

HYDROGEOLOGICAL SCREENING

FINAL REPORT

SITE 1
STATIONS 25+000 TO 25+500 MCNAB-BRAESIDE TOWNSHIP

Highway 17 Twinning Campbell Drive to Scheel Drive
GWP 4067-03-00

Geocres #31F-159

August 2007

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PROJECT No. R07-0261

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1.0 INTRODUCTION

McCormick Rankin Corporation (MRC) and Ecoplans Limited (Ecoplans) have been retained by the Ministry of Transportation - Eastern Region (MTO) in the detail design of Highway 17 Twinning Campbell to Scheel Drive Project. This project includes the twinning of approximately 5.5 kilometres (km) of Highway 17, pavement rehabilitation, one new interchange at Campbell Drive, two new bridge structures (Campbell and Scheel Drive underpasses), and other associate highway infrastructure improvements. In addition, the MTO has engaged MRC to carry out technical studies along Highway 17 between Scheel Drive and Bruce Street (north of Renfrew).

As part of these studies, Ecoplans will be undertaking Hydrogeological Screening Investigations of the following locations (sites) along Highway 17:

- **Site 1** - Station 25+000 to 25+500 McNab-Braeside Twp. located approximately 500 metres west of Campbell Drive
- **Site 2** – Station 12+980 McNab-Braeside Twp. located approximately 500 metres west of McCallum Drive.
- **Site 3** – Station 22+700 Horton Twp. located approximately 250 metres east of the CPR Overpass.
- **Site 4** – Station 19+080 Horton Twp. located approximately 500 metres south of Bruce Street

This report documents the Hydrogeological Screening Investigation for Site 1. The Hydrogeological Screening Investigations for Sites 2, 3 and 4 is covered under a separate report (one consolidated report).

1.1 Purpose of Study

The purpose of the Hydrogeological Screening Investigations is to evaluate the geology, and surface and subsurface hydrology of each location, and provide an assessment on potential groundwater impacts from the proposed highway construction.

1.2 Scope of Study

The scope of the study consisted of a site history review (“background information review”) and site reconnaissance (“site inspection”). Each is briefly discussed below.

1.2.1 Background Information Review

The background information review included reviewing and evaluating the following information sources:

- Topographic maps (Ontario Base Maps and National Topographic Survey Maps);
- Current and historical aerial photographs;
- Ministry of the Environment (MOE) water well records;
- Geological Maps (surficial and bedrock);
- Federal, provincial and municipal groundwater studies; and
- Background studies (geotechnical, environmental and drainage)

In addition, the local municipalities (Towns of Renfrew and Arnprior, and Counties of McNab-Braeside and Horton) were contacted to verify the location and nature of any municipal and communal water supply wells, land use, and water servicing for each location and all areas within 2 km of each location.

1.2.2 Site Inspection

Site inspections were completed at each location to document and evaluate existing conditions such as surface topography, surface and subsurface hydrology, water well locations, land use and structures, and municipal servicing. The site inspections included the following items:

- Describing the general topography and drainage characteristics of each location;
- Describing any significant geological features on and directly adjacent to each location including kettle holes and exposed bedrock;
- Verifying the location and nature of all permanent water courses and tributaries within one kilometer (km) of each location;
- Describing the location and nature of all significant water courses and associated features including wetlands, tributaries, closed depressions, kettle holes, and drainage ditches on and directly adjacent to each location;
- Verifying existing lands use and presence of structures within 500 metres of each location;
- Verifying the presence of municipal piped water to each location and surrounding areas;
- Verifying the location and nature of any significant groundwater discharge/seepage areas; and
- Completing a private water well survey of all wells within 500 m of each location.

1.2.3 Documentation

The results of the background information review and site inspection were documented into a written Hydrogeological Screening Report. The report provides an assessment of the local and regional groundwater system, and its vulnerability to potential highway construction activities. The vulnerability assessment includes the considerations:

- Location and significance of surface water courses at and around each location;
- Current and future use of groundwater in the vicinity of each location for water supply;
- Groundwater susceptibility to surface contamination;
- Presence of sensitive receptors (water wells and surface water courses) hydraulically downgradient of each location; and
- Hydraulic connectivity between shallow groundwater system and surface water courses.

The focus of this report is at Location 1 - Station 25+000 to 25+500 McNab-Braeside Twp. At this location, an underground watercourse was encountered during the Highway 17 Arnprior to Renfrew By-pass construction during the 1970's. Since the proposed twinning of Highway 17 at this location will include new westbound lanes cutting into the bedrock, there is the potential for intercepting a shallow bedrock aquifer.

2.0 SITE DESCRIPTION

The site is located along Highway 17 extending from approximately 500 metres to 1 km west of Campbell Drive (approximate 500 metre stretch), i.e. Stations 25+000 to 25+500. It extends in the north-south direction for approximately 115 metres within the proposed MTO R-O-W. Figure 1 shows the site location. Figure 2 shows the approximate site limits and significant site features. Site photographs have been included in Appendix A. These features are described below.

- The site is located on a large bedrock knoll/outcrop rising above the surrounding flat clay plains.
- The vertical profile of Highway 17 cuts through the bedrock rising moderately to the west from Station 25+475 to Station 25+000 (475 metre horizontal distance). The deepest part of the cut is approximately 5.6 metres from the base of the ditch to the top of the bedrock surface, and occurs at Station 25+260 on the north side of Highway 17.
- Open ditches flank the north and south sides of the highway between the road bed and bedrock. Flow in the ditches is to the east towards two culverts, one at Station 25+600 and the other at Station 25+760.
- At the time of the site inspection on May 10, 2007, two groundwater discharge zones (seeps) were observed on the north and south sides of the highway. Seep 1 occurs on the north side of Highway 17 at Station 25+370. It appears to be a discrete seep located at the base of the bedrock in the ditch. Water was observed to be pooling in the ditch and gently flowing along the north side of Highway 17 and into the culverts located east of the site, west of Campbell Drive. Seep 2 occurs on the south side of the highway at Station 25+400. It appears to be a discreet seep located at the base of a low bedrock cut in the ditch. Water was observed to be pooling in the ditch and gently flowing along the south side of Highway 17 and into the culverts located east of the site, west of Campbell Drive. The locations of the seeps are shown on Figure 2.
- The bedrock surface appears to be covered by a thin veneer of overburden vegetated with predominantly deciduous forest cover.
- There are shallow bedrock depressions scattered across the bedrock surface exhibiting poor drainage.
- The landscape surrounding the large forested bedrock outcrop is predominantly flat clay plains, especially to the north and east.

Current Land Use

According to the McNab-Braeside Township Official Plan, the site falls within the following land designations:

- *Rural* – found on both the north and south sides of Highway 17 extending from the east to the west limits of the Township of McNab-Braeside. Permitted land uses include: agricultural,

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forestry, low density residential, rural commercial, rural industrial, recreational and institutional.

- *Agricultural* – found northwest of Highway 17 at Division Street to immediately west of Campbell Drive. Permitted land uses include farm residences and structures relating to farming operations.

Ecoplans also completed a ground survey of the surrounding area to document current land use and any significant structures and water courses within 500 metres of the site. Figure 2 shows the approximate site limits and significant structures documented during the survey. The following relevant data from the ground survey is included below:

- The site is surrounded by forest with the exception to the east which is farmland.
- There are two farms and homesteads (houses, barns and other outbuildings) within 500 metres of the site. One is located approximately 250 metres north of the site (on the west side of Campbell Drive, north of Highway 17); and the other is located approximately 450 metres northeast of the site (on the east side of Campbell Drive, north of Highway 17).
- There is an abandoned building located approximately 150 metres southwest of the site on the south side of Highway 17, accessed through a driveway off of Campbell Drive.
- There are no significant water courses within 500 metres of the site.

Current Municipal and Private Servicing

Ecoplans completed a request for information from the Town of Renfrew for existing water and sanitary sewer systems. The information was used to identify and confirm the presence of municipal servicing of areas within two (2) kilometers of the site. Based on the information obtained from the Town, no municipal servicing is within 2 km of the site.

In addition to completing a request for information from the District, Ecoplans also carried out a ground survey to confirm the presence of private servicing of the site and the immediate surrounding area. At the time of inspection, Ecoplans did not identify any private servicing to the site. Ecoplans did confirm that the surrounding area is serviced privately, with each farm/dwelling serviced by a septic system and associated weeping tile bed; and water well (See Section 5.0).

There are no municipal and communal wells within 2 km of the site.

3.0 BACKGROUND INFORMATION REVIEW

Ecoplans completed a background information review for the site. The purpose of the review was to gain a general understanding of the regional and local geology and hydrogeology of the site. This was achieved by reviewing topographic and geological maps, water well records, current and historical aerial photographs, local and regional groundwater studies, and background geotechnical and environmental studies.

3.1 Topography

The site is located within the physiographic region known as the Ottawa Valley Clay Plains (Chapman and Putnam, 1984). This region is characterized by flat-lying tracts of clayey soils ranging from 10 to 30 km wide. The general topography of the site and surrounding area is variable. The site itself is located on a large bedrock outcrop gently dipping to the east, north and south. The outcrop extends for approximately 5 km in the east/west direction and 1.5 km in the north/south direction. The topography surrounding the bedrock outcrop is flat clay plains.

According to the Ontario Base Map (OBM) for the area, the approximate elevations of the Highway 17 road surface and the surrounding bedrock surface at the site are 119 and 125 metres above mean sea level (m amsl), respectively. The outcrop rises to the west to an elevation of 137 m amsl. The surrounding clay plain ranges in elevation between 116 and 118 m amsl.

3.2 Drainage

Regional drainage is to the north into Dochart Creek, which is a tributary of the Madawaska River. Both watercourses flow in a general easterly direction to the Ottawa River. The Madawaska River is the largest of the Ontario drainage systems discharging to the Ottawa River, and covers an area of approximately 8,500 km² (Chapman and Putnam, 1984).

