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Peto MacCallum Ltd.
CONSULTING ENGINEERS

PRELIMINARY HYDROGEOLOGICAL INVESTIGATION AND DESIGN REPORT FOR NEW PATROL YARDS
HIGHWAY 69, FROM PARRY SOUND TO SUDBURY
GWP NO. 5094-06-00
P.O. NO. 5000-E-0034

for

STANTEC CONSULTING LTD.

PETO MacCALLUM LTD.
165 CARTWRIGHT AVENUE
TORONTO, ONTARIO
M6A 1V5
Phone: (416) 785-5110
Fax: (416) 785-5120
Email: Toronto@petomaccallum.com

Distribution:
3 cc: Stantec Consulting Ltd for distribution to MTO, Project Manager + one digital copy text (WORD format) and Drawings (PDF format)
1 cc: Stantec Consulting Ltd. for distribution to MTO, Pavements and Foundations Section + one digital copy of text (WORD format) and Drawings (PDF format)
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Peto MacCallum Ltd.
CONSULTING ENGINEERS

PRELIMINARY HYDROGEOLOGICAL INVESTIGATION AND DESIGN REPORT
For New Patrol Yards
Highway 69, from Parry Sound to Sudbury
GWP NO. 5094-06-00
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PART A: PRELIMINARY HYDROGEOLOGICAL INVESTIGATION REPORT

1. INTRODUCTION

Peto MacCallum Ltd. is pleased to present the Draft Hydrogeological Investigation Report for New Patrol Yards prepared as part of the Hydrogeological Site Assessment for the Highway 69 Patrol Yard Site Selection Study, from Parry Sound to Sudbury, Ontario, for preliminary design services. The Draft Hydrogeological Design Report is presented in Part B of this submission.

1.1 Project Description

It is proposed to upgrade the existing 2-lane Highway 69 to a fully controlled access four-lane freeway facility under the jurisdiction of the Ontario Ministry of Transportation (MTO).

MTO has initiated the preliminary design and site selection studies for three (3) new Patrol Yards in the vicinity of the following three intersections along Highway 69 from Parry Sound to Sudbury, Ontario (see Drawing 1):

1) Highway 69 and Highway 637 or North Alternative Sites (**N Sites**);
2) Highway 69 and Highway 522 or Central Sites Alternative (**C Sites**); and
3) Highway 69 and Highway 529 Extension or South Alternative Sites (**S Sites**).

The project was undertaken by Stantec Consulting Ltd. (Stantec) in three stages; the Project Initiation, the Site Selection Review and the Evaluation and Preliminary Design. For these stages of the project, hydrogeological site assessment services were provided by Peto MacCallum Ltd. (PML) in the following major two steps:

Step 1: Hydrogeological Screening, and
Step 2: Preliminary Hydrogeological Investigation and Design Report

The tasks undertaken by PML under the Step 1 review included project initiation, site history review, site reconnaissance and a door-to-door water well survey which culminated to the Draft Hydrogeological Site Screening Report submitted on September 16, 2008.

Based on the findings of the site screening and consideration of the hydrogeological vulnerability factors, three sites were selected for preliminary hydrogeological investigation and design purposes. The selected sites were Site **N2** (North Site), Site **C2** (Central Site) and Site **S1** (South Site).

1.2 Purpose of Work

The Hydrogeological Screening provides an assessment of the vulnerability of local surface and groundwater resources with respect to potential impacts from the proposed Patrol Yard facility.

The Preliminary Hydrogeological Investigation and Design Report provides more specific information on the selected sites, including an assessment of the potential impacts of the sites on local groundwater and surface water as well as the requirements for appropriate mitigating measures and monitoring.

1.3 Scope of Work

The Preliminary Hydrogeological Investigation and Design Report (Step 2 of our assignment) that was undertaken for the selected sites involved the following major tasks:

- Hydrogeological Subsurface Investigation and Borehole Permeability Testing
- Groundwater Sampling and Analyses, and
- Preparation of Preliminary Hydrogeological Investigation and Design Report (this report)

The detailed tasks that were undertaken by PML to complete the Step 2 of our assignment are outlined as follows. **Tasks 1 through 7** were completed during the course of conducting the Hydrogeological Screening (Step 1).

Task 8: Finalize the number, depth and locations of boreholes, monitoring wells and multi-level (nested) monitoring wells based on the Hydrogeological Screening findings (Tasks 1 through 7),

Task 9: Locate, clear, survey, drill, sample and log five boreholes to depths up to 9.3 m and one set of multi-level monitoring wells in separate boreholes and four single monitoring well in the shallow bedrock for each selected site,

Task 10: Conduct borehole permeability testing in seven monitoring wells installed in each selected site to estimate the hydraulic conductivity K-values,

Task 11: Obtain and conduct chemical analyses on three representative groundwater samples for each selected site (N2, C2 and S1) to establish the baseline data on the groundwater quality. The groundwater samples were analysed for the following parameters:

- Metals
- Anions (chloride, fluoride, bromide, sulphate and cyanide)
- Major nutrients and nitrogen cycle(phosphorous, nitrate, nitrite and TKN ammonia)
- Petroleum hydrocarbon fractions F1 through F4, representing gas/diesel and heavy oils
- Benzene, toluene, ethylbenzene and xylene
- Hardness (pH, total organic carbon and total dissolved solids)

It is important to note that the original analytical program included laboratory testing of representative soil samples for grain size distribution and chemical/environmental characterization. As the boreholes were drilled mostly in the bedrock (rock coring), no soil samples were available for laboratory analyses.

Task 12: Prepare record of borehole sheets, borehole location plan, hydrogeological profiles and groundwater level contour maps for each selected site in accordance with the Ministry's standards, and

Task 13: Prepare a Draft Hydrogeological Investigation and Design Report for each selected site consisting of the following two parts.

Part A: The Preliminary Hydrogeological Investigation Report Including:

- Site description,
- Description of regional groundwater conditions including aquifer systems within 2 km of the site,
- Investigation procedures including site investigation and laboratory testing procedures,
- Description of subsurface conditions including soil, rock and groundwater,
- A summary of the groundwater chemical test results,
- Description of groundwater flow direction, gradients and velocity in each major aquifer system encountered at the site, and
- Description of the observed groundwater/surface water interaction including zones of groundwater seepage or discharge, if any.

Part B: Preliminary Hydrogeological Design Report Including:

- The hydrogeological regime at the site including static groundwater levels, vertical flow gradients, and horizontal flow gradients and flow patterns in each major aquifer system encountered at the site,
- Estimated hydraulic conductivity K-values,
- The interpreted groundwater/surface interaction including zones of groundwater seepage or discharge,
- The extent of elevated levels of soil and groundwater environmental quality standards, if any,
- The vulnerability of local groundwater and surface water systems to impact as a result of the Patrol Yard operations,
- The conceptual design of remedial or contingency measures to ensure protection of groundwater and surface water resources,
- Provision of monitoring program to include on-site monitoring wells and where appropriate, off-site water supply wells, and
- The ability of the site to comply with the appropriate Provincial policies (including the Reasonable Use Policy for Protection of Groundwater) and the appropriate control measures needed to ensure compliance.

1.4 Site Location and Description

1.4.1 North Site N2

The selected site N2 is located in the northeast quadrant of the existing Highway 69 and Highway 637 intersection in the Township of Servos, Municipality of Archipelago within the District of Sudbury (Drawings 1 and 2N).

The subject site is currently vacant and sparsely wooded. During our site reconnaissance, exposed bedrock outcrops were noted all over the site. The neighbouring properties are mostly vacant, sparsely wooded rural lands.

The subject site is located on the well-drained tablelands with approximate elevations of about 233 to 245 m with no significant drainage features. The central part of the site is relatively flat and slopes towards east/southeast.

A drainage ditch runs along the western boundary of the site, along Highway 69, and a low-lying swamp area is located along the northwestern part of the site. The site forms part of the Rock Bay drainage area, which is located in the headwaters of the Murdock River (Lovering Lake) watershed.

1.4.2 Central Site C2

The selected site C2 is located on the east side of the existing Highway 69, approximately 500 m south of the existing Highway 69 and Highway 522 intersection, in the Township of Mowat, Municipality of Archipelago within the District of Parry Sound (Drawings 1 and 2C).

Exposed bedrock was noted all over the site. A relatively thin veneer of overburden, most likely less than 2 m thick is expected. The neighbouring properties are mixed rural residential and commercial land uses.

The Grundy Lake Supply Post, with fuel oil underground storage tanks (USTs), propane tanks, water wells, septic tanks and a tile bed, is located approximately 200 m north of the site. The Key River Waste Disposal Facility, with fill materials overlying bedrock, is located approximately 100 m west of the site across Highway 69.

1.4.3 South Site S1

The selected site S1 is located on the west side of Highway 69, approximately 4 km south of the Highway 69 and Highway 529 Extension intersection in the Township of Archipelago, within the District of Parry Sound (Drawings 1 and 2S).

Surrounding land uses include mostly vacant rural lands. The CPR tracks are located approximately 250 m southwest of the site.

Exposed bedrock was noted all over the site. A relatively thin veneer of overburden, most likely less than 2 m thick, is expected.

2. REGULATORY REGIME

2.1 Relevant Regulatory Policy and Guideline Requirements

Snow and ice control by application of rock salt (sodium chloride) creates a potential for increasing the chloride concentration in groundwater, rivers and lakes.

In relation to the environmental impact of road salting and the snow disposal and de-icing operations on ecological and aquatic resources, the following regulatory policy, procedures, guidelines and legislation were considered:

i) MOE Procedure B0401, PIBS 412-01, Guidelines for Snow Disposal and De-icing Operations in Ontario, August 1975.

ii) MOE Guideline 13-3 (formerly 15-04), Resolution of Well Water Quality Problems Resulting from Winter Road Maintenance, April 1994.

iii) MOE Guideline 13-4 (formerly 15-05), Snow Disposal and De-icing Operations in Ontario, April 1994.

iv) MTO RR237, Environmental Impact of Road Salting - State of the Art, July 1986.

i) Code of Practice for the Environmental Management of Road Salts (Environmental Canada, 2004).

A cursory review of the above documents indicated the following pre-requisites for establishing de-icing salt storage facilities:

- Road salt or sand/salt stockpiles should always be protected from precipitation or surface runoff.
- The storage facility should be underlain with an impervious apron (liner) and dyked to prevent the seepage of salt leachate from the storage area to a nearby watercourse or to groundwater aquifers.
- Considering the noise and general aesthetic conditions, salt storage areas should be located away from residential zones.

The environment, including aquatic and terrestrial systems and selected aspects of the built environment can be adversely impacted by road salt pollution in the following manners:

- Higher human health risks through increased sodium levels in the drinking water supplies and damage to vegetation in areas where there is high water table.
- Increased concentration of chloride in water bodies could cause reduction in dissolved oxygen which is required to ensure the ecological health.
- Aquatic biotas are adversely affected by osmotic stress induced by increased salinity.
- Salt ions, through ion exchange processes, may liberate mercury and other heavy metals from benthic sediments.
- Saline runoff into soils can deteriorate soil characteristics, such as reducing aeration and water availability in soils through structural changes caused as sodium replaces calcium in the anion exchange process.

- The attraction of salt-hungry animals could be a traffic hazard and nuisance in the neighbourhood.
- Corrosion (namely an electrochemical process where metal becomes the anode and undergoes oxidation) affects vehicles and structures which come into contact with the de-icing salt.

The Canadian Environmental Protection Act (CEPA), dated 1999, lists road salts as a Priority Substance. The scientific assessment conducted on this substance has concluded that road salts containing inorganic chloride (with or without ferrocyanide salts) have an immediate and/or long term harmful effect on the environment and its biological diversity and constitute a danger to the environment.

As road salts have been defined to be ‘toxic’ pursuant to the CEPA, a *Code of Practice for the Environmental Management of Road Salts* was prepared by Environment Canada in 2004 to comply with the requirements of the Act. The Code of Practice applies to inorganic chloride salts with or without ferrocyanide salts. It is proposed that five years after the publication of the Code of Practice, it will be re-evaluated and updated to reflect information gained on the results of practices set out under the Code.

The Code of Practice applies to the organizations that use more than 500 tonnes of road salts per year (five-year rolling average); and the organizations that have vulnerable areas in their territory.

The Code of Practice does not apply to road salt for domestic, private or institutional uses. A vulnerable area is to be defined in accordance with Annex B to the Code of Practice. Annex B sets out various considerations including areas that are draining into bodies of water, significant wetlands adjacent to roadways or in the vicinity of roadways, potential impacts to local fish or fish habitat and areas adjacent to plants or agricultural crops that are salt-sensitive, sensitive wildlife habitats or areas where water is used as a source of drinking water.

Any entity that is required to comply with the Code of Practice must establish a salt management plan that uses best management practices to protect the environment from the impacts of road salt application. Specific requirements for the management plan are provided, including best management practices related to storage, disposal and application. Once a management plan has been prepared, reporting on the status of various monitoring and measuring programs must be provided to the Minister of Environment by June 30 of the year after the year in which the plan was implemented. Record keeping requirements are also imposed on parties that are subject to the Code of Practice and include the need to maintain training records, yearly review reports and revisions to the management plan.

In addition, the following guidelines and acts are considered to be relevant for the construction of a patrol yard facility.

- Clean water Act, 2006, S.O. 2006, Bill 43, Source Protection Act and the relevant regulations to protect existing and future sources of drinking water
- MTO Environmental Reference for Highway Design (ERHD), Version: October 2006, Section 3.3: Groundwater, Technical Requirements for Environmental Impact Study and Environmental Protection/Mitigation.
- MTO Environmental Guide for Patrol yard Design, Part of the Environmental Standards and Practices Version: October 2006
- Ontario regulation 153/04; Soil, Groundwater and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act for Full Depth Background (Table 1) and Generic Site Condition Standards in a Potable Groundwater Condition (Table 2) dated March 9, 2004.
- MOE **“**Watershed Based Source Protection Planning**"** dated March 2004 (provisional)
- MOE **"**Drinking Water Standards**"** dated April 2001
- Ontario Water Resources Act, dated 1990, Section 30
- Environmental Protection Act of Ontario, dated 1990, Section 6
- Environmental Assessment Act of Ontario, dated 1990, Section 5
- Canadian Environmental Protection Act, dated 1999

2.2 MTO Environmental Guide for Patrol Yard Design

The MTO Environmental Guide for Patrol Yard Design (October 2006, the Guide) is intended to outline the typical environmental concerns to be considered during the design of a new patrol yard so that the potential environmental impacts can be avoided, controlled, minimized or mitigated during siting, construction and operation.

The Guide describes the environmental impacts and provides environmental principles, goal and required permits, authorization and clearances, as well as environmental impact assessment, design and construction considerations.

In Preliminary Hydrogeological Design Report, the Guide is used to identify the potential environmental impacts and salt vulnerable areas, and provide hydrogeological design recommendations in relation to mitigating measures for proper facility management, hydrogeological issues in construction and future monitoring needs.

2.3 Applicable Environmental Site Condition Standards

In general, the applicable environmental soil and groundwater quality standards depend on the site location, land use, and source of potable water at the investigation sites. For the subject site, the Generic Criteria of the Ontario Regulation 153/04, Soil, Groundwater and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act dated March 9, 2004 (Soil/Groundwater Site Condition Standards) were selected and deemed applicable.

The subject sites are located in a rural setting. It is understood that the near future land use of subject sites will be Patrol Yards suggesting industrial/commercial land uses. Potable water for the subject sites and vicinity is to be obtained either from drilled wells or from surface water sources; thus the groundwater is considered to be a source of drinking water in the study areas.

Based on the site reconnaissance findings, bedrock outcrops were noted all over the subject sites.

Based on the above-noted conditions (particularly **“**shallow soil property**”** condition), the subject sites are considered to be environmentally sensitive areas in accordance with the above-mentioned Provincial regulation.

Therefore, the Ontario Regulation 153/04 Tables 1 and 2, background (for sensitive sites) and full depth Generic Site Condition Standards for industrial/commercial property use in a potable groundwater condition for coarse textured soils were considered applicable to the subject sites.

3. SUMMARIZED FINDINGS OF HYDROGEOLOGICAL SITE SCREENING

The findings of the Hydrogeological Screening previously completed and reported are summarized in the following paragraphs respecting site physiographic and geologic setting, hydrogeologic setting, existing water well conditions and hydrogeological vulnerability factors of the selected sites.

3.1 Physiographic and Geologic Settings

The study areas are located within a bedrock plain comprising exposed bedrock knobs, subordinate glacial till moraine and a peat/muck organic terrain over bedrock.

In general, the mineral soil cover is typically less than 1 m in the vicinity of the subject sites. The overburden deposit may vary greatly over short distances. Locally, the depth of soil cover in swampy lands may extend to depths exceeding 30 m. The soils were deposited by glacial Lake Algonquin and later partly by Lake Nipissing. The soil cover also originated from beach and near shore deposits, deltas, subaquatic fans, quiet water deposits of silt and clay, which were formed by sedimentation in and adjacent to Lake Algonquin and its successors.

The study areas are within a structural subdivision of the Canadian Precambrian Shield identified as the Grenville Province. In particular, the study area traverses the western portion of the Central Gneiss Belt within the Grenville Province wherein pink and grey gneiss are predominant.

The watercourses and fisheries of the study areas are considered to be highly significant by the Ministry of Natural Resources. The Georgian Bay and its associated drainage system are considered cold water watercourses as they support similar fish species. Numerous smaller wetlands are scattered throughout the study area. These wetlands collectively provide habitat for a variety of wildlife species.

3.1.1 North Site N2

During our site reconnaissance, exposed bedrock outcrops were noted all over the site. The ground surface elevations range from about 233 to 245 m with no significant drainage features.

A series of interconnected water bodies are located approximately 700 m to 1 km south/southwest of the proposed Highway 69 alignment and Highway 637 intersection.

A drainage ditch originating at the northwestern part of the site runs along the east side of the existing Highway 69.

A number of individual creeks and drainage channels form integral parts of the drainage basins. The Murdock River (Lovering Lake) and its tributaries, wetlands and associated water bodies (Rock Bay) form the headwaters of a drainage system for the subject site and vicinity, which are ultimately connected to the Georgian Bay drainage basin.

3.1.2 Central Site C2

During our site reconnaissance, exposed bedrock outcrops were noted all over the site. A relatively thin veneer of overburden, most likely less than 2 m thick is expected.

The central part of the site C2 is relatively flat, which slopes abruptly towards the northwest and southeast with a gradient of about 4.5% with the ground surface elevations between 187 to 202. The site is well-drained land with no significant on-site drainage features.

Surface water bodies and swamps are located along the southern and northern boundaries of the site respectively, that form part of the Key River drainage system.

3.1.3 South Site S1

The selected site S1 is relatively flat, gently sloping, well drained tableland and slopes east/southwest with a surface gradient of about 2.5% and ground surface elevations vary from 205 to 210 with no significant on-site drainage features except the northeastern part of the site, which is part of a relatively small wetland.

The site forms part of the Shawanaga River watershed located approximately 700 m south of the site. A surface water body connected to the Shawanaga River system is located approximately 250 m south/ southwest of the southern boundary of the site.

3.2 Hydrogeologic Setting

The topographic elevation, bedrock fracturing, and the thickness of overburden overlying the granodiorite, granitic gneiss and migmatite bedrock as well as numerous wetlands and low-lying areas associated with the tributaries and drainage courses of the Murdock River, the Key River and the Shawanaga River watersheds, largely control the hydrogeology of the study areas.

The overburden features are highly variable and dependent on the erosion and localized depositional patterns of the past glacial processes.

The hydraulic connection between the near surface fractured bedrock and deeper strata can not be readily established due to the variable nature of the fracture pattern. However, taking into consideration the predominant presence of vegetation over bedrock outcrops, it is assumed that where present, the upper part of the bedrock is fractured and hydraulic communication exists within the underlying fractured/weathered bedrock.

Based on the Ministry of the Environment water well records, regional geologic and hydrogeologic setting and topographic elevations, it is anticipated that the regional groundwater flow direction in general is towards west-southwest, towards the Georgian Bay.

Generally, the surface water runoff along the Highway 69 Corridor drains into streams, swamps and scattered ponds. The existing rivers and water bodies are typically incised into bedrock or in inferred bedrock fault lines. A significant flooding of Point-au-Baril Station (Highway 69 and Highway 529 Extension, South Site) occurred in January 2008, which is understood to be considered in the Highway Design for storm water management measures.

3.2.1 North Site N2

The selected site N2 forms part of a major drainage basins/watersheds namely, the Murdock River (Lovering Lake) drainage basin. A number of individual creeks and drainage channels form an integral part of the drainage systems, which eventually empty into the Georgian Bay.

The Murdock River (Lovering Lake) and its tributaries, wetlands and associated water bodies (Rock Bay) form the headwaters of a drainage system for the subject site and vicinity, which is ultimately connected to the Georgian Bay drainage basin. The predominant surface water drainage is from north to south and southeast.

3.2.2 Central Site C2

The selected site C2 forms part of a major drainage basin/watersheds namely, the Key River drainage system, which is located approximately 1.6 km south of the site.

The site is well-drained land with surface water bodies and swamps located along the northern and southern boundaries of the site.

The Key River and its tributaries (Nisbet Creek), wetlands and associated water bodies (Portage Lake) form the headwaters of a drainage system for the subject site and vicinity, which is ultimately connected to the Georgian Bay drainage basin. The predominant surface water drainage is from north to south and southwest.

3.2.3 South Site S1

The selected site S1 forms part of the Shawanaga River watershed located approximately 700 m south of the site. A surface water body connected to the Shawanaga River system is located approximately 250 m south/ southwest of the southern boundary of the site.

The site is relatively flat, gently sloping, well drained tableland and slopes easterly/southwesterly with a surface gradient of about 2.5% with no significant on-site drainage features except the northeastern part of the site, which is part of a relatively small wetland.

3.3 Water Well Conditions

A door-to-door water well survey program was carried out during the Step 1 investigation and the findings were discussed in the hydrogeological screening report as outlined below.

The water supply in the study areas is solely the responsibility of individual land owners.

3.3.1 North Site N2

Based on a review of the water well records and the door-to-door water well survey results, no water wells were identified within a 500 m radius of this site. During our Step 1 investigation, one water well was identified within the Township of Servos.

A review of the Ministry of the Environment water well records (presented in the Site Screening Report) well N1, located approximately 2.2 km southwest of the subject site was drilled in the granite bedrock and the overburden thickness was about 2 m and static water level was about 11 m below existing grades.

3.3.2 Central Site C2

Based on a review of the water well records and the door-to-door water well survey results, three functional water wells and six Ministry of the Environment recorded water wells were identified within a 500 m radius of this site. In addition, five groundwater monitoring wells existed within the Key River Waste Disposal Facility, about 100 m west of the subject site.

3.3.3 South Site S1

Based on a review of the water well records and the door-to-door water well survey results, no water wells were identified within a 500 m radius of this site.

3.4 Hydrogeological Vulnerability Factors

The vulnerability of an aquifer or a water body is usually defined as the sensitivity of the groundwater or surface water quality to an imposed contaminant load.

The vulnerability is controlled by the travel time in the classical contaminant “origin-pathway-target” model and the hydrogeological and geochemical environments that the water travels through to arrive at the target, which can be groundwater as a whole (resource) or a single well or spring for drinking water extraction (source). The travel time is controlled by the hydraulic conductivity and the porosity of the geologic layers and the hydraulic gradient.

In the hydrogeological screening report the following hydrogeological vulnerability factors were identified:

i) Topographic, geologic, hydrogeologic, and drainage features including watercourses and water bodies and ecological resources and fisheries as the sites resource features.

ii) Current land use activities and existing water wells as the site source features.

iii) Existing on-site origins of water quality impacts and existing (baseline) water quality.

iv) Potential contaminant migration pathways.

v) Other factors such as site-specific exposed bedrock conditions and buried valleys.

The hydrogeological vulnerability advantages and disadvantages associated with the selected sites, that were considered as some of the factors among others for the site selection, are outlined as follows:

3.4.1 North Site N2

The advantages associated with the this site are easily accessible, yet located in a remote location away from the residential hub, no functional water well exists within a 500 m radius of the site; and the potential for receptors of valued ecological components is relatively low.

The disadvantages are exposed bedrock where some measures of bedrock aquifer protection may be required.

3.4.2 Central Site C2

The advantage associated with this site is easily accessible, yet located in a remote location.

The disadvantages are three operating wells located within 500 m of the site boundaries the Grundy Lake Supply Post with a fuel oil underground storage tanks located approximately 200 m north, and the Key River waste disposal facility is located about 100 m west of the site across Highway 69. In addition, exposed bedrock was noted all over the site where some measures of bedrock aquifer protection may be required.

3.4.3 South Site S1

The advantages associated with this Site are easily accessible, yet located in a remote location away from the residential hub, no functional water well exists within a 500 m radius of the site; and the potential for receptors of valued ecological components is relatively low.

The disadvantages are exposed bedrock and marshland located east and northeast of the site where some measures of bedrock aquifer protection may be required.

4. SITE INVESTIGATION PROCEDURES

The field work for this investigation was carried out from August 15 to October 6, 2008. The investigation comprised a program of borehole drilling, logging, coring, sampling, installation of monitoring wells in the boreholes, conducting borehole permeability testing, groundwater level monitoring and sampling.

The results of the overburden and bedrock sampling, in-situ instrumentation, borehole permeability testing, groundwater level monitoring and sampling are shown in the appended Record of Borehole sheets and Appendix A.

Access for the drilling equipment to each borehole location was secured using a John Deere 120D excavator. The boreholes were advanced using a Bombardier mounted CME 55 high torque drill rig equipped with diamond tooth coring, supplied and operated by Walker Drilling Co. Ltd. of Utopia, Ontario. Bedrock coring was conducted in all boreholes. Continuous bedrock cores were obtained from boreholes using a 39 mm outside diameter core barrel.

The core description tables describing rock type, Rock Quality Designation, Rock Mass Rating, core recovery together with the core photographs are shown in the appended Record of Borehole sheets.

The field work was supervised on a full-time basis by members of our technical staff who directed the drilling and coring operations, logged the corings and monitored closely the field conditions in the open boreholes during the course of conducting the field work.

The locations and ground surface elevations at the boreholes were established in the field by Peto MacCallum Ltd. The horizontal northing and easting co-ordinates were referred to the MTM Zone 12 NAD 83 co-ordinate system.

4.1 Borehole Drilling

4.1.1 North Site N2

The borehole drilling program for this investigation was carried out during the period from August 15 to 21, 2008 which comprised seven boreholes, numbered boreholes N1 through N5S, N5M and N5D, drilled to shallow, medium and deep depths respectively ranging from about 4.7 to 9.3 m below existing grades at the selected locations as shown on Drawing 3N. Nested or multi-level monitoring wells were installed in separate boreholes N5S, N5M and N5D, and a single-level monitoring well in boreholes N1 through N4. The monitoring well casing was 38 mm in diameter.

Potable water obtained from the Township of Servos was brought to the subject site in a clean above-ground storage tank for bedrock drilling and coring.

The ground surface elevations were referred to the following benchmark (B.M.):

B.M.: Geodetic Survey of Canada BM 73U186.
Northwest Quadrant of the Highway 69 and Highway 637 Intersection

Elevation: 231.056 (metric, geodetic)

The northing and easting co-ordinates and the geodetic ground surface elevations at the borehole locations are shown on the Record of Boreholes and listed on the Borehole Location Plan (Drawing 3N).

4.1.2 Central Site C2

The borehole drilling program for this investigation was carried out during the period from September 16 to 24, 2008 which comprised seven boreholes, numbered boreholes C1 through C3, C4S, C4M, C4D and C5, drilled to shallow, medium and deep depths respectively ranging from about 4.7 to 9.2 m below existing grades at the selected locations as shown on Drawing 3C. Nested or multi-level monitoring wells were installed in separate boreholes C4S, C4M and C4D, and a single-level monitoring well in boreholes C1 through C3 and C5. The monitoring well casing was 38 mm in diameter.

Potable water obtained from the Grundy's Lake Supply Post was brought to the subject site in a clean above-ground storage tank for bedrock drilling and coring.

The ground surface elevations were referred to the following benchmark (B.M.):

B.M.: Geodetic Survey of Canada BM 73U155.
West Side of Highway 69 about 700 m south of the
Highway 69 and 522 Intersection
Elevation: 194.254 (metric, geodetic)

The northing and easting co-ordinates and the geodetic ground surface elevations at the borehole locations are shown on the Record of Boreholes and listed on the Borehole Location Plan (Drawing 3C).

4.1.3 South Site S1

The borehole drilling program for this investigation was carried out during the period from September 24 to 28, 2008 which comprised five boreholes, numbered boreholes S1 through S4S, S4M and S4D and S5, drilled to shallow, medium and deep depths ranging respectively from about 4.6 to 9.2 m below existing grades at the selected locations as shown on Drawing 3S. Nested or multi-level monitoring wells were installed in separate boreholes S4S, S4M and S4D, and a single-level monitoring well in boreholes S1 through S3 and S5. The monitoring well casing was 38 mm in diameter.

Potable water obtained from the Village of Point-au-Baril was brought to the subject site in a clean above-ground storage tank for bedrock drilling and coring.

The ground surface elevations were referred to the following benchmark (B.M.):

B.M.: Geodetic Survey of Canada BM 73U112.
East Side of Highway 69 about 4.8 km south of the Highway 69
and Highway 529 Extension Intersection
Elevation: 207.851 (metric, geodetic)

The northing and easting co-ordinates and the geodetic ground surface elevations at the borehole locations are shown on the Record of Boreholes and listed on the Borehole Location Plan (Drawing 3S).

4.2 Monitoring Well Installation and Abandonment

A total of 7 monitoring wells were installed in the boreholes drilled on each site. The monitoring wells were established by installing 38 mm diameter screened PVC pipe with threaded and coupled joints. The above-noted casing size was selected to be compatible with the rock-cored holes.

As shown in the appended Record of Borehole sheets, a 3.0 m long slotted pipe segment was part of the casing of each monitoring well for sampling and monitoring of the groundwater level and for conducting the borehole permeability testing. In borehole N5S, in the North Site, a 1.5 m long screen was used.

The monitoring wells were installed using 38 mm diameter threaded PVC well screen (10 slot) and 38 mm PVC riser pipe. The well materials were factory cleaned and sanitized and arrived on site in sealed plastic bags.

Clean silica sand was placed around the well screen (up to 0.3 m above the top of the well screen); hydrated bentonite pellet seal was then placed to seal the well casing and screen top and grouted at the surface (upper 0.8 m) with Portland concrete.

As shown in the appended Record of Borehole Sheets, the monitoring wells were installed within the bedrock.

The monitoring wells installed at the subject site will have to be abandoned eventually in accordance with the Ontario Regulation 903, amended to O.Reg. 128/03 under the Water Resources Act. The monitoring wells have been left now as they were installed for potential monitoring during the design phase.

The well abandonment will have to be conducted by a licensed well drilling contractor. At the end of the project design phase, after removing the well casings and screen, the wells will have to be abandoned using clean washed gravel (well screen section) and plugging the casing portion with Portland cement seal. The upper 0.5 to 1.0 m of the well will have to be sealed using a bentonite seal. A copy of the abandonment records including the GPS co-ordinates will have to be forwarded to the office of the Ministry of the Environment's Water Well Records department.

4.3 Borehole Permeability Testing

In order to estimate the hydraulic conductivity K-values of the fractured bedrock, in-situ permeability testing was conducted in the monitoring wells installed.

The permeability testing was conducted in monitoring wells using a rising head test method (bailing out test). During the rising head test, the wells were pumped out and the groundwater level was periodically measured as it recovered through the well screen. The rising groundwater level was measured periodically using a pre-programmed data logger (transducer) as the water level rose through the perforated well casing screen.

The borehole permeability tests were carried out from August 27 to August 29 and October 1 to 6, 2008.

After completion of the borehole permeability testing, the data was plotted on semi-logarithmic scale as shown on borehole permeability testing plots inserted in Appendix A, to estimate the time lag for calculation of the hydraulic conductivity K-values.

4.4 Laboratory Chemical Analyses

To determine the baseline geoenvironmental quality, three representative groundwater samples from each site were obtained from the monitoring wells located upstream, centre and downstream of the site and delivered to AGAT Laboratories (AGAT) for the chemical analyses listed below. The Canadian Association of Environmental Analytical Laboratories accredits AGAT.

- Selected trace metals, inorganic parameters such as pH, selected anions, total dissolved solids (TDS), and for ammonia and total keldjhal nitrogen (TKN).
- Total organic carbon (TOC).
- Petroleum hydrocarbon related parameters benzene, toluene, ethylbenzene and xylenes (BTEX) and petroleum hydrocarbon fractions F1 through F4, which includes total petroleum hydrocarbons (TPH) representing gas/diesel and heavy oil).

No soil samples were analyzed as there was no overburden on the subject sites.

5. SUBSURFACE CONDITIONS

Reference is made to the appended record of borehole Sheets for details of the visual soil/rock classification, inferred stratigraphy, monitoring well installation in the boreholes during and upon completion of drilling. Drawings 3N, 3C, 3S and 4N, 4C and 4S show the borehole locations and hydrogeological profiles for three North, Central and South sites, respectively.

5.1 Stratigraphy

The stratigraphy revealed in the exploratory boreholes comprised a discontinuous thin veneer of overburden and bedrock, which was encountered in all the boreholes.

5.1.1 North Site N2

Topsoil, about 100 mm thick surficial topsoil was encountered in boreholes N2, N5D, N5M and N5S. In boreholes N2, N5D, N5M and N4S, topsoil directly overlay the bedrock whereas in borehole N4M, a silty sand layer was encountered beneath the topsoil.

Silty Sand, a layer of silty sand, about 0.70 m thick, was encountered in borehole N5M overlying the Granodiorite Gneiss bedrock. The silty sand was poorly graded (SP) with traces of gravel, cobbles and boulders.

Bedrock, as shown on the appended Record of Borehole Sheets, Granodiorite Gneiss bedrock was encountered surficially in boreholes N1, N3, N4 and beneath the topsoil in boreholes N2, N5D, N5M and N5S. In borehole N5D, about 1.6 m of Gabro was encountered within the Granodiorite Gneiss. The top of the bedrock elevations ranged from 239.6 to 241.7 m.

In general, the bedrock was unweathered to slightly weathered with moderately to widely spaced flat to dipping cross joints. The joints were generally oxidized to slightly altered with occasional silt partings.

In borehole N2, about 5 mm wide vertical partings were noted within the bedrock, which were filled by secondary minerals and were partially void.

The measured Rock Quality Designation ranged from 69 to 100% with the exception of one core from borehole N5D (elevation 237.1 to 238.6 m) with an Rock Quality Designation value of 50%, indicating fair to excellent quality. The estimated Rock Mass Rating ranged from 32 to 79, indicating fair to good rock mass quality. Relatively low Rock Mass Rating (36 t0 64) was estimated for the upper part of the bedrocks in boreholes N2, N5M and N4S. The core recovery varied from 95 to 100%.

5.1.2 Central Site C2

Topsoil, about 100 mm thick surficial topsoil was encountered in boreholes C4D, C4M and C4S overlying a silty sand layer.

Silty Sand, a layer of silty sand, about 0.5 to 0.6 m thick, was encountered in boreholes C4D, C4M and C4S overlying the Migmatite bedrock. The silty sand was poorly graded (SP) with traces of gravel, cobbles and boulders.

Bedrock, as shown on the appended Record of Borehole Sheets, Granitic Gneiss bedrock was encountered surficially in boreholes C1 through C3 and C5. Migmatite bedrock was encountered beneath the silty sand deposit overburden in the locations of nested monitoring wells C4D, C4M and C4S and in borehole C1 beneath the Granitic Gneiss at a depth of 3.2 m below existing grade. The top of the bedrock elevation, ranged from 193.5 to 201.7 m.

In general, the bedrock was unweathered to slightly weathered with moderately to widely spaced flat to dipping cross joints. The joints were generally oxidized to slightly altered with occasional silt partings.

In borehole C4D, about 0.5 mm wide vertical partings/joints filled with silt were noted within the Migmatite bedrock.

The measured Rock Quality Designation ranged from 61 to 100% with the exception of one core from borehole C4D (elevations 186.2 to 187.8 m) with an Rock Quality Designation value of 34%, indicating fair to excellent quality, occasionally poor quality. The estimated Rock Mass Rating ranged from 52 to 79, indicating fair to good rock mass quality. The measured core recovery varied from 94 to 100%, however, one core from borehole C4M (elevations 192.2 to 193.5 m) had a recovery of 84%.

5.1.3 South Site S1

Topsoil, about 100 to 300 mm thick surficial topsoil was encountered in boreholes S1, S4D, S4S and S5 overlying the Migmatite bedrock.

Bedrock, as shown on the appended Record of Borehole Sheets, Migmatite bedrock was encountered surficially in boreholes S2, S3, S4M and beneath the surficial topsoil in boreholes S1, S4D, S4S and S5. The top of the bedrock elevations ranged from 206.9 to 209.9 m.

In general, the bedrock was unweathered to slightly weathered with moderately to widely spaced flat to dipping cross joints. The joints were generally oxidized to slightly altered with occasional silt partings.

The measured Rock Quality Designation ranged from 74 to 100% with the exception of one core from borehole S4D (elevations 201.0 to 202.5) with an Rock Quality Designation value of 48%, indicating fair to excellent quality, locally poor quality. The estimated Rock Mass Rating ranged from 61 to 79, indicating fair to good rock mass quality. However, two cores from borehole S1 (elevations 206.4 to 207.9 m, 42% Rock Mass Rating) and S4D (elevations 201.0 to 202.5 m, 47% Rock Mass Rating) exhibited locally poor rock mass quality. The measured core recovery varied from 95 to 100% with the exception of one core from borehole S4M (elevations 206.8 to 207.1 m), which had a recovery of 86%.

5.2 Groundwater Conditions

The local groundwater conditions underlying the subject sites were assessed by measuring the water level in the monitoring wells. As fresh water was introduced to advance the drilling in bedrock, the groundwater strike (the groundwater level first encountered during drilling) could not be recorded.

5.2.1 North Site N2

About one week after drilling completion (August 27, 2008) the water level was measured at depths ranging from about 1.5 to 6.5 m, elevations 233.9 to 240.3 m, in the monitoring wells installed within the bedrock. The highest and the lowest levels of the screens in the monitoring wells casings ranged from 1.6 to 9.1 m below existing grades or at elevations ranging from 231.7 to 240.2 m.

Drawing 5N shows the groundwater level contours indicating the groundwater flow potentiometric lines. As shown on Drawing 5N, the groundwater flow within the bedrock is interpreted in a southeasterly direction towards the Lovering Lake, located approximately 1.2 km east/southeast of the Site.

Based on the groundwater level contour map, the horizontal flow gradient was estimated to be about 5%.

An attempt was made to estimate the downward flow gradient using the water level readings recorded for N5S, N5M and N5D, however, the data obtained for the shallow monitoring well N5S and deep monitoring well N5D were considered inconclusive, most likely due to the lack of hydraulic connection between the uppermost (screen depth 1.6 to 3.1 m, elevation 238.7 to 240.2 m) and deep monitoring wells (screen depth 6.1 to 9.1 m, elevations 232.7 to 235.7 m).

Based on the site hydrogeological and topographic settings, the groundwater level contour map and the groundwater flow direction and gradient, it is apparent that Site N2 is in a recharge area for the neighbouring Lovering Lake.

5.2.2 Central Site C2

About one week after drilling completion (October 1, 2008) water level was measured at depths ranging from about 0.9 to 4.2 m, elevations 190.0 to 200.0 m, in the monitoring wells installed within the bedrock. The highest and the lowest levels of the screens in the monitoring well casings ranged from 1.4 to 8.9 m below existing grades or at elevations ranging from 185.3 to 197.4 m.

Drawing 5C shows the groundwater level contours indicating the groundwater flow potentiometric lines. As shown on Drawing 5C, the groundwater flow within the bedrock is interpreted in the east/northeasterly direction towards the Portage Lake and the low-lying swamp area. Portage Lake is located approximately 500 m east of the Site.

Based on the groundwater level contour map, the horizontal flow gradient was estimated to be about 7.3%.

An attempt was made to estimate the downward flow gradient using the water level readings recorded for C4S, C4M and C4D, however, the data obtained for the shallow monitoring well C4S and deep monitoring well C4D were considered inconclusive, most likely due to the lack of hydraulic connection between the uppermost (screen depth 1.4 to 3.4 m, elevations 189.7 to 192.7 m) and deep monitoring wells (screen depth 5.9 to 8.9 m, elevations 185.3 to 188.3 m).

Based on the site hydrogeological and topographic settings, the groundwater level contour map and the groundwater flow direction and gradient, it is apparent that Site C2 is in a recharge area for the neighbouring Portage Lake and the low-lying swamp area.

5.2.3 South Site S1

About one week after drilling completion (October 3, 2008) water level was measured at depths ranging from about 1.0 to 3.8 m, elevations 203.1 to 207.7 in the monitoring wells installed within the bedrock. The highest and the lowest levels of the screens in the monitoring wells casings ranged from 1.6 to 9.2 m below existing grades or at elevations ranging from 199.6 to 207.1 m.

Drawing 5S shows the groundwater level contours indicating the groundwater flow potentiometric lines. As shown on Drawing 5S, the west-central part of the Site act as a groundwater divide with a dominant groundwater flow direction towards north to the existing Highway 69 and to an unnamed water body.

Based on the groundwater contour level map, the horizontal flow gradient was estimated to be about 5.5% in the northerly direction towards an unnamed water body located approximately 600 m north/northeast of the site.

As shown on Drawing 5S, the groundwater flow direction in the western part of the site is towards south/southwest to the Shawanaga Bay and its associated water bodies with a relatively gentle gradient of about 1%. The Shawanaga Bay is located approximately 300 m west/southwest of the subject site.

The water level readings in monitoring wells S4S, S4M and S4D indicated a downward flow gradient of about 6%, indicating the subject site is in a recharge area.

5.3 Estimated Hydraulic Conductivity K-Values

The field permeability testing was conducted by using the rising head method, in which periodic water level measurements were recorded as the water level recovered inside the well through the perforated (screened) part of the well casing.

After purging each monitoring well, the rising head data was recorded in intervals of 20 seconds. The data was then plotted on semi-log scale to estimate the basic time lag T_0.

The geometric configuration of the monitoring well screen and the measured time lag were used in the following expression (Hvorslev's Method, NAVFAC DM 7.1, May 1982) to estimate the K-value for each monitoring well tested.

$$K = \frac{R^2}{2LT_0} \ln \frac{L}{R}$$

Where, K = hydraulic conductivity (cm/s)
L = the length of the screen (cm): 300 or 150 cm
R = the radius of the well screen (cm): 1.90 cm
T_0= the basic time lag (in seconds)
ln = Logarithm to the base e

The figures provided in Appendix A, show the plot of normalized head versus the elapsed time, which were used to estimate the basic time lag (in seconds) and the measured hydraulic conductivity test results are presented in the subsequent subsections.

5.3.1 North Site N2

The hydraulic conductivity K-values of the bedrock were estimated using the field permeability test data compiled from seven monitoring wells MW N1 through MW N5D, MW N5M and MW N5S tested from August 27 to August 29, 2008, as summarized below.

BEDROCK ESTIMATED HYDRAULIC CONDUCTIVITY K-VALUES FOR SITE N2

BOREHOLE NUMBER	**SCREEN DEPTH (m) (Elevation)**	**SCREEN LENGTH (m)**	**TIME LAG (T_0) (s)(1) (See Appendix A)**	**MEASURED HYDRAULIC CONDUCTIVITY(2) (X 10^{-5} cm/s)**
MW N1	6.1 to 9.1 (235.1 to 232.1)	3.0	12,200	0.3
MW N2	4.8 to 7.8 (235.9 to 232.9)	3.0	3,870	0.8
MW N3	4.9 to 7.9 (234.7 to 231.7)	3.0	270	15.0
MW N4	3.7 to 6.7 (236.7 to 233.7)	3.0	13,680	0.2
MW N5D	6.1 to 9.1 (235.7 to 232.7)	3.0	62,880	0.05
MW N5M	3.1 to 6.1 (238.7 to 235.7)	3.0	13,000	0.4
MW N5S	1.6 to 3.1 (240.2 to 238.7)	1.5	**(3)**	**(3)**

Notes:

1 - Time lag at 37% recovery.
2 - Measured hydraulic conductivity.
3 - Steady state was not reached in Monitoring Well N5S, therefore no estimated K-value.

Based on the above-listed results, the estimated hydraulic conductivity K-value of the bedrock ranged from 0.05 x 10^{-5} to 15.0 x 10^{-5} cm/s with an average value of 2.8 x 10^{-5} cm/s, or in terms of transmissivity about 0.025 m^3/day/m^2.

5.3.2 Central Site C2

The hydraulic conductivity K-values of the bedrock were estimated using the field permeability test data, compiled from seven monitoring wells C1 through C4D, C4M, C4S and C5 tested on October 1 and 2, 2008, as summarized below:

BEDROCK ESTIMATED HYDRAULIC CONDUCTIVITY K-VALUES FOR SITE C2

BOREHOLE NUMBER	**SCREEN DEPTH (m) (Elevation)**	**SCREEN LENGTH (m)**	**TIME LAG (T_0) (S) (1) (See Appendix A)**	**MEASURED HYDRAULIC CONDUCTIVITY(2) (X 10^{-5} cm/s)**
MW C1	4.5 to 7.5 (197.2 to 194.2)	3.0	7,800	0.4
MW C2	4.3 to 7.3 (197.4 to 194.4)	3.0	550	5.4
MW C3	4.8 to 7.8 (193.7 to 190.7)	3.0	(3)	(3)
MW C4D	5.9 to 8.9 (188.3 to 185.3)	3.0	18,420	0.2
MW C4M	4.5 to 7.5 (189.7 to 186.7)	3.0	3,850	0.8
MW C4S	1.4 to 4.4 (192.7 to 189.7)	3.0	16,200	0.2
MW C5	4.6 to 7.6 (193.7 to 190.7)	3.0	3,000	1.0

Notes:

1 - Time lag at 37% recovery.
2 - Measured hydraulic conductivity.
3 - Steady state was not reached in Monitoring Well C3, therefore no estimated K-value

Based on the above-listed results, the estimated hydraulic conductivity K-value of the bedrock ranged from 0.2 x 10^{-5} to 5.4 x 10^{-5} cm/s with an average value of 1.3 x 10^{-5} cm/s, or in terms of transmissivity about 0.011 m^3/day/m^2.

