Hydrogeologic Assessment Report

Laurelpark Subdivision

Part of Lot 19, Concession 6, Town of Caledon (Albion)

Prepared for:
Harbour View Investments, Ltd.

Prepared by:
Azimuth Environmental
Consulting, Inc.

June 2017

AEC 08-019

AZIMUTH ENVIRONMENTAL CONSULTING, INC.
Environmental Assessments & Approvals

June 16, 2017 AEC 08-019

Harbour View Investments, Ltd.
2458 Dundas Street West
Mississauga, Ontario L5K 1R8

Attention: Mr. Mark Crowe

Re: **Hydrogeological Assessment Report**
Part of Lot 19, Concession 6, Town of Caledon (Albion)

Dear Mr. Crowe:

Azimuth Environmental Consulting (Azimuth) is pleased to submit our Hydrogeological Assessment Report for the property located in Part of Lot 19, Concession 6, Town of Caledon, Region of Peel. To comply with the requirements of the ORMCP, this hydrogeological assessment has been prepared to determine and describe the hydrogeologic and hydrologic function of sensitive features identified on the subject property. The evaluation focused on the nature of the interaction between the ground and surface water systems and the potential effect of the proposed development on these features.

Based upon our interpretation of the available data, it is concluded that the present hydrological and hydrogeological conditions upon the subject property will not experience a significant change due to do the proposed development.

If you require further information or have any questions do not hesitate to contact us.

Yours truly,

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Mike Jones, M.Sc., P.Geo.
President

Drew West, A.Sc.T.
Environmental Technologist

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1.0 INTRODUCTION

Azimuth Environmental Consulting (Azimuth) has been retained by Harbour View Investments Limited to conduct a Hydrogeological Assessment Report for the proposed estate residential development to be located on Part of Lot 19, Concession 6, Town of Caledon, Region of Peel (Figure 1). The subject property is located within the within the limits of the Oak Ridges Moraine (Oak Ridges Moraine Conservation Plan [ORMCP], 2002). Since the proposed estate residential development site occurs within the Oak Ridges Moraine Conservation Plan (ORMCP) Area the Hydrogeologic Assessment Report incorporates a Hydrological Evaluation (HE) which is a requirement of both the ORMCP and the Town of Caledon Official Plan (TCOP, 2016).

The primary objective of this report is to identify all Hydrologically Sensitive Features (HSF) as per the ORMCP (i.e. streams, wetlands, kettle lakes, seeps and/or springs) and ensure that the proposed development plan adheres to the requirements of the ORMCP. This includes, maintaining, improving or restoring all the elements that contribute to the hydrological and hydrogeological functions of the Oak Ridges Moraine.

2.0 PLANNING CONTEXT

2.1 Provincial Policy Statement

Section 2.2 – Water

Subsection 2.2.2: Development and site alteration shall be restricted in or near sensitive surface water features and sensitive ground water features such that these features and their related hydrologic functions will be protected, improved or restored. Mitigative measures and/or alternative development approaches may be required in order to protect, improve or restore sensitive surface water features, sensitive ground water features or on the their hydrologic functions.

Each of the six wetlands on the subject property will be protected with a 30 metre buffer (vegetation protection zone) surrounding the outer edge of each feature, which will preserve the existing vegetation and natural slope within each buffer area. Grading within each wetland catchment area will also be minimal in an attempt to replicate existing drainage conditions within the subject property. The subject property is not considered a significant ground water recharge area and given the proposed form of development, the proposed development is not anticipated to have a significant impact on local ground water quality/quantity.

2.2 Oak Ridges Moraine Conservation Plan

The property is located within the limits of the Oak Ridges Moraine (ORMCP, 2017). Within the Oak Ridges Moraine Conservation Plan (ORMCP), the property is within the Palgrave Estates Residential Community.

Subsection 13 (2): Maintains and protects Countryside Areas by:

b) Maintaining, and where possible improving or restoring the health, diversity, size and connectivity of key natural features, hydrogeologically sensitive features and the related ecological functions.
c) Maintaining the quality and quantity of ground water and surface water.
d) Maintaining ground water recharge.
e) Maintaining natural stream form and flow characteristics.
f) Protecting landform features.

Subsection 16 (2)a): For every Subdivision and Site Plan approval, with respect to land in the Countryside Areas, the approval authority shall ensure that a condition requiring the applicant to ensure that natural self-sustaining vegetation is maintained or restored for the long-term protection of any key natural heritage feature or hydrologically sensitive feature on the lot or lots created is imposed.

Subsection 26 (1): Identifies Key Hydrologically Sensitive Features (KHSF) as:

1) Permanent or intermittent streams
2) Wetlands
3) Kettle lakes
4) Seepage areas and springs

Subsection 26 (2): States that all development and site alteration with respect to land within a hydrologically sensitive feature or the related minimum vegetation protection zone is prohibited, except the following:

1) Forest, fish and wildlife management
2) Conservation and flood or erosion control projects, but only if they are determined to be necessary in the public interest after all alternatives have been considered.
3) Development of infrastructure in accordance with the requirements set out in section 41.
4) Low-intensity recreational uses as described in Section 37.
5) Agricultural uses other than uses associated with on-farm buildings and structures, but only with respect to land in the minimum vegetation protection zone related to a key hydrologic feature and not in the key hydrologic feature itself.

No development is planned to occur within the boundaries of any hydrologically sensitive feature located on the subject property or within any related minimum vegetation protection zone. The maintenance of hydrologically sensitive features, wetlands, streams, aquifers, ground water recharge areas and landform features will be done through minimum protection zones, ground water infiltration balancing and minimal site grading.

Subsection 26 (3): States that an application for development or site alteration with respect to land within the minimum area of influence that relates to a hydrologically sensitive feature, but outside the hydrologically sensitive feature itself and the related minimum vegetation protection zone, shall be accompanied by a hydrological evaluation under subsection (4).

Please consider this report as the required hydrogeological evaluation to satisfy Subsection 26 (3) of the ORMCP.

Subsection 26 (4): States that a hydrological evaluation shall,

a) Demonstrate that the development or site alternation will have no adverse effects on the hydrologically sensitive feature or on the related hydrological functions;
b) Identify planning, design and construction practices that will maintain, and where possible, improve or restore, the health, diversity and size of the hydrologically sensitive feature;
c) Determine whether the minimum vegetated protection zone, and if it is not sufficient, specify the dimensions of the required minimum vegetation protection zone and provide for the maintenance and, where possible, improvement or restoration or natural self-sustaining vegetation within it; and
d) In the case of an application relating to land in a Natural Core Area, Natural Linkage Area or Countryside Area, demonstrate how connectivity within and between key natural heritage features and key hydrologic features will be maintained and, where possible, improved or restored before, during and after construction.

This report satisfies the requirements of subsection 26 (4) of the ORMCP.

Subsection 29 (5): States that the following uses are prohibited with respect to land in areas of high aquifer vulnerability:

1) Generation and storage of hazardous waste or liquid industrial waste.
2) Waste disposal sites and facilities, organic soil conditioning sites, and snow storage and disposal facilities.

3) Underground and above-ground storage tanks that are not equipped with an approved secondary contaminant device.
4) Storage of a contaminant listed in Schedule 3 (Severely Toxic Contaminants) to Regulation 347 of the Revised Regulations of Ontario, 1990.

Only a small area of land within the northeastern corner of the subject property is considered an area of high aquifer vulnerability under the ORMCP. None of the prohibited uses listed in subsection 29 (5) will be associated with the proposed development.

Region of Peel Official Plan

Section 2.2.5: Ground Water

2.2.5.1: It is policy of Regional Council to:

2.2.5.1.1: Protect, maintain and enhance the integrity of ecosystems through the proper planning and management of ground water resources and related natural systems in Peel.

2.2.5.1.2: Work with area municipalities, conservation authorities and other provincial agencies to protect, maintain and enhance ground water resources.

It is intended that the proposed development be serviced municipally by an existing watermain which is located along Mount Pleasant Road, which would lessen the impact on ground water resources within the local area. Section 9.0 of this report summarizes the predicted impacts on the local ground water regime from the construction and usage of eight individual septic systems to service the sewage disposal needs of the proposed development.

Section 2.2.9: Oak Ridges Moraine

2.2.9.3.8: Define key natural heritage features and hydrologically sensitive features in accordance with Policy 2.2.9.3.69 and Policy 2.2.9.3.10 of this Plan. Where key natural heritage features and hydrologically sensitive features coincide with components of the Greenlands System in Peel, the policies of Section 2.3 of this Plan shall also apply.

This report (specifically Sections 5.0 and 8.0) defines and describes in detail each hydrogeolocally sensitive feature found on the subject property.

2.2.9.3.10: As outlined in the ORMCP, the Peel Region OP defines hydrologically sensitive features as:

a) Permanent and intermittent stream;
b) Wetlands;
c) Kettle Lakes; and
d) Seepage areas and springs.

2.2.9.3.13: Direct the Town of Caledon to prohibit development and site alteration within key natural heritage features and/or a hydrologically sensitive feature and within the associated minimum vegetation protection zone, in accordance with the Table in Part III of the ORMCP, except as permitted by the ORMCP (e.g. existing uses and existing lots of record).

2.2.9.3.14: Direct the Town of Caledon to require that an application for new development or site alteration within the minimum area of influence of a key natural heritage feature or a hydrologically sensitive feature be accompanied by a natural heritage evaluation and/or a hydrological evaluation, as detailed in the ORMCP. The evaluationshall be prepared to the satisfaction of the Town of Caledon, in consultation with the Region of Peel and the applicable conservation authority, as appropriate. The Town of Caledon may develop guidelines to assist in the interpretation of this policy including appropriate mechanisms for refining and scoping evaluation requirements. These guidelines are to be developed in consultation with the Region of Peel and the applicable conservation authorities.

This report has been completed in accordance with Region of Peel OP policy 2.2.9.3.14

2.2.9.3.15: Direct the Town of Caledon to include, in its Official Plan, the appropriate policies that support connectivity. These policies should also include that applications for development or site alteration identify planning, design, and construction practices that ensure no buildings or other site alterations impede the movement of plants and animals along key natural heritage features, hydrologically sensitive features, and adjacent landwithin Natural Core Areas and Natural Linkage Areas.

Town of Caledon Official Plan

Section 7.1.9: Environmental Policies

7.1.9.5: No part of a Structure Envelope will be permitted in EZ 2 zones except for short sections of driveways which may cross short sections of EZ 2 if necessary to obtain reasonable access to a lot. Individual lot services will not be permitted to cross Policy Area 4 or EZ 1 and EZ 2 unless included within the driveway portion of a structural envelope crossing EZ 2.

No part of a structure envelope is proposed within EZ 2 zones.

7.1.9.28: The existing natural flow patterns into and from existing ponds should not be disturbed.

All wetlands on the subject property (with the exceptions of Wetland 1 and 2) are hydraulically isolated (offline) features. Wetland 1 outlets surface water into Wetland 2 during times of high water levels, and Wetland 2 outlets to an intermittent watercourse located off-site. Both of these surface flow pathways will be maintained within the 30 metre vegetation protection zones. All wetland catchment areas will also be maintained as much as possible in an attempt to replicated natural flow patterns.

7.1.9.39: Plans of subdivision shall be designated so as to minimize road crossings and extensions into EZ 2. Short sections of roads and associated subdivision services will be permitted to cross or extend into EZ 2 if necessary to allow economically efficient road or subdivision design, provided such road crossing is located in Policy Areas 1, 2 or 3.

A short section of Street A is proposed to cross an ephemeral swale between the pond at Mt. Pleasant and the neighbours dugout pond to the south. This swale directs storm runoff in both directions, With the site grading and road construction, this area would not be considered EZ 2 however, the same drainage function would continue. Significant impacts to the EZ 2 are not anticipated. The site is located within a Policy Area 1, which permits short sections of road to cross or extend into EZ 2.

7.1.9.45: If existing domestic wells are abandoned as a result of estate residential plans of subdivision the applicant must seal the abandoned well in accordance with the regulations of the Ministry of the Environment and Climate Change. Boreholes drilled for the geotechnical investigations detailed in Section 7.1.18.3 also must have piezometers removed and sealed prior to construction unless the borehole is approved by the Town for future environmental monitoring purposes.

No domestic wells exist on the property, and all monitoring wells will be decommissioned in accordance with the regulations of the Ministry of the Environment prior to development, unless a well(s) is approved by the Town for future environmental monitoring purposes.

Section 7.1.18.5: Hydrogeology Report

A Hydrogeology Report will be prepared which summarizes available domestic water well and borehole records and the characteristics and quality of the existing water table and deeper confined aquifers. This report will characterize the hydrogeology of the site and assess the risk of contamination from the proposed development to adjacent domestic and communal ground water supplies. Nitrate modeling will be undertaken as applicable for sand to water table soils. This report may form part of the environmental reporting. The Hydrogeology Report should take into consideration applicable provincial guidelines, such as the Guideline on Planning for Sewage and Water Servicing, and related Technical Appendices.

Sections 4.0, 6.0 and 9.0 of this report satisfy the requirements of Section 7.1.18.5 of the Town of Caledon Official Plan.

Section 7.10.5.1: Key Natural Heritage and Hydrologically Sensitive Features

Hydrologically sensitive features within the ORMCPA are permanent and intermittent streams, wetlands, kettle lakes and seepage areas and spring.

All hydrologically sensitive features on-site have been identified and will be protected with minimum 30-metre vegetation protection zones, as per Table 7.5 of the Town of Caledon Official Plan.

3.0 EXISTING CONDITIONS

3.1 Land Use

The property is approximately 11 hectares (ha) in size and located on the western side of Mount Pleasant Road just south of Oak Knoll Drive (Figure 1). The majority of the property is composed of active and idle agricultural production. A total of six wetlands have been identified on the property, which are scattered throughout the extent of the site (Figure 2). It is our understanding that some of the wetlands on-site were created by anthropogenic activities (Wetland 3 and unnamed pond along Mount Pleasant Road) such as soil/gravel excavation and damming.

To the best of our knowledge, no residential structures have ever been located on the subject property. Lands surrounding the property are dominated by estate residential development and agricultural fields.

3.2 Physiography

The subject property is located within the physiographic region referred to as the Oak Ridges Moraine (ORM) (Chapman and Putnam, 1984). The ORM is a prominent physiographic feature in south-central Ontario forming a west to east trending ridge that is approximately 160 km long and 2 to 11 km wide. Extending from the Niagara Escarpment to the Trent Talbot River, the ORM consists of several distinct sections. The subject property is located within the Albion Hills area of the Town of Caledon, where the hills consist of deep beds of evenly graded fine sand. However, in the vicinity of the subject property, the physiographic setting consists of a Till Moraine.

Locally, the subject property is situated on the southern flanks of Mount Wolfe, an isolated remnant of Northern Till/Newmarket Till. This outlier protrudes through the younger sediments of ORM and rises to approximately 365 masl, 65 metres above the surrounding moraine deposits. The topographic relief on the subject property is approximately 15 metres, ranging between 270 masl in the southwest corner of the property to 285 masl at the peak of a hill located within the central portion of the property.

3.3 Hydrology and Drainage

The subject property is located within the Humber River watershed. The drainage divide between the Humber and the Holland catchment areas is located approximately 1.5 km to the north-northeast, while the drainage divide between the Humber and Nottawasaga catchment areas is located approximately 2.5 km to the north.

Although there are no watercourses located on the subject property, a small tributary of the Humber River named Cold Creek is located just west of the site. It is presumed that the majority of surface and shallow ground water from the subject property drains to this watercourse. The on-site wetlands have also been found to receive a portion of the local surface runoff and shallow ground water contribution at certain periods (ground water contribution primarily during spring and fall).

MNRF classified these wetlands as “Kettle Wetlands” in the Mount Wolfe Wetland Complex Evaluation document dated July, 2012. Based on the geologic history of the area and the isolated (hydraulically) nature of the wetlands, Azimuth agrees that some of these wetlands are kettle features, but as previously mentioned, a portion of the wetlands were established by anthropogenic activities. Kettle features, particularly small features such as these, are abundant throughout sections of the Oak Ridges Moraine. However, they are not identified as kettle lakes.

4.0 GEOLOGY

4.1 Regional Geology

The key geological units found within the study area are the Thorncliffe Formation, the Northern Till, the ORM sediments, and the Halton Till. The subject property is located on the southern flanks of Mount Wolfe, which is an inlier of the Northern Till, which extends up through the younger deposits of the ORM. This physiographic / geological feature makes the study area somewhat unique with respect to the general geological characteristics of the ORM.

There is a general consensus that the base of the ORM is defined by a regional unconformity (erosional surface) that forms the top of the Northern Till (mapped as Newmarket Till; Gwyn, 1972; Sharpe *et al*., 1996). The Northern Till was deposited by the Laurentide Ice Sheet as it expanded southwards during the Nissourris Stadial (between 22,000 and 18,000 years ago; Karrow and Ochietti, 1989; Boyce et al., 1995) to cover all of Canada and adjacent parts of the United States. The origin of the erosional surface is contentious. Proposed models include sub-glacial outburst floods (Shaw and Sharpe, 1987), or from sub-glacial deformation (Boyce and Eyles, 1991). Regardless of the origin of the regional unconformity, the Northern Till is characterized by an undulating surface both beneath and north of the ORM (Peterborough Drumlin Field).

The Northern Till is a light grey, sandy till, which ranges in texture from a loam to a sandy loam and may contain appreciable percentages of gravel, cobble and boulders. The till is widely recognized as a very dense till, and often referred to as “hardpan” by water well drillers. Within the Till unit, lateral sand and gravel interbeds and boulder pavements marking erosional surfaces have been identified (Boyce et al., 1995; Boyce et al., 1997).

In most areas east of the Escarpment, the Till is mostly covered by younger deposits but it is also well exposed at the surface in several localities, such as Mono Mills and at Mt. Wolfe. The till is continuous beneath the discontinuous cover of the ORM sediments. The subject lands are mapped by Chapman and Putman (1984) to be located on the Till Moraine, while earlier mapping by White and Karrow (1975) has ORM deposits beneath the subject property. However, based on a site specific geological data, the sediments are found to have been deposited in a moraine environment.

Warming trends approximately 13,800 years ago resulted in the retreat of the Laurentide Ice Sheet and the separation into the Simcoe and Ontario Lobes. The first ice-free period (Mackinaw Interstadial Period) resulted in interbedded outwash sands and gravels were deposited by meltwater draining from the ice margin. After a brief ice-free period, the Laurentide Ice Sheet re-advanced to form an interlobate lake between the ice margins (13,300 years ago). The interlobate lake was confined between the Simcoe Lobe in the north, northeast; the Ontario Lobe in the south, southeast; and the Niagara Escarpment to the west. As ice margins receded, deltaic and glaciofluvial outwash sediments were deposited in the expanding glacial lake basin between the ice margins.

The glaciolacustrine and sub-aqueous deposits that formed the core of the ORM are approximately 95 metres thick and are interfingered and overlain by the Halton Till deposits as a result of several minor ice margin advances and retreats. Although absent along the crest of the moraine, the Halton Till drapes the southern flanks of the ORM, where it forms the uppermost stratigraphic unit. The Till consists of predominantly sandy silt to clayey silt and is typically massive.

The limit of the final ice advance is marked by the narrow zone of hummocky topography and numerous kettle features (lakes, wetlands, or dry depressions).

4.2 Local Geology

To ensure that the surficial geology is consistent with the regional mapping, a review of borehole data was completed. Terraprobe (2013) completed a geotechnical evaluation of the subject property and drilled at total of 12 boreholes ranging between 6.4 and 6.6 metres in depth. The borehole records which show detailed geologic descriptions (stratigraphy) across the extent of the subject property are provided in Appendix B.

The surficial geology is quite consistent across the subject property. The underlying deposits within the upper 6.6 metres of overburden are primarily silty in nature, with some sand and trace clay (Terraprobe, 2013) found in sporadic deposits across the subject property.

White (1975) reported that the localized areas of silt within the ice-contact stratified sands and gravels were deposited in fairly deep waters impounded in the moraine area. Deposition over buried ice masses is suggested by the common occurrences of disturbed structures of the stratified silts (wetland areas / depression). In the areas shown as ice contact stratified drift in the moraine zone, numerous exposures of till are seen either overlain by or underlying stratified sediments.

5.0 HYDROGEOLOGY

The ORM is widely recognized as an important aquifer system, which is referred to as the Oak Ridges Aquifer Complex (ORAC). The ORAC is generally unconfined, except where the Halton Till drapes the moraine on the southern flanks. The primarily coarse-grained nature of the outwash gravels that form the complex is reflected by the high values of hydraulic conductivity (Gerber and Howard, 2000). Consequently, the aquifer system has become a major source of potable water for domestic wells and communities in south-central Ontario. Yields are typically as high as 4 L/s (Sibul *et al*., 1997). The base of the aquifer system rests on the Northern Till. The aquifers thickness is largely a function of the thickness of the ORM deposits.

The outwash deposits of the ORM are in direct communication with, and stratigraphically equivalent to the sands (and gravels) of the Mackinew Interstadial deposits. Based on the local domestic water wells, the majority of the water supplies in the area are obtained from the Mackinaw Interstadial deposits.

There are four domestic water wells on record with the Groundwater Information Network (GIN) for Lot 19, Concession 6, Town of Caledon (former Township of Albion). Table 1 provides a summary of these records. The digital print out of the information is provided in Appendix C.

Table 1: Summary of Local Water Well Records

Water Well No.	Geologic Unit	Approximate Elevation (masl)	Static Water Level (masl)
4903021	Mackinaw Interstadial Sands	**275 - 270**	271
	Underlying Clay Deposits	270 - 263	
4903059	Mackinaw Interstadial Sands	**278 - 272**	270
	Underlying Clay Deposit	272 - 266	
4903634	ORM Deep Water Deposits	285 - 276	275
	Mackinaw Interstadial Sands	**276 - 274**	
	Underlying Clay Deposit	274 - 265	
4904873	ORM Deep Water Deposits	277 – 248	272
	Deeper Sand Deposit	**248 - 245**	

Bold = Zone of target aquifer source

Typically, wells within the vicinity of the subject property target the sandy zone between 270 and 278 masl. The wells that target this upper aquifer zone are dug wells and are not able to target deeper aquifer zones. Well #4904873 is a drilled well, which explains the deeper aquifer zone targeted. The well yields are variable yet sufficient for the requirements of domestic wells (between 5 and 6 IGPM).

5.1 Ground Water Flow – ORAC

To advance the understanding and management of the ground water system across a large part of southern Ontario, a partnership was developed between four municipal governments (Regional Municipalities of York, Peel, and Durham, and the City of Toronto (YPDT)) and the associated Conservation Authorities, including the Toronto and Region (TRCA). This study is known as the YPDT-CAMC Groundwater Management Strategy Study (Kassenaar and Wexler, 2006).

This report included an Aquifer Characterization Study for the TRCA Watersheds. Although it is recognized that this is a broad based regional study, the results provided a general understanding of the ground water flow conditions within the ORAC. Figure 97 and 98 of this report depict calibrated heads in the underlying Thorncliffe and Scarborough Aquifer Complexes (shown below). Both aquifer systems are shown to flow towards the Humber River valley to the southeast.

The Thorncliffe and Scarborough Aquifer Complexes are the major ground water systems within the Oak Ridges Moraine which exist below the upper Oak Ridges Aquifer Complex.

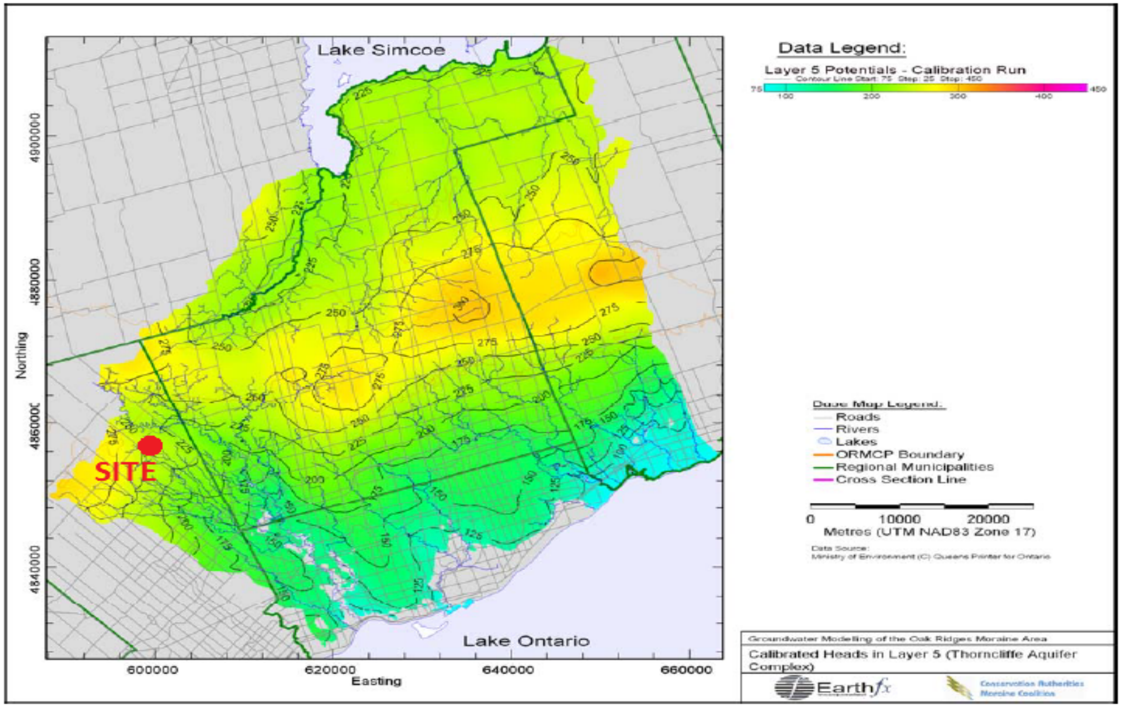


Figure 97: Calibrated heads in the Thorncliffe Aquifer Complex

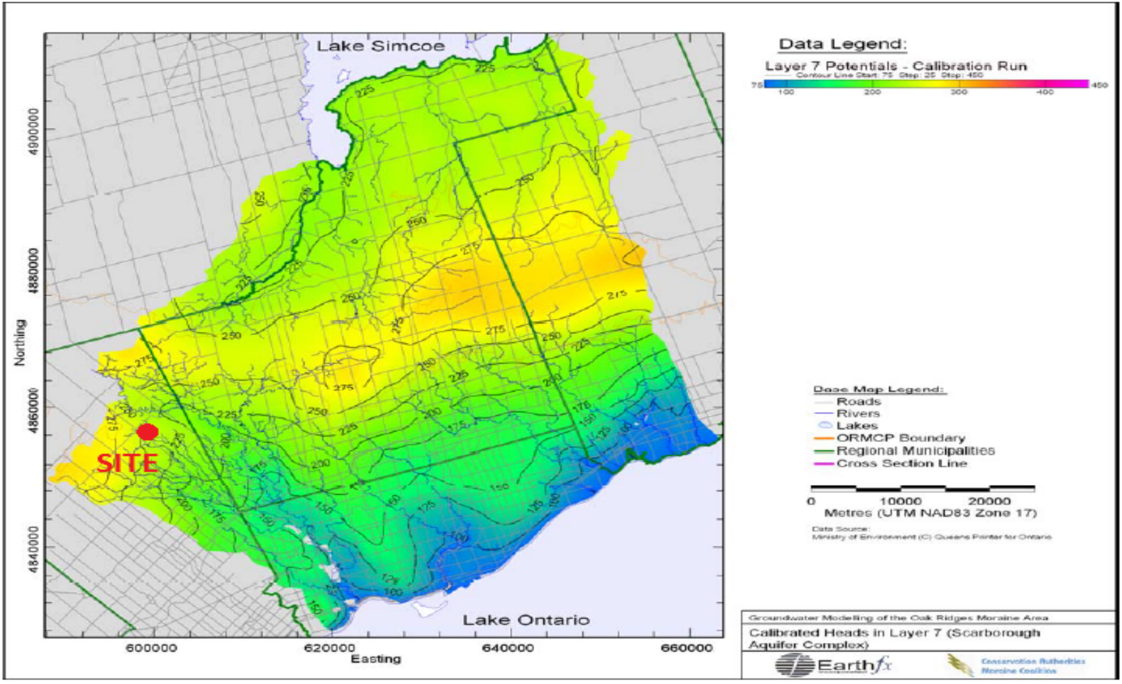


Figure 98: Calibrated heads in the Scarborough Aquifer Complex

Based on these two figures, the calibrated hydraulic heads in the Thorncliffe and Scarborough Aquifer Complex's (deeper aquifers) heads within the vicinity of the subject property fall in the approximate range of 225 - 250 masl. Deeper ground water flow is shown to flow in a southeasterly direction toward Lake Ontario.

Site specific ground water elevations (measured in March 2013) of the shallow upper aquifer monitored on the property, and ground water flow directions are presented in Figure 4. It has been determined that shallow ground water flows in a general south to southeasterly direction.

5.2 Local Hydrogeology

In order to observe the fluctuation of the underlying upper aquifer, automatic water levels were collected using hydrostatic pressure dataloggers installed in the 12 on-site monitoring wells (Figures 7 - 13). Azimuth's long term monitoring program (2012 – 2017) has shown that seasonal ground water level fluctuation within the subject property were in the range of 1.85 (MW-5II) to 5.10 (MW-2) metres. Considering the varying climatic conditions experienced within the monitoring period, this fluctuation range should be considered normal and expected to continue in the future.

Ground water elevations across the subject property ranged between a high of approximately 280.5 masl in the northern portion of the site to approximately 267.8 masl in the southeastern corner of the site. This difference in ground water elevation across the site suggests that the shallow ground water flow is controlled locally by topography, as anticipated.

The Town of Caledon Official Plan (2016) identifies areas of high ground water table (where the water table is usually within 1.5 metres or less below the ground surface), areas of seasonal flooding, dry swale lowlands and natural depressions which perform natural run-off, detention and ground water recharge functions, and smaller hedgerows and strips of native vegetation. These areas are termed EZ 2 (Environmental Zone 2). Figure 6 includes mapping of existing EZ 2 areas within the subject site, based on hydrogeological investigations completed by Azimuth and Terraprobe Inc. in 2013.

The Official Plan does not permit any part of a structure envelope within EZ 2 areas, with the exceptions of short sections of driveways and roads. As shown in Figure 6, no development feature will cross an EZ 2 area within the subject property.

6.0 GROUND WATER / SURFACE WATER INTERACTION

Nearly all surface water features (streams, wetlands) interact with ground water in some form or another. In many situations, surface water bodies receive ground water which maintain surface water levels throughout the year, and in others situations the surface water body provides a source of ground water recharge.

To understand the hydraulic significance of the ground water regime on the on-site surface water features, a detailed assessment was completed. This included a short term water level monitoring program for the five on-site wetlands (Wetland 6 not included in the assessment as no data was collected) and twelve on-site monitoring wells.

Based on the surface and ground water level data collected in and around the vicinity of each wetland, it has been found that all five on-site wetlands receive ground water contribution to some degree during the year, although the amount of ground water contribution varies on a site-specific basis. Surface water levels within each wetland could not be collected during the winter month due to each feature freezing over, so the comparison of ground and surface water levels was limited to spring, summer and fall. The elevation of the bottom of each wetland feature is known, which allowed for the tracking of ground water levels above or below these elevations during the winter months.

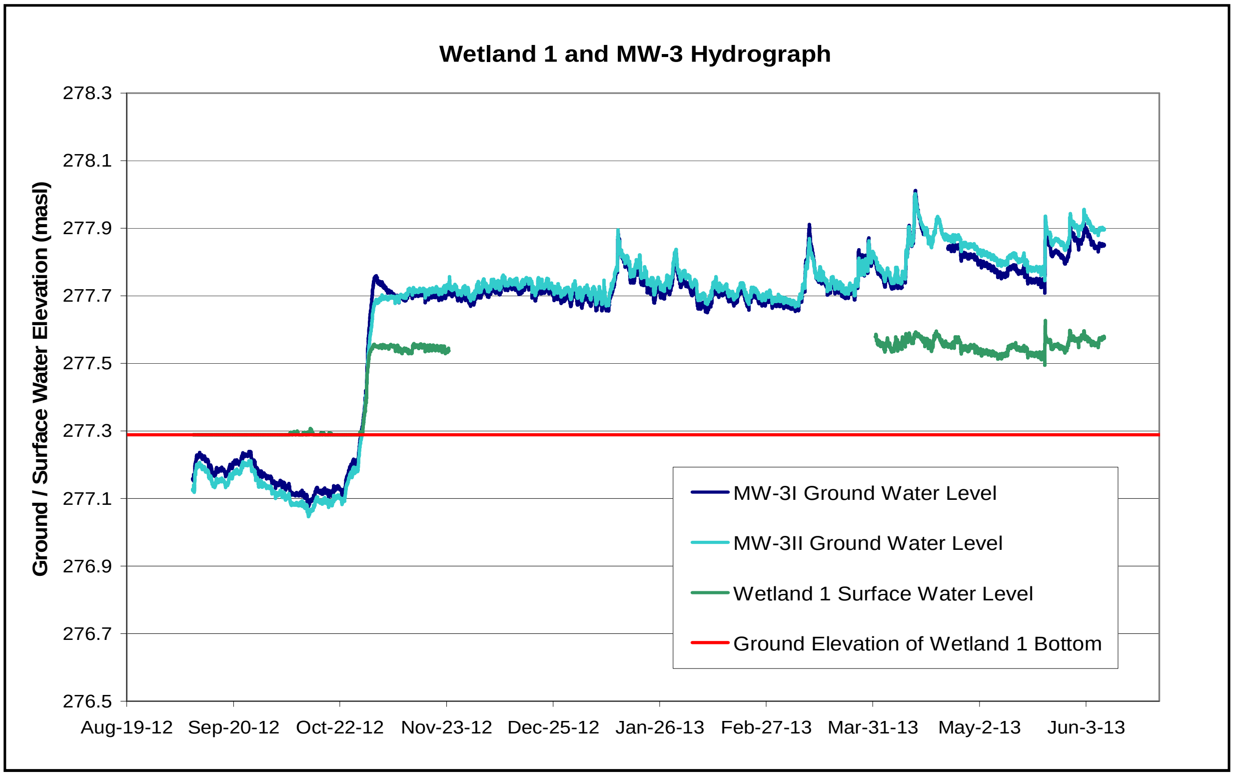
The following sections present the data collected for the purpose of assessing ground and surface water level interactions at five on-site wetland locations.

6.1 Wetland 1 / Monitoring Well 3

Wetland 1 is a small, oval-shaped feature located within the central portion of the subject property, which generally (based on monitoring data between 2012 and 2013, along with periodic visual inspections since 2008) contains surface water between the months of October and June. This feature has been found to dry out for extended periods of time between June and October each year, with the exception of significant storm events/extended periods of precipitation within this time span. This should be considered evidence that ground water contribution generally does not occur within Wetland 1 during the summer months. Further evidence to this notion is shown below in Graph 1.

Monitoring Well 3 is a nested well location containing two separate wells (MW-3I and MW3-II) and is constructed just east (upgradient) of Wetland 1. MW-3I is approximately 3.0 metres deep and MW-3II is approximately 6.7 metres deep. This well nest was installed to identify the degree of ground water contribution to Wetland 1.

Graph 1: Wetland 1 / MW-3 Hydrograph (2012 – 2013)



As can be seen in Graph 1, ground water levels between early September and late October 2012 were below the bottom of Wetland 1, which tells us that ground water contribution was not occurring during this period. A major storm event occurred within the last few days of October 2012 which raised both surface and ground water levels above the bottom of the wetland. This interaction is evidence that there is a correlation between surface and ground water levels at Wetland 1, and that ground water contribution is a factor in the maintenance of surface water levels within this wetland feature.

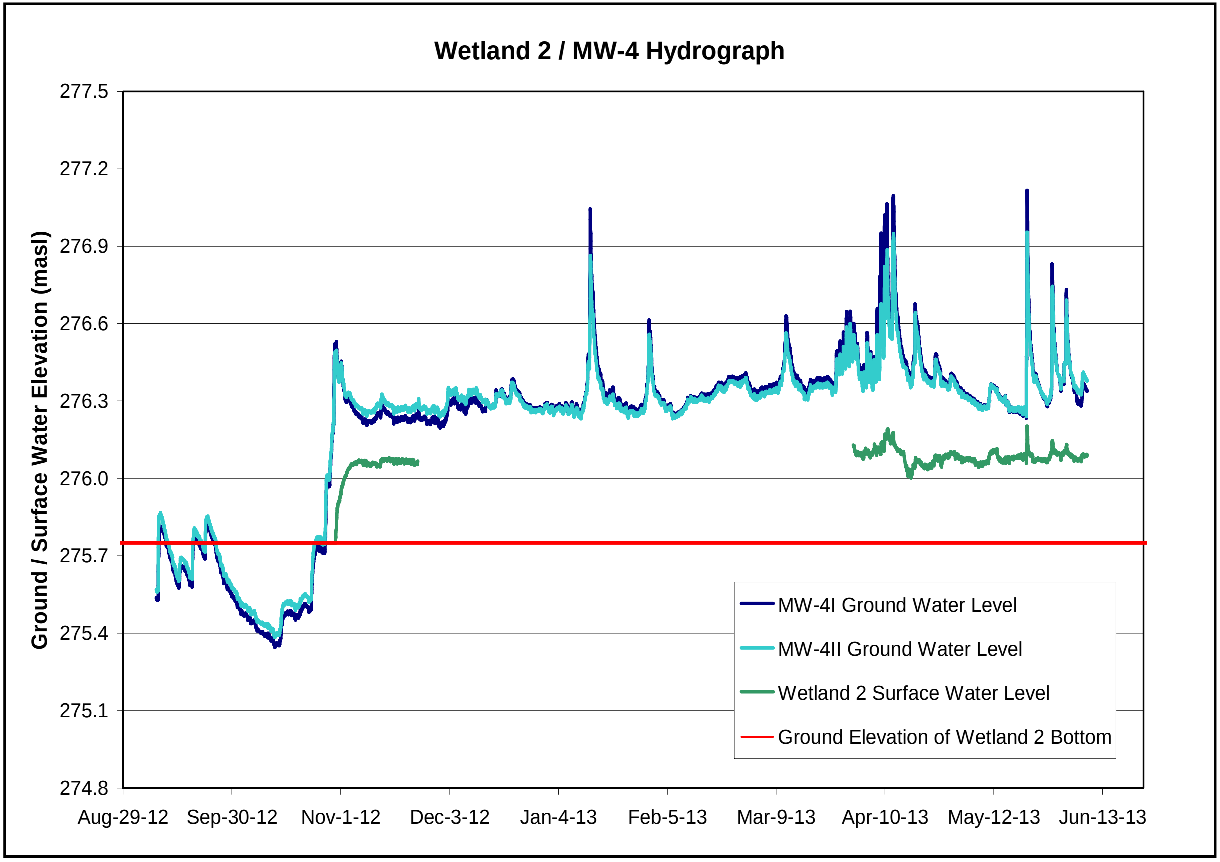
6.2 Wetland 2 / Monitoring Well 4

Wetland 2 is a small, kidney-shaped feature located within the central portion of the subject property, which generally (based on monitoring data from 2008, 2011, 2012 and 2013) contains surface water between the months of October and June. Wetland 2 is hydraulically connected to Wetland 1 during periods of high water conditions, as Wetland 1 drains into Wetland 2 when at capacity. Wetland 2 then drains in an easterly direction via an outlet channel which flows through the adjacent property.