Site drainage is generally poor on the bedrock surface with wetland depressions scattered across the bedrock surface. Drainage along the highway is conveyed through drainage ditches flanking the north and south sides of the highway which flow to the east towards two culverts between the east site limits and Campbell Drive. Culvert discharge is via direct infiltration into the soil. The clay plains surrounding the bedrock are poorly drained.

3.3 Geology

3.3.1 Surficial Geology

According to the groundwater report completed by Golder Associates Ltd (2003) for the Mississippi Valley Conservation Authority (MVCA), the site consists of Precambrian bedrock surrounded by surficial deposits of marine clay. The fine-grained deposits were laid down in quiet water environments, such as bedrock valleys or in depressions between drumlinized terrain. The thickness of the clay varies, and depends on the depth of depressions in which the clay was deposited. On average, the overburden surrounding the site is approximately 10-30 m thick. Figure 3 shows the surficial geology of the site and surrounding area.

3.3.2 Bedrock Geology

The bedrock geology of the site and surrounding area is composed of Precambrian igneous rock associated with the Mazinaw Terrane (OGS, 1991). The Mazinaw Terrane is located southeast of the Bancroft Terrane and consists of mafic metavolcanic, and meta-volcanoclastic rocks that appear in long thin bands. There are several major faults in the north portion of the Mazinaw Terrane, which are part of the Ottawa-Bonnechere Graben system (Golder Associates Ltd, 2003).

Overlying the Mazinaw Terrane are Palaeozoic deposits associated with the Gull River and Oxford Formations. The Gull River Formation is extremely complex and contains several different sedimentary sequences (Golder Associates Ltd, 2003). The lower portion of the formation consists mainly of limestone and silt dolostone, with shale and sandstone interbeds. The upper portion of the formation contains less dolostone. The Gull River Formation is limited to southeast trending bends in the vicinity of the site. The Oxford Formation is a dolomitic and sandstone unit occurring as two narrow isolated units northwest and southeast of the site

Figure 4 shows the bedrock geology of the site and surrounding area.

3.4 Hydrogeology

Preamble

Groundwater is found in water bearing zones below the ground. Less permeable or impermeable layers called aquitards may separate these water bearing zones or aquifers. The aquitards restrict groundwater movement typically between the shallow groundwater zone and the deeper groundwater zone. The shallow groundwater zone is usually perched, unconfined (i.e. not under hydrostatic pressure), limited in areal extent, and generally reflects the surface topography. On the other hand, the deeper groundwater zone is usually at depth, confined (i.e. under hydrostatic pressure/artesian conditions), regional in extent, and does not generally reflect the surface topography. The regional

aquifer, or groundwater system, is usually the potable water supply source for human and agricultural consumption.

Site

The hydrogeology of the site and surrounding area is predominantly characterized by the bedrock (regional) aquifer system. Since the overburden is largely composed of silt and clay, the overburden across the site would be considered a major confining unit (aquitard), and not an adequate source of potable groundwater. Hydraulic conductivities in the weathered clay deposits (top 3.0 to 5.0 m) have been measured by Dillon Consulting (1997) at 10^{-4} to 10^{-5} cm/s.

The bedrock aquifer system consists of aquifers located in Palaeozoic and Precambrian rock deposits. The Oxford and Gull River Formations hydrogeologic units associated with the Paleozoic bedrock are of adequate quality for domestic consumption (Golder Associates Ltd, 2003). The Oxford Formation is a dolostone aquifer and occurs as two narrow isolated units northwest and southeast of the site. The Gull River Formation is a dolostone, limestone, shale and sandstone aquifer and occurs to the north (north of the Oxford Formation) and further to the south and southeast of the site as a narrow band expanding further to the east. The groundwater yield of this formation typically decreases with depth, and the areal extent is small when compared to other bedrock aquifers.

The regionally extensive aquifer beneath the site, and to the south and west is the Precambrian bedrock. In general, fracture zones in the Precambrian aquifer yield marginal to adequate quantities of water for individual wells (Golder Associates Ltd, 2003). Groundwater flow is through secondary porosity from these fractures, while primary porosity will only account for approximately 2% of all flow (Freeze and Cherry, 1979). Near the bedrock surface stress releases can cause bedrock sheeting that result in the development of horizontal fractures parallel to the topographic surface. Vertical fractures can also form which may result in unconfined aquifer conditions where the bedrock is exposed at ground surface without adequate overburden cover, increasing the potential for surface contamination. Freeze and Cherry (1979) estimate the hydraulic conductivity of fractured igneous and metamorphic rocks at 10^{-6} to 10^{-2} cm/s.

Figure 4 shows the aerial distribution of the bedrock aquifers (associated with the bedrock geology) in the vicinity of the site.

3.5 Water Well Records

Preamble

The Ministry of the Environment's Water Well Database is a compilation of water wells drilled in the Province of Ontario for the purpose of human, agricultural and industrial consumption. Pursuant to the

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Ontario Water Resources Act, any well drilled for these purposes must be drilled by an MOE licensed well drilling contractor and documented on a Water Well Record. The record is then filed with the MOE. Examples of data recorded on a water well record include: location of well, date drilled, depth to water, static water level and subsurface stratigraphy. Since well records have been completed by many different drillers during the past 50 or so years, data accuracy and consistency is sometimes questionable. The most important data recorded on a record are the depth of the water supply aquifer and the subsurface stratigraphy. This information helps in determining whether the aquifer is hydraulically connected to the surface hydrology of an area through groundwater recharge and discharge. It is also important to realize that water wells are drilled into aquifers that can yield appreciable quantities of water for their intended purpose. The majority of these aquifers are normally found at depth in the deep groundwater zones. Therefore, shallow perched aquifers are rarely exploited as a resource due to high susceptibility to contamination, low yields, and potential impacts to surface water baseflow. Water well records seldom identify shallow perched aquifers.

However, given their limitations, water well records still provide a very useful source of both local and regional geological and hydrogeological information.

Site and Surrounding Area

Ecoplans completed a water well record search to within two (2) kilometers of the site. The results of the search identified a total of 105 water wells located in the vicinity of the site. The well locations are shown in Figure 5. However, it should be noted that the well locations are approximate and based on coordinate information provided within the water well records database, which are all subject to some margin of error. Documentation of the water well records has been included in Attachment B. The following relevant data from the records is included below:

- The earliest water well records available were from 1950 to as recent as 2006;
- All water wells are drilled into the bedrock aquifer, 106 wells in total (2 had no information recorded);
- Water wells drilled into the bedrock aquifer terminate between 7.3 metres to 99.0 metres below ground surface;
- Twenty-six (26) wells are drilled into granite deposits, and 73 wells are drilled into limestone deposits;
- The wells drilled into granite deposits are generally located south-southeast of the site, and wells drilled into limestone deposits are generally located north-northeast;
- The depth to water for water wells drilled into the bedrock aquifer range between 5.5 metres to 96.0 metres below ground surface;
- Twenty-eight (28) wells encounter water less than 15.0 metres below ground surface (i.e. shallow wells), 49 wells encounter water between 15.0 metres and 30.0 metres below ground surface (i.e.

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intermediate wells), and 25 wells encounter water greater than 30.0 metres below ground surface (i.e. deep wells);

- Shallow and intermediate wells are generally located southeast of the site in the vicinity of Pinegrove. Deep wells are generally located north-northeast and southeast of the site;
- Three (3) shallow wells (i.e. water less than 15.0 m from ground surface) are located close to the site. Two (2) wells (5510603 and 5510604) are approximately 250 metres south of the site, and one (1) well (5501316) is approximately 250 metres northeast of the site (based on the water well survey, Section 5.0, this well does not exist at the location identified in the well record);
- The groundwater elevations range from 38.1 m above sea level to 114.3 m above sea level;
- Two (2) wells are commercial water wells, 94 wells are domestic water wells, six (6) wells are stock water wells, and one (1) well is a public supply water well. The public supply well is located in Pinegrove, approximately 1.5 kilometres southeast of the site; and
- The general groundwater flow direction is north-northeast towards the Ottawa River.

Figures 6a and 6b show the geological interpretation of the site and surrounding area (geological cross-sections) based on those well records within 300 metres of a two-kilometre transect through the site. Figure 6a shows a geological cross-section based on 8 well records through the site and along Highway 17 while Figure 6b shows a cross-section based on 6 well records through the site and roughly perpendicular to Highway 17. It should be noted that some of the well records did not show surface elevations and therefore surface elevations were estimated based on OBM maps.

Based on interpretation of the cross-sections, the site and immediate surrounding area to the north and west of the site is underlain by Precambrian bedrock and to the south and east by Paleozoic limestone and dolostone bedrock. The thickest overburden (predominantly clays) occurs at and north of the Campbell Drive/Highway 17 intersection (12 – 17 metres thick). Water was encountered in the bedrock at elevations between 52 m amsl (approximately 1.5 km east of the site) to 115 m amsl (approximately 250 metres south of the site) with an average elevation of 87 m amsl. This represents the regional bedrock aquifer system.

3.6 Aerial Photographs

Historical aerial photographs (for the years 1946, 1959, 1978 and 1987) for the site and surrounding area were reviewed by Ecoplans to identify any surface features that are of potential hydrogeological significance (surface water bodies, vegetation cover and human development impacts). A description of the notable features for each aerial photo is summarized in Table 1.

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Table 1
Review of Aerial Photographs – Significant Site Features

Year	Significant Site Features
1946	<ul style="list-style-type: none">- Hwy 17 not present.- Site is sparsely covered with trees; however west and northwest of the site, tree cover density increases.- Farm homesteads to the north and east of site.- Surrounding lands predominantly agricultural.
1959	<ul style="list-style-type: none">- Hwy. 17 not present.- Forest cover has increased on site- No other significant changes since the 1946 aerial photo
1978	<ul style="list-style-type: none">- Forest cover has significantly increased on site and appears to have filled in with mostly deciduous trees.- Highway 17 drainage ditches flanking the north and south sides of the highway between the east site limits and Campbell Drive appear to be full of water, especially the north ditch.- No other significant changes since the 1959 aerial photo.
1987	<ul style="list-style-type: none">- No significant changes since the 1978 aerial photo.

