogen concentrations are not a concern in the quarry. The highest total nitrogen concentration obtained at the Guelph Limestone Quarry was 1.9 mg/L from a sample obtained within four hours of explosives detonation.

Holcim Quarries – Milton Ontario

The total nitrogen concentration in discharge water from the Milton Quarry (Conestoga Rovers and Associates, 2012) ranged from 0.67 mg/L to 0.99 mg/L depending on which discharge location was sampled. This is an active quarry with a 2012 tonnage of 3.9 million tonnes which equates to approximately 760,000 kg of explosives being used.

Florida, United States of America

Subaqueous mining is used extensively in southwest Florida. There are several limestone quarries that are extracting limestone from below the water table in Lee County Florida.

We were able to find two sites where there was nitrogen data available, the Cemex Alico Road site and the Verandah site.

The Alico Road site has ammonia levels less than 0.63 mg/L in groundwater and 0.35 mg/L measured in the surface water at the site. TKN values at this site do not exceed 1.2 mg/L in groundwater and 1.1 mg/L in surface water. We contacted Devan Coppock at Cemex who said that they blast a couple of times a month at this site, they have been blasting since 1972. Devan confirmed that they only use emulsion explosives.

At the Verandah site the maximum ammonia level is 0.55 mg/L in surface water. This is based on two sampling events, one in October where the high levels were measured and one in June of the same year (2007). The TKN values were measured up to 1.3 mg/L in the surface water.

We also contacted Lee Werst, the State Hydrogeologist for Lee County. He indicated that they do not commonly sample for nitrogen species because with the amount of dilution that is available, nitrogen is generally not a contaminant of concern.

A fact sheet (Appendix B) prepared by the Florida Department of Environmental Protection shows that there are no sources of groundwater contamination around the Cemex Brooksville Quarry well. This is a drinking water well drawing water from the same aquifer being mined and is within 152 m of the quarry pond. Similar results were found for the Florida Crushed Stone Camp Mine Quarry (2008) and the Rinker Fec Quarry Employees (2004).

Our conclusion is that nitrogen will not occur in significant concentrations at the Hidden Quarry site. A detailed nitrate balance for the Hidden Quarry site is discussed elsewhere in this letter.

Iron

Samples confirm that local groundwater contains reduced iron. The presence of a quarry pond with elevated concentrations of dissolved oxygen relative to the groundwater, will result in a reduction of iron concentrations in the surface water and groundwater downgradient of the quarry. Dissolved iron was not detected in monitoring well M15 and in the Rental House well (W1) a concentration of 0.13 mg/L was found. It is our opinion that dissolved iron will not increase downgradient of the quarry as a result of quarry activities.

Reduced iron will also assist in the denitrification of the surface water. Reduced iron is an efficient electron donor and facilitates conversion of nitrate to nitrogen gas and water in the following way;

$2\ NO_3^- + 10\ e^- + 12\ H^+ \rightarrow N_2 + 6\ H_2O$

This further limits the likelihood that iron will remain in the groundwater downgradient of the pond and helps reduce nitrogen compounds in the water system.

Nitrogen Mass Balance

There are two sources of nitrogen at the proposed quarry. The first source is nitrogen imported to the site within the explosives used to liberate the rock. The second is nitrogen flowing onto the site in groundwater. The origin of this nitrogen is upgradient farms which apply fertilizers (both commercial and natural) or generate manure. This balance has not included dry deposition of nitrogen as a source as this will be very small in comparison to the other sources.

Nitrogen will leave the site via the atmosphere following detonation of the explosives and also through the groundwater flow system. Neither denitrification processes in the groundwater regime nor nitrogen sequestering in organic sediments has been considered in this nitrogen balance.

1) Nitrogen From Explosives

The proposed explosive emulsion is known by its commercial name Hydromite 4400. This product contains between 70 and 82% ammonium nitrate. At the Guelph Limestone Quarry (formerly Dolime Quarry) 5.122 tonnes of rock is liberated per kilogram of explosives. Assuming that the maximum annual tonnage of rock of 700,000 tonnes is extracted at the Hidden Quarry, there will be a total mass of 136,665 kg of explosives required.

The basic chemical equation for explosions involving ammonium nitrate is as follows;

$3NH_4NO_3 + CH_2 \rightarrow CO_2 + 7\ H_2O + 3N_2$

The end products of the explosion are two gases and water. Explosions are not 100% efficient and some residue may remain to dissolve in the water in the quarry. In order to estimate the efficiency of the blasting process we have used detailed data available from the James Dick Construction quarry in Gamebridge Ontario (Table 1 following figures). The quarry is a dry quarry and all dissolved residue leaves the quarry via the dewatering system. The mass of explosives used annually from 2009 to 2013 ranged from 60,875 to 103,480 kg. A total of eighty five water samples were obtained in that period and the total concentration of nitrogen in the water is determined by summing the concentrations of nitrate, nitrite and total kjeldahl nitrogen. Multiplying the volume of water by the concentration of total nitrogen in the water provides an estimate of total nitrogen discharged from the quarry. The mass of nitrogen in the discharge water between 2009 and 2013 is summarized in Table 1. The loss of nitrogen to the water at the quarry is 2.28% on average between 2009 and 2013. Therefore, the efficiency of the blasting process is shown to average 97.72% over the past five years.

Assuming that the Hydromite 4400 contains 82% ammonium nitrate, the maximum mass of ammonium nitrate required at Hidden Quarry will be 112,066 kg. Based on atomic weights, ammonium nitrate is 35% nitrogen. Therefore, the maximum total annual mass of nitrogen required at the site will be approximately 39,223 kg. Assuming that the average blast efficiency is 97.72%, the total mass of nitrogen residue available for dissolving in the water is 894 kg/year.

2) Nitrogen from Groundwater Inflow

The average hydraulic gradient upgradient of the site is estimated to be 2 m over 175 m or 0.011 m/m. The width of the flow field is 700 m and the transmissivity is estimated to be 75 m^2/day. Using

$Q = T * i * W$

Where
Q – groundwater flow through (m^3/day)
T – transmissivity (m^2/day)
i – gradient (m/m)
W – width of flow field (m)

the estimated groundwater flow through the site under a natural gradient is 578 m^3/day or 210,970 m^3/year.

The drawdown within the excavation will result in additional water moving onto the site. Our experience with subaqueous aggregate mining in this area is that annual equilibrium occurs within the groundwater system and a year-over-year deficit does not occur. Therefore, the removal of 270,000 m^3 of rock will result in the inflow of 256,500 m^3 of water (after accounting for 5% rock porosity).

The total volume of groundwater moving onto the site from upgradient is therefore 467,470 m^3.

Nitrogen Mass From Upgradient Groundwater

The farming activity upgradient of the site results in the introduction of nitrogen compounds to the groundwater. Samples obtained in 1998 and in 2013 confirm that nitrate, ammonia and total kjeldhal nitrogen is found in the groundwater. Table 2 summarizes the nitrogen compounds found in surface and groundwater samples. The observed concentrations of nitrogen compounds in the groundwater entering the northern boundary of the site average 4.38 mg/L in 2013. The nitrogen compounds present in the lower portions of the aquifer are estimated to be 0.2 mg/L.

The water samples obtained from monitoring well M15 and the Rental House well (W1) represent vertically mixed groundwater quality and groundwater where natural attenuation has removed nitrate from the groundwater flow system. The values obtained from M15 and the Rental House were 2.0 mg/L and 0.13 mg/L respectively.

The average value of nitrogen compounds entering the site is 4.38 mg/L. Assuming that this represents the total nitrogen concentration in groundwater flowing through the upper third of the aquifer, the mass of nitrogen compounds entering the site under natural flow conditions is 4.38 mg/L x 70,323[1] m^3 or 308 kg per year. Nitrogen compounds flowing through the lower zones is estimated to be 28 kg/year.

In addition, 256,500 m^3 of water will be drawn into the site from the subaqueous mining processes on an annual basis. Assuming that a third of this water (85,500 m^3) is obtained from the upper aquifer and two thirds from middle and lower zones, the additional mass of nitrogen compounds entering the site from up gradient is 408 kg.

---

[1] 210,970 m^3/3

Table 3: Nitrogen Balance

Zone	Nitrogen Concentration (mg/L)	Groundwater Flow Volume (m^3)	Mass of Nitrogen (kg)	Total Nitrogen (kg)
Upper	4.38	70,323	308	
Middle	0.2	70,323	14	
Lower	0.2	70,323	14	336
Induced Flow				
Upper	4.38	85,500	374	
Middle	0.2	85,500	17	
Lower	0.2	85,500	17	408
Total from Groundwater			774	
Total from Explosives			894	1,668
Total Dilution		467,469		
Final Nitrogen Concentration	3.56			

The total mass of nitrogen input to the Hidden Quarry site on an annual basis is therefore estimated to be 1,668 kg/year. The amount of dilution for this nitrogen is 467,469 m^3/year (Table 3).

The resulting concentration of nitrogen compounds in groundwater is therefore estimated to be 3.56 mg/L.

It is our opinion that this nitrogen balance represents a worst case scenario as natural processes within the pond and the groundwater system will further reduce nitrogen movement in the groundwater system.

Surface Water Pathogens

We concur that surface water pathogens may be present in the quarry pond. However, the quarry will not be the most likely source of surface water pathogens in the area. According to the Ontario Ministry of Agriculture and Food (http://www.omafra.gov.on.ca/english/engineer/facts/04-015.htm), the list of most likely sources includes:

- sewage treatment plant discharge
- municipal storm sewer discharge
- overland runoff from manure storages and feedlots
- illegal connections of domestic septic systems to subsurface drains emptying into surface water
- wildlife
- runoff from fields receiving livestock manure
- runoff from fields receiving sewage sludge
- livestock manure entering streams as a result of defecation in or near streams
- other sewage sources (e.g. interception of septic plumes by surface water or marine discharge)

The quarry does not represent the most likely source of surface water pathogens. Considering the elevated nitrate observed in water samples from Tributary B indicating contamination from upgradient farming, the more likely source of surface pathogens is water infiltrating into the bedrock from Tributary B. Also, the elevated nitrate concentrations in groundwater indicate that the overburden does not provide effective protection from anthropogenic activity.

The bedrock aquifer is already susceptible to contaminants from the ground surface as recognized in several reports including Halton Rural Drinking Water Study, Phase 1 and City of Guelph Final Groundwater and Surface Water Vulnerability Report (Aqua Resources, March 2010). The water quality survey by Halton Region found that the water from 31% of drilled wells in their survey was unsafe for drinking. The Beak International (1999) study states that in the Blue Springs Creek watershed, the rapid movement of surface water into the bedrock leads to high susceptibility of contamination. Therefore, the quarry is being developed in an area already susceptible to contamination from the ground surface.

The mining is phased such that quarrying will commence in the northern portion of the site. This is the most distant part of the site from downgradient private water wells. The monitoring program is designed to determine if groundwater quality is being impacted by the quarry.

Two ponds will remain upon maturity of this site. These ponds are upgradient from five private wells as shown on Figure 2 as determined by reverse particle tracking from the private wells. At least one of the private wells (W19) is already utilizing an Ultra Violet Light to treat for a chronic bacteriological issue in the well water.

James Dick Construction Ltd. has agreed to a pre-bedrock extraction water well survey that includes a water quality assessment. James Dick Construction Ltd. has agreed to ameliorate water quality issues in private wells if in time the water quality of an individual well decreases as a result of the quarry activity. This can include one or more of the following remedies;

1) Lining of the well to restrict water intake to deep fractures,
2) Deepening of the well,
3) Installation of water treatment.

7.0 Recommended Multi-Level Installation Details

We agree with the proposed Burnside multi-level installation details in M15. In-situ hydraulic conductivity testing and water quality testing will be undertaken upon completion.

8.0 Discussion

We agree that the drawdown observed in M2 during the pumping of M15 is consistent with the groundwater flow direction and a fracture alignment in approximately a northwest to southeast orientation.

9.0 Response to Burnside Comments

72) The subaqueous blasting process is such that the full quarry depth is drilled and blasted in one event. Traditional mining allows for a series of working benches and mine lifts between 10 and 15 metres thick. In the Hidden Quarry case, the entire 30 metre lift will be drilled and blasted in one event. With the top of rock at approximately 350 m AMSL, the approach will be to drill and blast the rock to an elevation of 320 m AMSL. The full depth of the aquifer to an elevation of 320 m AMSL will thus be exposed and able to contribute water during the extraction process. It is our conservative estimate that based on an annual extraction rate of 700,000 tonnes per year, the daily extraction rate will be the equivalent of 1145 m^3 of rock. If the initial sinking cut has the dimensions of 25 m x 50 m, the anticipated daily drawdown will be 0.91 metres. The hydraulic modelling shows that where there is a drawdown of 2.54 metres, the drawdown in the nearest well is approximately 1.6 metres. Given the relatively high transmissitivity of the aquifer and availability of water from a wide range of depths within the aquifer, this predicted change in water level will not affect the functioning of the well. James Dick Construction Ltd. has agreed to limit the maximum drawdown in the excavation to 2.54

metres below the historic low water level. Based on the depth of upgradient wells and the availability of water from multiple depths in the aquifer, it is our opinion that no domestic well will be impacted by the proposed rock extraction activities. Based on our water well survey, there are no shallow dug wells being used for domestic or any other water supply reasons in the area upgradient of the quarry.

60) It is our opinion that the inclusion of a low flow zone at depth in close proximity to the quarry, will not have a significant effect on the model outcome or the model's ability to predict maximum water level changes in nearby wells. The model calculations were conducted using hydraulic conductivity as a variable rather than using a constant transmissivity. Therefore, where the thickness of the model layer increases, the transmissivity increases. Creating a lower hydraulic conductivity layer beneath the proposed quarry would decrease the overall transmissivity within the model proximal to the quarry. An analytical approach to estimating potential impacts from the quarry is presented in the accompanying letter. In the scenario where transmissivity is decreased, the potential impacts to nearby homes decreased. We do not feel that a change to the model is warranted considering that a) the analytical approach does not suggest a greater impact, b) Rockwood Well No. 3 has a large fracture set between the elevation of 313.2 and 316 m AMSL indicating that significant permeability occurs at depth, c) the 'water found at' distribution is scattered suggesting fractures are found throughout the rock body thickness and d) the field experience indicated by Burnside is that two wells drilled in close proximity can have different fracture patterns. Therefore expanding the conditions observed in M15 to the whole quarry is not reasonable.

54) We agree.

56) We agree with this statement and also conclude that the till layer is not an effective aquitard over this site as M12, M11 and M7 are consistently dry indicating no saturated overburden above the bedrock at those locations.

Respectully submitted,
Harden Environmental Services Ltd.

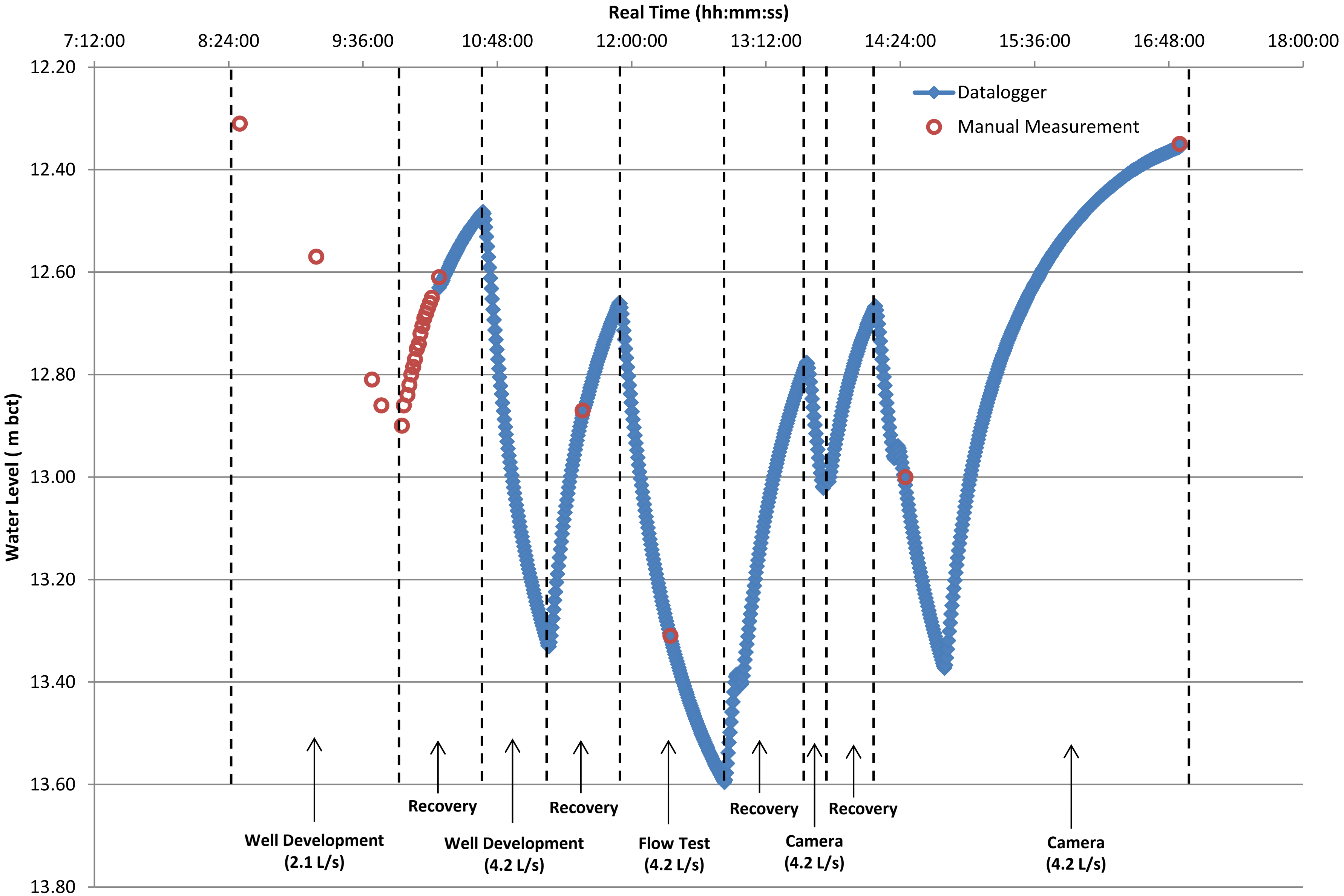
Stan Denhoed

Stan Denhoed, M.Sc., P. Eng.
Senior Hydrogeologist

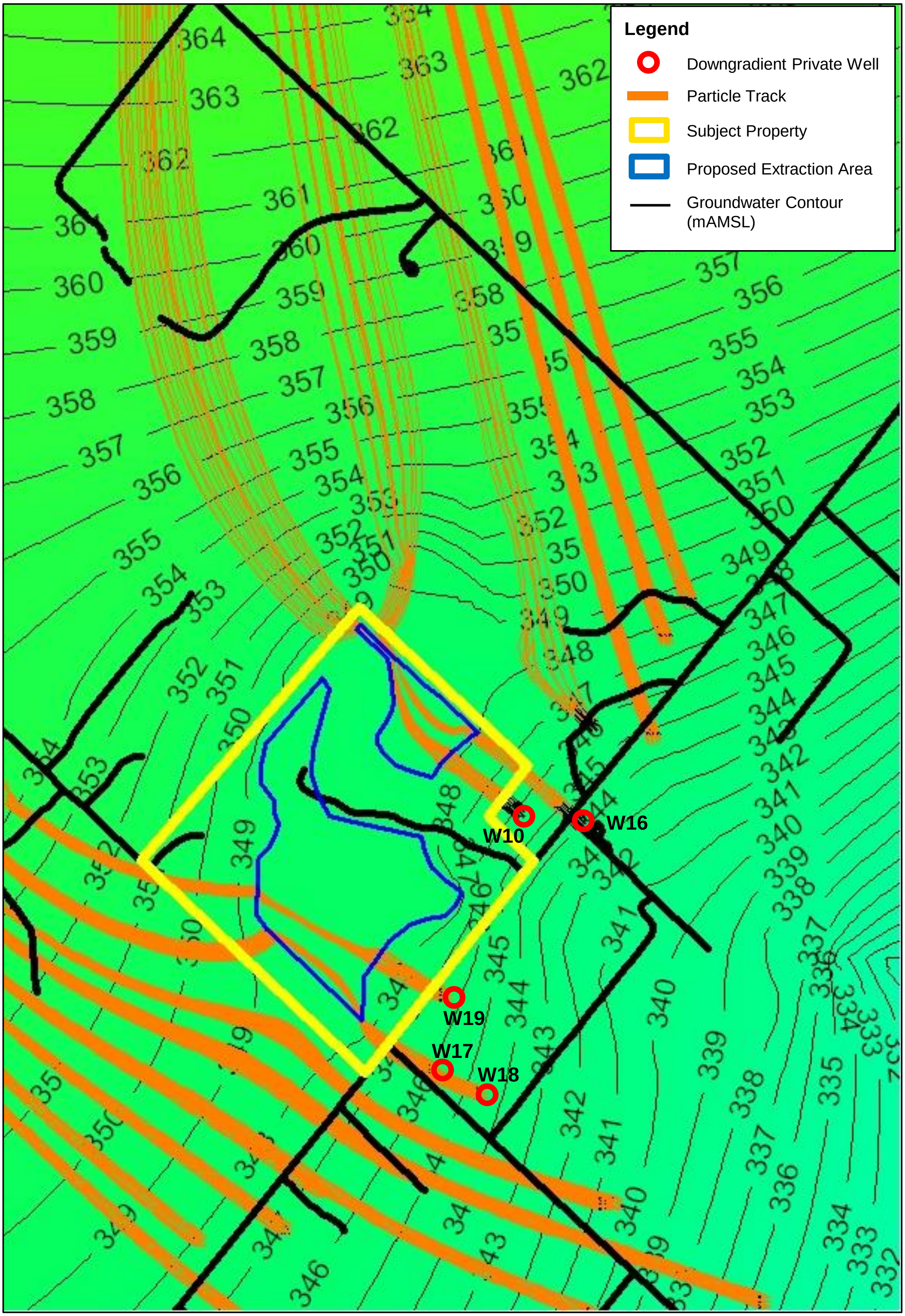
LICENSED PROFESSIONAL ENGINEER
S. E. DENHOED
Jun 14/14
PROVINCE OF ONTARIO

cc: Greg Sweetnam, James Dick Construction Limited

Figure 5: M2 Response During M15 Testing



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Summary of Drilling and Testing New Well M15	**Figure 5: M2 Response During M15 Testing**
	Date: June 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 2:**
	Date: Dec 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Downgradient Private Wells**
	Drawn By: SD		

Table 1: Loss of Total Nitrogen from Explosives at Gamebridge Quarry

Year	Total Pumping Volume (L)	Average N in Discharge (mg/L)	Average N Background (mg/L)	Total N Discharged From Quarry (kg)	Total Explosives (kg)	Total Ammonium Nitrate (kg)	Total N (kg)	% N Loss to Water
2009	182,333,606	6.50	1.4	930	71,192	66,920	23,422	3.97
2010	180,089,922	6.72	1.4	958	103,480	97,271	34,045	2.82
2011	201,966,454	4.17	1.4	559	86,030	80,868	28,304	1.97
2012	169,069,434	3.11	1.4	288	60,875	57,223	20,028	1.44
2013	144,973,994	3.81	1.4	350	88,090	82,805	28,982	1.21

Average % N Loss to Water	**2.28**

% Ammonium Nitrate in Explosives	94
% Nitrogen in Ammonium Nitrate	35

Note: Average background calculated from average ammonia in groundwater multiplied by 0.35 as groundwater component of quarry water. No background Nitrogen species accounted for in surface water entering the quarry.

Table 2: Nitrogen Compounds of Hidden Quarry Groundwater and Surface Water Samples

November 21, 1996

Location	Nitrate (mg/L)
Tributary A	8.2
M3	5.3
SW3	9.0
M2	6.8
M4	2.8
M1	0.7
TP1	0.9
M5	1.6
SW1	<0.05
Blue Springs Creek	1.8

May 18, 2012

Location	Nitrate (mg/L)	Total Ammonia-N (mg/L)
Rental House (W1)	0.13	<0.050

May 24, 2013

Location	Nitrate (mg/L)	Total Ammonia-N (mg/L)	TKN (mg/L)
M15	2.0	0.060	0.20

November 20, 2013

Location	Nitrate (mg/L)	Total Ammonia-N (mg/L)	TKN (mg/L)
M2	5.2	<0.050	0.77
M3	4.6	<0.050	1.3
M13D	0.9	<0.050	0.38

November 25, 2013

Location	Nitrate (mg/L)	Total Ammonia-N (mg/L)	TKN (mg/L)
Tributary B	6.7	<0.050	0.35

Appendix A

Burnside & Associates Comments

November 12, 2013

R.J. Burnside & Associates Limited 292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4 Canada
telephone (519) 823-4995 **fax** (519) 836-5477 **web** www.rjburnside.com

BURNSIDE
[THE DIFFERENCE IS OUR PEOPLE]

November 12, 2013

Via: Email/Mail

Mr. Stan Denhoed, M.Sc., P.Eng.
Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road,
R.R. 1
Moffat, ON L0P 1J0

Dear Mr. Denhoed:

Re: Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site
File No.: 300032475.0000

Thank you for providing R.J. Burnside & Associates Limited (Burnside) with a copy of the June 7, 2013 Harden Environmental Services Ltd. (Harden) letter which documents the drilling and testing of new well M15 at the Hidden Quarry site. The Burnside comments are provided under the same section headings as used in the Harden letter.

2.2 Bedrock

Harden indicates that the uppermost bedrock encountered was the Niagara Falls Member of the Goat Island Formation and is not representative of the Eramosa Formation.

Burnside Comment

This is consistent with OGS Map P955 which indicates the Eramosa Formation extends just to the west of Rockwood and is not present beneath the Hidden Quarry Site.

Gasport Formation

The Gasport Formation is found between 10.03 and 48.50 mbgs (350.00 mamsl to 311.53 mamsl).

Burnside Comment

The extraction will occur in the Niagara Falls Member and the Gasport Formation with the proposed base of the quarry at 320 masl.

2.3 Descriptions of Core Breaks

Harden looked at each core break in the field and at their office and recorded only naturally occurring core breaks as either open or closed fractures. The highest concentrations of open fractures occur between a depth of 20 and 40 mbgs.

Burnside Comment

The bedrock extraction will occur from 10 to 40 mbgs. The upper 10 m of rock is not as fractured and may not fill with water as quickly as the rock from 20 to 40 mbgs resulting in temporary localized dewatering of the shallow fracture system.

3.0 Pumping Tests

Brief pumping tests were completed on M15 at rates of 2.1 L/s (for 60 minutes) and 4.2 L/s (30 minutes) with 1.21 m and 2.67 m of drawdown respectively. Wells M1D, M3 and M13D had no response to pumping. Water levels in M2 declined about 1.23 m. The pumping test data has been used to estimate the Transmissivity and hydraulic conductivity (K) of the bedrock aquifer.

Burnside Comment

A review of Figure 3.17 (Bedrock Groundwater Contours) in the Hydrogeological Investigation Report indicates that M2 is upgradient of M15 and M3 is crossgradient.

Water levels prior to the start of testing were as follows:

	Start
M15	350.69
M1D	352.34
M3	349.40
M13D	354.70
M2	not reported

The borehole log of M15 indicates bedrock was encountered at 9.55 mbgs and flow profiling indicates no flow below 41 m. As a result, the effective aquifer thickness is only 31.45 m which is less than indicated.

Using an average T of 60 m^2/day (from M15) and an aquifer thickness (b) of 31.45 m results in a K of 2.2 x 10^{-5} m/s which is very similar to that calculated by Harden.

The rapid response to pumping at M2 suggests there is a system of interconnected fractures aligned in a northwest direction. The lack of responses in MD, M3 or M13D could be simply due to the limited duration of the test or may indicate that the fracture system present at M2 and M15 is not present at the other locations.

Notation should be added to Figure 5 (Well M2 response)to indicate which portions of the graph represent the pumping test, flow profiling and pumping video.

3.1 Flow Test

The flow testing completed indicates approximately one-third of the M15 yield is derived from fractures between 10 and 36 mbgl, one-third from a single set of fractures at 36 m and a third is obtained from a fracture at 42 mbgs.

Burnside Comment

The flow testing indicates that the flow in the upper portion of the rock is decreased between 19 and 26 m. Similarly, the bedrock between 36 and 42 mbgs produces minimal flow could result in some temporary dewatering of the fractures above these zones while this portion of the rock fills with water during the extraction process.

6.0 Water Quality Results

A water sample collected from M15 had a nitrate concentration of 2.0 mg/L and a chloride concentration of 16.0 mg/L. Iron was not detected.

Burnside Comment

Samples from M2 collected in 1996 had a nitrate concentration of 6.8 mg/L, a chloride concentration of 12 mg/L and iron of 0.68 mg/L. A sample from the Dolime pit following a subaqueous blast had a nitrate concentration of 1.2 mg/L. This indicates that blasting may increase nitrate concentrations in the bedrock aquifer.

Once the quarry pond is created, there will be water mixing from all directions and depths. Harden should provide additional detail on how the exposure of the groundwater to air will impact iron (the concentrations at M2 are already above the Ontario Drinking Water Quality Standards (ODWQS)). Although iron is an aesthetic parameter, Harden should comment on the potential for iron to increase in downgradient wells; possibly causing problems with fixture staining and odours. Similarly, a mass balance calculation should be performed to estimate the nitrate concentration at the downgradient end of the quarry. Once the pond is created during extraction, it is anticipated that surface water pathogens such as Cryptosporidium and Giardia possibly will be present. These have the potential to move rapidly through bedrock fractures, impacting nearby domestic wells.

7.0 Recommended Multi-level Installation Details

Harden proposes that M15 be converted into a multi-level well with the following zones for monitoring:

Monitoring Level	Interval (mbgs)		Interval (mamsl)	
	From	To	From	To
Shallow	10	28	350.03	332.03
intermediate	33	38	327.03	322.03
Deep	40	55	320.03	3,05.03

Burnside Comment

Flow profiling and the pumping video do not indicate any flow below 45 m so there is no need to monitor this interval. Also, the proposed separation between the intermediate and deep monitors is only 2 m which is less than ideal to provide a good separation between the fractures. Burnside recommends the following be considered.

Monitoring Level (including 0.30 m of sand pack above screen)	Interval (mbgs)	
	From	To
Shallow	10	28
Seal	28	34
Intermediate	34	37
Seal	37	40
Deep	40	43

Burnside suggests that the screened interval be 0.3 m less than the monitored interval to allow for the placement of 0.3 m of sand between the top of the screen and the bentonite seal.

Once the multi-level well has been constructed and developed, in situ hydraulic conductivity and water quality testing should be completed.

8.0 Discussion

Based on the installation of M15, Harden offers the following comments regarding the hydrogeological conditions at the site:

1. There are no significant karst features identified in the geological profile. This is in keeping with the observations at M1, M2, M3, M4, M13D and M14D. The core obtained from M15 contains fractures, however, none suggest karstification of the dolostone aquifer.
2. Water bearing zones occur throughout the geological profile. The Gasport Formation is well known for its water bearing ability and this characteristic was confirmed at M15. Water bearing zones occur from the top of bedrock at an elevation of 350 mamsl to an elevation of 318 mamsl. There was no indication of preferential flow through the upper three metres of the geological profile.
3. Lateral hydraulic connectivity within the aquifer occurs at depth. There was a hydraulic response noted in monitor M2 to the pumping of M15. M2 and M15 fully penetrate the dolostone aquifer and the response in M2 verifies that water transmission will occur through the aquifer. This proves that M2 will be a useful monitor during the quarry operation to observe changes in the aquifer during extraction.
4. Hydraulic responses were not observed within the shallow bedrock at M1D, M13D or M3 whose completion elevations are all above 346 mamsl. These wells are completed in the upper 3 m of the bedrock. The lack of immediate hydraulic response is due to a relatively poor hydraulic connectivity between the shallow bedrock and deeper fractures; and poor lateral connectivity in the shallow zone. It is

anticipated that the shallow bedrock zone will ultimately experience a hydraulic response after a prolonged water level change. Although pumping periods were short, the response in the pumping well and in M2 were used to estimate transmissivity of the aquifer. The near-well transmissivity is estimated to range from 50 m^2/day to 80 m^2/day. This correlates well to the bulk hydraulic conductivity used in the model for the dolostone aquifer. These values also correlate well to the hydraulic testing conducted on the adjacent Mudge property where transmissivity of the aquifer was found to range from 20 to 150 m^2/day.

Burnside Comment

Burnside concurs with the Harden discussion.

Under item 4, the lack of water level response in M1D, M3 and M13D while M15 was pumping appears to indicate a lack of hydraulic conductivity between the shallow bedrock and deeper fractures. However, the drawdown at M2 is consistent with the groundwater flow direction and may also indicate preferential alignment of water bearing fractures in a northwest direction.

9.0 Response to Burnside Comments

Harden provided updated responses to previous Burnside Comments 72, 60, 54 and 56.

Burnside Comments

72. Figure 7 provides a graphical presentation of the flow velocity. It indicates that 66% (2.78 L/s) of the flow is derived from fractures at 36 m and 41 mbgs with 30% (1.3 L/s) of flow found in the upper 36 m. There are several zones in the upper 36 m where there is no significant flow (i.e., from 19 to 26 m). As a result, as excavation proceeds between 19 and 26 m, water to make up the volume of rock removed will need to come from the bedrock between 10 and 19 mbgs. Burnside understands that this effect will decrease as each sinking cut is completed, however, the amount of drawdown during the initial cut should be quantified so that the impacts on nearby domestic wells can be realiably predicted.

60. The short term tests of M15 provide confirmation that the bulk hydraulic conductivity value used in the groundwater model is reasonable. Once the well is converted to a multi-level monitoring well, additional ‘K’ testing should be completed. Since the original groundwater model used a localized zone of higher ‘K’ to simulate conditions on the east side of the site, is there a benefit to including the low flow zone from 36 to 40 mbgs as a separate layer in the near site grid of the model. The Assessment of water quality impacts should consider the potential for nitrate, turbidity and surface water pathogens to move rapidly through fractures such as those seen at 36 and 41 mbgs in M15.

54. M15 was installed to address a concern with lack on onsite information on the bedrock formations. Once the multi-level monitor well is constructed and K tested and set up for long term monitor this comment will be satisfied.

56. Figure R8 indicates that there is a basal silt/till unit that is present throughout the site yet water from Tributary B is hypothesized to enter the bedrock at some point upstream of SW3. Since Harden indicates the water table is not present in the overburden throughout the entire site, there must be areas in the southern portion of the site where the silt unit is thin or absent. This was observed at M15 where granular sediments extended from the surface to the top of the bedrock.

Should you have any questions, please contact the undersigned.

Yours truly,

R.J. Burnside & Associates Limited

Dave Hopkins, P.Geo.
Hydrogeologist
DH:sd

cc: Ms. J. Sheppard, Township of Guleph/Eramosa (Hand Delivery)
Mr. D. McNalty, R.J. Burnside & Associates Limited (Email)
Cuesta Planning Consultants Inc. (Mail)
Mr. Greg Sweetnam, James Dick Construction Ltd. (Mail)

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Appendix B

Florida Department of Environmental Protection

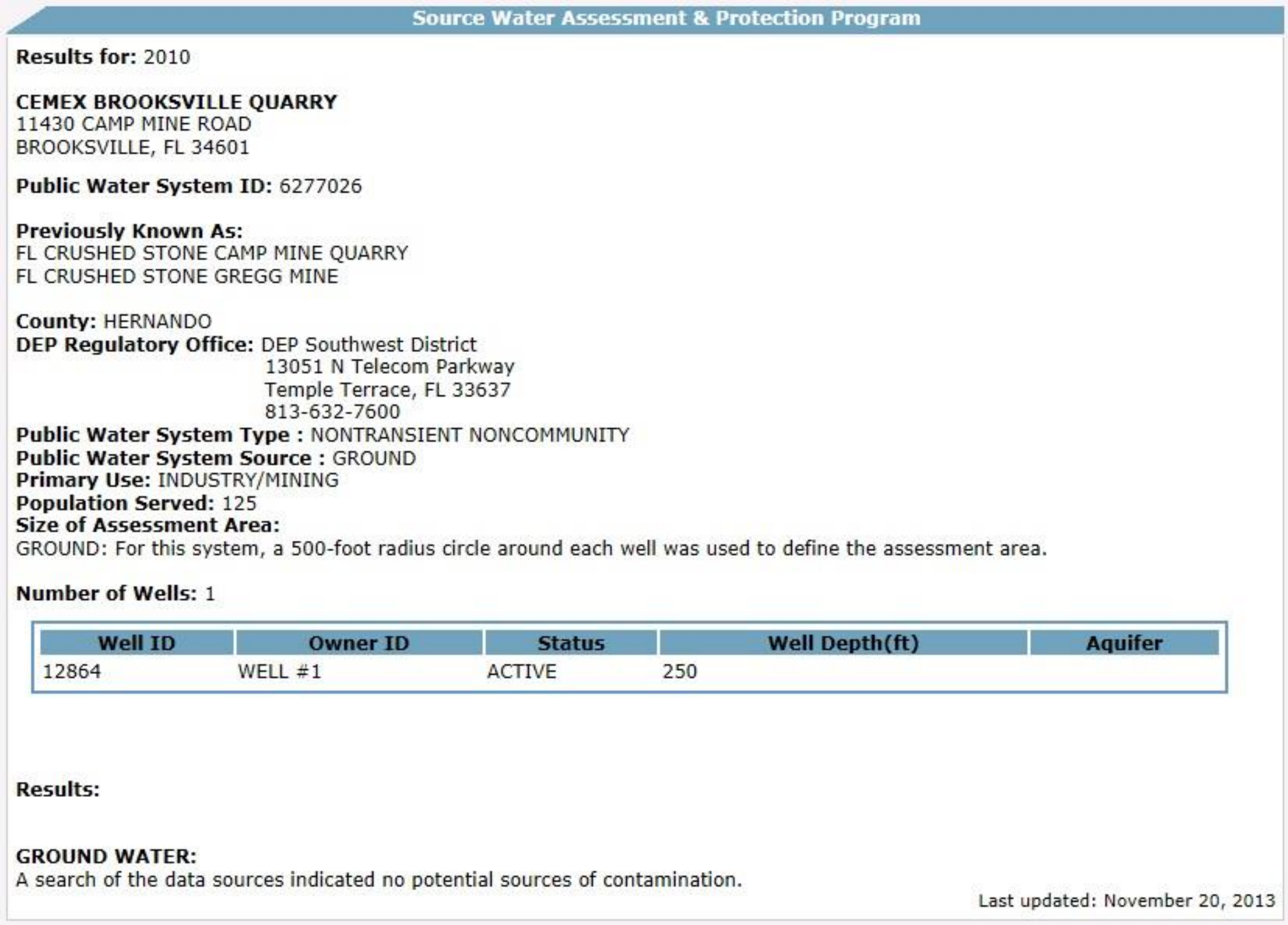
Source Water Assessment & Protection Program

Factsheets

Florida Department of Environmental Protection

Cemex Brooksville Quarry 2010

Source: http://www.dep.state.fl.us/swapp/DisplayPWS.asp?pws_id=6277026&odate=01-OCT-10



Source Water Assessment & Protection Program

Results for: 2010

CEMEX BROOKSVILLE QUARRY
11430 CAMP MINE ROAD
BROOKSVILLE, FL 34601

Public Water System ID: 6277026

Previously Known As:
FL CRUSHED STONE CAMP MINE QUARRY
FL CRUSHED STONE GREGG MINE

County: HERNANDO
DEP Regulatory Office: DEP Southwest District
13051 N Telecom Parkway
Temple Terrace, FL 33637
813-632-7600
Public Water System Type : NONTRANSIENT NONCOMMUNITY
Public Water System Source : GROUND
Primary Use: INDUSTRY/MINING
Population Served: 125
Size of Assessment Area:
GROUND: For this system, a 500-foot radius circle around each well was used to define the assessment area.

Number of Wells: 1

Well ID	Owner ID	Status	Well Depth(ft)	Aquifer
12864	WELL #1	ACTIVE	250	

Results:

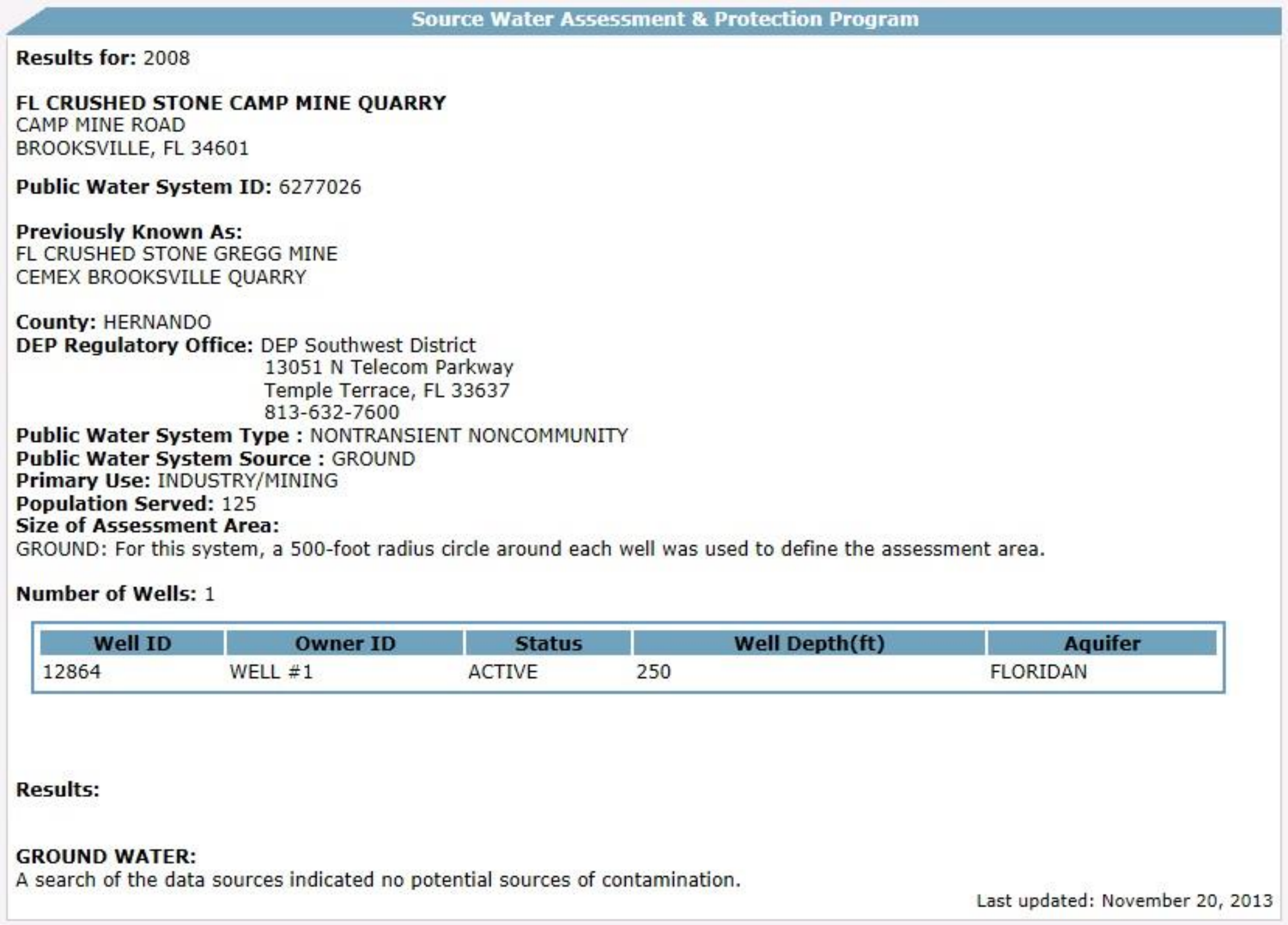
GROUND WATER:
A search of the data sources indicated no potential sources of contamination.

Last updated: November 20, 2013

Florida Department of Environmental Protection

FL Crushed Stone Camp Mine Quarry 2008

Source: http://www.dep.state.fl.us/swapp/DisplayPWS.asp?pws_id=6277026&odate=01-OCT-08



Source Water Assessment & Protection Program

Results for: 2008

FL CRUSHED STONE CAMP MINE QUARRY
CAMP MINE ROAD
BROOKSVILLE, FL 34601

Public Water System ID: 6277026

Previously Known As:
FL CRUSHED STONE GREGG MINE
CEMEX BROOKSVILLE QUARRY

County: HERNANDO
DEP Regulatory Office: DEP Southwest District
13051 N Telecom Parkway
Temple Terrace, FL 33637
813-632-7600
Public Water System Type : NONTRANSIENT NONCOMMUNITY
Public Water System Source : GROUND
Primary Use: INDUSTRY/MINING
Population Served: 125
Size of Assessment Area:
GROUND: For this system, a 500-foot radius circle around each well was used to define the assessment area.

Number of Wells: 1

Well ID	Owner ID	Status	Well Depth(ft)	Aquifer
12864	WELL #1	ACTIVE	250	FLORIDAN

Results:

GROUND WATER:
A search of the data sources indicated no potential sources of contamination.

Last updated: November 20, 2013

Florida Department of Environmental Protection

Rinker Fec Quarry Employees 2004

Source: http://www.dep.state.fl.us/swapp/DisplayPWS.asp?pws_id=4134527&odate=01-OCT-04

Source Water Assessment & Protection Program

Results for: 2004

RINKER FEC QUARRY EMPLOYEES
12150 NW 136 ST
MIAMI, FL 33178

Public Water System ID: 4134527

Previously Known As:
RINKER EMPLOYEES
CEMEX EMPLOYEES

County: MIAMI-DADE
DEP Regulatory Office: Dade County Health Dept.
1725 NW 167th St. Suite 119
Opa-Locka, FL 33056
305-623-3551
Public Water System Type : NONCOMMUNITY
Public Water System Source : GROUND
Primary Use: INDUSTRY/MINING
Population Served: 150
Size of Assessment Area:
GROUND: For this system, a 500-foot radius circle around each well was used to define the assessment area.

Number of Wells: 1

Well ID	Owner ID	Status	Well Depth(ft)	Aquifer
21034		ACTIVE	Not Available	BISCAYNE

Results:

GROUND WATER:
A search of the data sources indicated no potential sources of contamination.

Last updated: November 20, 2013

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

June 10, 2014

R.J. Burnside and Associates Limited
292 Speedvale Avenue West, Unit 20
Guelph, Ontario, N1H 1C4

Attention: Mr. David Hopkins, P.Geo.
Sr. Hydrogeologist

Dear Mr. Hopkins:

Re: Letter - Response to Burnside Review of Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site (Burnside Response April 8, 2014)
Harden Response to Burnside Review of Hydrogeological Summary Report (Burnside Response April 9, 2014)
Hidden Quarry Site for Township of Guelph/Eramosa
Burnside File No.: 300032475.0000

Thank you for your comments on our two January 14, 2014 submissions. We have combined the outstanding concerns from both Burnside and Associates letters into this response. Copies of these letters are provided in Appendix A. It is our intention to provide sufficient technical analysis in this letter to satisfy the outstanding concerns raised by Burnside and Associates. Burnside and Associates states that they are primarily concerned with the following;

1) Water levels in the upgradient domestic wells

2) Water quality in the downgradient domestic wells

3) Rockwood Well No. 4

In summary, with respect to the three main items of concern we restate the following.

The largest magnitude of water level change in the nearest domestic well is approximately 1.6 metres. It is our professional opinion, based on our knowledge that the dolostone aquifer has a relatively high transmissivity, that a water level change of 1.6 metres will not adversely affect the availability of water to any domestic well. A rigorous on-site monitoring program will be instituted to confirm this opinion. James Dick Construction Ltd. (JDCL) has also agreed to conduct a voluntary private well survey commencing well in advance of any below-water-table extraction. The combination of these two programs will allow the early detection of possible changes in the potentiometric elevation on the site and in neighbouring wells.

The water quality in downgradient domestic wells will be discussed at length in this submission. There are five domestic wells downgradient of the quarry that obtain water from the dolostone aquifer and that also may pass through the quarry. Based on monitoring at existing proxy quarry sites it is our opinion that this quarry will not impact on any chemical parameter that will affect the potability of water in the area. A monitoring program will be implemented that will ensure this is the case. Modifications have been made to the quarry design such that there will remain a substantial thickness of undisturbed rock beneath the quarry. Wells downgradient from the quarry will have access to water resources that flow in the undisturbed fracture sets beneath the quarry. Pro-active modifications or retrofitting of these down gradient wells such that they are only taking water from the deeper fracture sets will be undertaken at the request of the landowner. Out of an abundance of caution we have also recommended that at-source domestic UV treatment systems be installed at the downgradient wells. UV systems should be in place in this fractured bedrock environment area in any event even without a quarry. All modifications will be done at no cost to the landowners. With these measures in place it is our opinion that there will remain access to abundant high quality domestic water supplies at all receptors.

We are in agreement with Burnside that the quarry will not affect the GUDI status of Well No. 4 and JDCL has agreed to make the multi-level monitoring well M15 available for monitoring during the pumping test of Well No. 4.

In regards to the remaining comments, we have categorized the concerns into eight areas of interest. These are;

1) Karst
2) Groundwater Parameter – Hydraulic Connectivity – M15 Intervals
3) Nitrate Balance
4) Deeper Water Sources and Water Quality
5) Local Well Survey

6) Quarry Depth Limitation
7) Brydson Spring and Blue Springs Creek
8) Sinking Cut – Monitoring and Historical Low Water Level

1.0 Karst

Water losses in Tributary B are consistent with a "losing stream", a stream that loses water to either unsaturated sediments underlying the stream or the local groundwater regime due to the difference in hydraulic potential between the stream water level and underlying groundwater levels and are not consistent with characteristics of a stream that loses water to karstic bedrock.

The following observations are made from data collected on-site;

a) Tributary B is a losing stream across the length of the Hidden Quarry site,

b) Tributary B is not in direct contact with the underlying bedrock anywhere on the site,

c) Tributary B is physically separated from the underlying bedrock by several metres of permeable unconsolidated sediments. Jim Baxter of Burnside and Associates was present for the drilling of M15 (within 30 metres of Tributary B) where there are approximately ten metres of unconsolidated sediments comprising mainly coarse aggregate.

d) The water table is found to be several metres below the Tributary B stream bed.

Given these facts, the loss of streamflow is entirely due to the hydraulic potential of water in Tributary B being greater than that of the underlying unsaturated glacial outwash sediments. The loss of streamflow is in no way related to the underlying bedrock geology or structure.

Streamflow measurements have been obtained regularly since 2005. As shown on Figure 1, Tributary B only loses all of its water (no flow at SW3) when the incoming flow at SW4 is less than approximately 20 L/s. With flows of greater than 20 L/s, flow is found in all on-site reaches of Tributary B. Table 1 summarizes observations of flow conditions where streamflow has been observed to cease within different reaches of Tributary B. The surface water station locations are shown on Figure 2. Our observations are that the stream will cease to flow in various reaches within the proposed quarry boundaries depending on the incoming flow at SW4. This gradual loss of water supports the geological and hydrogeological observations of the creek being underlain by unsaturated unconsolidated sediments.

Table 1: Qualitative Observations of Flow in Tributary B

Monitoring Station	28-Jun-05	13-Jul-05	18-Jul-07	18-Aug-08	08-Sep-08	30-Oct-08	26-Jul-11	05-Oct-11
Streamflow at SW4 (L/s)	4.40	1.70	1.82	14.27	18.35	2.85	8.92	1.04
SW4	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow
SW5	Flow	Dry	Dry	Flow	Flow	Dry	Flow	Flow
SW7	Dry	Dry	Dry	Flow	Flow	Dry	Flow	Dry
SW3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry

Our conclusion is that it is unnecessary to instrument Tributary B with more continuous water level devices than already agreed upon. It has already been agreed upon to instrument two locations of the stream with continuous water level recording devices at SW4 and SW8.

Examination of the groundwater contours at the site, do not reveal large areas of the property with equal hydraulic potential. To the contrary, there is a gradual sloping water table across the property indicating hydraulic resistance to water movement. Therefore there is no indication of large contiguous karst features underlying the site. Furthermore, given the fact that this site will not be dewatered, karst geology is not an operational, water supply or safety issue at this site.

Further to this we find that a detailed study of the Blue Springs Creek watershed by Coward and Barouch[1] stated that *"...the karst in Blue Springs Creek is not well developed and that the flow in the dolomite must be taking place through joints and bedding planes. The groundwater flow pattern, therefore, has not been significantly affected by karst development."*

2.0 Groundwater Parameter – Hydraulic Connectivity

M15 was reconstructed as a multi-level monitoring station on May 1st and 2nd, 2014. There are four monitoring intervals as summarized in Table 2. 25 mm screen and riser

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[1] J.M.H. Coward and M Barouch, 1978, Hydrogeology and Groundwater Model of the Blue Springs Creek IHD Representative Drainage Basin

was used for the installation. No bridging of sand or bentonite seal was detected during the installation.

Table 2: M15 Monitoring Intervals

Monitoring Interval	Material	Depth From (mbct)	Depth To (mbct)
	Seal	9.03	10.00
M15-IV	Sand Pack	10.00	20.57
	Seal	20.57	24.33
M15-III	Sand Pack	24.33	30.51
	Seal	30.51	34.02
M15-II	Sand Pack	34.02	38.51
	Seal	38.51	40.82
M15-I	Sand Pack	40.82	44.72
	Seal	44.72	47.57
	Sand Pack	47.57	55.00

As shown on Figure 3, the test intervals were designed to isolate major fractures and water producing sections of the aquifer identified in the video log and flow test.

2.1 Groundwater Elevations Multi-Level M15

The water levels obtained from the monitoring intervals are summarized in Table 3.

Table 3: Water Levels Multi-Level M15

Monitoring Interval	May 1, 2014	May 2, 2014	May 5, 2014	May 6, 2014
	1613h (mbct)	1245h (mbct)	1000h (mbct)	1100 h (mbct)
M15-IV		8.77	8.66	8.71
M15-III	8.81	8.78	8.68	8.70
M15-II	9.00	9.08	8.98	9.00
M15-I	8.94	8.94	8.89	8.90

The water levels are found within a narrow range (30 centimeters). The lowest water level is observed in M15-II which has an interval across a known fracture. The highest water levels occur in the upper two intervals. This suggests a downward gradient between intervals M15-II and M15-III and an upward gradient between M15-I and M15-II. The water movement in the well is therefore both upward and downward towards the fracture set located at approximately thirty-six metres below ground surface.

This vertical profile gives no suggestion of a significant connection to lower hydraulic potential areas such as Brydson Spring or higher potential areas upgradient of the site.

This data shows that significant water level changes will not occur as a result of making vertical hydraulic connections within the quarry.

2.2 Hydraulic Testing in Multi-Level M15

The hydraulic testing of M15 was conducted on May 6, 2014. The testing was conducted both by adding a slug of water to the test interval (falling head test) and recording the response and by removing a physical slug from the test interval (rising head test) and recording the response. Graphs showing the response to this testing are found in Appendix B.

The analysis of the data was conducted in several ways. The methods used in the analysis are;

Method (1) Traditional Hvorslev (1951) analysis as presented in Freeze and Cherry (1979)

Method (2) High K Hvorslev (1951) as presented by Butler (2000)

Method (3) High K Bouwer and Rice (1976) as presented by Butler (2000)

Method (4) Hvorslev with Shape Factor Applicable to Test Intervals (Muldoon and Bradbury, 2005)

The intent of using multiple methods is not to evaluate each method but to show that using various methods results in similar estimates of hydraulic conductivity.

The hydraulic conductivity obtained from each of these methods represents the hydraulic conductivity of the test section and not individual fractures. These methods likely underestimate the hydraulic conductivity of individual fractures. However, the fractures are part of a larger fracture network that can be considered a continuum allowing a bulk hydraulic conductivity to be used in impact analysis.

The results of hydraulic testing are summarized in Table 4.

Table 4: Results of Hydraulic Conductivity Testing

Test Interval	Method 1	Method 2	Method 3	Method 4	Geometric Mean
M15-IV	2.2×10^{-5}	7.1×10^{-5}	5.3×10^{-5}	2.0×10^{-5}	3.6×10^{-5}
M15-III	3.4×10^{-5}			3.1×10^{-5}	3.3×10^{-5}
M15-II	1.0×10^{-4}	8.9×10^{-5}	8.1×10^{-5}	9.3×10^{-5}	9.1×10^{-5}
M15-I	6.7×10^{-5}	1.1×10^{-4}	9.9×10^{-5}	6.2×10^{-5}	8.2×10^{-5}

All results in m/s

The greater value hydraulic conductivity intervals M15-I and M15-II correspond with the greater flow velocities as observed in the flow test as shown on Figure 3. Approximately 75% of the flow to the well comes from the aquifer represented by test intervals M15-I and M15-II, both of which are below the proposed level of the quarry. This means that a significant proportion of the flow in the aquifer will not interact directly with the quarry water. In the unlikely event that the lake water from the quarry affects shallow aquifer water quality, there is a significant portion of the aquifer that can be accessed by downgradient wells. Burnside and Associates has made the recommendation that the quarry be limited to elevations above 327 m AMSL for this reason.

It is our opinion that these findings do not significantly affect the results of the groundwater-model-predicted-impacts to nearby upgradient wells. To test this opinion, we used the law of superposition and the modified Theis equilibrium equation to estimate the drawdown at nearby upgradient wells using a wide range of aquifer transmissivity. The northern edge of the quarry can be represented by a series of pumping wells. We have used a set of 20 wells, distributed as shown on Figure 4. Each well is designed to have a drawdown of 2.54 metres, thus representing the maximum drawdown allowed along the northern edge of the quarry. The drawdown occurring in the nearest private well W3 is then a summation of the drawdown attributed to each individual pumping well. We calculated the drawdown at private well W3 from transmissivity values ranging from 75 to 302,000 m^2/day. The drawdown at W3 is shown on Figure 5 to range from 1.8 metres to 2.2 metres[2]. Therefore, even at extremely high transmissivity, the impact to the nearest well is not great and in our opinion, will not affect the functioning of any private well. The curvature of the graph line in Figure 5 also shows that there is a maximum potential impact at extremely high transmissivity, being somewhat less than the maximum expected drawdown of 2.54 metres.

2.3 Combined Impact of Future Rockwood Well No. 4 and Hidden Quarry

Hydrogeologic work presented by both Gartner Lee and AquaResources in their modelling of the capture zones of future Well No. 4 show that the primary source area for this new well will be north and east of the well. This is north of the Hidden Quarry and thus the source area for Well No. 4 does not include Hidden Quarry. The most significant changes in aquifer water levels due to pumping from Well No. 4 will thus occur northeast of the well. This hydrogeologic interpretation is consistent with studies conducted at the Hidden quarry site.

The quarry will also become a large reservoir of water and therefore become a positive boundary condition for the expanding cone of influence of the well and for local wells.

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[2] This method is highly conservative as it does not account for recharge of the aquifer and therefore values presented in this report are greater than those of the groundwater model. This method is also conservative in that the estimated drawdown of 2.54 metres will only occur in a small central portion of the site and less drawdown occurring elsewhere.

This will result in a lessening of the impact of the Well No. 4 on aquifer water levels local to the quarry. According to our conversation with Mr. Jaroszewski, the mushroom farmer who takes water from well W3, there are some tens of metres of drawdown in his production well used to cool his farm building. This drawdown level is below the water level in the Hidden Quarry pond and therefore, the proposed Hidden Quarry pond becomes a significant potential source of water for well W3, thereby lessening the impact of well W3 on neighbouring wells.

2.4 Water Quality Testing in Multi-Level M15

Water quality samples were obtained from each of the test intervals. A minimum of six well volumes was removed from each of the test intervals prior to water quality samples being obtained. No external water was used in the construction of the well. The samples were analyzed by Maxxam Analytical Laboratories in Mississauga.

The test results are found in Appendix C. Graphs of TKN, DOC, nitrate, strontium and sulphate are shown on Figures 6 and 7. The strontium concentration increases with depth, a confirmation that sufficient water was removed from the test sections for water samples to be representative of the aquifer water at the interval depths sampled. Typical of the lower Gasport Formation, the strontium value is elevated in the lower elevations.

The highest TKN, DOC and nitrate concentrations occur in test interval M15-III. This indicates that this intermediate depth fracture set interacts with shallow fracture sets resulting in the movement of chemicals lower within the aquifer. The lower fracture sets represented by intervals M15-II and M15-I have lower nitrate, DOC and TKN concentrations than the M15-III interval. The sharp contrast in chemical concentrations with the lower fracture sets indicates some degree of isolation between the fracture sets, whereas the mere presence of these chemicals in the lower aquifer suggests interconnectivity between the lower and upper fracture sets.

The likely source of TKN and nitrate is anthropogenic activity. Water samples in groundwater obtained from the northern edge of the quarry contained nitrate in the range of 0.9 to 5.6 mg/L (November 2013) and in Tributary B was 4.64 mg/L upstream and 4.53 mg/L downstream. Thus the nitrate originating from upgradient sources is found to penetrate to all water producing levels of the aquifer.

The availability of DOC throughout the aquifer also provides opportunity for denitrification as the organic carbon is a food source for denitrifying bacteria.

In response to the Burnside comment that oxygenated water entering the aquifer may result in changes to existing downgradient water quality, we agree. However, the effect is benign since groundwater is oxygenated to a greater degree at every household tap prior to domestic use. As well, the oxygenated effect from the quarry is not likely to exist a significant distance from the quarry given the presence of iron (II) as found in pyrite in the aquifer. As described by C.A.J. Appelo and C. Postma (1993), the oxidation of pyrite occurs as follows;

$FeS_2 + 15/4O_2 + 7/2H_2O \rightarrow Fe(OH)_3 + 2SO_4^{2-} + 4H^+$

In this way, three and three quarters moles of oxygen are consumed for every mole of FeS_2 in the reaction.

3.0 Nitrate Balance M15 Results and Re-Testing of Guelph Limestone Quarry

3.1 Guelph Limestone Quarry Water Quality Sampling

Four additional water samples were obtained from the Guelph Limestone quarry (formerly Dolime Quarry) in order to evaluate the water quality impact of explosive use at the site. We observed the filling of the blast holes, each with 79.5 kg of Hydromite 4400 explosives. There were 102 holes resulting in a total loading of 8109 kg of explosives. A water sample was obtained from immediately below the blast location prior to the blast. The blast took place at 1722 h on Monday April 28th and samples were obtained 12 minutes, 78 minutes and fifteen hours after the blast. The samples were analyzed for nitrate, nitrite, total kjeldahl nitrogen (TKN) and ammonia. The samples following the blast were turbid and were not filtered prior to analysis. The results are shown in Table 5 and Appendix C.

Table 5: Summary of Nitrogen Testing at Guelph Limestone Quarry

Sampling Date		2014/04/28 11:50	2014/04/28 17:34	2014/04/28 18:40	2014/04/29 08:25
	Units	**S1: Before Blast**	**S2: +12 min**	**S3: +78 min**	**S4: + 903 min**
Inorganics					
Total Ammonia-N	mg/L	ND	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	mg/L	0.31	0.43	0.43	0.29
Nitrite (N)	mg/L	ND	ND	ND	ND
Nitrate (N)	mg/L	0.47	0.46	0.44	0.47

ND Not detected

There is no ammonia in the water before or after the blast. There is no nitrite in the water before or after the blast. The nitrate concentration before the blast was 0.47 mg/L and was 0.46 mg/L, 0.44 mg/L and 0.47 mg/L in the subsequent samples.

The TKN concentration was 0.31 mg/L before the blast and was 0.43 mg/L, 0.43 mg/L and 0.29 mg/L in the subsequent samples. TKN is a measure of organic nitrogen + ammonia. Ammonia was not detected in the water samples, therefore the increase in TKN is a result of increased organic nitrogen, not nitrogen products generated by the blasting materials. The water was very turbid after the blast and the increased organic nitrogen from stirred up organic material in the pond. Once settled, the organic nitrogen content of the water decreased as observed after fifteen hours of the blast. The data therefore shows that the use of explosives in a sub aqueous mining operation does not affect the nitrogen levels in the water of the quarry pond. As sampled on a previous occasion in 2012 and already reported to Burnside and Associates Ltd., the quarry water following a blast event at Guelph Limestone met all chemical Ontario Drinking Water Quality standards for a comprehensive parameter list including volatile organic compounds, petroleum hydrocarbons and polyaromatic hydrocarbons.

The Dolime Quarry water has less nitrogen content than either groundwater entering the Hidden Quarry site or surface water in Tributary A and Tributary B.

3.2 Nitrogen Compounds in Groundwater and Surface Water

We have obtained sixteen groundwater and surface water samples since February 2012 and analyzed the water for nitrate, nitrite, TKN and ammonia. The results are summarized in Table 6 (following Figures).

The results show that the Guelph Limestone quarry pond water quality is generally better than either groundwater flowing into the Hidden Quarry site or surface water flowing into the Hidden Quarry site. In all circumstances, the Ontario Drinking Water Quality Standards for nitrate or nitrite are not exceeded. The Operational Guideline for Organic Nitrogen is exceeded in every water type.

3.3 Revised Nitrate Prediction

The recent testing of the Guelph Limestone Quarry and the water quality testing of multiple levels in M15 indicate that the nitrate balance presented by Harden in January 14th, 2014 should be revised by;

a) distributing the nitrogen concentration evenly throughout the aquifer,

b) allowing mixing in only the upper and middle portions of the aquifer due to change in minimum quarry elevation change to 327 m AMSL,

c) reducing the introduction of nitrogen to the quarry pond by blasting activities as indicated by the recent Guelph Limestone Quarry sampling and

d) including dilution from infiltrating precipitation as suggested by Burnside and Associates Ltd.

The revised nitrate balance of the quarry is presented in Table 7.

Table 7: Revised Nitrogen Balance

Zone	Nitrogen Concentration (mg/L)	Groundwater Flow Volume (m^3)	Mass of Nitrogen (kg)	Total Nitrogen (kg)
Upper	4.38	70,323	308	
Middle	4.38	70,323	308	
Induced Flow				
Upper	4.38	85,500	374	
Middle	4.38	85,500	374	
Total from Groundwater			1,360	
Total from Explosives			0	1,360
Dilution from Groundwater		311,646		
Dilution from Infiltration		59,100		
Final Nitrogen Concentration	3.67			

The observed reduction in nitrate across the site is already more significant than presented in Table 7, suggesting that denitrification is already occurring in the aquifer. Biological activity in the future quarry ponds will also utilize nitrogen. Therefore, nitrogen concentrations downgradient of the quarry property will continue to be less than entering the quarry property.

4.0 Deeper Water Sources and Water Quality

James Dick Construction Ltd. has agreed to limit the depth of the quarry to an elevation of 327 m AMSL. The drilling of M15 has confirmed that significant water bearing fractures occur beneath the depth of the proposed quarry and the Rockwood Well No. 3 obtains water from fractures below this elevation.

4.1 Current State of Local Water Supplies and Vulnerability of the Aquifer

Water quality sampling on April 8th, 2014 of Tributaries B and C found that the surface water contained 40 and 10 Colony Forming Units (CFU) per 100 mL of surface water respectfully with respect to escherichia coli (*E. coli*). Tributary B had a flow exceeding 100 L/s and we estimate that 24 L of this water infiltrated within the Hidden Quarry property every second. This results in an estimated loading of 829,440,000 CFU per day of *E. coli* infiltrating beneath Tributary B. Therefore, a significant contaminant loading is already being introduced to the groundwater system. The drinking water standard for Ontario is 0 *E. coli*.

Water quality testing was also conducted on April 16th, 2014 of Tributary B and Tributary A. The samples were all analyzed for *E. coli* and for the presence of *E. coli* 0157:H7. The results of this testing are summarized in Table 8. It is found that none of the surface waters tested positive for *E. coli* 0157:H7. Tributary B and Tributary A contained 10 CFU/100 ml and 4 CFU/100ml respectively of *E. coli*. Certificates of Analysis are provided in Appendix C.

Table 8: Summary of Bacteriological Testing

Date	April 8 2014		April 16, 2014			
Location	Total Coliform (CFU/100 ml)	*E. coli* (CFU/100 ml)	Total Coliform (CFU/100 ml)	*E. coli* (CFU/100 ml)	Giardia	Crypto-Sporidium
Tributary A			1000	4		
Tributary B Upstream (SW4)	70	40	300	10		
Tributary B Downgradient (SW8)	120	20				
Tributary C	210	10				
Guelph Limestone Quarry			60	0	Negative	Negative

The bacteriological testing confirms that local streams are carrying bacteria including *E. coli*. These streams are contributing water to the local aquifer upgradient, cross-gradient and downgradient of the proposed Hidden Quarry. The samples obtained from the Guelph Limestone Quarry did not contain *E. coli*, giardia or cryptosporidium.

The source of the *E. coli* in local streams is likely farming activities such as cattle yards and manure spreading. The off-site watersheds of Tributary B (511,366 m^2) and Tributary C (1,924,590 m^2) are shown on Figure 8. These watersheds include surface water and groundwater contaminating activities such as cattle yards, cash crops, horse training facilities, manure storage and septic systems. Sampling at the Hidden Quarry site has already proven that shallow groundwater is impacted by nitrate from upgradient farming practices. Although the Hidden Quarry will be closer to the five downgradient wells than the farm fields, cattle yard and horse facilities, Tributaries A, B and C deliver contaminants to the lands just north of Hwy 7 where these contaminants infiltrate and enter the bedrock aquifer underlying the sand and gravel.

Quarrying is not considered a “threat” under source water protection. The potential for degradation of groundwater from quarry activities or the rehabilitated quarry is limited to biological factors emanating from the natural environment associated with the quarry, ie waste products from waterfowl or decomposing vegetation. Water quality monitoring from proxy sites demonstrates that the water quality in quarries is generally far better than that found in the tributaries A, B and C at the Hidden Quarry site. Thus, the potential for contamination of groundwater from quarry activities or the rehabilitated quarry is less than the potential for contamination from livestock farming or the application of manure to farm fields. In terms of stored volume of water, the dilution potential of the west quarry pond containing approximately some 2,400,000 m^3 of water is at least 20 times greater than the dilution potential of the existing bedrock aquifer.

It remains our opinion as stated in the January submission, that the Hidden Quarry will not be a major source of potential bacteriological contamination in this area.

4.2 Recent Research and Susceptibility of Local Wells to Contamination

Research conducted by A. Best at the University of Guelph in 2012 shows the vulnerability of the dolostone aquifer in nearby Arkell where one application of manure results in significant bacteriological contamination of the underlying bedrock aquifer. The bedrock aquifer at the Arkell research site is overlain by more than 12 metres of glacial sediments. This suggests that the aquifer downgradient of Tributary A, B, or C where glacial sediments are known to be less than ten metres thick are already susceptible to contamination originating from surface water infiltration.

Other recent research is telling us that bedrock wells are already vulnerable with 92% of wells tested by Amy Allen (M.Sc. Thesis, 2013) in Southern Wellington County having some indication of sewage derived contamination. Her conclusion as repeated below is astounding;

"all well types completed in the fractured bedrock aquifers of southern Wellington County are susceptible to contamination with at least one type of organic wastewater contaminant regardless of the well's construction, depth, surrounding land use, or overburden thickness. The wide array of wells sampled in this investigation revealed that areas served by sewers and septic systems are both vulnerable to human waste streams. As 95% of the wells exhibited wastewater contaminants, fractured bedrock seems to be more vulnerable to these contaminants than previous American (Barnes et al., 2008) and pan-European (Loos et al., 2010) studies would suggest."

Groundwater contamination from human activities is already occurring in this area. Measured existing nitrate levels in groundwater from agricultural activities in the area are already elevated. While not considered in the analysis for purposes of conservatism, it is likely that sunlight, biological activity within the quarry pond and the dilution potential of the quarry will result in improved water quality in the aquifer.

4.3 Waterfowl Use of Hidden Quarry Pond

The use of the East and West Pond by waterfowl will be limited by characteristics of the pond such as deep water, rocky shoreline and dense shoreline vegetation as discussed by GWS Ecological and Forestry Services (Appendix D).

Waterfowl were observed in the Guelph Limestone Pond at the time of the water quality sampling for *E. Coli*, cryptosporidium an giardia. None of these bacteria were detected in the water.

It is our conclusion that the natural introduction of nutrients and bacteria by waterfowl and wild mammals will not occur on a significant level.

4.4 Water Quality Early Warning and Mitigation

Quarry activities will commence in the northernmost extent of the site and west of Tributary B. As shown on Figure 9, groundwater monitor M3 and M16 will initially be downgradient of the sinking cut and ultimately M15 and M4 will be downgradient of the quarry pond. It will take approximately four years at maximum extraction levels to extend the quarry from the sinking cut near M3 to the western extent near M1. The proposed semi-annual water quality monitoring at M3, M16 and M15 will be able to detect water quality changes well in advance of water moving off-site. As shown on Figure 9, even after the end of four years (Phase 1 of the quarry), the only private wells downgradient of the quarry will be W10 and W16. Ultimately M4 will also be downgradient of the quarry pond(s). Through this monitoring effort, water quality changes in the aquifer will be observed and mitigative measures taken if necessary.

The drilling and testing of M16 will not occur until the quarry license has been approved. There will be several years of activity on the west side of Tributary B before the quarry on the east side of Tributary B is commenced. This will give ample time for baseline conditions (quality and quantity) to be established. Even after Phase 2 has been completed, the only potential downgradient wells of the open quarry ponds are W10 and W16.

Water well surveys of the five wells immediately downgradient of the site have been undertaken at various times since 1995. Table 9 summarizes the water well survey efforts made by Harden Environmental since 1995. The surveys confirm that none of the wells immediately downgradient meet current Ontario Regulation 903 standards. Two of the wells are buried (i.e. covered with soil), two are located in deep well pits and one has been damaged by landscaping equipment. In addition, at least one of the wells is located downgradient of their own septic system. These wells do not need to be accessed for water quality assessment (water will be taken from plumbing fixtures), therefore, upgrades to downgradient wells are not necessary (water levels are expected to rise, therefore regular water level monitoring is not necessary).

Baseline water quality and quantity assessments of these wells (W10, W16, W17, W18 and W19) will be undertaken as part of the overall private well survey. Pro-active modifications or retrofitting of these down gradient wells such that they are only taking water from the deeper fracture sets will be undertaken at the request of the landowner. Out of an abundance of caution we have also recommended that at-source domestic UV treatment systems be installed at the downgradient wells. UV systems should be in place in this fractured bedrock environment area in any event even without a quarry. All modifications will be done at no cost to the landowners. With these measures in place it is our opinion that there will remain access to abundant high quality domestic water supplies at all receptors.

Section 3.2 of the Monitoring Program addresses water quality monitoring and contingency measures for private wells.

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5.0 Local Well Survey

James Dick Construction Ltd. has agreed to undertake a voluntary detailed well inventory and water quality assessment of wells within 500 m of the quarry. This will be conducted to establish baseline water quality and quantity conditions. Harden Environmental has already undertaken three such studies as summarized in Table 9 and Figure 10. Since

1995 we have surveyed forty local residents and have on at least one occasion, visited every residence within 500 metres of the quarry.

James Dick Construction Ltd. has agreed to upgrade wells, those in pits or buried, to facilitate water level monitoring of upgradient wells, if agreed to by the home owner. Based on previous surveys, this will include wells W5, W8 and possibly W7. Downgradient wells and those distant from the quarry are not expected to experience any significant water level change, or have a higher water level, and thus regular water level monitoring is not needed and water quality can be obtained from the existing plumbing system.

Residents at locations W25 to W30 and W36 to W40 will be asked if they are willing to participate in the voluntary baseline monitoring program. These wells are beyond the 500 metre distance and unlikely to be impacted by the quarry. However, a one-time baseline survey will be conducted.

There will be a minimum period of two years after the quarry is given approval before below-water-table extraction can conmmence. This provides ample opportunity to obtain seasonal water quality data as recommended by Burnside and Associates.

6.0 Quarry Depth Limitation

James Dick Construction Ltd. has agreed to limit the depth of the quarry to a minimum elevation of 327 m AMSL.

7.0 Brydson Spring and Blue Springs Creek

We disagree that the quarry will decrease the flow in Brydson Spring. The hydraulic potential at the southern edge of the quarry will increase, thereby increasing the hydraulic gradient between the quarry and the spring. In addition, the volume of water stored in the quarry will moderate seasonal water level change, thereby providing a more stable source of water during drier conditions. It is likely that the infiltrating waters of Tributary B and C contribute significantly to the Brydson Spring discharge. Since flow in Tributary B and C will not be affected by the quarry operation, no change in the outflow from Brydson Spring will occur.

James Dick construction has agreed, providing that permission is given by the owner, to conduct flow and water quality testing of the spring to establish baseline conditions.

8.0 Rock Extraction Water Level Change Monitoring

JDCL has agreed to limit the depth of the quarry and thus the sinking cut will now extend from the top of the bedrock to a minimum elevation of 327 m AMSL. The elevation of the water table in the sinking cut is approximately 350 m AMSL, thus there will be approximately twenty-three metres of standing water in the sinking cut. James Dick Construction Ltd. is agreeing to a maximum drawdown of 2.54 metres in the sinking cut and will modify the extraction rate to ensure that this water level drawdown is not exceeded.

The nearest groundwater monitor to the sinking cut is M3. The hydrograph of M3 is found attached as Figure 11. The low water level in M3 is 349.37 m AMSL. We propose to use this as the reference elevation resulting in a minimum allowable water elevation in the sinking cut of 349.37 – 2.54 = 346.83 m AMSL. JDCL proposes to hang a buoy from a tether with the buoy floating in the water until the water level falls below an elevation of 346.83 m AMSL. The buoy will be a visual indicator of the minimum allowable water level to the operator. Once the extraction face has been established, a level logger will be used to verify that water levels in the sinking cut do not fall below 346.83 m AMSL.

There will only be two sinking cuts necessary for this quarry, one each on the east and west sides of Tributary B. James Dick Construction Ltd. is agreeing to a maximum water level change of 2.54 m in each sinking cut.

As suggested by Burnside and Associates, the frequency of automatic water level measurements during the first three months of bedrock extraction will be increased to five minute intervals. A revised monitoring program with this change is attached as Appendix E.

As suggested by Burnside and Associates, a dedicated monitoring well completed as an open hole to 327 m AMSL will be installed within the quarry limits. This well will be installed as M17 at the location shown on Figure 2. M17 will be installed upon approval of the quarry. This monitor has been added to the monitoring program.

8.1 Historic Low Water Level

There is a seasonal water level variability observed in groundwater monitors at the Hidden Quarry site. A similar magnitude of natural variability is expected to occur in private wells. It is expected that there will be a maximum water level change at the quarry edge of 2.45 metres and 1.6 metres at the nearest private well. This quarry induced change is in addition to the natural variation in water levels. Therefore, we are stating that when water levels are at their natural low (as obtained from historic water level data), an additional 1.6 metres of water level change is anticipated at the nearest well. James Dick Construction Ltd. has agreed to conduct a voluntary detailed private well survey to determine if any wells could be impacted by the predicted change in water level and either modify the well or decrease allowable drawdown in the quarry as necessary. It is anticipated that there may be small water level changes in wells W3, W4, W5, W7, W8 and W9, however, these small changes will not have any impact on the ability of these wells to supply the farm and domestic uses currently in place. With the permission of the land owner, James Dick has agreed to monitor these wells to establish baseline conditions prior to quarrying as outlined in Section 5 of this letter.

The details of how drawdown monitoring in the monitoring network is presented along with trigger levels in the proposed monitoring program (Appendix E). These trigger values are based on the lowest historical water level plus the anticipated water level change.

8.2 Monitoring Plan Revisions

The following revisions have been made to the monitoring plan. The revised monitoring plan is found in Appendix E.

1) At the request of the GRCA we have increased flow measurements at SW4, SW8 and SW3 to monthly.

2) At the request of the GRCA we have increased the automated frequency of water level measurements at SW4, SW8 and SW6 to four hours.

3) At the request of the GRCA we have included the Northwest Wetland in regular surface water quality monitoring.

4) The proposed sinking cut water level monitoring locations have been added to Figure C1.

5) The location of M17 has been added to Figure C1 and M17 has been added to the groundwater level monitoring program with a continuous water level recording device.

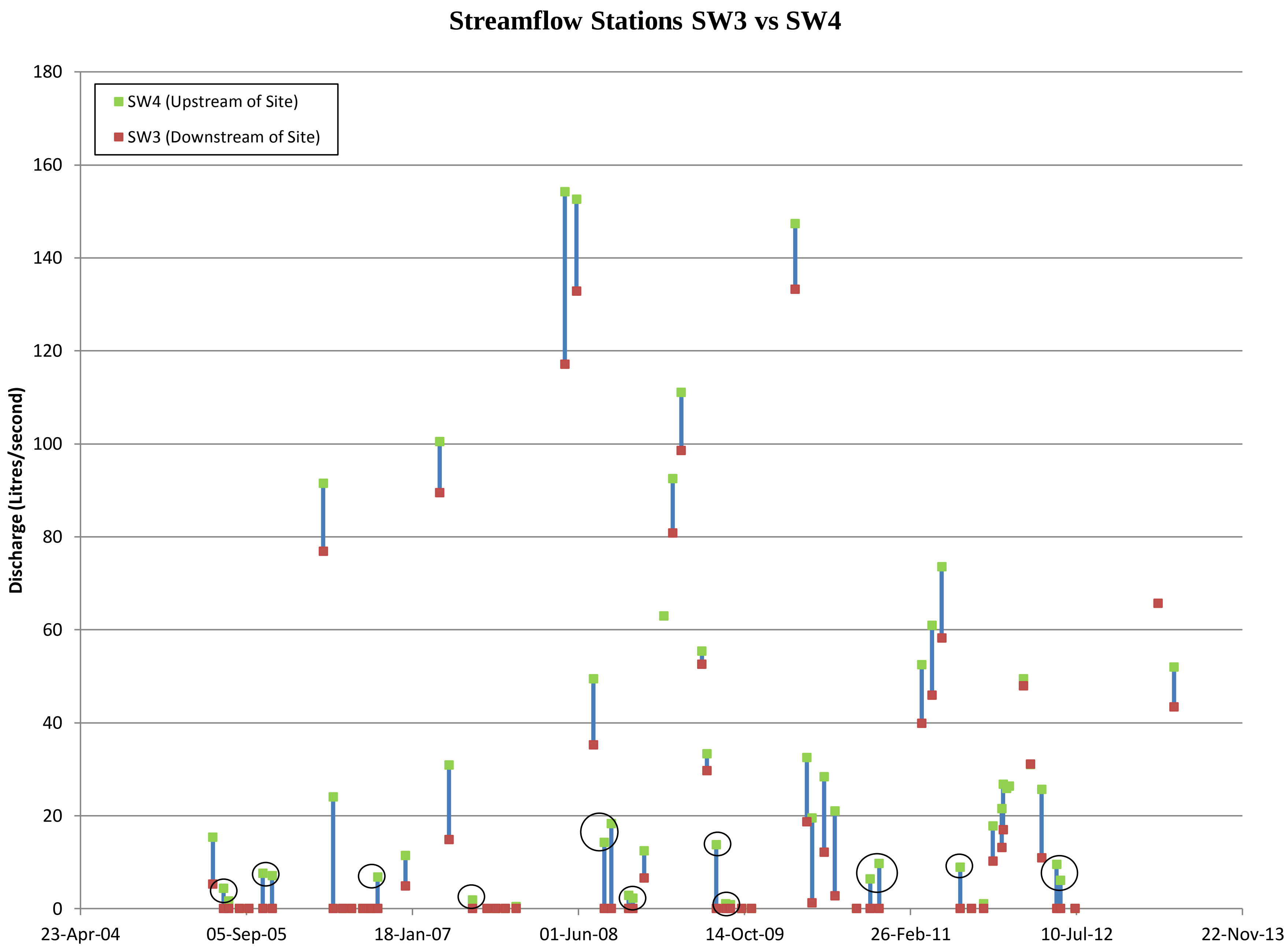
Respectfully submitted,
Harden Environmental Services Ltd.

Stan Denhoed

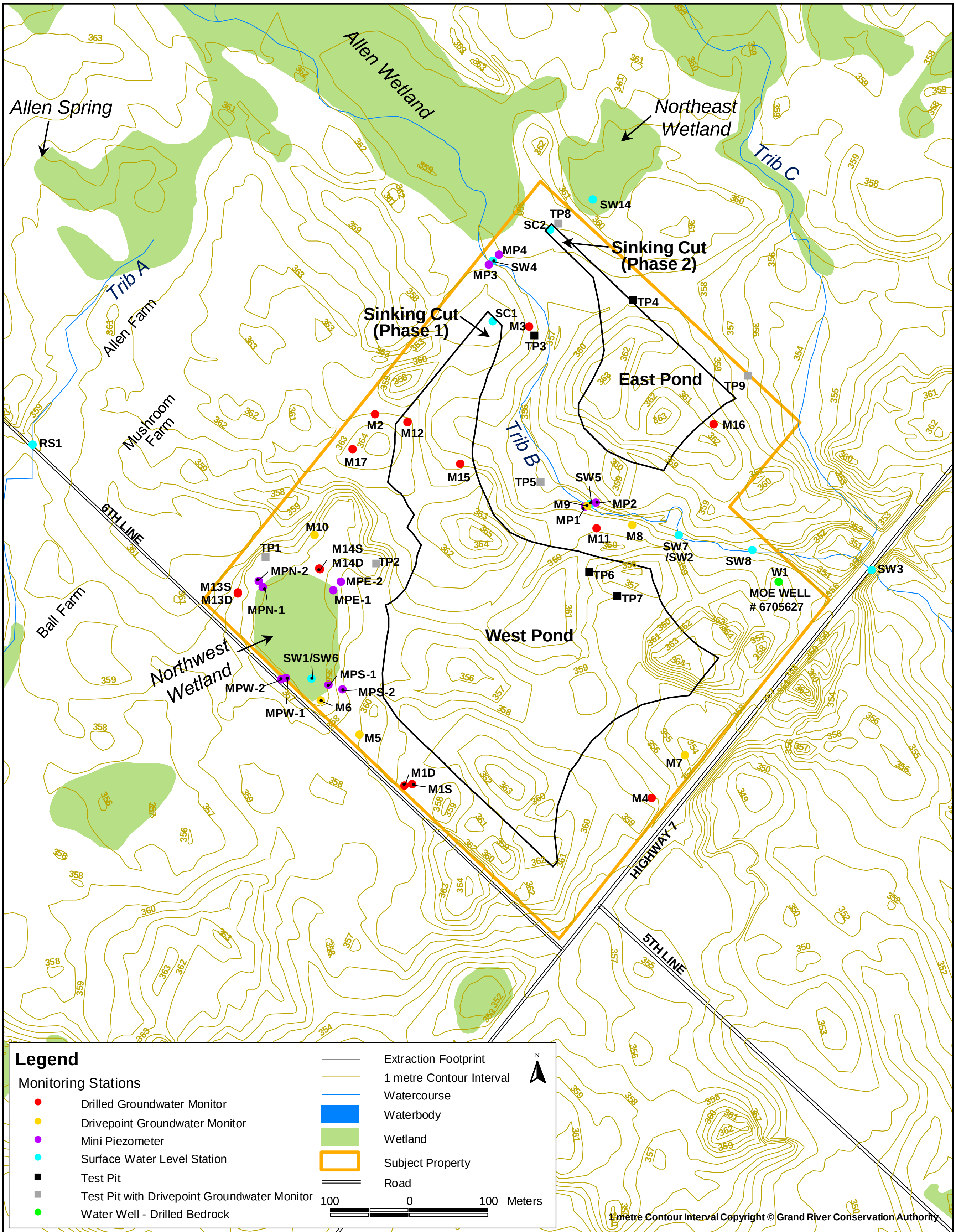
LICENSED PROFESSIONAL ENGINEER
June 10/14
S. E. DENHOED
PROVINCE OF ONTARIO

Stan Denhoed, M.Sc., P. Eng.
Senior Hydrogeologist

cc: Greg Sweetnam, James Dick Construction Limited



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 1: Streamflow Stations SW3 vs SW4**
	Date: Apr 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



1 metre Contour Interval Copyright © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506

Date: Apr 2014

Drawn By: AR

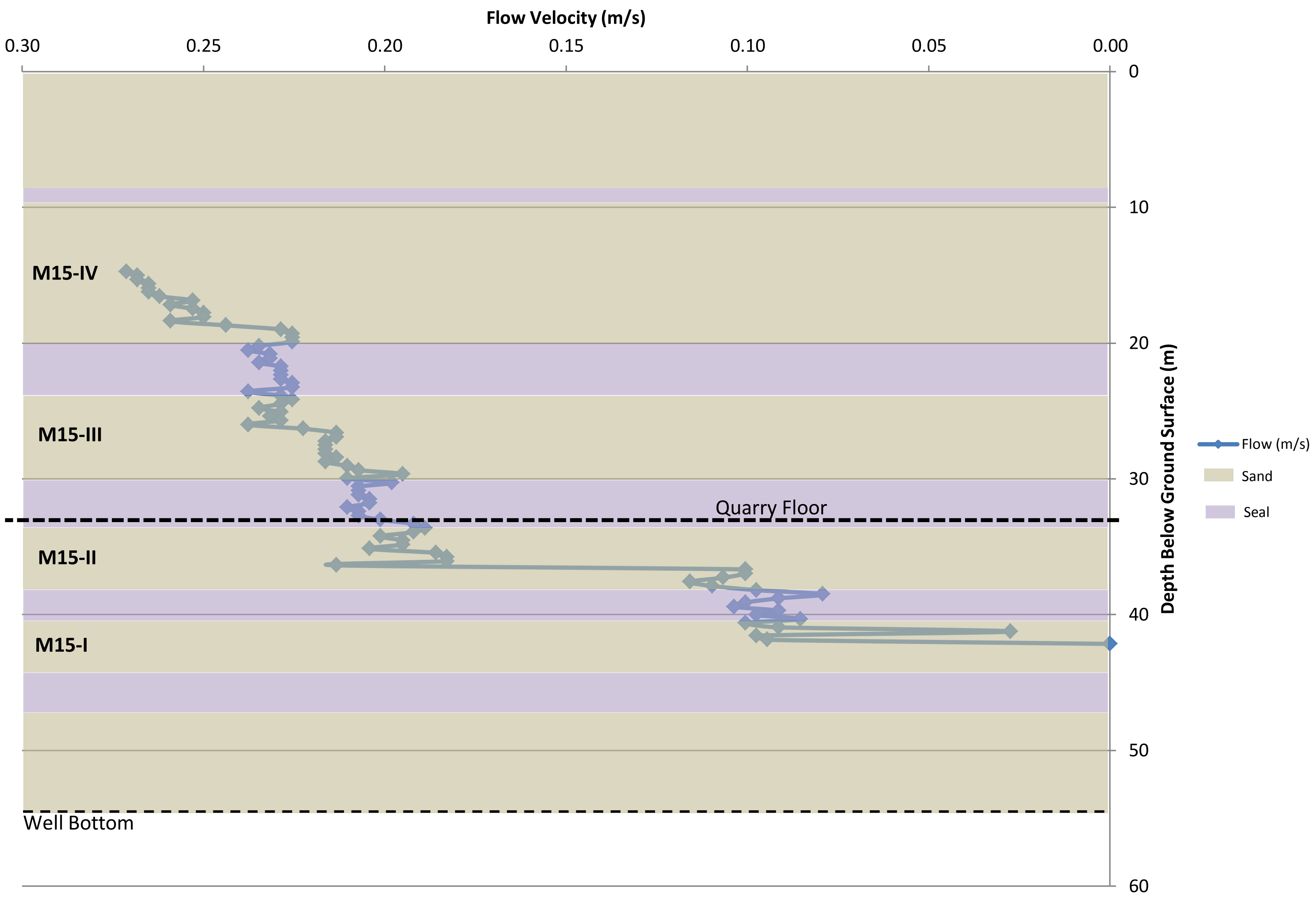
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 2:

Monitoring Locations

Installation of M15 versus Results of Flow Test



Harden Environmental Services Ltd.

Project No: 9506
Date: May 2014
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3: Installation of M15 versus Results of Flow Test

Harden Environmental Services Ltd.

Project No: 9506

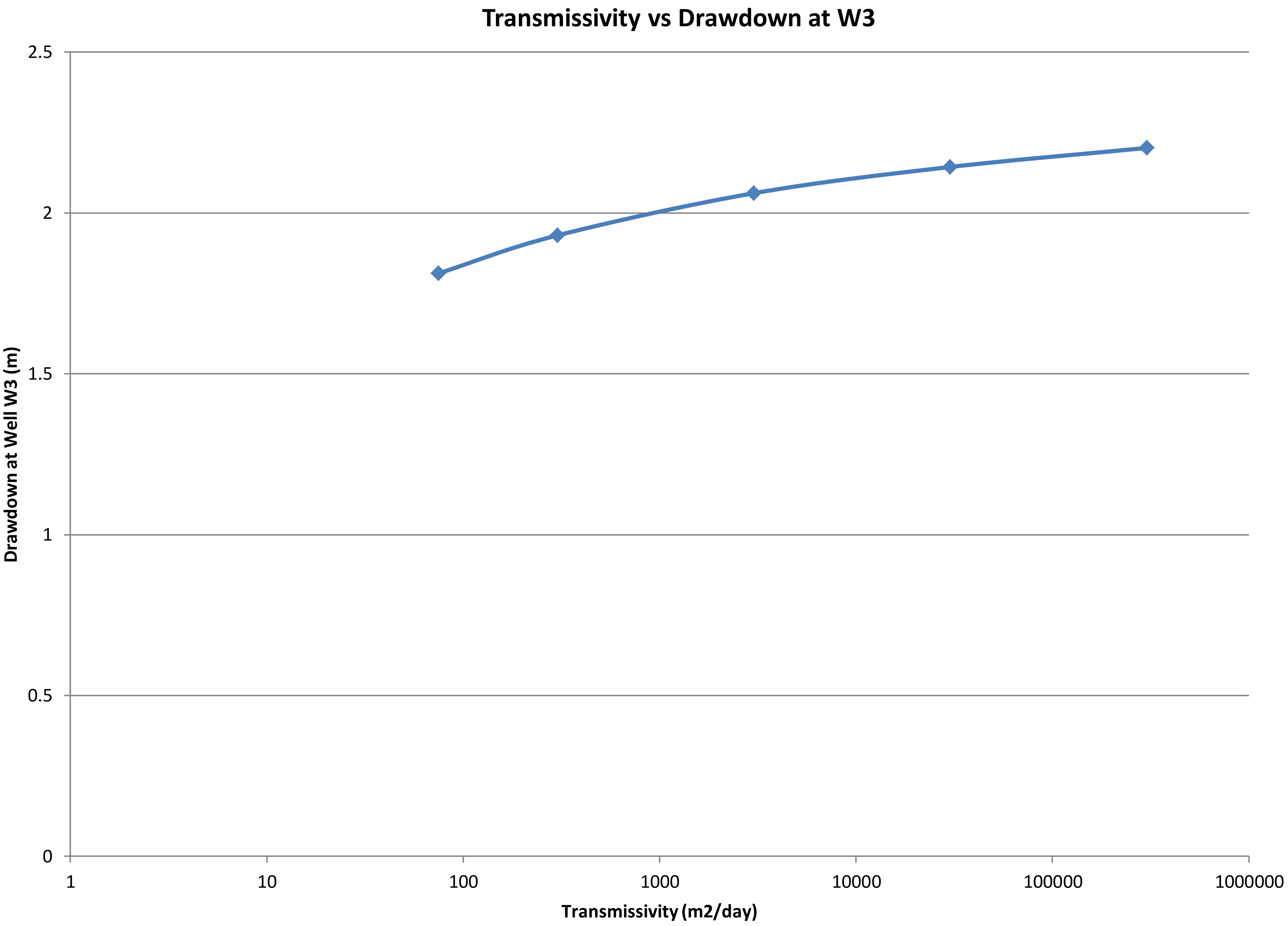
Date: May 2014

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 4: Dewatering Wells



Harden
Environmental
Services Ltd.

Project No: 9506

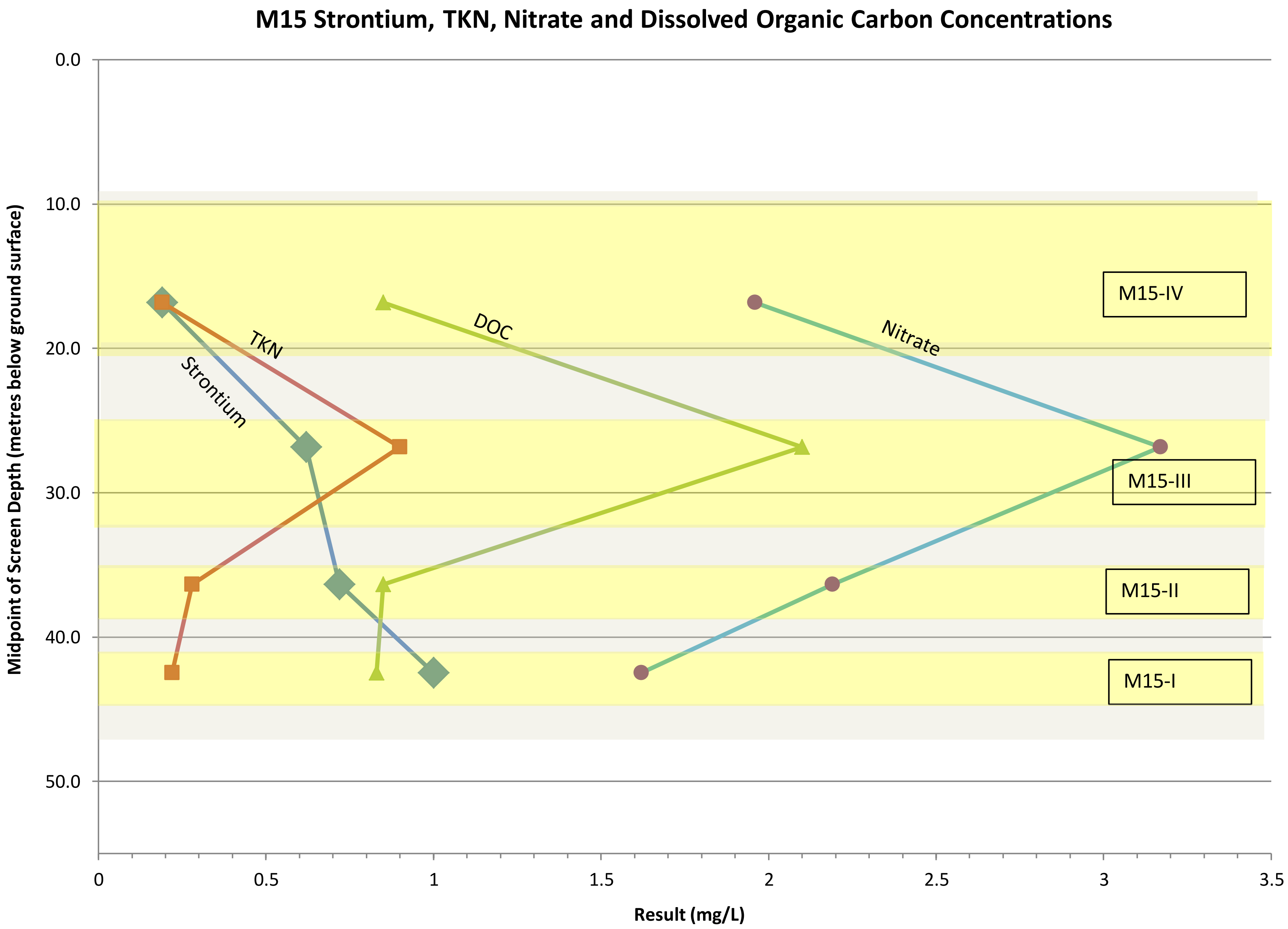
Date: May 2014

Drawn By: AR

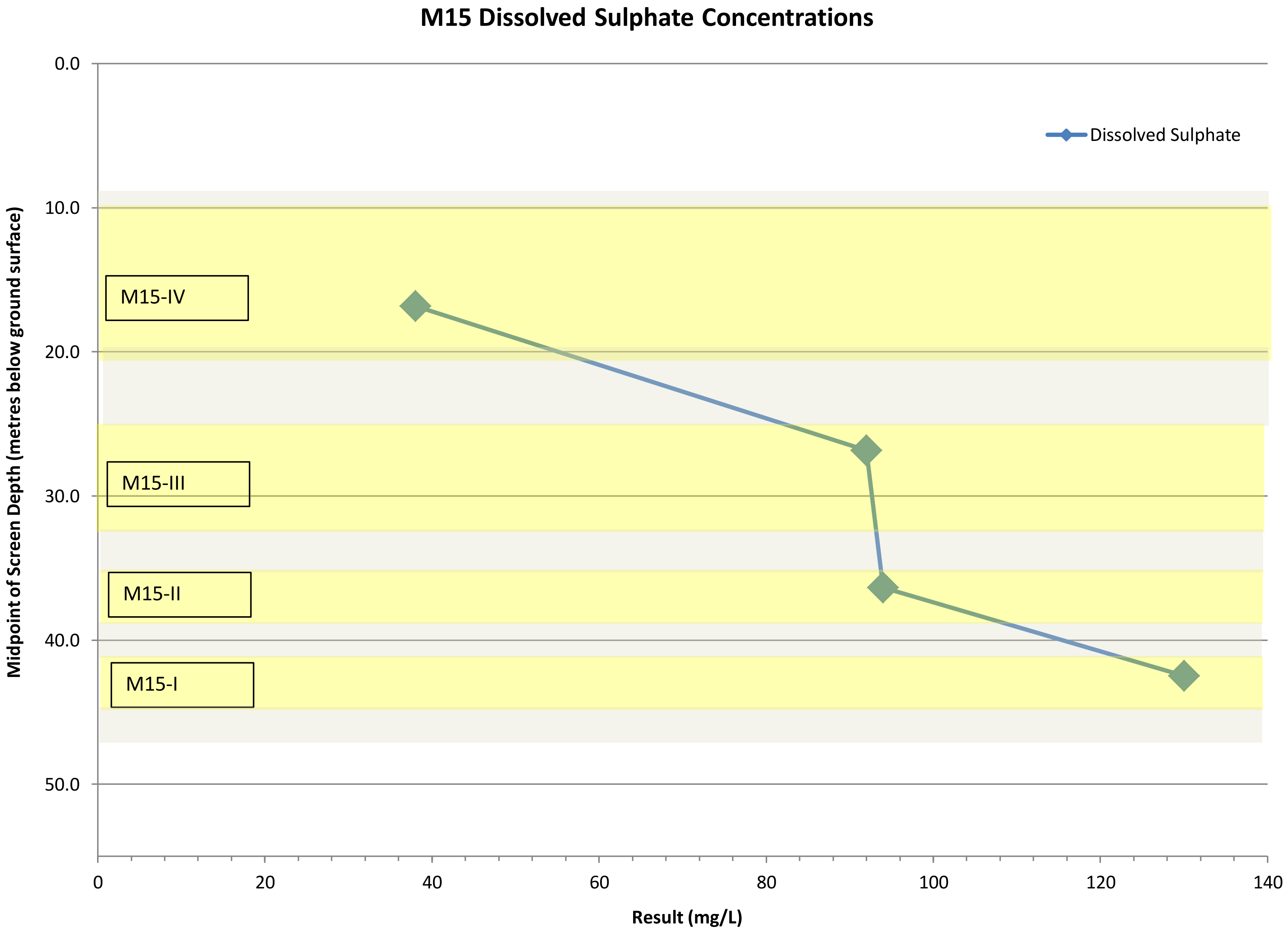
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 5: Transmissivity versus Drawdown at W3

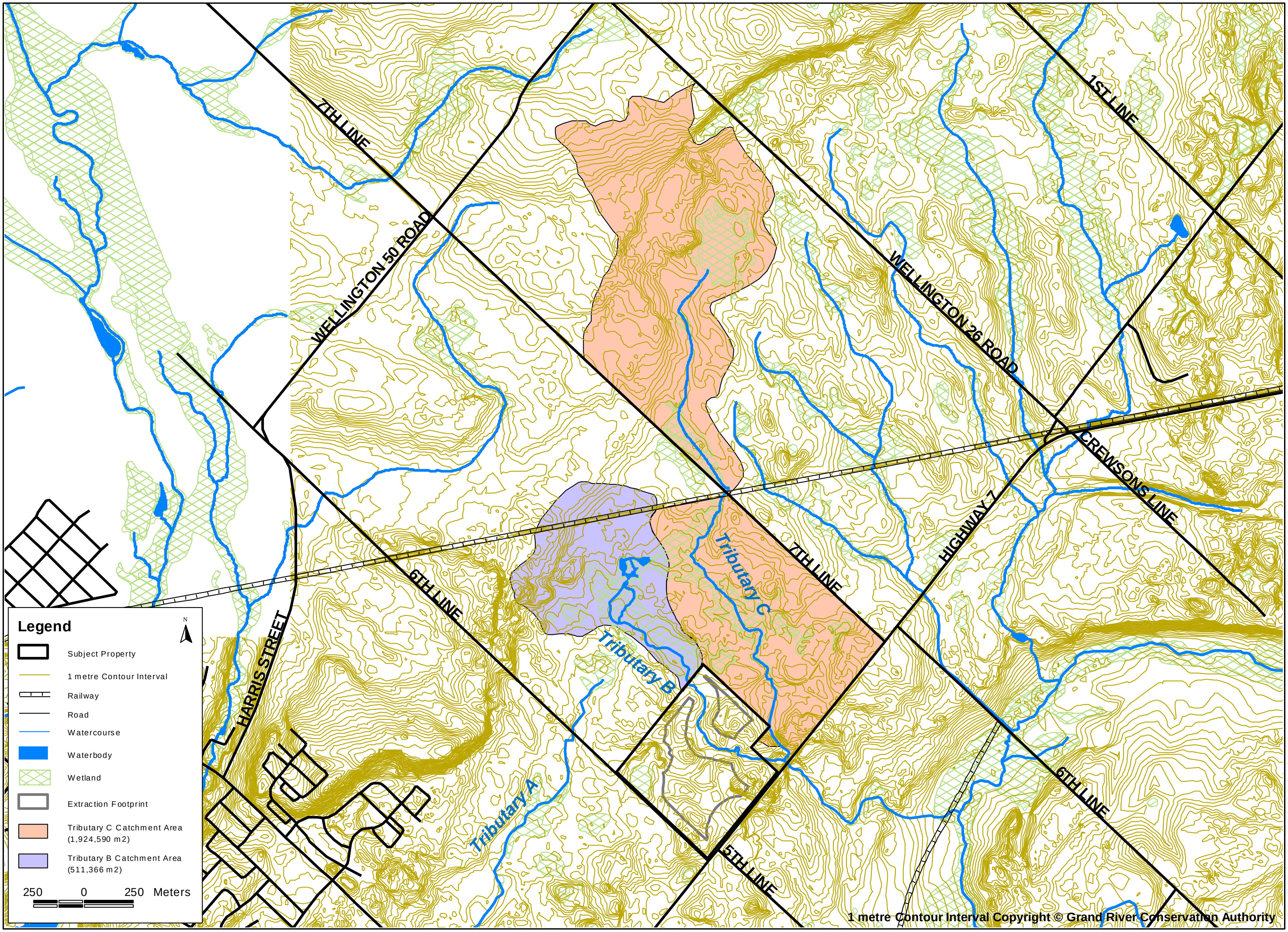


Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 6: M15 Water Quality Results**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 7: M15 Water Quality Results**
Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		



Harden Environmental Services Ltd.