This feature has been found to dry out for extended periods of time between June and October each year, with the exception of significant storm events/extended periods of precipitation within this time span. Historically, significant storm events have been found to restore surface water within the feature for short periods of time until it is evaporated by hot, dry weather and/or infiltrated into the ground water regime. This should be considered evidence that ground water contribution generally does not occur within Wetland 2 during the summer months. Further evidence to this notion is illustrated below in Graph 2.

Monitoring Well 4 is a nested well location containing two separate wells (MW-4I and MW4-II) and is constructed just north (upgradient) of Wetland 2. MW-4I is approximately 3.0 metres deep and MW-4II is approximately 7.6 metres deep. This well nest was installed to identify the degree of ground water contribution to Wetland 2.

Graph 2: Wetland 2 / MW-4 Hydrograph (2012 – 2013)



As can be seen in Graph 2, ground water levels between early September and late October 2012 were generally below the bottom on Wetland 2, which tells us that little to no ground water contribution to this feature was occurring during this period. A major storm event occurred within the last few days of October 2012 which raised both surface and ground water levels above the bottom of the wetland. This interaction is evidence that there is a correlation between surface and ground water levels at Wetland 2, and that ground water contribution is a factor in the maintenance of surface water levels within this wetland feature.

6.3 Wetland 3 / Monitoring Well 5

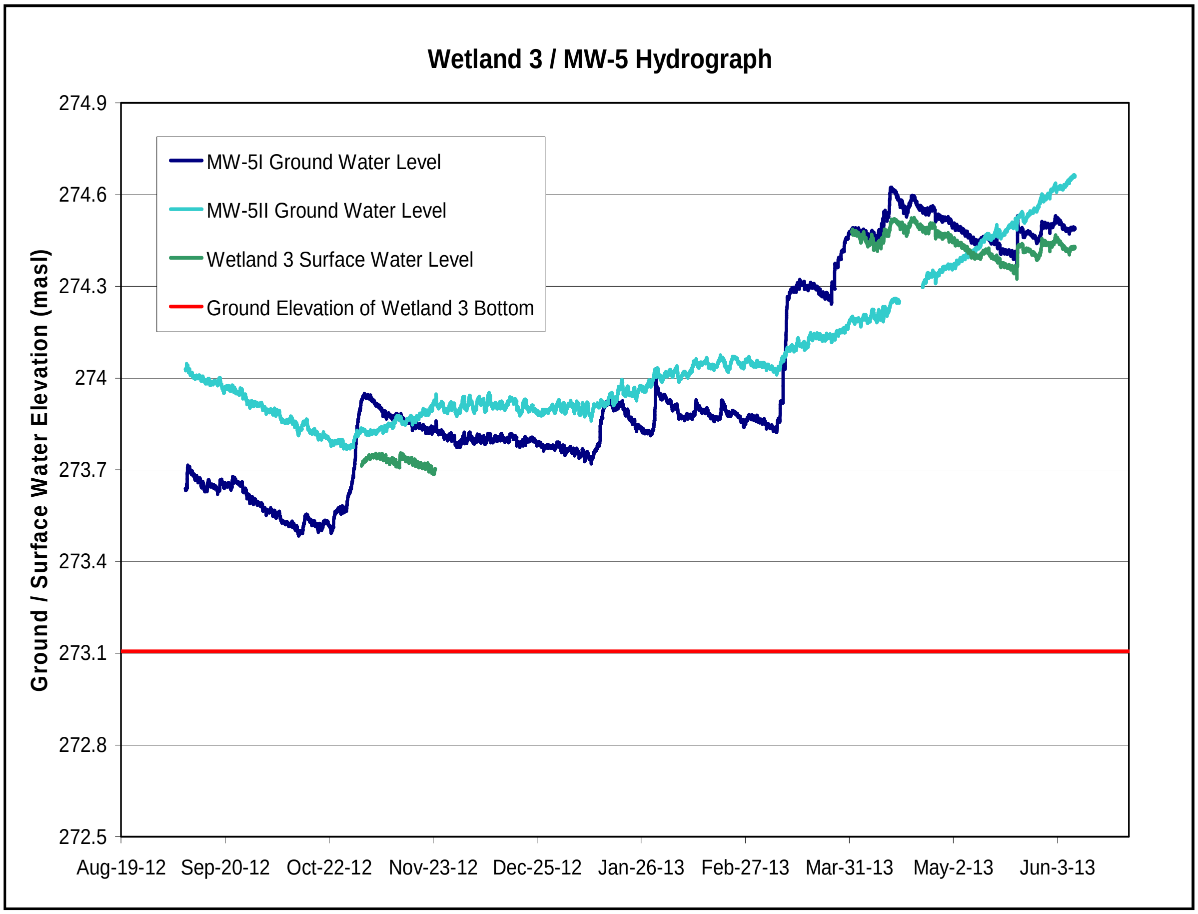
Wetland 3 is a small but deep, circular-shaped feature located within the southern central portion of the subject property, which (based on monitoring data from 2008, 2011, 2012 and 2013 and visual observations in 2015 and 2016) contains surface water throughout the entire year of a wet summer, although completely dries out during a dry summer. This feature has been found to contain water levels up to approximately 2 metres in depth at its deepest point.

Although Wetland 3 has been found to contain surface water longer into the year, the degree of ground water contribution to this feature has been found to be less than other wetlands on-site. This may be due to the site-specific hydrogeological conditions within the vicinity of this feature, which seem to differ from those at the other on-site wetlands.

As can be seen in Graph 3, MW-5I and MW-5II respond differently to precipitation events, which is the opposite to what has been observed in the other nested monitoring well sites. MW-5I (3.9 metres deep) shows distinct responses as the water level rises quickly when infiltration occurs from precipitation. MW-5II (7.6 metres deep) shows a slowly decreasing and increasing water level as the seasons change, and does not show quick responses to precipitation events. These varying trends are evidence that a local confining layer exists within the shallow overburden in the vicinity of Wetland 3 and MW-5 which impedes ground water contribution to the wetland feature. As shown in Graph 3, the Wetland 3 surface water level in April 2013 is either at or above the ground water levels in MW-5I and MW-5II, which shows that ground water contribution is minimal at a time when it should be significant (based on hydrographs for the other four on-site wetlands).

Other evidence that water levels within Wetland 3 are primarily controlled by surface water is the water chemistry data analyzed for this feature. As will be discussed in greater detail within Section 6.0, Wetland 3 water chemistry reflects that of a primary surface water source due to the relatively low major ion levels found.

Graph 3: Wetland 3 / MW-5 Hydrograph (2012 – 2013)



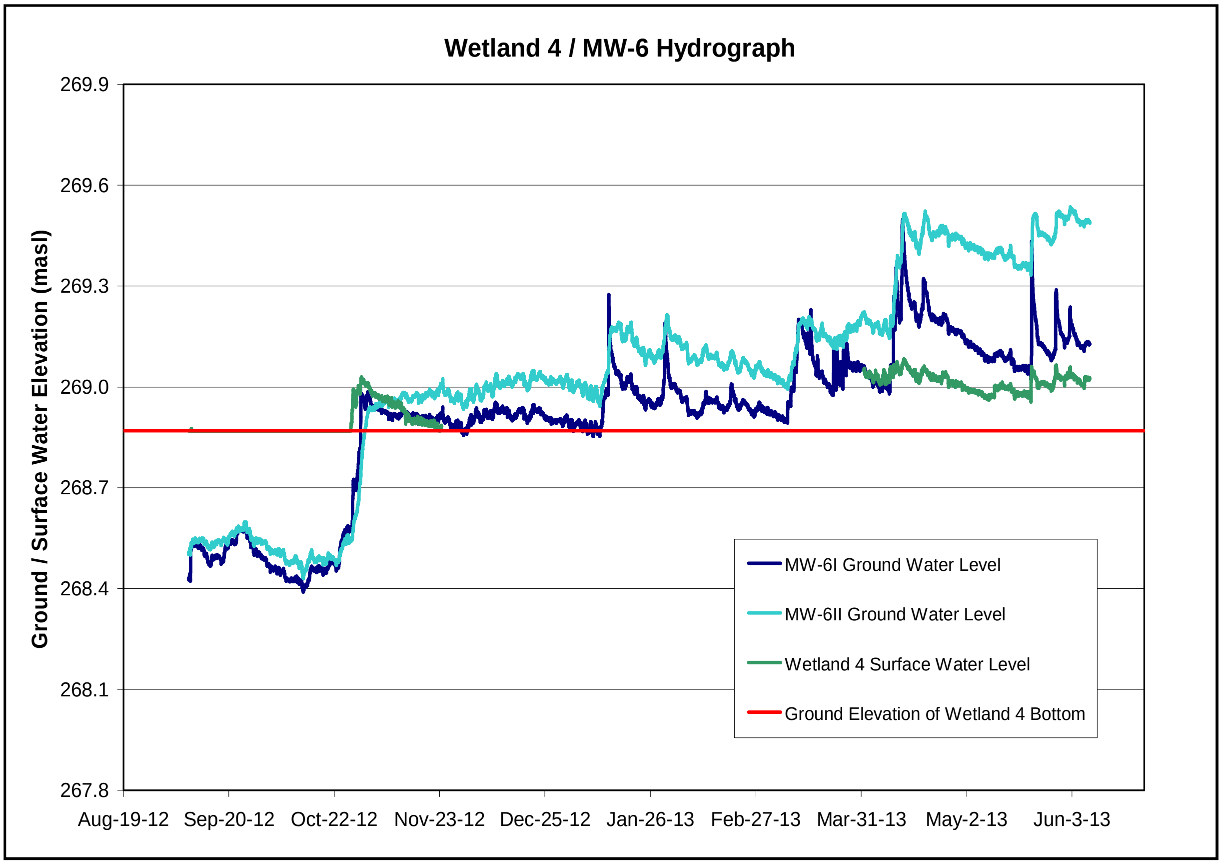
6.4 Wetland 4 / Monitoring Well 6

Wetland 4 is a small and shallow feature located at the southeastern corner of the subject property, and is part of a larger wetland feature primarily located on the adjacent property to the south. Approximately 15-20% of the feature is located on the subject property, with this portion generally drying out much faster than the deeper portion located on the adjacent lands.

On the subject property, Wetland 4 generally (based on monitoring data from 2012 and 2013, along with periodic visual inspections since 2008) contains surface water between the months of October and May. This feature has been found to dry out for extended periods of time between May and October each year, with the exception of significant storm events within this time span. Historically, significant storm events have been found to restore surface water within the feature for short periods of time until it is evaporated by hot, dry weather and/or infiltrated into the ground water regime. This should be considered evidence that ground water contribution generally does not occur within Wetland 2 during the summer months. Even ground water contribution, which is found to occur in the fall and spring, is minimal (as illustrated below in Graph 2).

Monitoring Well 6 is a nested well location containing two separate wells (MW-6I and MW6-II) and is constructed just north (upgradient) of Wetland 4. MW-6I is approximately 3.0 metres deep and MW-6II is approximately 6.1 metres deep. This well nest was installed to identify the degree of ground water contribution to Wetland 4.

Graph 4: Wetland 4 / MW-6 Hydrograph (2012 – 2013)



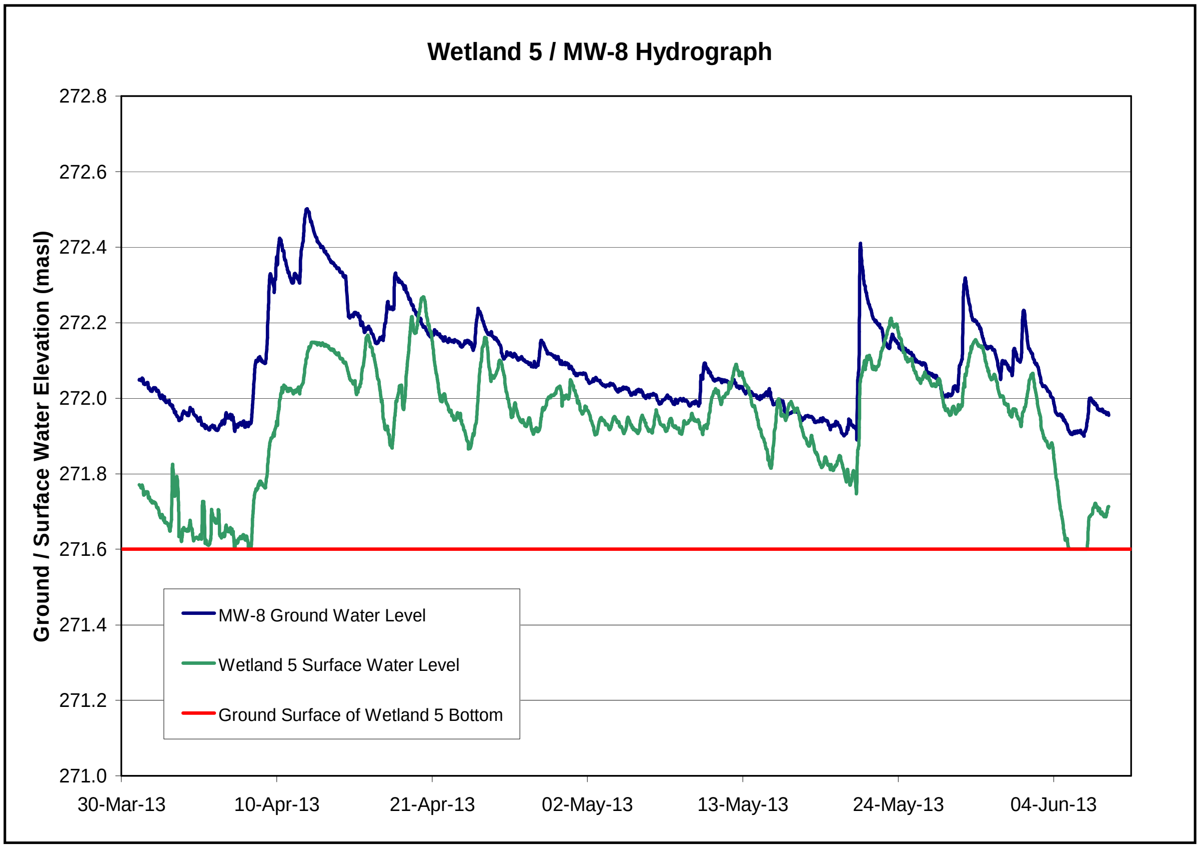
As can be seen in Graph 4, ground water levels between early September and late October 2012 were generally below the bottom on Wetland 2, which tells us that ground water contribution was not occurring during this period. A major storm event occurred within the last few days of October 2012 which raised both surface and ground water levels above the bottom of the wetland. This interaction is evidence that there is a correlation between surface and ground water levels at Wetland 2, and that ground water contribution plays some factor in the maintenance of surface water levels within this wetland feature.

6.5 Wetland 5 / Monitoring Well 8

Wetland 5 is a small, oval-shaped feature located within the southeastern portion of the subject property. Only spring data (2013) has been collected for this feature, although it is known to dry out fairly quickly after spring precipitation ceases each year (based on visual observations since 2008). As can be seen in Graph 5, ground water levels in MW-8 were above surface water levels in Wetland 5 throughout the spring, which is evidence that this feature does receive ground water contributions at some point during the year.

Monitoring Well 8 is a single shallow well (approximately 2.1 metres deep) constructed just north (upgradient) of Wetland 5. This well was installed to identify the degree of ground water contribution to Wetland 5.

Graph 5: Wetland 5 / MW-8 Hydrograph (2013)



6.6 Historical Wetland Water Levels

Further to the graphs shown above, the table below presents historical manual water levels taken seasonally between 2008 and 2013. As can be observed from this data, Wetland 3 is the only feature that did not dry out completely during this monitoring period, although as stated in subsection 6.3, it has dried out during extended drought periods (summers of 2015 and 2016).

Table 2: Manual Wetland Water Level Measurements

	Wetland Water Levels (m)				
Date	**Wetland 1**	**Wetland 2**	**Wetland 3**	**Wetland 4**	**Wetland 5**
11-Jun-08	Not Measured	0.21	0.82	Not Measured	Not Measured
03-Jul-08	Not Measured	0.14	0.75	Not Measured	Not Measured
13-Aug-08	Not Measured	0.19	0.69	Not Measured	Not Measured
15-Sep-08	Not Measured	0.14	0.57	Not Measured	Not Measured
21-Oct-08	Not Measured	Dry	0.55*	Not Measured	Not Measured
26-Mar-09	Not Measured	0.33	1.06	Not Measured	Not Measured
13-Apr-09	Not Measured	0.35	1.14	Not Measured	Not Measured
17-Jun-11	Not Measured	0.29	0.88	Not Measured	Not Measured
04-Nov-11	Not Measured	Dry	0.7	Not Measured	Not Measured
07-Mar-12	0.36	0.36	Not Measured	0.13	Not Measured
21-Mar-12	0.29	0.36	1.15	0.15	Not Measured
09-Apr-12	0.28	0.29	1.15	0.13	Not Measured
18-Apr-12	0.28	0.30	1.05	0.10	Not Measured
03-May-12	0.28	0.35	0.98	0.11	Not Measured
31-May-12	0.06	0.21	0.90	0.00	Not Measured
03-Jul-12	Dry	Dry	0.59	Dry	Not Measured
07-Aug-12	Dry	Dry	0.55*	Dry	Not Measured
07-Sep-12	Dry	Dry	0.55*	Dry	Not Measured
21-Oct-12	Dry	Dry	0.55*	Dry	Not Measured
23-Nov-12	0.24	0.31	0.61	0.01	Not Measured
31-Mar-13	0.29	0.38	1.37	0.18	0.17
15-Apr-13	0.29	0.34	1.40	0.18	0.48
07-May-13	0.28	0.30	1.34	0.14	0.35
08-Jun-13	0.28	0.30	1.31	0.15	0.09
08-Jul-13	0.28	0.31	1.16	0.14	0.04
21-Aug-13	Dry	Dry	0.35	Dry	Dry

*Wetland dry at stilling well but measurement is approximate at the deepest part of the feature.

7.0 WATER QUALITY ANALYSIS

On April 21, 2013 Azimuth staff collected surface (5) and ground water (2) samples from the subject property for water quality analysis. Ground water samples were taken from MW-3I and MW-5II, which provided samples from shallow (MW-3I) and deep (MW-5II) well locations.

Surface water samples were taken from the five on-site wetlands included in this investigation (Wetlands 1 – 5). All samples were obtained in adherence with accepted industry protocols and analyzed for a wide array of inorganic, metals, and nutrient parameters. The samples from the on-site monitoring wells were also analyzed for microbiological parameters.

All samples were couriered to AGAT Laboratories in Mississauga, Ontario, the morning after the samples were taken from the subject site. Surface water results were compared to the Provincial Water Quality Objectives (PWQO) and ground water samples were compared to the Ontario Drinking Water Quality Standards (ODWQS). Analytical results including PWQO and ODWQS exceedences are outlined below in subsections 6.1 and 6.2. Complete water quality results can be found in Appendix D.

7.1 Surface Water Quality

Surface water quality results for the five on-site wetlands were fairly consistent, with the exception of Wetland 3. As can be seen in Table 2, major ion parameters for Wetland 3 exhibited consistently lower levels than Wetlands 1, 2, 4 and 5.

Table 3: Major Ion Chemistry Results For Wetlands

Wetland I.D.	Bicarbonate (mg/L)	Sulphate (mg/L)	Calcium (mg/L)	Silica (mg/L)	Sodium (mg/L)
Wetland 1	343	6.60	138	11.7	31.8
Wetland 2	271	5.86	105	5.73	11.4
Wetland 3	**93**	**0.88**	**36.9**	**0.51**	**0.81**
Wetland 4	265	11.3	113	5.29	2.21
Wetland 5	242	2.04	93.4	9.94	1.47

These low levels in Wetland 3 reflect that of a primary surface water source. Ground water chemistry results for MW-3I and MW-5II are much different than those reported for Wetland 3, but are similar to the Wetland 1, 2, 4 and 5 results. This also provides evidence that Wetland 3 does not receive significant ground water contribution from the local regime.

The surface water chemistry results were compared to the PWQO. Parameters which exceeded the PWQO guideline/standard included Total Phosphorus (Wetland 1 and

Wetland 5), Iron (Wetland 4) and Zinc (Wetland 4). These exceedences are presented below in Table 3.

Table 4: PWQO Surface Water Exceedences

Parameter	**PWQO Objective**	**Exceedences**		
		Units	**Concentration**	**Location**
Total Phosphorus	0.03	mg/L	**0.05 – 0.06**	Wetlands 1 & 5
Iron	0.3	mg/L	**0.682**	Wetland 4
Zinc	0.03	mg/L	**0.034**	Wetland 4

7.2 Parameters Which Exceeded PWQO

7.2.1 Total Phosphorus

Total Phosphorus is an essential nutrient for plants and animals. It is naturally limited in most fresh water systems because it is not as abundant as carbon and nitrogen. Primary sources of phosphorus include soil and rocks, runoff from fertilized lawns and cropland, runoff from animal manure storage areas and decomposition of organic matter.

The exceedences of Total Phosphorus levels found in Wetland 1 and Wetland 5 can be explained primarily by the high amount of vegetation found within each wetland. Wetland 1 is heavily treed causing the decomposition of leaf matter to occur within the wetland basin. Wetland 5 is heavily vegetated with cattails throughout the wetland basin, which decompose on an annual basis. Both exceedences should be considered negligible.

7.2.2 Iron

Iron is the fourth most abundant element in the earth's crust and the most abundant heavy metal. The presence of iron in natural waters can be attributed to the weathering of rocks and minerals, landfill leachates, sewage effluents and iron-related industries.

The exceedence found in Wetland 4 can be attributed to natural sources (geological).

7.2.3 Zinc

Zinc is an element commonly found in the Earth's crust, which is released to the environment from both natural and anthropogenic sources; however, releases from anthropogenic sources are greater than those from natural sources. Common smale-scale anthropogenic sources of Zinc are primarily from commercial products such as fertilizers, fungicides, insecticides and wood preservative products which contain the element.

The negligible exceedence of Zinc found in Wetland 4 can be attributed to natural sources (geological), or from agricultural runoff from surrounding lands which may have been applied with fungicides/insecticides.

7.3 Ground Water Quality

The two ground water sampling locations (MW-3I and MW-5II) exhibited very similar concentrations of water quality parameters, which is expected due to the wells extending into the same upper aquifer, although at different depths. A summary of the exceedences of the ODWQS guidelines/standards are presented below in Table 4.

Table 5: Summary of ODWQS Exceedences

Parameter	**ODWQS Objective**	**Exceedences**		
		Units	**Concentration**	**Location**
Nitrate	10	mg/L	**14.2 – 15.4**	MW-3I & MW5II
Hardness (as calcium carbonate)	80 - 100	mg/L	**326 - 358**	MW-3I & MW5II
Manganese	0.05	mg/L	**0.084**	MW-5II

7.4 Parameters Which Exceeded ODWQS

7.4.1 Nitrate

Nitrate is present in water (particularly ground water) due to contamination by decaying plant or animal material, agricultural fertilizers, domestic sewage, or geological formations containing soluble nitrogen compounds. Nitrate poisoning, in terms of methaemoglobinaemia, from drinking water appears to be restricted to susceptible infants. Older children and adults drinking the same water are unaffected. Most water-related cases of have been associated with the use of water containing more than 10 mg/L nitrate. Although this guideline is based principally on effects in the most sensitive subgroup (i.e., infants), it would be prudent to minimize exposure of the entire population, owing to the weak evidence of an association between gastric cancer and high levels of nitrate in drinking water. This statement was prompted following a review of recent information on nitrate by the Federal-Provincial Subcommittee on Drinking Water.

Based on this information, the upper aquifer below the subject property would not be a suitable drinking water source due to the exceedence of the 10 mg/L Nitrate guideline/standard.

7.4.2 Hardness

Hard water can reduce the effectiveness of laundry soaps, cause scaling deposits when the water is heated (i.e., kettles / hot water heaters) and in extreme conditions restrict or clog water lines because of scaling. Hardness in excess of 500 mg/L is unacceptable for most domestic purposes. For example, the ODWQS (2003) notes that soft water (< 80 mg/L) may result in accelerated corrosion of water pipes.

The ground water in the upper aquifer below the subject property can be considered “hard”, and would require treatment (water softener) to soften the water prior to domestic use.

7.4.3 Manganese

Manganese is objectionable in water supplies because it stains laundry, and at excessive concentrations causes undesirable tastes in beverages. Manganese may also encourage the build up of a slimy coating in piping, which can slough off as black precipitate.

The Manganese exceedence found in MW-5II is not necessarily large enough to create issues with a domestic water distribution system. No exceedence was found in the MW-3I sample, which is evidence that Manganese levels vary across the subject property and should not be considered a significant ODWQS exceedence.

8.0 WATER BALANCE (ENTIRE SITE)

The proposed development plan consists of eight large estate lots with an average area of approximately 0.57 hectares (1.4 acres). The lots have been placed around the existing natural features which require a 30 metre buffer from all development lands. For the purposes of water budget calculations, the estate dwellings are assumed to have an average rooftop area of 350 m^2, and associated driveways of between approximately 25 – 150 metres in length. A road is also proposed for the estate housing development which will join Old Church Road and cul-de-sac within the central portion of the property. The lots will be serviced by municipal water and individual private septic systems, and stormwater runoff will be managed by a bioretention area constructed adjacent to Old Church Road which will be designed to infiltrate stormwater and outlet to the existing municipal ditching system when necessary.

In order to determine the potential changes to the natural ground water recharge conditions, a pre- and post-development water balance assessment has been completed using the Thornthwaite and Mather method (1957). This method evaluates evapotranspiration based on precipitation and temperature. Residual soil saturation is a function of topography and soil type. Monthly data are tabulated from daily average temperature and precipitation, and the water budget is a continuous calculation over the period of record. To clarify, the method and the approach used by many individuals in examining infiltration resets annual conditions (moisture deficit, snow storage, etc) over the winter months because of the general lack of infiltration during the frost period. However, we maintain those records and carry them forward from month to month during the entire period of record.

Values were determined on a monthly basis, compiled from daily Environment Canada meteorological data station located in Orangeville between 1969 – 2015. The calculations are based on the average conditions during this period; the average precipitation was 898 mm, rainfall was 676 mm, evapotranspiration was 503 mm and the surplus was 395 mm. Each parameter falls within a broad range that represents approximately 100% of the lowest values. For example, the observed precipitation falls between 682 and 1,227 mm.

Considering the surficial geology within the property is primarily silty in nature, the majority of the site being cultivated land and the ‘hilly’ nature of the topography, it was determined that approximately 40% of the water surplus will infiltrate (based on Table 2 – MOEE Hydrogeological Technical Information Requirements For Land Development Applications (1995)). By multiplying the annual average surplus amount (395 mm) by the soil infiltration rate (40%), infiltration is estimated to be approximately 158 mm/year for the subject site. Post-development infiltration rates will be affected by the presence of impervious surfaces (i.e., roads, dwelling rooftops), which based on the proposed development plan will comprise approximately 10% of the development property.

The table below provides a breakdown of pervious and impervious surfaces for the proposed development:

Table 6: Pervious/Impervious Surfaces Summary

Land Use	Area (m^2)
Total On-site Infiltration Area (excluding wetlands)	106,000
Roads	4,000 (3.8%)
Driveways (approx.)	3,500 (3.3%)
Rooftops	2,800 (2.6%)
Other (pervious areas)	95,700

It is assumed that rainfall from the proposed dwelling rooftops will be directed to grassy side/back yards to promote ground water infiltration. This is a safe assumption based on the large size of the estate lots to provide appropriate length of flow path (>5 metres based on CVC guidelines) to promote ground water infiltration, especially in rear yards. In the event that some downspouts are directed to driveways, the anticipated loss of infiltration is not significant as runoff from the driveways of Lots 4 – 8 will be directed to the proposed bioretention area (infiltration feature). Lot slopes are also sufficient to promote infiltration conditions.

Using the climate model data mentioned above, the following pre and post-development infiltration values have been determined:

Table 7: Water Balance Summary

Parameter	**Pre-Development**	**Post-Development-(No Mitigation)**	**Post-Development-(With Mitigation)**
Average Annual Rainfall	676 mm	610 mm	610 mm
Average Annual Surplus	319 mm	319 mm	319 mm
Infiltration Factor	0.4	0.4	0.4
Runoff Factor	0.6	0.6	0.6
Site Area of Potential Infiltration	106,000 m^2	95,700 m^2	95,700 m^2
Annual Infiltration – No Mitigation	16,750 m^3	15,120 m^3	--
Infiltration Gain From Rooftop Mitigation	--	--	475 m^3
Infiltration Gain From Bioretention Area	--	--	2,990 m^3
Annual Infiltration – With Mitigation	--	--	18,585 m^3
Infiltration Change	0% 0 mm/m^2	**-10%** **-11 mm/m^2**	**+11%** **+17 mm/m^2**
Pre/Post-Development Infiltration	158 mm/year	142 mm/year	175 mm/year

Upon completion of the site development, it is estimated that there will be a slight gain (~11%) in ground water infiltration between the pre-development and post-development conditions. This is assuming the site will be comprised of approximately 10% impervious surfaces (e.g., rooftops, driveways and roads), and mitigative controls are employed (described below). These controls will increase the ground water infiltration potential, some of which would otherwise be lost due to the presence of imperious surfaces as part of the proposed development. As pre- and post-development infiltration conditions are not expected to change significantly, runoff/infiltration coefficients are also not expected to experience a significant change.

Recovery of infiltration from rooftop drainage directed to back and side yards is determined from 8 (total rooftops) x 350 (average m^2 rooftop area) x 676 (mm rainfall) x 25% (runoff reduction factor) x 100% (infiltration factor) = ~475 m^3/year.

With the addition of 475 m^3/year of ground water infiltration from rooftop downspouts, there would still be an overall net infiltration loss of approximately 1,155 m^3/year. In this scenario, further mitigative measures would be required to create a balance of pre- and post-development infiltration conditions. The proposed bioretention facility would have the capacity to infiltrate enough stormwater runoff to create a gain in post-development infiltration, with the addition of approximately 2,990 m^3/year. This value was determined from 13,900 (m^2 area of sub-catchment) x 5 (mm minimum storm event to create runoff to facility) x 43 (average annual amount of >5mm storms based on climate data analysis) = ~2,990 m^3/year.

The above calculations do not include the water contribution from septic systems which would be incorporated in the development to service each dwelling. This amount is estimated to be the product of the average annual flow for each system (365 m^3/year), multiplied by the number of septic systems to be constructed on the site (8) = 2,920 m^3. Although TRCA does not accept septic input values in water balance calculations, this value has been included merely to show that a loss of ground water infiltration will not be experienced at the site post-development.

Although the development site is not considered a significant recharge area, pre-development ground water infiltration conditions can be effectively balanced by the rooftop mitigation and proposed bioretention area. As a result, it is not anticipated that the development will have any negative impact on ground/surface water contribution to on-site/adjacent wetland features.

9.0 FEATURES-BASED WATER BALANCES

In order to determine the potential changes to runoff and the natural ground water recharge conditions, a pre- and post- development feature-based water balance assessment has been completed. The feature-based water balance is based on similar methodology as the Thornthwaite and Mather method (1957), but uses daily climate records to determine weekly surplus characteristics. Daily data are tabulated from daily average temperature and precipitation to calculate weekly statistics. The water budget is a continuous calculation over the period of record. To clarify, we maintain those records and carry them forward from month to month during the entire period of record.

Values were determined on a weekly basis, compiled from daily Environment Canada meteorological data station located in Orangeville between 1983 - 2015. This period was selected as it is the period when daily records are available. Weekly data were determined for infiltration, runoff and runoff to the stormwater management controls for both the pre- and post-development scenarios for each catchment. This reflects an array of 5x52x34 for each catchment plus 3x52x34 for surplus, runoff and infiltration for each soil type. To make data presentation more straightforward, we have generated summary tables for each catchment that consider the weekly data on a seasonal basis. Winter is considered to include December of the preceding year plus January and February. Spring is considered to include March, April and May. Summer includes June, July and August and Fall includes September, October and November.

Post-development infiltration rates will be affected by the presence of impervious surfaces (e.g., rooftops, driveways and roads), which, based on the proposed development plan will comprise approximately 3 - 5% of the individual catchments. It is assumed that loss of infiltration from the rooftops will be partially mitigated by directing rooftop leaders to grassed areas (i.e. side yards, backyards). It is conservatively assumed that discharging rooftop run-off to grassed areas will capture 60% of the potential infiltration loss, due to the limited infiltration capacity of the soil. The estimate of additional infiltration is based on the increase in infiltration under wetter conditions, since the re-direction of rooftop leaders increases the effective precipitation rates for the yards. It is noted that the development footprint in each of the individual catchments is a small percentage of the catchment area so that only small changes are expected.

Using the climate model data mentioned above, the following pre and post-development water balance values have been determined for the subwatershed catchments that supply local runoff to Wetlands 1, 2, and 3. Calculations were not completed for wetlands 4 and 5 since there is no development (i.e. construction, grading, etc.) within those catchments.

The ground water monitoring indicates that Wetland 1 infiltrates in summer, and receives ground water discharge in winter. Since there is no overland flow from this catchment, runoff from the local catchment plus winter ground water discharge must be balanced with seasonal infiltration or evapotranspiration/evaporation from the wetland area.

Wetland 2 acts the same as Wetland 1 with infiltration in the summer and ground water discharge in the winter. However it has an outlet to the south and runoff can migrate from the site.

Wetland 3 is slightly different as the ground water level monitoring shows the effect of a shallow confining layer, which means that the active flow system is constrained to the shallow soils. Wetland 3 also provides infiltration in summer and receives discharge in winter, but the discharge effect occurs for longer period of time due to the confining layer.

The purpose of the calculations is to estimate the potential changes that might be experienced by each of the wetlands on a local scale. In the tables below, the runoff values are overland flow directed into each wetland feature. The infiltration values are infiltration that occurs within the catchment but outside of the wetland footprint. All of the values do not include water from the wetland that is either shallow ground water that has discharged (increases water to the wetland) nor the water from the wetland that re-infiltrates into the ground water regime each summer (dries out the wetland).

Tables A to C (presented in Appendix E) are the summary tables for Wetlands 1, 2 and 3. The tables show that there is an annual reduction in overland runoff to the wetlands by approximately 0 - 3%, equal to 96 to 276 m^3/year. Of interest, the wetlands will continue to dry out each summer and the hydroperiod will not change in a quantifiable fashion. The analysis indicates that the summer drought is 12 to 24 weeks in length for both the pre-development and post-development conditions. Infiltration (without mitigation) is also reduced by a small factor (0 – 1.7%). Mitigation by directing rooftop runoff to grassed areas and the use of infiltration galleries to supplement stormwater controls will offset the calculated losses so that no change in ground water levels are predicted.

The calculations assume post-development runoff from roadway and driveways are re-directed to the stormwater pond . These runoff values are included as a separate line item in the feature-based water balances and represent a net loss to the individual catchment, but a net increase in the runoff from the site.

10.0 ASSESSMENT OF ENVIRONMENTAL IMPACTS

To comply with Section 7.1.18.5 of the Palgrave Secondary Plan, an assessment of potential nitrate impacts to local domestic and communal ground water supplies was completed.

Potential impacts to both the local ground water regime are dependent upon the local hydrogeology / hydrology and the contaminant concentrations contained within the effluent (i.e., nitrate). For ground water purposes, the assessment has been examined within the scope of the MOECC Reasonable Use Policy (RUP).

10.1 Nitrate Modeling

The MOECC RUP describes acceptable levels of parameters (i.e., nitrate) that are permitted to reach the downgradient property boundary in the ground water regime. The policy forms the basis for natural attenuation site designs since it defines a minimum dilution or attenuation that should be observed at a given facility. The dilution calculation under RUP is based on an assessment of source concentrations, identification of key parameters, water budget assessment, and comparison to the Ontario Drinking Water Quality Standards (ODWQS).

In general, the Reasonable Use Policy is only applicable to large sewage works (i.e., individual septic systems that generate in excess of 10,000 Lpd). The sewage volumes for each lot are significantly less than 10,000 Lpd, and subsequently regulated under OBC (1997 and updates). Thus RUP does not apply under the proposed development concepts (i.e., individual private servicing) but can be used as a guide to determine the number of lots that could potentially be developed within the lot fabric and/ or determine concentrations levels at the downgradient property boundary to evaluate any undesirable environment impacts from the individual sewage systems.

Historical use of the RUP concept in municipal planning has accepted the maximum compliance criteria for nitrate at the downgradient property boundary as 10 mg/L (ODWQS for nitrate) for individual residential lot development.