The most significant observations noted on the aerial photos are:

- The forest cover had progressively increased on the site from at least 1959 to 1987. Prior to this part of the land may have been in limited agricultural production or could have been selectively logged; and
- The 1978 aerial photo shows the Highway 17 drainage ditches flanking the north and south sides of the highway immediately east of the site to contain significant water. This could be groundwater discharging from the bedrock cut seeps located on the north and south sides of the highway.

3.7 Background Studies

This section summarizes the background studies that were reviewed noting significant relevant information.

- Existing Conditions Report- Volume 3, Appendix F. Highway 17 Twinning Arnprior to Renfrew WP 647-92-00. Prepared by Totten Sims Hubicki Associates (TSH) and National Capital Engineering (NCE). November 2002.*

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Significant relevant information included:

- Based on the MOE Water Well Data Set, approximately 10 water wells were identified within 1 km of the site.
- The Towns of Arnprior and Renfrew are on municipal water systems.
- The bedrock along Highway 17 between Renfrew and Arnprior is Precambrian including granite, gneiss and carbonate rocks and crystalline limestone outcrops in certain areas (the site itself).
- The soils in the site are predominantly Tweed soils (sandy loams) associated with surface outcrops of crystalline limestone. These soils exhibit good drainage and high base status making them suitable for forest cover. Immediately to the north of the site are Ste. Rosalie soils (clay). These soils are imperfectly drained making them suitable for hay and grain crops.
- The physiography along Highway 17 between Arnprior and Renfrew consists mainly of clay plains (Ottawa Valley Clay Plains Physiographic Region) interrupted by shallow till and rock ridges, sand plains and a small area of kame moraines at County Road 6. The site itself lies within shallow till and rock ridges. The clay plains are extremely susceptible to surface erosion and are underlain with very soft blue-grey silt, silty clay and clay referred to as “leda clay”. Leda clay is extremely unstable and vulnerable to slope failure.
- Land use within and surrounding the site consists predominantly of natural areas/woodlots which flank Highway 17 through the site. Agricultural land is found to the northwest of the site.
- McNab-Braeside Township Official Plan describes the following land designations for the site:
 - *Rural* – found on both the north and south sides of Highway 17 extending from the east to the west limits of the Township of McNab-Braeside. Permitted land uses include: agricultural, forestry, low density residential, rural commercial, rural industrial, recreational and institutional.
 - *Agricultural* – found northwest of Highway 17 at Division Street to immediately west of Campbell Drive. Permitted land uses include farm residences and structures relating to farming operations.
- The existing highway drainage system within the site is typical of many current provincial highway drainage systems, i.e. open ditch and culverts. Ditches flank each side of the highway and flow to the east following the moderately sloped topography. There are two culverts located between the east limits of the site and Campbell Drive. Each culvert conveys drainage to the north side of Highway 17 into the adjacent agricultural fields.
- The site lies within a forested area. The forest cover is predominantly young, upland deciduous forest, the eastern areas showing the sparse undergrowth and open canopy indicative of woodlands with past grazing history. Tree species such as Sugar Maple, Red Maple, Ironwood, White Elm, White Ash, White Birch populate the forest cover which are reflective of a significant history of disturbance. White Pine forms distinct groves of young to submature trees

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in the site and several clusters of Red Pine were identified. Small bedrock-depression wetlands dominated by White Cedar, White Spruce and Balsam Fir occur at regular intervals in the site.

- ii) *Foundation Investigation and Design Report Campbell Drive Underpass Highway 17 Twinning Arnprior to Renfrew, Ontario. G.W.P. 647-92-00, Site No. 29-415 GEOCRES Number: 31F-129. Prepared by Thurber Engineering Ltd. September 20, 2004.*

Significant relevant information included:

- The site is located between the Laurentian upland to the north and west, and the Ottawa lowland to the south and east. The native soils consist typically of glaciolacustrine clayey silts and silty clays deposited in the geological past when the Champlain Sea inundated the Ottawa-St. Lawrence lowland. The clay deposits are interrupted by rock ridges and sand and silt deposits. To the west of Arnprior, the overburden deposits are underlain by bedrock consisting of Precambrian metamorphosed greywacke interbedded with limestone.
 - The subsurface investigation consisted of 9 boreholes ranging in depth between 2 metres and 7.9 m. Standpipe piezometers were installed in 3 of the boreholes.
 - A deposit of silty clay was encountered below a thin layer of fill or topsoil at all borehole locations. The silty clay extends to depths between 1.5 and 5.9 metres below ground surface (bgs).
 - A deposit of sandy silt to silty sand till was encountered at several borehole locations. The till was encountered from a depth of 1.5 m to 5.6 m and extended to a depth of 2 m to 7.6 m.
 - The bedrock that was encountered in all of the boreholes consists of crystalline limestone bedrock of the Ordovician period. The elevation of the bedrock surface ranged from 106.7 metres above mean sea level (m amsl) to 111.7 m amsl.
 - No free groundwater was observed in most of the boreholes.
 - Groundwater levels in the 3 piezometers ranged in elevation between 112.5 m amsl and 113.1 m amsl.
 - Based on the borehole logs, there appears to be an overburden aquifer within the lower sandy silt till and silty clay above the bedrock surface.
- iii) *Preliminary Foundation Report For Structural Crossings of Revised Highway #17 From Atrium Westerly to Lochiel Creek Regional Municipality of Ottawa Carleton and Renfrew County District No. 9. W.J. 69-F-86 W.P.'s 5-67 & 190-67. GEOCRES Number: 31F-23. Prepared by Foundation Section, Department of Highways. March 12, 1970.*

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Significant relevant information included:

- The site is located in the Ottawa Valley Clay Plains Physiographic Region. In this region, extensive deposits of clay are interrupted by ridges primarily composed of shallow glacial deposits overlying bedrock. The clay is generally underlain by glacial till and/or interglacial sand and gravel deposits followed in turn by bedrock, which west of Arnprior is of Precambrian age, while to the east it is predominantly it is limestone of the Trenton-Black River Formation of Ordovician age.
 - A borehole was completed at the Highway 17 and Campbell Drive Intersection to a depth of 47.6 feet. The upper 39 feet consisted of a very stiff silty clay overlying a thin basal layer (3.5 feet in thickness) of glacial till. This in turn overlies Greywacke Precambrian bedrock. The surface and bedrock elevations at this borehole were 369.1 feet amsl and 326.6 feet amsl, respectively.
 - The water level in the open borehole was at 5.1 feet bgs.
- iv) *Renfrew County-Mississippi-Rideau Groundwater Study, Volume 1 and 2, Summary Report and Technical Appendices.* Prepared by Golder Associates Limited. September 2003.
- Significant relevant information has been incorporated into Section 3.3 and Section 3.4.
- v) *Hydrogeology of Southern Ontario, Second Edition.* Prepared by S.N. Singer, C.K. Cheng and M.K. Scafe; Ministry of the Environment. 2003.
- Significant relevant information has been incorporated into Section 3.3 and Section 3.4.

4.0 SITE INSPECTION

A site inspection was carried out on May 10, 2007. The purpose of the site inspections was to observe and document any significant features of hydrogeologic concern such as surface water courses, seepage zones and springs (groundwater discharge), topography and surficial geology. Site photographs have been included in Appendix A. The results of the inspections are summarized below.

- The site is located on the east flank of a large Precambrian bedrock knoll/outcrop which is surrounded by a flat clay plain.
- Highway 17 cuts through the bedrock with a moderate upslope to the west. The cut is deepest near Station 25+260 approaching 5 to 6 metres.
- The bedrock surface to the north and south of the highway is forested on thin soils and slopes to the north and south. Scattered wetland depressions were observed on the bedrock surface.
- Two discrete groundwater discharge zones (seeps) were observed (Seeps 1 and 2) both at an estimated elevation of 119 m amsl.
- Seep 1 was noted at the base of the bedrock cut on the north side of Highway 17 at Station 25+370. The discharge is likely at or below ground surface as no obvious channelized flow was observed discharging from the rock cut. However, there was cold water in the ditch collecting at this point and gently flowing along the highway ditch to the east downslope towards the culverts located east of the site limits.
- Seep 2 was noted at the base of a smaller bedrock cut on the south side of Highway 17 at Station 25+400. As with Seep 1, the discharge is likely at or below ground surface as no obvious channelized flow was observed discharging from the rock cut. However, there was water in the ditch collecting at this point and gently flowing along the highway ditch to the east downslope towards the culverts located east of the site limits. Seep 2 appeared to discharge less groundwater than Seep 1.

5.0 WATER WELL SURVEY

Ecoplans completed a door-to-door water well survey of all wells within 500 metres of the site. The purpose of the door-to-door well survey was to confirm the presence, location, construction details and static water levels of each well, access permitting. The results of the survey identified three (3) residences using private water wells within 500 metres of the site. Of the three residents, two (2) were surveyed (762 and 767 Campbell Drive). There was no response at the third residence (664 Campbell Drive). Figure 5 shows the locations of the surveyed wells included 664 Campbell Drive (only the well location and diameter were confirmed). It should be noted that based on the well records and well survey, the well locations for 664 and 762 Campbell Drive roughly match. However the wells at 767 Campbell Drive as confirmed through the well survey may be the wells identified in the well records as being located approximately 250 metres southwest of their actual location.

All surveyed wells tap into the bedrock aquifer of the area with well depths ranging from 19 to 23 m. Groundwater levels are relatively shallow and are close to ground surface.

Table 5 summarizes the well survey results for the water wells within 500 metres of the site.