5.3.3 South Site S1

The hydraulic conductivity K-values of the bedrock were estimated using the field permeability test data compiled from seven monitoring wells S1 through S4D, S4M, S4S and S5 tested from October 3 to 6, 2008, as summarized below:

BEDROCK ESTIMATED HYDRAULIC CONDUCTIVITY K-VALUES FOR SITE S1

BOREHOLE NUMBER	**SCREEN DEPTH (m) (Elevation)**	**SCREEN LENGTH (m)**	**TIME LAG (T_0) (S) (1) (See Appendix A)**	**MEASURED HYDRAULIC CONDUCTIVITY(2) (X 10^{-5} cm/s)**
MW S1	4.4 to 7.4 (203.8 to 200.8)	3.0	34,630	0.1
MW S2	3.8 to 6.8 (203.1 to 200.1)	3.0	1,460	2.1
MW S3	4.8 to 7.8 (205.1 to 202.1)	3.0	6,120	0.5
MW S4D	6.2 to 9.2 (202.6 to 199.6)	3.0	10,660	0.3
MW S4M	4.4 to 7.4 (204.2 to 201.2)	3.0	360	8.3
MW S4S	1.6 to 4.6 (207.1 to 204.1)	3.0	5,400	0.6
MW S5	3.1 to 6.1 (205.6 to 202.6)	3.0	34,200	0.1

Notes:

1 - Time lag at 37% recovery.
2 - Measured hydraulic conductivity.

Based on the above-listed results, the estimated hydraulic conductivity K-value of the bedrock ranged from 0.1 x 10^{-5} to 8.3 x 10^{-5} cm/s with an average value of 1.7 x 10^{-5} cm/s, or in terms of transmissivity about 0.015 m^3/day/m^2.

An attempt was made to estimate bedrock fracture permeability by assessing the cored rock fracture spacing and aperture. However, due to the highly variable nature of the rock fractures and field conditions, the true aperture of the rock fractures could not be measured accurately. Therefore, the theoretical equations for calculation of the bedrock permeability [such as those of Snow (1965)] could not be used.

The secondary porosity and other related parameters were not assessed by downhole scanning or packer testing as they were not included in the scope of services.

5.4 Groundwater Sample Chemical Test Results

The chemical test results of the groundwater samples analyzed, as compared with the applicable Site Condition Standards are summarized on Tables 1N, 1C and 1S; and the laboratory certificates of chemical analyses conducted by AGAT are included in Appendix B.

5.4.1 North Site N2

Based on the chemical test results, the chemical quality of groundwater underlying the subject site complies with the selected trace metals, inorganics and petroleum related parameters (BTEX PHC fractions) standards listed in the Ontario Regulation 153/04 Table 2 for potable groundwater conditions.

However, the measured concentrations of cobalt, copper, lead and zinc in all three groundwater samples tested and toluene in a sample taken from monitoring well N5D exceeded the Table 1 standards. Also, as shown on Table 1N, low concentrations of chloride, fluoride, nitrate, nitrite, TKN, sulphate, total phosphorous and ammonia were detected in the analyzed groundwater samples for which there are no standard values in Table 1.

5.4.2 Central Site C2

Based on the chemical test results, the chemical quality of groundwater underlying the subject site complies with the selected trace metals, inorganics and petroleum related parameters

(BTEX PHC fractions) standards listed in the Ontario Regulation 153/04 Table 2 for potable groundwater conditions with the following exceptions.

- The measured concentrations of copper and lead in all three groundwater samples tested exceeded the Table 2 standards, and
- The measured concentrations of silver in a sample taken from monitoring well C2 exceeded the Table 2 standard value for silver.

Furthermore, the measured concentrations of cobalt, copper, lead, nickel and zinc in all three groundwater samples tested exceeded the Table 1 standards. The measured concentrations of cadmium, chromium, silver and vanadium exceeded the Table 1 standards in samples taken from monitoring wells C1 and C2, respectively.

Also, as shown on Table 1C, low concentrations of chloride, fluoride, nitrate, nitrite, TKN, sulphate, total phosphorous and ammonia were detected in the analyzed groundwater samples for which there are no standard values in Table 1.

5.4.3 South Site S1

Based on the chemical test results, the chemical quality of groundwater underlying the subject site complies with the selected trace metals, inorganics and petroleum related parameters (BTEX PHC fractions) standards listed in the Ontario Regulation 153/04 Table 2 for potable groundwater conditions except the measured concentrations of lead in a sample taken from monitoring well MW 4(S) that exceeded the Table 2 standard value for lead.

Furthermore, the measured concentrations of copper and lead in all three groundwater samples tested exceeded the Table 1 standards. The measured concentrations of cobalt, nickel, vanadium and zinc exceeded the Table 1 standards in a sample taken from monitoring wells S4D and S5, respectively.

Also, as shown on Table 1S, low concentrations of chloride, fluoride, nitrate, nitrite, TKN, sulphate, total phosphorous and ammonia were detected in the analyzed groundwater samples for which there are no standards in Table 1.

PART B: PRELIMINARY HYDROGEOLOGICAL DESIGN REPORT

6. INTRODUCTION

As described in Section 2.2 of Part A, the MTO Environmental Guide for Part Yard Design (October 2006, the Guide) was consulted to consider the environmental principles and goals as well as the potential environmental impacts and design considerations for the new patrol yards in the context of the hydrogeological issues as outlined below.

Generally, the Patrol Yards are intended for the storage and minor repair of provincial highway maintenance vehicles and equipment as well as the supplies and waste materials. However, operational needs can vary depending on the needs for determining the environmental impacts, for which the following are assumed:

- The storage of supplies and waste materials includes:
    1. \- the handling and storage of de-icing material (primarily road salt);
    2. \- the handling and storage of pre-wetting liquid (primarily brine);
    3. \- the storage and handling of above-ground storage tanks:
    4. \- the storage of the subject hazardous waste either generated on-site (primarily used oil) or brought into the patrol yard and stored temporarily prior to disposal: and
    5. \- snow storage and disposal.
- The repair of provincial highway maintenance vehicles and equipment includes:
    6. \- washing and
    7. \- minor repairs such as oil changes.

It is also assumed that a new patrol yard would include:

- an office, lunch, wash, and utility rooms;
- parking areas for staff vehicles and ministry/contractor equipment;
- a maintenance garage;
- winter maintenance material storage facilities;
- winter maintenance material handling area;

- vehicle washing area (indoor or outdoor);
- a garage and/or shed for highway maintenance equipment and materials;
- outside material storage area; gravel, posts, and the like; and
- pre-wetting and anti-icing liquid storage and transfer facilities (typically this would be in the same building as the salt loading area).

It is also assumed that the *MTO Salt Management Plan*, as related to patrol yards, will be implemented including the storage of all winter maintenance materials under cover in a storage facility with an impermeable floor.

A Winter Maintenance Area is a paved area of a patrol yard where all salt materials will be handled and vehicles will operate. Its purpose is to isolate those activities in order to contain and manage salt-impacted drainage. As such, all activities that can lead to salt-impacted drainage should be located within the Winter Maintenance Area. Such activities include:

- sand-salt mixing;
- salt deliveries;
- salt loading;
- material storage;
- access routes;
- equipment washing; and
- snow storage

It is understood that the patrol yard areas outside the Winter Management Area and Vehicular Maintenance Area are not to be salted, but winter sand (sand mixed with less than 10% of rock salt) is to be applied for winter traffic purposes within the yard.

Moreover it is also understood that two separate secondary collection systems by means of separate underground storage tanks for potentially released salt-impacted water for reuse and fuel or waste oil impacted water for off-site treatment/disposal respectively are the approach to be implement rather than an attenuating pond.

7. PRINCIPLES AND GOALS

By addressing the potential environmental impacts in the process of selecting the site and designing the new patrol yards, the potential adverse effects of the patrol yards footprint, construction and operation are:

i) avoided by careful selection of the sites and designing to mitigate and/or compensate;

ii) minimized by incorporating certain measures incorporated into the design to reduce the extent of impacts on the site environment where avoidance is not practical; and

iii) mitigated by establishing operating guidelines and proper materials management in addition to the mitigation measures incorporate in the design.

The goals and the required permits, authorization and clearances are to avoid potential impacts and adverse effects on significant terrestrial ecosystems including natural resources such as the groundwater regime and surface water bodies. Moreover, the selected sites are assessed for potential contaminants by undertaking Phases I and II Environmental Site Assessment in accordance with the provincial regulatory requirements and standards.

8. POTENTIAL ENVIRONMENTAL IMPACTS

The potential environmental impact of patrol yards can be grouped in:

a) the footprint of the patrol yard (changes in land cover and topography),

b) the patrol yard construction activities, and

c) the patrol yard operational activities.

In the context of the hydrogeological issues the potential impacts are outlined below:

i) The site preparation (cut and fill for grading) and patrol yard footprint impacts on the groundwater regime and drainage pattern,

ii) The impact of water-taking for operation of the patrol yard, and the patrol yard operational impacts on the facility's water quality,

iii) The impacts of storage and handling of salt as a de-icing material,

iv) The impacts of storage, handling and accidental leaks/spill of pre-wetting and anti-icing liquids,

v) The vehicles and equipment, storage, repair and washing impacts,

(vi) The impacts of storage and handling fuels and used oil, and

(vii) The snow storage and disposal impacts.

9. GROUNDWATER AND SURFACE WATER VULNERABILITY FROM PATROL YARDS

As described in Section 6 above, the proposed Patrol Yard facility is to consist of the storage of supplies and waste materials, a repair garage, a Winter Maintenance Area and non-salt facilities such as an office and parking areas.

A literature review of the de-icing winter salt and brine indicated that common de-icing salt (rock salt) contains 95.8 to 99.8% sodium chloride and brine contains a mixture of 23% sodium chloride and 77% water.

Considering the above-noted patrol yard activities and as described in the following sections, the regulatory requirements pertinent to the operation of the proposed patrol yard facilities are primarily related to the rock salt and/or brine and to the petroleum hydrocarbons in a limited extent.

Therefore, the vulnerability of the groundwater and surface water from the proposed development is primarily due to potential release and migration of sodium chloride and petroleum hydrocarbon components.

10. COMPLIANCE WITH MINISTRY OF THE ENVIRONMENT'S GUIDELINE B-7 (THE REASONABLE USE POLICY)

The Ministry of the Environment’s Guideline B-7 (formerly 15-08), Incorporation of the Reasonable Use Concept Into Ministry of the Environment Groundwater Management Activities, establishes the basis for determining the **"**reasonable use**"** of groundwater on a property adjacent to sources of contamination and for determining the levels of contaminant discharge considered acceptable by the Ministry.

This guideline facilitates implementation of the Ministry of the Environment Procedures document B-1-1, "Water Management, Policies, Guidelines, Provincial Water Management Objectives", which are predicted on the protection of existing and potential reasonable uses of water. The reasonable use, in this context, applies only to the groundwater quality management.

In general, the reasonable use of the groundwater at a particular location is based on three major considerations:

1) The present use of groundwater in the vicinity;
2) The potential use of groundwater in the vicinity; and
3) The existing quality and quantity of the groundwater in the vicinity.

The technical details necessary for the application of the reasonable use approach to operating disposal sites are outlined in the Ministry of the Environment's Procedures B-7-1 **"**Determination of Contaminants Limits and Attenuation Zones**"**.

As outlined in the above-mentioned Ministry of the Environment document, the reasonable use concept is applied to:

a) to determine quantitatively the acceptable levels of various contaminants originating in the disposal sites and impinging on adjacent properties; and
b) to assess the suitability of a contaminant attenuation zone, and a waste solid/liquid disposal site.

It should be noted that the above-noted guidelines (B-7 and B-7-1) are mostly applicable to the on-site sewage disposal facilities and have limited relevance to the patrol yard facilities primarily for storing and dispensing salt as a de-icing material to keep highways traffic safe under snow and ice.

Two calculations are required to determine the amount of contamination that can be discharged from a disposal site onto an adjacent property. The first calculation addresses the total contaminant impact at a location from all sources of contamination; and the second addresses the permissible impact from a particular disposal site.

The maximum concentration (Cm) of a particular contaminant, such as chloride, that would be acceptable in the groundwater beneath an adjacent property is calculated in accordance with the following equation:

$$Cm = Cb + x\,(Cr - Cb) \qquad (1)$$

The terms are defined as follows:

Cb **:** The background concentration of a particular contaminant in the groundwater before it has been affected by human activity. This allows consideration to be given to the amount of increase in the contaminant level.

Cr **:** This is the maximum concentration of a particular contaminant that can be, in accordance with the Province's water management guideline, present in the groundwater. This value is dependent on the reasonable use to be made of the groundwater. It allows consideration of the total amount of contamination.

x **:** This is a constant that reduces the contamination to a level that is considered by the Ministry to have only a negligible effect on the use of the water. For drinking water, x is 0.5 for non-health related parameters and 0.25 for health related parameters. For other reasonable uses it is 0.5.

The maximum concentration of a particular contaminant (Cw) originating in the disposal site that can be permitted to reach the adjacent property and still not cause Cm to exceed can be calculated in accordance with the following equation:

$$Cw = Cm - Cp - Co \qquad (2)$$

The terms are defined as follows:

Cp **:** This is the concentration of a particular contaminant in the groundwater at the time of assessment, (baseline/background). This water may already contain some contaminants. These contaminant levels must be subtracted to determine the contaminant increment that can be permitted from the disposal site.

Co **:** This is the potential contaminant increase from other sources with a high degree of probability. For example, the potential chloride contamination from a highway under construction next to the site (assumed 20 mg/L) must be subtracted to determine Cw.

The Ontario Drinking Water Object for chloride is 250 mg/L (Cr). The natural uncontaminated background concentration of chloride is estimated to be about 10 mg/L (Cb).

Considering that chloride is a non-health related parameter (Guideline B-7-1), constant **"**x**"** is 0.5; and the maximum allowable concentration of chloride (Cm) beneath an adjacent property in accordance with Equation (1) above is 10 + 0.5 (250-10) = 130 mg/L.

The maximum concentration of chloride (Cw) from the patrol yard sites that can be permitted to reach the adjacent properties, is calculated in accordance with Equation (2) above for each site, based on the chloride concentration in the groundwater underlying each site measured during this investigation, and presented in the following sections of the report. Other contaminants of minor significance such as petroleum hydrocarbon components and trace metals will be addressed during the final design phase.

11. HYDROGEOLOGICAL DESIGN CONSIDERATIONS

The hydrogeological recommendations provided in this report are consistent with the key concepts described in the Guide which are primarily focused on:

i) Management of salt-impacted wash water and drainage or accidental leaks/spills,

ii) Provision of safeguarding measures for spills associated with pre-wetting or anti-icing liquids/materials, fuel, product and waste storage and handling, and

iii) Planning for further monitoring.

The site-specific recommendations in the context of hydrogeological issues and the above-noted concepts are described in Part B4 of the report.

PART B1: NORTH SITE N2

12. SUMMARIZED SITE HYDROGEOLOGICAL CHARACTERISTICS

12.1 Subsurface Conditions

During our site reconnaissance, the exposed bedrock outcrop was noted on the majority of the site. The stratigraphy revealed in the exploratory boreholes comprised a discontinuous thin veneer of overburden, about 0.7 m of silty sand overburden in the central part of the site and bedrock.

Based on the findings of the subsurface investigation, the bedrock was unweathered to slightly weathered with moderately to widely spaced flat to dipping cross joints. The joints were generally oxidized to slightly altered with occasional silt partings. The general rock quality was fair to excellent and relatively low Rock Mass Rating was noted in the upper part of the bedrock.

It is apparent from the subsurface investigation findings that the weathering and fracture/joint pattern within the bedrock was variable with localized secondary infilling materials containing mostly silt partings.

12.2 Hydrogeologic Setting and Groundwater Flow Conditions

The subject site forms part of the Murdock River (Lovering Lake) major drainage basin. A number of individual creeks and drainage channels are part of the drainage systems, which eventually empty into the Georgian Bay.

The Murdock River (Lovering Lake) and its tributaries, wetlands and the associated water bodies (Rock Bay) from the headwaters of a drainage system for the subject site and vicinity, which is ultimately connected to the Georgina Bay drainage basin.

The measured groundwater level ranged from about 1.5 to 6.5 m below existing grades at elevations 233.9 to 240.3 m. The groundwater flow within the bedrock is interpreted in a southeasterly direction towards the Lovering Lake, located approximately 1.2 km east/southeast of the Site.

Based on the interpreted groundwater level contours shown on Drawing 5N, the horizontal flow gradient was estimated to be about 5%. The downward flow gradient using water level records in the shallow, medium and deep monitoring wells could not be estimated due to the lack of hydraulic connection between the uppermost and lower screen depths.

Based on the site hydrogeological and topographic settings, the interpreted groundwater level contour map, the groundwater flow direction and gradient, it is apparent that the subject site is a recharge area for the neighbouring Lovering Lake.

12.3 Aquifer Systems

As shown on the hydrogeological profiles (Drawing 4N) and appended Record of Borehole sheets, the overburden deposit is almost non-existent in the subject site. The granite bedrock forms the main water bearing formation in the Study area.

Based on the subsurface investigation findings, it seems that the unweathered to moderately weathered bedrock, which is mostly jointed and oxidized with secondary silt infilling, forms the main aquifer in the study area. The hydraulic communication between the shallow, near surface, and deep levels of bedrock is not well established and most likely dependent on localized fracture and/or joint pattern and continuity within the rock mass.

No water wells were identified within a 500 m radius of this site. During investigation, one water well was identified within the Township of Servos. Based on review of the Ministry of the Environment water well records, a water well located approximately 2.2 km southwest of the subject site was drilled in the granite bedrock where the overburden thickness was about 2 m and the static water level was about 11 m below the existing grades. The well screen is understood to be about 105 m deep.

12.4 Pathway Analysis

The general gradient of the ground surface at the subject site is about 5% from west to east. The northwestern part of the site locally slopes toward Highway 69 with a gradient of about 5%. A drainage ditch originating at the northwestern part of the site runs along the east side of the existing Highway 69.

As shown on Drawing 2N, the Murdock River (Lovering Lake) and its tributaries, wetlands and the associated water bodies (Rock Bay) form the headwaters of a drainage system for the subject site and vicinity, which are ultimately connected to the Georgian Bay drainage basin.

The measured hydraulic conductivity K-values of the bedrock ranged 0.05×10^{-5} to 15.0×10^{-5} cm/s with an average value 2.8×10^{-5} cm/s, or in terms of transmissivity about 0.025 $m^3/day/m^2$.

The pathways for migration of solutes exist through the groundwater flow from the central part of the site towards east/southeast along the dominant groundwater flow direction and locally towards the northwestern part of the site in a westerly/northwesterly direction.

The average lateral groundwater flow velocity (V) in porous media calculated based on the Darcian seepage flow equation V=Ki/n, where **‘**K**’** is the estimated hydraulic conductivity, **‘** i **’** is the prevailing hydraulic gradient and **‘**n**’** is the porosity.

However, for the groundwater flow in the bedrock, the rock mass fracture permeability depends very much on the bedrock secondary porosity represented by the joint/fracture spacing and frequency, aperture width and filling and the Rock Quality Designation and Rock Mass Rating values. As these parameters could not be characterized in the scope of the subject investigation, the rock mass fracture hydraulic conductivity is assumed to be one or two orders of magnitude higher than the average value measured by simple borehole permeability testing, namely 3.0×10^{-4} or 3.0×10^{-3} cm/s.

Based on the above-noted assumption, the highest migration rate of solute towards south/southeast direction will be about 15 cm/day or about 55 m/year. Considering Lovering Lake, located about 1.2 km east/southeast of the subject site, as a major ecological receiver of the solute, it will take the salt or other contaminants about 20 years to reach to the lake.

Considering the uncertainties associated with the actual hydraulic conductivity value of the fractured and/or weathered bedrock, the actual groundwater flow velocity and solute migration rate may be different from the calculated values noted above.

12.5 Existing Groundwater Environmental Quality

In general, the chemical quality of groundwater underlying the subject site complies with the standard values of the selected trace metals, inorganics and petroleum hydrocarbon components listed in the Ontario Regulation 153/04 Table 2 for the potable groundwater situation.

However, the measured concentrations of cobalt, copper, lead and zinc in all three groundwater samples tested and toluene in a sample taken from a monitoring well from the central part of the site exceeded the Table 1 background standards.

The concentrations of naturally occurring salt-related anions such as chloride ranged from 3.7 to 25.6 mg/L with an average concentration of 11.2 mg/L.

The measured low concentrations of sulphate, ammonia, TKN and total phosphorous detected in the groundwater underlying the subject site are also indicative of the site's natural groundwater environmental quality.

The above groundwater environmental quality criteria establish the baseline quality conditions of the groundwater underlying the subject site.

13. POTENTIAL IMPACTS ON WATER AND SOIL QUALITY

As described above, the baseline groundwater quality underlying the subject site is rather low in natural salt concentration and complies with the Ministry of the Environment Table 2 standard value for potable groundwater situation.

Considering the presence of permeable fractured rock mass at the subject site, the proposed land use activities may have the following potential impacts on the quality of water in the subject site and surrounding areas.

- Potential increases of salt content that may lead to future elevated levels of sodium and chloride exceeding the Ministry of the Environment Table 2 Standards for potable groundwater uses at the subject site and surrounding areas downgradient,
- Potential increases of trace metals such as lead and cadmium associated with the petroleum hydrocarbons and other trace metals present in the de-icing salt and/or brine,
- Potential increases of petroleum hydrocarbon related compounds such as benzene, toluene, ethylbenzene and xylenes (BTEX) and overall increase in petroleum hydrocarbon (PHC) Fraction concentrations that may impair the potable quality of the groundwater, and
- The increase of salt concentration in groundwater may lead to an increase in the sodium absorption ratio (SAR) values of the near surface soils that may retard the plant growth.

13.1 Seasonal Variations of Potential Adverse Effects

Due to the moderate infiltration capability of the unweathered bedrock, the surface runoff containing salt and any spillage/leakage of petroleum hydrocarbons will accumulate in an area to the northwestern part of the site along the east side of existing Highway 69. The surface water infiltration and run off and its diluting effect are dependent on the frequency, duration and intensity of precipitation.

Considering the seasonal nature of the salt storage and enhanced activities of the de-icing operations in the winter months, a temporal increase in salt content in groundwater is expected in the spring months due to snow melting and increased rainfall. Similarly, a low salt content is expected in relatively drier summer months due to less precipitations and absence of de-icing activities.

13.2 Groundwater Quality Compliance with Reasonable Use Policy

The groundwater sample chemical test results, particularly the measured chloride concentrations were compared with the Ministry of the Environment's Procedures B-7-1, described in Section 10 above.

The maximum concentration of chloride allowed beneath the adjacent property is 130 mg/L (Section 10). The chloride concentrations in groundwater underlying the subject site ranged from 3.7 to 25.6 mg/L with an average concentration of 11.2 mg/L. Therefore, using Equation (2) in Section 10, the maximum concentration of chloride that can be permitted to reach the adjacent properties from the subject patrol yard site is (130 - 11 – 20) mg/L or 99 mg/L, assuming the future Highway 69 contribution of chloride to be about 20 mg/L.

PART B2: CENTRAL SITE C2

14. SUMMARIZED SITE HYDROGEOLOGICAL CHARACTERISTICS

14.1 Subsurface Conditions

During our site reconnaissance, exposed bedrock outcrop was noted on the majority of the site. The stratigraphy revealed in the exploratory boreholes comprised a discontinuous thin veneer of overburden, about 0.5 to 0.6 m of silty sand overburden in the northeastern part of the site and bedrock.

In general, the bedrock was unweathered to slightly weathered with moderately to widely spaced flat to dipping cross-joints. The joints were generally oxidized to slightly altered with occasional silt partings. The general rock quality was fair to excellent, occasionally poor with fair to good rock mass quality.

Based on the subsurface investigation findings, the weathering and fracture/joint pattern within the bedrock was variable with localized secondary infilling materials containing mostly silt partings.

14.2 Hydrogeological Setting and Groundwater Flow Conditions

The Key River and its tributaries (Nisbet Creek), wetlands and the associated water bodies (Portage Lake) are part of the headwaters of a drainage system for the subject site and vicinity, which is ultimately connected to the Georgian Bay drainage basin.

The subject site is a well-drained parcel of land with surface water bodies and swamps located along the northern and southern boundaries of the site.

The measured groundwater levels ranged from about 0.9 to 4.2 m below the existing grades, at elevations 190.0 to 200.0 m. The groundwater flow within the bedrock is interpreted in the easterly/northeasterly direction, towards the Portage Lake and the low-lying swamp area. The Portage Lake is located approximately 500 m east of the Site.

Based on the interpreted groundwater level contours shown on Drawing 5C, the horizontal flow gradient was estimated to be about 7.3%. The downward flow gradient using the measured water levels in the shallow (about 3.0 m deep), medium (about 6.0 m deep) and deep (about 8.0 m deep) monitoring wells could not be estimated due to the lack of hydraulic connection between the uppermost and lower screen depths.

Based on the site hydrogeological and topographic settings, the interpreted groundwater level contour map and the groundwater flow direction and gradient, it is apparent that the subject site is a recharge area for the neighbouring Portage Lake and the low-lying swamp area.

14.3 Aquifer Systems

As shown on the hydrogeological profiles (Drawing 4C) and appended Record of Borehole sheets, the overburden deposit is almost non-existent in the subject site. The granite bedrock forms the main water bearing formation in the Study area.

Based on the subsurface investigation findings, it seems that the unweathered to moderately weathered bedrock, which is mostly jointed and oxidized with secondary silt infilling, forms the main aquifer in the study area.

Six water wells were identified within a 500 m radius of the subject site, which were drilled within the granite bedrock with the screen depths ranging from 53 to 114 m below the existing grades.

14.4 Pathway Analysis

The central and southern parts of the site are relatively flat, which slopes towards north with a gradient of about 4.5%. However, the southern part of the site slopes abruptly toward the south with a much steeper gradient of about 25%.

The measured hydraulic conductivity K-value of the bedrock ranged from 0.2×10^{-5} to 5.4×10^{-5} cm/s with an average value of 1.3×10^{-5} cm/s, or in terms of transmissivity about 0.011 m^3/day/m^2.

The pathways for migration of solutes through the groundwater flow exist from the central part of the site towards north/northeast along the dominant groundwater flow direction and locally towards southerly direction at the southern part of the site.

The average lateral groundwater flow velocity (V) in porous media is calculated based on the Darcian seepage flow equation V=Ki/n, where **'**K**'** is the estimated hydraulic conductivity, **'** i **'** is the prevailing hydraulic gradient and 'n' is the porosity.

However, for the groundwater flow in the bedrock, the rock mass fracture permeability depends very much on the bedrock secondary porosity represented by the joint/fracture spacing and frequency, aperture width and filling, the Rock Quality Designation and Rock Mass Rating values. As these parameters could not be characterized in the scope of the subject site investigation, the rock mass fracture hydraulic conductivity is assumed to be one or two orders of magnitude higher than the average value measured by simple borehole permeability testing, namely 1.5×10^{-4} cm/s or 1.5×10^{-3} cm/s.

Based on the above-noted assumption, the highest migration rate of solute towards north/northeast direction will be about 10 cm/day or about 40 m/year. Considering the drainage course located along the northern boundary of the site as a major ecological receiver of the solute, it may take the salt or other contaminants about 10 years to reach into the drainage course from the central part of the site, and will eventually reach into the Portage Lake within about 13 years period, located approximately 500 m east of the site, depending on the location of patrol yard salt handling facilities within the subject site.

Considering the uncertainties related to the actual hydraulic conductivity value of the fractured and/or weathered bedrock, the actual groundwater flow velocity and solute migration rate may be different from the above calculated values.

14.5 Existing Groundwater Environmental Quality

In general, the chemical quality of groundwater underlying the subject site complies with the standard values of the selected trace metals, inorganics and petroleum hydrocarbon components listed in the Ontario Regulation 153/04 Table 2 for the potable groundwater situation.

Elevated levels of copper, lead and silver exceeding the Table 2 standards were detected in the groundwater samples analyzed. It should be noted that the bedrock in the subject study area is rich in metallic minerals.

The concentrations of naturally occurring salt-related anions, such as chloride, ranged from 2.9 to 3.7 mg/L with an average concentration of 3.2 mg/L, indicating very low background salt concentration.

The measured low concentrations of sulphate, ammonia, TKN and total phosphorous detected in the groundwater underlying the subject site are also indicative of the site's natural/background groundwater environmental quality.

The above groundwater environmental quality criteria establish the baseline quality conditions of the groundwater underlying the subject site.

15. POTENTIAL IMPACTS ON WATER AND SOIL QUALITY

As described above, the baseline groundwater quality underlying the subject site is low in natural salt concentration and complies with the Ministry of the Environment Table 2 standards for the potable groundwater situation with the exception of elevated levels of copper, lead and silver.

Considering the presence of permeable fractured rock mass at the subject site, the proposed land use activities may have the following potential impacts on the quality of water in the subject site and surrounding areas.

- Potential increases of salt content that may lead to future elevated levels of sodium and chloride exceeding the Ministry of the Environment Table 2 Standards criteria for potable groundwater uses at the subject site and surrounding areas downgradient,
- Potential increases of trace metals such as lead and cadmium associated with the petroleum hydrocarbons and other trace metals present in the de-icing salt,
- Potential increases of petroleum hydrocarbon related compounds such as benzene, toluene, ethylbenzene and xylenes (BTEX) and overall increase in petroleum hydrocarbon (PHC) Fraction concentrations that may impair the potable quality of the groundwater, and

- The increase of salt concentration in groundwater may lead to an increase in the sodium absorption ratio (SAR) values of the near surface soils that may retard the plant growth.

15.1 Seasonal Variations of Potential Adverse Effects

Due to moderate infiltration capability of the unweathered bedrock, the surface runoff containing salt and any spillage/leakage of petroleum hydrocarbons will accumulate in the drainage course located along the northern boundary of the site. The surface water infiltration and runoff and its diluting effect are dependent on the duration, frequency, and intensity of precipitation.

Considering the seasonal nature of the salt storage and enhanced activities of the de-icing operations in the winter months, a temporal increase in salt content in groundwater is expected in the spring months due to snow melting and increased rainfall. Similarly, a low salt content is expected in relatively drier summer months due to less precipitations and absence of de-icing activities.

15.2 Groundwater Quality Compliance with Reasonable Use Policy

The groundwater sample chemical test results, particularly the measured chloride concentrations were compared with the Ministry of the Environment's Guideline B-7-1, described in Section 10 above.

The maximum concentration of chloride allowed beneath the adjacent property is 130 mg/L (Section 10). The chloride concentration in the groundwater underlying the subject site ranged from 2.9 to 3.7 mg/L with an average concentration of 3.2 mg/L. Therefore, using Equation (2) in Section 10, the maximum concentration of chloride that can be permitted to reach the adjacent properties from the subject patrol yard site is (130 - 3 - 20) mg/L or 107 mg/L, assuming the future Highway 69 contribution of chloride to be about 20 mg/L.

PART B3: SOUTH SITE S1

16. SUMMARIZED SITE HYDROGEOLOGICAL CHARACTERISTICS

16.1 Subsurface Conditions

During our site reconnaissance, the exposed bedrock outcrops were noted all over the site. The stratigraphy revealed in the exploratory boreholes comprised a discontinuous topsoil layer overlying the Migmatite bedrock. The top of the bedrock elevation, ranged from 206.9 to 209.9 m.

In general, the bedrock was unweathered to slightly weathered with moderately to widely spaced flat to dipping cross-joints. The joints were generally oxidized to slightly altered with occasional silt partings. The general rock quality was fair to excellent, occasionally poor with fair to good rock mass quality.

Based on the subsurface investigation results, the weathering and fracture/joint pattern within the bedrock was variable with localized secondary infilling materials containing mostly silt partings.

16.2 Hydrogeologic Setting and Groundwater Flow Conditions

The subject site forms part of the Shawanaga River watershed, located approximately 700 m south of the subject site. A surface water body connected to the Shawanaga River system is located approximately 300 m south/southwest of the southern boundary of the site.

The site is a relatively flat, gently sloping, well drained tableland and slopes easterly/southwesterly with a surface gradient of about 3% with no significant on-site drainage features except the northeastern part of the site, which is part of a relatively small wetland.

The measured groundwater level ranged from about 1.0 to 3.8 m below the existing grades at elevations 203.1 to 207.7 m. The west-central part of the site acts as a groundwater divide with a dominant groundwater flow direction towards north to the existing Highway 69 and to an unnamed water body.

The horizontal flow gradient was estimated to be about 5.5% in the northerly direction towards an unnamed water body located approximately 600 m north/northeast of the site. The groundwater flow direction in the eastern part of the site is towards south/southwest to the Shawanaga Bay and its associated water bodies with a relatively gentle gradient of about 1%. The Shawanaga Bay is located approximately 300 m west/southwest of the subject site.

A downward flow gradient of about 6% was recorded in the southwestern part of the site suggesting a hydraulic connection between the uppermost and deep monitoring well screens.

Based on the site hydrogeological and topographic settings, the interpreted groundwater level contour map and the groundwater flow direction and gradient, it is apparent that the subject site is a recharge area for the neighbouring Shawanaga Bay drainage basin.

16.3 Aquifer Systems

As discussed in the screening report, a review of the Ministry of the Environment water well records and geological setting of indicated that the granite bedrock forms the main water bearing formation in the study area.

As shown on the hydrogeological profiles (Drawing 4S) and appended Record of Borehole sheets, the overburden deposit is almost non-existent in the subject site. The granite bedrock forms the main water bearing formation in the study area.

Based on the subsurface investigation results, it seems that the unweathered to moderately weathered bedrock, which is mostly jointed and oxidized with secondary silt infilling, forms the main aquifer in the study area. The hydraulic communication between the shallow near surface and deep part of bedrock is well established and most likely dependent on the localized fracture and/or joint pattern within the bedrock.

No water wells were identified within a 500 m radius of this site. During investigation, water wells were identified in the Village of Point-au-Baril, about 4 km north of the subject site, which were mostly drilled in the granite bedrock.

16.4 Pathway Analysis

The subject site is relatively flat, gently sloping, well drained tableland and slopes east/southwest and northeast with a surface gradient of about 2.5% and ground surface elevations vary from 206 to 210 with no significant on-site drainage features except the northeastern part of the site, which is part of a relatively small wetland.

The site forms part of the Shawanaga River watershed, and a surface water body connected to the Shawanaga River system is located approximately 300 m south/southwest of the southern boundary of the site.

The measured hydraulic conductivity K-value of the bedrock ranged from 0.1 x 10^{-5} to 8.3 x 10^{-5} cm/s with an average value of 1.7 x 10^{-5} cm/s with an average value of 1.7 x 10^{-5} cm/s, or in terms of transmissivity about 0.015 m^3/day/m^2.

Therefore, pathways for migration of solutes exist through groundwater flow from the central part of the site towards north along the dominant groundwater flow direction. In addition, a secondary pathway exists along the southwestern part of the site towards the Shawanaga River.

The average lateral groundwater flow velocity (V) is calculated based on the Darcian seepage flow equation $V=Ki/n$, where ‘K’ is the estimated hydraulic conductivity, ‘ i ’ is the prevailing hydraulic gradient and ‘n’ is the porosity.

However, for the groundwater flow in the bedrock, the rock mass fracture permeability depends very much on the bedrock secondary porosity represented by the joint/fracture spacing and frequency, aperture width and filling, the Rock Quality Designation and Rock Mass Rating values. As these parameters could not be characterized in the scope of the subject site investigation, the rock mass fracture hydraulic conductivity is assumed to be one or two orders of magnitude higher than the average value measured by simple borehole permeability testing, namely 2.0 x 10^{-4} cm/s or 2.0 x 10^{-3} cm/s.

Based on the above-noted assumption, the highest migration rate of solute towards north direction (for i = 5.5%) will be about 10 cm/day or about 40 m/year. Considering the unnamed water body located approximately 600 m north/northeast of the site as a major ecological receiver of the solute, it will take salt and other contaminants about 15 years to reach into the water body from the central part of the site; and it will take about 8 years to reach to the Shawanaga River from the southwestern part of the site.

Considering the uncertainties associated with the actual hydraulic conductivity value of the fractured and/or weathered bedrock, the actual groundwater flow velocity and solute migration rate may be different from the above calculated values.

16.5 Existing Groundwater Environmental Quality

In general, the chemical quality of groundwater underlying the subject site complies with the standards of the selected trace metals, inorganics and petroleum hydrocarbons components listed in the Ontario Regulation 153/04 Table 2 for potable groundwater conditions.

Elevated level of lead exceeding the Table 2 standard was detected in one groundwater sample analyzed. It should be noted that the bedrock in the subject study area is rich in metallic minerals.

The concentrations of naturally occurring salt-related anions such as chloride ranged from 4.0 to 20.4 mg/L with an average concentration of 9.5 mg/L.

The above groundwater environmental quality criteria establish the baseline quality conditions of the groundwater underlying the subject site.

17. POTENTIAL IMPACTS ON WATER AND SOIL QUALITY

As described above, the baseline groundwater quality underlying the subject site is low in natural salt concentration and complies with the Ministry of the Environment Table 2 standards for the potable groundwater situation with the exception of elevated level of lead in one groundwater sample analyzed for borehole S4D, located on the southwestern part of the site.

Considering the presence of permeable fractured rock mass at the subject site, the proposed land use activities may have the following potential impacts on the quality of water in the subject site and surrounding areas.

- Potential increases of salt content that may lead to future elevated levels of sodium and chloride exceeding the Ministry of the Environment Table 2 Standards for potable groundwater uses at the subject site and surrounding areas downgradient,
- Potential increases of trace metals such as lead and cadmium associated with the petroleum hydrocarbons and other trace metals present in the de-icing salt,
- Potential increases of petroleum hydrocarbon related compounds such as benzene, toluene, ethylbenzene and xylenes (BTEX) and overall increase in petroleum hydrocarbon (PHC) Fraction concentrations that may impair the potable quality of the groundwater, and
- The increase of salt concentration in groundwater may lead to an increase in the sodium absorption ratio (SAR) values of the near surface soils that may retard the plant growth.

17.1 Seasonal Variations of Potential Adverse Effects

Due to moderate infiltration capability of the unweathered bedrock, the surface runoff containing salt and any spillage/leakage of petroleum hydrocarbons will accumulate in the low-lying areas east of the site. The surface water infiltration and runoff and its diluting effect are dependent on the duration, frequency, and intensity of precipitation.

Considering the seasonal nature of the salt storage and enhanced activities of the de-icing operations in the winter months, a temporal increase in salt content in groundwater is expected in the spring months due to snow melting and increased rainfall. Similarly, a low salt content is expected in relatively drier summer months due less precipitation and absence of de-icing activities.

It is assumed that the associated garage and petroleum fuelling activities of the Patrol Yard facility will be operational throughout the year. Hence, there will be always a potential for leakage and/or spillage of petroleum hydrocarbons on site.

17.2 Groundwater Quality Compliance with Reasonable Use Policy

The groundwater sample chemical test results, particularly the measures chloride concentrations, were compared with the Ministry of the Environment's Guideline B07-1, described in Section 10 above.

The maximum concentration of chloride allowed beneath the adjacent property is 130 mg/L (Section 10). The chloride concentration in the groundwater underlying the subject site ranged from 4.0 to 20.4 mg/L with an average concentration of 9.5 mg/L. Therefore, using Equation (2) in Section 10, the maximum concentration of chloride that can be permitted to reach the adjacent properties from the subject patrol yard is (130 - 10 - 20) mg/L or 100 mg/L, assuming the future Highway 69 contribution of chloride to be about 20 mg/L.

PART B4: PRELIMINARY HDYDROGEOLOGICAL DESIGN RECOMMENDATIONS FOR REMEDIAL, MONITORING AND CONTINGENCY MEASURES

As described in Section 7, the remedial, monitoring and contingency measures are to be incorporated in the design of the new patrol yards to avoid, minimize and/or mitigate the potential environmental impacts.

The preliminary hydrogeological design recommendations outlined in this section are based on the key concepts described in the MTO's Environmental Guide for Patrol Yard Design (October 2006, the Guide) which are outlined in Section 11 above.

18. REMEDIAL MEASURES

To avoid, minimize and/or mitigate the potential impacts on the groundwater and surface water bodies in the subject sites and surrounding areas, the salt-impacted water (from drainage and wash water, and potential brine release or fuel and waste oil leakages/spills) should be properly managed.

The potential release of the above-noted contaminants can be mitigated by taking one of the following two approaches:

1) Collection of the above-noted potentially released contaminated liquids for reuse, treatment or off-site disposal or
2) Attenuation of the released contaminants on site to the Ministry of the Environment Reasonable Use Criteria described in Section 10 above. The attenuation mechanism will have to be achieved by a quality and quantity control storm water management pond.

With respect to the remedial measures for potential release of salt impacted water and other contaminants in the Winter Management Area and Vehicle Maintenance Area, the environmental/aquatic issues, potential impacts, proposed mitigative/risk management measures and their advantages and disadvantages are summarized on Table 2.

For either approach outlined above, an initial containment and primary collection facility underneath the Winter Management Area, equipment and vehicle repair garage (with oil separators) and fuel storage and dispensing areas, is needed which may consist of:

i) A geomembrane/liner placed on a prepared smooth and sloped (for positive drainage) subgrade. As a result of site grading (cut and fill) operations, the majority of the subject three sites will end up to rough rock surfaces which should be smoothened for placement of the above-recommended liner. This can be achieved by placement of an about 150 mm thick compacted clay-based fill, or lean (dental or mud) concrete, or a sand fill base, similar to the sand drainage bed noted below. Among these options, the sand fill seems to be the most economically feasible option as there is no clayey soils available on the subject sites. The sand fill base should be sloped to accommodate the geomembrane slope for positive drainage into the subdrains.
ii) A free draining (sand) drainage bed about 0.50 m thick should be placed on top of the geomembrane,
iii) A network of perforated subdrains connected to a solid header pipe, should be placed downgradient of the subgrade and above the geomembrane within the sand bed, and connected to either a lined storm water management pond or to a collection (tank) system, and
iv) The top of sand bed where the facilities are to be installed should be paved with positive drainage.

It is understood that the patrol yard areas outside the Winter Management Area and Vehicle Maintenance Area are not to be salted, but winter sand (sand mixed with less than 10% of rock salt) is to be applied for winter traffic purposes within the yard.

Moreover, it is also understood that two separate secondary collection systems by means of separate underground storage tanks for potentially released salt-impacted water for reuse and fuel or waste oil impacted water for off-site treatment/disposal respectively are to be implemented rather than an attenuating pond.

As described in Section 5.4 above, the majority of groundwater samples obtained and analyzed from monitoring wells installed indicated elevated levels of some metals such as copper, lead and zinc as compared with the potable/drinking water quality criteria which are generally related to the intrinsic environmental conditions of the region’s geology and bedrock composition.

However, it is understood that water supply for each patrol yard is to be a water well to be developed on each site. Our recommendations for the water well are outlined as follows:

i) The water well should be located upgradient and upstream of the proposed septic tank and bed and Winter Management Area and Vehicle Maintenance Area and with an appropriate well head protection;

ii) The water well should be developed at a stratum within the bedrock to provide the yield required for the facility’s need by a pumping test; and

iii) The water withdrawn from the well may have to be treated for domestic/office use pending confirmatory sampling and testing during pumping test, particularly for the substances detected with elevated levels as described in Section 5.4 of this report.

19. MONITORING AND CONTINGENCY MEASURES

Once the patrol yard design is finalized for site preparation and implementation of the remedial measures as recommended above, the Reasonable Use Criteria for the contaminants that may potentially be released from the subject sites should be finalized and a groundwater and surface water quality control monitoring system should be designed, installed and maintained on each site as outlined below.

These measures are undertaken to confirm the desired performance of the constructed remedial measure on seasonal and long-term bases.

19.1 Finalization of Reasonable Use Criteria

As described in Section 10, the Reasonable Use Criteria (Cm and Cw) depend very much on the type and concentration of potential contaminants existing on the subject site and surrounding areas prior to the patrol yard operation (baseline conditions) as compared with those that may be released after the constructed facilities commence operation and maintained for a long period of time.

These criteria should be finalized for the baseline conditions once the site is prepared and monitoring instruments are installed prior to the operation by:

i) Sampling and chemical analysis of groundwater and surface water at the monitoring points established for potential contaminants such as chloride, trace metals and petroleum hydrocarbon components.

ii) Calculating the Reasonable Use Criteria by using Equations (1) and (2) in Section 10.

Moreover, upon completion of the patrol yards design, the concentrations of the potential contaminants that may be released to the natural system from the facilities accidentally and/or from the breached remedial measures will have to be further assessed by pathway/migration analyses and compared with the finalized Reasonable Use Criteria values for design consideration of the monitoring program and contingency measures.

19.2 Monitoring Wells and Surface Water Sampling Points

After the design is finalized and the site is prepared, monitoring wells and monitoring points will have to be established in the upstream (upgradient), surrounding the areas where remedial measures are to be constructed and site boundaries for seasonal groundwater and surface water sampling and chemical analysis (four times a year). The analytical protocol should include the potential contaminants and general chemistry parameters.

The results of quarterly sampling and testing program should be evaluated as compared with the Reasonable Use Criteria already established.

A quarterly monitoring program report should be prepared which will have to include the factual field and laboratory data as well as an assessment of the remedial measures performance objectives.