The proposed individual treatment systems will discharge the effluent to a standard Class IV leaching bed system located on the individual lots. For the purposes of this assessment, a value of 10 mg/L will be used as the maximum RUP compliance criteria (as discussed above). Reasonable Use Policy considers dilution only, and therefore it is highly conservative.

10.1.1 Water Budget

As previously determined in Section 6.0 of this report, the average annual water surplus is 395 mm representing the amount of water available annually to infiltrate into the ground water or run off as surface water. During this period, the average annual precipitation was 898 mm, the average annual rainfall was 676 mm, and the average annual evapotranspiration was 503 mm.

The majority of the recharge area is medium to fine-grained, which has a moderate to low infiltration rate of about 40% of surplus. Pre-development infiltration rates on the site were estimated as being low (0.4*395 mm/a = 158 mm/a). The RUP approach was updated by the MOECC in 2008; the new methodology uses a standard infiltration rate of 250 mm/a over the lot and area of the septic plume. Thus the older methodology for calculating contamination attenuation is conservative.

The water budget also provides information regarding the potential impacts on water quantity that could potentially arise from the new household wells. As an initial estimate, the infiltration within the property is approximately 40,000 m^3 and average annual use is estimated to be 5,475 m^3 or 13.7% of the infiltration. However, this is further mitigated since the majority of the well water is returned to the ground water regime through the septic beds so that the withdrawal represents approximately 3% of the annual infiltration. The assessment could be evaluated further in considering that the septic beds return water to the shallow system and the wells would draw water from the intermediate or deeper systems. In addition, the analysis should reflect lateral inflow into the aquifer, which will minimize the extent of the taking. Overall, residential wells in this setting are not the subject of high enough yield to create interference in most aquifer units, and the issue does not require further analysis.

For the use of ground water wells to provide residential supply, the drawdown from an individual well is primarily constrained within the property boundary (i.e. less than 50 metres (based on the Theis equation) and is insufficient to cause a discernible change to water levels, providing the water supply is drawn from an aquifer that has sufficient yield to sustain the development on the whole. Proof of aquifer sustainability and water well yield for individual wells is typically a municipal condition of approval. This assessment provides a “top-down” evaluation that demonstrates the regional suitability of the aquifer to act as a water supply.

The site is located within the Oak Ridges Moraine, and the local geology is conducive to more than adequate residential well supplies, particularly for large estate residential lots. The Oak Ridges Moraine consists of four main aquifer units, that can be capable of supplying 500-1,500 IGPM; for comparison an adequate residential well requires 3-5 IGPM. We recommend that residential wells target an aquifer unit that is not part of the surficial Oak Ridges Aquifer Complex (ORAC) as this unit is shallow and at surface, and is thus subject to potential contamination from shallow sources (e.g. septic beds) and may be affected by seasonal climatic variation in the water table (up to 1.5m variation seasonally). This is typically the case as water well records from locations near the subject property have average depths of 50 metres or greater.

It should be noted that the adjacent municipal watermain is the primary potable water option for the development, and should be suitable to provide the required volume to the residents. Individual wells were discussed (above) as an alternative potable drinking water source if the municipal watermain is not a suitable option. This discussion demonstrates that well water potentially drawn from the deep underlying aquifer would not affect the pre-development and post-development ground water infiltration volumes.

10.2 Nitrate Dilution - Entire Subject Property

For the purposes of this evaluation, a RUP assessment was completed for the smallest proposed lot size (i.e., approx. 0.45ha) and for the entire development area using 60% of the subject property (i.e., 60% of 11ha).

The nitrate concentration at the property boundary for the entire parcel of land can be estimated using the RUP nitrate dilution equation (below). The dilution calculation considers the land between each residential lot and the downgradient property boundary. For the purposes of this assessment, 60% of the entire parcel was used for the nitrate dilution calculation, which is considered conservative.

Assumptions utilized in the RUP evaluation for the entire development are as follows:

- The area contributing to ground water flow (downgradient) was estimated to be about 66,000 m^2 (6.6 ha),
- Background nitrate level of < 0.2 mg/L,
- Septic effluent nitrate concentration of 40 mg/L (regular septic systems),
- Average design flow 8,000 Lpd (average flow for 8 estate lots),
- Nitrate concentration at downgradient settlement area boundary (mg/L) is 10 mg/L.

The RUP calculation is outlined below:

$$C_{rup} = \frac{Q_1 C_1 + Q_2 C_2}{Q_T}$$

, where,

Q1 = (contribution from 60% of property) = total area (m2) x infiltration (m/a) (10,000 m2 *0.159 m/a infiltration =10,494 m^3/a),

C1 = (background nitrate concentration) ~ 0.2 mg/L,

Q2 = (contribution from the leaching beds) =8 dwellings * 8,000 Lpd = 8,000 Lpd (2,929 m3/a),

C2 = (septic effluent nitrate concentration) = 40 mg/L (conservative for tertiary treatment),

QT = (total offsite discharge) = Q1+Q2,

CRUP = nitrate concentration at downgradient property boundary (mg/L) = 10 mg/L

Using the above assumptions, the predicted concentration in the shallow ground water system at the downgradient property boundary is ~6.0 mg/L, which meets the MOECC reasonable use policy. A summary of the RUP calculations are provide in Appendix F. The net loading for the entire property boundary does not exceed 10 mg/L, thus we conclude that the guideline is met under this development scenario. However, the results of the RUP assessment are considered to be conservative for this property since they would not typically be advocated for small sewage systems.

10.3 Nitrate Dilution– Individual Lots

The nitrate dilution calculation was also completed for the smallest proposed lot(s) (0.45 ha) for this development to estimate the nitrate concentration as the property boundary.

Under the new MOECC methodology (MOECC, 2008), the predicted concentration in the shallow ground water system at the downgradient property boundary is ~9.8 mg/L which is slightly below the RUP criteria for small systems.

The results of the RUP assessment are considered to be conservative since they would not typically be advocated for small sewage systems. RUP does not consider biodegradation or denitrification in the subsurface and does not allow for plant uptake within the lot fabric or within the remaining lands downgradient of the property. The calculation considers dilution only and inherently assumes that the units are directly connected in a hydraulic sense. Thus, the RUP is conservative in terms of the overall site conditions and should only be used as a guideline.

As indicated previously, Reasonable Use is a provincial policy that is used by the MOECC to evaluate point source contaminant sources; it was not intended to be used to evaluate potential impacts from small septic system but was subsequently modified to provide a rapid evaluation methodology. The results of the RUP evaluation support the proposed 8-lot development such that off site impacts are expected to be negligible in nature. All RUP calculations are presented in Appendix F.

11.0 SUMMARY AND CONCLUSIONS

To comply with the requirements of the ORMCP and Palgrave Secondary Plan, this hydrogeologic assessment has been prepared to determine and describe the hydrogeologic and hydrologic functions of sensitive features. The evaluation focused on the nature of the interaction between the ground water system and the surface water system. The evaluation examined the effect of the proposed development and site alteration on the ground and surface water regimes through the completion of pre and post water balance assessments and RUP evaluation.

Data compiled during the long-term monitoring program provides sufficient evidence that impacts to surface/ground water quality and quantity will be minimal following construction of the proposed estate subdivision. Therefore no changes to the current proposed plan are recommended (i.e. lot density).

It is concluded that the present hydrologic and hydrogeologic conditions upon the subject property will not experience a significant change due to do the proposed development. By incorporating the criteria as described throughout this report, pre-development infiltration will experience an approximate gain of 11%. This gain in infiltration will have no negative impact on the local ground water regime and associated natural features.

The proposed development adheres to the requirements of the ORMCP. No negative post-construction impacts are predicted to occur to the quality / quantity of surface and ground water, ground water recharge, or natural sensitive features.

12.0 REFERENCES

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Table 8.2.1.3.A. Residential Occupancy

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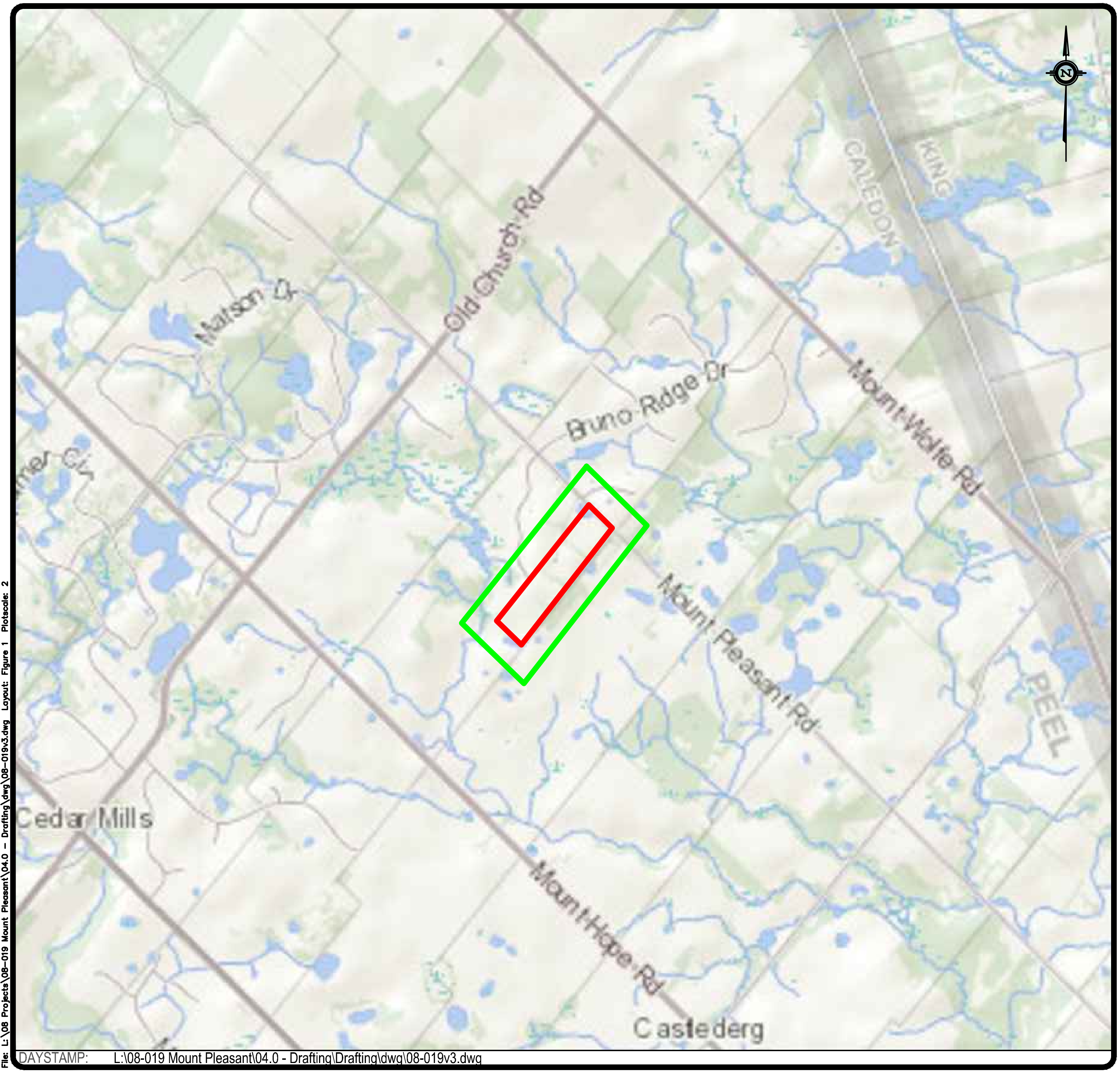
APPENDICES

Appendix A: Figures
Appendix B: On-site Investigation Borehole Logs
Appendix C: MOECC Water Well Records
Appendix D: Water Quality Laboratory Results
Appendix E: Features-Based Water Balance Summary Tables
Appendix F: Reasonable Use Policy Calculations

APPENDIX A

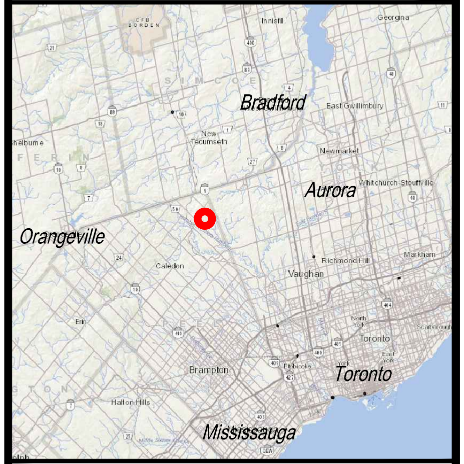
Figures



LEGEND:

🟥 Approx. Property Boundary

🟩 Approx. Study Area



REG MAP

250m 0 750m

HORIZONTAL SCALE 1:25,000

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Study Area Location

Pt. Lot 19, Concession 8,
Town of Caledon, ON

DATE ISSUED: February 2017
CREATED BY: JLM
PROJECT NO.: 08-019
REFERENCE: MNRF

Figure No. 1

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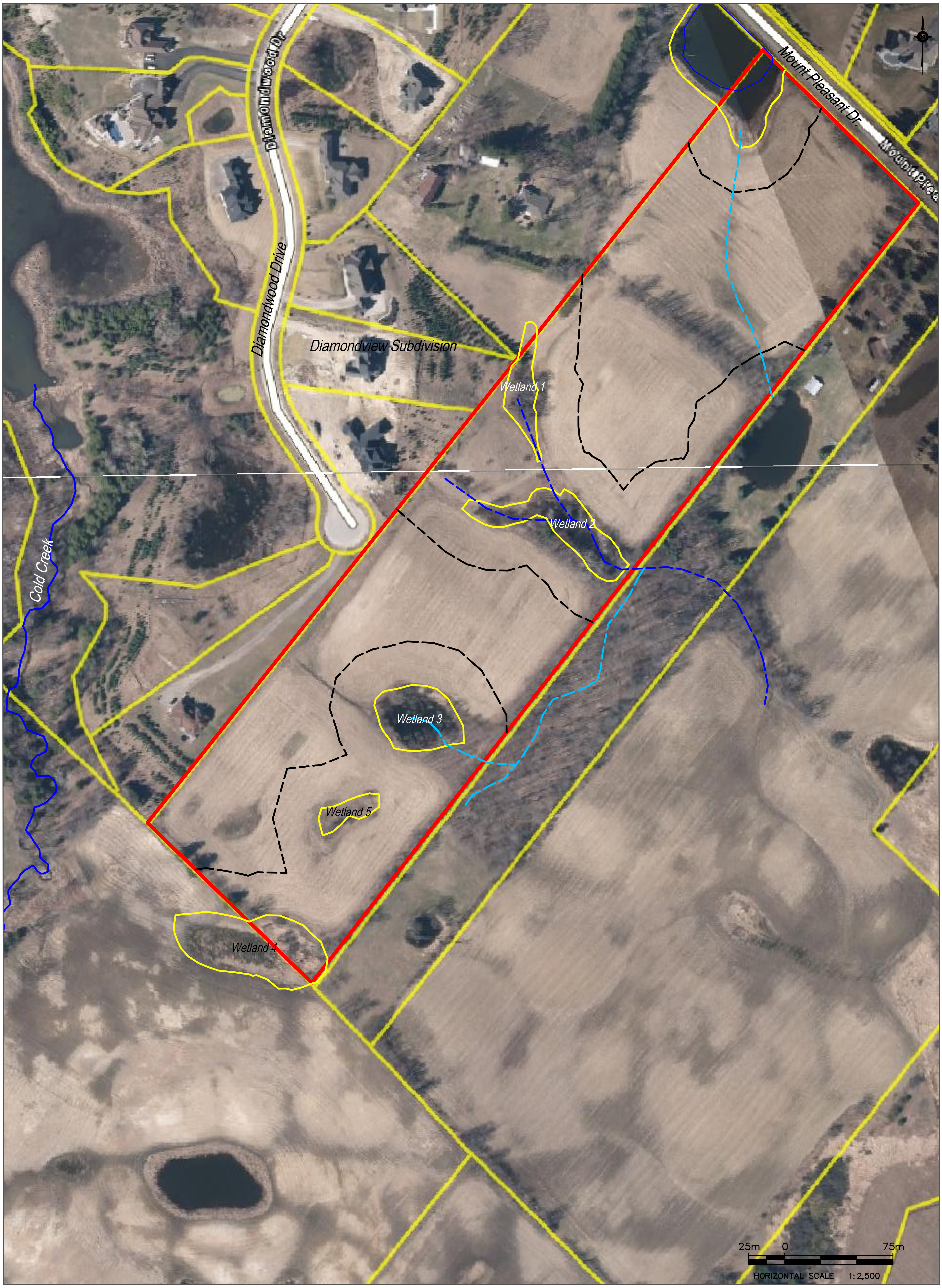

LEGEND:

▬	*Approx. Property Boundary*
▬	*Permanent Stream*
╌	*Intermittent Stream*
╌	*Drainage Feature*
╌	*30m Minimum Vegetation Protection Zone*
▬	*Wetlands*

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Environmental Protection
Components: Wetland

Pt. Lot 19, Con. 8
Town of Caledon

Date Issued:	March 2017	Figure No.
Created By:	JLM	2
Project No.	08-019	
Reference:	First Base Solutions	

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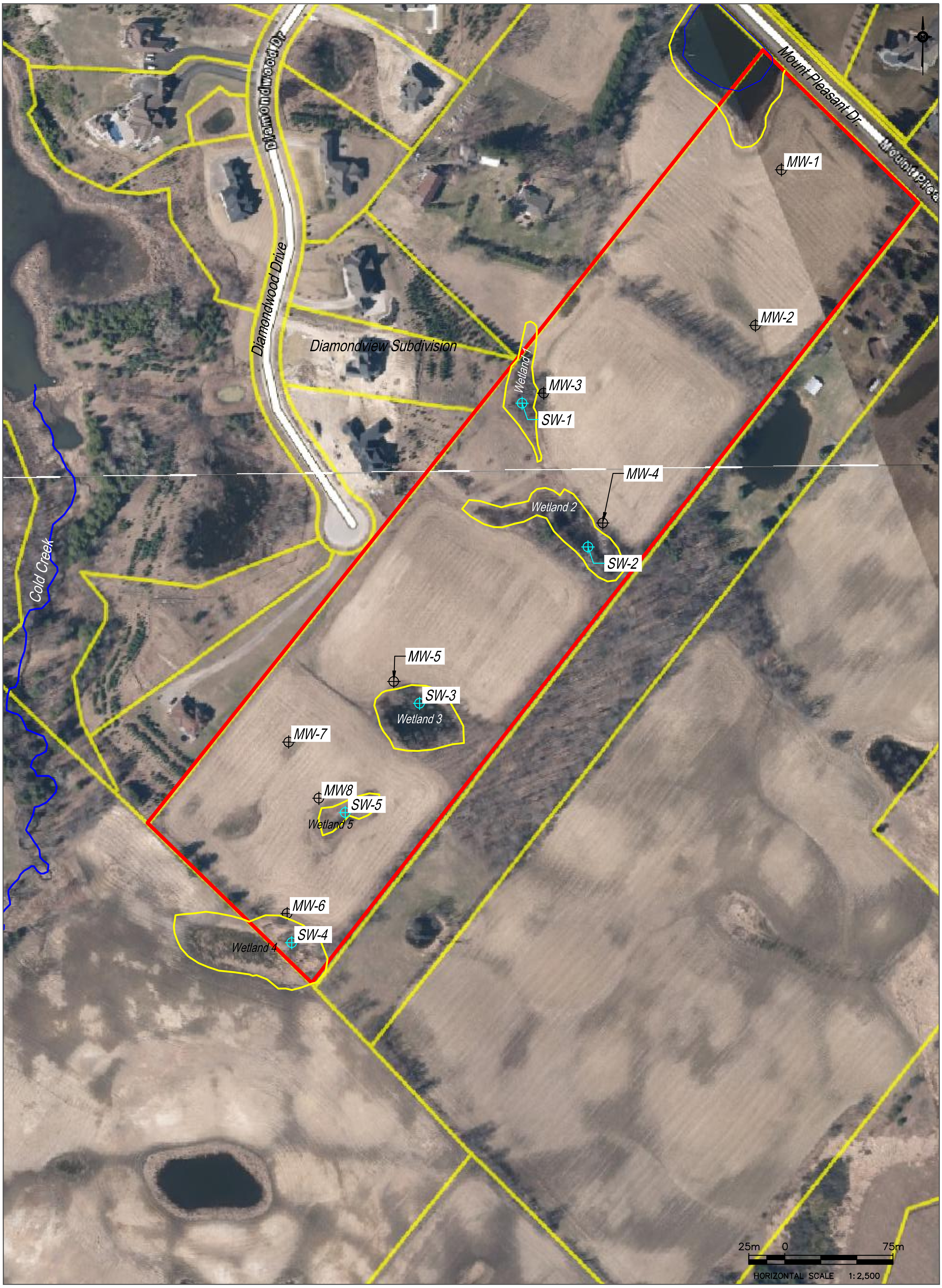

LEGEND:

—	Approx. Property Boundary
—	Permanent Stream
—	Wetlands
⊕	Monitoring Well Locations
⊕	Stilling Well Locations

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Monitoring Locations

Pt. Lot 19, Con. 8
Town of Caledon

Date Issued:	March 2017	Figure No.
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Project No.	08-019	
Reference:	First Base Solutions	

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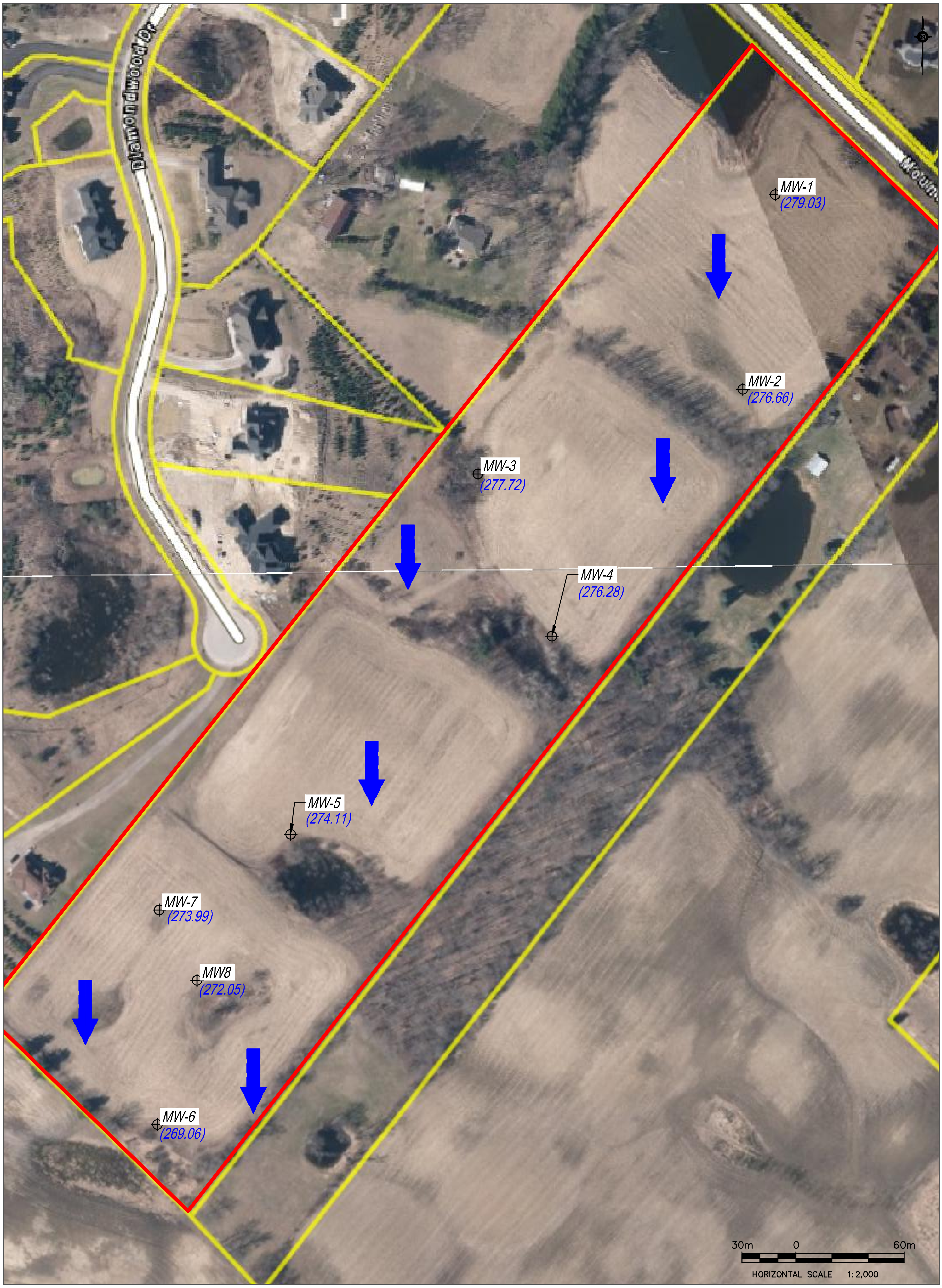

LEGEND:

—	*Property Boundary*
⊕	*Monitoring Well Locations*
➡	*Ground Water Flow Direction*
(277.0)	*Ground Water Elevation (masl) (March 2013)*

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Shallow Ground Water Flow

Pt. Lot 19, Con. 8
Town of Caledon

Date Issued:	March 2017	Figure No.
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Project No.	08-019	
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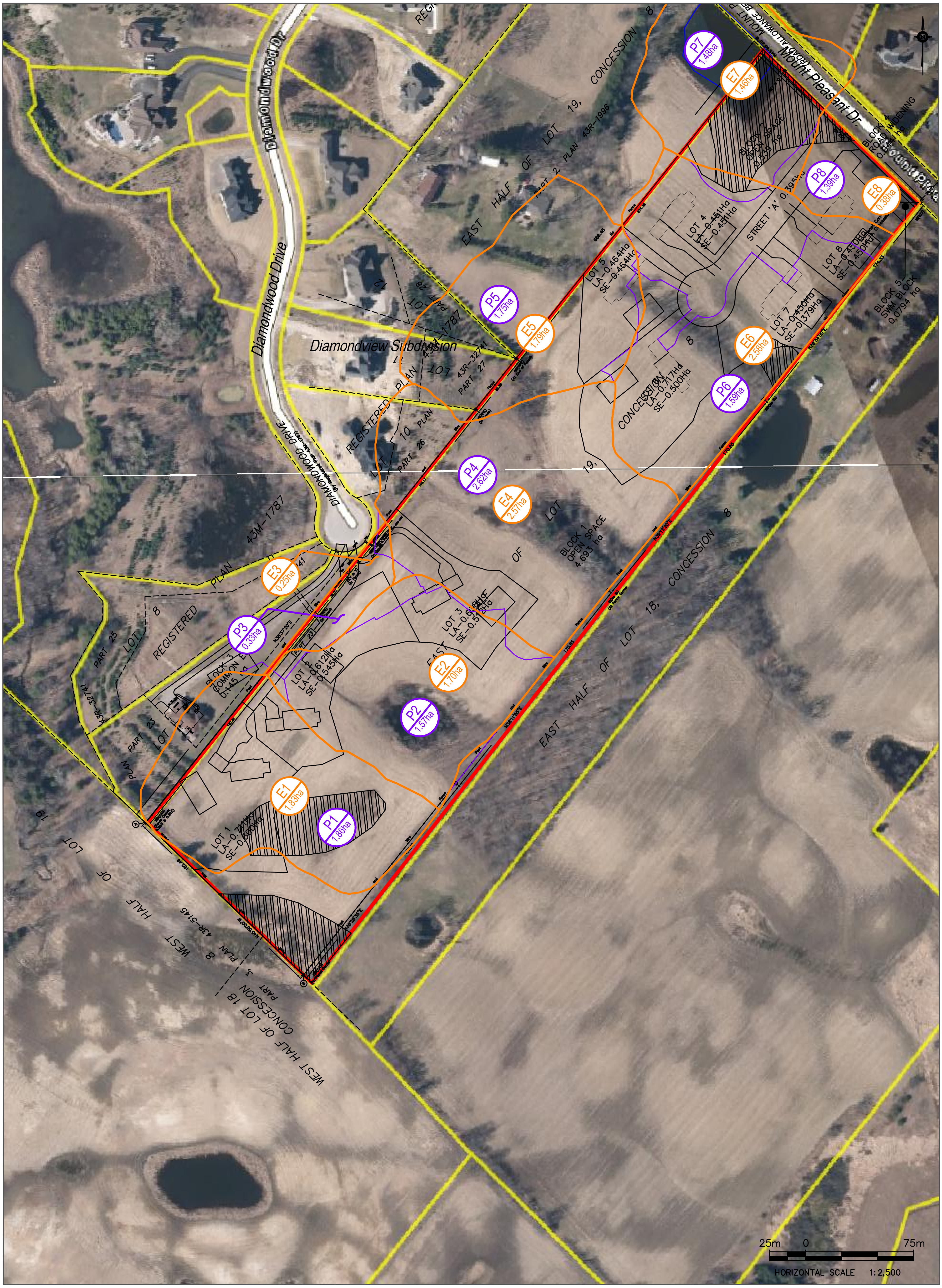

LEGEND:

🟥	*Approx. Property Boundary*
🟧	*Existing Drainage Catchment Areas*
🟪	*Proposed Drainage Catchment Areas*

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Drainage Catchment Analysis

Pt. Lot 19, Con. 8
Town of Caledon

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Project No.	08-019	
Reference:	First Base Solutions	

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LEGEND:

🟥 *Approx. Property Boundary*

━ *Permanent Stream*

╍ *Intermittent Stream*

╍ *Ephemeral Drainage*

▨ *Environmental Policy Area/Palgrave Estates Environmental Zone 1*
(Outermost limits of Minimum Vegetation Protection Zone)

▨ *Environmental Zone 2 (High Ground Water)*

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Onsite EZ1/EZ2 Areas

Pt. Lot 19, Con. 8
Town of Caledon

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Project No.	08-019	
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Figure 7: MW-1 Ground Water Elevations