Table 2
Water Wells Within 500 Metres of the Site

Address	GPS Coordinates	Date Installed*	Well Diameter (cm)	Well Type	Well Depth (m)	Static Water Level (m bgs)	Notes
767 Campbell Drive	389256E 5032633N	1982	0.15	Drilled	23*	2.1*	- Main source of water - Well Capacity at 74 gpm* - No water quality or quantity issues*
767 Campbell Drive	389223E 5032584N	U	Unknown	Drilled	19.1	1.8	- Rarely Used* - In very bad condition, source of direct contamination to the aquifer form

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Table 2
Water Wells Within 500 Metres of the Site

Address	GPS Coordinates	Date Installed*	Well Diameter (cm)	Well Type	Well Depth (m)	Static Water Level (m bgs)	Notes
							animal fecal matter stored at the well head
762 Campbell Drive	389628E 5032945N	U	Buried	Drilled	20*	I	- No water quality or quantity issues*
664 Campbell Drive	389968E 5032523N	U	0.15	Drilled	I	I	- No one home

Notes:

* = Well information based on information obtained through occupant interview.

U = Unknown

I = Inaccessible

6.0 EVALUATION OF GROUNDWATER RESOURCES

The surficial geology of the site and surrounding area is dominated by a large Precambrian bedrock outcrop extending approximately 5 km in the east/west direction and 1.5 km in the north/south direction. The outcrop is a prominent feature of the landscape as it rises more than 20 metres above the surrounding flat clay plains. Highway 17 cuts through the bedrock and roughly follows the east-west axis of the outcrop. A thin veneer of soil covers the bedrock outcrop with localized wetland depressions scattered across the bedrock surface. North and east of the site are dolostone and limestone rocks of Paleozoic age, and south of the site are predominantly igneous rocks of Precambrian age. These rocks are covered with marine clays ranging in thickness from 10 to 30 metres.

The hydrogeology of the site and surrounding area is dominated by bedrock driven groundwater systems found in the fractures and joints of the Precambrian (igneous) rock, and in the fractures and bedding planes of the Paleozoic (predominantly dolostone and limestone) rock. Within two kilometres of the site, the bedrock aquifer system is found at depths between 5.5 and 96 m bgs (elevations of between 115 and 52 m amsl), the deepest being approximately 1.5 km east of the site. All of the water wells servicing the 2-km radius area exploit the bedrock aquifer as a potable source with the majority of the wells drawing their water from the limestone aquifer, generally located to the north-northeast of the site. Based on the water well records and well survey, there are shallow wells to the northeast and south of the site. Groundwater flow in the bedrock aquifer system is generally to the north-northeast towards the Ottawa River.

The site inspection identified the presence of two groundwater discharge zones (seeps) on the north and south sides of Highway 17 approximately 600 metres west of Campbell Drive. Both seeps discharge groundwater at the base of the bedrock cut at which point the water pools and gently flows along the highway ditches to the east and downgradient towards the flatter clay plains. Most, if not all, of the water is lost through direct infiltration into the overburden and bedrock before reaching the Highway 17 culverts located between the east site limits and Campbell Drive. As such, the groundwater discharging from the seeps may be recharging the regional bedrock aquifer system.

The seeps likely discharge groundwater from a localized perched bedrock aquifer system (estimated elevation of 119 m amsl) in the Precambrian bedrock outcrop which is at a higher elevation than surrounding clay plains (estimated average elevation of 117 m amsl). This aquifer was breached during the construction of Highway 17 in the early 1970's, and was backfilled with gravel and rocks. The areal extent of the aquifer is unknown but could be localized. It appears that the discharge is not significant but does sustain flow in the ditches which is then lost to the subsurface through infiltration. It is likely that both seeps are hydraulically connected with the main groundwater discharge from the

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bedrock occurring at Seep 1 and an appreciable portion of the discharge contributes to Seep 2 by flowing under the highway through the highway bedding material.

Groundwater Impacts and Vulnerability

The proposed twinning of Highway 17 through the site will involve a significant cut (could be approximately 6 metres or more) into the bedrock to the north of the existing highway to accommodate construction of the westbound lanes. This will likely intercept the aquifer. If appropriate mitigation measures are not implemented then the aquifer breach could create similar conditions to that which is occurring today, i.e. discharging groundwater on the surface and potentially recharging the regional bedrock aquifer system through surface infiltration. The result would be a net loss to the perched aquifer system (local system) and a net gain to the regional aquifer system, i.e. transferring groundwater from one aquifer system to another. The potential physical impacts (i.e. groundwater quantity/supply) to these groundwater systems would likely not be significant due to the following reasons:

- The local aquifer under study is likely not the regionally extensive bedrock aquifer supplying potable water to the residential wells in the area. However it may be hydraulically connected through bedrock fractures and joints.
- The aquifer is likely not regionally extensive and may be confined to the bedrock outcrop.
- The aquifer's discharge appears not to be significant and may only contribute minimal recharge into the regional bedrock aquifer system.
- The only sensitive receptors in the area are the water wells associated with the residences to the north and northeast (groundwater flow in the regional bedrock aquifer system is the north-northeast). These wells are located approximately 250 and 450 metres north and northeast of the site.

The potential chemical impacts (i.e. groundwater quality) to the groundwater systems could be of a concern due to winter maintenance (road salting) activities and spills without implementing adequate mitigation measures. Since groundwater does not freeze it can mobilize and transport contaminants at and in close proximity of discharge location during the winter months resulting in a net flux of contaminants into the subsurface which could reach the bedrock aquifer system and potentially impact water well users downgradient.

Based on the above, the overall vulnerability of the local and regional groundwater systems to highway construction activities would be considered low with respect to groundwater quantity issues, and moderate with respect to groundwater quality issues. Provided adequate mitigation measures are implemented, any potential construction related groundwater impacts could be minimized.

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We trust the information outlined in this report meets with your requirements. Should you have any questions, please do not hesitate to contact our office.

Sincerely,

Ecoplans Limited



Derek A. Stewart, B.Sc., P.Geo
Senior Hydrogeologist



cc. Tony Sangiuliano, MTO
Manny Goetz, MRC

7.0 REFERENCES

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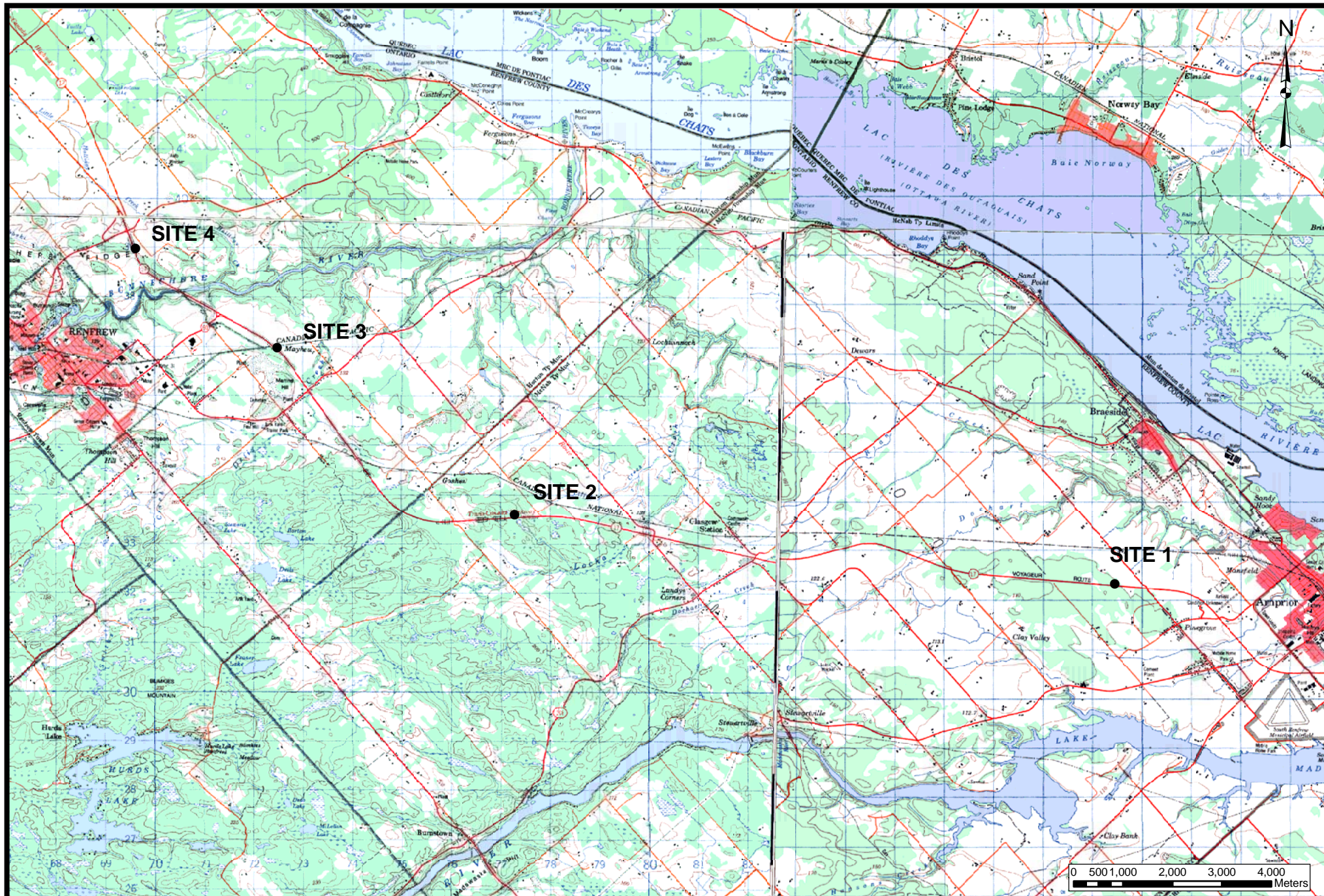
Page 22 of 22

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FIGURES

Site 1– Station 25+000 to 25+500 McNab-Braeside Twp.