The above-noted monitoring program will have to be undertaken seasonally (four times) every year for about 3 to 5 years until the trend in the surface water and groundwater environmental quality is established for compliance with the finalized Reasonable Use Criteria taking into consideration the baseline conditions, as well.

19.3 Contingency Measures

If the results of quarterly monitoring program reported by a qualified person indicate non-compliance with the Reasonable Use Criteria and other conditions of the Certificate of Approve (C of A), the Reasonable Use Criteria and operational procedures should be reviewed for improvement.

20. APPROVALS, PERMITS, AUTHORIZATIONS AND/OR CLEARANCES

The provincial and regional regulatory requirements should be satisfied in relation to the following operation needs of the patrol yards:

1) Permit-To-Take-Water in accordance with the Ministry of the Environment's Manual (April 2005) under Regulation 387104 - Water Taking and Transfer Regulation under Ontario Water Resources Act, if water taking is more than 50,000 l/day (or about 0.6 L/S).
2) Certificate-of-Authorization for potential discharge of contaminants from the patrol yards to the natural systems under Reasonable Use Guides (B-7) and B-7-1), described in Section 10.

The above-noted clearances may have to be authorized by both Ministries of the Environment and Natural Resources or Conservation Authorities where areas of natural and scientific interest, significant wetlands, or other sensitive areas exist in the vicinity.

21. STATEMENT OF LIMITATIONS

A statement of limitations is included in Appendix C that should be read in conjunction with this report.

22. REFERENCES

The following references were used in preparing this report.

- Barnett, P. J., 1992, *Quaternary Geology of Ontario*, In *Geology of Ontario*, Ontario Geological Survey, Special Volume 4, Part 2 Edited by: Thurston, P. C., Williams, H. R., Sutcliffe, R. H. and Stott, G. M., Ministry of Natural Resources, Ontario.

- Chapman, L. J. and Putnam, D. F., 1984, *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Ministry of Natural Resources, Ontario.

- Environmental Guide for Patrol Yard Design: Part of the Environmental Standards and Practices, Environmental Planning Office, Ministry of Transportation, Ontario Version: October 2006, Section 3.3.

- Ontario regulation 153/04; Soil, Groundwater and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act for Full Depth Background (Table 1) and Generic Site Condition Standards in a Potable Groundwater Condition (Table 2) dated March 9, 2004.

- Quaternary Geology of Ontario: Southern Sheet, Map 2566, Scale 1: 1,000,000, Ministry of Northern Development and Mines.

- Snow, D. T. (1965): A Parallel Plate Model of Fractured Permeable Media, Ph.D Thesis, University of California, Berkeley, U.S.A.

- Ministry of the Environment and Energy (MOEE) Hydrogeological Technical Information Requirements for Land Development Applications, Procedure B-7-1 (formerly 15-08), Determination of Contaminant limits and Attenuation Zones dated April 1995.

We trust this report serves your present requirements; should you have any questions, please do not hesitate to contact this office.

Sincerely

Peto MacCallum Ltd.

NOTE: Hard copies signed and stamped

Mahaboob Alam, PhD, P.Geo.
Manager, Geoenvironmental Services

NOTE: Hard copies signed and stamped

Mori H. Mortazavi, MEng, P.Eng., P.Geo.
Senior Consultant
Geoenvironmental and Hydrogeological Services

NOTE: Hard copies signed and stamped

Brian R. Gray, MEng, P.Eng.
MTO Designated Contact

BRG/MHM/MA-ma:lr

TABLE CC

ROCK CORE DESCRIPTION

CORE RECOVERY						CORE DESCRIPTION	
MW/BH	**RC**	**DEPTH (m)**	**REC (%)**	**RQD (%)**	**RMR**	**DEPTH (m)**	**DESCRIPTION**
C1	1 2 3 4 5	0.0 – 1.6 1.6 – 3.2 3.2 – 4.6 4.6 – 6.4 6.4 – 7.8	100 100 100 94 100	81 100 73 80 94	61 64 57 61 64	0.0 – 3.2	GRANITIC GNEISS: Grey, fine to medium grained, dipping bands, occasional distorted layers of pink feldspar, high strength, unweathered, close to wide spaced flat to dipping cross joints, rough planar, tight, with some vertical partings, brown oxidation on partings, minor silt in some joints, good to excellent quality.
						3.2 – 7.8	MIGMATITE: Light grey, fine grained, vertical bands, occasionally irregular, high strength, unweathered, close to moderate spaced flat to dipping cross joints, tight, becoming moderate (locally close) spaced dipping to vertical, with dark green to black oxidation on parting surface, minor silt in some joints, fair to excellent quality.
C2	1 2 3 4 5	0.0 – 1.6 1.6 – 3.3 3.3 – 4.5 4.5 – 6.1 6.1 – 7.6	100 100 100 97 100	84 98 87 92 89	61 74 61 64 61	0.0 – 7.6	GRANITIC GNEISS: Grey, fine to medium grained, dipping bands, with 550 mm thick layer of black amphibolite, high strength, unweathered, close to moderate spaced flat to dipping cross joints, rough planar, tight, with some vertical partings, oxidized to slightly altered dark green to black mineralization on partings, minor silt in some joints, good to excellent quality.
C3	1 2 3 4 5	0.0 – 1.6 1.6 – 3.3 3.3 – 4.7 4.7 – 6.2 6.2 – 7.8	100 100 100 100 97	88 96 97 100 95	61 64 74 64 64	0.0 – 7.8	GRANITIC GNEISS: Grey, fine to medium grained, dipping bands, high strength, unweathered, close to moderate spaced flat cross joints, rough planar, tight, occasional brown or white scale on partings, good to excellent quality.

Notes:

MW/BH = Borehole RC = Core Run REC = Recovery RQD: Rock Quality Designation RMR = Rock Mass Rating

Drilled: September 16, 2008

Logged: October 6, 2008

Originated: FP
Compiled: JFW
Checked: MA

TABLE CC

ROCK CORE DESCRIPTION

CORE RECOVERY						**CORE DESCRIPTION**	
MW/BH	**RC**	**DEPTH (m)**	**REC (%)**	**RQD (%)**	**RMR**	**DEPTH (m)**	**DESCRIPTION**
C4D	1	0.7 – 2.0	100	91	64	0.7 – 9.2	MIGMATITE: Grey, fine grained, with inclusions of black biotite, occasional coarse crystalline layers, becoming pink, veined with green pyroxene, high strength, unweathered, close to moderate (locally wide) spaced flat to dipping cross joints, rough planar, tight to slightly altered with green oxidation and/or grey scale on partings, also occasional vertical joints, rough planar to undulating, tight (locally open to 0.5 mm with silt infilling, excellent becoming poor to good quality.
	2	2.0 – 3.4	100	100	64		
	3	3.4 – 4.9	100	95	79		
	4	4.9 – 6.4	100	100	64		
	5	6.4 – 8.0	100	34	52		
	6	8.0 – 9.2	100	89	61		
C4M	1	0.7 – 2.0	84	61	57	0.7 – 7.8	MIGMATITE: Grey, fine grained, slight banding, occasional inclusions of black biotite, high strength, unweathered, close to moderate (locally wide) spaced flat to dipping cross joints, rough planar, tight to slightly altered with dark brown or red oxidation and/or grey scale on partings, separates readily on schistocity, fair becoming excellent quality.
	2	2.0 – 3.5	100	97	64		
	3	3.5 – 4.9	100	100	64		
	4	4.9 – 6.5	100	100	64		
	5	6.5 – 7.8	94	94	64		
C4S	1	0.6 – 1.9	94	86	61	0.6 – 4.7	MIGMATITE: Grey, fine grained, with occasional thin layers of black amphibolite, high strength, unweathered, close to moderate (locally wide) spaced flat to dipping cross joints, rough planar, tight, also dipping parting at contacts with amphibolite layer, smooth planar oxidized to slightly altered with discontinuous green scale on surface, good to excellent quality.
	2	1.9 – 3.4	100	98	64		
	3	3.4 – 4.7	100	100	79		
C5	1	0.0 – 1.6	100	100	64	0.0 – 7.8	GRANITIC GNEISS: Grey, fine to medium grained, slight banding, high strength, unweathered, close to moderate spaced flat cross joints, rough planar, tight, occasional silt on partings, with some vertical partings, closed, fair to excellent quality.
	2	1.6 – 3.1	100	73	57		
	3	3.1 – 4.6	98	93	64		
	4	4.6 – 6.1	100	100	74		
	5	6.1 – 7.6	100	96	74		

Notes:

MW/BH = Borehole RC = Core Run REC = Recovery RQD: Rock Quality Designation RMR = Rock Mass Rating

Drilled: September 16, 2008

Logged: October 6, 2008

Originated: FP
Compiled: JFW
Checked: MA

TABLE CN

ROCK CORE DESCRIPTION

CORE RECOVERY						CORE DESCRIPTION	
MW/BH	**RC**	**DEPTH (m)**	**REC (%)**	**RQD (%)**	**RMR**	**DEPTH (m)**	**DESCRIPTION**
N1	1	0.0 – 1.6	100	90	61	0.0 – 9.3	GRANODIORITE GNEISS: Grey to dark grey, fine to medium grained, dipping bands, with layer of pink pegmatite, high strength, unweathered, close to moderate (locally very closely) spaced flat to dipping cross joints, rough planar, tight to slightly altered with red iron oxide scale on partings, minor silt in some joints, fair to excellent quality.
	2	1.6 – 1.9	100	100	64		
	3	1.9 – 3.4	97	69	52		
	4	3.4 – 4.9	100	100	64		
	5	4.9 – 6.4	100	100	64		
	6	6.4 – 7.9	100	100	64		
	7	7.9 – 9.3	100	100	79		
N2	1	0.1 – 1.7	100	86	47	0.1 – 7.8	GRANODIORITE GNEISS: Pink to grey, medium grained, locally garnetiferous, high strength, slightly weathered, generally moderate to wide spaced (locally very closely to closely spaced) flat to dipping cross joints, rough planar, oxidized (variously with red, green and yellow staining) to slightly altered with silt on some partings. Also with occasional vertical partings, up to 5 mm wide, partially infilled with red and white secondary mineralization and partially voided, fair to excellent quality.
	2	1.7 – 3.3	100	65	53		
	3	3.3 – 4.7	100	80	56		
	4	4.7 – 6.1	100	89	71		
	5	6.1 – 7.3	100	100	74		
	6	7.3 – 7.8	100	100	74		
N3	1	0.0 – 1.3	96	96	79	0.0 – 7.9	GRANODIORITE GNEISS: Grey, fine to medium grained, with coarse, pegmatic texture at depth, high strength, unweathered, generally moderate to wide spaced (locally closely to moderately spaced) flat to dipping cross joints, rough planar, tight to slightly altered, with muscovite concentrations at some partings, excellent quality.
	2	1.3 – 1.6	100	100	79		
	3	1.6 – 3.2	100	100	79		
	4	3.2 – 4.8	100	100	79		
	5	4.8 – 6.4	100	100	79		
	6	6.4 – 7.9	100	100	79		
N4	1	0.0 – 1.6	100	70	52	0.0 – 6.7	GRANODIORITE GNEISS: Grey, fine to medium grained, high strength, slightly weathered, generally moderate to wide spaced (locally very closely to closely spaced) flat to dipping cross joints, rough planar, oxidized to slightly altered, occasional vertical partings with minor silt on surface, fair to excellent quality.
	2	1.6 – 2.1	95	85	71		
	3	2.1 – 3.7	100	100	50		
	4	3.7 – 5.2	98	91	74		
	5	5.2 – 6.7	98	97	74		

Notes:

MW/BH = Borehole RC = Core Run REC = Recovery RQD: Rock Quality Designation RMR = Rock Mass Rating

Drilled: August 19, 2008

Logged: September 11, 2008

Originated: FP
Compiled: JFW
Checked: MA

TABLE CN

ROCK CORE DESCRIPTION

CORE RECOVERY						CORE DESCRIPTION	
MW/BH	**RC**	**DEPTH (m)**	**REC (%)**	**RQD (%)**	**RMR**	**DEPTH (m)**	**DESCRIPTION**
N5D	1 2 3 4 5 6	0.0 – 1.6 1.6 – 3.2 3.2 – 4.7 4.7 – 6.1 6.1 – 7.7 7.7 – 9.2	98 100 100 100 100 97	84 100 50 100 100 97	61 74 52 32 74 79	0.0 – 5.6	GRANODIORITE GNEISS: Grey, medium grained, high strength, slightly weathered to unweathered, closely to widely spaced dipping cross joints, rough planar, tight to oxidized, locally sandy with brown scale on partings, good to excellent becoming fair quality.
						5.6 – 7.2	GABRO: Black, fine grained, medium to high strength, very closely to moderately spaced dipping partings, oxidized to slightly altered, locally sandy, with 100 mm and 50 mm thick dipping layers of rust brown schist near upper contact, low strength, moderately to highly weathered, red oxidation on partings, fair quality.
						7.2 – 9.2	GRANODIORITE GNEISS: As above, moderately to widely spaced flat to dipping cross joints, rough planar, oxidized to slightly altered, with red or green residue on partings, excellent quality.
N5M	1 2 3 4 5	0.8 – 1.9 1.9 – 3.3 3.3 – 4.6 4.6 – 6.4 6.4 – 7.7	98 95 100 100 98	69 82 100 100 98	38 36 79 64 60	0.8 – 7.7	GRANODIORITE GNEISS: Grey, medium grained, dipping bands, with layers of black gabro, high strength, slightly weathered to unweathered, very closely to closely, becoming moderately to widely spaced dipping cross joints, rough planar, oxidized to slightly altered, with 75 mm thick dipping layer of rust brown schist, low strength, moderately to highly weathered, red oxidation on partings, fair to excellent quality.
N5S	1 2 3	0.2 – 1.7 1.7 – 3.3 3.3 – 4.7	100 100 98	100 100 73	64 50 38	0.2 – 4.7	GRANODIORITE GNEISS: Grey, fine to medium grained, high strength, slightly weathered, closely to moderately spaced (locally very closely spaced) flat to dipping cross joints, rough planar, slightly altered to sandy, locally 1 to 2 mm wide, with red to brown silt residue on partings, excellent becoming fair quality.

Notes:

MW/BH = Borehole RC = Core Run REC = Recovery RQD: Rock Quality Designation RMR = Rock Mass Rating

Drilled: August 19, 2008

Logged: September 11, 2008

Originated: FP
Compiled: JFW
Checked: MA

TABLE CS
ROCK CORE DESCRIPTION

CORE RECOVERY						CORE DESCRIPTION	
MW/BH	**RC**	**DEPTH (m)**	**REC (%)**	**RQD (%)**	**RMR**	**DEPTH (m)**	**DESCRIPTION**
S1	1	0.3 – 1.8	100	77	42	0.3 – 7.4	MIGMATITE: Light grey to pink, fine grained becoming medium at depth, with layer of pink pegmatite, coarse crystalline, medium to high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping cross joints, rough (locally smooth) planar, tight to slightly altered with brown to rust coloured oxide on partings, single joint at 0.8 m depth open to 2 mm, sandy (friable on parting surface), occasionally separates on mica concentrations, good to excellent quality.
	2	1.8 – 3.4	100	94	65		
	3	3.4 – 4.8	100	100	64		
	4	4.8 – 6.4	100	96	64		
	5	6.4 – 7.4	97	92	64		
S2	1	0.0 – 1.6	100	97	64	0.0 – 7.0	MIGMATITE: Pink, fine grained, garnetiferous, slight vertical banding, with layer of pink pegmatite, coarse crystalline, high strength, unweathered, close to moderate spaced flat cross joints, rough planar, tight, locally oxidized with dark staining, occasionally with white scale on partings, excellent quality.
	2	1.6 – 3.2	100	97	64		
	3	3.2 – 4.9	100	100	64		
	4	4.9 – 5.4	100	100	74		
	5	5.4 – 6.1	100	100	64		
	6	6.1 – 6.4	100	100	64		
	7	6.4 – 7.0	100	100	64		
S3	1	0.0 – 1.6	100	97	64	0.0 – 7.8	MIGMATITE: Light grey, fine grained, slight vertical banding, with vertical layer of black amphiboloite, high strength, unweathered, close to moderate (locally wide) spaced flat (locally dipping) cross joints, rough planar, tight, locally slightly altered with white scale or silt on partings, excellent quality.
	2	1.6 – 3.2	100	100	64		
	3	3.2 – 4.8	100	100	79		
	4	4.8 – 6.3	100	93	64		
	5	6.3 – 7.8	99	98	64		

Notes:

MW/BH = Borehole RC = Core Run REC = Recovery RQD: Rock Quality Designation RMR = Rock Mass Rating

Drilled: September 26, 2008

Logged: October 14, 2008

Originated: FP

Compiled: JFW

Checked: MA

TABLE CS
ROCK CORE DESCRIPTION

CORE RECOVERY						CORE DESCRIPTION	
MW/BH	**RC**	**DEPTH (m)**	**REC (%)**	**RQD (%)**	**RMR**	**DEPTH (m)**	**DESCRIPTION**
S4D	1	0.1 – 1.6	95	87	61	0.1 – 9.2	MIGMATITE: Pink, fine grained becoming medium at depth, slight vertical banding, high strength, unweathered, close to wide (locally very close) spaced flat to dipping cross joints, rough planar, tight to oxidized with dark brown to red colouration on partings, some vertical partings, rough planar, tight, good to excellent (locally poor) quality.
	2	1.6 – 3.2	100	100	64		
	3	3.2 – 4.8	100	97	79		
	4	4.8 – 6.3	100	100	74		
	5	6.3 – 7.8	100	48	47		
	6	7.8 – 9.2	100	100	74		
S4M	1	0.0 – 1.5	98	74	57	0.0 – 7.4	MIGMATITE: Pink to grey, fine grained, slight vertical banding, high strength, unweathered, close to wide spaced flat cross joints, rough planar, tight to oxidized with light brown to red colouration on surface, some vertical partings, rough planar, tight to oxidized with dark brown to black colouration on surface, occasionally with silt, fair to excellent quality.
	2	1.5 – 1.8	86	86	61		
	3	1.8 – 3.3	100	100	74		
	4	3.3 – 4.9	97	78	61		
	5	4.9 – 6.3	100	100	64		
	6	6.3 – 7.4	98	86	71		
S4S	1	0.1 – 1.7	97	97	64	0.1 – 4.6	MIGMATITE: Pink, fine grained, slight vertical banding, high strength, unweathered, close to wide spaced flat to dipping cross joints, rough planar, tight to oxidized with brown colouration, locally silty, excellent quality.
	2	1.7 – 3.2	100	97	64		
	3	3.2 – 4.6	100	100	64		
S5	1	0.1 – 1.6	100	88	61	0.1 – 6.1	MIGMATITE: Pink, fine grained, slight vertical banding, high strength, unweathered, moderate to wide (locally close) spaced flat to dipping cross joints, rough planar, tight to oxidized with dark brown to red colouration, locally minor white scale or very slight pyritization on partings, good to excellent quality.
	2	1.6 – 2.1	100	100	74		
	3	2.1 – 2.6	100	88	74		
	4	2.6 – 3.2	100	100	74		
	5	3.2 – 3.7	100	100	79		
	6	3.7 – 3.9	100	100	79		
	7	3.9 – 4.7	100	100	74		
	8	4.7 – 6.1	98	98	64		

Notes:

MW/BH = Borehole RC = Core Run REC = Recovery RQD: Rock Quality Designation RMR = Rock Mass Rating
Drilled: September 26, 2008
Logged: October 14, 2008

Originated: FP
Compiled: JFW
Checked: MA

TABLE 1C

GROUNDWATER SAMPLE CHEMICAL TEST RESULTS AS COMPARED WITH THE SITE CONDITION STANDARD VALUES
CENTRAL SITE C2

(Concentrations in ug/L unless otherwise indicated)

PARAMETER	**SAMPLE IDENTIFICATION**			**ONTARIO REGULATION 153/04 STANDARDS(a)**	
	Borehole MW C1	**Borehole MW C2**	**Borehole MW C4(D)**	**Table 1(b)**	**Table 2(c)**
Trace Metals					
Antimony	1.46	2.69	<1.00	6.0	6.0
Arsenic	2.14	2.21	2.37	25	25
Barium	178	95.4	70.0	N/V	1000
Boron (available)	76.8	49.0	47.6	200	5000
Beryllium	<1.00	<1.00	<1.00	4.0	4.0
Cadmium	**0.60**	0.33	0.40	0.5	5.0
Cobalt	**30.2**	**6.99**	**7.58**	0.9	100
Chromium	**11.2**	5.84	3.08	8.9	50
Chromium (VI)	<5.0	<5.0	<5.0	10	50
Copper	**151**	**90.1**	**34.8**	2.5	23
Lead	**26.5**	**27.4**	**12.3**	1.0	10
Mercury	<0.02	<0.02	<0.02	0.02	0.12
Molybdenum	17.0	12.0	5.19	40	7300
Nickel	**94.8**	**27.2**	**27.5**	25	100
Selenium	<0.80	<0.80	1.71	5.0	10
Silver	**0.27**	**1.22**	<0.20	0.25	1.2
Thallium	<0.30	<0.30	<0.30	0.5	2.0
Vanadium	**17.4**	**8.07**	3.90	6.0	200
Zinc	**389**	**142**	**134**	20	1100

TABLE 1C

GROUNDWATER SAMPLE CHEMICAL TEST RESULTS AS COMPARED WITH THE SITE CONDITION STANDARD VALUES

CENTRAL SITE C2

(Concentrations in ug/L unless otherwise indicated)

PARAMETER	SAMPLE IDENTIFICATION			ONTARIO REGULATION 153/04 STANDARDS[(a)]	
	Borehole MW C1	**Borehole MW C2**	**Borehole MW C4(D)**	**Table 1[(b)]**	**Table 2[(c)]**
Inorganic Parameters					
PH	7.63	7.91	7.24		
Free Cyanide	<2.0	<2.0	<2.0	5.0	52
Fluoride	150	140	120	N/V	N/v
Bromide	<50.0	<50.0	<50.0	N/V	N/v
Chloride	3090	2940	3660	N/V	250000
Nitrite	<50.0	<50.0	<50.0	N/V	1000
Nitrate	<50.0	<50.0	<50.0	N/V	10000
Ammonia	40.0	70.0	60.0	N/V	N/V
Sulphate	12900	11500	38200	N/V	N/V
Electrical Conductivity (in uS/cm)	109	233	204	N/v	N/v
Total Kjeldahl Nitrogen	860	520	560	N/V	N/V
Total Organic Carbon	18200	12200	14100	N/V	N/V
Total Dissolved Solids	152000	190000	204000	N/V	N/V
Total Hardness	68000	141000	76000	N/V	N/V
Total Phosphorous	610	230	410	N/V	N/V
Petroleum Hydrocarbons					
Benzene	<0.20	<0.20	<0.20	5.0	5.0
Toluene	0.23	0.24	0.21	0.8	24
Ethylbenzene	<0.10	<0.10	<0.10	2.4	2.4

TABLE 1C

GROUNDWATER SAMPLE CHEMICAL TEST RESULTS AS COMPARED WITH THE SITE CONDITION STANDARD VALUES

CENTRAL SITE C2

(Concentrations in ug/L unless otherwise indicated)

PARAMETER	SAMPLE IDENTIFICATION			ONTARIO REGULATION 153/04 STANDARDS[(a)]	
	Borehole MW C1	Borehole MW C2	Borehole MW C4(D)	Table 1[(b)]	Table 2[(c)]
Xylenes	<0.20	<0.20	<0.20	72	300
Petroleum Hydrocarbon F1	<100	<100	<100	N/V	1000
Petroleum Hydrocarbon F2	<100	<100	<100	N/V	1000
Petroleum Hydrocarbon F3	<500	<500	<500	N/V	1000
Petroleum Hydrocarbon F4	<500	<500	<500	N/V	1000

Notes

(a) Ontario Regulation 153/04; Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act dated March 9, 2004.

(b) Ontario Regulation 153/04; Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act for Full Depth Background Site Condition Standards (Table 1) dated March 9, 2004.

(c) Ontario Regulation 153/04; Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act for Full Depth Generic Site Condition Standards in a Potable Ground Water Condition (Table 2) dated March 9, 2004.

N/V No Site Condition Standard Value

Bold Exceeds Table 1 Standard

Bold Exceeds Tables 1 and 2 Standards

TABLE 1N

GROUNDWATER SAMPLE CHEMICAL TEST RESULTS AS COMPARED WITH THE SITE CONDITION STANDARD VALUES

NORTH SITE N2

(Concentrations in ug/L unless otherwise indicated)

PARAMETER	SAMPLE IDENTIFICATION			ONTARIO REGULATION 153/04 STANDARDS[a]	
	Borehole MW N2	Borehole MW N4	Borehole MW N5(D)	Table 1[b]	Table 2[c]
Trace Metals					
Antimony	<1.00	<1.00	<1.00	6.0	6.0
Arsenic	<0.60	1.01	3.14	25	25
Barium	20.3	69.0	74.8	N/V	1000
Boron (available)	14.5	25.1	36.2	200	5000
Beryllium	<1.00	<1.00	<1.00	4.0	4.0
Cadmium	<0.20	<0.20	<0.20	0.5	5.0
Cobalt	**1.05**	**3.43**	**19.5**	0.9	100
Chromium	0.72	1.30	1.65	8.9	50
Chromium (VI)	<5.0	<5.0	<5.0	10	50
Copper	**7.97**	**18.5**	**21.5**	2.5	23
Lead	**2.15**	**3.45**	**8.14**	1.0	10
Mercury	<0.02	<0.02	<0.02	0.02	0.12
Molybdenum	1.49	2.28	5.73	40	7300
Nickel	9.59	13.3	**43.9**	25	100
Selenium	<0.80	<0.80	1.23	5.0	10
Silver	<0.20	<0.20	<0.20	0.25	1.2
Thallium	<0.30	<0.30	<0.30	0.5	2.0
Vanadium	0.60	3.93	4.14	6.0	200
Zinc	**33.2**	**35.1**	**68.1**	20	1100

TABLE 1N

GROUNDWATER SAMPLE CHEMICAL TEST RESULTS AS COMPARED WITH THE SITE CONDITION STANDARD VALUES
NORTH SITE N2
(Concentrations in ug/L unless otherwise indicated)

PARAMETER	**SAMPLE IDENTIFICATION**			**ONTARIO REGULATION 153/04 STANDARDS[(a)]**	
	Borehole MW N2	**Borehole MW N4**	**Borehole MW N5(D)**	**Table 1[(b)]**	**Table 2[(c)]**
Inorganic Parameters					
PH	6.29	7.05	6.59		
Free Cyanide	<2.0	<2.0	<2.0	5.0	52
Fluoride	<50.0	90.0	<50.0	N/V	N/v
Bromide	<50.0	<50.0	80.0	N/V	N/v
Chloride	4240	3670	25600	N/V	250000
Nitrite	<50.0	<50.0	<50.0	N/V	1000
Nitrate	70.0	70.0	<50.0	N/V	10000
Ammonia	<20.0	<20.0	<20.0	N/V	N/V
Sulphate	8010	23700	58000	N/V	N/V
Electrical Conductivity (in uS/cm)	74	159	279	N/v	N/v
Total Kjeldahl Nitrogen	390	390	540	N/V	N/V
Total Organic Carbon	4100	12800	19700	N/V	N/V
Total Dissolved Solids	62000	238000	240000	N/V	N/V
Total Hardness	33000	68000	102000	N/V	N/V
Total Phosphorous	80.0	130	150	N/V	N/V

TABLE 1N

GROUNDWATER SAMPLE CHEMICAL TEST RESULTS AS COMPARED WITH THE SITE CONDITION STANDARD VALUES
NORTH SITE N2

(Concentrations in ug/L unless otherwise indicated)

PARAMETER	SAMPLE IDENTIFICATION			ONTARIO REGULATION 153/04 STANDARDS[(a)]	
	Borehole MW N2	Borehole MW N4	Borehole MW N5(D)	Table 1[(b)]	Table 2[(c)]
Petroleum Hydrocarbons					
Benzene	<0.04	<0.04	0.05	5.0	5.0
Toluene	<0.04	<0.04	**3.6**	0.8	24
Ethylbenzene	<0.05	<0.05	0.09	2.4	2.4
Xylenes	<0.04	<0.04	0.29	72	300
Petroleum Hydrocarbon F1	<100	<100	<100	N/V	1000
Petroleum Hydrocarbon F2	<100	<100	<100	N/V	1000
Petroleum Hydrocarbon F3	<500	<500	<500	N/V	1000
Petroleum Hydrocarbon F4	<500	<500	<500	N/V	1000

Notes

(a) Ontario Regulation 153/04; Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act dated March 9, 2004.

(b) Ontario Regulation 153/04; Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act for Full Depth Background Site Condition Standards (Table 1) dated March 9, 2004.

(c) Ontario Regulation 153/04; Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act for Full Depth Generic Site Condition Standards in a Potable Ground Water Condition (Table 2) dated March 9, 2004.

N/V No Site Condition Standard Value

Bold Exceeds Table 1 Standards

TABLE 1S

GROUNDWATER SAMPLE CHEMICAL TEST RESULTS AS COMPARED WITH THE SITE CONDITION STANDARD VALUES

SOUTH SITE S1

(Concentrations in ug/L unless otherwise indicated)

PARAMETER	**SAMPLE IDENTIFICATION**			**ONTARIO REGULATION 153/04 STANDARDS(a)**	
	Borehole MW S1	**Borehole MW S4(D)**	**Borehole MW S5**	**Table 1(b)**	**Table 2(c)**
Trace Metals					
Antimony	<1.00	<1.00	<1.00	6.0	6.0
Arsenic	0.69	10.9	2.02	25	25
Barium	39.2	245	101	N/V	1000
Boron (available)	<10.0	18.8	12.6	200	5000
Beryllium	<1.00	2.55	<1.00	4.0	4.0
Cadmium	<0.20	<0.20	0.27	0.5	5.0
Cobalt	0.89	**4.75**	**3.62**	0.9	100
Chromium	1.60	0.88	2.21	8.9	50
Chromium (VI)	<5.0	<5.0	<5.0	10	50
Copper	**4.87**	**14.4**	**11.2**	2.5	23
Lead	**2.11**	**21.3**	**9.67**	1.0	10
Mercury	<0.02	<0.02	<0.02	0.02	0.12
Molybdenum	11.3	4.10	2.71	40	7300
Nickel	2.24	9.67	**6.56**	25	100
Selenium	<0.80	<0.80	<0.80	5.0	10
Silver	<0.20	<0.20	<0.20	0.25	1.2
Thallium	<0.30	<0.30	<0.30	0.5	2.0
Vanadium	2.04	**6.43**	1.89	6.0	200
Zinc	14.3	**36.8**	**86.0**	20	1100

TABLE 1S

GROUNDWATER SAMPLE CHEMICAL TEST RESULTS AS COMPARED WITH THE SITE CONDITION STANDARD VALUES
SOUTH SITE S1

(Concentrations in ug/L unless otherwise indicated)

PARAMETER	**SAMPLE IDENTIFICATION**			**ONTARIO REGULATION 153/04 STANDARDS[(a)]**	
	Borehole MW S1	**Borehole MW S4(D)**	**Borehole MW S5**	**Table 1[(b)]**	**Table 2[(c)]**
Inorganic Parameters					
PH	7.39	7.82	7.49		
Free Cyanide	<2.0	<2.0	<2.0	5.0	52
Fluoride	100	130	<50.0	N/V	N/v
Bromide	<50.0	<50.0	<50.0	N/V	N/v
Chloride	4030	3990	20400	N/V	250000
Nitrite	<50.0	<50.0	<50.0	N/V	1000
Nitrate	70.0	<50.0	50.0	N/V	10000
Ammonia	<20.0	80.0	160	N/V	N/V
Sulphate	6240	6120	3840	N/V	N/V
Electrical Conductivity (in uS/cm)	103	148	103	N/v	N/v
Total Kjeldahl Nitrogen	1500	1670	4120	N/V	N/V
Total Organic Carbon	18600	20800	9100	N/V	N/V
Total Dissolved Solids	58000	36000	150000	N/V	N/V
Total Hardness	14000	13000	15000	N/V	N/V
Total Phosphorous	2920	3020	900	N/V	N/V

TABLE 1S

GROUNDWATER SAMPLE CHEMICAL TEST RESULTS AS COMPARED WITH THE SITE CONDITION STANDARD VALUES

SOUTH SITE S1

(Concentrations in ug/L unless otherwise indicated)

PARAMETER	SAMPLE IDENTIFICATION			ONTARIO REGULATION 153/04 STANDARDS[(a)]	
	Borehole MW S1	**Borehole MW S4(D)**	**Borehole MW S5**	**Table 1[(b)]**	**Table 2[(c)]**
Petroleum Hydrocarbons					
Benzene	<0.20	<0.20	<0.20	5.0	5.0
Toluene	<0.20	<0.20	<0.20	0.8	24
Ethylbenzene	<0.10	<0.10	<0.10	2.4	2.4
Xylenes	<0.20	<0.20	<0.20	72	300
Petroleum Hydrocarbon F1	<100	<100	<100	N/V	1000
Petroleum Hydrocarbon F2	<100	<100	<100	N/V	1000
Petroleum Hydrocarbon F3	<500	<500	<500	N/V	1000
Petroleum Hydrocarbon F4	<500	<500	<500	N/V	1000

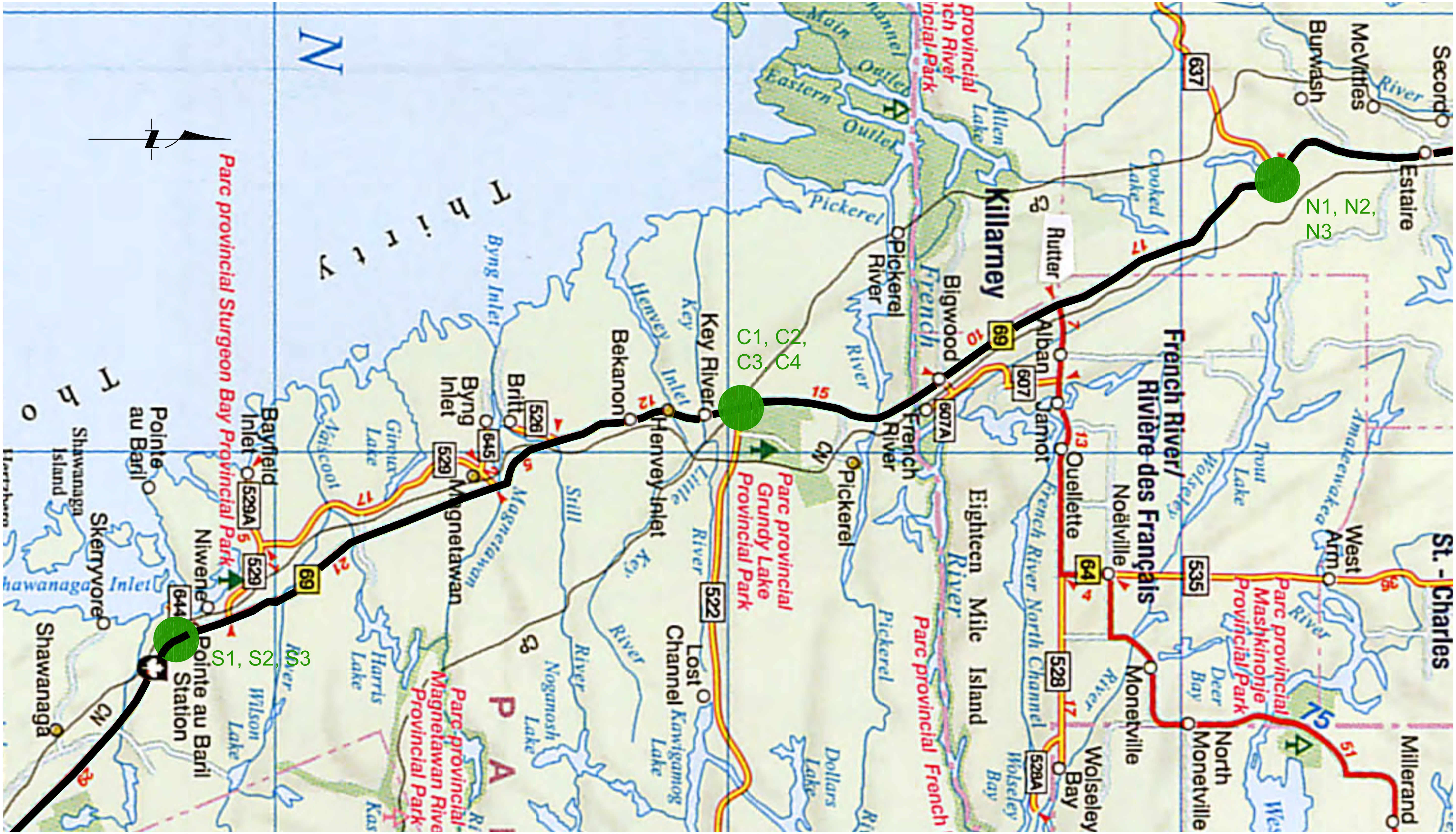
Notes

(a)	Ontario Regulation 153/04; Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act dated March 9, 2004.
(b)	Ontario Regulation 153/04; Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act for Full Depth Background Site Condition Standards (Table 1) dated March 9, 2004.
(c)	Ontario Regulation 153/04; Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act for Full Depth Generic Site Condition Standards in a Potable Ground Water Condition (Table 2) dated March 9, 2004.
N/V	No Site Condition Standard Value
Bold	Exceeds Table 1 Standard
Bold	Exceeds Tables 1 and 2 Standards

TABLE 2

SUMMARIZED ENVIRONMENTAL/AQUATIC ISSUES, PROPOSED MITIGATIVE/RISK MANAGEMENT MEASURES AND ADVANTAGES AND DISADVANTAGES

ENVIRONMENTAL AQUATIC ISSUES (GROUNDWATER, DRAINAGE AND SURFACE WATER)	POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS	PROPOSED MITIGATIVE/RISK MANAGEMENT MEASURES	ADVANTAGES	DISADVANTAGES
• Groundwater resource exists in the bedrock and the weathered/fractured rock mass is exposed in the majority of **all three sites**. • The central site **(C2)** exists in the headwaters of the Key River drainage system; and surface water bodies and swamps are located along the northern and southern boundaries of this site, with potential receptors of valued ecosystem and water wells existing within 500 m of the site boundaries. • Marsh lands exist east and northeast of the south site **(S1)** and a surface water body connected to the Shawanaga River is located about 250 m south/southwest of this site southern boundary.	• Deep cuts may intercept groundwater level and cause drawdown, • Accidental release of fuel, lubricants and other liquids from equipment and activities, • Accidental release of fuel, lubricants and other liquids from the Vehicle Maintenance Area, • Release of salt, salt solution (brine) and other deicing liquids from the Winter Maintenance Area, and • Salt and sediment/sand release by run off from the yard and ditch erosion	• Containment of salt, salt solution (brine) and other deicing liquids to the indoor space of the Winter Management Area.	• State-of-the-art salt management practices consistent with the Environment Canada's Code of Practice for the Environmental Management of Road Salts. • Primary confinement of salt handling operations against elements and adverse impacts to the environment.	• Additional construction, operation and maintenance costs.
		• Isolation of the Winter Management Area and Vehicle Maintenance Area from the underlying fractured rock mass and groundwater by a geomembrane/liner and installation of a subdrainage system over the liner to collect accidental spill, if any.	• Secondary confinement of released salt solutions to protect the environment • Collection of the released salt solutions for reuse	• Additional construction cost for excavated rock surface preparation and installation of the geomembrane/liner and subdrainage system.
		• Storage of the collected salt solution and other released contaminants into separate storage tanks in the Winter Management Area for reuse and installation of grassed drainage ditches/swales with rock check dams for run off **or:** • Installation of a quality and quantity control storm water management pond as a contaminant attenuation measure.	• Reuse of the released salt solutions. • More comprehensive risk management measure if a storm water management pond is installed, particularly for the run off if the grassed swales mitigation is not fully effective.	• Additional construction and maintenance cost. • The salt concentration in the released salt solutions may not be adequate for reuse. • The management of the contaminants other than salt and unuseful collected salt solution is more costly if a storm water management pond is not opted.
		• Installation and maintaining a monitoring program consisting of monitoring wells, surface water sampling points, seasonal sampling and chemical testing for compliance with the site-specific Rational Use criteria for a period of 3 to 5 years.	• The monitoring program results will demonstrate compliance with the Ontario Ministry of the Environment Rational Use criteria. • The monitoring period can be shortened once the consecutive results demonstrate a positive trend.	• The Ministry of the Environment regional office may have to be consulted for the site-specific Rational Use criteria for the groundwater • Additional operation and maintenance cost



KEY PLAN

SCALE

2.5 0 2.5 5km

LEGEND:

● APPROXIMATE LOCATION OF PROPOSED SITES: SOUTHERN(S1, S2 AND S3), CENTRAL (C1, C2, C3 AND C4) AND NORTHERN (N1, N2 AND N3).

METRIC

Ontario

Stantec Consulting Ltd.

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

HYDROGEOLOGICAL SITE SCREENING
PATROL YARD SITE SELECTION STUDY
HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO
G.W.P. 5094 - 06 - 00

DATE
DEC. 2008

PML REFERENCE:
07TX045

DRAWING
1

Preliminary Hydrogeological Site Investigation
NEW PATROL YARD SITE
HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO
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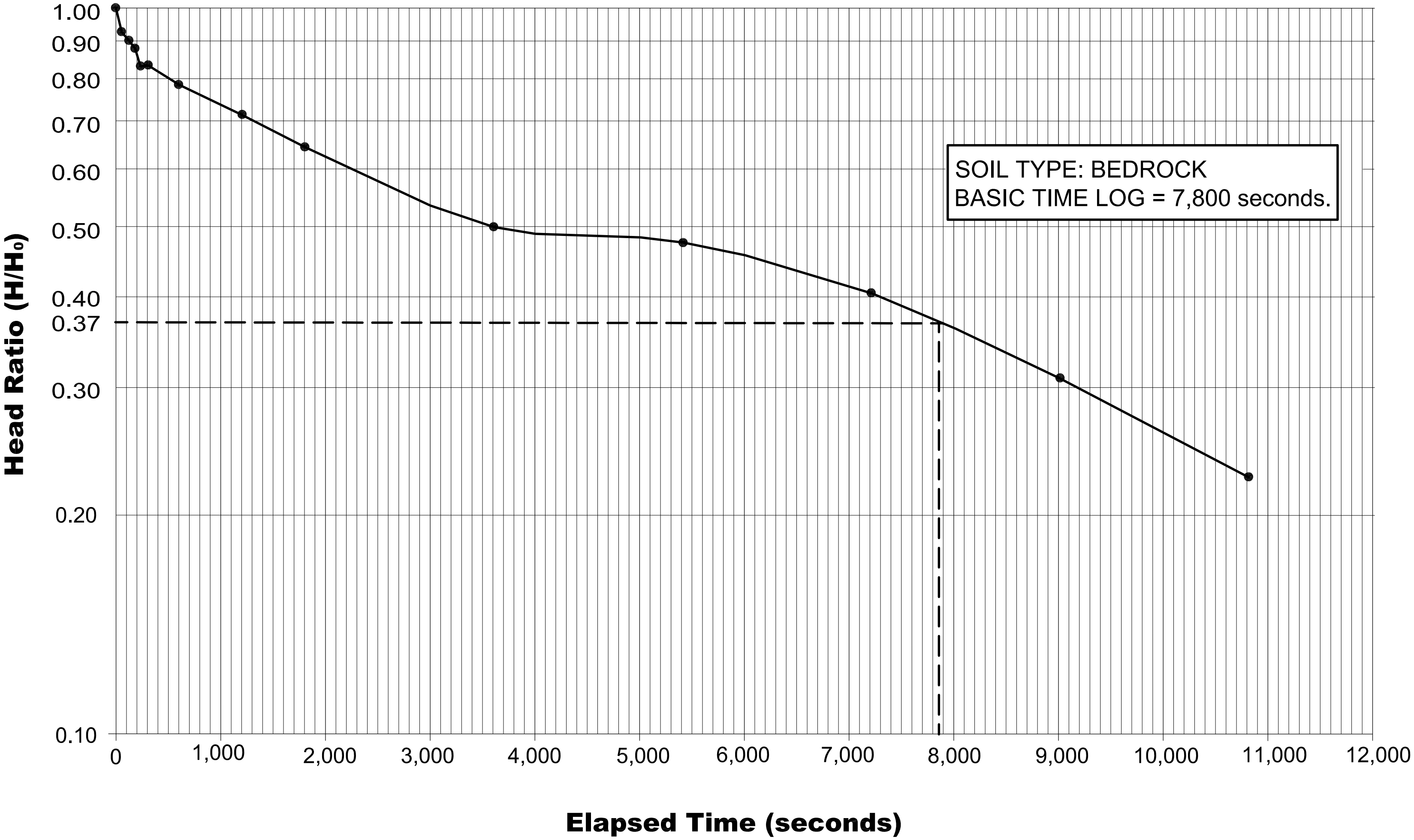

Figure 1C: Plot of Normalized Head Versus Elapsed Time

Monitoring Well C1

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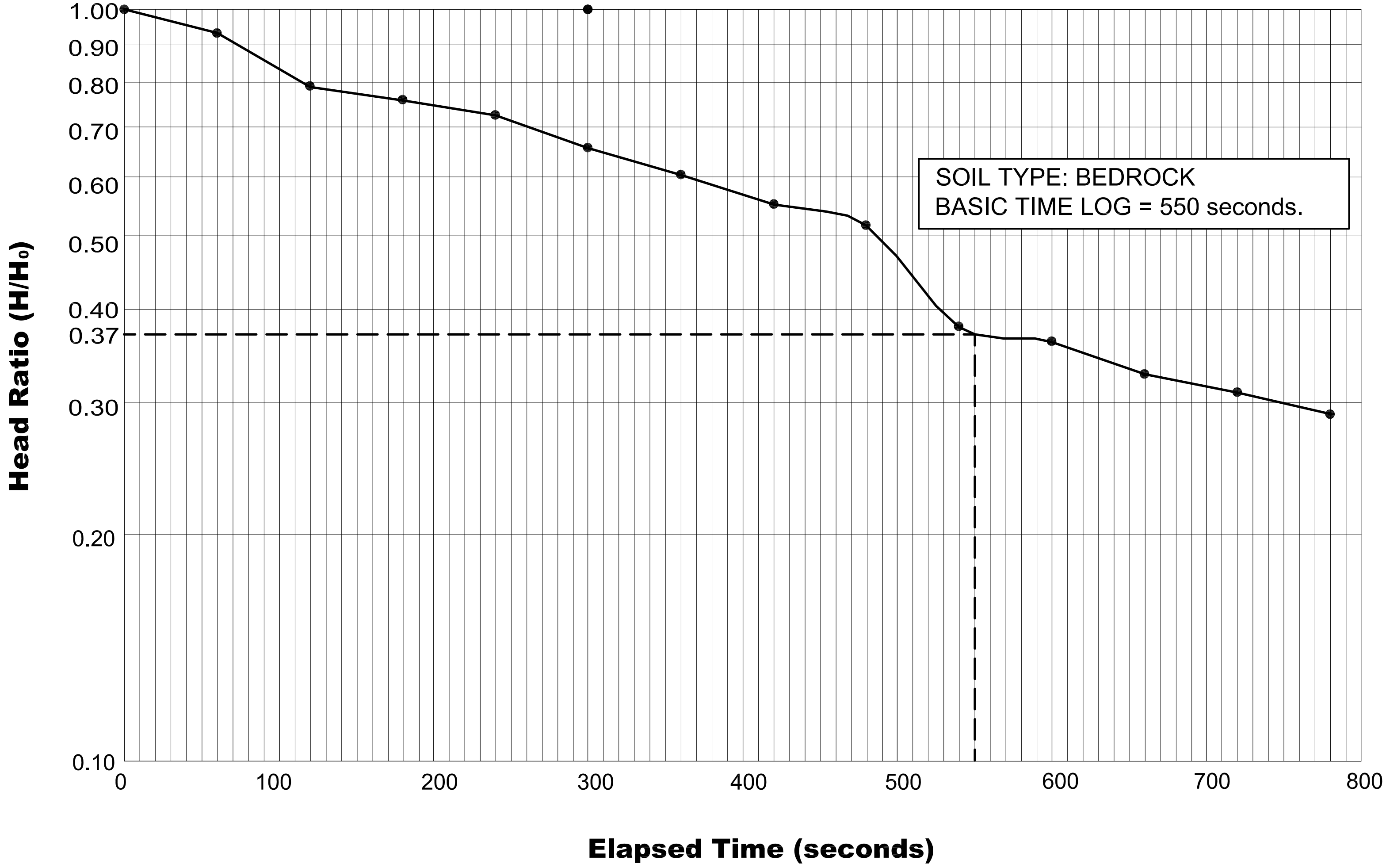

SOIL TYPE: BEDROCK
BASIC TIME LOG = 550 seconds.

