December 2014

ENVIRONMENTAL ASSESSMENT OF THE PROPOSED CAPITAL REGION RESOURCE RECOVERY CENTRE

TAGGART
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The complete Environmental Assessment Study Report consists of the following components:

VOLUME I

Environmental Assessment

TECHNICAL SUPPORT DOCUMENTS

TSD #1 – Comparison of Alternative Sites

TSD #2 – Atmosphere - Noise

TSD #3 – Atmosphere – Air

TSD #4 – Biology

TSD #5 – Land Use & Socio-Economic

TSD #6 – Archaeological Assessment

TSD #7 – Cultural Heritage Evaluation Report

TSD #8 – Agriculture

TSD #9 – Traffic Impact Study

TSD #10 – Leachate Management

VOLUME II

Consultation Record

VOLUME III

Geology, Hydrogeology and Geotechnical Report

VOLUME IV

Design and Operations Reports

February 2013

Technical Support Document # 1

COMPARATIVE EVALUATION OF ALTERNATIVE SITES CAPITAL REGION RESOURCE RECOVERY CENTRE

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Table of Contents

APPENDICES

INTRODUCTION

This supporting document provides the background information and rationale used for all environmental components to complete a comparison of the two Alternative Sites proposed for the CRRRC project. The information used in this comparison was that available from published information and from preliminary investigations/assessments on or in the vicinity of each of the Alternative Sites. Each of the following **Appendices TSD#1-A through TSD#1-I** provides the information and rationale used in the comparative assessment for each component, and identifies the Site that is preferred for that component. The comparison was undertaken in accordance with the Ministerial approved Terms of Reference for the Environmental Assessment of the proposed CRRRC. This comparison is summarized and the overall preferred Site for the CRRRC project is identified in the EASR.

APPENDIX TSD#1-A

Atmospheric Component

February 2013

February 2013

Atmospheric Component
Appendix TSD#1-A

COMPARATIVE EVALUATION OF ALTERNATIVE SITES

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Table of Contents

TABLES

FIGURES

INTRODUCTION

Two properties that are owned or have been optioned by Taggart Miller have been identified for the proposed Capital Region Resource Recovery Centre (CRRRC) (the Alternative Sites). The Alternative Sites are described below:

- **North Russell Road Site (NRR Site)** – located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell.
- **Boundary Road Site (BR Site)** – located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, Township of Cumberland.

The CRRRC is proposed to provide facilities and capacity for recovery of resources and diversion of material from disposal generated by the industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sectors primarily in Ottawa and secondarily a portion of eastern Ontario, for management and utilization of surplus and contaminated soils, as well as landfill disposal capacity for material that is not diverted.

1.0 ASSESSMENT CRITERIA, INDICATORS AND DATA SOURCES

The atmospheric component compared the Alternative Sites using the following criterion:

- Which site is preferred regarding potential effects due to air quality and noise?

The indicator is:

- The number, type and location of off-Site receptors in the Site-vicinity (within 500 metres (m) of the Site boundary).

The data sources used included aerial photographic mapping and field reconnaissance, land-use and zoning maps and consultation with Russell Township and the City of Ottawa (as required).

2.0 PRELIMINARY DESCRIPTION OF EXISTING ENVIRONMENT

The following sections describe the existing environmental conditions for the atmospheric component at each of the Alternative Sites based on the preliminary investigations and assessments.

2.1 Air Quality – General

The existing concentrations of indicator compounds in the region were noted as background information. The number and location of off-Site sensitive receptors in the Site-vicinity were evaluated. The Ontario Ministry of the Environment (MOE) considers potential receptors to be "sensitive receptors", where sensitive receptors are locations such as residential dwellings, childcare facilities, hospitals, hotels, campsites and places of worship.

Indicator compounds represent compounds that may be emitted from Site operations, waste processing and landfilling operations. Particulate matter is typically associated with airborne dust from vehicles travelling on on-Site paved roads and unpaved roads/haul routes, as well as material loading and unloading activities. Products of combustion (NO_X, NO_2, SO_2 and CO) are associated with the exhaust from on-Site vehicles. Potential emissions of hydrogen sulphide, vinyl chloride, methane and subsequent odours are the result of breakdown of waste material within the landfill or associated with the proposed organics processing (anaerobic digestion).

In Ontario, limits and guidelines for regulating air quality are established under Ontario Regulation (O. Reg.) 419/05 (Air Pollution – Local Air Quality) (MOE 2005). These include standards, point-of-impingement (POI) guidelines and ambient air quality criteria (AAQC) for various compounds (MOE 2012). The AAQC are commonly used in assessments of general air quality in a community, whereas the standards and POI guidelines are used to assess specific impacts of an individual facility for compliance and permitting requirements. The limits outlined in O.Reg. 419/05 must typically be met at the property line of the facility. For certain compounds, typically nuisance-based (such as odour), compliance is evaluated at the specific sensitive receptors.

In addition, there are two sets of federal objectives and criteria; namely, the National Ambient Air Quality Objectives (NAAQOs) and the Canada-Wide Standards (CCME 1999). The federal objectives and standards are benchmarks that are used to facilitate air quality management on a regional scale, and provide national goals for outdoor air quality that protect public health, the environment or aesthetic properties of the environment.

2.1.1 Existing Air Quality

In characterizing the existing environment for air, no Site-specific air quality monitoring was conducted. Instead, background air quality was determined from MOE monitoring stations. The closest air quality monitoring stations to the proposed Undertaking are the two stations located in Ottawa: Ottawa Downtown and Ottawa Central. The relative locations of the air monitoring stations to the two alternative Sites for the proposed Undertaking are summarized in Table 2.1-1.

Table 2.1-1: Location of Air Monitoring Stations

City	Station ID	Location	Lat/Long	Average Distance to Sites (km)	Direction
Ottawa Downtown (Ottawa DT)	51001	Outside Site-Vicinity	44.1502528, -77.3955	22	West-Northwest (generally upwind)
Ottawa Central (Ottawa C)	51002	Outside Site-Vicinity	45.033333 -75.675	23	West-Northwest (generally upwind)

At each station, not all compounds have the same data availability, as the monitoring of some compounds is added to the station while others are discontinued. Table 2.1-2 provides a summary of the monitoring data available from each of these stations.

Table 2.1-2: Availability of Ambient Air Quality Data

Compound	Ottawa DT	Ottawa C
SPM	N/A	N/A
PM_{10}	N/A	N/A
$PM_{2.5}$	2003-2011	2007-2011
NO_x	2000-2011	2007-2011
NO_2	2000-2011	2007-2011
SO_2	2001, 2003-2011	2007-2009
CO	2001, 2003-2011	2007-2009

Note: "NA" indicates that data for the compound were not available at that station.

The historic monitoring data for the two stations evaluated indicate that the compound levels in the area are typical when compared to other locations in Southeastern Ontario. All measured values were below their respective AAQC values. The existing values considered to be representative of background air quality are outlined in Table 2.1-3. Generally, the 90th percentile of measured concentration is considered representative of local background air quality.

Table 2.1-3: Background Air Quality Values (90th Percentile, Average for Annual Only)

Compound	Averaging Period	Ottawa DT ($\mu g/m^3$)	Ottawa C ($\mu g/m^3$)
$PM_{2.5}$	24-hour	12.26	9.92
NO_X	1-hour	62.07	37.62
	24-hour	57.12	35.17
	Annual	28.76	16.92
NO_2	1-hour	45.14	31.98
	24-hour	38.83	26.01
	Annual	20.45	13.30
SO_2	1-hour	7.86	5.24
	24-hour	7.64	6.02
	Annual	2.94	2.52
CO	1-hour	722.65	389.38
	8-hour	827.44	449.51

Note: $\mu g/m^3$ = micrograms per cubic metre

These stations are considered indicative of background air quality levels for both the NRR Site and the BR Site. The ambient air quality for the assessment of the preferred Site will include the contribution from all project works and activities from the preferred Site, as well as the background air quality concentrations. A separate assessment will be conducted to determine compliance with O. Reg. 419/05, which requires evaluation of project works and activities only (i.e., no background air quality added).

2.2 North Russell Road Site

2.2.1 Air

As described in Section 2.1, in Ontario compliance is determined at the property line of the Facility for the majority of compounds. The potential impact of compounds associated with the Undertaking at the property will be based on the actual design of the operations (e.g., number and types of equipment, size of open landfill working area, landfill gas collection systems), which are not fully defined at this point in time. For compounds with nuisance based effects, such as odour, compliance is based on distance to the sensitive receptor (also referred to as point-of-reception [POR]). All concentrations associated with project works and activities decrease with distance from the Site, therefore those PORs located closest to the Undertaking have the greatest potential for air quality impacts.

Based on the Site reconnaissance, 25 sensitive receptors have been identified within the Site-vicinity as shown on Figure 2.2-1. Of these, 13 are located adjacent to the property line, mostly on the west side of the Site. Two PORs were identified on the NRR Site property; however it is understood that these would be removed when the Undertaking is established, therefore they were not considered in the analysis.

N
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LEGEND

- ● POINT OF RECEPTION
- ─ WATER COURSE
- ▭ PROPERTY BOUNDARY

500 250 0 500

SCALE 1:20,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUCTION WITH THE ACCOMPANYING APPENDIX TSD1-A

REFERENCE

BACKGROUND IMAGERY - BING MAPS AERIAL (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

NORTH RUSSELL ROAD SITE
ATMOSPHERIC RECEPTORS

Golder Associates
Ottawa, Ontario

PROJECT NO. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	DD	JAN. 2013	FIGURE 2.2-1	
GIS	PJM	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0110_Atmosphere\1211250045-0500-0110-2.2-1_RussellRdSite_POR.mxd

2.2.2 Noise

The PORs located in the NRR Site-vicinity may be defined as Class 3 rural, as per MOE Publications NPC-232 and NPC-233 (MOE 1995a, 1995b). A Class 3 area can best be described as a rural area with an acoustical environment that is dominated by natural sounds, having little road traffic. The sound level limit for the PORs in a Class 3 area can be described as follows:

The energy averaged sound level (L_{eq}) produced by a source at a POR location in any one hour period should not exceed the greater of; the energy averaged sound level produced by road traffic in the same hour period, or 45 dBA [decibals] in the daytime period of 07:00-19:00, or 40 dBA in the evening period of 19:00-23:00 and 40 dBA in the night-time period of 23:00-07:00.