Project No: 9506

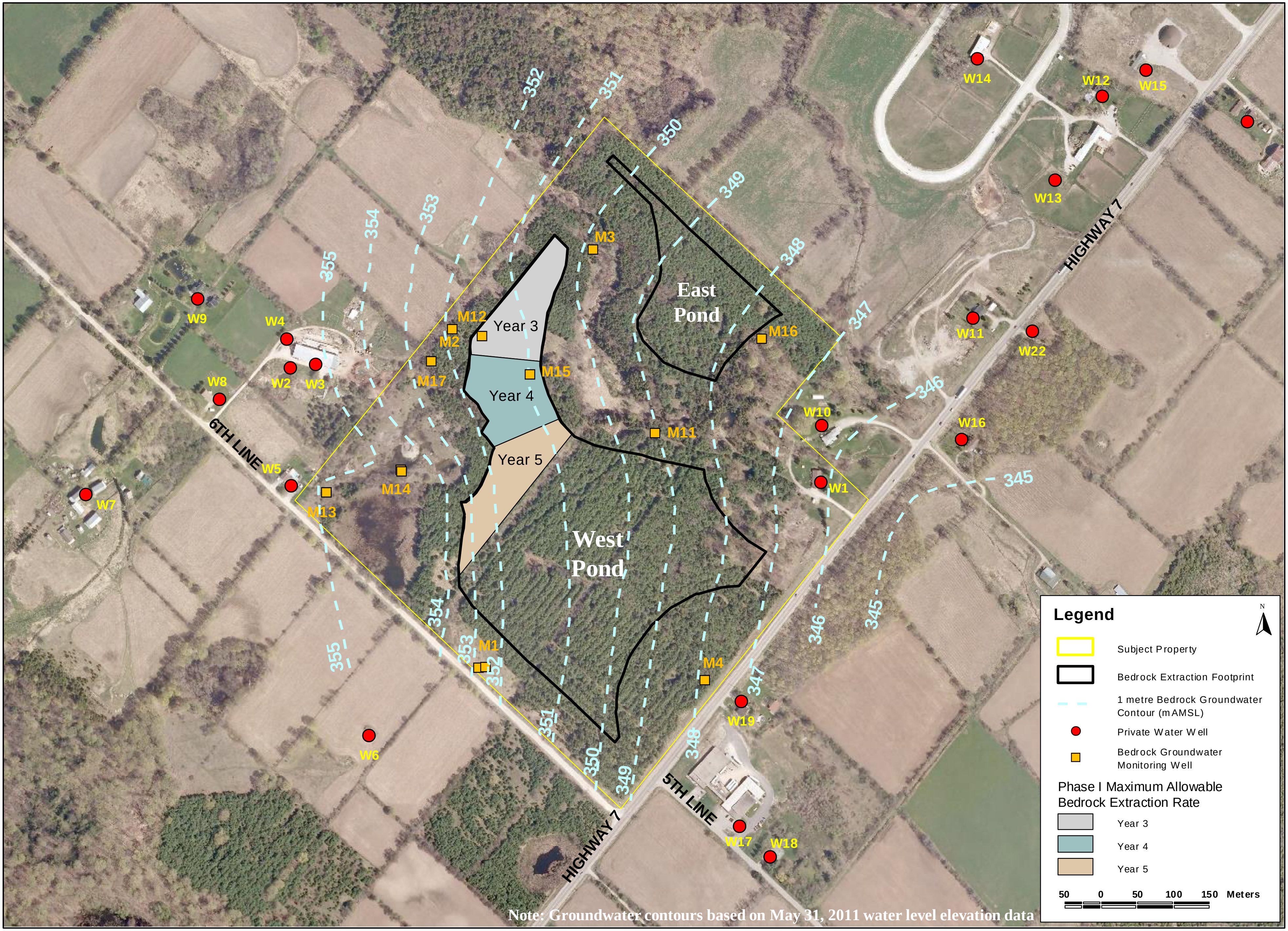
Date: Apr 2014

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 8: Watersheds of Tributaries B and C

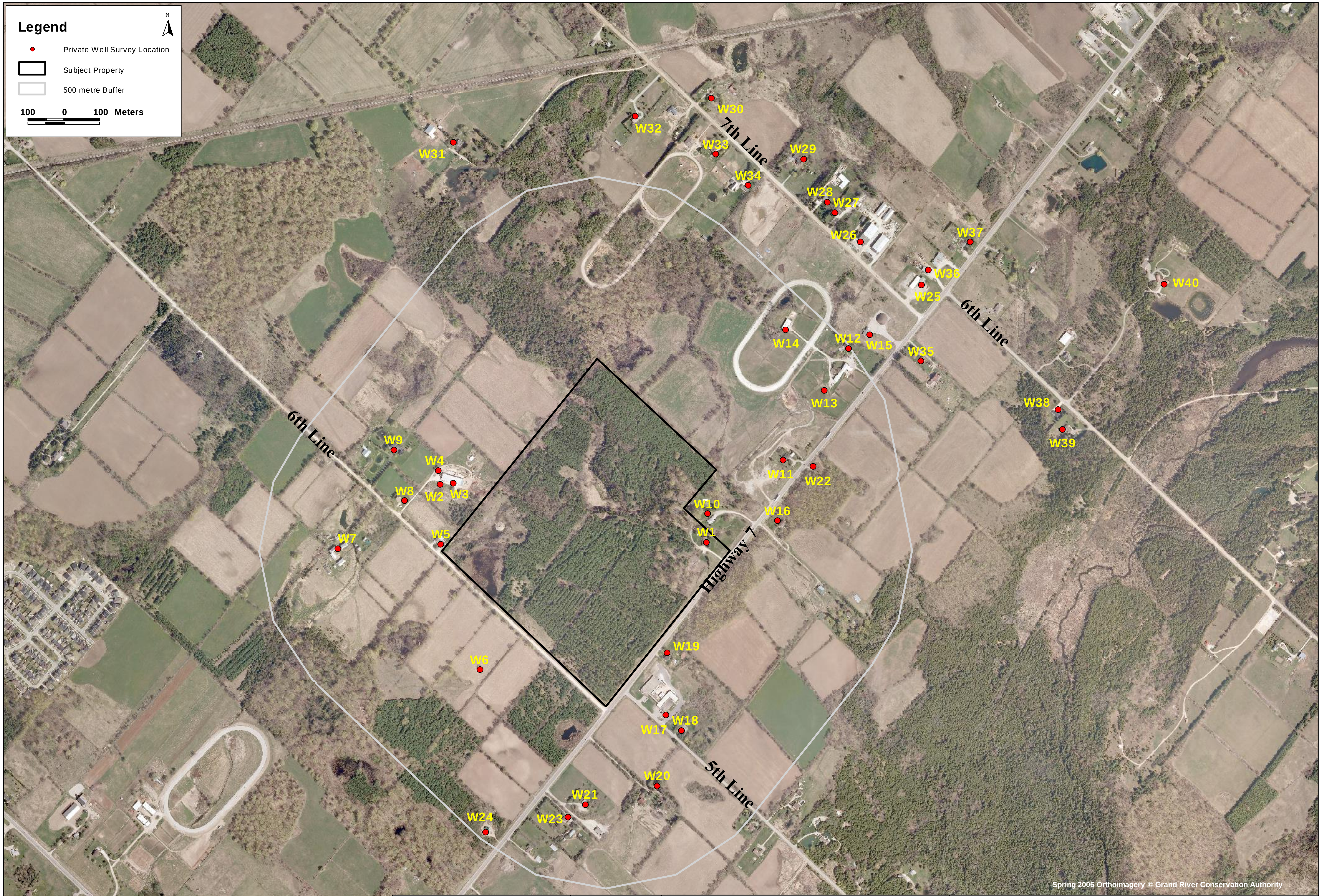


Note: Groundwater contours based on May 31, 2011 water level elevation data

Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction
Date: May 2014	
Drawn By: AR	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington

Figure 9: Maximum Rate of Bedrock Extraction



Spring 2006 Orthoimagery © Grand River Conservation Authority

Harden Environmental Services Ltd.

Project No: 9506

Date: Apr 2014

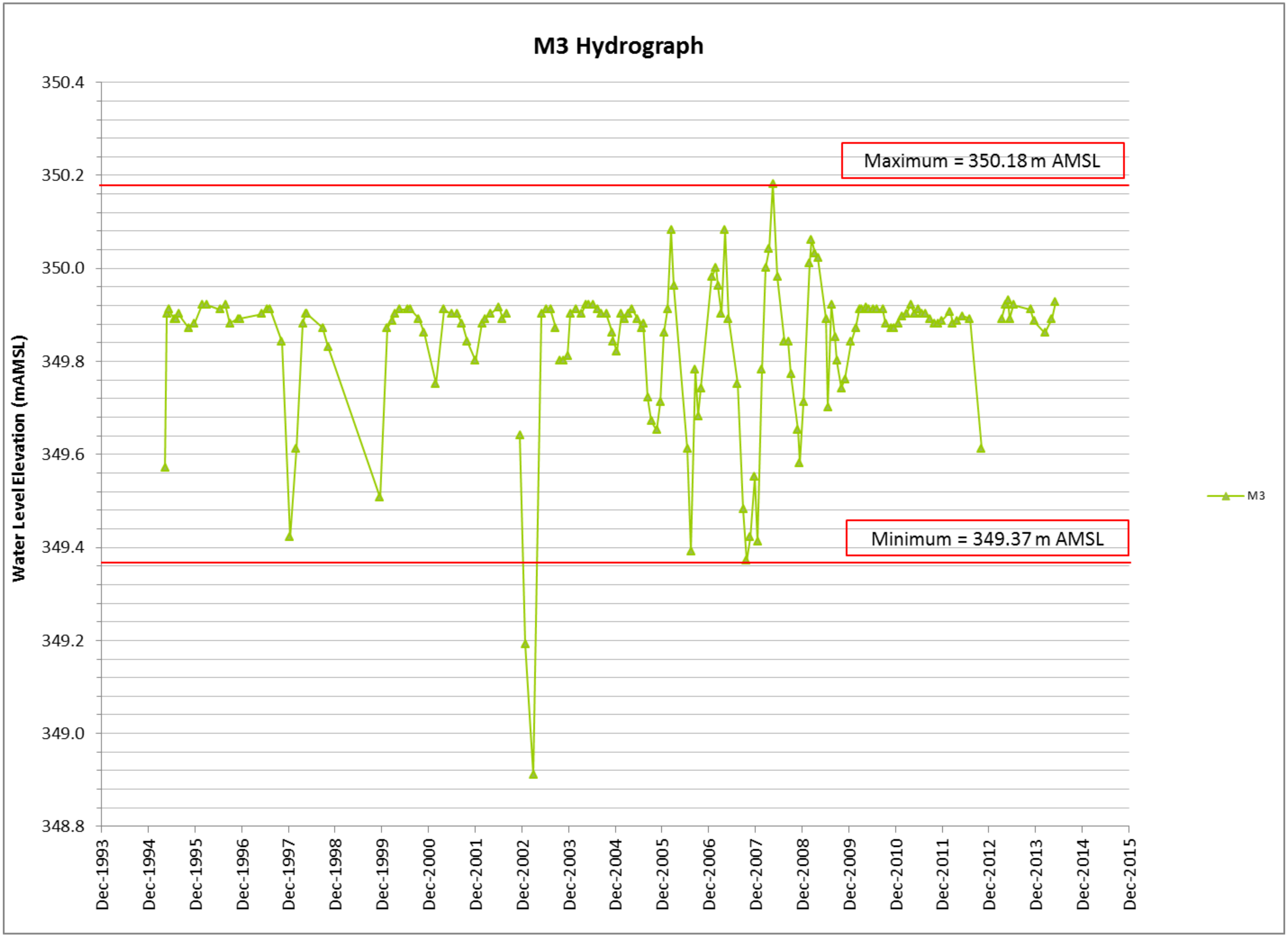
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 10:

Private Water Well Locations



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 11: M3 Hydrograph**
	Date: Jun 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Table 6: Nitrogen Compounds in Groundwater and Surface Water

Station	Type	Date	NH3-N (mg/L)	NO2-N (mg/L)	NO3-N (mg/L)	TKN (mg/L)	Calculated Organic Nitrogen (mg/L)	Total Nitrogen (mg/L)
M3	Groundwater	20-Nov-13	ND	ND	5.2	0.77	0.77	5.97
M2	Groundwater	20-Nov-13	ND	ND	4.6	1.3	1.3	5.9
SW4	Surface Water: Tributary B	08-Apr-14	ND	ND	4.64	0.54	0.54	5.18
SW8	Surface Water: Tributary B	08-Apr-14	ND	ND	4.53	0.43	0.43	4.96
M15-3	Groundwater	05-May-14	ND	ND	3.17	0.9	0.9	4.07
M15-2	Groundwater	05-May-14	ND	ND	2.19	0.28	0.28	2.47
Guelph Limestone 2012	Guelph Limestone Quarry Pond	15-Feb-12	0.39	0.05	1.2	0.7	0.31	2.34
M15-4	Groundwater	05-May-14	ND	ND	1.96	0.19	0.19	2.15
M15-I	Groundwater	05-May-14	ND	ND	1.62	0.22	0.22	1.84
SW11	Surface Water: Tributary C	08-Apr-14	ND	ND	0.9	0.62	0.62	1.52
M13D	Groundwater	20-Nov-13	ND	ND	0.9	0.38	0.38	1.28
Guelph Limestone S2	Guelph Limestone Quarry Pond	28-Apr-14	ND	ND	0.46	0.43	0.43	0.89
Guelph Limestone S3	Guelph Limestone Quarry Pond	28-Apr-14	ND	ND	0.44	0.43	0.43	0.87
Guelph Limestone S1	Guelph Limestone Quarry Pond	28-Apr-14	ND	ND	0.47	0.31	0.31	0.78
Guelph Limestone S4	Guelph Limestone Quarry Pond	28-Apr-14	ND	ND	0.47	0.29	0.29	0.76

Table 9: Private Well Surveys

		Date Surveyed			
Well Identifier	**Address**	**1995**	**1998**	**2011**	**2012**
W1	8532 Hwy 7		✓	✓	✓
W2	4949 6th Line		✓	✓	
W3	4949 6th Line			✓	
W4	4949 6th Line			✓	
W5	4943 6th Line		✓	✓	
W6	4958 6th Line		✓	✓	
W7	4958 6th Line		✓	✓	
W8	4953 6th Line		✓	✓	
W9	4963 6th Line		✓	✓	
W10	8540 Hwy 7		✓	✓	
W11	8554 Hwy 7		✓	✓	
W12	8572 Hwy 7		✓	✓	
W13	8572 Hwy 7			✓	
W14	8572 Hwy 7			✓	
W15	MTO Hwy 7 & 7th Line	✓	✓		
W16	5134 Hwy 7		✓	✓	
W17	14321 5th Line		✓	✓	✓
W18	14297 5th Line		✓	✓	
W19	5036 Hwy 7		✓	✓	✓
W20	4300 Hwy 7		✓	✓	
W21	4264 Hwy 7		✓	✓	
W22	5198 Hwy 7	✓		✓	
W23	4248 Hwy 7		✓	✓	
W24	8470 Hwy 7			✓	
W25	Northeast corner Hwy 7 & 7th Line	✓			
W26	Northeast corner Hwy 7 & 7th Line	✓			
W27	Northeast corner Hwy 7 & 7th Line	✓			
W28	4925 7th Line	✓			
W29	4935 7th Line	✓			
W30	4961 7th Line	✓			
W31	4970 7th Line	✓		✓	✓
W32	4964 7th Line	✓			
W33	4952 7th Line	✓		✓	
W34	4944 7th Line	✓		✓	
W35	Hwy 7 South Side first house west of 7th Line	✓			
W36	Hwy 7 North side East of Well ID 25	✓			
W37	Hwy 7 North side East of Well ID 36	✓			
W38	RR1 Acton	✓			
W39	RR1 Acton	✓			
W40	RR1 Acton	✓			

Appendix A

Burnside & Associates Comments

April 8, 2014
April 9, 2014

R.J. Burnside & Associates Limited 292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4 Canada
telephone (519) 823-4995 **fax** (519) 836-5477 **web** www.rjburnside.com

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April 8, 2014

Via: Email and Mail (sdenhoed@hardenv.com)

Mr. Stan Denhoed, M.Sc., P.Eng.
Sr. Hydrogeologist
Harden Environmental Services Limited
4622 Nassagaweya-Puslinch Townline Road
RR 1
Moffat ON L0P 1J0

Dear Mr. Denhoed:

Re: Harden Environmental Services Limited January 14, 2014 Letter – Response to Burnside Review of Summary of Drilling and Testing of New Well M15 at Hidden Quarry Site
File No.: 300032475.0000

Thank you for your letter of January 14, 2014 which provides your responses to the November 12, 2013 Burnside review of the Summary of Drilling and Testing of New Well M15 at the Hidden Quarry Site.

The level of on-site data has been improved. Additional assessment and background data collection is required to reduce the number of variables. Burnside recommends that the monitor well construction/testing/sampling and domestic well survey be completed as soon as possible to improve our understanding of the bedrock aquifer.

The Burnside responses below are ordered in the same number as your comments in the January 24, 2014 letter.

2.2 Bedrock

Burnside concurs with Harden that the Eramosa confining layer is not present at the site and that the extraction will occur in the Niagara Falls Member and Gas Port Formation.

2.3 Description of Core Breaks

Agreed.

3.0 Pumping Test

Burnside is satisfied with the Harden response. It is anticipated that the pre extraction monitoring program that will be conducted at the Site will assist in identifying which fractures are inter connected and as a result which of the bedrock fractures may be impacted during the extraction of rock from the Quarry.

3.1 Flow Test

Burnside is satisfied by the Harden response. The pre-extraction monitoring program will assist in confirming that the maximum allowable dewatering of the bedrock of 2.5 m as developed by Harden is an appropriate value. It is anticipated that Harden/James Dick will provide additional detail on how the daily maximum drawdown will be monitored. It is expected that monitoring of water levels during the initial stages of the site works will be intensive (less than hourly). Once conditions are understood then monitoring events can reduce to the frequency indicated. For example, setting automatic water level recorders to 5 minute sampling intervals for the first month of quarrying activities will provide an excellent indication of the water level response at no additional cost.

6.0 Water Quality Results

The Burnside comment expressed concerns that the quarrying activities could impact current concentrations of nitrate, iron and also introduce surface water pathogens into the nearby groundwater system. The Harden response is broken down by nitrate, iron and surface water pathogens. Our response is provided below:

Nitrate

Harden provides examples from the Guelph Limestone (formerly Dolime Quarry), the Holcim Quarry in Milton Ontario and from two much larger quarries located in Florida. The examples provided by Harden indicate that the amount of nitrogen added from the explosives is generally less than 2 mg/L. Burnside trusts that the information provided by Harden is accurate and that the amount of nitrogen added from the explosives used in the quarrying process will have a small impact the down gradient well's water quality. Water samples obtained from the standing water in the Dolime quarry would be useful in this assessment as the nitrogen concentration in the discharge from a dewatering pump appears to be reduced by Dilution as the nitrogen in the discharge (0.24 to 0.65 mg/L) was much less than that measured in a sample collected within 4 hours of explosives detonation (1.9 mg/L).

Iron

Harden indicates that although samples of local groundwater contain reduced iron, the presence of a quarry with elevated concentrations of dissolved oxygen will result in the reduction of iron concentration in surface water and the groundwater down gradient of the quarry. In addition, the reduced iron will assist in the denitrification of the surface water. Burnside concurs with Harden that concentrations of iron in the groundwater will not be increased significantly down gradient of the quarry. However, there is the potential that oxygenated water entering the downgradient bedrock aquifer may result in changes to the existing downgradient water quality.

Nitrogen Mass Balance

Harden indicates that there are two sources of nitrogen at the proposed quarry. The first source is nitrogen imported to the site within the explosives used to liberate the rock. The second is nitrogen flowing onto the site in groundwater. The origin of this nitrogen is up-gradient farms which apply fertilizers (both commercial and natural) or generate manure. Harden provides a number of calculations to show the mass of nitrogen provided from the explosives, from groundwater inflow and the mass of nitrogen from up-gradient groundwater.

Burnside points out that the following factors could significantly affect the predictions made by Harden:

- The nitrate concentrations entering the quarry from the up-gradient direction may increase or decrease significantly seasonally.
- The nitrate concentration in the deep well M15 was 2 mg/L on May 24, 2013. This well is open across the entire bedrock sequence and as a result this nitrate value likely represents a mixing of water from all zones.
- The water produced from the individual fractures is based on the distribution of flows from M15; a more accurate understanding of the individual fracture characteristics including water quality, static water level and hydraulic conductivity will be obtained once the monitor well is constructed.

Burnside recommends that once M15 has been reconstructed as a multi-level monitor that water quality, water levels and hydraulic parameters be assessed in order to provide a more defensible prediction. We also note that there may be additional dilution that occurs due to precipitation which falls on the site.

Surface Water Pathogens

In their response Harden provides a list of sources of pathogens and indicates that the quarry does not represent the most likely source of surface water pathogens. Harden indicates that "*considering the elevated nitrate observed in water samples from Tributary B indicating contamination from up-gradient farming, more likely source of surface pathogens is water infiltrating into the bedrock from Tributary B. Also, the elevated nitrate concentrations in groundwater indicate that the overburden does not provide effective protection from anthropogenic activity.*" Harden should provide some commentary as to the impact of water fowl on the surface water in the quarry and how this may impact down-gradient wells.

In addition, Harden indicates that the mining is phased such that quarrying will commence in the northern portion of the site. This is the most distant part of the site from down-gradient water wells. The monitoring program is designed to determine if groundwater quality is being impacted by the quarry. Harden should provide additional detail on how the existing monitoring well network will provide sufficient early warning so that treatment systems can be installed in down-gradient domestic wells before unacceptable impacts to drinking water have occurred. In addition, once the door to door well survey has been completed, Harden should provide details on which of the three listed remedial options is the most appropriate for each individual well in the event that water quality is impacted. It is likely that given the small diameter of the existing wells in the area that the use of a liner will be impractical. As a result, Harden will need to qualify if any existing wells can be deepened or whether the installation of water treatment equipment will be the preferred option.

7.0 Recommended Multi-level Installation Details

Agreed.

8.0 Discussion

No additional comment required. However, local residents continue to raise concerns with regards to the potential for karst features to be present on the site. This issue is discussed in the response to the January 14, 2014 Harden letter responding to the Burnside comments regarding the Hydrogeological Summary Report.

Section 9.0 Response to Burnside Comments

Comment 72

Harden has indicated that James Dick Construction Limited has agreed to limit the maximum drawdown in the excavation to 2.54 m below the historic low water level.

Burnside provides the following comments:

- The location of the drawdown measurement needs to be clearly defined and should actually be a monitoring well that is representative of water levels within the quarry limits and is completed as an open hole to 320 masl. In addition to monitoring pre extraction water levels for several years within the quarry limits, James Dick will need to monitor levels in nearby domestic wells to see how levels correlate with "quarry" water levels.
- The "historic low water level" requires additional clarification. As indicated above, the location of the water level measuring point needs to be defined as does the period of monitoring used to define the historic low water level. Harden predicts that a drawdown of 2.54 m in the quarry will result in 1.60 m of drawdown in the closest domestic well. Assuming that the historic low water level in the quarry corresponds to the historic low water level in the monitored domestic well, confirmation that an additional 1.6 m of drawdown in the domestic well will not impact it's use needs to be confirmed and the allowable drawdown in the quarry decreased as necessary.
- Harden should provide additional details on how the drawdown will be monitored and which wells will be used to decide what the water level is prior to extraction of the rock. Domestic wells to be monitored should also be identified. We understand from personal communication that the water level will be measured with a float connected to the excavation itself, but this approach needs to be documented.

Comment 60

Burnside agrees that the fracture distribution with depth can vary significantly in bedrock and two wells in close proximity can have different fracture patterns. However, we note that the reliability of the water found depths in MOE well records is subject to the experience of the well contractor whereas the fracture depths in M15 were identified by both visual and flow measurements. Once M15 has been completed as a multi-level well it should be tested so that the results of the flow profiling can be verified and the nitrate values with depth confirmed. Similarly, well M16 should be completed as soon as possible. Hydraulic and water quality data from the multi-level wells should be assessed and the model revised if necessary.

Collection of both water level and water quality data should continue so that predictions regarding water quality and water level response can be confirmed/revised.

Comment 54

No Comment.

Comment 56

The Burnside letter suggested that there must be areas in the southern portion of the site where the silt unit is thin or absent which results in Tributary B entering the bedrock at some point upstream of SW3. Harden agreed with the Burnside comment. Burnside notes that concerned residents have suggested that the disappearance of Tributary B suggests that there are karst features beneath the site. It is not clear to Burnside whether Tributary B always disappears at the same point on a consistent basis or if the tributary dries up in the summer and as a result there is no flow in the tributary at the southern end of the site. It may be that the stream disappears because of the lack of a till layer over lying the bedrock combined with low flow allowing infiltration to become dominant over lateral flow. However, this should be confirmed in order to alleviate residents' concerns. Collection of water level data in the tributary at several locations with automatic recorders will provide an improved understanding of the tributary and will provide better baseline data for the assessment of impacts in the future.

Should you have any questions regarding the above, please contact the undersigned.

Yours truly,

R.J. Burnside & Associates Limited

Dave Hopkins
Sr. Hydrogeologist
DH:sd

cc Kim Wingrove, Township of Guelph Eramosa (Via: Email) (kwingrove@get.on.ca)
Saidur Rahman, Township of Guelph Eramosa (Via: Email) (srahman@get.on.ca)
Leigh Mugford, James Dick Construction Ltd. (Via: Email) (lmugford@jamesdick.com)

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April 9, 2014

Via: Email and Mail (sdenhoed@hardenv.com)

Mr. Stan Denhoed, M.Sc., P.Eng.
Sr. Hydrogeologist
Harden Environmental Services Limited
Nassagaweya-Puslinch Townline
RR 1
Moffat ON L0P 1J0

Dear Mr. Denhoed:

Re: Harden Response to Burnside Review of Hydrogeological Summary Report
Hidden Quarry Site for Township of Guelph Eramosa
Letter Dated January 14, 2014
File No.: 300032475.0000

Thank you for your letter of January 14 2014 that provides your response to several issues and concerns addressed by R.J. Burnside & Associates Limited (Burnside) in our letter of November 12, 2013.

Burnside is primarily concerned with the impact of the proposed quarry on:

- Water levels in the upgradient domestic wells,
- The water quality in the down gradient domestic wells and,
- Rockwood Well 4

Although additional information has been provided in the latest letter, the predictions regarding the response of the fracture systems in the bedrock aquifer need to be confirmed through on going data collection and a thorough investigation of nearby domestic wells.

For consistency, our comments are presented using the same numbering as those contained in the Harden letter.

1.0 Karst

Burnside concurs with Harden that there is no evidence of cavernous karst features within the site. There have been a number of boreholes advanced into the underlying bedrock and as Harden indicates there is no evidence of cavernous karst features. However, the Rockwood area is identified by the Ontario Geological Survey as a Karst area and the water producing intervals in the bedrock are described as micro karst by some fractured bedrock specialists. It is Burnside's understanding that local residents have expressed concern that Karst features may exist beneath the Site, primarily because of the disappearance of Tributary B. Harden has indicated that there can be flow in Tributary B entering the north end of the Site and under dry conditions there is no flow in the tributary as it exits the southern portion of the site. It is not clear to Burnside if the flow always terminates at the same point in Tributary B or whether there is some variation depending on weather conditions. Clarification of this would assist in understanding whether this is a "disappearing stream" or simply an intermittent stream that dries up during the summer months.

2.0 Water Quality

Harden had originally calculated a nitrate (nitrogen) mass balance in their response letter to Burnside comments on the M15 well drilling. Harden has now recalculated the nitrogen mass balance assuming that the lower 33% of the fractured bedrock does not contribute to dilution of nitrogen. As a result the anticipated nitrogen value has increased from 4.38 to 4.54 mg/L at the down gradient property line.

Burnside recommends that detailed water level and water quality data be obtained from M15 (and also M16) following completion as a multi-level monitor so that the assumptions used in the mass balance calculation can be verified. In particular, water quality data should be collected from the various screened intervals along with the other wells on site and applied to Table1.

Deeper Water Sources

The Burnside comments had suggested that the quarry would allow the shallow groundwater to mix with water from deeper zones in the bedrock. These deeper zones at 36 and 41 m are currently secure sources of groundwater that are recharged over time by water moving into those formations. Burnside indicates that the excavation of the quarry into these factures will cause the water in the deeper fracture system to be under the influence of surface water and associated bacteria and viruses such as cryptosporidium and giardia. The existing secure water supply in the deep bedrock aquifer will therefore be changed to a surface water source for an unknown distance from the quarry. Burnside indicated that once the quarry is finished, there will be a large surface water body directly in contact with the bedrock fracture system which may allow rapid movement of water pathogens towards bedrock wells down-gradient at the site.

Harden concurred that the quarry activities will result in the mixing of groundwater from various depths and indicates that test results from monitoring well M15 indicates that confining conditions occur at depth. This suggests that the water sources at depth are somewhat isolated from shallower groundwater sources unless exposed to anthropogenic contamination. Harden goes on to indicate that the majority of wells obtain water from the upper and middle portions of the aquifer exposing those wells to contamination from anthropogenic activities and possibly surface water already. Harden concludes that the quarry is being developed in an area already susceptible to contamination from the ground surface. Harden concurs that the mixing of water in the quarry will occur, however they note that this mixing already occurs in each bedrock well drilled in the area including the deep well servicing the mushroom farm. The aquifer is also exposed to surface contaminants from the Eramosa River Valley and the Blue Springs Creek Valley.

Burnside agrees that each individual well allows an opportunity for connection between the shallow and intermediate depths in the bedrock and as a result water quality in these wells will be impacted by anthropogenic sources. This is only true for the deep bedrock wells; the shallow bedrock wells in the area do not allow mixing. The quarry will connect a much larger number of fractures and will also allow the opportunity for pathogens and bacteria from waterfowl, other wildlife and near quarry runoff to directly enter the surface water body and ultimately the down-gradient water system. Although pathogens and bacteria can be dealt with by currently available home treatment technology it is Burnsides opinion that most residents would prefer to have a "clean" source of water that does not require treatment. As a result this was the intent of Burnside suggesting that the quarry stop at a somewhat shallower depth in order to allow the opportunity for impacted down gradient wells to obtain water from the deeper fracture systems.

GUDI Condition in Proposed Rockwood Well 4

Burnside has suggested that the quarry may result in the classification of future Well Number 4 as groundwater under the direct influence of surface water (GUDI). Harden provides a detailed assessment from excerpts from Ontario Regulation 178-03 and the conditions anticipated at the future Well Number 4. Harden concludes that proposed Well Number 4 will be flagged as potentially GUDI even in the absence of the proposed quarry, and that there are other potential sources of surface water contamination closer than the proposed quarry. Harden suggests that it is unlikely that fractures are isolated to the extent that interconnections to the bedrock surface will not occur between proposed Well Number 4 and the proposed quarry. Based on the information currently available, Burnside concurs with the Harden assessment of the GUDI status of future well 4. Once Well Number 4 has been constructed, testing will be undertaken to see whether there is any connection between pumping at the new well and water level responses at the quarry.

Pathogen Movement

Harden Figure 4 provides information showing the wells that are down-gradient from the quarry. Harden indicates that these are the only wells that have any risk of water quality impacts. It is Harden's opinion that the detailed monitoring program will identify chemical and bacteriological movement from the quarry and contingency measures are in place in the event that a local well is impacted. Harden indicates that recent testing of the Guelph Limestone Quarry found that the water met all the drinking water quality standards for a comprehensive suite of parameters.

It is Burnside's opinion that Harden should undertake a detailed well inventory and water quality assessment of the wells that surround the quarry. The assessment should include a sampling of wells in the spring and fall of 2014 in order to establish baseline conditions. Sampling should continue on a semi-annual basis until a sufficient baseline of data is established prior to quarry operations. Once sufficient baseline data has been collected an individual approach to addressing the potential for impact should be devised for each well. Burnside is of the opinion that wells within 500 m of the site that are located in pits or have buried well heads should be proactively upgraded so that the wells meet Ontario Regulation 903 and are easily monitored. Data collected from the domestic well survey and re-construction and testing of M15 should be used to update the groundwater model and refine the predicted impacts.

Quarry Depth Limitation

The flow profiling at M15 indicates that there are significant fractures at elevations of 318 masl and 324 masl (42 and 36 m below ground surface respectively). The proposed quarry will extend to an elevation of 320 masl. Harden indicates that they do not think that limiting the depth of the quarry to an elevation greater than 324 masl will guarantee protection of the lower fracture set. They suggest that rather than limiting the depth of the quarry that mitigation of water quality issues be undertaken at the few down-gradient wells as they occur since there are proven effective measures designed specifically to address such water quality problems.

It is Burnsides opinion that most residents would prefer to have a safe secure source of water that does not require treatment rather than treating water that has been impacted by quarry activities. As a result, Burnside recommends that the current water quality be established for all of the wells within 500 m of the site and individual plans be devised to protect the water quality for each well.

3.0 Private Wells with Shallow Fracture Sources of Water

It is Burnside's contention that shallow wells have the greatest potential to be impacted by quarry activities. As a result, Harden identified the shallow wells on Figure 5 and indicates that none of the shallow wells are located up-gradient of the quarry. The shallow wells are located down-gradient of the quarry where water levels will rise. Harden indicates that with respect to wells that are up-gradient of the quarry it is their opinion that the magnitude of change will not affect the functioning of the domestic wells. Harden indicates that this opinion will be verified upon the completion of a detailed pre-bedrock extraction water well survey. If an up-gradient well is found, during a flow test, to have a drawdown near to the location of the pump then the pump will be set to a deeper depth.

Harden disagrees with Burnsides recommendation to proactively modify all existing well as a necessary step. In the case of wells that may currently be impacted by surface runoff such as those in well pits, the improvements to the well head may result in improved quality which would reduce the likelihood that the quarry operators will have to provide water quality treatment in the future.

The plan for protection of existing wells should be devised once the domestic well survey is completed.

4.0 Groundwater Model Parameter - Hydraulic Connectivity

In this section Harden uses data obtained from well M15 and the laws of super positioning in order to assess the potential impacts of drawdown in the quarry on neighbouring domestic wells. In order to estimate the magnitude of impact at the nearest private wells shown on Figure 6, Harden calculated the cumulative drawdown from each of six dewatering wells at each private well. The drawdown was estimated using the modified equilibrium equation (Cooper and Jacob, 1946). Harden also includes a list of nine conditions that need to be met in order for the Cooper and Jacob method to be valid. Although many of the conditions are not met, it is Burnside's opinion that this method does provide additional support for the groundwater model used by Harden in the December 2012 report. Harden indicates that the analytical analysis confirms that:

- The results obtained from the model are reasonable;
- If a lower fracture set does not contribute water to the quarry the water will fill more slowly but the impact on local wells is similar to the full depth scenario; and
- The maximum drawdown in the nearest wells is always less than will occur in the quarry.

Burnside recommends that following reconstruction of M15 as a multi-level well, hydraulic and water quality data be collected from each of the screened intervals and used to improve the current interpretation of the hydrogeologic environment. Harden also indicates that their exercise supports the assertion that a shallower quarry will not result in significantly less impact. It was Burnside's suggestion that the quarry be terminated at a shallower depth in order to reduce the potential for the lower fractures to be impacted; thereby providing an opportunity for potentially impacted domestic wells to be drilled deeper.

5.0 Brydson Spring and Blue Springs Creek

Burnside's agrees with Harden's assertion that the 2.5 m water level change in the quarry will not change the water level along the Southern boundary. However, a lowered water level at the northern end of the site will result in a reduced hydraulic gradient and therefore discharge from the bedrock to the Brydson Spring may be reduced.

A spring flows because the water level in the ground is above grade. The degree that the water level is above grade could range from 0.1 to 10 m. A change in water levels less than 1 m can result in a reduction in flow. The conditions at this spring including flow volume and water quality should be characterized to establish a baseline condition and the spring should be included in the monitoring program.

6.0 Rock Extraction Water Level Change

Harden uses four pumping wells to simulate potential impacts to local wells during the initial rock excavation from the sinking cut. The simulation results in a maximum predicted drawdown of 0.87 m at the nearest well.

Burnside agrees that based on a maximum drawdown of 2.5 m in the sinking cut is not likely to result in significant impacts to nearby wells. However, it is unclear why the maximum drawdown cannot be the same as the depth of the sinking cut. This conservative value seems appropriate until the impacts predicted by the model can be confirmed.

Regardless of the maximum drawdown agreed to, it is Burnside's opinion that this value is the maximum total drawdown allowed, not the amount that is allowed with each sinking cut. Details need to be provided regarding the location for monitoring the drawdown and also the method for establishing the pre extraction reference water level needs to be agreed upon.

Combined Impact from Rockwood Well No. 4 and Hidden Quarry

It is Burnside's opinion that the combined effect of the quarry and proposed Rockwood Well 4 cannot be predicted until M15 and the well are constructed and tested. The quarry will introduce bacteria into portions of the previously confined aquifer. Without detailed investigations there is no way to reliably predict the connection of fractures in the quarry with fractures found in domestic wells. The domestic well survey and water level/water quality monitoring program needs to be designed to identify the wells most likely to be impacted so they can be proactively protected.

7.0 Aquitard

Agreed

9.0 Monitoring Plan, Trigger Levels and Contingency Plan

The monitoring program should reference the pre extraction well survey that will include water quality/quantity testing and indicate the wells will be potentially involved in the monitoring program. Trigger levels for water quality and water levels should be established once baseline conditions are established. Investigation of the proposed pre-quarry well survey locations in Figure C-2 should be mandatory. Residents at wells W25 to W30 and W36 to W40 should be asked if they are willing to participate in the monitoring program.

1.0 On Site Monitoring Program

All of Burnside's suggestions have been incorporated into the monitoring program.

2.0 Trigger Levels

2.1 Trigger Levels for the Bedrock Aquifer

Agreed.

2.2 Trigger Level for Northwest Wetland

No comments.

3.0 Contingency Measures

3.1 Groundwater Levels and Northwest Wetland

Agreed.

3.2 Groundwater Quality

JDCL has agreed to Burnside's additions to the program.

4.0 Pre-Bedrock Extraction Water Well Survey

See comment under 3.0 Private Wells with Shallow Fracture Sources of Water.

10.0 Well Complaint

No comments.

11.0 Next Stages

Burnside agrees to the list of next steps but continues to request a reduction in the depth of the quarry and proactive improvements in surrounding existing wells based on the results of the well survey future documentation on this site should include detailed information on the domestic wells, construction and testing of M15/M16 and information on the Brydson Spring.

Yours truly,

R.J. Burnside & Associates Limited

David Hopkins
Sr. Hydrogeologist
DH:sd

cc Kim Wingrove, Township of Guelph Eramosa (Via: Email) (kwingrove@get.on.ca)
Saidur Rahman, Township of Guelph Eramosa (Via: Email) (srahman@get.on.ca)
Leigh Mugford, James Dick Construction Ltd. (Via: Email) (lmugford@jamesdick.com)

Appendix B

Hydraulic Testing in Multi-Level M15

Well			**M15-I**	
Test Method			Hvorslev (rising head test)	
Hydraulic Conductivity			6.67E-05	m/sec
Slug of water removed			1 Litre	
Screened Formation			Bedrock Dolostone	
Top of Intake Elevation			319.72	
Bottom of Intake Elevation			315.82	
Well Depth (mbtoc)			44.72	
TOC Elevation			360.54	
Test Date			06-May-14	
Datum			metres above datalogger sensor	
H	9.970	metres	[static water level]	
Ho	8.666	metres	[water level at t=0]	
To	1.2	sec	[t when H-h/H-Ho = 0.37]	
To	0.020	min	[t when H-h/H-Ho = 0.37]	
L	3.90	metres	[length of piezometer intake]	
R	0.0762	metres	[intake radius]	
r	0.0127	metres	[piezometer radius]	

K-Hvorslev	**6.67E-05**	**m/sec**
K-Hvorslev	**6.67E-03**	**cm/sec**
K-Hvorslev	**4.00E-03**	**m/min**
K-Hvorslev-Muldoon	**6.19E-05**	**m/sec**

Time (sec)	Time (min)	Water Level Above Datalogger Sensor (m)	H-h Change in Water Level (m)	H-h/H-Ho
0	0.000	8.6659	1.304	1.000
1	0.017	9.2378	0.732	0.561
1.5	0.025	9.6647	0.305	0.234
2	0.033	9.8516	0.118	0.091

Hvorslev Analysis

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LT_0}$$

Hvorslev-Muldoon Analysis

$$K_H = \frac{d^2 \ln[(\frac{mL}{D}) + \sqrt{1 + (\frac{mL}{D})^2}]}{8LT_0}$$

Harden Environmental Services Ltd.

Project No: 9506

Date: May 2014

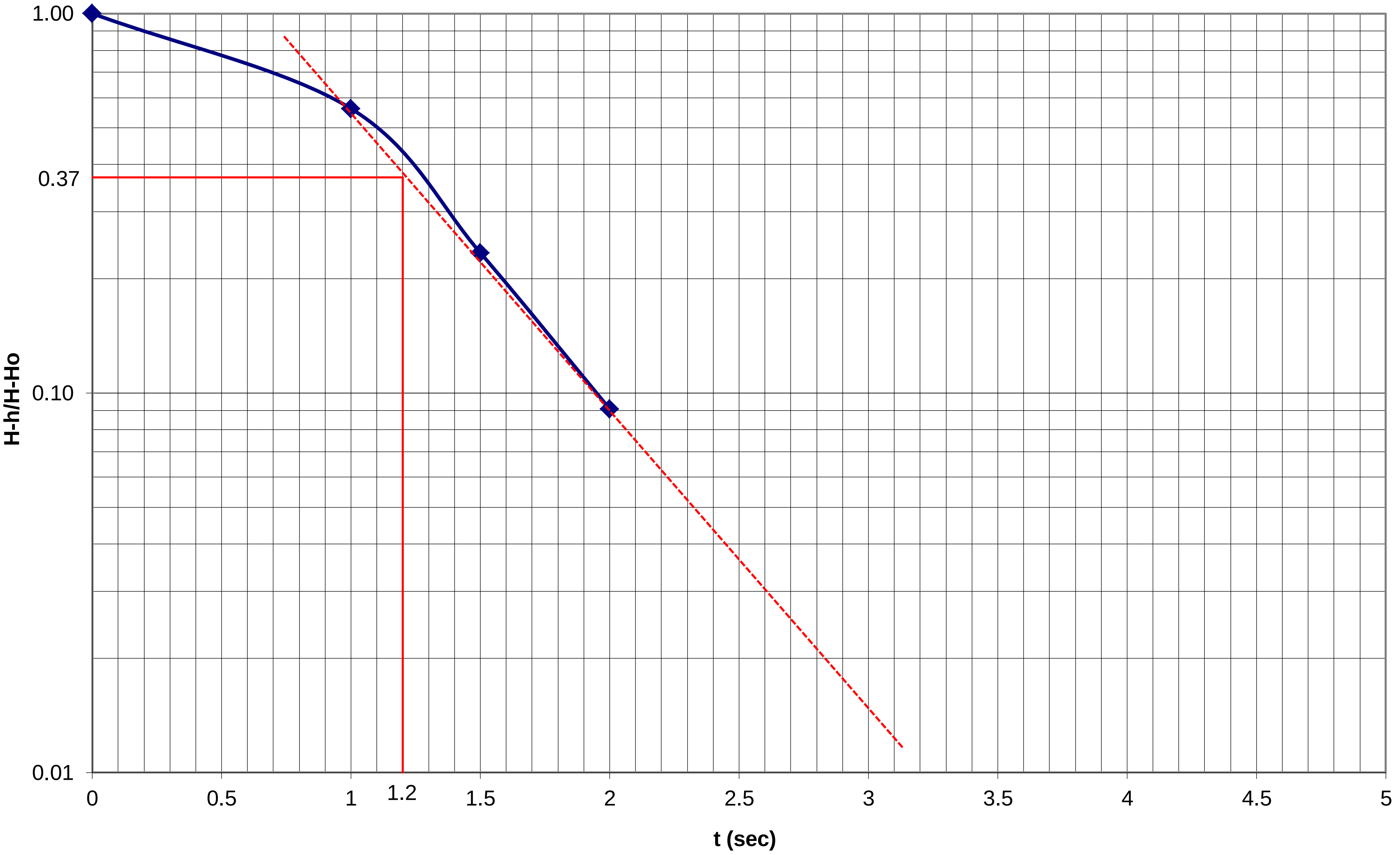
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

M15-I Rising Head Test

M15-I Rising Head Test (Hvorslev Method)
K = 6.7 x 10^{-5} m/sec



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Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

M15-I Rising Head Test

Well			**M15-II**	
Test Method			Hvorslev (rising head test)	
Hydraulic Conductivity			1.00E-04	m/sec
Slug of water removed			1 Litre	
Screened Formation			Bedrock Dolostone	
Top of Intake Elevation			326.52	
Bottom of Intake Elevation			322.03	
Well Depth (mbtoc)			38.51	
TOC Elevation			360.54	
Test Date			06-May-14	
Datum			metres above datalogger sensor	
H	9.887	metres	[static water level]	
Ho	6.890	metres	[water level at t=0]	
To	0.7	sec	[t when H-h/H-Ho = 0.37]	
To	0.01	min	[t when H-h/H-Ho = 0.37]	
L	4.49	metres	[length of piezometer intake]	
R	0.0762	metres	[intake radius]	
r	0.0127	metres	[piezometer radius]	

K-Hvorslev	**1.00E-04**	**m/sec**
K-Hvorslev	**1.00E-02**	**cm/sec**
K-Hvorslev	**6.02E-03**	**m/min**
K-Hvorslev-Muldoon	**9.28E-05**	**m/sec**

Time (sec)	Time (min)	Water Level Above Datalogger Sensor (m)	H-h Change in Water Level (m)	H-h/H-Ho
0	0.000	6.8897	2.998	1.000
1	0.017	9.0612	0.826	0.276
1.5	0.025	9.4523	0.435	0.145
2	0.033	9.6183	0.269	0.090
2.5	0.042	9.8027	0.085	0.028

Hvorslev Analysis

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LT_0}$$

Hvorslev-Muldoon Analysis

$$K_H = \frac{d^2 \ln[(\frac{mL}{D}) + \sqrt{1 + (\frac{mL}{D})^2}]}{8LT_0}$$

Harden
Environmental
Services Ltd.

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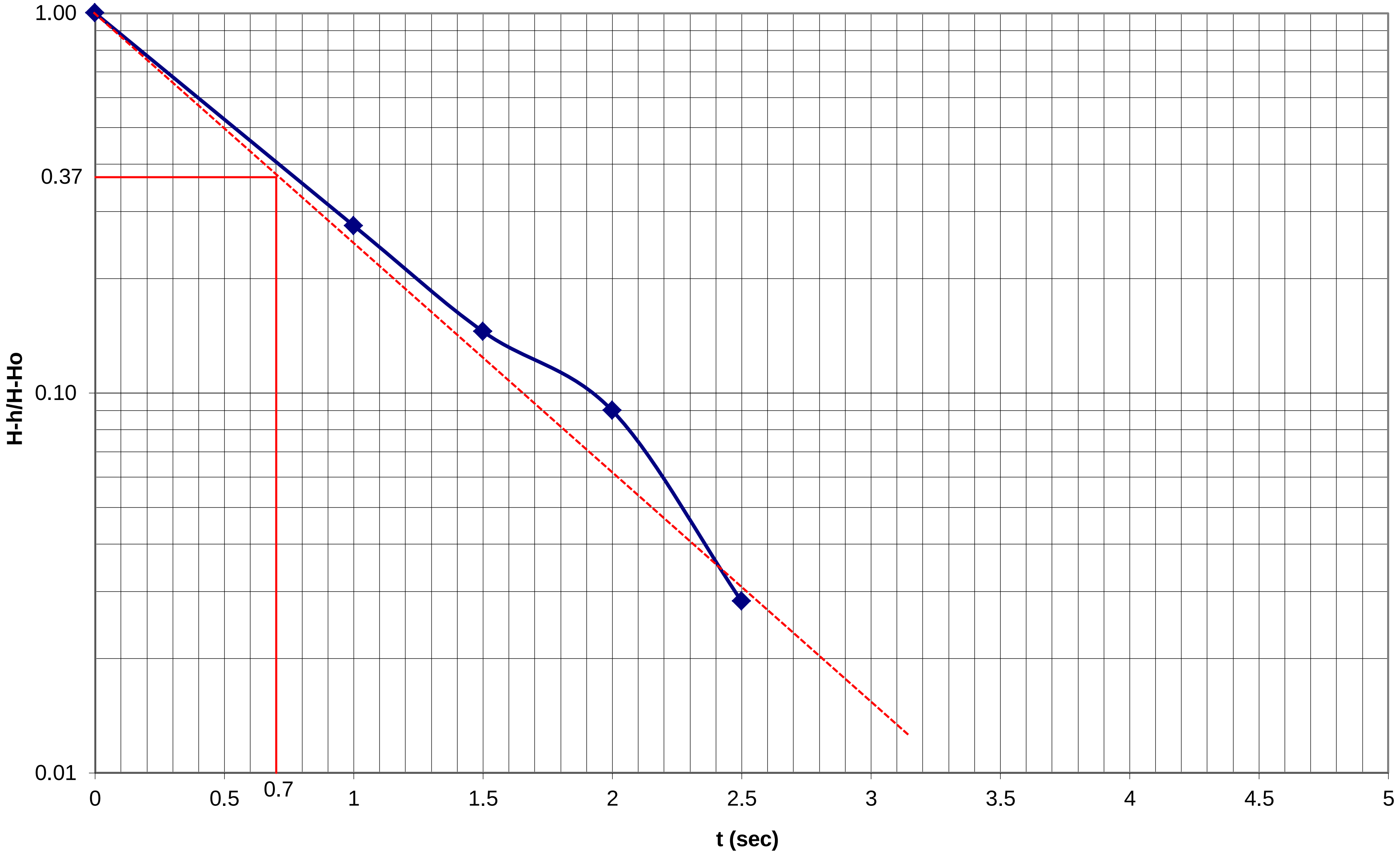
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

M15-II Rising Head Test

M15-II Rising Head Test (Hvorslev Method)
K = 1.0 x 10^{-4} m/sec



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-II Rising Head Test**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Well			**M15-III**	
Test Method			Hvorslev (rising head test)	
Hydraulic Conductivity			3.37E-05	m/sec
Slug of water removed			1 Litre	
Screened Formation			Bedrock Dolostone	
Top of Intake Elevation			336.21	
Bottom of Intake Elevation			330.03	
Well Depth (mbtoc)			30.51	
TOC Elevation			360.54	
Test Date			06-May-14	
Datum			metres above datalogger sensor	
H	10.146	metres	[static water level]	
Ho	8.302	metres	[water level at t=0]	
To	1.7	sec	[t when H-h/H-Ho = 0.37]	
To	0.03	min	[t when H-h/H-Ho = 0.37]	
L	6.18	metres	[length of piezometer intake]	
R	0.0762	metres	[intake radius]	
r	0.0127	metres	[piezometer radius]	

K-Hvorslev	**3.37E-05**	**m/sec**
K-Hvorslev	**3.37E-03**	**cm/sec**
K-Hvorslev	**2.02E-03**	**m/min**
K-Hvorslev-Muldoon	**3.10E-05**	**m/sec**

Time (sec)	Time (min)	Water Level Above Datalogger Sensor (m)	H-h Change in Water Level (m)	H-h/H-Ho
0	0.000	8.3022	1.844	1.000
0.5	0.008	8.5448	1.602	0.868
1	0.017	9.1061	1.040	0.564
1.5	0.025	9.276	0.870	0.472
2	0.033	9.5274	0.619	0.336
2.5	0.042	9.6607	0.486	0.263
3	0.050	9.8524	0.294	0.159
3.5	0.058	9.9576	0.189	0.102
4	0.067	10.0439	0.102	0.056
4.5	0.075	10.0911	0.055	0.030

Hvorslev Analysis

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LT_0}$$

Hvorslev-Muldoon Analysis

$$K_H = \frac{d^2 \ln[(\frac{mL}{D}) + \sqrt{1 + (\frac{mL}{D})^2}]}{8LT_0}$$

Harden Environmental Services Ltd.

Project No: 9506

Date: May 2014

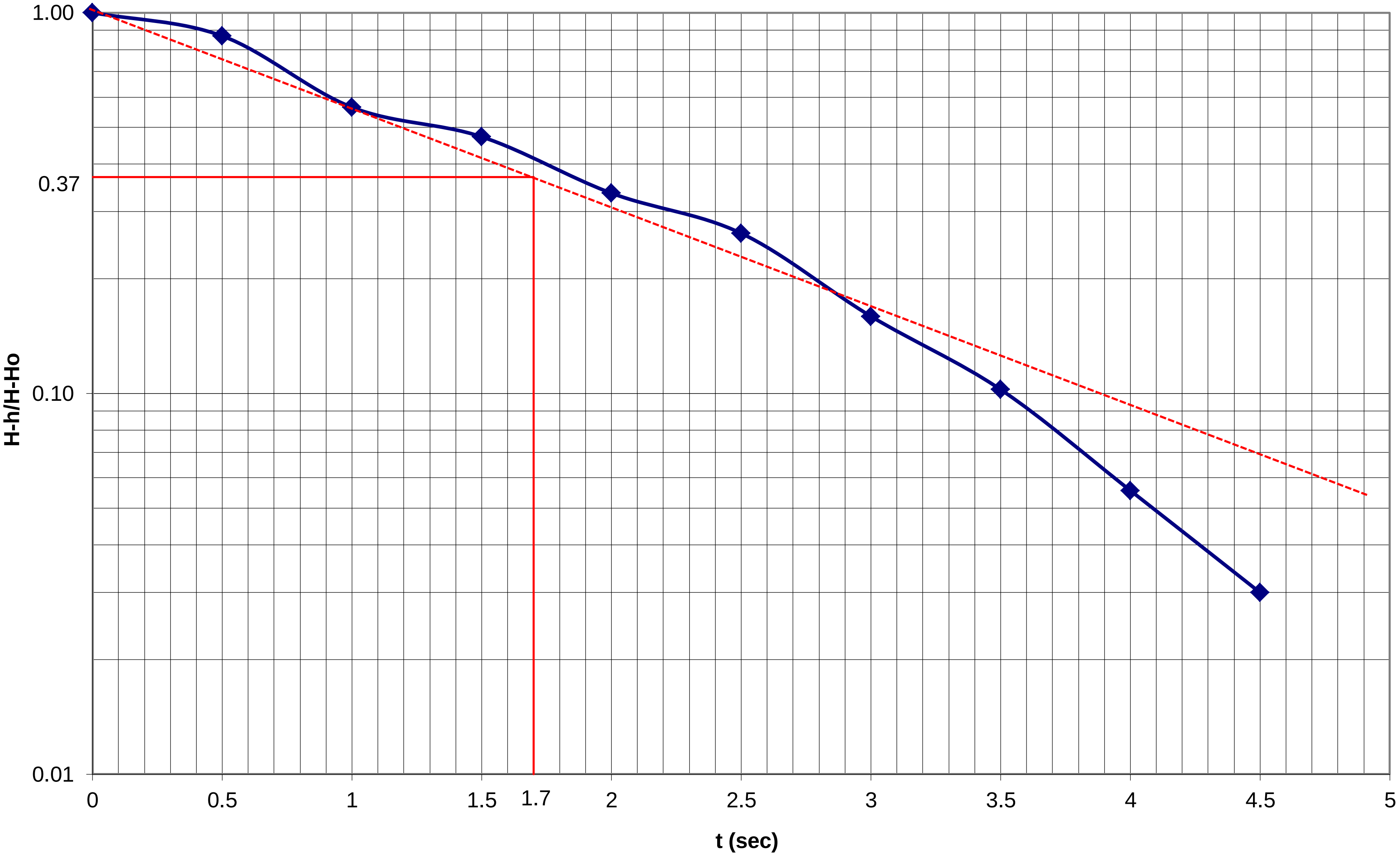
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

M15-III Rising Head Test

M15-III Rising Head Test (Hvorslev Method)
K = 3.4 x 10^{-5} m/sec



Harden Environmental Services Ltd.

Project No: 9506

Date: May 2014

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

M15-III Rising Head Test

Well	**M15-IV**		
Test Method	Hvorslev (rising head test)		
Hydraulic Conductivity	2.21E-05	m/sec	
Slug of water removed	1 Litre		
Screened Formation	Bedrock Dolostone		
Top of Intake Elevation	350.54		
Bottom of Intake Elevation	339.97		
Well Depth (mbtoc)	20.57		
TOC Elevation	360.54		
Test Date	06-May-14		
Datum	metres above datalogger sensor		

H	10.1981	metres	[static water level]
Ho	9.761	metres	[water level at t=0]
To	1.7	sec	[t when H-h/H-Ho = 0.37]
To	0.03	min	[t when H-h/H-Ho = 0.37]
L	10.57	metres	[length of piezometer intake]
R	0.0762	metres	[intake radius]
r	0.0127	metres	[piezometer radius]

K-Hvorslev	**2.21E-05**	**m/sec**
K-Hvorslev	**2.21E-03**	**cm/sec**
K-Hvorslev	**1.33E-03**	**m/min**
K-Hvorslev-Muldoon	**2.02E-05**	**m/sec**

Time (sec)	Time (min)	Water Level Above Datalogger Sensor (m)	H-h Change in Water Level (m)	H-h/H-Ho
0	0.000	9.7612	0.437	1.000
0.5	0.008	9.8511	0.347	0.794
1	0.017	9.93	0.268	0.614
1.5	0.025	10.0036	0.195	0.445
2	0.033	10.071	0.127	0.291
2.5	0.042	10.136	0.062	0.142
3	0.050	10.178	0.020	0.046
3.5	0.058	10.193	0.005	0.012

Hvorslev Analysis

$$K = \frac{r^2 \ln(\frac{L}{R})}{2LT_0}$$

Hvorslev-Muldoon Analysis

$$K_H = \frac{d^2 \ln[(\frac{mL}{D}) + \sqrt{1 + (\frac{mL}{D})^2}]}{8LT_0}$$

Harden Environmental Services Ltd.

Project No: 9506

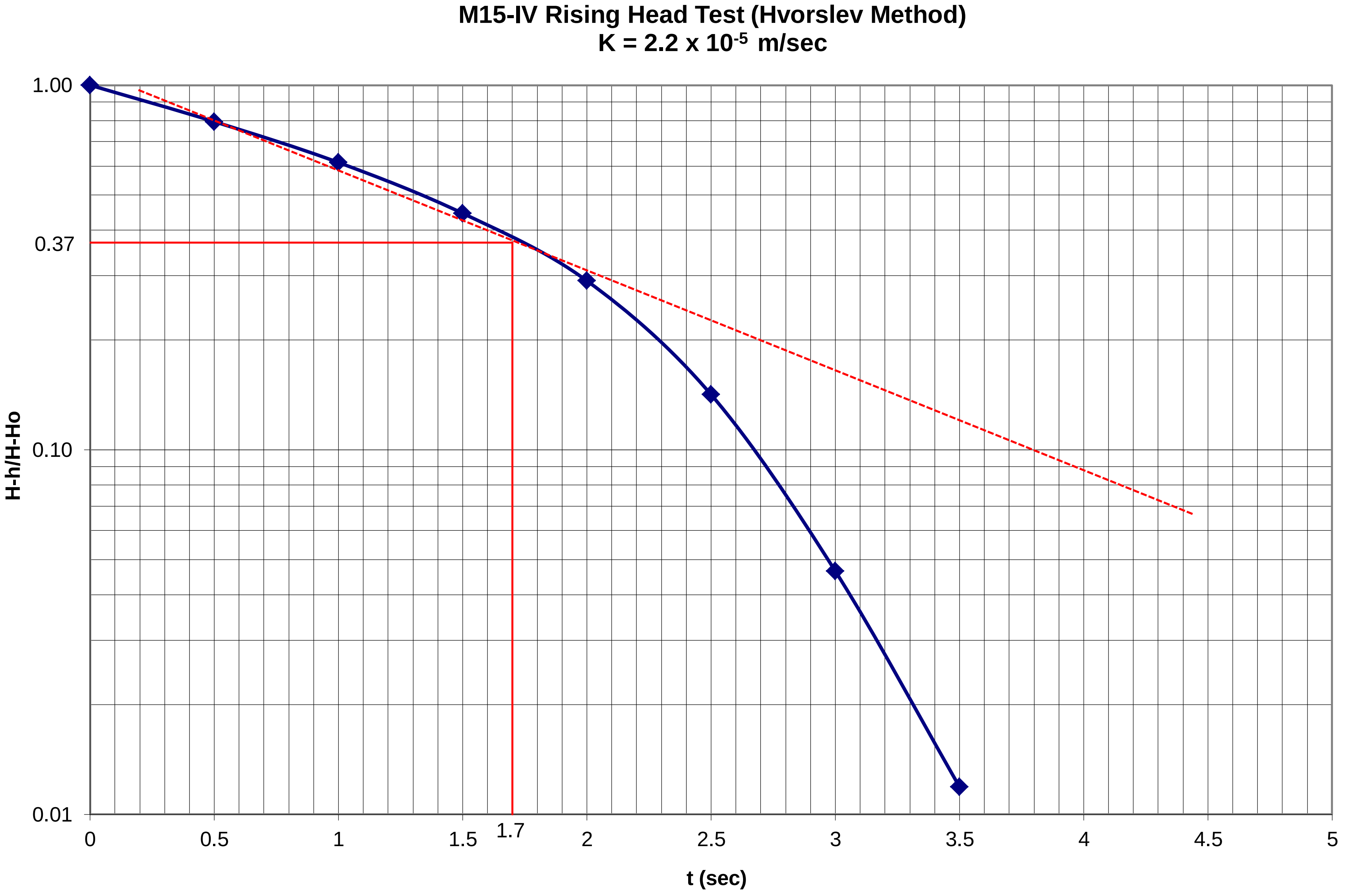
Date: May 2014

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

M15-IV Rising Head Test



Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-IV Rising Head Test**
Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		

High K Estimator Spreadsheet
Metric Units

General Test Data

Site Location:	Hidden	
Date:	06/05/2014	
Time:		
Test Designation:	M15-I	
Static Level:	9.97	m
Initial Water Level Change (H_0):	1.304	m
Start Time for Test:	42805	sec

Test Well Specs - "d" not used in confined case

Depth to Bottom of Screen (from toc):	40.82	m
Screen Length (b):	3.050	m
Depth to Static Water Level (from toc):	8.89	m
Top of Screen to Water Table (d):	35.82	m
Radius of Well Screen (r_w):	0.013	m
Nominal Radius of Well Casing (r_{nc}):	0.013	m
Radius of Transducer Cable (r_{tc}):	0.003	m
Effective Casing Radius (r_c =(r_{nc}^2-r_{tc}^2)^0.5):	0.013	m
Modified Screen Radius (r_w*):	0.017	m
Aspect Ratio (b/r_w*):	182.963	
Formation Thickness (B):	45	m

Time Correlation Ratio t_d*/t*	**Best Fit Type Curve C_D**
0.588	0.75

computed from ratio	Le =	28.351	m
nominal	Le =	30.478	m
% difference		7%	

Modulation Factor = 1.7

Unconfined - High-K Bouwer and Rice Model

$$K_r = \frac{t_d^* \, r_c\text{^}2 \ln[R_e/r_w^*]}{t^* \quad 2bC_D}$$

ln(R_e/r_w*)= 4.795

A = 5.776

B = 1.088

first term 1.1/(ln((d+b)/r_w*)

0.142

second term (***A*** +***B****(ln[(B-(d+b))/r_w*]))/(b/r_w*)

0.067

ln[(B-(d+b))/r_w*] 5.907 5.907

Cannot exceed 6.

See Butler (1997) - p.108.

K_r =	**9.90E-05 m/sec**	
	8.55E+00 m/day	**2.81E+01 ft/day**
	9.90E-03 cm/sec	

Confined - High-K Hvorslev Model

$$K_r = \frac{t_d^* \, r_c\text{^}2 \ln[b/(2r_w^*)+(1+(b/(2r_w^*))\text{^}2)\text{^}0.5]}{t^* \quad 2bC_D}$$

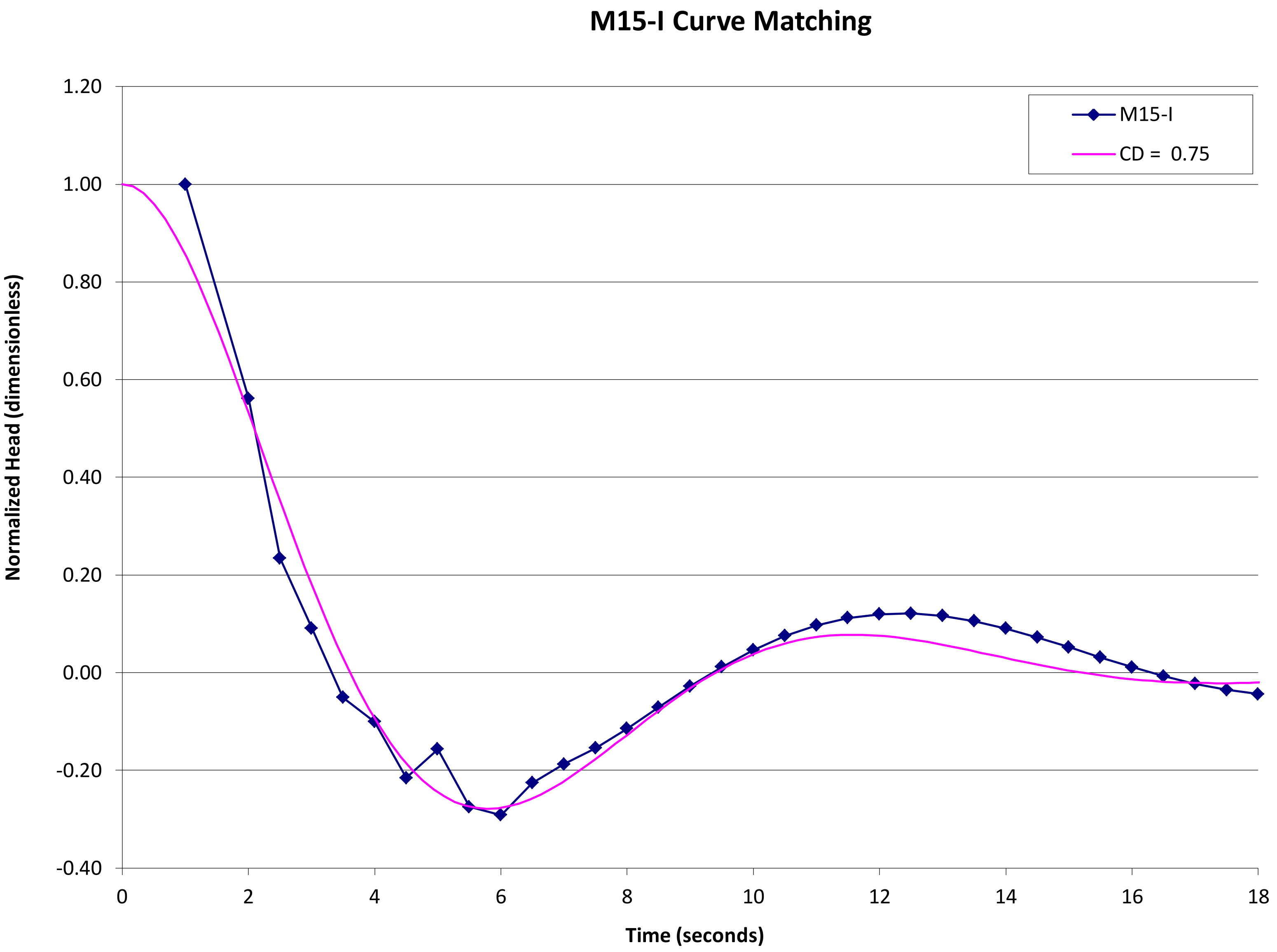
Bracketted quantity 182.969

K_r =	**1.08E-04 m/sec**	
	9.29E+00 m/day	**3.05E+01 ft/day**
	1.08E-02 cm/sec	

A = 1.4720+3.537E-2(b/r_w*)-8.148E-5(b/r_w*)^2+1.028E-7(b/r_w*)^3-6.484E-11(b/r_w*)^4+1.573E-14(b/r_w*)^5

B = 0.2372+5.151E-3(b/r_w*)-2.682E-6(b/r_w*)^2-3.491E-10(b/r_w*)^3+4.738E-13(b/r_w*)^4

HARDEN Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** May 2014 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**M15-I Underdamped Slug Test Analysis**



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-I Underdamped Slug Test Analysis**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

High K Estimator Spreadsheet
Metric Units

General Test Data

Site Location:	Hidden	
Date:	06/05/2014	
Time:		
Test Designation:	M15-II	
Static Level:	9.88	m
Initial Water Level Change (H_0):	2.990	m
Start Time for Test:	43232	sec

Test Well Specs - "d" not used in confined case

Depth to Bottom of Screen (from toc):	34.02	m
Screen Length (b):	3.050	m
Depth to Static Water Level (from toc):	8.89	m
Top of Screen to Water Table (d):	29.6	m
Radius of Well Screen (r_w):	0.013	m
Nominal Radius of Well Casing (r_{nc}):	0.013	m
Radius of Transducer Cable (r_{tc}):	0.003	m
Effective Casing Radius (r_c =(r_{nc}^2-r_{tc}^2)^0.5):	0.013	m
Modified Screen Radius (r_w*):	0.017	m
Aspect Ratio (b/r_w*):	182.963	
Formation Thickness (B):	45	m

Time Correlation Ratio t_d*/t*		**Best Fit Type Curve C_D**	
		1.1	
0.714			
computed from ratio	Le =	19.228	m
nominal	Le =	23.678	m
% difference		19%	
Modulation Factor =		1.4	

Unconfined - High-K Bouwer and Rice Model

$$K_r = \frac{t_d^*\ r_c{}^\wedge 2\ \ln[R_e/r_w^*]}{t^*\qquad 2bC_D}$$

ln(R_e/r_w*)=	4.709	***A*** =	5.776	
		B =	1.088	
first term	1.1/(ln((d+b)/r_w*)			
	0.145			
second term	(***A*** +***B****(ln[(B-(d+b))/r_w*]))/(b/r_w*)			
	0.067			
ln[(B-(d+b))/r_w*]	6.000			6.608
	Cannot exceed 6.			
	See Butler (1997) - p.108.			

K_r =	**8.05E-05 m/sec**	
	6.95E+00 m/day	**2.28E+01 ft/day**
	8.05E-03 cm/sec	

Confined - High-K Hvorslev Model

$$K_r = \frac{t_d^*\ r_c{}^\wedge 2\ \ln[b/(2r_w^*)+(1+(b/(2r_w^*))^\wedge 2)^\wedge 0.5]}{t^*\qquad 2bC_D}$$

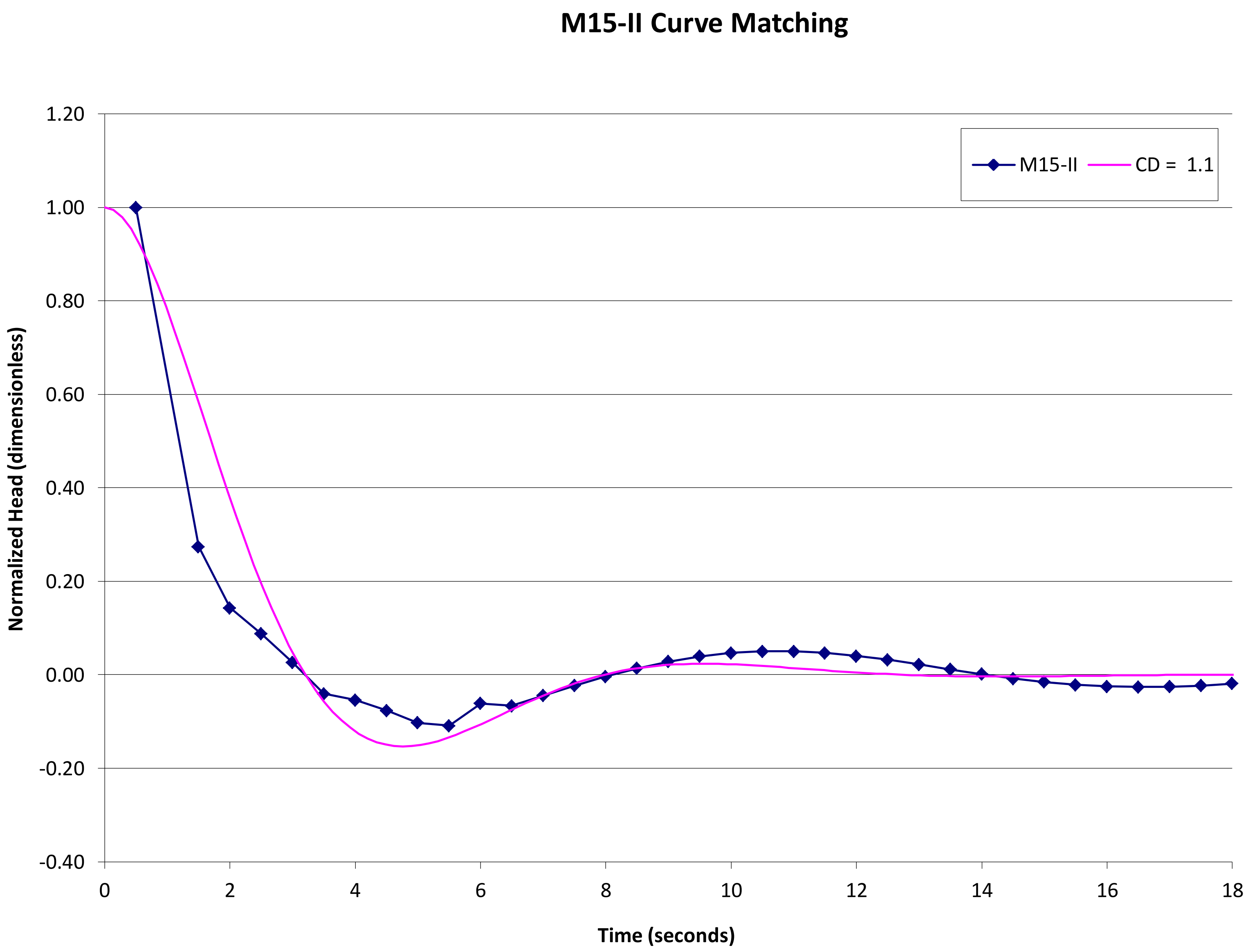
Bracketted quantity 182.969

K_r =	**8.91E-05 m/sec**	
	7.69E+00 m/day	**2.52E+01 ft/day**
	8.91E-03 cm/sec	

A = 1.4720+3.537E-2(b/r_w*)-8.148E-5(b/r_w*)^2+1.028E-7(b/r_w*)^3-6.484E-11(b/r_w*)^4+1.573E-14(b/r_w*)^5

B = 0.2372+5.151E-3(b/r_w*)-2.682E-6(b/r_w*)^2-3.491E-10(b/r_w*)^3+4.738E-13(b/r_w*)^4

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-II Underdamped Slug Test Analysis**
	Date: May 2014		
	Drawn By: AR	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-II Underdamped Slug Test Analysis**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

High K Estimator Spreadsheet
Metric Units

General Test Data

Site Location:	Hidden	
Date:	06/05/2014	
Time:		
Test Designation:	M15-IV	
Static Level:	10.17	m
Initial Water Level Change (H_0):	0.409	m
Start Time for Test:	44141.5	sec

Test Well Specs - "d" not used in confined case

Depth to Bottom of Screen (from toc):	20.57	m
Screen Length (b):	6.090	m
Depth to Static Water Level (from toc):	8.89	m
Top of Screen to Water Table (d):	2	m
Radius of Well Screen (r_w):	0.013	m
Nominal Radius of Well Casing (r_{nc}):	0.013	m
Radius of Transducer Cable (r_{tc}):	0.003	m
Effective Casing Radius (r_c =(r_{nc}^2-r_{tc}^2)^0.5):	0.013	m
Modified Screen Radius (r_w*):	0.017	m
Aspect Ratio (b/r_w*):	365.327	
Formation Thickness (B):	45	m

Time Correlation Ratio t_d^*/t^*	Best Fit Type Curve C_D
0.909	1

computed from ratio	Le =	11.870	m
nominal	Le =	8.781	m
% difference		35%	

Modulation Factor = 1.1

Unconfined - High-K Bouwer and Rice Model

$$K_r = \frac{t_d^*\ r_c\text{\^{}}2\ \ln[R_e/r_w^*]}{t^*\qquad 2bC_D}$$

ln(R_e/r_w*)=	4.403		***A*** =	7.479		
			B =	1.752		
	first term	1.1/(ln((d+b)/r_w*))				
		0.178				
	second term		(***A*** +***B****(ln[(B-(d+b))/r_w*]))/(b/r_w*)			
			0.049			
	ln[(B-(d+b))/r_w*]		6.000			7.703
			Cannot exceed 6.			
			See Butler (1997) - p.108.			

K_r =	**5.28E-05**	**m/sec**	
	4.56E+00	**m/day**	**1.50E+01 ft/day**
	5.28E-03	**cm/sec**	

Confined - High-K Hvorslev Model

$$K_r = \frac{t_d^*\ r_c\text{\^{}}2\ \ln[b/(2r_w^*)+(1+(b/(2r_w^*))\text{\^{}}2)\text{\^{}}0.5]}{t^*\qquad 2bC_D}$$

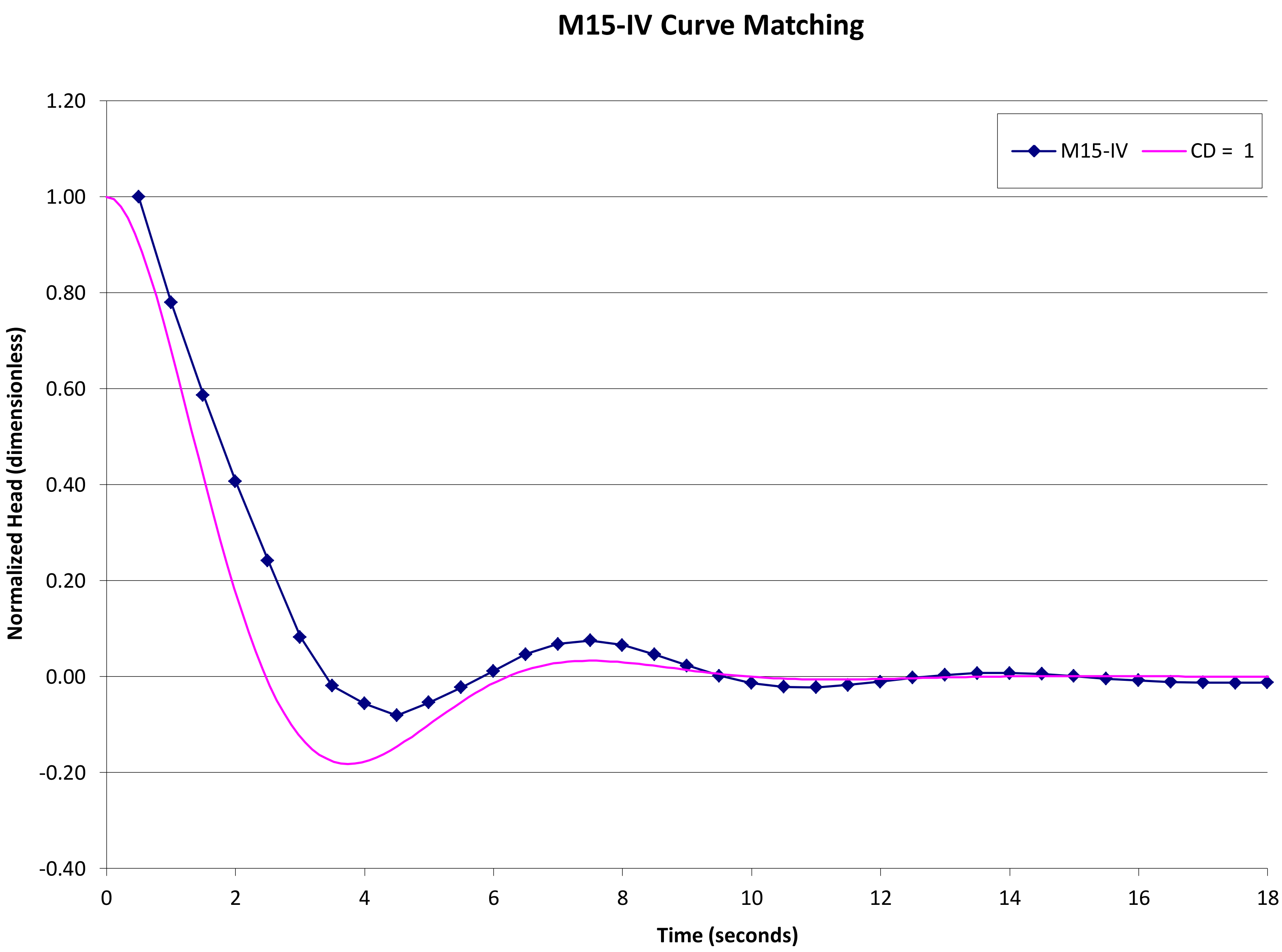
Bracketted quantity 365.330

K_r =	**7.07E-05**	**m/sec**	
	6.11E+00	**m/day**	**2.00E+01 ft/day**
	7.07E-03	**cm/sec**	

A = 1.4720+3.537E-2(b/r_w*)-8.148E-5(b/r_w*)^2+1.028E-7(b/r_w*)^3-6.484E-11(b/r_w*)^4+1.573E-14(b/r_w*)^5

B = 0.2372+5.151E-3(b/r_w*)-2.682E-6(b/r_w*)^2-3.491E-10(b/r_w*)^3+4.738E-13(b/r_w*)^4

Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-IV Underdamped Slug Test Analysis**
	Date: May 2014		
	Drawn By: AR	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**M15-IV Underdamped Slug Test Analysis**
	Date: May 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Appendix C

Water Quality Results

i. Hidden Quarry M15-I, M15-II, M15-III, M15-IV

ii. Guelph Limestone Quarry S1, S2, S3, S4

iii. Hidden Quarry Tributary B Upstream (SW4), Tributary B Downstream (SW8), Tributary C (SW11)

iv. Hidden Quarry Tributary B (Sample ID SW1), Hidden Quarry Tributary A (Sample ID SW2), Guelph Limestone Quarry (Sample ID SW3)

Your Project #: 9506
Site Location: ROCKWOOD
Your C.O.C. #: 34279

Attention:Stan Denhoed

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/05/08
Report #: R3023763
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B472934
Received: 2014/05/05, 14:39

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	4	N/A	2014/05/06	CAM SOP-00448	SM 2320B
Carbonate, Bicarbonate and Hydroxide	4	N/A	2014/05/07	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	4	N/A	2014/05/07	CAM SOP-00463	EPA 325.2
Conductivity	4	N/A	2014/05/06	CAM SOP-00414	SM 2510
Dissolved Organic Carbon (DOC) (1)	4	N/A	2014/05/07	CAM SOP-00446	SM 5310 B
Hardness (calculated as CaCO3)	4	N/A	2014/05/08	CAM SOP 00102/00408/00447	SM 2340 B
Dissolved Metals by ICPMS	4	N/A	2014/05/08	CAM SOP-00447	EPA 6020
Ion Balance (% Difference)	4	N/A	2014/05/08		
Anion and Cation Sum	4	N/A	2014/05/08		
Total Ammonia-N	4	N/A	2014/05/07	CAM SOP-00441	US GS I-2522-90
Nitrate (NO3) and Nitrite (NO2) in Water (2)	4	N/A	2014/05/06	CAM SOP-00440	SM 4500 NO3I/NO2B
pH	4	N/A	2014/05/06	CAM SOP-00413	SM 4500H+ B
Orthophosphate	4	N/A	2014/05/07	CAM SOP-00461	EPA 365.1
Sat. pH and Langelier Index (@ 20C)	4	N/A	2014/05/08		
Sat. pH and Langelier Index (@ 4C)	4	N/A	2014/05/08		
Sulphate by Automated Colourimetry	4	N/A	2014/05/07	CAM SOP-00464	EPA 375.4
Total Dissolved Solids (TDS calc)	4	N/A	2014/05/08		
Total Kjeldahl Nitrogen in Water	4	2014/05/06	2014/05/07	CAM SOP-00454	EPA 351.2 Rev 2

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Your Project #: 9506
Site Location: ROCKWOOD
Your C.O.C. #: 34279

Attention:Stan Denhoed

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/05/08
Report #: R3023763
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B472934
Received: 2014/05/05, 14:39

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Andrew Turner, Project Manager
Email: ATurner@maxxam.ca
Phone# (800)268-7396 Ext:233
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF WATER

Maxxam ID				VU0497	VU0498		VU0499		VU0500		
Sampling Date				2014/05/05 10:40	2014/05/05 11:00		2014/05/05 11:30		2014/05/05 11:45		
COC Number				34279	34279		34279		34279		
	Units	**Criteria A**	**A/O**	**M15-1**	**M15-2**	**RDL**	**M15-3**	**RDL**	**M15-4**	**RDL**	**QC Batch**
Calculated Parameters											
Anion Sum	me/L	-	-	8.48	7.96	N/A	8.17	N/A	7.03	N/A	3594544
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	-	260	260	1.0	270	1.0	290	1.0	3594475
Calculated TDS	mg/L	-	500	470	440	1.0	450	1.0	370	1.0	3594547
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	-	1.9	2.0	1.0	2.0	1.0	2.3	1.0	3594475
Cation Sum	me/L	-	-	8.30	7.92	N/A	7.96	N/A	7.03	N/A	3594544
Hardness (CaCO3)	mg/L	-	80:100	390	370	1.0	340	1.0	340	1.0	3593957
Ion Balance (% Difference)	%	-	-	1.07	0.230	N/A	1.33	N/A	0.0100	N/A	3594543
Langelier Index (@ 20C)	N/A	-	-	0.883	0.879		0.866		0.911		3594545
Langelier Index (@ 4C)	N/A	-	-	0.635	0.631		0.618		0.662		3594546
Saturation pH (@ 20C)	N/A	-	-	7.01	7.02		7.04		7.03		3594545
Saturation pH (@ 4C)	N/A	-	-	7.26	7.27		7.29		7.28		3594546
Inorganics											
Total Ammonia-N	mg/L	-	-	ND	ND	0.050	ND	0.050	ND	0.050	3596106
Conductivity	umho/cm	-	-	760	730	1.0	750	1.0	640	1.0	3595001
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	0.22	0.28	0.10	0.90	0.50	0.19	0.10	3595316
Dissolved Organic Carbon	mg/L	-	5	0.83	0.85	0.20	2.1	0.20	0.85	0.20	3595143
Orthophosphate (P)	mg/L	-	-	ND	ND	0.010	ND	0.010	ND	0.010	3595530
pH	pH	-	6.5:8.5	7.89	7.90	N/A	7.90	N/A	7.94	N/A	3595002
Dissolved Sulphate (SO4)	mg/L	-	500	130	94	1	92	1	38	1	3595531
Alkalinity (Total as CaCO3)	mg/L	-	30:500	260	270	1.0	270	1.0	290	1.0	3594997
Dissolved Chloride (Cl)	mg/L	-	250	18	19	1	20	1	12	1	3595528
Nitrite (N)	mg/L	**1**	-	ND	ND	0.010	ND	0.010	ND	0.010	3595183
Nitrate (N)	mg/L	**10**	-	1.62	2.19	0.10	3.17	0.10	1.96	0.10	3595183
Nitrate + Nitrite	mg/L	**10**	-	1.62	2.19	0.10	3.17	0.10	1.96	0.10	3595183

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Criteria A,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

N/A = Not Applicable

ND = Not detected

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID					VU0497	VU0498	VU0499	VU0500		
Sampling Date					2014/05/05 10:40	2014/05/05 11:00	2014/05/05 11:30	2014/05/05 11:45		
COC Number					34279	34279	34279	34279		
	Units	**Criteria A**	**IMC**	**A/O**	**M15-1**	**M15-2**	**M15-3**	**M15-4**	**RDL**	**QC Batch**
Metals										
Dissolved Aluminum (Al)	mg/L	-	-	0.1	0.0069	0.0065	0.014	0.0061	0.0050	3594697
Dissolved Antimony (Sb)	mg/L	-	0.006	-	0.0033	0.0027	0.0011	ND	0.00050	3594697
Dissolved Arsenic (As)	mg/L	-	0.025	-	ND	ND	ND	ND	0.0010	3594697
Dissolved Barium (Ba)	mg/L	**1**	-	-	0.12	0.096	0.094	0.070	0.0020	3594697
Dissolved Beryllium (Be)	mg/L	-	-	-	ND	ND	ND	ND	0.00050	3594697
Dissolved Bismuth (Bi)	mg/L	-	-	-	ND	ND	ND	ND	0.0010	3594697
Dissolved Boron (B)	mg/L	-	5	-	0.016	0.013	0.016	0.017	0.010	3594697
Dissolved Cadmium (Cd)	mg/L	**0.005**	-	-	ND	ND	ND	ND	0.00010	3594697
Dissolved Calcium (Ca)	mg/L	-	-	-	110	100	96	89	0.20	3594697
Dissolved Chromium (Cr)	mg/L	**0.05**	-	-	ND	ND	ND	ND	0.0050	3594697
Dissolved Cobalt (Co)	mg/L	-	-	-	ND	ND	ND	ND	0.00050	3594697
Dissolved Copper (Cu)	mg/L	-	-	1	ND	ND	ND	ND	0.0010	3594697
Dissolved Iron (Fe)	mg/L	-	-	0.3	ND	ND	ND	ND	0.10	3594697
Dissolved Lead (Pb)	mg/L	**0.01**	-	-	ND	ND	ND	ND	0.00050	3594697
Dissolved Magnesium (Mg)	mg/L	-	-	-	29	28	24	28	0.050	3594697
Dissolved Manganese (Mn)	mg/L	-	-	0.05	ND	0.0024	0.0080	ND	0.0020	3594697
Dissolved Molybdenum (Mo)	mg/L	-	-	-	0.0020	0.0029	0.0026	0.0013	0.00050	3594697
Dissolved Nickel (Ni)	mg/L	-	-	-	0.0031	0.0048	0.0024	ND	0.0010	3594697
Dissolved Phosphorus (P)	mg/L	-	-	-	ND	ND	ND	ND	0.10	3594697
Dissolved Potassium (K)	mg/L	-	-	-	4.5	5.1	7.1	2.0	0.20	3594697
Dissolved Selenium (Se)	mg/L	**0.01**	-	-	ND	ND	ND	ND	0.0020	3594697
Dissolved Silicon (Si)	mg/L	-	-	-	4.1	4.1	4.2	4.1	0.050	3594697
Dissolved Silver (Ag)	mg/L	-	-	-	ND	ND	ND	ND	0.00010	3594697
Dissolved Sodium (Na)	mg/L	**20**	-	200	8.0	8.3	**23**	5.4	0.10	3594697
Dissolved Strontium (Sr)	mg/L	-	-	-	1.0	0.72	0.62	0.19	0.0010	3594697
Dissolved Thallium (Tl)	mg/L	-	-	-	0.00011	0.000098	0.000067	0.000052	0.000050	3594697
Dissolved Titanium (Ti)	mg/L	-	-	-	ND	ND	ND	ND	0.0050	3594697
Dissolved Uranium (U)	mg/L	**0.02**	-	-	0.0010	0.00096	0.0015	0.00031	0.00010	3594697
Dissolved Vanadium (V)	mg/L	-	-	-	ND	ND	ND	ND	0.00050	3594697
Dissolved Zinc (Zn)	mg/L	-	-	5	0.028	0.040	0.017	0.034	0.0050	3594697

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Criteria A,IMC,A/O: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

ND = Not detected

TEST SUMMARY

Maxxam ID: VU0497
Sample ID: M15-1
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3594997	N/A	2014/05/06	Yogesh Patel
Carbonate, Bicarbonate and Hydroxide	CALC	3594475	N/A	2014/05/07	Automated Statchk
Chloride by Automated Colourimetry	AC	3595528	N/A	2014/05/07	Deonarine Ramnarine
Conductivity	COND	3595001	N/A	2014/05/06	Yogesh Patel
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3595143	N/A	2014/05/07	Anastasia Hamanov
Hardness (calculated as CaCO3)		3593957	N/A	2014/05/08	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman
Ion Balance (% Difference)	CALC	3594543	N/A	2014/05/08	Automated Statchk
Anion and Cation Sum	CALC	3594544	N/A	2014/05/08	Automated Statchk
Total Ammonia-N	LACH/NH4	3596106	N/A	2014/05/07	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3595183	N/A	2014/05/06	Chandra Nandlal
pH	PH	3595002	N/A	2014/05/06	Yogesh Patel
Orthophosphate	AC	3595530	N/A	2014/05/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3594545	N/A	2014/05/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3594546	N/A	2014/05/08	Automated Statchk
Sulphate by Automated Colourimetry	AC	3595531	N/A	2014/05/07	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	3594547	N/A	2014/05/08	Automated Statchk
Total Kjeldahl Nitrogen in Water	AC	3595316	2014/05/06	2014/05/07	Anastasia Hamanov

Maxxam ID: VU0498
Sample ID: M15-2
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3594997	N/A	2014/05/06	Yogesh Patel
Carbonate, Bicarbonate and Hydroxide	CALC	3594475	N/A	2014/05/07	Automated Statchk
Chloride by Automated Colourimetry	AC	3595528	N/A	2014/05/07	Deonarine Ramnarine
Conductivity	COND	3595001	N/A	2014/05/06	Yogesh Patel
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3595143	N/A	2014/05/07	Anastasia Hamanov
Hardness (calculated as CaCO3)		3593957	N/A	2014/05/08	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman
Ion Balance (% Difference)	CALC	3594543	N/A	2014/05/08	Automated Statchk
Anion and Cation Sum	CALC	3594544	N/A	2014/05/08	Automated Statchk
Total Ammonia-N	LACH/NH4	3596106	N/A	2014/05/07	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3595183	N/A	2014/05/06	Chandra Nandlal
pH	PH	3595002	N/A	2014/05/06	Yogesh Patel
Orthophosphate	AC	3595530	N/A	2014/05/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3594545	N/A	2014/05/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3594546	N/A	2014/05/08	Automated Statchk
Sulphate by Automated Colourimetry	AC	3595531	N/A	2014/05/07	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	3594547	N/A	2014/05/08	Automated Statchk
Total Kjeldahl Nitrogen in Water	AC	3595316	2014/05/06	2014/05/07	Anastasia Hamanov

TEST SUMMARY

Maxxam ID: VU0499
Sample ID: M15-3
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3594997	N/A	2014/05/06	Yogesh Patel
Carbonate, Bicarbonate and Hydroxide	CALC	3594475	N/A	2014/05/07	Automated Statchk
Chloride by Automated Colourimetry	AC	3595528	N/A	2014/05/07	Deonarine Ramnarine
Conductivity	COND	3595001	N/A	2014/05/06	Yogesh Patel
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3595143	N/A	2014/05/07	Anastasia Hamanov
Hardness (calculated as CaCO3)		3593957	N/A	2014/05/08	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman
Ion Balance (% Difference)	CALC	3594543	N/A	2014/05/08	Automated Statchk
Anion and Cation Sum	CALC	3594544	N/A	2014/05/08	Automated Statchk
Total Ammonia-N	LACH/NH4	3596106	N/A	2014/05/07	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3595183	N/A	2014/05/06	Chandra Nandlal
pH	PH	3595002	N/A	2014/05/06	Yogesh Patel
Orthophosphate	AC	3595530	N/A	2014/05/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3594545	N/A	2014/05/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3594546	N/A	2014/05/08	Automated Statchk
Sulphate by Automated Colourimetry	AC	3595531	N/A	2014/05/07	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	3594547	N/A	2014/05/08	Automated Statchk
Total Kjeldahl Nitrogen in Water	AC	3595316	2014/05/06	2014/05/07	Anastasia Hamanov

Maxxam ID: VU0500
Sample ID: M15-4
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3594997	N/A	2014/05/06	Yogesh Patel
Carbonate, Bicarbonate and Hydroxide	CALC	3594475	N/A	2014/05/07	Automated Statchk
Chloride by Automated Colourimetry	AC	3595528	N/A	2014/05/07	Deonarine Ramnarine
Conductivity	COND	3595001	N/A	2014/05/06	Yogesh Patel
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3595143	N/A	2014/05/07	Anastasia Hamanov
Hardness (calculated as CaCO3)		3593957	N/A	2014/05/08	Automated Statchk
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman
Ion Balance (% Difference)	CALC	3594543	N/A	2014/05/08	Automated Statchk
Anion and Cation Sum	CALC	3594544	N/A	2014/05/08	Automated Statchk
Total Ammonia-N	LACH/NH4	3596106	N/A	2014/05/07	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3595183	N/A	2014/05/06	Chandra Nandlal
pH	PH	3595002	N/A	2014/05/06	Yogesh Patel
Orthophosphate	AC	3595530	N/A	2014/05/07	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3594545	N/A	2014/05/08	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3594546	N/A	2014/05/08	Automated Statchk
Sulphate by Automated Colourimetry	AC	3595531	N/A	2014/05/07	Alina Dobreanu
Total Dissolved Solids (TDS calc)	CALC	3594547	N/A	2014/05/08	Automated Statchk
Total Kjeldahl Nitrogen in Water	AC	3595316	2014/05/06	2014/05/07	Anastasia Hamanov

TEST SUMMARY

Maxxam ID: VU0500 Dup
Sample ID: M15-4
Matrix: Water

Collected: 2014/05/05
Shipped:
Received: 2014/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Metals by ICPMS	ICP/MS	3594697	N/A	2014/05/08	John Bowman

GENERAL COMMENTS

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3594697	JBW	Matrix Spike [VU0500-04]	Dissolved Aluminum (Al)	2014/05/08		108	%	80 - 120
			Dissolved Antimony (Sb)	2014/05/08		111	%	80 - 120
			Dissolved Arsenic (As)	2014/05/08		105	%	80 - 120
			Dissolved Barium (Ba)	2014/05/08		106	%	80 - 120
			Dissolved Beryllium (Be)	2014/05/08		105	%	80 - 120
			Dissolved Bismuth (Bi)	2014/05/08		106	%	80 - 120
			Dissolved Boron (B)	2014/05/08		107	%	80 - 120
			Dissolved Cadmium (Cd)	2014/05/08		109	%	80 - 120
			Dissolved Calcium (Ca)	2014/05/08		NC	%	80 - 120
			Dissolved Chromium (Cr)	2014/05/08		101	%	80 - 120
			Dissolved Cobalt (Co)	2014/05/08		107	%	80 - 120
			Dissolved Copper (Cu)	2014/05/08		103	%	80 - 120
			Dissolved Iron (Fe)	2014/05/08		104	%	80 - 120
			Dissolved Lead (Pb)	2014/05/08		101	%	80 - 120
			Dissolved Magnesium (Mg)	2014/05/08		NC	%	80 - 120
			Dissolved Manganese (Mn)	2014/05/08		106	%	80 - 120
			Dissolved Molybdenum (Mo)	2014/05/08		103	%	80 - 120
			Dissolved Nickel (Ni)	2014/05/08		103	%	80 - 120
			Dissolved Phosphorus (P)	2014/05/08		112	%	80 - 120
			Dissolved Potassium (K)	2014/05/08		107	%	80 - 120
			Dissolved Selenium (Se)	2014/05/08		107	%	80 - 120
			Dissolved Silicon (Si)	2014/05/08		102	%	80 - 120
			Dissolved Silver (Ag)	2014/05/08		97	%	80 - 120
			Dissolved Sodium (Na)	2014/05/08		103	%	80 - 120
			Dissolved Strontium (Sr)	2014/05/08		106	%	80 - 120
			Dissolved Thallium (Tl)	2014/05/08		97	%	80 - 120
			Dissolved Titanium (Ti)	2014/05/08		107	%	80 - 120
			Dissolved Uranium (U)	2014/05/08		107	%	80 - 120
			Dissolved Vanadium (V)	2014/05/08		100	%	80 - 120
			Dissolved Zinc (Zn)	2014/05/08		103	%	80 - 120
3594697	JBW	Spiked Blank	Dissolved Aluminum (Al)	2014/05/08		103	%	80 - 120
			Dissolved Antimony (Sb)	2014/05/08		104	%	80 - 120
			Dissolved Arsenic (As)	2014/05/08		99	%	80 - 120
			Dissolved Barium (Ba)	2014/05/08		103	%	80 - 120
			Dissolved Beryllium (Be)	2014/05/08		100	%	80 - 120
			Dissolved Bismuth (Bi)	2014/05/08		104	%	80 - 120
			Dissolved Boron (B)	2014/05/08		101	%	80 - 120
			Dissolved Cadmium (Cd)	2014/05/08		104	%	80 - 120
			Dissolved Calcium (Ca)	2014/05/08		100	%	80 - 120
			Dissolved Chromium (Cr)	2014/05/08		97	%	80 - 120
			Dissolved Cobalt (Co)	2014/05/08		102	%	80 - 120
			Dissolved Copper (Cu)	2014/05/08		98	%	80 - 120
			Dissolved Iron (Fe)	2014/05/08		98	%	80 - 120
			Dissolved Lead (Pb)	2014/05/08		98	%	80 - 120
			Dissolved Magnesium (Mg)	2014/05/08		99	%	80 - 120
			Dissolved Manganese (Mn)	2014/05/08		101	%	80 - 120
			Dissolved Molybdenum (Mo)	2014/05/08		96	%	80 - 120
			Dissolved Nickel (Ni)	2014/05/08		99	%	80 - 120
			Dissolved Phosphorus (P)	2014/05/08		107	%	80 - 120
			Dissolved Potassium (K)	2014/05/08		102	%	80 - 120
			Dissolved Selenium (Se)	2014/05/08		103	%	80 - 120
			Dissolved Silicon (Si)	2014/05/08		100	%	80 - 120
			Dissolved Silver (Ag)	2014/05/08		88	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Dissolved Sodium (Na)	2014/05/08		98	%	80 - 120
			Dissolved Strontium (Sr)	2014/05/08		101	%	80 - 120
			Dissolved Thallium (Tl)	2014/05/08		93	%	80 - 120
			Dissolved Titanium (Ti)	2014/05/08		101	%	80 - 120
			Dissolved Uranium (U)	2014/05/08		102	%	80 - 120
			Dissolved Vanadium (V)	2014/05/08		95	%	80 - 120
			Dissolved Zinc (Zn)	2014/05/08		101	%	80 - 120
3594697	JBW	Method Blank	Dissolved Aluminum (Al)	2014/05/08	ND , RDL=0.0050		mg/L	
			Dissolved Antimony (Sb)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Arsenic (As)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Barium (Ba)	2014/05/08	ND , RDL=0.0020		mg/L	
			Dissolved Beryllium (Be)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Bismuth (Bi)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Boron (B)	2014/05/08	ND , RDL=0.010		mg/L	
			Dissolved Cadmium (Cd)	2014/05/08	ND , RDL=0.00010		mg/L	
			Dissolved Calcium (Ca)	2014/05/08	ND , RDL=0.20		mg/L	
			Dissolved Chromium (Cr)	2014/05/08	ND , RDL=0.0050		mg/L	
			Dissolved Cobalt (Co)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Copper (Cu)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Iron (Fe)	2014/05/08	ND , RDL=0.10		mg/L	
			Dissolved Lead (Pb)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Magnesium (Mg)	2014/05/08	ND , RDL=0.050		mg/L	
			Dissolved Manganese (Mn)	2014/05/08	ND , RDL=0.0020		mg/L	
			Dissolved Molybdenum (Mo)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Nickel (Ni)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Phosphorus (P)	2014/05/08	ND , RDL=0.10		mg/L	
			Dissolved Potassium (K)	2014/05/08	ND , RDL=0.20		mg/L	
			Dissolved Selenium (Se)	2014/05/08	ND , RDL=0.0020		mg/L	