Source: National Topographic System (NTS)

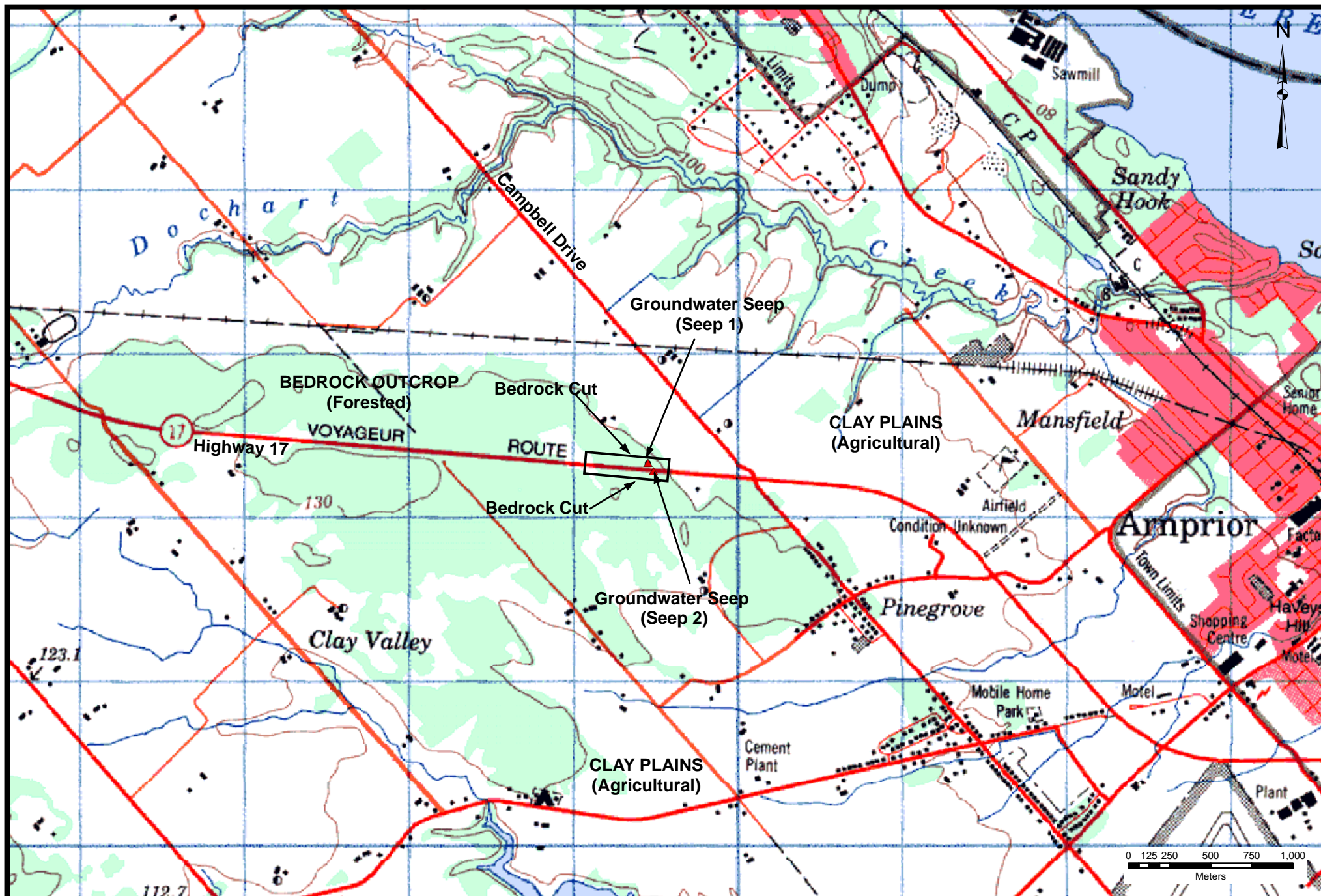
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HYDROGEOLOGICAL SCREENING REPORT
HIGHWAY 17 TWINNING CAMBELL DRIVE TO SCHEEL DRIVE, ONTARIO
 GWP 4067-03-00
SITE LOCATION PLAN

DATE:
AUGUST 2007
 PROJECT:
R07-0261

FIGURE
1



Source: National Topographic System (NTS)

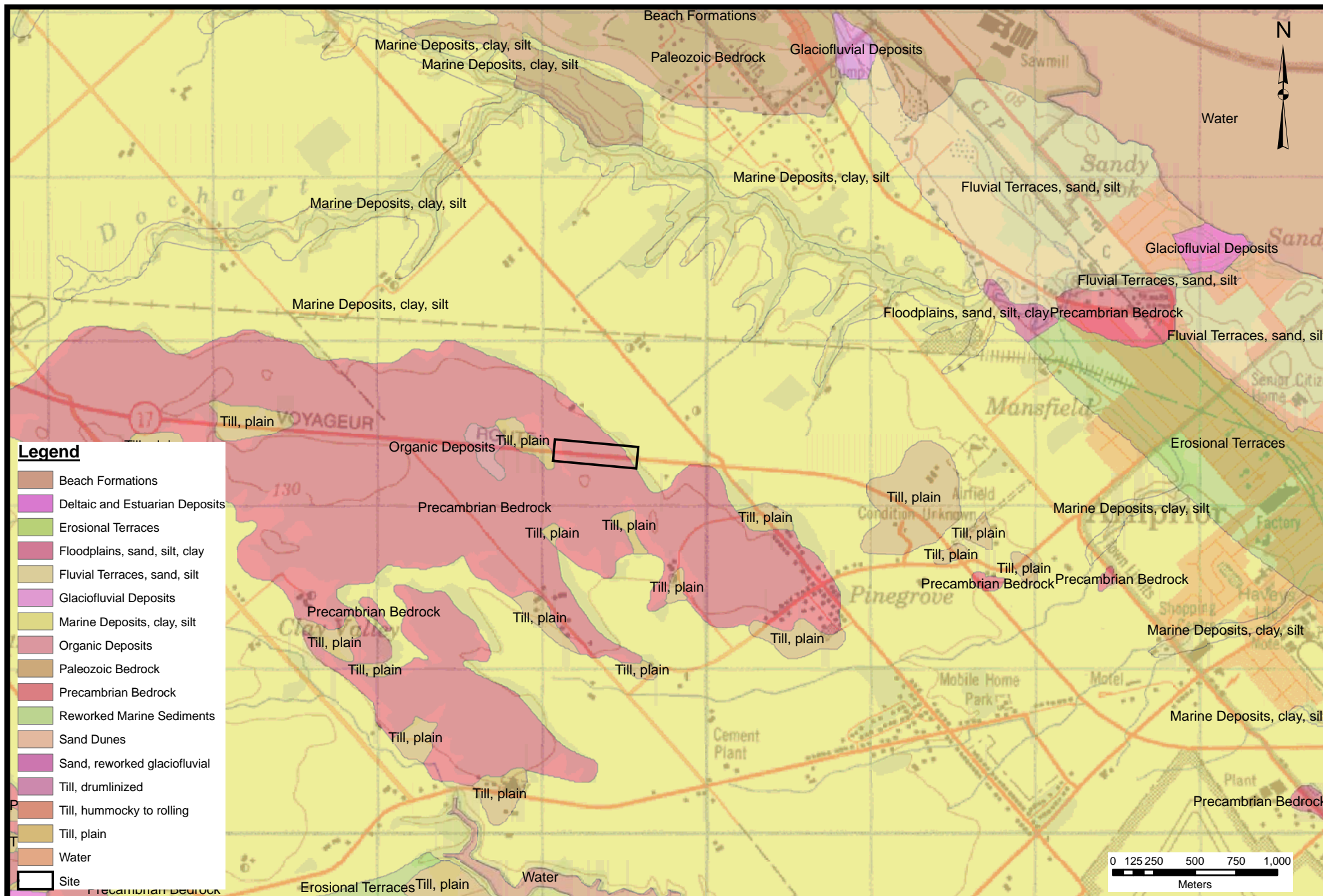
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HYDROGEOLOGICAL SCREENING REPORT
 HIGHWAY 17 TWINNING CAMBELL DRIVE TO SCHEEL DRIVE, ONTARIO
 GWP 4067-03-00
SITE PLAN