Twenty-five PORs have been identified as being the most sensitive potential receptors in the vicinity of the Undertaking as shown on Figure 2.2-1.

2.2.3 Summary of NRR Site Considerations

Table 2.2-1: Summary of NRR Site Considerations

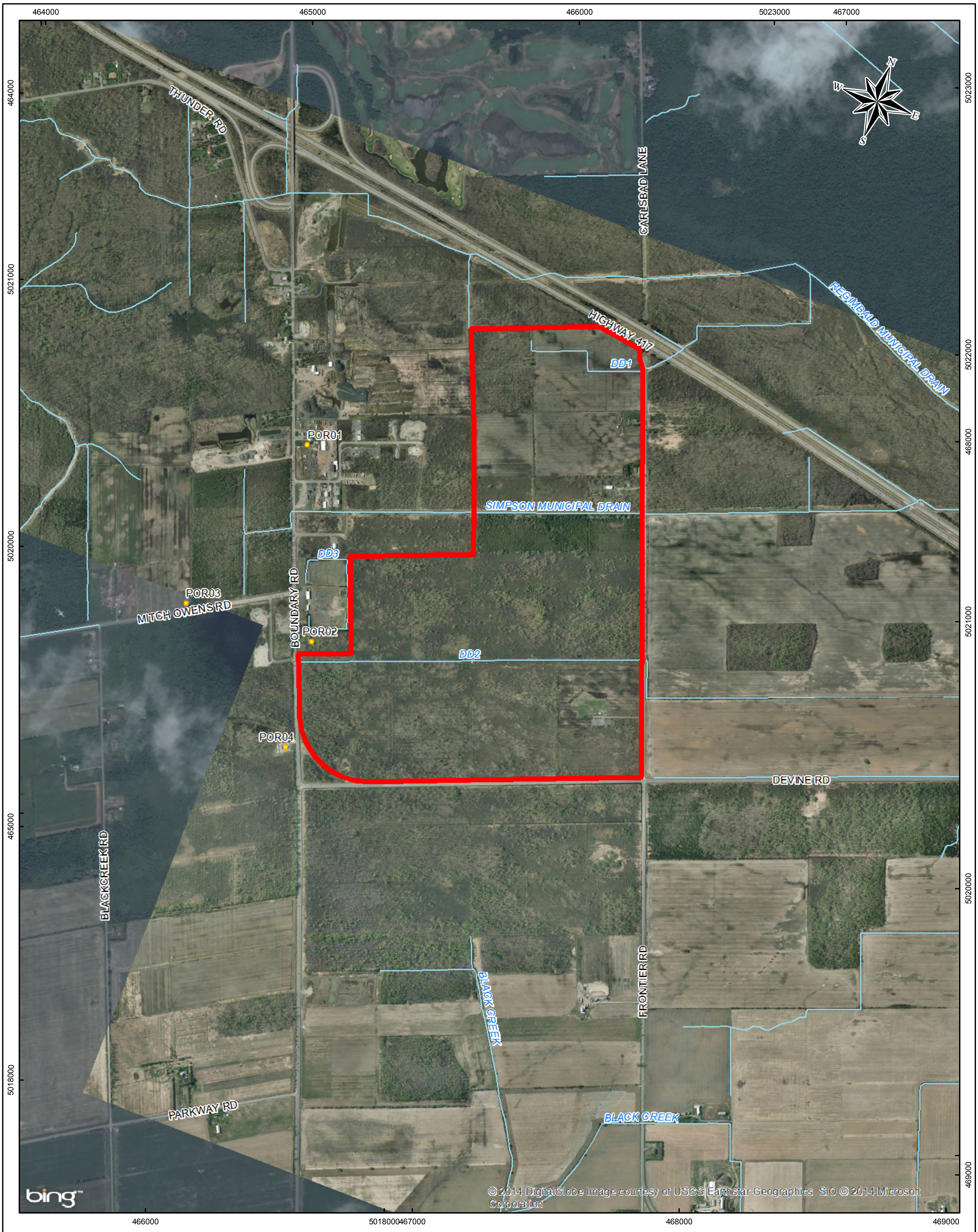
Component	Summary of Site Considerations
Atmospheric	■ Existing background air quality levels are below current AAQC limits. ■ Existing noise levels consistent with a Class 3 area as defined by the MOE in NPC-232 (i.e., 45 dBA daytime and 40 dBA nighttime). ■ Quiet rural environment. As such, the Undertaking is expected to likely result in a change to existing noise levels. ■ Relatively long alternative off-Site haul routes, with variable amounts and types of adjacent land uses as described in the traffic assessment in Appendix TSD#1-I. ■ Twenty-five PORs in the Site-vicinity (i.e., within 500 metres of the Site boundary). ■ Thirteen of these PORs adjacent to the Site boundaries.

2.3 Boundary Road Site

2.3.1 Air

As described in Section 2.1, in Ontario compliance is determined at the property line of the Facility for the majority of compounds. The potential impact of compounds associated with the Undertaking at the property will be based on the actual design of the operations (e.g., number and types of equipment, size of open landfill working area, landfill gas collection systems), which are not fully defined at this point in time. For compounds with nuisance based effects, such as odour, compliance is based on distance to the POR. All concentrations associated with project works and activities decrease with distance from the Site, therefore those PORs located closest to the Undertaking have the greatest potential for air quality impacts.

Based on the Site reconnaissance, 4 sensitive receptors have been identified within the Site-vicinity as shown on Figure 2.3-1. Of these, only one is directly adjacent to the property line and all are on the west side of the Site. Three receptors were identified on the BR Site property; however it is understood that these have been acquired and will be removed when the Undertaking is established, therefore they were not considered in the evaluation.



LEGEND

● POINT OF RECEPTION

— SURFACE WATER FEATURE

▭ PROPERTY BOUNDARY

500 250 0 500

SCALE 1:15,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUCTION WITH THE ACCOMPANYING APPENDIX TSD1-A

REFERENCE

BACKGROUND IMAGERY - BING MAPS AERIAL (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
AERIAL PHOTOGRAPHS PURCHASED FROM THE CITY OF OTTAWA.
LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

BOUNDARY ROAD SITE
ATMOSPHERIC RECEPTORS

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0.0
DESIGN	DD	JAN. 2013	FIGURE 2.3-1	
GIS	PJM	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase4000\TSD1\1211250045-4000-0110-2.3-1_BoundaryRdSite_POR.mxd

2.3.2 Noise

The PORs located in the BR Site-vicinity may be defined as Class 2 urban for PORs in proximity to Highway 417 and Class 3 rural for PORs further away from the highway, in accordance with MOE Publications NPC-205 (MOE 1995c), NPC-232 and NPC-233 (MOE 1995a, 1995b). A Class 2 area can best be described as an urban/suburban blend; whereby sound levels are moderately high during the day (typically 0700-1900) but decrease during the evening (typically 1900-2300) and night-time hours (typically 2300-0700).

The sound level limit for the PORs in a Class 2 area is described as follows;

The energy averaged sound level (L_{eq}) produced by a source at a POR location in any one hour period should not exceed the greater of; the energy averaged sound level produced by road traffic in the same hour period, or 50 dBA in the daytime period of 07:00-19:00, or 45 dBA in the evening period of 19:00-23:00 and 45 dBA in the night-time period of 23:00-07:00.

Existing noise levels for the Class 3 PORs for the BR Site would be similar to those at the NRR Site (i.e., 45 dBA daytime and 40 dBA nighttime).

Four PORs have been identified as being the most sensitive receptors in the vicinity of the Undertaking as shown on Figure 2.3-1.

2.3.3 Summary of BR Site Considerations

Table 2.3-1: Summary of BR Site Considerations

Component	Summary of Site Considerations
Atmospheric	■ Existing background air quality levels are below current AAQC limits. ■ Existing noise levels consistent with Class 2 and Class 3 areas as defined by the MOE in NPC-205 and NPC-232, respectively (i.e., 50 dBA daytime / 45 dBA nighttime and 45 dBA daytime / 40 dBA nighttime). ■ Traffic along Highway 417 results in higher background noise levels. As such, the Undertaking is expected to result in a relatively small change to existing noise levels. ■ Relatively short off-Site haul route with mostly commercial adjacent land uses as described in the traffic assessment in Appendix TSD#1-I. ■ Four PORs in the Site-vicinity (i.e., within 500 metres of the Site boundary). ■ One POR adjacent to the Site boundary.

3.0 SITE COMPARISON – ATMOSPHERIC

3.1 Comparison of Sites

In comparing the NRR Site and the BR Site with respect to air and noise, the number of PORs within 500 metres of the Site boundary was the approved indicator. The BR Site has far fewer PORs that could be potentially affected due to air and noise emissions from the Undertaking and is therefore the preferred Site for this criterion.

In comparing the two Sites, the following conclusions can be made:

- There are far fewer PORs in the Site-vicinity of the BR Site;
- The existing noise levels at some of the PORs in the Site-vicinity of the BR Site will have an elevated background noise level due to Highway 417:
    - These PORs will experience a smaller change in noise levels due to the Undertaking;
- There are far fewer PORs directly adjacent to the BR Site boundary;
- Considering that the prevailing wind direction is from the west, in terms of PORs and potential associated effects, there are no PORs immediately east (downwind) of the BR Site; and,
- The off-Site haul route for the BR Site is shorter and will result in smaller changes in noise levels due to the proximity to Highway 417.

3.2 Results of Site Comparison

Based on the comparative analysis summarized above, the BR Site is the preferred alternative for both air and noise constituents of the atmospheric environment.

REFERENCES

Canadian Council of Ministers of the Environment (CCME). 1999. *Canadian Environmental Quality Guidelines. Available at: http://www.ccme.ca/publications/ceqg_rcqe.html*

Ontario Ministry of the Environment (MOE). 1995a. Sound Level Limits for Stationary Sources in Class 3 Areas (Rural). October 1995.

MOE. 1995b. Information to be Submitted for Approval of Stationary Sources of Sound. October 1995.

MOE. 1995c. Sound Level Limits for Stationary Sources in Class 1 & 2 Areas (Urban). October 1995.

MOE. 2005. Ontario Regulation 419/05 – Air Pollution - Local Air Quality.