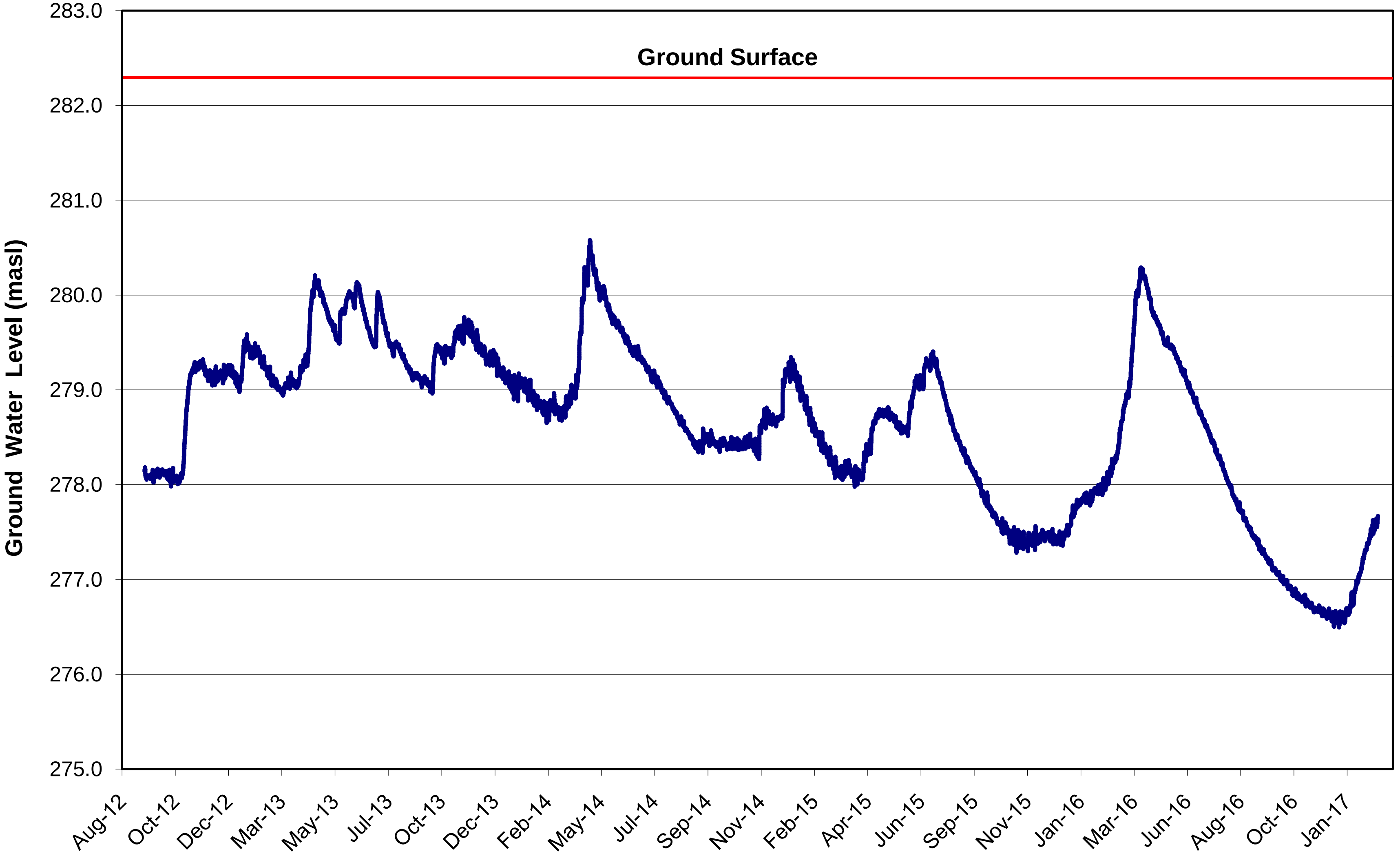


Figure 8: MW-2 Ground Water Elevations

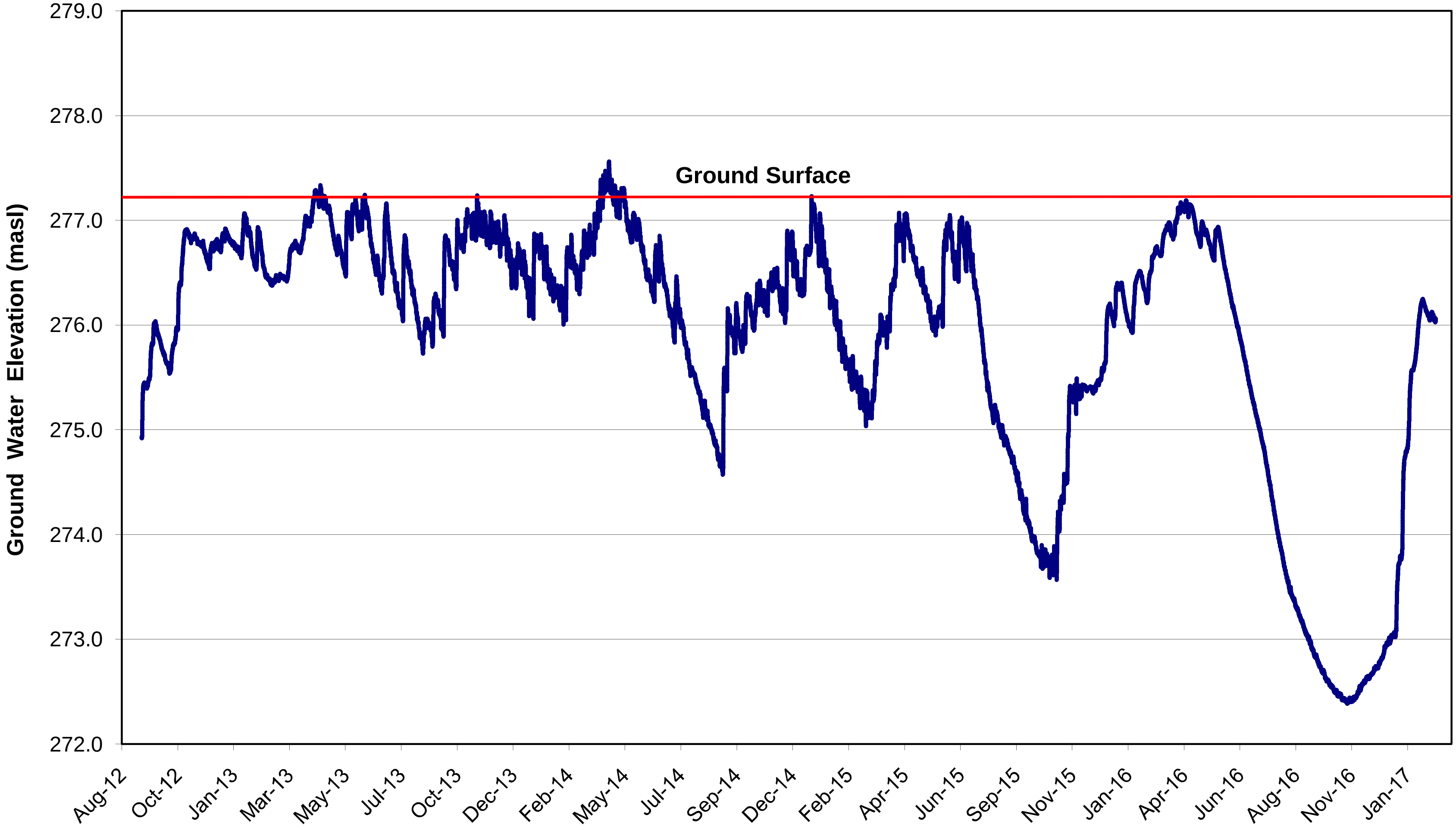


Figure 9: MW-3 Ground Water Elevations

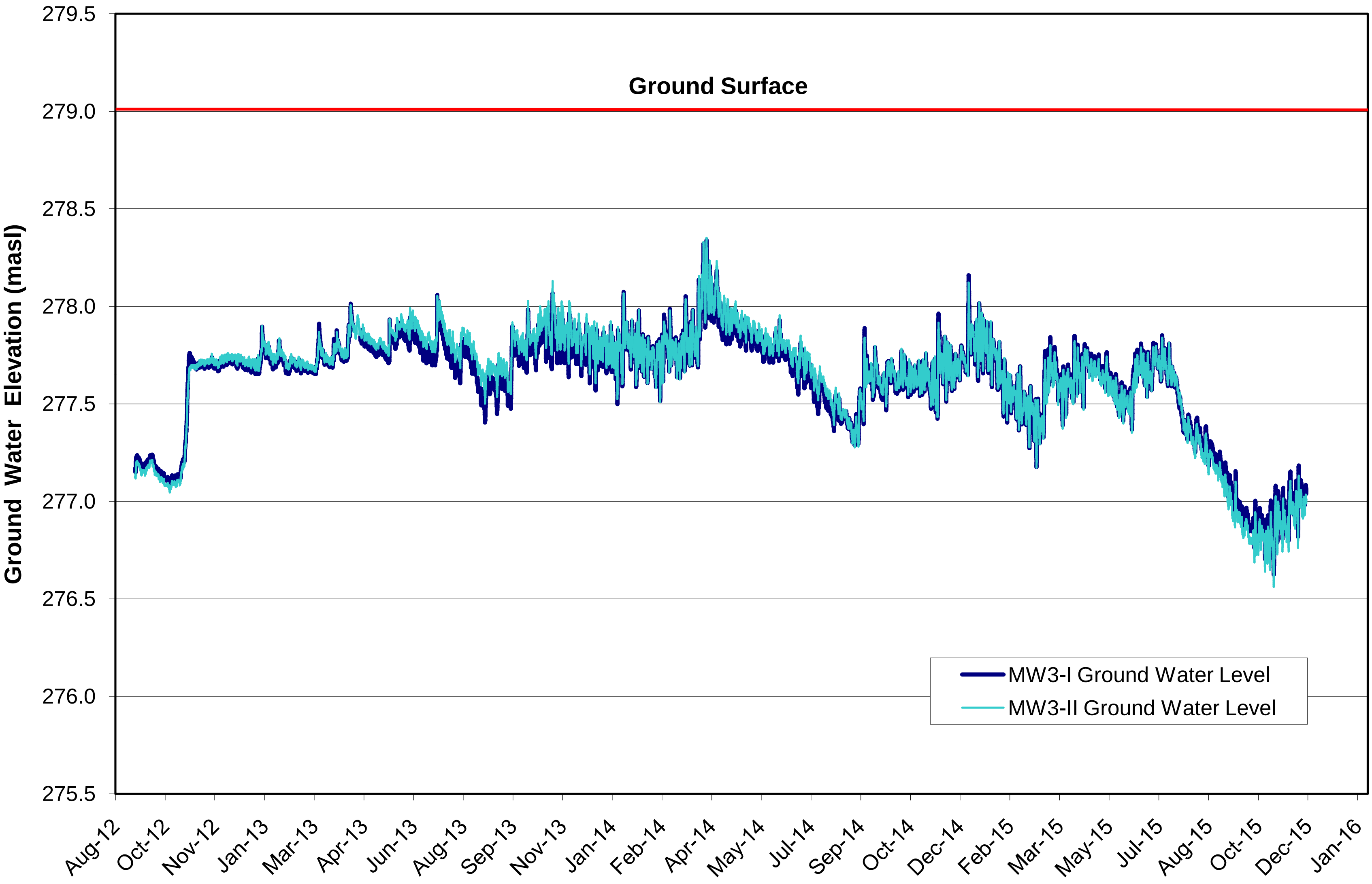


Figure 10: MW-4 Ground Water Elevations

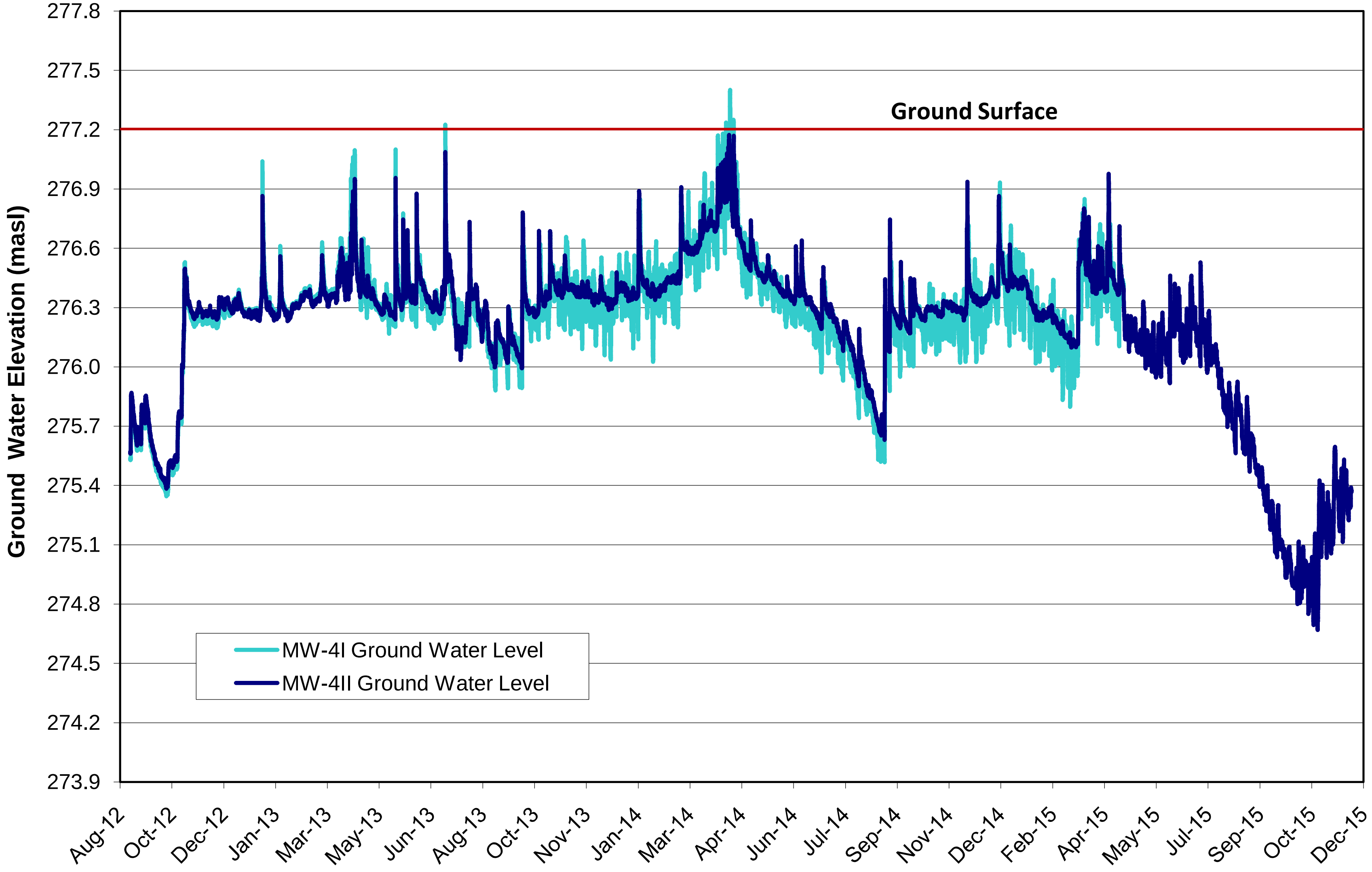


Figure 11: MW-5 Ground Water Elevations

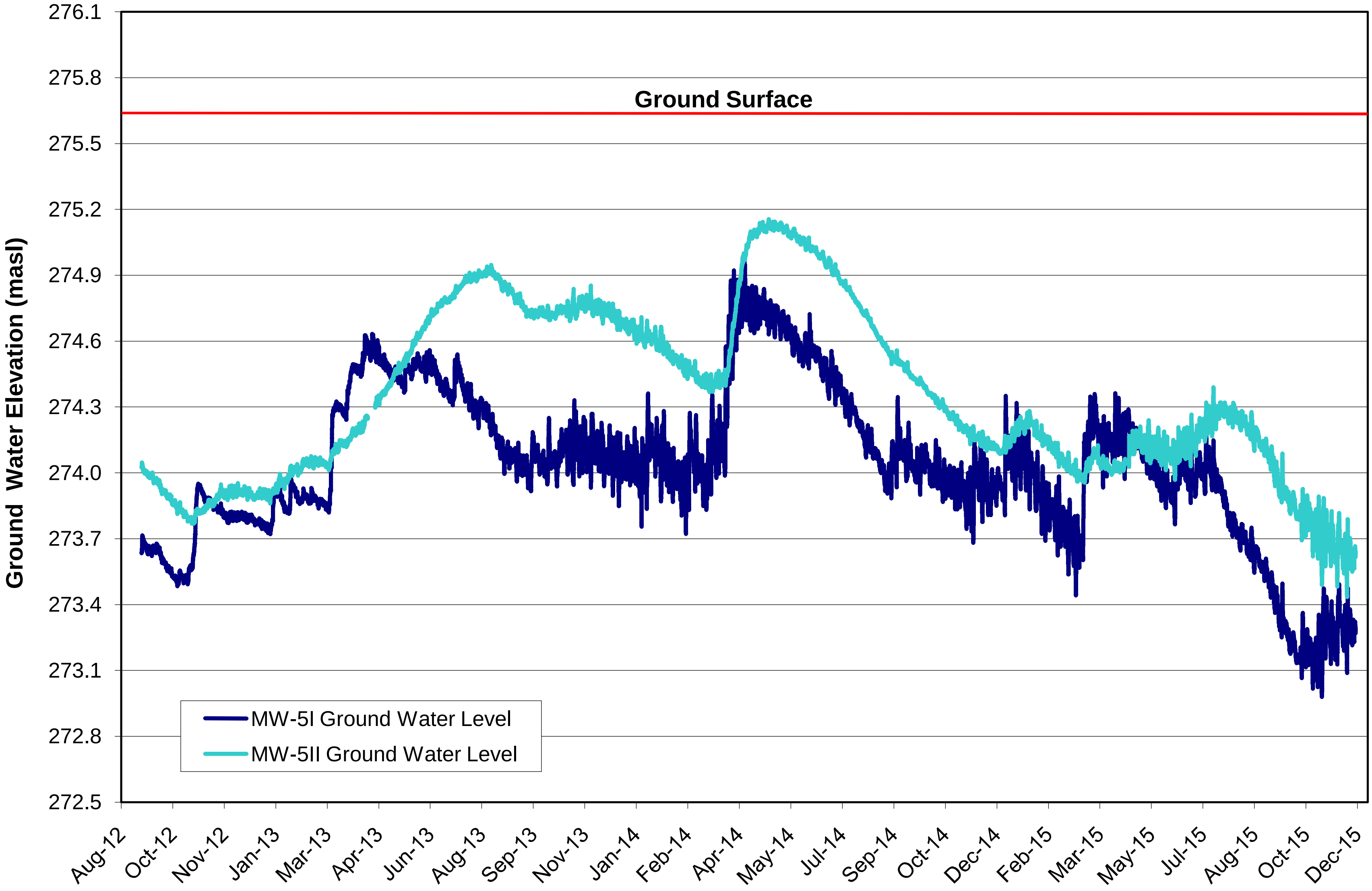
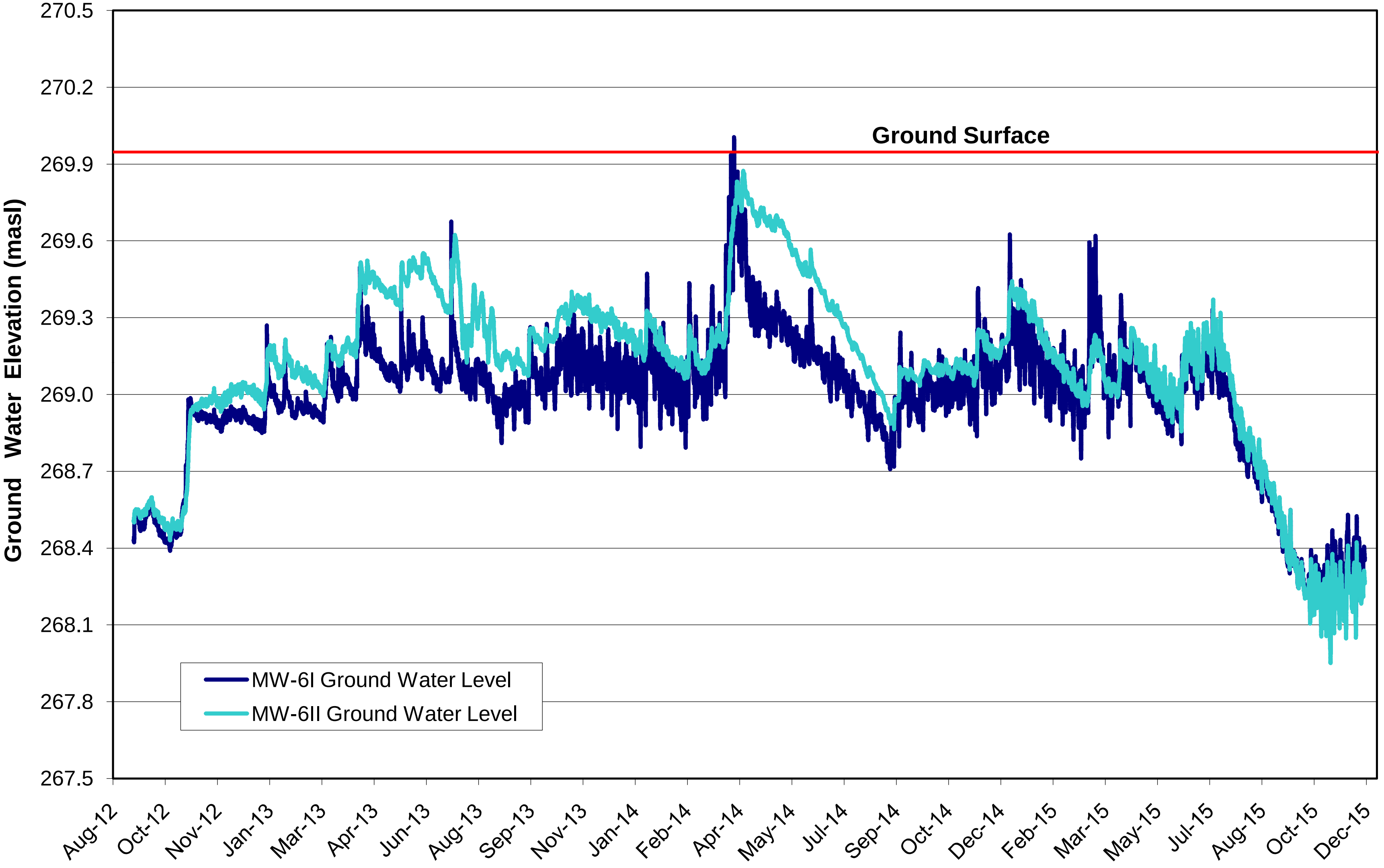


Figure 12: MW-6 Ground Water Elevations



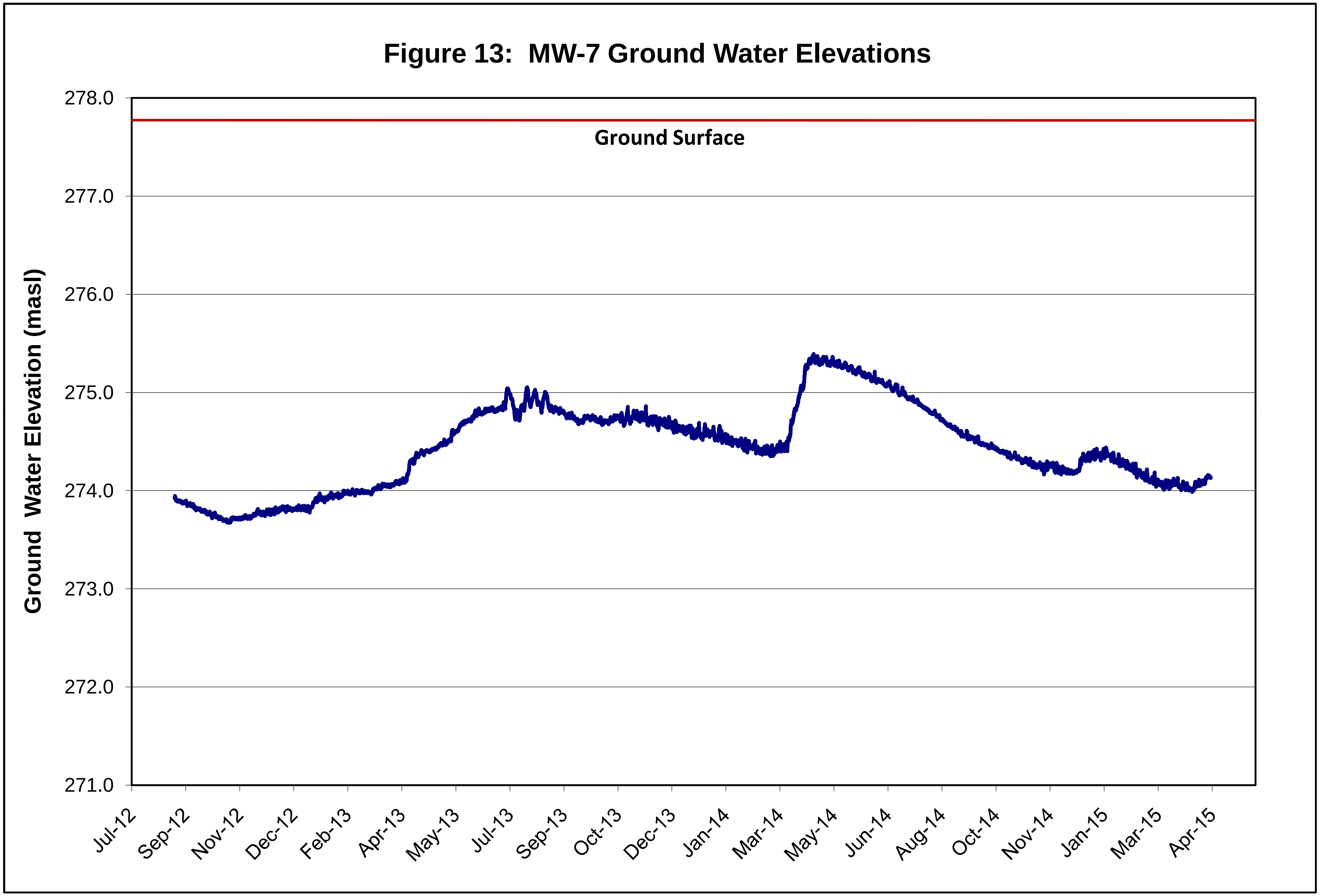
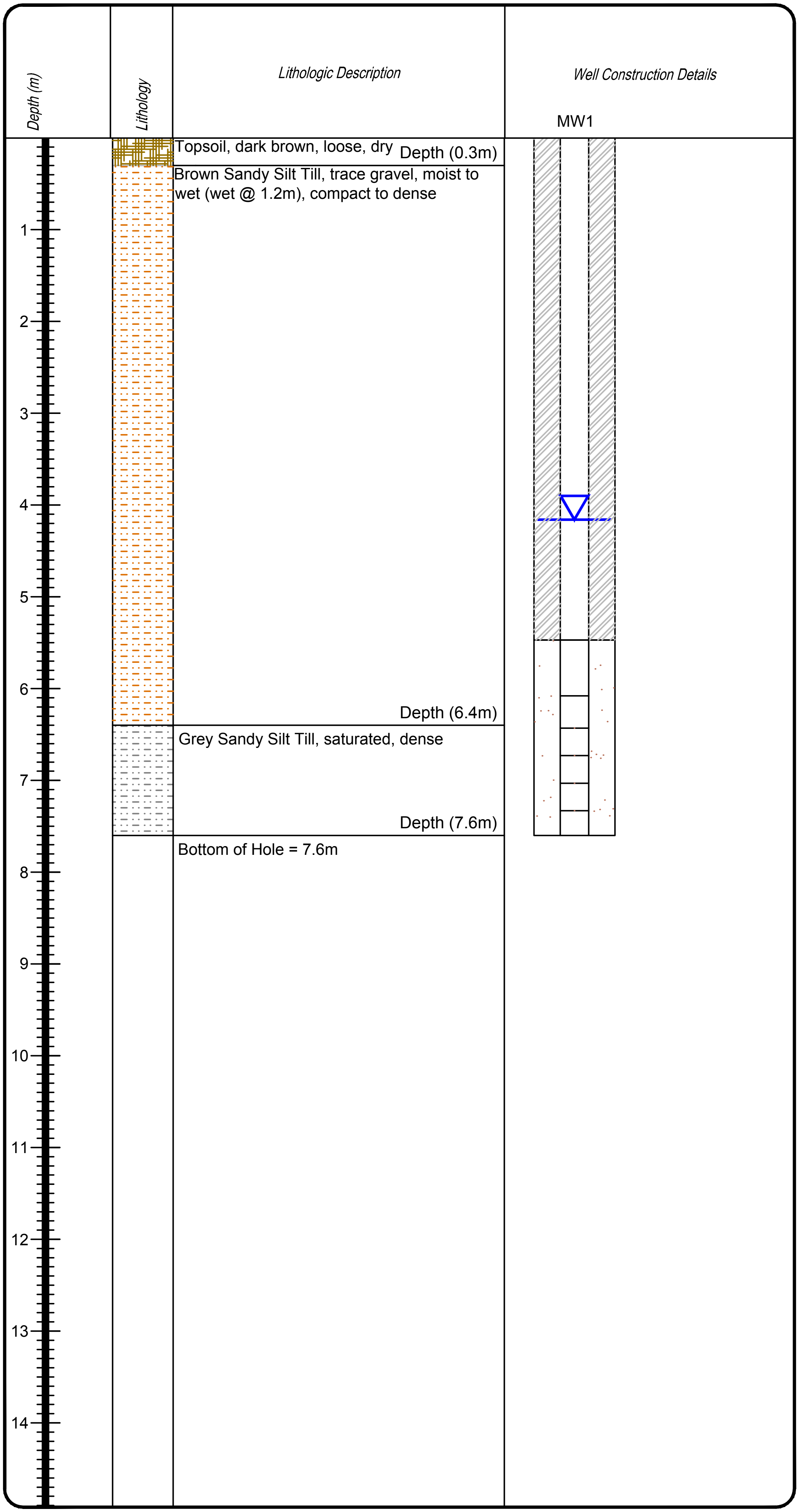


Figure 13: MW-7 Ground Water Elevations
Ground Water Elevation (masl)
278.0
277.0
276.0
275.0
274.0
273.0
272.0
271.0
Ground Surface
Jul-12
Sep-12
Nov-12
Dec-12
Feb-13
Apr-13
May-13
Jul-13
Sep-13
Oct-13
Dec-13
Jan-14
Mar-14
May-14
Jun-14
Aug-14
Oct-14
Nov-14
Jan-15
Mar-15
Apr-15

APPENDIX B

On-site Investigation Borehole Logs



Topsoil, dark brown, loose, dry Depth (0.3m)

Brown Sandy Silt Till, trace gravel, moist to wet (wet @ 1.2m), compact to dense

Depth (6.4m)

Grey Sandy Silt Till, saturated, dense

Depth (7.6m)

Bottom of Hole = 7.6m

Monitoring Well

MW1

Laurelpark Development

Mount Pleasant Rd.,
Caledon, ON

DRILLING DETAILS

Drill Date:	August 7, 2012
Drilling Method:	Direct Push
Driller:	Lantech Drilling
Geologist:	Drew West

MONITORING WELL INFORMATION

NAD 83 Zone 17 Easting: 598434
Northing: 4865885

Monitoring Well	MW1		
Ground Elev.	282.3masl		
Top of Casing Elev.	283.3masl		
Stick Up (m)	1.00		
Well Depth (m)	7.6mbgs		
High Water Level (date of water level)	4.16mbgs Aug 7, 2012		

All units expressed as metres above sea level unless otherwise noted

LEGEND

- ▽ Water Level Elevation
- ▽ Perched Water Table Elevation
- ▨ Bentonite
- ▦ Silica Sand
- ‖ Schedule 40 (2") PVC Riser Pipe
- ☰ Schedule 40 (2") 10-slot PVC Screen
- ▌▌ Steel Casing (6")

Geologic materials recovered and evaluated by: Drew West

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Project No.	08-019
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Page
1 of 1

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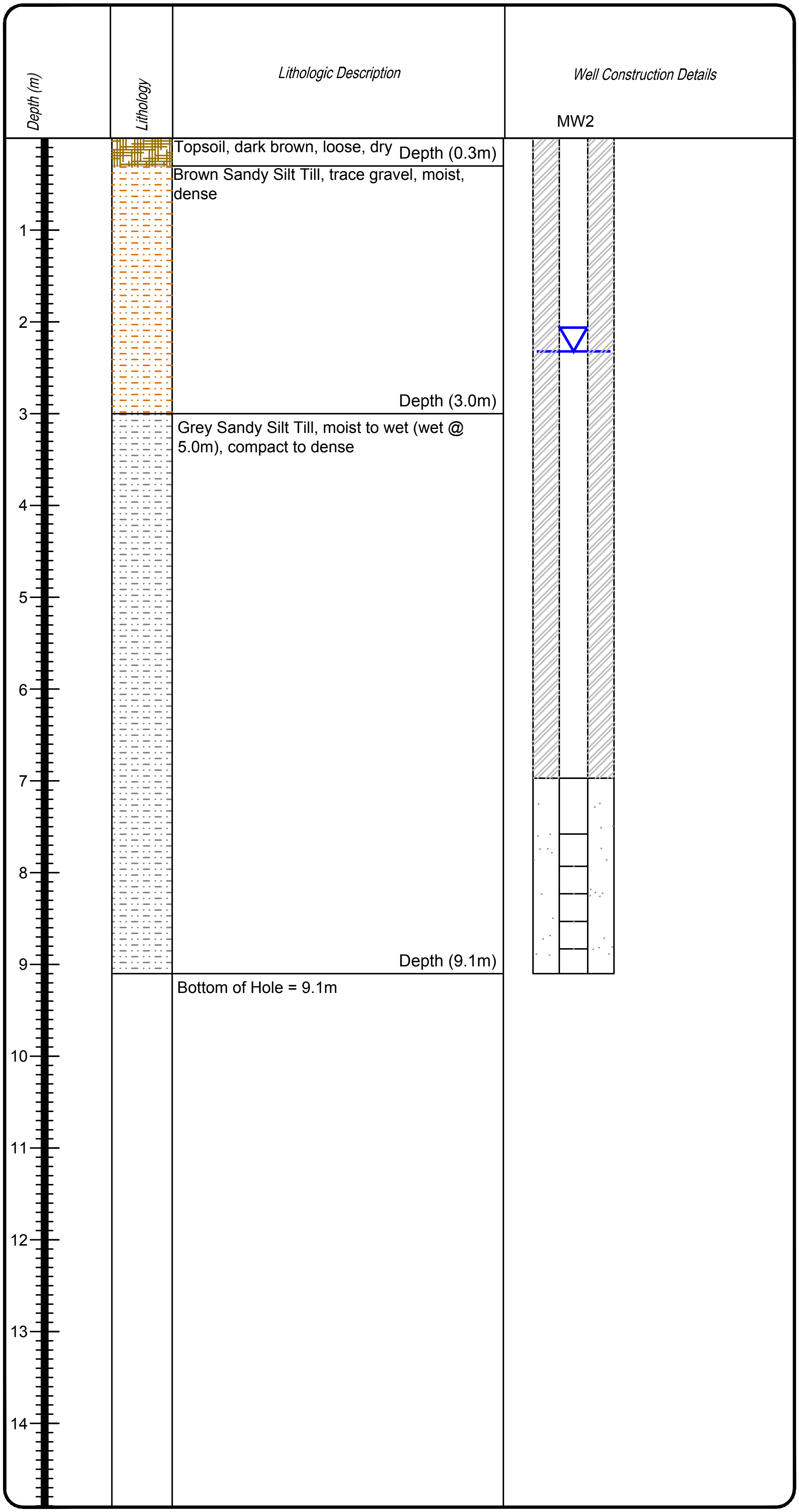

Lithologic Description

Topsoil, dark brown, loose, dry	Depth (0.3m)
Brown Sandy Silt Till, trace gravel, moist, dense	Depth (3.0m)
Grey Sandy Silt Till, moist to wet (wet @ 5.0m), compact to dense	Depth (9.1m)
Bottom of Hole = 9.1m	

Monitoring Well
MW2

Laurelpark Development

Mount Pleasant Rd.,
Caledon, ON

DRILLING DETAILS

Drill Date:	August 7, 2012
Drilling Method:	Direct Push
Driller:	Lantech Drilling
Geologist:	Drew West

MONITORING WELL INFORMATION

NAD 83 Zone 17	Easting:	598417
	Northing:	4865777

Monitoring Well	MW2		
Ground Elev.	277.25masl		
Top of Casing Elev.	278.25masl		
Stick Up (m)	1.00		
Well Depth (m)	9.1mbgs		
High Water Level (date of water level)	2.32mbgs Aug 7, 2012		

All units expressed as metres above sea level unless otherwise noted

LEGEND

▽	Water Level Elevation
▽	Perched Water Table Elevation
▨	Bentonite
⁘	Silica Sand
‖	Schedule 40 (2") PVC Riser Pipe
☷	Schedule 40 (2") 10-slot PVC Screen
▮▮	Steel Casing (6")

Geologic materials recovered and evaluated by: Drew West

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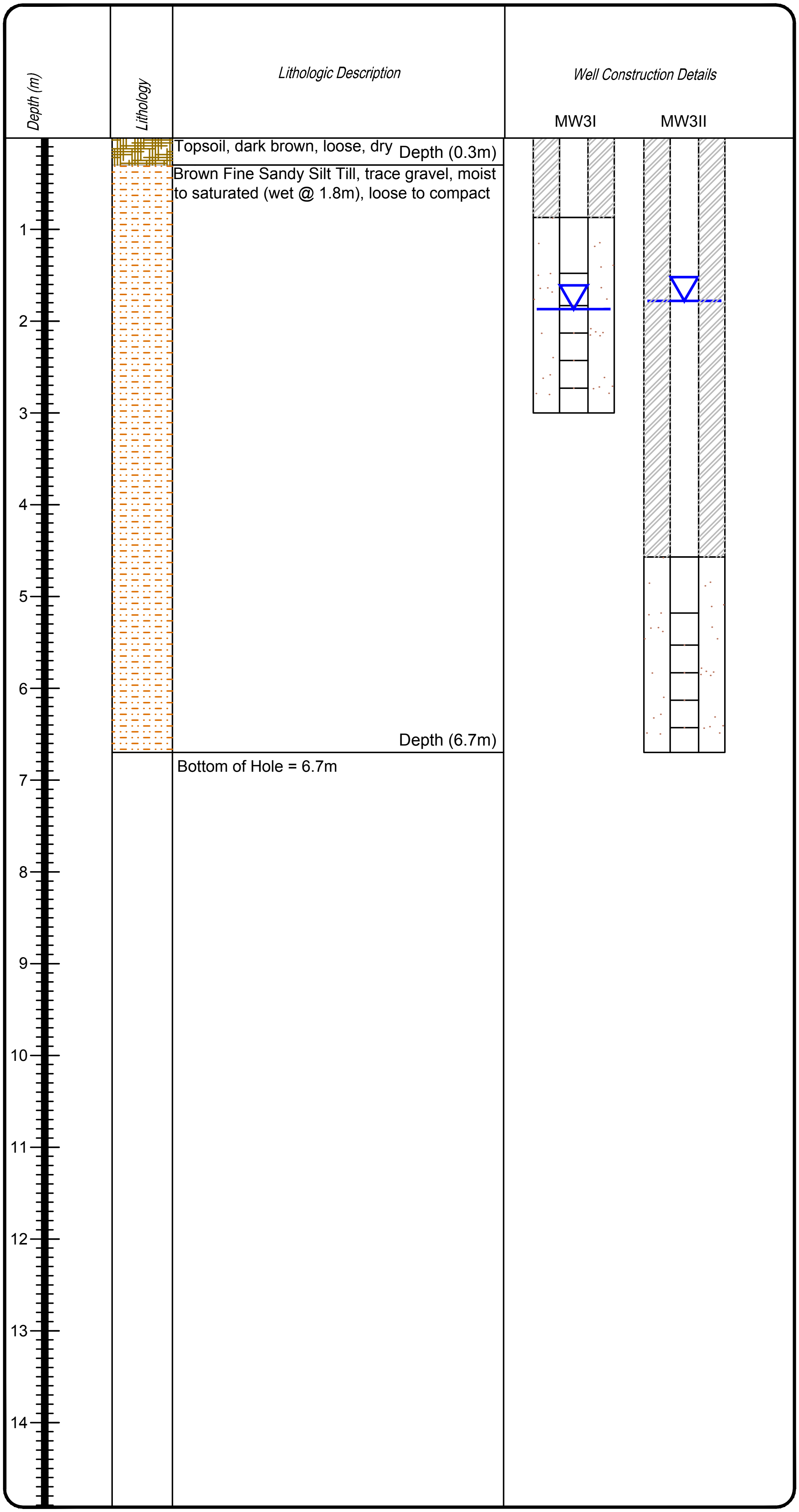

Topsoil, dark brown, loose, dry Depth (0.3m)

Brown Fine Sandy Silt Till, trace gravel, moist to saturated (wet @ 1.8m), loose to compact

Depth (6.7m)

Bottom of Hole = 6.7m

Monitoring Well

MW3

Laurelpark Development

Mount Pleasant Rd.,
Caledon, ON

DRILLING DETAILS

Drill Date:	August 7, 2012
Drilling Method:	Direct Push
Driller:	Lantech Drilling
Geologist:	Drew West

MONITORING WELL INFORMATION

NAD 83 Zone 17 Easting: 598269
Northing: 4865725

Monitoring Well	MW3I	MW3II	
Ground Elev.	279.0masl	279.0masl	
Top of Casing Elev.	280.05masl	279.95masl	
Stick Up (m)	1.05	0.95	
Well Depth (m)	3.0mbgs	6.7mbgs	
High Water Level (date of water level)	1.87mbgs Aug 7, 2012	1.78mbgs Aug 7, 2012	

All units expressed as metres above sea level unless otherwise noted

LEGEND

▽	Water Level Elevation
▽	Perched Water Table Elevation
▨	Bentonite
▒	Silica Sand
‖	Schedule 40 (2") PVC Riser Pipe
☰	Schedule 40 (2") 10-slot PVC Screen
▌▌	Steel Casing (6")

Geologic materials recovered and evaluated by: Drew West

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Project No.	08-019	
File Name:	08-019bh	

Plotted by: JMCCARTNEY on May 17, 2017 at 11:58am
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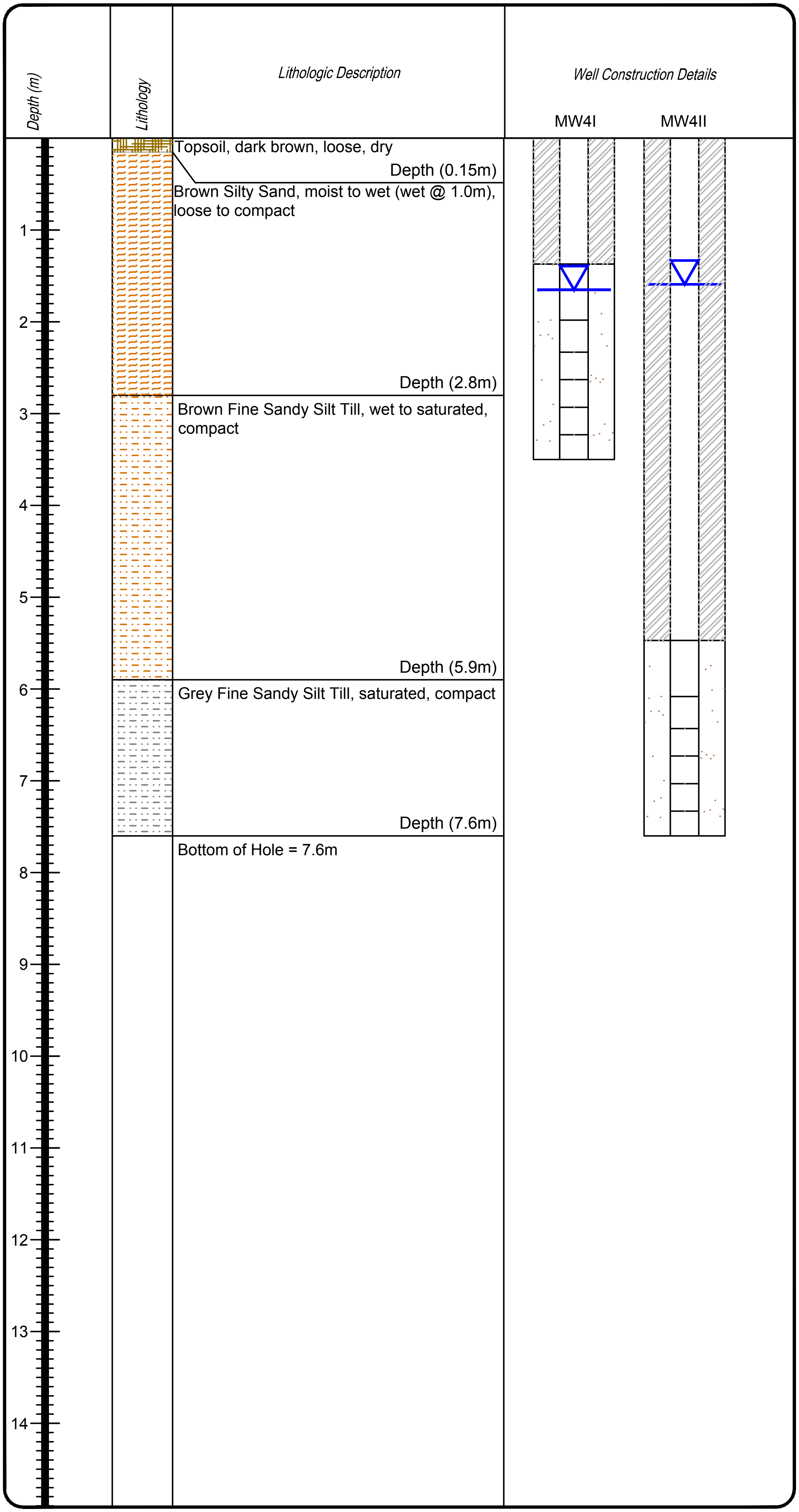