Maxxam Job #: B472934
Report Date: 2014/05/08

Harden Environmental
Client Project #: 9506
Site Location: ROCKWOOD

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Dissolved Silicon (Si)	2014/05/08	ND , RDL=0.050		mg/L	
			Dissolved Silver (Ag)	2014/05/08	ND , RDL=0.00010		mg/L	
			Dissolved Sodium (Na)	2014/05/08	ND , RDL=0.10		mg/L	
			Dissolved Strontium (Sr)	2014/05/08	ND , RDL=0.0010		mg/L	
			Dissolved Thallium (Tl)	2014/05/08	ND , RDL=0.000050		mg/L	
			Dissolved Titanium (Ti)	2014/05/08	ND , RDL=0.0050		mg/L	
			Dissolved Uranium (U)	2014/05/08	ND , RDL=0.00010		mg/L	
			Dissolved Vanadium (V)	2014/05/08	ND , RDL=0.00050		mg/L	
			Dissolved Zinc (Zn)	2014/05/08	ND , RDL=0.0050		mg/L	
3594697	JBW	RPD [VU0500-04]	Dissolved Aluminum (Al)	2014/05/08	NC		%	20
			Dissolved Antimony (Sb)	2014/05/08	NC		%	20
			Dissolved Arsenic (As)	2014/05/08	NC		%	20
			Dissolved Barium (Ba)	2014/05/08	0.5		%	20
			Dissolved Beryllium (Be)	2014/05/08	NC		%	20
			Dissolved Bismuth (Bi)	2014/05/08	NC		%	20
			Dissolved Boron (B)	2014/05/08	NC		%	20
			Dissolved Cadmium (Cd)	2014/05/08	NC		%	20
			Dissolved Calcium (Ca)	2014/05/08	0.3		%	20
			Dissolved Chromium (Cr)	2014/05/08	NC		%	20
			Dissolved Cobalt (Co)	2014/05/08	NC		%	20
			Dissolved Copper (Cu)	2014/05/08	NC		%	20
			Dissolved Iron (Fe)	2014/05/08	NC		%	20
			Dissolved Lead (Pb)	2014/05/08	NC		%	20
			Dissolved Magnesium (Mg)	2014/05/08	1.0		%	20
			Dissolved Manganese (Mn)	2014/05/08	NC		%	20
			Dissolved Molybdenum (Mo)	2014/05/08	NC		%	20
			Dissolved Nickel (Ni)	2014/05/08	NC		%	20
			Dissolved Phosphorus (P)	2014/05/08	NC		%	20
			Dissolved Potassium (K)	2014/05/08	0.8		%	20
			Dissolved Selenium (Se)	2014/05/08	NC		%	20
			Dissolved Silicon (Si)	2014/05/08	1.6		%	20
			Dissolved Silver (Ag)	2014/05/08	NC		%	20
			Dissolved Sodium (Na)	2014/05/08	0.2		%	20
			Dissolved Strontium (Sr)	2014/05/08	0.5		%	20
			Dissolved Thallium (Tl)	2014/05/08	NC		%	20
			Dissolved Titanium (Ti)	2014/05/08	NC		%	20
			Dissolved Uranium (U)	2014/05/08	NC		%	20
			Dissolved Vanadium (V)	2014/05/08	NC		%	20
			Dissolved Zinc (Zn)	2014/05/08	2.5		%	20
3594997	YPA	Spiked Blank	Alkalinity (Total as CaCO3)	2014/05/06		97	%	85 - 115
3594997	YPA	Method Blank	Alkalinity (Total as CaCO3)	2014/05/06	ND , RDL=1.0		mg/L	
3594997	YPA	RPD	Alkalinity (Total as CaCO3)	2014/05/06	0.7		%	25

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3595001	YPA	Spiked Blank	Conductivity	2014/05/06		100	%	85 - 115
3595001	YPA	Method Blank	Conductivity	2014/05/06	ND , RDL=1.0		umho/cm	
3595001	YPA	RPD	Conductivity	2014/05/06	0		%	25
3595143	AHA	Matrix Spike	Dissolved Organic Carbon	2014/05/07		NC	%	80 - 120
3595143	AHA	Spiked Blank	Dissolved Organic Carbon	2014/05/07		104	%	80 - 120
3595143	AHA	Method Blank	Dissolved Organic Carbon	2014/05/07	ND , RDL=0.20		mg/L	
3595143	AHA	RPD	Dissolved Organic Carbon	2014/05/07	0.2		%	20
3595183	C_N	Matrix Spike	Nitrite (N)	2014/05/06		102	%	80 - 120
			Nitrate (N)	2014/05/06		NC	%	80 - 120
3595183	C_N	Spiked Blank	Nitrite (N)	2014/05/06		99	%	80 - 120
			Nitrate (N)	2014/05/06		104	%	80 - 120
3595183	C_N	Method Blank	Nitrite (N)	2014/05/06	ND , RDL=0.010		mg/L	
			Nitrate (N)	2014/05/06	ND , RDL=0.10		mg/L	
3595183	C_N	RPD	Nitrite (N)	2014/05/06	NC		%	25
			Nitrate (N)	2014/05/06	0.2		%	25
3595316	AHA	Matrix Spike	Total Kjeldahl Nitrogen (TKN)	2014/05/07		87	%	80 - 120
3595316	AHA	QC Standard	Total Kjeldahl Nitrogen (TKN)	2014/05/07		103	%	80 - 120
3595316	AHA	Spiked Blank	Total Kjeldahl Nitrogen (TKN)	2014/05/07		97	%	80 - 120
3595316	AHA	Method Blank	Total Kjeldahl Nitrogen (TKN)	2014/05/07	ND , RDL=0.10		mg/L	
3595316	AHA	RPD	Total Kjeldahl Nitrogen (TKN)	2014/05/07	NC		%	20
3595528	DRM	Matrix Spike	Dissolved Chloride (Cl)	2014/05/07		NC	%	80 - 120
3595528	DRM	Spiked Blank	Dissolved Chloride (Cl)	2014/05/07		104	%	80 - 120
3595528	DRM	Method Blank	Dissolved Chloride (Cl)	2014/05/07	ND , RDL=1		mg/L	
3595528	DRM	RPD	Dissolved Chloride (Cl)	2014/05/07	0.3		%	20
3595530	ADB	Matrix Spike	Orthophosphate (P)	2014/05/07		102	%	75 - 125
3595530	ADB	Spiked Blank	Orthophosphate (P)	2014/05/07		100	%	80 - 120
3595530	ADB	Method Blank	Orthophosphate (P)	2014/05/07	ND , RDL=0.010		mg/L	
3595530	ADB	RPD	Orthophosphate (P)	2014/05/07	NC		%	25
3595531	ADB	Matrix Spike	Dissolved Sulphate (SO4)	2014/05/07		NC	%	75 - 125
3595531	ADB	Spiked Blank	Dissolved Sulphate (SO4)	2014/05/07		99	%	80 - 120
3595531	ADB	Method Blank	Dissolved Sulphate (SO4)	2014/05/07	ND , RDL=1		mg/L	
3595531	ADB	RPD	Dissolved Sulphate (SO4)	2014/05/07	1.0		%	20
3596106	COP	Matrix Spike	Total Ammonia-N	2014/05/07		96	%	80 - 120
3596106	COP	Spiked Blank	Total Ammonia-N	2014/05/07		99	%	85 - 115
3596106	COP	Method Blank	Total Ammonia-N	2014/05/07	ND , RDL=0.050		mg/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3596106	COP	RPD	Total Ammonia-N	2014/05/07	NC		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

CHARTERED
Eva Pranjic
CHEMIST

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Your Project #: 0508
Site Location: JAMES DICK
Your C.O.C. #: 24525

Attention:Stan Denhoed

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/05/01
Report #: R3017140
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B468586
Received: 2014/04/29, 10:30

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Total Ammonia-N	4	N/A	2014/05/01	CAM SOP-00441	US GS I-2522-90
Nitrate (NO3) and Nitrite (NO2) in Water (1)	4	N/A	2014/04/30	CAM SOP-00440	SM 4500 NO3I/NO2B
Total Kjeldahl Nitrogen in Water	4	2014/04/29	2014/04/30	CAM SOP-00454	EPA 351.2 Rev 2

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Andrew Turner, Project Manager
Email: ATurner@maxxam.ca
Phone# (800)268-7396 Ext:233

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 1

Maxxam Job #: B468586
Report Date: 2014/05/01

Harden Environmental
Client Project #: 0508
Site Location: JAMES DICK

RESULTS OF ANALYSES OF WATER

Maxxam ID			VR9820	VR9821	VR9822	VR9823		
Sampling Date			2014/04/28 11:50	2014/04/28 17:34	2014/04/28 18:40	2014/04/28 08:25		
COC Number			24525	24525	24525	24525		
	Units	**MAC**	**S1**	**S2**	**S3**	**S4**	**RDL**	**QC Batch**
Inorganics								
Total Ammonia-N	mg/L	-	ND	ND	ND	ND	0.050	3588966
Total Kjeldahl Nitrogen (TKN)	mg/L	-	0.31	0.43	0.43	0.29	0.10	3588404
Nitrite (N)	mg/L	**1**	ND	ND	ND	ND	0.010	3588115
Nitrate (N)	mg/L	**10**	0.47	0.46	0.44	0.47	0.10	3588115

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

MAC: Ontario Drinking Water Standards - Maximum Acceptable Concentration [Criteria A / MAC], Interim Maximum Acceptable Concentration [IMC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

ND = Not detected

TEST SUMMARY

Maxxam ID: VR9820
Sample ID: S1
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Ammonia-N	LACH/NH4	3588966	N/A	2014/05/01	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal
Total Kjeldahl Nitrogen in Water	AC	3588404	2014/04/29	2014/04/30	Anastasia Hamanov

Maxxam ID: VR9820 Dup
Sample ID: S1
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal

Maxxam ID: VR9821
Sample ID: S2
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Ammonia-N	LACH/NH4	3588966	N/A	2014/05/01	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal
Total Kjeldahl Nitrogen in Water	AC	3588404	2014/04/29	2014/04/30	Anastasia Hamanov

Maxxam ID: VR9822
Sample ID: S3
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Ammonia-N	LACH/NH4	3588966	N/A	2014/05/01	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal
Total Kjeldahl Nitrogen in Water	AC	3588404	2014/04/29	2014/04/30	Anastasia Hamanov

Maxxam ID: VR9823
Sample ID: S4
Matrix: Water

Collected: 2014/04/28
Shipped:
Received: 2014/04/29

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Ammonia-N	LACH/NH4	3588966	N/A	2014/05/01	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3588115	N/A	2014/04/30	Chandra Nandlal
Total Kjeldahl Nitrogen in Water	AC	3588404	2014/04/29	2014/04/30	Anastasia Hamanov

GENERAL COMMENTS

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3588115	C_N	Matrix Spike [VR9820-01]	Nitrite (N)	2014/04/30		102	%	80 - 120
			Nitrate (N)	2014/04/30		98	%	80 - 120
3588115	C_N	Spiked Blank	Nitrite (N)	2014/04/30		98	%	80 - 120
			Nitrate (N)	2014/04/30		98	%	80 - 120
3588115	C_N	Method Blank	Nitrite (N)	2014/04/30	ND , RDL=0.010		mg/L	
			Nitrate (N)	2014/04/30	ND , RDL=0.10		mg/L	
3588115	C_N	RPD [VR9820-01]	Nitrate (N)	2014/04/30	NC		%	25
3588404	AHA	Matrix Spike	Total Kjeldahl Nitrogen (TKN)	2014/04/30		61 (1)	%	80 - 120
3588404	AHA	QC Standard	Total Kjeldahl Nitrogen (TKN)	2014/04/30		104	%	80 - 120
3588404	AHA	Spiked Blank	Total Kjeldahl Nitrogen (TKN)	2014/04/30		91	%	80 - 120
3588404	AHA	Method Blank	Total Kjeldahl Nitrogen (TKN)	2014/04/30	ND , RDL=0.10		mg/L	
3588404	AHA	RPD	Total Kjeldahl Nitrogen (TKN)	2014/04/30	1.3		%	20
3588966	COP	Matrix Spike	Total Ammonia-N	2014/05/01		103	%	80 - 120
3588966	COP	Spiked Blank	Total Ammonia-N	2014/05/01		100	%	85 - 115
3588966	COP	Method Blank	Total Ammonia-N	2014/05/01	ND , RDL=0.050		mg/L	
3588966	COP	RPD	Total Ammonia-N	2014/05/01	NC		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere

Cristina Carriere, Scientific Services

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Your Project #: 9506 Rockwood
Your C.O.C. #: 46314602, 463146-02-01

Attention:Allan Rodie

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/04/15
Report #: R3001006
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B455991
Received: 2014/04/08, 15:14

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Alkalinity	3	N/A	2014/04/10	CAM SOP-00448	SM 2320B
Carbonate, Bicarbonate and Hydroxide	3	N/A	2014/04/11	CAM SOP-00102	APHA 4500-CO2 D
Chloride by Automated Colourimetry	3	N/A	2014/04/10	CAM SOP-00463	EPA 325.2
Conductivity	3	N/A	2014/04/10	CAM SOP-00414	SM 2510
Dissolved Organic Carbon (DOC) (1)	3	N/A	2014/04/09	CAM SOP-00446	SM 5310 B
Hardness (calculated as CaCO3)	3	N/A	2014/04/10	CAM SOP 00102/00408/00447	SM 2340 B
Lab Filtered Metals Analysis by ICP	3	2014/04/10	2014/04/10	CAM SOP-00408	SW-846 6010C
Total Metals Analysis by ICPMS	3	N/A	2014/04/14	CAM SOP-00447	EPA 6020
Ion Balance (% Difference)	3	N/A	2014/04/11		
Anion and Cation Sum	3	N/A	2014/04/11		
Coliform, (CFU/100mL)	3	N/A	2014/04/08	CAM SOP-00552	MOE LSB E3371
E.coli, (CFU/100mL)	3	N/A	2014/04/08	CAM SOP-00552	MOE LSB E3371
Total Ammonia-N	3	N/A	2014/04/14	CAM SOP-00441	US GS I-2522-90
Nitrate (NO3) and Nitrite (NO2) in Water (2)	3	N/A	2014/04/09	CAM SOP-00440	SM 4500 NO3I/NO2B
Organic Nitrogen	3	N/A	2014/04/14	APHA Standard Methods	SM4500
pH	3	N/A	2014/04/10	CAM SOP-00413	SM 4500H+ B
Orthophosphate	3	N/A	2014/04/10	CAM SOP-00461	EPA 365.1
Sat. pH and Langelier Index (@ 20C)	3	N/A	2014/04/11		
Sat. pH and Langelier Index (@ 4C)	3	N/A	2014/04/11		
Sulphate by Automated Colourimetry	3	N/A	2014/04/10	CAM SOP-00464	EPA 375.4
Total Kjeldahl Nitrogen in Water	3	2014/04/11	2014/04/11	CAM SOP-00454	EPA 351.2 Rev 2
Total Organic Carbon (TOC) (3)	3	N/A	2014/04/12	CAM SOP-00446	SM 5310B
Total Phosphorus (Colourimetric)	3	2014/04/14	2014/04/15	CAM SOP-00407	APHA 4500 P,B,F
Turbidity	3	N/A	2014/04/09	CAM SOP-00417	APHA 2130B

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting

Your Project #: 9506 Rockwood
Your C.O.C. #: 46314602, 463146-02-01

Attention:Allan Rodie

Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2014/04/15
Report #: R3001006
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B455991
Received: 2014/04/08, 15:14

results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(2) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.
(3) Total Organic Carbon (TOC) present in the sample should be considered as non-purgeable TOC.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Andrew Turner, Project Manager
Email: ATurner@maxxam.ca
Phone# (800)268-7396 Ext:233
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 2

Maxxam Job #: B455991
Report Date: 2014/04/15

Harden Environmental
Client Project #: 9506 Rockwood
Sampler Initials: AR

RESULTS OF ANALYSES OF WATER

Maxxam ID			VL9687	VL9688		VL9689		
Sampling Date			2014/04/08 10:30	2014/04/08 11:00		2014/04/08 12:00		
COC Number			463146-02-01	463146-02-01		463146-02-01		
	Units	**Criteria**	**SW 8**	**SW 4**	**QC Batch**	**SW 11**	**RDL**	**QC Batch**
Calculated Parameters								
Anion Sum	me/L	-	5.99	6.05	3566801	4.21	N/A	3566801
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	240	240	3566798	180	1.0	3566798
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	3.0	2.7	3566798	2.0	1.0	3566798
Cation Sum	me/L	-	6.50	6.89	3566801	4.60	N/A	3566801
Hardness (CaCO3)	mg/L	-	300	320	3566098	210	1.0	3566098
Ion Balance (% Difference)	%	-	4.09	6.49	3566800	4.43	N/A	3566800
Langelier Index (@ 20C)	N/A	-	1.02	0.984	3566803	0.710		3566803
Langelier Index (@ 4C)	N/A	-	0.770	0.736	3566804	0.461		3566804
Total Organic Nitrogen	mg/L	-	0.4	0.5	3566120	0.5	0.1	3566120
Saturation pH (@ 20C)	N/A	-	7.12	7.09	3566803	7.36		3566803
Saturation pH (@ 4C)	N/A	-	7.36	7.34	3566804	7.61		3566804
Inorganics								
Total Ammonia-N	mg/L	-	ND	ND	3571016	0.076	0.050	3571016
Conductivity	umho/cm	-	560	570	3568643	390	1.0	3568643
Total Kjeldahl Nitrogen (TKN)	mg/L	-	0.43	0.54	3570432	0.62	0.10	3570432
Dissolved Organic Carbon	mg/L	-	2.4	2.3	3567546	5.2	0.20	3568077
Total Organic Carbon (TOC)	mg/L	-	2.6	2.7	3571047	5.5	0.20	3571047
Orthophosphate (P)	mg/L	-	ND	ND	3568684	0.030	0.010	3568684
pH	pH	**6.5:8.5**	8.13	8.07	3568644	8.07	N/A	3568644
Total Phosphorus	mg/L	**0.01**	0.002	0.002	3572645	**0.047**	0.002	3572645
Dissolved Sulphate (SO4)	mg/L	-	14	14	3568685	7	1	3568685
Turbidity	NTU	-	0.4	0.3	3568272	1.4	0.2	3568272
Alkalinity (Total as CaCO3)	mg/L	-	240	240	3568642	180	1.0	3568642
Dissolved Chloride (Cl)	mg/L	-	20	21	3568680	14	1	3568680
Nitrite (N)	mg/L	-	ND	ND	3567578	ND	0.010	3567578
Nitrate (N)	mg/L	-	4.53	4.64	3567578	0.90	0.10	3567578

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

N/A = Not Applicable

ND = Not detected

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID			VL9687	VL9688	VL9689		
Sampling Date			2014/04/08 10:30	2014/04/08 11:00	2014/04/08 12:00		
COC Number			463146-02-01	463146-02-01	463146-02-01		
	Units	**Criteria**	**SW 8**	**SW 4**	**SW 11**	**RDL**	**QC Batch**
Metals							
Dissolved Calcium (Ca)	mg/L	-	85.1	90.4	60.7	0.05	3568899
Dissolved Magnesium (Mg)	mg/L	-	21.9	23.1	15.3	0.05	3568899
Dissolved Potassium (K)	mg/L	-	3	3	3	1	3568899
Dissolved Sodium (Na)	mg/L	-	9.1	9.6	5.3	0.5	3568899
Total Aluminum (Al)	mg/L	-	0.012	0.011	0.064	0.0050	3572799
Total Antimony (Sb)	mg/L	**0.02**	ND	ND	ND	0.00050	3572799
Total Arsenic (As)	mg/L	**0.1**	ND	ND	ND	0.0010	3572799
Total Barium (Ba)	mg/L	-	0.023	0.024	0.020	0.0020	3572799
Total Beryllium (Be)	mg/L	**0.011**	ND	ND	ND	0.00050	3572799
Total Boron (B)	mg/L	**0.2**	0.011	0.011	ND	0.010	3572799
Total Cadmium (Cd)	mg/L	**0.0002**	ND	ND	ND	0.00010	3572799
Total Calcium (Ca)	mg/L	-	78	79	56	0.20	3572799
Total Chromium (Cr)	mg/L	-	ND	ND	ND	0.0050	3572799
Total Cobalt (Co)	mg/L	**0.0009**	ND	ND	ND	0.00050	3572799
Total Copper (Cu)	mg/L	**0.005**	ND	ND	0.0015	0.0010	3572799
Total Iron (Fe)	mg/L	**0.3**	ND	ND	ND	0.10	3572799
Total Lead (Pb)	mg/L	**0.005**	ND	ND	ND	0.00050	3572799
Total Magnesium (Mg)	mg/L	-	20	21	14	0.050	3572799
Total Manganese (Mn)	mg/L	-	0.0031	0.0066	0.018	0.0020	3572799
Total Molybdenum (Mo)	mg/L	**0.04**	ND	ND	0.00053	0.00050	3572799
Total Nickel (Ni)	mg/L	**0.025**	ND	ND	ND	0.0010	3572799
Total Potassium (K)	mg/L	-	2.3	2.3	2.9	0.20	3572799
Total Silicon (Si)	mg/L	-	2.8	2.8	2.6	0.050	3572799
Total Selenium (Se)	mg/L	**0.1**	ND	ND	ND	0.0020	3572799
Total Silver (Ag)	mg/L	**0.0001**	ND	ND	ND	0.00010	3572799
Total Sodium (Na)	mg/L	-	8.3	8.5	4.7	0.10	3572799
Total Strontium (Sr)	mg/L	-	0.098	0.10	0.071	0.0010	3572799
Total Thallium (Tl)	mg/L	**0.0003**	ND	ND	ND	0.000050	3572799
Total Titanium (Ti)	mg/L	-	ND	ND	0.0054	0.0050	3572799
Total Uranium (U)	mg/L	**0.005**	0.00040	0.00039	0.00080	0.00010	3572799
Total Vanadium (V)	mg/L	**0.006**	ND	0.00051	0.00061	0.00050	3572799
Total Zinc (Zn)	mg/L	**0.03**	**0.032**	**0.032**	**0.076**	0.0050	3572799

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

ND = Not detected

MICROBIOLOGY (WATER)

Maxxam ID		VL9687	VL9688	VL9689		
Sampling Date		2014/04/08 10:30	2014/04/08 11:00	2014/04/08 12:00		
COC Number		463146-02-01	463146-02-01	463146-02-01		
	Units	**SW 8**	**SW 4**	**SW 11**	**RDL**	**QC Batch**
Microbiological						
Background	CFU/100mL	1900	1500	5100	10	3566835
Total Coliforms	CFU/100mL	120	70	210	10	3566835
Escherichia coli	CFU/100mL	20	40	10	10	3566832

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

TEST SUMMARY

Maxxam ID: VL9687
Sample ID: SW 8
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3568642	N/A	2014/04/10	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	3566798	N/A	2014/04/11	Automated Statchk
Chloride by Automated Colourimetry	AC	3568680	N/A	2014/04/10	Alina Dobreanu
Conductivity	COND	3568643	N/A	2014/04/10	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3567546	N/A	2014/04/09	Anastasia Hamanov
Hardness (calculated as CaCO3)		3566098	N/A	2014/04/10	Automated Statchk
Lab Filtered Metals Analysis by ICP	ICP	3568899	2014/04/10	2014/04/10	Jolly John
Total Metals Analysis by ICPMS	ICP/MS	3572799	N/A	2014/04/14	Kevin Comerford
Ion Balance (% Difference)	CALC	3566800	N/A	2014/04/11	Automated Statchk
Anion and Cation Sum	CALC	3566801	N/A	2014/04/11	Automated Statchk
Coliform, (CFU/100mL)	PL	3566835	N/A	2014/04/08	
E.coli, (CFU/100mL)	PL	3566832	N/A	2014/04/08	Maxima Hermanez
Total Ammonia-N	LACH/NH4	3571016	N/A	2014/04/14	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3567578	N/A	2014/04/09	Chandra Nandlal
Organic Nitrogen	CALC	3566120	N/A	2014/04/14	Automated Statchk
pH	PH	3568644	N/A	2014/04/10	Surinder Rai
Orthophosphate	AC	3568684	N/A	2014/04/10	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3566803	N/A	2014/04/11	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3566804	N/A	2014/04/11	Automated Statchk
Sulphate by Automated Colourimetry	AC	3568685	N/A	2014/04/10	Alina Dobreanu
Total Kjeldahl Nitrogen in Water	AC	3570432	2014/04/11	2014/04/11	Anastasia Hamanov
Total Organic Carbon (TOC)	TOCV/NDIR	3571047	N/A	2014/04/12	Anastasia Hamanov
Total Phosphorus (Colourimetric)	LACH/P	3572645	2014/04/14	2014/04/15	Viorica Rotaru
Turbidity	TURB	3568272	N/A	2014/04/09	Lemeneh Addis

Maxxam ID: VL9687 Dup
Sample ID: SW 8
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Metals Analysis by ICPMS	ICP/MS	3572799	N/A	2014/04/14	Kevin Comerford
Coliform, (CFU/100mL)	PL	3566835	N/A	2014/04/09	
Turbidity	TURB	3568272	N/A	2014/04/09	Lemeneh Addis

Maxxam ID: VL9688
Sample ID: SW 4
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3568642	N/A	2014/04/10	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	3566798	N/A	2014/04/11	Automated Statchk
Chloride by Automated Colourimetry	AC	3568680	N/A	2014/04/10	Alina Dobreanu
Conductivity	COND	3568643	N/A	2014/04/10	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3567546	N/A	2014/04/09	Anastasia Hamanov
Hardness (calculated as CaCO3)		3566098	N/A	2014/04/10	Automated Statchk

TEST SUMMARY

Maxxam ID: VL9688
Sample ID: SW 4
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Lab Filtered Metals Analysis by ICP	ICP	3568899	2014/04/10	2014/04/10	Jolly John
Total Metals Analysis by ICPMS	ICP/MS	3572799	N/A	2014/04/14	Kevin Comerford
Ion Balance (% Difference)	CALC	3566800	N/A	2014/04/11	Automated Statchk
Anion and Cation Sum	CALC	3566801	N/A	2014/04/11	Automated Statchk
Coliform, (CFU/100mL)	PL	3566835	N/A	2014/04/08	
E.coli, (CFU/100mL)	PL	3566832	N/A	2014/04/08	Maxima Hermanez
Total Ammonia-N	LACH/NH4	3571016	N/A	2014/04/14	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3567578	N/A	2014/04/09	Chandra Nandlal
Organic Nitrogen	CALC	3566120	N/A	2014/04/14	Automated Statchk
pH	PH	3568644	N/A	2014/04/10	Surinder Rai
Orthophosphate	AC	3568684	N/A	2014/04/10	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3566803	N/A	2014/04/11	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3566804	N/A	2014/04/11	Automated Statchk
Sulphate by Automated Colourimetry	AC	3568685	N/A	2014/04/10	Alina Dobreanu
Total Kjeldahl Nitrogen in Water	AC	3570432	2014/04/11	2014/04/11	Anastasia Hamanov
Total Organic Carbon (TOC)	TOCV/NDIR	3571047	N/A	2014/04/12	Anastasia Hamanov
Total Phosphorus (Colourimetric)	LACH/P	3572645	2014/04/14	2014/04/15	Viorica Rotaru
Turbidity	TURB	3568272	N/A	2014/04/09	Lemeneh Addis

Maxxam ID: VL9688 Dup
Sample ID: SW 4
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3568642	N/A	2014/04/10	Surinder Rai
Conductivity	COND	3568643	N/A	2014/04/10	Surinder Rai
Lab Filtered Metals Analysis by ICP	ICP	3568899	2014/04/10	2014/04/10	Jolly John
pH	PH	3568644	N/A	2014/04/10	Surinder Rai
Total Phosphorus (Colourimetric)	LACH/P	3572645	2014/04/14	2014/04/15	Viorica Rotaru

Maxxam ID: VL9689
Sample ID: SW 11
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity	PH	3568642	N/A	2014/04/10	Surinder Rai
Carbonate, Bicarbonate and Hydroxide	CALC	3566798	N/A	2014/04/11	Automated Statchk
Chloride by Automated Colourimetry	AC	3568680	N/A	2014/04/10	Alina Dobreanu
Conductivity	COND	3568643	N/A	2014/04/10	Surinder Rai
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3568077	N/A	2014/04/09	Anastasia Hamanov
Hardness (calculated as CaCO3)		3566098	N/A	2014/04/10	Automated Statchk
Lab Filtered Metals Analysis by ICP	ICP	3568899	2014/04/10	2014/04/10	Jolly John
Total Metals Analysis by ICPMS	ICP/MS	3572799	N/A	2014/04/14	Kevin Comerford
Ion Balance (% Difference)	CALC	3566800	N/A	2014/04/11	Automated Statchk
Anion and Cation Sum	CALC	3566801	N/A	2014/04/11	Automated Statchk

Maxxam Job #: B455991
Report Date: 2014/04/15

Harden Environmental
Client Project #: 9506 Rockwood
Sampler Initials: AR

TEST SUMMARY

Maxxam ID: VL9689
Sample ID: SW 11
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Coliform, (CFU/100mL)	PL	3566835	N/A	2014/04/08	
E.coli, (CFU/100mL)	PL	3566832	N/A	2014/04/08	Maxima Hermanez
Total Ammonia-N	LACH/NH4	3571016	N/A	2014/04/14	Charles Opoku-Ware
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	3567578	N/A	2014/04/09	Chandra Nandlal
Organic Nitrogen	CALC	3566120	N/A	2014/04/14	Automated Statchk
pH	PH	3568644	N/A	2014/04/10	Surinder Rai
Orthophosphate	AC	3568684	N/A	2014/04/10	Alina Dobreanu
Sat. pH and Langelier Index (@ 20C)	CALC	3566803	N/A	2014/04/11	Automated Statchk
Sat. pH and Langelier Index (@ 4C)	CALC	3566804	N/A	2014/04/11	Automated Statchk
Sulphate by Automated Colourimetry	AC	3568685	N/A	2014/04/10	Alina Dobreanu
Total Kjeldahl Nitrogen in Water	AC	3570432	2014/04/11	2014/04/11	Anastasia Hamanov
Total Organic Carbon (TOC)	TOCV/NDIR	3571047	N/A	2014/04/12	Anastasia Hamanov
Total Phosphorus (Colourimetric)	LACH/P	3572645	2014/04/14	2014/04/15	Viorica Rotaru
Turbidity	TURB	3568272	N/A	2014/04/09	Lemeneh Addis

Maxxam ID: VL9689 Dup
Sample ID: SW 11
Matrix: Water

Collected: 2014/04/08
Shipped:
Received: 2014/04/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Organic Carbon (DOC)	TOCV/NDIR	3568077	N/A	2014/04/09	Anastasia Hamanov

GENERAL COMMENTS

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
3567546	AHA	Matrix Spike	Dissolved Organic Carbon	2014/04/09		96	%	80 - 120
3567546	AHA	Spiked Blank	Dissolved Organic Carbon	2014/04/09		97	%	80 - 120
3567546	AHA	Method Blank	Dissolved Organic Carbon	2014/04/09	ND , RDL=0.20		mg/L	
3567546	AHA	RPD	Dissolved Organic Carbon	2014/04/09	6.5		%	20
3567578	C_N	Matrix Spike	Nitrite (N)	2014/04/09		105	%	80 - 120
			Nitrate (N)	2014/04/09		NC	%	80 - 120
3567578	C_N	Spiked Blank	Nitrite (N)	2014/04/09		102	%	80 - 120
			Nitrate (N)	2014/04/09		100	%	80 - 120
3567578	C_N	Method Blank	Nitrite (N)	2014/04/09	ND , RDL=0.010		mg/L	
			Nitrate (N)	2014/04/09	ND , RDL=0.10		mg/L	
3567578	C_N	RPD	Nitrite (N)	2014/04/09	NC		%	25
			Nitrate (N)	2014/04/09	1		%	25
3568077	AHA	Matrix Spike [VL9689-01]	Dissolved Organic Carbon	2014/04/09		98	%	80 - 120
3568077	AHA	Spiked Blank	Dissolved Organic Carbon	2014/04/09		99	%	80 - 120
3568077	AHA	Method Blank	Dissolved Organic Carbon	2014/04/09	ND , RDL=0.20		mg/L	
3568077	AHA	RPD [VL9689-01]	Dissolved Organic Carbon	2014/04/09	0.5		%	20
3568272	L_A	QC Standard	Turbidity	2014/04/09		98	%	85 - 115
3568272	L_A	Method Blank	Turbidity	2014/04/09	ND , RDL=0.2		NTU	
3568272	L_A	RPD [VL9687-01]	Turbidity	2014/04/09	NC		%	20
3568642	SAU	Spiked Blank	Alkalinity (Total as CaCO3)	2014/04/10		93	%	85 - 115
3568642	SAU	Method Blank	Alkalinity (Total as CaCO3)	2014/04/10	ND , RDL=1.0		mg/L	
3568642	SAU	RPD [VL9688-01]	Alkalinity (Total as CaCO3)	2014/04/10	0.4		%	25
3568643	SAU	Spiked Blank	Conductivity	2014/04/10		98	%	85 - 115
3568643	SAU	Method Blank	Conductivity	2014/04/10	ND , RDL=1.0		umho/cm	
3568643	SAU	RPD [VL9688-01]	Conductivity	2014/04/10	0.2		%	25
3568680	ADB	Matrix Spike	Dissolved Chloride (Cl)	2014/04/10		NC	%	80 - 120
3568680	ADB	Spiked Blank	Dissolved Chloride (Cl)	2014/04/10		103	%	80 - 120
3568680	ADB	Method Blank	Dissolved Chloride (Cl)	2014/04/10	ND , RDL=1		mg/L	
3568680	ADB	RPD	Dissolved Chloride (Cl)	2014/04/10	1		%	20
3568684	ADB	Matrix Spike	Orthophosphate (P)	2014/04/10		102	%	75 - 125
3568684	ADB	Spiked Blank	Orthophosphate (P)	2014/04/10		100	%	80 - 120
3568684	ADB	Method Blank	Orthophosphate (P)	2014/04/10	ND , RDL=0.010		mg/L	
3568684	ADB	RPD	Orthophosphate (P)	2014/04/10	NC		%	25
3568685	ADB	Matrix Spike	Dissolved Sulphate (SO4)	2014/04/10		114	%	75 - 125
3568685	ADB	Spiked Blank	Dissolved Sulphate (SO4)	2014/04/10		105	%	80 - 120
3568685	ADB	Method Blank	Dissolved Sulphate (SO4)	2014/04/10	ND , RDL=1		mg/L	
3568685	ADB	RPD	Dissolved Sulphate (SO4)	2014/04/10	NC		%	20
3568899	JOH	Matrix Spike [VL9688-01]	Dissolved Calcium (Ca)	2014/04/10		NC	%	80 - 120
			Dissolved Magnesium (Mg)	2014/04/10		NC	%	80 - 120
			Dissolved Potassium (K)	2014/04/10		95	%	80 - 120
			Dissolved Sodium (Na)	2014/04/10		NC	%	80 - 120
3568899	JOH	Spiked Blank	Dissolved Calcium (Ca)	2014/04/10		103	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Dissolved Magnesium (Mg)	2014/04/10		101	%	80 - 120
			Dissolved Potassium (K)	2014/04/10		101	%	80 - 120
			Dissolved Sodium (Na)	2014/04/10		104	%	80 - 120
3568899	JOH	Method Blank	Dissolved Calcium (Ca)	2014/04/10	ND , RDL=0.05		mg/L	
			Dissolved Magnesium (Mg)	2014/04/10	ND , RDL=0.05		mg/L	
			Dissolved Potassium (K)	2014/04/10	ND , RDL=1		mg/L	
			Dissolved Sodium (Na)	2014/04/10	ND , RDL=0.5		mg/L	
3568899	JOH	RPD [VL9688-01]	Dissolved Calcium (Ca)	2014/04/10	3.8		%	25
			Dissolved Magnesium (Mg)	2014/04/10	4.0		%	25
			Dissolved Potassium (K)	2014/04/10	NC		%	25
			Dissolved Sodium (Na)	2014/04/10	4.6		%	25
3570432	AHA	Matrix Spike	Total Kjeldahl Nitrogen (TKN)	2014/04/11		74 (1)	%	80 - 120
3570432	AHA	QC Standard	Total Kjeldahl Nitrogen (TKN)	2014/04/11		101	%	80 - 120
3570432	AHA	Spiked Blank	Total Kjeldahl Nitrogen (TKN)	2014/04/11		89	%	80 - 120
3570432	AHA	Method Blank	Total Kjeldahl Nitrogen (TKN)	2014/04/11	ND , RDL=0.10		mg/L	
3570432	AHA	RPD	Total Kjeldahl Nitrogen (TKN)	2014/04/11	4.4		%	20
3571016	COP	Matrix Spike	Total Ammonia-N	2014/04/14		105	%	80 - 120
3571016	COP	Spiked Blank	Total Ammonia-N	2014/04/14		99	%	85 - 115
3571016	COP	Method Blank	Total Ammonia-N	2014/04/14	ND , RDL=0.050		mg/L	
3571016	COP	RPD	Total Ammonia-N	2014/04/14	NC		%	20
3571047	AHA	Matrix Spike	Total Organic Carbon (TOC)	2014/04/12		NC	%	80 - 120
3571047	AHA	Spiked Blank	Total Organic Carbon (TOC)	2014/04/12		95	%	80 - 120
3571047	AHA	Method Blank	Total Organic Carbon (TOC)	2014/04/12	ND , RDL=0.20		mg/L	
3571047	AHA	RPD	Total Organic Carbon (TOC)	2014/04/12	1.2		%	20
3572645	VRO	Matrix Spike [VL9688-02]	Total Phosphorus	2014/04/15		98	%	80 - 120
3572645	VRO	QC Standard	Total Phosphorus	2014/04/15		105	%	80 - 120
3572645	VRO	Spiked Blank	Total Phosphorus	2014/04/15		98	%	80 - 120
3572645	VRO	Method Blank	Total Phosphorus	2014/04/15	ND , RDL=0.002		mg/L	
3572645	VRO	RPD [VL9688-02]	Total Phosphorus	2014/04/15	NC		%	20
3572799	KCO	Matrix Spike [VL9687-03]	Total Aluminum (Al)	2014/04/14		97	%	80 - 120
			Total Antimony (Sb)	2014/04/14		108	%	80 - 120
			Total Arsenic (As)	2014/04/14		101	%	80 - 120
			Total Barium (Ba)	2014/04/14		100	%	80 - 120
			Total Beryllium (Be)	2014/04/14		105	%	80 - 120
			Total Boron (B)	2014/04/14		95	%	80 - 120
			Total Cadmium (Cd)	2014/04/14		104	%	80 - 120
			Total Calcium (Ca)	2014/04/14		NC	%	80 - 120
			Total Chromium (Cr)	2014/04/14		100	%	80 - 120
			Total Cobalt (Co)	2014/04/14		95	%	80 - 120
			Total Copper (Cu)	2014/04/14		98	%	80 - 120
			Total Iron (Fe)	2014/04/14		98	%	80 - 120
			Total Lead (Pb)	2014/04/14		101	%	80 - 120
			Total Magnesium (Mg)	2014/04/14		NC	%	80 - 120
			Total Manganese (Mn)	2014/04/14		96	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Total Molybdenum (Mo)	2014/04/14		104	%	80 - 120
			Total Nickel (Ni)	2014/04/14		98	%	80 - 120
			Total Potassium (K)	2014/04/14		95	%	80 - 120
			Total Silicon (Si)	2014/04/14		101	%	80 - 120
			Total Selenium (Se)	2014/04/14		99	%	80 - 120
			Total Silver (Ag)	2014/04/14		97	%	80 - 120
			Total Sodium (Na)	2014/04/14		98	%	80 - 120
			Total Strontium (Sr)	2014/04/14		103	%	80 - 120
			Total Thallium (Tl)	2014/04/14		107	%	80 - 120
			Total Titanium (Ti)	2014/04/14		99	%	80 - 120
			Total Uranium (U)	2014/04/14		107	%	80 - 120
			Total Vanadium (V)	2014/04/14		97	%	80 - 120
			Total Zinc (Zn)	2014/04/14		100	%	80 - 120
3572799	KCO	Spiked Blank	Total Aluminum (Al)	2014/04/14		100	%	80 - 120
			Total Antimony (Sb)	2014/04/14		107	%	80 - 120
			Total Arsenic (As)	2014/04/14		101	%	80 - 120
			Total Barium (Ba)	2014/04/14		100	%	80 - 120
			Total Beryllium (Be)	2014/04/14		105	%	80 - 120
			Total Boron (B)	2014/04/14		95	%	80 - 120
			Total Cadmium (Cd)	2014/04/14		104	%	80 - 120
			Total Calcium (Ca)	2014/04/14		98	%	80 - 120
			Total Chromium (Cr)	2014/04/14		100	%	80 - 120
			Total Cobalt (Co)	2014/04/14		96	%	80 - 120
			Total Copper (Cu)	2014/04/14		99	%	80 - 120
			Total Iron (Fe)	2014/04/14		96	%	80 - 120
			Total Lead (Pb)	2014/04/14		100	%	80 - 120
			Total Magnesium (Mg)	2014/04/14		101	%	80 - 120
			Total Manganese (Mn)	2014/04/14		95	%	80 - 120
			Total Molybdenum (Mo)	2014/04/14		102	%	80 - 120
			Total Nickel (Ni)	2014/04/14		100	%	80 - 120
			Total Potassium (K)	2014/04/14		94	%	80 - 120
			Total Silicon (Si)	2014/04/14		100	%	80 - 120
			Total Selenium (Se)	2014/04/14		101	%	80 - 120
			Total Silver (Ag)	2014/04/14		97	%	80 - 120
			Total Sodium (Na)	2014/04/14		99	%	80 - 120
			Total Strontium (Sr)	2014/04/14		102	%	80 - 120
			Total Thallium (Tl)	2014/04/14		105	%	80 - 120
			Total Titanium (Ti)	2014/04/14		102	%	80 - 120
			Total Uranium (U)	2014/04/14		105	%	80 - 120
			Total Vanadium (V)	2014/04/14		97	%	80 - 120
			Total Zinc (Zn)	2014/04/14		101	%	80 - 120
3572799	KCO	Method Blank	Total Aluminum (Al)	2014/04/14	ND , RDL=0.0050		mg/L	
			Total Antimony (Sb)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Arsenic (As)	2014/04/14	ND , RDL=0.0010		mg/L	
			Total Barium (Ba)	2014/04/14	ND , RDL=0.0020		mg/L	
			Total Beryllium (Be)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Boron (B)	2014/04/14	ND , RDL=0.010		mg/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Total Cadmium (Cd)	2014/04/14	ND , RDL=0.00010		mg/L	
			Total Calcium (Ca)	2014/04/14	ND , RDL=0.20		mg/L	
			Total Chromium (Cr)	2014/04/14	ND , RDL=0.0050		mg/L	
			Total Cobalt (Co)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Copper (Cu)	2014/04/14	ND , RDL=0.0010		mg/L	
			Total Iron (Fe)	2014/04/14	ND , RDL=0.10		mg/L	
			Total Lead (Pb)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Magnesium (Mg)	2014/04/14	ND , RDL=0.050		mg/L	
			Total Manganese (Mn)	2014/04/14	ND , RDL=0.0020		mg/L	
			Total Molybdenum (Mo)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Nickel (Ni)	2014/04/14	ND , RDL=0.0010		mg/L	
			Total Potassium (K)	2014/04/14	ND , RDL=0.20		mg/L	
			Total Silicon (Si)	2014/04/14	ND , RDL=0.050		mg/L	
			Total Selenium (Se)	2014/04/14	ND , RDL=0.0020		mg/L	
			Total Silver (Ag)	2014/04/14	ND , RDL=0.00010		mg/L	
			Total Sodium (Na)	2014/04/14	ND , RDL=0.10		mg/L	
			Total Strontium (Sr)	2014/04/14	ND , RDL=0.0010		mg/L	
			Total Thallium (Tl)	2014/04/14	ND , RDL=0.000050		mg/L	
			Total Titanium (Ti)	2014/04/14	ND , RDL=0.0050		mg/L	
			Total Uranium (U)	2014/04/14	ND , RDL=0.00010		mg/L	
			Total Vanadium (V)	2014/04/14	ND , RDL=0.00050		mg/L	
			Total Zinc (Zn)	2014/04/14	ND , RDL=0.0050		mg/L	
3572799	KCO	RPD [VL9687-03]	Total Aluminum (Al)	2014/04/14	NC		%	20
			Total Antimony (Sb)	2014/04/14	NC		%	20
			Total Arsenic (As)	2014/04/14	NC		%	20
			Total Barium (Ba)	2014/04/14	0.6		%	20
			Total Beryllium (Be)	2014/04/14	NC		%	20
			Total Boron (B)	2014/04/14	NC		%	20
			Total Cadmium (Cd)	2014/04/14	NC		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Total Calcium (Ca)	2014/04/14	1.2		%	20
			Total Chromium (Cr)	2014/04/14	NC		%	20
			Total Cobalt (Co)	2014/04/14	NC		%	20
			Total Copper (Cu)	2014/04/14	NC		%	20
			Total Iron (Fe)	2014/04/14	NC		%	20
			Total Lead (Pb)	2014/04/14	NC		%	20
			Total Magnesium (Mg)	2014/04/14	1.1		%	20
			Total Manganese (Mn)	2014/04/14	NC		%	20
			Total Molybdenum (Mo)	2014/04/14	NC		%	20
			Total Nickel (Ni)	2014/04/14	NC		%	20
			Total Potassium (K)	2014/04/14	1.0		%	20
			Total Silicon (Si)	2014/04/14	1.4		%	20
			Total Selenium (Se)	2014/04/14	NC		%	20
			Total Silver (Ag)	2014/04/14	NC		%	20
			Total Sodium (Na)	2014/04/14	1.9		%	20
			Total Strontium (Sr)	2014/04/14	1.4		%	20
			Total Thallium (Tl)	2014/04/14	NC		%	20
			Total Titanium (Ti)	2014/04/14	NC		%	20
			Total Uranium (U)	2014/04/14	NC		%	20
			Total Vanadium (V)	2014/04/14	NC		%	20
			Total Zinc (Zn)	2014/04/14	0.06		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere

Cristina Carriere, Scientific Services

Vimukthi Gunawardhan

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

UNIVERSITY of GUELPH
LABORATORY SERVICES
Agriculture and Food Laboratory

FINAL Report
Submission# **14-028699**
Reported: 2014-Apr-25

Submitted By:

HARDEN ENVIRONMENTAL SER. INC.
STAN DENHOED
4622 NASSAGAWEYA-PUSLINCH TOWNLINE RD
R.R. 1
MOFFAT, ON L0P 1J0

Owner:
STAN DENHOED

Phone: 519 826-0099
Fax: 519 826-9099
Sampling Date: Not given Received Date: 2014-Apr-16

EC O157:H7 GDS detection

Date Authorized: 2014-Apr-18 10:53

Sample ID	Client Sample ID	Specimen type/ Sampling Date/Time	E. coli O157:H7 GDS detection
0001	**SW1**	Water	Negative
0002	**SW2**	Water	Negative
0003	**SW3**	Water	Negative

Wash/Irrigation- E Coli & Coli 100ml

Date Authorized: 2014-Apr-17 15:16

Sample ID	Client Sample ID	Specimen type/ Sampling Date/Time	Coliform - water	E. coli - water
0001	**SW1**	Water	3.00E+02 cfu/100mL	1.00E+01 cfu/100mL
0002	**SW2**	Water	1.00E+03 cfu/100mL	4.00E+00 cfu/100mL

Wash/Irrigation- E Coli & Coli 100ml ....Continued

Date Authorized: 2014-Apr-17 15:16

			Coliform - water	E. coli - water
0003	**SW3**	Water	6.00E+01 cfu/100mL	<1.00E+00 cfu/100mL

Test method(s): MID-216(MFLP-16) MID-160

Co-Supervisor: Susan Lee PhD 519 823-1268 ext 57211 suelee@uoguelph.ca
Co-Supervisor: Carlos Leon Velarde MSc 519 823-1268 ext 57301 cleonvel@uoguelph.ca

Cryptosporidium PCR

Date Authorized: 2014-Apr-25 16:29

Sample ID	**Client Sample ID**	**Specimen type/ Sampling Date/Time**	Cryptosporidium parvum - PCR
0004	**SW3**	Water	Negative

Giardia detectin by PCR

Date Authorized: 2014-Apr-25 16:29

Sample ID	**Client Sample ID**	**Specimen type/ Sampling Date/Time**	Giardia intestinalis - PCR
0004	**SW3**	Water	Negative

Test method(s): MOL-157 MOL-170

Supervisor: Shu Chen PhD 519 823 1268 ext. 57319 schen@uoguelph.ca

Appendix D

Potential Waterfowl Use of Hidden Quarry

GWS Ecological & Forestry Services Inc.

File: 3028
By: Email

June 9, 2014

James Dick Construction Limited
P.O. Box 470
Bolton, Ontario
L7E 5T4

Attention: Greg Sweetnam

Dear: Mr. Sweetnam

Re: Potential Waterfowl Use of Hidden Quarry

It is anticipated that waterfowl will utilize the rehabilitated quarry ponds but not in large numbers. Habitat conditions will generally be unfavourable to heavy waterfowl use of the area, particularly during spring and summer. Habitat features which will discourage waterfowl nesting and feeding include the following.

- There will be 316m of exposed unvegetated cliff face that is unsuitable for waterfowl nesting or feeding.
- After quarry sideslopes are topsoiled and seeded with an upland meadow mix they will be densely reforested. Waterfowl, particularly geese, do not like nesting in treed areas and hence as the trees grow the quality of nesting habitat will decline.
- The grassy reforested sideslopes will not be mowed or fertilized. Geese are attracted to grassy areas that are mowed and fertilized (e.g. golf courses) as these areas provide very nutritious goose pasture.
- Aquatic emergent vegetation will become densely established in shallow shoreline areas adjacent to graded sideslopes and this vegetation will retard the movement of ducklings and goslings from backshore areas to open water. This shoreline vegetation will make waterfowl, particularly young birds, vulnerable to predation.
- The ponds will be about 22m deep and aquatic emergent and submergent vegetation will therefore be limited to the relatively narrow littoral zone where water depths are less than 2m. As a result, there will not be an abundance of food available that is attractive to waterfowl. The wetlands that may develop in the shallow areas will be below the minimum size necessary to support waterfowl broods. Dabbling ducks typically feed in the top 20cm of the water column, so there will be limited areas that are suitable for foraging for them. Most diving ducks can dive to depths of only about 5m, far less than the 22m depth of the quarry ponds, so they will not be able to access food on the ponds' substrate.

Given the above considerations waterfowl nesting and brood rearing in the quarry during the spring and summer months should be minimal. The greatest waterfowl use of the area will likely occur during the fall migration although the number of birds should still be relatively low.

Yours truly,

GWS Ecological & Forestry Services Inc.

Greg Scheifele

Greg W. Scheifele, M. A., R.P.F.
Principal Ecologist/Forester

Appendix E

Monitoring Program and Contingency Measures

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

HIDDEN QUARRY

REVISED MONITORING PROGRAM AND CONTINGENCY MEASURES (JUNE 2014)

Colour Coding Scheme for Requested Agency Modifications to Monitoring Plan

Green – Ministry of the Environment

Orange – Grand River Conservation Authority

Magenta – Township of Guelph - Eramosa

1.0 ON-SITE MONITORING PROGRAM

Monitoring has taken place at this site since 1995. An extensive database of background groundwater and surface water elevations and flow measurements has been developed. A detailed monitoring program will continue to ensure that sensitive features and surface water flows are maintained. The monitoring program is designed to identify trends towards unacceptable impacts early on to allow for time to implement contingence measures.

The monitoring program for this proposed pit/quarry involves the following activities:

- measuring groundwater levels,
- obtaining water quality samples,
- monitoring water levels in the on-site wetland and stream, and
- stream flow measurements.

We recommend the following monitoring program.

Parameter	Monitoring Locations	Frequency
Groundwater Levels	M1S/D, M2, M3, M4, M6, M13S/D, M14S/D, MPN1, MPN2, MPS1, MPS2, MPE1, MPE2, MPW1, MPW2, TP1, TP8, TP9 MP1, MP2, MP3, MP4, M15, M16	Manually Monthly Automatic Daily Measurement in M1D, M2, M3, M4, M15, M16 for year prior to and year following bedrock extraction with re-evaluation of monitoring frequency after 1st year of bedrock extraction.
Groundwater Levels	M2, M3, TP1, M13S/D, M14S/D, M15, M16, M17	5 minute interval during first 3 months of extraction
Surface Water Level	Sinking Cut	Daily
Surface Water Level	SW14, SW5, SW7	Manually Monthly Coincident with groundwater monitoring
Surface Water Levels	SW6, SW4, SW8	Automated Water Level Readings (4 hour interval)
Surface Water Flow	SW4, SW8, SW3	Manually Monthly *coincident with groundwater monitoring
Groundwater Quality	W1, M2, M4, M15, M16	Semi-Annually
Surface Water Quality	West Pond, East Pond, Northwest Wetland, Tributary B (SW4, SW3)	Semi –Annually (Spring and Fall)
Climate	On-Site Weather Station at Scale House to include precipitation and temperature	Daily

Monitoring locations are shown on Figure C1.

2.0 TRIGGER LEVELS

Groundwater and surface water monitoring will be used at this site to a) verify that predictions of water level change in the bedrock aquifer do not exceed those predicted and b) verify that the hydro-period of the northwest wetland does not change. The water level measurements obtained as part of the monitoring program will be used to trigger contingency measures that may be necessary for the mitigation of a low water level in the northwest wetland, a lower than expected water level in the bedrock aquifer or an anomalous low flow level in Tributary B.

2.1 Trigger Levels for the Bedrock Aquifer

The greatest water level change in the bedrock aquifer is expected to occur to the north and northwest of the site. Water levels obtained from bedrock monitors M1D, M13D, M14D and M2 will be used to verify that actual water level changes do not exceed the predicted water level change. A warning level of 75% of the predicted change will be used to initiate bi-weekly manual measurements from the groundwater monitors.

Table 1: Trigger Levels for the Bedrock Aquifer

Monitor	**Historical Low**	**Predicted Change**	**Warning Level**	**Trigger Level**
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	347.81
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98
M15	TBD			
M16	TBD			

TBD – to be determined

The historical water levels, warning level and trigger level are presented in Figures C2, C3, C4 and C5.

2.2 Trigger Level for Northwest Wetland and Allen Wetland

Water levels from Station SW6 will be used to trigger contingency measures for the northwest wetland. Historical monitoring has shown that the water level in the wetland is somewhat independent from adjacent groundwater levels and therefore any potential change in the hydro-period is best determined by the surface water level in the wetland.

Trigger levels and warning levels have been determined for three periods as follows:

Winter Trigger Level - lowest water level observed between December 1 and March 1

Spring Trigger Level - lowest water level observed between March 2 and June 15

Summer/Fall Trigger Level - lowest water level observed between June 16 and November 30.

A warning level is established 0.15 metres higher than the trigger level. The warning and trigger levels relative to historical water levels are shown on Figure C6.

Table 2: Trigger Levels for the Surface Water Features

Station	Winter		Spring		Fall	
	Warning	Trigger	Warning	Trigger	Warning	Trigger
Northwest Wetland (SW6)	354.35	354.20	354.48	354.33	354.38	354.23
Allen Wetland (SW4)	The warning level will be a flow rate of less than 25 L/s occurring in May and the trigger level will be cessation of flow prior to June 22.					

Manual water level measurements will increase to bi-weekly if the warning level is exceeded.

2.3 Trigger Level for Sinking Cut

James Dick Construction Ltd. has agreed to a maximum water level change of 2.54 metres in the sinking cut. The nearest groundwater monitor to the sinking cut is M3. The hydrograph of M3 is found attached as Figure C7. The low water level in M3 is 349.37 m AMSL. We propose to use this as the reference elevation resulting in a minimum water elevation in the sinking cut of 349.37 – 2.54 = 346.83 m AMSL. JDCL proposes to hang a buoy from a tether with the buoy floating in the water until the water level falls below an elevation of 346.83 m AMSL. The buoy will be a visual indicator of the minimum allowable water level to the operator.

Extraction will cease if the water level falls below 346.83 m AMSL and can only recommence with a water level above 346.83 m AMSL in the sinking cut.

3.0 CONTINGENCY MEASURES

3.1 Groundwater Levels and Northwest Wetland

If any trigger level is breached, the following measures will be taken;

1) Confirmation of water level within 24 hours. Increase monitoring to weekly until source of the trigger level exceedence is identified.

2) Within seven days conduct an evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed.

3) If quarry activities are found to be responsible, the following actions will be considered and a response presented to the GRCA and the Township of Guelph-Eramosa.

- decreased rate (or stopping) subaqueous extraction
- increase the length and/or width of barrier
- change in configuration of mining or decrease in mining extent
- alter timing of extraction to coincide with high seasonal groundwater levels.

3.2 Water Quality

The water quality program will commence at least one year prior to bedrock extraction.

Groundwater Monitors and the East and West Pond

The parameters that will be included in the semi-annual monitoring will be general chemistry, cryptosporidium, giardia, E. coli, TKN, ammonia, DOC, pH, temperature, anions and metals.

In the event that there is an increasing trend in the concentration of one or more elements or compounds, a study will be conducted to determine the source of the water quality change. If the quarry is found to be responsible and if there is a potential for impact to downgradient wells, James Dick Construction Ltd. will commence with the following actions;

1) Semi-annual testing (commencing immediately) of the water quality of private wells that could potentially be impacted by the quarry.

2) In the event that a water quality issue related to the quarry occurs, James Dick Construction Ltd. will remedy the issue by either providing the appropriate treatment in the home, drilling a new well or isolating the water supply to the deeper aquifer

Northwest Wetland

The northwest wetland water will be analyzed for nitrate, dissolved oxygen, temperature, conductivity and pH for a period of three years or upon completion of construction activities in the surface water catchment area of the northwest wetland whichever is longer.

4.0 PRE-BEDROCK EXTRACTION WATER WELL SURVEY

We recommend that a detailed water well survey be completed prior to the commencement of the extraction of bedrock resources. This survey will as a minimum include all wells in the shaded area shown on Figure C8. The well survey will include the following;

- construction details of the well (drilled, bored, sand point etc..)
- depth of well and depth of pump
- location of well relative to septic system
- static water level
- history of water quantity or quality issues
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals
- one hour flow test

The purpose of the survey is to have a baseline evaluation of both water quality and water quantity in nearby water wells. Should an issue arise with a local water well, the baseline data can be used as a reference against future measurements.

If there are domestic wells suitable for water level monitoring identified in the survey, they will be included in the water level monitoring program and monitored on a semi-annual basis.

If the survey indicates that modification(s) to the well are necessary either for continued monitoring or to minimize the potential for impact, the modifications will be made to the well at the expense of James Dick Construction Ltd.

5.0 ANNUAL MONITORING REPORT AND INTERPRETATION

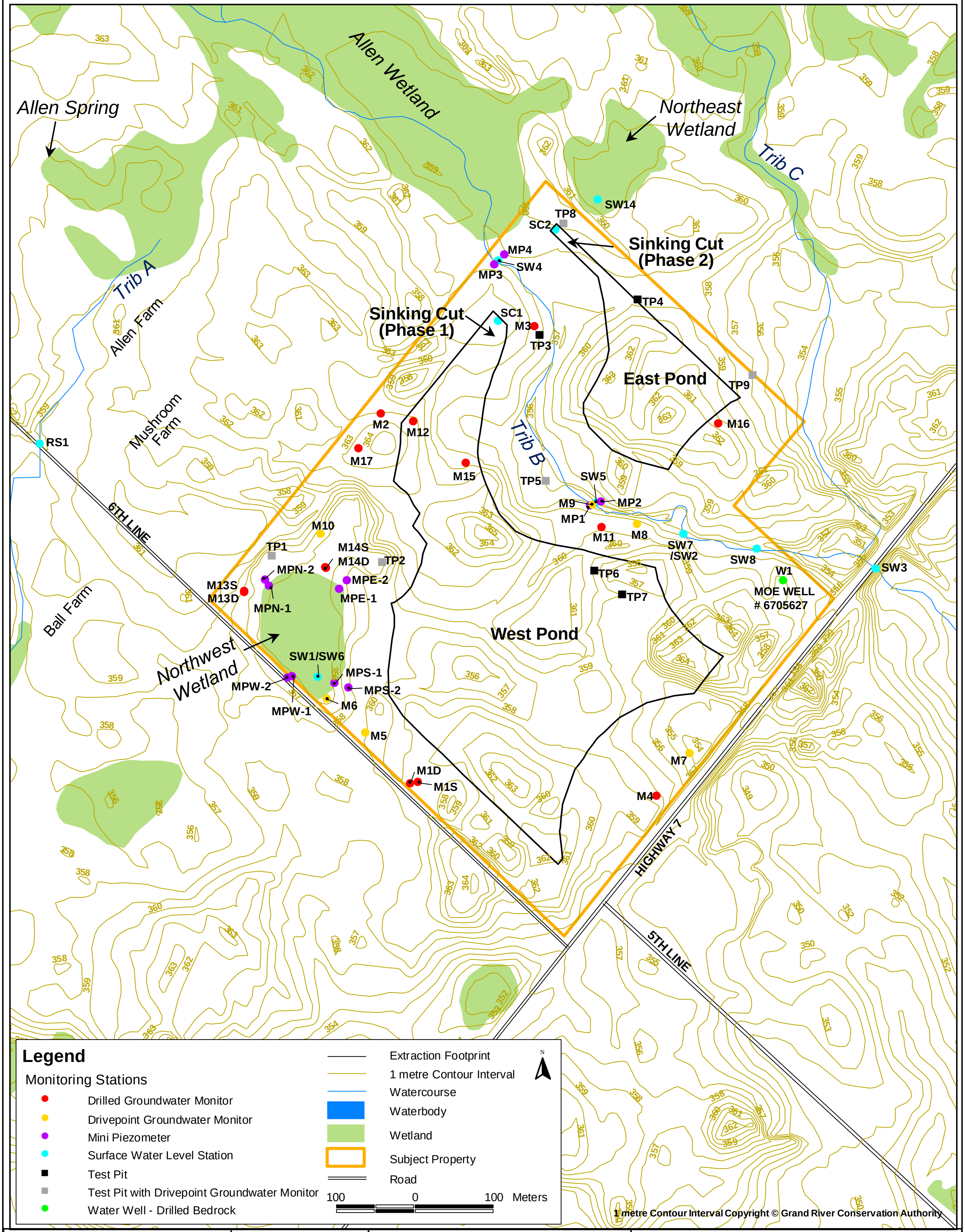
An annual report will be prepared and submitted to the Ministry of the Environment and the Ministry of Natural Resources on or before March 31st of the following calendar year.

The report will be prepared by a qualified professional, either a professional engineer or a professional geoscientist.

The monitoring report will include all historical monitoring data and an interpretation of the results with respect to potential impact to the quality and quantity of bedrock groundwater, hydro-period of the northwest wetland and streamflow loss from Tributary B.

6.0 Water Well Complaints

James Dick Construction Ltd. agrees to inform the Township of Guelph Eramosa and the Ministry of the Environment upon the receipt of a water well complaint and the results of any related investigation.



Harden Environmental Services Ltd.

Project No: 9506

Date: Apr 2014

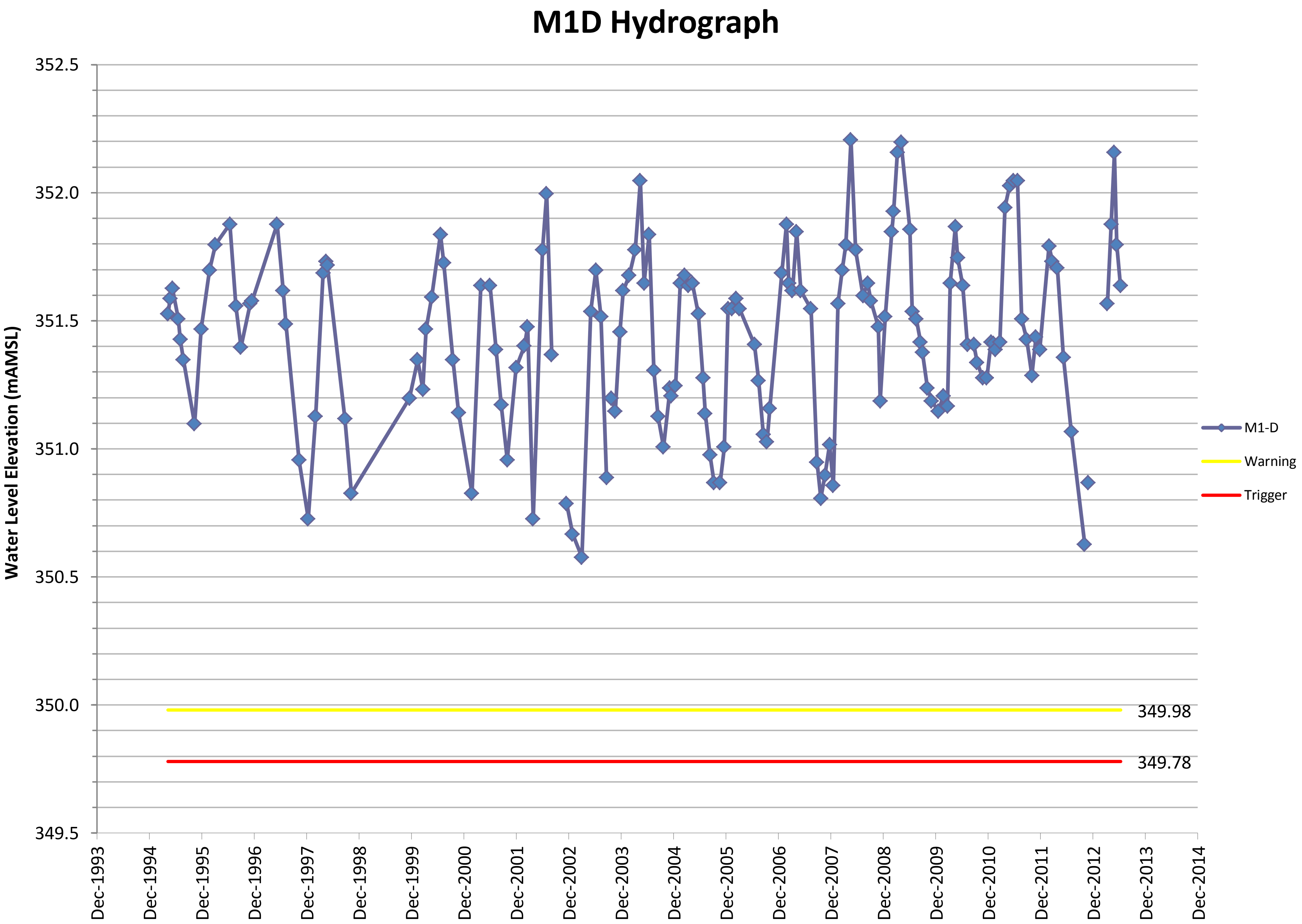
Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

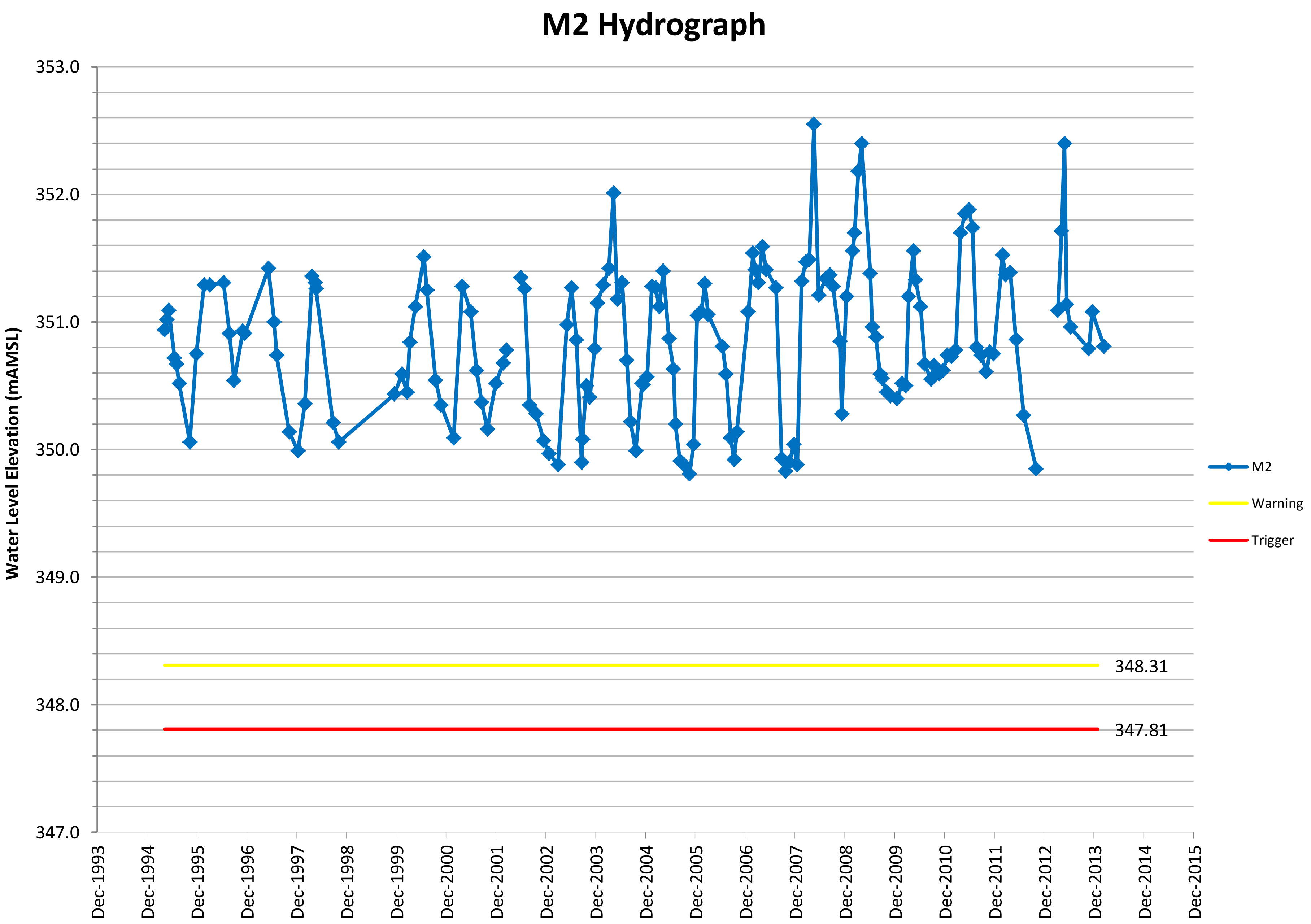
Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C1:

Monitoring Locations



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C2: M1D Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.

Project No: 9506

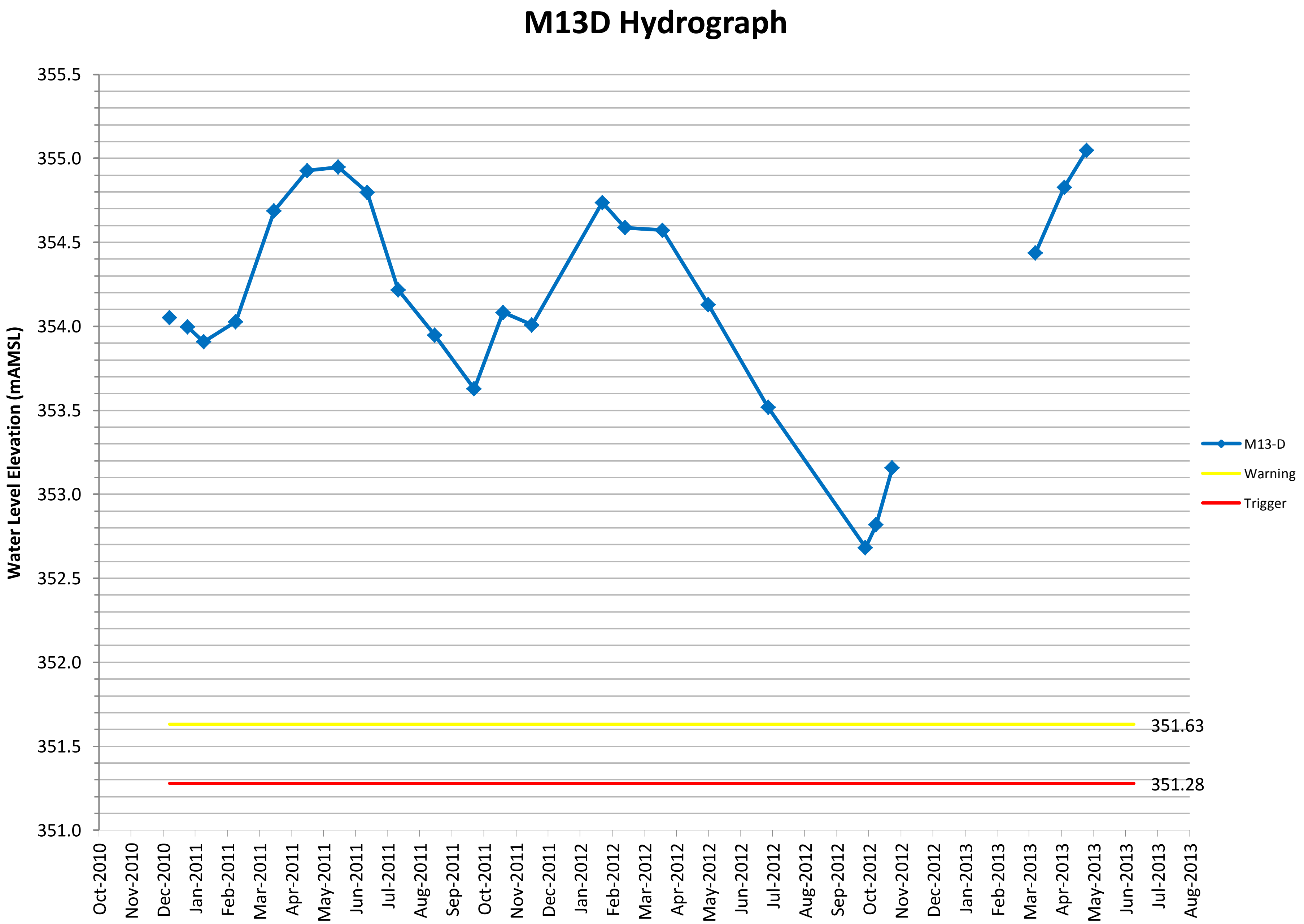
Date: Jul 2013

Drawn By: AR

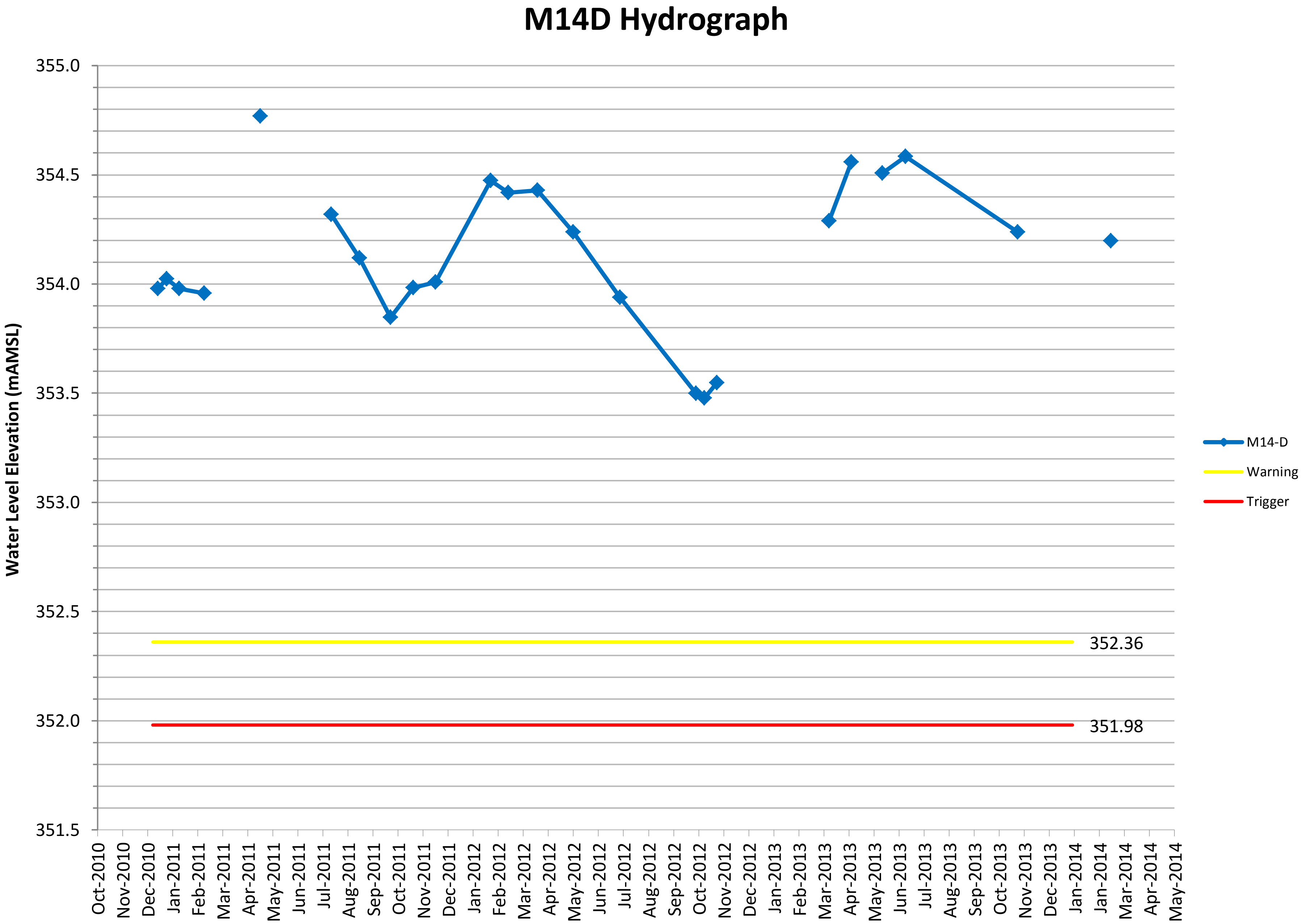
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C3: M2 Trigger Level

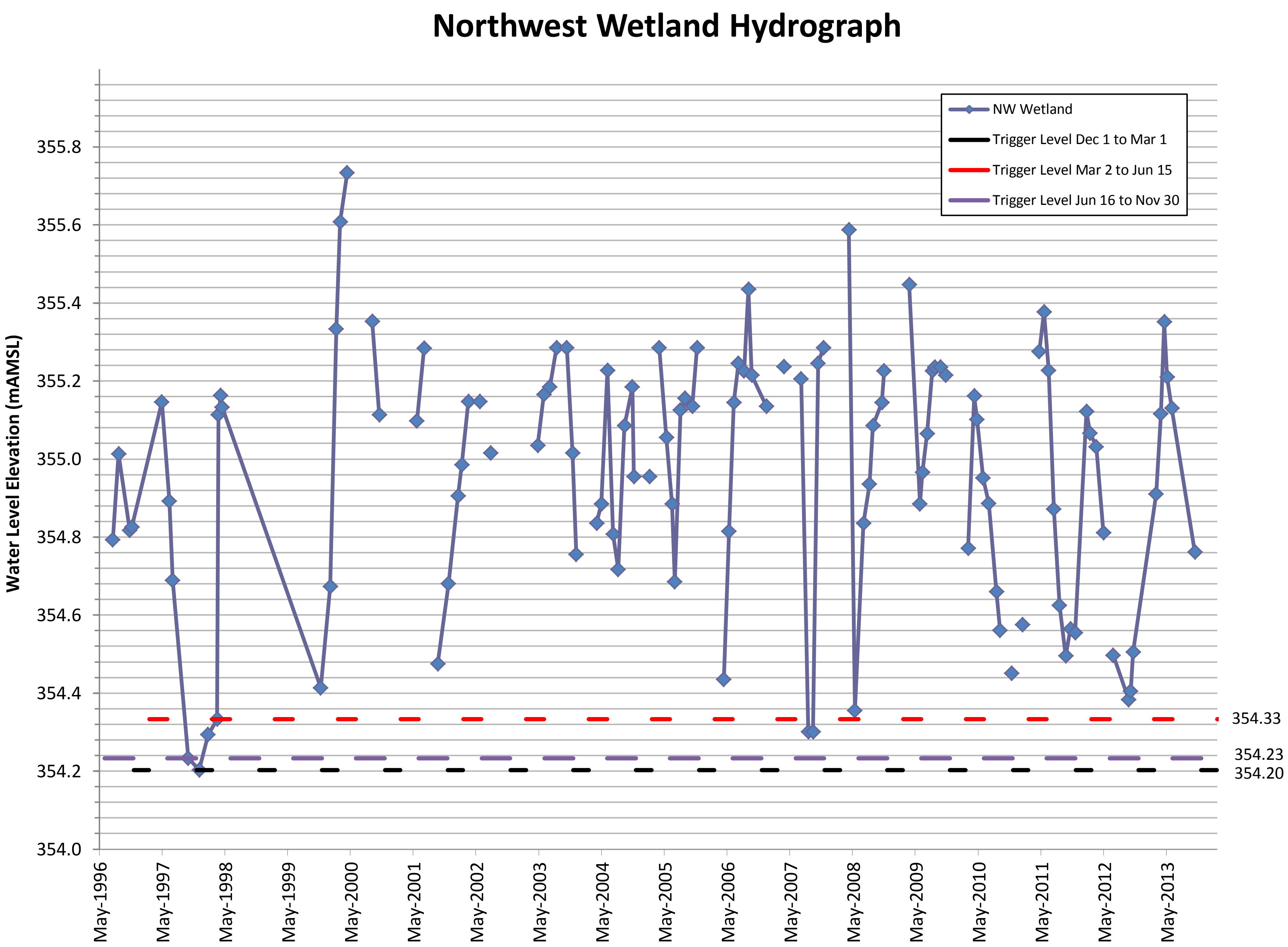


Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C4: M13D Trigger Level**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

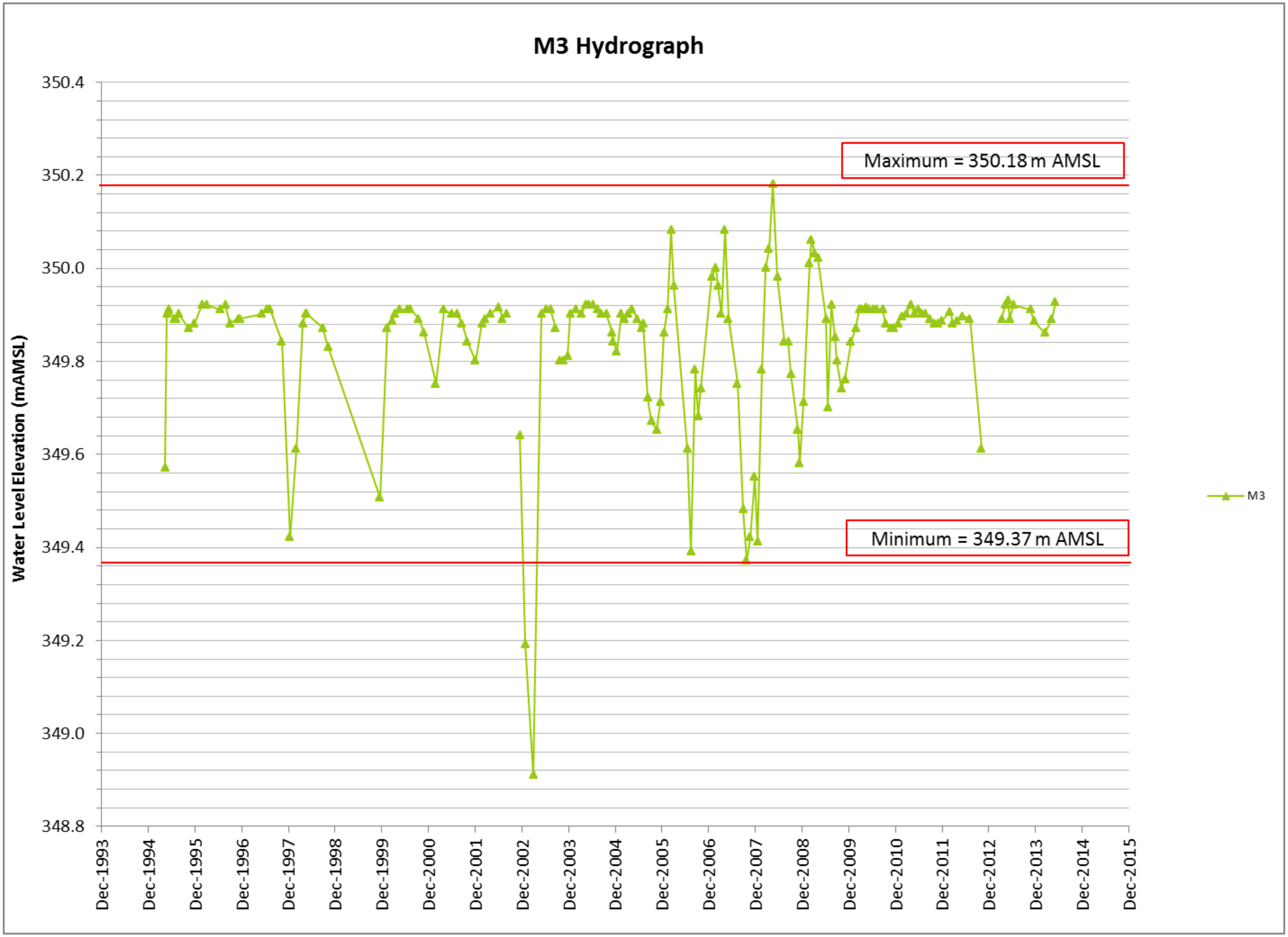


Harden Environmental Services Ltd.

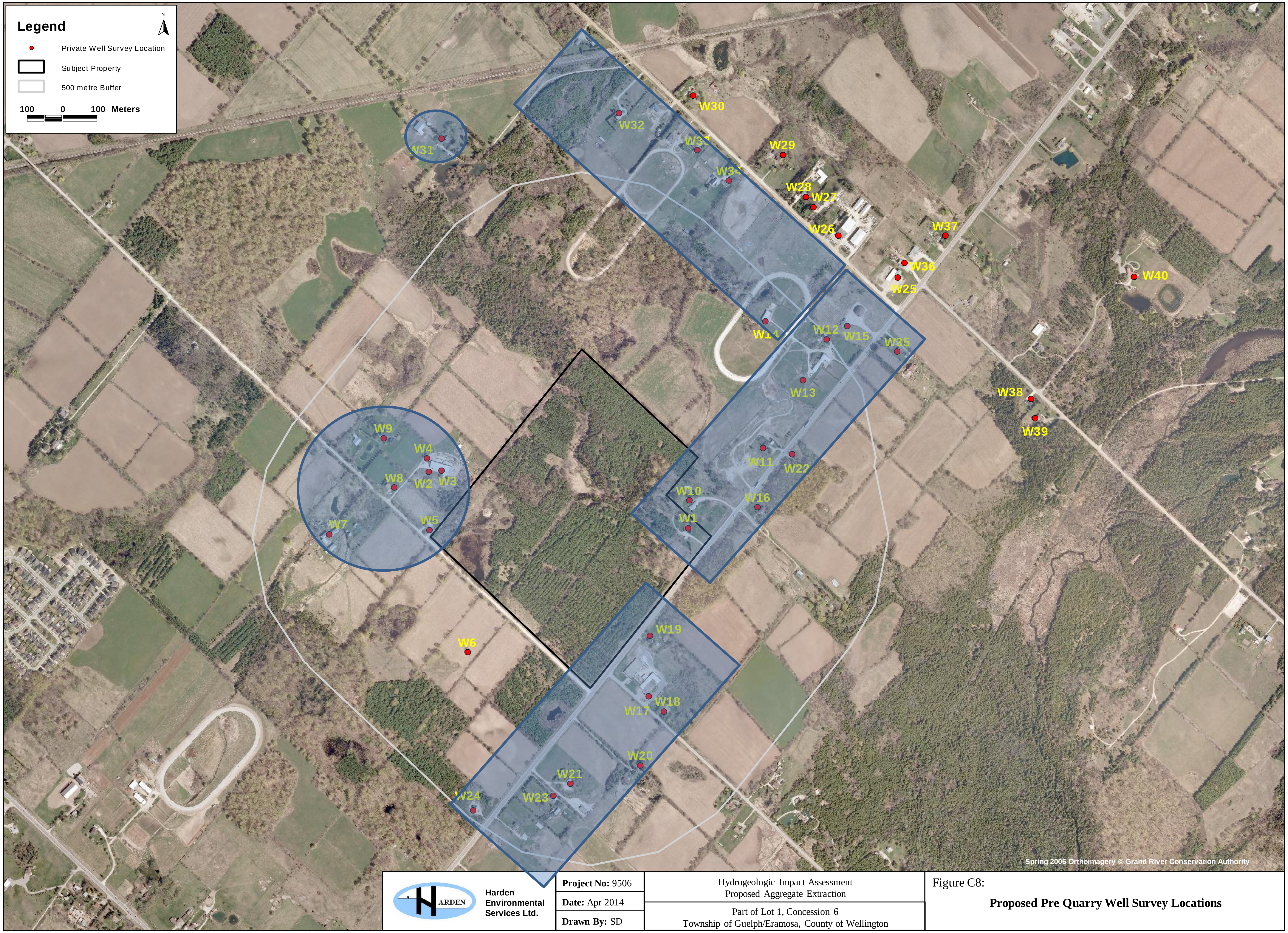
Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C5: M14D Trigger Level**
Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C6: Northwest Wetland Trigger Levels**
	Date: Jul 2013	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C7: M3 Hydrograph**
	Date: Jun 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.