Figure 2C: Plot of Normalized Head Versus Elapsed Time

Monitoring Well C2

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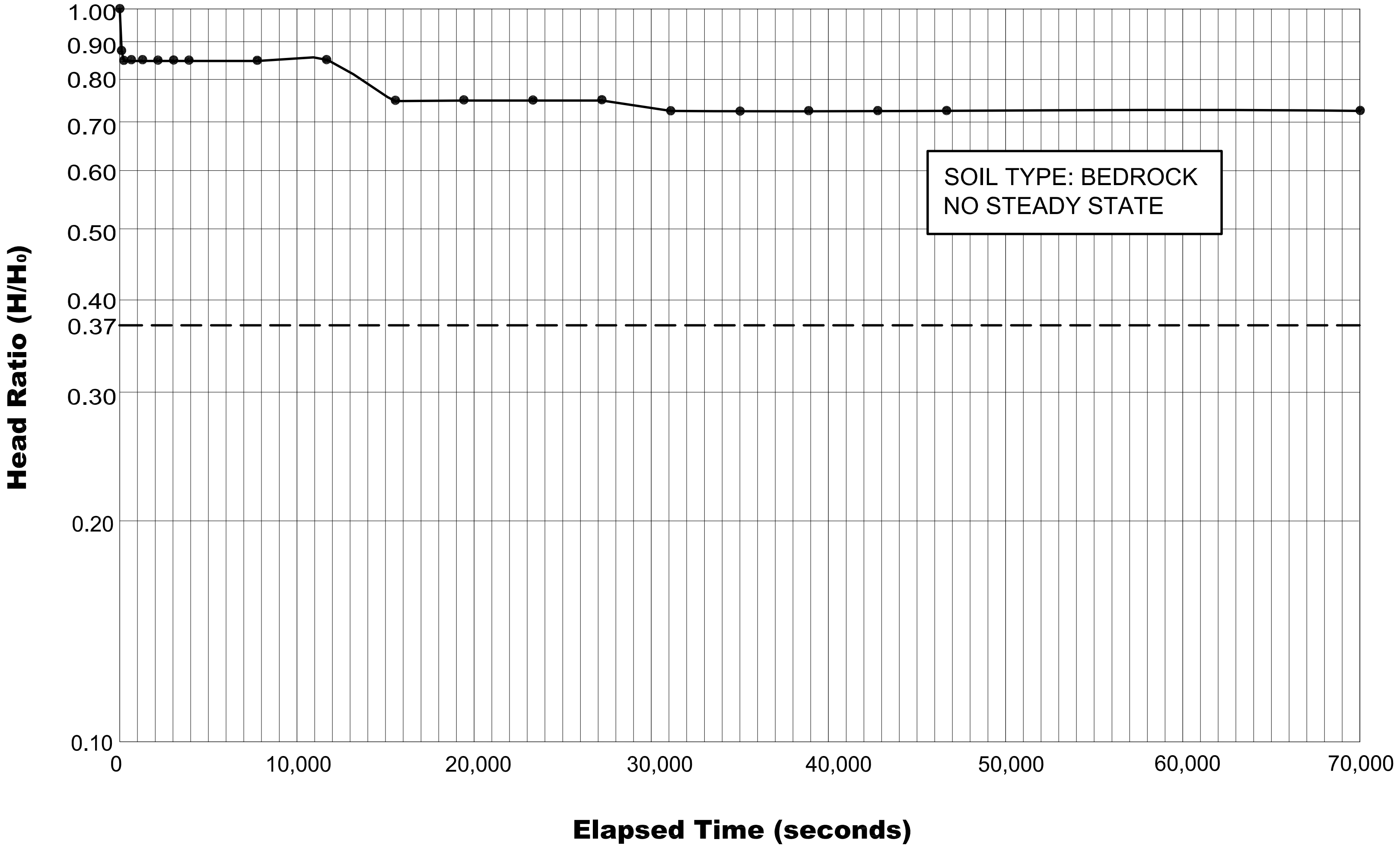

Figure 3C: Plot of Normalized Head Versus Elapsed Time

Monitoring Well C3

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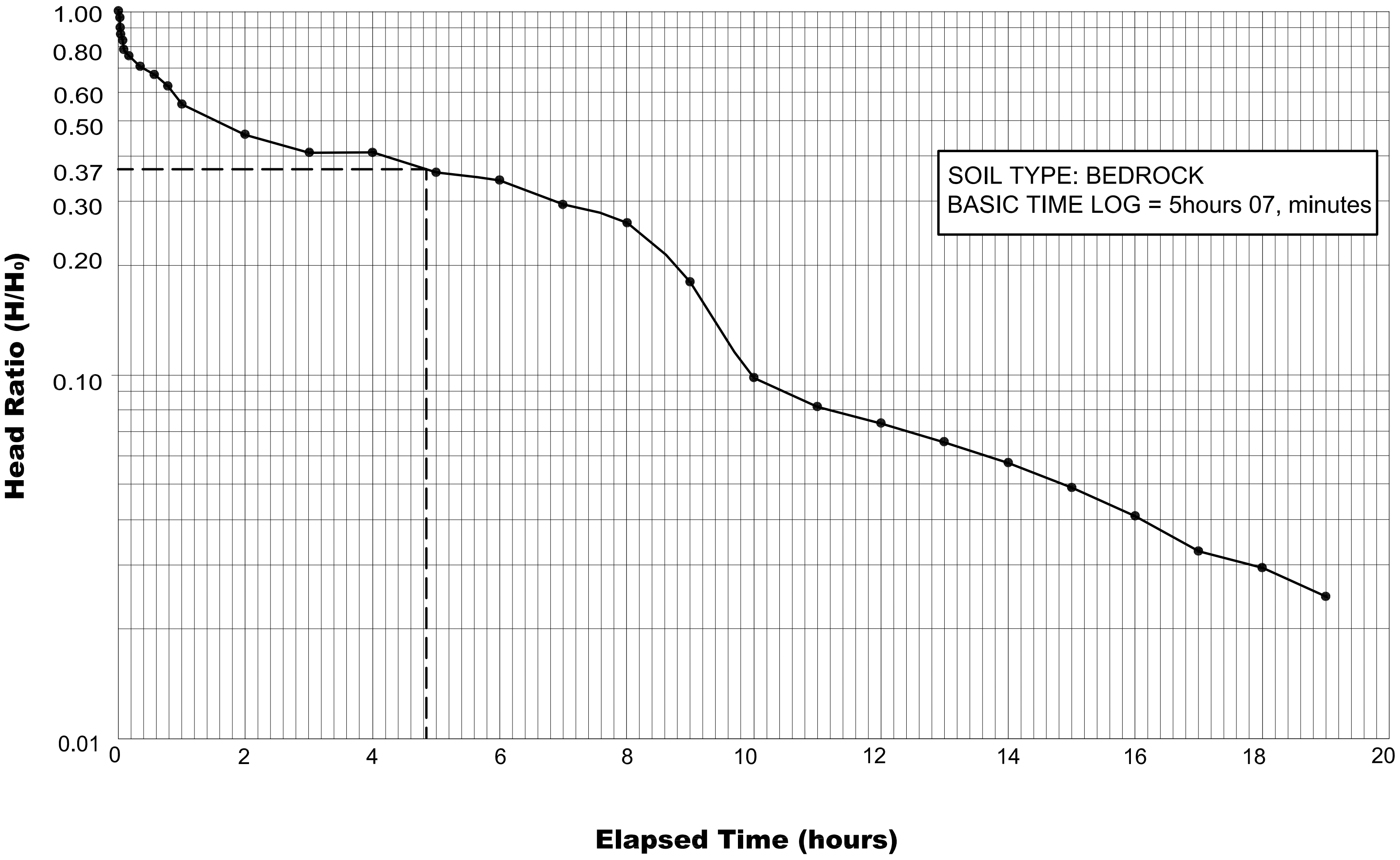

Figure 4C: Plot of Normalized Head Versus Elapsed Time

Monitoring Well C4D

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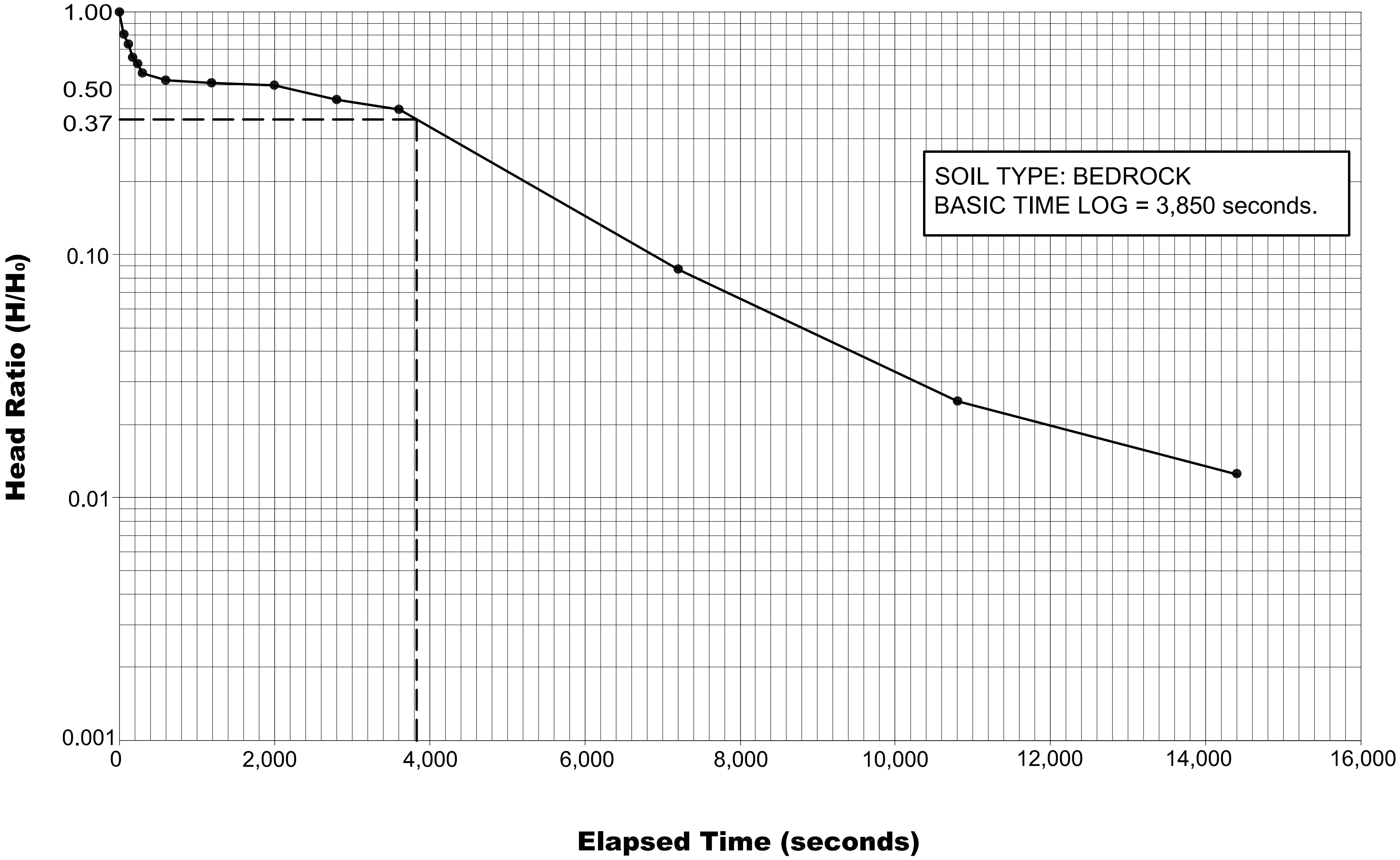

SOIL TYPE: BEDROCK
BASIC TIME LOG = 3,850 seconds.

Figure 5C: Plot of Normalized Head Versus Elapsed Time

Monitoring Well C4M

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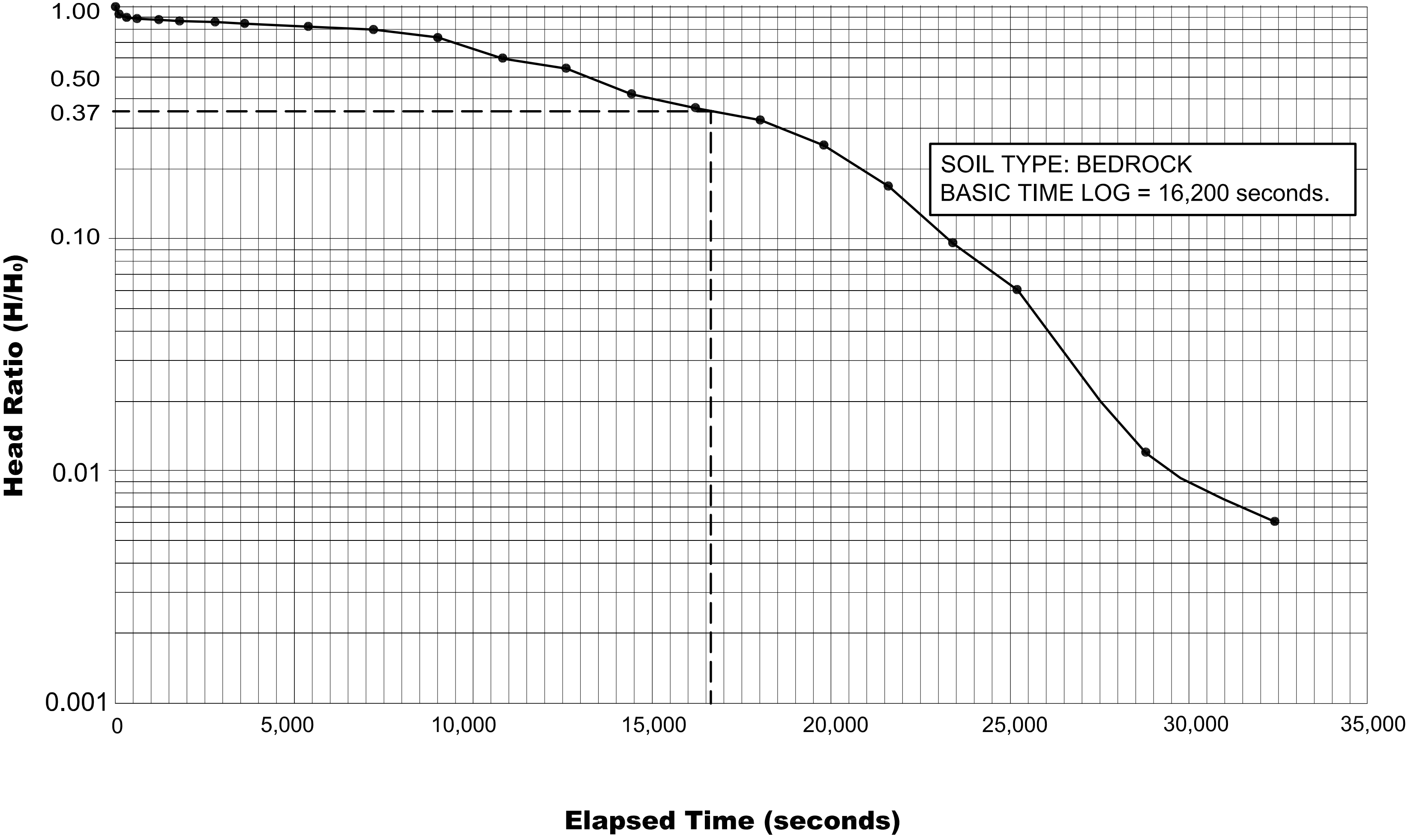

SOIL TYPE: BEDROCK
BASIC TIME LOG = 16,200 seconds.

Figure 6C: Plot of Normalized Head Versus Elapsed Time

Monitoring Well C4S

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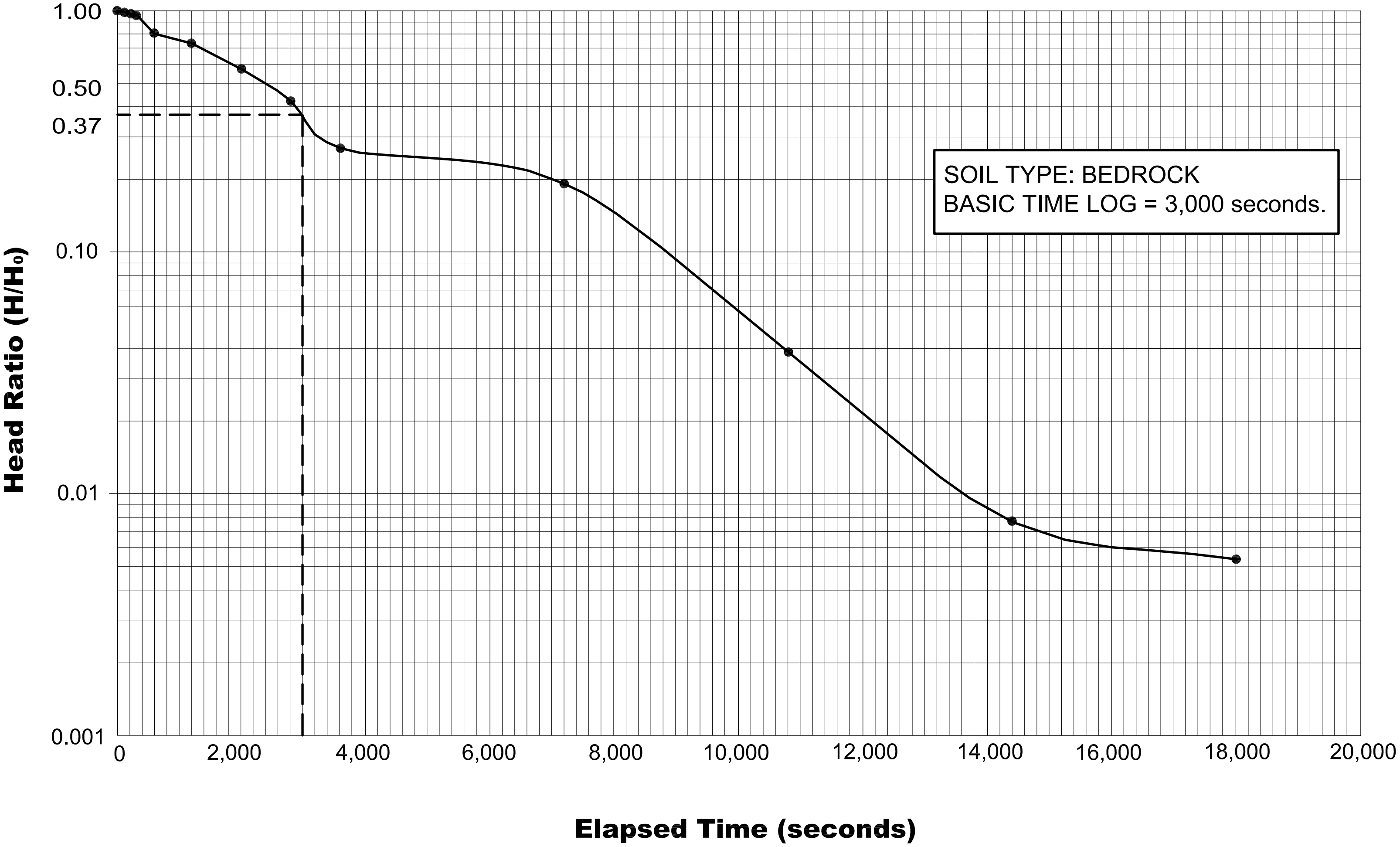

SOIL TYPE: BEDROCK
BASIC TIME LOG = 3,000 seconds.

Figure 7C: Plot of Normalized Head Versus Elapsed Time

Monitoring Well C5

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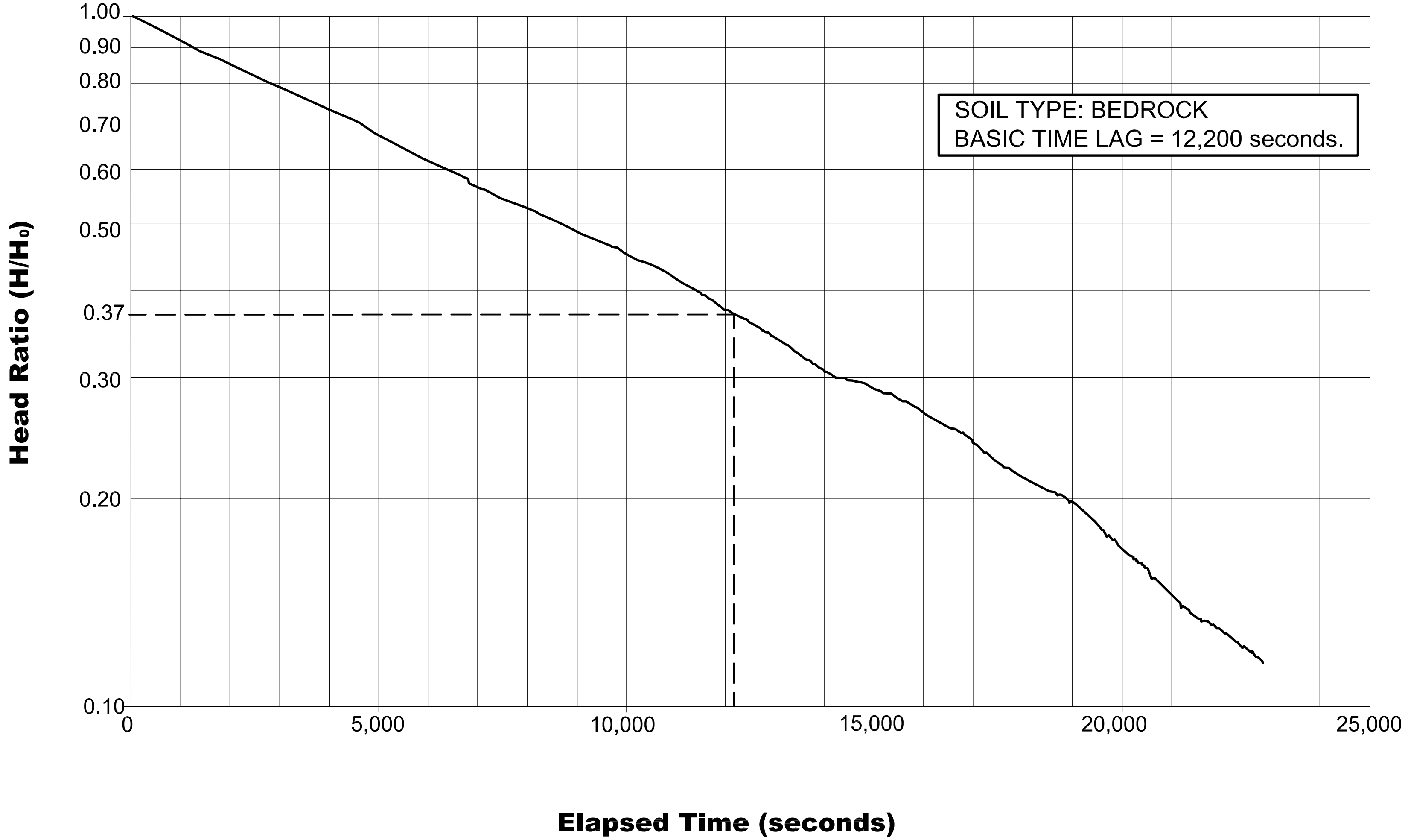

Figure 1N: Plot of Normalized Head Versus Elapsed Time

Monitoring Well N1

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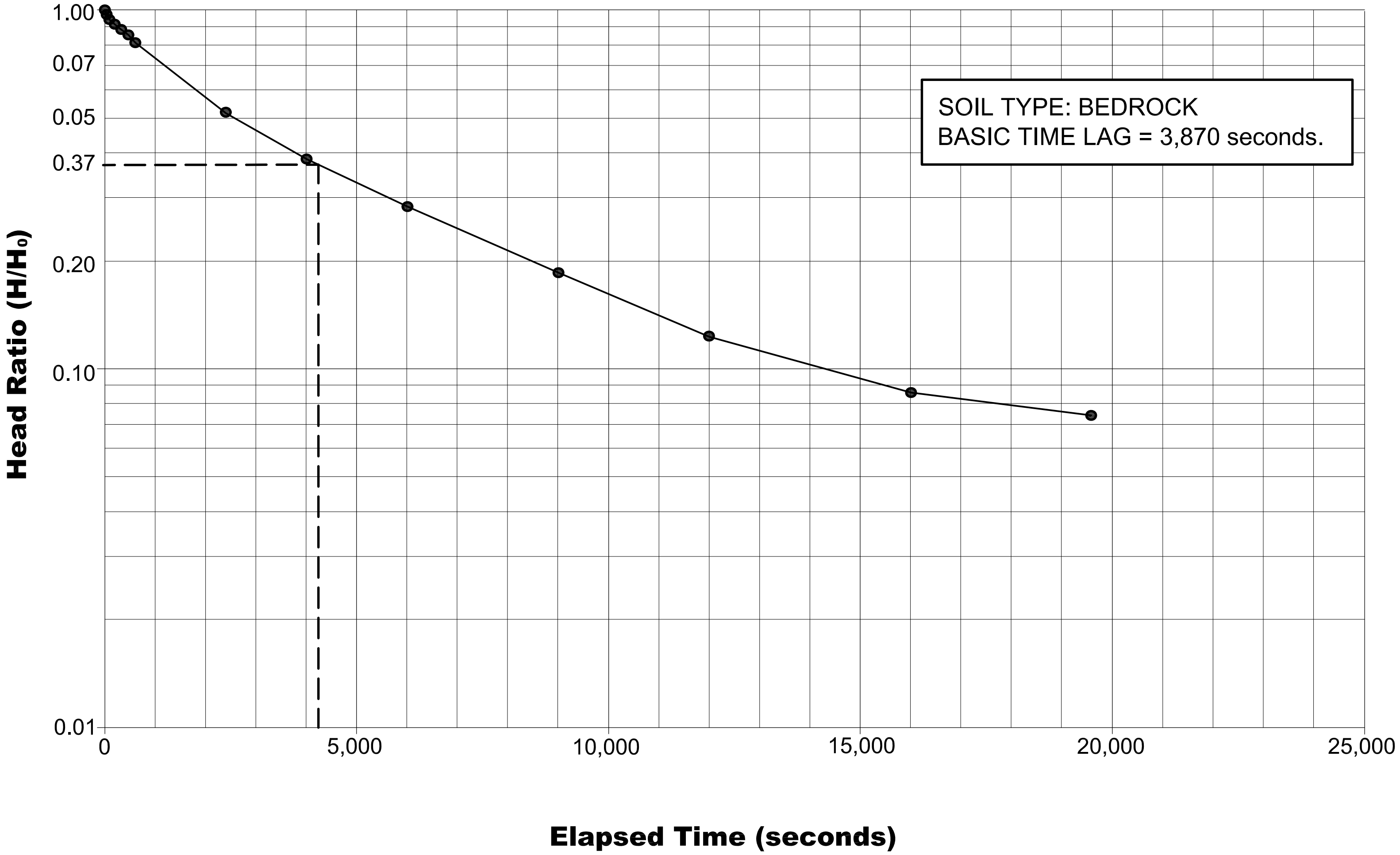

Figure 2N: Plot of Normalized Head Versus Elapsed Time
Monitoring Well N2

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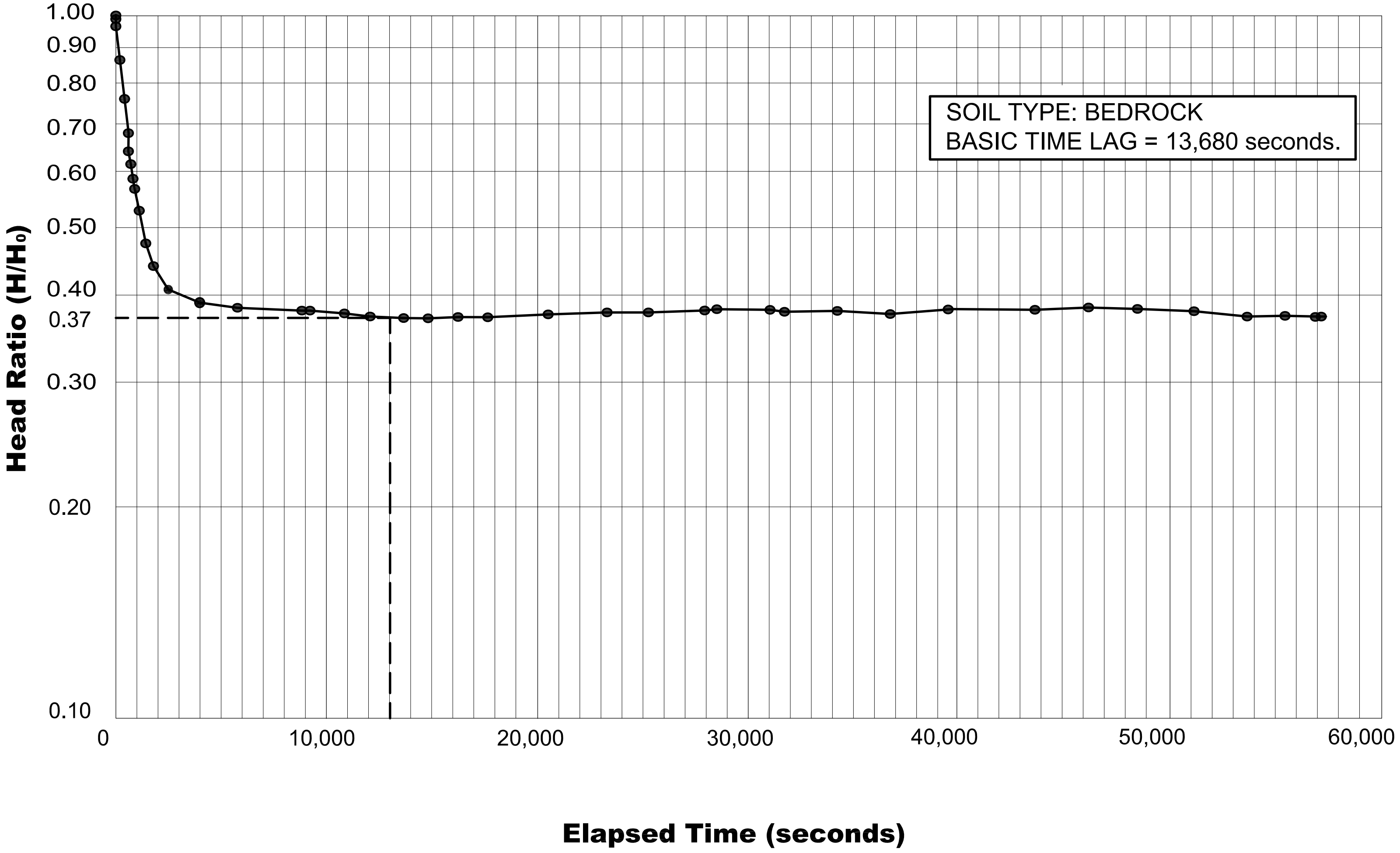

Figure 4N: Plot of Normalized Head Versus Elapsed Time

Monitoring Well N4

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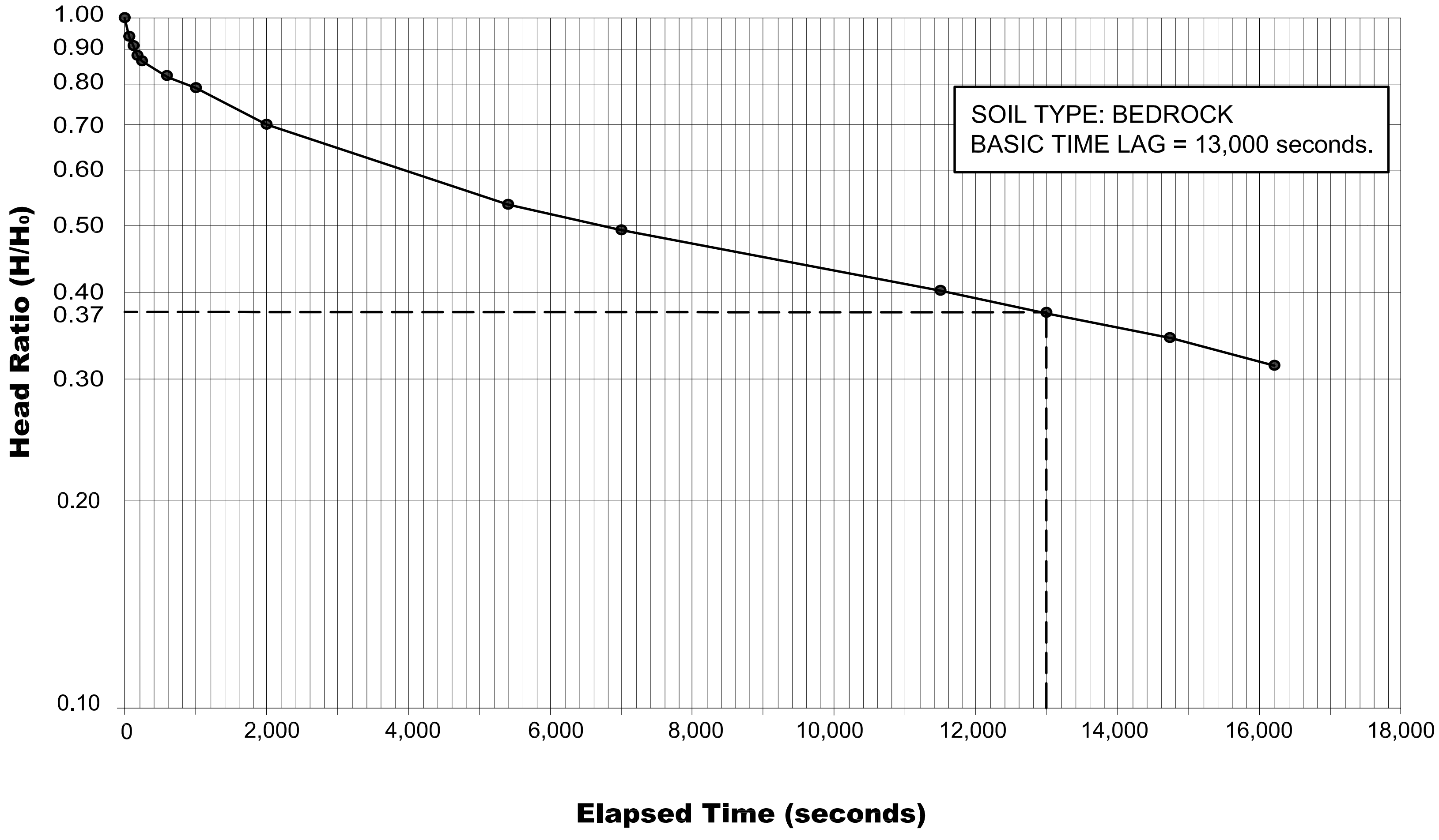

Figure 6N: Plot of Normalized Head Versus Elapsed Time

Monitoring Well N5M

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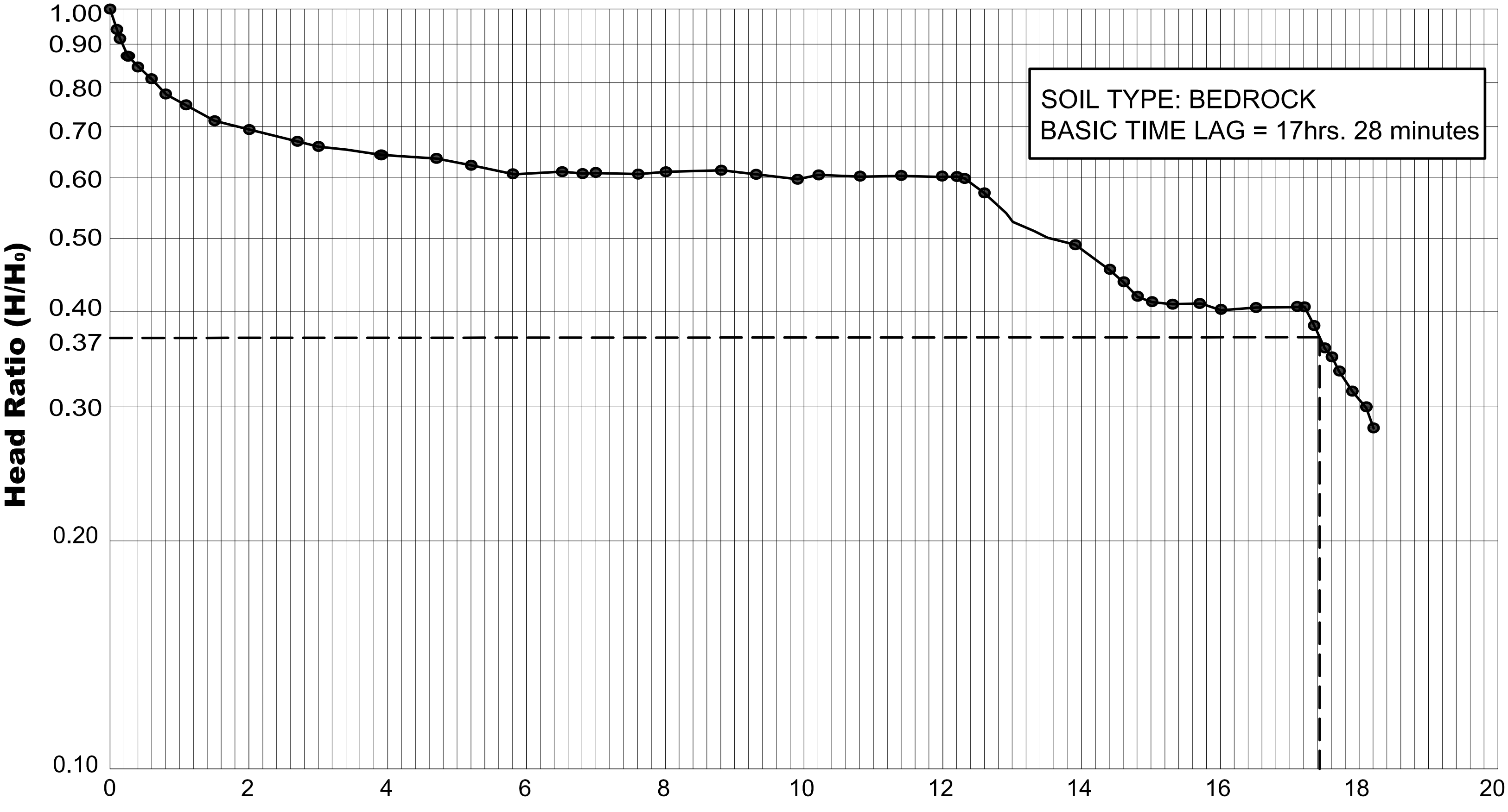

Elapsed Time (hours)

Figure 5N: Plot of Normalized Head Versus Elapsed Time

Monitoring Well N5D

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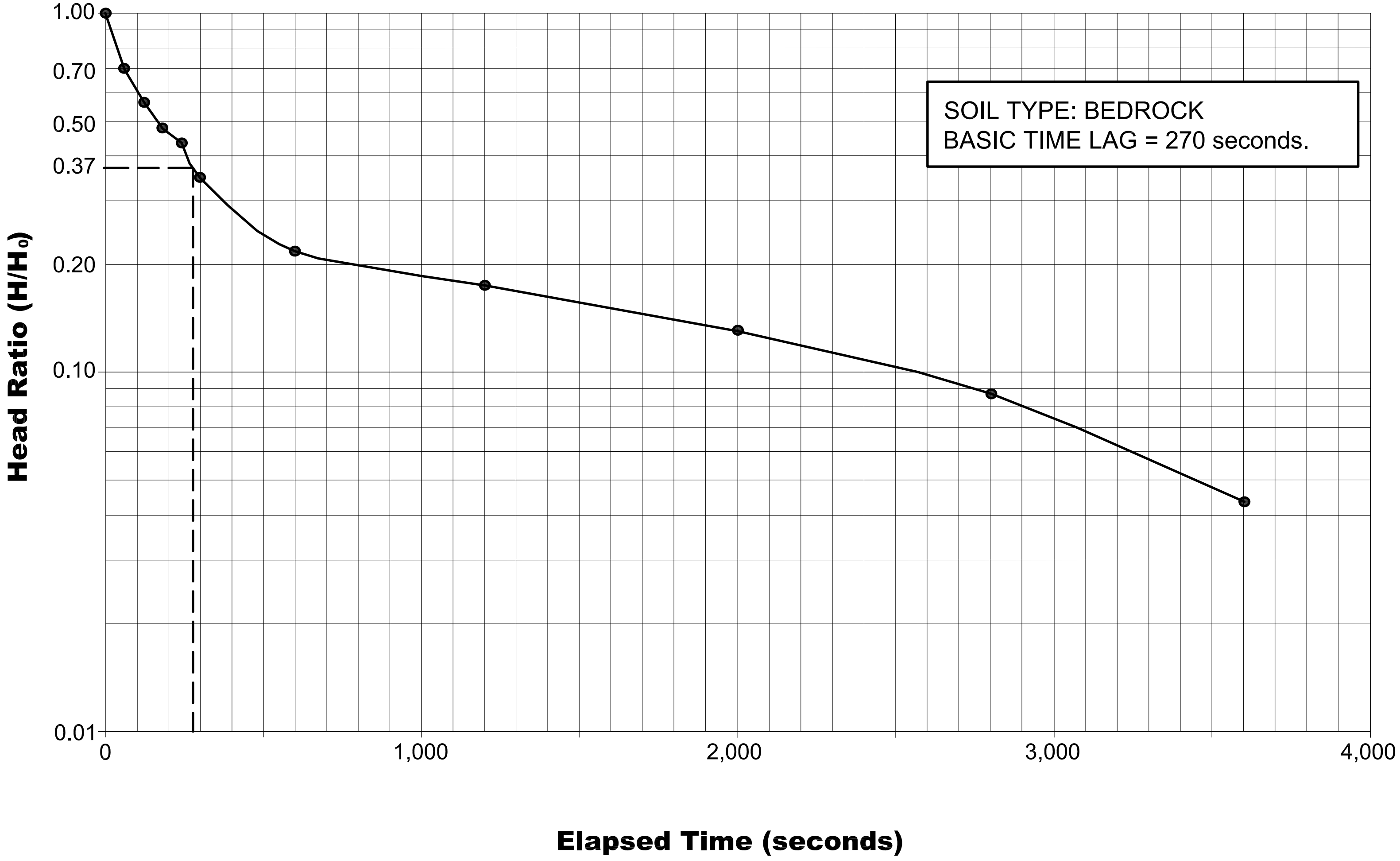