Topsoil, dark brown, loose, dry

Depth (0.15m)

Brown Silty Sand, moist to wet (wet @ 1.0m), loose to compact

Depth (2.8m)

Brown Fine Sandy Silt Till, wet to saturated, compact

Depth (5.9m)

Grey Fine Sandy Silt Till, saturated, compact

Depth (7.6m)

Bottom of Hole = 7.6m

Monitoring Well

MW4

Laurelpark Development

Mount Pleasant Rd.,
Caledon, ON

DRILLING DETAILS

Drill Date:	*August 7, 2012*
Drilling Method:	*Direct Push*
Driller:	*Lantech Drilling*
Geologist:	*Drew West*

MONITORING WELL INFORMATION

NAD 83 Zone 17

Easting: 598309
Northing: 4865642

Monitoring Well	*MW4I*	*MW4II*	
Ground Elev.	*277.15masl*	*277.15masl*	
Top of Casing Elev.	*278.1masl*	*278.05masl*	
Stick Up (m)	*0.95*	*0.90*	
Well Depth (m)	*3.5mbgs*	*3.5mbgs*	
High Water Level *(date of water level)*	*1.65mbgs* *Aug 7, 2012*	*1.59mbgs* *Aug 7, 2012*	

All units expressed as metres above sea level unless otherwise noted

LEGEND

- ▽ *Water Level Elevation*
- ▽ *Perched Water Table Elevation*
- ▨ *Bentonite*
- ░ *Silica Sand*
- ‖ *Schedule 40 (2") PVC Riser Pipe*
- ☰ *Schedule 40 (2") 10-slot PVC Screen*
- ▮▮ *Steel Casing (6")*

Geologic materials recovered and evaluated by: Drew West

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

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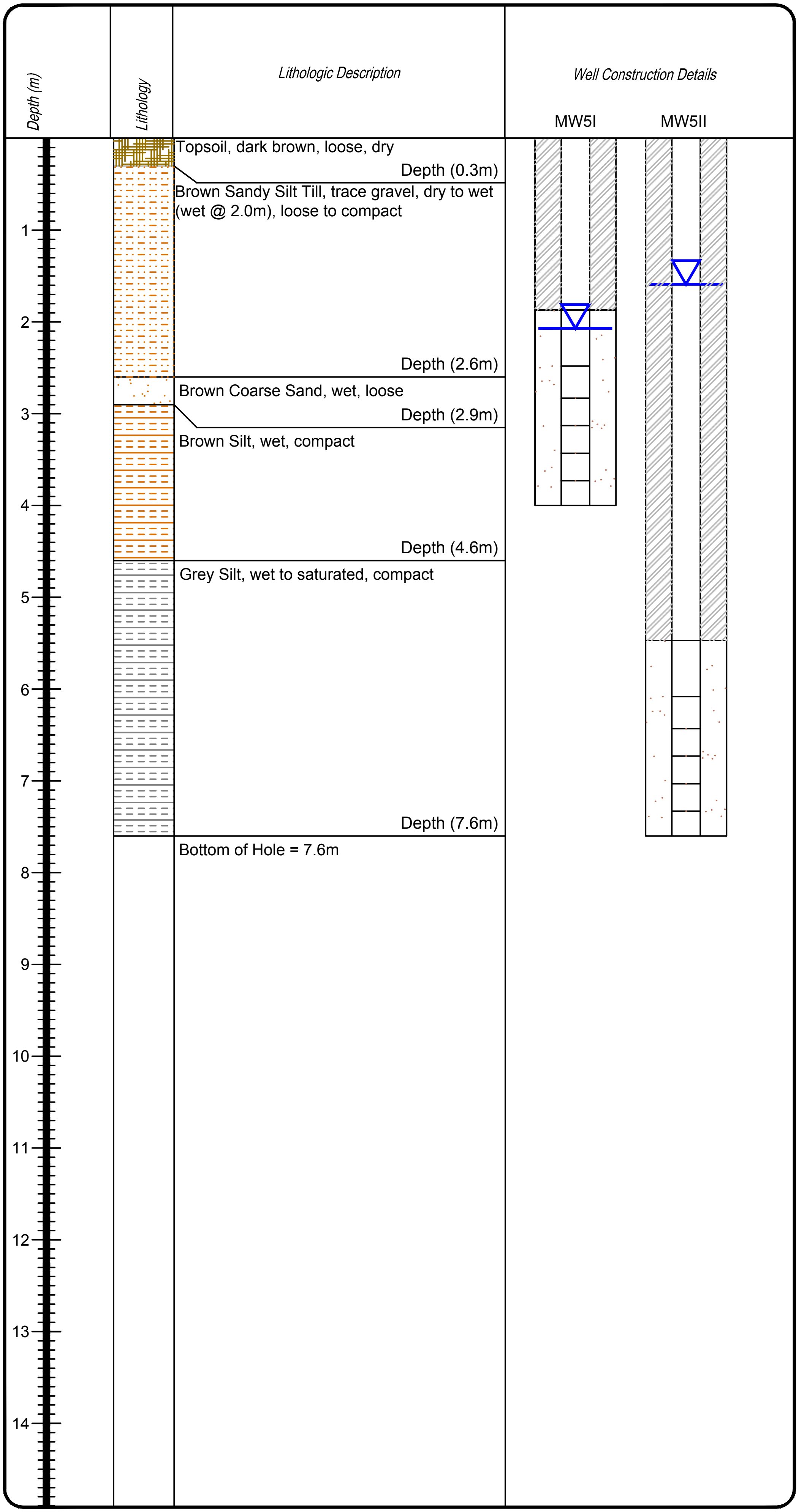

Topsoil, dark brown, loose, dry
Depth (0.3m)

Brown Sandy Silt Till, trace gravel, dry to wet (wet @ 2.0m), loose to compact
Depth (2.6m)

Brown Coarse Sand, wet, loose
Depth (2.9m)

Brown Silt, wet, compact
Depth (4.6m)

Grey Silt, wet to saturated, compact
Depth (7.6m)

Bottom of Hole = 7.6m

Monitoring Well

MW5

Laurelpark Development

Mount Pleasant Rd.,
Caledon, ON

DRILLING DETAILS

Drill Date:	August 8, 2012
Drilling Method:	Direct Push
Driller:	Lantech Drilling
Geologist:	Drew West

MONITORING WELL INFORMATION

NAD 83 Zone 17	Easting:	598156
	Northing:	4865527

Monitoring Well	MW5I	MW5II	
Ground Elev.	275.60masl	275.6masl	
Top of Casing Elev.	276.60masl	276.6masl	
Stick Up (m)	1.00	1.0	
Well Depth (m)	4.0mbgs	7.6mbgs	
High Water Level (date of water level)	2.07mbgs Aug 8, 2012	1.58mbgs Aug 8, 2012	

All units expressed as metres above sea level unless otherwise noted

LEGEND

▽	Water Level Elevation
▽	Perched Water Table Elevation
▨	Bentonite
⁘	Silica Sand
‖	Schedule 40 (2") PVC Riser Pipe
☰	Schedule 40 (2") 10-slot PVC Screen
▌▌	Steel Casing (6")

Geologic materials recovered and evaluated by: Drew West

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

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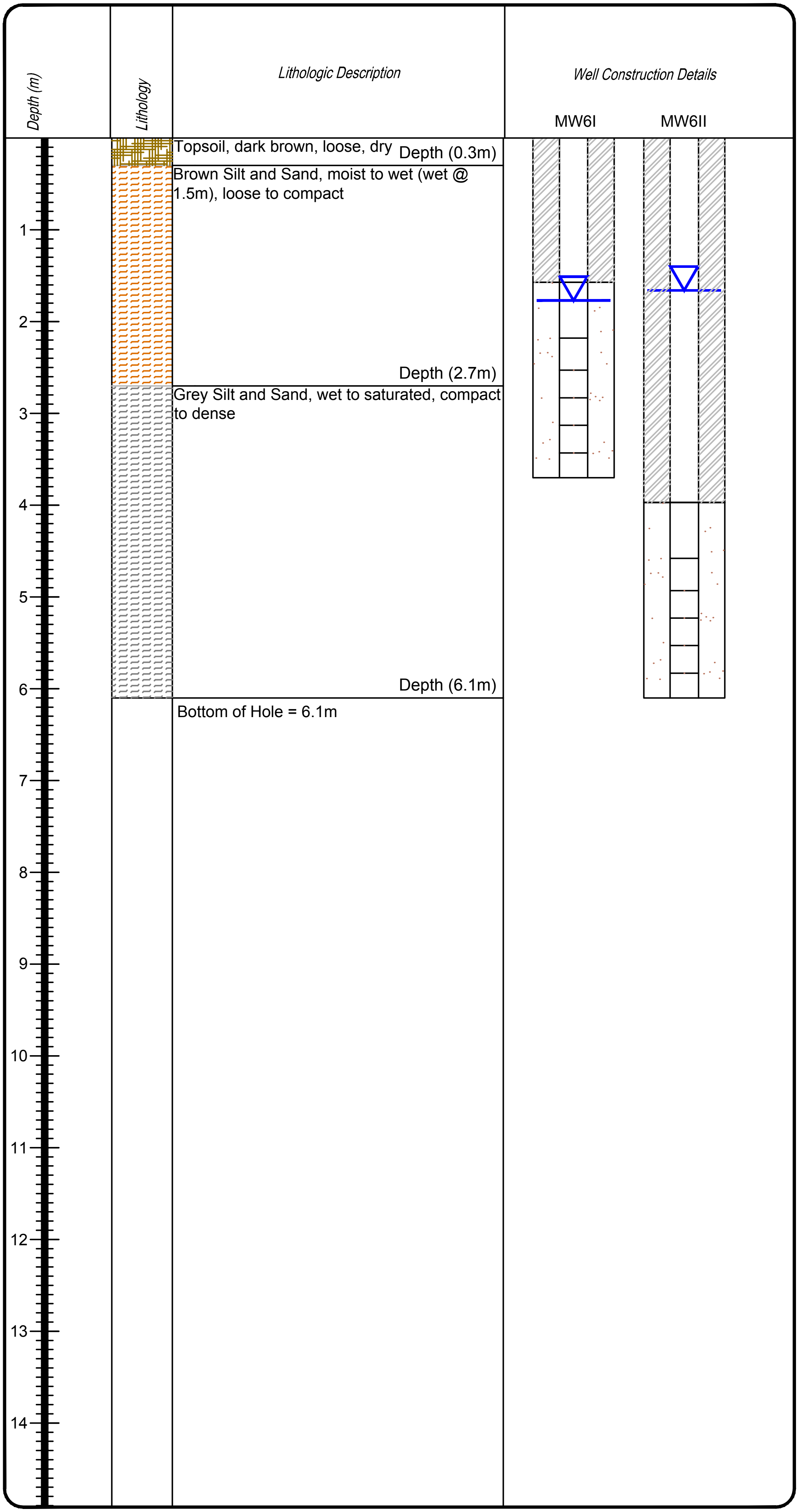

Topsoil, dark brown, loose, dry Depth (0.3m)

Brown Silt and Sand, moist to wet (wet @ 1.5m), loose to compact Depth (2.7m)

Grey Silt and Sand, wet to saturated, compact to dense Depth (6.1m)

Bottom of Hole = 6.1m

Monitoring Well

MW6

Laurelpark Development

Mount Pleasant Rd.,
Caledon, ON

DRILLING DETAILS

Drill Date:	August 9, 2012
Drilling Method:	Direct Push
Driller:	Lantech Drilling
Geologist:	Drew West

MONITORING WELL INFORMATION

NAD 83 Zone 17 Easting: 598099
Northing: 4865362

Monitoring Well	MW6I	MW6II	
Ground Elev.	270.18masl	270.18masl	
Top of Casing Elev.	270.98masl	270.98masl	
Stick Up (m)	0.8	0.8	
Well Depth (m)	3.7mbgs	6.1mbgs	
High Water Level (date of water level)	1.77mbgs Aug 9, 2012	1.66mbgs Aug 9, 2012	

All units expressed as metres above sea level unless otherwise noted

LEGEND

▽	Water Level Elevation
▽	Perched Water Table Elevation
▨	Bentonite
⁘	Silica Sand
‖	Schedule 40 (2") PVC Riser Pipe
☰	Schedule 40 (2") 10-slot PVC Screen
▮▮	Steel Casing (6")

Geologic materials recovered and evaluated by: Drew West

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

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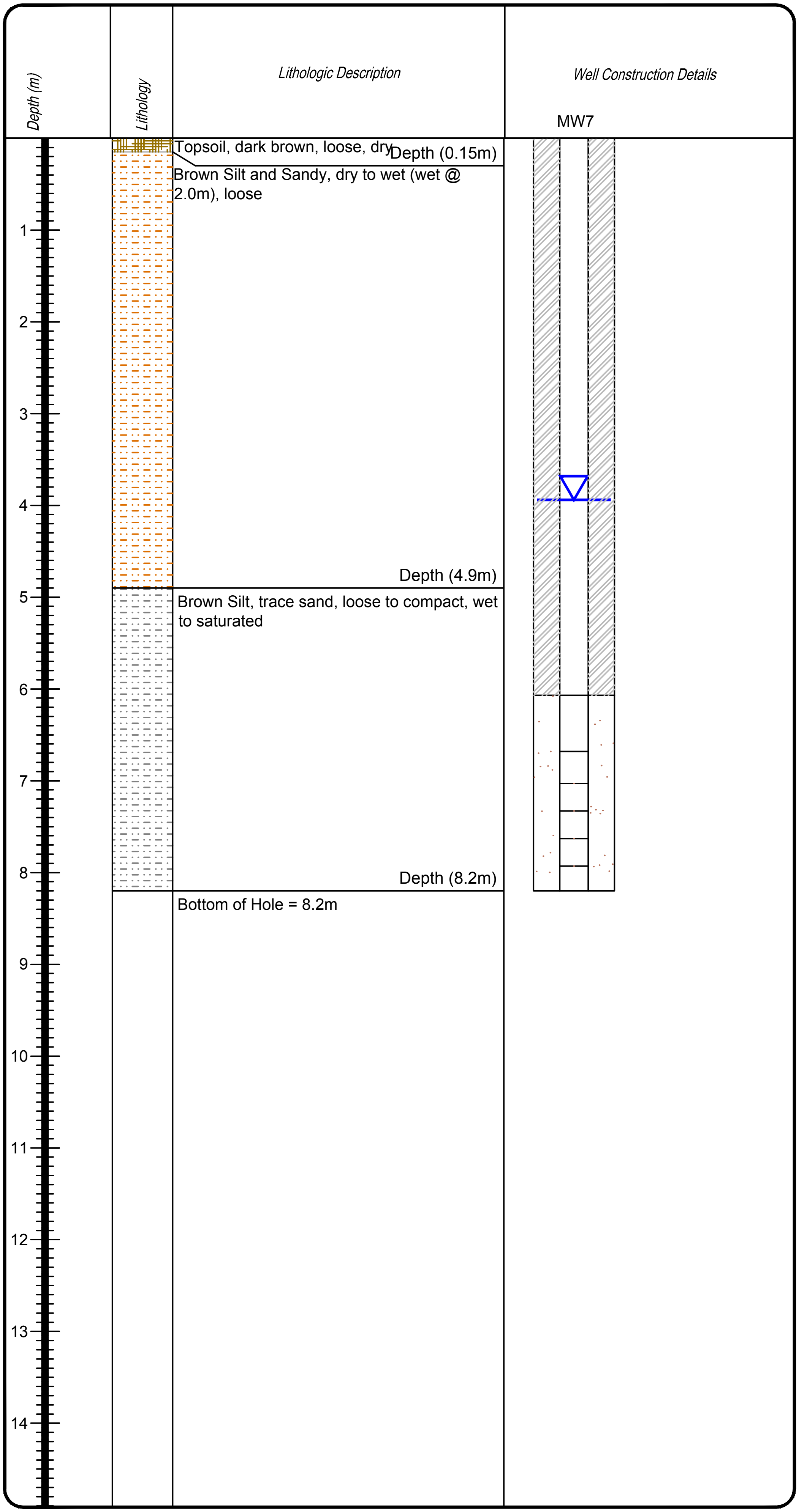

Topsoil, dark brown, loose, dry Depth (0.15m)

Brown Silt and Sandy, dry to wet (wet @ 2.0m), loose

Depth (4.9m)

Brown Silt, trace sand, loose to compact, wet to saturated

Depth (8.2m)

Bottom of Hole = 8.2m

Monitoring Well

MW7

Laurelpark Development

Mount Pleasant Rd.,
Caledon, ON

DRILLING DETAILS

Drill Date:	August 9, 2012
Drilling Method:	Direct Push
Driller:	Lantech Drilling
Geologist:	Drew West

MONITORING WELL INFORMATION

NAD 83 Zone 17	Easting:	598096
	Northing:	4865489

Monitoring Well	MW7		
Ground Elev.	272.94masl		
Top of Casing Elev.	274.04masl		
Stick Up (m)	1.10		
Well Depth (m)	8.2mbgs		
High Water Level (date of water level)	3.94mbgs Aug 9, 2012		

All units expressed as metres above sea level unless otherwise noted

LEGEND

▽ Water Level Elevation

▽ Perched Water Table Elevation

▨ Bentonite

⁘ Silica Sand

|| Schedule 40 (2") PVC Riser Pipe

☰ Schedule 40 (2") 10-slot PVC Screen

▌▌ Steel Casing (6")

Geologic materials recovered and evaluated by: Drew West

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

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Plotted by: JMCCARTNEY on May 17, 2017 at 11:58am
File: C:\Users\jmccartney\appdata\local\temp\AcPublish_6784\08-019bh.dwg Layout: MW7 Plotscale: 40

Terraprobe

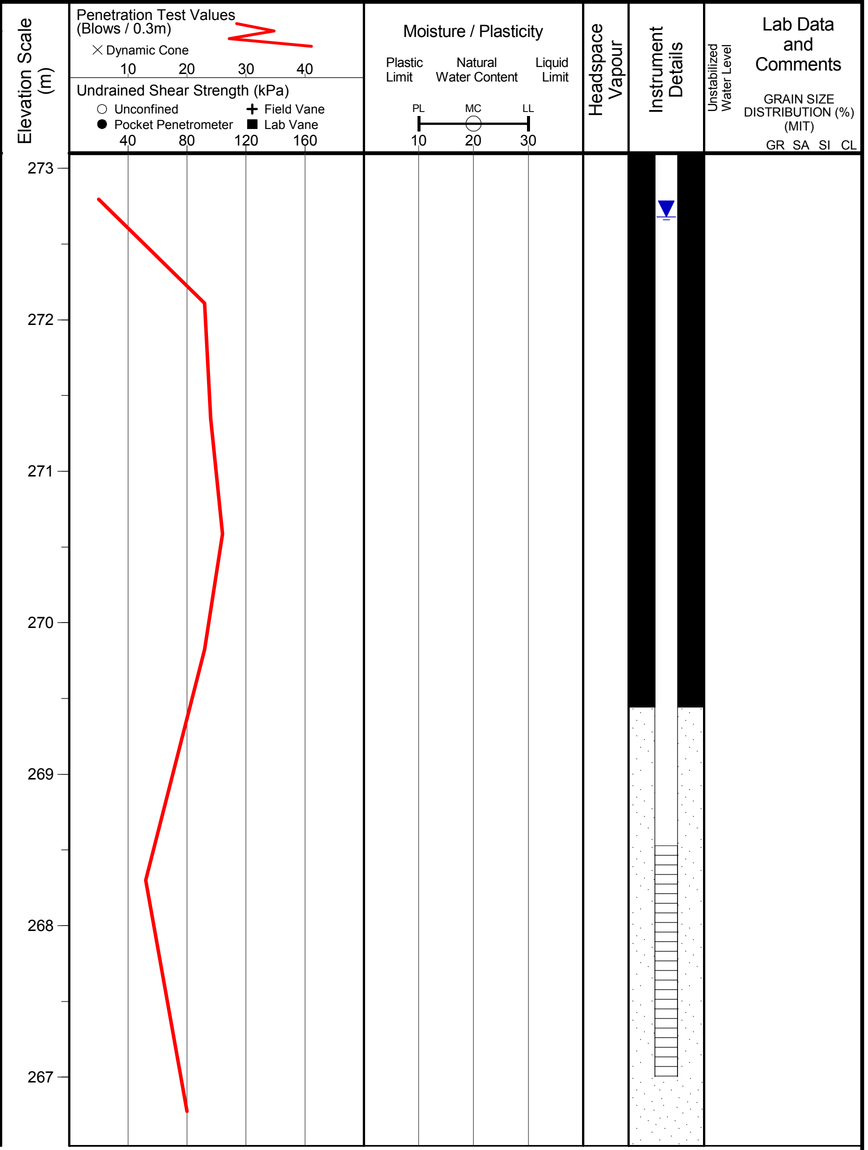
BOREHOLE LOG 1

Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

Project No.: 11-13-3052
Date started : May 16, 2013
Sheet No. : 1 of 1

Position : E: 598025, N: 4865443 (UTM 17T)
Rig type : track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
273.1	**GROUND SURFACE**			
	250mm **TOPSOIL**			
272.8 0.3	Trace organics (WEATHERED/DISTURBED)	1	SS	5
272.3 0.8	**SILT**, some sand to sandy, trace to some clay, trace gravel, compact, brown, moist	2	SS	23
		3	SS	24
		4	SS	26
		5	SS	23
268.5 4.6	**SILT AND CLAY**, trace sand, trace gravel, stiff to very stiff, grey, moist (GLACIAL TILL)	6	SS	13
		7	SS	20
266.5 6.6	**END OF BOREHOLE**			



Borehole was dry and open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
May 24, 2013	0.4	272.7

Terraprobe

BOREHOLE LOG 2

Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

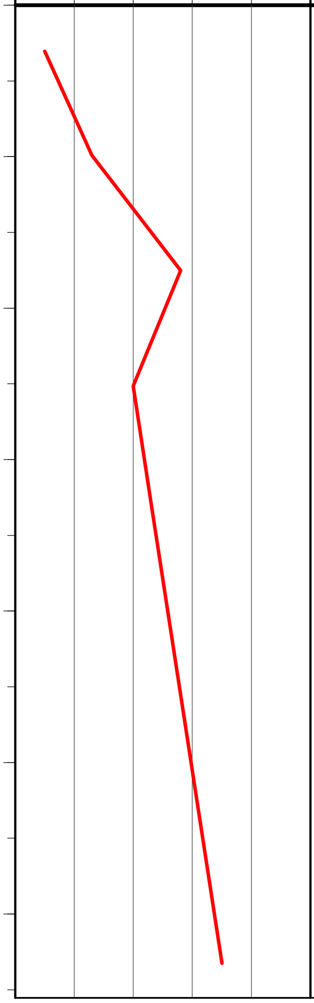
Project No.: 11-13-3052
Date started : May 16, 2013
Sheet No. : 1 of 1

Position : E: 598111, N: 4865495 (UTM 17T)
Rig type : track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description (SOIL PROFILE)	Number	Type	SPT 'N' Value	Elevation Scale (m)	Unstabilized Water Level
0	**280.0**	**GROUND SURFACE**				280	
		300mm **TOPSOIL**	1	SS	5		
	279.7 0.3	Trace organics (WEATHERED/DISTURBED)					
1	279.2 0.8	**SANDY SILT to SAND AND SILT**, trace clay, trace gravel, compact, brown, moist	2	SS	13	279	
			3	SS	28		
2			4	SS	20	278	
3			5	SS	23	277	
4						276	
5		...clayey	6	SS	29	275	
6						274	∇
	273.9 6.1	**SAND**, trace silt, trace gravel, dense, brown, wet	7	SS	35		
	273.4 6.6	**END OF BOREHOLE**					

Unstabilized water level measured at 6.0m below ground surface; borehole was open upon completion of drilling.

Penetration Test Values (Blows / 0.3m)
× Dynamic Cone
10 20 30 40
Undrained Shear Strength (kPa)
○ Unconfined ✚ Field Vane
● Pocket Penetrometer ■ Lab Vane
40 80 120 160



Moisture / Plasticity
Plastic Limit — Natural Water Content — Liquid Limit
PL MC LL
10 20 30

Headspace Vapour

Instrument Details

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

Terraprobe

BOREHOLE LOG 3

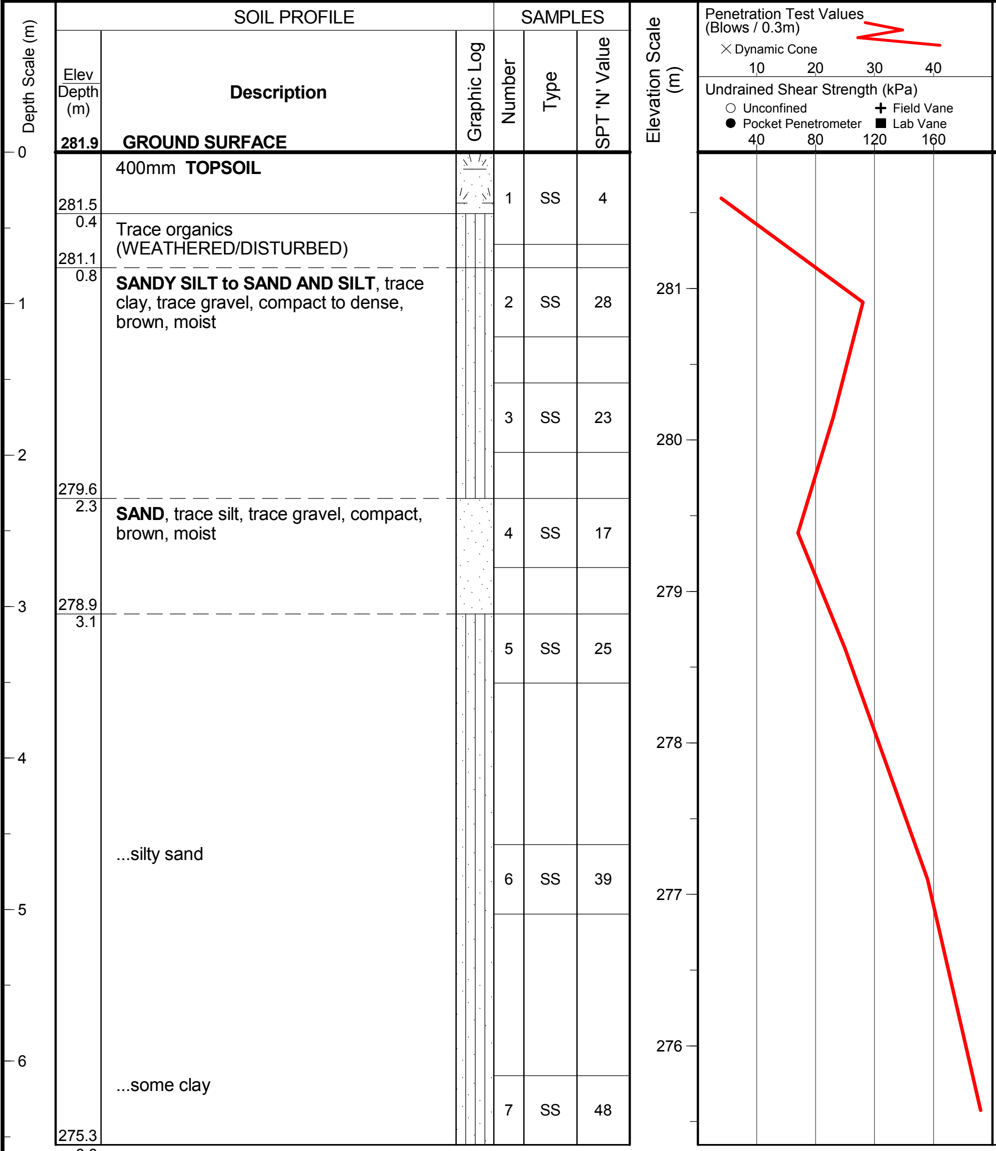
Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

Project No.: 11-13-3052
Date started : May 16, 2013
Sheet No. : 1 of 1

Position : E: 295137, N: 4865588 (UTM 17T)
Elevation Datum : Geodetic (NAD83)
Rig type : track-mounted
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
281.9	**GROUND SURFACE**			
	400mm **TOPSOIL**	1	SS	4
281.5 0.4	Trace organics (WEATHERED/DISTURBED)			
281.1 0.8	**SANDY SILT to SAND AND SILT**, trace clay, trace gravel, compact to dense, brown, moist	2	SS	28
		3	SS	23
279.6 2.3	**SAND**, trace silt, trace gravel, compact, brown, moist	4	SS	17
278.9 3.1		5	SS	25
	...silty sand	6	SS	39
	...some clay	7	SS	48
275.3 6.6	**END OF BOREHOLE**			

Borehole was dry and caved to 5.9m below ground surface upon completion of drilling.



Moisture / Plasticity
Plastic Limit | Natural Water Content | Liquid Limit
PL MC LL
10 20 30

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

Terraprobe

BOREHOLE LOG 4

Client : Laurelpark Inc.

Project : Palgrave Estates II

Location : Caledon, Ontario

Project No.: 11-13-3052

Date started : May 16, 2013

Sheet No. : 1 of 1

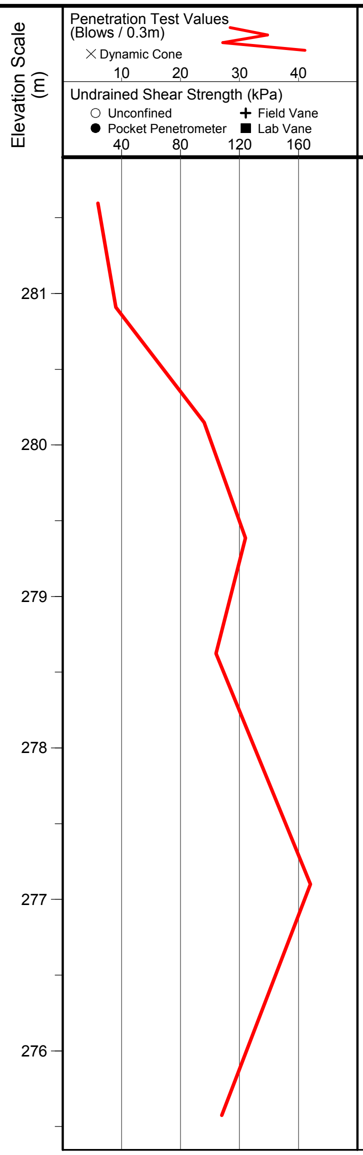
Position : E: 598223, N: 4865593 (UTM 17T)

Rig type : track-mounted

Elevation Datum : Geodetic (NAD83)

Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
0	**281.9**	**GROUND SURFACE**			
		300mm **TOPSOIL**			
	281.6 0.3	Trace organics (WEATHERED/DISTURBED)	1	SS	6
1	281.1 0.8	**SILT**, some clay to clayey silt, trace sand, trace gravel, stiff to hard, brown, moist (GLACIAL TILL)	2	SS	9
2			3	SS	24
			4	SS	31
3			5	SS	26
4					
5			6	SS	42
6		...grey below	7	SS	27
	275.3 6.6				



Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit (PL, MC, LL: 10, 20, 30)

Headspace Vapour

Instrument Details

Unstabilized Water Level

Lab Data and Comments: GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

library: library - terraprobe gint.glb **report:** terraprobe soil log **file:** 11-13-3052 bh logs.gpj

Terraprobe

BOREHOLE LOG 5

Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

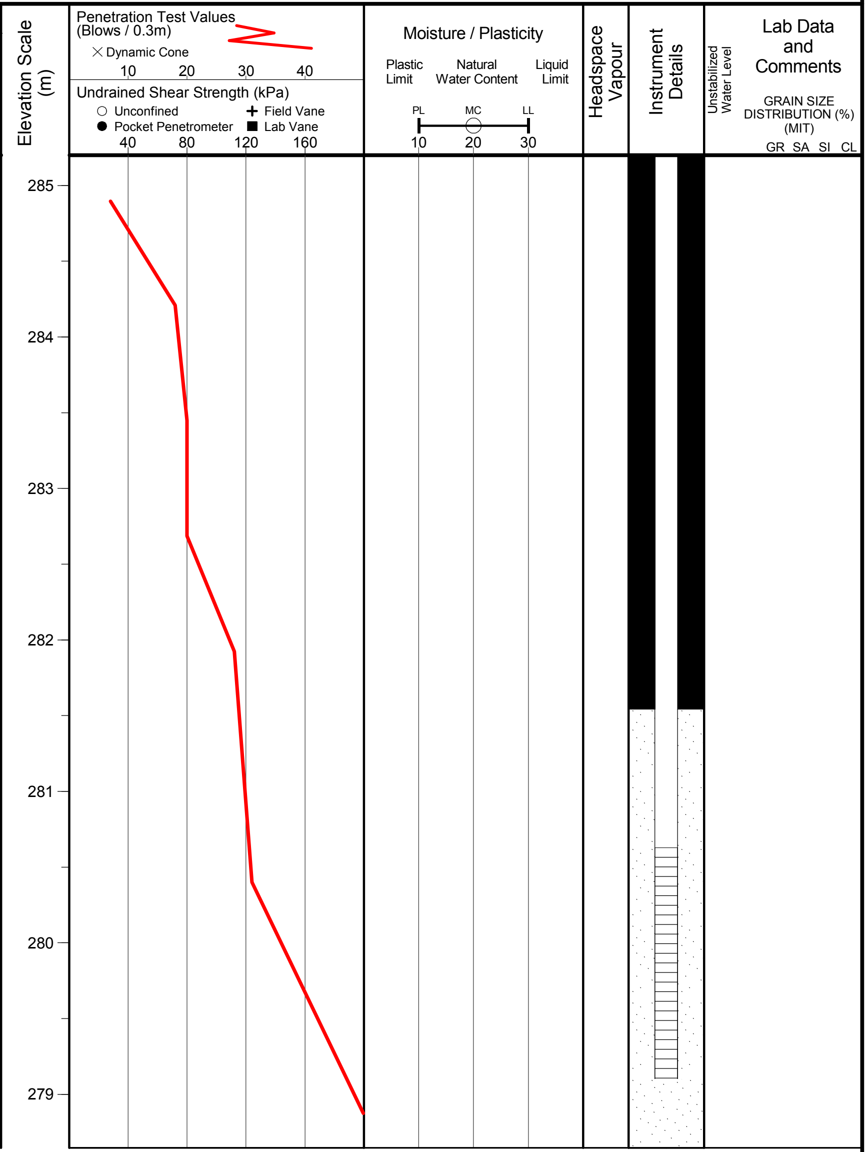
Project No.: 11-13-3052
Date started : May 16, 2013
Sheet No. : 1 of 1

Position : E: 598309, N: 4865735 (UTM 17T)
Rig type : track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

Elev Depth (m)	Description (SOIL PROFILE)
285.2	**GROUND SURFACE**
284.9 0.3	300mm **TOPSOIL**
284.4 0.8	Trace organics (WEATHERED/DISTURBED)
278.6 6.6	**SANDY SILT to SAND AND SILT**, trace clay, trace gravel, compact to very dense, brown, moist ...sand, some silt (at about 3 m)

Number	Type	SPT 'N' Value
1	SS	7
2	SS	18
3	SS	20
4	SS	20
5	SS	28
6	SS	31
7	SS	76

Depth Scale (m): 0, 1, 2, 3, 4, 5, 6



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
May 24, 2013	dry	n/a

Terraprobe

BOREHOLE LOG 6

Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

Project No.: 11-13-3052
Date started : May 15, 2013
Sheet No. : 1 of 1

Position : E: 598386, N: 4865796 (UTM 17T)
Rig type : track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

Elev Depth (m)	Description	Number	Type	SPT 'N' Value	Unstabilized Water Level	Lab Data and Comments
278.0	**GROUND SURFACE**					
	300mm **TOPSOIL**					
277.7 0.3	**FILL**, clayey silt, trace to some sand, trace gravel, trace organics, topsoil, firm, brown / grey, moist ...(REWORKED/DISTURBED)	1	SS	5		
		2	SS	6	▽	
276.5 1.5	**SILT**, some sand to sandy, trace to some clay, trace gravel, compact to very dense, brown, moist	3	SS	31		spoon wet
		4	SS	18		
	...grey below	5	SS	32		
		6	SS	49		
		7	SS	70		
271.4 6.6	**END OF BOREHOLE**					

Unstabilized water level measured at 1.2m below ground surface; borehole was open upon completion of drilling.

Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit (PL, MC, LL: 10, 20, 30)
Headspace Vapour
Instrument Details
Lab Data and Comments: GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

Terraprobe

BOREHOLE LOG 7

Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

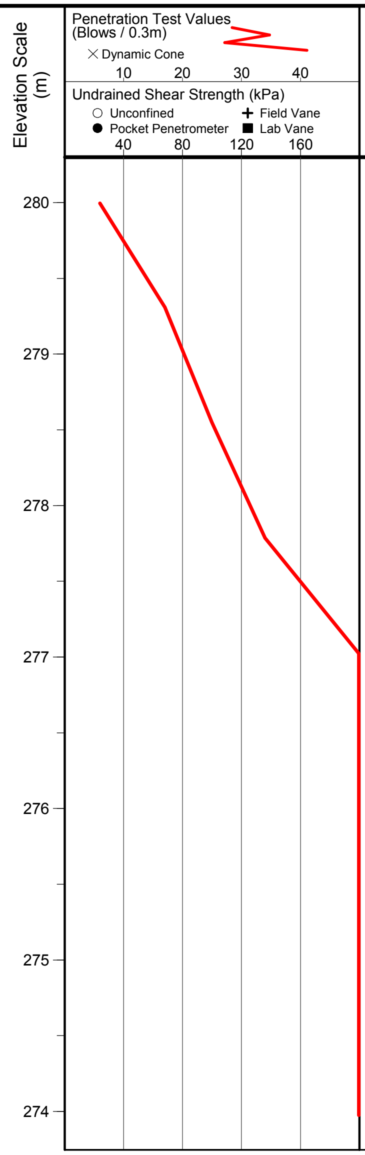
Project No.: 11-13-3052
Date started : May 15, 2013
Sheet No. : 1 of 1

Position : E: 598421, N: 4865843 (UTM 17T)
Rig type : track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value	Moisture / Plasticity	Headspace Vapour	Instrument Details	Unstabilized Water Level	Lab Data and Comments
0	**280.3**	**GROUND SURFACE**									
		350mm **TOPSOIL**		1	SS	6					
	279.9 0.4	Trace organics (WEATHERED/DISTURBED)									
1	279.5 0.8	**SILT**, some sand to sandy, trace to some clay, trace gravel, compact to very dense, brown, moist		2	SS	17					
2				3	SS	25					
				4	SS	34					
3				5	SS	55					spoon wet
4 5		...grey below		6	SS	67					
6				7	SS	68				∇	
	273.7 6.6	**END OF BOREHOLE**									

Moisture / Plasticity: Plastic Limit (PL), Natural Water Content (MC), Liquid Limit (LL); scale 10, 20, 30

Lab Data and Comments: GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL



Unstabilized water level measured at 5.9m below ground surface; borehole was open upon completion of drilling.

Terraprobe

BOREHOLE LOG 8

Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

Project No.: 11-13-3052
Date started : May 15, 2013
Sheet No. : 1 of 1

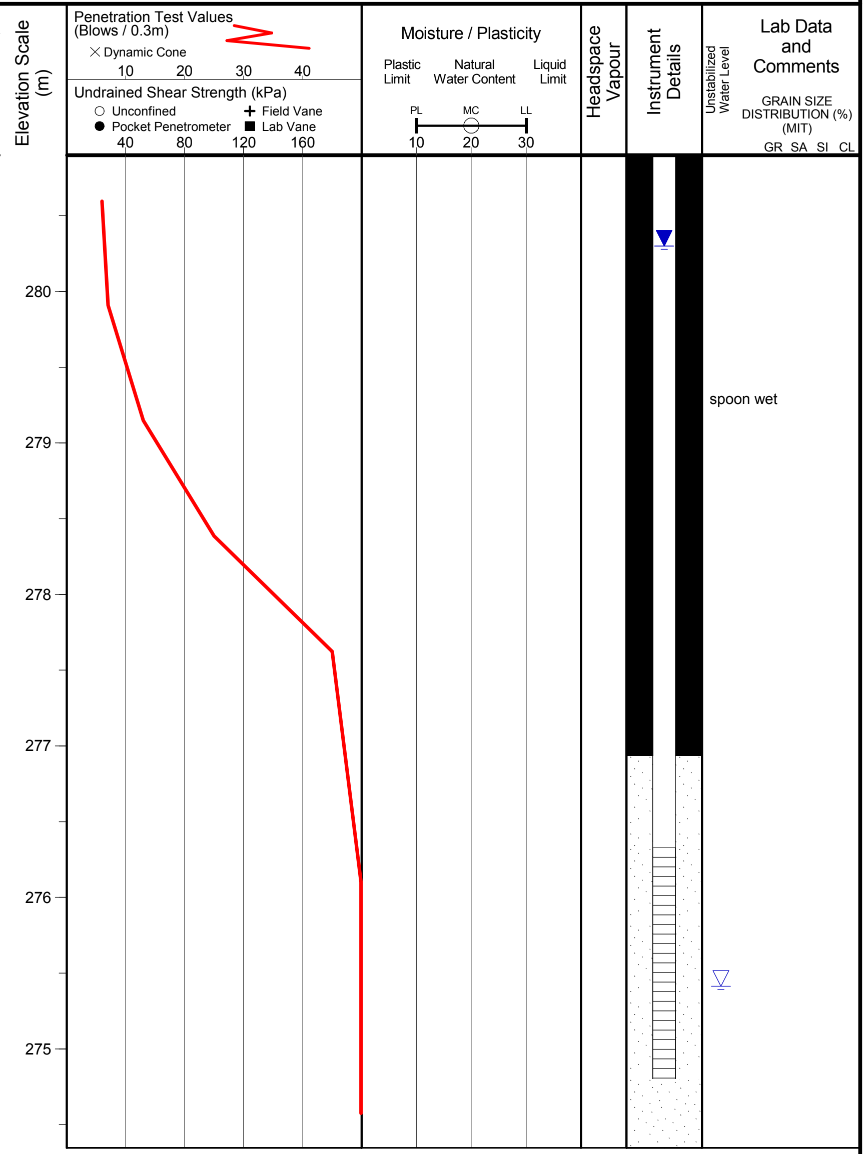
Position : E: 598465, N: 4865898 (UTM 17T)
Rig type : track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
280.9	**GROUND SURFACE**
	300mm **TOPSOIL**
280.6 0.3	**FILL**, clayey silt, trace to some sand, trace gravel, trace organics, topsoil, firm, brown / grey, moist ...(REWORKED/DISTURBED)
279.4 1.5	**SANDY SILT to SAND AND SILT**, trace clay, trace gravel, compact to very dense, brown, moist ...wet, dilatant ...grey below
274.3 6.6	**END OF BOREHOLE**

SAMPLES

Number	Type	SPT 'N' Value
1	SS	6
2	SS	7
3	SS	13
4	SS	25
5	SS	45
6	SS	73
7	SS	56



Unstabilized water level measured at 5.5m below ground surface; borehole was open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
May 24, 2013	0.6	280.3

Terraprobe

BOREHOLE LOG 9

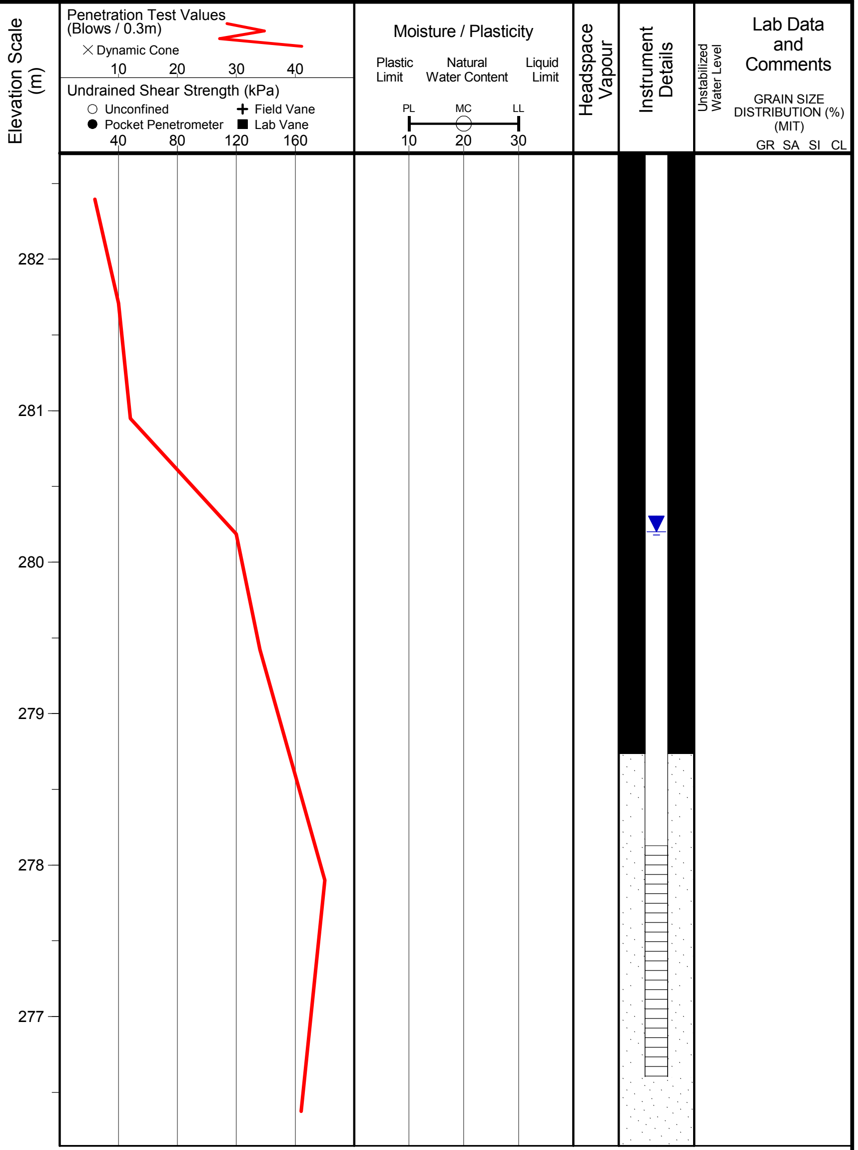
Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

Project No.: 11-13-3052
Date started : May 16, 2013
Sheet No. : 1 of 1

Position : E: 598343, N: 4865854 (UTM 17T)
Rig type : track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

SOIL PROFILE / SAMPLES

Elev Depth (m)	Description	Number	Type	SPT 'N' Value
282.7	**GROUND SURFACE**			
	300mm **TOPSOIL**	1	SS	6
282.4 0.3	Trace organics (WEATHERED/DISTURBED)			
281.9 0.8	**SILT**, some sand to sandy, trace to some clay, trace gravel, compact to dense, brown, moist	2	SS	10
		3	SS	12
		4	SS	30
		5	SS	34
		6	SS	45
		7	SS	41
276.1 6.6				



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
May 24, 2013	2.5	280.2

Terraprobe

BOREHOLE LOG 10

Client : Laurelpark Inc.

Project : Palgrave Estates II

Location : Caledon, Ontario

Project No.: 11-13-3052

Date started : May 15, 2013

Sheet No. : 1 of 1

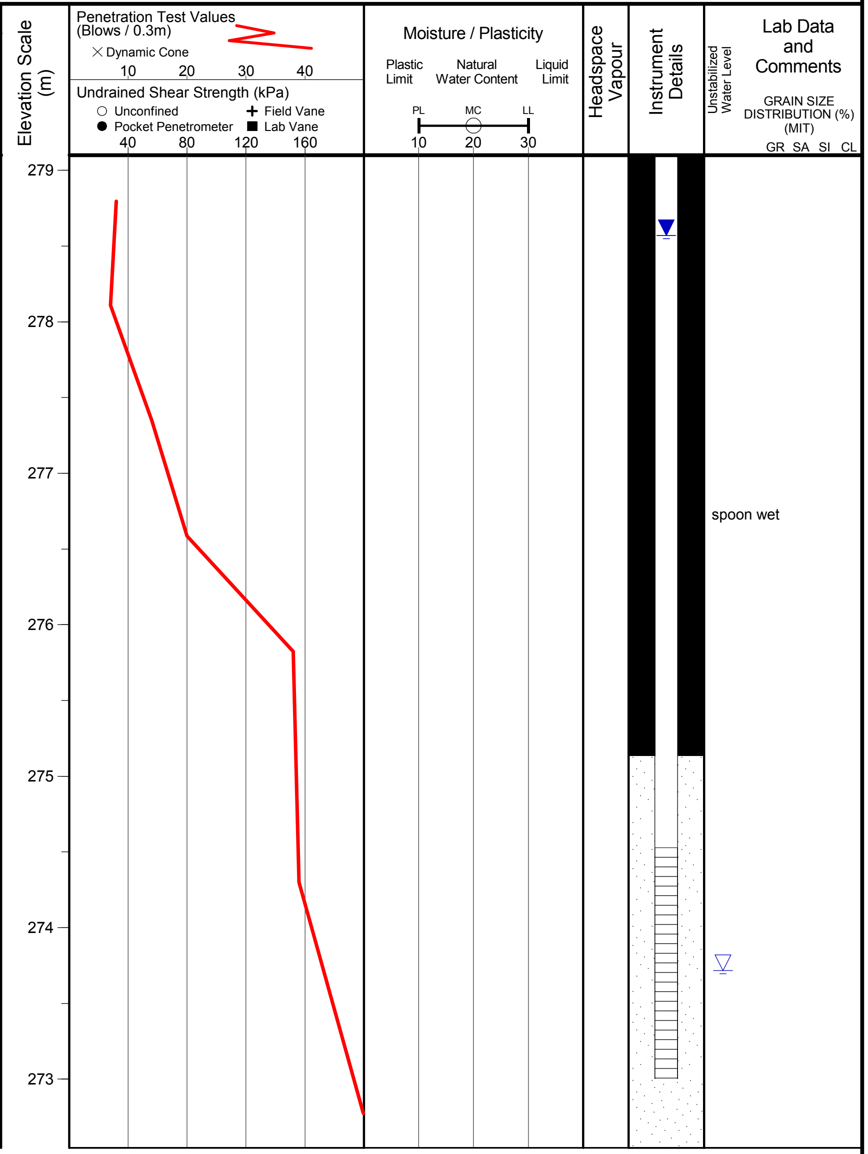
Position : E: 598480, N: 4865808 (UTM 17T)

Rig type : track-mounted

Elevation Datum : Geodetic (NAD83)

Drilling Method : Solid stem augers

Elev Depth (m)	Description (SOIL PROFILE)	Number (SAMPLES)	Type	SPT 'N' Value
279.1	**GROUND SURFACE**			
	350mm **TOPSOIL**	1	SS	8
278.7 0.4	**FILL**, silt, some sand, trace to some clay, trace organics, topsoil presence, firm, brown / grey, moist ...(REWORKED/DISTURBED)	2	SS	7
277.6 1.5	**SANDY SILT to SAND AND SILT**, trace clay, trace gravel, compact to dense, brown, moist	3	SS	14
		4	SS	20
		5	SS	38
	...grey below	6	SS	39
273.0 6.1	**SILT**, some clay to clayey silt, trace sand, trace gravel, hard, grey, moist (GLACIAL TILL)	7	SS	58
272.5 6.6	**END OF BOREHOLE**			



Unstabilized water level measured at 5.4m below ground surface; borehole was open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
May 24, 2013	0.5	278.6

BOREHOLE LOG 11

Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

Project No.: 11-13-3052
Date started : May 16, 2013
Sheet No. : 1 of 1

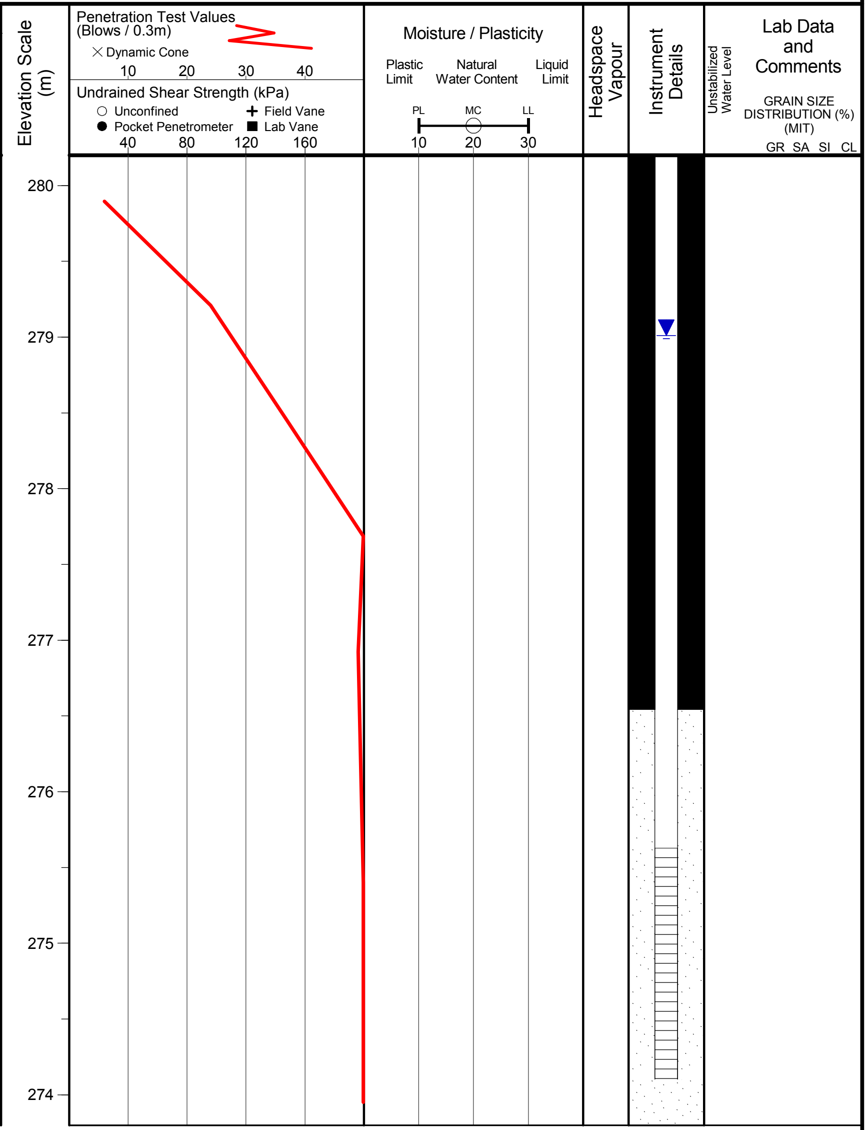
Position : E: 598392, N: 4865760 (UTM 17T)
Rig type : track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
280.2	**GROUND SURFACE**
	300mm **TOPSOIL**
279.9 0.3	Trace organics (WEATHERED/DISTURBED)
279.4 0.8	**SANDY SILT to SAND AND SILT**, trace clay, trace gravel, compact to very dense, brown, moist
	...grey below
273.8 6.4	

SAMPLES

Number	Type	SPT 'N' Value
1	SS	6
2	SS	24
3	SS	37
4	SS	62
5	SS	49
6	SS	62
7	SS	50 / 150mm



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
May 24, 2013	1.2	279.0

Terraprobe

BOREHOLE LOG 12

Client : Laurelpark Inc.
Project : Palgrave Estates II
Location : Caledon, Ontario

Project No.: 11-13-3052
Date started : May 16, 2013
Sheet No. : 1 of 1

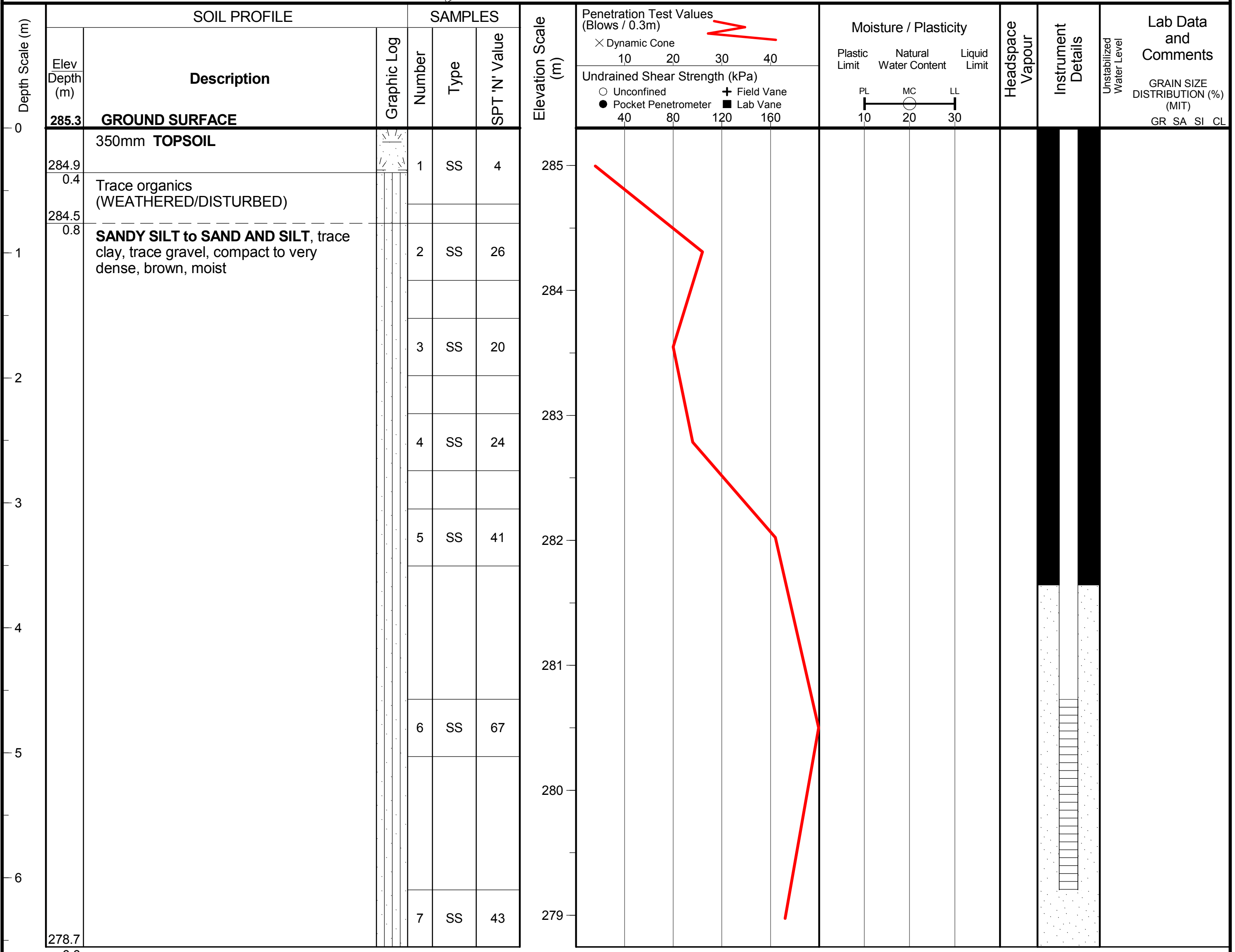
Position : E: 598168, N: 4865581 (UTM 17T)
Rig type : track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
285.3	GROUND SURFACE
	350mm **TOPSOIL**
284.9 0.4	Trace organics (WEATHERED/DISTURBED)
284.5 0.8	**SANDY SILT to SAND AND SILT**, trace clay, trace gravel, compact to very dense, brown, moist
278.7 6.6	

SAMPLES

Number	Type	SPT 'N' Value
1	SS	4
2	SS	26
3	SS	20
4	SS	24
5	SS	41
6	SS	67
7	SS	43

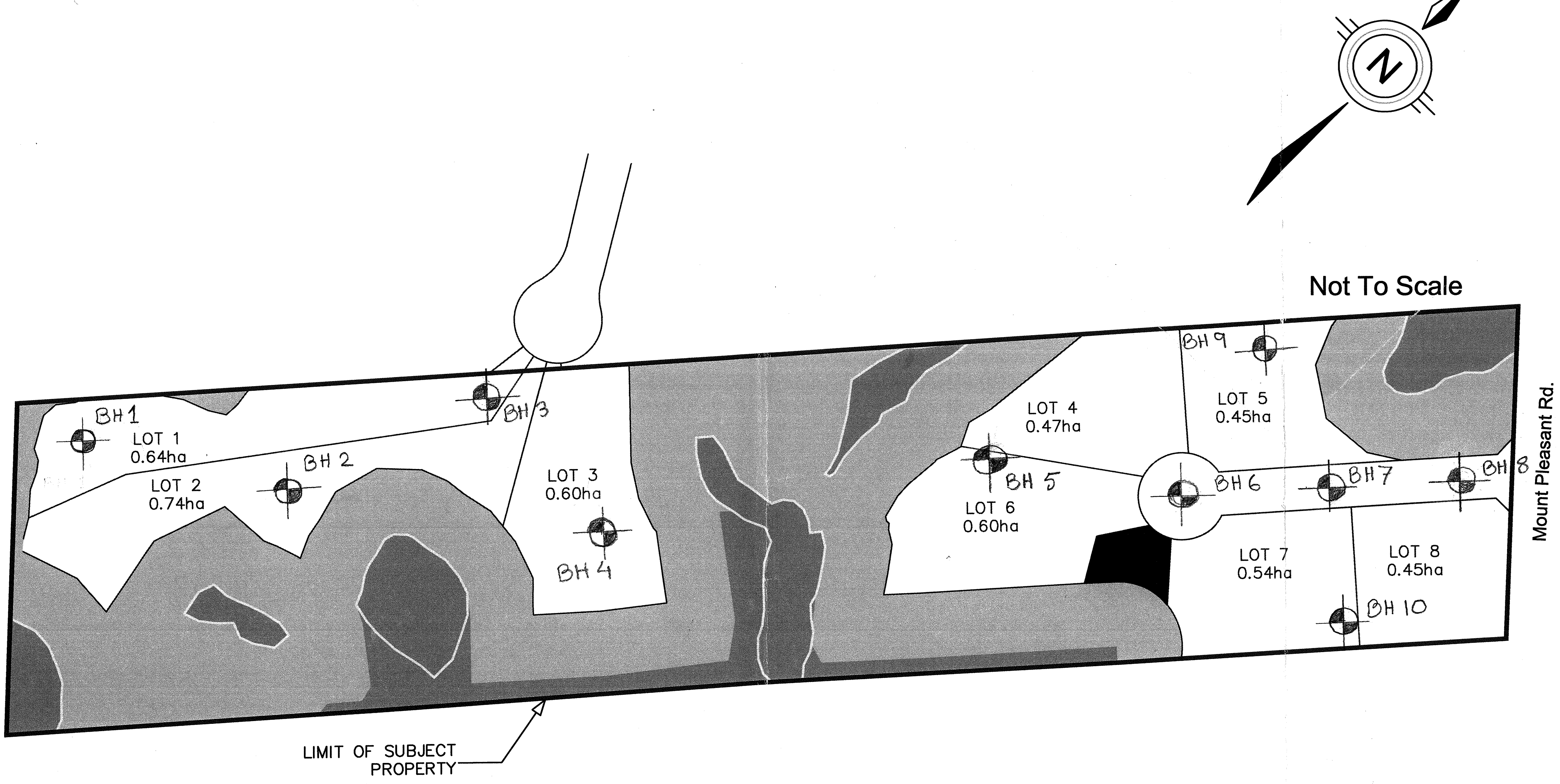


END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
May 24, 2013	dry	n/a



PROPOSED BOREHOLE LOCATIONS

FIGURE 1

Job No. 11-13-3052

FIGURE 8
PROPOSED LOTTING

PALGRAVE ESTATES II
CALEDON, ONTARIO

SCALE	NTS
DATE	2013 02 11
PROJECT No.	30477

LEGEND

▩	EZ 1
▨	EZ 2
■	S.W.M.

IBI
GROUP

SUITE 308
30 EGLINTON AVENUE WEST
MISSISSAUGA, ONTARIO
L5R 3E7
(905) 890-3550
www.ibigroup.com

APPENDIX C

MOECC Water Well Records

Well ID Number: 4903021

Well Audit Number: *none*
Well Tag Number: *none*

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

Well Location

Address of Well Location	*Township*	*Lot*	*Concession*
not available	Caledon Town (Albion)	019	CON 08
County/District/Municipality	*City/Town/Village*	*Province*	*Postal Code*
PEEL		ON	n/a
UTM Coordinates	*Municipal Plan and Sublot Number*	*Other*	
NAD83 — Zone 17 Easting: 598474.5 Northing: 4865673			

Overburden and Bedrock Materials Interval

General Colour	*Most Common Material*	*Other Materials*	*General Description*	*Depth* *From*	*To*
	CLAY	MSND		0 ft	12 ft
	CSND			12 ft	16 ft
BLUE	CLAY			16 ft	40 ft

Annular Space/Abandonment Sealing Record

Depth From	*To*	*Type of Sealant Used (Material and Type)*	*Volume Placed*

Method of Construction	**Well Use**
Boring	Domestic

Status of Well

Water Supply

Construction Record - Casing

Inside Diameter	*Open Hole OR material*	*Depth From*	*To*
30 inch	CONCRETE		40 ft

Construction Record - Screen

Outside Diameter	*MaterialX*	*Depth From*	*To*

Well Contractor and Well Technician Information

Well Contractor's Licence Number	4102

Results of Well Yield Testing

	Draw Down		*Recovery*	
	Time (min)	*Water level*	*Time (min)*	*Water level*
After test of well yield, water was CLEAR	SWL	15 ft		
	1			
If pumping discontinued, give reason	2			
Pump intake set at	3			
	4			
Pumping Rate 5 GPM	5			
Duration of Pumping	10			
Final water level	15			
If flowing give rate	20			
	25			
Recommended pump depth 38 ft	30			
	40			
Recommended pump rate 4 GPM	45			
Well Production PUMP	50			
Disinfected?	60			

Well ID Number: 4903634

Well Audit Number: *none*
Well Tag Number: *none*

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

Well Location

Address of Well Location	*Township*	*Lot*	*Concession*
not available	Caledon Town (Albion)	019	CON 08
County/District/Municipality	*City/Town/Village*	*Province*	*Postal Code*
PEEL		ON	n/a
UTM Coordinates	*Municipal Plan and Sublot Number*	*Other*	
NAD83 — Zone 17 Easting: 598239.5 Northing: 4865873			

Overburden and Bedrock Materials Interval

General Colour	*Most Common Material*	*Other Materials*	*General Description*	*Depth From*	*To*
BRWN	OBDN			0 ft	30 ft
BRWN	CSND			30 ft	36 ft
GREY	CLAY			36 ft	66 ft

Annular Space/Abandonment Sealing Record

Depth From	*To*	*Type of Sealant Used (Material and Type)*	*Volume Placed*

Method of Construction	**Well Use**
Boring	Domestic

Status of Well

Water Supply

Construction Record - Casing

Inside Diameter	*Open Hole OR material*	*Depth From*	*To*
30 inch	CONCRETE		66 ft

Construction Record - Screen

Outside Diameter	*MaterialX*	*Depth From*	*To*

Well Contractor and Well Technician Information

Well Contractor's Licence Number	1307

Results of Well Yield Testing

After test of well yield, water was	CLEAR
If pumping discontinued, give reason	
Pump intake set at	
Pumping Rate	6 GPM
Duration of Pumping	1 h:0 m
Final water level	56 ft
If flowing give rate	
Recommended pump depth	64 ft
Recommended pump rate	6 GPM
Well Production	BAILER
Disinfected?	

Draw Down		*Recovery*	
Time (min)	*Water level*	*Time (min)*	*Water level*
SWL	30 ft		
1			
2			
3			
4			
5			
10			
15		15	53 ft
20			
25			
30		30	50 ft
40			
45		45	47 ft
50			
60		60	44 ft

Well ID Number: 4904873

Well Audit Number: *none*
Well Tag Number: *none*

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

Well Location

Address of Well Location	*Township*	*Lot*	*Concession*
not available	Caledon Town (Albion)	019	CON 09
County/District/Municipality	*City/Town/Village*	*Province*	*Postal Code*
PEEL		ON	n/a
UTM Coordinates	*Municipal Plan and Sublot Number*	*Other*	
NAD83 — Zone 17 Easting: 598295.5 Northing: 4866057			

Overburden and Bedrock Materials Interval

General Colour	*Most Common Material*	*Other Materials*	*General Description*	*Depth From*	*To*
BLCK	LOAM			0 ft	3 ft
BRWN	CLAY	SAND		3 ft	26 ft
BLUE	CLAY			26 ft	71 ft
GREY	CLAY	SAND		71 ft	95 ft
	SAND	GRVL		95 ft	105 ft

Annular Space/Abandonment Sealing Record

Depth From	*To*	*Type of Sealant Used (Material and Type)*	*Volume Placed*

Method of Construction

Cable Tool

Well Use

Domestic

Status of Well

Water Supply

Construction Record - Casing

Inside Diameter	*Open Hole OR material*	*Depth From*	*To*
7 inch	STEEL		95 ft

Construction Record - Screen

Outside Diameter	*MaterialX*	*Depth From*	*To*
6 inch		95 ft	101 ft

Well Contractor and Well Technician Information

Well Contractor's Licence Number 3108

Results of Well Yield Testing

After test of well yield, water was	CLEAR	
If pumping discontinued, give reason		
Pump intake set at		
Pumping Rate	5 GPM	
Duration of Pumping	6 h:0 m	
Final water level	100 ft	
If flowing give rate		
Recommended pump depth	104 ft	
Recommended pump rate	5 GPM	
Well Production	PUMP	
Disinfected?		

Draw Down Time (min)	*Draw Down Water level*	*Recovery Time (min)*	*Recovery Water level*
SWL	18 ft		
1			
2			
3			
4			
5			
10			
15			
20			
25			
30			
40			
45			
50			
60			

Well ID Number: 4903059

Well Audit Number: *none*
Well Tag Number: *none*

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

Well Location

Address of Well Location	*Township*	*Lot*	*Concession*
not available	Caledon Town (Albion)	019	CON 08
County/District/Municipality	*City/Town/Village*	*Province*	*Postal Code*
PEEL		ON	n/a
UTM Coordinates	*Municipal Plan and Sublot Number*	*Other*	
NAD83 — Zone 17 Easting: 598564.5 Northing: 4865773			

Overburden and Bedrock Materials Interval

General Colour	*Most Common Material*	*Other Materials*	*General Description*	*Depth From*	*To*
	LOAM			0 ft	2 ft
BRWN	CSND	CLAY		2 ft	21 ft
GREY	CLAY	STNS		21 ft	27 ft
BLUE	CLAY			27 ft	40 ft

Annular Space/Abandonment Sealing Record

Depth From	*To*	*Type of Sealant Used (Material and Type)*	*Volume Placed*

Method of Construction

Boring

Well Use

Domestic

Status of Well

Water Supply

Construction Record - Casing

Inside Diameter	*Open Hole OR material*	*Depth From*	*To*
36 inch	CONCRETE		40 ft

Construction Record - Screen

Outside Diameter	*MaterialX*	*Depth From*	*To*

Well Contractor and Well Technician Information

Well Contractor's Licence Number 3612

Results of Well Yield Testing

After test of well yield, water was CLOUDY

If pumping discontinued, give reason

Pump intake set at

Pumping Rate 0 GPM

Duration of Pumping 1 h:0 m

Final water level 38 ft

If flowing give rate

Recommended pump depth 38 ft

Recommended pump rate 0 GPM

Well Production PUMP

Disinfected?

Draw Down		*Recovery*	
Time (min)	*Water level*	*Time (min)*	*Water level*
SWL	28 ft		
1			
2			
3			
4			
5			
10			
15			
20			
25			
30			
40			
45			
50			
60			

APPENDIX D

Water Quality Laboratory Results

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

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING,
85 BAYFIELD STREET, SUITE 400
BARRIE, ON L4M3A7
(705) 721-8451

ATTENTION TO: Drew West

PROJECT NO: 08-019c

AGAT WORK ORDER: 13T707868

MICROBIOLOGY ANALYSIS REVIEWED BY: Anthony Dapaah, PhD (Chem), Inorganic Lab Manager

WATER ANALYSIS REVIEWED BY: Elizabeth Polakowska, MSc (Animal Sci), PhD (Agri Sci), Inorganic Lab Supervisor

DATE REPORTED: Apr 26, 2013

PAGES (INCLUDING COVER): 13

VERSION*: 1

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

NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Microbiological Analysis (water)

DATE RECEIVED: 2013-04-22 **DATE REPORTED: 2013-04-26**

			SAMPLE DESCRIPTION:	MW-5 II	MW-3 I
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	4/21/2013	4/21/2013
Parameter	**Unit**	**G / S**	**RDL**	**4282874**	**4282984**
Escherichia coli	CFU/100mL	0	1	ND	ND
Total Coliforms	CFU/100mL	0	1	ND	ND
Fecal Coliform	CFU/100mL		1	ND	ND
Heterotrophic Plate Count	CFU/1mL		10	ND	ND

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to SDWA - Microbiology
4282874-4282984 ND - Not Detected.