Project No: 9506

Date: Apr 2014

Drawn By: SD

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C8:

Proposed Pre Quarry Well Survey Locations

Hidden Quarry - Response to Township regarding CRC Hunter Queries

July-08-14

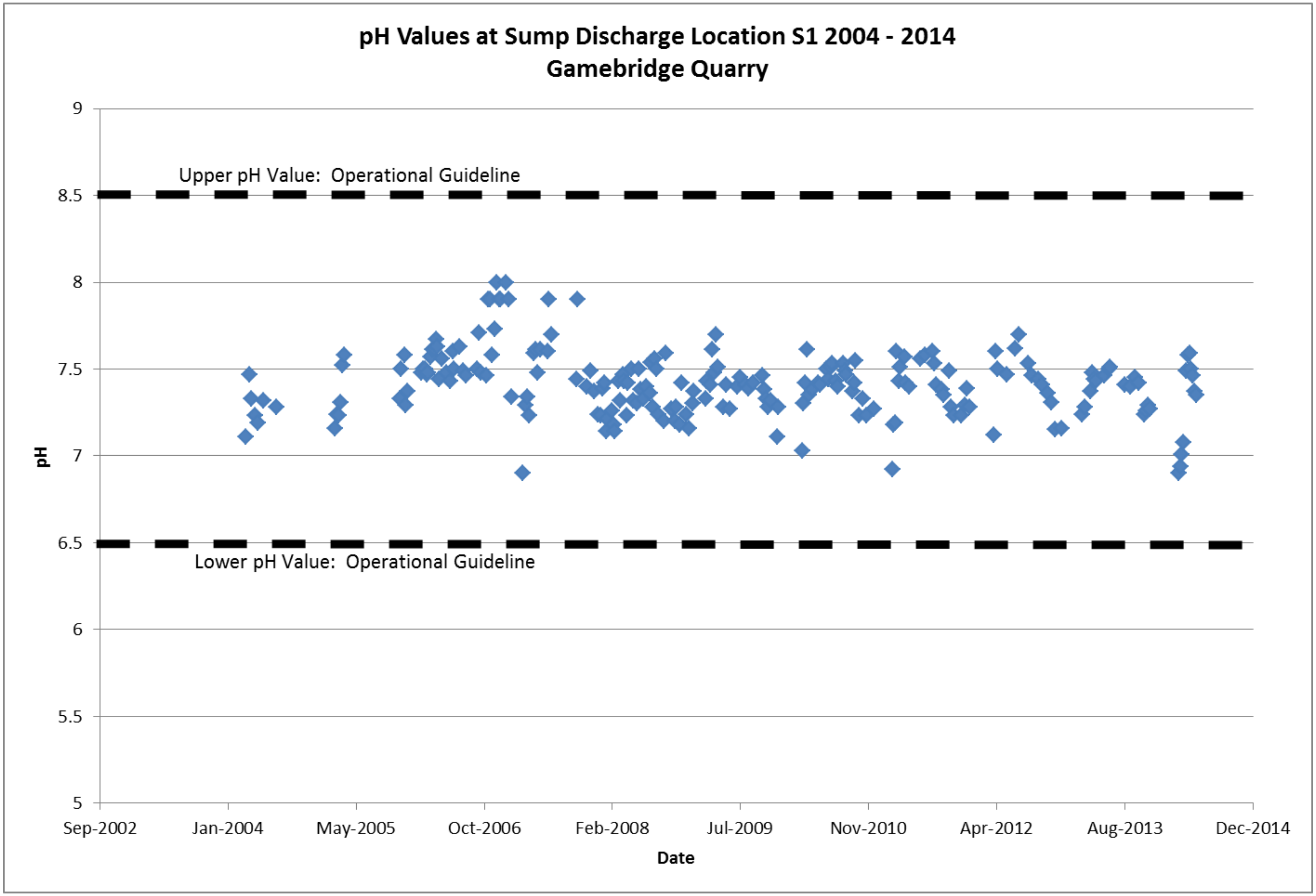
#	Contact	Date	Question	Response	Action Item
1	Gary Hunter	20-May-14	What is the vertical geodetic benchmark used to reference the groundwater monitoring infrastructure and site features?	The groundwater monitors and water wells included in the level survey used a benchmark known as the 1978 Southern Ontario Adjustment available from the Ministry of Transport Ontario. The vertical benchmark is based on the Canadian Geodetic Vertical Datum 1928 (CGVD28). The actual benchmark used was DHO PRECISE BM 700-87 ELEVATION 347.587 m AMSL.	None
2	Gary Hunter	20-May-14	Are all infrastructure features, contour mapping and the Site Plan referenced to this same vertical benchmark network?	The contour mapping is based on the 1 m contour interval available from the GRCA. No vertical benchmark is noted in the meta data for this layer other than being a projection of NAD83/UTM Zone 17N. As shown on Figure 3.5, all purple coloured well locations and yellow colour monitoring well locations were surveyed with a common vertical datum based on the MTO benchmark.	None
3	Gary Hunter	20-May-14	What is the source of the MOE Water Well Record ground elevations in the Harden 2012 Report Appendix F - Table F1? Have any location corrections been applied?	The ground elevations are obtained from the MOE Water Well Information System (WWIS). No elevation or location corrections have been applied in this table.	None
4	Gary Hunter	20-May-14	Have ground elevations been adjusted for the referenced MOE Well Records in Appendix G Table G1?	There are no ground elevations referenced on Table G1. Of the wells listed in Table G1, the following have been level-surveyed relative to the on-site monitors; W1, W3, W4, W8,W10, W12, W13, W14, W17, W18, W19, W25 and W26	None
5	Gary Hunter	20-May-14	In Table G1, what is the source of the well depths and static water levels? Where 'btoc' is referenced, what is the 'stick up' to allow equation with the Water Well record ground elevation depth references?	Well depths and static water levels are field measurements where value is provided. When the homeowner provided an approximate depth this is noted as such. Stick-up measurements were made on the following wells: W1, W2, W3, W4, W8, W12, W13, W14, W16, W25 and W26.	None
6	Gary Hunter	20-May-14	In Table G1 Site W22 (5198 Hwy 7) the well is reported to be in a 'pit' for survey dates of Oct 1995 and Nov 2011. How did the Applicant confirm this is MOE well No. 28-02047 ?	MOE Licenced Well Technicians visited the site on those occasions and found the 4" well to be in a pit. The age of the well based on site interview with the owner and the diameter of the well led us to assign the MOE well number to the well.	None
7	Gary Hunter	20-May-14	Well MOE 67-08195 completed June 10, 1985 contains a sketch dimensioned location at 150 ft north of Hwy 7 and 300 ft east of the 6th Line within the proposed Hidden Quarry property. The stratigraphy, water founds and static levels are consistent with other wells on the property. Is the Applicant aware of this well? I do not see it in monitoring records; please explain.	This well does not exist at this location. It was plotted on Figure 2.6 for completeness and then was removed from consideration in all subsequent discussions and evaluations. The original well record has the well located in Concession 5, Lot 1 and the overburden is approximately 2 metres thick. This does not correlate to any on-site investigations. The well owner given as Joseph Scarola was never an owner of this property.	None
8	Gary Hunter	20-May-14	Correspondence with the owner confirms that MOE Well No. 67-0745 is located at 4943 6th Line (W5), not at 4953 6th Line (W8) as indicated in Table G-1. A well record for W8 has not yet been found. How does this revised well location impact the Applicant's response to Burnside? Please provide a copy of your Table G-1 well survey notes for the W8 site.	We have no knowledge of well No. 67-0745 and do not reference this well anywhere in our documents. Based on our well survey and discussions with Mr. Mike Bonus (the home owner at the time of survey) at 4953 6th Line the previous owner was Mr. Glendenning matching the name on the water well record. The resident at 4943 6th Line has on three occasions refused to particpate in our well survey. If the well record has been incorrectly assigned and should be assigned to 4943 6th Line, there is no change in our intepretation of potential impact to the well yield. The well record shows that water was found at 18.8 m and there is a static water level of 4.57 metres. Pumping at a rate of 15 gallons per minute resulted in a drawdown of 1.52 metres. This confirms that the well is a high volume producing well with low water level change when stressed.	None
9	Gary Hunter	20-May-14	Table G1 reports surveying W31 (4970 7th Line) well on Oct 1995 and Mar 2012. A drilled well is reported located in front of the house. Well depth and static level are reported as unknown. No MOE # has been found. How is the Table G1 survey consistent with the well in use at the property or with the Harden (2012) Sec 3.6.1.1 pg 19 the and No 63 Response in the Hidden Quarry Comment Documentation which each describe a dug well at the property? Please explain and provide your detailed survey inspection field notes and sketches for the well at 4970 7th Line. A survey by an independent MOE licenced well technician may be required to correct the records.	When visisted in 1995 the owner indicated that the well was drilled and did not provide access to the well as the concrete well cover was in poor condition. The same answer was provided in 2011. It was not until 2012 that access was permitted to the well by Ms. Degrandis and it was found to be a shallow dug well. A licensed MOE well technician did survey the well on each occasion.	None
10	Gary Hunter	20-May-14	Table G1 is unreliable and to be useful requires a rigorous on site well inspection and update including surveyed ground elevations, well depths and static water level observations at each well by an independent MOE licenced well technician.	A detailed well survey has been agreed to by James Dick Construction Ltd. This will be carried out by a licensed well technician.	None
11	Gary Hunter	20-May-14	Please provide the digital spreadsheet (.xls) for Table B2 and B4 updated to May 2014. Also corresponding updated Hydrographs as available.	Tables submitted show data back to the 1990's. Data collection will occur according to the monitoring program and all data will be presented in the monitoring reports.	None
12	Gary Hunter	20-May-14	Please provide a copy of the Harden (1998) Report as referenced in Sec 2.5 Hydraulic Testing pg 7 (Harden 2012).	Available as a public document from the Township of Guelph Eramosa for East Half of Lot 1, Concession 6, Township of Guelph-Eramosa. Property is owned by Graham and Charlotte Mudge.	None
13	Gary Hunter	20-May-14	Please provide Table C1 with updated monitoring to April 2014 in digital spreadsheet form. Also corresponding Fig C1 Hydrographs as available.	Tables submitted show data back to the 1990's. Data collection will occur according to the monitoring program and all data will be presented in the monitoring reports.	None
14	Gary Hunter	20-May-14	Does the Applicant have any information on the formational dip of the bedrock strata (top of Cabot Head) at the Hidden Quarry site?	The top of shale was encountered at an elevation of 308.52 m AMSL in M15 and 308.81 m AMSL in M2. The regional dip of the bedrock strata is estimated to be 0.2 to 0.3%, dipping towards the south west.	None
15	Gary Hunter	20-May-14	The Applicant has identified Goat Island Formation above 350 m asl in Borehole M15 at Hidden Quarry site. Is Goat Island present in other site boreholes where the bedrock surface is higher than about 350 m asl?	Bedrock was encountered at higher elevations in M2, M12 and TP9. It is possible that the Goat Island formation is present at those locations.	None
16	Gary Hunter	20-May-14	Please provide a copy of the preliminary assignment of the unsubdivided Ambel Formation in borehole M2 into Goat Island, Gasport, Irondequoit, Rockway and Merritton Formations and any comments from Dr Brunton (Harden 2012, Sec 3.5.1, pg 15).	The Harden 2012 report states that there has been no assignment of the core into the new nomenclature suggested by Frank Brunton.	None
17	Gary Hunter	20-May-14	Please provide a copy of the MW-08-T3-06 well log as referenced in Harden 2012, Sec 3.5.1, pg 15).	This is available from the City of Guelph and or the Grand River Conservation Authority. We do not have permission to distribute.	None
18	Gary Hunter	20-May-14	Will the Goat Island Rock be separated from or blended into the commercial crushed rock aggregate produced in the proposed quarry?	The Goat Island, where present in trace amounts, will not be mined in a separate bench and will be blended into the appropriate products.	None
19	Gary Hunter	20-May-14	What preparation of the weathered bedrock surface will be required to provide a staging area for underwater blasting preparation at Hidden Quarry?	No special preparation is required.	None
20	Gary Hunter	20-May-14	The Sept 2012 Site Plan Notes specify maximum extraction depth at 317 m asl (pg 3 of 5) and the figures on pg 4 of 5 specify the floor of the rehabilitated quarry lake at 320 m asl. The Applicant response in the Hidden Quarry comment documentation says the minimum depth will be 320 m asl. What quarry depth has the Applicant's Hydrogeologist recommended?	No recommendation with respect to final depth were made by Harden Environmental Services Ltd. The current mining elevation of 327 MASL is a compromise made by the operator to leave undisturbed rock at depth and is a practical depth of extraction for equipment currenly employed by the operator. Burnside suggested that the quarry depth should be adjusted to avoid the deeper fracture set. The operator has agreed to this.	None

21	Gary Hunter	20-May-14	The Applicant’s bedrock flow test for Well M15 (Harden July 15, 2013 Letter Appendix B Sec 3.1 pg 6) indicated that approximately one third of the well yield was obtained from various fractures between elevation 350 m asl to above 324 m asl and two thirds of the well yield was obtained from a single set of fractures at 324 m asl and from a fracture at 318 m asl (one third each).	No comment.	None
22	Gary Hunter	20-May-14	The Applicant also reported poor hydraulic connectivity between the shallow bedrock and deeper fractures at M15. The lower part of the borehole below about 315 m asl including the Cabot Head formation contact at 308.5 m asl was described as not an active part of the flow system. Does the Applicant have any comparative observations of shallow vs deeper aquifer hydraulic heads (vertical gradients) in the proposed Site Plan Extraction Area?	M15 is located within the Site Plan extraction area. Hydrualic potentials for four individual sections of the aquifer are provided in the Harden Environmental response to R. J. Burnside on June 10, 2014	None
23	Gary Hunter	20-May-14	Will the higher yield deeper aquifer from 324 to 318 m asl be the primary control for quarry pond water levels and the upgradient propagation of quarry drawdown impacts?	No. James Dick Construction Ltd. has agreed to limit quarry depth to 327 m AMSL.	None
24	Gary Hunter	20-May-14	Does the Applicant have any observations at all of the hydraulic heads in the 324 to 318 m asl deep aquifer zone? What aquifer zones do the static levels observed in Monitors M2 and M4 actually represent?	Yes. M15 was converted into a multi-level monitoring station with hydraulic heads measured in the fractures identified at 324 and 318m AMSL. This information is provided in Harden , June 10, 2014. The vertical head profile shows very little difference, with both vertically downward and upward gradients observed betwen fractures. The static water levels in M2 and M4 represent average hydraulic potential over the open borehole between the bottom of the well and the bottom of the well seal shown on the borehole records.	None
25	Gary Hunter	20-May-14	Is the 324 to 318 m asl fractured rock aquifer zone in M15 coincident with the aquifer discharge zone on the lower slopes and floor of the Blue Spring Creek Valley to the south?	The elevation of Blue Springs Creek nearest to the site is approximaetly 330 m AMSL and where it crosses beneath 5th Line Nassagaweya has an elevation of approximatley 325 m AMSL. Therefore, these fractures are lower than the ground surface in the Blue Springs Creek valley.	None
26	Gary Hunter	20-May-14	When will the Hidden Quarry Comment Documentation (Mar 13, 2013) be updated to reflect the results from the M15 hydrogeological testing and the extended on site groundwater monitoring?	All testing of M15 has been included in correspondence with R.J. Burnside and Associates.	None
27	Gary Hunter	20-May-14	Would you agree that the vertical interval from 324 to 318 m asl in borehole M-15 is part of Brunton’s and Gartner Lee’s regional ‘Production Zone’ Aquifer?	There is no 'production zone aquifer' identified as a separate aquifer within the Gasport Formation. Our review of the Brunton (OFR 6226) confirms that the term 'production zone ' was not used to describe any portion of the Gasport aquifer. A 'production zone' was identifed by Gartner Lee as a higher yielding section of the formerly unsubdivided Amabel aquifer. We agree that the fractures identified at 324 and 318 m AMSL in M15 could fall within the 'production zone' of the Gasport Aquifer.	None
28	Gary Hunter	20-May-14	What would the Applicant estimate the specific yield of M15 and the potential capacity of a production well if located at Hidden Quarry M15?	Similar to the Municipal wells TW3 and TW4.	None
29	Gary Hunter	20-May-14	Please provide copies of the database input files. Please also provide the water and observation well files including static water level observation dates for the area within 1500 m of the proposed quarry site boundaries.	Appendix H describes the input parameters. MOE well data is available for the area.	None
30	Gary Hunter	20-May-14	Is it fair to say that the modelling is based primarily on 'kriged' multi season 'open hole' water well static level data with a general bias towards shallower bedrock water wells?	The statement is inaccurate. The modeling output is not based on any water levels. The groundwater model output is based on the assigned parameters of recharge, hydraulic conductivity and porosity (storage) and the vertical and horizontal constraints assigned within the model (i.e. boundary conditions).	None
31	Gary Hunter	20-May-14	What is the statistical variability of the ‘predicted water levels’ and ‘maximum predicted water level change’ estimated in Fig 10 and Fig 11 of the Modelling Report? Is ± 5 m a fair estimate for Fig 10? What about Fig 11?	There is no statistical variability in the outcome of the model. The values presented in Figures H10 and H11 represent unique values based on a certain set of model input values.	None
32	Gary Hunter	20-May-14	Is there sufficient unique regional hydraulic data to model the hydraulic heads of the deep aquifer as identified in the Hidden Quarry site for the elevation interval between 324 and 318 m asl?	It is well accepted that the Gasport Aquifer can be modelled as a continuum. The fractures located between 324 m AMSL and 318 m AMSL will not be intersected by the quarry.	None
33	Gary Hunter	20-May-14	Considering that there will be a water deficit within the quarry pond footprint due to evaporation increases, where will the water come from that raises the Applicant predicted groundwater levels and increases flows on the downgradient side of the quarry?	It is estimated that there will be an additional capture of 3600 m3 of water in microdrainage area D1 and 2500 m3 of water in microdrainage area D2. The estimated increase in evaporation at the site is 18,765 m3 resulting in an overall loss of 12,665 m3 annually. To put this into perspective, the annual precipitation at the site has historically ranged from 243,712 m3 to 482,854 m3. Thus the change in evaporation is insignificant relative to the variability in precipitation. The extraction of the rock creates a space within the aquifer with infinite transmissivity. This results in the same hydraulic potential in the quarry pond despite groundwater potentials decreasing northwest to southeast by several metres in the adjacent aquifer. The magnitude of the hydraulic potential in the pond has been shown via the modeling effort and as observed at several existing gravel pit ponds to be somewhat of an average between the pre-extrction upgradient and downgradient hydraulic potentials in the aquifer. This effect results in a drawdown at the upgradient side of the quarry and a potentiometric surface rise in the downgradient side of the quarry. The "increased" flow downgradient is a very localized effect and results from adjacent aquifer water flowing into the quarry pond in the northern half of the pond needing to flow out of the southern half of the pond.	None
34	Gary Hunter	20-May-14	Will the upgradient groundwater divides move away from the quarry with reduced water level elevation to capture more water from adjacent catchments?	The Eramosa River/Blue Springs Creek groundwater shed divide occurs at a hydrualic potential of approximatley 365 m AMSL or 15 metres greater in hydraulic potential than occurs at the site. The watersheds are very large and any potential disturbance to the groundwater shed divide is small and local to the proposed quarry. Any diversion of water from the Eramosa River to the Blue Springs Creek watershed will not be measureable.	None
35	Gary Hunter	20-May-14	The Sept 21, 2012 Site Plan Notes (pg 4 of 5) predicts the west quarry final lake level at 348.6 m asl and the east quarry lake at 348.4 m asl. However the wetland creation Notes (pg 4 of 5) estimate final quarry pond water tables at ± 346 to 349 m asl.	It appears that Hunter has misunderstood this Site Plan Note. The elevations (+/- 346 to 349 masl) refer to the bottom of the wetlands not the pond water elevation. These elevations are noted as it is desireable to have 0- 2m of water in the wetland areas.	None
36	Gary Hunter	20-May-14	The Harden (2012) Fig 3.17 shows a water level decline across the quarry extraction limits from 354 to 347 m asl (7 m difference). Appendix H Fig 11 shows a drawdown of 1.8 m on the north extraction limit and a rise of about 1.2 m at the south limit. Where did the other 4 m of the pre-quarry vertical gradient go?	As indicated in our report, the maximum water level decline in the quarry is 2.45 m at the northern edge and a rise of 2.81 at the southern edge for a total change of 5.26 metres. The reason that this does not add up to 7 metres is that the final predicted water level determined by the model equalizes inputs to the pond with outputs. For example, only a small portion of the proposed pond perimeter is presently exposed to the lower hydraulic potential of 347 m AMSL and thus has less of an influence on the final water level. If the quarry edges were parallel to the groundwater equipotentials, then the final water level in the pond would be a statistical mean of the pre and post hydruaulic potentials.	None
37	Gary Hunter	20-May-14	Has the Applicant overestimated the final quarry pond levels and underestimated the bedrock aquifer drawdowns upgradient of the quarry?	No. A scientifically sound approach was used to estimate the final quarry pond level and bedrock aquifer water level changes upgradient of the site.	None
38	Gary Hunter	20-May-14	Are the average late summer / early fall water low levels more likely to be in the 346 m asl range consistent with the lower limit shown in the Site Plan Rehabilitation Notes (pg 4 of 5)?	It is not reasonable to expect the final water level in the West Pond to be in the order of 346 m AMSL. The lowest historical water level recorded in M4 at the southern edge of the licensed area is 345.5 m AMSL and the lowest historical water level in M1D located near the upper edge of the proposed quarry is 350.63 m AMSL. The final water level in the West Pond will stabilize somewhat above the mean of these two values (348.6 m AMSL) . Hunter has misread the notes on Page 4 of 5 as they pertain to the floor elevation of the wetland, not the water level of the quarry pond.	None

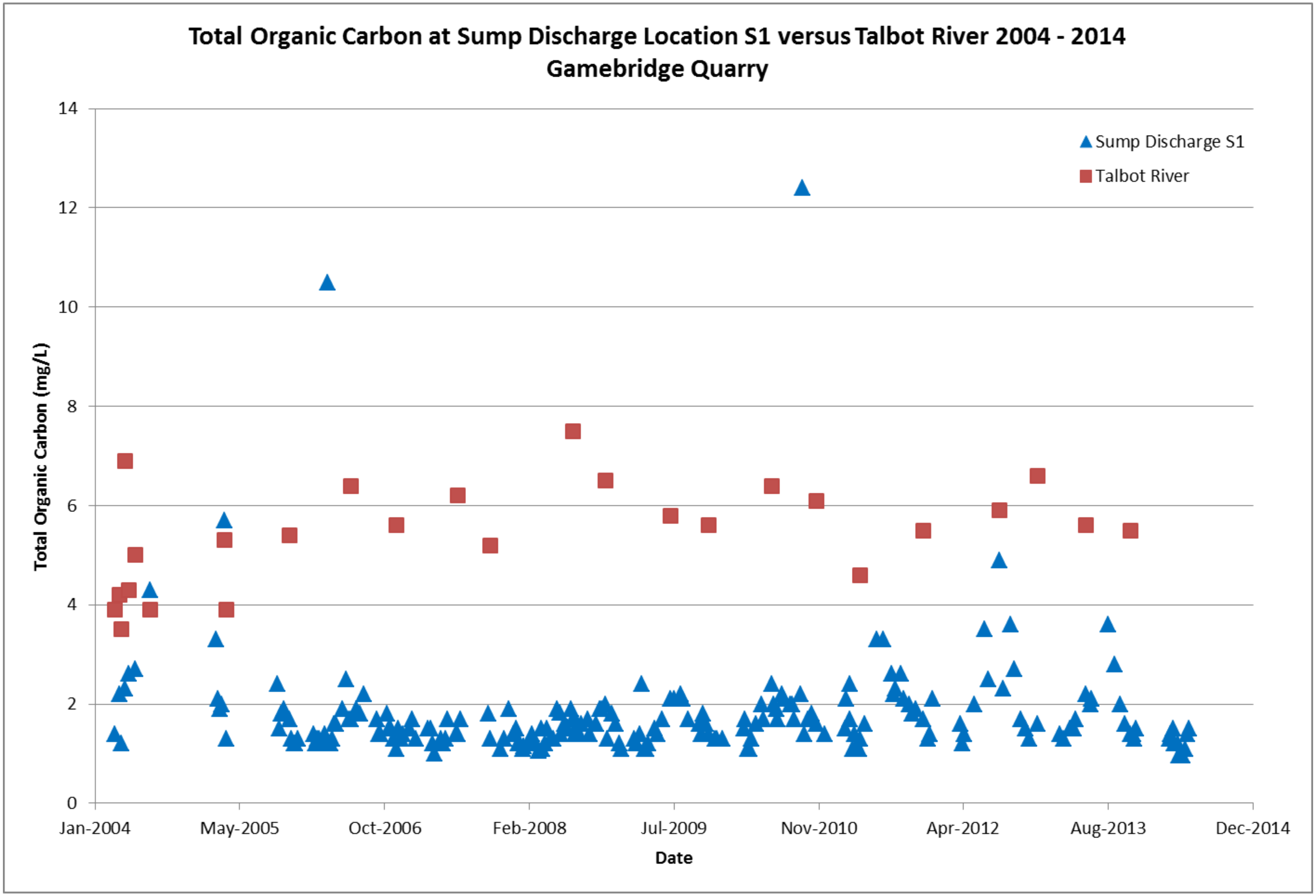
39	Gary Hunter	20-May-14	The Harden (2012) Fig 3.17 plot referenced above is based mainly on spring season (May 31, 2011) high water levels. Please provide a corresponding late summer / early fall plot using 'same date' data.	A substantial quantity of data has been presented including late summer and fall. Please refer to the tables in the report.	None
40	Gary Hunter	20-May-14	Will the actual drawdowns be sufficient during dry season to interfere with bored and shallow bedrock wells and streams (and ponds) fed by bedrock springs up to 1 km or more upgradient of the quarry?	It is our professional opinion, as expressed in our report, that springs, ponds and shallow dug wells upgradient of the site will not be affected by the anticipated change in bedrock water levels. A high degree of monitoring as requested by the Township of Guelph Eramasa and the Ministry of the Environment has been agreed to by James Dick Construction Ltd. to verify this opinion. Phase 1 of the quarry extraction is predicted to have a negligable impact on bedrock water levels upgradient of the site thus providing a significant period of time to obtain additional baseline information to be gathered prior to potential water level changes occuring in the bedrock upgradient.	None
41	Gary Hunter	20-May-14	Based on the Applicant predicted increased quarry water level at 348.6 m asl, will the forested kettle depression located on private property immediately south of MW4 and Highway 7 experience root zone flooding and dieback?	The kettle depression has an estimated minimum elevation of 349 m AMSL according to the one metre contour interveal mapping provided by the GRCA. As shown on Figure 3.17 the potentiometric surface has an elevation of approximately 346 m AMSL. The predicted water level rise beneath the kettle depression, as shown on Figure 4.3 is approximately one metre. Therefore, root zone flooding is not predicted to occur.	None
42	Gary Hunter	20-May-14	How does the Applicant propose to create a dry staging platform for drilling and blasting? Will positive or passive dewatering be required?	The dry platform is either formed by the surface of the bedrock, or where the surface of the bedrock is submerged, by a layer of shot rock. No dewatering will occur. Drilling will occur to a maximum of 327 masl.	None
43	Gary Hunter	20-May-14	Has the Applicant considered progressively mining from the southeast upgradient into the higher northwest water tables of the site?	Various scenarios have been considered and the current phasing as presented is the preferred approach.	None
44	Gary Hunter	20-May-14	Will adaptive management based on southerly site quarrying with a more gradual drawdown of northerly boundary groundwater monitors be more effective than initiating quarrying in the deeper water to the north as proposed on the Sept 2012 Site Plans (pg 2 of 5)?	No. The greatest water level change occurs when mining Phase 3 (southern half of the quarry on the west side of Tributary B). The mining of Phase 1 (northern half of the west side of Tributary B) results in a predicted water level change of less than five centimetres beneath the Allen and De Grandis properties.	None
45	Gary Hunter	20-May-14	Does the Applicant propose to waste the silty till overburden spoil or place imported fill in the quarry excavation?	There is no proposal to import any offsite fill or snow onto the property. Native onsite soils may be used for wetland and habitat creation in the pond.	None
46	Gary Hunter	20-May-14	How does the Applicant propose to maintain clear clean unobstructed groundwater flow to nearby domestic and commercial wells through the life cycle of the quarry excavation ?	The quarry ponds are stillwater features and therefore the majority of deposition of rock fines will occur in the quarry ponds themselves. Groundwater flow occurs very slowly and any turbidity entering the aqufier downgradient of the site will settle out of the water. The mobilzation of fine particles in the Gasport Aquifer and was observed during thepumping of M15 and also in other Gasport aquifer wells. This shows that the flow rate in the aquifer is too slow to mobilize fine particles. No obstructions to southerly groundwater flow are being proposed at this quarry (e.g. barrier walls) and therefore groundwater flow will continue to occur as it presently does. Approximately half of the overall bedrock thickness will remain undisturbed and water will continue to flow beneath the quarry as it does today.	None
47	Gary Hunter	20-May-14	Will the quarry walls become clogged with silt turbidity or be barricaded by lower permeability waste spoil ?	Our experience with other quarries is that quarry walls do not become clogged with silty turbidity and we do not anticipate any clogging of fractures at this quarry. Fine-grained material generated by the extraction of the overburden will be used in rehabilitation above-the-water-table, where needed for wetlands within the quarry pond or removed from the site to be used in products produced elsewhere.	None
48	Gary Hunter	20-May-14	Will the Site Plans specify that a Permit to Take Water and an Environmental Compliance Approval to Discharge Wash Water is required?	Any permits required by the MOE are governed by other legislation. The site plan makes note of permits that may be required.	None
49	Gary Hunter	20-May-14	Please provide Warnock Lake supporting technical information - say pre and post extraction hydroperiod monitoring and historical aerial imagery to support this observation.	The attached report "Evaluation of Three Hydraulic Barriers in Southern Ontario" (Harden Environmental, 2001) shows pre and post water level monitoring confirming barrier effectiveness at Warnock Lake and Heritage Lake.	"Evaluation of Three Hydraulic Barriers in Southern Ontario" (Harden Environmental, 2001) attached.
50	Gary Hunter	20-May-14	What will stop groundwater flows around the ends of the proposed northwest wetland hydraulic barrier in the proposed Hidden Quarry?	Groundwater must flow around the ends of the proposed hydraulic barrier. The purpose of the hydraulic barrier is to cause water levels to rise and flow around the barrier. The barrier is positioned parallel to groundwater flow and similar to an obstruction in a stream, will cause the water level to rise and flow around the obstruction. Our observation is that there is significant groundwater flow in the overburden sand and gravel on the upgradient side of the wetland and therefore we have included an overflow structure at 355.8 m AMSL to prevent excessive flooding of this wetland.	None
51	Gary Hunter	20-May-14	The Harden Sept 2012 Appendix E Fig 1 Sampling Location illustrates a rock drill operating from a dry platform. Is this dry platform maintained by dewatering (sump reference in the title of Table 1)? What are the depths of rock drilling? Is this dry drilling platform the top of the 'Gasport' Formation?	The dry platform is either formed by the surface of the bedrock, or where the surface of the bedrock is submerged, by a layer of shot rock. No dewatering will occur. Drilling will occur to a maximum of 327 masl.	None
52	Gary Hunter	20-May-14	Please provide a certified copy of the Laboratory Analytical Report(s) for this Feb 15, 2012 sample.	See attached.	Maxaam Validated Certificate of Analysis attached.
53	Gary Hunter	20-May-14	However this single grab sample (Appendix E Table 1) illustrates Provincial Water Quality Objective criteria exceedances for Cobalt, Lead and Zinc (Note Zinc (revised) as 20 µg/L). Total Ammonia -N concentration is at about 80%, Unionized Ammonia at 25 % and Nitrate at about 12 % of the PWQO. Benzene is reported at a trace amount. Please comment.	Cobalt, lead and zinc naturally occur in the Eramosa Formation being extracted at the Guelph Limestone Quarry. We concur that Total Ammonia - N, un-ionized ammonia and nitrate do not exceed Provincial Water Quality Objectives. The source of benzene in trace amounts could be derived from many sources including the naturally bituminous Eramosa Formation or from traffic on Highways 7 and 6 adjacent to the quarry.	None

54	Gary Hunter	20-May-14	Hardness, Alkalinity, pH, Sulphate, Total Organic Carbon, Organic Nitrogen, Colour, Total Dissolved Solids, Total Suspended Solids, Oil and Grease and Pathogens were not reported in Appendix E Table 1. Many of these parameters are likely to be elevated in an active quarry environment with frequent blasting especially if the underwater quarry is used for washwater silt and overburden disposal.	There is no proposal to emplace any fill, other than for wetland creation, in the pond. Hunter has not provided any data to substantiate his opinion that Hardness, Alkalinity, pH, sulphate, Total Organic Carbon, Organic Nitrogen, Colour, Total Dissolved Solids, Total Suspended Solids, Oil and Grease or Pathogens are likely to be elevated in an active quarry environment. Our reported findings are that in an active quarry environment hardness, alkalinity, pH, sulphate, TOC, Organic Nitrogen, Colour, TDS, TSS, Oil and Grease and pathogens are not elevated as a result of quarry activity. Hardness is naturally elevated in the Gasport Aquifer and is un-related to quarry activities. For example, 100% of the samples tested for Hardness by the City of Guelph in 2013 exceeded the Maximum Acceptable Concentration in the Annual & Summary Report available on-line. The Aesthetic/Operational standard for Alkalinity is 30 to 500 mg/L. As mainly a measure of the concentrations of carbonate and bicarbonate in the water, alkalinity will be naturally elevated in the Gasport Aquifer. The quarry activity will not introduce alkalinity to the water and the natural buffering capacity of the water will regulate the concentrations of carbonate and bicarbonate in the water. A total of 219 samples were obtained from an active limestone quarry near Brechin, Ontario. Blasting is conducted at the quarry. The attached Figure 1 shows the range of pH in the sump water at the quarry. As expected, because of the high buffering capacity of limestone and dolostone, the pH of the discharge water remains within the Ontario Drinking Water Operational Guideline of 6.5 to 8.5 pH units. There is no justification in the suggestion that pH will be elevated in the Hidden Quarry pond water or downgradient in the groundwater. Total Organic Carbon (TOC)is a measure of the dissolved and particulate carbon in the water. Again, a total of 219 samples tested for Total Organic Carbon in quarry sump water in Gamebridge, Ontario, found that the quarry water has lower TOC than the nearby natural waters of the Talbot River (26 samples) (attached Figure 2). There is no source of organic carbon in the quarry environment in comparison to the natural environment where wetlands, lakes and streams will contain elevated TOC. Organic Nitrogen is used to measure the concentration of nitrogen attached to organic molecules. Groundwater samples obtained from the Hidden Quarry site from stations M2, M15-3 and M3 and surface water samples obtained from stations SW4, SW11 and SW3 contained higher concentrations of organic nitrogen than samples obtained from the Guelph Limestone site following a blast. There is no reason to expect that the Colour of the water will be affected by the quarry activities. Unlike natural surface waters which dissolve organic matter, the quarry pond will be relatively sterile and the dissolution of the rock does not affect the colour of the water. Total Dissolved Solds will not necessarily increase. The action of the quarry is to remove dolostone from below-the-water table thereby decreasing the volume of rock interacting with the water. Total Suspended Solids (TSS) may increase in close proximity to the excavating equipment. There is no environmental consequence of having higher TSS in the quarry pond proximal to the excavating equipment. A total of 227 oil and grease samples were obtained at the Gamebridge Quarry. None exceeded the MOE Specified Daily Effluent Limit of 30 mg/L. Of the 227 samples, oil and grease was not detected in 190 samples, and of the 37 samples where oil and grease was detected, the average result was 1.3 mg/L with a maximum value of 7.7 mg/L. This water was discharged to the Talbot River with no consequence. Pathogens were not found in the Guelph Limestone quarry water sample obtained on April 16, 2014. Samples obtained from Tributary A (at RS1) and Tributary B (at SW4) near to the proposed quarry contained E. coli (Appendix C, Harden Response to Burnside Review, June 10 2014).	pH and TOC figures attached.
55	Gary Hunter	20-May-14	The Total Ammonia and Total Kjeldahl Nitrogen at the Dolime Quarry are elevated above the Hidden Quarry pre-development groundwater at M15 at 0.06 mg/L and 0.20 mg/L respectively (Appendix B to Harden July 15, 2013 letter to James Dick Construction Ltd). Total Ammonia-N is reported as Non-Detectible at Harden W1 (MOE 67-05627).	Subsequent samples from Guelph Limestone Quarry as reported to R.J. Burnside and Associates on June 10, 2014 show that ammonia is not present before or after a blast. Ammonia will not persist in the oxygenated quarry pond water and is therefore not an environmental threat. The additional samples from Gueplh Limestone Quarry also show that the quarry water has less TKN than samples obtained from M3, M2 and M15-II. With respect to Total Nitrogen, water samples from M3, M2, M15-III, M15-II, SW4 and SW8 exceed those obtained from the quarry in February 2012.	
56	Gary Hunter	20-May-14	There is a known direct relationship between the ammonia and nitrate levels and the amount of undetonated explosives in the rock through which water flows (Revey 1996). Are the Nitrogen parameters in this Dolime Quarry grab sample elevated due to incomplete detonation or combustion of explosives in a wet environment? Was the blast 'smoke' produced orange or white in colour in the Feb 12, 2012 detonation?	There is no evidence to suggest that nitrogen chemicals are elevated in the Guelph Limestone Quarry samples. A review of several quarry sites is provided in the Harden January 14, 2014 response to R.J. Burnside that shows that nitrogen chemicals are not an issue in quarry water discharge.	None
57	Gary Hunter	20-May-14	The difference between Total Kjeldahl Nitrogen (0.7 mg/L) and Total Ammonia N (0.39 mg/L) in Table 1 indicates that Organic Nitrogen in the grab sample is 0.31 mg/L. This value exceeds by 2x the Ontario Drinking Water Standards (2006) of 0.15 mg/L for Organic Nitrogen.	Organic Nitrogen does not have an Ontario Drinking Water Standard. There is an Operational Guideline of 0.15 mg/L, but this is a guideline, not a standard. None of the present M15 samples pass the guideline. None of the northern wells on-site pass the guideline (one is 10x the guideline) due to off-site contamination of the groundwater. None of the stream samples pass the guideline. Biological activity such as plant growth in the rehabilitated wetlands, will assist in the improvement of water quality presently impaired by farming activities upgradient of the Hidden Quarry site.	None
58	Gary Hunter	20-May-14	What blasting management protocols are employed at Guelph Dolime Quarry to minimize spillage, reduce product leaching and reduce undetonated explosives and incomplete combustion. How deep are the drill holes? What 'sleep' times typically occur? What is the frequency of blasting? What blasting agents are used?	At the Guelph Limestone Quarry, JDCL uses waterproof emulsions, blast tubes and excellent hygiene to minimize spillage, leaching and incomplete combustion. Explosives are used within manufacturers specifications for sleep times. Depths vary but we have seen these techniques up to 35m. The Guelph Limestone Quarry blasts generally once a week during peak operations, but only about 22 times per year. Each event has a duration of about one second.	None
59	Gary Hunter	20-May-14	This single grab sample is not sufficient as an analogue to establish a Water Quality comfort level for underwater blasting and quarrying at the Hidden Quarry.	Additional samples were obtained and reported to R.J. Burnside and Associates in the Harden Environmental June 10, 2014 letter.	None
60	Gary Hunter	20-May-14	I request that the Applicant discloses all Water Quality Compliance Monitoring for the Guelph Dolime Quarry and provides additional immediate post blast water quality sampling and analysis for the parameters in para 7 above and the BTEX suite.	Additional samples were obtained and reported to R.J. Burnside and Associates in the Harden Environmental June 10, 2014 letter.	None
61	Gary Hunter	20-May-14	I request a site inspection, together with other CRC members who may be interested, of the Dolime Quarry at the time of and following an underwater blast event.	The operator takes this request under advisement and will consider this request.	None
62	Gary Hunter	20-May-14	Has the bedrock outcrop / subcrop evidence at the De Grandis farm area been considered in the Applicant Hydrogeological Investigation and reporting?	We visited the De Grandis property on no less than five occasions and potential impacts to the De Grandis dug well and pond were carefully considered in our assessment. We mention the De Grandis property on twenty-eight occasions in our report and dedicate Section 5.3.2 to potential impacts to the De Grandis property. The geological conditions observed at the De Grandis property were given a significant amount of consideration. Similar boulder conditions occur on the Hidden Quarry site as shown on the cover page of the report. These are not bedrock/subcrop conditions as the overburden is approximately ten metres thick. These are glacial remnants and similar large boulders are found elsewhere at the height of the Paris Moraine. For example, on the Nassagaweya-Puslinch Townline between the 25th Sideroad and the 20th Sideroad there are numerous very large boulders found at the height of the Paris Moraine and between 30 and 40 metres above the bedrock.	None

63	Gary Hunter	20-May-14	What evidence does the Applicant have to support its hypothesis apparently based on extrapolated data from the Hidden Quarry site that the De Grandis ponds, the source of Tributary B, are perched above the basal silty till and fed by upper overburden granular aquifers? This condition likely exists on the W½ Lot 3 of the De Grandis Farm where the topographically high Paris Moraine deposits are prominent but not on the E½ of Lot 2 and adjacent Lot 3.	None of our opinions in regards to the De Grandis well and pond are based on extrapolated data from the Hidden Quarry site. There are several lines of evidence that form our opinion in regards to overburden source of water for the Degrandis Ponds. 1) The geological mapping provided by the Ontario Geological Survey as shown on our Figure 3.6 identifies the surficial quaternary geology as Kames and Eskers. These geological deposits are widely accepted as being relatively permeable with relatively high infiltration. Additional work conducted by Abigail Burt (2011) as shown on our Figure 3.7 also confirms the potential for the Port Stanley till in this area, a till that pre-dates the eskers and kame deposits. 2) Soil samples obtained from the Allen property in close proximity to the De Grandis ponds identify a silty glacial till in samples A8, A11 and A12. 3) Ms. De Grandis identified a spring west of her farm house, occuring at higher elevation, at the base of the moraine feature. Hunter agrees that this spring may have a source derived from the moraine sediments 4) Streamflow measurements confirm downward hydrualic gradients between surface water station SW9 and SW4 shown on Figure 2.4. therefore, shortly after discharging from the De Grandis pond, the hydraulic gradients are downward beneath Tributary B. 5) The De Grandis well is a shallow dug well in the overburden and is a high yielding well from an unconfined source. 6) The description of the pond excavation by Ms. Degrandis was that the pond was dry, digging through 'clay'. When the known spring located along the north shore of the pond was excavated, this resulted in a source of water for the pond. 6) On our visit to the De Grandis farm, Ms. De Grandis identifed several springs located in shallow water along the north shore of the pond. 7) The water quality of the De Grandis shallow dug well is indicative of a shallow, unconfined source. Therefore, none of the scientific or anecdotal information supports a bedrock source of water on the De Grandis farm.	None
64	Gary Hunter	20-May-14	How are the groundwater model predicted bedrock water level contours calibrated in the De Grandis Pond area?	The baseline groundwater conditions, used to calibrate the groundwater model before predictions are made, were obtained from regional water well record data, on-site monitoring well data and private water well survey information.	None
65	Gary Hunter	20-May-14	Similarly what geological evidence does the Applicant have that the Allen Spring is not a bedrock spring?	1) The water level of the Allen Spring is approximately six metres above the bedrock water level in the Allen well. The static water level in the Allen well should be flowing artesian if the bedrock water levels were six metres higher. 2) The elevation of the bedrock at the Allen Farm well is approximately 354 m AMSL and at the Harden test site 352 m AMSL (See Figure 3.5) whereas the spring has an elevation of approximatley 361 m AMSL 3) the description in the well record of the 5.5 metres of overburden is clay with gravel and stones 4) Hunter concedes that the spring conditions in the west half of Lot 3 are likely to be from permeable sediments overlying silty till sedimients.	None
66	Gary Hunter	20-May-14	The Applicant predicts bedrock aquifer drawdowns at 80 cm at the Allen Spring vicinity. Is this drawdown likely sufficient to terminate dry season discharge to streamflow at this location?	Historical seasonal water level changes in the Hidden Quarry bedrock water level of up to two metres have been measured and the Allen Spring has never gone dry. Water taking by the mushroom farmer resulting in a drawdown of approximately fifty metres in the bedrock have not affected spring flow from the Allen Spring. It is therefore, our opinion that the predicted 80 cm change in bedrock water levels at the Allen Spring will not affect discharge from the spring.	None
67	Gary Hunter	20-May-14	Is the applicant willing to construct boreholes and sentry observation wells in the vicinity of the Allen Spring and the De Grandis ponds in support of its application?	There is no requirement for offsite monitoring at these locations. SW4 is a surrogate monitoring site that corelates to flow coming from De Grandis pond and RS1 quantifies flow coming from the Allen Spring.	None
68	Gary Hunter	20-May-14	Please provide a digital copy of the UTM geographic coordinate string for the GRCA field staked setback base line and the proposed setback limit.	The setbacks are graphically shown on the updated site plan.	None
69	Gary Hunter	20-May-14	Please verify the last paragraph statements on pg 57 (Sec 6.0) related to total aggregate tonnage resources and that only 20% of the aggregate resource occurring below the water table.	This is a typo. It will be corrected in Final GWS Report referenced on the site plan.	None
70	Gary Hunter	20-May-14	If site boreholes confirm the evidence of a bedrock platform and bedrock springs at the De Grandis ponds and at the Allen Springs, how would this change the Sec 7.1 (pg 58) statements attributed to Harden Environmental (2012) .	See responses 62 and 63 above.	None
71	Gary Hunter	20-May-14	How would this loss of bedrock spring flow influence the sustainability of the Provincially Significant Allen Wetland and Tributary A and B - Brydson Creek?	Based on the evidence available including our observations and measurements in the Provincially Significant Wetland indicate that a cessation of flow from the De Grandis pond would not have an effect on the sustainability of the wetland. The basis for this opinion is 1) The berm separating the open water in the De Grandis ponds and the PSW has been breached, allowing for a relatively free flow of water. It appears that when intact, the berm would have retained a significant volume of water resulting in a premature cessation of stream flow to the PSW, there is no obvious effect of this loss of flow to the wetland, 2) Cessation of flow from the De Grandis ponds is an annual occurance and the wetland is conditioned for this occurence 3) The soil beneath the PSW is a sandy silt till and there are drainage ditches dug through the wetland as evidence of attempts to remove water from the wetland (i.e. the wetland retains stormwater and direct precipitation). Therefore, direct precipitation and runoff are significant contributers to the PSW.	None
72	Gary Hunter	20-May-14	Please provide us with a complete set of up-to-date digital AutoCAD .dwg or equivalent high resolution Site Plan files or legible hard copy for formal comment.	June 6, 2014 site plans available on Township Website. http://www.get.on.ca/uploads/userfiles/files/planning/hidden-quarry-site-plans-2014-06-06.pdf	June 6 2014 Site Plan PDF available on Township website



Harden Environmental Services Ltd.	**Project No:** 9506 **Date:** Jul 2014 **Drawn By:** AR	Hydrogeologic Impact Assessment Proposed Aggregate Extraction Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Figure 1: pH Values at Sump Discharge Gamebridge Quarry**



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure 2: Total Organic Carbon Gamebridge Quarry**
	Date: Jul 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		

Attention: Aaron Warkentin
Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2012/02/24

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B222699
Received: 2012/02/16, 08:46

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Methylnaphthalene Sum	1	2012/02/16	2012/02/22	CAM SOP - 00301	EPA 8270
Perchlorate in water	1	2012/02/17	2012/02/21	CAM SOP-00451	EPA 331.0/6850 (mod)
Petroleum Hydro. CCME F1 & BTEX in Water	1	N/A	2012/02/22	CAM SOP-00315	CCME CWS
Petroleum Hydrocarbons F2-F4 in Water	1	2012/02/21	2012/02/21	CAM SOP-00316	CCME Hydrocarbons
Total Metals Analysis by ICPMS	1	N/A	2012/02/22	CAM SOP-00447	EPA 6020
Total Ammonia-N	1	N/A	2012/02/22	CAM SOP-00441	US GS I-2522-90
Nitrate (NO3) and Nitrite (NO2) in Water (1)	1	N/A	2012/02/23	CAM SOP-00440	SM 4500 NO3I/NO2B
PAH Compounds in Water by GC/MS (SIM)	1	2012/02/17	2012/02/21	CAM SOP-00318	EPA 8270
Total Kjeldahl Nitrogen in Water	1	2012/02/22	2012/02/23	CAM SOP-00454	EPA 351.2 Rev 2
Volatile Organic Compounds in Water	1	N/A	2012/02/21	CAM SOP-00226	EPA 8260 modified

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. Reporting results to two significant figures at the RDL is to permit statistical evaluation and is not intended to be an indication of analytical precision.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited by SCC (Lab ID 97) for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other

Attention: Aaron Warkentin
Harden Environmental
4622 Nassagaweya-Puslinch Twnl
Moffat, ON
L0P 1J0

Report Date: 2012/02/24

CERTIFICATE OF ANALYSIS

-2-

warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

ANDREW TURNER, Project Manager
Email: ATurner@maxxam.ca
Phone# (800) 268-7396 Ext:233

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

RESULTS OF ANALYSES OF WATER

Maxxam ID		MN9623		
Sampling Date		2012/02/15 16:00		
	Units	**SUMP**	**RDL**	**QC Batch**
Inorganics				
Total Ammonia-N	mg/L	0.39	0.05	2768497
Total Kjeldahl Nitrogen (TKN)	mg/L	0.7	0.1	2770291
Nitrite (N)	mg/L	0.05	0.01	2768472
Nitrate (N)	mg/L	1.2	0.1	2768472
Nitrate + Nitrite	mg/L	1.2	0.1	2768472
Miscellaneous Parameters				
Perchlorate (CLO4)	ug/L	ND	0.05	2767145

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Harden Environmental

Maxxam Job #: B222699
Report Date: 2012/02/24

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID			MN9623		
Sampling Date			2012/02/15 16:00		
	Units	**Criteria**	**SUMP**	**RDL**	**QC Batch**
Metals					
Total Aluminum (Al)	mg/L	**-**	0.016	0.0050	2770314
Total Antimony (Sb)	mg/L	**0.02**	0.00090	0.00050	2770314
Total Arsenic (As)	mg/L	**0.1**	0.0016	0.0010	2770314
Total Barium (Ba)	mg/L	**-**	0.051	0.0020	2770314
Total Beryllium (Be)	mg/L	**0.011**	ND	0.00050	2770314
Total Bismuth (Bi)	mg/L	**-**	ND	0.0010	2770314
Total Boron (B)	mg/L	**0.2**	0.056	0.010	2770314
Total Cadmium (Cd)	mg/L	**0.0002**	ND	0.00010	2770314
Total Calcium (Ca)	mg/L	**-**	120	0.20	2770314
Total Chromium (Cr)	mg/L	**-**	ND	0.0050	2770314
Total Cobalt (Co)	mg/L	**0.0009**	**0.0013**	0.00050	2770314
Total Copper (Cu)	mg/L	**0.005**	0.0019	0.0010	2770314
Total Iron (Fe)	mg/L	**0.3**	ND	0.10	2770314
Total Lead (Pb)	mg/L	**0.005**	**0.0055**	0.00050	2770314
Total Lithium (Li)	mg/L	**-**	ND	0.0050	2770314
Total Magnesium (Mg)	mg/L	**-**	32	0.050	2770314
Total Manganese (Mn)	mg/L	**-**	0.026	0.0020	2770314
Total Molybdenum (Mo)	mg/L	**0.04**	0.0069	0.00050	2770314
Total Nickel (Ni)	mg/L	**0.025**	0.014	0.0010	2770314
Total Potassium (K)	mg/L	**-**	3.5	0.20	2770314
Total Silicon (Si)	mg/L	**-**	3.6	0.050	2770314
Total Selenium (Se)	mg/L	**0.1**	ND	0.0020	2770314
Total Silver (Ag)	mg/L	**0.0001**	ND	0.00010	2770314
Total Sodium (Na)	mg/L	**-**	80	0.10	2770314
Total Strontium (Sr)	mg/L	**-**	1.1	0.0010	2770314
Total Tellurium (Te)	mg/L	**-**	ND	0.0010	2770314
Total Thallium (Tl)	mg/L	**0.0003**	0.000056	0.000050	2770314
Total Tin (Sn)	mg/L	**-**	ND	0.0010	2770314
Total Titanium (Ti)	mg/L	**-**	ND	0.0050	2770314
Total Tungsten (W)	mg/L	**0.030**	ND	0.0010	2770314

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID			MN9623		
Sampling Date			2012/02/15 16:00		
	Units	**Criteria**	**SUMP**	**RDL**	**QC Batch**
Total Uranium (U)	mg/L	**0.005**	0.0020	0.00010	2770314
Total Vanadium (V)	mg/L	**0.006**	ND	0.00050	2770314
Total Zinc (Zn)	mg/L	**0.03**	**0.057**	0.0050	2770314
Total Zirconium (Zr)	mg/L	**0.004**	ND	0.0010	2770314

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

Harden Environmental

Maxxam Job #: B222699
Report Date: 2012/02/24

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID			MN9623		
Sampling Date			2012/02/15 16:00		
	Units	**Criteria**	**SUMP**	**RDL**	**QC Batch**
Calculated Parameters					
Methylnaphthalene, 2-(1-)	ug/L	**-**	ND	0.071	2766069
Polyaromatic Hydrocarbons					
Biphenyl	ug/L	**0.2**	ND	0.050	2768173
Acenaphthene	ug/L	**-**	ND	0.050	2768173
Acenaphthylene	ug/L	**-**	ND	0.050	2768173
Anthracene	ug/L	**0.0008**	ND	0.050	2768173
Benzo(a)anthracene	ug/L	**0.0004**	ND	0.050	2768173
Benzo(a)pyrene	ug/L	**-**	ND	0.010	2768173
Benzo(b/j)fluoranthene	ug/L	**-**	ND	0.050	2768173
Benzo(g,h,i)perylene	ug/L	**0.00002**	ND	0.050	2768173
Benzo(k)fluoranthene	ug/L	**0.0002**	ND	0.050	2768173
Chrysene	ug/L	**0.0001**	ND	0.050	2768173
Dibenz(a,h)anthracene	ug/L	**0.002**	ND	0.050	2768173
Fluoranthene	ug/L	**0.0008**	ND	0.050	2768173
Fluorene	ug/L	**0.2**	ND	0.050	2768173
Indeno(1,2,3-cd)pyrene	ug/L	**-**	ND	0.050	2768173
1-Methylnaphthalene	ug/L	**2**	ND	0.050	2768173
2-Methylnaphthalene	ug/L	**2**	ND	0.050	2768173
Naphthalene	ug/L	**7**	ND	0.050	2768173
Phenanthrene	ug/L	**0.03**	ND	0.030	2768173
Pyrene	ug/L	**-**	ND	0.050	2768173
Surrogate Recovery (%)					
D10-Anthracene	%	-	89		2768173
D14-Terphenyl (FS)	%	-	96		2768173
D8-Acenaphthylene	%	-	86		2768173

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

VOLATILE ORGANICS BY GC/MS (WATER)

Maxxam ID			MN9623		
Sampling Date			2012/02/15 16:00		
	Units	**Criteria**	**SUMP**	**RDL**	**QC Batch**

Volatile Organics					
Acetone (2-Propanone)	ug/L	**-**	ND	10	2767160
Benzene	ug/L	**100**	0.11	0.10	2767160
Bromodichloromethane	ug/L	**200**	ND	0.10	2767160
Bromoform	ug/L	**60**	ND	0.20	2767160
Bromomethane	ug/L	**0.9**	ND	0.50	2767160
Carbon Tetrachloride	ug/L	**-**	ND	0.10	2767160
Chlorobenzene	ug/L	**15**	ND	0.10	2767160
Chloroform	ug/L	**-**	ND	0.10	2767160
Dibromochloromethane	ug/L	**40**	ND	0.20	2767160
1,2-Dichlorobenzene	ug/L	**2.5**	ND	0.20	2767160
1,3-Dichlorobenzene	ug/L	**2.5**	ND	0.20	2767160
1,4-Dichlorobenzene	ug/L	**4**	ND	0.20	2767160
Dichlorodifluoromethane (FREON 12)	ug/L	**-**	ND	0.50	2767160
1,1-Dichloroethane	ug/L	**200**	ND	0.10	2767160
1,2-Dichloroethane	ug/L	**100**	ND	0.20	2767160
1,1-Dichloroethylene	ug/L	**40**	ND	0.10	2767160
cis-1,2-Dichloroethylene	ug/L	**200**	ND	0.10	2767160
trans-1,2-Dichloroethylene	ug/L	**200**	ND	0.10	2767160
1,2-Dichloropropane	ug/L	**0.7**	ND	0.10	2767160
cis-1,3-Dichloropropene	ug/L	**-**	ND	0.20	2767160
trans-1,3-Dichloropropene	ug/L	**7**	ND	0.20	2767160
Ethylbenzene	ug/L	**8**	ND	0.10	2767160
Ethylene Dibromide	ug/L	**5**	ND	0.20	2767160
Hexane	ug/L	**-**	ND	0.50	2767160
Methylene Chloride(Dichloromethane)	ug/L	**100**	ND	0.50	2767160
Methyl Isobutyl Ketone	ug/L	**-**	ND	5.0	2767160
Methyl Ethyl Ketone (2-Butanone)	ug/L	**400**	ND	5.0	2767160
Methyl t-butyl ether (MTBE)	ug/L	**200**	ND	0.20	2767160
Styrene	ug/L	**4**	ND	0.20	2767160
1,1,1,2-Tetrachloroethane	ug/L	**20**	ND	0.10	2767160

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

VOLATILE ORGANICS BY GC/MS (WATER)

Maxxam ID			MN9623		
Sampling Date			2012/02/15 16:00		
	Units	**Criteria**	**SUMP**	**RDL**	**QC Batch**
1,1,2,2-Tetrachloroethane	ug/L	**70**	ND	0.20	2767160
Tetrachloroethylene	ug/L	**50**	ND	0.10	2767160
Toluene	ug/L	**0.8**	ND	0.20	2767160
1,1,1-Trichloroethane	ug/L	**10**	ND	0.10	2767160
1,1,2-Trichloroethane	ug/L	**800**	ND	0.20	2767160
Trichloroethylene	ug/L	**20**	ND	0.10	2767160
Vinyl Chloride	ug/L	**600**	ND	0.20	2767160
p+m-Xylene	ug/L	**-**	ND	0.10	2767160
o-Xylene	ug/L	**40**	ND	0.10	2767160
Xylene (Total)	ug/L	**-**	ND	0.10	2767160
Trichlorofluoromethane (FREON 11)	ug/L	**-**	ND	0.20	2767160
Surrogate Recovery (%)					
4-Bromofluorobenzene	%	-	94		2767160
D4-1,2-Dichloroethane	%	-	106		2767160
D8-Toluene	%	-	103		2767160

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: ONTARIO PROVINCIAL WATER QUALITY OBJECTIVES
Ref. to MOEE Water Management document dated Feb.1999

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		MN9623		
Sampling Date		2012/02/15 16:00		
	Units	**SUMP**	**RDL**	**QC Batch**

BTEX & F1 Hydrocarbons				
F1 (C6-C10)	ug/L	ND	25	2770026
F1 (C6-C10) - BTEX	ug/L	ND	25	2770026
F2-F4 Hydrocarbons				
F2 (C10-C16 Hydrocarbons)	ug/L	ND	100	2768808
F3 (C16-C34 Hydrocarbons)	ug/L	ND	100	2768808
F4 (C34-C50 Hydrocarbons)	ug/L	ND	100	2768808
Reached Baseline at C50	ug/L	Yes		2768808
Surrogate Recovery (%)				
1,4-Difluorobenzene	%	99		2770026
4-Bromofluorobenzene	%	100		2770026
D10-Ethylbenzene	%	105		2770026
D4-1,2-Dichloroethane	%	103		2770026
o-Terphenyl	%	107		2768808

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Test Summary

Maxxam ID MN9623
Sample ID SUMP
Matrix Water

Collected 2012/02/15
Shipped
Received 2012/02/16

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Methylnaphthalene Sum	CALC	2766069	2012/02/22	2012/02/22	AUTOMATED STATCHK
Perchlorate in water	LCMS	2767145	2012/02/17	2012/02/21	JANET DALISAY
Petroleum Hydro. CCME F1 & BTEX in Wat	HSGC/MSFD	2770026	N/A	2012/02/22	SUNG HO KIM
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	2768808	2012/02/21	2012/02/21	JOLANTA KAWZOWICZ
Total Metals Analysis by ICPMS	ICP/MS	2770314	N/A	2012/02/22	AREFA DABHAD
Total Ammonia-N	LACH/NH4	2768497	N/A	2012/02/22	ALINA DOBREANU
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	2768472	N/A	2012/02/23	BAVANI KAILAYA
PAH Compounds in Water by GC/MS (SIM)	GC/MS	2768173	2012/02/17	2012/02/21	YUAN ZHOU
Total Kjeldahl Nitrogen in Water	AC	2770291	2012/02/22	2012/02/23	CHANDRA NANDLAL
Volatile Organic Compounds in Water	P&T/MS	2767160	N/A	2012/02/21	VIVEK AKOLKAR

Maxxam ID MN9623 Dup
Sample ID SUMP
Matrix Water

Collected 2012/02/15
Shipped
Received 2012/02/16

Test Description	Instrumentation	Batch	Extracted	Analyzed	Analyst
Perchlorate in water	LCMS	2767145	2012/02/17	2012/02/21	JANET DALISAY
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	2768808	2012/02/21	2012/02/21	JOLANTA KAWZOWICZ
Nitrate (NO3) and Nitrite (NO2) in Water	LACH	2768472	N/A	2012/02/23	BAVANI KAILAYA
Total Kjeldahl Nitrogen in Water	AC	2770291	2012/02/22	2012/02/23	CHANDRA NANDLAL

GENERAL COMMENTS

Results relate only to the items tested.

Quality Assurance Report

Maxxam Job Number: WB222699

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2767145 JDA	Matrix Spike [MN9623-01]	Perchlorate (CLO4)	2012/02/21		101	%	75 - 115
	Spiked Blank	Perchlorate (CLO4)	2012/02/21		100	%	75 - 115
	Method Blank	Perchlorate (CLO4)	2012/02/21	ND, RDL=0.05		ug/L	
	RPD [MN9623-01]	Perchlorate (CLO4)	2012/02/21	NC		%	20
2767160 VAK	Matrix Spike	4-Bromofluorobenzene	2012/02/21		102	%	70 - 130
		D4-1,2-Dichloroethane	2012/02/21		107	%	70 - 130
		D8-Toluene	2012/02/21		100	%	70 - 130
		Acetone (2-Propanone)	2012/02/21		112	%	60 - 140
		Benzene	2012/02/21		96	%	70 - 130
		Bromodichloromethane	2012/02/21		95	%	70 - 130
		Bromoform	2012/02/21		97	%	70 - 130
		Bromomethane	2012/02/21		96	%	60 - 140
		Carbon Tetrachloride	2012/02/21		91	%	70 - 130
		Chlorobenzene	2012/02/21		92	%	70 - 130
		Chloroform	2012/02/21		97	%	70 - 130
		Dibromochloromethane	2012/02/21		95	%	70 - 130
		1,2-Dichlorobenzene	2012/02/21		91	%	70 - 130
		1,3-Dichlorobenzene	2012/02/21		92	%	70 - 130
		1,4-Dichlorobenzene	2012/02/21		92	%	70 - 130
		Dichlorodifluoromethane (FREON 12)	2012/02/21		96	%	60 - 140
		1,1-Dichloroethane	2012/02/21		94	%	70 - 130
		1,2-Dichloroethane	2012/02/21		99	%	70 - 130
		1,1-Dichloroethylene	2012/02/21		99	%	70 - 130
		cis-1,2-Dichloroethylene	2012/02/21		94	%	70 - 130
		trans-1,2-Dichloroethylene	2012/02/21		91	%	70 - 130
		1,2-Dichloropropane	2012/02/21		101	%	70 - 130
		cis-1,3-Dichloropropene	2012/02/21		108	%	70 - 130
		trans-1,3-Dichloropropene	2012/02/21		105	%	70 - 130
		Ethylbenzene	2012/02/21		104	%	70 - 130
		Ethylene Dibromide	2012/02/21		98	%	70 - 130
		Hexane	2012/02/21		109	%	70 - 130
		Methylene Chloride(Dichloromethane)	2012/02/21		96	%	70 - 130
		Methyl Isobutyl Ketone	2012/02/21		118	%	70 - 130
		Methyl Ethyl Ketone (2-Butanone)	2012/02/21		109	%	60 - 140
		Methyl t-butyl ether (MTBE)	2012/02/21		115	%	70 - 130
		Styrene	2012/02/21		87	%	70 - 130
		1,1,1,2-Tetrachloroethane	2012/02/21		91	%	70 - 130
		1,1,2,2-Tetrachloroethane	2012/02/21		97	%	70 - 130
		Tetrachloroethylene	2012/02/21		85	%	70 - 130
		Toluene	2012/02/21		91	%	70 - 130
		1,1,1-Trichloroethane	2012/02/21		88	%	70 - 130
		1,1,2-Trichloroethane	2012/02/21		95	%	70 - 130
		Trichloroethylene	2012/02/21		86	%	70 - 130
		Vinyl Chloride	2012/02/21		90	%	70 - 130
		p+m-Xylene	2012/02/21		99	%	70 - 130
		o-Xylene	2012/02/21		101	%	70 - 130
		Trichlorofluoromethane (FREON 11)	2012/02/21		87	%	70 - 130
	Spiked Blank	4-Bromofluorobenzene	2012/02/21		101	%	70 - 130
		D4-1,2-Dichloroethane	2012/02/21		101	%	70 - 130
		D8-Toluene	2012/02/21		102	%	70 - 130
		Acetone (2-Propanone)	2012/02/21		120	%	60 - 140
		Benzene	2012/02/21		98	%	70 - 130
		Bromodichloromethane	2012/02/21		94	%	70 - 130
		Bromoform	2012/02/21		97	%	70 - 130

Quality Assurance Report (Continued)

Maxxam Job Number: WB222699

QA/QC Batch Num	Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2767160	VAK	Spiked Blank	Bromomethane	2012/02/21		102	%	60 - 140
			Carbon Tetrachloride	2012/02/21		97	%	70 - 130
			Chlorobenzene	2012/02/21		95	%	70 - 130
			Chloroform	2012/02/21		100	%	70 - 130
			Dibromochloromethane	2012/02/21		95	%	70 - 130
			1,2-Dichlorobenzene	2012/02/21		94	%	70 - 130
			1,3-Dichlorobenzene	2012/02/21		96	%	70 - 130
			1,4-Dichlorobenzene	2012/02/21		97	%	70 - 130
			Dichlorodifluoromethane (FREON 12)	2012/02/21		105	%	60 - 140
			1,1-Dichloroethane	2012/02/21		97	%	70 - 130
			1,2-Dichloroethane	2012/02/21		98	%	70 - 130
			1,1-Dichloroethylene	2012/02/21		105	%	70 - 130
			cis-1,2-Dichloroethylene	2012/02/21		96	%	70 - 130
			trans-1,2-Dichloroethylene	2012/02/21		95	%	70 - 130
			1,2-Dichloropropane	2012/02/21		101	%	70 - 130
			cis-1,3-Dichloropropene	2012/02/21		107	%	70 - 130
			trans-1,3-Dichloropropene	2012/02/21		104	%	70 - 130
			Ethylbenzene	2012/02/21		99	%	70 - 130
			Ethylene Dibromide	2012/02/21		96	%	70 - 130
			Hexane	2012/02/21		122	%	70 - 130
			Methylene Chloride(Dichloromethane)	2012/02/21		95	%	70 - 130
			Methyl Isobutyl Ketone	2012/02/21		107	%	70 - 130
			Methyl Ethyl Ketone (2-Butanone)	2012/02/21		112	%	60 - 140
			Methyl t-butyl ether (MTBE)	2012/02/21		106	%	70 - 130
			Styrene	2012/02/21		88	%	70 - 130
			1,1,1,2-Tetrachloroethane	2012/02/21		93	%	70 - 130
			1,1,2,2-Tetrachloroethane	2012/02/21		94	%	70 - 130
			Tetrachloroethylene	2012/02/21		94	%	70 - 130
			Toluene	2012/02/21		95	%	70 - 130
			1,1,1-Trichloroethane	2012/02/21		93	%	70 - 130
			1,1,2-Trichloroethane	2012/02/21		94	%	70 - 130
			Trichloroethylene	2012/02/21		91	%	70 - 130
			Vinyl Chloride	2012/02/21		96	%	70 - 130
			p+m-Xylene	2012/02/21		100	%	70 - 130
			o-Xylene	2012/02/21		102	%	70 - 130
			Trichlorofluoromethane (FREON 11)	2012/02/21		92	%	70 - 130
		Method Blank	4-Bromofluorobenzene	2012/02/21		90	%	70 - 130
			D4-1,2-Dichloroethane	2012/02/21		101	%	70 - 130
			D8-Toluene	2012/02/21		104	%	70 - 130
			Acetone (2-Propanone)	2012/02/21	ND, RDL=10		ug/L	
			Benzene	2012/02/21	ND, RDL=0.10		ug/L	
			Bromodichloromethane	2012/02/21	ND, RDL=0.10		ug/L	
			Bromoform	2012/02/21	ND, RDL=0.20		ug/L	
			Bromomethane	2012/02/21	ND, RDL=0.50		ug/L	
			Carbon Tetrachloride	2012/02/21	ND, RDL=0.10		ug/L	
			Chlorobenzene	2012/02/21	ND, RDL=0.10		ug/L	
			Chloroform	2012/02/21	ND, RDL=0.10		ug/L	
			Dibromochloromethane	2012/02/21	ND, RDL=0.20		ug/L	
			1,2-Dichlorobenzene	2012/02/21	ND, RDL=0.20		ug/L	
			1,3-Dichlorobenzene	2012/02/21	ND, RDL=0.20		ug/L	
			1,4-Dichlorobenzene	2012/02/21	ND, RDL=0.20		ug/L	
			Dichlorodifluoromethane (FREON 12)	2012/02/21	ND, RDL=0.50		ug/L	
			1,1-Dichloroethane	2012/02/21	ND, RDL=0.10		ug/L	
			1,2-Dichloroethane	2012/02/21	ND, RDL=0.20		ug/L	
			1,1-Dichloroethylene	2012/02/21	ND, RDL=0.10		ug/L	

Quality Assurance Report (Continued)

Maxxam Job Number: WB222699

QA/QC Batch Num	Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2767160	VAK	Method Blank	cis-1,2-Dichloroethylene	2012/02/21	ND, RDL=0.10		ug/L	
			trans-1,2-Dichloroethylene	2012/02/21	ND, RDL=0.10		ug/L	
			1,2-Dichloropropane	2012/02/21	ND, RDL=0.10		ug/L	
			cis-1,3-Dichloropropene	2012/02/21	ND, RDL=0.20		ug/L	
			trans-1,3-Dichloropropene	2012/02/21	ND, RDL=0.20		ug/L	
			Ethylbenzene	2012/02/21	ND, RDL=0.10		ug/L	
			Ethylene Dibromide	2012/02/21	ND, RDL=0.20		ug/L	
			Hexane	2012/02/21	ND, RDL=0.50		ug/L	
			Methylene Chloride(Dichloromethane)	2012/02/21	ND, RDL=0.50		ug/L	
			Methyl Isobutyl Ketone	2012/02/21	ND, RDL=5.0		ug/L	
			Methyl Ethyl Ketone (2-Butanone)	2012/02/21	ND, RDL=5.0		ug/L	
			Methyl t-butyl ether (MTBE)	2012/02/21	ND, RDL=0.20		ug/L	
			Styrene	2012/02/21	ND, RDL=0.20		ug/L	
			1,1,1,2-Tetrachloroethane	2012/02/21	ND, RDL=0.10		ug/L	
			1,1,2,2-Tetrachloroethane	2012/02/21	ND, RDL=0.20		ug/L	
			Tetrachloroethylene	2012/02/21	ND, RDL=0.10		ug/L	
			Toluene	2012/02/21	ND, RDL=0.20		ug/L	
			1,1,1-Trichloroethane	2012/02/21	ND, RDL=0.10		ug/L	
			1,1,2-Trichloroethane	2012/02/21	ND, RDL=0.20		ug/L	
			Trichloroethylene	2012/02/21	ND, RDL=0.10		ug/L	
			Vinyl Chloride	2012/02/21	ND, RDL=0.20		ug/L	
			p+m-Xylene	2012/02/21	ND, RDL=0.10		ug/L	
			o-Xylene	2012/02/21	ND, RDL=0.10		ug/L	
			Xylene (Total)	2012/02/21	ND, RDL=0.10		ug/L	
			Trichlorofluoromethane (FREON 11)	2012/02/21	ND, RDL=0.20		ug/L	
		RPD	Acetone (2-Propanone)	2012/02/21	NC		%	30
			Benzene	2012/02/21	10.4		%	30
			Bromodichloromethane	2012/02/21	NC		%	30
			Bromoform	2012/02/21	NC		%	30
			Bromomethane	2012/02/21	NC		%	30
			Carbon Tetrachloride	2012/02/21	NC		%	30
			Chlorobenzene	2012/02/21	NC		%	30
			Chloroform	2012/02/21	NC		%	30
			Dibromochloromethane	2012/02/21	NC		%	30
			1,2-Dichlorobenzene	2012/02/21	NC		%	30
			1,3-Dichlorobenzene	2012/02/21	NC		%	30
			1,4-Dichlorobenzene	2012/02/21	NC		%	30
			1,1-Dichloroethane	2012/02/21	NC		%	30
			1,2-Dichloroethane	2012/02/21	NC		%	30
			1,1-Dichloroethylene	2012/02/21	NC		%	30
			cis-1,2-Dichloroethylene	2012/02/21	NC		%	30
			trans-1,2-Dichloroethylene	2012/02/21	NC		%	30
			1,2-Dichloropropane	2012/02/21	NC		%	30
			cis-1,3-Dichloropropene	2012/02/21	NC		%	30
			trans-1,3-Dichloropropene	2012/02/21	NC		%	30
			Ethylbenzene	2012/02/21	11.6		%	30
			Ethylene Dibromide	2012/02/21	NC		%	30
			Methylene Chloride(Dichloromethane)	2012/02/21	NC		%	30
			Methyl Isobutyl Ketone	2012/02/21	NC		%	30
			Methyl Ethyl Ketone (2-Butanone)	2012/02/21	NC		%	30
			Methyl t-butyl ether (MTBE)	2012/02/21	NC		%	30
			Styrene	2012/02/21	NC		%	30
			1,1,1,2-Tetrachloroethane	2012/02/21	NC		%	30
			1,1,2,2-Tetrachloroethane	2012/02/21	NC		%	30
			Tetrachloroethylene	2012/02/21	NC		%	30

Harden Environmental
Attention: Aaron Warkentin
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report (Continued)

Maxxam Job Number: WB222699

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2767160 VAK	RPD	Toluene	2012/02/21	NC		%	30
		1,1,1-Trichloroethane	2012/02/21	NC		%	30
		1,1,2-Trichloroethane	2012/02/21	NC		%	30
		Trichloroethylene	2012/02/21	NC		%	30
		Vinyl Chloride	2012/02/21	NC		%	30
		p+m-Xylene	2012/02/21	12.5		%	30
		o-Xylene	2012/02/21	NC		%	30
		Xylene (Total)	2012/02/21	12.5		%	30
2768173 YZ	Matrix Spike	D10-Anthracene	2012/02/21		92	%	50 - 130
		D14-Terphenyl (FS)	2012/02/21		61	%	50 - 130
		D8-Acenaphthylene	2012/02/21		87	%	50 - 130
		Biphenyl	2012/02/21		80	%	50 - 130
		Acenaphthene	2012/02/21		91	%	50 - 130
		Acenaphthylene	2012/02/21		89	%	50 - 130
		Anthracene	2012/02/21		94	%	50 - 130
		Benzo(a)anthracene	2012/02/21		91	%	50 - 130
		Benzo(a)pyrene	2012/02/21		75	%	50 - 130
		Benzo(b/j)fluoranthene	2012/02/21		70	%	50 - 130
		Benzo(g,h,i)perylene	2012/02/21		74	%	50 - 130
		Benzo(k)fluoranthene	2012/02/21		74	%	50 - 130
		Chrysene	2012/02/21		86	%	50 - 130
		Dibenz(a,h)anthracene	2012/02/21		80	%	50 - 130
		Fluoranthene	2012/02/21		95	%	50 - 130
		Fluorene	2012/02/21		91	%	50 - 130
		Indeno(1,2,3-cd)pyrene	2012/02/21		76	%	50 - 130
		1-Methylnaphthalene	2012/02/21		72	%	50 - 130
		2-Methylnaphthalene	2012/02/21		72	%	50 - 130
		Naphthalene	2012/02/21		79	%	50 - 130
		Phenanthrene	2012/02/21		92	%	50 - 130
		Pyrene	2012/02/21		97	%	50 - 130
	Spiked Blank	D10-Anthracene	2012/02/21		102	%	50 - 130
		D14-Terphenyl (FS)	2012/02/21		98	%	50 - 130
		D8-Acenaphthylene	2012/02/21		91	%	50 - 130
		Biphenyl	2012/02/21		93	%	50 - 130
		Acenaphthene	2012/02/21		99	%	50 - 130
		Acenaphthylene	2012/02/21		93	%	50 - 130
		Anthracene	2012/02/21		98	%	50 - 130
		Benzo(a)anthracene	2012/02/21		97	%	50 - 130
		Benzo(a)pyrene	2012/02/21		91	%	50 - 130
		Benzo(b/j)fluoranthene	2012/02/21		83	%	50 - 130
		Benzo(g,h,i)perylene	2012/02/21		87	%	50 - 130
		Benzo(k)fluoranthene	2012/02/21		87	%	50 - 130
		Chrysene	2012/02/21		81	%	50 - 130
		Dibenz(a,h)anthracene	2012/02/21		97	%	50 - 130
		Fluoranthene	2012/02/21		105	%	50 - 130
		Fluorene	2012/02/21		96	%	50 - 130
		Indeno(1,2,3-cd)pyrene	2012/02/21		90	%	50 - 130
		1-Methylnaphthalene	2012/02/21		87	%	50 - 130
		2-Methylnaphthalene	2012/02/21		89	%	50 - 130
		Naphthalene	2012/02/21		94	%	50 - 130
		Phenanthrene	2012/02/21		101	%	50 - 130
		Pyrene	2012/02/21		108	%	50 - 130
	Method Blank	D10-Anthracene	2012/02/21		97	%	50 - 130
		D14-Terphenyl (FS)	2012/02/21		101	%	50 - 130
		D8-Acenaphthylene	2012/02/21		87	%	50 - 130

Harden Environmental
Attention: Aaron Warkentin
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report (Continued)

Maxxam Job Number: WB222699

QA/QC Batch Num	Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2768173	YZ	Method Blank	Biphenyl	2012/02/21	ND, RDL=0.050		ug/L	
			Acenaphthene	2012/02/21	ND, RDL=0.050		ug/L	
			Acenaphthylene	2012/02/21	ND, RDL=0.050		ug/L	
			Anthracene	2012/02/21	ND, RDL=0.050		ug/L	
			Benzo(a)anthracene	2012/02/21	ND, RDL=0.050		ug/L	
			Benzo(a)pyrene	2012/02/21	ND, RDL=0.010		ug/L	
			Benzo(b/j)fluoranthene	2012/02/21	ND, RDL=0.050		ug/L	
			Benzo(g,h,i)perylene	2012/02/21	ND, RDL=0.050		ug/L	
			Benzo(k)fluoranthene	2012/02/21	ND, RDL=0.050		ug/L	
			Chrysene	2012/02/21	ND, RDL=0.050		ug/L	
			Dibenz(a,h)anthracene	2012/02/21	ND, RDL=0.050		ug/L	
			Fluoranthene	2012/02/21	ND, RDL=0.050		ug/L	
			Fluorene	2012/02/21	ND, RDL=0.050		ug/L	
			Indeno(1,2,3-cd)pyrene	2012/02/21	ND, RDL=0.050		ug/L	
			1-Methylnaphthalene	2012/02/21	ND, RDL=0.050		ug/L	
			2-Methylnaphthalene	2012/02/21	ND, RDL=0.050		ug/L	
			Naphthalene	2012/02/21	ND, RDL=0.050		ug/L	
			Phenanthrene	2012/02/21	ND, RDL=0.030		ug/L	
			Pyrene	2012/02/21	ND, RDL=0.050		ug/L	
		RPD	Acenaphthene	2012/02/21	NC		%	30
			Acenaphthylene	2012/02/21	NC		%	30
			Anthracene	2012/02/21	NC		%	30
			Benzo(a)anthracene	2012/02/21	NC		%	30
			Benzo(a)pyrene	2012/02/21	NC		%	30
			Benzo(b/j)fluoranthene	2012/02/21	NC		%	30
			Benzo(g,h,i)perylene	2012/02/21	NC		%	30
			Benzo(k)fluoranthene	2012/02/21	NC		%	30
			Chrysene	2012/02/21	NC		%	30
			Dibenz(a,h)anthracene	2012/02/21	NC		%	30
			Fluoranthene	2012/02/21	NC		%	30
			Fluorene	2012/02/21	NC		%	30
			Indeno(1,2,3-cd)pyrene	2012/02/21	NC		%	30
			1-Methylnaphthalene	2012/02/21	21.4		%	30
			2-Methylnaphthalene	2012/02/21	20.3		%	30
			Naphthalene	2012/02/21	28.0		%	30
			Phenanthrene	2012/02/21	NC		%	30
			Pyrene	2012/02/21	NC		%	30
2768472	BAV	Matrix Spike [MN9623-01]	Nitrite (N)	2012/02/23		96	%	80 - 120
			Nitrate (N)	2012/02/23		87	%	80 - 120
		Spiked Blank	Nitrite (N)	2012/02/23		93	%	85 - 115
			Nitrate (N)	2012/02/23		94	%	85 - 115
		Method Blank	Nitrite (N)	2012/02/23	ND, RDL=0.01		mg/L	
			Nitrate (N)	2012/02/23	ND, RDL=0.1		mg/L	
		RPD [MN9623-01]	Nitrite (N)	2012/02/23	NC		%	25
			Nitrate (N)	2012/02/23	2.9		%	25
2768497	ADB	Matrix Spike	Total Ammonia-N	2012/02/22		99	%	80 - 120
		Spiked Blank	Total Ammonia-N	2012/02/22		102	%	85 - 115
		Method Blank	Total Ammonia-N	2012/02/22	ND, RDL=0.05		mg/L	
		RPD	Total Ammonia-N	2012/02/22	NC		%	20
2768808	JKA	Matrix Spike	o-Terphenyl	2012/02/21		107	%	50 - 130
			F2 (C10-C16 Hydrocarbons)	2012/02/21		98	%	50 - 130
			F3 (C16-C34 Hydrocarbons)	2012/02/21		98	%	50 - 130
			F4 (C34-C50 Hydrocarbons)	2012/02/21		91	%	50 - 130
		Spiked Blank	o-Terphenyl	2012/02/21		107	%	50 - 130

Harden Environmental
Attention: Aaron Warkentin
Client Project #:
P.O. #:
Site Location:

Quality Assurance Report (Continued)

Maxxam Job Number: WB222699

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2768808 JKA	Spiked Blank	F2 (C10-C16 Hydrocarbons)	2012/02/21		83	%	70 - 130
		F3 (C16-C34 Hydrocarbons)	2012/02/21		96	%	70 - 130
		F4 (C34-C50 Hydrocarbons)	2012/02/21		87	%	70 - 130
	Method Blank	o-Terphenyl	2012/02/21		105	%	50 - 130
		F2 (C10-C16 Hydrocarbons)	2012/02/21	ND, RDL=100		ug/L	
		F3 (C16-C34 Hydrocarbons)	2012/02/21	ND, RDL=100		ug/L	
		F4 (C34-C50 Hydrocarbons)	2012/02/21	ND, RDL=100		ug/L	
	RPD [MN9623-04]	F2 (C10-C16 Hydrocarbons)	2012/02/21	NC		%	30
		F3 (C16-C34 Hydrocarbons)	2012/02/21	NC		%	30
		F4 (C34-C50 Hydrocarbons)	2012/02/21	NC		%	30
2770026 SHK	Matrix Spike	1,4-Difluorobenzene	2012/02/23		100	%	70 - 130
		4-Bromofluorobenzene	2012/02/23		102	%	70 - 130
		D10-Ethylbenzene	2012/02/23		110	%	70 - 130
		D4-1,2-Dichloroethane	2012/02/23		103	%	70 - 130
		F1 (C6-C10)	2012/02/23		81	%	70 - 130
	Spiked Blank	1,4-Difluorobenzene	2012/02/22		101	%	70 - 130
		4-Bromofluorobenzene	2012/02/22		100	%	70 - 130
		D10-Ethylbenzene	2012/02/22		106	%	70 - 130
		D4-1,2-Dichloroethane	2012/02/22		103	%	70 - 130
		F1 (C6-C10)	2012/02/22		108	%	70 - 130
	Method Blank	1,4-Difluorobenzene	2012/02/22		98	%	70 - 130
		4-Bromofluorobenzene	2012/02/22		99	%	70 - 130
		D10-Ethylbenzene	2012/02/22		103	%	70 - 130
		D4-1,2-Dichloroethane	2012/02/22		103	%	70 - 130
		F1 (C6-C10)	2012/02/22	ND, RDL=25		ug/L	
		F1 (C6-C10) - BTEX	2012/02/22	ND, RDL=25		ug/L	
	RPD	F1 (C6-C10)	2012/02/22	NC		%	30
		F1 (C6-C10) - BTEX	2012/02/22	NC		%	30
2770291 C_N	Matrix Spike [MN9623-03]	Total Kjeldahl Nitrogen (TKN)	2012/02/23		96	%	80 - 120
	QC Standard	Total Kjeldahl Nitrogen (TKN)	2012/02/23		99	%	85 - 115
	Spiked Blank	Total Kjeldahl Nitrogen (TKN)	2012/02/23		94	%	85 - 115
	Method Blank	Total Kjeldahl Nitrogen (TKN)	2012/02/23	ND, RDL=0.1		mg/L	
	RPD [MN9623-03]	Total Kjeldahl Nitrogen (TKN)	2012/02/23	3.1		%	20
2770314 ADA	Matrix Spike	Total Aluminum (Al)	2012/02/22		103	%	80 - 120
		Total Antimony (Sb)	2012/02/22		104	%	80 - 120
		Total Arsenic (As)	2012/02/22		103	%	80 - 120
		Total Barium (Ba)	2012/02/22		102	%	80 - 120
		Total Beryllium (Be)	2012/02/22		102	%	80 - 120
		Total Bismuth (Bi)	2012/02/22		103	%	80 - 120
		Total Boron (B)	2012/02/22		99	%	80 - 120
		Total Cadmium (Cd)	2012/02/22		102	%	80 - 120
		Total Calcium (Ca)	2012/02/22		NC	%	80 - 120
		Total Chromium (Cr)	2012/02/22		102	%	80 - 120
		Total Cobalt (Co)	2012/02/22		101	%	80 - 120
		Total Copper (Cu)	2012/02/22		NC	%	80 - 120
		Total Iron (Fe)	2012/02/22		106	%	80 - 120
		Total Lead (Pb)	2012/02/22		102	%	80 - 120
		Total Lithium (Li)	2012/02/22		103	%	80 - 120
		Total Magnesium (Mg)	2012/02/22		NC	%	80 - 120
		Total Manganese (Mn)	2012/02/22		101	%	80 - 120
		Total Molybdenum (Mo)	2012/02/22		107	%	80 - 120
		Total Nickel (Ni)	2012/02/22		101	%	80 - 120
		Total Potassium (K)	2012/02/22		104	%	80 - 120
		Total Silicon (Si)	2012/02/22		101	%	80 - 120

Quality Assurance Report (Continued)

Maxxam Job Number: WB222699

QA/QC Batch Num	Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2770314	ADA	Matrix Spike	Total Selenium (Se)	2012/02/22		101	%	80 - 120
			Total Silver (Ag)	2012/02/22		101	%	80 - 120
			Total Sodium (Na)	2012/02/22		101	%	80 - 120
			Total Strontium (Sr)	2012/02/22		NC	%	80 - 120
			Total Tellurium (Te)	2012/02/22		101	%	80 - 120
			Total Thallium (Tl)	2012/02/22		102	%	80 - 120
			Total Tin (Sn)	2012/02/22		104	%	80 - 120
			Total Titanium (Ti)	2012/02/22		110	%	80 - 120
			Total Tungsten (W)	2012/02/22		108	%	80 - 120
			Total Uranium (U)	2012/02/22		104	%	80 - 120
			Total Vanadium (V)	2012/02/22		105	%	80 - 120
			Total Zinc (Zn)	2012/02/22		102	%	80 - 120
			Total Zirconium (Zr)	2012/02/22		108	%	80 - 120
		Spiked Blank	Total Aluminum (Al)	2012/02/22		105	%	80 - 120
			Total Antimony (Sb)	2012/02/22		107	%	80 - 120
			Total Arsenic (As)	2012/02/22		103	%	80 - 120
			Total Barium (Ba)	2012/02/22		105	%	80 - 120
			Total Beryllium (Be)	2012/02/22		105	%	80 - 120
			Total Bismuth (Bi)	2012/02/22		104	%	80 - 120
			Total Boron (B)	2012/02/22		101	%	80 - 120
			Total Cadmium (Cd)	2012/02/22		105	%	80 - 120
			Total Calcium (Ca)	2012/02/22		103	%	80 - 120
			Total Chromium (Cr)	2012/02/22		104	%	80 - 120
			Total Cobalt (Co)	2012/02/22		103	%	80 - 120
			Total Copper (Cu)	2012/02/22		104	%	80 - 120
			Total Iron (Fe)	2012/02/22		108	%	80 - 120
			Total Lead (Pb)	2012/02/22		104	%	80 - 120
			Total Lithium (Li)	2012/02/22		104	%	80 - 120
			Total Magnesium (Mg)	2012/02/22		106	%	80 - 120
			Total Manganese (Mn)	2012/02/22		104	%	80 - 120
			Total Molybdenum (Mo)	2012/02/22		105	%	80 - 120
			Total Nickel (Ni)	2012/02/22		103	%	80 - 120
			Total Potassium (K)	2012/02/22		103	%	80 - 120
			Total Silicon (Si)	2012/02/22		104	%	80 - 120
			Total Selenium (Se)	2012/02/22		103	%	80 - 120
			Total Silver (Ag)	2012/02/22		102	%	80 - 120
			Total Sodium (Na)	2012/02/22		103	%	80 - 120
			Total Strontium (Sr)	2012/02/22		103	%	80 - 120
			Total Tellurium (Te)	2012/02/22		105	%	80 - 120
			Total Thallium (Tl)	2012/02/22		101	%	80 - 120
			Total Tin (Sn)	2012/02/22		107	%	80 - 120
			Total Titanium (Ti)	2012/02/22		108	%	80 - 120
			Total Tungsten (W)	2012/02/22		107	%	80 - 120
			Total Uranium (U)	2012/02/22		105	%	80 - 120
			Total Vanadium (V)	2012/02/22		105	%	80 - 120
			Total Zinc (Zn)	2012/02/22		105	%	80 - 120
			Total Zirconium (Zr)	2012/02/22		108	%	80 - 120
		Method Blank	Total Aluminum (Al)	2012/02/22	0.0085, RDL=0.0050		mg/L	
			Total Antimony (Sb)	2012/02/22	ND, RDL=0.00050		mg/L	
			Total Arsenic (As)	2012/02/22	ND, RDL=0.0010		mg/L	
			Total Barium (Ba)	2012/02/22	ND, RDL=0.0020		mg/L	
			Total Beryllium (Be)	2012/02/22	ND, RDL=0.00050		mg/L	
			Total Bismuth (Bi)	2012/02/22	ND, RDL=0.0010		mg/L	
			Total Boron (B)	2012/02/22	ND, RDL=0.010		mg/L	
			Total Cadmium (Cd)	2012/02/22	ND, RDL=0.00010		mg/L	

Quality Assurance Report (Continued)

Maxxam Job Number: WB222699

QA/QC Batch Num	Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2770314	ADA	Method Blank	Total Calcium (Ca)	2012/02/22	ND, RDL=0.20		mg/L	
			Total Chromium (Cr)	2012/02/22	ND, RDL=0.0050		mg/L	
			Total Cobalt (Co)	2012/02/22	ND, RDL=0.00050		mg/L	
			Total Copper (Cu)	2012/02/22	ND, RDL=0.0010		mg/L	
			Total Iron (Fe)	2012/02/22	ND, RDL=0.10		mg/L	
			Total Lead (Pb)	2012/02/22	ND, RDL=0.00050		mg/L	
			Total Lithium (Li)	2012/02/22	ND, RDL=0.0050		mg/L	
			Total Magnesium (Mg)	2012/02/22	ND, RDL=0.050		mg/L	
			Total Manganese (Mn)	2012/02/22	ND, RDL=0.0020		mg/L	
			Total Molybdenum (Mo)	2012/02/22	ND, RDL=0.00050		mg/L	
			Total Nickel (Ni)	2012/02/22	ND, RDL=0.0010		mg/L	
			Total Potassium (K)	2012/02/22	ND, RDL=0.20		mg/L	
			Total Silicon (Si)	2012/02/22	ND, RDL=0.050		mg/L	
			Total Selenium (Se)	2012/02/22	ND, RDL=0.0020		mg/L	
			Total Silver (Ag)	2012/02/22	ND, RDL=0.00010		mg/L	
			Total Sodium (Na)	2012/02/22	ND, RDL=0.10		mg/L	
			Total Strontium (Sr)	2012/02/22	ND, RDL=0.0010		mg/L	
			Total Tellurium (Te)	2012/02/22	ND, RDL=0.0010		mg/L	
			Total Thallium (Tl)	2012/02/22	ND, RDL=0.000050		mg/L	
			Total Tin (Sn)	2012/02/22	ND, RDL=0.0010		mg/L	
			Total Titanium (Ti)	2012/02/22	ND, RDL=0.0050		mg/L	
			Total Tungsten (W)	2012/02/22	ND, RDL=0.0010		mg/L	
			Total Uranium (U)	2012/02/22	ND, RDL=0.00010		mg/L	
			Total Vanadium (V)	2012/02/22	ND, RDL=0.00050		mg/L	
			Total Zinc (Zn)	2012/02/22	ND, RDL=0.0050		mg/L	
			Total Zirconium (Zr)	2012/02/22	ND, RDL=0.0010		mg/L	
		RPD	Total Aluminum (Al)	2012/02/22	NC		%	20
			Total Antimony (Sb)	2012/02/22	NC		%	20
			Total Arsenic (As)	2012/02/22	NC		%	20
			Total Barium (Ba)	2012/02/22	4.4		%	20
			Total Beryllium (Be)	2012/02/22	NC		%	20
			Total Bismuth (Bi)	2012/02/22	NC		%	20
			Total Boron (B)	2012/02/22	0.2		%	20
			Total Cadmium (Cd)	2012/02/22	NC		%	20
			Total Calcium (Ca)	2012/02/22	5.1		%	20
			Total Chromium (Cr)	2012/02/22	NC		%	20
			Total Cobalt (Co)	2012/02/22	NC		%	20
			Total Copper (Cu)	2012/02/22	4.1		%	20
			Total Iron (Fe)	2012/02/22	NC		%	20
			Total Lead (Pb)	2012/02/22	NC		%	20
			Total Lithium (Li)	2012/02/22	NC		%	20
			Total Magnesium (Mg)	2012/02/22	3.4		%	20
			Total Manganese (Mn)	2012/02/22	NC		%	20
			Total Molybdenum (Mo)	2012/02/22	NC		%	20
			Total Nickel (Ni)	2012/02/22	5.3		%	20
			Total Potassium (K)	2012/02/22	3.4		%	20
			Total Silicon (Si)	2012/02/22	3.4		%	20
			Total Selenium (Se)	2012/02/22	NC		%	20
			Total Silver (Ag)	2012/02/22	NC		%	20
			Total Sodium (Na)	2012/02/22	4.2		%	20
			Total Strontium (Sr)	2012/02/22	1.6		%	20
			Total Tellurium (Te)	2012/02/22	NC		%	20
			Total Thallium (Tl)	2012/02/22	NC		%	20
			Total Tin (Sn)	2012/02/22	NC		%	20
			Total Titanium (Ti)	2012/02/22	NC		%	20

Quality Assurance Report (Continued)

Maxxam Job Number: WB222699

QA/QC Batch Num	Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
2770314	ADA	RPD	Total Tungsten (W)	2012/02/22	NC		%	20
			Total Uranium (U)	2012/02/22	5.4		%	20
			Total Vanadium (V)	2012/02/22	NC		%	20
			Total Zinc (Zn)	2012/02/22	NC		%	20
			Total Zirconium (Zr)	2012/02/22	NC		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Validation Signature Page

Maxxam Job #: B222699

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

ADAM ROBINSON, Technical Service

BRAD NEWMAN, Scientific Specialist

FLOYD MAYEDE, Senior Analyst

JEEVARAJ JEEVARATRNAM, Senior Analyst

MAMDOUH SALIB, Analyst, Hydrocarbons

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Evaluation of Three Hydraulic Barriers in Southern Ontario

Prepared for: James Dick Construction Ltd.
February, 2001
File: 9603

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Our File: 9603

March 8, 2001

James Dick Construction Ltd.
Box 470
Bolton, Ontario
L7E 5T4

Attention: Mr. Gregory Sweetnam
Property Manager

Dear Mr. Sweetnam,

Re: Barrier Performance Report

We are pleased to present our evaluation of groundwater barriers installed at two sand and gravel pits in Southern Ontario. The barriers are effective in protecting adjacent surface water features.

Sincerely,

Stan Denhoed, M.Sc., P.Eng.

Introduction

Hydraulic barriers are becoming common features on site plans for aggregate extraction operations. Barriers are features designed to protect groundwater sensitive areas such as wetlands or fisheries. A hydraulic barrier is typically constructed by removing natural geologic material (e.g. sand and gravel) that has a relatively high hydraulic conductivity, and replacing it with geologic materials (e.g. silt or clay) that has a relatively low hydraulic conductivity.

This barrier performance report is an evaluation of the effectiveness of three such hydraulic barriers in southern Ontario. The purpose of the barriers installed at Heritage Lake Pit is to protect Mill Creek and MacCrimmon Creek from hydrogeological impact due to pit operations (Figure 1). The barrier installed at Caledon Sand and Gravel Pit is intended to maintain pre-extraction groundwater levels around Warnock Lake (Figure 2).

Site Descriptions

Heritage Lake Pit

Located in Puslinch Township the site occupies approximately 33 hectare. The site is licensed for a maximum extraction of 500,000 tonnes/year. When removed from below the water table, this volume of material translates into an equivalent water displacement of 6 L/s (98 gal/min). The predominant overburden material is an outwash gravel deposit with a hydraulic conductivity of approximately 10^{-3} m/s. Beneath the sand and gravel deposits lies Wentworth Till, a sandy, stony, silt till. The Wentworth Till overlies the porous, fine-grained dolostone bedrock of the Guelph Formation. Although the till is an effective aquitard, it is not continuous over the entire site. The barriers are necessary during active extraction to minimize impacts to Mill Creek and MacCrimmon Creek the located at distances of 120 m and 650 m, respectively. Post extraction, the influence of the barriers on groundwater flow will be evaluated and the barrier configuration altered if necessary.

Caledon Sand and Gravel Pit

Caledon Sand and Gravel extracts material from the Caledon Meltwater Channel and from the Paris Moraine. Sand and gravel are the dominant materials ranging in hydraulic conductivities from 10^{-2} to 10^{-4} m/s. Relatively continuous lenses of till underlie the sand and gravel. Regionally, the thickness of the overburden ranges from 20 to 75 m overtop of dolostone bedrock of the Manitoulin Formation. The barrier is required post-extraction to address the potential of causing additional water loss from Warnock Lake.

Barrier Construction

Heritage Lake Pit

Construction of the barrier walls was carried out in the period of 24 August to 26 September 1998. The barriers are located between the extractive operations and both Mill Creek and MacCrimmon Creek. The barriers, constructed of a mixture of bentonite, on-site granular material and silt pond fines, were installed to a depth ranging from 2 m to 14 m, concluding 0.5 m into a low permeability soil stratum. During construction, samples of the barrier were taken and testing indicated a hydraulic conductivity of 1.8×10^{-8} cm/s. The barrier locations are shown in Figure 1. The East-West barrier is approximately 750 m long and the North-South barrier is approximately 400 m long.

Caledon Sand and Gravel

Construction of the barrier wall commenced in the Spring of and was 95% completed by October 2000. The barrier is situated between pit operations and Warnock Lake. The core of the barrier is constructed with silt and granular material from on site washing operations. The base of the barrier is 11 m wide, and terminates in natural till. The hydraulic conductivity of the barrier is estimated to be 10^{-8} cm/s. The barrier location is shown on Figure 2. The barrier is approximately 750 m long. A cross-section of the barrier is illustrated in Figure 3.

Barrier Performance Evaluation

The performance of the barrier walls is based on their ability to maintain a greater hydraulic head gradient across the barrier compared to pre-barrier conditions.

Heritage Lake Pit

The hydraulic head distribution across the North-South Barrier on April 24, July 31 and October 11, 2000, is shown in Figure 4. The hydraulic gradient across the barrier is greater than occurred in the natural sand and gravel and water level fluctuations on the MacCrimmon Creek side of the barrier are small relative to the extraction side. A comparison of seasonal water levels before and after barrier installation suggests that groundwater levels continue to fluctuate within pre-barrier limits on the MacCrimmon Creek side of the barrier. The hydraulic head values for the East-West Barrier on September 29 and October 11, 2000, are shown in Figure 5. Water levels on the Mill Creek side of the barrier appear unaffected, despite a lowering of the water levels in the extraction area.

Caledon Sand and Gravel

The hydraulic head distribution across the barrier on May 19, June 28, and November 29, 2000 is illustrated in Figure 6. The dashed lines in this figure show the hydraulic gradient before the barrier was installed, on May 23, 1996 and August 20, 1997. Before the barrier was installed a small hydraulic gradient was present from 98-2 to 94-2. The available data shows that the seasonal changes in Warnock Lake water levels occur, and remain comparable to historical levels.

Conclusions

The hydraulic barriers installed at Heritage Lake Pit and Caledon Sand and Gravel are effective in maintaining hydraulic separation between pit operations and the groundwater system outside of the barriers. It is found that properly designed and constructed hydraulic barriers are providing adequate protection to the streams and wetlands at the Heritage Lake Pit and the Caledon Sand and Gravel sites.

Stan Denhoed, P.Eng, M.Sc.
Principal

Dru Heagle, M.Sc.
Hydrogeologist

References

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England Naylor Engineering Ltd., 1994. Hydrological Investigation Proposed Heritage Lake Residential Subdivision Part of Lots 23, 24, 25, Concession 2, Puslinch Township. Reference No. 0402G1.R01.

Harden Environmental Services Ltd., 2000. Caledon Sand and Gravel 1998/1999 Monitoring Report. File 9401.

MacNaughton, Hermsen, Britton, Clarkson Planning Ltd., 1996. Caledon Sand and Gravel Site Plan, 1996.

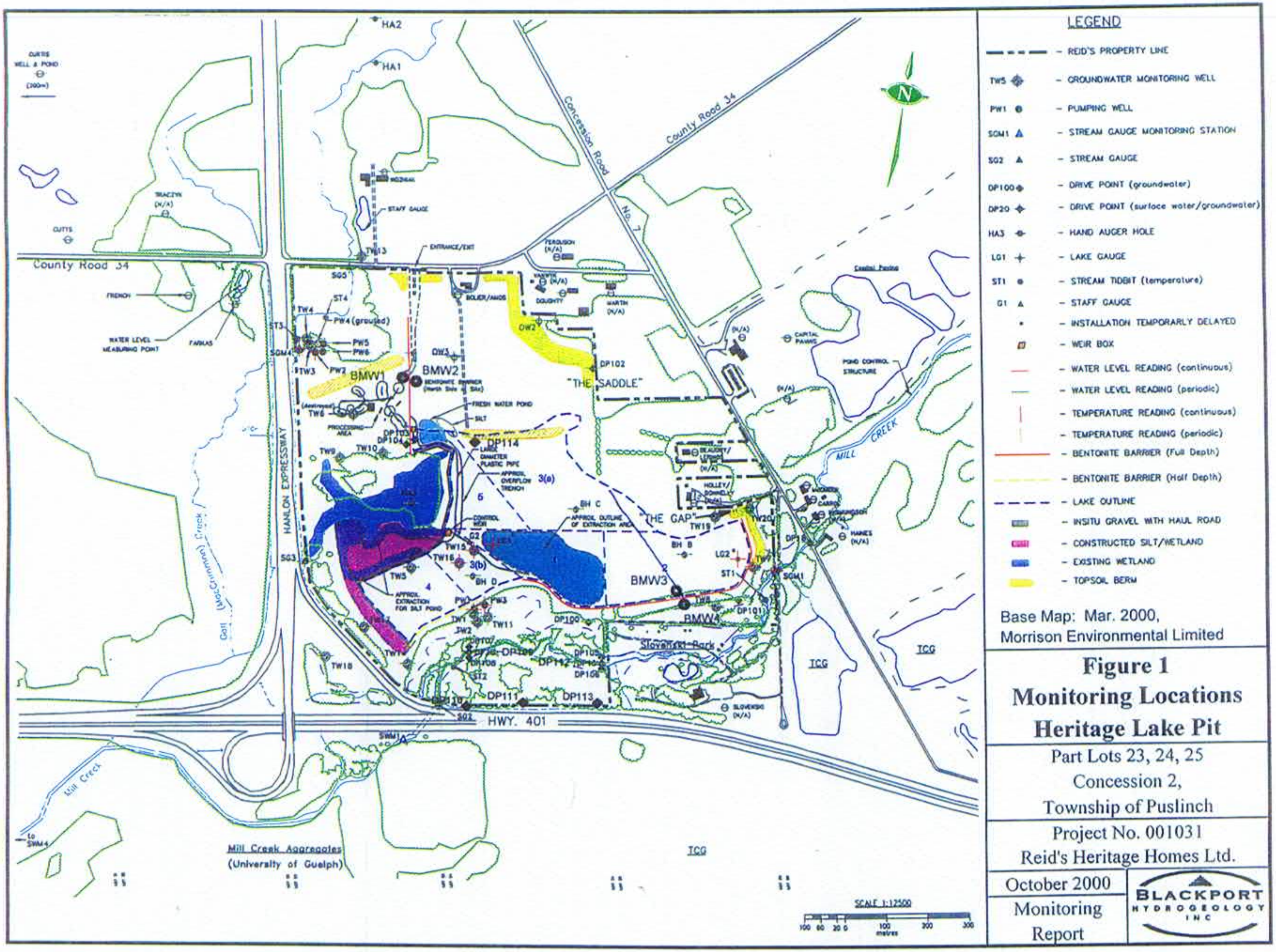


Figure 1. Barrier and Monitoring Well Locations, Heritage Lake Pit. Source: Blackport Hydrogeology Inc., 2000.

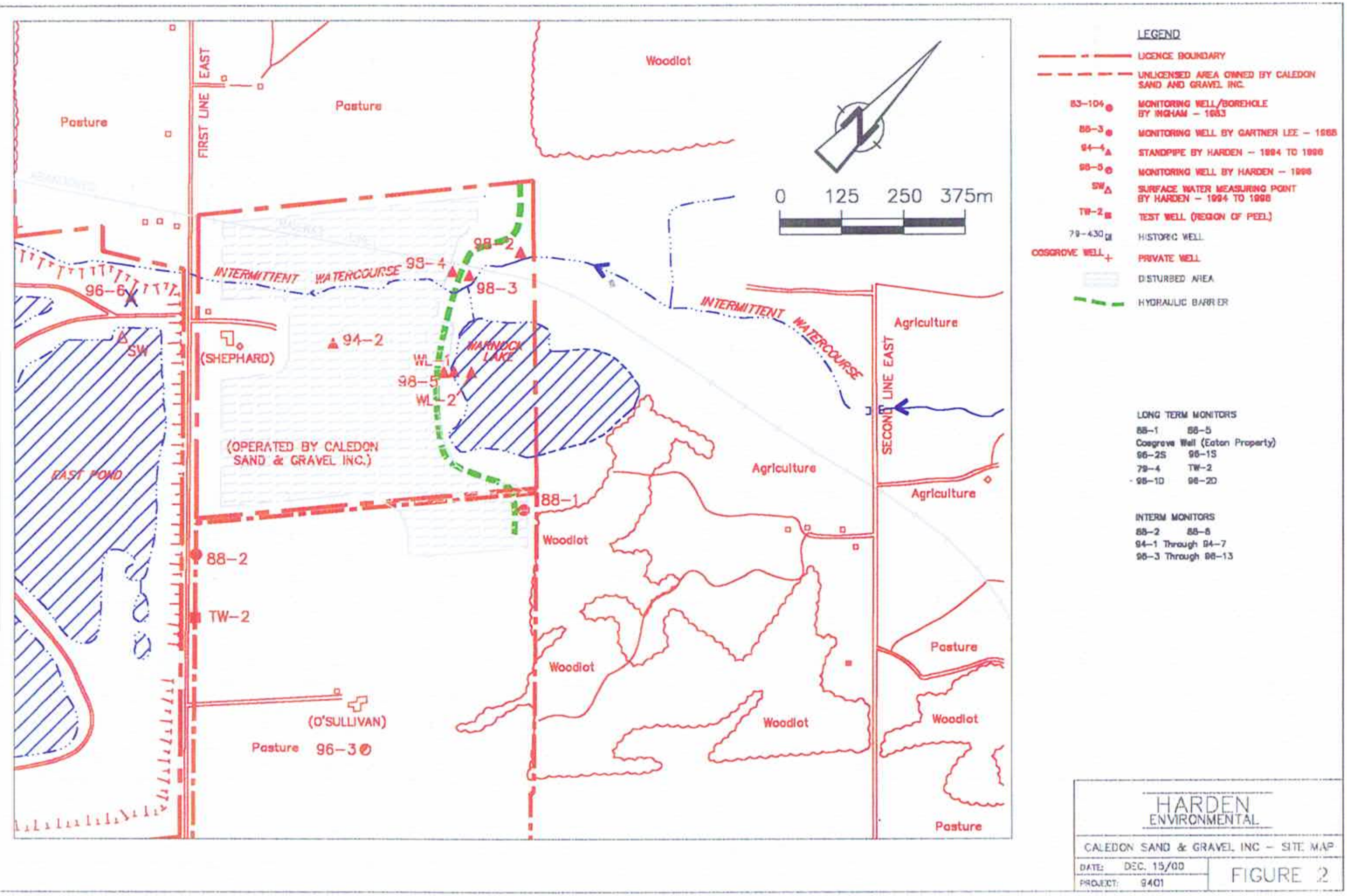
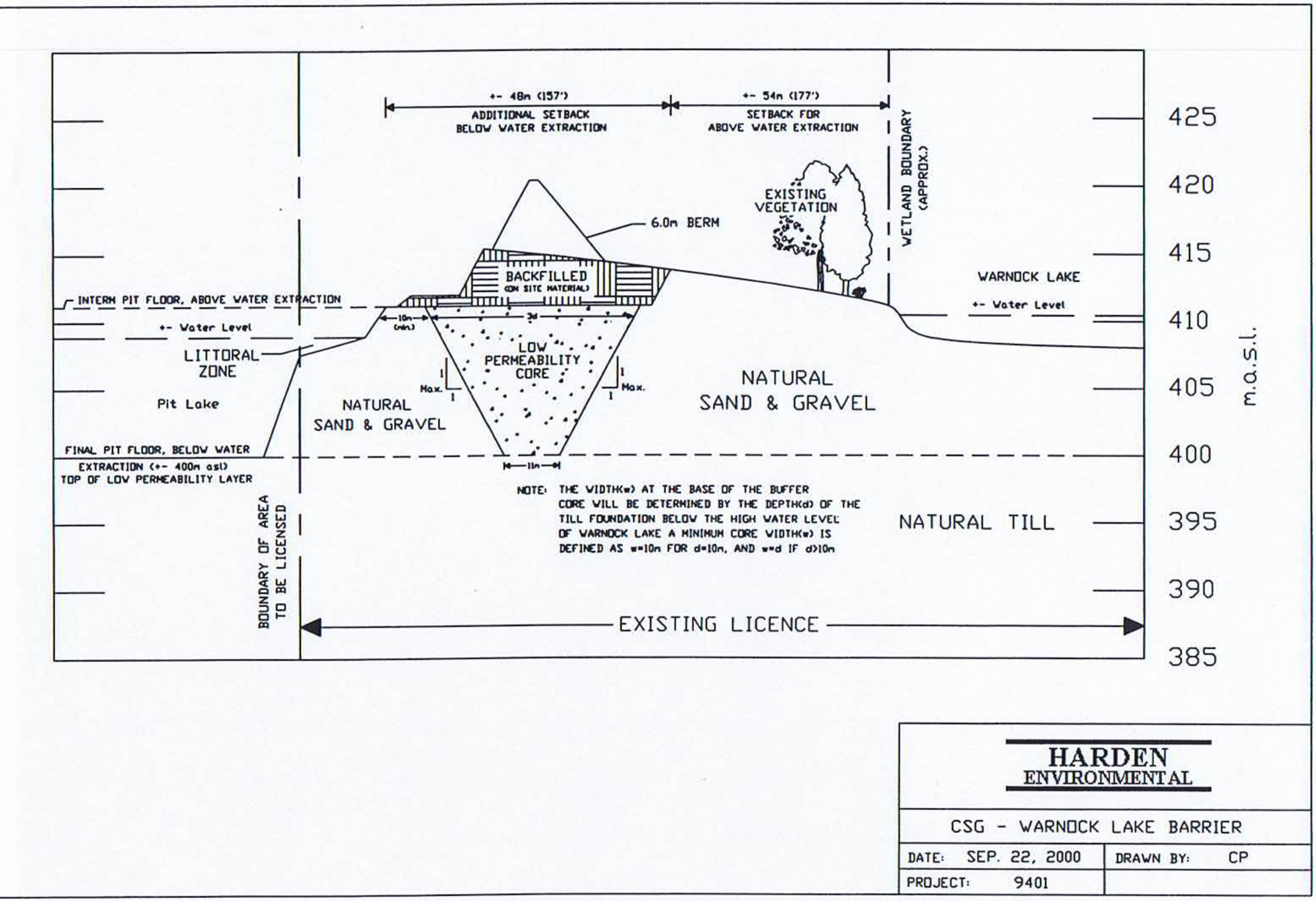


Figure 2. Barrier and Monitroing Well Locations, Caledon Sand & Gravel



gure 3. Warnock Lake Hydraulic Barrier Cross-Section

Source: MacNaughton, Hermsen, Britton, Clarkson Planning Ltd., 1996.

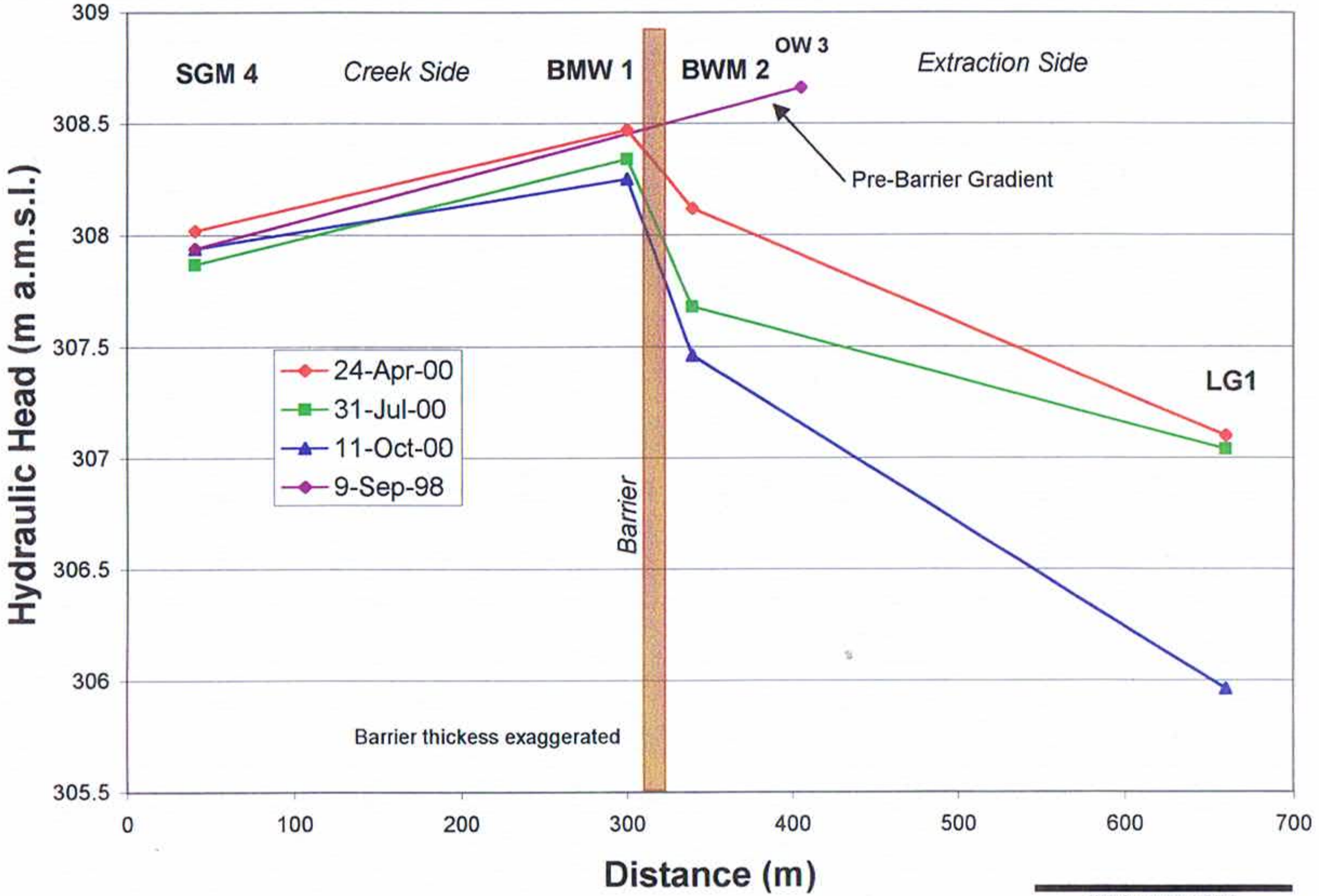


Figure 4. Hydraulic Head Values Across North-South Barrier Heritage Lake Pit

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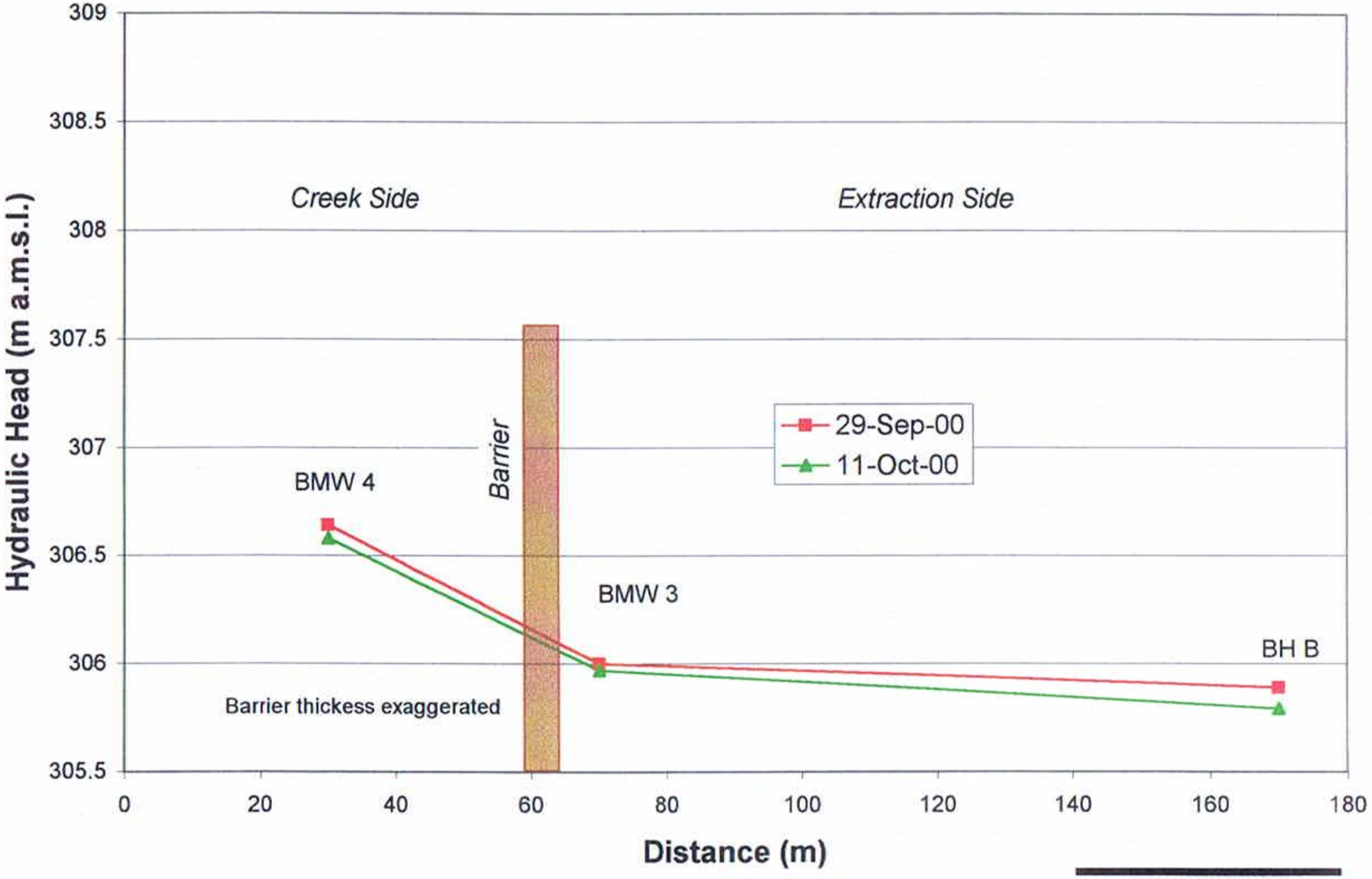

Figure 5. Hydraulic Head Values Across East-West Barrier Heritage Lake Pit

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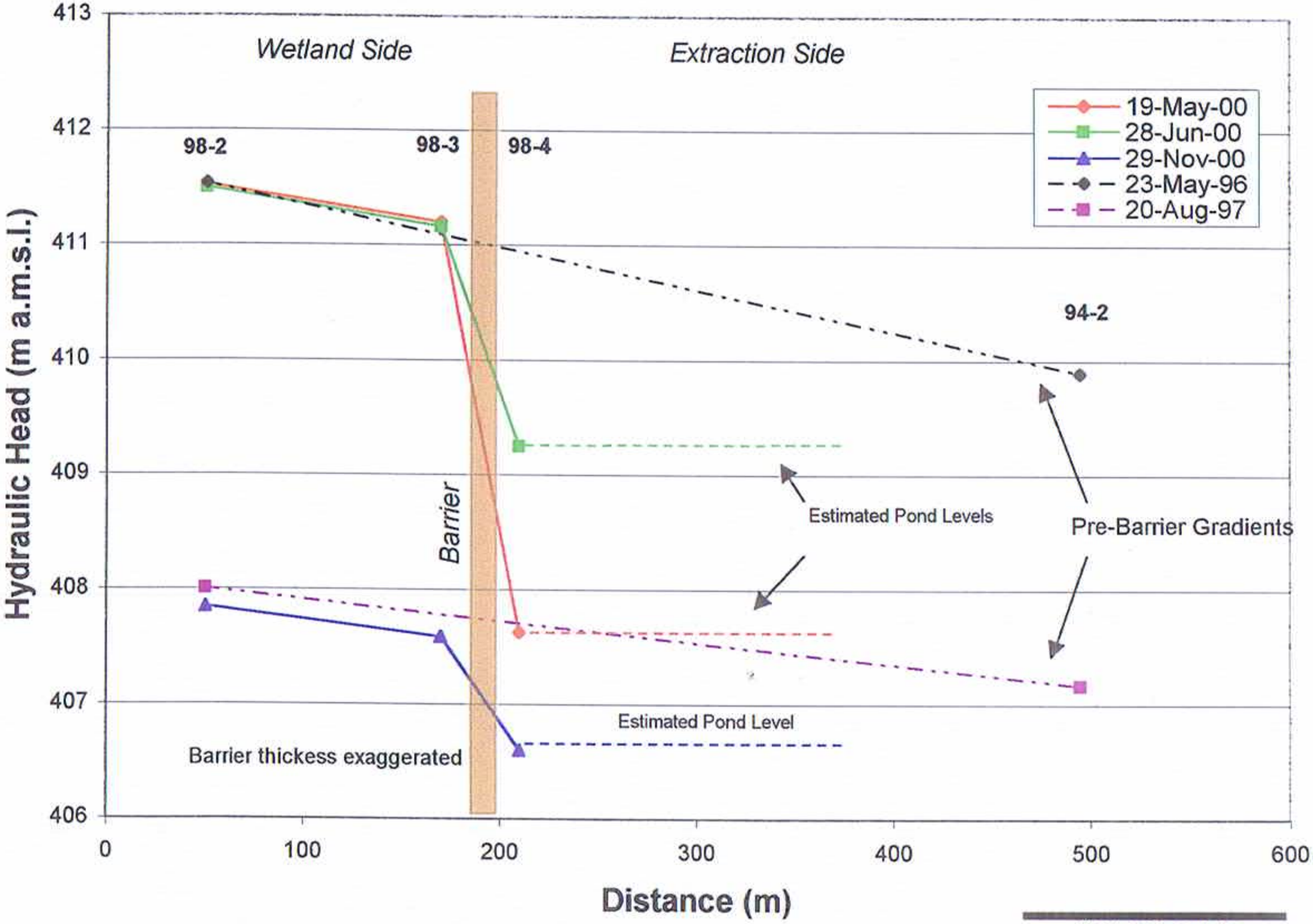

Figure 6. Hydraulic Gradients Across Warnock Lake Barrier Caledon Sand and Gravel

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Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

December 9, 2014

R.J. Burnside and Associates Limited
292 Speedvale Avenue West, Unit 20
Guelph, Ontario, N1H 1C4

Attention: Mr. David Hopkins, P.Geo.
Senior Hydrogeologist

Dear Mr. Hopkins:

Re: Hidden Quarry
Burnside Letter of October 6, 2014
Burnside Project No.: 300032475.0000

Thank you for your October 6, 2014 letter responding to the Harden Environmental Services Ltd. (Harden) letter dated June 10, 2014 regarding the proposed Hidden Quarry Site.