Figure 3N: Plot of Normalized Head Versus Elapsed Time

Monitoring Well N3

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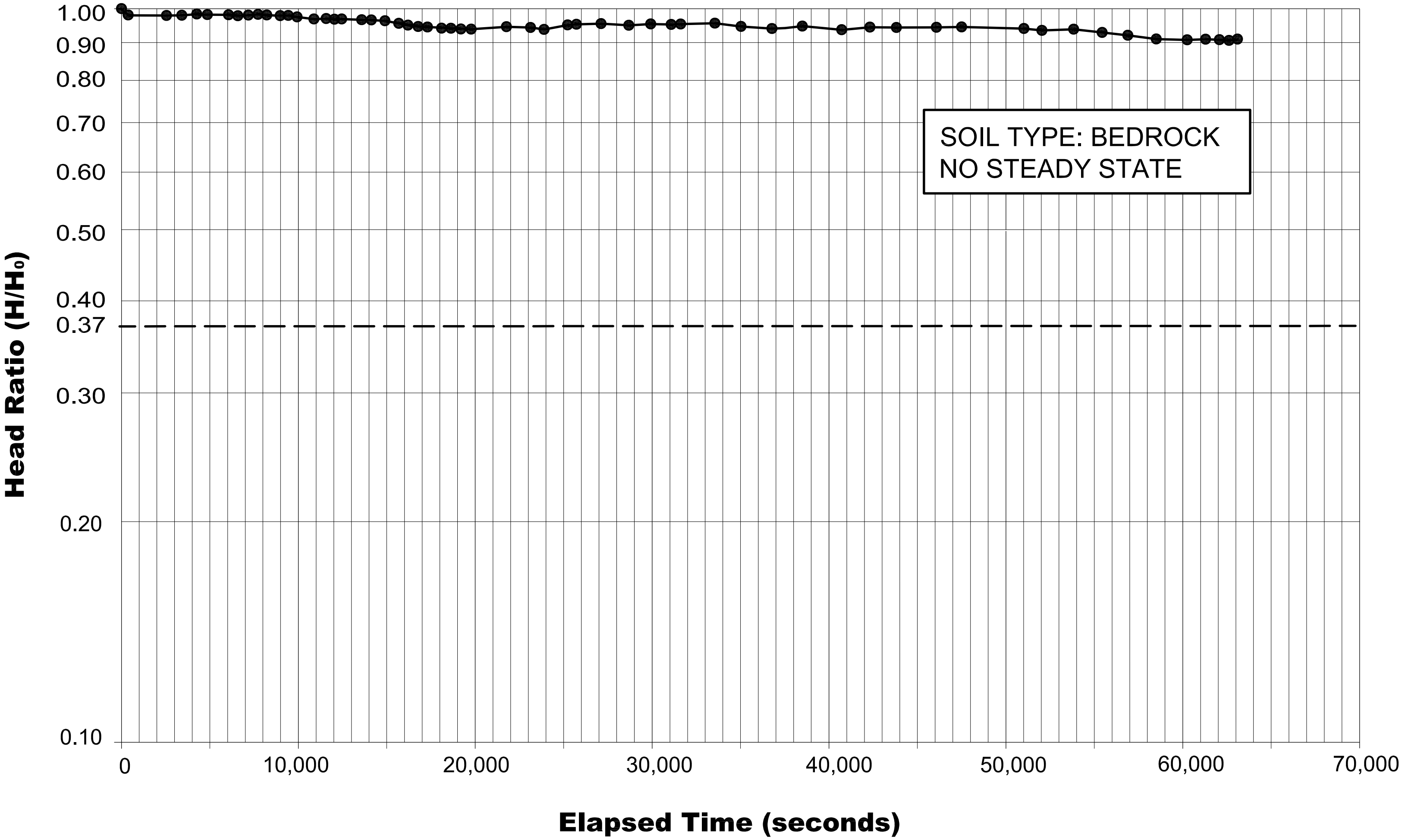

Figure 7N: Plot of Normalized Head Versus Elapsed Time

Monitoring Well N5S

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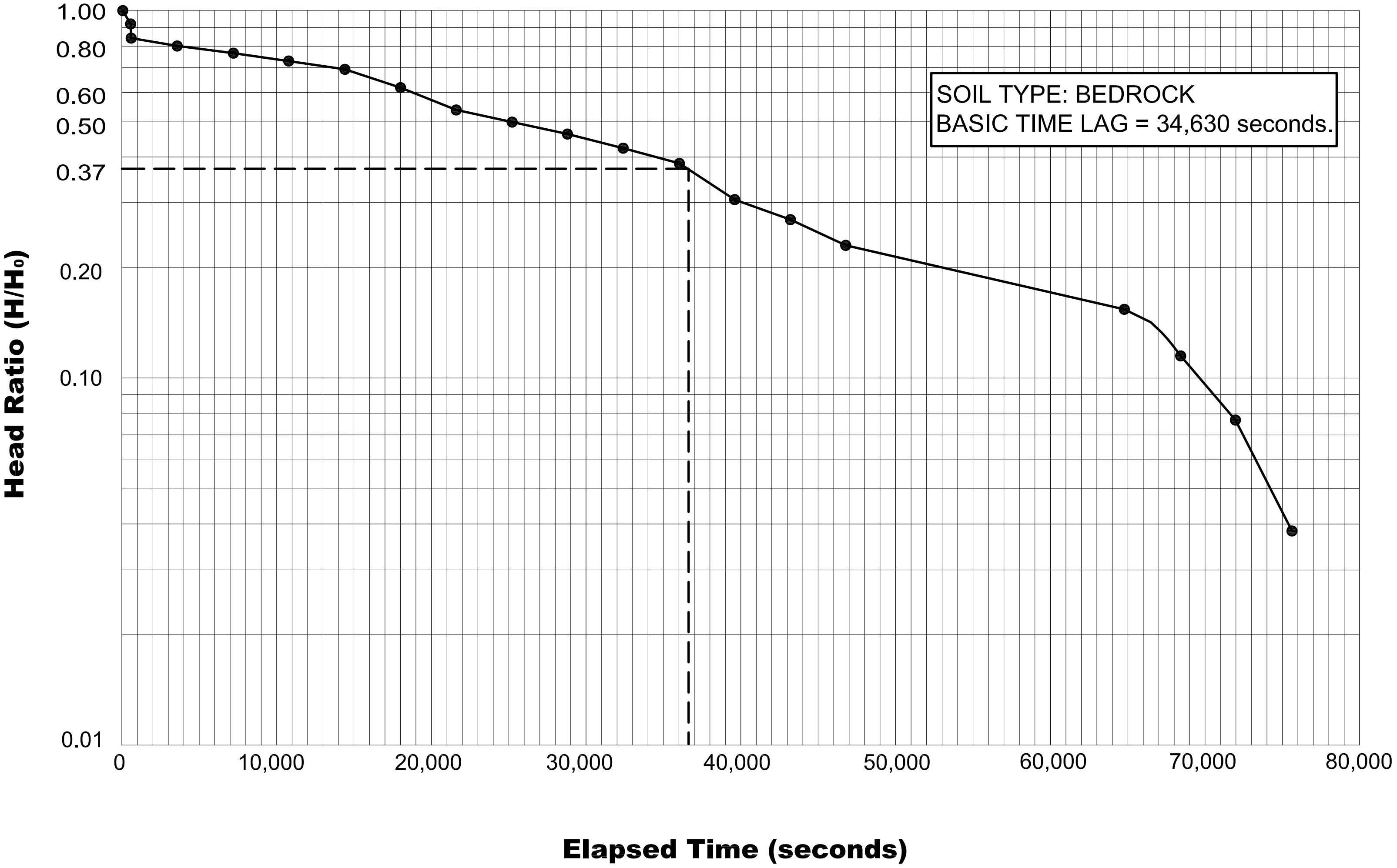

Figure1S: Plot of Normalized Head Versus Elapsed Time

Monitoring Well S1

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HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO
G.W.P. 5094 - 06 - 00

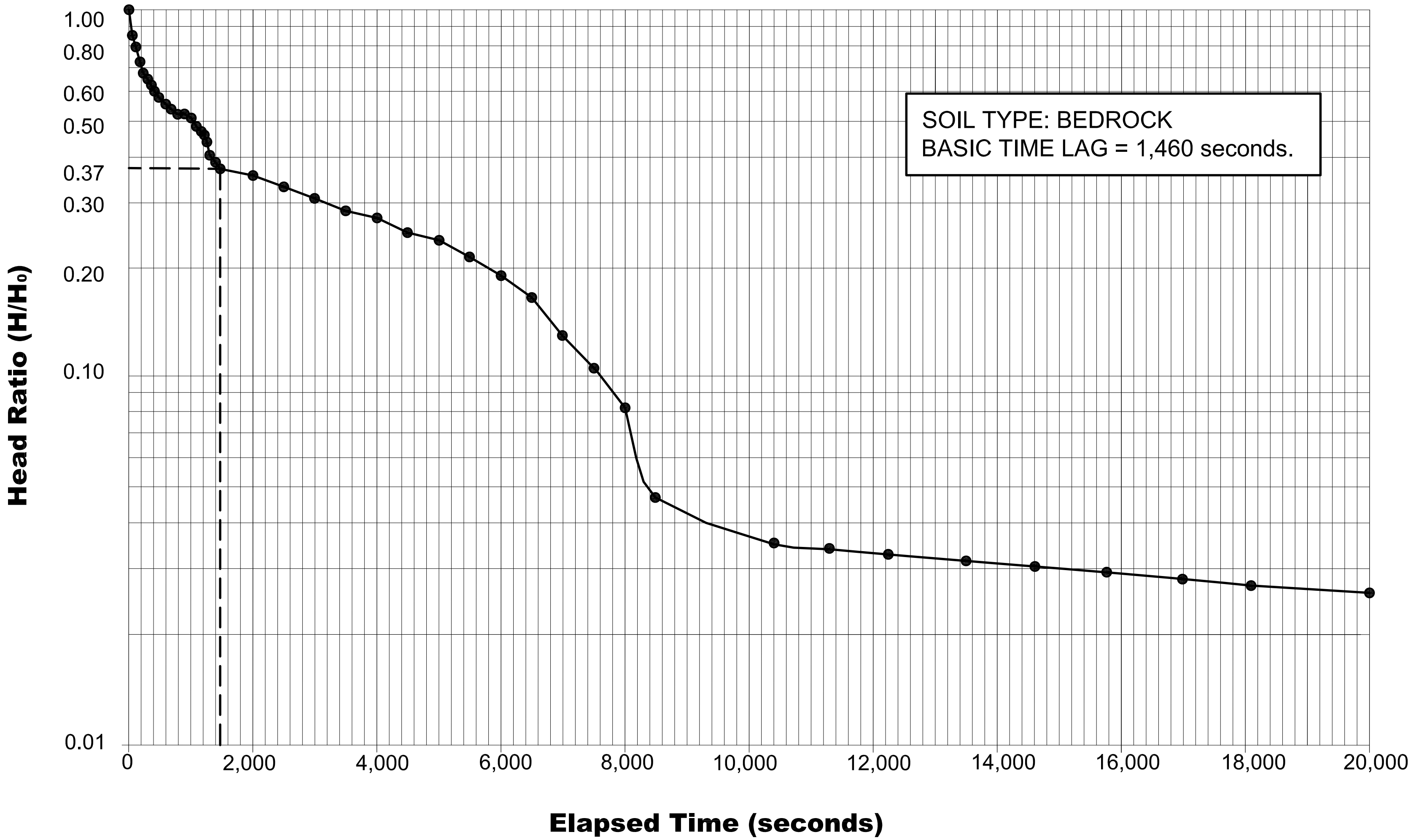
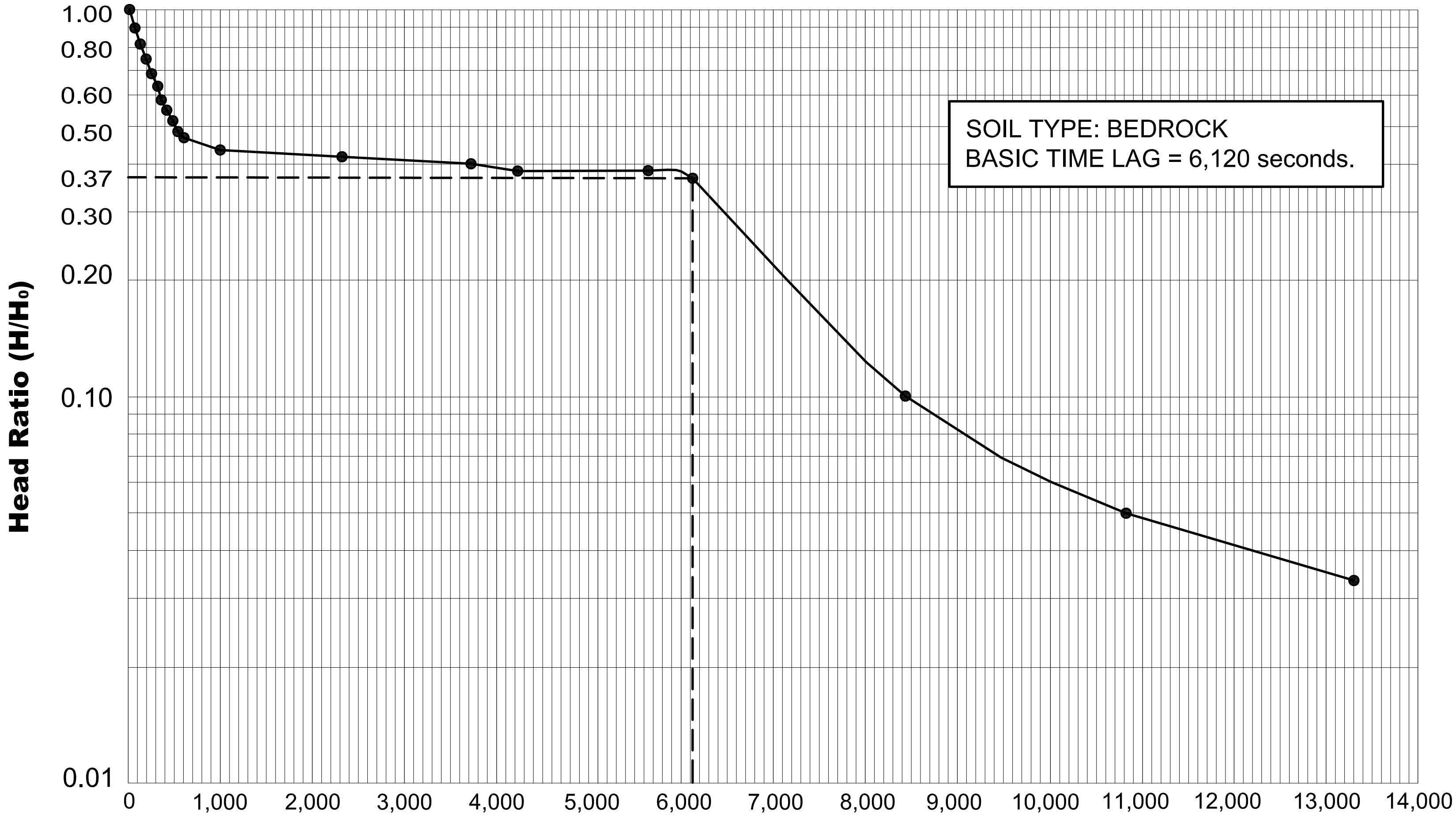


Figure 2S: Plot of Normalized Head Versus Elapsed Time

Monitoring Well S2

Peto MacCallum Ltd.
CONSULTING ENGINEERS

Preliminary Hydrogeological Site Investigation
NEW PATROL YARD SITE
HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO
G.W.P. 5094 - 06 - 00



Elapsed Time (seconds)

Figure 3S: Plot of Normalized Head Versus Elapsed Time

Monitoring Well S3

Preliminary Hydrogeological Site Investigation
NEW PATROL YARD SITE
HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO
G.W.P. 5094 - 06 - 00

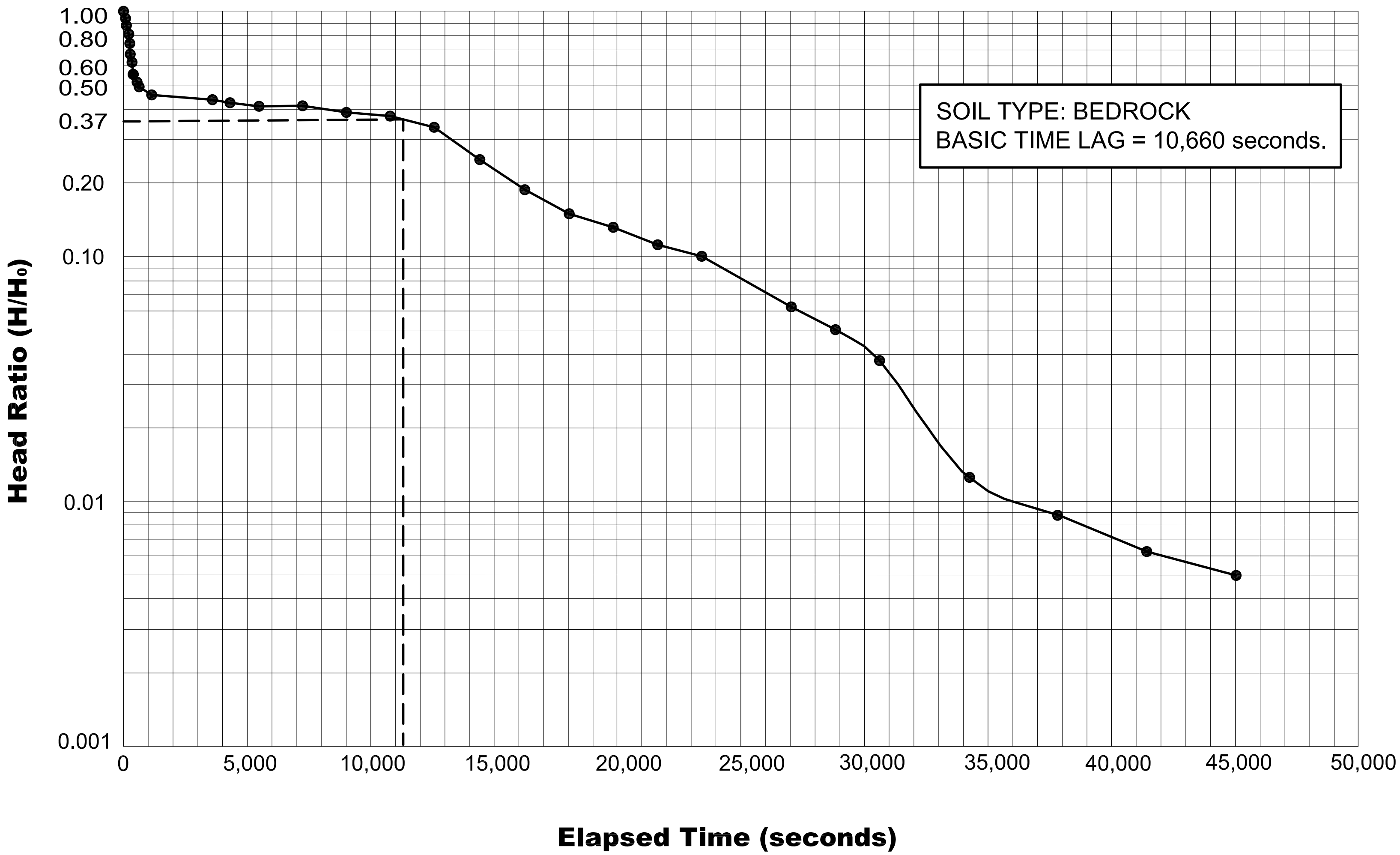


Figure 4S: Plot of Normalized Head Versus Elapsed Time

Monitoring Well S4D

Peto MacCallum Ltd.
CONSULTING ENGINEERS

Preliminary Hydrogeological Site Investigation
NEW PATROL YARD SITE
HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO
G.W.P. 5094 - 06 - 00

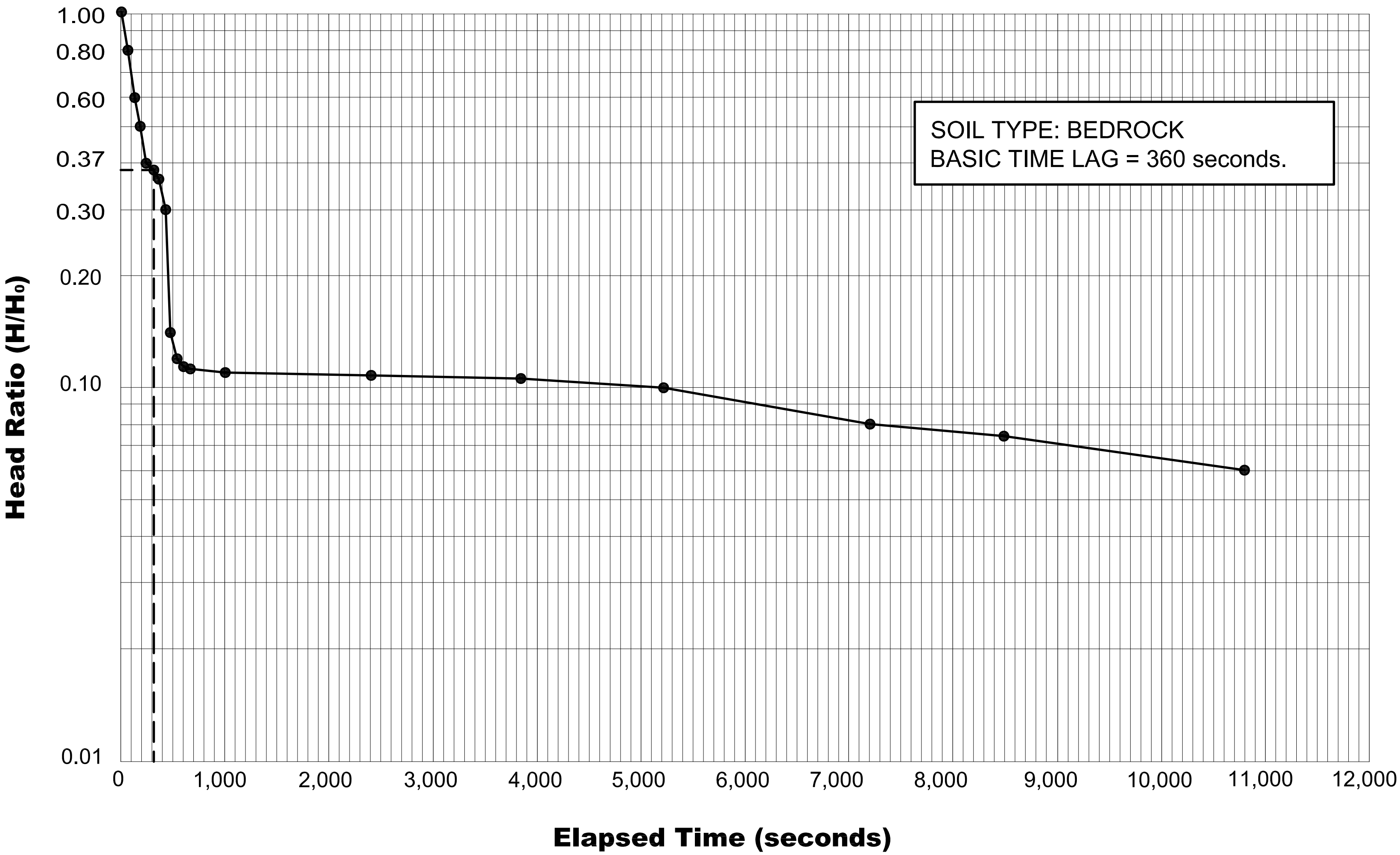


Figure 5S: Plot of Normalized Head Versus Elapsed Time

Monitoring Well S4M

Peto MacCallum Ltd.
CONSULTING ENGINEERS

Preliminary Hydrogeological Site Investigation
NEW PATROL YARD SITE
HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO
G.W.P. 5094 - 06 - 00

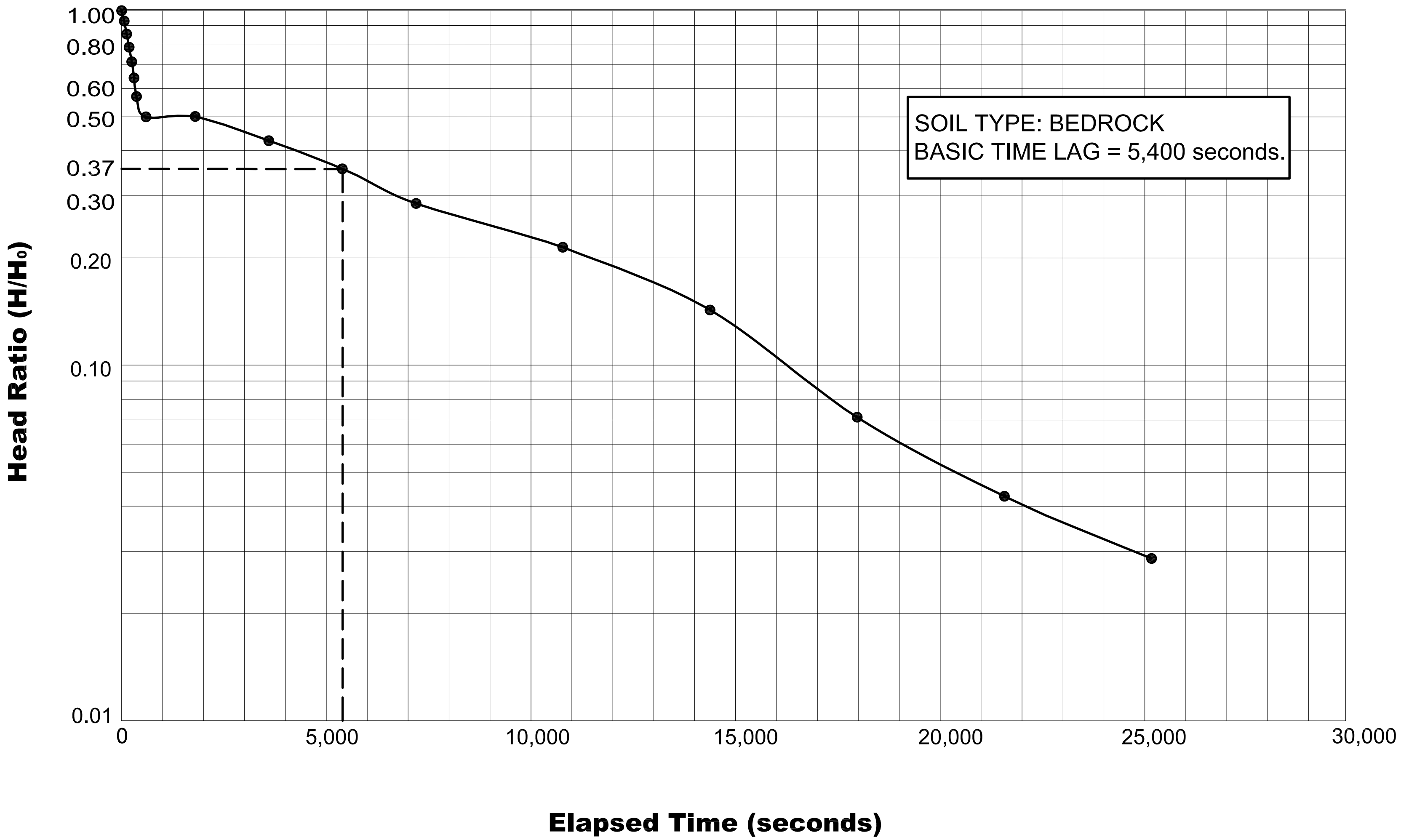


Figure 6S: Plot of Normalized Head Versus Elapsed Time

Monitoring Well S4S

Peto MacCallum Ltd.
CONSULTING ENGINEERS

Preliminary Hydrogeological Site Investigation
NEW PATROL YARD SITE
HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO
G.W.P. 5094 - 06 - 00

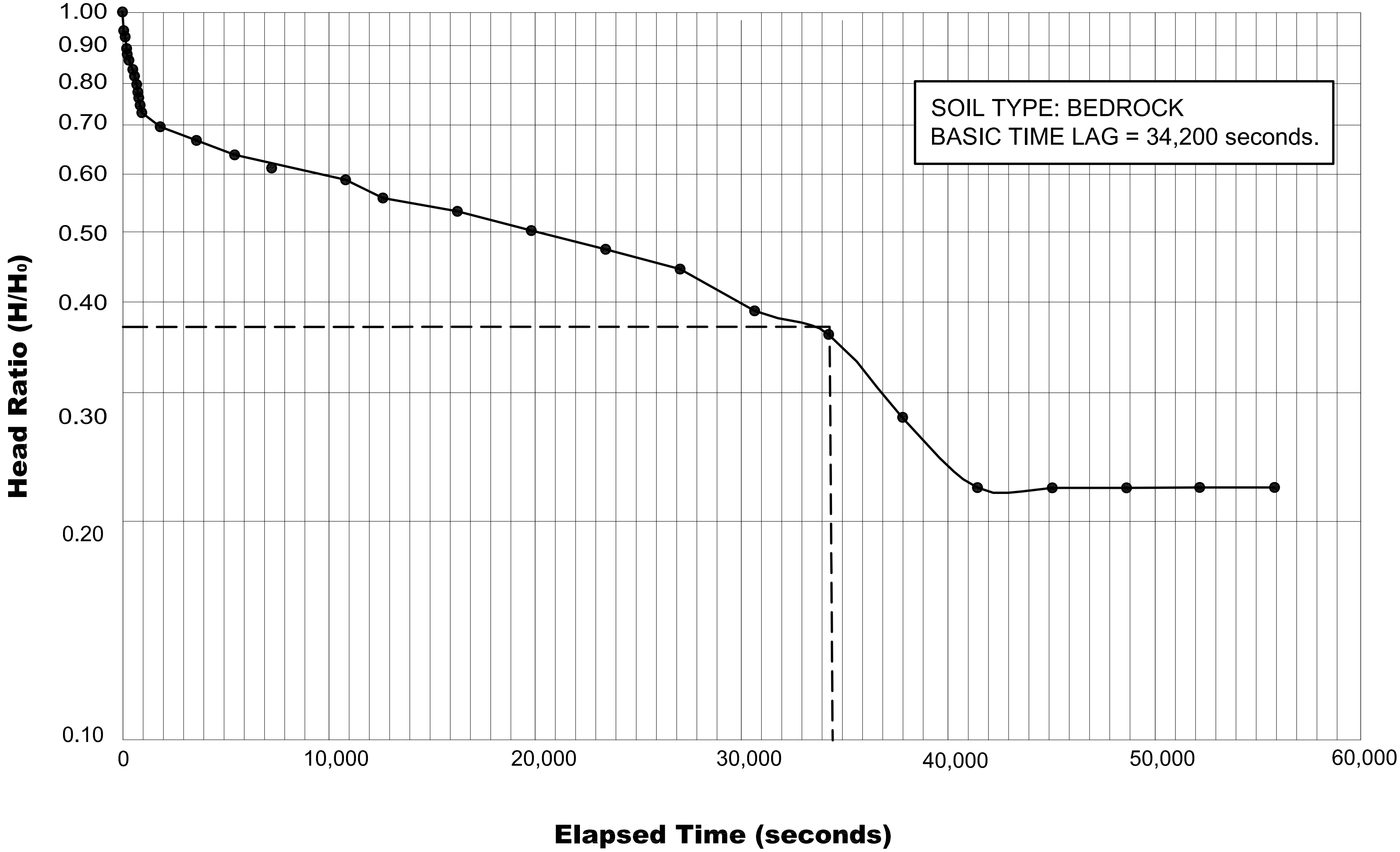


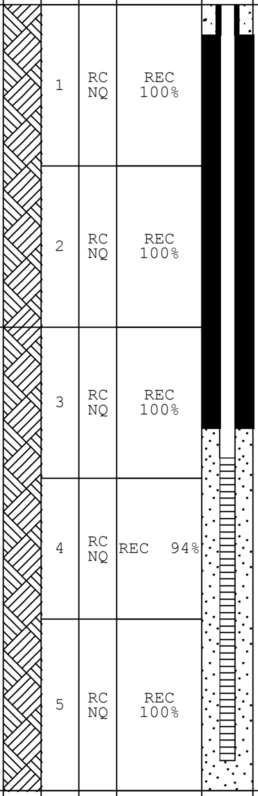
Figure 7S: Plot of Normalized Head Versus Elapsed Time

Monitoring Well S5

RECORD OF BOREHOLE No C1

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 085 834 N; 221 602 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE September 22, 2008 CHECKED BY M.A.



ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
201.7	Ground Surface									
0.0	Granitic Gneiss Bedrock Unweathered High strength Good to excellent quality	1	RC NQ	REC 100%		201				RQD 81%
		2	RC NQ	REC 100%		200 199				RQD 100%
198.5 3.2	Migmatite Bedrock Unweathered High strength Fair to excellent quality	3	RC NQ	REC 100%		198				RQD 73%
		4	RC NQ	REC 94%		197 196				RQD 80%
		5	RC NQ	REC 100%		195 194				RQD 94%
193.9 7.8	End of borehole									

* Borehole charged with drilling water

PIEZOMETER LEGEND:

▥	Concrete
■	Bentonite seal
⁚	Filter sand
☰	Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/01/08	1.7	200.0

$+^7$, $\times^5$: Numbers refer to Sensitivity

20 / 15 – 5 / 10 (%) STRAIN AT FAILURE

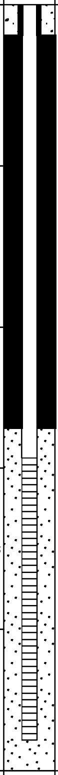
Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No C2

1 of 1 **METRIC**

G.W.P. 5094-06-00	LOCATION Co-ords: 5 085 798 N; 221 649 E		ORIGINATED BY F.P.
DIST 54 HWY 69	BOREHOLE TYPE NQ DIAMOND CORING		COMPILED BY J.W.
DATUM Geodetic	DATE September 23, 2008		CHECKED BY M.A.



ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
201.7	Ground Surface					*					
0.0	Granitic Gneiss Bedrock Unweathered High strength Good to excellent quality		1	RC NQ	REC 100%		201				RQD 84%
			2	RC NQ	REC 100%		200 199				RQD 98%
			3	RC NQ	REC 100%		198				RQD 87%
			4	RC NQ	REC 97%		197 196				RQD 92%
			5	RC NQ	REC 100%		195				RQD 89%
194.1 7.6	End of borehole										

* Borehole charged with drilling water

PIEZOMETER LEGEND:

Concrete

Bentonite seal

Filter sand

Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/01/08	3.6	198.1

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$+^7$, $\times^5$: Numbers refer to Sensitivity

20
15 —○— 5 (%) STRAIN AT FAILURE
10

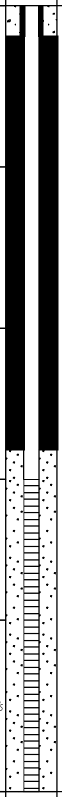
RECORD OF BOREHOLE No C3

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 085 867 N; 221 648 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE September 16 and 17, 2008 CHECKED BY M.A.

ELEV DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLES – NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.5	Ground Surface				
0.0	Granitic Gneiss Bedrock Unweathered High strength Good to excellent quality	1	RC NQ	REC 100%	RQD 88%
		2	RC NQ	REC 100%	RQD 96%
		3	RC NQ	REC 100%	RQD 97%
		4	RC NQ	REC 100%	RQD 100%
		5	RC NQ	REC 97%	RQD 95%
190.7 7.8	End of borehole				

Column headings: STRAT PLOT; GROUND WATER CONDITIONS *; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100; PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³



* Borehole charged with drilling water

PIEZOMETER LEGEND:

- ▥ Concrete
- ■ Bentonite seal
- ▒ Filter sand
- ☷ Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/01/08	3.1	195.4

$+^7$, $\times^5$: Numbers refer to Sensitivity

20
15 —○— 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No C4D

1 of 1 **METRIC**

G.W.P. 5094-06-00	LOCATION	Co-ords: 5 085 961 N; 221 617 E	ORIGINATED BY F.P.
DIST 54 HWY 69	BOREHOLE TYPE	NQ DIAMOND CORING	COMPILED BY J.W.
DATUM Geodetic	DATE	September 23, 2008	CHECKED BY M.A.

SOIL PROFILE · SAMPLES · GROUND WATER CONDITIONS · ELEVATION SCALE · DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 · SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100 · PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60 · UNIT WEIGHT γ kN/m³ · REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%)
194.2	Ground Surface				*		
0.0	Topsoil					194	
0.1	Silty sand, trace gravel cobbles and boulders						
193.5 0.7	Migmatite Bedrock Unweathered High strength Excellent becoming poor to good quality	1	RC NQ	REC 100%		193	RQD 91%
		2	RC NQ	REC 100%		192 191	RQD 100%
		3	RC NQ	REC 100%		190	RQD 95%
		4	RC NQ	REC 100%		189 188	RQD 100%
		5	RC NQ	REC 100%		187	RQD 34%
		6	RC NQ	REC 100%		186	RQD 89%
185.0 9.2	End of borehole					185	

* Borehole charged with drilling water

PIEZOMETER LEGEND:

▯	Concrete
■	Bentonite seal
⁚	Filter sand
☰	Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/01/08	4.2	190.0

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$+^7$, $\times^5$: Numbers refer to Sensitivity

20, 15, 5, 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C4M

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 085 964 N; 221 618 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE September 24, 2008 CHECKED BY M.A.

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%)
194.2	Ground Surface					
0.0	Topsoil				194	
0.1	Silty sand, trace gravel cobbles and boulders					
193.5 0.7	Migmatite Bedrock Unweathered High strength Fair becoming excellent quality	1	RC NQ	REC 84%	193	RQD 61%
		2	RC NQ	REC 100%	192 191	RQD 97%
		3	RC NQ	REC 100%	190	RQD 100%
		4	RC NQ	REC 100%	189 188	RQD 100%
		5	RC NQ	REC 94%	187	RQD 94%
186.4 7.8	End of borehole					

DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 20 40 60 80 100
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%): 20 40 60
UNIT WEIGHT γ kN/m³
GR SA SI CL

GROUND WATER CONDITIONS *

* Borehole charged with drilling water

PIEZOMETER LEGEND:

- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/01/08	1.1	193.1

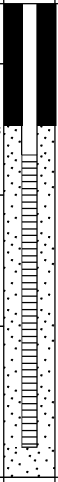
$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 ○ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C4S

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 085 960 N; 221 620 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE September 24, 2008 CHECKED BY M.A.

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	* GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.1	Ground Surface										
0.0	Topsoil						194				
0.1	Silty sand, trace gravel cobbles and boulders										
193.5 0.6	Migmatite Bedrock Unweathered High strength Good to excellent quality		1	RC NQ	REC 94%		193				RQD 61%
			2	RC NQ	REC 100%		192 191				RQD 64%
			3	RC NQ	REC 100%		190				RQD 79%
189.4 4.7	End of borehole										

* Borehole charged with drilling water

PIEZOMETER LEGEND:

▥	Concrete
■	Bentonite seal
⁙	Filter sand
☰	Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/01/08	0.9	193.2

$+^7$, $\times^5$: Numbers refer to Sensitivity

20 / 15 —○— 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C5

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 085 923 N; 221 571 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE September 16, 2008 CHECKED BY M.A.

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.3	Ground Surface										
0.0	Granitic Gneiss Bedrock Unweathered High strength Fair to excellent quality		1	RC NQ	REC 100%		198 197				RQD 100%
			2	RC NQ	REC 100%		196				RQD 73%
			3	RC NQ	REC 98%		195 194				RQD 93%
			4	RC NQ	REC 100%		193				RQD 100%
			5	RC NQ	REC 100%		192 191				RQD 96%
190.7 7.6	End of borehole										

* Borehole charged with drilling water

PIEZOMETER LEGEND:

- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/01/08	1.7	196.6

$+^7$, $\times^5$: Numbers refer to Sensitivity

20 / 15 —○— 5 / 10 (%) STRAIN AT FAILURE

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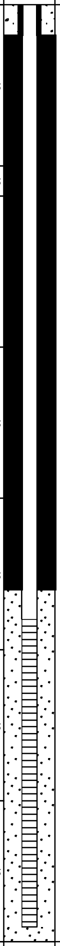
RECORD OF BOREHOLE No N1

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 024 N; 322 025 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE August 20, 2008 CHECKED BY M.A.

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE				
241.2	Ground Surface					*					
0.0	Granodiorite Gneiss Bedrock Unweathered High strength Fair to excellent quality		1	RC NQ	REC 100%		241 240				RQD 90%
			2	RC NQ	REC 100%						RQD 100%
			3	RC NQ	REC 97%		239 238				RQD 69%
			4	RC NQ	REC 100%		237				RQD 100%
			5	RC NQ	REC 100%		236				RQD 100%
			6	RC NQ	REC 100%		235 234				RQD 100%
			7	RC NQ	REC 100%		233				RQD 100%
231.9 9.3	End of borehole						232				



* Borehole charged with drilling water

PIEZOMETER LEGEND:

▥ Concrete
■ Bentonite seal
▨ Filter sand
▤ Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	5.2	236.0

$+^7$, $\times^5$: Numbers refer to Sensitivity 20 / 15 ○ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No N2

1 of 1 **METRIC**

G.W.P. 5094-06-00	LOCATION Co-ords: 5 121 069 N; 321 899 E		ORIGINATED BY F.P.
DIST 54 HWY 69	BOREHOLE TYPE NQ DIAMOND CORING		COMPILED BY J.W.
DATUM Geodetic	DATE August 21, 2008		CHECKED BY M.A.

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.7	Ground Surface					
0.0	Topsoil					
0.1	Granodiorite Gneiss Bedrock Slightly weathered High strength Fair to excellent quality	1	RC NQ	REC 100%	240	RQD 86%
		2	RC NQ	REC 100%	239 238	RQD 65%
		3	RC NQ	REC 100%	237	RQD 80%
		4	RC NQ	REC 100%	236 235	RQD 89%
		5	RC NQ	REC 100%	234	RQD 100%
232.9		6	RC NQ	REC 100%	233	RQD 100%
7.8	End of borehole					

GROUND WATER CONDITIONS *

DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 20 40 60 80 100

PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

* Borehole charged with drilling water

PIEZOMETER LEGEND:

- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	2.4	238.3

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+⁷, ×⁵ : Numbers refer to Sensitivity

20, 15, 5, 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No N3

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 180 N; 321 902 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE August 21, 2008 CHECKED BY M.A.

SOIL PROFILE		SAMPLES			ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES		GR SA SI CL
239.6	Ground Surface					
0.0	Granodiorite Gneiss Bedrock Unweathered High strength Excellent quality	2	RC NQ	REC 96%	239	RQD 96%
		2	RC NQ	REC 100%	238	RQD 100%
		3	RC NQ	REC 100%	237	RQD 100%
		4	RC NQ	REC 100%	236 235	RQD 100%
		5	RC NQ	REC 100%	234	RQD 100%
		6	RC NQ	REC 100%	233 232	RQD 100%
231.7 7.9	End of borehole					

GROUND WATER CONDITIONS *

DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%): 20 40 60
UNIT WEIGHT γ kN/m³

* Borehole charged with drilling water

PIEZOMETER LEGEND:
▯ Concrete
■ Bentonite seal
▨ Filter sand
▤ Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	1.4	238.2

$+^7$, $\times^5$: Numbers refer to Sensitivity

20, 15, 5, 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No N4

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 104 N; 322 098 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE August 19 and 20, 2008 CHECKED BY M.A.

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE				
240.4	Ground Surface					*					
0.0	Granodiorite Gneiss Bedrock Slightly weathered High strength Fair to excellent quality	▨	1	RC NQ	REC 100%		240 239				RQD 70%
		▨	2	RC NQ	REC 95%						RQD 85%
		▨	3	RC NQ	REC 100%		238 237				RQD 100%
		▨	4	RC NQ	REC 98%		236				RQD 91%
233.7		▨	5	RC NQ	REC 98%		235 234				RQD 97%
6.7	End of borehole										

* Borehole charged with drilling water

PIEZOMETER LEGEND:

▦ Concrete
■ Bentonite seal
⁙ Filter sand
☰ Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	6.5	233.9

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20
15 —○— 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No N5D

1 of 1

METRIC

G.W.P. 5094-06-00	LOCATION Co-ords: 5 121 077 N; 322 006 E		ORIGINATED BY F.P.
DIST 54 HWY 69	BOREHOLE TYPE NQ DIAMOND CORING		COMPILED BY J.W.
DATUM Geodetic	DATE August 18 and 19, 2008		CHECKED BY M.A.

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%)
241.8	Ground Surface					
0.0	Topsoil					
0.1	Granodiorite Gneiss Bedrock Slightly weathered to unweathered High strength Good to excellent becoming fair quality	1	RC NQ	REC 98%	241	RQD 84%
		2	RC NQ	REC 100%	240 239	RQD 100%
		3	RC NQ	REC 100%	238	RQD 50%
		4	RC NQ	REC 100%	237	RQD 100%
	Gabro Bedrock Moderately to highly weathered Medium to high strength Fair quality	5	RC NQ	REC 100%	236 235	RQD 100%
	Granodiorite Gneiss Bedrock Slightly weathered to unweathered High strength Excellent quality	6	RC NQ	REC 97%	234 233	RQD 97%
232.6 9.2	End of borehole					

STRAT PLOT | GROUND WATER CONDITIONS *

DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE — 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

GR SA SI CL

* Borehole charged with drilling water

PIEZOMETER LEGEND:

- ▯ Concrete
- ■ Bentonite seal
- ▨ Filter sand
- ☰ Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	3.7	238.1

$+^7$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ⌀ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No N5M

1 of 1 **METRIC**

G.W.P. 5094-06-00
LOCATION Co-ords: 5 121 081 N; 322 001 E
ORIGINATED BY F.P.
DIST 54 HWY 69
BOREHOLE TYPE NQ DIAMOND CORING
COMPILED BY J.W.
DATUM Geodetic
DATE August 15, 2008
CHECKED BY M.A.