Certified By:

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 13T707868

PROJECT NO: 08-019c

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

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING,

ATTENTION TO: Drew West

Water Quality Assessment (excl. Hg)

DATE RECEIVED: 2013-04-22

DATE REPORTED: 2013-04-26

			SAMPLE DESCRIPTION:	**Wetland 1**		**Wetland 2**		**Wetland 3**	**Wetland 4**	**Wetland 5**
			SAMPLE TYPE:	**Water**		**Water**		**Water**	**Water**	**Water**
			DATE SAMPLED:	**4/21/2013**		**4/21/2013**		**4/21/2013**	**4/21/2013**	**4/21/2013**
Parameter	**Unit**	**G / S**	**RDL**	**4282731**	**RDL**	**4282799**	**RDL**	**4282822**	**4282851**	**4282853**
Saturation pH				6.75		6.94		7.80	6.93	7.04
pH	pH Units	6.5-8.5	NA	8.13	NA	7.97	NA	7.84	7.61	7.95
Langlier Index				1.38		1.03		0.04	0.68	0.91
Alkalinity (as CaCO3)	mg/L		5	343	5	271	5	93	265	242
Bicarbonate (as CaCO3)	mg/L		5	343	5	271	5	93	265	242
Carbonate (as CaCO3)	mg/L		5	<5	5	<5	5	<5	<5	<5
Hydroxide (as CaCO3)	mg/L		5	<5	5	<5	5	<5	<5	<5
Electrical Conductivity	uS/cm		2	788	2	564	2	192	522	457
Fluoride	mg/L		0.25	<0.25	0.10	<0.10	0.05	<0.05	<0.05	<0.05
Chloride	mg/L		0.50	56.9	0.20	24.2	0.10	2.35	4.74	3.70
Nitrate as N	mg/L		0.25	<0.25	0.10	<0.10	0.05	<0.05	<0.05	<0.05
Nitrite as N	mg/L		0.25	<0.25	0.10	<0.10	0.05	<0.05	<0.05	<0.05
Bromide	mg/L		0.25	<0.25	0.10	<0.10	0.05	<0.05	<0.05	<0.05
Sulphate	mg/L		0.50	6.60	0.20	5.86	0.10	0.88	11.3	2.04
Calcium	mg/L		0.05	138	0.05	105	0.05	36.9	113	93.4
Magnesium	mg/L		0.05	7.89	0.05	6.47	0.05	2.12	4.06	5.15
Sodium	mg/L		0.05	31.8	0.05	11.4	0.05	0.81	2.21	1.47
Potassium	mg/L		0.05	2.14	0.05	1.74	0.05	2.29	1.00	4.39
Ammonia as N	mg/L		0.02	<0.02	0.02	0.03	0.02	<0.02	0.06	0.02
Phosphate as P	mg/L		0.50	<0.50	0.20	<0.20	0.10	<0.10	<0.10	<0.10
Total Phosphorus	mg/L	0.03	0.02	**0.06**	0.02	0.02	0.02	0.02	0.03	**0.05**
Reactive Silica	mg/L		0.05	11.7	0.05	5.73	0.05	0.51	5.29	9.94
Total Organic Carbon	mg/L		0.5	10.0	0.5	8.7	0.5	7.4	12.7	8.2
Colour	TCU		5	38	5	30	5	41	57	31
Turbidity	NTU		0.5	2.1	0.5	0.8	0.5	0.9	1.4	1.9
Aluminum	mg/L		0.004	0.027	0.004	0.030	0.004	0.028	0.055	0.035
Arsenic	mg/L	0.1	0.003	<0.003	0.003	<0.003	0.003	<0.003	<0.003	<0.003
Barium	mg/L		0.002	0.012	0.002	0.017	0.002	0.010	0.024	0.017
Boron	mg/L	0.20	0.010	0.029	0.010	0.015	0.010	0.013	<0.010	0.011
Cadmium	mg/L	0.0002	0.0001	<0.0001	0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L		0.003	<0.003	0.003	<0.003	0.003	<0.003	<0.003	<0.003

Certified By: Elizabeth Rolakowska

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING, **ATTENTION TO: Drew West**

Water Quality Assessment (excl. Hg)

DATE RECEIVED: 2013-04-22 **DATE REPORTED: 2013-04-26**

			SAMPLE DESCRIPTION:	Wetland 1		Wetland 2		Wetland 3	Wetland 4	Wetland 5
			SAMPLE TYPE:	Water		Water		Water	Water	Water
			DATE SAMPLED:	4/21/2013		4/21/2013		4/21/2013	4/21/2013	4/21/2013
Parameter	**Unit**	**G / S**	**RDL**	**4282731**	**RDL**	**4282799**	**RDL**	**4282822**	**4282851**	**4282853**
Copper	mg/L	0.005	0.003	<0.003	0.003	<0.003	0.003	<0.003	<0.003	<0.003
Iron	mg/L	0.3	0.010	0.197	0.010	0.096	0.010	0.179	**0.682**	0.202
Lead	mg/L	0.005	0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001
Manganese	mg/L		0.002	0.336	0.002	0.042	0.002	0.032	0.394	0.103
Molybdenum	mg/L	0.04	0.002	<0.002	0.002	<0.002	0.002	<0.002	<0.002	<0.002
Nickel	mg/L	0.025	0.003	<0.003	0.003	<0.003	0.003	<0.003	<0.003	<0.003
Selenium	mg/L	0.1	0.004	<0.004	0.004	<0.004	0.004	<0.004	<0.004	<0.004
Silver	mg/L	0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001
Strontium	mg/L		0.005	0.224	0.005	0.175	0.005	0.057	0.172	0.134
Thallium	mg/L	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	<0.0003	<0.0003
Tin	mg/L		0.002	<0.002	0.002	<0.002	0.002	<0.002	<0.002	<0.002
Titanium	mg/L		0.002	<0.002	0.002	<0.002	0.002	<0.002	<0.002	<0.002
Uranium	mg/L	0.005	0.002	<0.002	0.002	<0.002	0.002	<0.002	<0.002	<0.002
Vanadium	mg/L	0.005	0.002	<0.002	0.002	<0.002	0.002	<0.002	<0.002	<0.002
Zinc	mg/L	0.03	0.005	<0.005	0.005	<0.005	0.005	<0.005	**0.034**	<0.005
Total Dissolved Solids	mg/L		20	410	20	292	20	82	268	242
Total Hardness (as CaCO3)	mg/L		0.5	377	0.5	289	0.5	101	299	254
% Difference/ Ion Balance			0.1	2.2	0.1	0.8	0.1	4.1	3.7	2.8

Certified By: Elizabeth Rolakowska

Water Quality Assessment (excl. Hg)

DATE RECEIVED: 2013-04-22 **DATE REPORTED: 2013-04-26**

			SAMPLE DESCRIPTION:	MW-5 II	MW-3 I
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	4/21/2013	4/21/2013
Parameter	**Unit**	**G / S**	**RDL**	**4282874**	**4282984**
Saturation pH				6.97	6.85
pH	pH Units	6.5-8.5	NA	8.08	8.07
Langlier Index				1.11	1.22
Alkalinity (as CaCO3)	mg/L		5	238	286
Bicarbonate (as CaCO3)	mg/L		5	238	286
Carbonate (as CaCO3)	mg/L		5	<5	<5
Hydroxide (as CaCO3)	mg/L		5	<5	<5
Electrical Conductivity	uS/cm		2	613	654
Fluoride	mg/L		0.10	<0.10	<0.10
Chloride	mg/L		0.20	8.44	5.85
Nitrate as N	mg/L		0.10	15.4	14.2
Nitrite as N	mg/L		0.10	<0.10	<0.10
Bromide	mg/L		0.10	<0.10	<0.10
Sulphate	mg/L		0.20	26.8	13.5
Calcium	mg/L		0.05	104	117
Magnesium	mg/L		0.05	16.2	16.1
Sodium	mg/L		0.05	3.95	4.96
Potassium	mg/L		0.05	1.57	0.52
Ammonia as N	mg/L		0.02	0.06	<0.02
Phosphate as P	mg/L		0.20	<0.20	<0.20
Total Phosphorus	mg/L	0.03	0.02	0.03	0.02
Reactive Silica	mg/L		0.05	16.4	15.5
Total Organic Carbon	mg/L		0.5	5.0	1.7
Colour	TCU		5	<5	<5
Turbidity	NTU		0.5	<0.5	<0.5
Aluminum	mg/L		0.004	0.026	0.027
Arsenic	mg/L	0.1	0.003	<0.003	<0.003
Barium	mg/L		0.002	0.026	0.023
Boron	mg/L	0.20	0.010	<0.010	<0.010
Cadmium	mg/L	0.0002	0.0001	<0.0001	<0.0001
Chromium	mg/L		0.003	<0.003	<0.003

Certified By: Elizabeth Rolakowska

Certificate of Analysis

AGAT WORK ORDER: 13T707868
PROJECT NO: 08-019c

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING, **ATTENTION TO: Drew West**

Water Quality Assessment (excl. Hg)

DATE RECEIVED: 2013-04-22 **DATE REPORTED: 2013-04-26**

			SAMPLE DESCRIPTION:	MW-5 II	MW-3 I
			SAMPLE TYPE:	Water	Water
			DATE SAMPLED:	4/21/2013	4/21/2013
Parameter	Unit	G / S	RDL	4282874	4282984
Copper	mg/L	0.005	0.003	<0.003	<0.003
Iron	mg/L	0.3	0.010	<0.010	<0.010
Lead	mg/L	0.005	0.001	<0.001	<0.001
Manganese	mg/L		0.002	0.084	<0.002
Molybdenum	mg/L	0.04	0.002	0.005	<0.002
Nickel	mg/L	0.025	0.003	<0.003	<0.003
Selenium	mg/L	0.1	0.004	<0.004	<0.004
Silver	mg/L	0.0001	0.0001	<0.0001	<0.0001
Strontium	mg/L		0.005	0.198	0.203
Thallium	mg/L	0.0003	0.0003	<0.0003	<0.0003
Tin	mg/L		0.002	<0.002	<0.002
Titanium	mg/L		0.002	<0.002	<0.002
Uranium	mg/L	0.005	0.002	<0.002	<0.002
Vanadium	mg/L	0.005	0.002	<0.002	<0.002
Zinc	mg/L	0.03	0.005	<0.005	<0.005
Total Dissolved Solids	mg/L		20	336	360
Total Hardness (as CaCO3)	mg/L		0.5	326	358
% Difference/ Ion Balance			0.1	0.7	1.5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO (mg/L)

4282731-4282799 The RDLs were increased for anions to reflect a dilution of the samples prior to analysis.

4282874-4282984 The RDLs were increased for anions to reflect a dilution of the samples prior to analysis.

Certified By: Elizabeth Rolakowska

Guideline Violation

AGAT WORK ORDER: 13T707868

PROJECT NO: 08-019c

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

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING, **ATTENTION TO: Drew West**

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
4282731	Wetland 1	PWQO (mg/L)	Water Quality Assessment (excl. Hg)	Total Phosphorus	0.03	0.06
4282851	Wetland 4	PWQO (mg/L)	Water Quality Assessment (excl. Hg)	Iron	0.3	0.682
4282851	Wetland 4	PWQO (mg/L)	Water Quality Assessment (excl. Hg)	Zinc	0.03	0.034
4282853	Wetland 5	PWQO (mg/L)	Water Quality Assessment (excl. Hg)	Total Phosphorus	0.03	0.05

Quality Assurance

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING, **AGAT WORK ORDER: 13T707868**

PROJECT NO: 08-019c **ATTENTION TO: Drew West**

Microbiology Analysis

RPT Date: Apr 26, 2013			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Microbiological Analysis (water)															
Escherichia coli	1		ND	ND	NA	< 1	NA			NA			NA		
Total Coliforms	1		180	162	10.5%	< 1	NA			NA			NA		
Fecal Coliform	1		4	2	NA	< 1	NA			NA			NA		
Heterotrophic Plate Count	1	4282874	ND	ND	NA	< 10	NA			NA			NA		

Comments: ND - Not Detected, ; NA - % RPD Not Applicable
NA - % RPD Not Reportable based on the number of colonies count acceptable for RPD calculation
NA - Not Applicable

Certified By:

Quality Assurance

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING, **AGAT WORK ORDER: 13T707868**

PROJECT NO: 08-019c **ATTENTION TO: Drew West**

Water Analysis

RPT Date: Apr 26, 2013			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Water Quality Assessment (excl. Hg)															
pH	4280718		7.97	8.07	1.2%	NA	100%	90%	110%	NA			NA		
Alkalinity (as CaCO3)	4280718		223	225	0.8%	< 5	97%	80%	120%	NA			NA		
Bicarbonate (as CaCO3)	4280718		223	225	0.8%	< 5	NA	80%	120%	NA			NA		
Carbonate (as CaCO3)	4280718		<5	<5	0.0%	< 5	NA	80%	120%	NA			NA		
Hydroxide (as CaCO3)	4280718		<5	<5	0.0%	< 5	NA	80%	120%	NA			NA		
Electrical Conductivity	4280718		526	524	0.4%	< 2	97%	80%	120%	NA			NA		
Fluoride	4282731	4282731	<0.05	<0.05	0.0%	< 0.05	98%	90%	110%	95%	90%	110%	100%	80%	120%
Chloride	4282731	4282731	56.9	55.8	1.9%	< 0.10	101%	90%	110%	97%	90%	110%	97%	80%	120%
Nitrate as N	4282731	4282731	<0.05	<0.05	0.0%	< 0.05	95%	90%	110%	110%	90%	110%	110%	80%	120%
Nitrite as N	4282731	4282731	<0.05	<0.05	0.0%	< 0.05	NA	90%	110%	107%	90%	110%	108%	80%	120%
Bromide	4282731	4282731	<0.05	<0.05	0.0%	< 0.05	110%	90%	110%	108%	90%	110%	95%	80%	120%
Sulphate	4282731	4282731	6.60	6.51	1.3%	< 0.10	108%	90%	110%	97%	90%	110%	99%	80%	120%
Calcium	1	4282799	105	108	2.8%	< 0.05	100%	90%	110%	101%	90%	110%	108%	70%	130%
Magnesium	1	4282799	6.47	6.48	0.2%	< 0.05	101%	90%	110%	102%	90%	110%	108%	70%	130%
Sodium	1	4282799	11.4	11.7	2.6%	< 0.05	96%	90%	110%	97%	90%	110%	101%	70%	130%
Potassium	1	4282799	1.74	1.74	0.0%	< 0.05	98%	90%	110%	98%	90%	110%	103%	70%	130%
Ammonia as N	1	4282731	< 0.02	< 0.02	0.0%	< 0.02	100%	90%	110%	105%	90%	110%	99%	80%	120%
Phosphate as P	4282731	4282731	<0.10	<0.10	0.0%	< 0.10	106%	90%	110%	107%	90%	110%	103%	80%	120%
Total Phosphorus	1		0.06	0.06	0.0%	< 0.02	94%	90%	110%	102%	90%	110%	96%	80%	120%
Reactive Silica	1	4282874	16.4	16.4	0.0%	< 0.05	105%	90%	110%	106%	90%	110%	82%	80%	120%
Total Organic Carbon	1		1.0	1.1	9.5%	< 0.5	99%	90%	110%	105%	90%	110%	104%	80%	120%
Colour	1	4282731	38	38	0.0%	< 5	103%	90%	110%	NA			NA		
Turbidity	1		16.3	16.2	0.6%	< 0.5	97%	90%	110%	NA			NA		
Aluminum	1	4282984	0.027	0.024	11.8%	< 0.004	99%	90%	110%	100%	90%	110%	109%	70%	130%
Arsenic	1	4282984	< 0.003	< 0.003	0.0%	< 0.003	102%	90%	110%	103%	90%	110%	109%	70%	130%
Barium	1	4282984	0.023	0.022	4.4%	< 0.002	102%	90%	110%	101%	90%	110%	108%	70%	130%
Boron	1	4282984	< 0.010	< 0.010	0.0%	< 0.010	107%	90%	110%	104%	90%	110%	107%	70%	130%
Cadmium	1	4282984	< 0.0001	< 0.0001	0.0%	< 0.0001	102%	90%	110%	101%	90%	110%	110%	70%	130%
Chromium	1	4282984	< 0.003	< 0.003	0.0%	< 0.003	93%	90%	110%	92%	90%	110%	112%	70%	130%
Copper	1	4282984	< 0.003	< 0.003	0.0%	< 0.003	96%	90%	110%	95%	90%	110%	99%	70%	130%
Iron	1	4282984	< 0.010	< 0.010	0.0%	< 0.010	100%	90%	110%	93%	90%	110%	90%	70%	130%
Lead	1	4282984	< 0.001	< 0.001	0.0%	< 0.001	93%	90%	110%	92%	90%	110%	100%	70%	130%
Manganese	1	4282984	< 0.002	< 0.002	0.0%	< 0.002	91%	90%	110%	92%	90%	110%	100%	70%	130%
Molybdenum	1	4282984	< 0.002	< 0.002	0.0%	< 0.002	100%	90%	110%	98%	90%	110%	105%	70%	130%
Nickel	1	4282984	< 0.003	< 0.003	0.0%	< 0.003	105%	90%	110%	106%	90%	110%	114%	70%	130%
Selenium	1	4282984	< 0.004	< 0.004	0.0%	< 0.004	101%	90%	110%	94%	90%	110%	103%	70%	130%
Silver	1	4282984	< 0.0001	< 0.0001	0.0%	< 0.0001	105%	90%	110%	114%	90%	110%	128%	70%	130%
Strontium	1	4282984	0.203	0.187	8.2%	< 0.005	94%	90%	110%	93%	90%	110%	103%	70%	130%
Thallium	1	4282984	< 0.0003	< 0.0003	0.0%	< 0.0003	102%	90%	110%	106%	90%	110%	113%	70%	130%

Quality Assurance

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING, **AGAT WORK ORDER: 13T707868**

PROJECT NO: 08-019c **ATTENTION TO: Drew West**

Water Analysis (Continued)

RPT Date: Apr 26, 2013			**DUPLICATE**			**Method Blank**	**REFERENCE MATERIAL**			**METHOD BLANK SPIKE**			**MATRIX SPIKE**		
PARAMETER	**Batch**	**Sample Id**	**Dup #1**	**Dup #2**	**RPD**		**Measured Value**	**Acceptable Limits**		**Recovery**	**Acceptable Limits**		**Recovery**	**Acceptable Limits**	
								Lower	**Upper**		**Lower**	**Upper**		**Lower**	**Upper**
Tin	1	4282984	< 0.002	< 0.002	0.0%	< 0.002	95%	90%	110%	97%	90%	110%	92%	70%	130%
Titanium	1	4282984	< 0.002	< 0.002	0.0%	< 0.002	102%	90%	110%	97%	90%	110%	104%	70%	130%
Uranium	1	4282984	< 0.002	< 0.002	0.0%	< 0.002	102%	90%	110%	104%	90%	110%	88%	70%	130%
Vanadium	1	4282984	< 0.002	< 0.002	0.0%	< 0.002	102%	90%	110%	98%	90%	110%	107%	70%	130%
Zinc	1	4282984	< 0.005	< 0.005	0.0%	< 0.005	95%	90%	110%	95%	90%	110%	100%	70%	130%
Total Dissolved Solids	1	4282874	336	326	3.0%	< 20	92%	80%	120%	NA			NA		

Comments: QA Qualifier for metals (Ag): In a multielement scan for lab control standards and matrix spikes, up to 10% of analytes may exceed the quoted limits by up to 10% absolute and it is considered acceptable.

Certified By: Elizabeth Rolakowska

QA Violation

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING, **AGAT WORK ORDER: 13T707868**

PROJECT NO: 08-019c **ATTENTION TO: Drew West**

RPT Date: Apr 26, 2013			REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Sample Id	Sample Description	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
				Lower	Upper		Lower	Upper		Lower	Upper
Water Quality Assessment (excl. Hg)											
Silver	4282984	Wetland 1	105%	90%	110%	114%	90%	110%	128%	70%	130%

Comments: QA Qualifier for metals (Ag): In a multielement scan for lab control standards and matrix spikes, up to 10% of analytes may exceed the quoted limits by up to 10% absolute and it is considered acceptable.

Method Summary

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING,

AGAT WORK ORDER: 13T707868

PROJECT NO: 08-019c

ATTENTION TO: Drew West

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Total Coliforms	MIC-93-7010	EPA 1604	Membrane Filtration
Fecal Coliform	MIC-93-7000	SM 9222 D	MF/INCUBATOR
Heterotrophic Plate Count	MIC-93-7020	SM 9215C	Spread Plate

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Method Summary

CLIENT NAME: AZIMUTH ENVIRONMENTAL CONSULTING, **AGAT WORK ORDER: 13T707868**

PROJECT NO: 08-019c **ATTENTION TO: Drew West**

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Saturation pH		SM 2320 B	CALCULATION
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Langlier Index			CALCULATION
Alkalinity (as CaCO3)	INOR-93-6000	SM 2320 B	PC TITRATE
Bicarbonate (as CaCO3)	INOR-93-6000	SM 2320 B	PC TITRATE
Carbonate (as CaCO3)	INOR-93-6000	SM 2320 B	PC TITRATE
Hydroxide (as CaCO3)	INOR-93-6000	SM 2320 B	PC TITRATE
Electrical Conductivity	INOR-93-6000	SM 2510 B	PC TITRATE
Fluoride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Bromide	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Calcium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Magnesium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Sodium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Potassium	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Ammonia as N	INOR-93-6002	AQ2 EPA-103A & SM 4500 NH3-F	AQ-2 DISCRETE ANALYZER
Phosphate as P	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Total Phosphorus	INOR-93-6022	SM 4500-P B&E	SPECTROPHOTOMETER
Reactive Silica	INOR-93-6047	AQ2 EPA-122A & SM 4500 SiO2 D	AQ2 DISCRETE ANALYSER
Total Organic Carbon	INOR-93-6049	EPA 415.1 & SM 5310	SHIMADZU CARBON ANALYZER
Colour	INOR-93-6046	SM 2120 B	SPECTROPHOTOMETER
Turbidity	INOR-93-6044	SM 2130 B	NEPHELOMETER
Aluminum	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Barium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Boron	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Cadmium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Chromium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Copper	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Iron	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Lead	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Manganese	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Nickel	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Selenium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Silver	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Strontium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Thallium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Tin	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Titanium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Uranium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Zinc	MET-93-6103	EPA SW-846 6020A & 200.8	ICP-MS
Total Dissolved Solids	INOR-93-6028	SM 2540 C	BALANCE
Total Hardness (as CaCO3)	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
% Difference/ Ion Balance		SM 1030 E	CALCULATION

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only

Arrival Temperature: 70 . 7.2 . 7.4

AGAT WO #:

Lab Temperature: 5.0 5.2 5.4

Notes: 13T707868

Client Information

Company: Azimuth Environmental

Contact: Drew West

Address: 85 Bayfield Street, Suite 400
Barrie, ON L4M 3A7

Phone: (705) 721-8451 Fax: (705) 721-8926

Project: 08-019c PO:

AGAT Quotation #:

Please note, if quotation number is not provided, client will be billed full price for analysis.

Regulatory Requirements

☐ Regulation 153/04 (reg. 511 Amend.)
Table ______ Indicate one
☐ Ind/Com
☐ Res/Park
☐ Agriculture

Soil Texture (*check one*)
☐ Coarse ☐ Fine

☐ Sewer Use
Region ______ Indicate one
☐ Sanitary
☐ Storm

☐ Regulation 558
☐ CCME
☐ Other (*specify*)
☑ Prov. Water Quality Objectives (PWQO)
☐ None

Turnaround Time Required (TAT) Required*

Regular TAT
☐ 5 to 7 Working Days

Rush TAT (please provide prior notification)
Rush Surcharges Apply
☑ 3 Working Days
☐ 2 Working Days
☐ 1 Working Day

OR

Date Required (Rush surcharges may apply):

**TAT is exclusive of weekends and statutory holidays*

Invoice To

Same: Yes ☑ No ☐

Company:

Contact: Lorna Salgado

Address:

Is this a drinking water sample?
(potable water intended for human consumption)
☐ Yes ☑ No

If "Yes", please use the
Drinking Water Chain of Custody Form

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

Legend Matrix

GW	Ground Water	**O**	Oil
SW	Surface Water	**P**	Paint
SD	Sediment	**S**	Soil

Report Information – reports to be sent to:

1. Name: Drew West
Email: drew@azimuthenvironmental.com

2. Name:
Email:

Sample Identification	Date Sampled	Time Sampled	Sample Matrix	# of Containers	Comments Site/Sample Information	Metals and Inorganics	Metal Scan	Hydride Forming Metals	Client Custom Metals	ORPs: ☐ B-HWS ☐ Cl- ☐ CN- ☐ EC ☐ FOC ☐ Cr+6- ☐ SAR ☐ NO_3/NO_2 ☐ N- Total ☐ Hg ☐ pH	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3/NO_2	VOC: ☐ VOC ☐ THM ☐ BTEX	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use	94-085	94-086	94-088 (microbiology)
Wetland 1	Apr 21	12:00pm	SW	3																	X	X	
Wetland 2	↓	↓	SW	3																	X	X	
Wetland 3	↓	↓	SW	3																	X	X	
Wetland 4	↓	↓	SW	3																	X	X	
Wetland 5	↓	↓	SW	3																	X	X	
MW-5 I	↓	1:00pm	GW	4																	X	X	X
MW-3 I	↓	1:30pm	GW	4																	X	X	X

Samples Relinquished By (Print Name and Sign): Drew West	Date/Time Apr. 22/13	Samples Received By (Print Name and Sign): H. Gilmour 22 Apr 13	Date/Time 10:20	Pink Copy - Client Yellow Copy - AGAT White Copy- AGAT	Page 1 of 1
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time 12:30		Nº: 185966

APPENDIX E

Features-Based Water Balance Summary Tables

TABLE A: Wetland 1 - Features Based Water Balance Summary

Catchment for Wetland 1

Pre-development Runoff & Infiltration

		1983	1984	1985	1986	1987	1988	1989	1990	1991
runoff	spring	1218.0	874.7	870.9	773.5	756.5	478.1	790.7	1071.2	411.0
	summer	270.3	143.8	552.8	935.4	104.4	42.7	566.2	264.9	9.7
	fall	686.7	683.9	1183.3	1355.5	936.9	1269.5	1039.4	1270.1	576.7
	winter	1098.5	1111.0	1373.0	899.9	807.2	1054.1	885.3	1267.1	748.8
	annual	3273.5	2813.3	3980.0	3964.3	2605.1	2844.4	3281.6	3873.3	1746.1
infiltration	spring	659.0	473.3	471.2	418.5	409.4	258.7	427.8	579.6	222.4
	summer	146.3	77.8	299.1	506.2	56.5	23.1	306.4	143.3	5.2
	fall	371.5	370.0	640.3	733.4	507.0	686.9	562.4	687.3	312.0
	winter	594.4	601.1	742.9	487.0	436.8	570.4	479.1	685.6	405.2
	annual	1771.3	1522.3	2153.6	2145.1	1409.6	1539.1	1775.7	2095.8	944.8
	total	5044.7	4335.5	6133.6	6109.4	4014.7	4383.6	5057.3	5969.2	2690.9

		1992	1993	1994	1995	1996	1997	1998	1999	2000
runoff	spring	935.4	549.3	857.4	861.2	1124.2	895.1	930.6	542.9	1090.6
	summer	890.4	372.8	29.0	11.1	816.2	302.2	314.3	279.8	1008.0
	fall	1378.2	539.6	592.8	1340.1	969.1	681.1	208.1	806.2	612.9
	winter	918.6	992.4	815.1	1117.1	1257.4	1117.1	943.7	1272.6	1087.7
	annual	4122.7	2454.0	2294.2	3329.6	4166.9	2995.6	2396.7	2901.5	3799.2
infiltration	spring	506.2	297.2	463.9	466.0	608.3	484.3	503.5	293.8	590.1
	summer	481.8	201.7	15.7	6.0	441.7	163.5	170.1	151.4	545.4
	fall	745.7	292.0	320.7	725.1	524.4	368.5	112.6	436.2	331.6
	winter	497.1	537.0	441.1	604.5	680.3	604.5	510.6	688.6	588.6
	annual	2230.8	1327.9	1241.4	1801.6	2254.7	1620.9	1296.8	1570.0	2055.7
	total	6353.4	3781.9	3535.6	5131.2	6421.6	4616.4	3693.5	4471.5	5854.9

TABLE A: Wetland 1 - Features Based Water Balance Summary

Catchment for Wetland 1

Pre-development Runoff & Infiltration

		2001	2002	2003	2004	2005	2006	2007	2008	2009
runoff	spring	625.6	1236.9	564.9	1197.9	801.0	1102.7	769.5	1192.3	934.3
	summer	309.0	286.7	335.8	255.0	820.1	270.8	0.0	192.9	514.3
	fall	1183.9	666.7	1265.9	568.3	925.5	1125.1	529.6	660.8	669.5
	winter	879.0	587.4	1101.6	1243.1	1496.6	1841.0	1663.3	2999.2	1425.5
	annual	2997.5	2777.8	3268.3	3264.4	4043.2	4339.7	2962.3	5045.1	3543.7
infiltration	spring	338.5	669.3	305.7	648.2	433.4	596.7	416.3	645.2	505.6
	summer	167.2	155.1	181.7	138.0	443.7	146.5	0.0	104.4	278.3
	fall	640.6	360.8	685.0	307.5	500.8	608.8	286.6	357.5	362.3
	winter	475.6	317.9	596.1	672.7	809.8	996.2	900.0	1622.8	771.3
	annual	1622.0	1503.0	1768.4	1766.3	2187.8	2348.2	1602.9	2729.9	1917.5
	total	4619.5	4280.8	5036.7	5030.7	6231.0	6687.8	4565.2	7775.0	5461.1

		2010	2011	2012	2013	2014	2015	Average
runoff	spring	1045.4	1421.6	417.2	1085.1	533.5	501.6	804.9
	summer	934.0	208.2	356.5	570.5	644.9	402.1	321.1
	fall	882.4	840.6	1102.4	867.0	723.9	767.0	1000.2
	winter	1128.9	1661.0	880.0	1332.5	1013.2	1002.5	1027.2
	annual	3990.6	4131.4	2756.2	3855.1	2915.5	2673.3	3153.5
infiltration	spring	565.7	769.2	225.8	587.2	288.7	271.4	435.6
	summer	505.4	112.6	192.9	308.7	349.0	217.6	173.8
	fall	477.4	454.9	596.5	469.1	391.7	415.0	541.2
	winter	610.8	898.8	476.2	721.0	548.3	542.5	555.8
	annual	2159.3	2235.5	1491.3	2086.0	1577.6	1446.5	1706.4
	total	6150.0	6366.8	4247.5	5941.1	4493.1	4119.9	4859.9

TABLE A: Wetland 1 - Features Based Water Balance Summary

Catchment for Wetland 1

Post-Development Runoff & Infiltration

		1983	1984	1985	1986	1987	1988	1989	1990	1991
runoff to wetland	spring	1177.9	845.9	842.3	748.0	731.6	462.3	764.7	1036.0	397.5
	summer	261.4	139.0	534.7	904.7	101.0	41.3	547.6	256.2	9.4
	fall	664.1	661.4	1144.4	1310.9	906.1	1227.8	1005.2	1228.4	557.7
	winter	1062.4	1074.4	1327.8	870.4	780.7	1019.4	856.2	1225.4	724.1
	annual to SWMP	179.4	154.2	218.1	217.2	142.7	155.9	179.8	212.2	95.7
	annual to wetland	3165.8	2720.8	3849.1	3834.0	2519.4	2750.9	3173.7	3746.0	1688.7
	annual total	3345.2	2874.9	4067.2	4051.2	2662.2	2906.8	3353.5	3958.2	1784.4
infiltration	spring	632.4	454.1	452.1	401.6	392.8	248.2	410.5	556.2	213.4
	summer	140.3	74.6	287.0	485.7	54.2	22.2	294.0	137.5	5.0
	fall	356.5	355.0	614.3	703.7	486.4	659.1	539.6	659.4	299.4
	winter	570.3	576.8	712.8	467.2	419.1	547.3	459.7	657.8	388.7
	annual	1699.5	1460.6	2066.3	2058.2	1352.5	1476.8	1703.7	2011.0	906.5
	total	4865.3	4181.4	5915.5	5892.2	3871.9	4227.7	4877.5	5757.0	2595.3

		1992	1993	1994	1995	1996	1997	1998	1999	2000
runoff to wetland	spring	904.7	531.2	829.2	832.9	1087.2	865.7	900.0	525.0	1054.8
	summer	861.2	360.5	28.0	10.7	789.4	292.3	304.0	270.6	974.8
	fall	1332.9	521.9	573.3	1296.1	937.2	658.7	201.2	779.7	592.7
	winter	888.4	959.8	788.3	1080.4	1216.0	1080.4	912.7	1230.8	1051.9
	annual to SWMP	225.9	134.5	125.7	182.4	228.3	164.1	131.3	159.0	208.2
	annual to wetland	3987.1	2373.4	2218.8	3220.1	4029.9	2897.1	2317.9	2806.1	3674.3
	annual total	4213.0	2507.8	2344.5	3402.5	4258.2	3061.2	2449.2	2965.1	3882.5
infiltration	spring	485.6	285.2	445.1	447.1	583.7	464.7	483.1	281.9	566.2
	summer	462.3	193.5	15.0	5.8	423.8	156.9	163.2	145.3	523.3
	fall	715.5	280.2	307.8	695.8	503.1	353.6	108.0	418.6	318.2
	winter	476.9	515.2	423.2	580.0	652.8	580.0	490.0	660.7	564.7
	annual	2140.4	1274.1	1191.1	1728.6	2163.4	1555.2	1244.3	1506.4	1972.5
	total	6127.5	3647.4	3409.9	4948.7	6193.2	4452.3	3562.2	4312.5	5646.7

TABLE A: Wetland 1 - Features Based Water Balance Summary

Catchment for Wetland 1

Post-Development Runoff & Infiltration

		2001	2002	2003	2004	2005	2006	2007	2008	2009
runoff to wetland	spring	605.1	1196.3	546.4	1158.5	774.7	1066.5	744.2	1153.1	903.6
	summer	298.8	277.2	324.8	246.6	793.1	261.9	0.0	186.5	497.4
	fall	1145.0	644.8	1224.3	549.6	895.1	1088.1	512.2	639.0	647.5
	winter	850.1	568.1	1065.4	1202.3	1447.4	1780.5	1608.6	2900.6	1378.6
	annual to SWMP	164.2	152.2	179.1	178.9	221.5	237.8	162.3	276.4	194.2
	annual to wetland	2899.0	2686.4	3160.8	3157.0	3910.3	4197.0	2864.9	4879.2	3427.2
	annual total	3063.2	2838.6	3339.9	3335.9	4131.8	4434.8	3027.3	5155.7	3621.3
infiltration	spring	324.8	642.2	293.3	621.9	415.9	572.5	399.5	619.0	485.1
	summer	160.4	148.8	174.3	132.4	425.8	140.6	0.0	100.1	267.0
	fall	614.7	346.1	657.2	295.1	480.5	584.1	275.0	343.1	347.6
	winter	456.4	305.0	572.0	645.4	777.0	955.8	863.5	1557.1	740.1
	annual	1556.3	1442.1	1696.8	1694.8	2099.1	2253.1	1538.0	2619.3	1839.8
	total	4455.2	4128.6	4857.6	4851.8	6009.4	6450.0	4402.9	7498.5	5266.9

		2010	2011	2012	2013	2014	2015	Average
runoff to wetland	spring	1011.1	1374.9	403.5	1049.4	515.9	485.2	778.5
	summer	903.3	201.3	344.7	551.8	623.7	388.9	310.6
	fall	853.3	813.0	1066.2	838.5	700.1	741.8	967.3
	winter	1091.8	1606.4	851.1	1288.7	979.9	969.6	993.4
	annual to SWMP	218.7	226.4	151.0	211.2	159.8	146.5	172.8
	annual to wetland	3859.4	3995.5	2665.5	3728.4	2819.6	2585.5	3049.8
	annual total	4078.1	4221.9	2816.6	3939.6	2979.4	2731.9	3222.6
infiltration	spring	542.8	738.1	216.6	563.4	277.0	260.4	417.9
	summer	484.9	108.1	185.1	296.2	334.8	208.8	166.7
	fall	458.1	436.4	572.3	450.1	375.8	398.2	519.3
	winter	586.1	862.3	456.9	691.8	526.1	520.5	533.3
	annual	2071.9	2144.9	1430.9	2001.5	1513.7	1387.9	1637.2
	total	5931.3	6140.5	4096.5	5729.8	4333.3	3973.4	4687.1

TABLE A: Wetland 1 - Features Based Water Balance Summary

Catchment for Wetland 1

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		1983	1984	1985	1986	1987	1988	1989	1990	1991
runoff	spring	-40	-29	-29	-25	-25	-16	-26	-35	-14
	summer	-9	-5	-18	-31	-3	-1	-19	-9	-0
	fall	-23	-22	-39	-45	-31	-42	-34	-42	-19
	winter	-36	-37	-45	-30	-27	-35	-29	-42	-25
	annual to wetland	-108	-92	-131	-130	-86	-94	-108	-127	-57
	percent change to wetland	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%
	annual to SWMP	179	154	218	217	143	156	180	212	96
infiltration	spring	-27	-19	-19	-17	-17	-10	-17	-23	-9
	summer	-6	-3	-12	-21	-2	-1	-12	-6	-0
	fall	-15	-15	-26	-30	-21	-28	-23	-28	-13
	winter	-24	-24	-30	-20	-18	-23	-19	-28	-16
	annual	-72	-62	-87	-87	-57	-62	-72	-85	-38
	annual mitigation	67	53	81	95	56	55	74	81	31
	percent change	-0.2%	-0.6%	-0.3%	0.4%	-0.1%	-0.4%	0.1%	-0.2%	-0.8%

TABLE A: Wetland 1 - Features Based Water Balance Summary

Catchment for Wetland 1

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		1992	1993	1994	1995	1996	1997	1998	1999	2000
runoff	spring	-31	-18	-28	-28	-37	-29	-31	-18	-36
	summer	-29	-12	-1	-0	-27	-10	-10	-9	-33
	fall	-45	-18	-19	-44	-32	-22	-7	-27	-20
	winter	-30	-33	-27	-37	-41	-37	-31	-42	-36
	annual to wetland	-136	-81	-75	-109	-137	-98	-79	-95	-125
	percent change to wetland	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%
	annual to SWMP	226	134	126	182	228	164	131	159	208

infiltration	spring	-21	-12	-19	-19	-25	-20	-20	-12	-24
	summer	-20	-8	-1	-0	-18	-7	-7	-6	-22
	fall	-30	-12	-13	-29	-21	-15	-5	-18	-13
	winter	-20	-22	-18	-24	-28	-24	-21	-28	-24
	annual	-90	-54	-50	-73	-91	-66	-53	-64	-83
	annual mitigation	99	45	46	69	90	58	45	50	84
	percent change	0.4%	-0.6%	-0.4%	-0.2%	-0.1%	-0.5%	-0.6%	-0.8%	0.0%

TABLE A: Wetland 1 - Features Based Water Balance Summary

Catchment for Wetland 1

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		2001	2002	2003	2004	2005	2006	2007	2008	2009
runoff	spring	-21	-41	-19	-39	-26	-36	-25	-39	-31
	summer	-10	-9	-11	-8	-27	-9	0	-6	-17
	fall	-39	-22	-42	-19	-30	-37	-17	-22	-22
	winter	-29	-19	-36	-41	-49	-61	-55	-99	-47
	annual to wetland	-99	-91	-107	-107	-133	-143	-97	-166	-117
	percent change to wetland	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%
	annual to SWMP	164	152	179	179	222	238	162	276	194
infiltration	spring	-14	-27	-12	-26	-18	-24	-17	-26	-20
	summer	-7	-6	-7	-6	-18	-6	0	-4	-11
	fall	-26	-15	-28	-12	-20	-25	-12	-14	-15
	winter	-19	-13	-24	-27	-33	-40	-36	-66	-31
	annual	-66	-61	-72	-72	-89	-95	-65	-111	-78
	annual mitigation	66	68	67	63	79	77	40	63	66
	percent change	-0.0%	0.5%	-0.3%	-0.5%	-0.4%	-0.8%	-1.5%	-1.7%	-0.6%