MOE. 2012. Summary of Standards and Guidelines to support Ontario Regulation 419/05 – Air Pollution – Local Air Quality (including Schedule 6 of O.Reg.419/05 on Upper Risk Thresholds (sorted by contaminant name). Standards Development Branch PIBS 6569e01.

APPENDIX TSD#1-B

Geology, Hydrogeology & Geotechnical Component

February 2013

February 2013

Geology, Hydrogeology & Geotechnical Component

Appendix TSD#1-B

COMPARATIVE EVALUATION OF ALTERNATIVE STUDIES

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Table of Contents

TABLES

FIGURES

ATTACHMENTS

ATTACHMENT TSD#1-B-1
Records of Test Pits and Augerholes and Grain Size Distribution (NRR Site)

ATTACHMENT TSD#1-B-2
Borehole/Drillhole Logs and MOE Water Well Records

ATTACHMENT TSD#1-B-2-1
Borehole/Drillhole Logs and MOE Water Well Records (NRR Site)

ATTACHMENT TSD#1-B-2-2
CPT Logs, Borehole Logs and Grain Size Distribution (BR Site)

ATTACHMENT TSD#1-B-3
Packer Testing Results – BH09-3 through BH09-6 (NRR Site)

ATTACHMENT TSD#1-B-4
Geophysical Logging Results (NRR Site)

ATTACHMENT TSD#1-B-4-1
Stratigraphic Correlation Figures

ATTACHMENT TSD#1-B-4-2
Geophysical Logging Results for BH09-4

ATTACHMENT TSD#1-B-4-3
Geophysical Logging Results for BH09-7

ATTACHMENT TSD#1-B-4-4
Geophysical Logging Results for BH09-8

ATTACHMENT TSD#1-B-5
Groundwater and Quarry Water Elevation Data (NRR Site)

ATTACHMENT TSD#1-B-6
On-Site Groundwater Quality Results

ATTACHMENT TSD#1-B-6-1
On-Site Groundwater Quality Results (NRR Site)

ATTACHMENT TSD#1-B-6-2
On-Site Groundwater Quality Results (BR Site)

ATTACHMENT TSD#1-B-7
Residential Water Quality Results and Completed Water Supply Surveys

ATTACHMENT TSD#1-B-7-1
Residential Water Quality Results and Completed Water Supply Surveys (NRR Site)

ATTACHMENT TSD#1-B-7-2
Residential Water Quality Results and Completed Water Supply Surveys (BR Site)

INTRODUCTION

Two properties that are owned or have been optioned by Taggart Miller have been identified for the proposed Capital Region Resource Recovery Centre (CRRRC) (the Alternative Sites). The Alternative Sites are described below:

- **North Russell Road Site (NRR Site)** – located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell.
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The CRRRC is proposed to provide facilities and capacity for recovery of resources and diversion of material from disposal generated by the industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sectors primarily in Ottawa and secondarily a portion of eastern Ontario, for management and utilization of surplus and contaminated soils, as well as landfill disposal capacity for material that is not diverted.

1.0 ASSESSMENT CRITERIA, INDICATORS AND DATA SOURCES

The geology, hydrogeology & geotechnical component compared the Alternative Sites using the following criterion:

- Which Site is preferred for protection of groundwater?

The indicators are:

- Geological setting;
- Type and thickness of any natural on-Site attenuation layer;
- Presence and quality of groundwater resources on-Site and in Site-vicinity; and
- Interpreted direction of vertical groundwater flow on-Site and in Site-vicinity, i.e., area of groundwater recharge, transitional flow, or groundwater discharge.

The data sources used are published geological, hydrogeological and geotechnical maps and reports including applicable source water protections plans and related studies/reports; municipal Official Plans, specifically any groundwater protection zones, recharge areas, etc.; Ministry of the Environment (MOE) water well records and determination of water well users in the area (using topographic maps, aerial photos and field reconnaissance); and findings of on-Site testing completed for this project or otherwise available to confirm/compare information.

2.0 PRELIMINARY DESCRIPTION OF EXISTING ENVIRONMENT

The following sections describe the existing environmental conditions for the geology, hydrogeology & geotechnical component at each of the Alternative Sites based on the preliminary investigations and assessments.

2.1 North Russell Road Site

2.1.1 Introduction

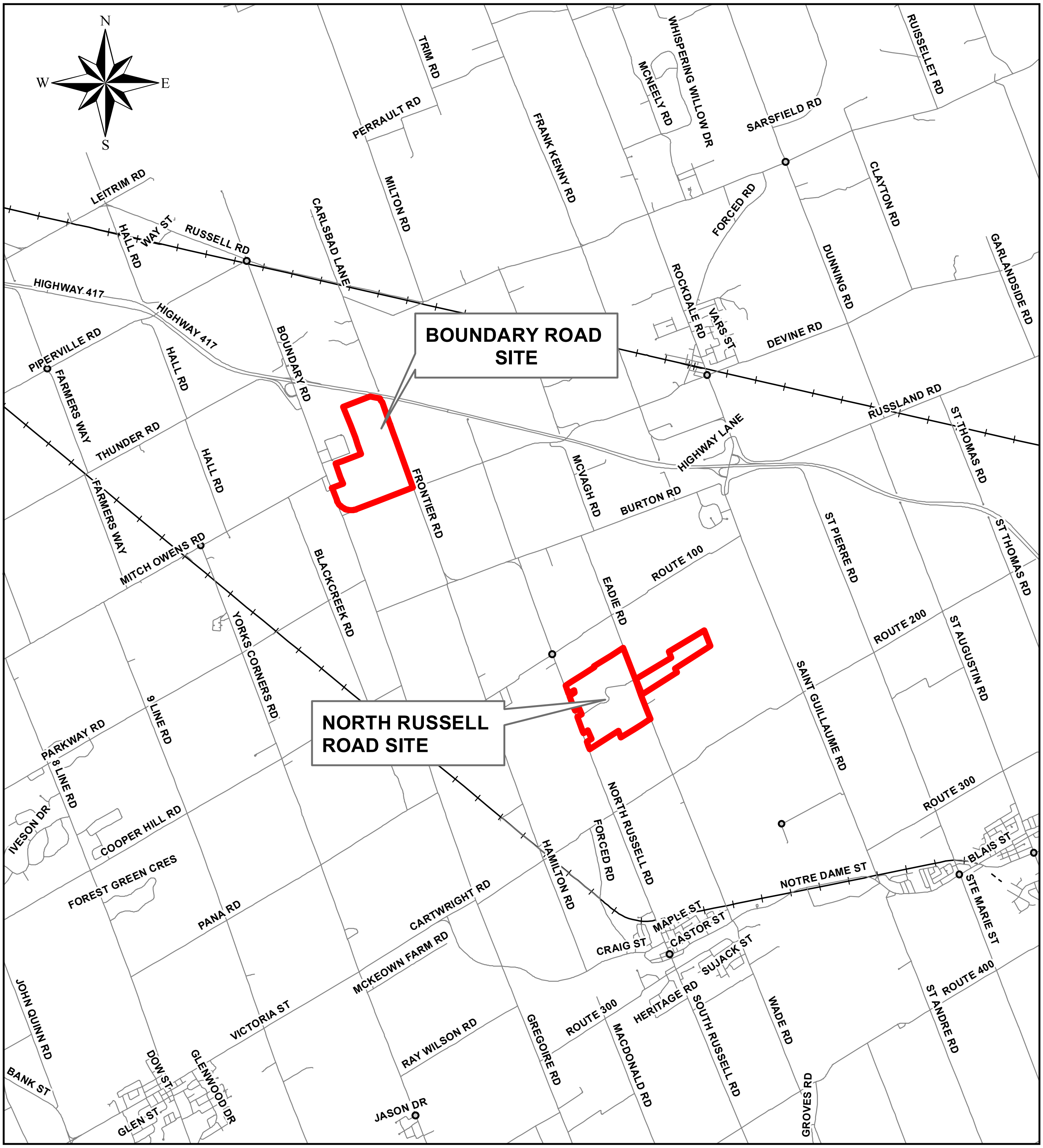
This report summarizes the results of the preliminary subsurface investigation and hydrogeological assessment of the former Hanson Brick Quarry property and adjacent lands located on parts of Lots 18 and 19, Concessions III and IV in the Township of Russell, Ontario. The general location of the NRR Site is shown on Figure 2.1-1. A preliminary subsurface investigation was completed by Golder Associates Ltd. (Golder) to obtain Site-specific geological, hydrogeological and geotechnical information.

2.1.1.1 Site Description

The boundary of the NRR Site is shown on Figure 2.1-2. The NRR Site consists of the former Hanson Brick Quarry property and two pieces of adjoining land. The first piece is a roughly square parcel abutting the northwest side of the former Hanson Brick Quarry property, and the second is a rectangular parcel spanning between Russell Road and Eadie Road to the south of the former Hanson Brick property.

The NRR Site contains a quarry licensed for shale extraction under the *Aggregate Resources Act*, license number 5881, dated May 1999. The approximate extent of the existing quarry extraction area is shown on Figure 2.1-2. The quarry has steep sidewalls and has had material removed down to about elevation 74 metres above sea level (masl), approximately 8 to 12 metres below the surrounding land surface.

The land use surrounding the NRR Site is primarily agricultural and associated rural residential. The NRR Site is generally flat, and slopes from the local high at the western end of the NRR Site towards the lowest portion of the NRR Site found along the eastern edge. Drainage in the vicinity of the NRR Site is mainly by means of a network of agricultural ditches, municipal drains and small creeks. The Fournier Municipal Drain flows easterly away from the NRR Site, and runs through the east portion of the Concession IV part of the property (as shown on Figure 2.1-2). There are also two other Municipal Drains that receive runoff from the Site. The nearest river is the Castor River located about 4.5 kilometres south of the property and running west-east through the Village of Russell.



NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

2,500 0 2,500

SCALE 1:100,000 METRES

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

Golder Associates
Ottawa, Ontario

PROJECT No.	12-1125-0045		
SCALE	AS SHOWN	REV.	0

DATE	FEB. 2013
DESIGN	JPAO
GIS	BR
CHECK	PLE
REVIEW	PAS

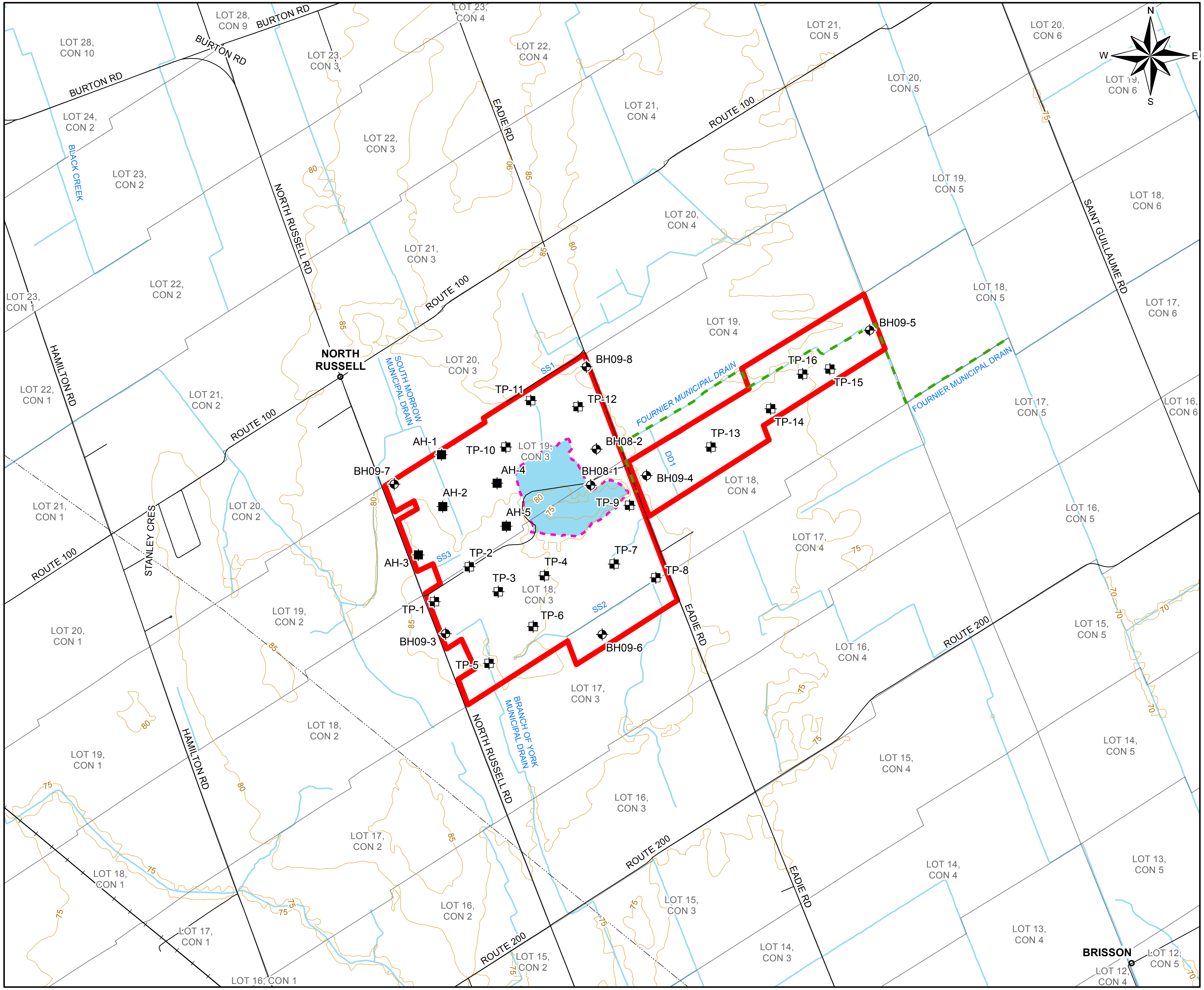
TITLE

KEY PLAN

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

FIGURE 2.1-1

Path: \\golder.gds\gal\Ottawa\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0120_GHandG\1211250045-2.1-1-KeyPlan.mxd



LEGEND

- ○ POPULATED PLACENAME
- ■ AUGERHOLE LOCATION
- ⊕ BOREHOLE/MONITORING WELL LOCATION
- ⊞ TEST PIT LOCATION
- — ROAD
- ┼ RAIL ROAD
- -··- UTILITY LINE
- — CONTOUR LINE, (5m)
- - - FOURNIER MUNICIPAL DRAIN
- — SURFACE WATER FEATURE
- 🟦 WATER AREA
- ☐ LOT/CONCESSION
- ⬚ APPROXIMATE EXTENT OF EXISTING QUARRY EXCAVATION
- 🟥 PROPERTY BOUNDARY

390 195 0 390

SCALE 1:20,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
NRR SITE PLAN

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045		
DESIGN	JPAO	JAN. 2013
GIS	BR	JAN. 2013
CHECK	PLE	AUG. 2014
REVIEW	PAS	AUG. 2014

SCALE AS SHOWN
REV. 0

FIGURE 2.1-2

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0120_GHandG\1211250045-2.1-2-SitePlan.mxd

2.1.2 Local Setting

The following sections provide general information from published sources on the local geology and hydrogeology in the vicinity of the NRR Site. This information was gathered as part of a review of background information completed prior to beginning the subsurface investigation at the NRR Site.

2.1.2.1 Surficial Geology

The surficial geology in the vicinity of the NRR Site is shown on Figure 2.1-3.

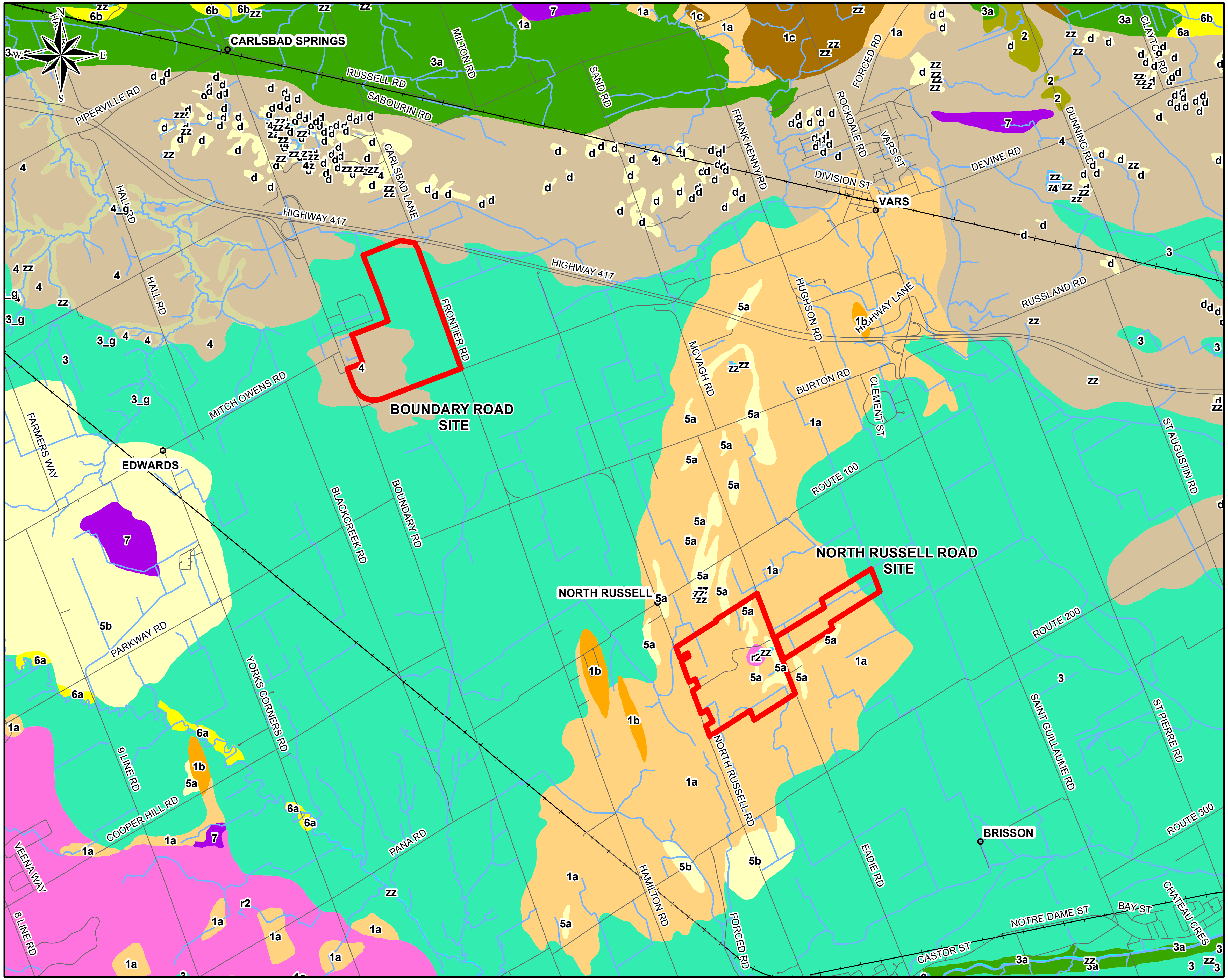
The NRR Site is located within an extensive north-south trending deposit of glacial till (unit 1a on Figure 2.1-3). The glacial till typically consists of sandy silt to silty sand, with gravel, a trace of clay and variable cobble and boulder content. From a review of the published MOE Water Well Information System (WWIS) for wells within the vicinity of the NRR Site, and observations at the NRR Site, the till cover over the bedrock is relatively thin, likely varying from about zero to four metres. The till feature protrudes through, and is surrounded by, an extensive deposit of marine silty clay (unit 3 on Figure 2.1-3). The thickness of the clay generally increases with distance from the till feature, and is indicated from the MOE well records to typically be about 10 to 15 metres thick in the vicinity of the NRR Site, and increasing to about 30 metres with increasing distance from the till feature; the clay is generally underlain by a basal gravelly till deposit followed by bedrock.