DATE:
AUGUST 2007
 PROJECT:
R07-0261

FIGURE
2



Source: Geological Survey of Canada, 2003

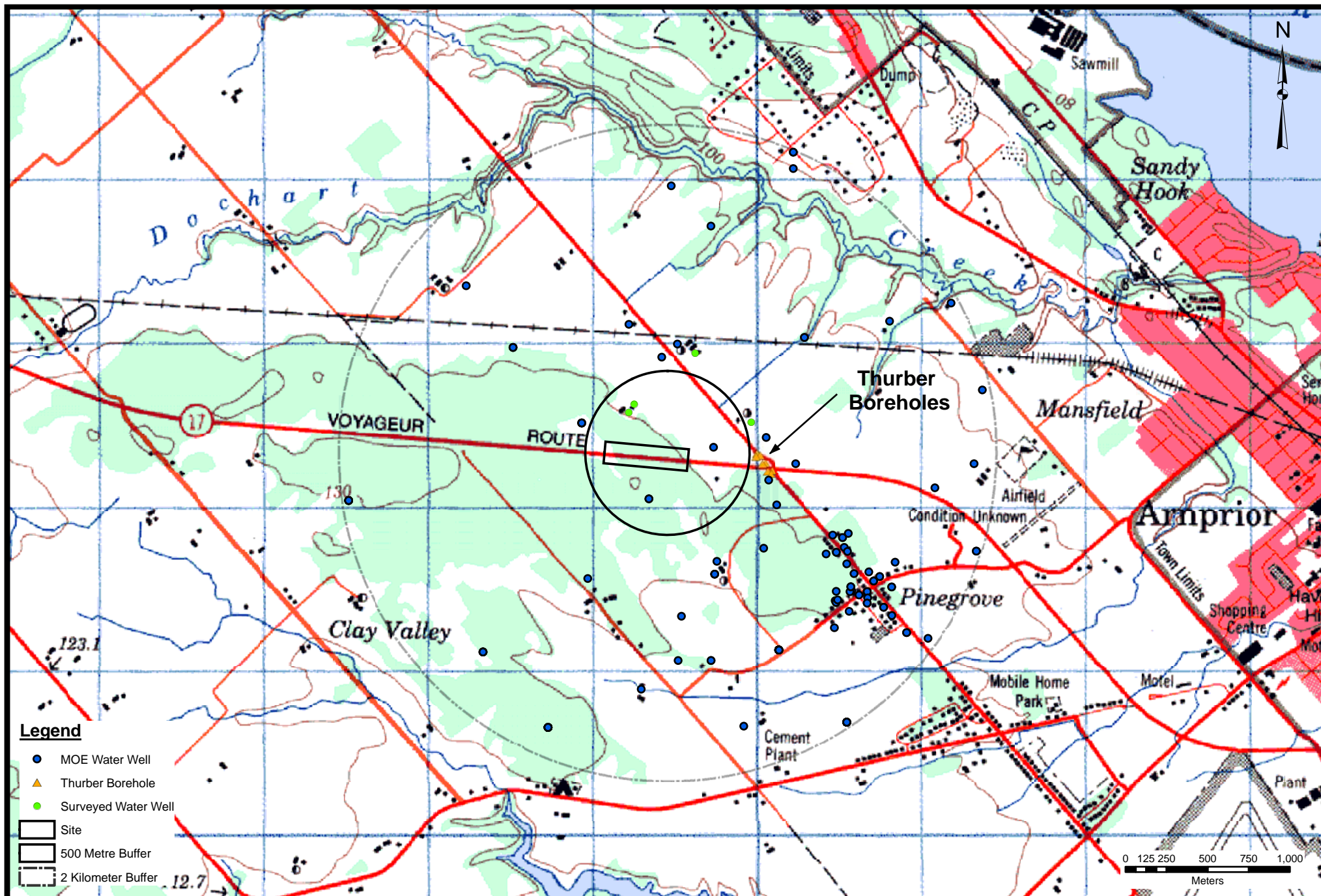
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HYDROGEOLOGICAL SCREENING REPORT
HIGHWAY 17 TWINNING CAMBELL DRIVE TO SCHEEL DRIVE, ONTARIO
GWP 4067-03-00
SURFICIAL GEOLOGY OF THE SITE AND SURROUNDING AREA

DATE:
AUGUST 2007
PROJECT:
R07-0261

FIGURE
3



Source: National Topographic System (NTS)

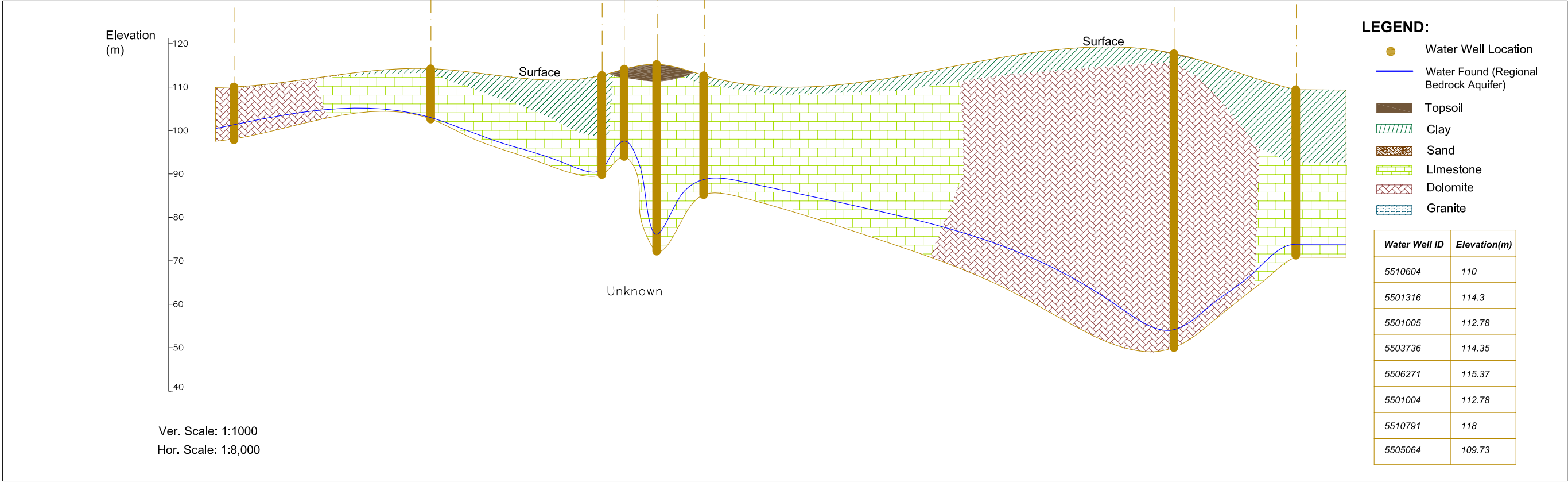
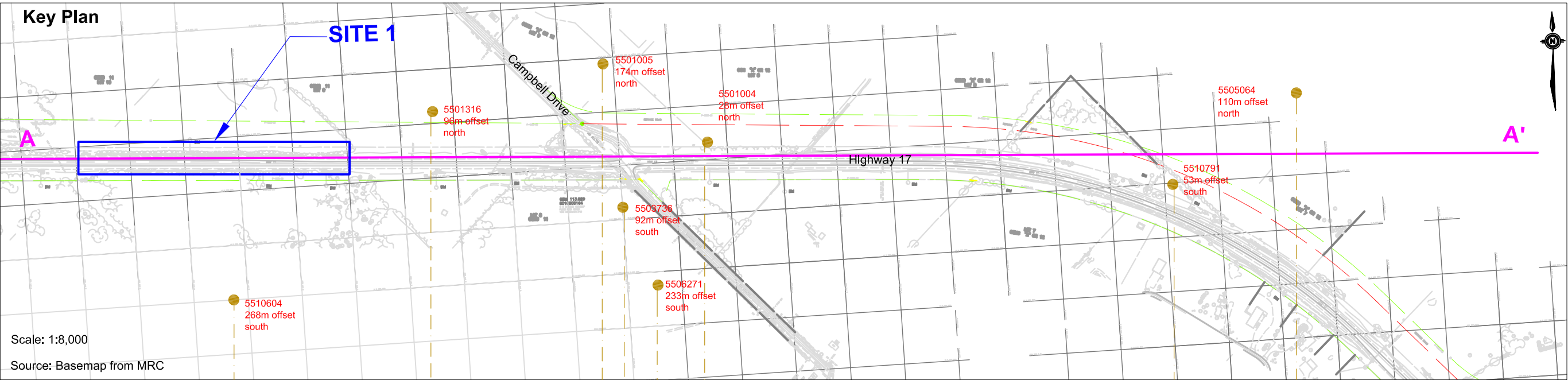
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HYDROGEOLOGICAL SCREENING REPORT
 HIGHWAY 17 TWINNING CAMBELL DRIVE TO SCHEEL DRIVE, ONTARIO
 GWP 4067-03-00
WATER WELL LOCATION PLAN

DATE:
AUGUST 2007
 PROJECT:
R07-0261

FIGURE
5



FILE LOCATION: I:\Ecoplans\03 - Remediation\PROJECTS\03-0261 17 Twinning - Campbell to Scheel\0261-700 Drawings
DRAWING NAME: Eco-Cross Section.DWG
DRAWN BY: G. Yang
MODIFIED: 07/06/16
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Revised

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DRAWING NAME: Eco-Cross Section.DWG
DRAWN BY: G. Yang
MODIFIED: 07/06/16 12:08:16 Revised