We offer the following supporting comments and analysis by section heading for issues raised by R.J. Burnside and Associates Limited (Burnside).

2.1 Groundwater Elevations Multi-Level M15

Figure 1 is a summary of the water levels obtained since May 2014. The relationship between the three deeper intervals (M15-I, II and III) remain the same throughout the summer and into the fall. The hydraulic relationship between the shallowest interval (M15-IV) and the deeper intervals changes from one of downward gradients in the spring to upward gradients in the fall. This change in relationship shows that the hydraulic seal installed effectively isolates M15-IV from the lower intervals and that on a local scale, M15-IV behaves somewhat differently than the lower intervals, although the general trend in water levels is the same. Interval M15-II has a consistently lower hydraulic head than interval M15-III above and M15-I below resulting in both upward and downward hydraulic gradients within the Gasport Aquifer. This observation confirms hydraulic isolation between these intervals.

The difference in water levels in M15-III and M15-IV, representing intervals within the proposed depth of Hidden Quarry, ranges from 0.2 to 0.5 metres. Creating a hydraulic connection between these two intervals will not result in a significant water level change.

The other significant observation is that the water levels in the intervals respond similarly to seasonal change (i.e. highest in the spring and falling until fall). This suggests that each interval is influenced in a similar manner to the seasonal increase and decrease in recharge to the aquifer. This behavior shows that the various zones within the aquifer do not behave independently of regional influences and therefore can be considered to act as a continuum.

2.2 Hydraulic Testing in Multi-Level M15

Model Results

The estimated hydraulic conductivity of M15-II is 9.1 x 10^{-5} m/s as detailed in the June 10, 2014 letter from Harden Environmental to R. J. Burnside. The groundwater model used a hydraulic conductivity of 2 x 10^{-5} m/s for the entire aquifer (Harden, 2012). This is a five-fold difference with the hydraulic conductivity used in the groundwater model being less than that measured in M15-II. Burnside has questioned how a high hydraulic conductivity zone may influence predicted water levels off site by the groundwater model.

Transmissivity used in the model is related to hydraulic conductivity in the following way;

$T = kb*86,400$ (1)

where,

T = transmissivity (m^2/day)

k – hydraulic conductivity (m/s)

b –aquifer thickness (m)

The average thickness of the aquifer beneath the site is 41 metres resulting in an average transmissivity of 71 m^2/day. The impact of an aquifer with higher transmissivity was detailed in the Harden Environmental response to Burnside and Associates in the June 10, 2014 letter in Section 2.2 where the hydraulic properties of the aquifer are discussed. In that letter, the effective drawdown at the nearest residential well was estimated from transmissivities ranging from 75 m^2/day to 302,000 m^2/day (a range of hydraulic conductivity between 2 x 10^{-5} m/s and 8 x 10^{-2} m/s) and calculated to be between 1.8 and 2.2 metres. This clearly shows that there is a very narrow range of possible impact even over a range in hydraulic conductivity of three orders of magnitude. Therefore, it is our conclusion that the effect of a smaller portion of the aquifer having a hydraulic conductivity of 9.1 x 10^{-5} m/s compared to an average hydraulic conductivity of 2 x 10^{-5} m/s will not be significant.

A revised groundwater model was prepared in order to address this issue of a zone of higher permeability beneath the quarry. Unlike the original model which used a constant hydraulic conductivity for the bedrock, this re-evaluation a) used a ten metre zone of higher hydraulic conductivity at a depth of three metres below the bottom of the quarry and b) used a relatively low hydraulic conductivity for the lowest layer. This re-evaluation was based on measured hydraulic conductivities at M15.

The layers used in the groundwater model are shown conceptually on Figure 2. There are four model layers representing a portion of the dolostone aquifer as follows;

Layer 1 – upper portion of the aquifer including full quarry depth

Layer 2 – portion of the upper aquifer between quarry and high conductivity layer

Layer 3 – portion of the aquifer with relatively greater hydraulic conductivity

Layer 4 – lower portion of the aquifer with relatively lower hydraulic conductivity

Two scenarios were tested as follows;

Scenario 1

The hydraulic conductivities as measured in M15 were used. The average of measured hydraulic conductivities for M15-IV and M15-II was used for the Model Layer 1 and Model Layer 2 hydraulic conductivity value. The average of hydraulic conductivities measured in M15-II and M15-I was used for Model Layer 3 hydraulic conductivity. A relatively low hydraulic conductivity value was used for Layer 4. A summary of values used is shown in Table 1.

Scenario 2

A significantly higher hydraulic conductivity was estimated for Layer 3 in order to assess the impact of such a zone on nearby wells.

Table 1: Summary of Model Results

Parameter	Layer 1 / Layer 2	Layer 3	Layer 4
Scenario 1			
Hydraulic Conductivity (m/s)	3.5 x 10^{-5}	8.6 x 10^{-5}	2.0x 10^{-6}
Recharge (mm/year)	352		
Maximum Drawdown at North End of Quarry (m)	2.5		
Maximum Water Level Increase at South end of Quarry (m)	2.6		
Influence at W3 (m)	1.2	1.2	
RMS Calibration Statistic	5.54		
Scenario 2			
Hydraulic Conductivity (m/s)	1.2 x 10^{-5}	2.3 x 10^{-4}	2.0 x 10^{-6}
Recharge (mm/year)	352		
Maximum Drawdown at North End of Quarry (m)	3.0		
Maximum Water Level Increase at South end of Quarry (m)	2.0		
Influence at W3 (m)	0.7	0.7	
RMS Calibration Statistic	4.94		

The water level change in private well W3 was predicted for each model scenario and it was found that;

a) for conditions presented in Scenario 1, the potential impact to private well W3 was less than predicted in the original model (Harden, 2012) and

b) where a zone of high hydraulic conductivity exists (Scenario 2), the impact to local wells will be less than originally predicted and less than estimated from Scenario 1.

The model results predict that the presence of a zone with greater permeability results in less impact to local wells than the scenario without a zone of greater permeability within the Gasport Aquifer. Therefore the predictions of water level change on nearby wells is conservatively high in the Harden 2012 report submitted with the quarry application.

Connectivity between M15-III and M15-IV

The water levels shown on Figure 1 confirm that the relationship changes seasonally and confirms that there is hydraulic separation between these intervals and that the integrity of the bentonite seals is intact.

The integrity of the bentonite seals was further investigated by manually pumping each interval (using a Waterra system) for ten minutes and observing water levels in the other intervals. This is far more stress to the system than monitoring other intervals during the slug-testing procedure as suggested by Burnside and Associates. The observations are as follows;

Table 2: Summary of Observations during Interval Pumping

Pumping Interval	**Response Measured in Observed Interval (m)**			
	M15-I	**M15-II**	**M15-III**	**M15-IV**
M15-II	0.00		0.00	0.00
M15-III	0.00	0.00		0.00
M15-IV	0.00	0.00	0.00	

There was no observed change in the water level of any other interval during or following the ten minute pumping period. These observations and those of the water level differences confirm seal integrity.

2.4 Water Quality in M15

See Section 4.1 of this letter report.

3.1 Guelph Limestone Quarry Water Quality Sampling

a) The active dewatering at the Guelph Limestone Quarry is necessary because the quarry floor is below the level of the Speed River and water from the overburden, the unconfined Guelph Formation, storm water runoff and groundwater from the underlying Gasport Aquifer flow into the quarry. The background water quality in the quarry ponds represents an averaged concentration from each of these sources as well as dry deposition from nearby highways, residential areas and industrial areas. Burnside noted correctly that the background nitrate value in the pond on the day of sampling is approximately 0.5 mg/L. The only nitrogen compound that increased in concentration following the blast was organic nitrogen. This is attributed to the increased turbidity in the water following the blast since explosives do not contain organic nitrogen. There was no increase in the concentration of ammonia, nitrate or nitrite in the pond water.

The first sample was obtained within minutes of the blast and therefore there is limited influence on water chemistry by dilution from other inputs to the quarry pond. There could be dilution from water in the quarry pond. However, there was no measured increase in concentration of nitrate, ammonia or nitrite. Therefore, there was no measurable loss of nitrogen from the explosives to the pond water.

b) The mass of nitrogen in a typical blast at the Hidden Quarry will be greater than a typical blast at the Guelph Limestone Quarry and this calculation was provided to Burnside in our letter of January 14, 2014. The volume of water at the Hidden Quarry will be significantly greater than at the Guelph Limestone Quarry considering that the depth of the Guelph Limestone Quarry is approximately four metres compared with the proposed twenty-three metre depth at the Hidden Quarry. The present volume of water in the Guelph Limestone Quarry is approximately 206,000 m^3 compared to the future 4.4 million cubic metres in the Hidden Quarry ponds (west side only). By the time the Hidden Quarry pond is 0.9 hectares in area, there will be more water in the Hidden Quarry pond than in the Guelph Limestone quarry pond. Therefore, there will be significantly more dilution available at the Hidden Quarry. Nonetheless, based on the measured concentrations of nitrogen compounds in the effluent from the Dufferin Milton Quarry, the James Dick Gamebridge Quarry and the Guelph Limestone Quarry there is no indication that nitrogen compounds in quarry pond water is an environmental or health concern.

3.2 Nitrogen Compounds in Groundwater and Surface Water

Table 7 (Harden, June 10, 2014) shows that the mass of nitrogen to be input to the future quarry pond on an annual basis is 1360 kg. The annual volume of water flowing into the future quarry pond and infiltrating is 370,146 m^3. The resulting nitrate concentration in water will be 3.67 mg/L.

3.3 Revised Nitrate Prediction

A detailed assessment of nitrate from explosives was presented in our January 14, 2014 letter to Burnside including the chemical formula for the combustion of an explosive. Based on our research into explosive use at quarries we concluded that nitrogen is not a chemical of concern, however, we provided some conservatively high estimates of the potential increase in nitrogen compounds arising from the use of explosives. The recent testing of water at Guelph Limestone refutes our findings and shows that our conservative prediction of nitrogen input to water from explosives far exceeded the measured. Our conclusion is that the method of explosive use at the Guelph Limestone quarry results in a very efficient explosion with the nitrogen in the explosives converting to nitrogen gas during the combustion event as should occur. Similar explosive handling procedures are proposed for the Hidden Quarry.

4.1 Current State of Local Water Supplies and Vulnerability of the Aquifer

Two baseline samples of water quality will be obtained as indicted in the proposed monitoring program. The samples will be obtained post approval of the quarry. The samples will be obtained during a period of relatively high water table and relatively low water table. The analysis included in the sampling event will be general chemistry, anions, metals, nutrients, coliform bacteria and e. coli.

As agreed in the meeting of October 21 2014, fifteen select private wells, nine on-site monitoring wells and five surface water samples were obtained in the weeks of November 3rd to November 11th (Figure 3). Private well W7 at 4958 6th Line Eramosa was not sampled because the well is inaccessible. Private well W20 at 4300 Highway 7 was not sampled because a new well was drilled a few days prior to the sampling event, at the time of sampling, this well was not connected to the house.

The results of private well sampling are provided in Table 3. Well Records (if available) for these wells are provided in Appendix A. Approximately 70% of the residents did not want to have their water quality results made public, therefore a three digit random number is used to identify all individual wells. The results of surface water sampling are summarized in Table 4. On-site monitoring well sampling is summarized in Table 5.

4.1.1 Private Well Sampling

The following general observations are made from the water sampling program;

1) Four of the fourteen wells (29%) have significant coliform bacteria concentrations. Letters were immediately emailed or hand delivered to those residents with recommendations to shock chlorinate their wells. The bacteria was present in both drilled wells with above-ground-casings as well as those in well-pits.

2) Every well exceeded aesthetic guidelines for hardness. This is expected in the dolostone aquifer. Six of the fourteen wells (43%) have water softeners to address the hardness issue.

3) The nitrate concentration in the private wells ranged from 6.74 mg/L to not-detected (ND).

4) The chloride concentration in two wells exceeded the aesthetic objective of 250 mg/L. This is attributed to road salting activities and highest concentrations occurred in wells obtaining water from the uppermost portion of the aquifer.

5) The iron concentration in three wells exceeded the aesthetic objective of 0.3 mg/L.

6) The sodium concentration in two wells exceeded the aesthetic objective of 200 mg/L and four wells exceed the 20 mg/L criteria for the medical officer of health notification.

7) Four of the fourteen residences have either a UV light or chlorination system installed.

8) Six wells exceed the 500 mg/L aesthetic objective for total dissolved solids (TDS). The elevated concentrations of TDS are caused by either iron, sulphate or chloride ions.

Individual letters were sent to the homeowners explaining their results. These results will be kept on file and upon approval of the quarry, another sample will be obtained from these wells during a high water level period (springtime) as well as two samples (springtime and fall) obtained from all remaining wells within 500 metres of the quarry.

Details of the water supply well are also summarized in Table 3.

4.1.2 Surface Water Quality

Water samples were obtained from surface water stations RS1 (Tributary .A), SW4, SW7, SW11 (Tributary C) and Brydson Spring. The results are summarized in Table 4. The following observations are made from the data;

1) The highest concentrations of coliform bacteria were found in Tributary B with 20,000 CFU/100ml found at SW4 and 50,000 CFU/100 ml found at SW7.

2) E.coli is present in all of the surface waters with highest concentrations found in Tributary B with 40 cfu/100ml found at SW4 and 20 cfu/100ml found at SW7.

3) The Provincial Water Quality Objective of 0.03 mg/L for zinc was exceeded at stations SW7 and Brydson Spring.

4) The Provincial Water Quality Objective of 0.01 mg/L for total phosphorous was exceeded at station SW11 (Trib.C).

5) The nitrate concentration in surface waters range from 6.02 mg/L to not-detected (ND).

6) The highest sodium and chloride concentrations are found in the Brydson Spring sample. This is a result of road salting of Highway 7.

4.1.3 On-site Monitoring Wells Groundwater Quality

Groundwater samples were obtained from M1D, M2, M3, M4, M13D, M15-I, M15-II, M15-III and M15-IV. Three well volumes were removed from each well prior to sampling. The wells were chlorinated approximately ten days prior to sampling and free-chlorine was not present in the monitoring well water when sampled.

The following observations are made from the data;

1) M15-IV is the only monitoring well with coliform bacteria. The sample contained a bacterial concentration of 14 cfu/100 ml.

2) Water obtained from M1D had a manganese concentration of 0.058 mg/L. This exceeds the Aesthetic Objective of 0.05 mg/L.

3) All wells exceeded the Aesthetic Objectives for Hardness and M1D exceeded the Aesthetic Objective for Total Dissolved Solids due to the presence of sodium and chloride from road salting activities.

4) Nitrate concentrations in the groundwater range from not detected (ND) to 3.99 mg/L. Nitrate occurred in all wells except M1D.

5) The chemistry of each interval in monitoring well M15 is distinct. This corroborates the findings of the hydraulic testing that there is not leakage between the test sections.

4.2 Recent Research and Susceptibility of Local Wells to Contamination

Two baseline samples of water quality will be obtained as indicted in the proposed monitoring program. The samples (other than the fifteen already obtained) will be obtained post approval of the quarry. The samples will be obtained during a period of relatively high water table and relatively low water table. The analysis included in the sampling event will be general chemistry, anions, metals, nutrients, coliform bacteria and e. coli.

4.3 Waterfowl Use of Hidden Quarry Pond

As requested previously by R. J. Burnside, bacteria, cryptosporidium and giardia are included in the sampling program. Appendix D of our June 10, 2014 submission addresses the potential for waterfowl from using the quarry pond. It is clearly stated that as designed, the quarry will not be favourable for heavy waterfowl use.

4.4 Water Quality Early Warning and Mitigation

James Dick Construction has agreed to a detailed well survey including;

- Surface condition of the well
- Depth of pump
- potential to deepen the well to an elevation below 327 m AMSL will be evaluated
- identification of repairs needed for the well
- Brief pumping test and
- Collection of water samples

James Dick Construction Ltd. has also agreed to install M16 and M17 upon approval of the quarry. These are shown on Figure 2, Figure 9 and Figure C1 in the June 10, 2014 letter from Harden Environmental to R.J. Burnside.

5.0 Local Well Survey

JDCL has agreed to update the local well survey. Water levels and water quality samples will be obtained from wells downgradient of the quarry. Retrofits of the well head(s) will be undertaken as suggested by R.J. Burnside and Associates.

7.0 Brydson Spring and Blue Springs Creek

JDCL has agreed to include the Brydson Spring in the background study and will include flow measurements and water quality testing.

Two flow measurements of the Brydson Spring were obtained on October 16th 2014. The average of the two flow measurements was 22.4 L/s (approximately 300 imperial gallons per minute). Flow in Tributary B was not occurring beneath Hwy 7 at the time of these measurements.

8.0 Rock Extraction Water Level Change Monitoring

JDCL has agreed to install M17 as shown on Figure 2 of the June 10, 2014 letter from Harden Environmental to R.J. Burnside.

A trigger level for M17 will be established prior to commencement of quarry activities. Trigger levels have also been established for groundwater monitors M1D, M2, M13D, M14D, M15 and M16.

8.1 Historic Low Water Level

In addition to the well survey a well construction drawing will be prepared for each well. A safety factor type rating will be developed and contingency plans for each well will be prepared.

8.2 Monitoring Plan Revisions

a) In their response Section 8.0, Burnside concurs with the use of M17 as a full quarry depth hole. M17 will be situated between the sinking cut and the nearest residences making it a useful and effective monitoring well for future water level changes. A trigger level for M17 will be established before quarrying activities commence.

   In response to comments from Halton Hills, two additional multi-level monitoring wells along Hwy 7 have been agreed to by JDCL. These are named M18 and M19 and are shown on Figure 4.

b) Water level monitoring of private wells will be conducted as part of the baseline data gathering prior to commencement of extractive activities. There are, or will be, dedicated groundwater monitors situated between the quarry and the nearest domestic wells upgradient and downgradient of the quarry. The dedicated monitors provide a superior opportunity to determine water level changes between the quarry and the domestic wells as they are not influenced by daily water taking by the homeowner. Also, every time a well is accessed there is the chance of introducing bacteria to the well or damaging the well. James Dick Construction Ltd. is agreeing to a trigger level in the quarry pond that is higher than any water level downgradient. Therefore, no water level downgradient can ever be impacted by the quarry. Water quality can be taken from the existing household system, however, we agree that retrofits of the nearest wells should occur to reduce the opportunity for surface-contamination of the well. The nature of these retrofits will be determined during the detailed domestic well survey.

Table 1 of the monitoring program (Appendix B) has been updated to include monitoring of upgradient wells (quantity) and downgradient wells (quality).

We concur that M16 through M19 will be constructed as soon as possible following quarry approval. There will be a minimum of two years data obtained prior to below-water-table extraction occurring.

c) We disagree that a rigorous domestic well monitoring program is necessary. The degree of water level change that can occur is small relative to the water available in each domestic well and it is unlikely that any well will be impacted by water level changes. Trigger levels have been established for the quarry pond and monitors along the northern edge of the quarry where water level changes are most likely to occur. Other than the temporary disturbance in the water table created by the sinking cut, water level changes will not occur until the southern half of the west pond is excavated. A well complaint system has been established and a detailed baseline survey will assess the likelihood of any issue related to the quarrying activities.

This said, the residents listed in Table 6 will be contacted for the opportunity to have water level monitoring conducted post approval;

Table 6: Post Approval Water Level Monitoring

Well Identifier	Owner Name	Address
W4	Witold Jaroszewski	4949 6th Line Eramosa
W5	Bob Girardi	4943 6th Line Eramosa
W8	Steinar Moy	4953 6th Line Eramosa
W9	Shirley Allen	4963 6th Line Eramosa

JDCL is also in agreement with post approval water quality monitoring (quarterly bacteriological sampling and annual nitrate sampling) of the residents listed in Table 7;

Table 7: Post Approval Quarterly Bacteriological and Annual Nitrate Sampling

Well Identifier	Owner Name	Address
W10	Dennis and Laurea Campbell	8540 Hwy 7
W11	Payman Akhavan-Tabassi	8554 Hwy 7
W16	Richard Owen	5134 Hwy 7
W17	System Fencing - President, Dwayne Job	14321 5th Line Nassagaweya
W18	Albert Poelstra	14297 5th Line Nassagaweya
W19	Ian Haslem	5036 Hwy 7
W20	Henrietta & Harry Reinders - HH Reinders Holdings Company Inc.	4300 Hwy 7
W21	Lori Monte	4264 Hwy 7
W22	David and Lisa Lewis	5198 Hwy 7
W23	Judith McDonald and William G. Clemens	4248 Hwy 7
W24	Markham Hill Farms	8470 Hwy 7

2.3 Trigger Levels for Sinking Cut

We recommend that the agreed to monitoring network be used to establish the level of disturbance to the water levels between the sinking cut and domestic wells. The proposed ball and tether system is designed to inform on-site workers that trigger levels may be breached if the water level falls below the established datum. The Township of Guelph Eramosa will be informed on a regular basis of water levels with comparison to the agreed upon trigger levels. There are established protocols should a trigger level be breached. The established trigger levels are very conservative in that an environmental impact or significant influence to a domestic well will not occur even if the trigger level is breached temporarily. However, the consequences of breaching a trigger level are serious for JDCL and therefore all efforts to avoid breaching trigger levels will be taken by the company.

3.0 Contingency Measures

a) Wording has been changed to “complete” from “conduct”.

b) If a trigger level is breached, James Dick Construction Ltd. agrees to limit below water table extraction or cease below water table extraction while contingency plans are enacted. Normal extractive activities can commence when the water level has risen above the trigger level. This change is made on the attached monitoring plan (Appendix B).

3.2 Water Quality

We agree that the wording is unclear however, there are many existing anthropogenic influences to water quality downstream from the quarry including Highway 7, Tributaries A, B and C, industrial development along Highway 7 including horse training facilities, farm fields etc.. The quarry will be one additional potential influence on the water quality for the five wells down gradient of the quarry. The on-site monitoring locations including M13D, M2, M17 (upgradient) M15 and M1 (cross gradient) and M18, M4, M19 and M16 (downgradient), SW4 upgradient and SW7 downgradient will effectively determine water quality changes occurring as a result of the quarry operations and provide adequate opportunity to address these changes should they pose any threat to human health.

We have reviewed the water quality data obtained for the Rockwood pumping wells, on-site monitors and the on-site rental well. It is our conclusion that the water quality can naturally or with existing anthropogenic inputs exceed on Ontario Drinking Water Quality Standards, Aesthetic Objectives or Operational Guidelines for the following parameters; iron, sodium, manganese, hardness, total dissolved solids, nitrate, organic nitrogen. There are other parameters such as sulphate, fluoride and alkalinity that approach or exceed 50% of the standard, operational objective or aesthetic objective. We therefore agree that baseline water quality testing should be conducted and that a minimum of two samples representing spring conditions and fall conditions be obtained. This sampling will become the baseline against which future water quality can be compared.

5.0 Annual Reporting and Interpretation

Agreed.

9.0 Additional Work

a) A detailed well survey will be conducted.

b) New wells M16, M17, M18 and M19 will be drilled on approval of the quarry and instrumented as necessary. The intended purpose of each of the wells is to be a surrogate water well for either water quality or water level testing. Therefore, completion in the same manner as M15 is not warranted. It has been agreed to install M18 and M19 as multi-level monitors.

c) The flow in Brydson Spring has been tested and reported herein and will be included in on-going monitoring.

d) Water quality samples will be obtained from on-site monitoring wells, Tributaries A, B and C, Brydson Spring and domestic wells during the baseline study required for domestic wells.

Respectfully submitted,
Harden Environmental Services Ltd.

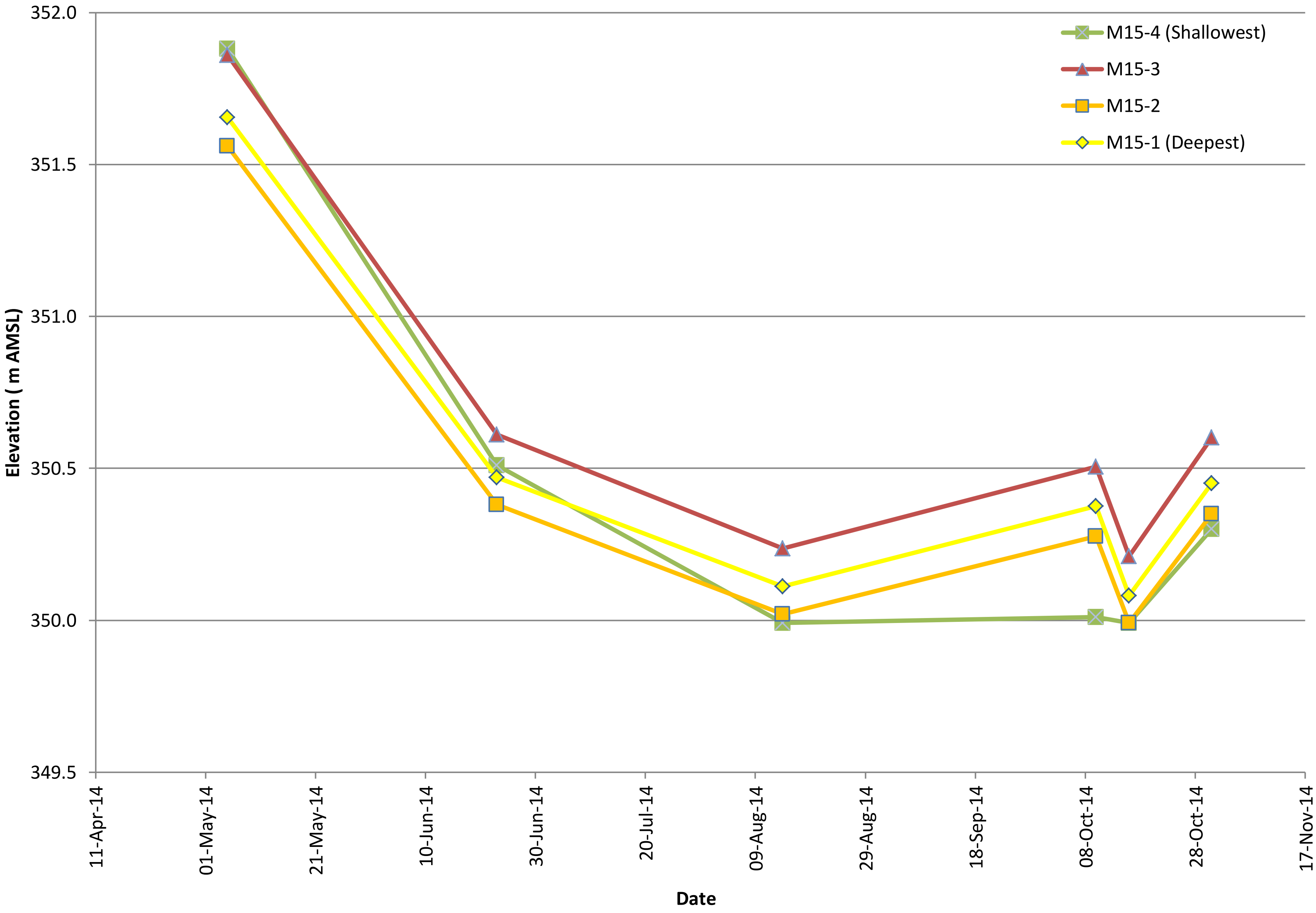
Stan Denhoed, M.Sc., P.Eng.
Senior Hydrogeologist

LICENSED PROFESSIONAL ENGINEER
S. E. DENHOED
Dec 9/14
PROVINCE OF ONTARIO

cc: Greg Sweetnam, James Dick Construction Limited

Figures

Water Levels in Multi-Level M15



Harden
Environmental
Services Ltd.

Project No: 9506

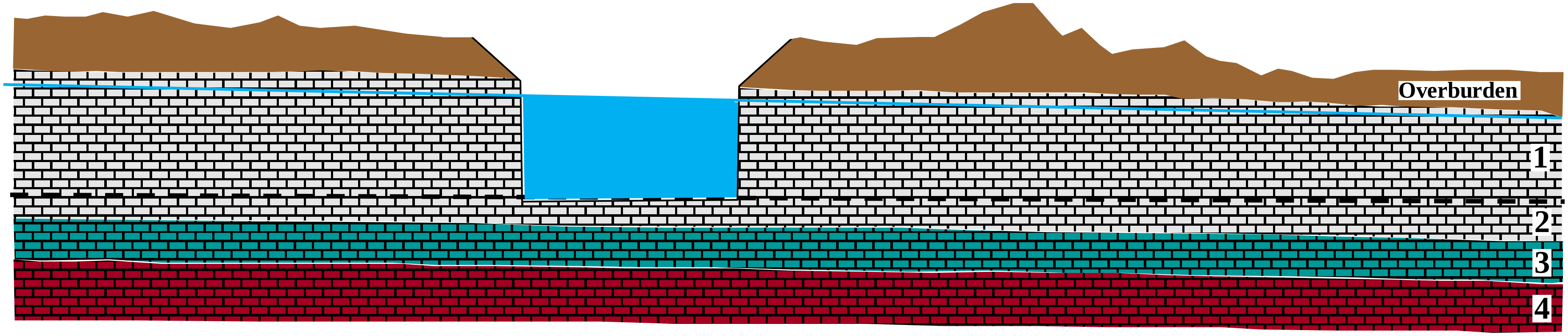
Date: Nov 2014

Drawn By: AR

Hidden Quarry Proposed Aggregate Extraction
Response to Burnside Letter of October 6, 2014

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 1: Water Levels in Multi-Level M15



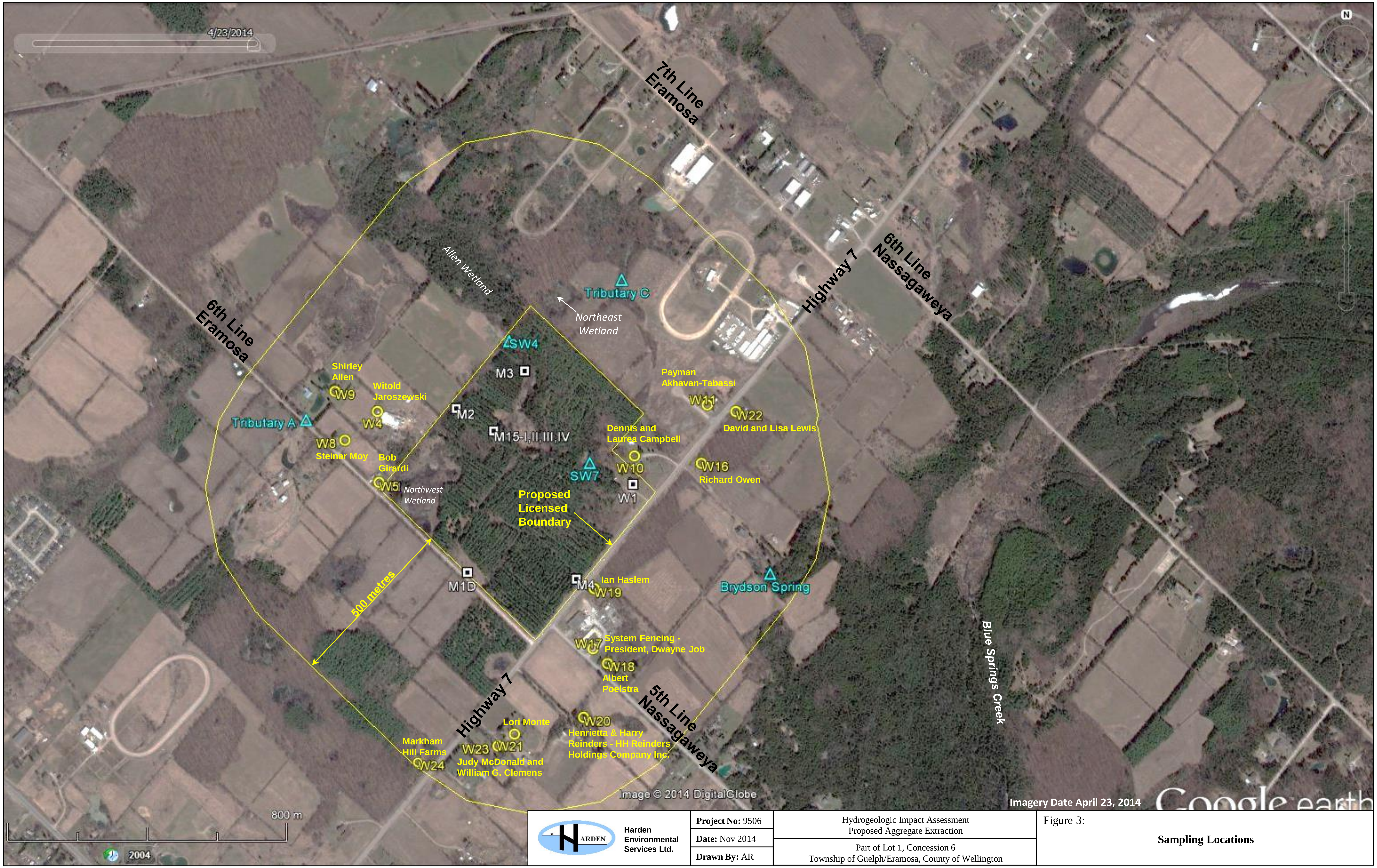
Layer 1 – upper portion of the aquifer to be removed during aggregate extraction

Layer 2 – portion of the upper aquifer to remain following aggregate extraction

Layer 3 – portion of the aquifer with relatively greater hydraulic conductivity

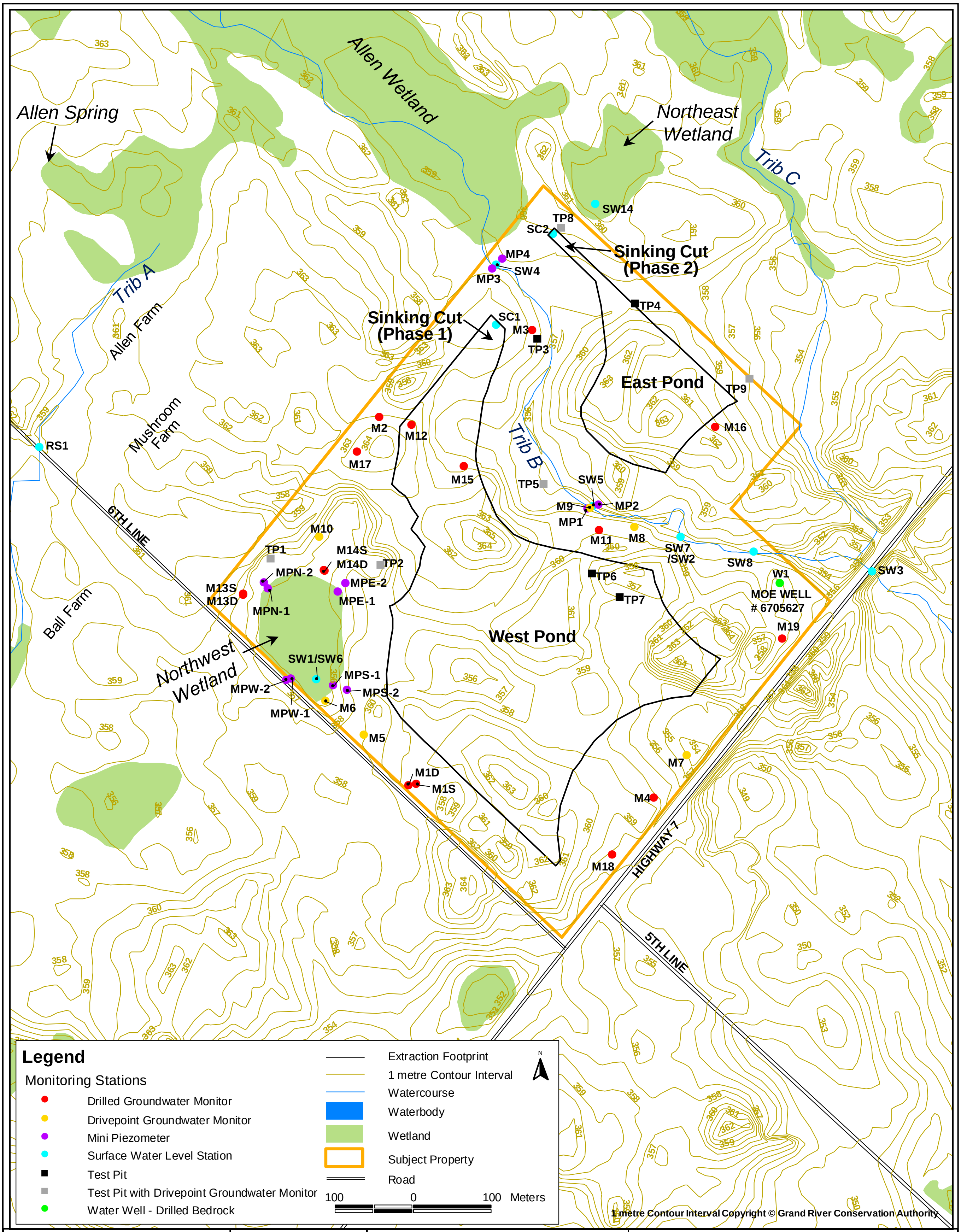
Layer 4 – lower portion of the aquifer with relatively lower hydraulic conductivity

Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Proposed Aggregate Extraction Response to Burnside Letter of October 6, 2014	**Figure 2: Groundwater Model Layers**
	Date: Nov 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.

Project No: 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	Figure 3:
Date: Nov 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Sampling Locations**
Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hidden Quarry Proposed Aggregate Extraction Response to Burnside Letter of October 6, 2014	**Figure 4:**
	Date: Nov 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Monitoring Locations**
	Drawn By: AR		

Tables

Table 3: Private Well Water Quality

RESULTS OF PRIVATE WELL SURVEY

Sample No.	Units	ODWS	IMC	A/O	125	Duplicate (125)	177	244	297	315	476	498
Sampling Date					2014/11/03 14:30	2014/11/03 14:30	2014/11/03 17:30	2014/11/04 12:15	2014/11/04 11:35	2014/11/04 17:30	2014/11/03 13:40	2014/11/03 12:30
Wellhead Condition					Pit with Concrete Lid	Pit with Concrete Lid	Buried	Unknown	Pit with Concrete Lid	Buried	Steel Casing	Pit with Concrete Lid
Observations					In well pit 1.73 metres below grade, well seal replaced November 2014, septic system upgradient	In well pit 1.73 metres below grade, well seal replaced November 2014, septic system upgradient	Buried in front garden area 3 feet from front of house	Well behind house. Concrete cover is very low to ground with grass all around.	In well pit approx 6 feet below grade inside concrete casing	West side of house buried beneath lawn or garden, owner reported 2 days of brown water and air in pipes Nov 6-8 2014 (first time event)	Steel casing with stick-up of 0.63 metres	Concrete lid is cracked
Pump Type					Submersible	Submersible	Submersible	unknown	unknown	Submersible	Submersible	Submersible
Well Depth (metres)					30.48	30.48	22.86	unknown	33.20	30.48	14.63	31.7
Recommended Pump Setting (metres)					21.34	21.34	15.24	unknown	unknown	24.38	14.02	15.24
Measured Static Water Level (metres)					12.41	12.41	inaccessible	access denied	4.18	inaccessible	7.71	inaccessible
Measured Static Water Level Date					01-Nov-11	01-Nov-11	inaccessible	access denied	29-Apr-98	inaccessible	10-Nov-11	inaccessible
Static Water Level from Well Record (metres)					13.11	13.11	10.67	unknown	unknown	13.72	8.23	9.14
Available Drawdown to Well Bottom (metres)					18.07	18.07	12.19	unknown	29.02	16.76	6.92	22.56
Available Drawdown to Recommended Pump Setting (metres)					8.93	8.93	4.57	unknown	unknown	10.66	6.31	6.1
Ground Elevation (m AMSL)					358.46	358.46	354.00	355.00	359.99	361.00	353.37	354.18
RESULTS OF FIELD MEASUREMENTS												
Field pH					7.25	7.25	7.04	7.1	7.01	7.09	7.05	7.12
Field Conductivity (µS/cm)					846	846	721	609	620	752	970	696
Field Temperature (°C)					10.1	10.1	10.7	13.4	10	10.2	9	11.1
Field TDS (mg/L)					422	422	360	301	311	377	486	
RESULTS OF BACTERIOLOGICAL ANALYSIS												
Total Coliform cfu/100 mL					30	30	0	0	0	0	3	0
E. coli cfu/100 mL					0	0	0	0	0	0	0	0
RESULTS OF ANALYSES OF WATER												
Maxxam ID					YI6863	YI6861	YI6847	YI6841	YI6756	YI6795	YI6796	YI6563
Sample No.	**Units**	**ODWS**	**IMC**	**A/O**	**125**	**Duplicate (125)**	**177**	**244**	**297**	**315**	**476**	**498**
Calculated Parameters												
Anion Sum	me/L	-		-	10.2	10.1	8.15	6.97	7.32	8.45	10.1	8.07
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-		-	220	220	270	270	290	280	320	260
Calculated TDS	mg/L	-		500	600	600	450	370	390	460	540	440
Carb. Alkalinity (calc. as CaCO3)	mg/L	-		-	1.5	1.5	1.8	1.8	1.6	1.8	2.0	1.8
Cation Sum	me/L	-		-	10.5	10.4	8.39	7.16	7.51	8.73	10.5	8.35
Hardness (CaCO3)	mg/L	-		80:100	510	500	380	340	350	400	380	390
Ion Balance (% Difference)	%	-		-	1.46	1.06	1.41	1.30	1.28	1.62	1.99	1.72
Langelier Index (@ 20C)	N/A	-		-	0.891	0.890	0.838	0.814	0.779	0.877	0.874	0.855
Langelier Index (@ 4C)	N/A	-		-	0.644	0.643	0.590	0.565	0.531	0.629	0.627	0.607
Saturation pH (@ 20C)	N/A	-		-	6.96	6.97	7.02	7.04	7.00	6.96	6.94	7.00
Saturation pH (@ 4C)	N/A	-		-	7.21	7.21	7.27	7.29	7.25	7.20	7.19	7.25

ODWS = Ontario Drinking Water Standard | A/O = Aesthetic Objective/Operational Guideline | IMC = Interim Maximum Acceptable Concentration | ND = Not detected

Table 3: Private Well Water Quality

RESULTS OF PRIVATE WELL SURVEY

Sample No.	Units	ODWS	IMC	A/O	125	Duplicate (125)	177	244	297	315	476	498
Sampling Date					2014/11/03 14:30	2014/11/03 14:30	2014/11/03 17:30	2014/11/04 12:15	2014/11/04 11:35	2014/11/04 17:30	2014/11/03 13:40	2014/11/03 12:30
Inorganics												
Total Ammonia-N	mg/L	-		-	ND	ND	ND	ND	ND	ND	ND	ND
Conductivity	umho/cm	-		-	890	930	790	660	690	800	1000	740
Total Kjeldahl Nitrogen (TKN)	mg/L	-		-	ND	ND	ND	ND	0.15	ND	0.12	ND
Dissolved Organic Carbon	mg/L	-		5	0.61	0.61	0.75	0.87	0.94	0.60	1.4	1.0
Orthophosphate (P)	mg/L	-		-	ND	ND	ND	ND	ND	ND	0.011	ND
pH	pH	-		6.5:8.5	7.85	7.86	7.85	7.85	7.78	7.83	7.82	7.85
Total Suspended Solids	mg/L	-		-	ND	ND	ND	ND	ND	ND	ND	ND
Dissolved Sulphate (SO4)	mg/L	-		500	260	260	82	28	28	69	23	99
Alkalinity (Total as CaCO3)	mg/L	-		30:500	230	230	270	270	290	290	320	270
Dissolved Chloride (Cl)	mg/L	-		250	7	7	34	20	23	44	110	21
Nitrite (N)	mg/L	**1**		-	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate (N)	mg/L	**10**		-	ND	ND	1.89	6.74	4.38	1.12	1.44	1.67
Nitrate + Nitrite	mg/L	**10**		-	ND	ND	1.89				1.44	1.67
Metals												
. Aluminum (Al)	mg/L	-	-	0.1	ND	ND	ND	ND	0.012	ND	ND	ND
. Antimony (Sb)	mg/L	-	0.006	-	ND	ND	ND	ND	ND	ND	ND	ND
. Arsenic (As)	mg/L	-	0.025	-	0.0034	0.0033	ND	ND	ND	ND	ND	ND
. Barium (Ba)	mg/L	**1**	-	-	0.030	0.029	0.068	0.039	0.042	0.052	0.042	0.071
. Beryllium (Be)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND
. Boron (B)	mg/L	-	5	-	0.014	0.017	ND	ND	0.012	0.014	0.013	ND
. Cadmium (Cd)	mg/L	**0.005**	-	-	ND	ND	ND	ND	0.00010	ND	ND	ND
. Calcium (Ca)	mg/L	-	-	-	150	150	100	94	95	110	110	110
. Chromium (Cr)	mg/L	**0.05**	-	-	ND	ND	ND	ND	ND	ND	ND	ND
. Cobalt (Co)	mg/L	-	-	-	ND	ND	ND	ND	ND	0.00050	ND	ND
. Copper (Cu)	mg/L	-	-	1	0.0061	0.0066	0.0066	0.0083	0.0046	0.0033	0.0088	0.020
. Iron (Fe)	mg/L	-	-	0.3	0.99	1.2	ND	ND	ND	ND	ND	ND
. Lead (Pb)	mg/L	**0.01**	-	-	0.00067	0.00080	ND	0.00072	ND	ND	ND	ND
. Magnesium (Mg)	mg/L	-	-	-	34	33	29	25	27	28	27	30
. Manganese (Mn)	mg/L	-	-	0.05	0.033	0.033	ND	ND	ND	0.0043	ND	ND
. Molybdenum (Mo)	mg/L	-	-	-	0.0017	0.0026	0.0013	0.0014	0.0017	0.0029	ND	0.0016
. Nickel (Ni)	mg/L	-	-	-	ND	ND	0.0011	0.0011	0.0012	0.0066	ND	0.0033
. Phosphorus (P)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND
. Potassium (K)	mg/L	-	-	-	0.90	0.88	2.5	1.8	2.5	0.99	1.6	3.0
. Selenium (Se)	mg/L	**0.01**	-	-	ND	ND	ND	ND	ND	ND	ND	ND
. Silicon (Si)	mg/L	-	-	-	4.3	4.4	3.5	3.5	3.8	4.5	4.0	3.5
. Silver (Ag)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND
. Sodium (Na)	mg/L	**20**	-	200	5.3	5.2	18	7.0	10	19	**67**	9.2
. Strontium (Sr)	mg/L	-	-	-	3.5	3.5	0.58	0.15	0.20	0.49	0.17	0.68
. Thallium (Tl)	mg/L	-	-	-	ND	ND	ND	ND	ND	0.000052	ND	ND
. Titanium (Ti)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND
. Uranium (U)	mg/L	**0.02**	-	-	0.00013	0.00016	0.00032	0.00024	0.00034	0.00047	0.00046	0.00039
. Vanadium (V)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND
. Zinc (Zn)	mg/L	-	-	5	0.018	0.020	0.067	0.28	0.078	0.076	0.034	0.056

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Table 3: Private Well Water Quality

RESULTS OF PRIVATE WELL SURVEY

Sample No.	Units	ODWS	IMC	A/O	501	516	532	688	812	858	991
Sampling Date					2014/11/04 11:05	2014/11/05 19:30	2014/11/04 17:05	2014/11/03 13:15	2014/11/05 10:55	2014/11/03 16:10	2014/11/03 14:10
Wellhead Condition					Steel Casing	Steel Casing	Steel Casing	Pit with Concrete Lid	Pit with Concrete Lid	Pit with Concrete Lid	Pit with Concrete Lid
Observations					Vermin ingress opportunity at electrical connection in well cap, vermin proof wellhead installed Dec 4 2014, stick-up 0.55 metres, bacteria sampled Nov 10 & 25, 2014	Well head in good shape, appropriate stick-up. Very little available drawdown.	Appropriate stick-up	Close to house on east side in well pit 9 feet below grade, bacteria issues in 1996	In well pit approx 6 feet below grade inside concrete casing, new septic 2006	South side of house with wishing well and concrete cover. Septic on east side. Use pickled sand for driveway.	Behind house in well pit, two pipes and breather, tidy, water quality issue with iron
Pump Type					Submersible	Submersible	Submersible	Jet	Submersible	Jet	Jet
Well Depth (metres)					21.34	18.29	39.62	20.12	18.9	21.03	28.96
Recommended Pump Setting (metres)					12.19	16.76	24.38	9.14	9.14	16.76	21.34
Measured Static Water Level (metres)					4.94 / 5.24	not taken	7.71	9.63	access denied	inaccessible	inaccessible
Measured Static Water Level Date					29Apr98/4Dec14	not taken	04-Nov-11	25-Apr-12	access denied	inaccessible	inaccessible
Static Water Level from Well Record (metres)					5.49	16.49	7.92	8.53	4.57	13.72	8.84
Available Drawdown to Well Bottom (metres)					16.4	1.8	31.91	11.59	14.33	7.31	20.12
Available Drawdown to Recommended Pump Setting (metres)					7.25	0.27	16.67	0.61	4.57	3.04	12.5
Ground Elevation (m AMSL)					360.00	360.00	361.33	355.52	360.00	361.00	357.00
RESULTS OF FIELD MEASUREMENTS											
Field pH					6.86	7.05	7.08	7.31	7.36	7.13	7.36
Field Conductivity (µS/cm)					620	1987	632	670	612	1649	945
Field Temperature (°C)					12.5	11	10	10.2	9.8	10.5	9.7
Field TDS (mg/L)					290	985	317		305		469
RESULTS OF BACTERIOLOGICAL ANALYSIS											
Total Coliform cfu/100 mL					14 / overgrown	0	0	18	0	0	4
E. coli cfu/100 mL					0 /overgrown	0	0	0	0	0	0
RESULTS OF ANALYSES OF WATER											
Maxxam ID					YI6845	YI6901	YI6856	YI6808	YI6805	YI6840	YI6886
Sample No.	**Units**	**ODWS**	**IMC**	**A/O**	**501**	**516**	**532**	**688**	**812**	**858**	**991**
Calculated Parameters											
Anion Sum	me/L	-		-	7.26	19.9	7.33	7.70	7.05	16.1	11.4
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-		-	300	390	270	270	270	310	220
Calculated TDS	mg/L	-		500	380	1100	390	420	380	920	690
Carb. Alkalinity (calc. as CaCO3)	mg/L	-		-	1.5	2.4	2.3	2.4	1.8	1.9	1.6
Cation Sum	me/L	-		-	7.38	21.1	7.59	8.08	7.34	17.7	11.7
Hardness (CaCO3)	mg/L	-		80:100	340	460	360	380	340	410	570
Ion Balance (% Difference)	%	-		-	0.850	2.88	1.73	2.41	1.99	4.63	1.30
Langelier Index (@ 20C)	N/A	-		-	0.728	0.963	0.933	0.978	0.821	0.847	0.946
Langelier Index (@ 4C)	N/A	-		-	0.479	0.718	0.685	0.729	0.572	0.601	0.699
Saturation pH (@ 20C)	N/A	-		-	6.98	6.85	7.02	7.00	7.04	6.96	6.93
Saturation pH (@ 4C)	N/A	-		-	7.23	7.09	7.27	7.25	7.29	7.20	7.18

ODWS = Ontario Drinking Water Standard | A/O = Aesthetic Objective/Operational Guideline | IMC = Interim Maximum Acceptable Concentration | ND = Not detected

Table 3: Private Well Water Quality

RESULTS OF PRIVATE WELL SURVEY

Sample No.	Units	ODWS	IMC	A/O	501	516	532	688	812	858	991
Sampling Date					2014/11/04 11:05	2014/11/05 19:30	2014/11/04 17:05	2014/11/03 13:15	2014/11/05 10:55	2014/11/03 16:10	2014/11/03 14:10
Inorganics											
Total Ammonia-N	mg/L	-		-	ND	ND	ND	ND	ND	ND	ND
Conductivity	umho/cm	-		-	680	2000	690	730	670	1800	980
Total Kjeldahl Nitrogen (TKN)	mg/L	-		-	0.20	0.12	ND	ND	0.11	0.11	ND
Dissolved Organic Carbon	mg/L	-		5	1.4	1.1	0.85	0.72	0.85	1.1	0.59
Orthophosphate (P)	mg/L	-		-	0.019	ND	ND	ND	ND	0.011	ND
pH	pH	-		6.5:8.5	7.71	7.81	7.95	7.98	7.86	7.80	7.88
Total Suspended Solids	mg/L	-		-	ND	ND	ND	ND	ND	ND	ND
Dissolved Sulphate (SO4)	mg/L	-		500	14	36	49	76	35	18	330
Alkalinity (Total as CaCO3)	mg/L	-		30:500	310	390	270	270	270	310	220
Dissolved Chloride (Cl)	mg/L	-		250	21	400	21	21	22	330	7
Nitrite (N)	mg/L	**1**		-	ND	ND	ND	ND	ND	ND	ND
Nitrate (N)	mg/L	**10**		-	3.63	1.64	2.90	1.98	4.66	2.40	ND
Nitrate + Nitrite	mg/L	**10**		-	3.63	1.64	2.90	1.98		2.40	ND
Metals											
. Aluminum (Al)	mg/L	-	-	0.1	ND	ND	ND	0.020	ND	ND	ND
. Antimony (Sb)	mg/L	-	0.006	-	ND	ND	0.00096	ND	ND	ND	ND
. Arsenic (As)	mg/L	-	0.025	-	ND	ND	ND	ND	ND	ND	0.0016
. Barium (Ba)	mg/L	**1**	-	-	0.032	0.11	0.042	0.069	0.043	0.060	0.016
. Beryllium (Be)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND
. Boron (B)	mg/L	-	5	-	0.012	0.014	ND	ND	0.010	ND	0.017
. Cadmium (Cd)	mg/L	**0.005**	-	-	ND	0.00016	ND	ND	ND	0.00017	ND
. Calcium (Ca)	mg/L	-	-	-	94	130	97	110	94	120	170
. Chromium (Cr)	mg/L	**0.05**	-	-	ND	ND	ND	ND	ND	ND	ND
. Cobalt (Co)	mg/L	-	-	-	0.00079	ND	ND	ND	ND	ND	ND
. Copper (Cu)	mg/L	-	-	1	0.084	0.020	ND	0.0042	0.0093	0.015	ND
. Iron (Fe)	mg/L	-	-	0.3	0.48	ND	ND	ND	ND	ND	0.45
. Lead (Pb)	mg/L	**0.01**	-	-	0.0017	0.0016	ND	ND	ND	ND	ND
. Magnesium (Mg)	mg/L	-	-	-	27	30	28	28	27	25	36
. Manganese (Mn)	mg/L	-	-	0.05	0.037	ND	0.0064	ND	ND	ND	0.014
. Molybdenum (Mo)	mg/L	-	-	-	0.00072	0.00058	0.025	0.00083	0.0020	0.00072	0.0022
. Nickel (Ni)	mg/L	-	-	-	0.0017	0.0021	0.0083	ND	0.0012	ND	ND
. Phosphorus (P)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND
. Potassium (K)	mg/L	-	-	-	2.9	1.7	1.9	2.5	2.2	1.3	0.93
. Selenium (Se)	mg/L	**0.01**	-	-	ND	ND	ND	ND	ND	ND	ND
. Silicon (Si)	mg/L	-	-	-	4.0	4.1	3.5	3.6	3.6	3.5	4.3
. Silver (Ag)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND
. Sodium (Na)	mg/L	**20**	-	200	9.4	270	8.8	9.6	9.1	220	6.1
. Strontium (Sr)	mg/L	-	-	-	0.13	0.26	0.14	0.51	0.22	0.17	4.4
. Thallium (Tl)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND
. Titanium (Ti)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND
. Uranium (U)	mg/L	**0.02**	-	-	0.00034	0.00025	0.0017	0.00027	0.00036	0.00020	ND
. Vanadium (V)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND
. Zinc (Zn)	mg/L	-	-	5	0.057	0.11	0.12	0.051	0.075	0.082	0.019

ODWS = Ontario Drinking Water Standard | A/O = Aesthetic Objective/Operational Guideline | IMC = Interim Maximum Acceptable Concentration | ND = Not detected

Table 4: Surface Water Quality

RESULTS OF ANALYSES OF WATER

Maxxam ID			YI6748	YI6749	YI6750	YI6751	YB2354
Sampling Date			5-Nov-14	5-Nov-14	5-Nov-14	5-Nov-14	16-Oct-14
Sampling Time			11:40	13:31	14:05	15:12	14:25
	Units	**PWQO**	**RS1/TRIB.A**	**SW4**	**SW7**	**SW11/TRIB.C**	**B SPRING**
Field pH			8.07	8.05	7.93	8.00	7.31 (Nov 5)
Field Conductivity (µS/cm)			601	574	576	588	699 (Nov 5)
Field Temperature (°C)			7.1	6.5	6.7	7.0	8.8 (Nov 5)
Field TDS (mg/L)			300	286	282	294	350 (Nov 5)
Bacteriological Analysis							
Total Coliform cfu/100 mL			3000	20000	50000	4500	500 (Nov 5)
E. coli cfu/100 mL			10	40	20	10	1 (Nov 5)
Calculated Parameters							
Anion Sum	me/L	-	6.97	6.69	6.56	6.84	7.94
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	270	290	280	310	290
Calculated TDS	mg/L	-	380	350	340	360	420
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	5.3	4.1	3.8	4.2	3.2
Cation Sum	me/L	-	7.58	7.27	6.88	7.74	8.25
Hardness (CaCO3)	mg/L	-	350	340	320	370	350
Ion Balance (% Difference)	%	-	4.19	4.21	2.39	6.18	1.96
Langelier Index (@ 20C)	N/A	-	1.31	1.19	1.12	1.24	1.08
Langelier Index (@ 4C)	N/A	-	1.06	0.942	0.875	0.993	0.828
Saturation pH (@ 20C)	N/A	-	7.00	7.00	7.03	6.92	6.99
Saturation pH (@ 4C)	N/A	-	7.25	7.25	7.28	7.17	7.23
Inorganics							
Total Ammonia-N	mg/L	-	0.058	ND	ND	ND	0.064
Conductivity	umho/cm	-	640	610	600	630	760
Total Kjeldahl Nitrogen (TKN)	mg/L	-	0.17	0.47	0.51	0.56	0.27
Total Organic Carbon (TOC)	mg/L	-	2.2	6.5	6.9	9.2	1.3
Orthophosphate (P)	mg/L	-	ND	ND	ND	0.018	ND
pH	pH	**6.5:8.5**	8.31	8.19	8.16	8.16	8.06
Total Phosphorus	mg/L	**0.01**	0.006	0.008	0.008	**0.026**	0.004
Dissolved Sulphate (SO4)	mg/L	**-**	16	8	9	ND	26
Turbidity	NTU	**-**	ND	ND	0.2	0.4	ND
Alkalinity (Total as CaCO3)	mg/L	**-**	280	290	280	310	300
Dissolved Chloride (Cl)	mg/L	**-**	21	22	23	22	46
Nitrite (N)	mg/L	**-**	0.017	ND	ND	ND	ND
Nitrate (N)	mg/L	**-**	6.02	1.05	0.80	ND	2.39
Metals							
Dissolved Calcium (Ca)	mg/L	-	98.2	94.0	88.1	105	98.6
Dissolved Magnesium (Mg)	mg/L	-	26.2	25.9	24.7	25.6	25.4
Dissolved Potassium (K)	mg/L	-	3	3	4	4	2
Dissolved Sodium (Na)	mg/L	-	10.1	8.5	8.3	7.0	27.3
Total Aluminum (Al)	mg/L	-	0.0074	0.0080	0.0096	0.022	0.016
Total Antimony (Sb)	mg/L	**0.02**	ND	ND	ND	ND	ND
Total Arsenic (As)	mg/L	**0.1**	ND	ND	ND	ND	ND
Total Barium (Ba)	mg/L	-	0.026	0.025	0.026	0.022	0.036
Total Beryllium (Be)	mg/L	**0.011**	ND	ND	ND	ND	ND

Table 4: Surface Water Quality

RESULTS OF ANALYSES OF WATER

Maxxam ID			YI6748	YI6749	YI6750	YI6751	YB2354
Sampling Date			5-Nov-14	5-Nov-14	5-Nov-14	5-Nov-14	16-Oct-14
Sampling Time			11:40	13:31	14:05	15:12	14:25
	Units	**PWQO**	**RS1/TRIB.A**	**SW4**	**SW7**	**SW11/TRIB.C**	**B SPRING**
Total Boron (B)	mg/L	**0.2**	0.017	0.014	0.012	0.011	ND
Total Cadmium (Cd)	mg/L	**0.0002**	ND	0.00018	ND	ND	ND
Total Calcium (Ca)	mg/L	-	92	90	86	96	110
Total Chromium (Cr)	mg/L	-	ND	ND	ND	ND	ND
Total Cobalt (Co)	mg/L	**0.0009**	ND	ND	ND	ND	ND
Total Copper (Cu)	mg/L	**0.005**	ND	ND	ND	ND	ND
Total Iron (Fe)	mg/L	**0.3**	ND	ND	ND	ND	ND
Total Lead (Pb)	mg/L	**0.005**	ND	ND	ND	ND	ND
Total Magnesium (Mg)	mg/L	-	26	26	25	24	31
Total Manganese (Mn)	mg/L	-	ND	0.0041	0.0059	0.0080	0.0033
Total Molybdenum (Mo)	mg/L	**0.04**	ND	ND	ND	0.00074	0.00052
Total Nickel (Ni)	mg/L	**0.025**	ND	ND	ND	ND	ND
Total Potassium (K)	mg/L	-	2.5	2.8	3.3	3.1	2.5
Total Silicon (Si)	mg/L	-	3.4	4.6	4.4	5.5	4.4
Total Selenium (Se)	mg/L	**0.1**	ND	ND	ND	ND	ND
Total Silver (Ag)	mg/L	**0.0001**	ND	ND	ND	ND	ND
Total Sodium (Na)	mg/L	-	9.7	8.3	7.9	6.1	35
Total Strontium (Sr)	mg/L	-	0.13	0.12	0.12	0.12	0.23
Total Thallium (Tl)	mg/L	**0.0003**	ND	ND	ND	ND	ND
Total Titanium (Ti)	mg/L	-	ND	ND	ND	ND	ND
Total Uranium (U)	mg/L	**0.005**	0.00045	0.00034	0.00035	0.00067	0.00038
Total Vanadium (V)	mg/L	**0.006**	ND	ND	ND	ND	ND
Total Zinc (Zn)	mg/L	**0.03**	0.028	0.022	**0.046**	0.018	**0.035**

PWQO = Provincial Water Quality Objective | ND = Not detected

Table 5: Groundwater Quality - Monitoring Wells

RESULTS OF ANALYSES OF WATER

Maxxam ID					YK4274	YK4275	YK4276	YK4277	YK4278	YK4279	YK4280	YK4281	YK4282	YK4283	
Sampling Date					11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	
Sampling Time					11:00	12:20	13:00	12:00	11:15	13:25	13:40	13:55	14:12	14:26	
	Units	**ODWS**	**IMC**	**A/O**	**M1D**	**M2**	**M3**	**M4**	**M13D**	**M15-I**	**M15-II**	**M15-III**	**M15-IV**	**Duplicate (M15-III)**	**RDL**
Well Depth (metres)					12.80	55.47	11.13	18.59	10.06	42.49	36.37	26.84	16.83	26.84	
Field pH					6.98	7.50	7.28	7.21	7.25	7.16	7.29	7.19	7.29	7.19	
Field Conductivity (µS/cm)					1074	752	680	790	740	823	782	708	762	708	
Field Temperature (°C)					10.0	8.6	8.2	8.9	10.8	8.5	8.2	8.3	8.2	8.3	
Field TDS (mg/L)					532	342	335	390	365	409	391	353	380	353	
Bacteriological Analysis															
Total Coliform cfu/100 mL					< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	14	< 1	
E. coli cfu/100 mL					< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	
Calculated Parameters															
Anion Sum	me/L	-		-	11.3	7.43	7.03	8.17	7.60	8.52	8.11	7.53	8.00	7.37	N/A
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-		-	270	280	300	270	280	260	270	260	280	260	1.0
Calculated TDS	mg/L	-		500	610	400	360	450	400	470	450	410	430	400	1.0
Carb. Alkalinity (calc. as CaCO3)	mg/L	-		-	1.0	1.8	2.3	1.8	1.9	1.7	1.7	1.7	1.8	1.9	1.0
Cation Sum	me/L	-		-	11.3	7.58	7.20	8.33	7.68	8.66	8.35	7.48	8.19	7.51	N/A
Hardness (CaCO3)	mg/L	-		80:100	510	350	340	390	350	410	390	360	390	360	1.0
Ion Balance (% Difference)	%	-		-	0.0200	1.01	1.18	0.960	0.480	0.840	1.49	0.350	1.18	0.930	N/A
Langelier Index (@ 20C)	N/A	-		-	0.692	0.817	0.913	0.861	0.830	0.835	0.835	0.814	0.833	0.847	
Langelier Index (@ 4C)	N/A	-		-	0.445	0.568	0.665	0.613	0.581	0.587	0.587	0.565	0.585	0.599	
Saturation pH (@ 20C)	N/A	-		-	6.92	7.02	6.99	7.00	7.04	6.99	7.00	7.03	6.99	7.03	
Saturation pH (@ 4C)	N/A	-		-	7.16	7.27	7.23	7.24	7.28	7.24	7.25	7.28	7.24	7.28	
Inorganics															
Total Ammonia-N	mg/L	-		-	0.064	0.079	0.16	ND	0.082	ND	ND	ND	ND	ND	0.050
Conductivity	umho/cm	-		-	1100	690	660	740	720	790	760	690	740	680	1.0
Total Kjeldahl Nitrogen (TKN)	mg/L	-		-	0.37	0.26	0.26	0.18	ND	0.15	0.24	0.25	0.14	0.14	0.10
Dissolved Organic Carbon	mg/L	-		5	2.9	1.4	1.3	0.98	1.2	1.1	1.2	1.1	1.2	1.0	0.20
Orthophosphate (P)	mg/L	-		-	ND	ND	ND	ND	ND	ND	0.016	ND	ND	ND	0.010
pH	pH	-		6.5:8.5	7.61	7.83	7.90	7.86	7.86	7.83	7.84	7.85	7.83	7.88	N/A
Total Suspended Solids	mg/L	-		-	24	260	19	140	120	68	43	290	220	370	10
Dissolved Sulphate (SO4)	mg/L	-		500	100	49	10	97	44	120	98	81	82	75	1
Alkalinity (Total as CaCO3)	mg/L	-		30:500	270	280	310	270	280	260	270	260	280	260	1.0
Dissolved Chloride (Cl)	mg/L	-		250	140	19	22	20	30	20	20	16	20	16	1
Nitrite (N)	mg/L	**1**		-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.010
Nitrate (N)	mg/L	**10**		-	ND	3.99	1.12	2.48	3.55	2.01	1.99	2.33	2.25	2.32	0.10

Table 5: Groundwater Quality - Monitoring Wells

RESULTS OF ANALYSES OF WATER

Maxxam ID					YK4274	YK4275	YK4276	YK4277	YK4278	YK4279	YK4280	YK4281	YK4282	YK4283	
Sampling Date					11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	11-Nov-14	
Sampling Time					11:00	12:20	13:00	12:00	11:15	13:25	13:40	13:55	14:12	14:26	
	Units	**ODWS**	**IMC**	**A/O**	**M1D**	**M2**	**M3**	**M4**	**M13D**	**M15-I**	**M15-II**	**M15-III**	**M15-IV**	**Duplicate (M15-III)**	**RDL**
Metals															
Dissolved Aluminum (Al)	mg/L	-	-	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0050
Dissolved Antimony (Sb)	mg/L	-	0.006	-	0.0013	ND	ND	ND	0.0011	0.0022	0.0025	ND	ND	ND	0.00050
Dissolved Arsenic (As)	mg/L	-	0.025	-	0.0014	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0010
Dissolved Barium (Ba)	mg/L	**1**	-	-	0.098	0.051	0.028	0.081	0.075	0.098	0.079	0.058	0.095	0.059	0.0020
Dissolved Beryllium (Be)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00050
Dissolved Boron (B)	mg/L	-	5	-	ND	0.013	0.021	0.013	0.012	0.014	0.013	0.012	0.012	0.012	0.010
Dissolved Cadmium (Cd)	mg/L	**0.005**	-	-	0.00023	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00010
Dissolved Calcium (Ca)	mg/L	-	-	-	140	96	92	110	92	110	110	99	100	99	0.20
Dissolved Chromium (Cr)	mg/L	**0.05**	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0050
Dissolved Cobalt (Co)	mg/L	-	-	-	0.0026	0.0016	ND	ND	ND	ND	ND	ND	ND	ND	0.00050
Dissolved Copper (Cu)	mg/L	-	-	1	0.0056	ND	ND	ND	0.0012	ND	ND	ND	ND	ND	0.0010
Dissolved Iron (Fe)	mg/L	-	-	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.10
Dissolved Lead (Pb)	mg/L	**0.01**	-	-	0.00051	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00050
Dissolved Magnesium (Mg)	mg/L	-	-	-	39	28	26	31	29	31	30	27	32	27	0.050
Dissolved Manganese (Mn)	mg/L	-	-	0.05	0.058	ND	ND	ND	ND	ND	0.0045	ND	ND	ND	0.0020
Dissolved Molybdenum (Mo)	mg/L	-	-	-	0.0088	0.0022	ND	0.0013	0.0075	0.0024	0.0035	0.0024	0.0016	0.0025	0.00050
Dissolved Nickel (Ni)	mg/L	-	-	-	0.011	ND	ND	0.0012	0.0026	0.0025	0.0055	0.0038	0.0018	ND	0.0010
Dissolved Phosphorus (P)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.10
Dissolved Potassium (K)	mg/L	-	-	-	1.8	7.5	2.4	3.2	1.8	6.0	5.8	3.4	3.6	3.4	0.20
Dissolved Selenium (Se)	mg/L	**0.01**	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0020
Dissolved Silicon (Si)	mg/L	-	-	-	4.4	3.5	3.7	3.5	4.2	3.6	3.5	3.5	3.6	3.5	0.050
Dissolved Silver (Ag)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00010
Dissolved Sodium (Na)	mg/L	**20**	-	200	**24**	7.1	8.5	8.3	14	8.8	8.9	5.3	7.7	5.4	0.10
Dissolved Strontium (Sr)	mg/L	-	-	-	0.15	0.22	0.12	0.64	0.13	1.0	0.80	0.43	0.38	0.43	0.0010
Dissolved Thallium (Tl)	mg/L	-	-	-	ND	ND	ND	ND	ND	0.000088	0.000054	ND	0.000069	ND	0.000050
Dissolved Titanium (Ti)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0050
Dissolved Uranium (U)	mg/L	**0.02**	-	-	0.0022	0.00037	0.00042	0.00038	0.00085	0.00090	0.0012	0.00047	0.00053	0.00050	0.00010
Dissolved Vanadium (V)	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00050
Dissolved Zinc (Zn)	mg/L	-	-	5	0.65	0.043	0.038	0.048	0.098	0.043	0.047	0.036	0.059	0.036	0.0050

ODWS = Ontario Drinking Water Standard | A/O = Aesthetic Objective/Operational Guideline | IMC = Interim Maximum Acceptable Concentration | RDL = Reportable Detection Limit | ND = Not detected

Appendix A

Well Records for Wells Sampled November 2014

/ W1-8532 Hwy 7

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

40PAE

Ontario

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

11 | 6705424 | MUNICIP. 67002 | CON. CON 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
Wellington	Eramosa	conc. 6	001

[redacted] x 7, R.R.# 2, ROCKWOOD, Ontario

DATE COMPLETED 48-53 DAY 11 MO 02 YR. 75

[redacted]28271 | RC. 5 | ELEVATION 1170 | RC. 5 | BASIN CODE 23 | AUG 05, 1977 | 323

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Brown	clay, sand	stones		0	25
"	" "	gravel		25	35
L. Brown	rock			35	41
Gray	"			41	100
			Total Depth 100 Feet		

31 | 0025605281 2 | 0035605281 1 | 004162675 | 0100226

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0085	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
0100	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
05"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0036
05"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		36	0100
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE: 0010 GPM.

DURATION OF PUMPING: 01 HOURS 00 MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
043 FEET	060 FEET	043 FEET	FEET	FEET	FEET

WATER LEVELS DURING: 1 ☐ PUMPING 2 ☒ RECOVERY

IF FLOWING, GIVE RATE: —— GPM.

PUMP INTAKE SET AT: —— FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 070 FEET

RECOMMENDED PUMPING RATE: 0010 GPM.

—— GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL 1

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01

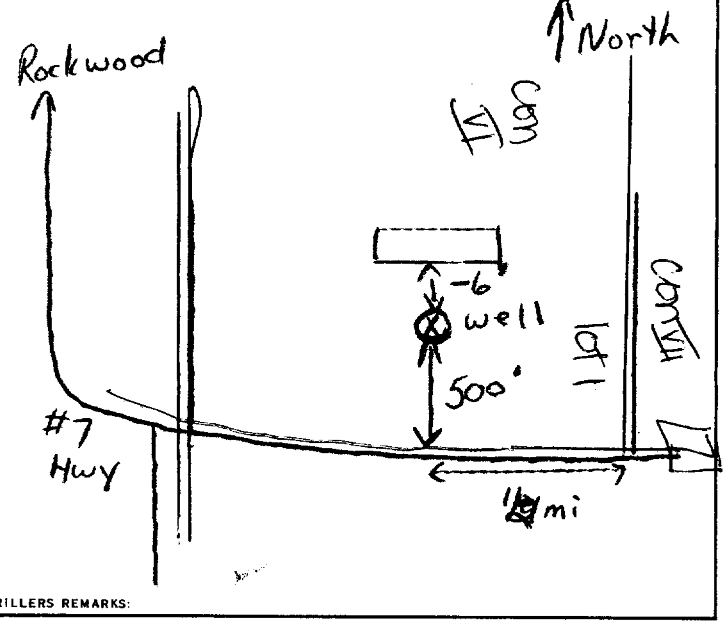
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 1

1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☒ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL 7229

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: GRAHAM WELL DRILLING LIMITED | LICENCE NUMBER: 2336

ADDRESS: 212 Waverley Drive, GUELPH, Ont

NAME OF DRILLER OR BORER: J. Hawkins & 10-R 22871 | LICENCE NUMBER:

SIGNATURE OF CONTRACTOR: R.H. Graham | SUBMISSION DATE DAY 11 MO. 2 YR. 75

OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 2336 | DATE RECEIVED 070375

DATE OF INSPECTION | INSPECTOR

REMARKS: | P KP | CSS.ES WI

MINISTRY OF THE ENVIRONMENT COPY

FORM 7 MOE 07-091

Ontario Ministry of Environment and Energy

W3-4949 6th Line

The Ontario Water Resources Act
WATER WELL RECORD

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

11

6714491

Municipality 67002 Con. CON 06

28-03

County or District WELLINGTON	Township/Borough/City/Town/Village ERAMOSA TWP	Con block tract survey, etc. CON 6	Lot 2
Owner's surname First Name W&T MUSHROOMS LTD	Address of Well Location RR#2 ROCKWOOD ONT. N0B-2K0	Date completed 06 06 03 (day month year)	

21 UTM Zone Easting Northing RC Elevation RC Basin Code

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth - feet From	Depth - feet To
BROWN	CLAY	STONES		0	18
BROWN	GRAVEL	SAND		18	25
BROWN	CLAY	SAND - GRAVEL		25	31
GREY	ROCK			31	170
BLUE	SHALE			170	178
RED	SHALE			178	180
			TOTAL DEPTH	180'	
		6" DRIVE SHOE			

31

32

41 WATER RECORD

Water found at - feet	Kind of water
120	☒ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
165	☒ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas

51 CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth - feet From	Depth - feet To
6"	☒ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	.188	+2	32
6"	☐ Steel ☐ Galvanized ☐ Concrete ☒ Open hole ☐ Plastic		32	180
	☐ 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

61 PLUGGING & SEALING RECORD

☒ Annular space ☐ Abandonment

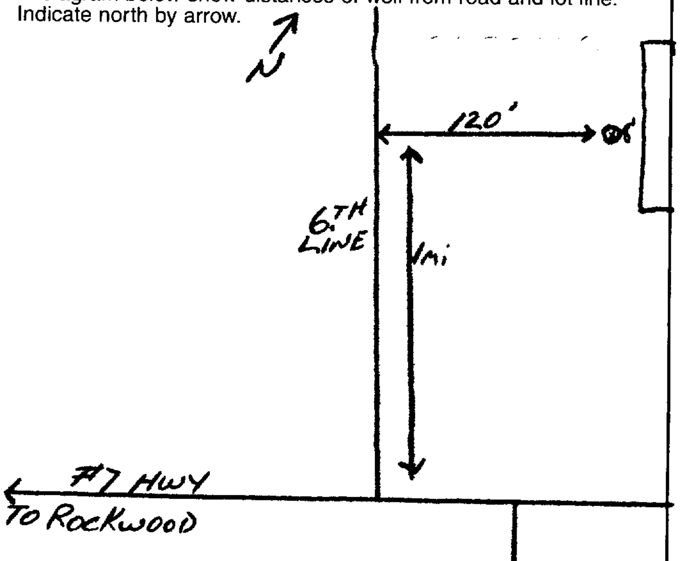
Depth set at - feet From	Depth set at - feet To	Material and type (Cement grout, bentonite, etc.)
0	25	BENTONITE

71 PUMPING TEST

Pumping test method ☒ Pump ☐ Bailer		Pumping rate 80 U.S. GPM		Duration of pumping 2 Hours ... Mins	
Static level	Water level end of pumping	Water levels during ☒ Pumping ☐ Recovery			
		15 minutes	30 minutes	45 minutes	60 minutes
23 feet	134 feet	96 feet	127 feet	134 feet	134 feet
If flowing give rate — GPM		Pump intake set at 147 feet		Water at end of test ☒ Clear ☐ Cloudy	
Recommended pump type ☐ Shallow ☒ Deep		Recommended pump setting 160 feet		Recommended pump rate 80 U.S. GPM	

LOCATION OF WELL

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



254142

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

Name of Well Contractor GRAHAM WELL DRILLING LTD	Well Contractor's Licence No. 2336
Address RR#5 ROCKWOOD, ONT. N0B-2K0	
Name of Well Technician JIM WILSON	Well Technician's Licence No. T-1924
Signature of Technician/Contractor Robert H. Graham	Submission date 030 06 03 (day mo yr)

MINISTRY USE ONLY

Data source	Contractor 2336	Date received JUL 08 2003
Date of inspection	Inspector	
Remarks		

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0506 (06/02) Front Form 9

Ministry of Environment and Energy
Ontario

W4-4949 6th Line

The Ontario Water Resources Act
WATER WELL RECORD

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

11

6712824

Municipality 67002 Con. CON 06

County or District WELLINGTON	Township/Borough/City/Town/Village ERAMOSA	Con block tract survey, etc. VI	Lot 2
[redacted]	Address RR2 ROCKWOOD ONT. N0B 2K0	Date completed 23 day 11 month 98 year	

21

UTM | Northing | RC | Elevation | RC | Basin Code | ii | iii | iv

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth – feet From	Depth – feet To
	GRAVEL	BOULDERS		0	20
	CLAY	STONES, SAND LAYERS		20	29
GR.	LIMESTONE			29	120
BR. & GR.	LIMESTONE			120	130

31

32

41 WATER RECORD

Water found at – feet	Kind of water
100 & 125	1 ☒ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas

51 CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth – feet From	Depth – feet To
6¼	1 ☒ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic	188	0	33'6"
6⅛	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☒ Open hole 5 ☐ Plastic		33'6"	130
	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic			

SCREEN

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

Material and type | Depth at top of screen feet

61 PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at – feet From	To	Material and type (Cement grout, bentonite, etc.)

71 PUMPING TEST

Pumping test method AIR 1 ☐ Pump 2 ☐ Bailer	Pumping rate GPM	Duration of pumping 1 Hours 30 Mins	

Water levels during 1 ☒ Pumping 2 ☐ Recovery

Static level	Water level end of pumping	15 minutes	30 minutes	45 minutes	60 minutes
26 feet	50 feet	50 feet	50 feet	50 feet	50 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	80 feet	15 GPM

FINAL STATUS OF WELL

1 ☒ Water supply
2 ☐ Observation well
3 ☐ Test hole
4 ☐ Recharge well
5 ☐ Abandoned, insufficient supply
6 ☐ Abandoned, poor quality
7 ☐ Abandoned (Other)
8 ☐ Dewatering
9 ☐ Unfinished
10 ☐ Replacement well

WATER USE

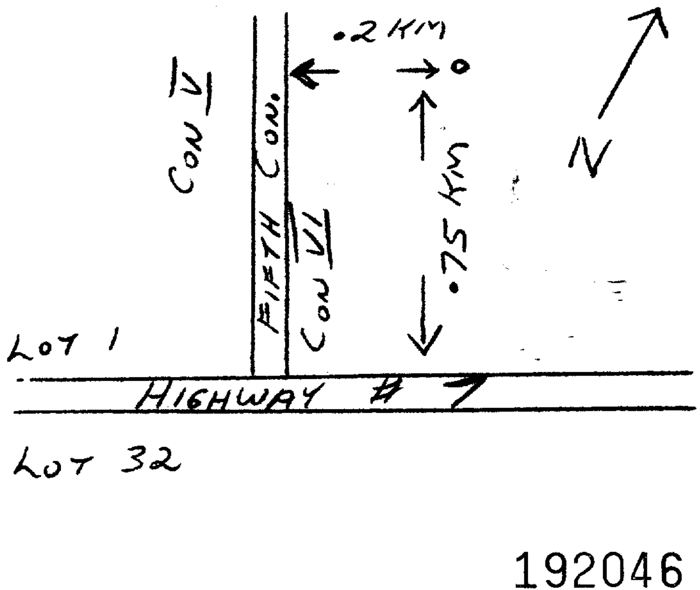
1 ☒ Domestic
2 ☐ Stock
3 ☐ Irrigation
4 ☐ Industrial
5 ☐ Commercial
6 ☐ Municipal
7 ☐ Public supply
8 ☐ Cooling & air conditioning
9 ☐ Not used
10 ☐ Other ....

METHOD OF CONSTRUCTION

1 ☐ Cable tool
2 ☒ Rotary (conventional)
3 ☐ Rotary (reverse)
4 ☐ Rotary (air)
5 ☐ Air percussion
6 ☐ Boring
7 ☐ Diamond
8 ☐ Jetting
9 ☐ Driving
10 ☐ Digging
11 ☐ Other ....

LOCATION OF WELL

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



192046

TWC 30

Name of Well Contractor LANG WELL DRILLING LTD	Well Contractor's Licence No. 3317
Address R.R.1 HILLSBURGH ONT	
Name of Well Technician ROY LANG	Well Technician's Licence No. T-0158
Signature of Technician/Contractor R. Lang	Submission date 26 day 12 mo 98 yr

MINISTRY USE ONLY

Data source	Contractor 3317	Date received JAN 07 1999
Date of inspection	Inspector	
Remarks	CSS.ES9	

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W5-4943 6th Line

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Ministry of the Environment
Ontario

The Ontario Water Resources Act
WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
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(11) 6707545 MUNICIP 67002 CON. CON 06

COUNTY OR DISTRICT [redacted]

TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE Eramosa

CON., BLOCK, TRACT, SURVEY, ETC VI

LOT 002

DATE COMPLETED DAY 13 MO 08 YR 81

NG 1829250 RC 5 ELEVATION 1200 RC 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
	Gravel, Boulders			0	20
Grey	Limestone			20	62

(31) 0020 1113 0062215

32

(41) WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
~~0060~~ 62	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY #5 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

(51) CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
05"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0029
05	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		29	0062
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

(71) PUMPING TEST

PUMPING TEST METHOD AIR 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE 0015 GPM

DURATION OF PUMPING 01 HOURS 15 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
015 FEET	020 FEET	FEET	FEET	FEET	020 FEET

WATER LEVELS DURING 1 ☒ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE GPM

PUMP INTAKE SET AT FEET

WATER AT END OF TEST 1 ☒ CLEAR 2 ☐ CLOUDY

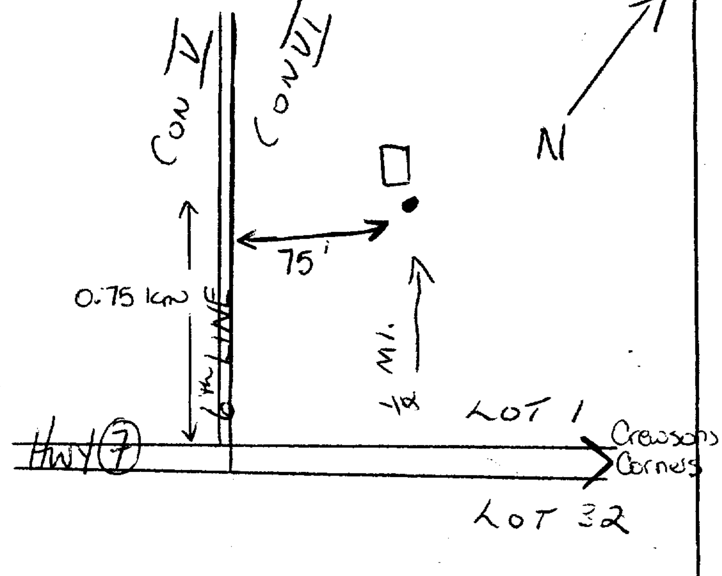
RECOMMENDED PUMP TYPE ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING 030 FEET

RECOMMENDED PUMPING RATE 0015 GPM

LOCATION OF WELL

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



DRILLERS REMARKS

FINAL STATUS OF WELL 1

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01

1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 2

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

NAME OF WELL CONTRACTOR Lang Well Drilling Ltd. LICENCE NUMBER 3317

ADDRESS R.R. #1 Hillsburgh Ontario

NAME OF DRILLER OR BORER Roy LANG LICENCE NUMBER 3317

SIGNATURE OF CONTRACTOR R. Lang

SUBMISSION DATE DAY 13 MO 8 YR 81

OFFICE USE ONLY

DATA SOURCE 1 CONTRACTOR 3317 DATE RECEIVED 200182

DATE OF INSPECTION June 26/84 INSPECTOR KW

REMARKS

CSS.ES

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Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

27/83

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11

6708039

MUNICIP. 67002 CON. CON 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
[redacted]	RAMOSA	6	W½ 002

MILL ST. E ACTON, ONT.

DATE COMPLETED DAY 17 MO 08 YR 83

ING 29400 RC. 5 ELEVATION 1200 RC. 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
TOP	SOIL			0	1
BROWN	CLAY	GRAVEL + STONES		1	18
GRAY	ROCK			18	70
			TOTAL DEPTH	70 ft.	

MOE VE 17

31 0001 02 0018605 11 12 0070212

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0026	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
0070	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
05"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0025
05"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		25	0070
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
—		

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
—		

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER

PUMPING RATE: 0025 GPM

DURATION OF PUMPING: 01 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
018 FEET	027 FEET	018 FEET	FEET	FEET	FEET

WATER LEVELS DURING: 1 ☐ PUMPING 2 ☒ RECOVERY

IF FLOWING, GIVE RATE: GPM

PUMP INTAKE SET AT: FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 040 FEET

RECOMMENDED PUMPING RATE: 0020 GPM

FINAL STATUS OF WELL 1

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01

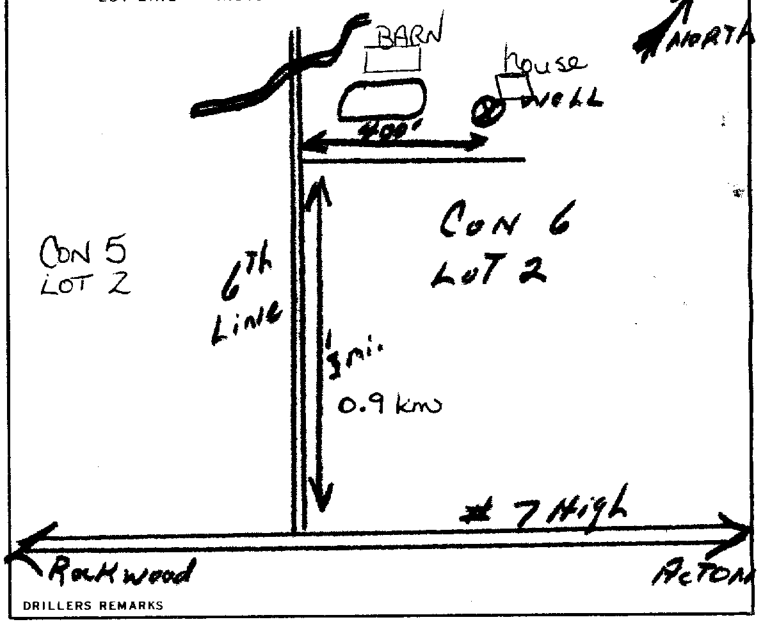
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 2

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☒ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS REMARKS

CONTRACTOR

NAME OF WELL CONTRACTOR: GRAHAM WELL DRILLING LTD.
LICENCE NUMBER: 2336
ADDRESS: Guelph, ONT.
NAME OF DRILLER OR BORER: R. GRAHAM
LICENCE NUMBER:
SIGNATURE OF CONTRACTOR: R. Graham
SUBMISSION DATE: DAY 031 MO 08 YR 83

OFFICE USE ONLY

DATA SOURCE: 1
CONTRACTOR: 2336
DATE RECEIVED: 09 09 83
DATE OF INSPECTION: June 26/84
INSPECTOR: KW
REMARKS: changed from 6707739

CSS.ES

FORM NO. 0506-4-77 FORM 7

MINISTRY OF THE ENVIRONMENT COPY

Ontario

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

W10-8540 Hwy 7
40P/9E

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

11 | 6705627 | MUNICIP. 67002 | CON. CON 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
Wellington	Eramosa	6 VI	001

[redacted] Box 7 Rockwood

DATE COMPLETED DAY 24 MO. 07 YR. 74

	RC.	ELEVATION	RC.	BASIN CODE	II	III	IV
[redacted] 828198	5	1175	5	23	AUG 05, 1977		323

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
	CLAY - ROCKS			0	45
GREY	- LIMESTONE			45	95

31 | 0045 0512 | 0095215
32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0090	1 ☑ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
05"	1 ☑ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0052
05"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☑ OPEN HOLE		52	0095
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☑ BAILER
PUMPING RATE: 0008 GPM
DURATION OF PUMPING: 01 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
029 FEET	045 FEET	045 FEET	045 FEET	045 FEET	045 FEET

WATER LEVELS DURING: 1 ☑ PUMPING 2 ☐ RECOVERY
IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☐ CLEAR 2 ☑ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☑ DEEP
RECOMMENDED PUMP SETTING: 070 FEET
RECOMMENDED PUMPING RATE: 0008 GPM
— — — . — GPM./FT. SPECIFIC CAPACITY

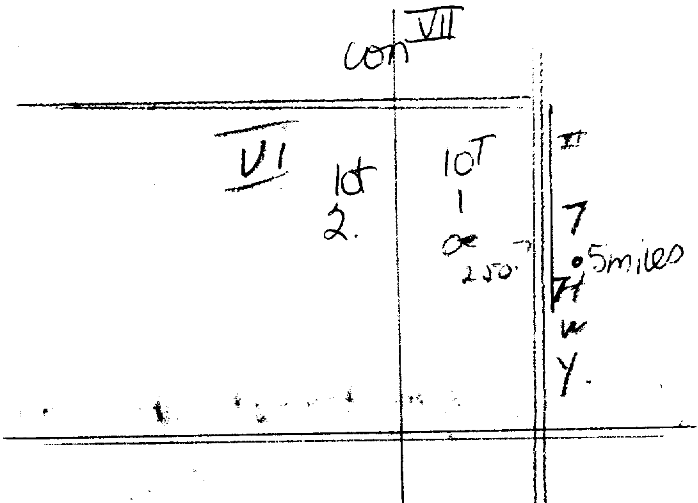
FINAL STATUS OF WELL 1
1 ☑ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01
1 ☑ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 2
1 ☐ CABLE TOOL
2 ☑ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL 7229

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: LADCO DRILLING
LICENCE NUMBER: 3316
ADDRESS: Hillsburg R.R. #1
NAME OF DRILLER OR BORER: THOMAS LAING
LICENCE NUMBER: 3316
SIGNATURE OF CONTRACTOR: T. Laing
SUBMISSION DATE DAY 24 MO. July YR. 74

OFFICE USE ONLY

DATA SOURCE: 1
CONTRACTOR: 3316
DATE RECEIVED: 220875
DATE OF INSPECTION:
INSPECTOR:
REMARKS:
PKP
WI
CSS.ES

FORM 7 07-091

MINISTRY OF THE ENVIRONMENT COPY

The Ontario Water Resources Commission Act W11-8554 Hwy 7

WATER WELL RECORD

40P/9E

Water management in Ontario

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

11 6705003 MUNICIP. 67002 CON. CON 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
Well.	Eramosa	Con 6 ~~[illegible]~~	001

[redacted] ADDRESS RR#4 Rockwood.

DATE COMPLETED 48-53 DAY 27 MO. ~~Mar~~ 03 YR. 74

829286 4 1175 5 23 MAR 20, 1975 49

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
		gravel		0	22
		clay gravel		22	38
White		rock		38	60
Brown		Lime rock		60	100

31 0022 11 0038 05 11 0060 126 0100 615

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0060	1 ☐ FRESH 3 ☐ ~~SULPHUR~~ 2 ☐ SALTY 4 ☒ MINERAL 100
0098	1 ☐ ~~FRESH~~ 3 ☐ SULPHUR 2 ☒ SALTY 4 ☐ MINERAL 100 5
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
~~5½~~ 05	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ ~~OPEN HOLE~~	188	0 ~~39~~	~~39~~ 0039 ~~100~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		39	0100
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)

DIAMETER INCHES

LENGTH FEET

MATERIAL AND TYPE

DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER

PUMPING RATE ~~15~~ 0015 GPM.

DURATION OF PUMPING 03 HOURS 00 MINS.

STATIC LEVEL 45 FEET

WATER LEVEL END OF PUMPING 70 FEET

WATER LEVELS DURING 1 ☒ PUMPING 2 ☐ RECOVERY

15 MINUTES 070 FEET; 30 MINUTES 070 FEET; 45 MINUTES 070 FEET; 60 MINUTES 070 FEET

IF FLOWING, GIVE RATE GPM.

PUMP INTAKE SET AT 80 FEET

WATER AT END OF TEST 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE ☐ SHALLOW ☒ DEEP

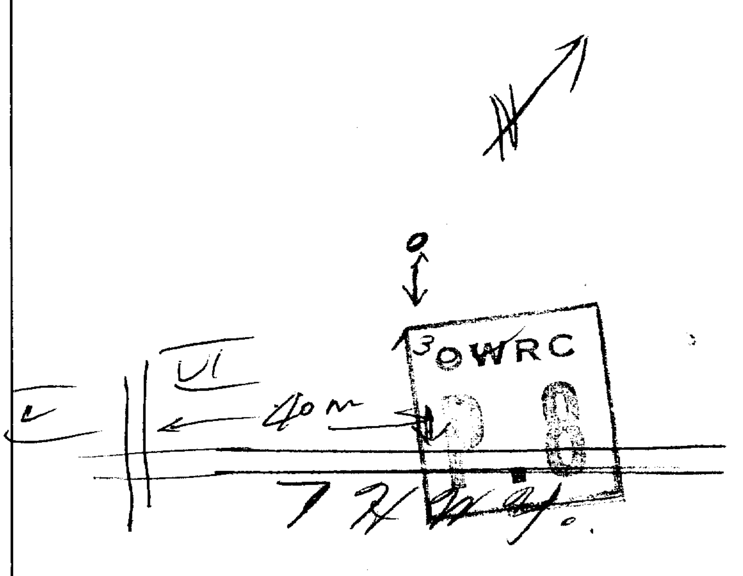
RECOMMENDED PUMP SETTING 080 FEET

RECOMMENDED PUMPING RATE 0015 GPM.

000.6 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

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



OWRC

DRILLERS REMARKS:

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01

1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING

1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR Albert Earley LICENCE NUMBER 1906

ADDRESS 202 Neeve St Guelph

NAME OF DRILLER OR BORER Albert Earley LICENCE NUMBER 1906

SIGNATURE OF CONTRACTOR Albert Earley SUBMISSION DATE DAY 27 MO. Mar YR. 74

OFFICE USE ONLY

DATA SOURCE 1 CONTRACTOR 1906 DATE RECEIVED 01 04 74

DATE OF INSPECTION INSPECTOR

REMARKS:

P

WI

CSS.ES

OWRC COPY

W16-5134 Hwy 7

40f9E

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

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

2805483   28002   Con 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	~~CON~~ BLOCK, TRACT, SURVEY, ETC	LOT
W[redacted]	Nassagaweya	VI	032

[redacted] 83 Dufferin, Guelph, Ont.

DATE COMPLETED DAY 17 MO Dec YR 79

29200 5 1150 5 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
brown	sand	gravel, boulders		0	41
grey	limestone			41	48

Coded

WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
45 to 46	☒ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL

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	188	0 42	42 48
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER, ETC.)

PUMPING TEST

PUMPING TEST METHOD ☐ PUMP ☒ BAILER

PUMPING RATE 20 GPM

DURATION OF PUMPING 1 HOURS ____ MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
27 FEET	27 FEET	27 FEET	27 FEET	27 FEET	27 FEET

WATER LEVELS DURING ☒ PUMPING ☐ RECOVERY

IF FLOWING, GIVE RATE ____ GPM

PUMP INTAKE SET AT ____ FEET

WATER AT END OF TEST ☒ CLEAR ☐ CLOUDY

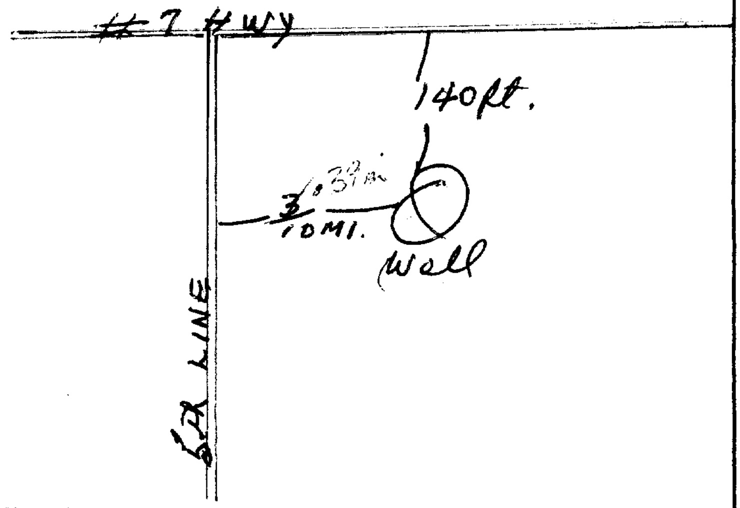
RECOMMENDED PUMP TYPE ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING 46 FEET

RECOMMENDED PUMPING RATE 10 GPM

LOCATION OF WELL

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



DRILLERS REMARKS:

FINAL STATUS OF WELL

☒ WATER SUPPLY
☐ OBSERVATION WELL
☐ TEST HOLE
☐ RECHARGE WELL
☐ ABANDONED, INSUFFICIENT SUPPLY
☐ ABANDONED, POOR QUALITY
☐ UNFINISHED

WATER USE

☒ DOMESTIC
☐ STOCK
☐ IRRIGATION
☐ INDUSTRIAL
☐ OTHER
☐ COMMERCIAL
☐ MUNICIPAL
☐ PUBLIC SUPPLY
☐ COOLING OR AIR CONDITIONING
☐ NOT USED

METHOD OF DRILLING

☒ CABLE TOOL
☐ ROTARY (CONVENTIONAL)
☐ ROTARY (REVERSE)
☐ ROTARY (AIR)
☐ AIR PERCUSSION
☐ BORING
☐ DIAMOND
☐ JETTING
☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Ruttan's Well Drilling

LICENCE NUMBER: 4602

ADDRESS: Milton R.R. 2.