ELEV DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.8	Ground Surface					
0.0 0.1	Topsoil					
	Silty sand, trace gravel cobble and boulders					
241.0 0.8	Granodiorite Gneiss Bedrock Slightly weathered to unweathered High strength Fair to excellent quality				241	
		1	RC NQ	REC 98%	240	RQD 69%
		2	RC NQ	REC 95%	239	RQD 82%
		3	RC NQ	REC 100%	238	RQD 100%
		4	RC NQ	REC 100%	237 236	RQD 100%
		5	RC NQ	REC 98%	235	RQD 98%
234.1 7.7	End of borehole					

Column headings with nothing entered below them: STRAT PLOT; GROUND WATER CONDITIONS (marked *); DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L, WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³

* Borehole charged with drilling water

PIEZOMETER LEGEND:

▯■▯ Concrete
■▯■ Bentonite seal
⁚▯⁚ Filter sand
⁚☰⁚ Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	1.7	240.1

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20
15 —○— 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No N5S

1 of 1 **METRIC**

G.W.P.	5094-06-00	LOCATION	Co-ords: 5 121 087 N; 322 005 E	ORIGINATED BY	F.P.
DIST	54 HWY 69	BOREHOLE TYPE	NQ DIAMOND CORING	COMPILED BY	J.W.
DATUM	Geodetic	DATE	August 19, 2008	CHECKED BY	M.A.

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%)
241.8	Ground Surface				*		
0.0	Topsoil				▯		
0.2	Granodiorite Gneiss Bedrock Slightly weathered High strength Excellent becoming fair quality	1	RC NQ	REC 100%	■	241	RQD 100%
		2	RC NQ	REC 100%	▤	240 239	RQD 100%
		3	RC NQ	REC 98%	■	238	RQD 73%
237.1 4.7	End of borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60
UNIT WEIGHT γ kN/m³
GR SA SI CL

* Borehole charged with drilling water

PIEZOMETER LEGEND:

▯ Concrete
■ Bentonite seal
▒ Filter sand
▤ Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	1.5	240.3

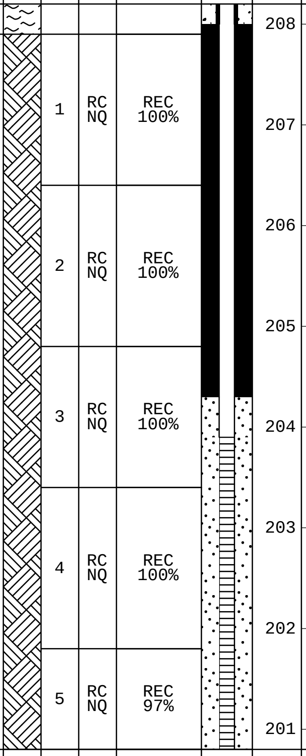
$+^7$, $\times^5$: Numbers refer to Sensitivity 20 15 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No S1

1 of 1 **METRIC**

G.W.P. 5094-06-00	LOCATION Co-ords: 5 048 033 N; 239 558 E	ORIGINATED BY F.P.
DIST 54 HWY 69	BOREHOLE TYPE NQ DIAMOND CORING	COMPILED BY J.W.
DATUM Geodetic	DATE September 26, 2008	CHECKED BY M.A.

ELEV DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
208.2	Ground Surface				
0.0	Topsoil				
207.9 0.3	Migmatite Bedrock Slightly weathered to unweathered Medium to high strength Good to excellent quality	1	RC NQ	REC 100%	RQD 77%
		2	RC NQ	REC 100%	RQD 94%
		3	RC NQ	REC 100%	RQD 100%
		4	RC NQ	REC 100%	RQD 96%
		5	RC NQ	REC 97%	RQD 92%
200.8 7.4	End of borehole				



DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³

* Borehole charged with drilling water

PIEZOMETER LEGEND:

▯▮▯	Concrete cap
■□■	Bentonite seal
⁚□⁚	Filter sand
⁚☰⁚	Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/03/08	1.0	207.2

$+^7$, $\times^5$: Numbers refer to Sensitivity

20
15—○—5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No S2

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 048 090 N; 239 443 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE September 24, 2008 CHECKED BY M.A.

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%)
206.9	Ground Surface					
0.0	Migmatite Bedrock Unweathered High strength Excellent quality	1	RC NQ	REC 100%	206	RQD 97%
		2	RC NQ	REC 100%	205 204	RQD 97%
		3	RC NQ	REC 100%	203	RQD 100%
		4	RC NQ	REC 100%	202	RQD 100%
		5	RC NQ	REC 100%	201	RQD 100%
		6	RC NQ	REC 100%		RQD 100%
199.9		7	RC NQ	REC 100%	200	RQD 100%
7.0	End of borehole					

Other column headings: STRAT PLOT; * GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED ✚ FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100; PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³; GR SA SI CL

* Borehole charged with drilling water

PIEZOMETER LEGEND:
▨ Concrete cap
■ Bentonite seal
░ Filter sand
☰ Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/03/08	3.8	203.1

+7, ×5 : Numbers refer to Sensitivity

20
15—○—5 (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

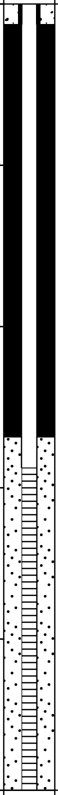
Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No S3

1 of 1

METRIC

G.W.P.	5094-06-00	LOCATION	Co-ords: 5 048 015 N; 239 480 E	ORIGINATED BY	F.P.
DIST 54	HWY 69	BOREHOLE TYPE	NQ DIAMOND CORING	COMPILED BY	J.W.
DATUM	Geodetic	DATE	September 26, 2008	CHECKED BY	M.A.

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	* GROUND WATER CONDITIONS	ELEVATION SCALE				
209.9	Ground Surface										
0.0	Migmatite Bedrock Unweathered High strength Excellent quality		1	RC NQ	REC 100%		209				RQD 97%
			2	RC NQ	REC 100%		208 207				RQD 100%
			3	RC NQ	REC 100%		206				RQD 100%
			4	RC NQ	REC 100%		205 204				RQD 93%
			5	RC NQ	REC 99%		203				RQD 98%
202.1 7.8	End of borehole										

* Borehole charged with drilling water

PIEZOMETER LEGEND:

▯	Concrete cap
■	Bentonite seal
⁘	Filter sand
☰	Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/03/08	2.8	207.1

$+^7$, $\times^5$: Numbers refer to Sensitivity

20 / 15 — ○ — 5 / 10 (%) STRAIN AT FAILURE

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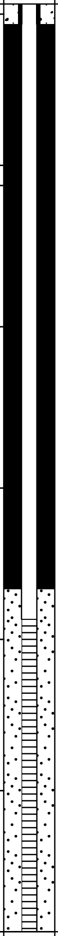
RECORD OF BOREHOLE No S4D

1 of 1

METRIC

G.W.P. 5094-06-00	LOCATION Co-ords: 5 047 961 N; 239 500 E		ORIGINATED BY F.P.
DIST 54 HWY 69	BOREHOLE TYPE NQ DIAMOND CORING		COMPILED BY J.W.
DATUM Geodetic	DATE September 28, 2008		CHECKED BY M.A.

SOIL PROFILE		SAMPLES					REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	* GROUND WATER CONDITIONS	ELEVATION SCALE	GR SA SI CL
208.8 0.0	Ground Surface						
208.7 0.1	Topsoil						
	Migmatite Bedrock Unweathered High strength Good to excellent quality	1	RC NQ	REC 95%		208	RQD 87%
		2	RC NQ	REC 100%		207 206	RQD 100%
		3	RC NQ	REC 100%		205	RQD 97%
		4	RC NQ	REC 100%		204 203	RQD 100%
		5	RC NQ	REC 100%		202	RQD 48%
		6	RC NQ	REC 100%		201 200	RQD 100%
199.6 9.2	End of borehole						



DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa
20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%)
20 40 60

UNIT WEIGHT γ kN/m^3

* Borehole charged with drilling water

PIEZOMETER LEGEND:

- ▯ Concrete cap
- ■ Bentonite seal
- ▨ Filter sand
- ▤ Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/03/08	2.1	206.7

ON_MOT VER3 07TX045I-N.GPJ ON_MOT.GDT 1/8/2009 2:44:58 PM

$+^7$, $\times^5$: Numbers refer to Sensitivity

20
15—○—5 (%) STRAIN AT FAILURE
10

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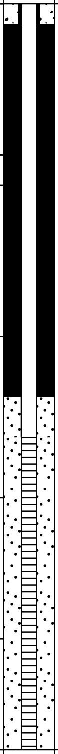
RECORD OF BOREHOLE No S4M

1 of 1

METRIC

G.W.P. 5094-06-00	LOCATION Co-ords: 5 047 959 N; 239 502 E	ORIGINATED BY F.P.
DIST 54 HWY 69	BOREHOLE TYPE NQ DIAMOND CORING	COMPILED BY J.W.
DATUM Geodetic	DATE September 27, 2008	CHECKED BY M.A.

DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%): 20 40 60
UNIT WEIGHT γ kN/m³
REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL



SOIL PROFILE: ELEV DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	ELEVATION SCALE	REMARKS
208.6	Ground Surface					
0.0	Migmatite Bedrock Unweathered High strength Fair to excellent quality	1	RC NQ	REC 98%	208	RQD 74%
		2	RC NQ	REC 86%	207	RQD 86%
		3	RC NQ	REC 100%	206	RQD 100%
		4	RC NQ	REC 97%	205 204	RQD 78%
		5	RC NQ	REC 100%	203	RQD 100%
		6	RC NQ	REC 98%	202	RQD 86%
201.2 7.4	End of borehole					

* Borehole charged with drilling water

PIEZOMETER LEGEND:

▯	Concrete cap
■	Bentonite seal
▒	Filter sand
☰	Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/03/08	1.8	206.8

$+^7$, $\times^5$: Numbers refer to Sensitivity

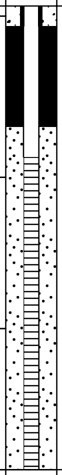
20, 15, 5, 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No S4S

1 of 1 **METRIC**

G.W.P. 5094-06-00 LOCATION Co-ords: 5 047 958 N; 239 499 E ORIGINATED BY F.P.
DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.
DATUM Geodetic DATE September 27, 2008 CHECKED BY M.A.

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	* GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
208.7 0.0	Ground Surface										
208.6 0.1	Topsoil										
	Migmatite Bedrock Unweathered High strength Excellent quality		1	RC NQ	REC 97%		208				RQD 97%
			2	RC NQ	REC 100%		207 206				RQD 97%
			3	RC NQ	REC 100%		205				RQD 100%
204.1 4.6	End of borehole										



* Borehole charged with drilling water

PIEZOMETER LEGEND:

Concrete cap
Bentonite seal
Filter sand
Screen

Water Level Readings:

Date	Depth (m)	Elev.
10/03/08	1.5	207.2

$+^7$, $\times^5$: Numbers refer to Sensitivity

20
15—○—5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No S5

1 of 1

METRIC

G.W.P. 5094-06-00	LOCATION Co-ords: 5 048 021 N; 239 400 E	ORIGINATED BY F.P.
DIST 54 HWY 69	BOREHOLE TYPE NQ DIAMOND CORING	COMPILED BY J.W.
DATUM Geodetic	DATE September 28, 2008	CHECKED BY M.A.

SOIL PROFILE		SAMPLES						DYNAMIC CONE PENETRATION RESISTANCE PLOT kPa 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	* GROUND WATER CONDITIONS	ELEVATION SCALE				
208.7 0.0	Ground Surface										
208.6 0.1	Topsoil Migmatite Bedrock Unweathered High strength Good to excellent quality		1	RC NQ	REC 100%		208				RQD 88%
			2	RC NQ	REC 100%		207				REC 100%
			3	RC NQ	REC 100%						RQD 88%
			4	RC NQ	REC 100%		206				REC 100%
			5	RC NQ	REC 100%		205				REC 100%
			6	RC NQ	REC 100%						REC 100%
			7	RC NQ	REC 100%		204				REC 100%
			8	RC NQ	REC 98%		203				RQD 98%
202.6 6.1	End of borehole										

* Borehole charged with drilling water

PIEZOMETER LEGEND:

- ▯ Concrete cap
- ■ Bentonite seal
- ▒ Filter sand
- ☰ Screen

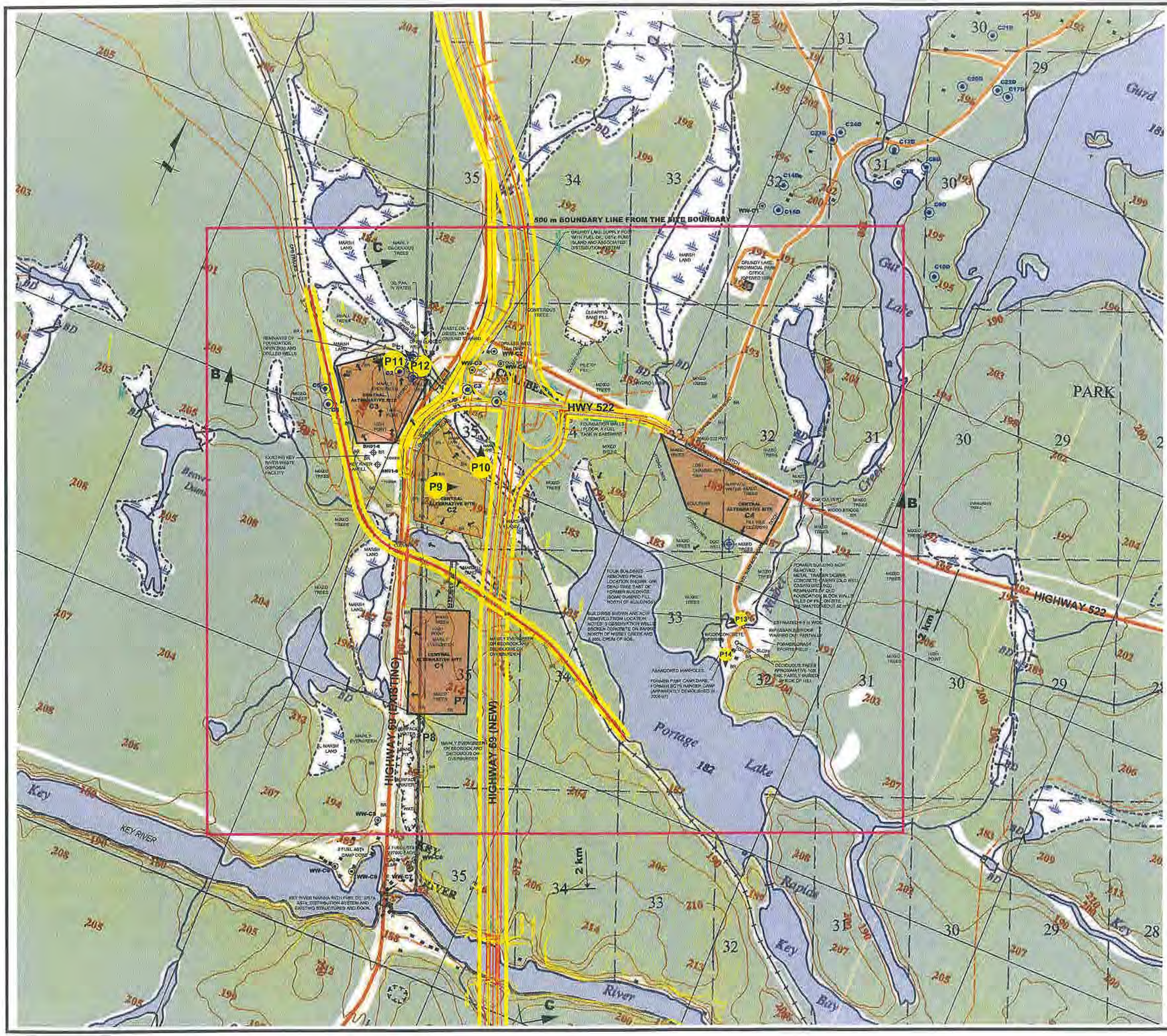
Water Level Readings:

Date	Depth (m)	Elev.
10/03/08	1.0	207.7

ON_MOT VER3 07TX045I-N.GPJ ON_MOT.GDT 1/8/2009 2:45:01 PM

+7, ×5 : Numbers refer to Sensitivity

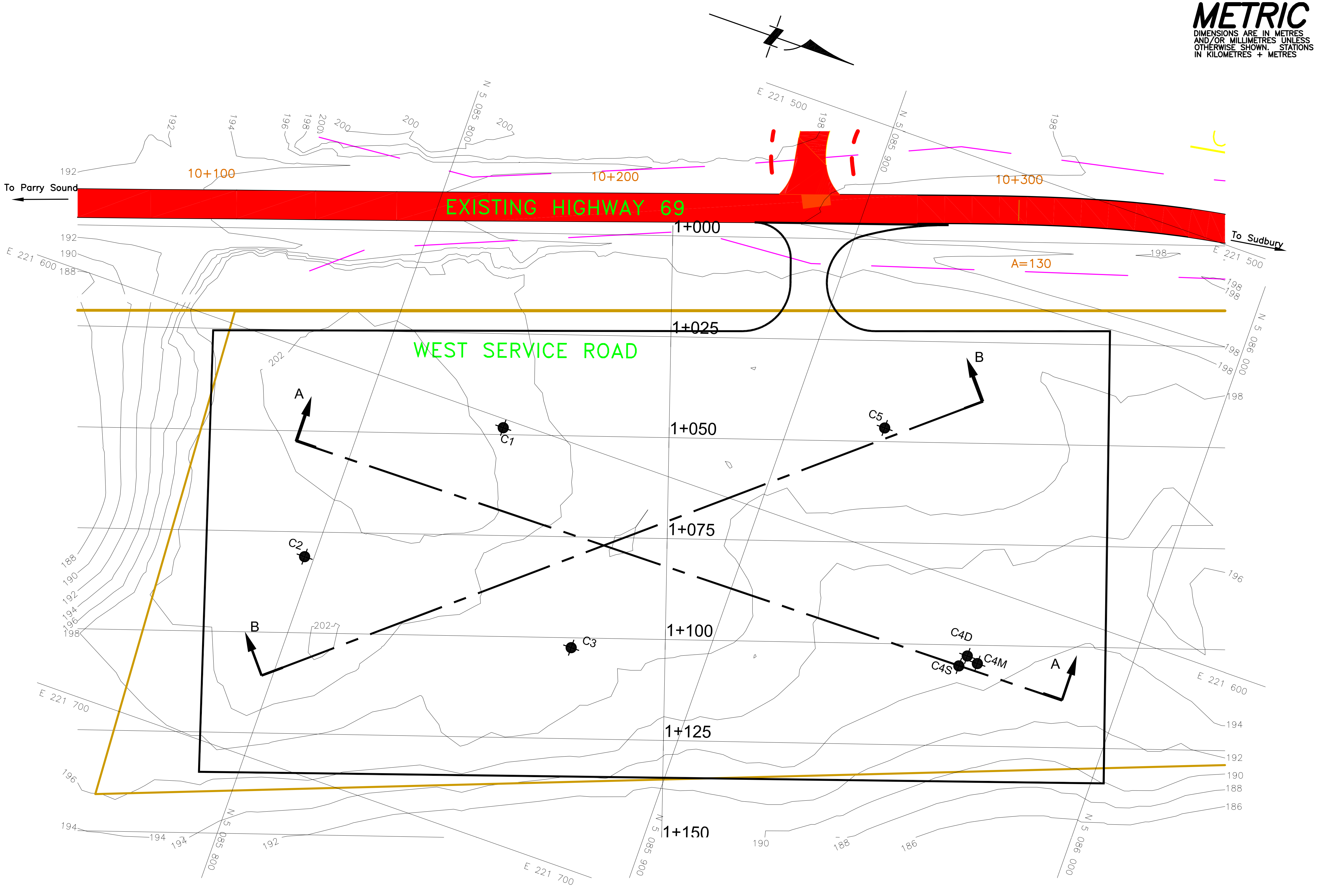
15 —○— 5 (20 above, 10 below) (%) STRAIN AT FAILURE



● C24D

Stantec Consulting Ltd.

PML



METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

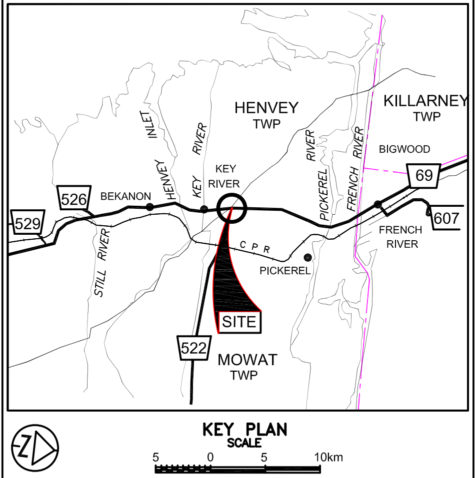
CONT No
GWP No 5094–06–00

SHEET

HIGHWAY 69

HIGHWAY 69 FOUR–LANING
PATROL YARD SELECTION STUDY CENTRAL SITE
BOREHOLE LOCATIONS PLAN

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE
5 0 5 10km

LEGEND

●	Borehole with monitoring well
▼	W L at time of investigation October 1, 2008

BH No	ELEVATION	NORTHINGS	EASTINGS
C1	201.7	5 085 834	221 602
C2	201.7	5 085 798	221 649
C3	198.5	5 085 867	221 648
C4D	194.2	5 085 961	221 617
C4M	194.2	5 085 964	221 618
C4S	194.1	5 085 960	221 620
C5	198.3	5 085 923	221 571

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

H. S. MORTAZAVI
Dec. 18, 2008

B. R. GRAY
Dec. 18, 2008

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No. 41H–66

HWY No	69					DIST	54
SUBM'D	MA	CHECKED	MA	DATE	DEC. 18, 2008	SITE	––
DRAWN	NA	CHECKED	MHM	APPROVED	BRG	DWG	3C

SECTIONS
SCALE
10 0 10 20m

NOTE:

1. REFER TO DRAWING 4C FOR HYDROGEOLOGICAL PROFILES.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REF No. Stantec Drawing;
652_Design_Central_Interchange_522_CAN83–10_pic2.dwg
dated July 25, 2008

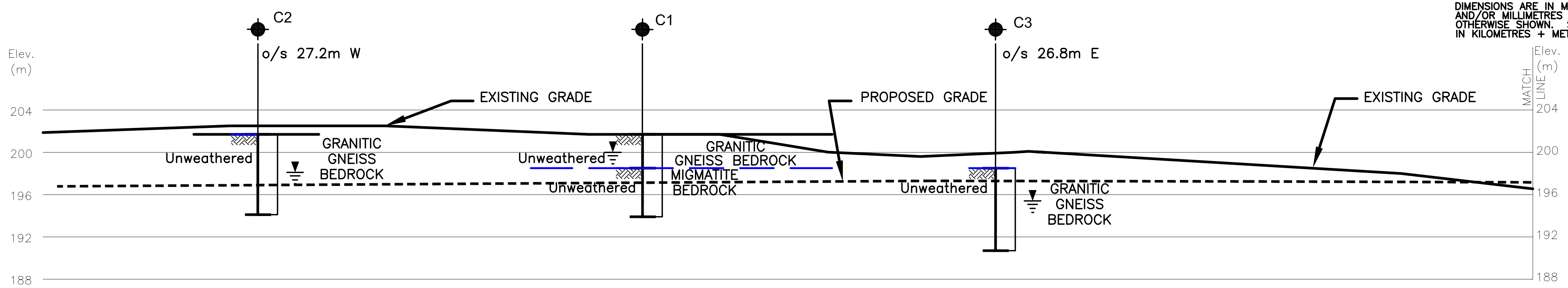
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 5094-06-00

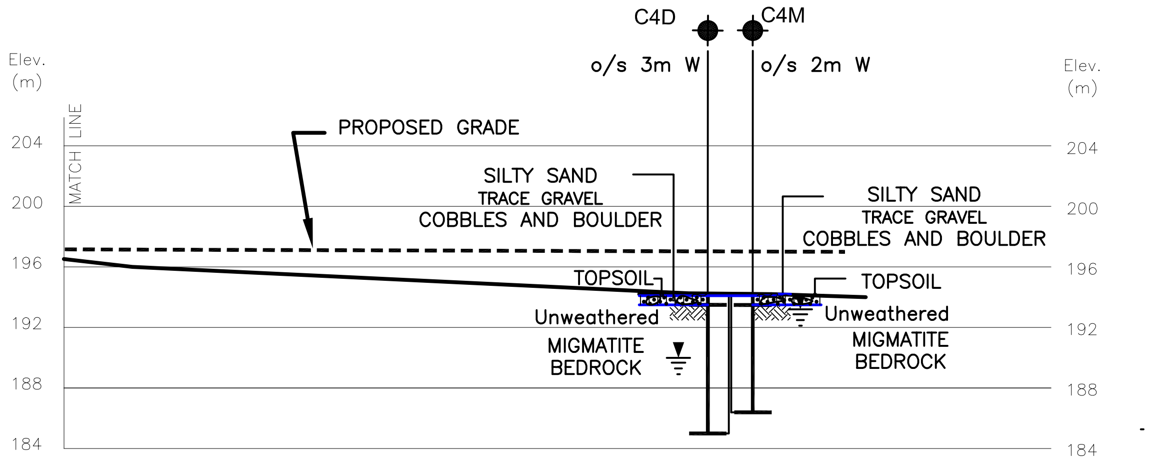
HIGHWAY 69
HIGHWAY 69 FOUR-LANING
PATROL YARD SELECTION STUDY CENTRAL SITE
SOIL STRATA

SHEET

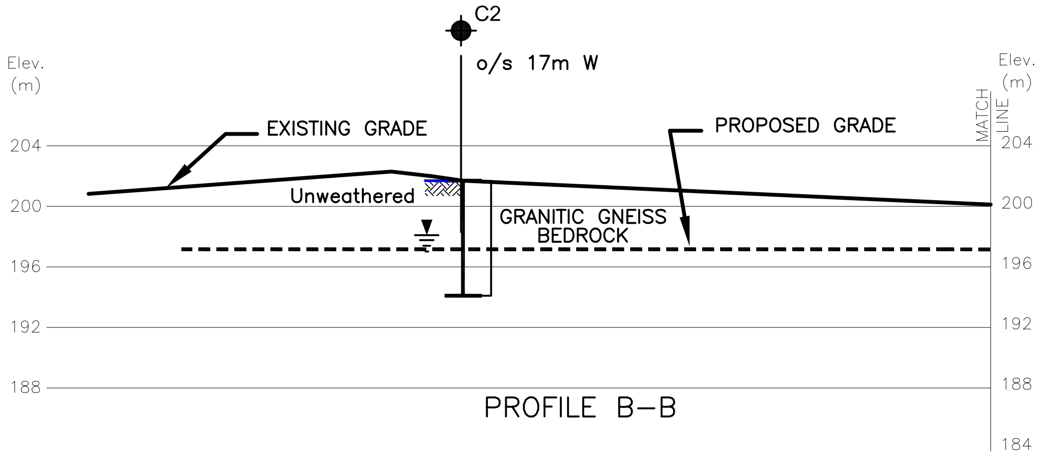
Peto MacCallum Ltd.
CONSULTING ENGINEERS



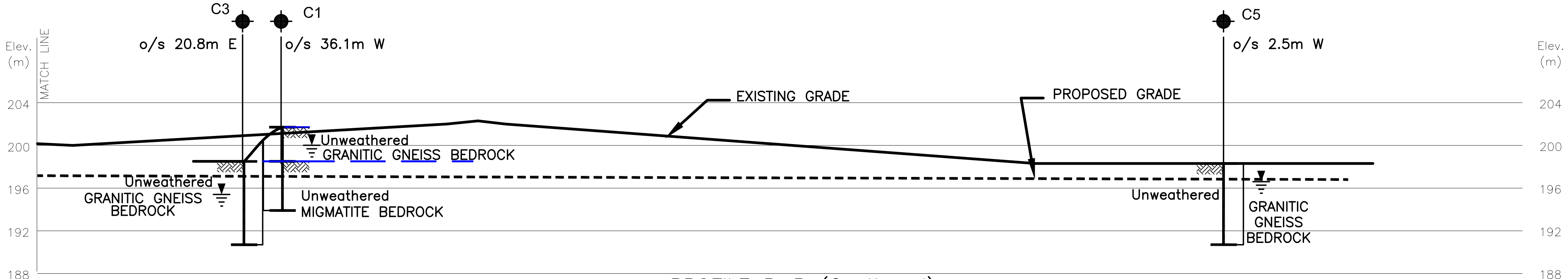
PROFILE A–A



PROFILE A–A (Continued)

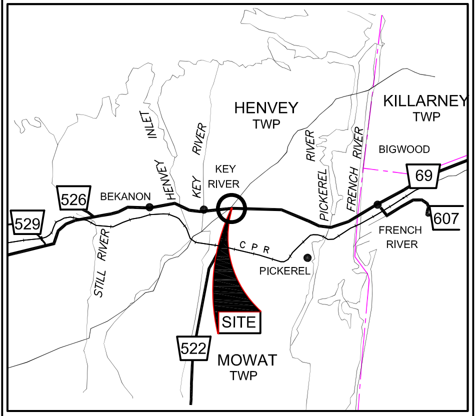


PROFILE B–B



PROFILE B–B (Continued)

SECTIONS
SCALE
5 0 5 10m



KEY PLAN
SCALE
5 0 5 10km

LEGEND

●	Borehole with monitoring well
▽	W L at time of investigation October 1, 2008

BH No	ELEVATION	NORTHINGS	EASTINGS
SEE DRAWING 3C FOR DETAILS			

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

H. S. MORTAZAVI
Dec 18, 2008

B. R. GRAY
Dec. 18, 2008

REVISIONS

DATE	BY	DESCRIPTION

Geocres No. 41H-66

HWY No	69			DIST	54
SUBM'D	MA	CHECKED MA	DATE DEC. 18, 2008	SITE	--
DRAWN	NA	CHECKED MHM	APPROVED BRG	DWG	4C

NOTES:

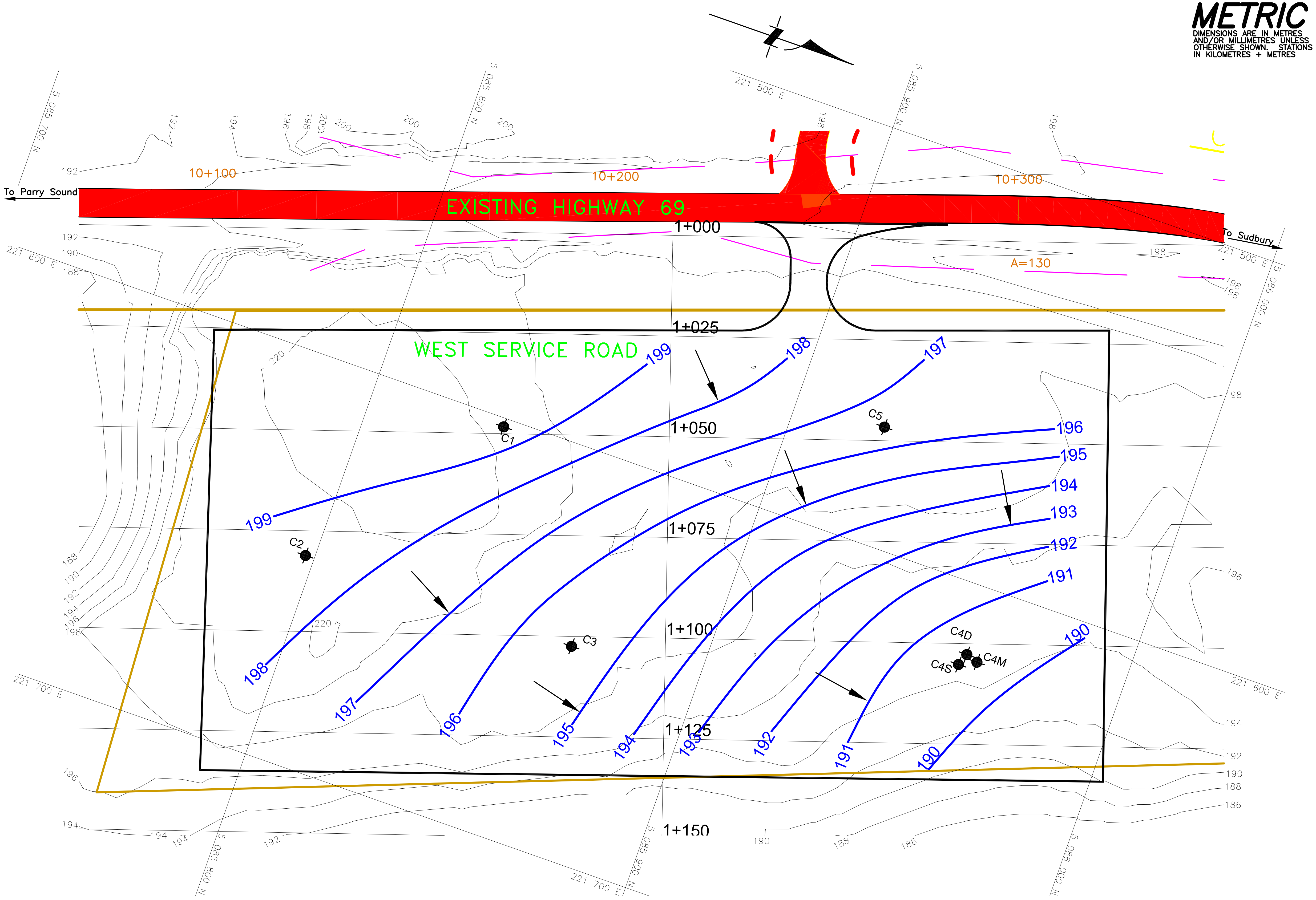
1. REFER TO DRAWING 3C FOR BOREHOLE LOCATIONS PLAN.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REF No. Stantec Drawing;
652_Design_Central_Interchange_522_CAN83-10_pic2.dwg
dated July 25, 2008

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

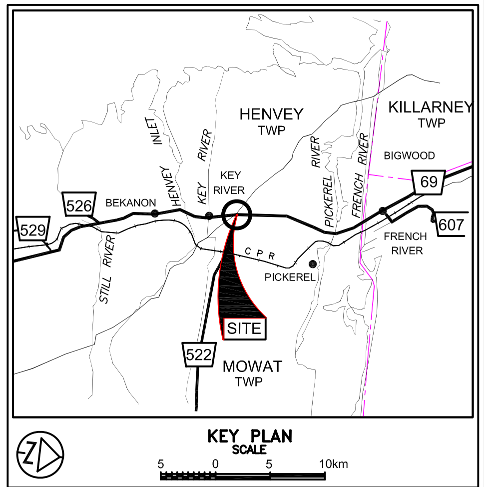
CONT No GWP No 5094-06-00	
HIGHWAY 69 HIGHWAY 69 FOUR-LANING PATROL YARD SELECTION STUDY CENTRAL SITE **GROUND WATER LEVEL CONTOUR MAP**	SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



PLAN

SCALE
10 0 10 20m



KEY PLAN
SCALE
5 0 5 10km

LEGEND

●	Borehole with monitoring well
▽	W L at time of investigation October 1, 2008
→	Interpreted Ground water flow direction
⁓	Interpreted Ground water contour

BH No	ELEVATION	NORTHINGS	EASTINGS
SEE DRAWING 3C FOR DETAILS			

H. S. MORTAZAVI
Dec. 18, 2008

B. R. GRAY
B R Gray
Dec. 18, 2008

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

DATE	BY	DESCRIPTION

REVISIONS

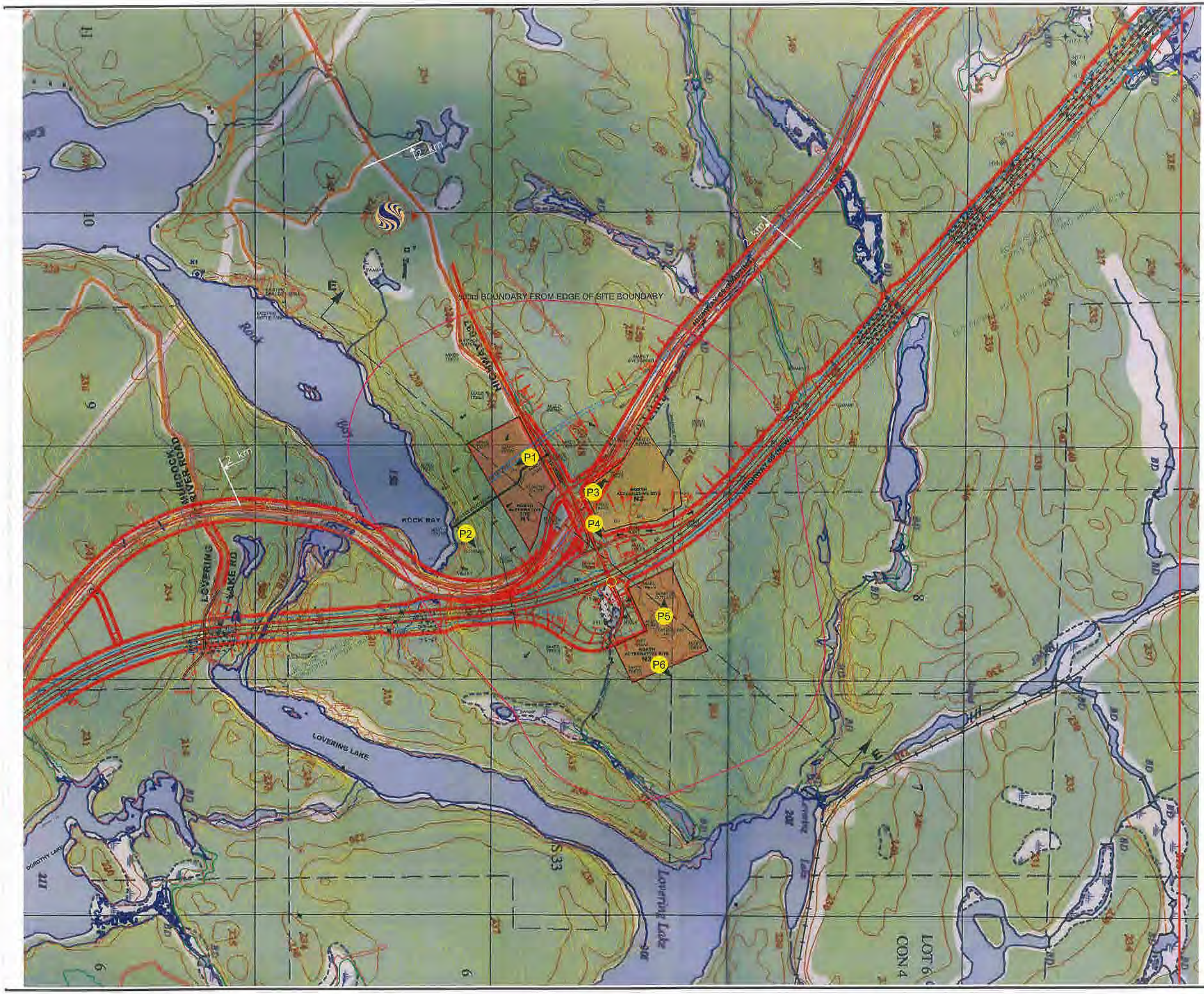
Geocres No. 41H–66

HWY No 69			DIST 54
SUBM'D MA	CHECKED MA	DATE DEC. 18, 2008	SITE ––
DRAWN NA	CHECKED MHM	APPROVED BRG	DWG 5C

REF No. Stantec Drawing;
652_Design_Central_Interchange_522_CAN83–10_pic2.dwg
dated July 25, 2008

NOTE:

1. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.



N1

Stantec Consulting Ltd.

PML

METRIC

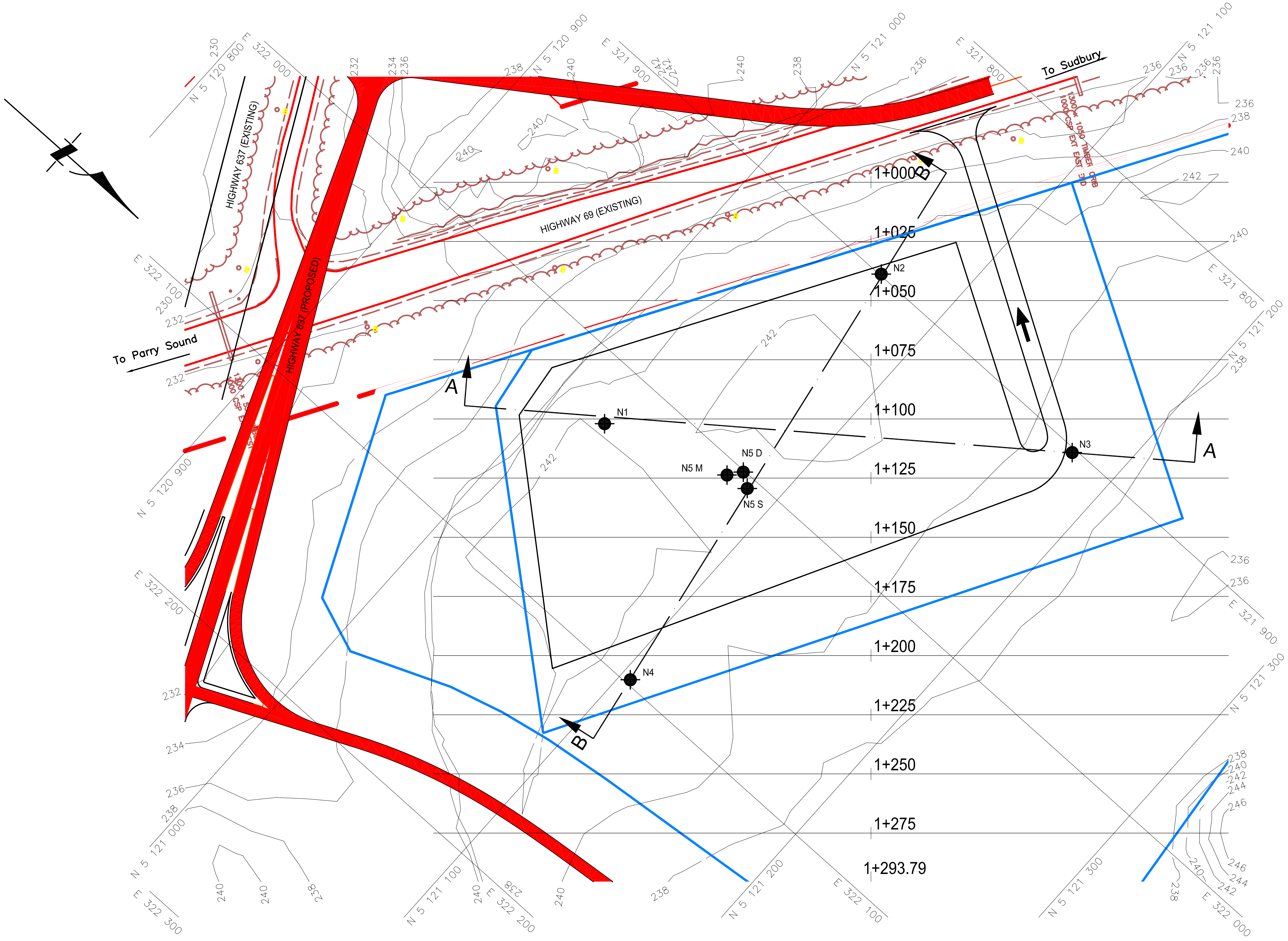
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS

CONT No
GWP No 5094-06-00

HIGHWAY 69
HIGHWAY 69 FOUR-LANING
PATROL YARD SELECTION STUDY – NORTH SITE
BOREHOLE LOCATIONS PLAN

SHEET

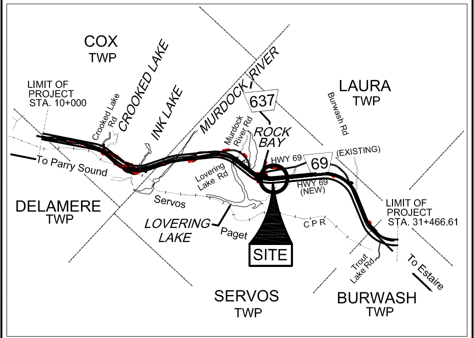
Peto MacCallum Ltd.
CONSULTING ENGINEERS



PLAN

SCALE

20 0 20 40m



KEY PLAN
SCALE
2 0 2 4 6km

LEGEND

⊕ Borehole with monitoring well

▽ W L at time of investigation August 27, 2008

BH No	ELEVATION	CO-ORDINATES	
		NORTHINGS	EASTINGS
N1	241.2	5 121 024	322 025
N2	240.7	5 121 069	321 899
N3	239.6	5 121 180	321 902
N4	240.4	5 121 104	322 098
N5 M	241.8	5 121 081	322 001
N5 D	241.8	5 121 077	322 006
N5 S	241.8	5 121 087	322 005

(Legend Continues)

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

LICENSED PROFESSIONAL ENGINEER
H. S. MORTAZAVI
Dec. 18, 2008
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
B R Gray
B. R. GRAY
Dec. 18, 2008
PROVINCE OF ONTARIO

REVISIONS	DATE	BY	DESCRIPTION

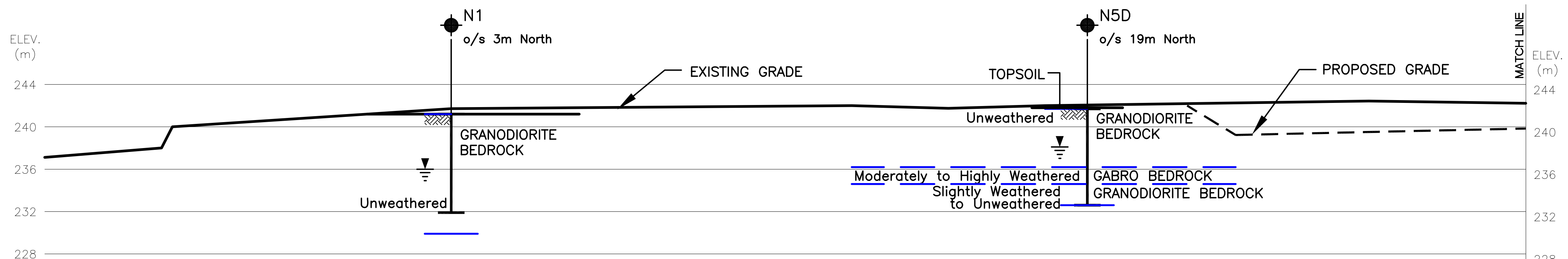
NOTES:

1. REFER TO DRAWINGS 4N FOR HYDROGEOLOGICAL PROFILES A–A AND B–B.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION..