Geological Cross-Section B - B' of Site1

Highway 17 Twinning from Campbell Drive to Scheel Drive
GWP 4067-03-00

DATE:
August 2007

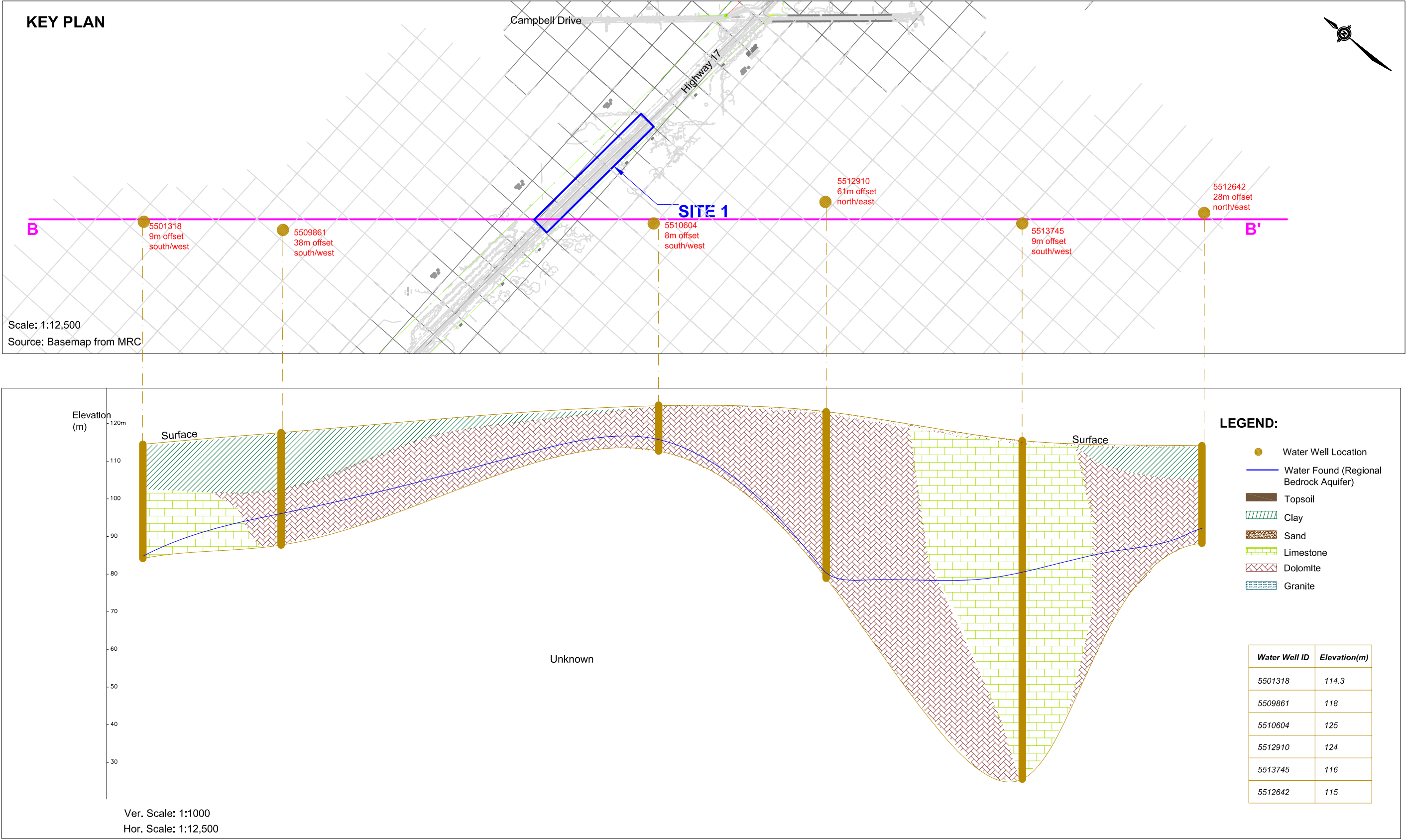
PROJECT NO.:
R07-0261

DRAWN BY:
G. Yang

CHECKED BY:
D. Stewart

FIGURE NO.:

6b



APPENDIX A
Site Photographs



← Photo 1
Highway 17 bedrock cut through site.
Photo taken facing east.



Photo 2 →
Highway 17 bedrock cut through site.
Photo taken facing west.



← Photo 3
Bedrock cut on north side of Highway 17
noting pool of water generated from
groundwater seep (Seep 1). Photo taken
facing west.



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Hydrogeological Screening Report
Highway 17 Twinning Campbell Drive to Scheel Drive
GWP 4067-03-00
SITE 1: Site Photographs

Date:
August 2007

Project No.:
R07-0261

Figure No.

A-1



← Photo 4
Close up of bedrock groundwater discharge seep (Seep 1). Photo taken facing northeast.



Photo 5 →
Seep 1 discharge location noting flow and pooling to the east along the ditch.
Photo taken facing east.



← Photo 6
Close up of groundwater discharge seep (Seep 2) located on the south side of Highway 17. Photo taken facing east.

APPENDIX B

Ministry of the Environment (MOE) Water Well Records

Summary of Water Well Records Within 2 km of Site
Hydrogeological Screening Report
Highway 17 Twinning Campbell Drive to Scheel Drive
GWP 4067-03-00

<i>MOE</i>	<i>UTM Coordinates</i>		<i>Ground Surface</i>	<i>Depth</i>	<i>Depth</i>	<i>Depth</i>	<i>Groundwater</i>	<i>Date</i>	<i>Water</i>		<i>Bedrock</i>
<i>Well ID</i>	<i>Easting</i>	<i>Northing</i>	<i>Elevation</i>	<i>of Well</i>	<i>to Bedrock</i>	<i>to Water</i>	<i>Elevation</i>	<i>Constructed</i>	<i>Supply Type</i>	<i>Well Type</i>	<i>Unit</i>
5502376	390650	5031270	115.8	30.8	1.2	5.5	110.3	12/17/1969	Domestic	Bedrock	Limestone
5513379	388913	5032298	NA	9.1	0.9	6.1	NA	8/7/1998	Domestic	Bedrock	Granite
5501308	390570	5031380	115.8	7.3	1.2	6.7	109.1	5/4/1963	Domestic	Bedrock	Limestone
5501315	390020	5031535	121.9	22.9	0.6	7.6	114.3	8/11/1965	Stock	Bedrock	Limestone
5513793	388312	5030902	NA	13.7	1.8	7.9	NA	9/27/1999	Domestic	Bedrock	Limestone
5516170	391314	5031517	NA	21.3	3.4	9.1	NA	8/20/2005	Commercial	Bedrock	Granite
5510604	389322	5031836	NA	12.2	0.3	9.1	NA	7/24/1991	Domestic	Bedrock	Granite
5509463	390112	5030914	NA	85.3	0.6	9.1	NA	5/5/1989	Domestic	Bedrock	Granite
5515484	390113	5030913	NA	51.8	0.6	10.4	NA	10/28/2003	Domestic	Bedrock	Limestone
5501306	390460	5031205	117.3	11.9	NA	11.3	106.1	8/5/1961	Domestic	Bedrock	Limestone
5501316	389715	5032150	114.3	12.2	1.2	11.6	102.7	1/5/1961	Stock	Bedrock	Limestone
5501302	390600	5031250	115.8	12.2	NA	11.6	104.2	7/15/1960	Domestic	Bedrock	Limestone
5501304	390455	5031215	117.3	11.6	4.6	11.6	105.8	5/8/1961	Domestic	Bedrock	Limestone
5501303	390535	5031625	117.3	12.2	2.4	11.6	105.8	5/4/1961	Domestic	Bedrock	Limestone
5501305	390555	5031275	117.3	12.2	3.0	11.6	105.8	6/15/1961	Domestic	Bedrock	Limestone
5501295	390890	5031020	114.3	15.2	0.6	12.2	102.1	7/13/1961	Domestic	Bedrock	Limestone
5503139	390461	5031272	115.8	12.2	3.0	12.2	103.6	8/31/1973	Domestic	Bedrock	Limestone
5510603	389322	5031836	NA	14.3	0.9	12.2	NA	7/24/1991	Domestic	Bedrock	Granite
5501313	389520	5031120	117.3	13.4	NA	12.8	104.5	4/23/1958	Domestic	Bedrock	Limestone
5501312	390470	5031220	117.3	14.3	NA	12.8	104.5	7/7/1966	Domestic	Bedrock	Limestone
5502697	389275	5030675	117.3	18.9	NA	12.8	104.5	10/21/1971	Domestic	Bedrock	Limestone
5513501	390112	5030914	NA	29.0	1.5	12.8	NA	11/5/1998	Domestic	Bedrock	Granite
5511068	387495	5031826	NA	14.0	8.8	13.1	NA	8/17/1992	Domestic	Bedrock	Granite
5502828	390820	5031450	114.3	15.2	0.6	13.7	100.6	4/29/1972	Domestic	Bedrock	Limestone
5512642	390525	5030474	NA	25.9	9.8	13.7	NA	6/3/1996	Domestic	Bedrock	Granite
5515952	390689	5031335	NA	47.2	0.3	14.3	NA	2/25/2005	Domestic	Bedrock	Granite
5501293	390800	5031125	114.3	15.2	NA	14.6	99.7	7/25/1960	Domestic	Bedrock	Limestone
5502375	389700	5030850	114.3	15.2	NA	14.6	99.7	9/12/1969	Domestic	Bedrock	Limestone
5501002	390660	5031390	114.3	17.7	0.9	15.2	99.1	6/25/1956	Public Supply	Bedrock	Limestone
5509620	390112	5030914	NA	22.9	0.6	15.2	NA	7/11/1989	Domestic	Bedrock	Limestone
5513695	388913	5032298	NA	24.4	1.8	15.2	NA	7/22/1999	Domestic	Bedrock	Limestone

Summary of Water Well Records Within 2 km of Site
Hydrogeological Screening Report
Highway 17 Twinning Campbell Drive to Scheel Drive
GWP 4067-03-00