NAME OF DRILLER OR BORER: same

LICENCE NUMBER:

SIGNATURE OF CONTRACTOR: Burton Ruttan

SUBMISSION DATE DAY 8 MO Jan YR 80

OFFICE USE ONLY

240180

HILL [illegible] [illegible] Cy.

[illegible] 02/15/80

CONTRACTOR'S COPY

FORM NO. 0506—4—77 FORM 7

14321 5th Line
40P 9E
W17

The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

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

11 | 2803457 | MUNICIP. 28002 | CON. CON 06

COUNTY OR DISTRICT: Halton
TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Nassagaweya
CON., BLOCK, TRACT, SURVEY, ETC.: W ½ of 6.
LOT: ~~pt 32~~ 032
OWNER (SURNAME FIRST): Ontario Plastics Ltd.
ADDRESS: Box 84 Rockwood Ont.
DATE COMPLETED: DAY 21 MO. ~~Aug~~ 08 YR. ~~1970~~ 70

21 | UTM ZONE 17 | EASTING 572180 | NORTHING 4828730 | RC. 4 | ELEVATION 1170 | RC. 5 | BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	TO
brown	boulders	Very small amt. of clay		0	28
grey	Limestone			28	104

APL

31 | 0028 1305 | 0104 2 15
32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0052	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0075	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0085	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0103	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	TO
~~4 ⅛"~~ 04	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ ~~OPEN HOLE~~	.188 3/4	0	0032 ~~31½~~ ~~104~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE			0104
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER
PUMPING RATE: 0020 GPM.
DURATION OF PUMPING: 01 HOURS 00 MINS.
WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
030 FEET	035 FEET	035 FEET	035 FEET	035 FEET	035 FEET

IF FLOWING, GIVE RATE: GPM.
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING: 050 FEET
RECOMMENDED PUMPING RATE: 0020 GPM.
004.0 GPM./FT. SPECIFIC CAPACITY

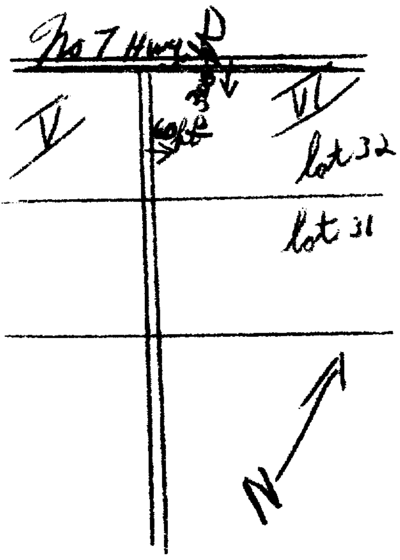
FINAL STATUS OF WELL
1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 45
1 ☐ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☒ INDUSTRIAL
☐ OTHER
5 ☒ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING
1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: John R. Sprowl
LICENCE NUMBER: 4805
ADDRESS: 40 Eastern Ave. Acton Ont
NAME OF DRILLER OR BORER: same as above
LICENCE NUMBER: 4805
SIGNATURE OF CONTRACTOR: John R. Sprowl Per B.J.S.
SUBMISSION DATE: DAY 21 MO. Aug YR. 1970

OFFICE USE ONLY

DATA SOURCE: 1
CONTRACTOR: 4805
DATE RECEIVED: 231170
DATE OF INSPECTION:
INSPECTOR: P/F
REMARKS: CSS.SS

OWRC COPY

W18-14297 5th Line

28 № 2049

UTM 17 Z 572224 E

Conc 6 R 4828654 N 40899e

Elev 2a4 R 321155

Basin 23

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District Halton

Township, Village, Town or City Nassagaweya

Con. 6

Lot 32

Date completed 6 (day) Sept (month) 1966 (year)

[redacted] ress R. R. no. 2. Rockwood, Ont.

Casing and Screen Record

Inside diameter of casing 4"

Total length of casing 24 ½ ft

Type of screen —

Length of screen —

Depth to top of screen —

Diameter of finished hole 4"

Pumping Test

Static level 35

Test-pumping rate 15 G.P.M.

Pumping level 38

Duration of test pumping 1 hr

Water clear or cloudy at end of test fairly clear

Recommended pumping rate 15 G.P.M.

with pump setting of 50 feet below ground surface

Well Log

Water Record

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
gravel & clay	0	20	45	fresh
dark grey Limestone	20	78	63	
			75	

For what purpose(s) is the water to be used? dwelling

Is well on upland, in valley, or on hillside? on upland

Drilling or ~~Boring~~ Firm J. R + J. C. Sprowl

Address R.R. 4 Acton & 137 Renfield St Guelph

Licence Number 2131 + 2130

Name of Driller or ~~Borer~~ J. R + J. C. Sprowl

Address R.R. 4. Acton + 137 Renfield St Guelph

Date Sept 1966

J. R + J. C. Sprowl

(Signature of Licensed Drilling or Boring Contractor)

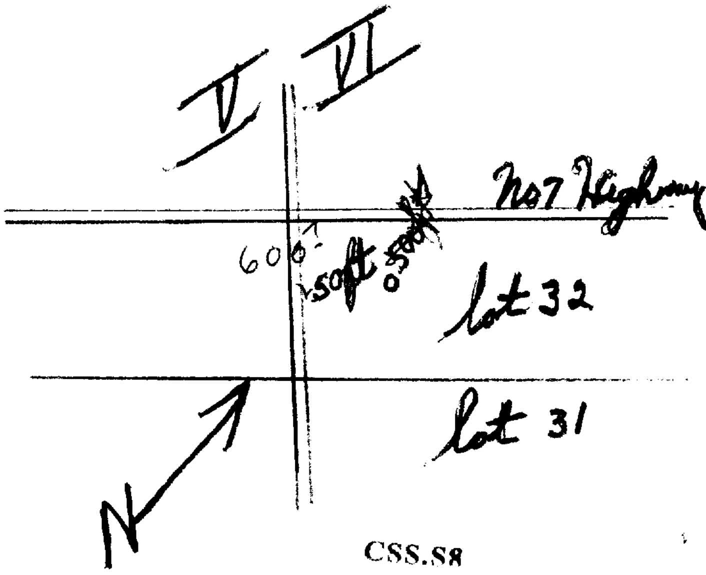
Per. B. J. S.

Form 7 15M-60-4138

OWRC COPY

Location of Well

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



CSS.S8

UTM 17 Z 572182 E
5 R 4828860 N
Elev. 4 R 1150 40P90
Basin 23

W19-5036 Hwy 7

28 № 2048

OCT 27 1959

The Ontario Water Resources Commission Act, 1957

WATER WELL RECORD

County or District Halton

Township, Village, Town or City Nassagaweya

[redacted]

Date completed 14 (day) July (month) 1959 (year)

...ress R.R. Rockwood

Casing and Screen Record

Inside diameter of casing 4 1/4"
Total length of casing 25 ft 4"
Type of screen —
Length of screen —
Depth to top of screen —
Diameter of finished hole 4 1/4"

Pumping Test

Static level 28 ft
Test-pumping rate 6 G.P.M.
Pumping level 30
Duration of test pumping 2 hrs
Water clear or cloudy at end of test clear
Recommended pumping rate 6 G.P.M.
with pumping level of 30 ft

Well Log

Overburden and Bedrock Record	From ft.	To ft.
Top earth	0	1 1/2
a few boulder	1 1/2	4
gravel	4	10
a big boulder	10	12
stoney gravel	12	20
Light grey limestone	20	66

Water Record

Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, sulphur)
54	38 ft	fresh
63	"	"

For what purpose(s) is the water to be used?
Home

Is well on upland, in valley, or on hillside?
on hillside

Drilling Firm J R Sproul
Address RR 4 Acton Ont

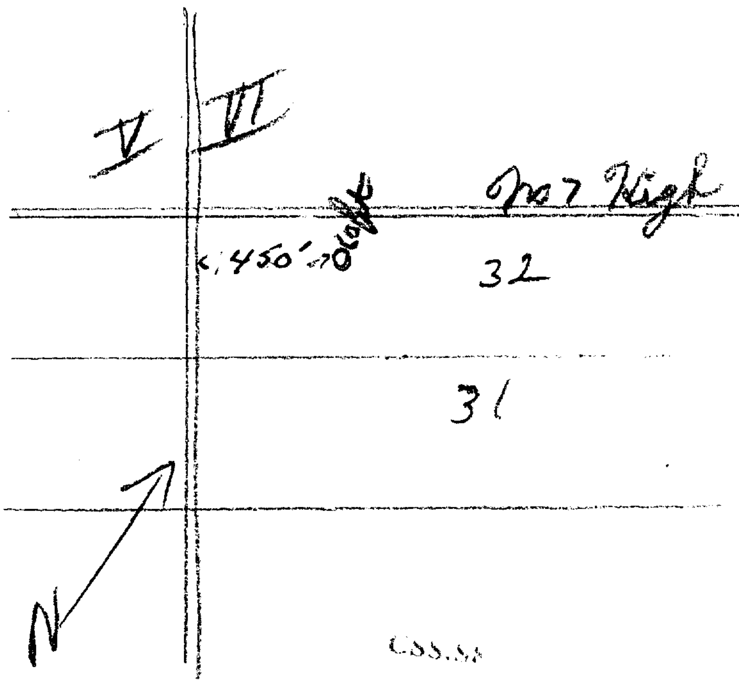
Licence Number 154 + 189
Name of Driller J R & J C Sproul
Address R R 4 Acton
Date July 1959
J R & J C Sproul
(Signature of Licensed Drilling Contractor)
Per B J S.

Form 5
15M-58-4149

Location of Well

11

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



CSS.SS

The Ontario Water Resources Commission Act W21-4264 Hwy 7

WATER WELL RECORD

Water management in Ontario

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

11 | 2803220 | MUNICIP. 28002 | CON. C⌀N 05

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
HALTON	NASSAGAWEYA	5	032

[redacted] R#2 ROCKWOOD

DATE COMPLETED 48-53: DAY 19 MO. 09 ~~Sept~~ YR. 69

28430 | RC. 4 | ELEVATION 1175 | RC. 5 | BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
			stones gravel	0	52
light Blue			rock	52	69

31 0052 12 11 | 0069 3 15

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
10-13 0069	1 ☑ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
15-18	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
20-23	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
25-28	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
30-33	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
10-11 04	1 ☑ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	205"	0	13-16 ~~548~~" 0055
17-18	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☑ OPEN HOLE		54.8	20-23 0069 ~~64~~
24-25	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			27-30

SCREEN

SIZE(S) OF OPENING (SLOT NO.) 31-33 | DIAMETER 34-38 INCHES | LENGTH 39-40 FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN 41-44 FEET | 80

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	DEPTH SET AT – FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
10-13 ~~50~~	14-17 ~~52~~	~~cement~~
18-21	22-25	
26-29	30-33	80

71 PUMPING TEST

PUMPING TEST METHOD 10: 1 ☑ PUMP 2 ☐ BAILER

PUMPING RATE 11-14: 0010 GPM

DURATION OF PUMPING: 15-16 02 HOURS 17-18 00 MINS.

STATIC LEVEL 19-21: 045 FEET

WATER LEVEL END OF PUMPING 22-24: 055 FEET

25 WATER LEVELS DURING 1 ☒ PUMPING 2 ☐ RECOVERY

15 MINUTES 26-28	30 MINUTES 29-31	45 MINUTES 32-34	60 MINUTES 35-37
055 FEET	055 FEET	055 FEET	055 FEET

IF FLOWING, GIVE RATE 38-41: GPM.

PUMP INTAKE SET AT: 60 FEET

WATER AT END OF TEST 42: 1 ☑ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☑ DEEP

RECOMMENDED PUMP SETTING 43-45: 055 ~~050~~ FEET

RECOMMENDED PUMPING RATE 46-49: 0010 GPM.

50-53 001.0 GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL

54
- 1 ☑ WATER SUPPLY
- 2 ☐ OBSERVATION WELL
- 3 ☐ TEST HOLE
- 4 ☐ RECHARGE WELL
- 5 ☐ ABANDONED, INSUFFICIENT SUPPLY
- 6 ☐ ABANDONED, POOR QUALITY
- 7 ☐ UNFINISHED

WATER USE

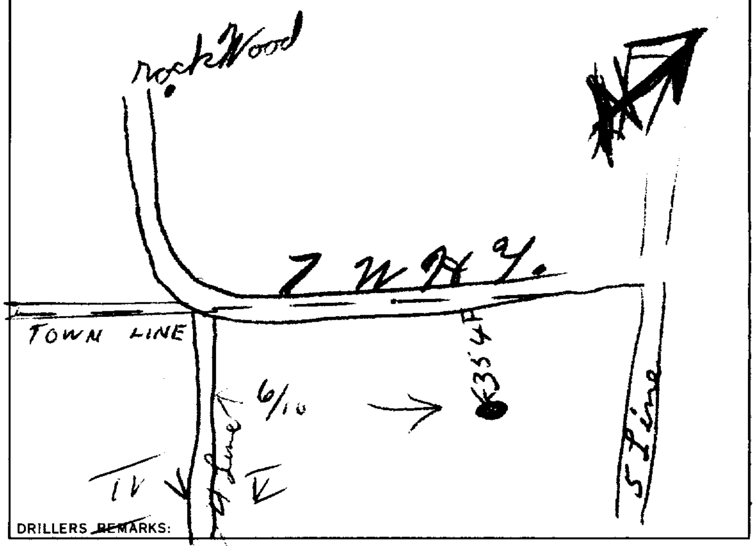
55-56 01
- 1 ☑ DOMESTIC
- 2 ☐ STOCK
- 3 ☐ IRRIGATION
- 4 ☐ INDUSTRIAL
- ☐ OTHER
- 5 ☐ COMMERCIAL
- 6 ☐ MUNICIPAL
- 7 ☐ PUBLIC SUPPLY
- 8 ☐ COOLING OR AIR CONDITIONING
- 9 ☐ NOT USED

METHOD OF DRILLING

57
- 1 ☑ CABLE TOOL
- 2 ☐ ROTARY (CONVENTIONAL)
- 3 ☐ ROTARY (REVERSE)
- 4 ☐ ROTARY (AIR)
- 5 ☐ AIR PERCUSSION
- 6 ☐ BORING
- 7 ☐ DIAMOND
- 8 ☐ JETTING
- 9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS ~~REMARKS~~:

CONTRACTOR

NAME OF WELL CONTRACTOR: Albert Earley | LICENCE NUMBER: 3299

ADDRESS: 202 Neeve St

NAME OF DRILLER OR BORER: Albert Earley | LICENCE NUMBER: 3299

SIGNATURE OF CONTRACTOR: Albert Earley

SUBMISSION DATE: DAY 19 MO. Sept YR. 1969

OFFICE USE ONLY

DATA SOURCE 58: 1 | CONTRACTOR 59-62: 1706 | DATE RECEIVED 63-68: 241069 | 80

DATE OF INSPECTION | INSPECTOR

REMARKS:

7

OWRC COPY

W22-5198 Hwy 7   7187172

Ontario Ministry of the Environment

Measurements recorded in: ☑ Metric ☑ Imperial

Well Tag No. (Place Sticker and/or Print Below)
Tag#: A126461

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

[redacted]

Address of Well Location (Street Number/Name)	Township	Lot	Concession
#5198 Hwy #7	Guelph / Eramosa	1	4

County/District/Municipality	City/Town/Village	Province	Postal Code
Wellington	Rockwood	Ontario	N0B2K0

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	17	572612	4829585		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	To
Brown	Top Soil			0	2
Brown	Silt	Sand		2	8
Grey	Boulder			8	12
Brown	Silt	Sand		12	22
Grey	Boulder			22	25
Brown	Silt	Sand		25	34
Grey/Brown	Limestone			34	37
Grey	Limestone		Fracture @55FT - 60FT	37	60
	* 6¼" Casing Drive Shoe *		Total = 60FT.		

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	20	Quick Grout	90FT.

Method of Construction

☐ Cable Tool
☑ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☐ Other, specify
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

☐ Public
☑ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, specify
☐ Commercial
☐ Municipal
☐ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☐ Monitoring

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
6¼	Steel	.188	+2	37
6⅛	Open Hole		37	60

Status of Well

☑ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To

Water Details

Water found at Depth 60 (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☑ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	20	10"
20	60	6⅛"

Results of Well Yield Testing

After test of well yield, water was:
☑ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft): 55

Pumping rate (l/min / GPM): 20

Duration of pumping: 1 hrs + ____ min

Final water level end of pumping (m/ft):

If flowing give rate (l/min / GPM):

Recommended pump depth (m/ft):

Recommended pump rate (l/min / GPM):

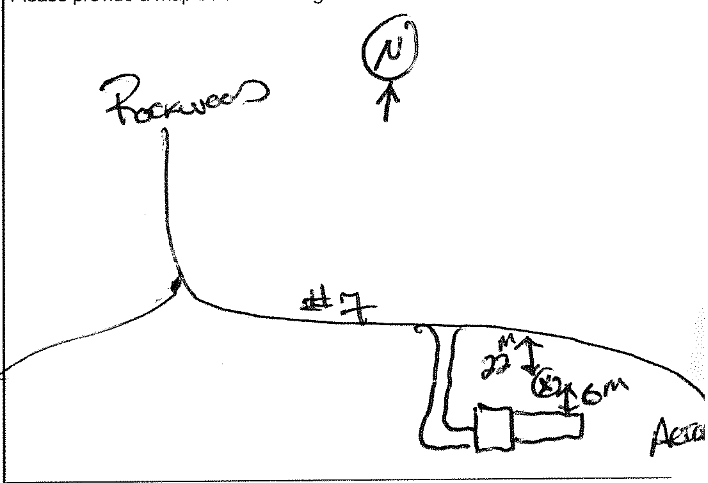
Well production (l/min / GPM):

Disinfected? ☐ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	54.1		56
1	54.2	1	55.6
2		2	55.3
3	54.5	3	55
4	54.6	4	54.8
5	54.7	5	54.6
10	54.9	10	54.1
15	55.0	15	
20	55.2	20	
25	55.3	25	
30	55.5	30	
40	55.7	40	
50	55.9	50	
60	56.0	60	

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Hannon Well Drilling LTD
Well Contractor's Licence No.	2663
Business Address (Street Number/Name)	#5896 Well Rd #7 RR#5
Municipality	Guelph
Province	ON
Postal Code	N1H6J2
Business E-mail Address	hanlonwelldrilling@bellnet.c
Bus. Telephone No. (inc. area code)	5197638239
Name of Well Technician (Last Name, First Name)	Langer Travis
Well Technician's Licence No.	3580
Signature of Technician and/or Contractor	
Date Submitted	20120630

Well owner's information package delivered ☑ Yes ☐ No

Date Package Delivered: 20120502

Date Work Completed: 20120605

Ministry Use Only
Audit No. Z151986
SEP 14 2012
Received

0506E (2007/12) **Ministry's Copy**

Appendix B

Monitoring Program and Contingency Measures

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

HIDDEN QUARRY

REVISED MONITORING PROGRAM AND CONTINGENCY MEASURES (DECEMBER 2014)

Colour Coding Scheme for Requested Agency Modifications to Monitoring Plan

Green – Ministry of the Environment

Orange – Grand River Conservation Authority

Magenta – Township of Guelph – Eramosa

Blue – Halton Region

1.0 ON-SITE MONITORING PROGRAM

Monitoring has taken place at this site since 1995. An extensive database of background groundwater and surface water elevations and flow measurements has been developed. A detailed monitoring program will continue to ensure that sensitive features and surface water flows are maintained. The monitoring program is designed to identify trends towards unacceptable impacts early on to allow for time to implement contingence measures.

The monitoring program for this proposed pit/quarry involves the following activities:

- measuring groundwater levels,
- obtaining water quality samples,
- monitoring water levels in the on-site wetland and stream, and
- stream flow measurements.

We recommend the following monitoring program.

Table 1: Monitoring Program

Parameter	**Monitoring Locations**	**Frequency**
Groundwater Levels	M1S/D, M2, M3, M4, M6, M13S/D, M14S/D, MPN1, MPN2, MPS1, MPS2, MPE1, MPE2, MPW1, MPW2, TP1, TP8, TP9 MP1, MP2, MP3, MP4, M15, M16, M17, M18, M19	Manually Monthly Automatic Daily Measurement in M1D, M2, M3, M4, M15, M16 for year prior to and year following bedrock extraction with re-evaluation of monitoring frequency after 1st year of bedrock extraction.
Groundwater Levels	M2, M3, TP1, M13S/D, M14S/D, M15, M16, M17	5 minute interval during first 3 months of extraction
Surface Water Level	Sinking Cut	Automatic Daily after safe quarry face is established.
Surface Water Level	SW14, SW5, SW7	Manually Monthly Coincident with groundwater monitoring
Surface Water Levels	SW6, SW4, SW8	Automated Water Level Readings (4 hour interval)
Surface Water Flow	SW4, SW8, SW3	Manually Monthly *coincident with groundwater monitoring
Groundwater Quality	W1, M2, M4, M15, M16, M18, M19	Semi-Annually
Surface Water Quality	West Pond, East Pond, Northwest Wetland, Tributary B (SW4, SW3)	Semi –Annually (Spring and Fall)

Parameter	Monitoring Locations	Frequency
Climate	On-Site Weather Station at Scale House to include precipitation and temperature	Daily
Domestic Wells Water Level	W4, W5, W8,W9 (W7 removed at request of landowner)	Data Loggers
Domestic Well Water Quality	W10, W11, W16, W17, W18, W19, W20, W21, W22, W23, W24	Quarterly bacteria and annual nitrate.

Monitoring locations are shown on Figures C1 and C8.

2.0 TRIGGER LEVELS

Groundwater and surface water monitoring will be used at this site to a) verify that predictions of water level change in the bedrock aquifer do not exceed those predicted and b) verify that the hydro-period of the northwest wetland does not change. The water level measurements obtained as part of the monitoring program will be used to trigger contingency measures that may be necessary for the mitigation of a low water level in the northwest wetland, a lower than expected water level in the bedrock aquifer or an anomalous low flow level in Tributary B.

The trigger levels are used to initiate contingency and mitigation responses outlined in Section 3. Once water levels recover above the trigger level, normal operations will commence at the site.

2.1 Trigger Levels for the Bedrock Aquifer

The greatest water level change in the bedrock aquifer is expected to occur to the north and northwest of the site. Water levels obtained from bedrock monitors M1D, M13D, M14D and M2 will be used to verify that actual water level changes do not exceed the predicted water level change. A warning level of 75% of the predicted change will be used to initiate bi-weekly manual measurements from the groundwater monitors.

Table 2: Trigger Levels for the Bedrock Aquifer

Monitor	Historical Low	Predicted Change	Warning Level	Trigger Level
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	347.81
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98
M15	TBD			
M16	TBD			
M17	TBD			

TBD – to be determined

The historical water levels, warning level and trigger level are presented in Figures C2, C3, C4 and C5.

2.2 Trigger Level for Northwest Wetland and Allen Wetland

Water levels from Station SW6 will be used to trigger contingency measures for the northwest wetland. Historical monitoring has shown that the water level in the wetland is somewhat independent from adjacent groundwater levels and therefore any potential change in the hydro-period is best determined by the surface water level in the wetland.

Trigger levels and warning levels have been determined for three periods as follows:

Winter Trigger Level - lowest water level observed between December 1 and March 1

Spring Trigger Level - lowest water level observed between March 2 and June 15

Summer/Fall Trigger Level - lowest water level observed between June 16 and November 30.

A warning level is established 0.15 metres higher than the trigger level. The warning and trigger levels relative to historical water levels are shown on Figure C6.

Table 3: Trigger Levels for the Surface Water Features

Station	Winter		Spring		Fall	
	Warning	Trigger	Warning	Trigger	Warning	Trigger
Northwest Wetland (SW6)	354.35	354.20	354.48	354.33	354.38	354.23
Allen Wetland (SW4)	The warning level will be a flow rate of less than 25 L/s occurring in May and the trigger level will be cessation of flow prior to June 22.					

Manual water level measurements will increase to bi-weekly if the warning level is exceeded.

2.3 Trigger Level for Sinking Cut

James Dick Construction Ltd. has agreed to a maximum water level change of 2.54 metres in the sinking cut. The nearest groundwater monitor to the sinking cut is M3. The hydrograph of M3 is found attached as Figure C7. The low water level in M3 is 349.37 m AMSL. We propose to use this as the reference elevation resulting in a minimum water elevation in the sinking cut of 349.37 – 2.54 = 346.83 m AMSL. JDCL proposes to hang a buoy from a tether with the buoy floating in the water until the water level falls below an elevation of 346.83 m AMSL. The buoy will be a visual indicator of the minimum allowable water level to the operator. Alternative methods such as a sonic water level reader may be employed.

Extraction will cease if the water level falls below 346.83 m AMSL and can only recommence with a water level above 346.83 m AMSL in the sinking cut.

3.0 CONTINGENCY MEASURES

3.1 Groundwater Levels and Northwest Wetland

If any trigger level is breached, the following measures will be taken;

1) Confirmation of water level within 24 hours. Increase monitoring to weekly until source of the trigger level exceedence is identified.

2) Within seven days complete an evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed.

3) If quarry activities are found to be responsible, James Dick Construction Ltd. will limit or cease below water table extraction and the following actions will be considered and a response presented to the GRCA and the Township of Guelph-Eramosa.

- increase the length and/or width of barrier
- change in configuration of mining or decrease in mining extent
- alter timing of extraction to coincide with high seasonal groundwater levels.

3.2 Water Quality

The water quality program will commence at least one year prior to bedrock extraction.

Groundwater Monitors and the East and West Pond

The parameters that will be included in the semi-annual monitoring will be general chemistry, cryptosporidium, giardia, E. coli, TKN, ammonia, DOC, pH, temperature, anions and metals.

In the event that there is an increasing trend in the concentration of one or more elements or compounds, listed on the Ontario Drinking Water Quality Standards list, occurs over three sampling events, a study will be conducted to determine the source of the water quality change. If the quarry is found to be responsible and if there is a potential for an element or compound listed on the Ontario Drinking Water Quality Standard list to exceed the Ontario Drinking Water Quality Standard at a downgradient well, James Dick Construction Ltd. will commence with the following actions;

1) Semi-annual testing (commencing immediately) of the water quality of private wells that could potentially be impacted by the quarry.

2) In the event that the quarry is determined to be responsible for water quality at a private well to become unpotable, JDCL will offer to return the water quality to within ODWQ Standards by providing appropriate treatment in the home, drilling a new well or isolating the water supply to the deeper aquifer.

Northwest Wetland

The northwest wetland water will be analyzed for nitrate, dissolved oxygen, temperature, conductivity and pH for a period of three years or upon completion of construction activities (i.e. berms, barriers, access roads) in the surface water catchment area of the northwest wetland whichever is longer.

Domestic Wells

Private domestic wells W10, W11, W16, W17, W18, W19, W20, W21, W22, W23 and W24 will be sampled four times a year for bacteria and once a year for nitrate.

4.0 PRE-BEDROCK EXTRACTION WATER WELL SURVEY

We recommend that a detailed water well survey be completed prior to the commencement of the extraction of bedrock resources. This survey will as a minimum include all wells in the shaded area shown on Figure C8. The well survey will include the following;

- construction details of the well (drilled, bored, sand point etc..)
- depth of well and depth of pump
- location of well relative to septic system
- static water level
- history of water quantity or quality issues
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals
- one hour flow test

The purpose of the survey is to have a baseline evaluation of both water quality and water quantity in nearby water wells. Should an issue arise with a local water well, the baseline data can be used as a reference against future measurements.

If there are domestic wells suitable for water level monitoring identified in the survey, they will be included in the water level monitoring program and monitored on a semi-annual basis.

If the survey indicates that modification(s) to the well are necessary either for continued monitoring or to minimize the potential for impact, the modifications will be made to the well at the expense of James Dick Construction Ltd.

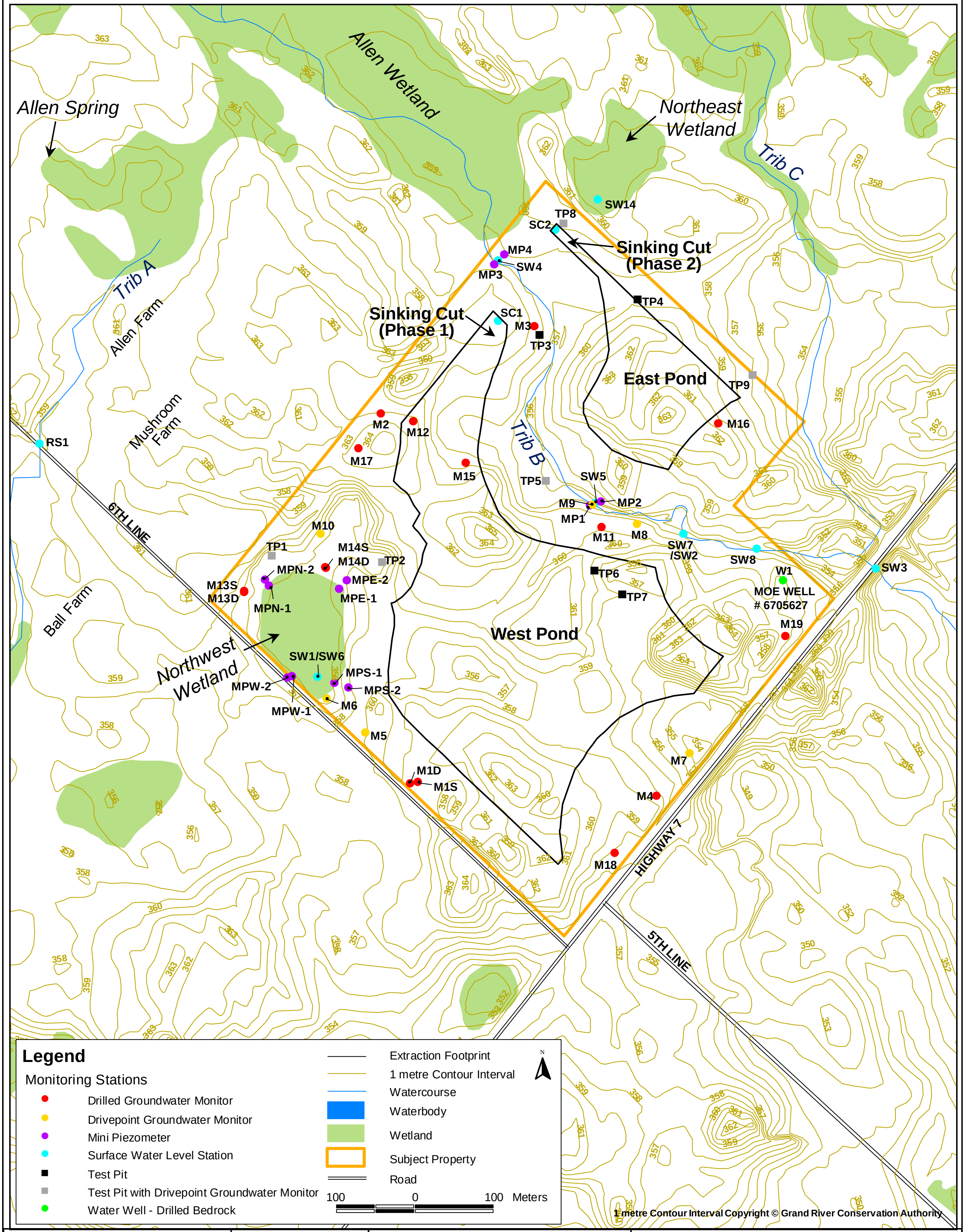
5.0 ANNUAL MONITORING REPORT AND INTERPRETATION

An annual report will be prepared and submitted to the Ministry of the Environment and the Ministry of Natural Resources on or before March 31st of the following calendar year. The report will be prepared by a qualified professional, either a professional engineer or a professional geoscientist.

The monitoring report will include all historical monitoring data and an interpretation of the results with respect to potential impact to the quality and quantity of bedrock groundwater, hydro-period of the northwest wetland and streamflow loss from Tributary B.

6.0 Water Well Complaints

James Dick Construction Ltd. agrees to inform the Township of Guelph Eramosa and the Ministry of the Environment upon the receipt of a water well complaint and the results of any related investigation. A detailed well complaint protocol is attached as Appendix A.



HARDEN

Harden Environmental Services Ltd.

Project No: 9506

Date: Nov 2014

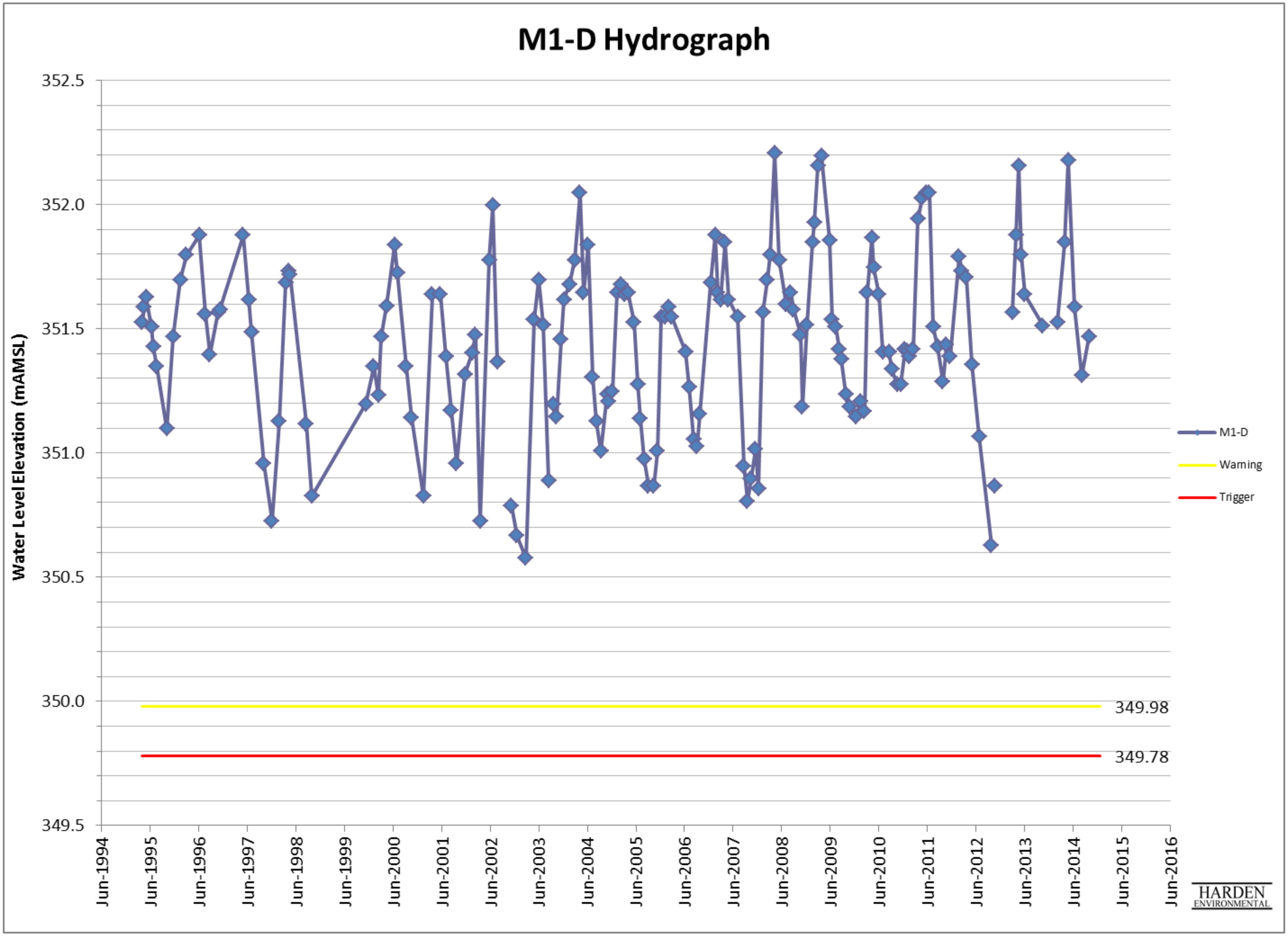
Drawn By: AR

Hidden Quarry Proposed Aggregate Extraction
Response to Burnside Letter of October 6, 2014

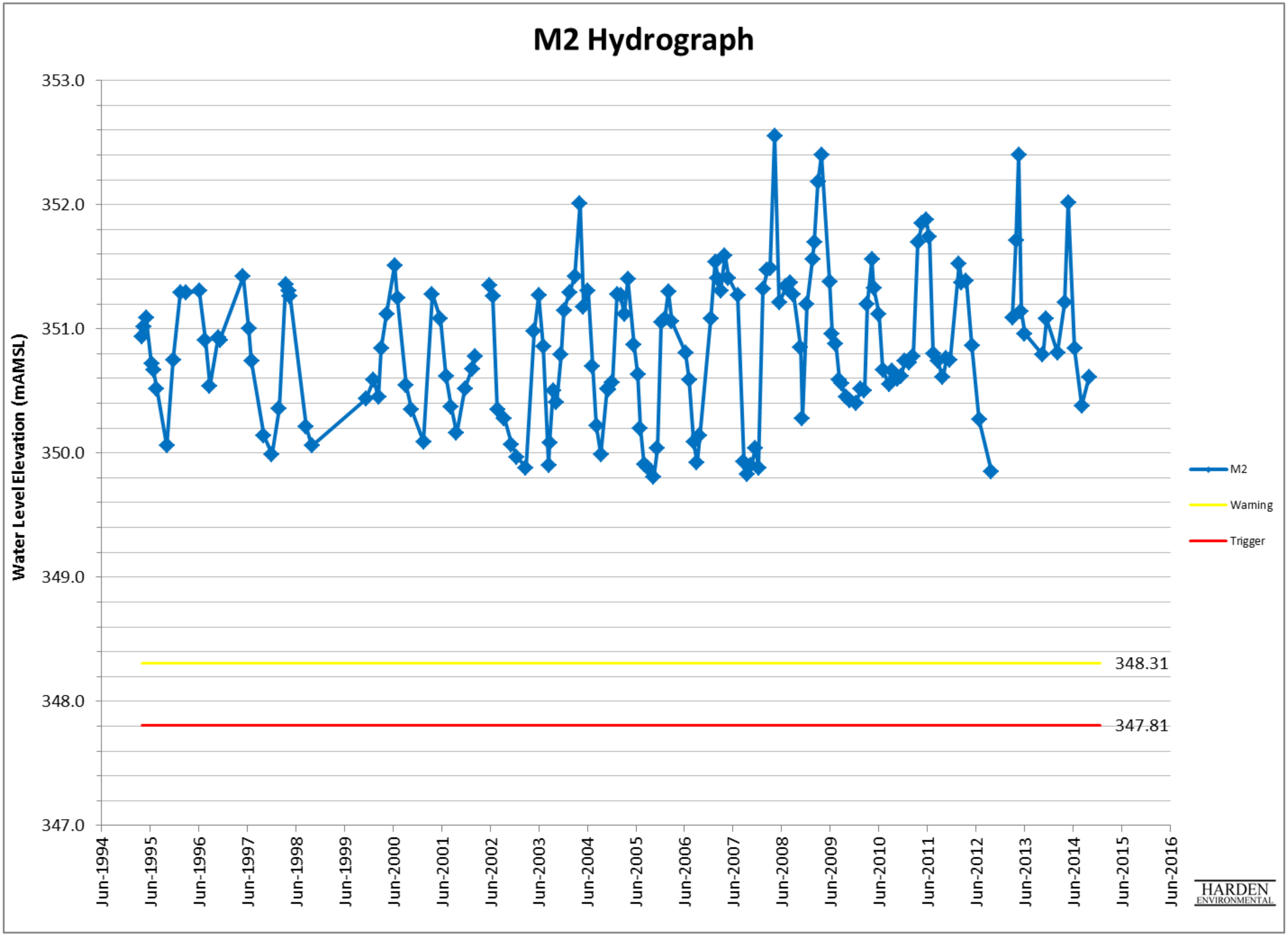
Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C1:

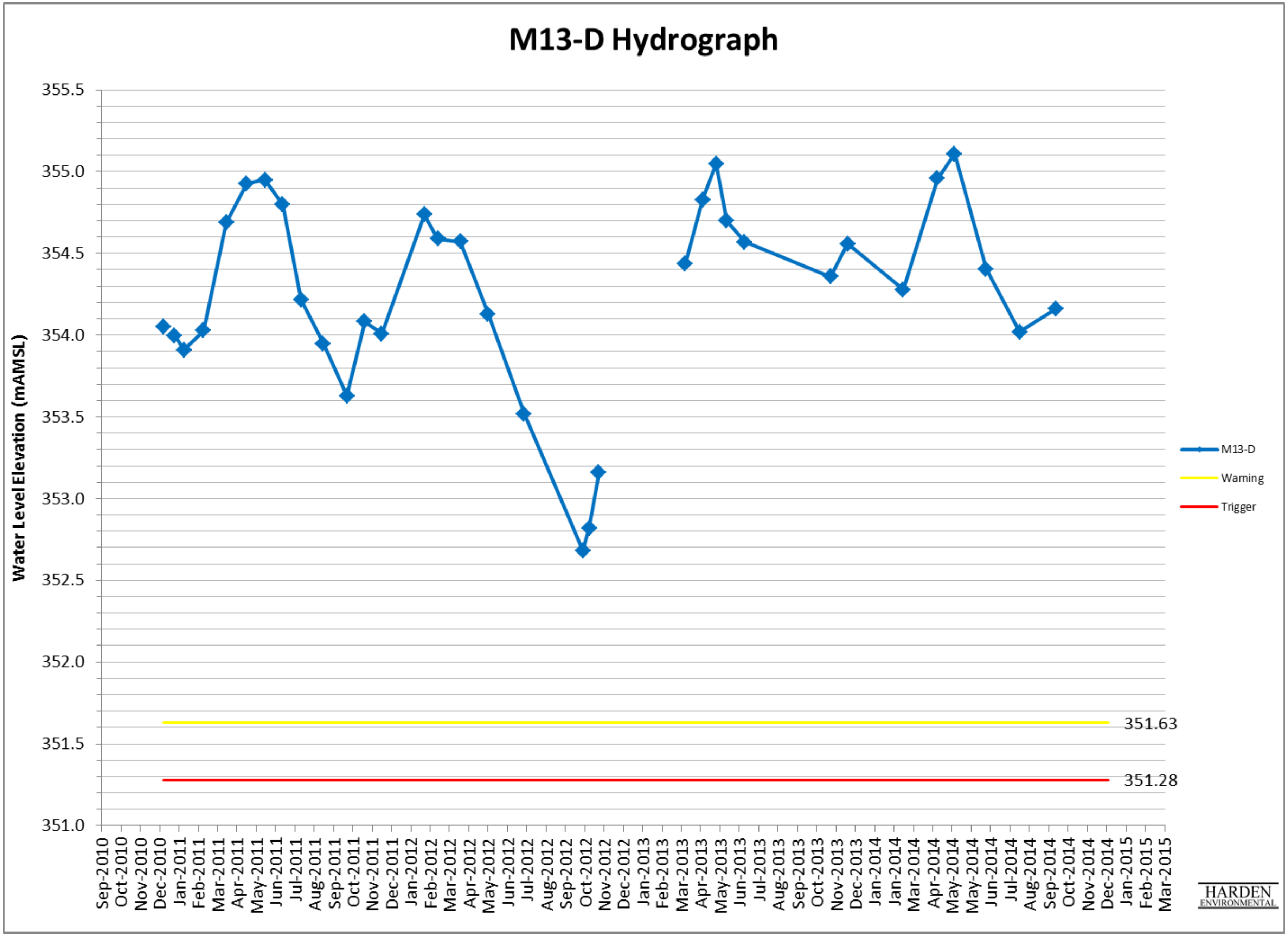
Monitoring Locations



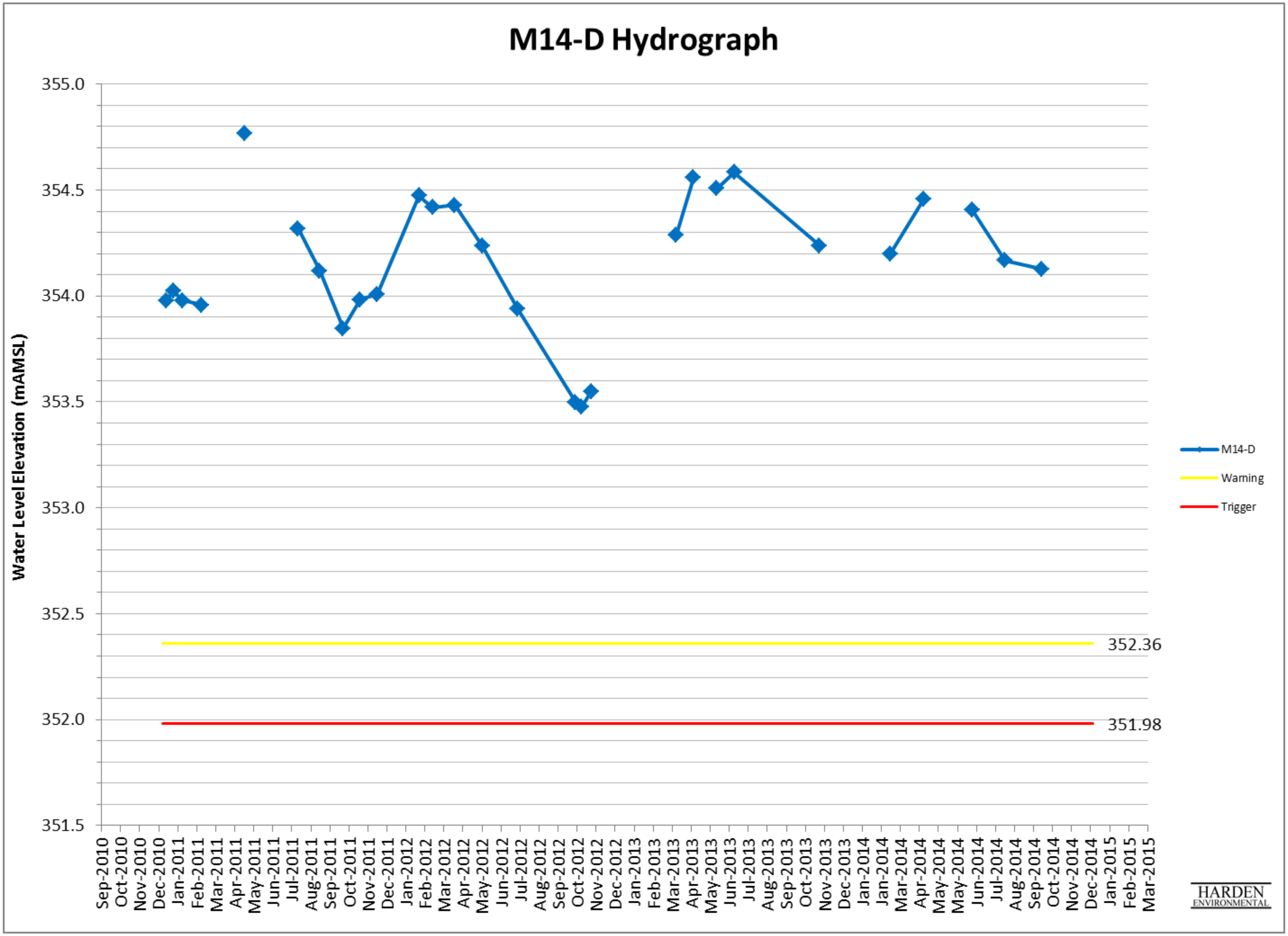
Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C2: M1D Trigger Level**
	Date: Nov 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C3: M2 Trigger Level**
	Date: Nov 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C4: M13D Trigger Level**
	Date: Nov 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.

Project No: 9506

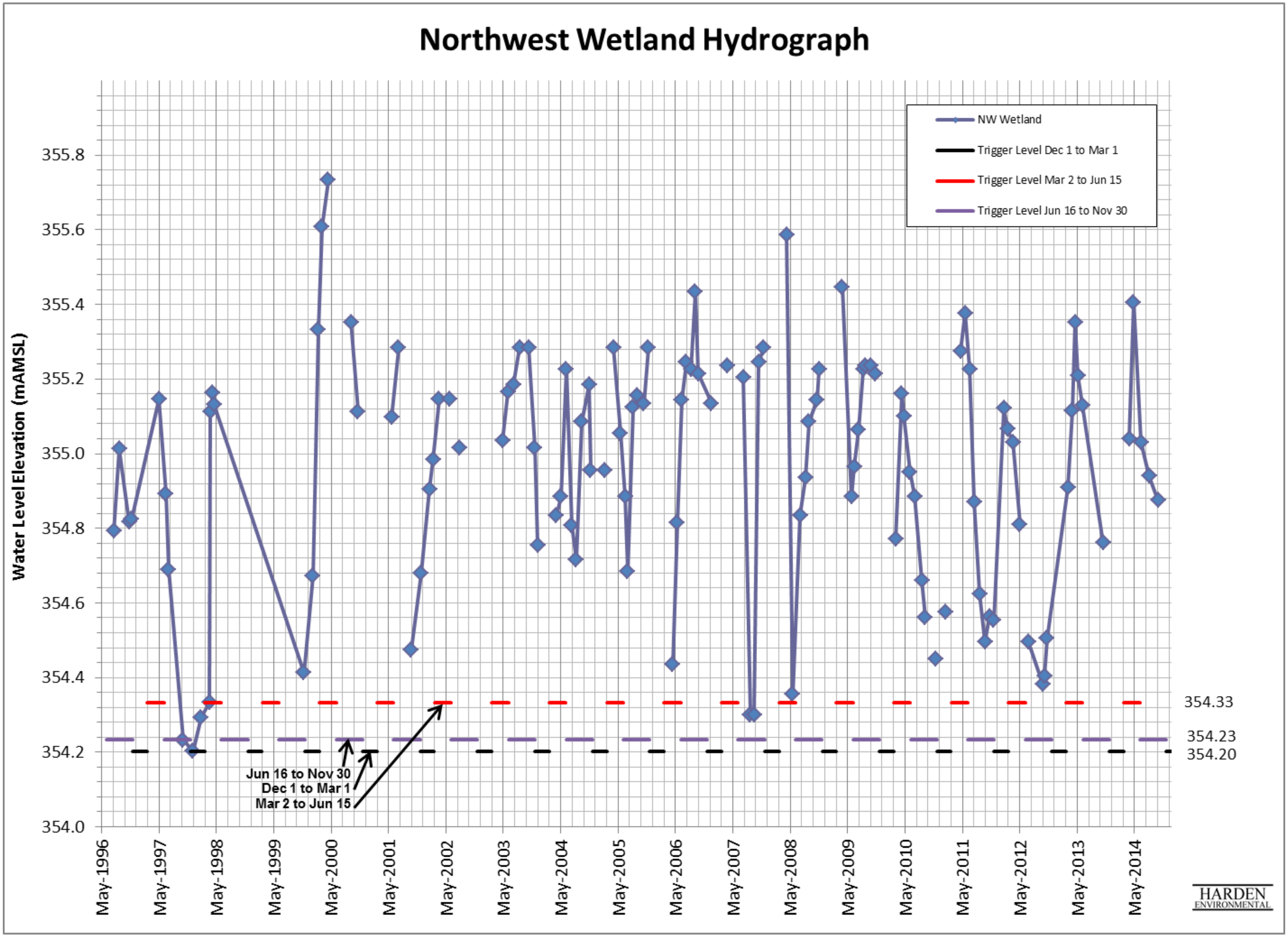
Date: Nov 2014

Drawn By: AR

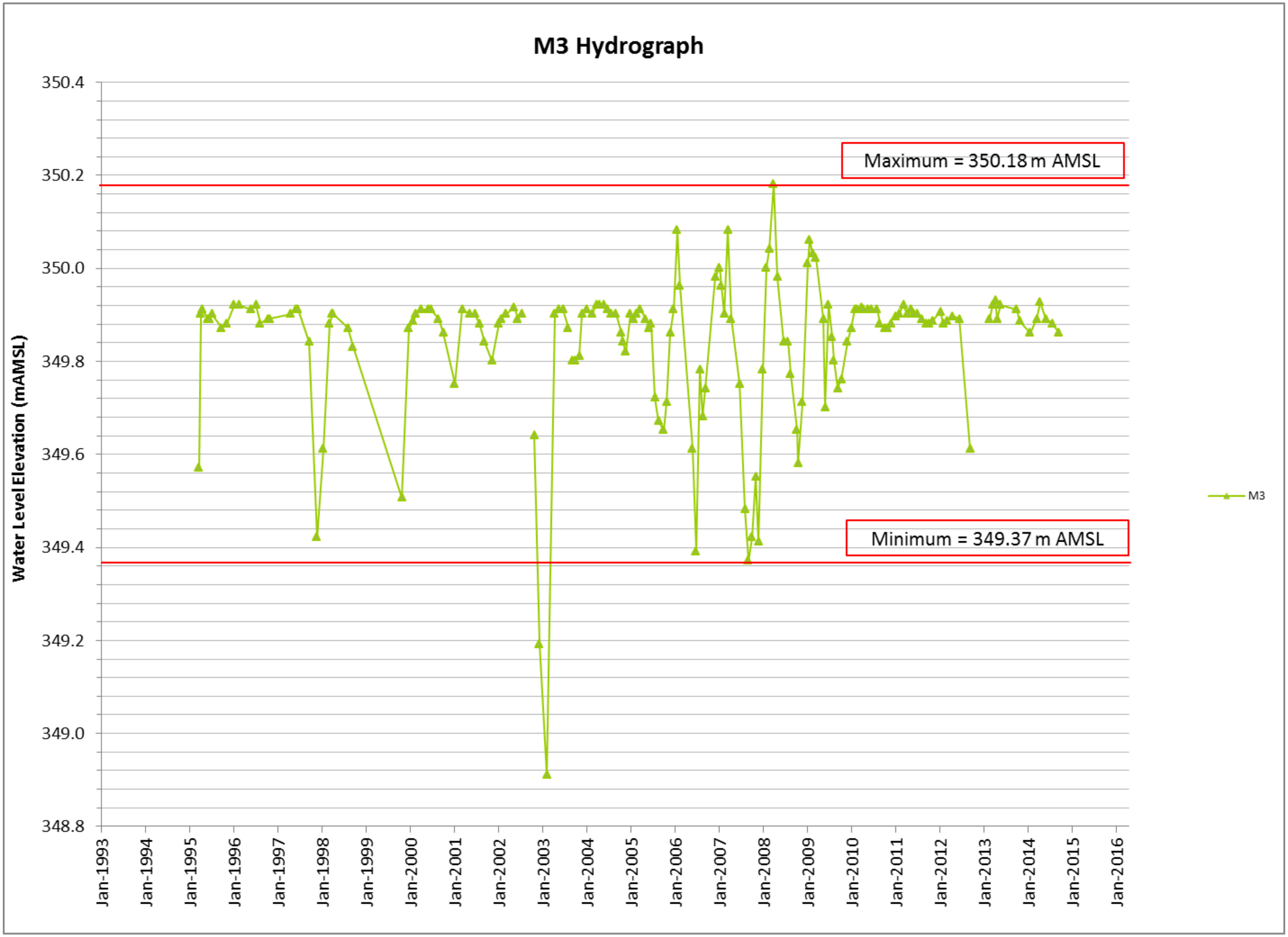
Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

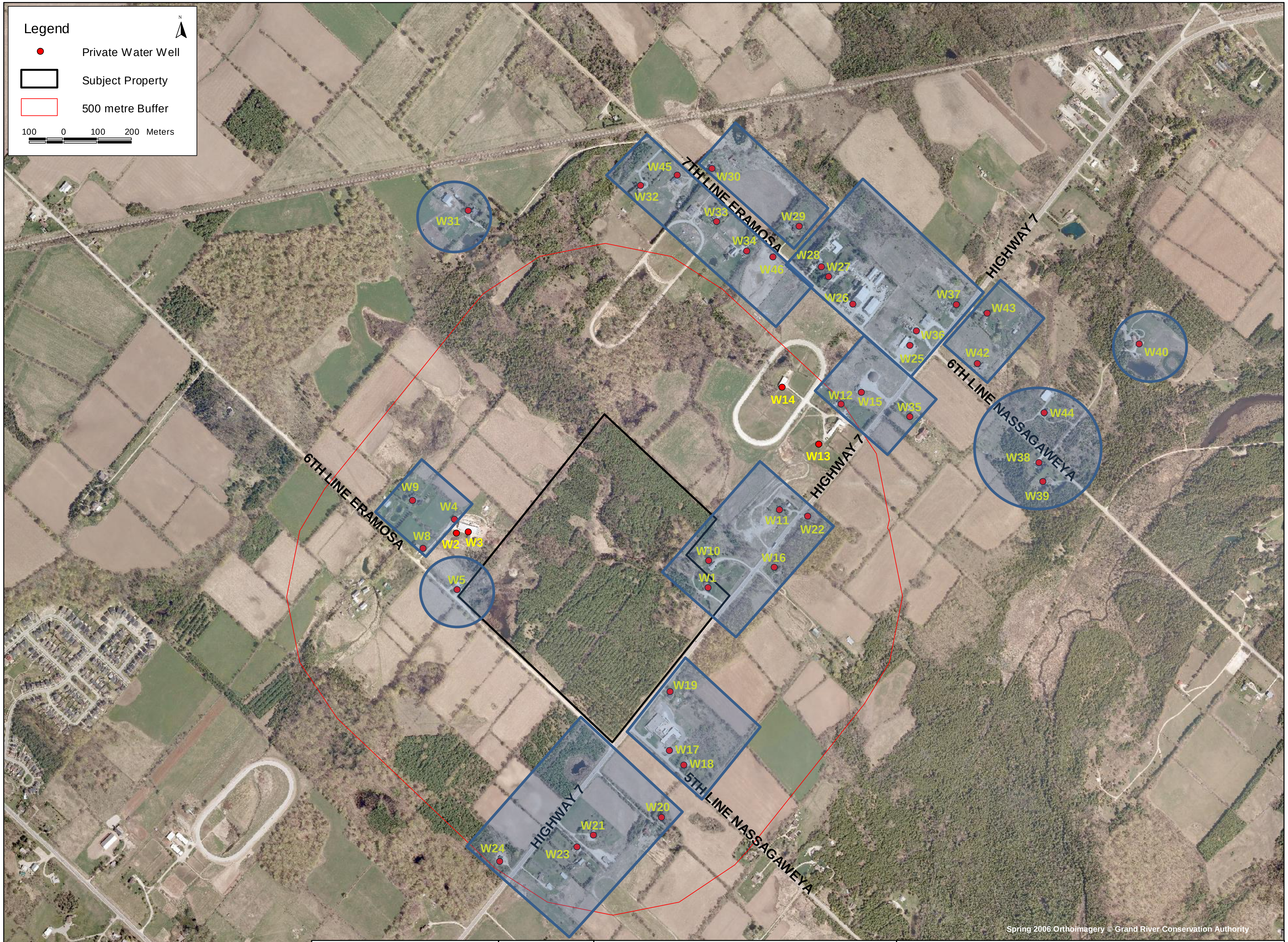
Figure C5: M14D Trigger Level



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C6: Northwest Wetland Trigger Levels**
	Date: Nov 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	**Figure C7: M3 Hydrograph**
	Date: Nov 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	
	Drawn By: AR		



Harden Environmental Services Ltd.

Project No: 9506

Date: Dec 2014

Drawn By: SD

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure C8:

Proposed Pre Quarry Well Survey Locations

Appendix A

Water Well Complaint Protocol

Hidden Quarry

James Dick Construction Ltd. has committed to remedying any and all issues arising as a result of quarry activities. The following complaint protocol will be followed;

Complaints about water well issues will be received any time at ___ ______. Text messages can be sent to ___ ___ ____ or email to ____@____.

James Dick Construction Ltd. has a water well contractor on stand-by to address any water quantity or quality issue that arises.

In the event of a water shortage a supply of bottled water for drinking/cooking will be delivered within 12 hours of the complaint and an alternative water supply will be delivered within 24 hours of the complaint being received.

Within 48 hours, JDCL will initiate a hydrogeological investigation conducted by an independent hydrogeologist to determine the cause of the water issue. The investigation will include but not be limited to the following actions;

- Confirmation of water levels in on-site groundwater monitoring wells
- Review of historical trends in groundwater levels and groundwater quality obtained in on-site groundwater monitoring wells.
- Review of historical measured precipitation rates
- Interview with resident regarding well complaint
- Investigation of subject well including flow testing, water level measurements and water quality testing if necessary
- Written report summarizing the findings.

In the event that quarry activities are likely to be the cause of the complaint, James Dick Construction will undertake appropriate mitigative measures such as;

- Lowering the level of the pump within the well
- Extending the cased portion of the well
- Deepening the well
- Well replacement
- Water Treatment
- Modification of quarry activities.

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Memorandum

To: David Hopkins, R.J. Burnside and Associates Ltd.

Cc: Greg Sweetnam, Leigh Mugford, Kim Wingrove

From : Stan Denhoed, P.Eng., M.Sc.

Date: January 8, 2015

Re: Hidden Quarry: Specific Well Contingency Plans

The attached Table 1 contains information of individual wells from well surveys and water well records. Figure 1 shows the locations of the wells and Appendix A contains the available water well records.

Confirmation and updating of these details will made prior to aggregate extraction, however, there is no indication that any private well is susceptible to loss/reduction of water supply as a result of the quarry development. Nonetheless, there are contingency measures available to remedy any loss of yield in private wells. The contingency measures for decreased yield or loss of well yield include;

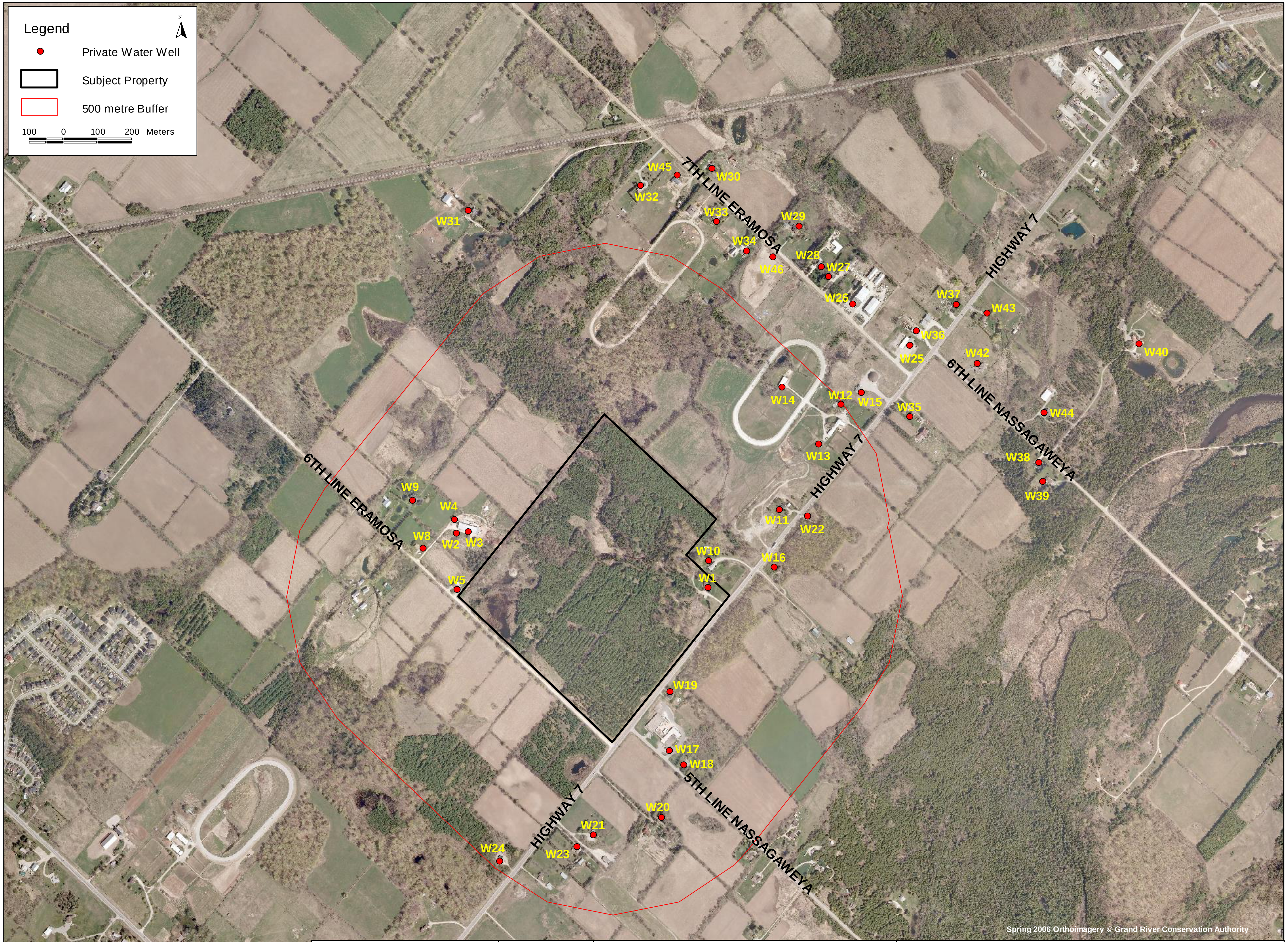
1) re-setting of pump to a lower depth or
2) drilling of a new well.

Excellent quality water is available throughout the aquifer as determined from on-site testing and testing of private wells. There are only five wells located along Hwy 7 and 5th Line Nassagaweya where water quality might involve the quarry property as all other wells receive water that flows around the property. Therefore, the quarry will not be capable of having an impact on the water quality of the majority of wells near to the property, including those on the 6th and 7th Line Eramosa. Nonetheless, two comprehensive water quality samples will be obtained from all nearby wells as a precautionary measure, thereby providing a 'before' characterization of the water quality. The contingency measures for loss of water potability include;

1) Addition of water purification such as UV Light, chlorination, water softeners and iron filters, or

2) Limiting the inflow of water to the well to sections of the aquifer below the proposed quarry depth. This can be achieved by the installation of a steel liner in existing wells or by drilling new wells with steel casings installed to depths below the proposed quarry.

It is our opinion that the need for a contingency is unlikely for any private well, however, if necessary; any of these contingencies can be used for any private well to ensure maintenance of existing conditions or improved water quantity and quality.



Harden Environmental Services Ltd.	**Project No:** 9506	Hydrogeologic Impact Assessment Proposed Aggregate Extraction	Figure 1:
	Date: Dec 2014	Part of Lot 1, Concession 6 Township of Guelph/Eramosa, County of Wellington	**Proposed Pre Quarry Well Survey Locations**
	Drawn By: SD		

Table 1: Results of Private Well Survey

Well Identifier	W1	W4	W5	W8	W9	W10	W11	W12	W15
Address	8532 Hwy 7	4949 6th Line Eramosa	4943 6th Line Eramosa	4953 6th Line Eramosa	4963 6th Line Eramosa	8540 Hwy 7	8554 Hwy 7	8572 Hwy 7	MTO Works Yard Hwy 7 & 7th Line
Township/Town	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa
County/Region	Wellington	Wellington	Wellington	Wellington	Wellington	Wellington	Wellington	Wellington	Wellington
Concession	6	6	6	6	6	6	6	6	6
Lot	1	2	2	2	2	1	1	1	1
Well Record No.	6705424	6712824	6707545	unknown	6708039	6705627	6705003	6707178	6700487
Wellhead Condition	Pit with Concrete Lid	Steel Casing	Pit with Concrete Lid	Pit with Concrete Lid	Steel Casing	Pit with Concrete Lid	Buried	Steel Casing	unknown
Observations	In well pit 1.73 metres below grade, well seal replaced November 2014, septic system upgradient	Appropriate stick-up, water use is domestic and commercial (mushroom irrigation)	In well pit approx 6 feet below grade inside concrete casing, new septic 2006	In well pit approx 6 feet below grade inside concrete casing	Vermin ingress opportunity at electrical connection in well cap, vermin proof wellhead installed Dec 4 2014, stick-up 0.55 metres, bacteria sampled Nov 10 & 25, 2014	Behind house in well pit, two pipes and breather, tidy, water quality issue with iron	West side of house buried beneath lawn or garden, owner reported 2 days of brown water and air in pipes Nov 6-8 2014 (first time event)	Steel above ground casing, stick-up 0.27m, owner reported issues with hardness, some iron staining	Location of well unknown, reported depth 46.6m
Contingency Plan	No changes to well will be necessary as a result of quarry activity. UV Light is installed and water level expected to rise.	Well is very deep and if pump installed to recommended settting there are already more than sixteen metres of water above the pump. Well is accessible. Pump can be set lower if necessary.Water sourced from area north of the well and no water quality changes will occur.	Approximately 4.5 metres to the recommended pump setting but more than 14 metres of available drawdown to well bottom. Well produces high yield with little drawdown according to well record. Pump can be set lower if necessary. Water sourced from area north of the well and no water quality changes will occur.	There are approximately 29 metres of water above the bottom of the well. Well is accessible. Pump setting unknown but can be moved down if necessary.Water sourced from area north of the well and no water quality changes will occur.	Approximately 7 metres available drawdown above the recommended pump setting. High yielding well, little drawdown during pumping for sixty minutes. Pump is accessible and can be moved downward if necessary.Water sourced from area north of the well and no water quality changes will occur.	Water level expected to rise in the well. No change necessary for pump setting. Well is accessible. Chlorination system is installed. If water quality decreases can extend casing or drill new well with casing set below depth of quarry.	Water level expected to rise in the well. System is UV light protected. If necessary casing can be extended in existing well or new well drilled with casing below quarry depth.	Water level expected to decrease by less than 0.2 metres in the well. Well is very deep and pump can be set lower if necessary. Water sourced from area east of the quarry therefore no water quality issues can arise.	Water level expected to decrease by less than 0.2 metres in the MTO works yard well. Well is very deep with approximatley 20 metres of available drawdown to recommended pump settingd depth. Water sourced from an area east of 7th Line Eramosa, therefore no quality impact can occur.
Water Treatment	none	softener	softener	none	none	chlorinator, non-operational softener	UV light, softener	unknown	unknown
Date Well Completed	11-Feb-75	23-Nov-98	13-Aug-81	unknown	17-Aug-83	24-Jul-74	27-Mar-74	21-Sep-79	29-Jul-63
Pump Type	Submersible	Submersible	Submersible	unknown	Submersible	Jet	Submersible	unknown	unknown
Well Depth (metres)	30.48	39.62	18.9	33.20	21.34	28.96	30.48	38.1	46.63
Recommended Pump Setting (metres)	21.34	24.38	9.14	unknown	12.19	21.34	24.38	19.81	30.48
Measured Static Water Level (metres)	12.41	7.71	access denied	4.18	4.94 / 5.24	inaccessible	inaccessible	9.79	inaccessible
Measured Static Water Level Date	01-Nov-11	04-Nov-11	access denied	29-Apr-98	29Apr98/4Dec14	inaccessible	inaccessible	04-Nov-11	inaccessible
Static Water Level from Well Record (metres)	13.11	7.92	4.57	unknown	5.49	8.84	13.72	10.67	10.97
Available Drawdown to Well Bottom (metres)	18.07	31.91	14.33	29.02	16.1	20.12	16.76	28.31	35.66
Available Drawdown to Recommended Pump Setting (metres)	8.93	16.67	4.57	unknown	6.95	12.5	10.66	10.02	19.51
Ground Elevation (m AMSL)	358.46	361.33	360.00	359.99	360.00	357.00	361.00	362.74	363.00
Well Depth Elevation (m AMSL)	327.98	321.71	341.10	326.79	338.66	328.04	330.52	324.64	316.37

Table 1: Results of Private Well Survey

Well Identifier	W16	W17	W18	W19	W20	W21	W22	W23	W24
Address	5134 Hwy 7	14321 5th Line Nassagaweya	14297 5th Line Nassagaweya	5036 Hwy 7	4300 Hwy 7	4264 Hwy 7	5198 Hwy 7	4248 Hwy 7	8470 Hwy 7
Township/Town	Milton	Milton	Milton	Milton	Milton	Milton	Milton	Milton	Guelph/Eramosa
County/Region	Halton	Halton	Halton	Halton	Halton	Halton	Halton	Halton	Wellington
Concession	6	6	6	6	5	5	6	5	5
Lot	32	32	32	32	32	32	32	32	1
Well Record No.	2805483	2803457	2802049	2802048	unknown	2803220	7187172	unknown	6715120
Wellhead Condition	Steel Casing	Pit with Concrete Lid	Buried	Pit with Concrete Lid	unknown	Pit with Concrete Lid	Steel Casing	unknown	Steel Casing
Observations	Steel casing with stick-up of 0.63 metres	Concrete lid is cracked	Buried in front garden area 3 feet from front of house	Close to house on east side in well pit 9 feet below grade, bacteria issues in 1996	New well drilled in October 2014, old well was in well pit (20.9m deep, static water level 9.20m, Apr 1998), no response from owners to Harden request made Nov 6, 2014 to sample and survey new well	South side of house with wishing well and concrete cover. Septic on east side. Use pickled sand for driveway.	Well head in good shape, appropriate stick-up. Very little available drawdown.	Well behind house. Concrete cover is very low to ground with grass all around.	Well is 2.7m west of SW corner of house, stick-up 0.25m, cap is not vermin proof
Contingency Plan	Relatively shallow drilled well but in an area where water levels will increase. Potential for water quality change therefore contingency includes installing UV light protection drilling new well with casing extending below quarry level.	Water level expected to rise at the Systems Fencing property. If water quality issues arise contingency plans include installing UV light protection or the well can be redrilled and casing extended below the depth of the quarry.	Water level expected to rise at the Poelstra property. If water quality issues arise the well contingency plans include installing UV light protection or well can be redrilled/replaced and casing extended below the depth of the quarry.	Water level expected to rise at the well. If water quality issues arise the well can be redrilled and casing extended below the depth of the quarry.	New well recently drilled, no information available at this time. Well contingency plans include installing UV light protection. Well is 6" in diameter and a 5" sleeve can be installed to limit inflow of water from a greater depth.	Water level expected to rise at the well. Static water level is relatively low in comparison to recommended pump setting. If water quality issues arise well contingency plans include installing UV light protection.	Water level expected to rise at the well. Static water level is very similar to recommended pump setting. Well is high yeilding from fracture near the bedrock surface. If water quality issues arise we recommend a new well (or redrilled well) with casing extending beneath quarry depth.	Water level expected to rise at the well. Should water quality issues arise we recommend installing UV light protection.	Water level expected to rise at the well. Well depth is relatively shallow. Well can be drilled deeper or replaced with new well.
Water Treatment	none	none	none	UV light, reverse osmosis, softener	unknown	softener	UV light, charcoal filter, softener	none	unknown
Date Well Completed	17-Dec-79	21-Aug-70	06-Sep-66	14-Jul-59	October 2014	19-Sep-69	05-Jun-12	unknown	15-Aug-04
Pump Type	Submersible	Submersible	Submersible	Jet	unknown	Jet	Submersible	unknown	unknown
Well Depth (metres)	14.63	31.7	22.86	20.12	unknown	21.03	18.29	unknown	8.84
Recommended Pump Setting (metres)	14.02	15.24	15.24	9.14	unknown	16.76	16.76	unknown	6.00
Measured Static Water Level (metres)	7.71	inaccessible	inaccessible	9.63	unknown	inaccessible	not taken	access denied	5.79
Measured Static Water Level Date	10-Nov-11	inaccessible	inaccessible	25-Apr-12	unknown	inaccessible	not taken	access denied	27-Oct-14
Static Water Level from Well Record (metres)	8.23	9.14	10.67	8.53	unknown	13.72	16.49	unknown	5.10
Available Drawdown to Well Bottom (metres)	6.92	22.56	12.19	11.59	unknown	7.31	1.80	unknown	3.05
Available Drawdown to Recommended Pump Setting (metres)	6.31	6.10	4.57	0.61	unknown	3.04	0.27	unknown	0.21
Ground Elevation (m AMSL)	353.37	354.18	354.00	355.52	357.00	361.00	360.00	355.00	356.00
Well Depth Elevation (m AMSL)	338.74	322.48	331.14	335.40	unknown	339.97	341.71	unknown	347.16

Table 1: Results of Private Well Survey

Well Identifier	W25	W26	W27	W28	W29	W30	W31	W32	W33
Address	4907 7th Line Eramosa	4917, 4919 and 4921 7th Line Eramosa	4923 7th Line Eramosa	4925 7th Line Eramosa	4935 7th Line Eramosa	4961 7th Line Eramosa	4970 7th Line Eramosa	4964 7th Line Eramosa	4952 7th Line Eramosa
Township/Town	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa	Guelph/Eramosa
County/Region	Wellington	Wellington	Wellington	Wellington	Wellington	Wellington	Wellington	Wellington	Wellington
Concession	7	7	7	7	7	7	6	6	6
Lot	1	1	1	1	1	2	3	2	2
Well Record No.	6703720	6710793/6713908	6704980	6704349	6705878	unknown	unknown	6703695/6703839	6703540/7172745
Wellhead Condition	unknown	unknown	unknown	unknown	unknown	unknown	Dug Well Vermin Proof Lid	unknown	unknown
Observations	Measuring point top of casing, well location south side of office	Well location in front of office, 6710793 is domestic use / 6713908 is commercial use	Well location in front of house	Reportedly approx 50m deep, well location south side of house	Reportedly approx 25m deep, well location behind house	Well location southeast corner of house	Well location in front of house, stick-up 0.57m, new casing extension and vermin proof lid installed May 22, 2012, previous wellhead not vermin proof and near ground surface level	Well location in front of house, well records appear to be duplicates	Measuring point top of casing, well location south side of house, casing extended above ground as described in Well Record No. 7172745
Contingency Plan	Water levels expected to decrease by less than 0.4 metres at the well. Well is relatively deep with a high static water level. Source area for the well is east of 7th Line therefore no water quality changes can occur. Pump can be lowered if necessary.	Water levels expected to decrease by less than 0.4 metres at the well. Well is relatively deep with a high static water level. Source area for the well is east of 7th Line therefore no water quality changes can occur.Pump can be lowered if necessary.	Water levels expected to decrease by less than 0.4 metres at the well. Well is relatively deep with a high static water level. Source area for the well is east of 7th Line therefore no water quality changes can occur.Pump can be lowered if necessary.	Less than 0.40 metres of water level change expected at the well. Well is relatively deep with a high static water level. Pump can be set lower. Source area for the well is east of 7th Line therefore no water quality changes can occur.	Less than 0.40 metres of water level change expected at the well. Well is relatively deep with a high static water level. Pump can be set lower. Source area for the well is east of 7th Line therefore no water quality changes can occur.	'Less than 0.40 metres of water level change expected at the well. 7.5 metres of available water above well bottom. Water is sourced from an area east of 7th Line. No water quality change can occur. Pump can be lowered if necessary.	Shallow dug well with less than 0.70 metres of water. Expected to have approximatley 0.55 m of water level change in the bedrock aquifer. Water sourced from area north and east of well therefore no water quality change can occur. Contingency plan includes drilling of new well.	Very deep well with more than 40 metres of water available depending on pump setting. Less than 0.4 metres of predicted water level change therefore no impact anticipated. Water sourced from areas east of 7th Line Eramosa therefore no water quality change expected. Contingecy measures include setting pump lower.	More than tweny metres of available water in the well depending on actual pump setting. Water sourced from areas east of 7th Line. Contingency plan includes lowering the pump setting.
Water Treatment	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Date Well Completed	09-Apr-70	15-Oct-91	02-Jan-74	23-Aug-72	07-Aug-75	unknown	unknown	13-May-70	04-Aug-69
Pump Type	unknown	unknown	unknown	unknown	unknown	unknown	Jet	unknown	unknown
Well Depth (metres)	30.48	44.50	22.25	26.21	24.38	12.50	3.78	48.16	24.38
Recommended Pump Setting (metres)	29.26	21.34	7.62	15.24	22.86	unknown	unknown	15.24	15.24
Measured Static Water Level (metres)	4.78	3.15	not taken	not taken	not taken	5.00	3.11	not taken	3.54
Measured Static Water Level Date	3-Oct-95	3-Oct-95	not taken	not taken	not taken	3-Oct-95	5-Oct-12	not taken	4-Jun-98
Static Water Level from Well Record (metres)	5.49	4.88	2.13	3.66	2.44	unknown	unknown	4.27	4.57
Available Drawdown to Well Bottom (metres)	25.70	41.35	20.12	22.55	21.94	7.50	0.67	43.89	20.84
Available Drawdown to Recommended Pump Setting (metres)	24.48	18.19	5.49	11.58	20.42	unknown	unknown	10.97	11.70
Ground Elevation (m AMSL)	362.12	360.00	361.50	363.00	365.00	371.00	365.00	367.00	366.00
Well Depth Elevation (m AMSL)	331.64	315.50	339.25	336.79	340.62	358.50	361.22	318.84	341.62

Table 1: Results of Private Well Survey

Well Identifier	W34	W35	W36	W37	W38	W39	W40	W42	W43
Address	4944 7th Line Eramosa	5290 Hwy 7	8610 Hwy 7	8616 Hwy 7	14200 6th Line Nassagaweya	14184 6th Line Nassagaweya	14211 6th Line Nassagaweya	14413 6th Line Nassagaweya	5388 Hwy 7
Township/Town	Guelph/Eramosa	Milton	Guelph/Eramosa	Guelph/Eramosa	Milton	Milton	Milton	Milton	Milton
County/Region	Wellington	Halton	Wellington	Wellington	Halton	Halton	Halton	Halton	Halton
Concession	6	6	7	7	6	6	7	7	7
Lot	2	32	1	1	32	32	32	32	32
Well Record No.	6704252	unknown	6700504	unknown	unknown	2803030	2803959	2810143	unknown
Wellhead Condition	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Observations	Location of well unknown	Measuring point top of casing, well location behind barn	Well location inside auto body shop	Reportedly 20m deep, well location east corner of house	Well location in front of house	Reportedly 30m deep, well location in behind house	Reportedly 35m deep, static level near top, issues with hardness, occasionally goes dry in long droughts		
Contingency Plan	Less than 0.40 metres of water level change expected at the well. Well is relatively deep with a high static water level. Pump can be set lower if necessary. Source area for the well is east of 7th Line therefore no water quality changes can occur.	Approximately 0.10 m water level change anticipated. Source area for the well is north and east of the well. Historic issues with elevated nitrate. Contingency plans include setting pump lower.	Approximately 0.10 m water level change anticipated. Source area for the well is north and east of the well. Contingency plans include setting pump lower.	Approximately 0.10 m water level change anticipated. Source area for the well is north and east of the well. Contingency plans include setting pump lower.	No significant water level change anticipated. Source area for the well is north and east of the well. Contingency plans include setting pump lower.	No significant water level change anticipated. Well has more than ten metres of water above recommended pump setting. Source area for the well is north and east of the well. Contingency plans include setting pump lower.	No significant water level change anticipated. Well has more than twenty-five metres of water above recommended pump setting. Source area for the well is north and east of the well. Contingency plans include setting pump lower.	No significant water level change anticipated. Well has more than twenty-five metres of water above recommended pump setting. Source area for the well is north and east of the well. Contingency plans include setting pump lower.	No significant water level change anticipated. Source area for the well is north and east of the well. Contingency plans include setting pump lower.
Water Treatment	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Date Well Completed	14-Jun-72	unknown	02-May-49	unknown	unknown	31-Mar-69	12-Oct-72	02-Nov-04	unknown
Pump Type	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Well Depth (metres)	16.76	22.30	12.19	approx 20 m	unknown	27.43	34.44	44.20	unknown
Recommended Pump Setting (metres)	12.19	unknown	unknown	unknown	unknown	21.34	30.48	30.48	unknown
Measured Static Water Level (metres)	not taken	10.90	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Measured Static Water Level Date	not taken	3-Oct-95	not taken	not taken	not taken	not taken	not taken	not taken	not taken
Static Water Level from Well Record (metres)	3.66	unknown	4.57	unknown	unknown	10.67	4.57	5.18	unknown
Available Drawdown to Well Bottom (metres)	13.10	11.40	7.62	unknown	unknown	16.76	29.87	39.02	unknown
Available Drawdown to Recommended Pump Setting (metres)	8.53	unknown	unknown	unknown	unknown	10.67	25.91	25.30	unknown
Ground Elevation (m AMSL)	366.00	364.00	361.00	357.00	351.00	347.00	353.00	356.00	354.00
Well Depth Elevation (m AMSL)	349.24	341.70	348.81	unknown	unknown	319.57	318.56	311.80	unknown

Table 1: Results of Private Well Survey

Well Identifier	W44	W45	W46
Address	14301 6th Line Nassagaweya	4960 7th Line Eramosa	4936 7th Line Eramosa
Township/Town	Milton	Guelph/Eramosa	Guelph/Eramosa
County/Region	Halton	Wellington	Wellington
Concession	7	6	6
Lot	32	2	1
Well Record No.	2807654	6715237	6712825 / 6712826 / 7043462
Wellhead Condition	unknown	unknown	unknown
Observations			6712825 and 6712826 are test wells, 7043462 is domestic
Contingency Plan	No significant water level change anticipated. Well has more than eleven metres of water above recommended pump setting. Source area for the well is north and east of the well. Contingency plans include setting pump lower.	Deep well with more than nineteen metres of water available depending on pump setting. Less than 0.4 metres of predicted water level change therefore no impact anticipated. Water sourced from areas east of 7th Line Eramosa therefore no water quality change expected. Contingecy measures include setting pump lower.	Deep well with more than nineteen metres of water available depending on pump setting. Less than 0.4 metres of predicted water level change therefore no impact anticipated. Water sourced from areas east of 7th Line Eramosa therefore no water quality change expected. Contingecy measures include setting pump lower.
Water Treatment	unknown	unknown	unknown
Date Well Completed	01-Aug-90	21-Oct-04	17-Apr-07
Pump Type	unknown	unknown	unknown
Well Depth (metres)	26.52	36.58	25.30
Recommended Pump Setting (metres)	15.24	24.38	22.86
Measured Static Water Level (metres)	not taken	not taken	not taken
Measured Static Water Level Date	not taken	not taken	not taken
Static Water Level from Well Record (metres)	3.66	4.57	3.66
Available Drawdown to Well Bottom (metres)	22.86	32.01	21.64
Available Drawdown to Recommended Pump Setting (metres)	11.58	19.81	19.20
Ground Elevation (m AMSL)	352.00	368.00	365.00
Well Depth Elevation (m AMSL)	325.48	331.42	339.70

Appendix A

Water Well Records

Ontario

W1-8532 Hwy 7

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

40PKE

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

11 | 6705424 | MUNICIP. 67002 | CON. CON | 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
Wellington	Eramosa	conc. 6	001

[redacted] x 7, R.R.# 2, ROCKWOOD, Ontario

DATE COMPLETED 48-53 DAY 11 MO. 02 YR. 75

HING	RC.	ELEVATION	RC.	BASIN CODE	II	III	IV
28271	5	1170	5	23	AUG 05, 1977		323

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Brown	clay, sand	stones		0	25
"	" "	gravel		25	35
L. Brown	rock			35	41
Gray	"			41	100
			Total Depth 100 Feet		

31 00256052812 00356052811 004162675 0100226

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0085	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
0100	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
05"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0036
05"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		36	0100
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE

DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE: 0010 GPM.

DURATION OF PUMPING: 01 HOURS 00 MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
043 FEET	060 FEET	043 FEET	FEET	FEET	FEET

WATER LEVELS DURING: 1 ☐ PUMPING 2 ☒ RECOVERY

IF FLOWING, GIVE RATE: —— GPM.

PUMP INTAKE SET AT: —— FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 070 FEET

RECOMMENDED PUMPING RATE: 0010 GPM.

—— GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL 1

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01

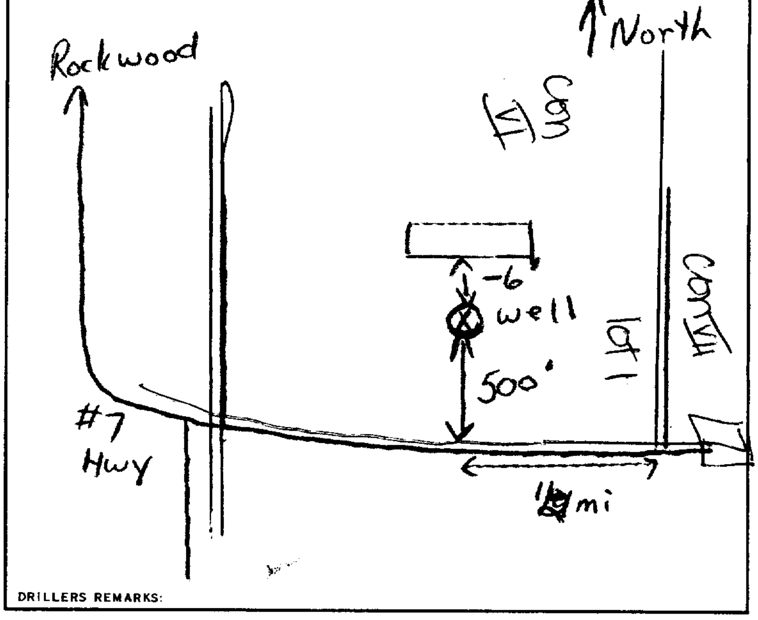
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 1

1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☒ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL 7229

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR	LICENCE NUMBER
GRAHAM WELL DRILLING LIMITED	2336

ADDRESS: 212 Waverley Drive, GUELPH, Ont

NAME OF DRILLER OR BORER	LICENCE NUMBER
J. Hawkins & 10-R 2271	

SIGNATURE OF CONTRACTOR: R.H. Graham

SUBMISSION DATE: DAY 11 MO. 2 YR. 75

OFFICE USE ONLY

DATA SOURCE	CONTRACTOR	DATE RECEIVED
1	2336	070375

DATE OF INSPECTION

INSPECTOR

REMARKS:

P KP

WI
CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM 7 MOE 07-091

Ministry of Environment and Energy
Ontario

W4-4949 6th Line

The Ontario Water Resources Act
WATER WELL RECORD

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

11 (1 2)

6712824

Municipality 67002 (10 14) Con. CON 06 (15 22 23 24)

County or District	Township/Borough/City/Town/Village	Con block tract survey, etc.	Lot 25-27
WELLINGTON	ERAMOSA	VI	2
[redacted]	Address RR2 ROCKWOOD ONT. N0B 2K0	Date completed 23 day 11 month 98 year (48-53)	

21 (1 2) | U T M 10 12 17 | Northing 18 24 | RC 25 | Elevation 26 30 | RC | Basin Code 31 ii iii iv 47

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth – feet From	Depth – feet To
	GRAVEL	BOULDERS		0	20
	CLAY	STONES, SAND LAYERS		20	29
GR.	LIMESTONE			29	120
BR. & GR.	LIMESTONE			120	130

31
32
10 14 15 21 32 43 54 65 75 80

41 WATER RECORD

Water found at – feet	Kind of water
100 & 125 (10-13)	1 ☒ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas (14)
(15-18)	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas (19)
(20-23)	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas (24)
(25-28)	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas (29)
(30-33)	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas (34) 80

51 CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth – feet From	Depth – feet To
(10-11) 6 1/4"	1 ☒ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic (12)	.188	0	33'6" (13-16)
(17-18) 6 1/8"	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☒ Open hole 5 ☐ Plastic (19)		33'6"	130 (20-23)
(24-25)	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic (26)			(27-30)

SCREEN

Sizes of opening (Slot No.) 31-33	Diameter 34-38 inches	Length 39-40 feet
Material and type	Depth at top of screen 41-44 feet 30	

61 PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at – feet From	To	Material and type (Cement grout, bentonite, etc.)
10-13	14-17	
18-21	22-25	
26-29	30-33	80

PUMPING TEST

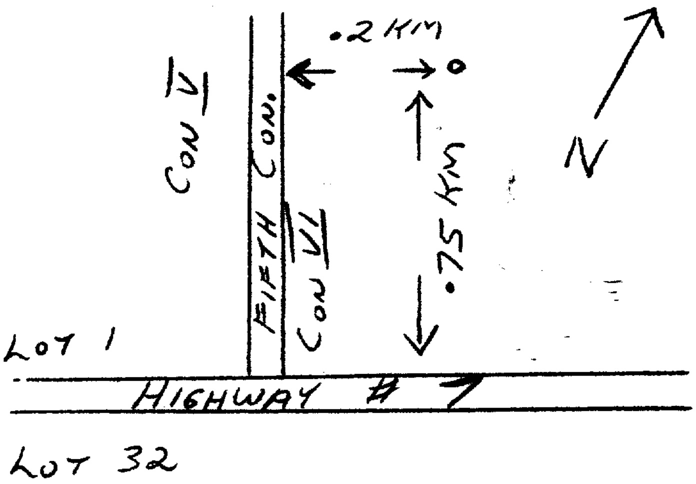
71 Pumping test method AIR (10) 1 ☐ Pump 2 ☐ Bailer
Pumping rate (11-14) GPM
Duration of pumping 1 Hours (15-16) 30 Mins (17-18)

Static level	Water level end of pumping	25 Water levels during 1 ☒ Pumping 2 ☐ Recovery			
		15 minutes	30 minutes	45 minutes	60 minutes
26 feet (19-21)	50 feet (22-24)	50 feet (26-28)	50 feet (29-31)	50 feet (32-34)	50 feet (35-37)

If flowing give rate (38-41) GPM
Pump intake set at feet
Water at end of test (42) ☒ Clear ☐ Cloudy
Recommended pump type ☐ Shallow ☒ Deep
Recommended pump setting (43-45) 80 feet
Recommended pump rate (46-49) 15 GPM
50-53

LOCATION OF WELL

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



192046

TWC 30

FINAL STATUS OF WELL

54
- 1 ☒ Water supply
- 2 ☐ Observation well
- 3 ☐ Test hole
- 4 ☐ Recharge well
- 5 ☐ Abandoned, insufficient supply
- 6 ☐ Abandoned, poor quality
- 7 ☐ Abandoned (Other)
- 8 ☐ Dewatering
- 9 ☐ Unfinished
- 10 ☐ Replacement well

WATER USE

55-56
- 1 ☒ Domestic
- 2 ☐ Stock
- 3 ☐ Irrigation
- 4 ☐ Industrial
- 5 ☐ Commercial
- 6 ☐ Municipal
- 7 ☐ Public supply
- 8 ☐ Cooling & air conditioning
- 9 ☐ Not used
- 10 ☐ Other ....

METHOD OF CONSTRUCTION

57
- 1 ☐ Cable tool
- 2 ☒ Rotary (conventional)
- 3 ☐ Rotary (reverse)
- 4 ☐ Rotary (air)
- 5 ☐ Air percussion
- 6 ☐ Boring
- 7 ☐ Diamond
- 8 ☐ Jetting
- 9 ☐ Driving
- 10 ☐ Digging
- 11 ☐ Other ....

Name of Well Contractor LANG WELL DRILLING LTD	Well Contractor's Licence No. 3317
Address R.R.1 HILLSBURGH ONT	
Name of Well Technician ROY LANG	Well Technician's Licence No. T-0158
Signature of Technician/Contractor R. Lang	Submission date 26 day 12 mo 98 yr

MINISTRY USE ONLY

Data source 58	Contractor 59-62 3317	Date received 63-68 JAN 07 1999	80
Date of inspection	Inspector		
Remarks CSS.ES9			

0506 (07/94) Front Form 9

2 - MINISTER OF ENVIRONMENT & ENERGY COPY

W5-4943 6th Line

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Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

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

(11) 6707545 MUNICIP. 67002 CON. CON 06

COUNTY OR DISTRICT: [redacted]
TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Eramosa
CON., BLOCK, TRACT, SURVEY, ETC: VI
LOT: 002
DATE COMPLETED: DAY 13 MO 08 YR 81

829250 RC 5 ELEVATION 1200 RC 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
	Gravel, Boulders			0	20
Grey	Limestone			20	62

(31) 0020 11 13 0062 2 15

32

(41) WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0060 62	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL #5
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

(51) CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
05"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0029
05	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		29	0062
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

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

61 PLUGGING & SEALING RECORD

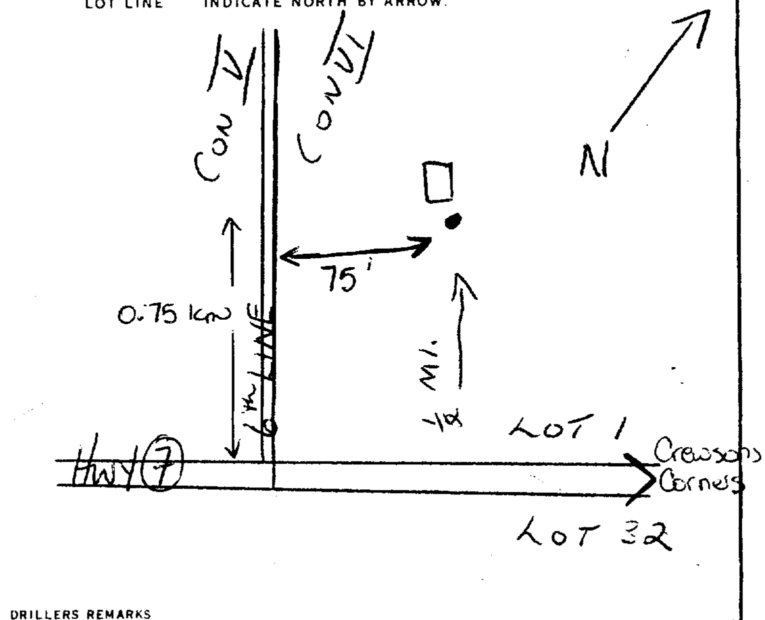
DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER ETC.)

(71) PUMPING TEST

PUMPING TEST METHOD: AIR 1 ☐ PUMP 2 ☒ BAILER
PUMPING RATE: 0015 GPM
DURATION OF PUMPING: 01 HOURS 15 MINS
STATIC LEVEL: 015 FEET
WATER LEVEL END OF PUMPING: 020 FEET
WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY
15 MINUTES: FEET
30 MINUTES: FEET
45 MINUTES: FEET
60 MINUTES: 020 FEET
IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING: 030 FEET
RECOMMENDED PUMPING RATE: 0015 GPM

LOCATION OF WELL

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



DRILLERS REMARKS

FINAL STATUS OF WELL 1
1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 2
1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

NAME OF WELL CONTRACTOR: Lang Well Drilling Ltd.
LICENCE NUMBER: 3317
ADDRESS: R.R.#1 Hillsburgh Ontario
NAME OF DRILLER OR BORER: Roy LANG
LICENCE NUMBER: 3317
SIGNATURE OF CONTRACTOR: Lang
SUBMISSION DATE: DAY 13 MO 8 YR 81

OFFICE USE ONLY
DATA SOURCE: 1
CONTRACTOR: 3317
DATE RECEIVED: 200182
DATE OF INSPECTION: June 26/84
INSPECTOR: KW
REMARKS:

CSS.ES

ISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506-4-77

W9-4963 6th Line

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Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

27/83

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11

6708039

MUNICIP. 67002 CON. CON 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC	LOT W½ 27
[redacted]	FRAMOSA	6	002

[redacted] 2 MILL ST. E ACTON, ONT.

DATE COMPLETED 48-53 DAY 17 MO 08 YR 83

…ING 29400 RC. 5 ELEVATION 1200 RC. 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
TOP	SOIL			0	1
BROWN	CLAY	GRAVEL & STONES		1	18
GRAY	ROCK			18	70
			TOTAL DEPTH	70 ft.	

MOE VE-17

31 0001 02 | 0018605 11 12 | 0070212

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0025	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
0070	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
05"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0025
05"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		25	0070
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
—		

71 PUMPING TEST

PUMPING TEST METHOD 1 ☒ PUMP 2 ☐ BAILER
PUMPING RATE 0025 GPM
DURATION OF PUMPING 01 HOURS 00 MINS

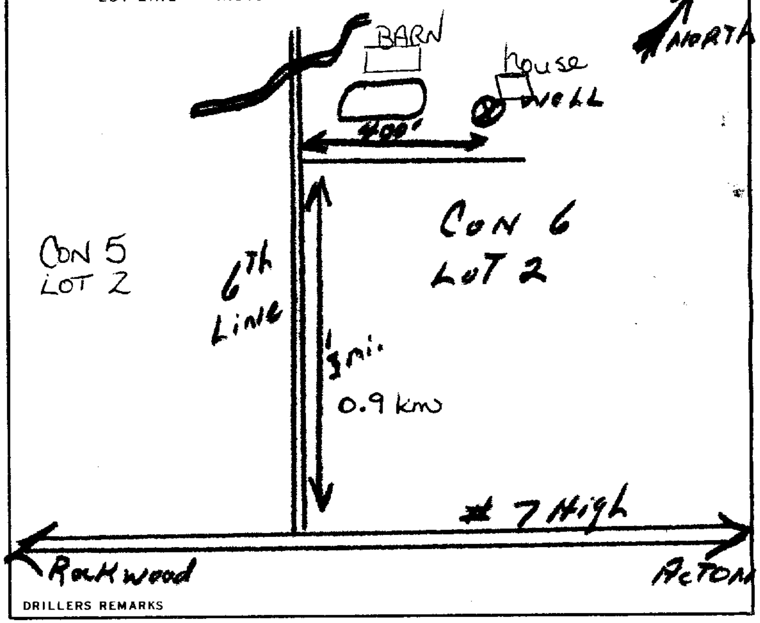
STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
018 FEET	027 FEET	018 FEET	FEET	FEET	FEET

WATER LEVELS DURING 1 ☐ PUMPING 2 ☒ RECOVERY

IF FLOWING, GIVE RATE GPM
PUMP INTAKE SET AT FEET
WATER AT END OF TEST 1 ☒ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING 040 FEET
RECOMMENDED PUMPING RATE 0020 GPM

LOCATION OF WELL

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



DRILLERS REMARKS

FINAL STATUS OF WELL 1
1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 2
1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☒ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

CONTRACTOR
NAME OF WELL CONTRACTOR: GRAHAM WELL DRILLING LTD. LICENCE NUMBER: 2336
ADDRESS: Guelph, ONT.
NAME OF DRILLER OR BORER: R. GRAHAM LICENCE NUMBER:
SIGNATURE OF CONTRACTOR: R. Graham
SUBMISSION DATE DAY 031 MO 08 YR 83

OFFICE USE ONLY
DATA SOURCE 1 CONTRACTOR 2336 DATE RECEIVED 09 09 83
DATE OF INSPECTION June 26/84 INSPECTOR KW
REMARKS changed from 6707739
CSS.ES

FORM NO. 0506-4-77 FORM 7

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The Ontario Water Resources Act

WATER WELL RECORD

Ontario

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11 | 6705627 | MUNICIP. 67002 | CON. CON 06

COUNTY OR DISTRICT: Wellington
TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Eramosa
CON., BLOCK, TRACT, SURVEY, ETC.: 6 VI
LOT: 001

[redacted] Box 7 Rockwood

DATE COMPLETED: DAY 24 MO. ~~07~~ YR. 74

				RC.	ELEVATION	RC.	BASIN CODE	II	III	IV
6705627	17	551554	4828198	5	1175	5	23	AUG 05, 1977		323

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
	CLAY - ROCKS			0	45
GREY - LIMESTONE				45	95

31 0045 0512 0095215
32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0090	1 ☑ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
05"	1 ☑ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0052
05"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☑ OPEN HOLE		52	0095
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☑ BAILER
PUMPING RATE: 0008 GPM
DURATION OF PUMPING: 01 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
029 FEET	045 FEET	045 FEET	045 FEET	045 FEET	045 FEET

WATER LEVELS DURING: 1 ☑ PUMPING 2 ☐ RECOVERY
IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☐ CLEAR 2 ☑ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☑ DEEP
RECOMMENDED PUMP SETTING: 070 FEET
RECOMMENDED PUMPING RATE: 0008 GPM
_____ GPM./FT. SPECIFIC CAPACITY

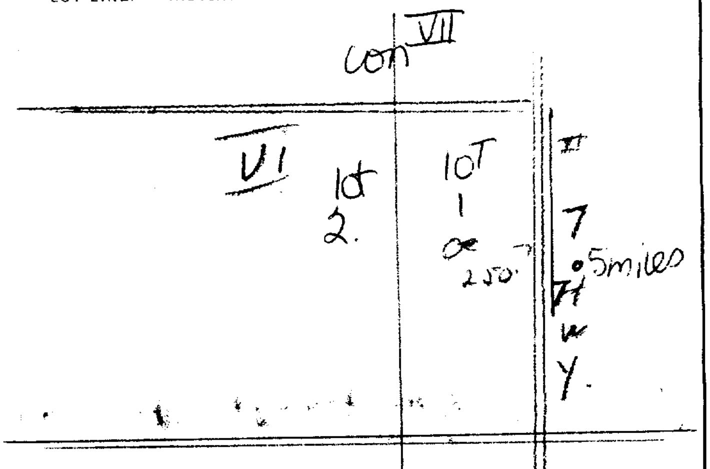
FINAL STATUS OF WELL 1
1 ☑ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01
1 ☑ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 2
1 ☐ CABLE TOOL
2 ☑ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL 7229

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



DRILLERS REMARKS:

CONTRACTOR
NAME OF WELL CONTRACTOR: LADCO DRILLING
LICENCE NUMBER: 3316
ADDRESS: Hillsburg R.R. #1
NAME OF DRILLER OR BORER: THOMAS LAING
LICENCE NUMBER: 3316
SIGNATURE OF CONTRACTOR: T. Laing
SUBMISSION DATE: DAY 24 MO. July YR. 74

OFFICE USE ONLY
DATA SOURCE: 1
CONTRACTOR: 3316
DATE RECEIVED: 220875
DATE OF INSPECTION:
INSPECTOR:
REMARKS:
PKP
CSS.ES WI

FORM 7 07-091

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The Ontario Water Resources Commission Act

WATER WELL RECORD

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Water management in Ontario

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11 6705003 MUNICIP. 67002 CON. CON 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
Well.	Eramosa	Con 6 ~~[illegible]~~	001

[redacted] RR# 4 Rockwood.