TABLE A: Wetland 1 - Features Based Water Balance Summary

Catchment for Wetland 1

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		2010	2011	2012	2013	2014	2015	Average
runoff	spring	-34	-47	-14	-36	-18	-16	-26
	summer	-31	-7	-12	-19	-21	-13	-11
	fall	-29	-28	-36	-29	-24	-25	-33
	winter	-37	-55	-29	-44	-33	-33	-34
	annual to wetland	-131	-136	-91	-127	-96	-88	-104
	percent change to wetland	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%	-3.3%
	annual to SWMP	219	226	151	211	160	146	173
infiltration	spring	-23	-31	-9	-24	-12	-11	-18
	summer	-20	-5	-8	-13	-14	-9	-7
	fall	-19	-18	-24	-19	-16	-17	-22
	winter	-25	-36	-19	-29	-22	-22	-23
	annual	-87	-91	-60	-84	-64	-59	-69
	annual mitigation	89	77	58	78	59	52	66
	percent change	0.1%	-0.6%	-0.2%	-0.3%	-0.3%	-0.5%	-0.2%

All values in cubic meters (except where shown as percentages)

winter= Dec, Jan, Feb
spring= Mar, Apr, May
summer= Jun, Jul, Aug
fall = Sep, Oct Nov

TABLE B: Wetland 2 - Features Based Water Balance Summary

Catchment for Wetland 2

Pre-development Runoff & Infiltration

		1983	1984	1985	1986	1987	1988	1989	1990	1991
runoff	spring	3061.6	2198.7	2189.1	1944.2	1901.7	1201.7	1987.5	2692.7	1033.1
	summer	679.5	361.4	1389.6	2351.4	262.5	107.5	1423.3	665.9	24.4
	fall	1726.0	1719.0	2974.5	3407.3	2355.2	3191.2	2612.7	3192.7	1449.6
	winter	2761.3	2792.6	3451.3	2262.2	2029.0	2649.7	2225.5	3185.1	1882.2
	annual	8228.5	7071.8	10004.5	9965.1	6548.4	7150.1	8249.0	9736.4	4389.2
infiltration	spring	1693.5	1216.2	1210.9	1075.4	1051.9	664.7	1099.4	1489.4	571.5
	summer	375.9	199.9	768.7	1300.7	145.2	59.4	787.3	368.3	13.5
	fall	954.7	950.9	1645.3	1884.7	1302.7	1765.2	1445.2	1766.0	801.8
	winter	1527.4	1544.7	1909.0	1251.3	1122.3	1465.6	1231.0	1761.8	1041.1
	annual	4551.5	3911.6	5533.8	5512.1	3622.1	3954.9	4562.8	5385.5	2427.8
	total	12779.9	10983.4	15538.3	15477.2	10170.5	11105.0	12811.8	15122.0	6817.1

		1992	1993	1994	1995	1996	1997	1998	1999	2000
runoff	spring	2351.4	1380.7	2155.1	2164.8	2825.9	2250.1	2339.1	1364.6	2741.5
	summer	2238.3	937.0	72.8	27.9	2051.7	759.7	790.1	703.3	2533.8
	fall	3464.3	1356.4	1490.0	3368.7	2436.0	1712.1	523.1	2026.6	1540.6
	winter	2309.2	2494.5	2048.9	2808.2	3160.6	2808.1	2372.2	3198.9	2734.2
	annual	10363.1	6168.7	5766.9	8369.5	10474.3	7529.9	6024.5	7293.4	9550.0
infiltration	spring	1300.6	763.7	1192.1	1197.4	1563.1	1244.6	1293.8	754.8	1516.4
	summer	1238.1	518.3	40.3	15.4	1134.9	420.2	437.0	389.0	1401.5
	fall	1916.2	750.3	824.2	1863.3	1347.5	947.0	289.3	1121.0	852.2
	winter	1277.3	1379.8	1133.3	1553.3	1748.2	1553.3	1312.1	1769.4	1512.4
	annual	5732.2	3412.1	3189.9	4629.5	5793.7	4165.1	3332.3	4034.3	5282.4
	total	16095.3	9580.8	8956.8	12999.0	16268.0	11695.0	9356.8	11327.7	14832.4

TABLE B: Wetland 2 - Features Based Water Balance Summary

Catchment for Wetland 2

Pre-development Runoff & Infiltration

		2001	2002	2003	2004	2005	2006	2007	2008	2009
runoff	spring	1572.6	3109.3	1420.1	3011.1	2013.5	2771.9	1934.2	2997.1	2348.6
	summer	776.6	720.6	844.1	641.1	2061.4	680.7	0.0	484.8	1292.9
	fall	2976.1	1675.9	3182.1	1428.6	2326.4	2828.2	1331.3	1660.9	1682.9
	winter	2209.6	1476.6	2769.2	3124.9	3762.1	4627.7	4180.9	7539.0	3583.3
	annual	7534.9	6982.4	8215.4	8205.6	10163.4	10908.6	7446.4	12681.8	8907.7
infiltration	spring	869.9	1719.8	785.5	1665.5	1113.7	1533.3	1069.9	1657.8	1299.1
	summer	429.6	398.6	466.9	354.6	1140.2	376.5	0.0	268.2	715.1
	fall	1646.2	927.0	1760.1	790.2	1286.8	1564.4	736.4	918.7	930.9
	winter	1222.2	816.8	1531.7	1728.5	2080.9	2559.7	2312.6	4170.1	1982.1
	annual	4167.8	3862.2	4544.2	4538.8	5621.7	6033.9	4118.9	7014.7	4927.1
	total	11702.7	10844.6	12759.7	12744.4	15785.1	16942.5	11565.3	19696.6	13834.8

		2010	2011	2012	2013	2014	2015	Average
runoff	spring	2627.9	3573.5	1048.8	2727.7	1341.0	1261.0	2023.4
	summer	2347.7	523.3	896.1	1434.2	1621.2	1010.8	807.3
	fall	2218.0	2113.1	2771.1	2179.3	1819.5	1928.1	2514.2
	winter	2837.6	4175.2	2212.2	3349.4	2547.0	2520.1	2582.1
	annual	10031.3	10385.0	6928.1	9690.6	7328.7	6720.0	7927.0
infiltration	spring	1453.6	1976.6	580.1	1508.8	741.8	697.5	1119.2
	summer	1298.6	289.4	495.6	793.3	896.7	559.1	446.5
	fall	1226.8	1168.8	1532.8	1205.4	1006.5	1066.5	1390.7
	winter	1569.6	2309.5	1223.6	1852.7	1408.8	1393.9	1428.2
	annual	5548.6	5744.3	3832.2	5360.2	4053.7	3717.1	4384.7
	total	15579.9	16129.3	10760.3	15050.7	11382.4	10437.0	12311.7

TABLE B: Wetland 2 - Features Based Water Balance Summary

Catchment for Wetland 2

Post-Development Runoff & Infiltration

		1983	1984	1985	1986	1987	1988	1989	1990	1991
runoff to wetland	spring	3021.6	2170.0	2160.5	1918.8	1876.8	1186.0	1961.5	2657.5	1019.6
	summer	670.6	356.6	1371.5	2320.7	259.1	106.0	1404.7	657.2	24.0
	fall	1703.5	1696.6	2935.5	3362.7	2324.4	3149.5	2578.5	3151.0	1430.6
	winter	2725.2	2756.1	3406.1	2232.6	2002.5	2615.0	2196.4	3143.4	1857.5
	annual to SWMP	179.4	154.2	218.1	217.2	142.7	155.9	179.8	212.2	95.7
	annual to wetland	8120.9	6979.3	9873.7	9834.8	6462.8	7056.6	8141.1	9609.1	4331.8
	annual total	8300.2	7133.4	10091.7	10052.0	6605.5	7212.4	8320.9	9821.3	4427.5
infiltration	spring	1666.8	1197.0	1191.8	1058.5	1035.3	654.2	1082.0	1466.0	562.4
	summer	369.9	196.7	756.5	1280.1	142.9	58.5	774.8	362.5	13.3
	fall	939.7	935.9	1619.3	1855.0	1282.2	1737.3	1422.4	1738.2	789.2
	winter	1503.3	1520.3	1878.9	1231.6	1104.6	1442.5	1211.6	1734.0	1024.7
	annual	4479.7	3850.0	5446.6	5425.2	3565.0	3892.6	4490.9	5300.6	2389.6
	total	12600.6	10829.2	15320.3	15260.0	10027.8	10949.2	12632.0	14909.7	6721.4

		1992	1993	1994	1995	1996	1997	1998	1999	2000
runoff to wetland	spring	2320.6	1362.6	2126.9	2136.5	2788.9	2220.6	2308.5	1346.8	2705.6
	summer	2209.0	924.7	71.9	27.5	2024.9	749.7	779.8	694.1	2500.6
	fall	3419.0	1338.7	1470.6	3324.6	2404.2	1689.7	516.2	2000.1	1520.5
	winter	2279.0	2461.9	2022.1	2771.4	3119.3	2771.4	2341.2	3157.1	2698.4
	annual to SWMP	225.9	134.5	125.7	182.4	228.3	164.1	131.3	159.0	208.2
	annual to wetland	10227.6	6088.0	5691.5	8260.1	10337.3	7431.4	5945.7	7198.1	9425.1
	annual total	10453.5	6222.5	5817.2	8442.5	10565.6	7595.6	6077.0	7357.0	9633.3
infiltration	spring	1280.1	751.7	1173.3	1178.5	1538.5	1225.0	1273.5	742.9	1492.5
	summer	1218.5	510.1	39.6	15.2	1117.0	413.6	430.1	382.9	1379.4
	fall	1886.0	738.5	811.2	1833.9	1326.2	932.1	284.8	1103.3	838.7
	winter	1257.1	1358.1	1115.5	1528.8	1720.7	1528.8	1291.5	1741.5	1488.5
	annual	5641.8	3358.3	3139.6	4556.5	5702.4	4099.4	3279.8	3970.7	5199.2
	total	15869.4	9446.3	8831.1	12816.6	16039.6	11530.8	9225.5	11168.7	14624.3

TABLE B: Wetland 2 - Features Based Water Balance Summary

Catchment for Wetland 2

Post-Development Runoff & Infiltration

		2001	2002	2003	2004	2005	2006	2007	2008	2009
runoff to wetland	spring	1552.1	3068.6	1401.5	2971.7	1987.2	2735.7	1908.9	2957.9	2317.9
	summer	766.5	711.2	833.0	632.7	2034.4	671.8	0.0	478.5	1276.0
	fall	2937.2	1654.0	3140.4	1409.9	2296.0	2791.2	1313.9	1639.2	1660.9
	winter	2180.7	1457.3	2733.0	3084.0	3712.9	4567.2	4126.3	7440.4	3536.4
	annual to SWMP	164.2	152.2	179.1	178.9	221.5	237.8	162.3	276.4	194.2
	annual to wetland	7436.4	6891.1	8108.0	8098.3	10030.5	10765.9	7349.0	12516.0	8791.2
	annual total	7600.6	7043.3	8287.1	8277.1	10252.0	11003.7	7511.3	12792.4	8985.4
infiltration	spring	856.2	1692.7	773.1	1639.3	1096.2	1509.1	1053.0	1631.7	1278.6
	summer	422.8	392.3	459.5	349.0	1122.2	370.6	0.0	263.9	703.9
	fall	1620.2	912.4	1732.4	777.8	1266.5	1539.7	724.8	904.2	916.2
	winter	1202.9	803.9	1507.6	1701.2	2048.1	2519.4	2276.2	4104.3	1950.8
	annual	4102.1	3801.3	4472.6	4467.2	5533.1	5938.8	4053.9	6904.2	4849.5
	total	11538.5	10692.4	12580.6	12565.5	15563.6	16704.7	11402.9	19420.1	13640.7

		2010	2011	2012	2013	2014	2015	Average
runoff to wetland	spring	2593.6	3526.7	1035.1	2692.0	1323.5	1244.5	1996.9
	summer	2317.0	516.4	884.3	1415.4	1600.0	997.6	796.7
	fall	2189.0	2085.4	2734.9	2150.8	1795.7	1902.9	2481.4
	winter	2800.5	4120.6	2183.2	3305.6	2513.7	2487.1	2548.3
	annual to SWMP	218.7	226.4	151.0	211.2	159.8	146.5	172.8
	annual to wetland	9900.1	10249.2	6837.5	9563.8	7232.8	6632.1	7823.3
	annual total	10118.7	10475.6	6988.5	9775.1	7392.6	6778.6	7996.1
infiltration	spring	1430.7	1945.4	571.0	1485.0	730.1	686.5	1101.6
	summer	1278.1	284.9	487.8	780.8	882.6	550.3	439.5
	fall	1207.5	1150.4	1508.6	1186.4	990.6	1049.7	1368.8
	winter	1544.9	2273.0	1204.3	1823.5	1386.6	1372.0	1405.7
	annual	5461.2	5653.7	3771.8	5275.7	3989.8	3658.5	4315.6
	total	15361.2	15902.9	10609.3	14839.5	11222.7	10290.6	12138.9

TABLE B: Wetland 2 - Features Based Water Balance Summary

Catchment for Wetland 2

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		1983	1984	1985	1986	1987	1988	1989	1990	1991
runoff	spring	-40	-29	-29	-25	-25	-16	-26	-35	-14
	summer	-9	-5	-18	-31	-3	-1	-19	-9	-0
	fall	-23	-22	-39	-45	-31	-42	-34	-42	-19
	winter	-36	-37	-45	-30	-27	-35	-29	-42	-25
	annual to wetland	-108	-92	-131	-130	-86	-94	-108	-127	-57
	percent change to wetland	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%
	annual to SWMP	179	154	218	217	143	156	180	212	96
infiltration	spring	-27	-19	-19	-17	-17	-10	-17	-23	-9
	summer	-6	-3	-12	-21	-2	-1	-12	-6	-0
	fall	-15	-15	-26	-30	-21	-28	-23	-28	-13
	winter	-24	-24	-30	-20	-18	-23	-19	-28	-16
	annual	-72	-62	-87	-87	-57	-62	-72	-85	-38
	annual mitigation	67	53	81	95	56	55	74	81	31
	percent change	-0.1%	-0.2%	-0.1%	0.1%	-0.0%	-0.2%	0.1%	-0.1%	-0.3%

TABLE B: Wetland 2 - Features Based Water Balance Summary

Catchment for Wetland 2

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		1992	1993	1994	1995	1996	1997	1998	1999	2000
runoff	spring	-31	-18	-28	-28	-37	-29	-31	-18	-36
	summer	-29	-12	-1	-0	-27	-10	-10	-9	-33
	fall	-45	-18	-19	-44	-32	-22	-7	-27	-20
	winter	-30	-33	-27	-37	-41	-37	-31	-42	-36
	annual to wetland	-136	-81	-75	-109	-137	-98	-79	-95	-125
	percent change to wetland	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%
	annual to SWMP	226	134	126	182	228	164	131	159	208

infiltration	spring	-21	-12	-19	-19	-25	-20	-20	-12	-24
	summer	-20	-8	-1	-0	-18	-7	-7	-6	-22
	fall	-30	-12	-13	-29	-21	-15	-5	-18	-13
	winter	-20	-22	-18	-24	-28	-24	-21	-28	-24
	annual	-90	-54	-50	-73	-91	-66	-53	-64	-83
	annual mitigation	99	45	46	69	90	58	45	50	84
	percent change	0.2%	-0.2%	-0.1%	-0.1%	-0.0%	-0.2%	-0.2%	-0.3%	0.0%

TABLE B: Wetland 2 - Features Based Water Balance Summary

Catchment for Wetland 2

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		2001	2002	2003	2004	2005	2006	2007	2008	2009
runoff	spring	-21	-41	-19	-39	-26	-36	-25	-39	-31
	summer	-10	-9	-11	-8	-27	-9	0	-6	-17
	fall	-39	-22	-42	-19	-30	-37	-17	-22	-22
	winter	-29	-19	-36	-41	-49	-61	-55	-99	-47
	annual to wetland	-99	-91	-107	-107	-133	-143	-97	-166	-117
	percent change to wetland	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%
	annual to SWMP	164	152	179	179	222	238	162	276	194
infiltration	spring	-14	-27	-12	-26	-18	-24	-17	-26	-20
	summer	-7	-6	-7	-6	-18	-6	0	-4	-11
	fall	-26	-15	-28	-12	-20	-25	-12	-14	-15
	winter	-19	-13	-24	-27	-33	-40	-36	-66	-31
	annual	-66	-61	-72	-72	-89	-95	-65	-111	-78
	annual mitigation	66	68	67	63	79	77	40	63	66
	percent change	-0.0%	0.2%	-0.1%	-0.2%	-0.2%	-0.3%	-0.6%	-0.7%	-0.2%

TABLE B: Wetland 2 - Features Based Water Balance Summary

Catchment for Wetland 2

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		2010	2011	2012	2013	2014	2015	Average
runoff	spring	-34	-47	-14	-36	-18	-16	-26
	summer	-31	-7	-12	-19	-21	-13	-11
	fall	-29	-28	-36	-29	-24	-25	-33
	winter	-37	-55	-29	-44	-33	-33	-34
	annual to wetland	-131	-136	-91	-127	-96	-88	-104
	percent change to wetland	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%
	annual to SWMP	219	226	151	211	160	146	173
infiltration	spring	-23	-31	-9	-24	-12	-11	-18
	summer	-20	-5	-8	-13	-14	-9	-7
	fall	-19	-18	-24	-19	-16	-17	-22
	winter	-25	-36	-19	-29	-22	-22	-23
	annual	-87	-91	-60	-84	-64	-59	-69
	annual mitigation	89	77	58	78	59	52	66
	percent change	0.0%	-0.2%	-0.1%	-0.1%	-0.1%	-0.2%	-0.1%

All values in cubic meters (except where shown as percentages)

winter= Dec, Jan, Feb
spring= Mar, Apr, May
summer= Jun, Jul, Aug
fall = Sep, Oct Nov

Table C: Wetland 3 - Features Based Water Balance Summary

Catchment for Wetland 3

Pre-development Runoff & Infiltration

		1983	1984	1985	1986	1987	1988	1989	1990	1991
runoff	spring	2173.2	1560.7	1553.9	1380.0	1349.8	853.0	1410.8	1911.3	733.3
	summer	482.3	256.5	986.4	1669.1	186.3	76.3	1010.3	472.6	17.3
	fall	1225.2	1220.2	2111.3	2418.5	1671.7	2265.2	1854.5	2266.2	1028.9
	winter	1960.0	1982.2	2449.7	1605.7	1440.2	1880.8	1579.7	2260.8	1336.0
	annual	5840.7	5019.6	7101.3	7073.3	4648.1	5075.2	5855.2	6911.0	3115.5
infiltration	spring	1142.9	820.8	817.2	725.8	709.9	448.6	741.9	1005.2	385.7
	summer	253.7	134.9	518.8	877.8	98.0	40.1	531.3	248.6	9.1
	fall	644.3	641.7	1110.4	1271.9	879.2	1191.3	975.3	1191.8	541.1
	winter	1030.8	1042.5	1288.3	844.5	757.4	989.1	830.8	1189.0	702.6
	annual	3071.7	2639.9	3734.7	3720.0	2444.5	2669.1	3079.3	3634.6	1638.5
	total	8912.3	7659.5	10836.0	10793.3	7092.6	7744.3	8934.5	10545.6	4754.0

		1992	1993	1994	1995	1996	1997	1998	1999	2000
runoff	spring	1669.0	980.0	1529.7	1536.6	2005.8	1597.1	1660.3	968.6	1945.9
	summer	1588.7	665.1	51.7	19.8	1456.3	539.2	560.8	499.2	1798.5
	fall	2459.0	962.8	1057.6	2391.1	1729.1	1215.3	371.3	1438.5	1093.5
	winter	1639.1	1770.7	1454.4	1993.3	2243.4	1993.2	1683.8	2270.6	1940.7
	annual	7355.8	4378.6	4093.4	5940.8	7434.7	5344.8	4276.2	5177.0	6778.7
infiltration	spring	877.8	515.4	804.5	808.1	1054.9	839.9	873.2	509.4	1023.4
	summer	835.5	349.8	27.2	10.4	765.9	283.6	294.9	262.5	945.8
	fall	1293.2	506.4	556.2	1257.5	909.4	639.1	195.3	756.5	575.1
	winter	862.0	931.2	764.9	1048.3	1179.8	1048.3	885.5	1194.1	1020.7
	annual	3868.5	2302.8	2152.8	3124.3	3910.0	2810.9	2248.9	2722.6	3565.0
	total	11224.4	6681.4	6246.2	9065.1	11344.8	8155.7	6525.2	7899.6	10343.7

Table C: Wetland 3 - Features Based Water Balance Summary

Catchment for Wetland 3

Pre-development Runoff & Infiltration

		2001	2002	2003	2004	2005	2006	2007	2008	2009
runoff	spring	1116.3	2207.0	1008.0	2137.3	1429.2	1967.5	1372.9	2127.4	1667.1
	summer	551.3	511.5	599.1	455.0	1463.2	483.2	0.0	344.1	917.7
	fall	2112.4	1189.6	2258.7	1014.0	1651.3	2007.5	945.0	1179.0	1194.5
	winter	1568.4	1048.1	1965.6	2218.1	2670.3	3284.8	2967.7	5351.2	2543.5
	annual	5348.3	4956.2	5831.4	5824.4	7214.1	7743.0	5285.5	9001.7	6322.8
infiltration	spring	587.1	1160.7	530.1	1124.0	751.6	1034.8	722.0	1118.8	876.7
	summer	289.9	269.0	315.1	239.3	769.5	254.1	0.0	181.0	482.6
	fall	1111.0	625.6	1187.9	533.3	868.5	1055.8	497.0	620.0	628.2
	winter	824.8	551.2	1033.7	1166.5	1404.4	1727.5	1560.7	2814.3	1337.6
	annual	2812.8	2606.5	3066.8	3063.1	3794.0	4072.1	2779.7	4734.1	3325.2
	total	8161.1	7562.7	8898.2	8887.5	11008.0	11815.2	8065.2	13735.8	9648.0

		2010	2011	2012	2013	2014	2015	Average
runoff	spring	1865.3	2536.5	744.5	1936.1	951.9	895.1	1436.2
	summer	1666.4	371.4	636.0	1018.0	1150.7	717.5	573.0
	fall	1574.3	1499.9	1967.0	1546.9	1291.5	1368.6	1784.6
	winter	2014.2	2963.6	1570.2	2377.5	1807.9	1788.8	1832.8
	annual	7120.3	7371.4	4917.7	6878.5	5202.0	4769.9	5626.7
infiltration	spring	981.0	1334.0	391.5	1018.2	500.6	470.7	755.3
	summer	876.4	195.3	334.5	535.4	605.2	377.3	301.4
	fall	828.0	788.8	1034.5	813.5	679.2	719.8	938.6
	winter	1059.3	1558.6	825.8	1250.3	950.8	940.7	963.9
	annual	3744.6	3876.7	2586.3	3617.5	2735.8	2508.6	2959.1
	total	10864.9	11248.1	7503.9	10495.9	7937.7	7278.5	8585.8

Table C: Wetland 3 - Features Based Water Balance Summary

Catchment for Wetland 3

Post-Development Runoff & Infiltration

		1983	1984	1985	1986	1987	1988	1989	1990	1991
runoff to wetland	spring	2133.1	1531.9	1525.2	1354.6	1324.9	837.3	1384.8	1876.1	719.8
	summer	473.4	251.8	968.2	1638.3	182.9	74.9	991.6	463.9	17.0
	fall	1202.6	1197.7	2072.4	2374.0	1640.9	2223.4	1820.4	2224.5	1010.0
	winter	1923.9	1945.7	2404.6	1576.1	1413.7	1846.1	1550.6	2219.2	1311.4
	annual to SWMP	179.4	154.2	218.1	217.2	142.7	155.9	179.8	212.2	95.7
	annual to wetland	5733.0	4927.1	6970.4	6943.0	4562.5	4981.7	5747.3	6783.7	3058.1
	annual total	5912.4	5081.3	7188.5	7160.2	4705.2	5137.5	5927.1	6995.9	3153.8
infiltration	spring	1116.2	801.6	798.1	708.8	693.3	438.1	724.6	981.7	376.7
	summer	247.7	131.7	506.6	857.3	95.7	39.2	518.9	242.8	8.9
	fall	629.3	626.7	1084.4	1242.2	858.6	1163.4	952.5	1164.0	528.5
	winter	1006.7	1018.1	1258.3	824.7	739.7	966.0	811.4	1161.2	686.2
	annual	2999.9	2578.2	3647.4	3633.1	2387.4	2606.8	3007.4	3549.7	1600.2
	total	8733.0	7505.3	10617.9	10576.1	6949.9	7588.4	8754.7	10333.3	4658.3

		1992	1993	1994	1995	1996	1997	1998	1999	2000
runoff to wetland	spring	1638.3	962.0	1501.5	1508.3	1968.9	1567.7	1629.7	950.8	1910.1
	summer	1559.5	652.8	50.7	19.4	1429.5	529.3	550.5	490.0	1765.4
	fall	2413.7	945.1	1038.2	2347.1	1697.3	1192.9	364.4	1412.0	1073.4
	winter	1608.9	1738.0	1427.6	1956.5	2202.1	1956.5	1652.8	2228.8	1905.0
	annual to SWMP	225.9	134.5	125.7	182.4	228.3	164.1	131.3	159.0	208.2
	annual to wetland	7220.3	4297.9	4018.0	5831.3	7297.8	5246.3	4197.4	5081.6	6653.8
	annual total	7446.2	4432.4	4143.7	6013.8	7526.1	5410.5	4328.8	5240.6	6862.0
infiltration	spring	857.3	503.4	785.7	789.2	1030.3	820.3	852.8	497.5	999.5
	summer	816.0	341.6	26.5	10.2	748.0	277.0	288.1	256.4	923.8
	fall	1263.0	494.5	543.2	1228.1	888.1	624.2	190.7	738.8	561.7
	winter	841.9	909.5	747.0	1023.8	1152.3	1023.8	864.8	1166.3	996.8
	annual	3778.2	2249.0	2102.5	3051.3	3818.7	2745.2	2196.4	2659.0	3481.7
	total	10998.5	6546.9	6120.5	8882.7	11116.4	7991.6	6393.8	7740.6	10135.5

Table C: Wetland 3 - Features Based Water Balance Summary

Catchment for Wetland 3

Post-Development Runoff & Infiltration

		2001	2002	2003	2004	2005	2006	2007	2008	2009
runoff to wetland	spring	1095.7	2166.3	989.4	2097.9	1402.9	1931.3	1347.6	2088.2	1636.4
	summer	541.1	502.1	588.1	446.6	1436.2	474.3	0.0	337.8	900.8
	fall	2073.5	1167.7	2217.0	995.4	1620.9	1970.5	927.6	1157.2	1172.5
	winter	1539.5	1028.8	1929.4	2177.2	2621.1	3224.3	2913.0	5252.6	2496.6
	annual to SWMP	164.2	152.2	179.1	178.9	221.5	237.8	162.3	276.4	194.2
	annual to wetland	5249.8	4864.9	5723.9	5717.1	7081.1	7600.3	5188.1	8835.8	6206.3
	annual total	5414.0	5017.1	5903.0	5896.0	7302.7	7838.1	5350.5	9112.3	6400.4
infiltration	spring	573.3	1133.6	517.7	1097.8	734.1	1010.6	705.2	1092.7	856.3
	summer	283.1	262.7	307.7	233.7	751.5	248.2	0.0	176.7	471.4
	fall	1085.0	611.0	1160.1	520.8	848.2	1031.1	485.4	605.5	613.5
	winter	805.6	538.3	1009.6	1139.3	1371.6	1687.2	1524.3	2748.5	1306.4
	annual	2747.1	2545.6	2995.2	2991.6	3705.3	3977.0	2714.8	4623.5	3247.5
	total	7996.8	7410.5	8719.1	8708.7	10786.5	11577.4	7902.9	13459.3	9453.8

		2010	2011	2012	2013	2014	2015	Average
runoff to wetland	spring	1831.0	2489.7	730.7	1900.5	934.3	878.6	1409.8
	summer	1635.7	364.6	624.3	999.2	1129.5	704.3	562.4
	fall	1545.3	1472.2	1930.7	1518.4	1267.7	1343.4	1751.8
	winter	1977.1	2909.0	1541.3	2333.6	1774.6	1755.8	1799.0
	annual to SWMP	218.7	226.4	151.0	211.2	159.8	146.5	172.8
	annual to wetland	6989.1	7235.6	4827.0	6751.7	5106.1	4682.0	5523.0
	annual total	7207.7	7461.9	4978.1	6962.9	5265.9	4828.5	5695.8
infiltration	spring	958.1	1302.8	382.4	994.4	488.9	459.7	737.7
	summer	855.9	190.8	326.7	522.9	591.0	368.5	294.3
	fall	808.6	770.4	1010.3	794.5	663.4	703.0	916.6
	winter	1034.5	1522.2	806.5	1221.1	928.6	918.8	941.4
	annual	3657.2	3786.1	2525.8	3533.0	2671.9	2450.0	2890.0
	total	10646.3	11021.7	7352.9	10284.7	7778.0	7132.0	8413.0

Table C: Wetland 3 - Features Based Water Balance Summary

Catchment for Wetland 3

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		1983	1984	1985	1986	1987	1988	1989	1990	1991
runoff	spring	-40	-29	-29	-25	-25	-16	-26	-35	-14
	summer	-9	-5	-18	-31	-3	-1	-19	-9	-0
	fall	-23	-22	-39	-45	-31	-42	-34	-42	-19
	winter	-36	-37	-45	-30	-27	-35	-29	-42	-25
	annual to wetland	-108	-92	-131	-130	-86	-94	-108	-127	-57
	percent change to wetland	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%
	annual to SWMP	179	154	218	217	143	156	180	212	96
infiltration	spring	-27	-19	-19	-17	-17	-10	-17	-23	-9
	summer	-6	-3	-12	-21	-2	-1	-12	-6	-0
	fall	-15	-15	-26	-30	-21	-28	-23	-28	-13
	winter	-24	-24	-30	-20	-18	-23	-19	-28	-16
	annual	-72	-62	-87	-87	-57	-62	-72	-85	-38
	annual mitigation	67	53	81	95	56	55	74	81	31
	percent change	-0.1%	-0.3%	-0.2%	0.2%	-0.1%	-0.3%	0.1%	-0.1%	-0.4%

Table C: Wetland 3 - Features Based Water Balance Summary

Catchment for Wetland 3

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		1992	1993	1994	1995	1996	1997	1998	1999	2000
runoff	spring	-31	-18	-28	-28	-37	-29	-31	-18	-36
	summer	-29	-12	-1	-0	-27	-10	-10	-9	-33
	fall	-45	-18	-19	-44	-32	-22	-7	-27	-20
	winter	-30	-33	-27	-37	-41	-37	-31	-42	-36
	annual to wetland	-136	-81	-75	-109	-137	-98	-79	-95	-125
	percent change to wetland	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%
	annual to SWMP	226	134	126	182	228	164	131	159	208

infiltration	spring	-21	-12	-19	-19	-25	-20	-20	-12	-24
	summer	-20	-8	-1	-0	-18	-7	-7	-6	-22
	fall	-30	-12	-13	-29	-21	-15	-5	-18	-13
	winter	-20	-22	-18	-24	-28	-24	-21	-28	-24
	annual	-90	-54	-50	-73	-91	-66	-53	-64	-83
	annual mitigation	99	45	46	69	90	58	45	50	84
	percent change	0.2%	-0.4%	-0.2%	-0.1%	-0.0%	-0.3%	-0.3%	-0.5%	0.0%

Table C: Wetland 3 - Features Based Water Balance Summary

Catchment for Wetland 3

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		2001	2002	2003	2004	2005	2006	2007	2008	2009
runoff	spring	-21	-41	-19	-39	-26	-36	-25	-39	-31
	summer	-10	-9	-11	-8	-27	-9	0	-6	-17
	fall	-39	-22	-42	-19	-30	-37	-17	-22	-22
	winter	-29	-19	-36	-41	-49	-61	-55	-99	-47
	annual to wetland	-99	-91	-107	-107	-133	-143	-97	-166	-117
	percent change to wetland	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%
	annual to SWMP	164	152	179	179	222	238	162	276	194
infiltration	spring	-14	-27	-12	-26	-18	-24	-17	-26	-20
	summer	-7	-6	-7	-6	-18	-6	0	-4	-11
	fall	-26	-15	-28	-12	-20	-25	-12	-14	-15
	winter	-19	-13	-24	-27	-33	-40	-36	-66	-31
	annual	-66	-61	-72	-72	-89	-95	-65	-111	-78
	annual mitigation	66	68	67	63	79	77	40	63	66
	percent change	-0.0%	0.3%	-0.1%	-0.3%	-0.3%	-0.4%	-0.9%	-1.0%	-0.4%

Table C: Wetland 3 - Features Based Water Balance Summary

Catchment for Wetland 3

Change in Runoff to the Wetland and Infiltration (Negative = loss from pre-development)

		2010	2011	2012	2013	2014	2015	Average
runoff	spring	-34	-47	-14	-36	-18	-16	-26
	summer	-31	-7	-12	-19	-21	-13	-11
	fall	-29	-28	-36	-29	-24	-25	-33
	winter	-37	-55	-29	-44	-33	-33	-34
	annual to wetland	-131	-136	-91	-127	-96	-88	-104
	percent change to wetland	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%	-1.8%
	annual to SWMP	219	226	151	211	160	146	173
infiltration	spring	-23	-31	-9	-24	-12	-11	-17.6
	summer	-20	-5	-8	-13	-14	-9	-7.0
	fall	-19	-18	-24	-19	-16	-17	-21.9
	winter	-25	-36	-19	-29	-22	-22	-22.5
	annual	-87	-91	-60	-84	-64	-59	-69.1
	annual mitigation	89	77	58	78	59	52	65.9
	percent change	0.0%	-0.4%	-0.1%	-0.2%	-0.2%	-0.3%	-0.1%

All values in cubic meters (except where shown as percentages)

winter=	Dec, Jan, Feb
spring=	Mar, Apr, May
summer=	Jun, Jul, Aug
fall =	Sep, Oct Nov

APPENDIX F

Reasonable Use Policy Calculations

TABLE 1 - Reasonable Use Concept Calculation (Individual Systems)

$$C_m = C_b + x*(C_r - C_b)$$

where

C_m = maximum concentration of a particular contaminant
C_r = maximum permissible concentration in the environment (ODWS)
C_b = background concentration of the particular contaminant in the groundwater
x = reduction factor for analysis

C_r = 10 mg/L
C_b = 0.2 MOE Guidelines (2008)
x = 0.25 **(0.25 for health related parameters)**

C_m = 2.65 mg/L

$$C_w = C_m - C_p - C_o$$

where

= maximum concentration of a particular contaminant originating in the disposal site
C_p = present background concentration
C_o = potential contaminant increase from other sources

C_p = 0 mg/L (assumed)
C_o = 0 mg/L (assumed)

C_w = 2.7 mg/L **or 10mg/L for small individual systems**

Detailed Calculation

$$C_e = (C_p*P*A + C_{s*}Q_s + C_b*Q_b)/(P*A + Q_s + Q_b)$$

where

Total Property Area		**0.45**	**ha**	
Downgradient Area	(A)	4,500	m^2	
Annual Infiltration Rate	(P)	250	mm	MOE guideline is 250mm/a
Diluting Volume	(P*A)	1,125	m^3/a	
Aquifer Thickness	(b)	-	m	
Aquifer Velocity	(v)	3.3E-06	m/s	
		0.3	m/day	
Aquifer Cross-sectional Width	(l)	-	m	
Base Flow	(Q_b)	-	m^3/a	
Average Daily Sewage Volume	(Q_s)	1,000	L/day	Input (average Annual Flow)
		365	m^3/a	
Effluent Nitrate Concentration	(C_s)	40.0	mg/L	Class IV
Estimated Site Concentration	(C_e)	**9.8**	mg/L	>10mg/L

TABLE 2 - Reasonable Use Concept Calculation (Entire Development)

$$C_m = C_b + x*(C_r - C_b)$$

where

C_m = maximum concentration of a particular contaminant
C_r = maximum permissible concentration in the environment (ODWS)
C_b = background concentration of the particular contaminant in the groundwater
x = reduction factor for analysis

C_r = 10 mg/L
C_b = 0.2 0
x = 0.25 (0.25 for health related parameters)

C_m = 2.65 mg/L

$$C_w = C_m - C_p - C_o$$

where

C_w = maximum concentration of a particular contaminant originating in the disposal site
C_p = present background concentration
C_o = potential contaminant increase from other sources

C_p = mg/L (assumed)
C_o = 0 mg/L (assumed)

C_w = 2.7 mg/L **or 10mg/L for small individual systems**

Detailed Calculation

$$C_e = (C_p*P*A + C_{s*}Q_s + C_b*Q_b)/(P*A + Q_s + Q_b)$$

where

Total Property Area		**11.00**	**ha**	
Downgradient Area	(A)	66,000	m^2	
Annual Infiltration Rate	(P)	250	mm	MOE guideline is 250mm/a
Diluting Volume	(P*A)	16,500	m^3/a	
Aquifer Thickness	(b)	-	m	assumed
Aquifer Velocity	(v)	3.3E-06	m/s	assumed
		0.3	m/day	
Aquifer Cross-sectional Width	(l)	-	m	assumed
Base Flow	(Q_b)	-	m^3/a	
Average Daily Sewage Volume	(Q_s)	8,000	L/day	Input (based on MOE guidelines for Average Annual Flow)
		2,922	m^3/a	
Effluent Nitrate Concentration	(C_s)	40.0	mg/L	Class IV standard septic system
Estimated Site Concentration	(C_e)	**6.02**	mg/L	<10 mg/L (meets criteria)