<i>MOE</i>	<i>UTM Coordinates</i>		<i>Ground Surface</i>	<i>Depth</i>	<i>Depth</i>	<i>Depth</i>	<i>Groundwater</i>	<i>Date</i>	<i>Water</i>	<i>Well Type</i>	<i>Bedrock</i>
<i>Well ID</i>	<i>Easting</i>	<i>Northing</i>	<i>Elevation</i>	<i>of Well</i>	<i>to Bedrock</i>	<i>to Water</i>	<i>Elevation</i>	<i>Constructed</i>	<i>Supply Type</i>		<i>Unit</i>
			<i>(m ASL)</i>	<i>(m bgs)</i>	<i>(m)</i>	<i>(m bgs)</i>	<i>(m ASL)</i>				
5511372	388708	5030442	NA	43.6	4.9	15.2	NA	9/2/1992	Domestic	Bedrock	Limestone
5513967	390525	5030474	NA	30.5	10.7	15.2	NA	6/7/2000	Domestic	Bedrock	Shale
5501006	389495	5032780	112.8	16.5	5.8	15.8	96.9	10/18/1960	Stock	Bedrock	Limestone
5512107	388312	5030902	NA	28.7	NA	16.2	NA	9/20/1994	Domestic	Bedrock	Limestone
5503096	389899	5030450	115.8	18.3	4.3	16.8	99.1	6/29/1973	Domestic	Bedrock	Limestone
5501003	390510	5031540	114.3	18.3	3.0	17.7	96.6	6/10/1961	Domestic	Bedrock	Limestone
5501310	390525	5031440	117.3	18.6	4.9	18.0	99.4	11/19/1965	Domestic	Bedrock	Limestone
5503174	390653	5031232	117.3	19.5	NA	18.3	99.1	7/24/1973	Domestic	Bedrock	Limestone
5503736	390050	5031950	117.3	20.1	0.6	18.3	99.1	6/11/1975	Domestic	Bedrock	Limestone
5509714	387495	5031826	NA	45.7	NA	18.3	NA	9/13/1989	Domestic	Bedrock	Granite
5508059	388708	5030442	NA	22.9	0.9	18.3	NA	12/13/1985	Domestic	Bedrock	Limestone
5511960	387495	5031826	NA	22.9	NA	18.9	NA	6/23/1994	Domestic	Bedrock	Granite
5503734	390450	5031050	115.8	19.2	NA	19.2	96.6	4/29/1975	Domestic	Bedrock	Limestone
5501311	390462	5031510	118.9	25.0	1.2	19.8	99.1	8/29/1966	Domestic	Bedrock	Limestone
5510058	387495	5031826	NA	27.4	0.9	19.8	NA	6/12/1990	Domestic	Bedrock	Granite
5504415	388950	5031350	125.0	22.9	12.8	20.1	104.9	3/10/1977	Domestic	Bedrock	Limestone
5501341	390530	5031515	114.3	24.7	NA	20.4	93.9	7/15/1966	Domestic	Bedrock	Limestone
5511373	388708	5030442	NA	45.7	6.1	20.4	NA	9/10/1992	Domestic	Bedrock	Limestone
5501309	390540	5031150	115.8	21.3	NA	20.7	95.1	3/1/1965	Domestic	Bedrock	Limestone
5509301	388708	5030442	NA	29.9	6.1	20.7	NA	11/10/1988	Domestic	Bedrock	Granite
5501000	391020	5030985	112.8	21.9	11.3	21.3	91.4	5/5/1959	Domestic	Bedrock	Limestone
5510182	390112	5030914	NA	25.0	2.7	21.3	NA	8/16/1990	Domestic	Bedrock	Granite
5509861	388495	5032759	NA	29.9	14.3	21.3	NA	12/1/1989	Domestic	Bedrock	Granite
5503725	390550	5031300	115.8	32.0	2.7	21.6	94.2	12/7/1974	Domestic	Bedrock	Limestone
5503665	390500	5031600	118.9	32.0	2.7	21.6	97.2	12/7/1974	Domestic	Bedrock	Rock
5508143	390525	5030474	NA	22.9	12.2	21.9	NA	5/28/1986	Domestic	Bedrock	Limestone
5501005	390035	5032210	112.8	22.9	13.4	22.3	90.5	1/6/1961	Domestic	Bedrock	Limestone
5511588	390112	5030914	NA	26.2	6.1	24.1	NA	6/1/1993	Domestic	Bedrock	Granite
5501004	390215	5032050	112.8	27.4	1.8	24.4	88.4	6/24/1953	Domestic	Bedrock	Limestone
5509930	390525	5030474	NA	30.5	0.9	24.4	NA	4/19/1990	Domestic	Bedrock	Granite
5507947	388312	5030902	NA	59.4	NA	24.4	NA	9/2/1985	Domestic	Bedrock	Granite

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<i>MOE</i>	<i>UTM Coordinates</i>		<i>Ground Surface</i>	<i>Depth</i>	<i>Depth</i>	<i>Depth</i>	<i>Groundwater</i>	<i>Date</i>	<i>Water</i>		<i>Bedrock</i>
<i>Well ID</i>	<i>Easting</i>	<i>Northing</i>	<i>Elevation</i>	<i>of Well</i>	<i>to Bedrock</i>	<i>to Water</i>	<i>Elevation</i>	<i>Constructed</i>	<i>Supply Type</i>	<i>Well Type</i>	<i>Unit</i>
			<i>(m ASL)</i>	<i>(m bgs)</i>	<i>(m)</i>	<i>(m bgs)</i>	<i>(m ASL)</i>				
5507417	388312	5030902	NA	25.9	1.5	24.4	NA	6/23/1983	Domestic	Bedrock	Limestone
5506273	390799	5031299	114.3	27.7	NA	25.9	88.4	9/3/1980	Domestic	Bedrock	Limestone
5502583	390750	5031175	114.3	30.5	0.6	25.9	88.4	4/17/1971	Domestic	Bedrock	Limestone
5512510	390112	5030914	NA	36.6	NA	25.9	NA	10/31/1995	Domestic	Bedrock	Granite
5501307	390545	5031270	117.3	27.4	3.7	26.8	90.5	7/18/1962	Domestic	Bedrock	Limestone
5501340	390440	5031615	118.9	27.4	NA	26.8	92.0	5/20/1965	Domestic	Bedrock	Limestone
5504859	390200	5033850	108.2	29.0	20.7	27.4	80.8	7/15/1976	Domestic	Bedrock	Limestone
5504211	389200	5032900	115.8	30.5	16.5	27.4	88.4	8/20/1976	Domestic	Bedrock	Limestone
5501314	389735	5031455	118.9	28.0	2.1	27.4	91.4	11/16/1962	Stock	Bedrock	Limestone
5508190	390525	5030474	NA	30.5	7.6	28.0	NA	7/5/1986	Domestic	Bedrock	Limestone
5508191	388913	5032298	NA	25.9	1.2	29.0	NA	6/18/1986	Domestic	Bedrock	Limestone
5507480	388708	5030442	NA	30.5	8.2	29.3	NA	5/26/1982	Domestic	Bedrock	Limestone
5501318	388210	5033135	114.3	30.2	11.6	29.6	84.7	5/21/1959	Stock	Bedrock	Limestone
5502999	390786	5032919	106.7	31.4	21.6	29.9	76.8	1/26/1973	Domestic	Bedrock	Limestone
5501317	388495	5032759	NA	30.5	20.4	29.9	NA	12/9/1950	Domestic	Bedrock	Limestone
5509244	390525	5030474	NA	38.1	8.8	32.0	NA	10/11/1988	Domestic	Bedrock	Granite
5512235	388708	5030442	NA	43.6	NA	32.0	NA	2/27/1995	Domestic	Bedrock	Sandstone
5501353	391160	5033030	99.1	36.0	27.4	32.3	66.8	6/8/1966	Domestic	Bedrock	Limestone
5512910	389722	5031377	NA	44.2	NA	32.6	NA	6/7/1997	Stock	Bedrock	Granite
5513659	390268	5032820	NA	36.6	24.7	34.1	NA	6/24/1999	Domestic	Bedrock	Limestone
5513745	390112	5030914	NA	89.9	0.9	35.1	NA	8/30/1999	Domestic	Bedrock	Limestone
5505064	391300	5032050	109.7	38.1	16.8	36.0	73.8	6/12/1978	Domestic	Bedrock	Limestone
5505765	389400	5032700	106.7	38.1	0.6	36.6	70.1	8/30/1979	Domestic	Bedrock	Limestone
5507923	390525	5030474	NA	38.1	2.1	36.6	NA	8/1/1985	Domestic	Bedrock	Limestone
5505381	390200	5033950	108.2	38.1	21.6	37.2	71.0	10/5/1978	Domestic	Bedrock	Limestone
5506057	390400	5031500	121.9	41.1	1.2	39.6	82.3	9/20/1979	Domestic	Bedrock	Limestone
5505380	390200	5033950	108.2	42.7	21.9	40.2	68.0	10/5/1978	Domestic	Bedrock	Limestone
5506271	390099	5031799	118.9	43.0	1.2	41.1	77.7	10/16/1980	Domestic	Bedrock	Limestone
5516355	390726	5031362	NA	59.4	1.5	41.1	NA	3/15/2006	Domestic	Bedrock	Granite
5509107	390525	5030474	NA	76.2	3.7	41.1	NA	8/5/1988	Commercial	Bedrock	Limestone
5503995	390650	5031200	115.8	49.1	0.6	43.0	72.8	11/12/1975	Domestic	Bedrock	Limestone

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<i>MOE</i>	<i>UTM Coordinates</i>		<i>Ground Surface</i>	<i>Depth</i>	<i>Depth</i>	<i>Depth</i>	<i>Groundwater</i>	<i>Date</i>	<i>Water</i>		<i>Bedrock</i>
<i>Well ID</i>	<i>Easting</i>	<i>Northing</i>	<i>Elevation</i>	<i>of Well</i>	<i>to Bedrock</i>	<i>to Water</i>	<i>Elevation</i>	<i>Constructed</i>	<i>Supply Type</i>	<i>Well Type</i>	<i>Unit</i>
			<i>(m ASL)</i>	<i>(m bgs)</i>	<i>(m)</i>	<i>(m bgs)</i>	<i>(m ASL)</i>				
5513421	388708	5030442	NA	74.7	1.2	43.0	NA	7/7/1998	Domestic	Bedrock	Granite
5507595	389458	5033745	NA	50.0	32.3	49.4	NA	8/29/1984	Domestic	Bedrock	Limestone
5506390	389699	5033499	99.1	53.3	NA	51.8	47.2	7/23/1980	Domestic	Bedrock	Limestone
5505114	391350	5032500	109.7	61.0	7.3	57.9	51.8	7/16/1978	Domestic	Bedrock	Limestone
5511961	390112	5030914	NA	89.9	1.8	61.6	NA	7/6/1994	Domestic	Bedrock	Granite
5510791	391062	5031903	NA	67.7	2.1	64.0	NA	2/20/1992	Domestic	Bedrock	Dolomite
5506758	390799	5031299	114.3	83.8	1.2	76.2	38.1	12/12/1980	Domestic	Bedrock	Limestone
5509110	388708	5030442	NA	91.4	12.2	83.8	NA	8/17/1988	Domestic	Bedrock	Granite
5508969	390525	5030474	NA	99.1	NA	96.0	NA	6/7/1988	Domestic	Bedrock	Granite
5513502	390112	5030914	NA	NA	NA	NA	NA	11/11/1998	NA	NA	NA
5513746	390112	5030914	NA	NA	NA	NA	NA	9/1/1999	Not Used	NA	NA
5504062	389500	5030850	117.3	22.9	0.6	NA	NA	5/5/1976	Domestic	Bedrock	Limestone

Notes:

UTM - Universal Transverse Mercator

m ASL - metres above sea level

m bgs - metres below ground surface

NA - No information recorded in the well record