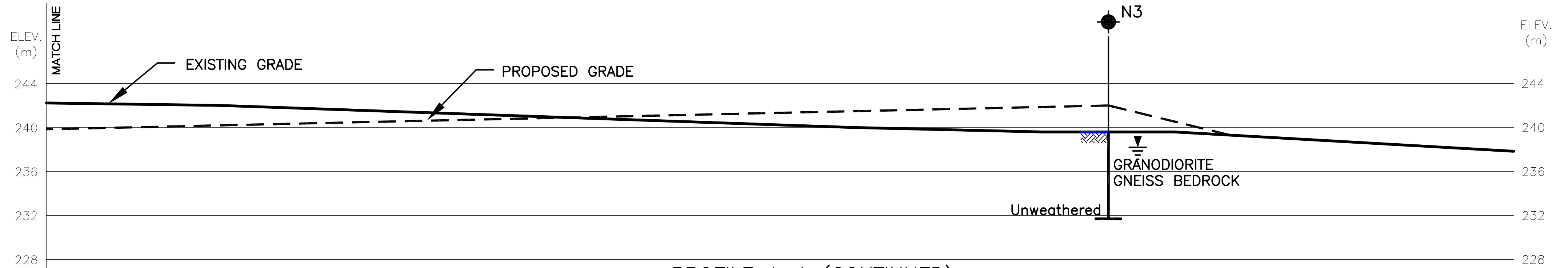
REF No. STANTEC DRAWING:
625_Design_North_Interchange_637_CAN83–12_PIC2.dwg
dated July 25, 2008 and North_Contours_Rev.dwg
dated August 05, 2008

Geocres No. 41H–66

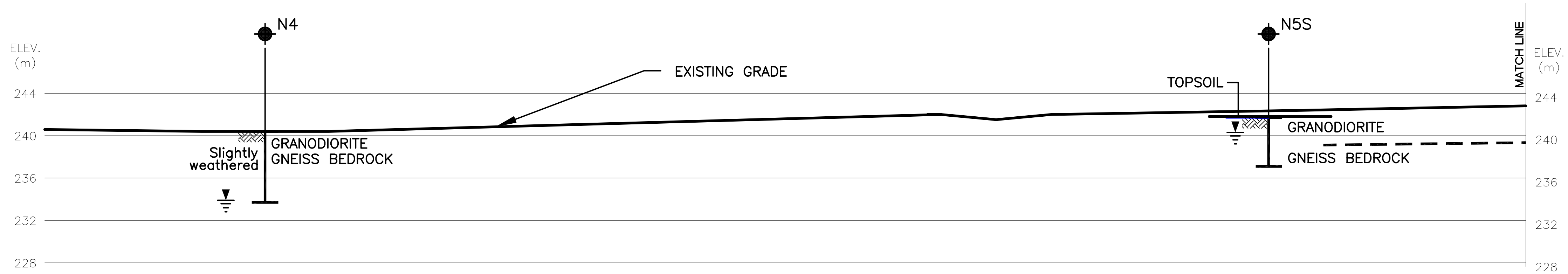
HWY No 69			DIST 54
SUBM'D MA	CHECKED MA	DATE DEC. 18, 2008	SITE ––
DRAWN NA	CHECKED MHM	APPROVED BRG	DWG 3N



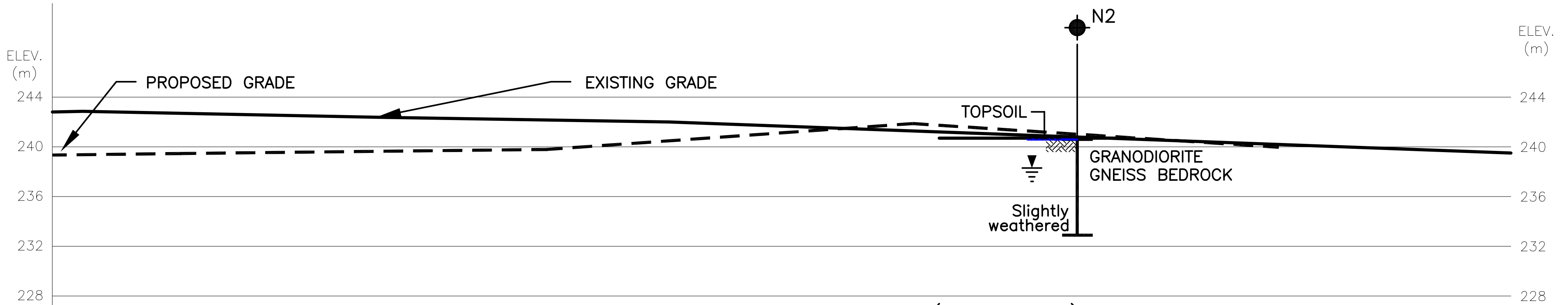
PROFILE A–A



PROFILE A–A (CONTINUED)



PROFILE B–B



PROFILE B–B (CONTINUED)

PROFILES

SCALE

5 0 5 10m

NOTES:

1. REFER TO DRAWING 3N FOR BORHOLE LOCATIONS PLAN.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REF No. STANTEC DRAWING:
625_Design_North_Interchange_637_CAN83–12_PIC2.dwg
dated July 25, 2008 and North_Contours_Rev.dwg
dated August 05, 2008

H. S. MORTAZAVI
Dec-18, 2008

B. R. GRAY
Dec. 18, 2008

METRIC

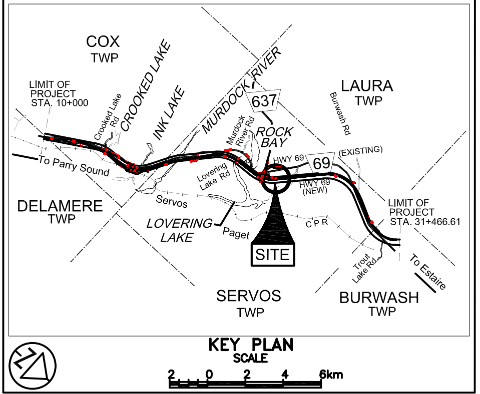
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS

CONT No
GWP No 5094–06–00

SHEET

HIGHWAY 69
HIGHWAY 69 FOUR–LANING
PATROL YARD SELECTION STUDY – NORTH SITE
SOIL STRATA

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE
2 0 2 4 6km

LEGEND

● Borehole with monitoring well

▽ W L at time of investigation August 27, 2008

BH No	ELEVATION	CO–ORDINATES	
		NORTHINGS	EASTINGS
SEE DRAWING 3N FOR DETAILS			

(Legend Continues)

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No. 41H–66

HWY No	69			DIST	54
SUBM'D	MA	CHECKED MA	DATE DEC. 18, 2008	SITE	---
DRAWN	NA	CHECKED MHM	APPROVED BRG	DWG	4N

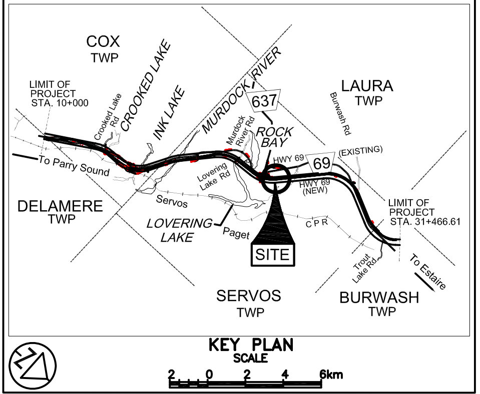
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS

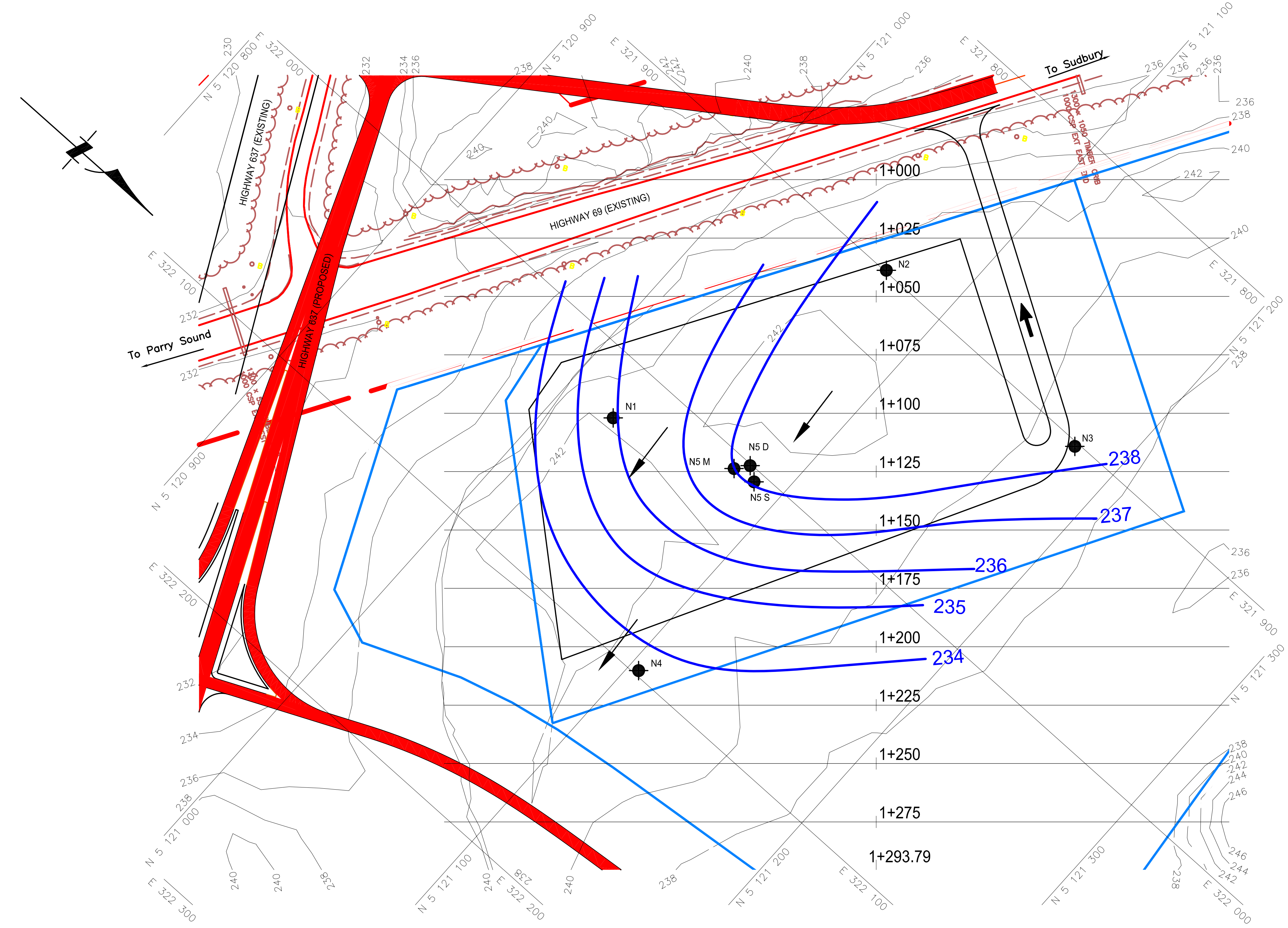
CONT No
GWP No 5094-06-00

SHEET

HIGHWAY 69
HIGHWAY 69 FOUR-LANING
PATROL YARD SELECTION STUDY – NORTH SITE
GOUND WATER LEVEL CONTOUR MAP

Peto MacCallum Ltd.
CONSULTING ENGINEERS





PLAN
SCALE
20 0 20 40m

	LEGEND
⌖	Borehole with monitoring well
⊻	W L at time of investigation August 27, 2008
→	Interpreted Ground water flow direction
⁓	Interpreted Ground water contour

BH No	ELEVATION	CO-ORDINATES	
		NORTHINGS	EASTINGS
SEE DRAWING 3N FOR DETAILS			

(Legend Continues)

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

H. S. MORTAZAVI
Dec. 18, 2008

B. R. GRAY
Dec. 18, 2008

REVISIONS DATE	BY	DESCRIPTION

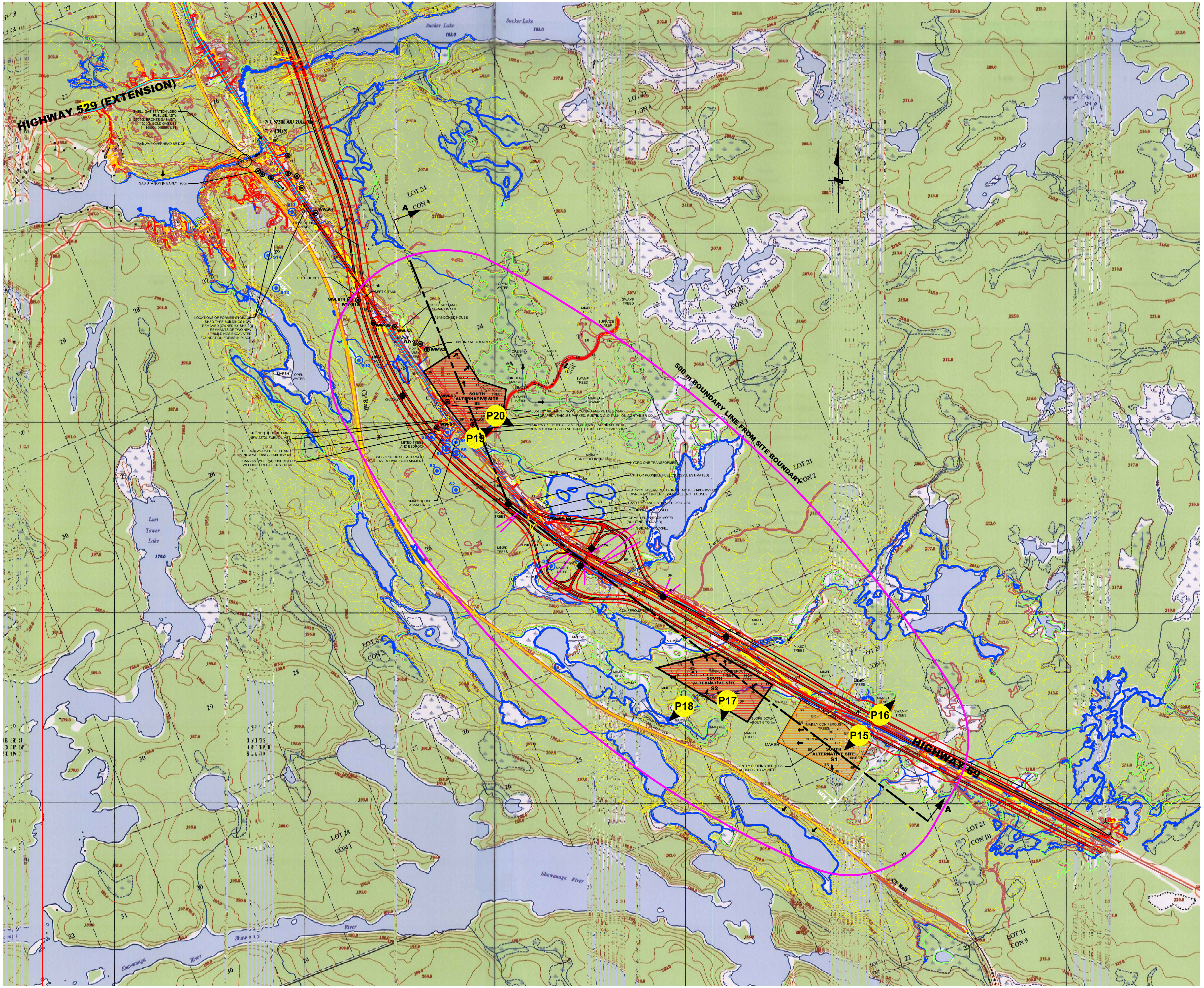
Geocres No. 41H-66

HWY No 69			DIST 54
SUBM'D MA	CHECKED MA	DATE DEC. 18, 2008	SITE --
DRAWN NA	CHECKED MHM	APPROVED BRG	DWG 5N

REF No. STANTEC DRAWING:
625_Design_North_Interchange_637_CAN83-12_PIC2.dwg
dated July 25, 2008 and North_Contours_Rev.dwg
dated August 05, 2008

NOTES:

1. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
2. THIS GROUND WATER CONTOUR LINES ARE AS OF AUGUST 27, 2008.



METRIC

LEGEND:

SW-FN-4	BOREHOLE BY AMEC CONSULTING ENGINEERS REF.: TT53126-STRUCTURES, GEOCRES No. 41H-58
S14	MOE WATER WELL (SEE TABLE 1)
WW-S11	DOOR-TO-DOOR WATER WELL SURVEYED IN MAY 2008 (SEE TABLE 2)
←	SURFACE WATER FLOW DIRECTION
BR	EXPOSED BEDROCK
A A	HYDROGEOLOGICAL PROFILE (SEE DRAWING 3S)
P20	SITE PHOTOGRAPH PLATE No. AND VIEW DIRECTION

SCALE

100 0 100 200m

NOTE:

THIS DRAWING WAS REPRODUCED FROM A PLAN DRAWING; 652_Display_Locations.dwg; PROVIDED BY STANTEC CONSULTING LIMITED AND COMPOSITE OF ONTARIO BASE MAPS:
10 17 5450 50450, 10 17 5450 50500, 10 17 5500 50450 AND
10 17 5500 50500.

No.	REVISIONS	DATE	BY

HYDROGEOLOGICAL SITE SCREENING
PATROL YARD SITE SELECTION STUDY

HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO

G.W.P. 5094 - 06 - 00

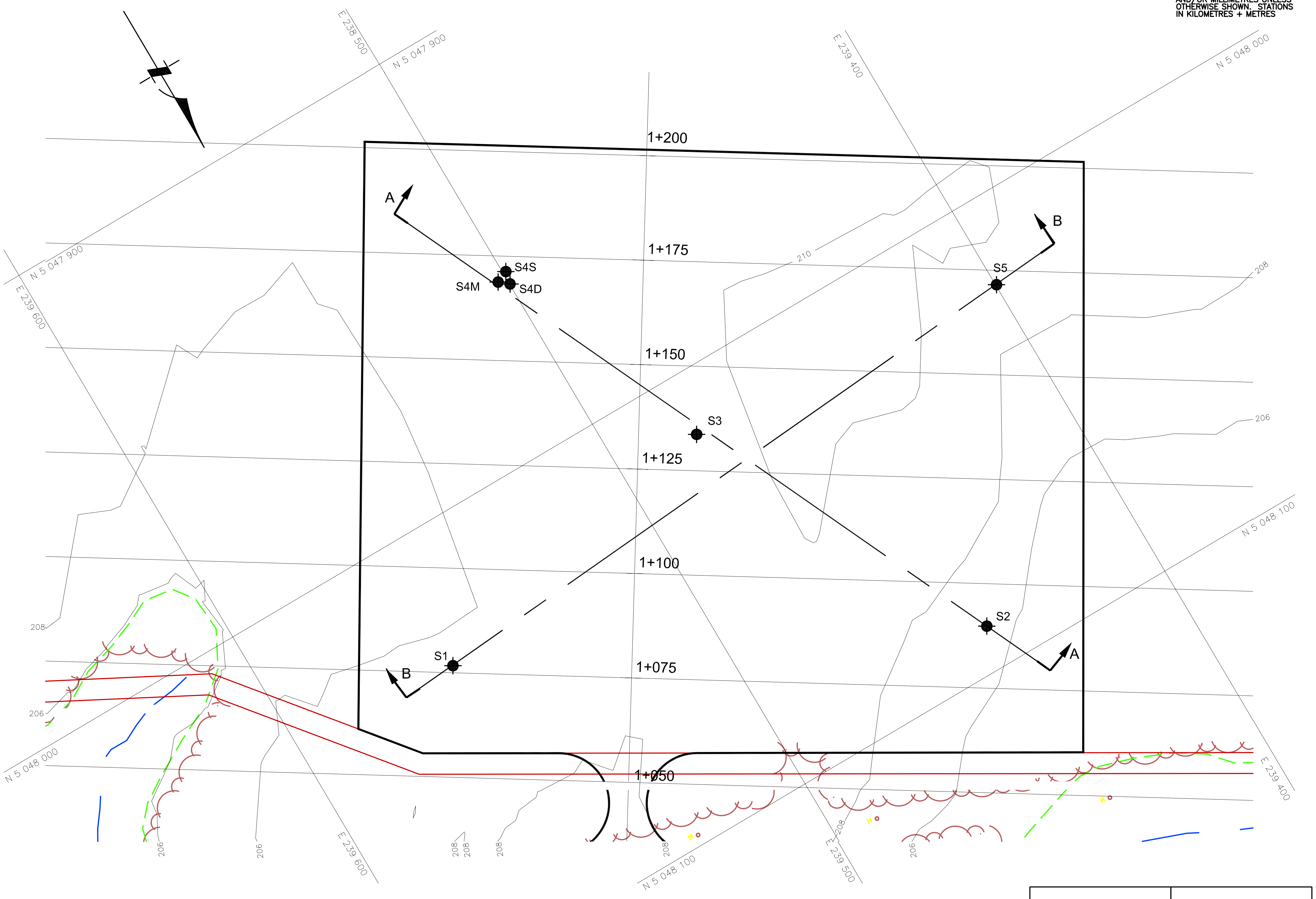
LOCATION PLAN - SOUTH ALTERNATIVE SITES AND SITE FEATURES OBSERVED IN MAY 2008

Ontario

Stantec Consulting Ltd.

Peto MacCallum Ltd.
CONSULTING ENGINEERS

	DATE	SCALE	JOB NO.	DRAWING NO.
DRAWN: N.A. CHECKED: M.A. APPROVED: M.H.M.	DEC. 2008	1 : 20,000	07TX045	2S



PLAN

SCALE

METRIC

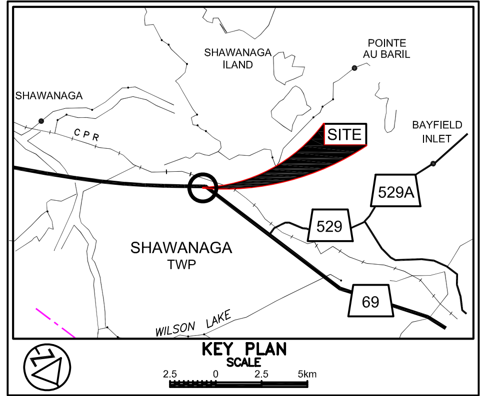
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 9406-06-00

SHEET

HIGHWAY 69
HIGHWAY 69 FOUR LANING
PATROL YARD SELECTION STUDY – SOUTH SITE
BOREHOLE LOCATIONS PLAN

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE

LEGEND

- ● Borehole
- W L at time of investigation October 3, 2008

BH No	ELEVATION	NORTHINGS	EASTINGS
S1	208.2	5 048 033	239 558
S2	206.9	5 048 090	239 443
S3	209.9	5 048 015	239 480
S4D	208.8	5 047 961	239 500
S4M	208.6	5 047 959	239 502
S4S	208.7	5 047 958	239 499
S5	208.7	5 048 021	239 400

(Legend Continues)

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

H. S. MORTAZAVI
Dec. 18, 2008

B. R. GRAY
Dec. 18, 2008

REVISIONS DATE	BY	DESCRIPTION

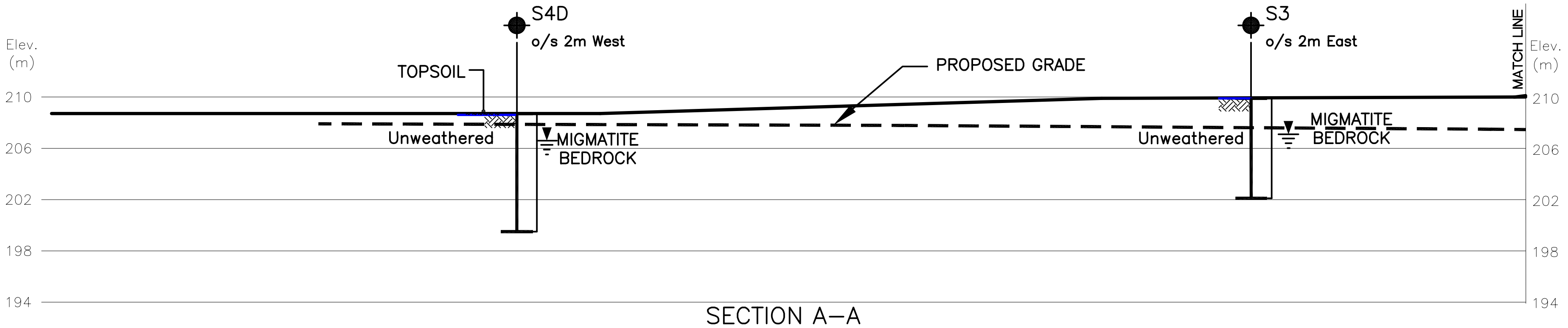
Geocres No. 41H-66

HWY No 69			DIST 54
SUBM'D MA	CHECKED MA	DATE DEC. 18, 2008	SITE --
DRAWN NA	CHECKED MHM	APPROVED BRG	DWG 3S

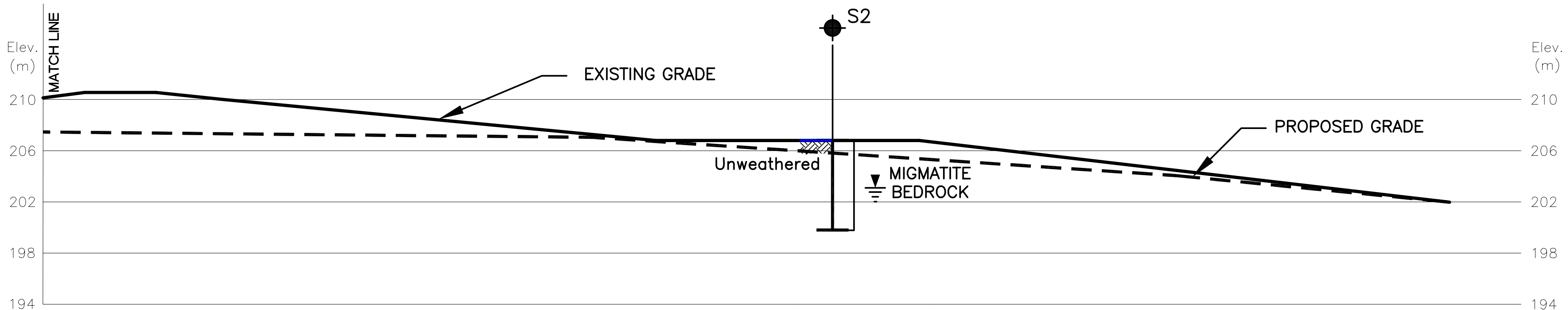
REF No. Stantec Drawing;
652_Design_South_interchange_522_CAN83-10_pic2.dwg

NOTES:

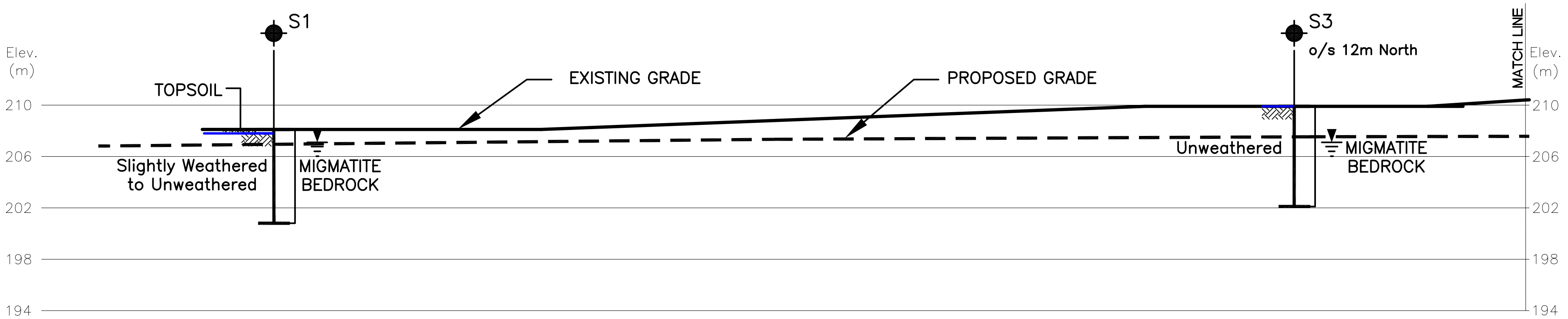
1. REFER TO DRAWING 4S FOR HYDROGEOLOGICAL PROFILES A-A AND B-B.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.



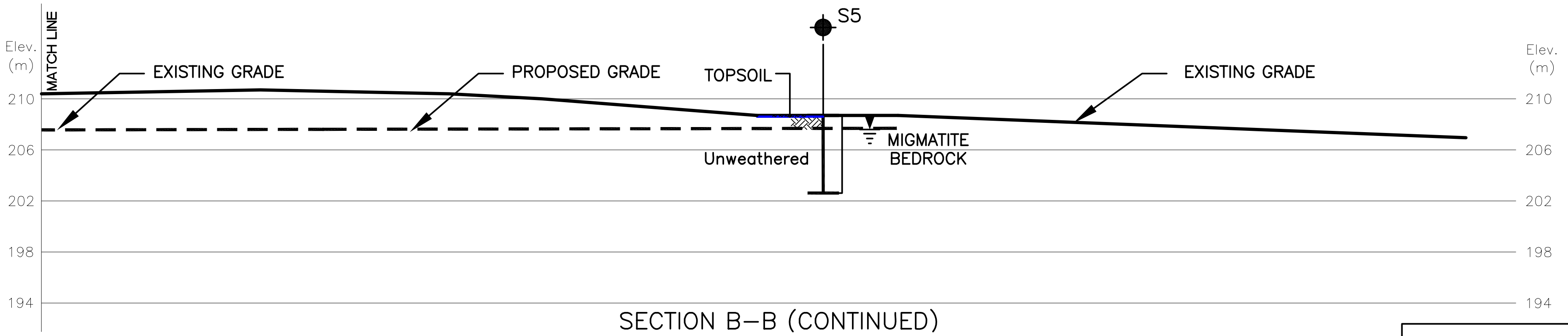
SECTION A–A



SECTION A–A (CONTINUED)



SECTION B–B



SECTION B–B (CONTINUED)

SECTIONS

SCALE

5 0 5 10

NOTE:

1. REFER TO DRAWING 3S FOR BOREHOLE LOCATIONS PLAN.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REF No. Stantec Drawing;
652_Design_South_interchange_522_CAN83–10_pic2.dwg

METRIC

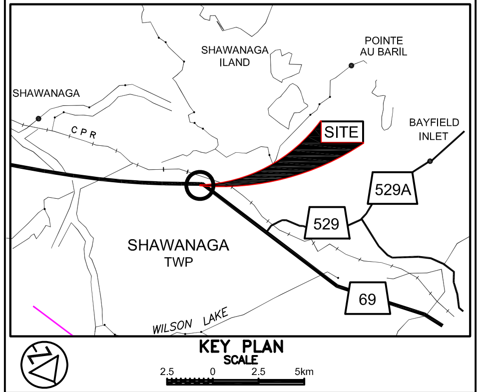
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 9406–06–00

HIGHWAY 69
HIGHWAY 69 FOUR LANING
PATROL YARD SELECTION STUDY – SOUTH SITE
SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE

LEGEND

●	Borehole
▼	W L at time of investigation October 3, 2008

BH No	ELEVATION	NORTHINGS	EASTINGS
SEE DRAWING 3S FOR DETAILS			

(Legend Continues)

– NOTE –

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

H. S. MORTAZAVI
Dec. 18, 2008

B. R. GRAY
Dec. 18, 2008

REVISIONS DATE	BY	DESCRIPTION

Geocres No. 41H–66

HWY No 69			DIST 54
SUBM'D MA	CHECKED MA	DATE DEC. 18, 2008	SITE ––
DRAWN NA	CHECKED MHM	APPROVED BRG	DWG 4S

METRIC

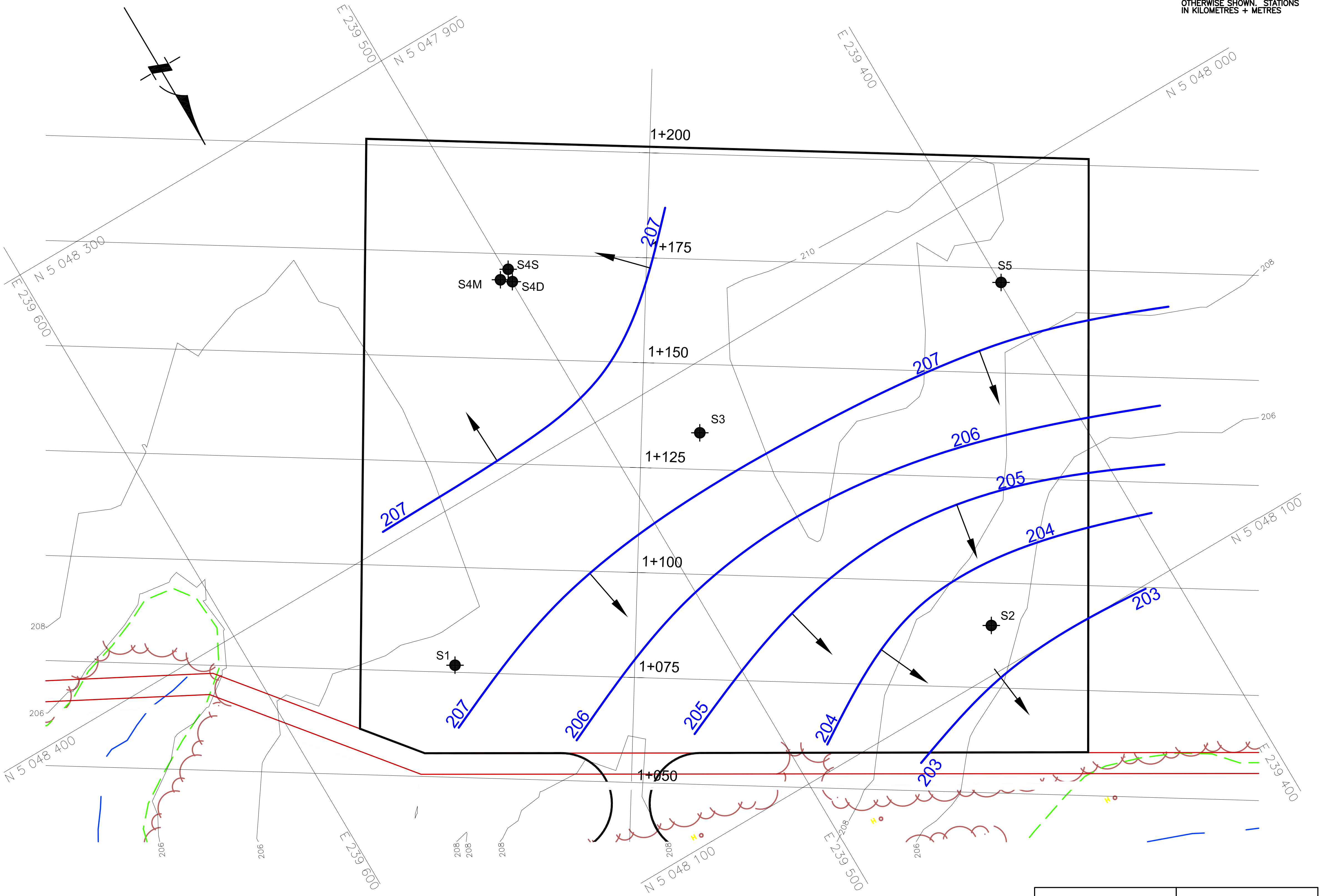
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 9406–06–00

HIGHWAY 69
HIGHWAY 69 FOUR LANING
PATROL YARD SELECTION STUDY – SOUTH SITE
GROUND WATER LEVEL CONTOUR PLAN

SHEET

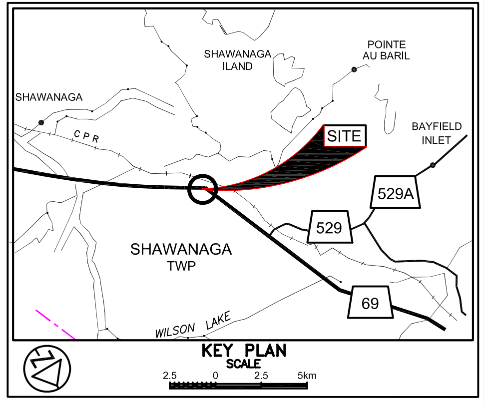
Pete MacCallum Ltd.
CONSULTING ENGINEERS



PLAN
SCALE
10 0 10 20m

NOTE:

1. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.



KEY PLAN
SCALE
2.5 0 2.5 5km

LEGEND

●	Borehole with monitoring well
▽	W L at time of investigation October 3, 2008
→	Interpreted Ground water flow direction
⌒	Interpreted Ground water contour

BH No	ELEVATION	NORTHINGS	EASTINGS
SEE DRAWING 3S FOR DETAILS			

(Legend Continues)

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

H. S. MORTAZAVI
Dec 18, 2008

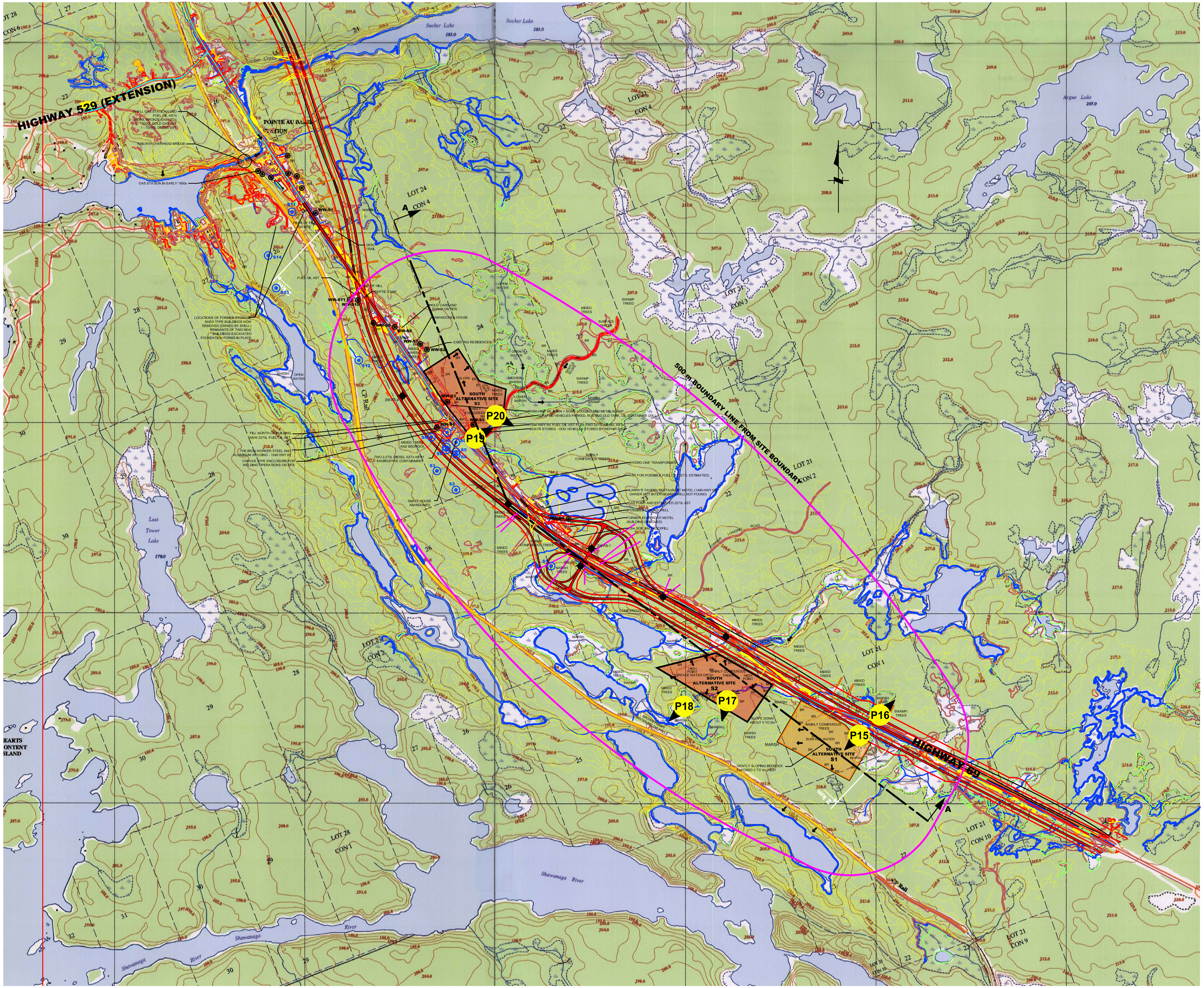
B. R. GRAY
BRGray
Dec. 18, 2008

REF No. Stantec Drawing;
652_Design_South_interchange_522_CAN83–10_pic2.dwg

REVISIONS DATE	BY	DESCRIPTION

Geocres No. 41H–66

HWY No 69			DIST 54
SUBM'D MA	CHECKED MA	DATE DEC. 18, 2008	SITE ––
DRAWN NA	CHECKED MHM	APPROVED BRG	DWG 5S



METRIC

LEGEND:

SW-FN-4	BOREHOLE BY AMEC CONSULTING ENGINEERS REF.: TT53126-STRUCTURES, GEOCRES No. 41H-58
S14	MOE WATER WELL (SEE TABLE 1)
WW-S11	DOOR-TO-DOOR WATER WELL SURVEYED IN MAY 2008 (SEE TABLE 2)
←	SURFACE WATER FLOW DIRECTION
BR	EXPOSED BEDROCK
A A	HYDROGEOLOGICAL PROFILE (SEE DRAWING 3S)
P20	SITE PHOTOGRAPH PLATE No. AND VIEW DIRECTION

SCALE

100 0 100 200m

NOTE:

THIS DRAWING WAS REPRODUCED FROM A PLAN DRAWING; 652_Display_Locations.dwg; PROVIDED BY STANTEC CONSULTING LIMITED AND COMPOSITE OF ONTARIO BASE MAPS:
10 17 5450 50450, 10 17 5450 50500, 10 17 5500 50450 AND
10 17 5500 50500.

No.	REVISIONS	DATE	BY

HYDROGEOLOGICAL SITE SCREENING
PATROL YARD SITE SELECTION STUDY

HIGHWAY 69, FROM PARRY SOUND TO SUDBURY, ONTARIO

G.W.P. 5094 - 06 - 00

LOCATION PLAN - SOUTH ALTERNATIVE SITES AND SITE FEATURES OBSERVED IN MAY 2008

Ontario

Stantec Consulting Ltd.

Stantec

Peto MacCallum Ltd.