2.1.2.2 Bedrock Geology

The bedrock geology in the vicinity of the NRR Site is illustrated on Figure 2.1-4. This figure shows the mapped uppermost bedrock unit beneath the soil cover. The area in the vicinity of the NRR Site is underlain by shale of the Queenston Formation, which is the youngest formation of sedimentary rock in eastern Ontario. Queenston shale is a red, laminated to thickly bedded calcareous siltstone/mudstone and shale. The property is shown to be located near the middle of a band of Queenston shale that is mapped to be approximately 4 kilometres north-south by 15 kilometres west-east. The contacts between bedrock formations are typically caused by a series of near-vertical faults, which caused downthrowing of adjacent blocks of bedrock. To the south, the uppermost bedrock is mapped to be limestone (unit 8 followed by unit 6), while to the north and southwest Carlsbad Formation layered shale and limestone is shown (unit 12). Further southwest is Oxford Formation dolomite (unit 4); this comprises the area of shallow/exposed bedrock shown as unit r2 on Figure 2.1-3.

Information on the thickness of the various bedrock formations in the immediate area of the NRR Site is available from two deep drill cores completed by the Ontario Geological Survey (OGS). As reported in OGS Open File Report 5770 (Williams, 1991), drill hole RU-24, located about two kilometres north of the NRR Site had a total depth of 835 metres and encountered the following: 13 metres of Queenston shale; followed by 187 metres of Carlsbad Formation shale and limestone; followed by the lower formations.

OGS Open File Report 6094 (Armstrong and Sergerie, 2003) was conducted to provide information for Ontario’s brick industry, and reports on drill hole OGS 01-06 completed at the former Hanson Brick Quarry property to a total depth of 61 metres. This hole encountered the following: 1.5 metres of soil followed by 21.5 metres of Queenston shale, and was terminated in the underlying Carlsbad Formation.



LEGEND

- ○ POPULATED PLACENAME
- — ROAD
- ┼ RAILWAY
- — SURFACE WATER FEATURE
- ▭ PROPERTY BOUNDARY

SURFICIAL GEOLOGY

1a	TILL, PLAIN WITH LOCAL RELIEF <5m
1b	TILL, DRUMLINIZED
1c	TILL, HUMMOCKY TO ROLLING WITH LOCAL RELIEF 5 TO 10 m
2	ICE CONTACT STRATIFIED DRIFT: GRAVEL & SAND
3	OFFSHORE MARINE DEPOSITS: CLAY, SILTY CLAY & SILT
3_g	OFFSHORE MARINE DEPOSITS: CLAY, SILTY CLAY & SILT (GULLIES & RAVINES)
3a	OFFSHORE MARINE DEPOSITS: CLAY & SILT UNDERLYING EROSIONAL TERRACES
3a_g	OFFSHORE MARINE DEPOSITS: CLAY & SILT UNDERLYING EROSIONAL TERRACES (GULLIES & RAVINES)
4	DELTAIC AND ESTUARY DEPOSITS: MEDIUM TO FINE GRAINED SAND
4_g	DELTAIC AND ESTUARY DEPOSITS: MEDIUM TO FINE GRAINED SAND (GULLIES & RAVINES)
5a	NEARSHORE SEDIMENTS: GRAVEL, SAND & BOULDERS
5b	NEARSHORE SEDIMENTS: FINE TO MEDIUM GRAINED SAND
6a	ALLUVIAL DEPOSITS: SILTY SAND, SILT, SAND & CLAY
6a_g	ALLUVIAL DEPOSITS: SILTY SAND, SILT, SAND & CLAY (GULLIES & RAVINES)
6b	ALLUVIAL DEPOSITS: MEDIUM GRAINED STRATIFIED SAND WITH SOME SILT
6b_g	ALLUVIAL DEPOSITS: MEDIUM GRAINED STRATIFIED SAND WITH SOME SILT (GULLIES & RAVINES)
7	ORGANIC DEPOSITS: MUCK & PEAT
d	DUNE
d_g	DUNE (GULLIES & RAVINES)
l	LANDSLIDE AREA
l_g	LANDSLIDE AREA (GULLIES & RAVINES)
r1	BEDROCK: INTRUSIVE & METAMORPHIC
r2	BEDROCK: LIMESTONE, DOLOMITE, SANDSTONE & LOCAL SHALE
r2_g	BEDROCK: LIMESTONE, DOLOMITE, SANDSTONE & LOCAL SHALE (GULLIES & RAVINES)
zz	WATER

1,000 0 1,000

SCALE 1:50,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

BELANGER, J. R., URBAN GEOLOGY OF THE NATIONAL CAPITAL AREA. GEOLOGICAL SURVEY OF CANADA, OPEN FILE D3256, 2001 © QUEEN'S PRINTER OF ONTARIO.
LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

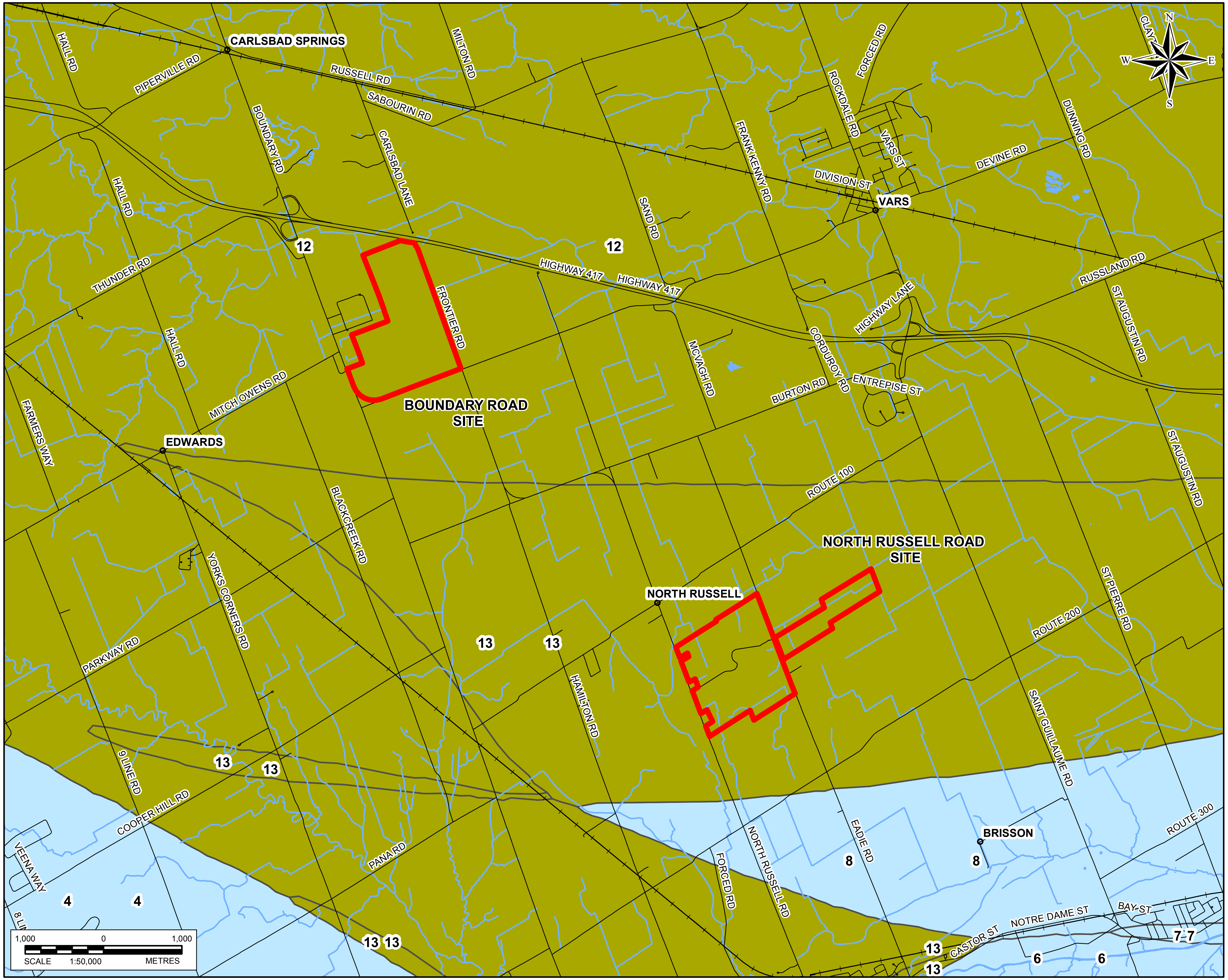
SURFICIAL GEOLOGY

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN
DESIGN	JPAO	JAN. 2013	REV. 0
GIS	BR	JAN. 2013	
CHECK	PLE	AUG. 2014	
REVIEW	PAS	AUG. 2014	

FIGURE 2.1-3

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase4000\TSD1\1211250045-4000-2.1-3-SurficialGeology.mxd