DATE COMPLETED 48-53 DAY 27 MO. 03 ~~Mar~~ YR. 74

RC ELEVATION RC BASIN CODE

829286 4 1175 5 23 MAR 20, 1975 49

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
		gravel		0	22
		clay gravel		22	38
White		rock		38	60
Brown		Lime rock		60	100

31 0022 11 0038 05 11 0060 126 0100 615

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0060	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☑ MINERAL 14 ~~1005~~
0098	1 ☐ FRESH 2 ☑ SALTY 3 ☑ SULPHUR 4 ☐ MINERAL 19 ~~1005~~
20-23	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL 24
25-28	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL 29
30-33	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL 34 80

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
~~5~~ 05	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ~~☑ OPEN HOLE~~	188	0 ~~39~~	~~39~~ 0039 ~~100~~
17-18	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		39	0100
24-25	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			27-30

SCREEN

SIZE(S) OF OPENING (SLOT NO.) 31-33

DIAMETER 34-38 INCHES

LENGTH 39-40 FEET

MATERIAL AND TYPE

DEPTH TO TOP OF SCREEN 41-44 FEET 80

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	DEPTH SET AT – FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
10-13	14-17	
18-21	22-25	
26-29	30-33	80

71 PUMPING TEST

PUMPING TEST METHOD 10: 1 ☒ PUMP 2 ☐ BAILER

PUMPING RATE 11-14: ~~15~~ 0015 GPM.

DURATION OF PUMPING: 03 15-16 HOURS 00 17-18 MINS.

STATIC LEVEL 19-21	WATER LEVEL END OF PUMPING 22-24	15 MINUTES 26-28	30 MINUTES 29-31	45 MINUTES 32-34	60 MINUTES 35-37
045 FEET	070 FEET	070 FEET	070 FEET	070 FEET	070 FEET

25 WATER LEVELS DURING 1 ☒ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE 36-41 GPM.

PUMP INTAKE SET AT 80 FEET

WATER AT END OF TEST 42: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

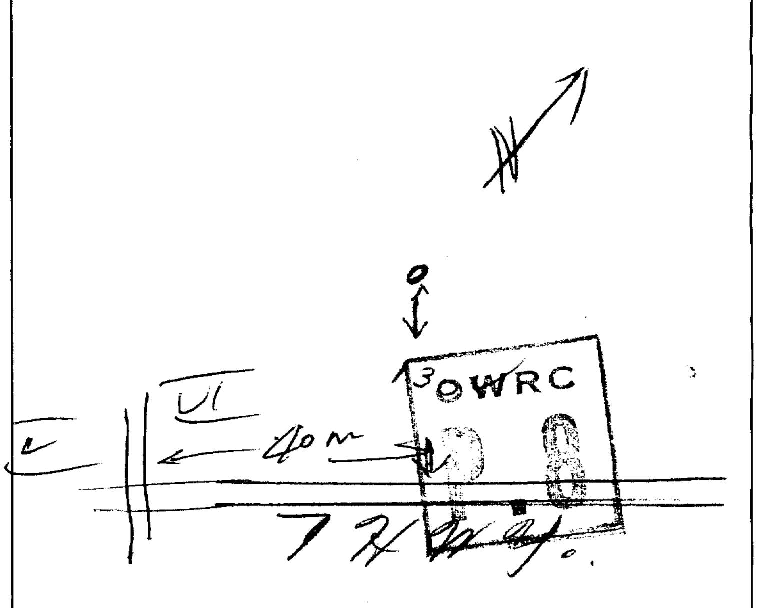
RECOMMENDED PUMP SETTING 43-45: 080 FEET

RECOMMENDED PUMPING RATE 46-49: 0015 GPM.

50-53 000.6 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

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



3 OWRC

DRILLERS REMARKS:

FINAL STATUS OF WELL 54

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 55-56 01

1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 57

1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Albert Earley LICENCE NUMBER: 1906

ADDRESS: 202 Neeve St Guelph

NAME OF DRILLER OR BORER: Albert Earley LICENCE NUMBER: 1906

SIGNATURE OF CONTRACTOR: Albert Earley SUBMISSION DATE DAY 27 MO. Mar YR. 74

OFFICE USE ONLY

DATA SOURCE 58: 1 CONTRACTOR 59-62: 1906 DATE RECEIVED 63-68: 01 04 74 80

DATE OF INSPECTION

INSPECTOR

REMARKS:

P

WI

CSS.ES

OWRC COPY

W12-8572 Hwy 7

Ministry of the Environment
Ontario

The Ontario Water Resources Act

40P/9

WATER WELL RECORD

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

11 6707178 MUNICIP. 67002 CON. CON 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
WELLINGTON	ERAMOSA	VI	001

[redacted] 24 ROCKWOOD ONT

DATE COMPLETED 48-53 DAY 21 MO 09 YR 79

828600 RC. 5 ELEVATION 1175 RC. 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
	CLAY-STONES			0	20
	ROCK LEDGES			20	28
	LIMESTONE			28	125

31 0020 0512 0028 12 0125 15

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0112 ~~112~~ ~~125~~	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
05"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0033
05"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		33	0125
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER

PUMPING RATE: 0020 GPM

DURATION OF PUMPING: 02 HOURS 00 MINS

STATIC LEVEL: 035 FEET

WATER LEVEL END OF PUMPING: 045 FEET

WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
FEET	FEET	FEET	045 FEET

IF FLOWING, GIVE RATE: GPM

PUMP INTAKE SET AT: 65 FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

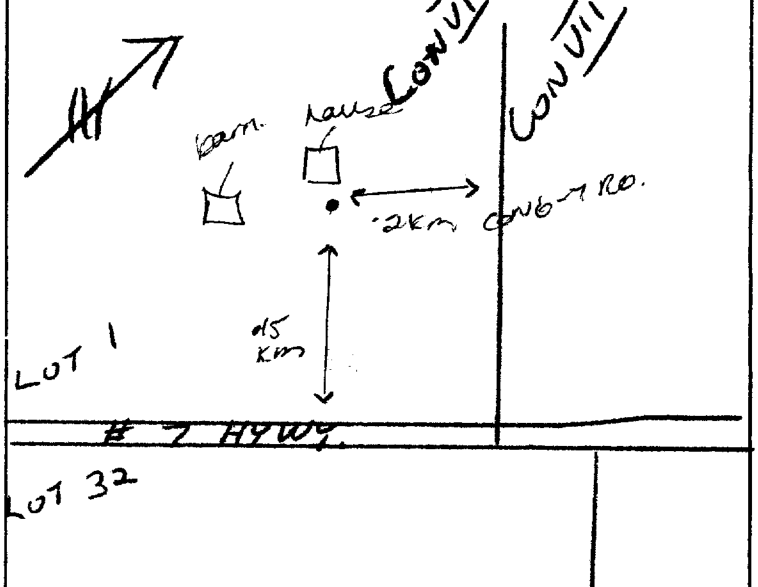
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 065 FEET

RECOMMENDED PUMPING RATE: 0012 GPM

LOCATION OF WELL

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



DRILLERS REMARKS

FINAL STATUS OF WELL 1

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 12

1 ☒ DOMESTIC
2 ☒ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 2

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Lang Well Drilling Ltd. LICENCE NUMBER: 3317

ADDRESS: RR1 Hillsburgh Ont

NAME OF DRILLER OR BORER: ROY LANG LICENCE NUMBER: 3317

SIGNATURE OF CONTRACTOR: Roy Lang

SUBMISSION DATE: DAY 21 MO. 9 YR. 79

OFFICE USE ONLY

DATA SOURCE: 1
CONTRACTOR: 3317
DATE RECEIVED: 150180
DATE OF INSPECTION: July 17, 1980
INSPECTOR:
REMARKS: P-W

CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506-4-77

W15-Hwy 7 MTO Works Yard

GROUND WATER BRA
67 Nº 487
AUG 20 19
ONTARIO WATER
RESOURCES COMMISSION

UTM Z E
C 5 R VI N
Elev. L 5 R 1 1 1 9 3
Basin 23

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District Wellington Township, Village, Town or City Eramosa
Con. 6 Lot 1 Date completed 29 (day) July (month) 1 (year)
Owner Dept of Highways, 3 miles west Acton (print in block letters) Address Acton, P.O.

Casing and Screen Record

Inside diameter of casing 5 1/4"
Total length of casing 29 1/2 ft
Type of screen —
Length of screen —
Depth to top of screen —
Diameter of finished hole 5 1/4"

Pumping Test

Static level 36 ft
Test-pumping rate 10 G.P.M.
Pumping level 70 ft
Duration of test pumping 8 hrs
Water clear or cloudy at end of test clear
Recommended pumping rate 10 G.P.M.
with pump setting of 100 feet below ground surface

Well Log

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
boulders + gravel	0	21	65	fresh
White Limestone	21	130	150	"
bluish coloured Limestone	130	153		

Water Record

For what purpose(s) is the water to be used?
For Dept of Highways use

Is well on upland, in valley, or on hillside? on upland

Drilling or ~~Boring~~ Firm J. K. Sorand
R R 4

Address Acton
Ont

Licence Number 996 + 997

Name of Driller or ~~Borer~~ J. K + J. C. Sorand

Address R R 4. Acton + 137 Bl...field St

Date July 1963 Guelph

J. K + J. C. Sorand Ont

(Signature of Licensed Drilling or Boring Contractor)

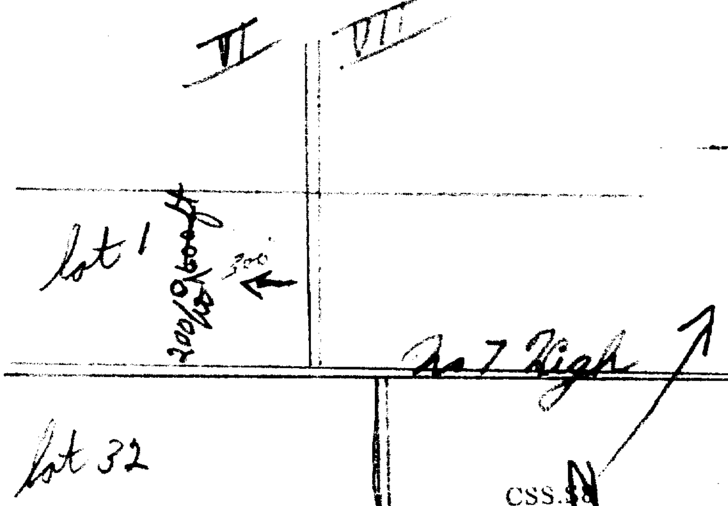
Per. B. J. S.

Form 7 15M-60-4138

OWRC COPY

Location of Well

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



CSS.58

W16-5134 Hwy 7

40f9E

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

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

2805483 28002 Con 06

COUNTY OR DISTRICT: [redacted]
TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: agaweya .
~~CON.~~ BLOCK, TRACT, SURVEY, ETC: VI
LOT: 032.

83 Dufferin, Guelph, Ont.
DATE COMPLETED: DAY 17 MO Dec YR 79

29 200 5 1150 5 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
brown	sand	gravel, boulders		0	41
grey	limestone			41	48

Coded

WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
45 to 46	☒ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL

CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
6 1/4	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	188	0 42	42 48
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			

SCREEN

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

PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

PUMPING TEST

PUMPING TEST METHOD: ☐ PUMP ☒ BAILER
PUMPING RATE: 20 GPM
DURATION OF PUMPING: 1 HOURS ____ MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING ☒ PUMPING ☐ RECOVERY. 15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
27 FEET	27 FEET	27 FEET	27 FEET	27 FEET	27 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: 46 FEET
RECOMMENDED PUMPING RATE: 10 GPM

FINAL STATUS OF WELL

☒ WATER SUPPLY
☐ OBSERVATION WELL
☐ TEST HOLE
☐ RECHARGE WELL
☐ ABANDONED, INSUFFICIENT SUPPLY
☐ ABANDONED, POOR QUALITY
☐ UNFINISHED

WATER USE

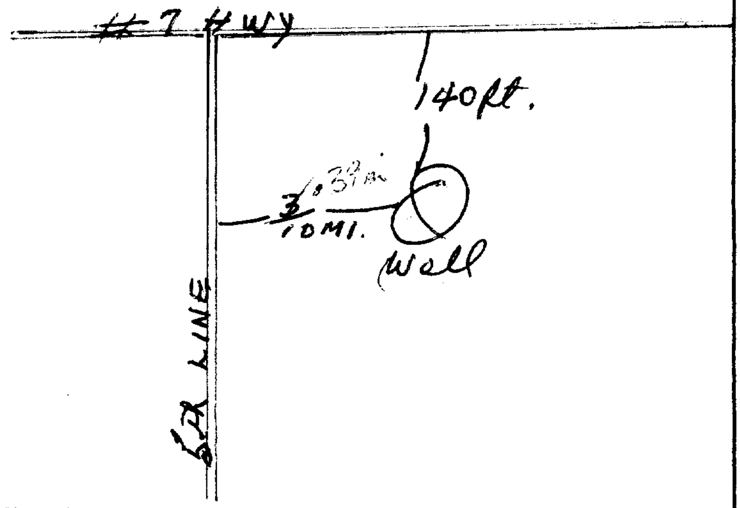
☒ DOMESTIC
☐ STOCK
☐ IRRIGATION
☐ INDUSTRIAL
☐ OTHER
☐ COMMERCIAL
☐ MUNICIPAL
☐ PUBLIC SUPPLY
☐ COOLING OR AIR CONDITIONING
☐ NOT USED

METHOD OF DRILLING

☒ CABLE TOOL
☐ ROTARY (CONVENTIONAL)
☐ ROTARY (REVERSE)
☐ ROTARY (AIR)
☐ AIR PERCUSSION
☐ BORING
☐ DIAMOND
☐ JETTING
☐ DRIVING

LOCATION OF WELL

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: Ruttan's Well Drilling
LICENCE NUMBER: #602
ADDRESS: Milton R.R. 2.
NAME OF DRILLER OR BORER: same
LICENCE NUMBER:
SIGNATURE OF CONTRACTOR: Burton Ruttan
SUBMISSION DATE: DAY 8 MO. Jan YR 80

CONTRACTOR'S COPY

OFFICE USE ONLY

240180

HILL

FORM NO. 0506—4—77 FORM 7

14321 5th Line
W17
4OP 9E

The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

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

11 2803457

MUNICIP. 28002 CON. CON 06

COUNTY OR DISTRICT Halton	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE Nassagaweya	CON., BLOCK, TRACT, SURVEY, ETC. W ½ of 6.	LOT ~~pt 32~~ 032
OWNER (SURNAME FIRST) Ontario Plastics Ltd.	ADDRESS Box 84 Rockwood Ont.		DATE COMPLETED DAY 21 MO. ~~Aug~~ 08 YR. ~~1970~~ 70

21 UTM ZONE 17 EASTING 572180 NORTHING 4828730 RC. 4 ELEVATION 1170 RC. 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
brown	boulders	Very small amt. of clay		0	28
grey	Limestone			28	104

APL

31 0028 61305 0104215

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0052	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0075	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0085	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0103	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
~~5⅝~~ 04	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ ~~OPEN HOLE~~	.188 3/4	0	0032 ~~31½~~ ~~104~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE			0104
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	DEPTH SET AT – FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE 0020 GPM.

DURATION OF PUMPING 01 HOURS 00 MINS.

WATER LEVELS DURING 1 ☒ PUMPING 2 ☐ RECOVERY

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
030 FEET	035 FEET	035 FEET	035 FEET	035 FEET	035 FEET

IF FLOWING, GIVE RATE GPM.

PUMP INTAKE SET AT FEET

WATER AT END OF TEST 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING 050 FEET

RECOMMENDED PUMPING RATE 0020 GPM.

004.0 GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 45

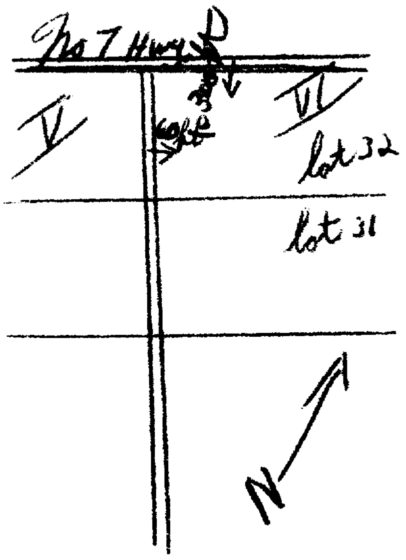
1 ☐ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☒ INDUSTRIAL
☐ OTHER
5 ☒ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING

1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR John R. Sprowl LICENCE NUMBER 4805
ADDRESS 40 Eastern Ave. Acton Ont
NAME OF DRILLER OR BORER same as above LICENCE NUMBER 4805
SIGNATURE OF CONTRACTOR John R. Sprowl Per B.J.S.
SUBMISSION DATE DAY 21 MO. Aug YR. 1970

OFFICE USE ONLY

DATA SOURCE 1 CONTRACTOR 4805 DATE RECEIVED 231170
DATE OF INSPECTION INSPECTOR P/F
REMARKS:

OWRC COPY

W18-14297 5th Line

28 № 2049

UTM |1|7| Z |5|7|2|2|2|4| E

Cont

~~Elev~~ 6 R |V4|8|2|8|6|5|7| N 4099e

Elev 2 R 32 |1|5|5|

Basin |2|3| |_|_|_|

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District Halton

Township, Village, Town or City Nassagaweya

Con. 6 Lot 32

Date completed 6 (day) Sept (month) 1966 (year)

[redacted] ress R.R. no. 2. Rockwood, Ont.

Casing and Screen Record

Inside diameter of casing 4"

Total length of casing 24 1/2 ft

Type of screen —

Length of screen —

Depth to top of screen —

Diameter of finished hole 4"

Pumping Test

Static level 35

Test-pumping rate 15 G.P.M.

Pumping level 38

Duration of test pumping 1 hr

Water clear or cloudy at end of test fairly clear

Recommended pumping rate 18 G.P.M.

with pump setting of 50 feet below ground surface

Well Log / Water Record

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
gravel & clay	0	20	45	fresh
dark grey Limestone	20	78	63	
			75	

For what purpose(s) is the water to be used? dwelling

Is well on upland, in valley, or on hillside? on upland

Drilling or ~~Boring~~ Firm J. R + J. C. Sprowl

Address R.R. 4 Acton & 137 Renfield St Guelph

Licence Number 2131 + 2130

Name of Driller or ~~Borer~~ J. R + J. C. Sprowl

Address R.R. 4. Acton + 137 Renfield St Guelph

Date Sept 1966

J. R + J. C. Sprowl

(Signature of Licensed Drilling or Boring Contractor)

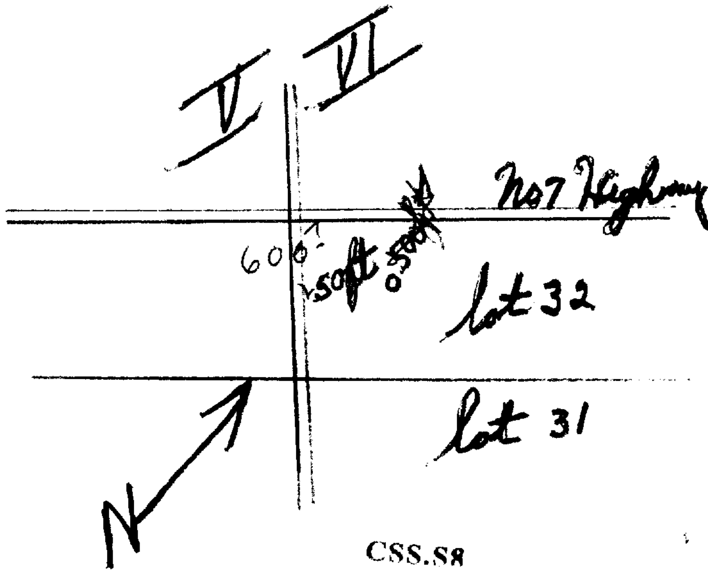
Per. B. J. S.

Form 7 15M-60-4138

OWRC COPY

Location of Well

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



CSS.S8

W19-5036 Hwy 7

UTM 17 Z 572182 E

5 R 4828860 N

Elev. 4 R 1150 40P90

Basin 23

28 № 2048

OCT 27 1959

The Ontario Water Resources Commission Act, 1957

WATER WELL RECORD

County or District Halton Township, Village, Town or City Nassagaweya

[redacted]

Date completed 14 (day) July (month) 1959 (year)

Address R.R. Rockwood

Casing and Screen Record

Inside diameter of casing 4¼"

Total length of casing 25 ft 4"

Type of screen —

Length of screen —

Depth to top of screen —

Diameter of finished hole 4¼"

Pumping Test

Static level 28 ft

Test-pumping rate 6 G.P.M.

Pumping level 30

Duration of test pumping 2 hrs

Water clear or cloudy at end of test clear

Recommended pumping rate 6 G.P.M.

with pumping level of 30 ft

Well Log

Water Record

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, sulphur)
Top earth	0	1½	54	38ft	fresh
a few boulder	1½	4	63		
gravel	4	10			
a big boulder	10	12			
stony gravel	12	20			
Light grey [illegible]	20	66			

For what purpose(s) is the water to be used?

Home

Is well on upland, in valley, or on hillside?

on hillside

Drilling Firm J R Sproul

Address RR 4 Acton Ont

Licence Number 154 + 189

Name of Driller J R & J C Sproul

Address R R 4 Acton

Date July 1959

J R J C Sproul

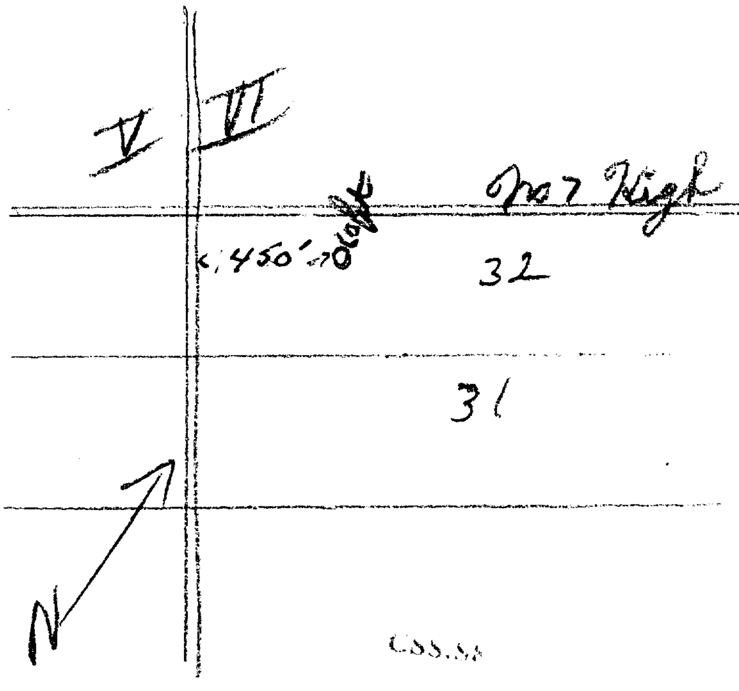
(Signature of Licensed Drilling Contractor)

Per B S S.

Form 5
15M-58-4149

Location of Well

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



The Ontario Water Resources Commission Act W21-4264 Hwy 7

WATER WELL RECORD

Water management in Ontario

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

11 | 2803220 | MUNICIP. 28002 | CON. C ø N 05

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
HALTON	NASSAGAWEYA	5	032

[redacted] R#2 ROCKWOOD

DATE COMPLETED 48-53: DAY 19 MO. 09 ~~Sept~~ YR. 69

28430 | RC. 4 | ELEVATION 1175 | RC. 5 | BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
			stones gravel	0	52
light Blue			rock	52	69

31 0052 1211 0069 315

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0069	1 ☑ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
04	1 ☑ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	205"	0	~~548~~" 0055
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☑ OPEN HOLE		54.8	0069 ~~64~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	DEPTH SET AT – FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
~~50~~	~~52~~	~~cement~~

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☑ PUMP 2 ☐ BAILER

PUMPING RATE: 0010 GPM

DURATION OF PUMPING: 02 HOURS 00 MINS.

WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
045 FEET	055 FEET	055 FEET	055 FEET	055 FEET	055 FEET

IF FLOWING, GIVE RATE: GPM.

PUMP INTAKE SET AT: 60 FEET

WATER AT END OF TEST: 1 ☑ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☑ DEEP

RECOMMENDED PUMP SETTING: 055 ~~050~~ FEET

RECOMMENDED PUMPING RATE: 0010 GPM.

001.0 GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL

- 1 ☑ WATER SUPPLY
- 2 ☐ OBSERVATION WELL
- 3 ☐ TEST HOLE
- 4 ☐ RECHARGE WELL
- 5 ☐ ABANDONED, INSUFFICIENT SUPPLY
- 6 ☐ ABANDONED, POOR QUALITY
- 7 ☐ UNFINISHED

WATER USE 01

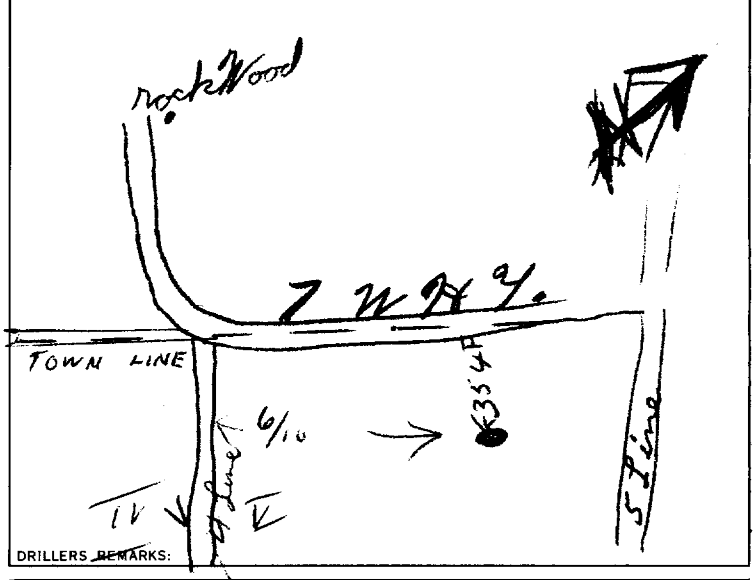
- 1 ☑ DOMESTIC
- 2 ☐ STOCK
- 3 ☐ IRRIGATION
- 4 ☐ INDUSTRIAL
- ☐ OTHER
- 5 ☐ COMMERCIAL
- 6 ☐ MUNICIPAL
- 7 ☐ PUBLIC SUPPLY
- 8 ☐ COOLING OR AIR CONDITIONING
- 9 ☐ NOT USED

METHOD OF DRILLING

- 1 ☑ CABLE TOOL
- 2 ☐ ROTARY (CONVENTIONAL)
- 3 ☐ ROTARY (REVERSE)
- 4 ☐ ROTARY (AIR)
- 5 ☐ AIR PERCUSSION
- 6 ☐ BORING
- 7 ☐ DIAMOND
- 8 ☐ JETTING
- 9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS ~~REMARKS~~:

CONTRACTOR

NAME OF WELL CONTRACTOR: Albert Earley — LICENCE NUMBER 3299

ADDRESS: 202 Neeve St

NAME OF DRILLER OR BORER: Albert Earley — LICENCE NUMBER 3299

SIGNATURE OF CONTRACTOR: Albert Earley

SUBMISSION DATE: DAY 19 MO. Sept YR. 1969

OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 1706 | DATE RECEIVED 241069

DATE OF INSPECTION | INSPECTOR

REMARKS:

7

OWRC COPY

W22-5198 Hwy 7 7187172

Ontario Ministry of the Environment

Measurements recorded in: ☑ Metric ☑ Imperial

Well Tag No. (Place Sticker and/or Print Below)
Tag#: A126461

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

[redacted]

Address of Well Location (Street Number/Name): #5198 Hwy #7
Township: GUELPH / ERAMOSA
Lot: 1
Concession: 7
County/District/Municipality: WELLINGTON
City/Town/Village: ROCKWOOD
Province: Ontario
Postal Code: N0B2K0
UTM Coordinates NAD 8 3 Zone 17 Easting 572612 Northing 4829585
Municipal Plan and Sublot Number:
Other:

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	To
BROWN	TOP SOIL			0	2
BROWN	SILT	SAND		2	8
GREY	BOULDER			8	12
BROWN	SILT	SAND		12	22
GREY	BOULDER			22	25
BROWN	SILT	SAND		25	34
GREY/BROWN	LIMESTONE			34	37
GREY	LIMESTONE		FRACTURE @55FT - 60FT	37	60

* 6¼" CASING DRIVE SHOE * TOTAL = 60FT.

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	20	QUICK GROUT	90FT.

Results of Well Yield Testing

After test of well yield, water was:
☑ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft): 55

Pumping rate (l/min / GPM): 20

Duration of pumping: 1 hrs + ___ min

Final water level end of pumping (m/ft):

If flowing give rate (l/min / GPM):

Recommended pump depth (m/ft):

Recommended pump rate (l/min / GPM):

Well production (l/min / GPM):

Disinfected? ☐ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	54.1		56
1	54.2	1	55.6
2		2	55.3
3	54.5	3	55
4	54.6	4	54.8
5	54.7	5	54.6
10	54.9	10	54.1
15	55.0	15	
20	55.2	20	
25	55.3	25	
30	55.5	30	
40	55.7	40	
50	55.9	50	
60	56.0	60	

Method of Construction

☐ Cable Tool
☑ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☐ Other, specify
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

☐ Public
☑ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, specify
☐ Commercial
☐ Municipal
☐ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☐ Monitoring

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
6¼	STEEL	.188	+2	37
6⅛	OPEN HOLE		37	60

Status of Well

☑ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To

Water Details

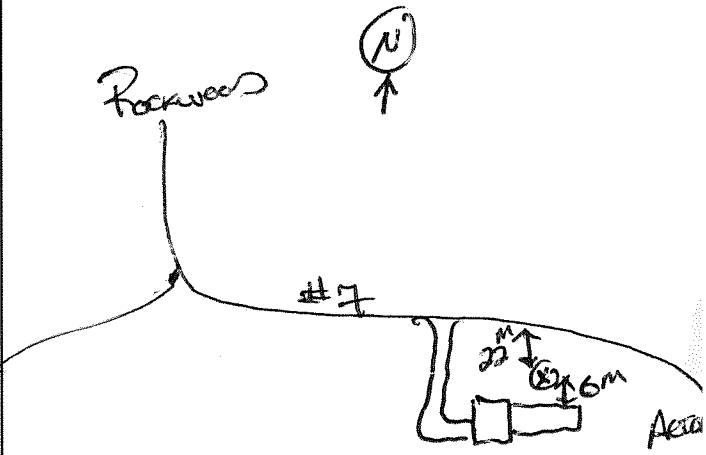
Water found at Depth 60 (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☑ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	20	10"
20	60	6⅛"

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor: HANLON WELL DRILLING LTD
Well Contractor's Licence No.: 2663
Business Address (Street Number/Name): #5896 WELL. RD #7 RR#5
Municipality: GUELPH
Province: ON
Postal Code: N1H6J2
Business E-mail Address: hanlonwelldrilling@bellnet.c
Bus.Telephone No. (inc. area code): 5197638239
Name of Well Technician (Last Name, First Name): [redacted] LANGER TRAVIS
Well Technician's Licence No.: 3580
Signature of Technician and/or Contractor:
Date Submitted: 20120630

Well owner's information package delivered: ☑ Yes ☐ No
Date Package Delivered: 20120502
Date Work Completed: 20120505

Ministry Use Only
Audit No. Z151986
SEP 14 2012
Received

0506E (2007/12) © Queen's Printer for Ontario, 2007

Ministry's Copy

W24-8470 Hwy 7

Ontario Ministry of the Environment

Well Tag Number (Place sticker and print number below)
A007390
A007390

Well Record

Regulation 903 Ontario Water Resources Act

6715120

page 1 of 1

Instructions for Completing Form

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

Ministry Use Only

[redacted]

Address of Well Location (County/District/Municipality) WELLINGTON	Township EROMOSO	Lot 1	Concession 5
RR#/Street Number/Name HWY # 7	City/Town/Village ROCKWOOD	Site/Compartment/Block/Tract etc.	
GPS Reading NAD 83 Zone 17 Easting 571721 Northing 4828572	Unit Make/Model MAP 410	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	SAND	CLAY GRAVEL	STONES	0	7.92
GREY	LIMESTONE			7.92	8.84

Hole Diameter

Depth Metres From	Depth Metres To	Diameter Centimetres

Water Record

Water found at Metres	Kind of Water
8.8 m	☑ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
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

Chlorinated ☑ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	Depth Metres To
Casing				
16.8	☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	.48	0	8.2
	☐ 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		8.2	8.8

Test of Well Yield

	Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Pumping test method PUMP				
Pump intake set at - (metres)	Static Level	5.1 ~~7.0~~		
Pumping rate - (litres/min) 17	1		1	
Duration of pumping 1 hrs + 0 min	2		2	
Final water level end of pumping 5.2 metres	3		3	
Recommended pump type. ☑ Shallow ☐ Deep	4		4	
Recommended pump depth. 6 metres	5		5	
Recommended pump rate. 16 (litres/min)	10		10	
	15	5.2	15	
If flowing give rate - (litres/min)	20		20	
	25		25	
If pumping discontinued, give reason.	30	5.2	30	
	40		40	
	50		50	
	60	5.2	60	

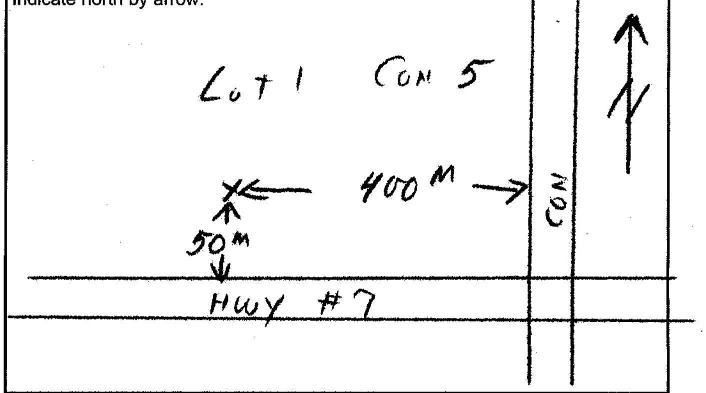
Plugging and Sealing Record

☑ 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	BENTONITE HOLE PLUG	

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 19433

Date Well Completed YYYY 2004 MM 8 DD 15

Was the well owner's information package delivered? ☐ Yes ☐ No

Date Delivered YYYY MM DD

Well Contractor/Technician Information

Name of Well Contractor: FRED CONSTABLE & SON LTD

Well Contractor's Licence No.: 1663

Business Address (street name, number, city etc.): 3519 5TH LINE BRADFORD

Name of Well Technician (last name, first name): STEVE THOMSON

Well Technician's Licence No.: 1212 0

Signature of Technician/Contractor: X

Date Submitted YYYY 2004 MM 10 DD 20

Ministry Use Only

Data Source

Contractor 1663

Date Received NOV 30 2004 YYYY MM DD

Date of Inspection YYYY MM DD

Remarks

Well Record Number 6715120

0506E (09/03) Contractor's Copy ☐ Ministry's Copy ☐ Well Owner's Copy ☐ *Cette formule est disponible en français*

40P/9E W25

4907 7th Line

Water management in Ontario

The Ontario Water Resources Commission Act

WATER WELL RECORD

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

11

6703720

MUNICIP. 67002

CON. CON 07

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
~~HALTON~~ Wellington	ERAMOSA.	7	001

[redacted] R #1 Acton, Ont.

DATE COMPLETED DAY 09 MO. 04 ~~YR.~~ 70

29850 RC. 4 ELEVATION 1195 RC. 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
	TOPSOIL			0	4
	LIME ROCK			4	100

APL

31 0004 02 | 0100 15

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0097	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
~~64~~ 06	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	0	~~11~~ 0011
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		11	0100
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	DEPTH SET AT – FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE: 0011 GPM.

DURATION OF PUMPING: 01 HOURS 00 MINS.

WATER LEVELS DURING: 1 ☐ PUMPING 2 ☒ RECOVERY

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
018 FEET	093 FEET	038 FEET	025 FEET	020 FEET	018 FEET

IF FLOWING, GIVE RATE: GPM.

PUMP INTAKE SET AT: FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

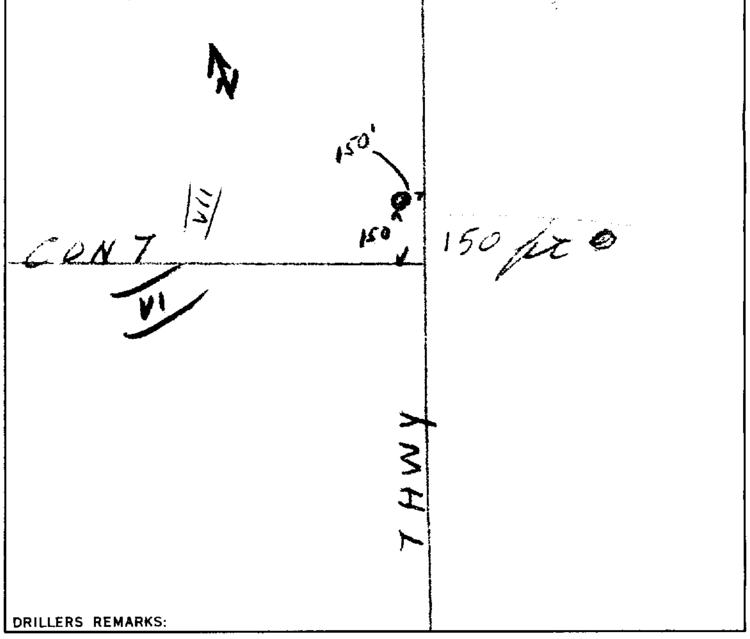
RECOMMENDED PUMP SETTING: 096 FEET

RECOMMENDED PUMPING RATE: 0010 GPM.

0001 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

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



DRILLERS REMARKS:

FINAL STATUS OF WELL
- 1 ☒ WATER SUPPLY
- 2 ☐ OBSERVATION WELL
- 3 ☐ TEST HOLE
- 4 ☐ RECHARGE WELL
- 5 ☐ ABANDONED, INSUFFICIENT SUPPLY
- 6 ☐ ABANDONED, POOR QUALITY
- 7 ☐ UNFINISHED

WATER USE 04
- 1 ☐ DOMESTIC
- 2 ☐ STOCK
- 3 ☐ IRRIGATION
- 4 ☒ INDUSTRIAL
- ☐ OTHER
- 5 ☐ COMMERCIAL
- 6 ☐ MUNICIPAL
- 7 ☐ PUBLIC SUPPLY
- 8 ☐ COOLING OR AIR CONDITIONING
- 9 ☐ NOT USED

METHOD OF DRILLING
- 1 ☒ CABLE TOOL
- 2 ☐ ROTARY (CONVENTIONAL)
- 3 ☐ ROTARY (REVERSE)
- 4 ☐ ROTARY (AIR)
- 5 ☐ AIR PERCUSSION
- 6 ☐ BORING
- 7 ☐ DIAMOND
- 8 ☐ JETTING
- 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Frank Ince

LICENCE NUMBER: 2803

ADDRESS: 175 alderman ave Hamilton

NAME OF DRILLER OR BORER: same

LICENCE NUMBER:

SIGNATURE OF CONTRACTOR:

SUBMISSION DATE: DAY 29 MO. 7 YR. 70

OFFICE USE ONLY

DATA SOURCE: 1

CONTRACTOR: 2803

DATE RECEIVED: 040870

DATE OF INSPECTION: 23/12/70

INSPECTOR: P/L

REMARKS:

CSS.ES

OWRC COPY

Ministry of the Environment
Ontario

W26
4917-4919-4921
7th Line

The Ontario Water Resources Act

WATER WELL RECORD

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

11

6710793

MUNICIP 67002 CON. CON 07

COUNTY OR DISTRICT: WELLINGTON
TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: ERAMOSA
CON., BLOCK, TRACT, SURVEY ETC: VII
LOT 25-27: 1
OWNER (SURNAME FIRST) 28-47: THM CONSTR. LIMITED
ADDRESS: 2384 QUEENSWAY DRIVE, UNIT#5 BURLINGTON ONT. L7R 3T3
DATE COMPLETED 48-53: DAY 15 MO 10 YR 91

21 UTM ZONE 10 EASTING 12 17 NORTHING 18 24 RC. 25 ELEVATION 26 RC. 30 BASIN CODE 31 II III IV 47

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BR.	CLAY	STONES		0	15
GR.	LIMESTONE			15	146

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
125	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
140 to 145	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
6	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC	.188	0	33½
6	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE 5 ☐ PLASTIC		33½	146
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) 31-33
DIAMETER 34-38 INCHES
LENGTH 39-40 FEET
MATERIAL AND TYPE
DEPTH TO TOP OF SCREEN 41-44 FEET

61 PLUGGING & SEALING RECORD

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

71 PUMPING TEST

PUMPING TEST METHOD: AIR 1 ☐ PUMP 2 ☐ BAILER
PUMPING RATE: 30 GPM
DURATION OF PUMPING: 1 HOURS 30 MINS
STATIC LEVEL: 12 FEET
WATER LEVEL END OF PUMPING: 30 FEET
WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
30 FEET	30 FEET	30 FEET	30 FEET

IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING: 70 FEET
RECOMMENDED PUMPING RATE: 30 GPM

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED
☐ DEWATERING

WATER USE

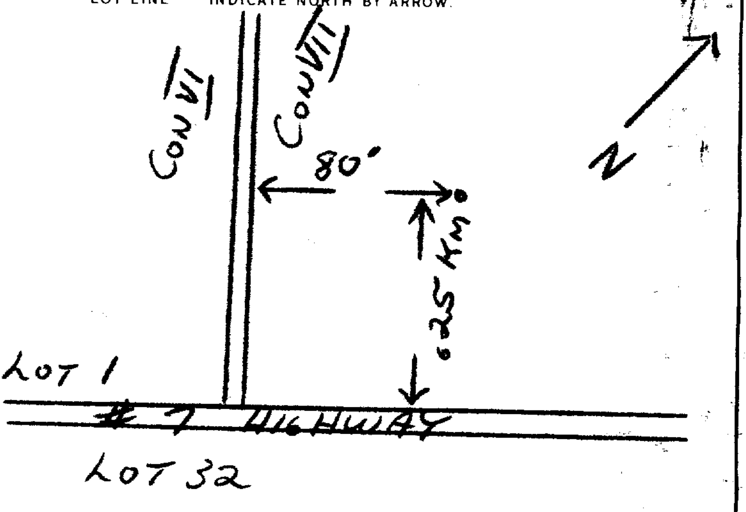
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF CONSTRUCTION

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING
☐ DIGGING
☐ OTHER

LOCATION OF WELL

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



DRILLERS REMARKS: TWC 75

108067

CONTRACTOR

NAME OF WELL CONTRACTOR: LANG WELL DRILLING LTD.
WELL CONTRACTOR'S LICENCE NUMBER: 3317
ADDRESS: RR1 HILLSBURGH ONT
NAME OF WELL TECHNICIAN: ROY LANG
WELL TECHNICIAN'S LICENCE NUMBER: T-0158
SIGNATURE OF TECHNICIAN/CONTRACTOR: R Lang
SUBMISSION DATE: DAY 15 MO 01 YR 92

OFFICE USE ONLY

DATA SOURCE
CONTRACTOR: 3317
DATE RECEIVED: JAN 20 1992
DATE OF INSPECTION
INSPECTOR
REMARKS
CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

Ontario Ministry of the Environment

W26 4917-4919-4921
7th Line

The Ontario Water Resources Act
WATER WELL RECORD

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

11 6713908

Municipality 67002 Con. CON 07

77-01

County or District	Township/Borough/City/Town/Village	Con block tract survey, etc.	Lot 25-27
WELLINGTON	ERAMOSA TWP.	CON I	6

[redacted]

Address RR#4 ROCKWOOD, ONT. NOB-2KO

Date completed 48-53: 22 day 10 month 01 year

21 UTM 10 12 17 Northing 18 24 RC 25 Elevation 26 RC 30 Basin Code 31 ii iii iv 47

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth - feet From	Depth - feet To
BROWN	CLAY	STONES		0	14
GREY	ROCK			14	140
			TOTAL DEPTH	140	
		6" DRIVE SHOE			

31

32

41 WATER RECORD

Water found at - feet	Kind of water
10-13 135-140	1 ☒ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas 14
15-18	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas 19
20-23	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas 24
25-28	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas 29
30-33	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas 34

51 CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth - feet From	Depth - feet To
10-11 6"	1 ☒ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic 12	.188	+1	13-16 25
17-18 6"	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☒ Open hole 5 ☐ Plastic 19		25	20-23 140
24-25	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic 26			27-30

SCREEN

Sizes of opening (Slot No.) 31-33	Diameter 34-38 inches	Length 39-40 feet
Material and type	Depth at top of screen 41-44 feet	30

61 PLUGGING & SEALING RECORD

☒ Annular space ☐ Abandonment

Depth set at - feet From	Depth set at - feet To	Material and type (Cement grout, bentonite, etc.)
10-13 0	14-17 23	BENTONITE
18-21	22-25	
26-29	30-33	80

71 PUMPING TEST

Pumping test method 10: 1 ☒ Pump 2 ☐ Bailer

Pumping rate 11-14: 20 GPM

Duration of pumping 15-16: 1 Hours 17-18: 0 Mins

Static level 19-21	Water level end of pumping 22-24	15 minutes 26-28	30 minutes 29-31	45 minutes 32-34	60 minutes 35-37
16 feet	17 feet	17 feet	17 feet	17 feet	17 feet

25 Water levels during 1 ☒ Pumping 2 ☐ Recovery

If flowing give rate 38-41: GPM

Pump intake set at: feet

Water at end of test 42: ☒ Clear ☐ Cloudy

Recommended pump type: ☐ Shallow ☒ Deep

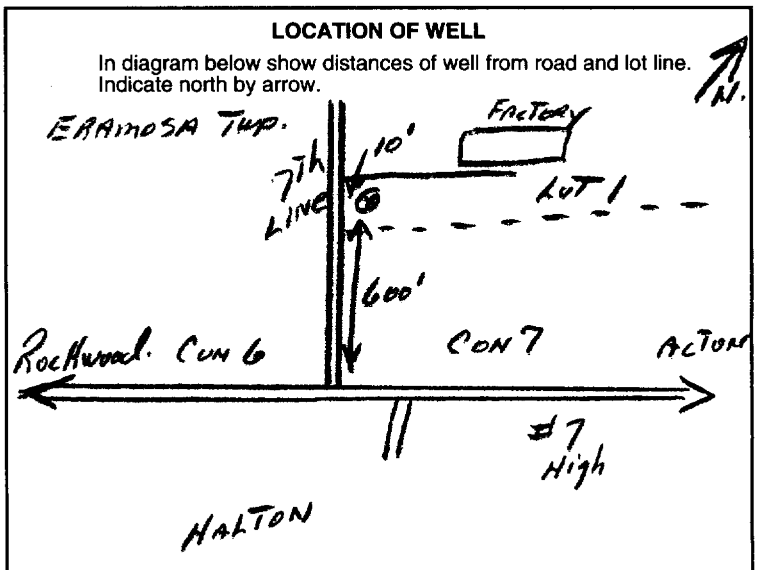
Recommended pump setting 43-45: 60 feet

Recommended pump rate 46-49: 15-20 GPM

50-53

LOCATION OF WELL

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



224213

FINAL STATUS OF WELL 54

- 1 ☒ Water supply
- 2 ☐ Observation well
- 3 ☐ Test hole
- 4 ☐ Recharge well
- 5 ☐ Abandoned, insufficient supply
- 6 ☐ Abandoned, poor quality
- 7 ☐ Abandoned (Other)
- 8 ☐ Dewatering
- 9 ☐ Unfinished
- 10 ☐ Replacement well

WATER USE 55-56

- 1 ☐ Domestic
- 2 ☐ Stock
- 3 ☐ Irrigation
- 4 ☐ Industrial
- 5 ☒ Commercial
- 6 ☐ Municipal
- 7 ☐ Public supply
- 8 ☐ Cooling & air conditioning
- 9 ☐ Not use
- 10 ☐ Other

METHOD OF CONSTRUCTION 57

- 1 ☐ Cable tool
- 2 ☐ Rotary (conventional)
- 3 ☐ Rotary (reverse)
- 4 ☒ Rotary (air)
- 5 ☐ Air percussion
- 6 ☐ Boring
- 7 ☐ Diamond
- 8 ☐ Jetting
- 9 ☐ Driving
- 10 ☐ Digging
- 11 ☐ Other

Name of Well Contractor: GRAHAM WELL DRILLING LTD

Well Contractor's Licence No.: 2336

Address: RR#5 ROCKWOOD, ONT. NOB-2KO

Name of Well Technician: Jim WILSON

Well Technician's Licence No.: T-1924

Signature of Technician/Contractor: Robert H. Graham

Submission date: day 31 mo 10 yr 01

MINISTRY USE ONLY

Data source 58	Contractor 59-62	Date received 63-68	80
	2336	NOV 06 2001	

Date of inspection

Inspector

Remarks

2 - MINISTRY OF THE ENVIRONMENT COPY

0506 (07/00) Front Form 9

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

W27-4923 7th Line

40119E

Ontario

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

11 | 6704980 | MUNICIP. 67002 | CON. C 01 07

COUNTY OR DISTRICT: ~~Halton~~ WELLINGTON

TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Eramosa

CON., BLOCK, TRACT, SURVEY, ETC.: conc. 7

LOT 25-27: 001

[redacted] Hwy. 25 Oakville, Ont.

DATE COMPLETED 48-53: DAY 02 MO. 01 YR. 74

30132 | RC 4 | ELEVATION 1178 | RC 5 | BASIN CODE 23 | MAR 20, 1975 | 49

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
		dug well		0	5
Brown	clay	stones, gravel		5	15
Gray	rock			15	33
Brown	"			33	53
White	"			53	73
			Total Depth 73 ft.		

31: 0005 23 | 0015 605 211 | 0033 226 | 0053 626 | 0073 126

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
10-13: 0065	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL 14
15-18	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL 19
20-23	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL 24
25-28	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL 29
30-33	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL 34 80

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
10-11: 05	12: 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	5	13-16: 0022
17-18: 05	19: 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		22	20-23: 0073
24-25	26: 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			27-30

SCREEN

SIZE(S) OF OPENING (SLOT NO.) 31-33	DIAMETER 34-38 INCHES	LENGTH 39-40 FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN 41-44 FEET	80

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
10-13	14-17	
18-21	22-25	
26-29	30-33	80

71 PUMPING TEST

PUMPING TEST METHOD 10: 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE 11-14: 0010 GPM.

DURATION OF PUMPING: 01 15-16 HOURS 00 17-18 MINS

STATIC LEVEL 19-21	WATER LEVEL END OF PUMPING 22-24	25 WATER LEVELS DURING 1 ☐ PUMPING 2 ☒ RECOVERY: 15 MINUTES 26-28	30 MINUTES 29-31	45 MINUTES 32-34	60 MINUTES 35-37
007 FEET	014 FEET	1007 FEET	FEET	FEET	FEET

IF FLOWING GIVE RATE 38-41: — GPM

PUMP INTAKE SET AT: 30 FEET

WATER AT END OF TEST 42: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING 43-45: 025 FEET

RECOMMENDED PUMPING RATE 46-49: 0010 GPM.

50-53: 0064

FINAL STATUS OF WELL

54
- 1 ☒ WATER SUPPLY
- 2 ☐ OBSERVATION WELL
- 3 ☐ TEST HOLE
- 4 ☐ RECHARGE WELL
- 5 ☐ ABANDONED, INSUFFICIENT SUPPLY
- 6 ☐ ABANDONED, POOR QUALITY
- 7 ☐ UNFINISHED

WATER USE

55-56: 01
- 1 ☒ DOMESTIC
- 2 ☐ STOCK
- 3 ☐ IRRIGATION
- 4 ☐ INDUSTRIAL
- ☐ OTHER
- 5 ☐ COMMERCIAL
- 6 ☐ MUNICIPAL
- 7 ☐ PUBLIC SUPPLY
- 8 ☐ COOLING OR AIR CONDITIONING
- 9 ☐ NOT USED

METHOD OF DRILLING

57
- 1 ☒ CABLE TOOL
- 2 ☐ ROTARY (CONVENTIONAL)
- 3 ☐ ROTARY (REVERSE)
- 4 ☐ ROTARY (AIR)
- 5 ☐ AIR PERCUSSION
- 6 ☐ BORING
- 7 ☐ DIAMOND
- 8 ☐ JETTING
- 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: R.H. Graham Well Drilling

LICENCE NUMBER: 2406

ADDRESS: 212 Waverley Drive, GUELPH, Ont.

NAME OF DRILLER OR BORER: Jim Wilson 22w69

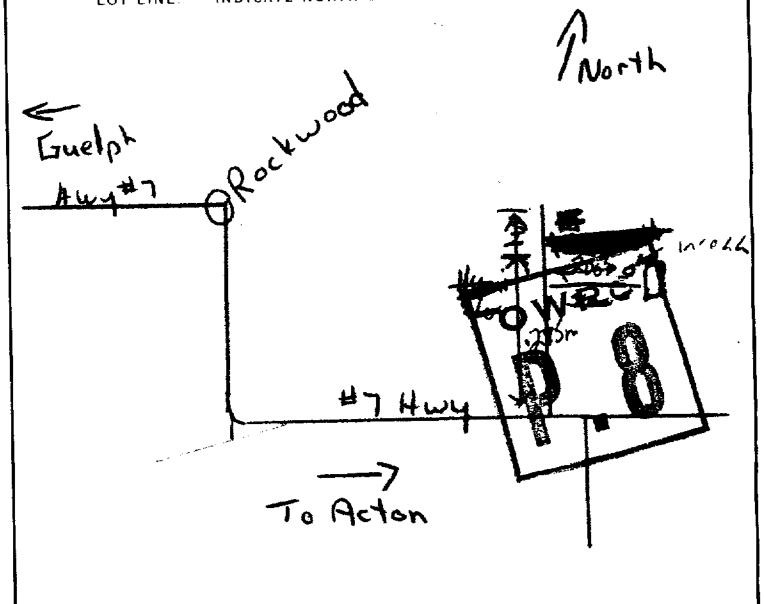
LICENCE NUMBER:

SIGNATURE OF CONTRACTOR: R H Graham Per J.G.

SUBMISSION DATE: DAY 9 MO. 1 YR. 74

LOCATION OF WELL

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



DRILLERS REMARKS:

OFFICE USE ONLY

DATA SOURCE 58: 1

CONTRACTOR 59-62: 2406

DATE RECEIVED 63-68: 05 02 74

80

DATE OF INSPECTION:

INSPECTOR:

REMARKS:

CSS.ES

FORM 7 07-091

MINISTRY OF THE ENVIRONMENT COPY

The Ontario Water Resources Commission Act W28-4925 7th Line

WATER WELL RECORD

40.P19E

Water management in Ontario
1. PRINT ONLY IN SPACES PROVIDED
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11 6704349 MUNICIP. 67002 CON. CON 07

COUNTY OR DISTRICT: Wellington
TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Eramosa
CON., BLOCK, TRACT, SURVEY, ETC.: 7
LOT: ~~pt~~ ~~1~~ 001
OWNER (SURNAME FIRST): [redacted]
ADDRESS: R. no 4 Rockwood
DATE COMPLETED: DAY 23 MO. ~~Aug~~ 08 YR. ~~1972~~ 72
830170 RC. 4 ELEVATION 1195 RC. 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
brown	clay	and gravel		0	15
grey	Limestone			15	86

31 0015495 11 0086215
32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0042	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0067	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0085	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
~~4 8~~ 04	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ ~~OPEN HOLE~~	.188	0 20	~~20~~ 0020 ~~86~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE			0086
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

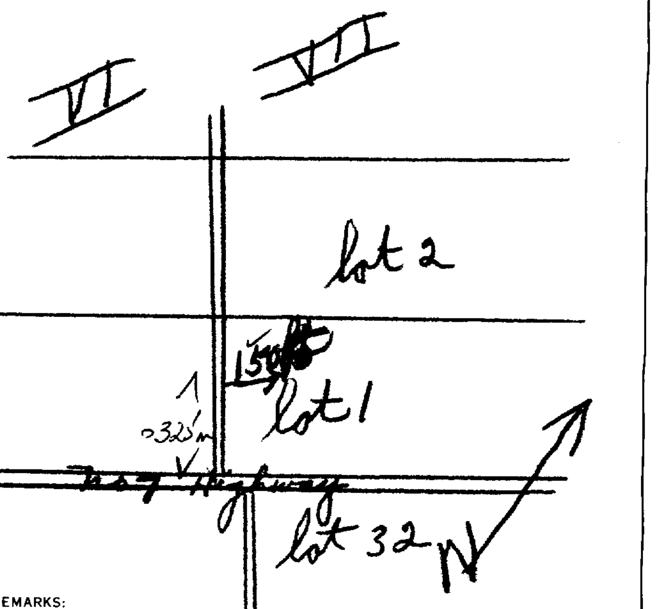
PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER
PUMPING RATE: 0006 GPM.
DURATION OF PUMPING: 01 HOURS 30 MINS.
WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
012 FEET	037 FEET	025 FEET	030 FEET	037 FEET	037 FEET

IF FLOWING, GIVE RATE: GPM.
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING: 050 FEET
RECOMMENDED PUMPING RATE: 0006 GPM.
000.2 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

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



DRILLERS REMARKS:

FINAL STATUS OF WELL
1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING
1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

CONTRACTOR
NAME OF WELL CONTRACTOR: John R. Sprowl
LICENCE NUMBER: 4805
ADDRESS: 40 Eastern Ave Acton
NAME OF DRILLER OR BORER: J.R + J.C. Sprowl
LICENCE NUMBER: 4805 4820
SIGNATURE OF CONTRACTOR: J. R. Sprowl Per. B.J.S.
SUBMISSION DATE: DAY 25 MO. Aug YR. 1972

OFFICE USE ONLY
DATA SOURCE: 1
CONTRACTOR: 4805
DATE RECEIVED: 200972
DATE OF INSPECTION:
INSPECTOR:
REMARKS:
P
W1
CSS.ES

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W29-4935 7th Line

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MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

Ontario

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11

6705878

MUNICIP. 67002 CON. CON 07

COUNTY OR DISTRICT [redacted]

TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Eramosa

CON., BLOCK, TRACT, SURVEY, ETC.: 7

LOT: 001

Breslau Ont

DATE COMPLETED: DAY 07 MO. 08 aug YR. 75

21 30190 5 1195 5 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Brown	muddy sand			0	12
Light Grey	Limestone			12	80

31 0012628 0080215

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0045	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
0075	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06 6 1/4	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	0	0015
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER
PUMPING RATE: 0010 GPM
DURATION OF PUMPING: 01 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
008 FEET	080 FEET	012 FEET	010 FEET	009 FEET	009 FEET

WATER LEVELS DURING: 1 ☐ PUMPING 2 ☒ RECOVERY
IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING: 075 FEET
RECOMMENDED PUMPING RATE: 0010 GPM
GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL: 1

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE: 04

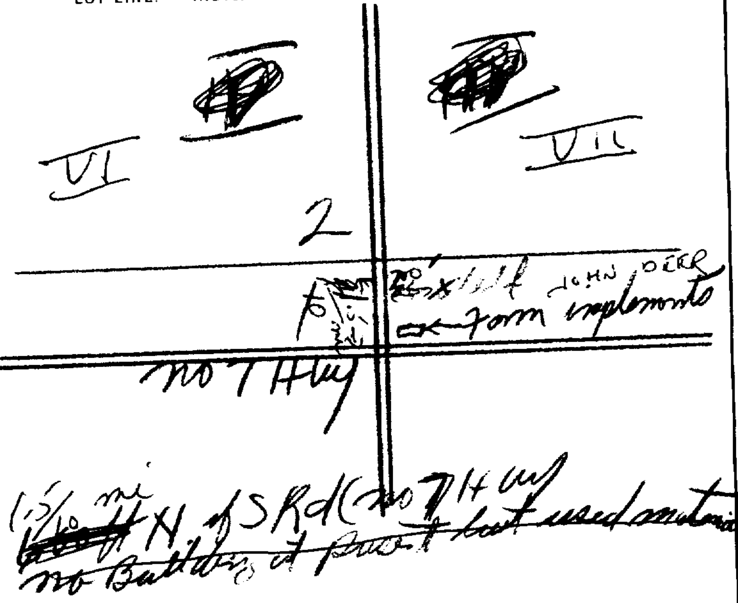
1 ☐ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☒ INDUSTRIAL ?
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING: 2

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

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



1 5/10 mi ~~[illegible]~~ N of S Rd (No 7 Hwy ~~that used materi~~
~~no Building at pres~~

DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: Wesley Packham
LICENCE NUMBER: 4208
ADDRESS: RR2 Ancaster
NAME OF DRILLER OR BORER: Wesley Packham
LICENCE NUMBER: 4208
SIGNATURE OF CONTRACTOR: Wesley Packham
SUBMISSION DATE: DAY 7 MO aug YR 75

OFFICE USE ONLY

DATA SOURCE: 1
CONTRACTOR: 4208
DATE RECEIVED: 300176
DATE OF INSPECTION: May 16/77
INSPECTOR:
REMARKS:
P
WI

CSS.ES
FORM 7 MOE 07-091

MINISTRY OF THE ENVIRONMENT COPY

40P/9E W32

4964 7th Line

The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

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11 (1 2) | 6703695- | MUNICIP. 67002 (10 14) | CON. CON (15) 06 (22 23 24)

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
~~Peel~~ WELLINGTON	~~Chinguacousy~~ ERAMOSA	6 ~~4 E 2 EAST~~	002

[redacted]

ADDRESS: ~~R.R. # 1 BRAMPTON~~ R.R.#4 ROCKWOOD

DATE COMPLETED: DAY ~~13~~ 13 MO ~~MAY~~ 05 YR ~~1970~~ 70

NORTHING 830360 (24) | RC. 4 (25) | ELEVATION ~~1205~~ 1205 (26) | RC. 5 (30) | BASIN CODE 23 (31) | II | III | IV (47)

ROCKWOOD

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
	CLAY - ROCKS			0	17
LIGHT	GREY - LIMESTONE			17	158

31: 0017 0512 | 0158 2215

32:

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0154 ~~154~~ (10-13)	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL (14)
(15-18)	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL (19)
(20-23)	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL (24)
(25-28)	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL (29)
(30-33)	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL (34) 80

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
04 (10-11)	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE (12)	205	0	~~30~~ 0030 (13-16)
04 (17-18)	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE (19)		30	0158 (20-23)
(24-25)	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE (26)			(27-30)

SCREEN

SIZE(S) OF OPENING (SLOT NO.) 31-33	DIAMETER 34-38 INCHES	LENGTH 39-40 FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN 41-44 FEET	80

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	DEPTH SET AT – FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
10-13	14-17	
18-21	22-25	
26-29	30-33	80

71 PUMPING TEST

PUMPING TEST METHOD (10): 1 ☒ PUMP 2 ☐ BAILER

PUMPING RATE (11-14): 0015 GPM.

DURATION OF PUMPING: 01 HOURS (15-16) 00 MINS. (17-18)

WATER LEVELS DURING (25): 1 ☒ PUMPING 2 ☐ RECOVERY

STATIC LEVEL (19-21)	WATER LEVEL END OF PUMPING (22-24)	15 MINUTES (26-28)	30 MINUTES (29-31)	45 MINUTES (32-34)	60 MINUTES (35-37)
014 FEET	020 FEET	020 FEET	020 FEET	020 FEET	020 FEET

IF FLOWING, GIVE RATE (38-41): GPM.

PUMP INTAKE SET AT: FEET

WATER AT END OF TEST (42): 1 ☐ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☑ DEEP

RECOMMENDED PUMP SETTING (43-45): 050 FEET

RECOMMENDED PUMPING RATE (46-49): 0010 GPM.

(50-53) 002.5 GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL (54)

- 1 ☒ WATER SUPPLY
- 2 ☐ OBSERVATION WELL
- 3 ☐ TEST HOLE
- 4 ☐ RECHARGE WELL
- 5 ☐ ABANDONED, INSUFFICIENT SUPPLY
- 6 ☐ ABANDONED, POOR QUALITY
- 7 ☐ UNFINISHED

WATER USE 01 (55-56)

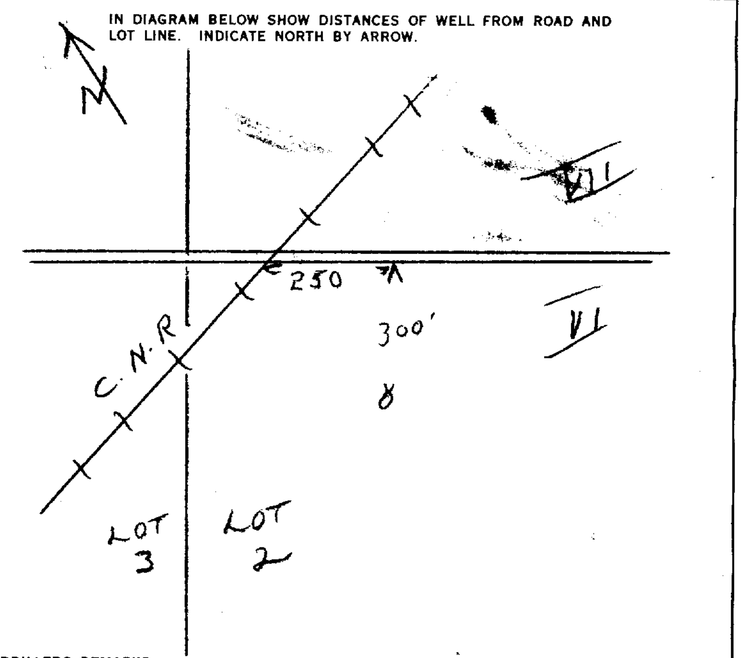
- 1 ☒ DOMESTIC
- 2 ☐ STOCK
- 3 ☐ IRRIGATION
- 4 ☐ INDUSTRIAL
- ☐ OTHER
- 5 ☐ COMMERCIAL
- 6 ☐ MUNICIPAL
- 7 ☐ PUBLIC SUPPLY
- 8 ☐ COOLING OR AIR CONDITIONING
- 9 ☐ NOT USED

METHOD OF DRILLING (57)

- 1 ☐ CABLE TOOL
- 2 ☒ ROTARY (CONVENTIONAL)
- 3 ☐ ROTARY (REVERSE)
- 4 ☐ ROTARY (AIR)
- 5 ☐ AIR PERCUSSION
- 6 ☐ BORING
- 7 ☐ DIAMOND
- 8 ☐ JETTING
- 9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: LADCO DRILLING | LICENCE NUMBER: 3316

ADDRESS: Hillsburg R.R. # 1

NAME OF DRILLER OR BORER: ~~THOMAS~~ LAING | LICENCE NUMBER: 3316

SIGNATURE OF CONTRACTOR: J. Laing

SUBMISSION DATE: DAY 13 MO MAY YR 1970

OFFICE USE ONLY

DATA SOURCE (58): 1 | CONTRACTOR (59-62): 3316 | DATE RECEIVED (63-68): 100770 | 80

DATE OF INSPECTION: 23/12/70 | INSPECTOR: F/L

REMARKS:

CSS.ES 7

OWRC COPY

W32 40 P/9E
4964 7th Line

The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

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

11

6703839 MUNICIP. 67002 CON. CON 06

COUNTY OR DISTRICT: Wellington
TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: ERAMOSA
CON., BLOCK, TRACT, SURVEY, ETC.: 6
LOT 25-27: 002

[redacted]

OCKWOOD

DATE COMPLETED 05 48-53 DAY 13 MO. ~~MAY~~ YR. 70 ~~170~~

30340 RC. 4 ELEVATION 1200 RC. 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	TO
Clay – Rocks –				0	17
Light grey – Limestone				17	158

31 0017 05/12 0158 2/15
32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0154	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	TO
04"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.205	0	~~30~~ 0030
04"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		30	0158 ~~158~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER
PUMPING RATE: 0015 GPM.
DURATION OF PUMPING: 01 HOURS 00 MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
014 FEET	020 FEET	020 FEET	020 FEET	020 FEET	020 FEET

WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY
IF FLOWING, GIVE RATE: GPM.
PUMP INTAKE SET AT: FEET
WATER AT END OF TEST: 1 ☐ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING: 050 FEET
RECOMMENDED PUMPING RATE: 0010 GPM.
0025 GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE

01

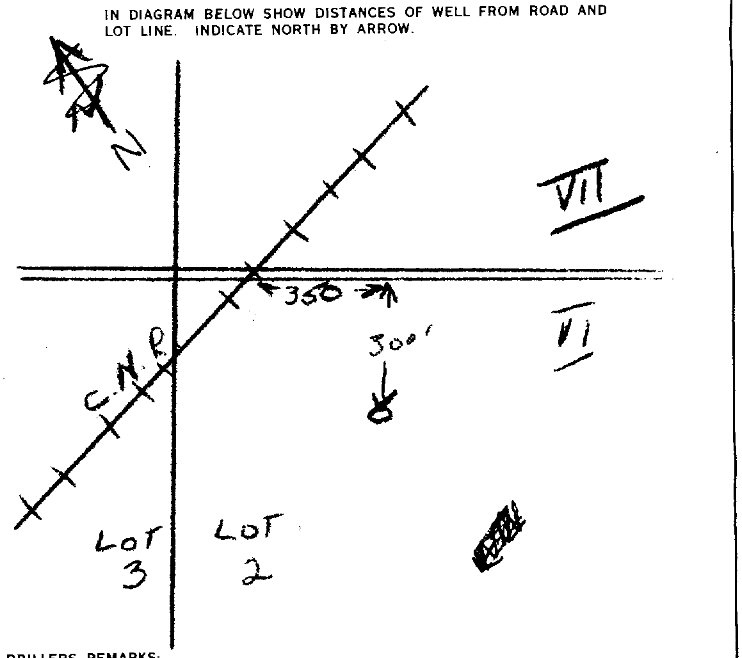
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: LADCO DRILLING
LICENCE NUMBER: 3316
ADDRESS: Hillsburg, R.R. #1
NAME OF DRILLER OR BORER: Thomas Lang
LICENCE NUMBER: 3316
SIGNATURE OF CONTRACTOR: T. Lang
SUBMISSION DATE: DAY 13 MO. May YR. 1970

OFFICE USE ONLY

DATA SOURCE: 1
CONTRACTOR: 3316
DATE RECEIVED: 301270
DATE OF INSPECTION:
INSPECTOR:
REMARKS:
P 2
CSS.ES

OWRC COPY

W33 4t P/9E
4952 7th Line

The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

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

11

6703540

MUNICIP. 67002
CON. Con 06

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
Wellington	Eramosa	VI	002

[redacted] R.R #4 Rockwood

DATE COMPLETED 48-53 DAY 04 MO. 08 YR. 69

30230 RC. 4 ELEVATION 1200 RC. 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
BROWN	CLAY		CLAY & STONES	0	10
GREY	LIMESTONE			10	80

31 0010605112 0080215

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0062	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
0079	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
04"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.205	0	~~21~~ 0021
04"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		21	0080 ~~80~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	DEPTH SET AT – FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ~~☐ BAILER~~

PUMPING RATE: 0015 GPM.

DURATION OF PUMPING: 01 HOURS 30 MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING 1 ☒ PUMPING 2 ☐ RECOVERY 15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
015 FEET	025 FEET	025 FEET	025 FEET	025 FEET	025 FEET

IF FLOWING, GIVE RATE: GPM.

PUMP INTAKE SET AT: 35 FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 050 FEET

RECOMMENDED PUMPING RATE: 0010 GPM.

001.5 GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01

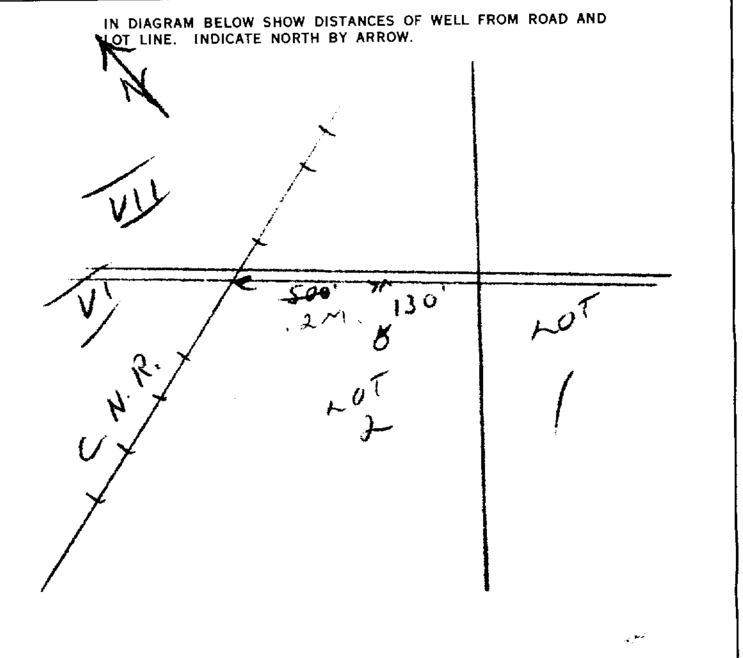
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING

1 ☐ CABLE TOOL
2 ☒ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: LADCO DRILLING
LICENCE NUMBER: 3423
ADDRESS: HILLSBURGH RR#1
NAME OF DRILLER OR BORER: ROY LANG
LICENCE NUMBER: 3424
SIGNATURE OF CONTRACTOR: Roy Lang
SUBMISSION DATE: DAY 4 MO. 8 YR. 69

OFFICE USE ONLY

DATA SOURCE: 1
CONTRACTOR: 3316
DATE RECEIVED: 191169
DATE OF INSPECTION: 10, 3, 70
INSPECTOR: 7/P
REMARKS:
CSS.ES

OWRC COPY

W33-4952 7th Line

7172745

Ontario Ministry of the Environment

Measurements recorded in: ☐ Metric ☒ Imperial

Well Tag No: A103462

A103462.

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 3.

[redacted]

Address of Well Location (Street Number/Name) Same	Township Eramosa	Lot 2	Concession 6
County/District/Municipality Same	City/Town/Village Rockwood	Province Ontario	Postal Code N0B2K0
UTM Coordinates NAD 83 Zone 17 Easting 572357 Northing 4830444	Municipal Plan and Sublot Number	Other	

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	To
5' OF 5" CASING USED TO EXTEND WELL ABOVE GROUND. INSTALLED PITLESS ADAPTOR, GROUTED CASING, REG. #903, WELL RECORD, TAG, GPS.					

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)

Method of Construction

☐ Cable Tool
☐ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☐ Other, specify
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, specify
☐ Commercial
☐ Municipal
☐ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☐ Monitoring

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To

Status of Well

☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☒ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping
hrs + min

Final water level end of pumping (m/ft)

If flowing give rate (l/min / GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min / GPM)

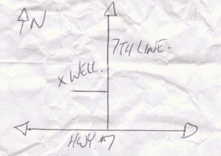
Well production (l/min / GPM)

Disinfected?
☐ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Water Details

Water found at Depth (m/ft) Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify

Water found at Depth (m/ft) Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify

Water found at Depth (m/ft) Kind of Water: ☐ Fresh ☐ Untested ☐ Gas ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)

Well Contractor and Well Technician Information

Business Name of Well Contractor: TOM'S WELL DRILLING INC.

Well Contractor's Licence No.: 7143

Business Address (Street Number/Name): 8 JOHN AVE.

Municipality: NEW TEC

Province: ON

Postal Code: L9R1J8

Business E-mail Address:

Bus. Telephone No. (inc. area code): 7054358851

Name of Well Technician (Last Name, First Name): EBDON, STEVE

Well Technician's Licence No.: 2934

Signature of Technician and/or Contractor

Date Submitted: 20110730

Well owner's information package delivered ☒ Yes ☐ No

Date Package Delivered: 20110722

Date Work Completed: 20110722

Ministry Use Only

Audit No. Z128064

DEC 01 2011
Received

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Ministry's Copy

The Ontario Water Resources Commission Act

WATER WELL RECORD

4oP/9E W34
4944 7th Line

Water management in Ontario

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

11 (1 2) | 6704252 | MUNICIP. 67002 (10 14) | CON. CON (15) 06 (22 23 24)

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
Wellington	Eramosa	~~con 7~~ ~~VI~~ VI	~~21~~ 001

[redacted] R # 4 Rodkwood Ontario

DATE COMPLETED 48-53: DAY 14 MO. ~~June~~ 06 YR. 72

30100 (24) | RC. 4 (25) | ELEVATION 1200 (26) | RC. 5 (30) | BASIN CODE 23 (31) | II | III | IV | 47

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
brown	clay	and stones		0	23
dk grey	rock			23	35
lt grey	rock			35	55
	total	depth - 55 ft			
rig (1)					

31 | 0023605 12 | 0055226
32
1 2 | 10 | 14 15 | 21 | 32 | 43 | 54 | 65 | 75 | 80

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
10-13 0050 ~~50-55'~~	1 ☒ FRESH 3 ☐ SULPHUR 14 2 ☐ SALTY 4 ☐ MINERAL
15-18 0055	1 ☒ FRESH 3 ☐ SULPHUR 19 2 ☐ SALTY 4 ☐ MINERAL
20-23	1 ☐ FRESH 3 ☐ SULPHUR 24 2 ☐ SALTY 4 ☐ MINERAL
25-28	1 ☐ FRESH 3 ☐ SULPHUR 29 2 ☐ SALTY 4 ☐ MINERAL
30-33	1 ☐ FRESH 3 ☐ SULPHUR 34 80 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
10-11 04	12 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	13-16 ~~27~~ 0027
17-18	19 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		27 ~~27~~	20-23 ~~55~~ 0055
24-25	26 1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			27-30

SCREEN

SIZE(S) OF OPENING (SLOT NO.) 31-33	DIAMETER 34-38 INCHES	LENGTH 39-40 FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN 41-44 FEET	80

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
10-13	14-17	
18-21	22-25	
26-29	30-33	80

71 PUMPING TEST

PUMPING TEST METHOD 10: 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE 11-14: 0008 GPM.

DURATION OF PUMPING: 00 15-16 HOURS ~~30~~ 30 17-18 MINS.

STATIC LEVEL 19-21	WATER LEVEL END OF PUMPING 22-24	25 WATER LEVELS DURING 1 ☒ PUMPING 2 ☐ RECOVERY 15 MINUTES 26-28	30 MINUTES 29-31	45 MINUTES 32-34	60 MINUTES 35-37
012 FEET	025 FEET	025 FEET	025 FEET	FEET	FEET

IF FLOWING, GIVE RATE 38-41: GPM.

PUMP INTAKE SET AT: FEET

WATER AT END OF TEST 42: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING 43-45: 040 FEET

RECOMMENDED PUMPING RATE 46-49: 0008 GPM.

50-53 000.8 GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL

54
1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01

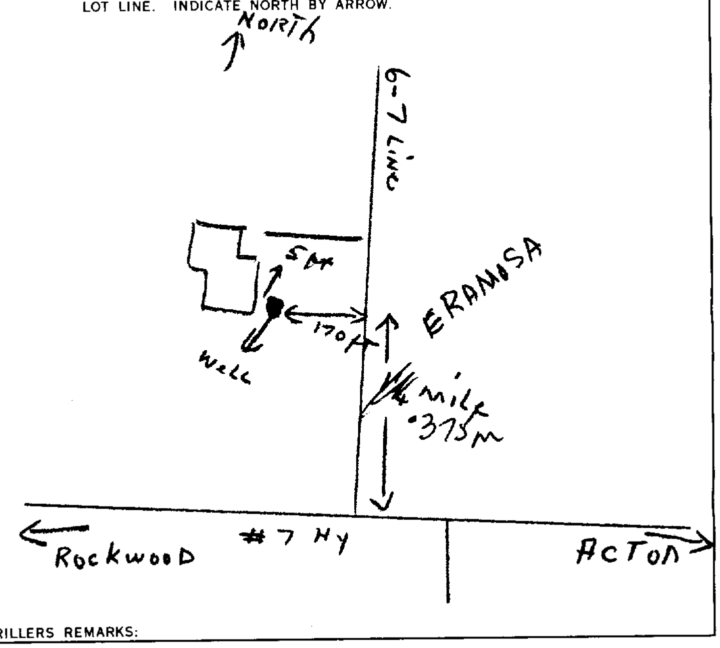
55-56
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING

57
1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS REMARKS:

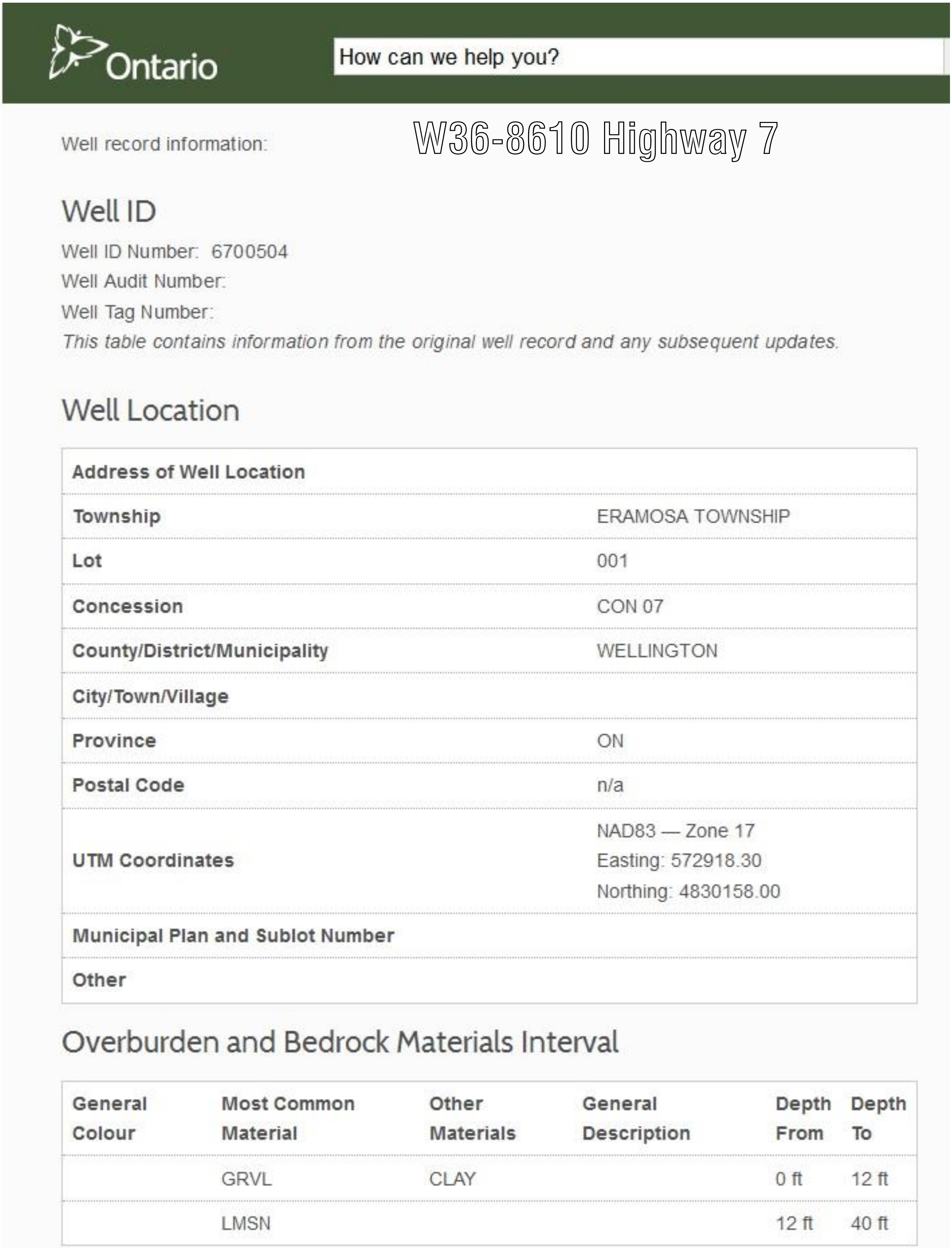
CONTRACTOR

NAME OF WELL CONTRACTOR: Graham Well Drilling
LICENCE NUMBER: 2406
ADDRESS: R R # 2 Guelph Ont.
NAME OF DRILLER OR BORER: James Hawkins
LICENCE NUMBER:
SIGNATURE OF CONTRACTOR: J L Graham per
SUBMISSION DATE: DAY 14 MO. June YR. 72

OFFICE USE ONLY

DATA SOURCE 58: 1
CONTRACTOR 59-62: 2406
DATE RECEIVED 63-68: 270672
80
DATE OF INSPECTION:
INSPECTOR:
REMARKS:
P
W1
CSS.ES

OWRC COPY



Well record information: **W36-8610 Highway 7**

Well ID

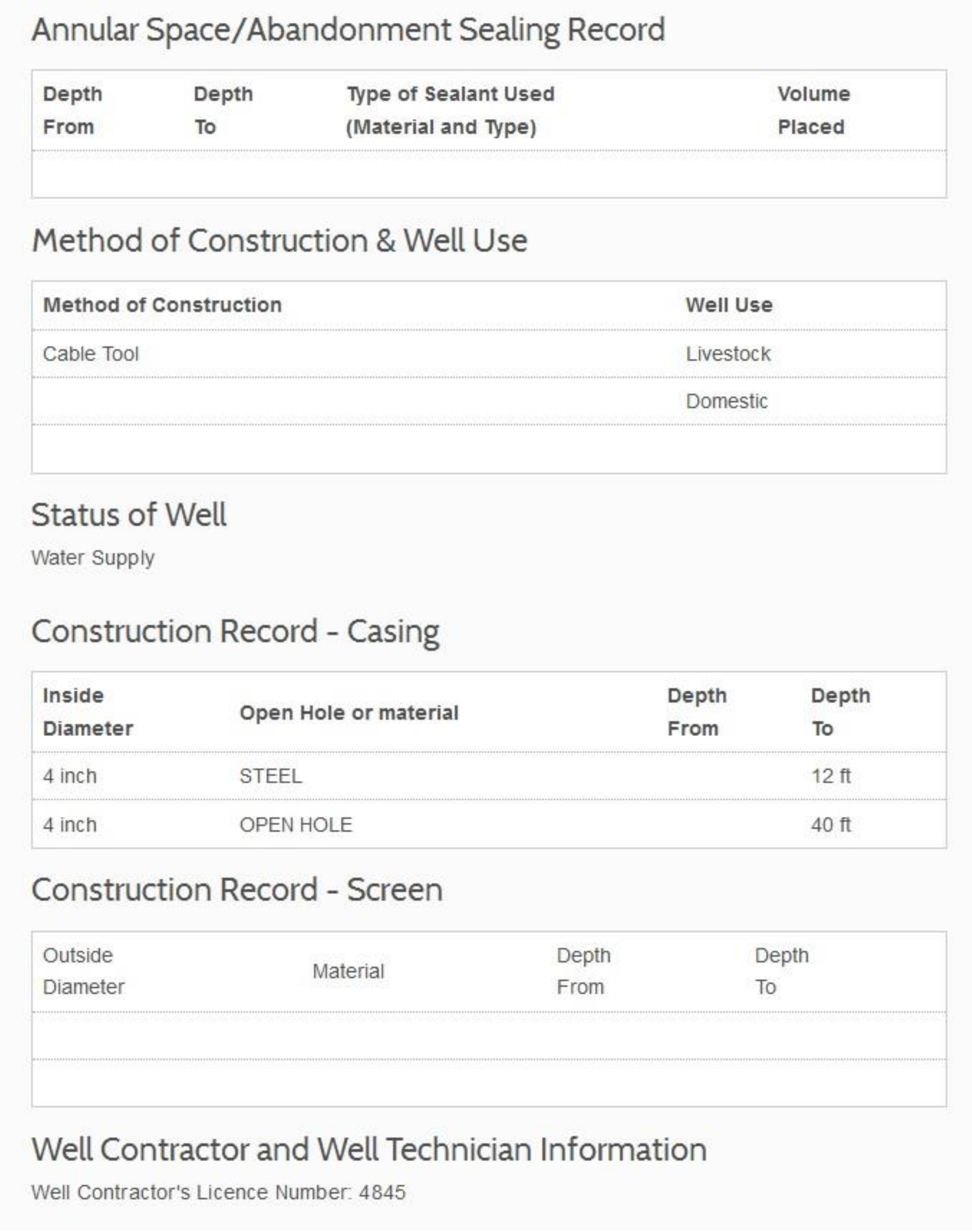
Well ID Number: 6700504
Well Audit Number:
Well Tag Number:
This table contains information from the original well record and any subsequent updates.

Well Location

Address of Well Location	
Township	ERAMOSA TOWNSHIP
Lot	001
Concession	CON 07
County/District/Municipality	WELLINGTON
City/Town/Village	
Province	ON
Postal Code	n/a
UTM Coordinates	NAD83 — Zone 17 Easting: 572918.30 Northing: 4830158.00
Municipal Plan and Sublot Number	
Other	

Overburden and Bedrock Materials Interval

General Colour	Most Common Material	Other Materials	General Description	Depth From	Depth To
	GRVL	CLAY		0 ft	12 ft
	LMSN			12 ft	40 ft



Annular Space/Abandonment Sealing Record

Depth From	Depth To	Type of Sealant Used (Material and Type)	Volume Placed

Method of Construction & Well Use

Method of Construction	Well Use
Cable Tool	Livestock
	Domestic

Status of Well

Water Supply

Construction Record - Casing

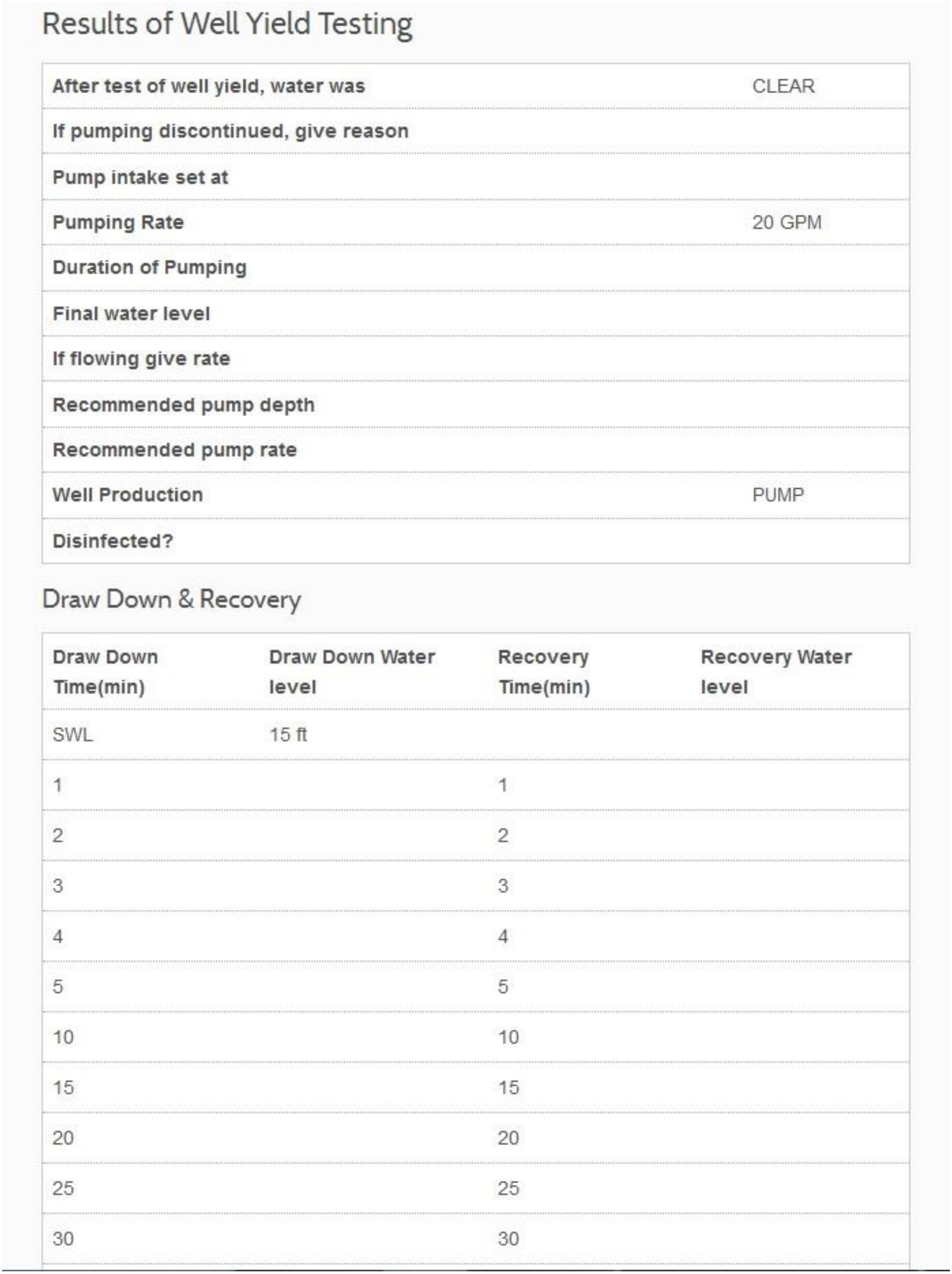
Inside Diameter	Open Hole or material	Depth From	Depth To
4 inch	STEEL		12 ft
4 inch	OPEN HOLE		40 ft

Construction Record - Screen

Outside Diameter	Material	Depth From	Depth To

Well Contractor and Well Technician Information

Well Contractor's Licence Number: 4845

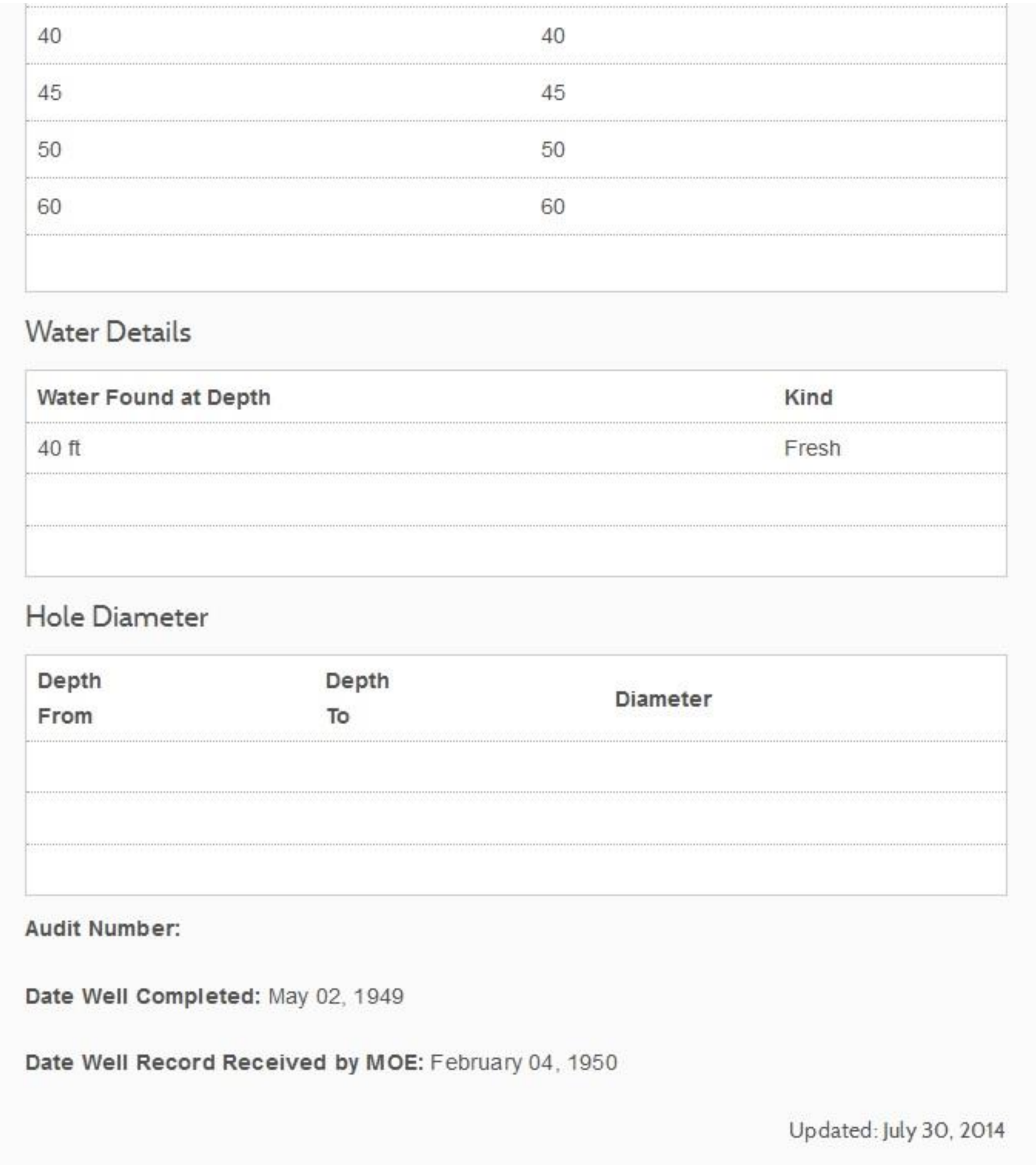


Results of Well Yield Testing

After test of well yield, water was	CLEAR
If pumping discontinued, give reason	
Pump intake set at	
Pumping Rate	20 GPM
Duration of Pumping	
Final water level	
If flowing give rate	
Recommended pump depth	
Recommended pump rate	
Well Production	PUMP
Disinfected?	

Draw Down & Recovery

Draw Down Time(min)	Draw Down Water level	Recovery Time(min)	Recovery Water level
SWL	15 ft		
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	



40	40
45	45
50	50
60	60

Water Details

Water Found at Depth	Kind
40 ft	Fresh

Hole Diameter

Depth From	Depth To	Diameter

Audit Number:

Date Well Completed: May 02, 1949

Date Well Record Received by MOE: February 04, 1950

Updated: July 30, 2014

J.B.

2303030

JTM 17 Z 5732610

4 R 4829460

Elev. 6 R 1140

23 Halton

Con 6
Lot 32

CODED

W39-14184 6th Line

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District Halton

Township, Village, Town or City Nassagaweya

Con. E ½ of 6

Lot part of 32

Date completed 31 (day) March (month) 1969 (year)

[redacted]

dress 8 Walter St. Guelph

SB

Casing and Screen Record

Inside diameter of casing 4 1/8"

Total length of casing 14 1/2 ft

Type of screen —

Length of screen —

Depth to top of screen —

Diameter of finished hole 4"

-24 1969
ONTARIO WATER
COMMISSION

Pumping Test

Static level 35 ft

Test-pumping rate 10 G.P.M.

Pumping level 40

Duration of test pumping 1 hour

Water clear or cloudy at end of test clear

Recommended pumping rate 10 G.P.M.

with pump setting of 70 feet below ground surface

Well Log

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
gravel + clay	0	6	54	fresh
grey Limestone	6	90	72	
			86	

r what purpose(s) is the water to be used? dwelling

ell on upland, in valley, or on hillside? on upland

ing or Boring Firm J. R + J. C. Sprowl 40 Eastern Ave. Acton + 137 Renfield St. Guelph

ss 137 Renfield St. Guelph

Number 3317 + 3316

f Driller or Borer J. R + J. C. Sprowl 40 Eastern Ave Acton + 137 Renfield St Guelph

March 1969.

R + J. C. Sprowl Per. B.J.S.

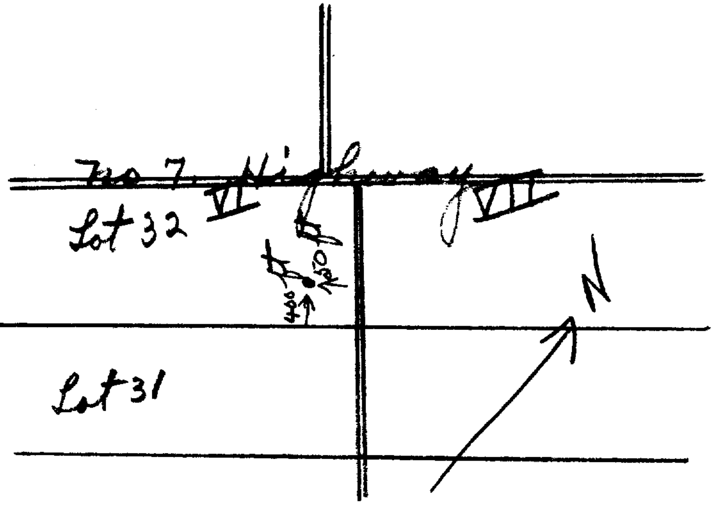
ignature of Licensed Drilling or Boring Contractor)

60-20912

OPY

Location of Well

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



CSS.S8

The Ontario Water Resources Commission Act W40 14211 6th Line

WATER WELL RECORD

40 P/9E

Water management in Ontario

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

11

2803959 MUNICIP. 28002 CON. CON 07

COUNTY OR DISTRICT: Halton

TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: Nassagaweya

CON., BLOCK, TRACT, SURVEY, ETC.: W ½ of 7

LOT: 032

DATE COMPLETED: DAY 12 MO. ~~Oct~~ 10 YR. ~~1972~~ 72

[redacted] R.R. No1. Acton Ont.

29800 RC. 4 ELEVATION 1135 RC. 5 BASIN CODE 23

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
brown	boulders +	stones with a small amount	of earth	0	11
grey	Limestone	very hard		11	80
Whitish	Limestone			80	113

31 0011612 0080215 011315

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0048	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
0085	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
00106	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
~~5¼~~ 05	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ ~~OPEN HOLE~~	.188	0 ~~17~~	~~17~~ 0017 ~~113~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)

DIAMETER INCHES

LENGTH FEET

MATERIAL AND TYPE

DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE: 0015 GPM.

DURATION OF PUMPING: 02 HOURS 00 MINS.

WATER LEVELS DURING: 1 ☑ PUMPING 2 ☐ RECOVERY

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
015 FEET	075 FEET	075 FEET	075 FEET	075 FEET	075 FEET

IF FLOWING, GIVE RATE: GPM.

PUMP INTAKE SET AT: FEET

WATER AT END OF TEST: 1 ☐ ~~fairly~~ CLEAR 2 ☒ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 100 FEET

RECOMMENDED PUMPING RATE: 0015 GPM.

000.3 GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01

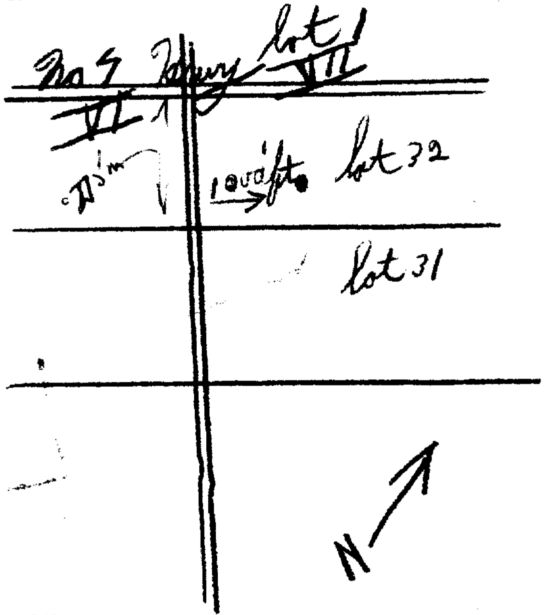
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING

1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

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



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: J. R. Sprowl LICENCE NUMBER: 4805

ADDRESS: ~~40~~ Eastern Ave. Acton

NAME OF DRILLER OR BORER: J R + J C Sprowl LICENCE NUMBER: 4805 4820

SIGNATURE OF CONTRACTOR: J. R. Sprowl Per. B.J.S.

SUBMISSION DATE: DAY 24 MO. Oct. YR. 1972

OFFICE USE ONLY

DATA SOURCE: 1 CONTRACTOR: 4805 DATE RECEIVED: 241172

DATE OF INSPECTION

INSPECTOR

REMARKS: CSS.S8

P

WI

OWRC COPY

Ontario Ministry of the Environment

Well Tag Numbe A 007193

A007193

W42 14413 6th Line

Well Record

Regulation 903 Ontario Water Resources Act

2810143

page ___ of ___

Instructions for Completing Form

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

Ministry Use Only

MUN | CON | LOT

[redacted]

Address of Well Location (County/District/Municipality) Halton

Township [redacted] Nassagaweya

Lot 32

Concession 7

RR#/Street Number/Name 6th Line

City/Town/Village Milton

Site/Compartment/Block/Tract etc.