CONSULTING ENGINEERS

	DATE	SCALE	JOB NO.	DRAWING NO.
DRAWN: N.A. CHECKED: M.A. APPROVED: M.H.M.	DEC. 2008	1 : 20,000	07TX045	2S

METRIC

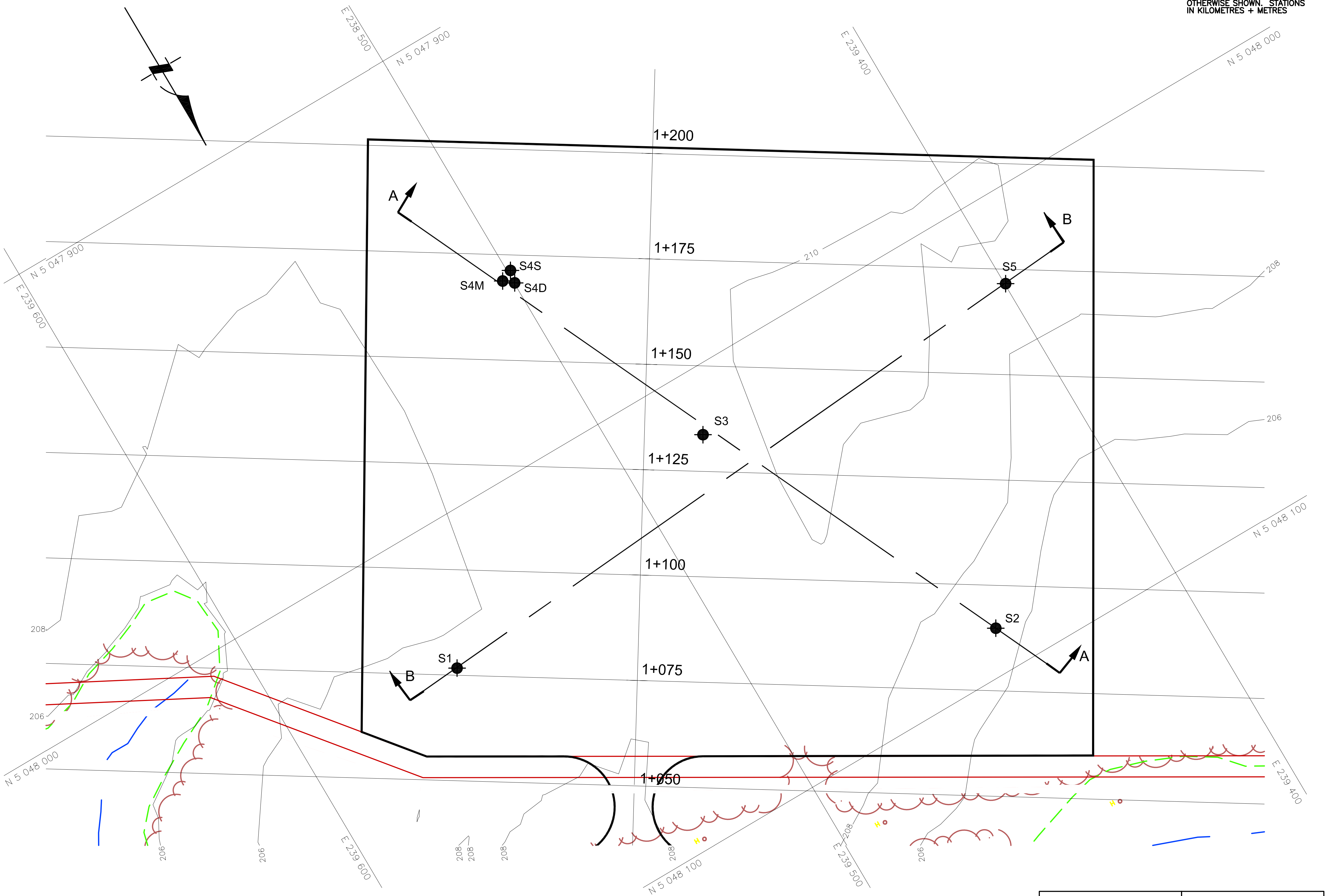
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 9406-06-00

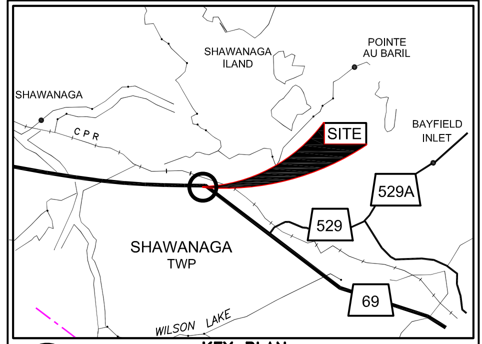
HIGHWAY 69
HIGHWAY 69 FOUR LANING
PATROL YARD SELECTION STUDY – SOUTH SITE
BOREHOLE LOCATIONS PLAN

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



PLAN
SCALE
10 0 10 20m



KEY PLAN
SCALE
2.5 0 2.5 5km

LEGEND

● Borehole

▽ W L at time of investigation October 3, 2008

BH No	ELEVATION	NORTHINGS	EASTINGS
S1	208.2	5 048 033	239 558
S2	206.9	5 048 090	239 443
S3	209.9	5 048 015	239 480
S4D	208.8	5 047 961	239 500
S4M	208.6	5 047 959	239 502
S4S	208.7	5 047 958	239 499
S5	208.7	5 048 021	239 400

(Legend Continues)

– NOTE –

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H. S. MORTAZAVI
Dec. 18, 2008

B. R. GRAY
Dec. 18, 2008

REVISIONS		
DATE	BY	DESCRIPTION

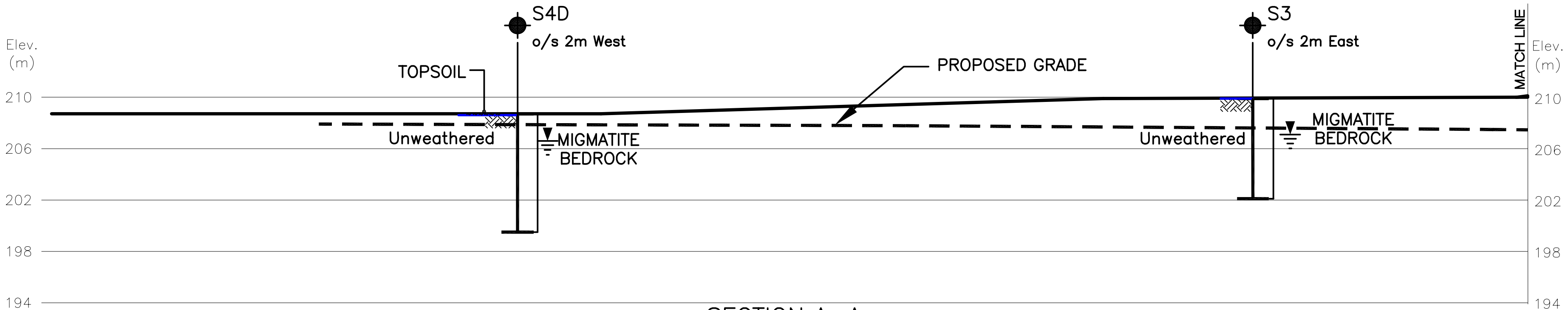
Geocres No. 41H-66

HWY No 69			DIST 54
SUBM'D MA	CHECKED MA	DATE DEC. 18, 2008	SITE --
DRAWN NA	CHECKED MHM	APPROVED BRG	DWG 3S

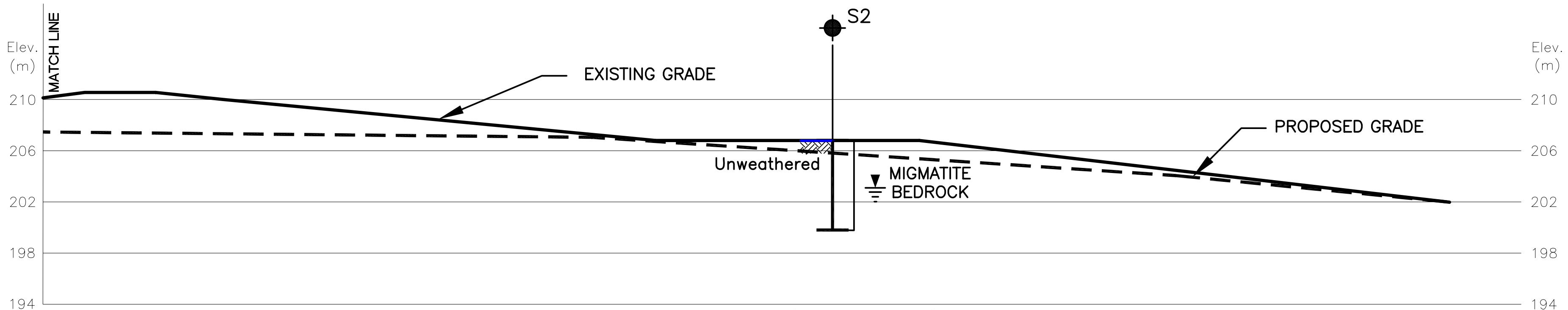
NOTES:

1. REFER TO DRAWING 4S FOR HYDROGEOLOGICAL PROFILES A-A AND B-B.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

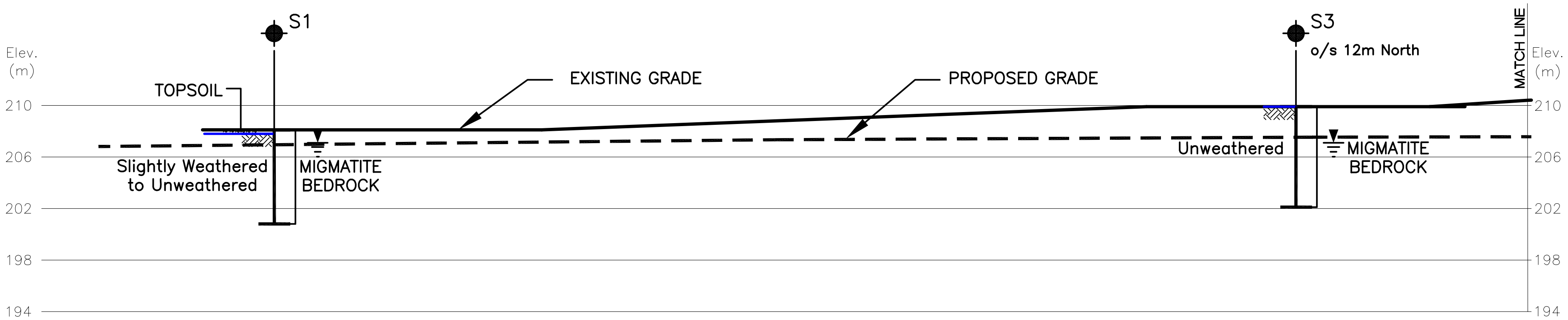
REF No. Stantec Drawing;
652_Design_South_interchange_522_CAN83-10_pic2.dwg



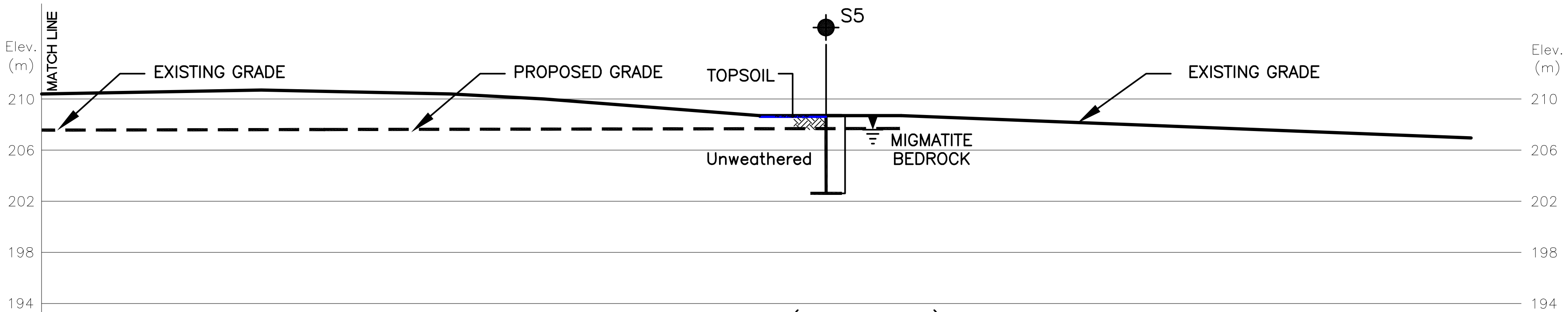
SECTION A–A



SECTION A–A (CONTINUED)



SECTION B–B



SECTION B–B (CONTINUED)

SECTIONS
SCALE
5 0 5 10

NOTE:

1. REFER TO DRAWING 3S FOR BOREHOLE LOCATIONS PLAN.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

METRIC

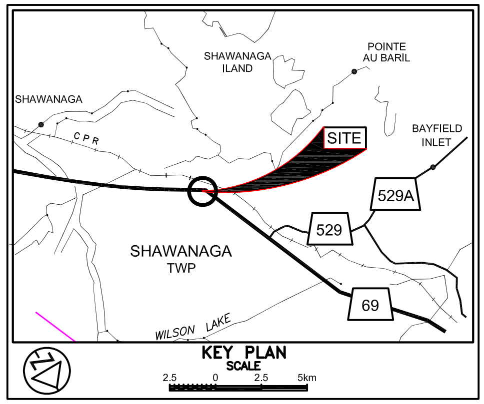
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 9406-06-00

HIGHWAY 69
HIGHWAY 69 FOUR LANING
PATROL YARD SELECTION STUDY – SOUTH SITE
SOIL STRATA

SHEET

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS



LEGEND

● Borehole

W L at time of investigation October 3, 2008

BH No	ELEVATION	NORTHINGS	EASTINGS

SEE DRAWING 3S FOR DETAILS

(Legend Continues)

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

H. S. MORTAZAVI
Dec. 18, 2008

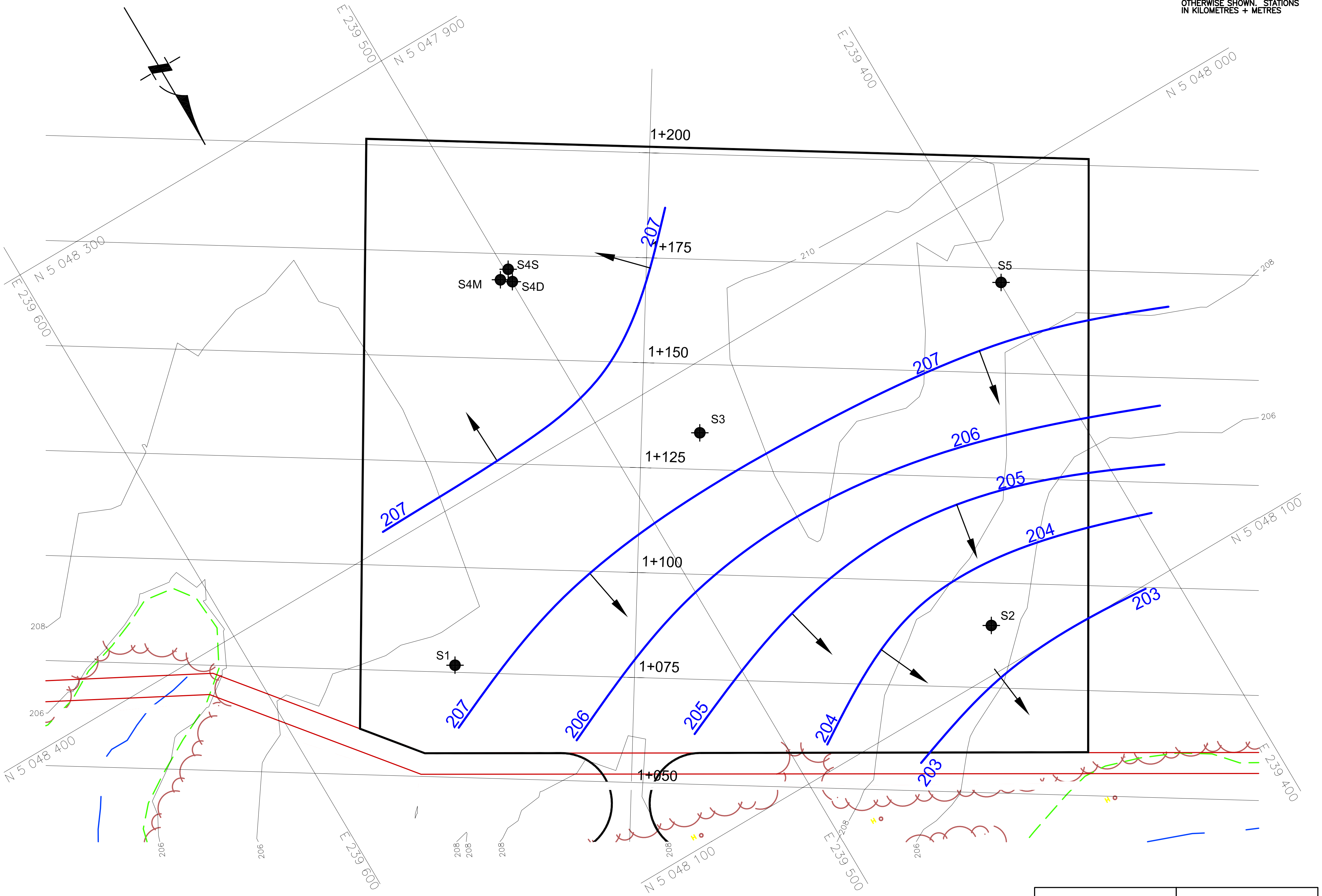
B. R. Gray
B. R. GRAY
Dec. 18, 2008

REF No. Stantec Drawing;
652_Design_South_interchange_522_CAN83–10_pic2.dwg

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 41H–66

HWY No 69			DIST 54
SUBM'D MA	CHECKED MA	DATE DEC. 18, 2008	SITE ––
DRAWN NA	CHECKED MHM	APPROVED BRG	DWG 4S



PLAN

SCALE

10 0 10 20m

NOTE:

1. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REF No. Stantec Drawing;
652_Design_South_interchange_522_CAN83–10_pic2.dwg

H. S. MORTAZAVI
Dec 16, 2008

B. R. GRAY
Dec. 18, 2008

METRIC

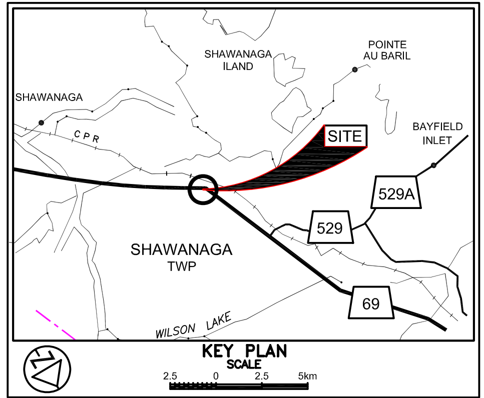
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 9406–06–00

HIGHWAY 69
HIGHWAY 69 FOUR LANING
PATROL YARD SELECTION STUDY – SOUTH SITE
GROUND WATER LEVEL CONTOUR PLAN

SHEET

Pete MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE
2.5 0 2.5 5km

LEGEND

- ● Borehole with monitoring well
- W L at time of investigation October 3, 2008
- → Interpreted Ground water flow direction
- Interpreted Ground water contour

BH No	ELEVATION	NORTHINGS	EASTINGS
SEE DRAWING 3S FOR DETAILS			

(Legend Continues)

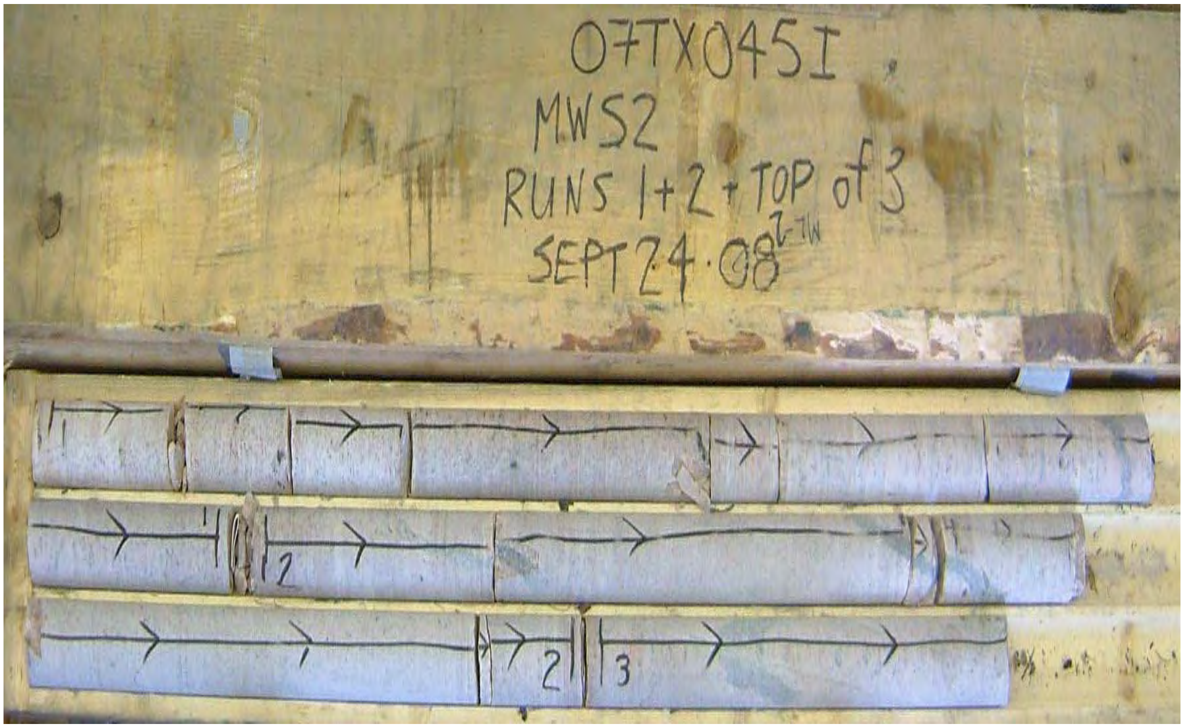
– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS DATE	BY	DESCRIPTION

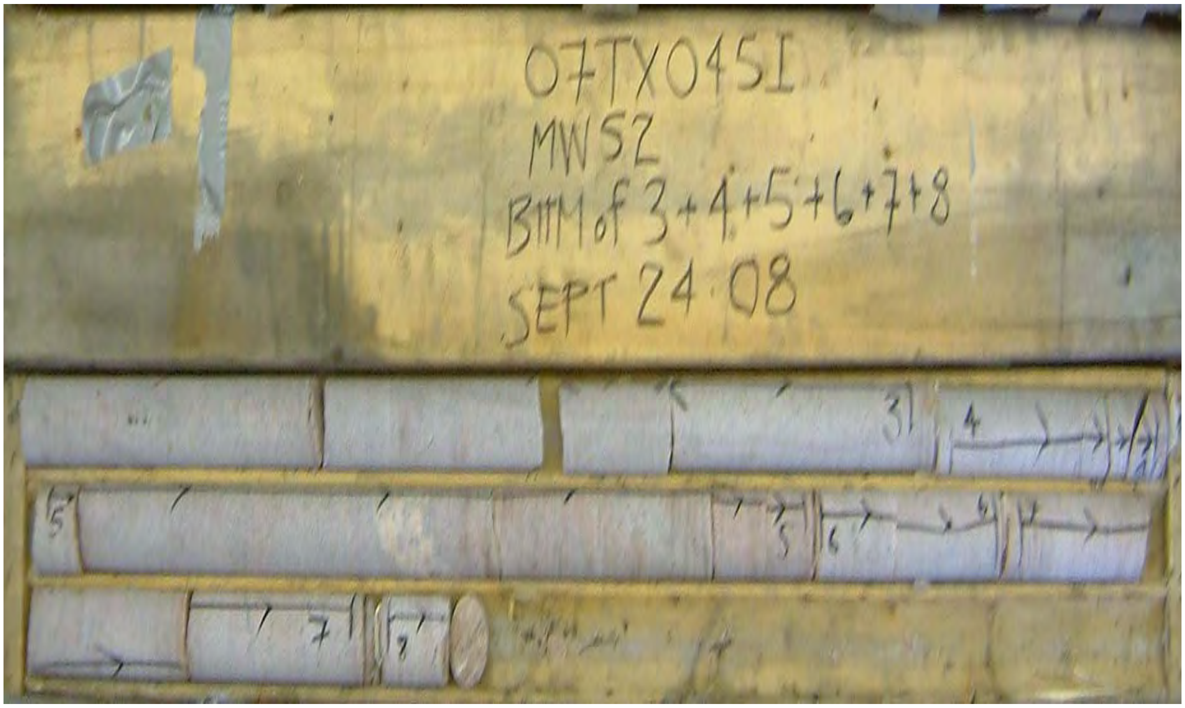
Geocres No. 41H–66

HWY No 69			DIST 54
SUBM'D MA	CHECKED MA	DATE DEC. 18, 2008	SITE ––
DRAWN NA	CHECKED MHM	APPROVED BRG	DWG 5S

Core Photo 1: Borehole S1, Run 3 to 5, 3.4 to 7.4 m.

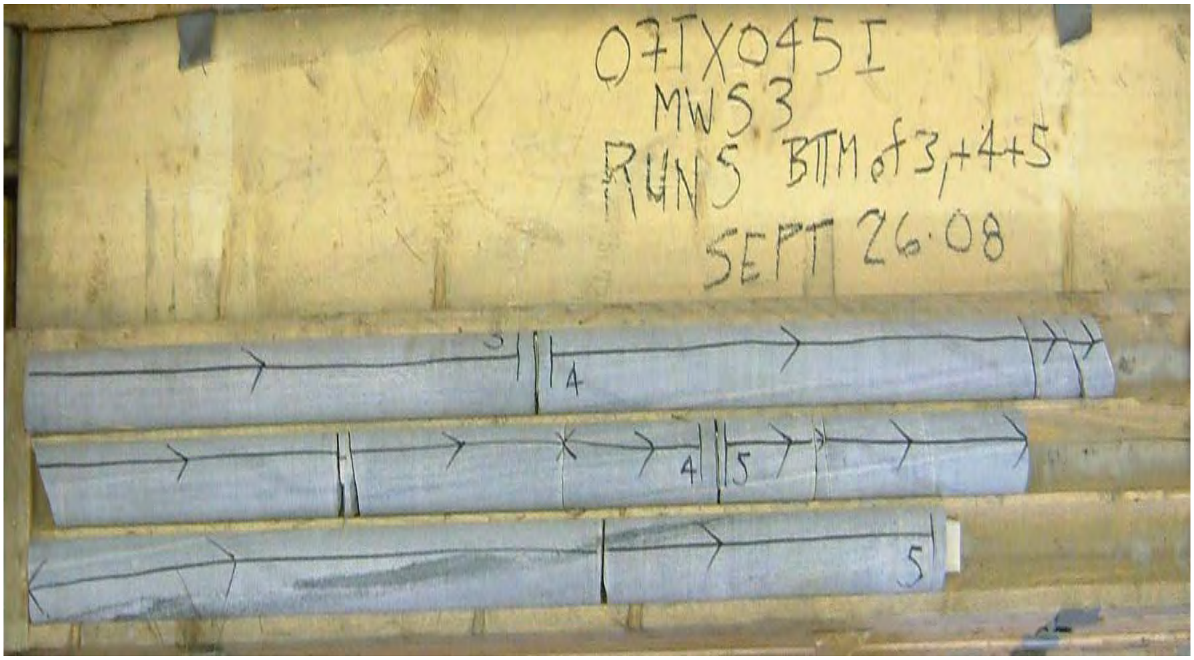


Core Photo 2: Borehole S2, Run 1 to 3, 0.0 to 4.2 m.



Core Photo 3: Borehole S2, run 4 to 7 and bottom part of Run 3, 4.2 to 7.0 m.

Core Photo 4: Borehole 3, Run 1 to 3, 0.0 to 4.0 m.



Core Photo 5: Borehole S3, Run 4, 5 and bottom part of Run 3, 4.0 to 7.8 m.

Core Photo 6: Borehole S4D, Run 1 to 3, 0.1 to 4.5 m.

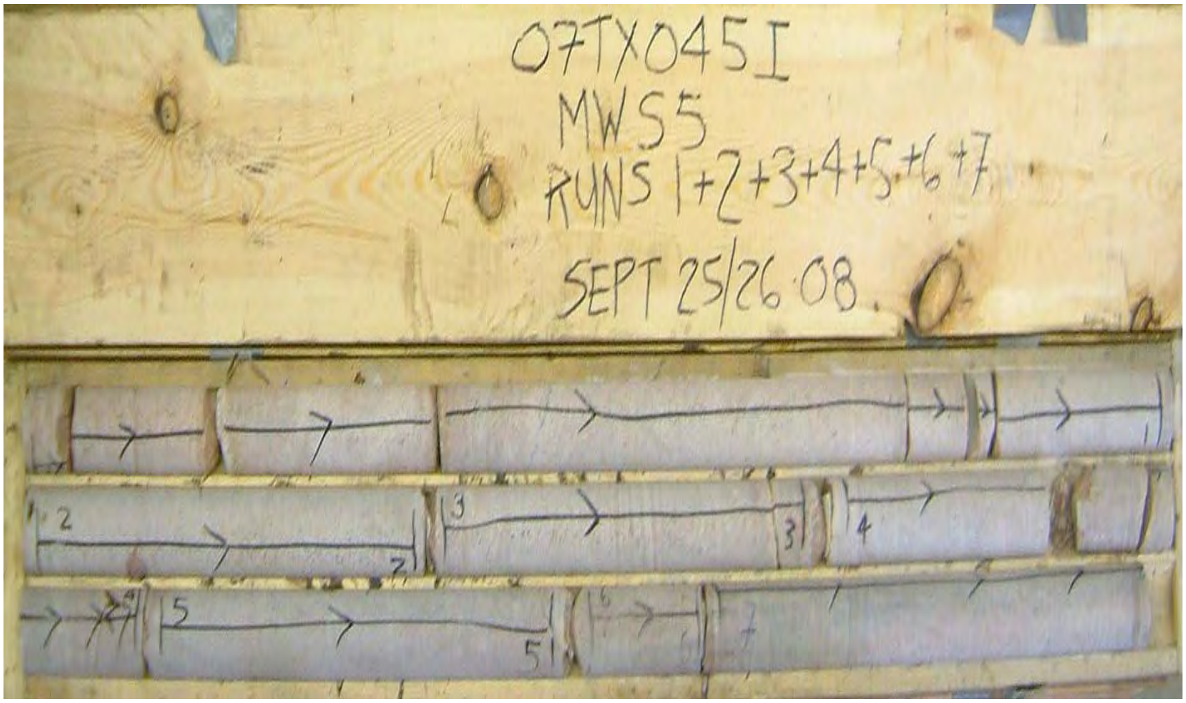
Core Photo 7: Borehole S4D, Run 4, 5 and bottom part of Run 3, 4.5 to 7.8 m.

Core Photo 8: Borehole S4D, Run 6, 7.8 to 9.2 m.

Core Photo 9: Borehole S4M, Run 1 to 4, 4.0 to 4.6 m.

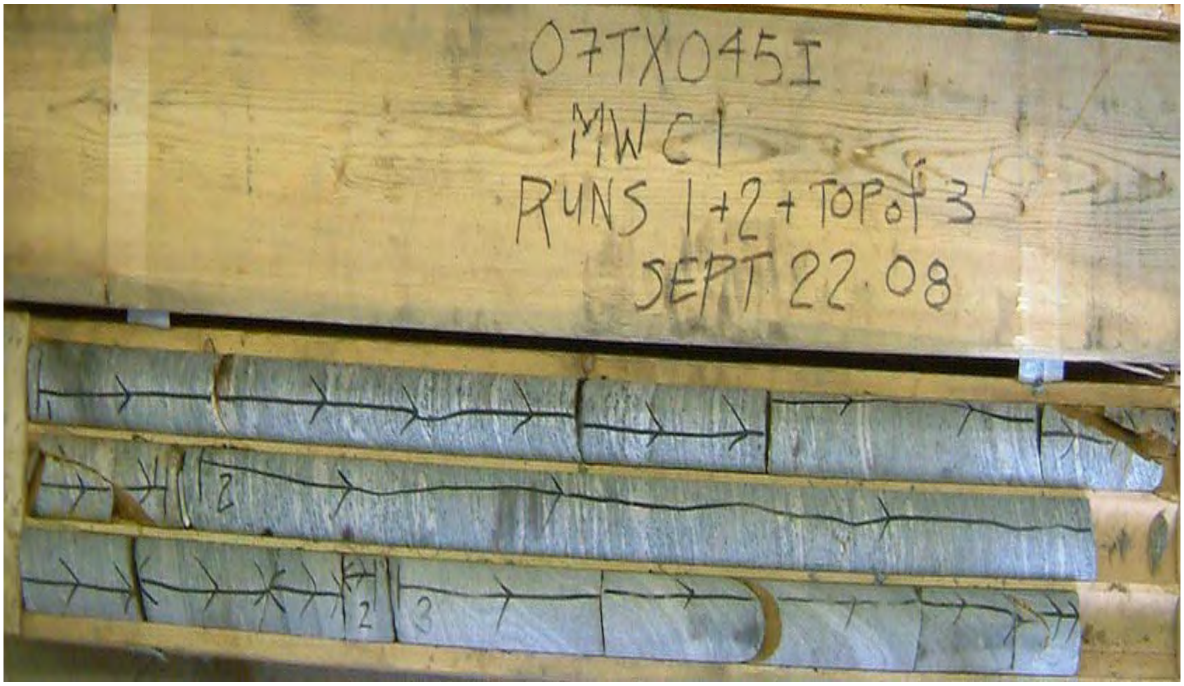
Core Photo 10: Borehole S4M, Run 5, 6 and bottom part of Run 4, 4.6 to 7.4 m.

Core Photo 11: Borehole S4S, Run 1 to 3, 0.1 to 4.6 m.



Core Photo 12: Borehole S5, Run 1 to 7, 0.1 to 4.4 m.

Core Photo 13: Borehole S5, Run 8 and bottom part of Run 7, 4.4 to 6.1 m.



Core Photo 1: Borehole C1, Run 1 to 3, 0.0 to 2.7 m.

Core Photo 2: Borehole C1, Run 4, 5 and bottom part of Run 3, 2.7 to 7.8 m.

Core Photo 3: Borehole C2, Run 1 to 3, 0.0 to 4.0 m.

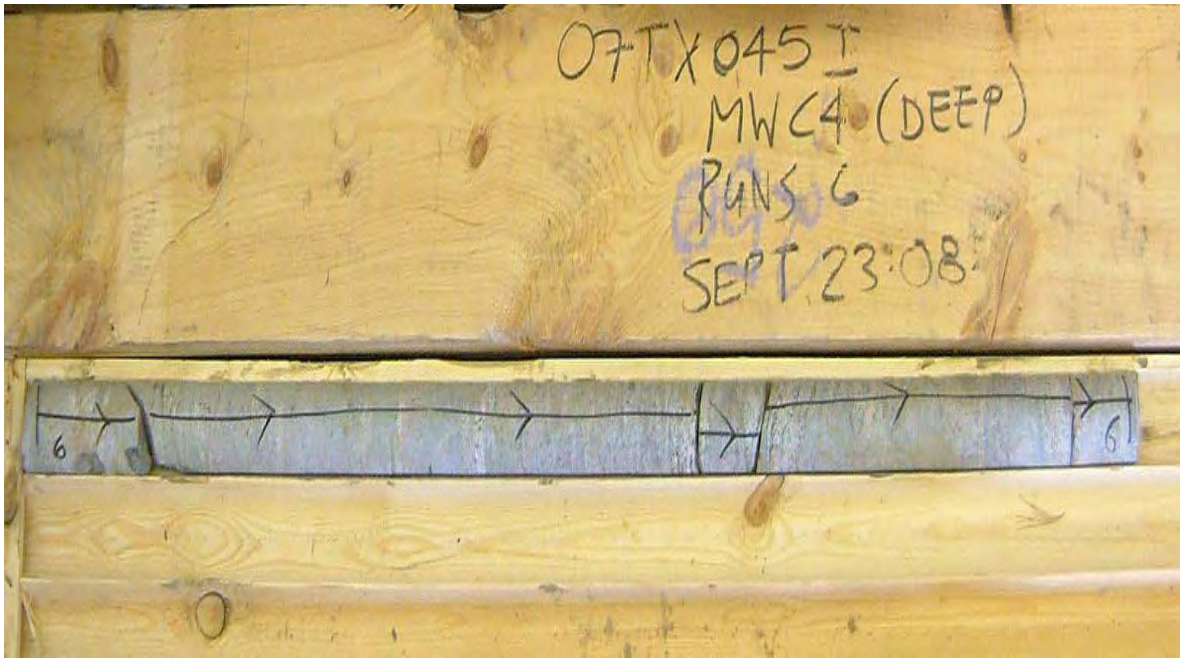
Core Photo 4: Borehole C2, Run 4, 5 and bottom part of Run 3, 4.0 to 7.6 m.

Core Photo 5: Borehole C3, Run 1 to 3, 0.0 to 4.5 m.

Core Photo 6: Borehole C3, Run 4, 5 and bottom part of Run 3, 4.5 to 7.8 m.

Core Photo 7: Borehole C4D, Run 1 to 3, 0.7 to 4.9 m.

Core Photo 8: Borehole C4D, Run 4 and 5, 4.9 to 8.0 m.



Core Photo 9: Borehole C4D, Run 6, 8.0 to 9.2 m.

Core Photo 10: Borehole C4M, Run 1 to 3, 0.7 to 4.9 m.

Core Photo 11: Borehole C4M, Run 4 and 5, 4.9 to 7.8 m.

Core Photo 12: Borehole C4S, Run 1 to 3, 0.6 to 4.7 m.

Core Photo 13: Borehole C5, Run 1 to 3, 0.0 to 4.1 m.

Core Photo 14: Borehole C5, Run 4, 5 and bottom part of Run 3, 4.1 to 7.5 m.

Core Photo 1: Borehole N1, Run 1 to 4, 0.0 to 4.2 m.

Core Photo 2: Borehole N1, Run 5, 6 and bottom part of Run 4, 4.2 to 7.9 m.

Core Photo 3: Borehole N1, Run 7, 7.9 to 9.3 m.

Core Photo 4: Borehole N2, Run 1 to 3, 0.1 to 4.4 m.

Core Photo 5: Borehole N2, Run 2, Close up view showing vertical partings upto 5 mm wide with secondary mineralization.

Core Photo 6: Borehole N2, Run 4 to 6 and Bottom Part of Run 3, 4.4 to 7.8 m.

Core Photo 7: Borehole N3, Run 1 to 3, 0.0 to 3.2 m.

Core Photo 8: Borehole N3, Run 4 and 5, 3.2 to 6.4 m.

Core Photo 9: Borehole N4, Run 1 to 3, 0.0 to 3.7 m.

Core Photo 10: Borehole N4, Run 4 and 5, 3.7 to 6.7 m.

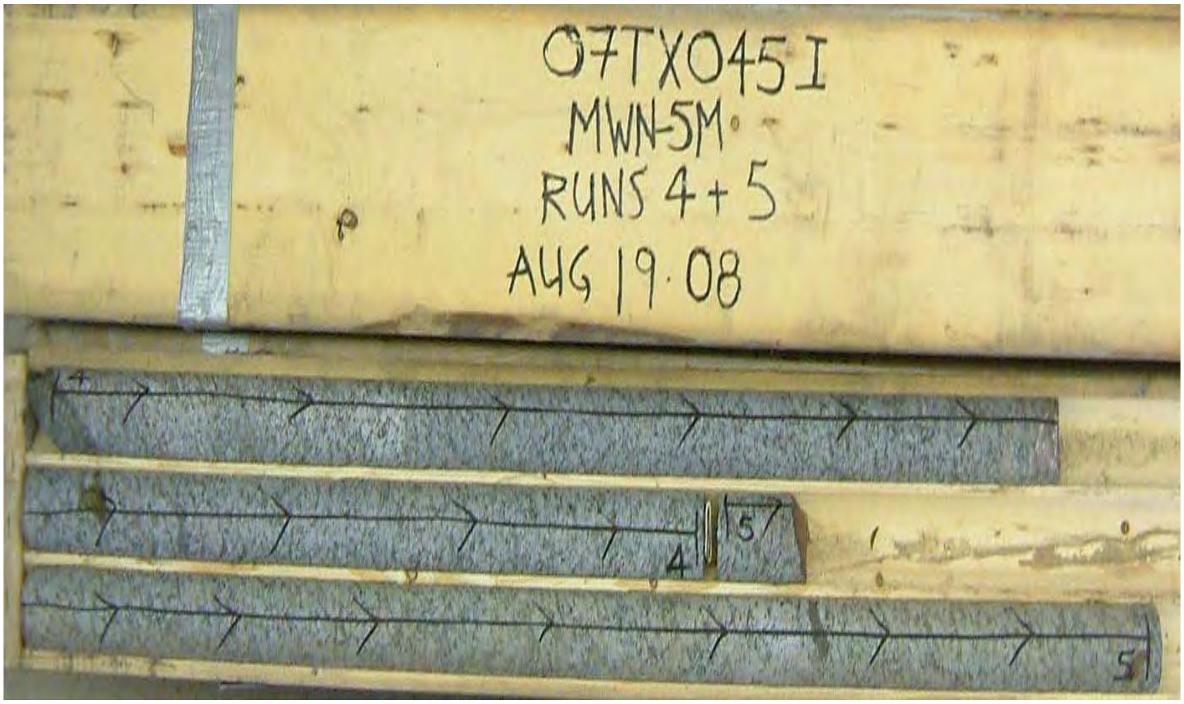
Core Photo 11: Borehole N5D, Run 1 and 2, 0.0 to 3.2 m.

Core Photo 12: Borehole N5D, Run 3 and 4, 3.2 to 6.1 m.

Core Photo 13: Borehole N5D, Run 5 and 6, 6.1 to 9.2 m.

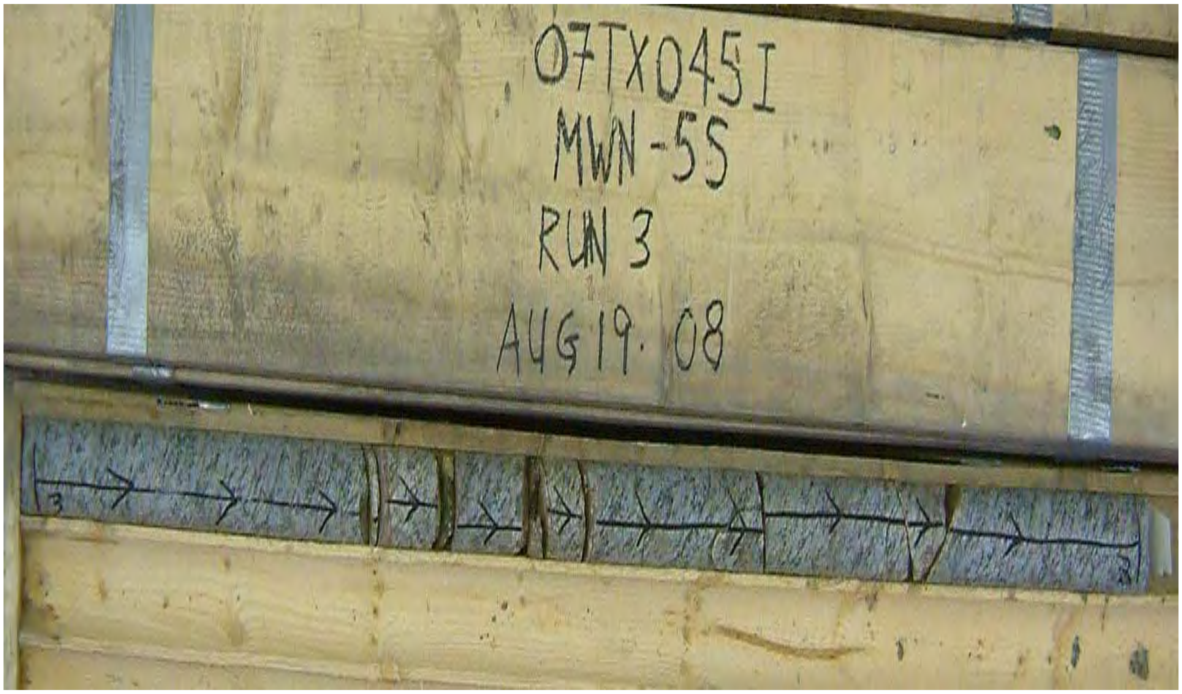
Core Photo 14: Borehole N5M, Run 1 to 3, 0.8 to 4.6 m.

Core Photo 15: Borehole N5M, Close up view of Run 2 showing oxidation and weathering.



Core Photo 16: Borehole N5M, Run 4 and 5, 4.6 to 7.7 m.

Core Photo 17: Borehole N5S, Run 1 and 2, 0.2 to 3.3 m.



Core Photo 18: Borehole N5S, Run 3, 3.3 to 4.7 m.

STATEMENT OF LIMITATIONS

This report is prepared for and made available for the sole use of the client named. Peto MacCallum Ltd. (PML) hereby disclaims any liability or responsibility to any person or entity, other than those for whom this report is specifically issued, for any loss, damage, expenses, or penalties that may arise or result from the use of any information or recommendations contained in this report. The contents of this report may not be used or relied upon by any other person without the express written consent and authorization of PML.

This report shall not be relied upon for any purpose other than as agreed with the client named without the written consent of PML. It shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. A portion of this report may not be used as a separate entity: that is to say the report is to be read in its entirety at all times.

The report is based solely on the scope of services which are specifically referred to in this report. No physical or intrusive testing has been performed, except as specifically referenced in this report. This report is not a certification of compliance with past or present regulations, codes, guidelines and policies.

Environmental site assessment studies are performed in different phases by the application of different levels of effort and expense. The phase or phases in this report and the level of effort proposed for this assignment were based solely on PML's understanding of the client's needs as described in the scope of services contained in this report.

This assessment does not wholly eliminate uncertainty regarding the potential for existing or future costs, hazards or losses in connection with the subject property and must be viewed as a mechanism to reduce risk rather than eliminate the risk of contamination concerns.

The scope of services carried out by PML is based on details of the proposed development and land use to address certain issues, purposes and objectives with respect to the specific site as identified by the client. Services not expressly set forth in writing are expressly excluded from the services provided by PML. In other words, PML has not performed any observations, investigations, study analysis, engineering evaluation or testing that is not specifically listed in the scope of services in this report. PML assumes no responsibility or duty to the client for any such services and shall not be liable for failing to discover any condition, whose discovery would require the performance of services not specifically referred to in this report.

STATEMENT OF LIMITATIONS (Cont'd)

The findings and comments made by PML in this report are based on the conditions observed at the time of PML's site reconnaissance. No assurances can be made and no assurances are given with respect to any potential changes in site conditions following the time of completion of PML's field work. Furthermore, regulations, codes and guidelines may change at any time subsequent to the date of this report and these changes may effect the validity of the findings and recommendations given in this report.

The results and conclusions with respect to site conditions are therefore in no way intended to be taken as a guarantee or representation, expressed or implied, that the site is free from any contaminants from past or current land use activities or that the conditions in all areas of the site and beneath or within structures are the same as those areas specifically sampled.

Any investigation, examination, measurements or sampling explorations at a particular location may not be representative of conditions between sampled locations. Soil, groundwater, surface water, or building material conditions between and beyond the sampled locations may differ from those encountered at the sampling locations and conditions may become apparent during construction which could not be detected or anticipated at the time of the intrusive sampling investigation.

Budget estimates contained in this report are to be viewed as an engineering estimate of probable costs and provided solely for the purposes of assisting the client in its budgeting process. It is understood and agreed that PML will not in any way be held liable as a result of any budget figures provided by it.

The Client expressly waives its right to withhold PML's fees, either in whole or in part, or to make any claim or commence an action or bring any other proceedings, whether in contract, tort, or otherwise against PML in anyway connected with advice or information given by PML relating to the cost estimate or Environmental Remediation/Cleanup and Restoration or Soil and Groundwater Management Plan Cost Estimate.