LEGEND

○ POPULATED PLACENAME

— ROAD

┼ RAILWAY

— SURFACE WATER FEATURE

🟥 PROPERTY BOUNDARY

PHANEROZOIC

PALEOZOIC

UPPER ORDOVICIAN

13	QUEENSTON FORMATION: RED TO LIGHT GREENISH GRAY SILTSTONE AND SHALE, WITH INTERBEDS OF SILTY BIOCLASTIC LIMESTONE IN LOWER PART
12	CARLSBAD FORMATION: INTERBEDDED DARK GRAY SHALE, FOSSILIFEROUS CALCAREOUS SILTSTONE, AND SILTY BIOCLASTIC LIMESTONE
11	BILLINGS FORMATION: DARK BROWN TO BLACK SHALE, WITH LAMINATIONS OF CALCAREOUS SILTSTONE
10	EASTVIEW FORMATION: INTERBEDDED SUBLITHOGRAPHIC TO FINE CRYSTALLINE LIMESTONE AND DARK BROWN TO DARK GREY SHALE
MIDDLE TO UPPER ORDOVICIAN	
9	LINDSAY FORMATION: SUBLITHOGRAPHIC TO FINE CRYSTALLINE LIMESTONE, NODUALAR IN PART, WITH INTERBEDS OF CALCARENITE AND SHALE
8	VERULAM FORMATION: INTERBEDDED BIOCLASTIC LIMESTONE, SUBLITHOGRAPHIC TO FINE CRYSTALLINE LIMESTONE
7	BOBCAYGEON FORMATION: INTERBEDDED SILTY DOLOMITE, LITHOGRAPHIC TO FINE CRYSTALLINE LIMESTONE, OOLITIC LIMESTONE, SHALE, AND FINE-GRAINED CALCAREOUS QUARTZ SANDSTONE
6	GULL RIVER FORMATION: INTERBEDDED SILTY DOLOMITE, LITHOGRAPHIC TO FINE CRYSTALLINE LIMESTONE, OOLITIC LIMESTONE , SHALE, AND FINE-GRAINED CALCAREOUS QUARTZ SANDSTONE
5	ROCKCLIFFE FORMATION: INTERBEDDED FINE-GRAINED LIGHT GREENISH GREY QUARTZ SANDSTONE, SHALEY LIMESTONE AND SHALE, LOCALLY CONGLOMERATE AT BASE, INTERBEDS OF CALCARENITE (ST. MARTIN MEMBER, 5A) AND SILTY DOLOSTONE IN UPPER PART
LOWER ORDOVICIAN	
4	OXFORD FORMATION: SUBLITHOGRAPHIC TO FINE CRYSTALLINE DOLOSTONE
3	MARCH FORMATION: INTERBEDDED QUARTZ SANDSTONE, SANDY DOLOSTONE, AND DOLOSTONE
CAMBRIO ORDOVICIAN	
2	NEPEAN FORMATION: FINE TO COARSE GRAINED QUARTZ SANDSTONE, PARTIALLY CALCAREOUS IN UPPER PART
1	COVEY HILL FORMATION: NONCALCAREOUS FELDSPATHIC, FINE TO COARSE GRAINED QUARTZ SANDSTONE AND QUARTZ PEBBLE CONGLOMERATE
UNCONFORMITY	
PRECAMBRIAN	
PC	UNDIFFERENTIATED METAMORPHIC AND IGNEOUS ROCKS

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

BELANGER, J. R., URBAN GEOLOGY OF THE NATIONAL CAPITAL AREA. GEOLOGICAL SURVEY OF CANADA, OPEN FILE D3256, 2001 © QUEEN'S PRINTER OF ONTARIO.

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.

PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

BEDROCK GEOLOGY

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	JAN. 2013	**FIGURE 2.1-4**	
GIS	BR	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

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2.1.2.3 Hydrogeology

Based on a preliminary review of the MOE WWIS, static water levels for private supply wells within 500 metres of the NRR Site were reported to be 1.5 to 7.6 metres below ground surface (mbgs), and the primary aquifer is the Carlsbad Formation (i.e., most wells do not find adequate supplies of water within the Queenston shale). Flow within the bedrock formations occurs through secondary porosity associated with fractures, as both the shale and limestone layers have relatively low intrinsic permeability. Although individual wells installed in the Carlsbad Formation can provide adequate yields for domestic use, yields are often limited due to the proportion of low hydraulic conductivity shale. This unit is considered a poor aquifer due to both uncertainty in yield and poor water quality (Golder, 2003).

Within a five-kilometre radius of the property, water supply wells to the north and south of the NRR Site are reported to encounter water from zones within the shale or limestone bedrock. Elsewhere, where the area is underlain by relatively thick clay deposits, water is typically encountered in drilled wells completed in the basal sand and gravel layer at the soil/bedrock interface, or may be obtained using shallow dug wells completed in a surficial sand layer and upper portion of the clay.

The Prescott Russell Official Plan, dated May 2006, identifies groundwater recharge areas that are interpreted to supply water through communal wells for the Village of Embrun and the Village of Russell as well as the Village of Limoges (see Schedule B of the official plan). Within the limits of the identified groundwater recharge areas, permitted uses are restricted to those which will not result in negative impacts on groundwater. The NRR Site is not located within a groundwater recharge area identified in the official plan. It is noted that both Embrun and Russell have since been connected to the City of Ottawa central water supply system, and the formerly used communal wells are no longer in use.

Additional source water protection work was completed for the Vars and Limoges communal well systems since the Prescott Russell Official Plan was completed in 2006. The results of the additional work are presented in the Assessment Report for the South Nation Source Protection Area dated December 10, 2012. The Vars and Limoges communal wells are the closest communal drinking water supply systems to the NRR Site. Based on the results presented in the Assessment Report, the NRR Site is not located within the wellhead protection area for the Vars or the Limoges communal well system.

2.1.3 Study Methodology

To allow for a preliminary assessment of the suitability of the NRR Site for use as a waste management facility, a work plan was develop to gather Site-specific geological, hydrogeological and geotechnical data to supplement the available published information. The methodology applied during the subsurface investigation and hydrogeological assessment is briefly described below.

2.1.3.1 Test Pit and Augerhole Program

The purpose of the test pit excavation and augerhole drilling program was to define the overburden types, and the thickness and distribution of the overburden on the property. Excavation of the test pits and drilling of the augerholes was monitored by a member of Golder's field staff, who was responsible for classifying the materials exposed on the sides of the test pit and in the samples collected from the augerholes (split spoon sampling) through a visual and tactile examination. Samples of the various materials encountered were collected, labelled and returned to Golder's Ottawa office for subsequent examination. The groundwater seepage conditions were also observed in the open test pits, and the location where water was encountered in the augerholes was noted.

2.1.3.2 Borehole Drilling

The borehole drilling program at the NRR Site was divided into two programs, which included the borehole coring program and the air rotary drilling program.

2.1.3.2.1 Borehole Coring Program

The borehole coring program at the NRR Site included the drilling of four boreholes. The cored boreholes were identified as BH09-3, BH09-4, BH09-5 and BH09-6 (see locations on Figure 2.1-2). At each hole, HW sized casing was installed into the top of the bedrock, and an appropriate stick-up was left as a protective casing. The boreholes were drilled by Marathon Drilling Co. Ltd. (Marathon Drilling) using rotary drilling methods, and involved the collection of rock core from each borehole (HQ or NQ size core). The rock core obtained from each borehole was logged on-Site by Golder staff, and returned to Golder’s Ottawa office for detailed core logging by an experienced geologist.

2.1.3.2.2 Air Rotary Drilling Program

The air rotary drilling program at the NRR Site included the drilling of four boreholes. The boreholes were identified as BH08-1, BH08-2, BH09-7 and BH09-8 (see locations on Figure 2.1-2). All four boreholes were drilled as 0.15-metre diameter open holes using an air rotary drill rig supplied and operated by Bourgeois Well Drilling Ltd. Steel water well casing was installed at all locations, and the annular space between the casing and the formation was sealed using a bentonite grout slurry. Samples of the bedrock (chip samples) produced during the drilling process were collected at regular intervals (i.e., approximately every three metres) for the entire length of the borehole. The samples were examined and described on-Site by Golder staff and returned to Golder’s Ottawa office for additional examination by an experienced geologist.

2.1.3.3 Packer Testing

Pressure packer testing was conducted in the four cored holes (BH09-3, BH09-4, BH09-5 and BH09-6) to assess the hydraulic conductivity of the bedrock along the length of the boreholes. The packer testing was carried out using the drill rig and equipment supplied by Marathon Drilling. The packer testing initially involved a single packer array at the base of the borehole, followed by upstaging to ground surface using a double packer array with a test interval of 2.44 metres.

2.1.3.4 Borehole Geophysical Logging Program

For the purpose of further defining the distribution of the bedrock units at the NRR Site (including potential stratigraphic and/or structural controls) and interpreting the bedrock geology across the NRR Site, boreholes BH09-3 through BH09-8 were geophysically logged.

Locations BH09-3, BH09-5 and BH09-6 were logged for stratigraphy only (see below), while BH09-4, BH09-7 and BH09-8 also included logging for structure (optical/acoustic televiewer and caliper) and “hydrogeophysical” logs (fluid temperature, fluid resistivity and heat pulse flow meter). The term “hydrogeophysical” describes the logs that can be used to infer flowing fractures in the borehole wall and the vertical migration of fluid within the borehole.

A list of the geophysical logs collected includes:

- Stratigraphy:
  - Natural Gamma - passive nuclear log
  - Electromagnetic Induction - apparent conductivity
- Structure:
  - Optical/Acoustic Televiewer - borehole wall imaging
  - Caliper - borehole diameter
- Hydrogeophysics:
  - Fluid Temperature - borehole fluid temperature
  - Fluid Resistivity - borehole fluid resistivity
  - Heat Pulse Flow Meter - vertical borehole fluid movement

At locations BH09-4, BH09-7 and BH09-8, the log acquisition procedure consisted of the following:

- The optical televiewer log was collected first to take advantage of undisturbed (clear) water in the boreholes.
- The natural gamma, apparent conductivity, caliper, acoustic televiewer logs were then collected in no particular order.
- The fluid temperature and fluid resistivity logs were collected under static (non-pumping) and dynamic (pumping) borehole conditions. For the dynamic testing, the pump was run at a rate that would cause drawdown in the boreholes. A 51-milimetre diameter submersible Grundfoss pump was used for the pumping from the borehole for the dynamic testing.

2.1.3.5 Monitoring Well Installation and Elevation Surveying Program

Multi-level groundwater monitoring wells were constructed in BH09-3, BH09-4 and BH09-6 through BH09-8. A single monitoring well was installed in BH09-5, and locations BH08-1 and BH08-2 were left as open holes. The monitoring wells were installed at specific depths to allow for the measurement of groundwater levels and to obtain estimates of horizontal hydraulic conductivity and gradients within the various bedrock formations encountered at the NRR Site. The conversion of the boreholes into multi-level monitoring wells was completed by Golder Associates Innovative Applications (GAIA). GAIA is a licensed well contractor. The preferred locations for the screened intervals of the monitoring wells were determined based on observations during the drilling program, geophysical data and geological core log data and packer testing data (in the case of the cored boreholes), or visual examination of the rock chips (in the case of the air rotary boreholes).

All monitoring wells were constructed of 0.032-metre diameter, threaded, PVC slot #10 screen and solid risers. Clear stone was placed in the borehole around the screened portions of the monitors and bentonite was used to provide seals between the screened intervals and to seal the borehole up to ground surface. Each monitoring well is protected at surface by a steel casing with a lockable cap. An elevation survey of the ground surface and top of casing for the monitoring wells was completed by Golder.

The deepest monitoring well installation at each borehole is designated as monitoring well "A", with each successively shallower monitoring well at each borehole designated as "B" and "C", where appropriate. The monitoring wells were developed following their installation prior to undertaking hydraulic conductivity testing, groundwater level measurements and groundwater sampling.