GPS Reading NAD 8 3 Zone 17 Easting 573141 Northing 4830087

Unit Make/Model Magellan Sportrack

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	FT TO	Depth From	Metres To
Black	Top Soil			0	2	0	0.61
Brown	Clay	Stones		2	6	0.61	1.83
Grey	Limestone			6	130	1.83	39.62
Blue	Shale			130	143	39.62	43.59
Red	Shale			143	145	43.59	44.20

TOTAL = 145 FT / 44.20

6¼ / 40.32 Casing Drive Shoe

Hole Diameter

Depth From	Metres To	Diameter Centimetres
0	6.09	25.4
6.09	44.20	15.87

Water Record

Water found at Metres / Kind of Water

39.62 m ☑ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other: UNTESTED

44.20 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 ______

Chlorinated ☑ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth From	Metres To
Casing				
15.87 / 6¼	☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	0.48 / .188	0.91 / +3	6.10 / 20
	☐ 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		6.10 / 20	44.20 / 145

Test of Well Yield

Pumping test method Submersible Pump	Draw Down Time min	Draw Down Water Level Metres	Recovery Time min	Recovery Water Level Metres
Pump intake set at - (metres) 100	Static Level	17		30
Pumping rate - (litres/min) 15	1	30	1	48
Duration of pumping 1 hrs + ______ min	2	37	2	47
Final water level end of pumping 43 metres	3	43	3	45
Recommended pump type. ☐ Shallow ☑ Deep	4	45	4	50
Recommended pump depth. 100 FT metres	5	50	5	39
Recommended pump rate. 15 GPM ~~(litres/min)~~	10	50	10	27
	15	50	15	20
If flowing give rate - (litres/min)	20	50	20	17
	25	50	25	
If pumping discontinued, give reason.	30	50	30	
	40	50	40	
	50	50	50	
	60	50	60	

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	Quick Grout	40 GAL

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 Hannon Well Drilling LTD

Well Contractor's Licence No. 2663

Business Address (street name, number, city etc.) RR#5 Guelph ONT. N1H6J2

Name of Well Technician (last name, first name) Whitney John

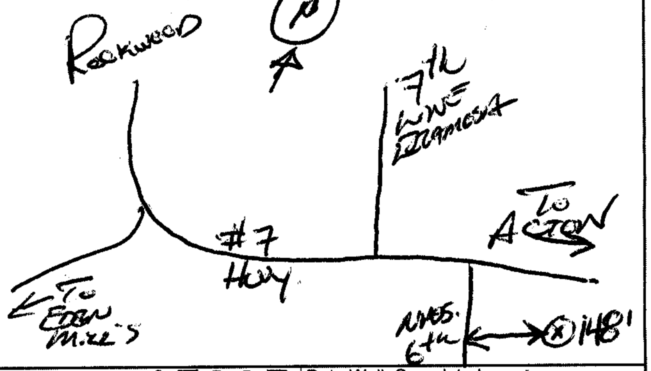
Well Technician's Licence No. T-2790

Signature of Technician/Contractor X

Date Submitted YYYY 2004 MM 12 DD 01

Location of Well

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



Audit No. Z 17965

Date Well Completed YYYY 2004 MM 11 DD 02

Was the well owner's information package delivered? ☑ Yes ☐ No

Date Delivered YYYY 2004 MM 11 DD 02

Ministry Use Only

Data Source

Contractor 2663

Date Received YYYY MM DD FEB 15 2005

Date of Inspection YYYY MM DD

Remarks

Well Record Number

0506E (09/03) Contractor's Copy ☐ Ministry's Copy ☐ Well Owner's Copy ☐

Cette formule est disponible en français

W44-14301 6th Line

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

HALTON

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

11 2807654 MUNICIP. 28002 CON. CON 07

COUNTY OR DISTRICT: NASSAGAWEYA

TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: [redacted] OF MILTON (Nassg)

CON., BLOCK, TRACT, SURVEY, ETC: CON 7

LOT:

BOWER ST. ACTON

DATE COMPLETED: DAY 1 MO 8 YR. 90

RC. ELEVATION RC BASIN CODE II III IV

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BROWN	SAND	STONES & BOULDERS		0	10
BROWN	LIMESTONE			10	27
GREY	LIMESTONE			27	49
WHITE	LIMESTONE			49	87

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
32	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
79	1 ☒ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS
	1 ☐ FRESH 2 ☐ SALTY 3 ☐ SULPHUR 4 ☐ MINERALS 6 ☐ GAS

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
6	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC	188	0	11
6	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE 5 ☐ PLASTIC		11	87
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE 5 ☐ PLASTIC			

SCREEN

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

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER

PUMPING RATE: 8 GPM

DURATION OF PUMPING: 2 HOURS 0 MINS

STATIC LEVEL: 12 FEET

WATER LEVEL END OF PUMPING: 15 FEET

WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
15 FEET	15 FEET	15 FEET	15 FEET

IF FLOWING, GIVE RATE: GPM

PUMP INTAKE SET AT: FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 50 FEET

RECOMMENDED PUMPING RATE: 8 GPM

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED POOR QUALITY
7 ☐ UNFINISHED
☐ DEWATERING

WATER USE

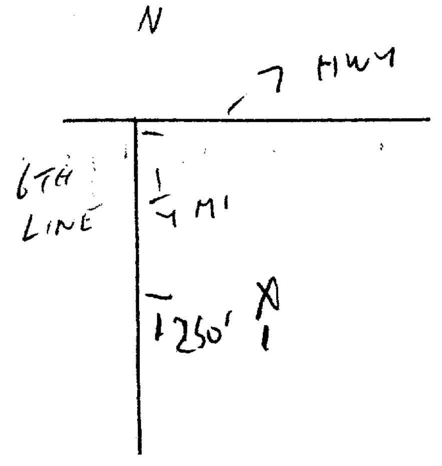
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF CONSTRUCTION

1 ☒ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING
☐ DIGGING
☐ OTHER

LOCATION OF WELL

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



75008

DRILLERS REMARKS

CONTRACTOR

NAME OF WELL CONTRACTOR: JACKSON CO. WELLDRILLING

WELL CONTRACTOR'S LICENCE NUMBER: 2918

ADDRESS: 6 VICTORIA AVE ACTON

NAME OF WELL TECHNICIAN: JACK VERHEUL

WELL TECHNICIAN'S LICENCE NUMBER: T-0582

SIGNATURE OF TECHNICIAN/CONTRACTOR:

SUBMISSION DATE: DAY 1 MO. 8 YR. 90

OFFICE USE ONLY

DATA SOURCE:
CONTRACTOR: 2918
DATE RECEIVED: SEP 25 1990
DATE OF INSPECTION:
INSPECTOR:
REMARKS:

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

Ontario Ministry of the Environment

Well Tag Number (Place sticker and print number below)

A007196

W45 4960 7th Line

Well Record

Regulation 903 Ontario Water Resources Act

6715237

page ___ of ___

Instructions for Completing Form

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- Questions regarding completing this application can be directed to the Water Well Management Coordinator at 416-235-6203.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only

MUN ___ CON ___ LOT ___

[redacted]

Address of Well Location (County/District/Municipality)	Township	Lot	Concession
Wellington	Guelph / Eramosa	1/2	7

RR#/Street Number/Name: 7th Line Eramosa

City/Town/Village:

Site/Compartment/Block/Tract etc.:

GPS Reading NAD 83 Zone 17 Easting 572208 Northing 4830568

Unit Make/Model: [illegible]

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	Stones		0	18	0	5.49
Grey	Limestone	Beige		18	120	5.49	36.58
			Total = 120'/36.58				
		6¼ / 40.32	Casing Drive Shoe				

Hole Diameter

Depth Metres From	To	Diameter Centimetres
0	6.09	25.4
6.09	36.58	15.87

Water Record

Water found at Metres	Kind of Water		
36.58 m	☑ Fresh	☐ Salty	☐ Sulphur
☐ Gas	☐ Minerals	☐ Other: Untested	
m	☐ Fresh	☐ Salty	☐ Sulphur
☐ Gas	☐ Minerals	☐ Other:	
m	☐ Fresh	☐ Salty	☐ Sulphur
☐ Gas	☐ Minerals	☐ Other:	

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

Chlorinated ☑ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	To
Casing				
15.87 / 6¼	☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	0.48 / .188	0.61 / +2	6.40 / 21
	☐ 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		6.40 / 21	36.58 / 120

Test of Well Yield

	Draw Down Time min	Water Level Metres	Recovery Time min	Water Level Metres
Pumping test method: Submersible Pump				
Pump intake set at - (metres)	Static Level	15		37
Pumping rate - (litres/min)	1	25	1	[illegible]
Duration of pumping ___hrs + ___ min	2	30	2	23
Final water level end of pumping ___ metres	3	37	3	20
Recommended pump type. ☐ Shallow ☐ Deep	4	37	4	18
Recommended pump depth. 80 Ft metres	5	37	5	15
Recommended pump rate. (litres/min)	10	37	10	
	15	37	15	
If flowing give rate - (litres/min)	20	37	20	
	25	37	25	
If pumping discontinued, give reason.	30	37	30	
	40	37	40	
	50	37	50	
	60	37	60	

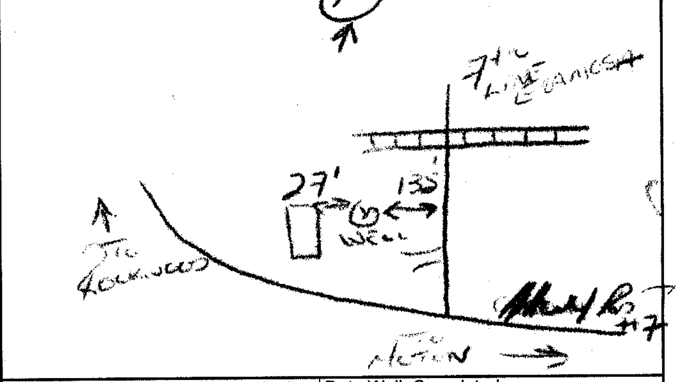
Plugging and Sealing Record

☑ 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	Quick Grout	40 Gal.

Location of Well

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



Audit No. Z 17956

Date Well Completed YYYY MM DD 2004/10/21

Was the well owner's information package delivered? ☑ Yes ☐ No

Date Delivered YYYY MM DD 2004/10/21

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: Hanlon Well Drilling Ltd

Well Contractor's Licence No.: 2663

Business Address (street name, number, city etc.): RR#5 Guelph Ont. N1H 6J2

Name of Well Technician (last name, first name): Whitney John

Well Technician's Licence No.: T-2790

Signature of Technician/Contractor X

Date Submitted YYYY MM DD 2004/11/01

Ministry Use Only

Data Source

Contractor 2663

Date Received YYYY MM DD FEB 15 2005

Date of Inspection YYYY MM DD

Remarks

Well Record Number

0506E (09/03)

Contractor's Copy ☐ Ministry's Copy ☐ Well Owner's Copy ☐

Cette formule est disponible en français

Ontario Ministry of the Environment

Well Tag Number (Pl A 039554

A039554

7043462

Well Reco

Regulation 903 Ontario Water Resources Ac

W46-4936 7th Line

Page ____ of ____

Instructions for Completing Form

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

Ministry Use Only

MUN ____ CON ____ LOT ____

Well Owner's Information and Location of Well Information

[redacted]

Address of Well Location (County/District/Municipality)	Township	Lot	Concession
Wellington	Guelph Eramosa	1	6

RR#/Street Number/Name	City/Town/Village	Site/Compartment/Block/Tract etc.
7 Line Eramosa	Guelph / Eramosa	

GPS Reading NAD 8 3 Zone 17 Easting 570456 Northing 4830258 Unit Make/Model Magellan SporTrak 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 Ft. From	To	Depth From	Metres To
Brown	Clay	Stones	0	23	0	7.01
Grey	Limestone		23	40	7.01	12.19
Beige	Limestone		40	65	12.19	22.62
Grey	Limestone		65	83	22.62	25.30
			Total	83 Ft		25.30

* 6¼ | 40 23 Casing Drive Shoe *

Hole Diameter

Depth Metres From	To	Diameter Centimetres
0	6.09	25.4
6.09	25.30	15.87

Water Record

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

Chlorinated ☑ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth Metres From	To
Casing				
15.87 / 6¼	☑ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	0.48 / .188	1.22 / +4	7.01 / 23
	☐ 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		7.01 / 23	25.30 / 83

Test of Well Yield

Pumping test method: Submersible Pump

Pump intake set at - (metres) 75 Ft.

Pumping rate - (litres/min) 20 GPM

Duration of pumping 1 hrs + ____ min

Final water level end of pumping 59½ Ft metres

Recommended pump type. ☐ Shallow ☑ Deep

Recommended pump depth. 75 Ft metres

Recommended pump rate. (litres/min) 20 GPM

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	12		59½
1	26	1	44
2	34	2	36
3	36	3	30
4	40	4	25
5	45	5	22
10	52	10	18
15	54	15	16
20	56	20	15
25	57	25	
30	58	30	
40	59	40	
50	59	50	
60	59½	60	

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	Quick Grout	90 Gal.

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: Hunter Well Drilling Ltd. — Well Contractor's Licence No.: 2663

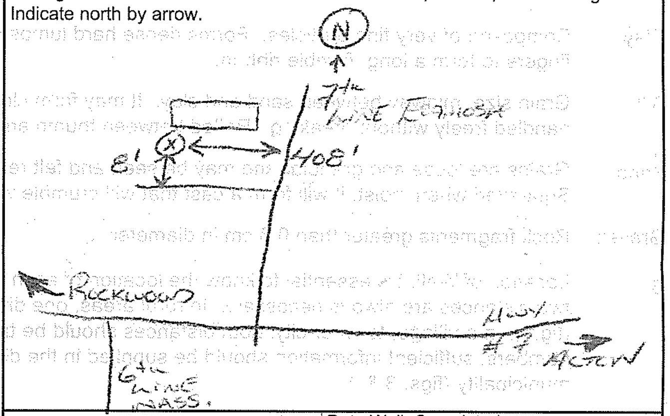
Business Address (street name, number, city etc.): RR#5 #5898 County Rd. #7 Guelph N1H 6J2

Name of Well Technician (last name, first name): Whitney John — Well Technician's Licence No.: T-2790

Signature of Technician/Contractor X — Date Submitted YYYY 2007 MM 05 DD 01

Location of Well

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



Audit No. Z 41632

Date Well Completed YYYY 2007 MM 04 DD 17

Was the well owner's information package delivered? ☑ Yes ☐ No

Date Delivered YYYY 2007 MM 04 DD 17

Ministry Use Only

Data Source ____ Contractor 2663

Date Received MAY 11 2007 — Date of Inspection YYYY MM DD

Remarks ____ Well Record Number ____

0506E (09/03) Contractor's Copy ☐ Ministry's Copy ☐ Well Owner's Copy ☐ *Cette formule est disponible en français*

Ontario Ministry of Environment and Energy

W46-4936 7th Line

The Ontario Water Resources Act
WATER WELL RECORD

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

11

6712825

Municipality 67002 Con. CON 06

County or District WELLINGTON	Township/Borough/City/Town/Village ERAMOSA	Con block tract survey, etc. VI	Lot DT LOT 1
[redacted]	Address HARDEN ENVIRONMENTAL SERVICES LTD 497 EXMOOR ST, WATERLOO ONT. N2K 3T8	Date completed 05 day 05 month 98 year	

21 Northing RC Elevation RC Basin Code ii iii iv

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth – feet From	To
	TOPSOIL			0	2
	SAND	CLAY		2	9
	CLAY, STONES, GRAVEL			9	19
GR.	LIMESTONE		BR. LAYERS	19	70
GR.	LIMESTONE			70	129

31

32

41 WATER RECORD

Water found at – feet	Kind of water
80-85	☒ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
95-100	☒ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
115-125	☒ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas
	☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals ☐ Gas

51 CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth – feet From	To
6¼	☒ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	188	0	25'6"
6⅛	☐ Steel ☐ Galvanized ☐ Concrete ☒ Open hole ☐ Plastic		25'6"	129
	☐ 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	

61 PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

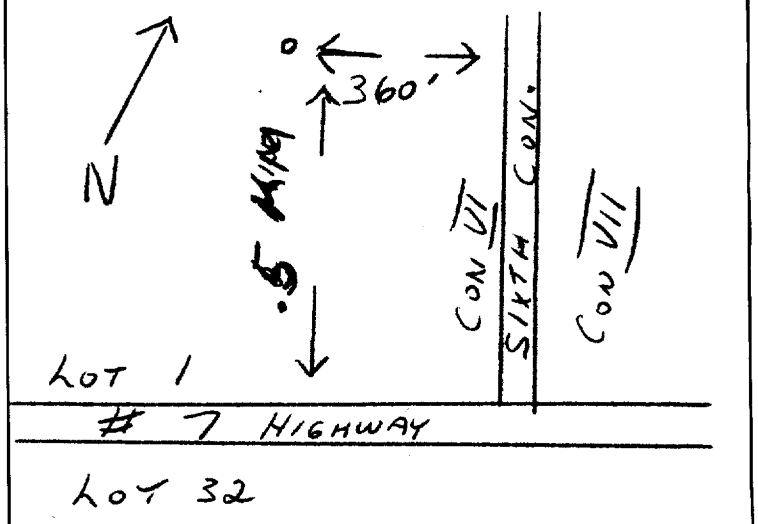
Depth set at – feet From	To	Material and type (Cement grout, bentonite, etc.)

71 PUMPING TEST

Pumping test method AIR ☐ Pump ☐ Bailer		Pumping rate 25 GPM		Duration of pumping 1 Hours 30 Mins	
Static level	Water level end of pumping	Water levels during ☒ Pumping ☐ Recovery			
		15 minutes	30 minutes	45 minutes	60 minutes
25 feet	80 feet	80 feet	80 feet	80 feet	80 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 55 feet		Recommended pump rate 10 GPM	

LOCATION OF WELL

In diagram below show distances of well from road and lot line. Indicate north by arrow. #2 WELL



TWC 28 181394

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 used
- ☐ Other TEST WELL

METHOD OF CONSTRUCTION

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

Name of Well Contractor LANG WELL DRILLING LTD	Well Contractor's Licence No. 3317
Address RR1 HILLSBURGH ONT	
Name of Well Technician ROY LANG	Well Technician's Licence No. T-0158
Signature of Technician/Contractor R Lang	Submission date 26 day 12 mo 98 yr

MINISTRY USE ONLY

Data source	Contractor 3317	Date received JAN 07 1999
Date of inspection	Inspector	
Remarks CSS.ES9		

0506 (07/94) Front Form 9

2 - MINISTRY OF ENVIRONMENT & ENERGY COPY

Ministry of Environment and Energy
Ontario

W46-4936 7th Line

The Ontario Water Resources Act
WATER WELL RECORD

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

11

6712826

Municipality 67002 Con. CON 06

County or District	Township/Borough/City/Town/Village	Con block tract survey, etc.	Lot 25-27
WELLINGTON	ERAMOSA	VI	PT LOT 1

[redacted]

Address HARDEN ENVIRONMENTAL SERVICES LTD
497 EXMOOR ST, WATERLOO ONT. N2K 3T8

Date completed 04 day 05 month 98 year

21 UTM Zone Easting Northing RC Elevation RC Basin Code ii iii iv

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see instructions)

General colour	Most common material	Other materials	General description	Depth – feet From	Depth – feet To
	TOPSOIL			0	1
BR.	CLAY, STONE			1	2
BR.	GRAVEL	CLAY		2	22
GR.	LIMESTONE			22	59
BR.	LIMESTONE	LEDGES		59	65
GR.	LIMESTONE			65	95

31

32

41 WATER RECORD

Water found at – feet	Kind of water
70-80	1 ☒ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas
85-95	1 ☒ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas
	1 ☐ Fresh 2 ☐ Salty 3 ☐ Sulphur 4 ☐ Minerals 6 ☐ Gas

51 CASING & OPEN HOLE RECORD

Inside diam inches	Material	Wall thickness inches	Depth – feet From	Depth – feet To
6¼	1 ☒ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic	.188	0	28'6"
6⅛	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☒ Open hole 5 ☐ Plastic		28'6"	95
	1 ☐ Steel 2 ☐ Galvanized 3 ☐ Concrete 4 ☐ Open hole 5 ☐ Plastic			

SCREEN

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

61 PLUGGING & SEALING RECORD

☐ Annular space ☐ Abandonment

Depth set at – feet From	To	Material and type (Cement grout, bentonite, etc.)

71 PUMPING TEST

Pumping test method AIR 1 ☐ Pump 2 ☐ Bailer
Pumping rate 6½ GPM
Duration of pumping 1 Hours 30 Mins

Water levels during 1 ☒ Pumping 2 ☐ Recovery

Static level	Water level end of pumping	15 minutes	30 minutes	45 minutes	60 minutes
11 feet	85 feet	85 feet	85 feet	85 feet	85 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 80 feet
Recommended pump rate 5 GPM

FINAL STATUS OF WELL

1 ☐ Water supply
2 ☒ Observation well
3 ☐ Test hole
4 ☐ Recharge well
5 ☐ Abandoned, insufficient supply
6 ☐ Abandoned, poor quality
7 ☐ Abandoned (Other)
8 ☐ Dewatering
9 ☐ Unfinished
10 ☐ Replacement well

WATER USE

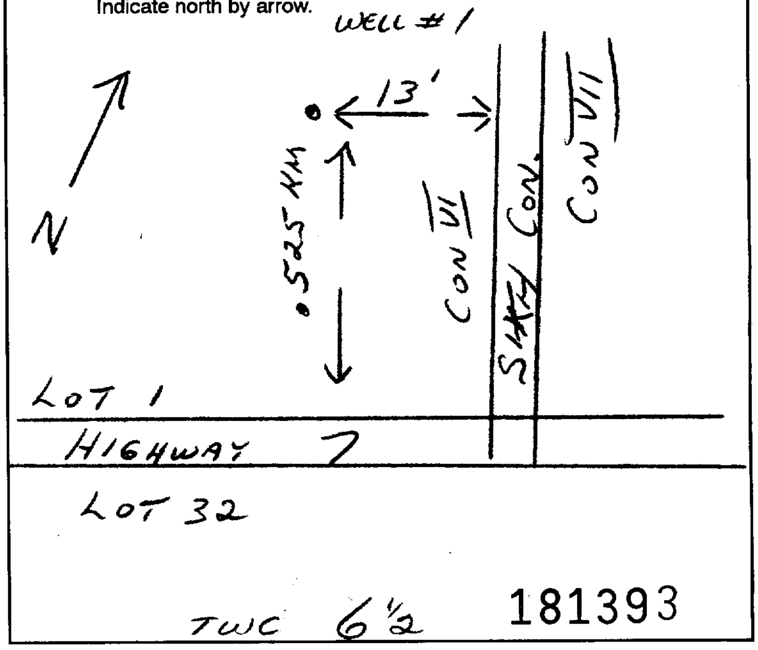
1 ☐ Domestic
2 ☐ Stock
3 ☐ Irrigation
4 ☐ Industrial
5 ☐ Commercial
6 ☐ Municipal
7 ☐ Public supply
8 ☐ Cooling & air conditioning
9 ☐ Not used
10 ☑ Other TEST WELL

METHOD OF CONSTRUCTION

1 ☐ Cable tool
2 ☒ Rotary (conventional)
3 ☐ Rotary (reverse)
4 ☐ Rotary (air)
5 ☐ Air percussion
6 ☐ Boring
7 ☐ Diamond
8 ☐ Jetting
9 ☐ Driving
10 ☐ Digging
11 ☐ Other

LOCATION OF WELL

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



TWC 6½ 181393

Name of Well Contractor LANG WELL DRILLING LTD
Well Contractor's Licence No. 3317
Address RR1 HILLSBURGH ONT
Name of Well Technician ROY LANG
Well Technician's Licence No. T-0158
Signature of Technician/Contractor
Submission date 26 day 12 mo 98 yr

MINISTRY USE ONLY

Data source
Contractor 3317
Date received JAN 07 1999
Date of inspection
Inspector
Remarks CSS.ES9

0506 (07/94) Front Form 9

2 - MINISTRY OF ENVIRONMENT & ENERGY COPY

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline
RR1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

June 12, 2015

R.J. Burnside and Associates Limited
292 Speedvale Avenue West, Unit 20
Guelph, Ontario, N1H 1C4

Attention: Mr. David Hopkins, P.Geo.
Senior Hydrogeologist

Dear Mr. Hopkins:

Re: Hidden Quarry
Burnside Letters of April 24, 2015
Burnside Project No.: 300032475.0000

We are pleased to respond to the R.J. Burnside and Associates letters of April 24, 2015 in regards to the Hidden Quarry application. There are only a few comments required. We have retained the same section numbers for cross comparison.

4.1.1 Private Well Sampling

Additional water quality samples will be obtained in advance of any quarry activities. To date it has been found that the average nitrate concentration upgradient of the quarry is 3.89 mg/L vs 1.39 mg/L elsewhere.

4.2 Resent Research and Susceptibility of Local Wells to Contamination

On site monitor M2 is upgradient of the proposed quarry activates and will be used to monitor nitrate impacts from agricultural activities.

4.4 Water Quality and Early Warning and Mitigation

The required testing and completion for M16 through M19 will be done as recommended.

7.0 Brydson Spring and Blue Springs Creek

The measurement of the flow from the Brydson Spring and comparison to flow at SW4, SW5 and SW3 has commenced. The results to date are summarized below;

Monitoring Station	16-Oct-14	28-Apr-15	20-May-15
SW4 (Upstream of Site)	1*	17.10	11.03
SW5	0*	18.94	8.88
SW8	0*	14.27	4.38
SW3 (Downstream of Site)	0	9.37	dry
Brydson Spring	22.4	64.43	43.14

*measurement obtained on October 10 2014

The monitoring plan attached has been modified to include the surface water stations requested by R.J. Burnside and Associates.

8.0 Rock Extraction Water Level Change Monitoring

James Dick Construction Ltd. is in agreement that M3 will be deepened in advance of any quarry activities.

8.1 Historic Low Water Level

JDCL has agreed to conduct additional investigation in upgradient wells post approval. This includes a pumping test to determine available drawdown above current well setting and well bottom. Well specific contingency plans will then be updated.

8.2 Monitoring Plan Revisions

JDCL has agreed to a detailed private well monitoring program.

2.3 Trigger Levels for Sinking Cut

JDCL agrees to providing the Township with data from the automatic water level recording device on a bi-weekly basis until the data indicates that water levels are remaining consistently above the trigger level.

9.0 Additional Work

The required testing and completion for M16 through M19 will be done as recommended.

Response to comments on Hidden Quarry Specific Well Contingency Plans

Our response to Burnside's recommendations on page 2 of 3 of the April 24, 2015 letter are as follows:

1. Status of W7

W7 is a well servicing the former Ball Farm. Mrs. Florida Ball refused us entry on the grounds that the building that houses the well is unsafe. We visited the site in 1998 and Mr. Gordon Ball refused us entry at that time as well. According to Mrs. Ball, she is trying to prepare the property for sale and the well is not in use.

2. Wells W2 and W3 on the Mushroom Farm property

To understand the wells on the mushroom farm a brief description of their use is necessary. W3 is a deep bedrock well that is used to pump large volumes of water (approximately 80 gallons per minute) to the cooling system in the mushroom barn. A series of pipes and heat exchangers raise the temperature of the water and lower the temperature of the air. The warm water is then recharged into W2, a shallow dug well used as an injection well. There is neither a Permit to Take Water nor an Environmental Compliance Approval for a Sewage Works in place for this system even though one would normally be required. W2 was measured to be 3.97 metres deep with a static water level of 2.42 metres below casing top (April 29, 1998). The well had a concrete casing with plywood cover. The well owner said that it dried up in the summer.

W3 is 54.86 metres deep and is open from the top of the dolostone formation to the top of the shale formation (44.8 metres). Graham Well drilling pumped the well at a rate of 80 US gpm and static water level was drawn down to 40.8 m below casing top after 45 minutes. The recommended pump setting is 48.8 m below casing top. Water was 'found at' depths of 36.5 m and 50.3 m, both below the proposed depth of the quarry. The water level during pumping is estimated to be 319 m AMSL which is eight metres below the proposed depth of the quarry and about 28 metres below lowest allowable water level in on-site monitors during extraction phase. The quarry represents a significant potential recharge boundary for Well W3. To our knowledge none of the neighbours have complained about this water use despite the pumping by the Mushroom Farm that has a drawdown more than ten times that of the proposed quarry. On the day of a site visit in 2011, the owner and I could hear the cavitation of the pump, indicating that the water was being lowered to the pump intake level, presumably at the recommended pump depth of 48.8 metres.

Figure 1 shows the on-site response in a shallow (OW13D) and deep well (M2) well to pumping at the Mushroom Farm. The farm well was pumped continuously during a hot spell between May 23 and May 30, 2015. The maximum response in the shallow bedrock well OW13D at a distance of 150 metres was 0.11 metres and the response in the deep well (M2) at a distance of 215 metres was 0.26 metres. It is our assumption that the pumping well is being operated as observed in 2011 and as recorded on the water well record and has an approximate drawdown of 48 metres. The minimal interference observed on-site verifies that the interference from the proposed 2.54 metre water level change in the quarry will have a negligible impact on private wells north of the quarry along 6th Line Eramosa.

3. Short term tests for W2, W3, W4, W5,W6, W7 and W8

James Dick Construction has agreed to short term tests and additional baseline survey information for wells W3, W4,W5 and W8 to be conducted post approval provided that there is agreement with the homeowner. Short term tests in W2, W6 and W7 cannot be conducted for reasons provided herein. The observed limited interference from pumping at the Mushroom Farm with significantly greater drawdown than the proposed quarry confirms that interference between the quarry and these private wells will be less than originally predicted.

W2 is a shallow dug well presently being used as an injection site for water used in Mushroom Farm cooling system. As stated above there is no Environmental Compliance Approval in place for this works. W2 is thus no longer a viable water well and is not being used as such. The home owner indicated during the well survey that this well went dry during the summer months. No test will be conducted.

W3 is being pumped at a rate (approximately 85 igpm) and requires a Permit to Take Water to be issued for continued use. No Permit to Take Water has been issued. The quarry pond will become a significant reservoir of water and thereby become a potential a long term source of water for the well thereby improving the well performance. A short term test will be conducted on W3.

W4 Mushroom Farm private well is thirty nine metres deep with twenty four metres of available drawdown to recommended pump setting. According to the well drilling record, water was found at 34.8 and 38.1 metres below ground surface. This is below the proposed quarry depth. Also, the well record shows that the well was pumped for 90 minutes with a drawdown of 7.9 metres and a recommended pumping rate of 1.13 L/s (15 igpm). A short term test will be conducted.

W5 test conducted by driller and recorded on well record shows very little drawdown at 15 gpm. There are 14 metres of total available drawdown to bottom of well and 4.5 m available drawdown to recommended pump setting. A short term test will be conducted.

W6 is a dug well that has not been in use for decades. The well was dry in November 2014 and April 2015. No test will be conducted.

W7 Owner refused permission for us to visit well due to safety concerns. No test will be conducted.

W8 – there are twenty nine metres of water in the well with a relatively high static water level (4.18 metres below ground surface). The pump setting not known but there is no need to determine the pump setting pre approval considering limited potential drawdown from the quarry. A short term test will be conducted.

4. Source of Water for W31

Harden Environmental assisted the well owner with adding a concrete casing to the top of the well in May of 2012 and hereby confirm that W31 is a dug well lined with field stone from just below ground surface to a depth of 3.83 metres below ground surface. There is no visual evidence of dolostone bedrock in the well (see attached photo).

Following the upgrading, the well was pumped for thirty minutes at a rate of approximately 0.38 L/s during which a total of 681 litres of water were removed. This resulted in a drawdown of only one centimeter. The diameter of the well is approximately 0.91 metres giving a volume of 6.5 L/cm. The aquifer therefore yielded 675 litres in the thirty minutes. The minimal drawdown proves that the aquifer is both transmissive and has high storativity. The well is not dug into the bedrock, therefore the overburden aquifer yielded the groundwater.

The water quality of the well shows obvious contamination from adjacent farming (barnyard) activities. This proves that the well is not from a confined source and that there is a hydraulic connection between the adjacent barnyard and the well water. There is no indication that this connection is made via surface drainage. The source of water is therefore an unconfined aquifer.

The water level decline in the dug well between upgrading the well on May 22nd and a follow up visit on October 5, 2012 was 0.53 metres. The water level decline in the surface water pond is very similar at 0.52 metres. This similarity in water level change suggests that the well and pond have the same source and/or the pond level influences the water level in the well. That is, the small berm surrounding the pond artificially keeps the water level in the pond elevated and thus influences the nearby well. During a site visit we noted a forty to fifty centimeter difference in elevation between the main pond and the adjacent pond to the south.

As detailed to us by the home owner on our visits, the pond is fed by springs located along the northern shoreline (the upgradient edge of the pond). Originally there was a stone crock at ground surface around the main spring. There is neither bedrock exposure in the ponds nor along the northern shore, even when water levels in the pond are extremely low as observed in October 2012. As detailed by the home owner, springs occur elsewhere on the property, namely at the base of the rock strewn hill located west of her residence. We estimate the elevation of this spring to be 364 m AMSL compared to the estimated pond elevation at 362.5 m AMSL. Groundwater seepage was also observed along the northern edge of the Allan Wetland (southern edge of the property) within 50 metres of the De Grandis pond. Soil samples taken at that location taken with a soil gouge, found a silt till containing 40 to 60% silt, confirming a relatively impermeable layer beneath the seepage zone.

Streamflow measurements obtained from the channel leading away from the De Grandis ponds confirm a loss of streamflow downstream of the De Grandis ponds. Therefore, downward hydraulic gradients prevail, despite being at a lower topographical elevation than the main pond.

Our conclusion from this physical evidence is that the pond and well are sourced from groundwater moving predominantly laterally in permeable layers within the overburden.

As shown on the quaternary geology map (Figure 3.2 of 2012 Harden Report) Well 31 is located in an area of kame and esker deposits. The kame and esker sands and gravels are the most recent geological materials deposited during the glacial period. Coward and Barouch, 1978 identify the kame deposits and underlying till unit as the sandy till reservoir and state that it forms only ‘minor groundwater aquifers in the Blue Springs Creek basin’. Furthermore, they state that ‘sand and gravel lenses occur in the sandy till unit, but for the most part are not interconnected and have little influence on the hydrogeologic behavior of this unit’. Detailed geological investigations for the Hidden Quarry, in the same geological formation, confirm the existence of permeable deposits underlain by a silty till resulting in preferentially lateral groundwater movement and spring discharge to the ground surface.

Groundwater elevations as determined from local water well records and presented in various reports (Coward and Barouch, 1978, Harden 2012, Matrix Solutions, 2014 and Gartner Lee 2004) decrease through the De Grandis property from north to south and from east to west. Therefore, the source area for Well 31 are the lands north and east of the well.

All observations and physical evidence obtained from the site and immediate surroundings confirm that the well and pond are sourced from an unconfined overburden aquifer with a source area found towards the north or north east.

5. Additional information for wells W20, W35, W38,W42 and W43

James Dick has agreed to provide this information as a condition of the development.

Respectfully submitted,
Harden Environmental Services Ltd.

Stan Denhoed, M.Sc., P.Eng.
Senior Hydrogeologist

cc: Greg Sweetnam, James Dick Construction Limited

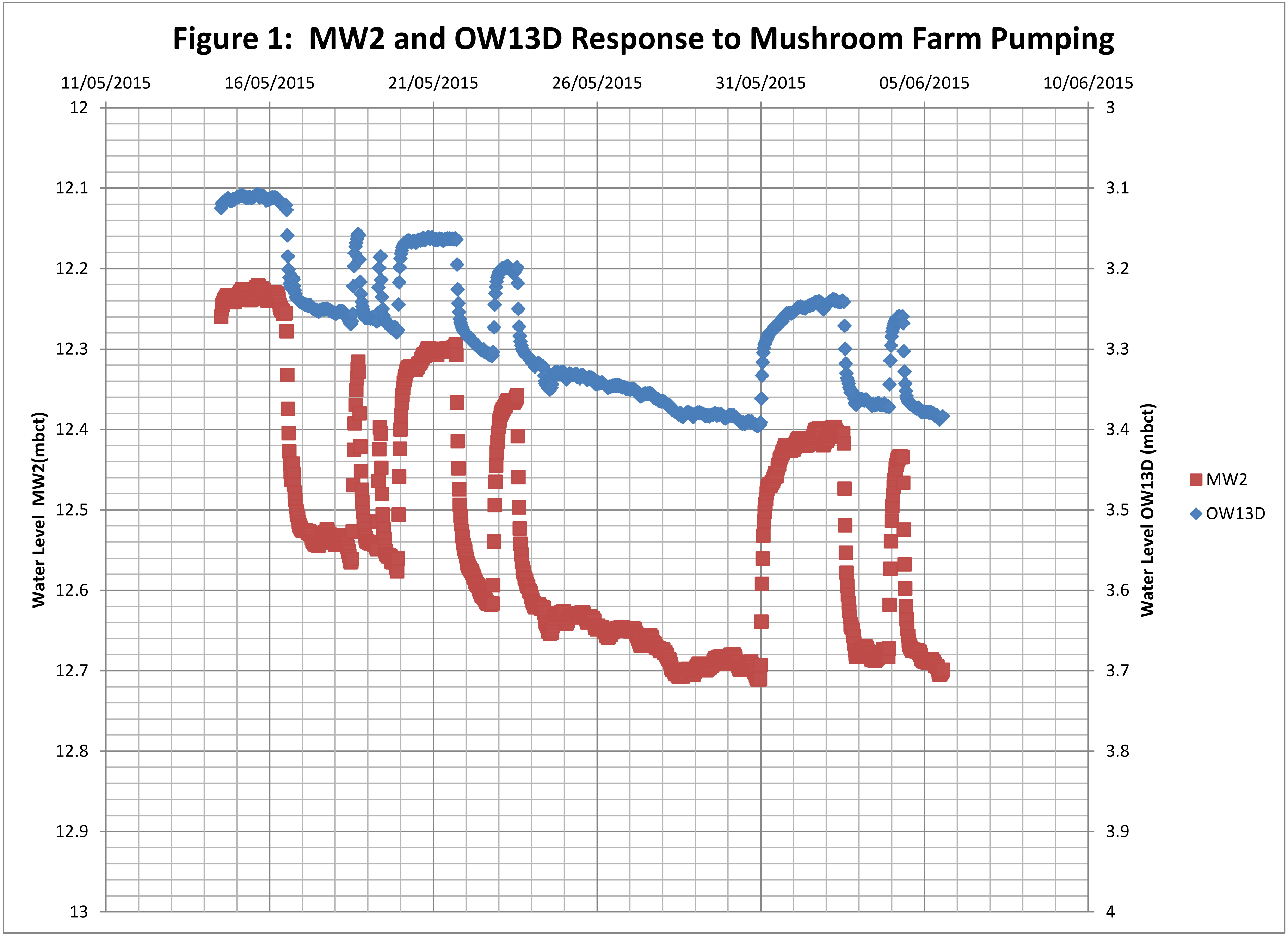


Figure 1: MW2 and OW13D Response to Mushroom Farm Pumping
11/05/2015
16/05/2015
21/05/2015
26/05/2015
31/05/2015
05/06/2015
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3.6
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4
Water Level MW2(mbct)
Water Level OW13D (mbct)
MW2
OW13D

Well W31

HARDEN

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Moffat, Ontario, L0P 1J0
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Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our File: 9506

July 16, 2015

James Dick Construction Ltd.
14442 Highway 50
P.O. Box 470
Bolton, Ontario L7E 5T4

Attention: Mr. Greg Sweetnam

Dear Mr. Sweetnam;

**Re:	Proposed Hidden Quarry**
Peer Review on Behalf of the Concerned Residents Coalition
Hunter and Associates May 15 2015

We are pleased to respond to the issues raised by Hunter and Associates Peer Review dated May 15, 2015 regarding the proposed Hidden Quarry.

In summary Mr. Hunter does not use any hydrogeological terms including transmissivity, storativity, porosity or hydraulic conductivity. Mr. Hunter's analysis is mainly statistical, a comparison of one water level or chemical parameter to another or to a standard without any analysis or evaluation of what the measured value represents in either the local or regional hydrogeological context.

There are two areas where the site plans could be improved upon in recognition of Mr. Hunter's comments.

1) A range of water levels for the proposed quarry pond elevations could be shown instead of one value. We recommend showing a range of 347.6 m AMSL to 349.6 m AMSL to reflect seasonal water level changes.
2) A review of the quarry floor elevation relative to high groundwater level should be done to ensure that the working floor is not below the water table. There will be no dewatering, therefore, if the quarry floor is below the high water table, an elevation adjustment will need to be made. I have attached a figure of high groundwater elevations for Rob Stovel to consider.

The following responses address hydrogeological issues raised in the Hunter and Associates May 15 2015 Peer Review. Responses are organized by the same section numbering system.

1.0 SITE PLANS

1.4 Recommendations and Operational Pit Floor (Top of Bedrock)

Due to the sloping water table, the proposed quarry floor elevation of 349 m AMSL will be below the seasonal high water table in portions of Phases 1 and 3. I have attached a figure showing the high water table applicable for Phases 1 and 3 and the quarry floor should be raised to this elevation. The proposed quarry floor of 354 m AMSL in Phase 2 will allow the quarry to operate in dry conditions.

2.0 GROUNDWATER

2.1 Applicant's Mixed Season Bedrock Contour Water Levels (September 2012, Fig 3.17)

The use of November 2011 data for two of the private residential water wells was carefully considered by the project hydrogeologists and deemed to be useful in terms of being reasonably representative of bedrock groundwater elevations and fitting with the overall pattern of groundwater flow established from on-site dedicated groundwater monitors. We expect that the November data used for these two wells are approximately 1.5 metres lower than would have occurred in May of the same year when all other values on Figure 3.17 were obtained. When looking at Figure 3.17 then, the use of November data provides a conservatively high estimate of overall water level change occurring in the bedrock. In efforts to recreate this water level change within the groundwater model, the model will therefore over predict the potential impact of the quarry activity on upgradient wells.

The calibration of the regional groundwater model was achieved by including static water levels from bedrock wells including dedicated groundwater monitors on-site. The purpose being to obtain a reasonable representation of the groundwater flow system in the vicinity of the site. The convergence of groundwater flow along the Tributary B corridor is reasonable given the significant groundwater discharge at the Brydson Spring. Measured static water levels obtained from level-surveyed wells east of the site corroborate this pattern of groundwater flow.

- **Monitor M3**

The water level in monitor M3 has been measured for many years and has a relatively narrow range of seasonal water levels. However, the well has been tested on several occasions and found to respond to the addition and withdrawal of slugs of water, thereby confirming the functioning of the well screen.

The water level in W1 has been measured on three occasions and found to have a range of 0.62 m and found to maintain similar seasonal water level change relative other on-site monitors. A pumping test was performed on W1 and W1 was found to be functioning. The groundwater model is not intended to represent extreme conditions (wet or dry). The main purpose of the model is to provide an estimate of water level change occurring post extraction. With only small natural changes in aquifer transmissivity occurring between spring and fall ("wet and dry") seasons of approximately 4%, the model reasonably predicts potential water level change.

- **Tributary B Corridor Water Levels**

The water levels in the Tributary B corridor are adequately represented by M3, M11, M15 (I, II, III and IV) and sporadically by water levels obtained in W1.

- **Wet and Dry Bedrock Levels in Vicinity of TP8**

We concur that there are no bedrock water levels in the vicinity of TP8. This is a relatively small site and there are nine monitoring locations along the northern property boundary. These are M13S, M13D, TP1, M14S, M14D, M2, M3, SW4 and TP8. These monitors provide adequate background information for overburden and bedrock groundwater systems.

- **Wet Season Monitor M15**

The water levels in each of the monitors vary from season to season and higher water levels in the spring are a normal occurrence. The water levels in M2 were 0.64 meters higher in April 2014 than shown on Figure 3.17 and the water levels in M4 were 0.82 meters higher in April 2014 than shown on Figure 3.17. Therefore a higher water level in M15 compared to the interpolated potentiometric contours shown on Figure 3.17 is expected.

- **Distorted Data in Tributary B Corridor**

The model calibration was conducted on a regional scale and the addition of one or two more data points will not significantly improve the overall accuracy of the model. The model is a reasonable tool to understand the potential impacts of the mining on bedrock groundwater levels. Several variations of the model have been developed with each providing similar results. The nature of groundwater flow in the aquifer is understood adequately to allow for the development of the groundwater model. Multi-level groundwater monitor M15 was installed at the request of the Township of Guelph/Eramosa in the Tributary B corridor and the water levels obtained and aquifer characteristics estimated from in-situ testing proved that the model was using reasonable estimates of aquifer characteristics.

2.2 Groundwater Modelling

The model has been used as a tool to assist in the predictions of change to the water levels in the bedrock groundwater system. The understanding of groundwater flow in this area is based on;

- monitoring groundwater levels for seventeen years
- conducting pumping tests in the Gasport Aquifer in several places east of Rockwood

- observing drilling of bedrock wells
- obtaining streamflow measurements in Tributary A, Tributary B and Tributary C
- working as a professional hydrogeologist in Wellington County for twenty five years with knowledge of other groundwater models, monitoring the water level changes in other quarries and gravel pits, reviewing the monitoring results of other gravel pits and quarries.

Seasonal variation occurs in all of the on-site monitoring wells and when water levels at one well are elevated, they are elevated in all wells. Therefore, during a relatively wet year, all of the water levels in the area will be high and during a dry year, all of the water levels will be lower. The predicted final water levels in the east and west ponds are based on a reasonably calibrated groundwater model using regional groundwater data obtained at different times of the year. As such, the model likely represents average groundwater condition (not dry and not wet season conditions). The final pond levels will also fluctuate seasonally by the same amount as the existing groundwater does (approximately one and a half metres).

The groundwater model uses estimates of transmissivity and saturated thickness in order to calculate groundwater flux and re-calculate groundwater levels. The model is not sensitive to minor changes in transmissivity or saturated thickness, therefore minor seasonal changes will not influence the usefulness of the model to predict water level change.

2.2.2 Adversely Affected Groundwater Model

The groundwater model is a tool to understand groundwater flow in the bedrock aquifer on a regional scale and how the removal of the aquifer rock via quarrying will alter the groundwater flow pattern and level at a local scale. Water levels from 330 wells were used to calibrate the model to industry standards. The regional groundwater pattern is similar to that of other calibrated models and potentiometric maps of water levels obtained from water wells.

The underestimation of predicted water levels at specified locations north of the proposed quarry and overestimation of predicted water levels elsewhere does not translate into an underestimation of predicted drawdown. Drawdown is a function of transmissivity, saturated thickness and time. The transmissivity estimate used in the model has been proven to be a reasonable estimate through the testing conducted in M15 and is similar to other groundwater models prepared for this area. The reviewer is confusing an underestimation of modelled baseline conditions with an underestimation of predicted drawdown conditions.

2.3 Predicted Maximum Lake Water Levels (Post-Extraction)

The bedrock surface and groundwater levels in Phase 1 are higher than the 349 m AMSL quarry floor shown on the site plans. This means that the quarry will have to operate at least temporarily as high as at the 354 m AMSL water level. Noise predictions may need to be updated.

All groundwater and ecological assumptions for worst case scenario are based on the maximum potential impact and therefore are not affected by proposed elevation of pit floor. In order to remain dry during Phase 1, the pit floor will need to be raised to 354 m AMSL.

2.4 Drainage Ditch 'Tributary B'

The peer reviewer is of the opinion that historically, water seasonally retained in Tributary B would have been of benefit to the Brydson Spring. The quarry will provide a similar if not greater benefit through the storage of water in the future ponds.

2.5 Guelph Limestone Quarry not Valid as an Analogue for Hidden Quarry

No volumetric balance/mass balance was prepared for the Guelph Limestone Quarry as an analogue for the Hidden Quarry. The Guelph Limestone Quarry is used as a local example of subaqueous extraction and the potential impact on water quality that can occur from blasting. No analogy was made between the Guelph Limestone Quarry and the proposed Hidden quarry.

The source area for the Brydson Spring incorporates a much larger area than just the proposed Hidden Quarry, therefore, flow in the creek will be greater than that predicted to flow through the quarry.

3.0 DRY OPERATIONAL QUARRY FLOOR AND ACTUAL OPERATIONAL DRAWDOWNS

The assumption made by the reviewer that the quarry needs to operate at the elevation of the bedrock/overburden contact is incorrect.

3.1 Top of Bedrock

No dewatering is required for the operation of the quarry. The quarry does not need to operate at the overburden/bedrock contact. Drilling efforts including that for M3, M15 and M11 in the Tributary B corridor do not corroborate the peer reviewer's supposition that there is a depression in the bedrock surface beneath the Tributary B corridor.

3.2.1 Phase 1 Operations (Fig 3.1)

There will be no active dewatering of the quarry. The quarry floor in Phase 1 will remain above the high bedrock water level. The site plan will be revised.

The hydraulic barrier will be installed in the vicinity of TP2, thereby maintaining overburden water levels beneath the wetland and allowing overburden water levels to decline in the active quarry area.

Full drawdown of the quarry will occur passively over the lifetime of the quarry.

3.2.1.1 Dewatering (Phase 1)

There will be no dewatering of the quarry. Where necessary, the site plans will be revised to show the pit floor above the water table.

3.2.1.2 Wash Water and Silt Ponds

Silt ponds require the retention of water, not the exfiltration of water. Therefore, the ponds can be established in the water table or above. The purpose of the silt ponds is not to infiltrate water. Therefore, mounding of water is not an issue for the silt ponds. Excess water is returned to the source pond in order to maintain water levels and loss of water is not desired.

There will be no dewatering of the quarry and therefore, no loss of baseflow to Brydson Spring.

3.2.2 Phase 2 (Fig 3.2)

The peer reviewer has incorrectly assumed that the quarry must operate at the bedrock/overburden contact. Therefore, the assumed pit floor elevation of 351 m AMSL is incorrect.

Two sets of mini piezometers confirm that Tributary B is a losing stream to the east and to the west.

There will be no dewatering of Phase 2. The ultimate lake level depends entirely on existing groundwater levels. The predicted drawdown at the north end of Phase 2, is approximately 1.4 metres. This is less than on the west side because the quarry excavation has less length in the direction parallel with groundwater flow.

3.2.3 Phase 3 (Fig 3.3)

There will be no dewatering of the quarry. The pit floor will be adjusted to remain above the water table.

4.0 ADAPTIVE MANAGEMENT

4.1 Groundwater Monitor - Trigger Levels

A discussion on trigger levels should occur once additional groundwater monitors have been installed and seasonal data obtained. I have not reviewed Mr. Hunter's suggestions at this time.

4.2 Groundwater Quality

Baseline water quality samples will be obtained prior to quarry activities commencing. Details of water quality triggers can be developed after additional samples are obtained and prior to commencement of active quarrying. A detailed groundwater quality monitoring program has been presented to hydrogeologists representing the Ministry of the Environment and Climate Change and the Township of Guelph Eramosa. Through their comments a stringent protocol for water quality testing has been developed.

5.0 DOMESTIC WATER WELL INTERFERENCE

5.1.1 W5 (MOE 67-07545)

The peer reviewer is confusing predicted water level at baseline conditions with drawdown. There cannot be a four metre drawdown at Well W5 when there is a maximum predicted drawdown of 2.54 m in the quarry. Well W5 is a high producing well which according to the well record had about 1.5m of drawdown at a pumping rate of 1.1 L/s. Water was “found at” a depth of 18.8 m, significantly below the final water elevation in the quarry. The large volume of water stored in the quarry ultimately becomes a positive recharge boundary, thereby improving the overall productivity of the aquifer.

5.1.2 W7 (No MOE Well Record)

The owner has categorically refused entry to both Guelph/Eramosa Township (during pumping test of TW2) and Harden Environmental. The well house is unsafe. Inspection was not allowed in 1998 for the same reason. Nonetheless, James Dick Construction Ltd. is responsible for well replacement if the quarry interferes with the functioning of the well.

5.1.3 W31 (No MOE Well Record)

The water quality presented by Mr. Hunter clearly identifies that the well water quality is being compromised by nearby farming activities. In 2012 the water sample exceeded the Ontario Drinking Water Standard for nitrate and in 2014 the nitrate concentration is 96.3% of the drinking water standard. Nitrate is an indicator of anthropogenic contamination of well water, in this case, barnyard wastes. The resident has been aware of the elevated nitrate issue for some time and should be taking measures to reduce nitrate concentrations through treatment methods. The presence of nitrate in the well is an indication that there may be other undetected contamination in the well.

5.1.4 Domestic Well W24

There is opportunity to lower the pump in the well. James Dick Construction Ltd. will make this adjustment to the well if necessary or provide the residence with a new well if necessary.

5.2 Water Quality Impacts on Downgradient Domestic Wells

The potential mitigation for these wells include deepening or replacement as agreed to by James Dick Construction Ltd.

5.3 Drawdown Impacts on Allen Wetlands, Allen Springs, De Grandis Ponds and Brydson Springs

The minor differences in observed static water levels in M15-II and M15-III compared to M15-IV do not have any relationship to the distance to potential areas of recharge. Greater hydraulic potentials (than occur in any of the M15 multi-level piezometers) occur within the proposed Hidden Quarry site boundaries and can be the source of greater hydraulic potentials observed in M15.

5.3.1 Allen Wetlands

The elevation of the Allen Wetlands is higher than Tributary C (a losing stream), the proposed Hidden Quarry site and depressions immediately west of the wetland. There is no groundwater discharge to the Allen Wetland from these areas. The water levels in TP8 confirm that the water table on the site is at least four metres below that of the wetland. Any drawdown in the bedrock aquifer at the site cannot have an impact on support hydrology for the Allen Wetland. The greatest direct impact to the wetland comes from (a) water retained by the De Grandis ponds and (b) channelization of Tributary B through portions of the Allen Wetland. In the absence of the De Grandis ponds, the spring discharge water would flow from the De Grandis spring for a longer period of time. Provided with a complete application, the GRCA was prepared to issue a permit to Ms. De Grandis to deepen the ponds and thereby allow alteration of the surface water flow to the wetland (delay flow from the ponds in the fall). Although this would potentially have a direct impact to the hydro-period of the Allen wetland the GRCA has deemed this acceptable.

5.3.2 Allen Springs and Farm Pond

The Allen Spring is located immediately downgradient from a prominent topographical feature rising some twenty metres above the Allen Farm. The quaternary geology unit where the spring is found is identified as kame and esker deposits, a relatively permeable formation. The other prominent geological formation identified in this area is the Wentworth Till, a geological formation that is less permeable. The source area for the Allen Spring is north and east of the spring (away from the proposed quarry). Two measurements on the Allen property confirm that there are six to eight metres of overburden overlying bedrock beneath the Allen property. The bedrock well on the Allen Farm has a static water level approximately six metres below that of the Allen Spring confirming that flowing artesian conditions are not prevalent in the area. Therefore, it is not likely that the Allen Spring has a bedrock source. The emergence of groundwater to the ground surface signifies that the preferential flow path (the path of least resistance) is not to remain in the subsurface, suggesting that greater resistance to groundwater flow occurs in the subsurface. The resistance to groundwater flow cannot be affected by the quarry, therefore, groundwater originating from the north and northeast of the Allen Spring will continue to follow the same flow path.

5.3.3 De Grandis Farm Ponds (W31)

The water quality of Tributary B is more reflective of shallow groundwater than surface water and consistently contains elevated nitrate concentrations consistent with farming activities occurring on the De Grandis farm. The spring discharge observed by Ms. De Grandis also confirms that this is groundwater discharge. However, there are no chemical parameters suggestive that the water in Tributary B is of a bedrock origin and in fact, the elevated nitrate and low sulphate concentration suggest a shallow overburden source.

5.3.4 Brydson Springs

There will be no reduction in groundwater levels upgradient of the Brydson Spring, therefore there is no potential for loss of groundwater discharge to the Brydson Spring or associate creek flow.

6.0 PROPOSED MONITOR WELL LOCATION DEFICIENCIES AND NEW MONITOR WELLS RECOMMENDED

6.1 New Groundwater Monitoring Wells

Evaluation by hydrogeologists from the Ministry of the Environment and Climate Change, Halton Region, the Township of Guelph-Eramosa and the Grand River Conservation Authority resulted in the addition of four monitoring wells at the site. In addition, James Dick Construction has agreed to modify/replace monitoring well M3.

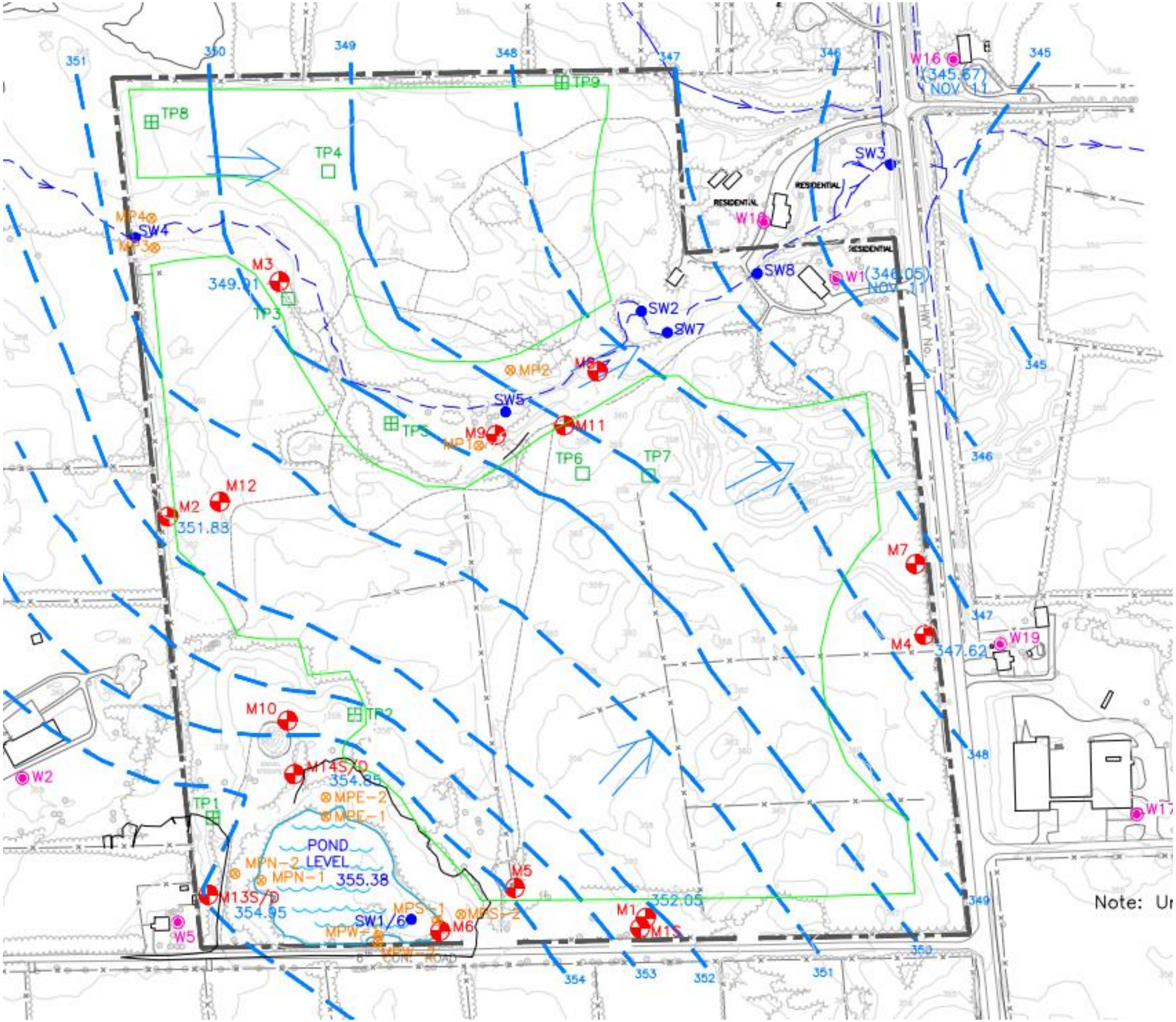
The purpose of the existing and additional monitoring wells is to provide verification of water level change during extraction and verification of the maintenance of water quality standards. Detailed contingency and mitigation plans will be invoked should water levels or water quality changes exceed threshold values.

In addition to the on-site monitoring network, James Dick Construction Limited has agreed to 1) off-site streamflow monitoring of Tributary A and B and 2) include select private wells where accessible and with owner permission.

Where needed, trigger levels will be developed for the monitoring wells and included on the site plans prior to commencement of quarry activities.

Sincerely,
Harden Environmental Services Ltd.

Stan Denhoed, M.Sc., P.Eng
Senior Hydrogeologist



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POND
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M13S/D
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M1
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MPS-1
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Groundwater Studies
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Groundwater Mapping

Our File: 9506

August 17, 2015

R.J. Burnside and Associates Limited
292 Speedvale Avenue West, Unit 20
Guelph, Ontario, N1H 1C4

Attention: Mr. David Hopkins, P.Geo.
Senior Hydrogeologist

Dear Mr. Hopkins:

Re: Hidden Quarry
Burnside Letters of July 28, 2015
Burnside Project No.: 300032475.0000

In your letter dated July 28, 2015 and addressed to Ms. Kimberly Wingrove at the Township of Guelph Eramosa you made a number of statements and information requests. These have been addressed in the attached response matrix.

In Response 4- Well Specific Contingency Plans - Source of Water for W31, you request that field investigations be made on private land at the home farm of Ms. De Grandis. We understand from our discussion that in the event that access permission is not granted by the landowner, the onsite monitoring network already established on the Hidden Quarry property will be adequate to monitor the impact of the quarry.

You have requested that Harden Environmental approach Ms. De Grandis regarding some onsite fieldwork to assist in establishing the water source for her pond. This additional information, while not essential, would give R.J. Burnside some clarity to the issue of the source of water for the De Grandis well and ponds. If Ms. De Grandis is amenable to this proposal, Ms. De Grandis will be asked to sign a waiver indemnifying James Dick Construction Ltd. and Harden Environmental Services Ltd. of any liability related to potential damage to the water source of the pond.

With Ms. De Grandis' permission, Harden Environmental Services Ltd. will undertake a limited field investigation upgradient from her pond.

Photographs provided by Ms. De Grandis identify at least two distinct springs, or groundwater discharge zones, that support the pond (Figure 1). Photographs of the area also suggest that large boulders may be encountered as well as stony glacial till. Soil sampling may be difficult with hollow stem augers, therefore, it is proposed that two test pits be dug within twenty metres of the pond in the approximate locations shown on Figure 1. The exact locations are subject to owner permission and landscaping features. Soil samples will be obtained on regular intervals and photographs will be taken of the test pits. Test pit coordinates will be obtained with a hand held GPS unit and a survey elevation of the test pits will obtained with a rod and level using the top of concrete well casing as benchmark. Groundwater seepage conditions will be noted.

In the event that it is identified that a bedrock water source for her pond is possible, within 90 days of quarry approval, JDCL will drill a multi level sentry well in the vicinity of the De Grandis pond provided that monitoring access to the well is given by Ms. De Grandis. An overburden well will be established above the bedrock/overburden contact and a bedrock well will be established within the bedrock. Data loggers will be installed in the wells in order to establish baseline conditions prior to quarrying activities. Going forward, water levels will be tracked in order to detect changes to bedrock groundwater levels. In the unforeseen event that quarry activities are predicted to cause an unacceptable change to water levels in the pond, James Dick Construction Ltd. would immediately prepare a mitigation plan for review and acceptance by the Ministry of Natural Resources, the GRCA, the Township of Guelph-Eramosa and the property owner. Possible measures to be incorporated in the mitigation plan could be reinforcing the dyke on the downstream edge of the De Grandis Ponds, deepening the De Grandis pond or operational changes at the quarry.

We remain of the opinion that there will be no adverse impacts on the De Grandis ponds from the quarry and that the water source for the ponds is a source emanating from the upgradient Moraine slope. As such, we remain of the opinion that these further investigations are not necessary. Notwithstanding the above, JDCL has agreed to undertake these investigations pending permission of the landowner for the purpose of satisfying the comments made by the Township engineer, R.J Burnside, in order to achieve a sign off on this issue.

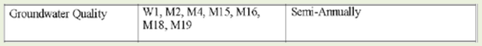
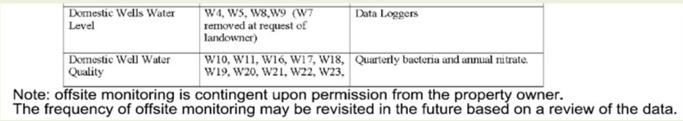
Sincerely,

Harden Environmental Services Ltd.

Stan Denhoed, P.Eng.,M.Sc.
Senior Hydrogeologist

Figure 1: Proposed Test Pit Locations

Response Matrix for Burnside Letter dated July 28, 2015

Agency	#	Comment	Response	Action Item
Burnside Hydrogeology Comments	1	There are a number of existing domestic wells that are located downgradient of the proposed quarry site and as a result, it is possible that future changes in water quality may be attributed to quarry activities by the homeowners. A number of domestic wells downgradient of the proposed quarry have been sampled and some have elevated nitrate. As indicated in Letter 1, it will be important that the probable cause of the elevated nitrate be established prior to the onset of quarrying activities.	Ongoing monitoring before quarrying activities commence will assist in identifying the existing cause of elevated nitrate levels, likey attributable to local agricultural activities.	None
Burnside Hydrogeology Comments	2	Burnside recommends that new well M17 be used in conjunction with M2 to monitor nitrate impacts from upgradient agricultural activities. Similarly, M3 (following reconstruction) should be used as a part of the monitoring network for upgradient agricultural impacts. These wells should be added to the monitoring plan.	M2 is already on the water quality program (see below taken from Page 2 of 5 of the ARA Site Plans). M17 and M3 following reconstruction will be added to the Ground Water Quality group.  Groundwater Quality | W1, M2, M4, M15, M16, M18, M19 | Semi-Annually	Add M17 and M3 (as reconstructed) to Ground Water Quality Group in Water Monitoring Program.
Burnside Hydrogeology Comments	3	A detailed private well monitoring program will allow for an expedited resolution to any future well interference claims. Specific wells cannot be identified in the proposed monitoring program until the land owners agree to have their wells included. However, the monitoring program should be updated to indicate that private off site wells will be included.	The private wells agreed to have been added to the water monitoring program. A note has been added to the site plan indicating that access to these wells is contingent upon landowner permission (see below taken from page 2 of 5 ARA Site Plans).  Domestic Wells Water Level | W4, W5, W8,W9 (W7 removed at request of landowner) | Data Loggers Domestic Well Water Quality | W10, W11, W16, W17, W18, W19, W20, W21, W22, W23, | Quarterly bacteria and annual nitrate. Note: offsite monitoring is contingent upon permission from the property owner. The frequency of offsite monitoring may be revisited in the future based on a review of the data.	None
Burnside Hydrogeology Comments	4	The MOECC database does not indicate a well on the Ball property. It appears that Harden has made a number of attempts to investigate the well. Ideally this well will be included in the monitoring program; Burnside recommends that JDCL obtain written confirmation from the Ball family that they do not wish to have their well monitored.	Mrs. Ball has indicted on numerous occasions the she does not wish her well to be monitored. We have included the well on the monitoring program in the event a future owner wishes it included. A note (removed at request of landowner, is simply there to inform an enforcement officer that there will not likely be any data from this well under current ownership.	None
Burnside Hydrogeology Comments	5	W2 is being used as an injection well for cooling water. W3 appears to be the main well supplying the mushroom farm and should be included in the monitoring program.	W3 will be added to the Domestic Wells Water Level Group. Access will, of course, be subject to landowner permission .	Add W3 to Domestic Wells Water Level group.
Burnside Hydrogeology Comments	6	It may be possible to access W7 if the property is sold in the future. Short term tests at W3, W4, W5 and W8 will be helpful in finalizing contingency plans for these wells.	W7 is included on the monitoring program under Domestic Wells Water Level and can be reinstated at the request of a future landowner.	None
Burnside Hydrogeology Comments	7	W31 has limited available drawdown and therefore is susceptible to changes in water levels. If the well obtains some of its water from the bedrock, the predicted change in bedrock water levels as a result of the quarry could have a significant impact on the well. Harden has visited the DeGrandis property on numerous occasions and it is their opinion that W31 and the nearby ponds are fed from a shallow overburden aquifer with a source to the north. However, the wells and spring may also be fed from a bedrock fracture which comes to the top of the rock and is accessed by fractures in the till. Burnside recommends that on-site investigations be completed to confirm the source of water for W31 and the ponds on the DeGrandis property. Since the well reportedly supplies water for a number of livestock it is important that the contingency plan be able to maintain the water supply.	In order to get final resolution on this comment, JDCL agrees to perform additional fieldwork as further detailed in a letter dated August 17, 2015 from Harden Environmental to R.J. Burnside and Associates.	Harden.

HARDEN

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Groundwater Mapping

HIDDEN QUARRY

MONITORING PROGRAM AND CONTINGENCY MEASURES

November 11, 2015

1.0 ON-SITE MONITORING PROGRAM

Monitoring has taken place at this site since 1995. An extensive database of background groundwater and surface water elevations and flow measurements has been developed. A detailed monitoring program will continue to ensure that sensitive features and surface water flows are maintained. The monitoring program is designed to identify trends towards unacceptable impacts early on to allow for time to implement contingence measures.

The monitoring program for this proposed pit/quarry involves the following activities:

- measuring groundwater levels,
- obtaining water quality samples,
- monitoring water levels in the on-site wetland and stream, and
- stream flow measurements.

We recommend the following monitoring program.

Parameter	**Monitoring Locations**	**Frequency**
Groundwater Levels	M1S/D, M2, M3, M4, M6, M13S/D, M14S/D, M15, M16, M17, M18, M19,MPN1, MPN2, MPS1, MPS2, MPE1, MPE2, MPW1, MPW2, TP1, TP8, TP9 MP1, MP2, MP3, MP4,	Manually Monthly Automatic Daily Measurement in M1D, M2, M3, M4, M13D, M15, M16 for year prior to and year following bedrock extraction with re-

Parameter	Monitoring Locations	Frequency
		evaluation of monitoring frequency after 1st year of bedrock extraction.
Groundwater Levels	M2, M3, TP1, M13S/D, M14S/D, M15, M16, M17	5 minute interval during first 3 months of extraction
Surface Water Level	Sinking Cut	Automatic Daily after safe quarry face is established.
Surface Water Level	SW14, SW5, SW7	Manually Monthly Coincident with groundwater monitoring
Surface Water Levels	SW6, SW4, SW8	Automated Water Level Readings (4 hour interval)
Surface Water Flow	SW4, SW8, SW3	Manually Monthly *coincident with groundwater monitoring
Surface Water Flow	Brydson Spring	Monthly
Groundwater Quality	W1, M2, M3,M4, M15, M16, M17,M18, M19	Semi-Annually
Surface Water Quality	West Pond, East Pond, Northwest Wetland, Tributary B (SW4, SW3)	Semi –Annually (Spring and Fall)
Climate	On-Site Weather	Daily

Parameter	Monitoring Locations	Frequency
	Station at Scale House to include precipitation and temperature	
Domestic Wells Water Level	W3, W4, W5, W8,W9 (W7 removed at request of landowner)(see also Section 4.0)	Data Loggers
Domestic Well Water Quality	W10, W11, W16, W17, W18, W19, W20, W21, W22, W23, W24	Quarterly bacteria and annual nitrate.

Monitoring locations are shown on Figure C1.

2.0 WARNING AND TRIGGER LEVELS

Groundwater and surface water monitoring will be used at this site to a) verify that predictions of water level change in the bedrock aquifer do not exceed those predicted and b) verify that the hydro-period of the northwest wetland does not change. The water level measurements obtained as part of the monitoring program will be used to trigger contingency measures that may be necessary for the mitigation of a low water level in the northwest wetland, a lower than expected water level in the bedrock aquifer or an anomalous low flow level in Tributary B.

The trigger levels are used to initiate contingency and mitigation responses outlined in Section 3. Once water levels recover above the trigger level, normal operations will commence at the site.

2.1 Warning levels

If a warning level is breached, on site manual water levels will increase from monthly to bi-weekly and an analysis will be undertaken to determine the cause. If it is determined that quarry activity is the cause, the activity will be modified to avoid breaching a Trigger Level. Monitoring frequency will return to normal after the level recovers above the warning level.

2.2 Trigger Levels for the Bedrock Aquifer

The greatest water level change in the bedrock aquifer is expected to occur to the north and northwest of the site. Water levels obtained from bedrock monitors M1D, M13D, M14D and M2 will be used to verify that actual water level changes do not exceed the predicted water level change. A warning level of 75% of the predicted change will be used to initiate bi-weekly manual measurements from the groundwater monitors.

Table 1: Trigger Levels for the Bedrock Aquifer

Monitor	Historical Low	Predicted Change	Warning Level	Trigger Level
M1D	350.58	0.8	349.98	349.78
M2	349.81	2.0	348.31	347.81
M13D	352.68	1.4	351.63	351.28
M14D	353.48	1.5	352.36	351.98
M15	TBD			
M16	TBD			
M17	TBD			

TBD – to be determined

The historical water levels, warning level and trigger level are presented in Figures C2, C3, C4 and C5.

2.3 Trigger Level for Northwest Wetland and Allen Wetland

Water levels from Station SW6 will be used to trigger contingency measures for the northwest wetland. Historical monitoring has shown that the water level in the wetland is somewhat independent from adjacent groundwater levels and therefore any potential change in the hydro-period is best determined by the surface water level in the wetland.

Trigger levels and warning levels have been determined for three periods as follows:

Winter Trigger Level - lowest water level observed between December 1 and March 1

Spring Trigger Level - lowest water level observed between March 2 and June 15

Summer/Fall Trigger Level - lowest water level observed between June 16 and November 30.

A warning level is established 0.15 metres higher than the trigger level. The warning and trigger levels relative to historical water levels are shown on Figure C6.

Table 2: Trigger Levels for the Surface Water Features

Station	Winter		Spring		Fall	
	Warning	Trigger	Warning	Trigger	Warning	Trigger
Northwest Wetland (SW6)	354.35	354.20	354.48	354.33	354.38	354.23
Allen Wetland (SW4)	The warning level will be a flow rate of less than 25 L/s occurring in May and the trigger level will be cessation of flow prior to June 22.					

Manual water level measurements will increase to bi-weekly if the warning level is exceeded.

2.4 Trigger Level for Sinking Cut

James Dick Construction Ltd. has agreed to a maximum water level change of 2.54 metres in the sinking cut. The nearest groundwater monitor to the sinking cut is M3. The hydrograph of M3 is found attached as Figure C7. The low water level in M3 is 349.37 m AMSL. We propose to use this as the reference elevation resulting in a minimum water elevation in the sinking cut of 349.37 – 2.54 = 346.83 m AMSL. JDCL proposes to hang a buoy from a tether with the buoy floating in the water until the water level falls below an elevation of 346.83 m AMSL. The buoy will be a visual indicator of the minimum allowable water level to the operator. Alternative methods such as a sonic water level reader may be employed.

Extraction will cease if the water level falls below 346.83 m AMSL and can only recommence with a water level above 346.83 m AMSL in the sinking cut.

James Dick Construction Ltd. will also provide data from an automatic water level recording device on a bi-weekly basis until data indicates that water levels are remaining consistently above the trigger level.

3.0 CONTINGENCY MEASURES

3.1 Groundwater Levels and Northwest Wetland

If any trigger level is breached, the following measures will be taken;

1) Confirmation of water level within 24 hours. Increase monitoring to weekly until source of the trigger level exceedence is identified. Data from automatic water level recorders (AWLR) will be downloaded and reviewed on a weekly basis.

2) Within seven days complete an evaluation of precipitation, groundwater monitoring data and quarry activities to determine if quarry activities are responsible for the low water level observed. The water level data from the AWLR's will be plotted and the water level trends analyzed so that the time it will take for the water level to recover above the trigger level can be predicted.

3) Data from all ALWRs will be provided to the Township of Guelph Eramosa on a bi-weekly basis until the data indicates that water level are remaining consistently above the trigger level.

4) If quarry activities are found to be responsible, James Dick Construction Ltd. will undertake one of the following contingency measures and a response will be presented to the MNRF, the GRCA, and the Township of Guelph Eramosa.

- Decrease the rate of or cease below water table extraction
- Increase the length or width of the hydraulic barrier
- Alter mining configuration or mining extent
- Alter timing of mining activities to coincide with seasonal high water levels.

5) If quarry activity is not found to be the cause or contributor to the trigger level breach, then quarry activity will continue and monitoring frequency will return to normal.

3.2 Water Quality

The water quality program will commence at least one year prior to bedrock extraction.

Groundwater Monitors and the East and West Pond

The monitoring parameters that will be included in the semi-annual monitoring will be general chemistry, cryptosporidium, giardia, E. coli, TKN, ammonia, DOC, pH, temperature, anions and metals.

In the event that there is an increasing trend in the concentration of a monitoring parameter, that is also listed on the Ontario Drinking Water Quality Standards list, occurring over three sampling events, a study will be conducted to determine the source of the water quality change. If the quarry is found to be responsible and if there is a potential for monitoring parameter, that is also listed on the Ontario Drinking Water

Quality Standard list, to exceed the Ontario Drinking Water Quality Standard at a downgradient well, James Dick Construction Ltd. will commence with the following actions;

1) Semi-annual testing (commencing immediately) of the water quality of private wells that could potentially be impacted by the quarry.

2) In the event that the quarry is determined to be responsible for water quality at a private well to become unpotable, JDCL will offer to return the water quality to within ODWQ Standards by providing appropriate treatment in the home, drilling a new well or isolating the water supply to the deeper aquifer.

Northwest Wetland

The northwest wetland water will be analyzed for nitrate, dissolved oxygen, temperature, conductivity and pH for a period of three years or upon completion of construction activities (i.e. berms, barriers, access roads) in the surface water catchment area of the northwest wetland whichever is longer. Sampling will occur on a semi-annual basis.

Domestic Wells

Private domestic wells W10, W11, W16, W17, W18, W19, W20, W21, W22 and W23 will be sampled four times a year for bacteria and once a year for nitrate.

4.0 PRE-BEDROCK EXTRACTION WATER WELL SURVEY

We recommend that a detailed water well survey be completed prior to the commencement of the extraction of bedrock resources. This survey will as a minimum include all wells in the shaded area shown on Figure C8. The well survey will include the following;

- construction details of the well (drilled, bored, sand point etc..)
- depth of well and depth of pump
- location of well relative to septic system
- static water level
- history of water quantity or quality issues
- comprehensive water sample including bacteriological analysis, general chemistry, anions and metals

- one hour flow test

The purpose of the survey is to have a baseline evaluation of both water quality and water quantity in nearby water wells. Should an issue arise with a local water well, the baseline data can be used as a reference against future measurements.

If there are domestic wells suitable for water level monitoring identified in the survey, they will be included in the water level monitoring program and monitored on a semi-annual basis.

If the survey indicates that modification(s) to the well are necessary either for continued monitoring or to minimize the potential for impact, the modifications will be made to the well at the expense of James Dick Construction Ltd.

5.0 ANNUAL MONITORING REPORT AND INTERPRETATION

An annual report will be prepared and submitted to the Ministry of the Environment and the Ministry of Natural Resources on or before March 31st of the following calendar year. The report will be prepared by a qualified professional, either a professional engineer or a professional geoscientist.

The monitoring report will include all historical monitoring data and an interpretation of the results with respect to potential impact to the quality and quantity of bedrock groundwater, hydro-period of the northwest wetland and streamflow loss from Tributary B.

6.0 WATER WELL COMPLAINTS

James Dick Construction Ltd. agrees to inform the Township of Guelph Eramosa and the Ministry of the Environment upon the receipt of a water well complaint and the results of any related investigation. A detailed well complaint protocol is attached as Appendix A.

7.0 ONTARIO LOW WATER RESPONSE PROGRAM

The quarry operation will comply with any requirements of the Ontario Low Water Response Program.

Appendix A

Water Well Complaint Protocol

Hidden Quarry

James Dick Construction Ltd. has committed to remedying any and all issues arising as a result of quarry activities. The following complaint protocol will be followed;

Complaints about water well issues will be received any time at ___ ______. Text messages can be sent to ___ ___ ____ or email to ____@____.

James Dick Construction Ltd. has a water well contractor on stand-by to address any water quantity or quality issue that arises.

In the event of a water shortage a supply of bottled water for drinking/cooking will be delivered within 12 hours of the complaint and an alternative water supply will be delivered within 24 hours of the complaint being received. The same commitment is made for agricultural operations and includes sufficient water supply for all farm requirements.

Within 48 hours, JDCL will initiate a hydrogeological investigation conducted by an independent hydrogeologist to determine the cause of the water issue. The investigation will include but not be limited to the following actions;

- Confirmation of water levels in on-site groundwater monitoring wells
- Review of historical trends in groundwater levels and groundwater quality obtained in on-site groundwater monitoring wells.
- Review of historical measured precipitation rates
- Interview with resident regarding well complaint
- Investigation of subject well including flow testing, water level measurements and water quality testing if necessary
- Written report summarizing the findings.

In the event that quarry activities are likely to be the cause of the complaint, James Dick Construction will undertake appropriate mitigative measures such as;

- Lowering the level of the pump within the well
- Extending the cased portion of the well
- Deepening the well
- Well replacement
- Water Treatment
- Modification of quarry activities.

HARDEN

Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
R.R. 1, Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modelling
Groundwater Mapping

Our file: 9506

To: Greg Sweetnam, James Dick Construction Ltd.

From: Stan Denhoed, P.Eng., M.Sc.

Re: Hidden Quarry Wash Plant

Date: January 11, 2016

We are pleased to provide additional details in regards to the wash pond and the associated aggregate washing operation. The washing system to be installed at the Hidden Quarry is a rinsing system for processed stone and works as follows:

- All water used for washing is recycled and used in a closed loop system.

- The wash water pond is built into the dolostone rock and obtains water from the natural groundwater system and from runoff within the active pit area.

- Water from the wash water pond is pumped to the wash plant.

- Fine particles attached to stone particles are rinsed off the stone by spray bars as the material is screened.

- Stone product is stockpiled and any residual water left in the stone quickly drains and infiltrates the pit floor.

- Fine particles are recovered and dewatered for sale as a product.

- Water containing silt sized particles is piped to the silt pond where the silt settles out of suspension as water clarifies. Pond fines are periodically excavated, allowed to dewater and sold as a product.

- Clear water is returned to the original wash pond to close the loop. There is no treatment of the water needed prior to re-use in the aggregate washing operation.

- The taking of water for aggregate washing, even in a closed loop recycling system, is regulated by MOECC and a Permit to Take Water will be required.

The ponds have been located on the site plan symbolically according to the following criteria:

- Wash ponds and the silt pond are located close to the plant. The silt pond is at a higher elevation and return water flows by gravity back to the wash water pond.
- Silt pond is located in an area where the surface of the rock is above the water table. The fine silt effectively 'seals' the pond although limited exfiltration of water from the silt pond will occur. Any such loss returns water to the groundwater system.
- Silt ponds are located within an area not proposed for subaqueous quarrying (pit operation only).
- The location of the wash pond is mapped symbolically on the site plan (approximate size 50 mx 65m) and initially may not be as large as shown. Eventually it will be merged with the West Pond in Phase 3 and as shown on the rehabilitation plan.

Water Quantity Issues

There are no water quantity issues associated with the proposed wash plant. The recirculated water largely replenishes water obtained from the wash pond. However, there is a small loss of water to entrainment with the shipped product and evaporation. This loss is estimated to be between 1 and 3% of total recycled water. Assuming a loss of 3%, there will be a daily loss of approximately 50 m^3 of water representing a drawdown of less than two centimeters in the wash pond. This daily drawdown will be replenished by groundwater and storm water from the floor of the quarry. The annual loss is estimated to be 7,500 m^3. This quantity of water is insignificant with respect to the historic annual variability in precipitation falling at the site of 200,000 m^3 or the daily infiltration of water from Tributary B of 2,073 m^3. Also, the small loss of water from the aggregate washing operation becomes negligible as groundwater storage in the quarry pond increases.

Water Quality Issues

Water quality is also not an issue in regards to aggregate washing operations. No chemicals or admixtures are added to the water. The wash water contains suspended solids made from fine particles of dolostone rock. These particles readily settle out of the water in the silt pond. Dolostone is largely made of the mineral dolomite ($CaMg(CO_3)_2$) and contains calcium, magnesium and carbonate. There are several reasons why the proposed crushing of dolostone and washing operation does not lead to deterioration of water quality. First, the solubility of dolomite is very low. In relative terms, dolomite is ten orders of magnitude less soluble than calcite (the main mineral in limestone) and almost twenty orders of magnitude less soluble than halite (table salt). This means that dolomite is a very stable mineral in an aqueous environment. Secondly, the natural soils in the vicinity of the site are already calcareous, meaning that they contain fine grained particles of calcite and dolomite and infiltrating rainwater (slightly acidic) slowly dissolves these particles resulting in groundwater with relatively high concentrations of calcium, magnesium and carbonate. Thirdly, the natural buffering capacity of groundwater containing calcium, magnesium and carbonate is significant any trend towards higher concentrations of calcium, magnesium or carbonate is readily buffered by the natural carbonate equilibrium processes.

Sincerely,

Harden Environmental Services Ltd.

LICENSED PROFESSIONAL ENGINEER
S. E. DENHOED
PROVINCE OF ONTARIO

Stan Denhoed, P.Eng, M.Sc.

Senior Hydrogeologist

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Our File: 9506

April 4, 2016

James Dick Construction Ltd.
Box 470
Bolton, Ontario
L7E 5T4

Attention: Mr. Greg Sweetnam

Dear Mr. Sweetnam;

Re: Potential Thermal Impact of Quarry Pond Water on Brydson Creek and Water Taking for Wash Plant at Hidden Quarry

We are pleased to submit our report on the issues;

1) the potential thermal impact that the Hidden Quarry pond will have on shallow groundwater and its potential impact on Brydson Creek and

2) the impact of taking water for the wash plant at Hidden Quarry.

Potential Thermal Impact of Quarry Pond on Groundwater

Sunlight and atmospheric temperatures at the future quarry site will influence the temperature of the surface water and shallow groundwater. It can be expected that surface water temperatures will rise to 25° C in July and decrease to 0° C in January. Temperatures obtained from the Acton Quarry pond discharge water show this annual temperature variation. The extreme warm temperatures will occur in the upper portion of the quarry pond with decreasing solar and atmospheric thermal influence with increasing depth below the quarry pond surface. Warm water is less dense than cool water, therefore total mixing of the warm shallow water with deep water will not occur. Warm and cold water from the pond will slowly migrate into the bedrock and flow southerly as groundwater. A portion of this water may reappear as discharge in the Brydson pond and creek. Brydson Creek is a known spawning area for brook trout whose survival is water temperature sensitive. The brook trout were abundant and were found in all age classes of a 400 m reach of the creek (Schiefer, 2015). The spawning areas (redds) were identified throughout the studied reach between an elevation of 338 m AMSL and 345 m AMSL.

Background Technical Information

The following technical information is pertinent to the following discussion on thermal impact.

1) The elevation of the quarry pond water along the southern edge of the quarry is predicted to be 348.6 m AMSL.

2) The top of bedrock at the southern quarry edge is between 347 and 349 m AMSL and is therefore similar to the post extraction quarry pond surface.

3) Brydson Creek begins at an approximate elevation of 345 m AMSL. The creek begins at a small pond. The area of the pond is 400 m^2 and the approximate depth is one metre.

4) The elevation of Byrdson Creek at the confluence with Blue Springs Creek is approximately 330 m AMSL.

5) The distance between the Brydson pond and the southern edge of the quarry pond is approximately 400 m.

On-going and historical thermal monitoring of groundwater at aggregate extraction sites in Puslinch Township has identified that heat transport from pit ponds does occur, however, in each example the distance of measured thermal impact on groundwater temperatures has been less than 100 metres.

Example 1: Mill Creek Aggregates Annual Monitoring Report 2014. (WSP 2015)

Groundwater at monitor 92-32 registered a 3° C degrees change at 65 m downgradient of a pit pond and 92-28 at a distance of 50 metres had no appreciable change.

Example 2: Tikal Pit (MTE, 2013)

Groundwater monitor OW11 located 50 metres from the pit pond registered a 4.5° C change.

In addition to these measured observations, research work conducted by Markle and Shincariol (2007) found that the heat signature from a gravel pit pond near London, Ontario could migrate up to 250 m downgradient of the pond.

These measured observations is evidence of significant heat loss from groundwater to the aquifer, in these instances, a sand and gravel aquifer. Molson et. al. (2007) evaluates heat loss in a dolostone aquifer near Guelph, and finds that there is significant heat loss from fractures to the dolostone matrix. Molson finds that the retardation factor for heat loss from the fractured media is in the order of 500 times whereas for a sand and gravel aquifer as evaluated by Markle and Shincariol is in the order of 2-3 times. Therefore due to the diffusivity of the heat into the dolostone matrix, greater heat loss will occur in the dolostone aquifer than observed in the two sand and gravel scenarios mentioned above.

The pre conditioning (chilling) of the dolostone during the winter months creates an even greater heat sink local to the quarry.

Measured thermal impacts at gravel pit ponds and the measured natural attenuation potential of the dolostone by Molson prove the attenuating capability of the dolostone aquifer. The four hundred metres of separation distance between the quarry pond and the emergence of Brydson Creek is sufficient to attenuate the thermal signature of the shallow groundwater flowing from the quarry pond. Therefore a thermal impact will not extend to the Brydson pond.

In addition to the natural attenuating ability of the dolostone aquifer the other significant reason why there will be no impact to groundwater temperature discharge temperatures is that the emerging groundwater at the Brydson pond and along Brydson Creek to Blue Springs Creek is not all derived from the Hidden Quarry site and will not all originate from Hidden Quarry ponds in the future. Static water levels obtained from on-site monitoring wells and local private water wells (Figure 3.15 of Harden (2012) attached) shows that groundwater with the greatest potential along Hwy 7 occurs at wells identified by their water well record numbers 6704285 and 2802047. The potential shows groundwater to flow towards Brydson. Groundwater from the northeast converges with that from the northwest and thereby contributes to baseflow. This provides a continual supply of groundwater with ambient groundwater temperatures to the Brydson Creek.

The saturated thickness of the aquifer decreases by approximately 3.5 metres between the southern edge of the proposed quarry and the emergence of Brydson Creek and by 18 metres to Blue Springs Creek. Groundwater hydraulic gradients being somewhat neutral at the Hidden Quarry site become strongly upward beneath Brydson Creek as evidenced by springs. The upwelling of deeper groundwater will continue to be sources of groundwater with ambient temperatures. The concentration of strontium in Brydson Creek is twice that of Tributary B and is an indication of deeper aquifer groundwater contributions to Brydson Creek.

Therefore, topographical and hydrogeological conditions result in the discharge of both widely sourced groundwater and groundwater from depth that will not be influenced by the quarry.

Water Taking for Wash Water and Dust Control

A Permit to Take Water will be required for the proposed aggregate washing operation. The purpose of the washing is to remove fine particles attached to the aggregate. This is different and less water intensive that washing operations that are needed to sort fine sand from coarse coarse sand as needed at sand and gravel pits. The proposed washing will be conducted in a wash plant capable of using 2,500,000 L/day. 97% of the water is recycled via silt pond(s) and approximately 3% is lost due to evaporation and entrainment in the aggregate product. This results in a potential consumption of 75,000 L/day (11.5 igpm, 52 L/min)[1]. In addition, it is estimated that there will be a maximum of 13,000 m^2 of internal roads which may require dust control. Dust control provided by water will consume 1.5 L/hour of water for each square meter of road resulting in an additional potential consumption of 195,000 litres per day. Therefore, the maximum consumption of water is estimated to be 270,000 litres per day.

Dust Control Water Requirement (worst case per phase)

Phase	Road Length	Road Width	Watering Rate*	Units	Hours	Max Daily Water Requirement
1	1175	8	1.5	l/m2	10	141000
2	1625	8	1.5	l/m2	10	195000
3	975	8	1.5	l/m2	10	117000

*RWDI in the Best Management Practices document recommends 1.5 l/Hour per m2.

Wash water and dust control water will be obtained from a man made clear water pond located in the processing area. The clear water pond will have the approximate dimensions of 50m x 65m x 23.5m and will store 76,000,000 litres of water. The surface area is 3250 m^2 and the consumption of 270,000 litres per day results in a potential daily drawdown of eight centimetres. The drawdown will occur only during working hours and assuming a 12 hour working day, there will be 12 hours of inactivity and 84 hours of inactivity every weekend. Total recovery of the drawdown will occur in the inactive period and if not, total recovery will occur on weekends. Therefore, there will be no development of significant drawdown during the active day and rest periods will ensure that any drawdown that does occur recovers in short periods of time. The magnitude of potential drawdown is very small.

Furthermore:

1) The West Pit pond will have been started prior to the commencement of washing and for every hectare of pond there will be 235,000,000 litres of water stored. Any small area of influence created by the clear water wash pond cannot extend beyond the West Pond.

2) The approximate location of the clear water wash pond is shown on Page 3 of 5 of the site plans. The pond will be approximately 115 m from Tributary B where on average, 24 L/s infiltrates. This is an average infiltration of more than 2,000,000 litres per day. The area of influence of the pond will not extend beyond this recharge boundary. This is a shorter distance

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[1] In our January 11, 2016 letter we used the average daily taking of 1,600,000 litres per day as measured at the Erin Pit wash plant. The 2,500,000 represents the max daily usage.

than between the clear water pond and Hwy 7, therefore, the area of influence of this pond will not extend off-site.

3) The development of the quarry ponds will result in the raising of water levels along the southern quarry boundary. This will result in hydraulic gradients between the site and off-site receptors being maintained or increased.

It is thus shown that there will be no drawdown effect felt off-site as a result of the proposed wash plant.

Monitoring

Groundwater monitors M4, M18 and M19 are downgradient of the process area and will either be monitored with a data logger or by monthly manual readings. This monitoring will verify that off-site impacts are not occurring.

Respectfully Submitted,

Harden Environmental Services Ltd.

Stan Denhoed, M.Sc. P.Eng.

Senior Hydrogeologist

References:

Harden Environmental Services Ltd., 2012, Level I and Level II Hydrogeological Investigation Hidden Quarry Rockwood Ontario,

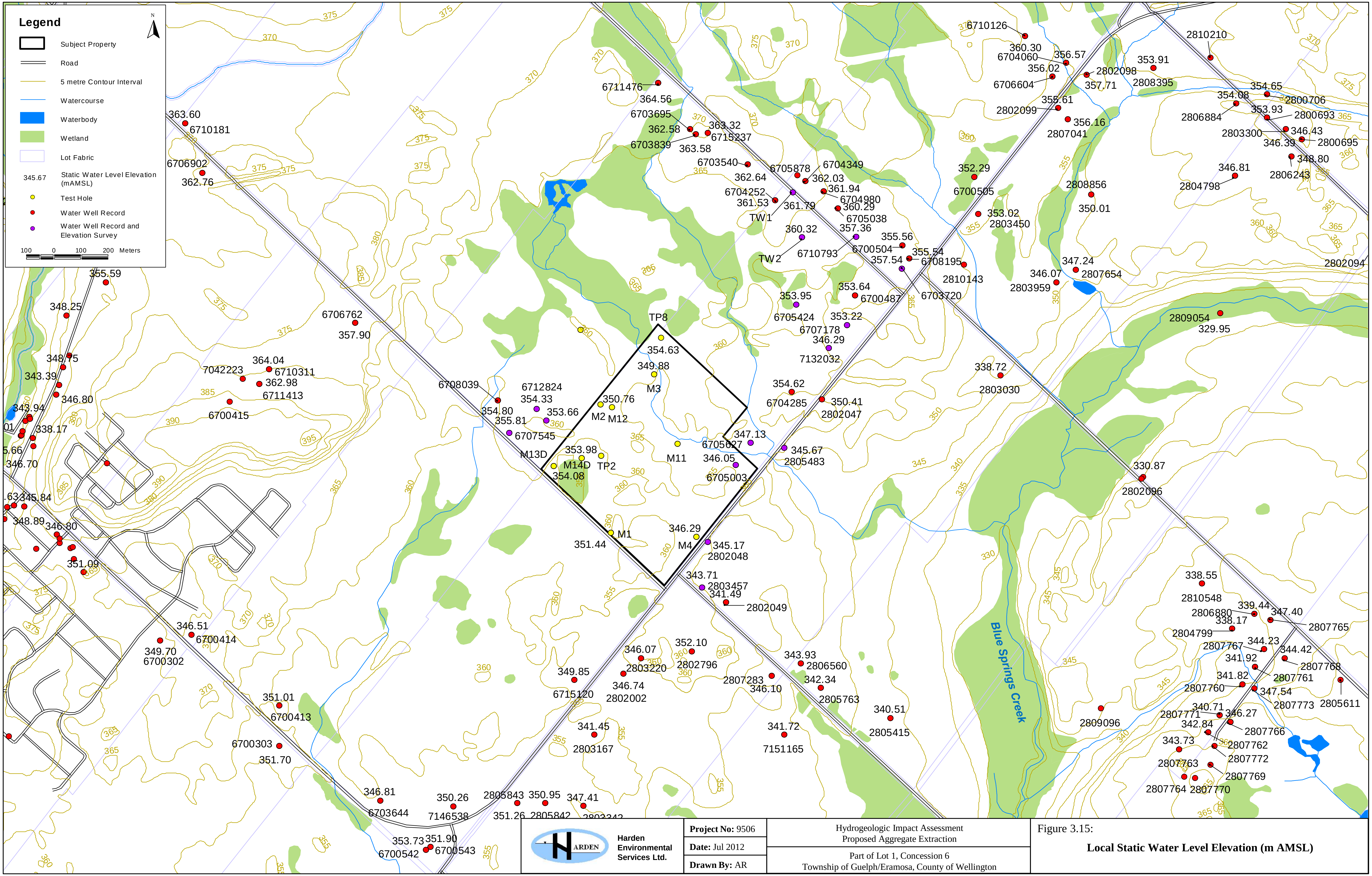
Markle, J.M.and Shincariol, R.A., 2007, Thermal Plume Transport from sand and gravel pits-Potential Impacts on cool water streams, Journal of Hydrology, 338, p 174 – 195

Molson, J., Pehme, P., Cherry, J. and Parker B., 2007, 2007 NGWA/US EPA Fractured Rock Conference: State of the Science and Measuring Success in Remediation, Portland, Maine, September 24-26, 2007

MTE Consultants Inc.,2013, 2012 Annual Groundwater Monitoring Report Tikal Pit, File: 33865-100

Schiefer, K, 2015, Aquatic Habitat and Fish Survey of Brydson Creek,

WSP Canada Inc., 2015, Mill Creek Aggregates Pit, Hydrogeology, Appendix B of the 2014 Coordinated Monitoring Report, File: 111-52958-000



Harden Environmental Services Ltd.

Project No: 9506

Date: Jul 2012

Drawn By: AR

Hydrogeologic Impact Assessment
Proposed Aggregate Extraction

Part of Lot 1, Concession 6
Township of Guelph/Eramosa, County of Wellington

Figure 3.15:

Local Static Water Level Elevation (m AMSL)

Stan Denhoed, P.Eng., M.Sc.

Senior Hydrogeologist

Education:

Institute for Hydraulic Engineering, Delft, The Netherlands, 1994
Master of Science in Hydrological Engineering Degree

University of Waterloo, Waterloo, Ontario, 1986
Bachelor of Applied Science Degree, Geological Engineering

Professional Experience

Contaminant Experience

2012 Evaluation of inorganic chemical contamination of quarry water in Brechin, Ontario. Deep formation water contains elevated concentrations of chloride, aluminium, boron and other metals. Water is discharged to provincial waterway.

2011 Phase II Environmental Site Assessment for former wrecking yard in Hamilton, Ontario. Test pit soil samples obtained and tested for inorganic and organic contamination. Estimates of contaminated soils were prepared.

2009 Hydrocarbon contamination of former Township works yard in Puslinch, Ontario. Excavations were made and samples were obtained to determine potential for soil and groundwater contamination.

Evaluation of water quality results from the Marathon Landfill and preparation of annual monitoring reports from 2008 to 2010.

2007 Toluene contamination of municipal drinking water supply well in Marathon, Ontario. Responsible for identifying source and removal of source of toluene.

2007 Sampling of 120 private wells in Coleman Township investigating the presence of arsenic in drinking water. Results of sampling was compared to locations of mine tailings and historical mining activity.

Source Water Protection/Groundwater Management Studies

Senior hydrogeologist for five-Township groundwater protection study (Artemesia, Melancthon, Osprey, Euphrasia and Town of Blue Mountains) including preparation of recharge/discharge maps, aquifer susceptibility maps, groundwater flow maps and geological maps. Senior hydrogeologist/Project Manager for groundwater management studies for Marathon, Blind River, Burk's Falls, St. Joseph's Island and Gogama (2002-2005).

Peer reviewer of Tier One and Tier Two Source Water Protection Studies for the Ausable-Bayfield Coalition and the Maitland Valley Conservation Area. Peer reviewer of the Vulnerability Assessment reports for the Trent Conservation Authority and Upper Thames Regional Conservation Authority.

Supervision of Well Drilling and Water Sampling

Supervision of aquifer testing for water supply and for cone of influence of pumping wells or dewatering systems. Supervision of drilling contractors for the installation of pumping wells. Extensive experience with the evaluation of groundwater movement through fractured rock and the analysis of pumping test data related to confined and unconfined aquifers. Extensive experience in the sampling of well water and evaluation of water quality results.

Document Review/Peer Review

Review of mining applications, subdivisions, golf courses and septic system impacts on behalf of the Township of Puslinch, Grand River Conservation Authority and the County of Wellington. Evaluation of applications to gauge compliance with Ministry of the Environment policies and environmental guidelines developed by the Township and the County. Peer reviewer for the 2002 GUDI studies and peer reviewer for the Ausable Bayfield Maitland Coalition (Source Water Protection) and for Saugeen Valley Conservation Authority (Source Water Protection). Peer Reviewer for Vulnerability Assessment Reports for Lower Thames Conservation Authority and Trent Conservation Authority.

Aggregate Licensing, Letters of Opinion and Level I/II Hydrogeological Reports

Environmental investigations to ascertain potential impacts from dewatering or extractive activities in bedrock and sand and gravel. Compliance monitoring of active quarries and pits. Development of detailed water balances for extractive operation. Groundwater flow studies related to extraction and dewatering. I have worked in the following geological environments in regards to pits and quarries; Aberfoyle Outwash Deposit, Paris Moraine, Galt Moraine, Oro Hills, Caledon Outwash, Amabel Formation, Guelph Formation, Eramosa Formation, Gull River Formation, Bobcaygeon Formation, Verulum Formation, Oak Ridges Moraine, Precambrian Shield, Bois Blanc Formation, Simcoe Uplands.

Environmental Audits (Phase I and II ESAs)

Investigations of properties during real estate transactions to ascertain potential environmental liabilities associated with the property.

Surface Water / Groundwater Interactions

Evaluation of changing groundwater levels on wetlands and fisheries. Working with both the Ministry of Natural Resources and the Federal Department of Fisheries and Oceans on projects related to man-induced groundwater level changes and their real and potential impacts on cold water fisheries. Investigation of groundwater inflow component to wetlands to evaluate potential impacts of urbanization in recharge areas.

Ontario Municipal Board Experience

Representation of clients’ interest at three OMB hearings (Oro Hills, Penetanguishene and Aikensville) related to gravel pit applications and three mediated hearings in relation to septic system impacts (Goderich), quarry application(Owen Sound) and large water taking application (Artemesia).

Stan Denhoed, P.Eng., M.Sc.

Senior Hydrogeologist

Employment History

1993- Present	Harden Environmental Services Ltd., Moffat, Ontario *President/Senior Hydrogeologist*
1991- 1992	Keewatin-Aski Ltd., Concord, Ontario *Manager of Hydrogeological Projects*
1987- 1990	M.M. Dillon Ltd., Toronto, Ontario *Project Hydrogeologist*
1986- 1987	Environment Canada, Burlington, Ontario *Research Hydrogeologist*

Associations, Licenses and Committee Participation

Professional Engineers of Ontario, Professional Engineers of Yukon

Licensed Water Well Contractor/Technician in the Province of Ontario

Low Water Response Committees for Hamilton Conservation and Halton Conservation Authorities

Publications

Denhoed, S.E., 1994, *The Role of Sorption in the Accumulation of Arsenic by Peat in the Western Netherlands*, M.Sc. Thesis, Institute for Hydraulic Engineering, Delft, The Netherlands

Denhoed, S.E., Kell, R. and G. Parker.,1990, *Predictive Monitoring of Groundwater Quality at a Municipal Landfill Site*, Proceedings of Canadian Society for Civil Engineers, Annual Conference, Hamilton, Ontario, May 1990

Priddel, M., Jackson, R.E., Novakowski, K.S. and Denhoed, S.E., 1986, *Migration and Fate of Aldicarb in the sandstone Aquifer of Prince Edward Island*, Groundwater in Canada, Special Issue.

Harman, J., McLellan, J. Rudolph, D., Heagle, D, Piller, C. and S. Denhoed, 2001, *A proposed Framework for Managing the Impacts of Agriculture on Groundwater: A Report Prepared For the Sierra/Alert Coalition for Submission in Part 2 of the Walkerton Inquiry*.

Presentations

Source Water Protection Conference: Cornwall, Ontario, 2006: *Surface Water / Groundwater Interactions: Mill Creek Experience*

Source Water Protection Committee: Trent Coalition, July 2009: *Groundwater Modelling*

Ontario Research Fund April 2011: Sustainable Bedrock Water Supplies for Ontario Communities: *Compromised Aquitards – Unwelcome Transport Pathways*

Ontario

Ontario Municipal Board

Commission des affaires municipales de l'Ontario

ACKNOWLEDGMENT OF EXPERT'S DUTY

Case Number	**Municipality**
PL 150494	County of Wellington

1. My name is Stanley Edward Denhoed (*name*)
   I live at the Township of Puslinch (*municipality*)
   in the County of Wellington (*county or region*)
   in the Province of Ontario (*province*)
2. I have been engaged by or on behalf of James Dick Construction Ltd. (*name of party/parties*) to provide evidence in relation to the above-noted Board proceeding.
3. I acknowledge that it is my duty to provide evidence in relation to this proceeding as follows:
   a. to provide opinion evidence that is fair, objective and non-partisan;
   b. to provide opinion evidence that is related only to matters that are within my area of expertise; and
   c. to provide such additional assistance as the Board may reasonably require, to determine a matter in issue.
4. I acknowledge that the duty referred to above prevails over any obligation which I may owe to any party by whom or on whose behalf I am engaged.

Date April 15/16

Signature