2.1.3.6 Hydraulic Conductivity Testing

Well response tests were carried out in the monitoring intervals using the rising-head method. The well response testing was undertaken to provide information on the *in-situ* horizontal hydraulic conductivity of the bedrock adjacent to the monitoring well intervals. The rising-head tests consisted of pumping each monitor for approximately 15 to 30 seconds using inertial samplers and polyethylene tubing, followed by monitoring of the groundwater level recovery within the monitor. Before the start of the hydraulic testing, static water levels were measured at all locations. Each hydraulic test was deemed complete when the monitoring well recovered to approximately 95% of the original static water level, or after two hours of monitoring for locations having slow recovery.

The intervals for response testing were defined as the gravel pack interval (i.e., the zone filled with gravel surrounding the screens) between the bentonite seals. The water level recovery data were analyzed using the Hvorslev method (Hvorslev, 1951) to provide an estimate of the horizontal hydraulic conductivity.

2.1.3.7 Groundwater Level Monitoring Program

A groundwater level monitoring program was conducted to provide information on hydraulic gradients, the range in water levels observed at the NRR Site over time and the groundwater flow direction(s). The depth to groundwater was measured relative to the surveyed top of PVC pipes for the monitoring wells in BH09-3 through BH09-8, and from the top of the steel casing for open holes BH08-1 and BH08-2. The water elevations in the monitoring wells were calculated by subtracting the measured depth to water from the top of pipe reference elevations.

Pressure transducers and data loggers were installed at four selected monitoring intervals to provide an ongoing record of groundwater levels. The data loggers were set to record the groundwater levels at the four locations every six hours (i.e., four readings per day).

2.1.3.8 Groundwater Quality Sampling Program

The water quality sampling program at the NRR Site was divided into two programs, which included the on-Site monitoring well sampling program and the residential water supply well sampling program.

2.1.3.8.1 On-Site Monitoring Well Sampling Program

The on-Site monitoring well water quality sampling program involved collecting groundwater samples from the depth-specific monitoring wells installed in BH09-3 through BH09-8. The primary objective of the water quality monitoring program is to define existing background groundwater quality at the NRR Site over a sufficient period of time to establish the potential seasonal and/or spatial/depth variability in groundwater quality. The groundwater samples were analyzed for the parameters specified in *Ontario Regulation 232/98* (except for total suspended solids), which relates to the construction and expansion of landfill sites. Three rounds of groundwater sampling were conducted as part of this study. All samples were entered on Chain of Custody forms and delivered to Exova Laboratories of Ottawa, Ontario for the required analysis.

2.1.3.8.2 Residential Well Sampling Program

The residential water supply well sampling program involved collecting groundwater samples from supply wells in the vicinity of the NRR Site to characterize background groundwater quality for typical organic and inorganic landfill leachate parameters. The parameters analyzed for the residential wells were the same as the on-Site monitoring wells. Prior to sampling, Golder staff completed a survey with the homeowners to gather information about their water supply (i.e., well type, depth, location, satisfaction with water quality and quantity, etc.). If the water supply is treated (i.e., water softener), the water sample was collected from an untreated location, or the treatment system was bypassed. All samples were entered on Chain of Custody forms and delivered to Maxxam Analytics Inc. (Maxxam) of Ottawa, Ontario for the required analysis.

2.1.4 Results and Discussion

2.1.4.1 Test Pit and Augerhole Program

A total of five augerholes and 16 test pits were completed across the NRR Site between November 18 and 23, 2009, to define the overburden types, and the thickness and distribution of the overburden. The approximate locations of the augerholes and test pits are shown on Figure 2.1-2. A description of the various material and groundwater conditions encountered in the test pits and augerholes are provided in the augerhole and test pit records in Attachment TSD#1-B-1.

All test pits and augerholes were excavated/advanced to bedrock refusal with the exception of test pits TP-15 and TP-16 on the easternmost extent of the property where the bedrock is at a depth greater than six metres. For the augerholes and test pits reaching refusal, bedrock was found between 0.25 mbgs (AH09-3) and 4.5 mbgs (TP09-14). Overall, the bedrock is less than 2.7 mbgs, with the exception of the eastern half of the Concession IV portion of the property east of Eadie Road (i.e., at TP09-14, TP09-15 and TP09-16).

The central portion of the NRR Site has various thicknesses of completely weathered shale overlying the shale bedrock. In the northwestern and southwestern portions of the NRR Site, the bedrock is typically overlain by glacial till. At some locations, the glacial till is overlain by a thin layer of silty clay or silty sand. On the eastern half of the Concession IV portion of the property, the bedrock surface is deeper with significant thicknesses of overlying silty clay and glacial till (i.e., greater than six metres).

Laboratory testing for water content and Atterberg Limits was completed using a variety of weathered shale samples collected from TP09-2, TP09-3 and TP09-6, and silty clay samples collected from TP09-14 and TP09-15. The results of the laboratory testing are provided on the test pit logs in Attachment TSD#1-B-1. Grain size analyses were also carried out on selected samples collected from TP09-3 (completely weathered shale at 0.5 mbgs), TP09-14 (silty clay at 0.45 to 0.70 mbgs) and TP09-15 (silty clay at 1.20 mbgs). The grain size curves are provided following the test pit logs in Attachment TSD#1-B-1.

2.1.4.2 Borehole Drilling Program

The subsurface conditions encountered in the boreholes at the NRR Site are shown on the Record of Drillhole Sheets in Attachment TSD#1-B-2-1.

2.1.4.2.1 Overburden

The following presents a summarized overview of the overburden encountered within the boreholes.

Topsoil

Approximately 240, 250 and 200 millimetres of topsoil was encountered at ground surface at BH09-3, BH09-5 and BH09-6, respectively.

Sandy Silt

The topsoil at BH09-6 is underlain by about 0.7 metres of sandy silt.

Sensitive Silty Clay

The topsoil at BH09-5 is underlain by a deposit of silty clay. The silty clay was fully penetrated to a depth of about 7.9 metres below the existing ground surface.

The upper 3.1 metres of the silty clay have been weathered to a grey brown crust. The silty clay below the depth of weathering is grey in colour and unweathered. This unweathered portion of the deposit is about 4.6 metres thick.

Glacial Till

The topsoil at BH09-3 and the silty clay at BH09-5 are underlain by a deposit of glacial till. The glacial till is a heterogeneous mixture of gravel, cobbles and boulders in a matrix of sandy silt and clayey silt with a trace of clay. This deposit was fully penetrated to depths of about 5.0 and 16.5 metres below the existing ground surface at BH09-3 and BH09-5, respectively.

A thin layer of sand and gravel underlies the glacial till at BH09-5.

2.1.4.2.2 Borehole Coring Program

The coring program at the NRR Site included the drilling of four boreholes. The cored boreholes were identified as BH09-3, BH09-4, BH09-5 and BH09-6 (see locations on Figure 2.1-2). The following table provides the drilling details for cored holes.

Table 2.1-1: NRR Site Cored Hole Drilling Details – BH09-3 through BH09-6

Location	Date Drilled	Ground Surface Elevation (masl)	Depth to Bedrock (m)	Total Depth (m)
BH09-3	Nov. 17-18, 2009	86.30	5.0	30.56
BH09-4	Nov. 3-9, 2009	79.05	0.61	30.84
BH09-5	Nov. 11-16, 2009	73.93	16.92	25.60
BH09-6	Nov. 24-26, 2009	84.94	0.91	30.51

The intent of the borehole coring program was to penetrate the entire thickness of the Queenston Formation and to finish the cored holes in the upper part of the underlying Carlsbad Formation. An assessment of the lithology and stratigraphy was completed using the bedrock core recovered from BH09-3 through BH09-6. The assessment involved a systematic description of the core including: weathered state; structure; colour; grain size; bedding; texture; material type; and, the location of open bedding planes/voids. The geologic descriptions and sequence of bedrock formations encountered in BH09-3 through BH09-6 are included in the drillhole logs provided in Attachment TSD#1-B-2-1.

The following provides a summary of the material encountered at each borehole location:

- BH09-3: 5 metres of glacial till underlain by 5.5 metres of Queenston Formation followed by the Carlsbad Formation to the end of the borehole (30.5 mbgs);
- BH09-4: 0.6 metres of completely weathered mudstone underlain by 20.7 metres of Queenston Formation followed by the Carlsbad Formation to the end of the borehole (30.8 mbgs);
- BH09-5: 7.9 metres of silty clay underlain by 8.5 metres of glacial till followed by the Carlsbad Formation to the end of the borehole (25.6 mbgs); and
- BH09-6: 3.6 metres of overburden (sandy silt followed by moderately to completely weathered mudstone) underlain by 4.1 metres of Queenston Formation followed by the Carlsbad Formation to the end of the borehole (30.5 mbgs).

Based on the results of the borehole coring program, the bedrock at the NRR Site is typically close to ground surface with the exception of the eastern extent of the property where close to 17 metres of overburden was present. The thickness of the Queenston Formation in the cored boreholes is variable across the NRR Site and ranges between 0 metres at BH09-5 and 20.7 metres at BH09-4. The Carlsbad Formation was encountered in all cored boreholes.

2.1.4.2.3 Air Rotary Drilling Program

The air rotary drilling program at the NRR Site included the drilling of four boreholes. The boreholes were identified as BH08-1, BH08-2, BH09-7 and BH09-8 (see locations on Figure 2.1-2). The following table provides the drilling details for air rotary boreholes.

Table 2.1-2: NRR Site Air Rotary Drilling Details - BH08-1, BH08-2, BH09-7 and BH09-8

Location	Date Drilled	Ground Surface Elevation (masl)	Depth to Bedrock (m)	Total Depth (m)
BH08-1	April 24, 2008	82.57	1.0	9.1
BH08-2	April 24, 2008	80.77	1.5	9.1
BH09-7	Nov. 20, 2009	83.52	4.88	33.55
BH09-8	Nov. 30, 2009	79.38	2.13	30.50

BH08-1 and BH08-2 were drilled to monitor changes in water levels in the shallow bedrock during the dewatering of the on-Site quarry in the spring and summer of 2008. The deeper boreholes (BH09-7 and BH09-8) were completed to a depth of approximately 30 metres for the purpose of defining Site stratigraphy (using geophysical methods) at key locations. The geology at all four locations was assessed based on chip samples collected during drilling (the overburden was not sampled as part of the air rotary drilling program). A summary of the geology encountered at BH08-1, BH08-2, BH09-7 and BH09-8 is provided on the borehole logs in Attachment TSD#1-B-2-1. The MOE water well records for the four boreholes are also provided in Attachment TSD#1-B-2-1.

The following provides a summary of the material encountered at each borehole location:

- BH08-1 – 1 metre of overburden followed by the Queenston Formation to the end of the borehole (9.1 mbgs);
- BH08-2 – 1.5 metres of overburden followed by the Queenston Formation to the end of the borehole (9.1 mbgs);
- BH09-7 – 4.9 metres of overburden followed by the Queenston Formation to the end of the borehole (33.6 mbgs); and
- BH09-8 – 2.1 metres of overburden underlain by 23.6 metres of Queenston Formation followed by Carlsbad Formation to the end of the borehole (30.5 mbgs).

The results of the air rotary drilling program indicates there is a significant thickness of the Queenston Formation along the northern extent of the NRR Site. The thickest sequence of Queenston Formation observed at the NRR Site was encountered at BH09-7, where the formation was greater than 28 metres in thickness.

2.1.4.3 Packer Testing

A total of 30 packer tests were carried out to assess the horizontal hydraulic conductivity of the bedrock beneath the NRR Site. The packer tests were conducted in the open cored boreholes (BH09-3 through BH09-6) prior to the installation of the monitoring wells. The test intervals for the packer testing ranged between 2.44 and 3.05 metres, and focused on the bedrock between the bottom of the hole and the water table or the casing, whichever was lower. The hydraulic conductivity estimates obtained during the packer testing are provided on the drillhole logs for BH09-3 through BH09-6 provided in Attachment TSD#1-B-2-1. The results of the packer testing for all intervals tested are provided in Table TSD#1-B-3-1 in Attachment TSD#1-B-3. The following table summarizes the packer testing result for all zones where a measurement of hydraulic conductivity could be obtained (i.e., all intervals having "no take" are not presented in the table below).

Table 2.1-3: NRR Site Packer Testing Results

Location	Interval Tested (mbgs)	Hydraulic Conductivity (m/sec)	Formation Tested
BH09-3	7.32 to 9.75	1.7×10^{-7}	Queenston Formation
BH09-4	2.74 to 5.18	3.0×10^{-6}	Queenston Formation
BH09-4	4.88 to 7.32	3.0×10^{-7}	Queenston Formation
BH09-4	24.69 to 27.74	2.3×10^{-8}	Carlsbad Formation
BH09-6	18.29 to 21.34	1.3×10^{-8}	Carlsbad Formation

Based on the results of the packer testing, 25 of the 30 intervals tested had "no take" indicating the hydraulic conductivity for the interval being tested was less than 1×10^{-8} metres per second (m/sec). Overall, the hydraulic conductivity of the bedrock beneath the NRR Site is low with the exception of some areas of slightly enhanced permeability in the Queenston Formation within the upper 10 metres at BH09-3 and BH09-4.

2.1.4.4 Borehole Geophysical Logging Program

This section provides an interpretation and summary of the borehole geophysical logging carried out at boreholes BH09-3, BH09-4, BH09-5, BH09-6, BH09-7 and BH09-8. Locations BH09-3, BH09-5 and BH09-6 were logged for stratigraphy only, while BH09-4, BH09-7 and BH09-8 also include logging for structure (optical/acoustic televiewer and caliper) and "hydrogeophysical" logs (fluid temperature, fluid resistivity and heat pulse flow metre). The geophysical logging of the boreholes was completed between November 30 and December 4, 2009.

The natural gamma and apparent conductivity logs are presented on Figure TSD#1-B-4-1-1 through Figure TSD#1-B-4-1-5 in Attachment TSD#1-B-4-1 and are interpreted to show the stratigraphic correlation between the boreholes. The geophysical logs (full suite) for BH09-4, BH09-7 and BH09-8 are presented in Attachment TSD#1-B-4-2, TSD#1-B-4-3 and TSD#1-B-4-4, respectively. The data presented includes measured and derived log data. The measured logs are for natural gamma, apparent conductivity, optical televiewer, acoustic televiewer (amplitude and travel time), caliper (3-arm) and fluid temperature, fluid resistivity and heat pulse flow meter under static and dynamic borehole fluid conditions. The derived logs include the average caliper from the acoustic televiewer travel time and the structure and tadpole logs interpreted from the optical and acoustic televiewer logs. The logs have been annotated to show permeable zones in the borehole walls interpreted from the hydrogeophysical logs.

2.1.4.4.1 Stratigraphic Interpretation

The natural gamma and apparent conductivity logs are presented on Figure TSD#1-B-4-1-1 in Attachment TSD#1-B-4-1 and interpreted sections are shown on Figure TSD#1-B-4-1-2 through Figure TSD#1-B-4-1-5. These logs are shown together with schematic geological logs based on the borehole logs in Attachment TSD#1-B-2-1.

The log data were compared to the lithologic logs and geologic contacts were plotted based on both sets of data. The natural gamma signatures were found to be consistent with the lithologic description but were used to refine the logged depths. The schematic geology logs show overburden (from drill records) and the stratigraphy in the underlying bedrock, which consists of sedimentary bedrock of the Queenston and Carlsbad Formations. A "marker bed" was identified within the Queenston Formation allowing for a correlation of the stratigraphy between boreholes. The contoured surface of the top of the "marker bed" interpolated from boreholes BH09-3 through BH09-8 is shown in the inset on Figure TSD#1-B-4-1-1.

The stratigraphy is interpreted to dip at two to three degrees from BH09-3, BH09-6 and BH09-5 towards BH09-7 and BH09-8. This is supported by the predominant dip direction for bedding/banding/foliation and geological planes encountered in boreholes BH09-4, BH09-7 and BH09-8 (i.e., at low angle and slightly west of north).

2.1.4.4.2 Structure Analysis

Geophysical logs for boreholes BH09-4, BH09-7 and BH09-8 were analyzed for structure intersecting the borehole walls including:

- Major open fractures;
- Minor open fractures;
- Partially open fractures;
- Healed fractures;
- Bedding, banding and foliation; and
- Geological contacts (where apparent).

The structure data (structure sinusoids and tadpoles) are shown on the logs together with summary plots in Attachments TSD#1-B-4-2, TSD#1-B-4-3 and TSD#1-B-4-4 for borehole BH09-4, BH09-7 and BH09-8, respectively. Depicted on the structure summary logs is a Schmidt Plot for the plane feature strike and a rose plot of the dip azimuth.

2.1.4.4.3 Hydrogeophysical Logs

The fluid temperature/resistivity and heat pulse flow meter logs were collected under non-pumping and pumping conditions. Both sets of data are shown on the logs in Attachments TSD#1-B-4-2, TSD#1-B-4-3 and TSD#1-B-4-4. The data are also shown in tables contained within the appendices.

The general result for boreholes BH09-4, BH09-7 and BH09-8 is that the majority of flow encountered is shallow, from within the shallow fractured bedrock zones, and that permeability is lower with depth.

2.1.4.5 Monitoring Well Installation and Elevation Surveying Program

Groundwater monitoring wells were constructed to allow for the measurement of groundwater levels and to obtain estimates of horizontal hydraulic conductivity and gradients within the various bedrock formations encountered at the NRR Site. Multi-level groundwater monitoring wells were constructed in BH09-3, BH09-4 and BH09-6 through BH09-8. A single monitoring well was installed in BH09-5, and locations BH08-1 and BH08-2 were left as open holes. The selected locations for the screened intervals were determined based on observations during the drilling and geophysical logging programs. To isolate the potential water bearing zones within the bedrock, the monitoring intervals were completed such that permeable zones identified during the packer testing in the cored holes (i.e., where there was water take) and the flow zones identified by the hydrogeophysical logs completed at BH09-7 and BH09-8 were included within the selected screened intervals.

The following table summarizes the monitoring well completion details for the monitoring wells constructed in boreholes BH09-3 through BH09-8. The monitoring well installations are shown on the borehole/drillhole logs in Attachment TSD#1-B-2-1.

Table 2.1-4: NRR Site Monitoring Well Completion Details

Location	Ground Surface Elevation (masl)	TOP Elevation (masl)	Screened Interval* (mbgs)	
			Top	Bottom
BH08-1	82.57	83.17	open hole to 9.1 mbgs	
BH08-2	80.77	81.44	open hole to 9.1 mbgs	
BH09-3A	86.30	87.13	15.80	21.95
BH09-3B	86.30	87.13	6.10	13.41
BH09-4A	79.05	79.94	16.46	21.95
BH09-4B	79.05	79.96	1.83	7.62
BH09-5	73.93	74.69	18.90	25.60
BH09-6A	84.94	85.06	16.46	22.56
BH09-6B	84.94	85.09	4.88	10.36
BH09-7A	83.52	84.29	26.16	33.55
BH09-7B	83.52	84.31	18.29	24.23
BH09-7C	83.52	84.31	6.71	11.89
BH09-8A	79.38	80.27	24.38	30.50
BH09-8B	79.38	80.31	14.02	21.34
BH09-8C	79.38	80.33	3.96	8.23

Notes: TOP – top of pipe
* The screened interval refers to the entire gravel pack area – not just the length of the slotted screen

2.1.4.6 Hydraulic Conductivity Testing

Well response tests were carried out in the 13 monitoring intervals installed within the on-Site boreholes using the rising-head method. The results of the *in-situ* hydraulic conductivity testing are summarized in the following Table 2.1-5. The depth of the screened interval and comments relating to the interval tested are provided. The packer testing result for the corresponding interval is also provided for the cored boreholes (BH09-3 through BH09-6).

Table 2.1-5: NRR Site Hydraulic Conductivity Results

Location	Screened Interval* (mbgs)	Hydraulic Conductivity (m/sec)		Formation Monitored	Comments
		Rising-Head Test	Corresponding Packer Test**		
BH09-3A	15.80 to 21.95	8.6 x 10^{-7}	<1 x 10^{-8}	Carlsbad	hydraulic conductivity from packer testing is an estimate based on no observed take
BH09-3B	6.10 to 13.41	1.0 x 10^{-6}	1.7 x 10^{-7}	Queenston/ Carlsbad Contact	- -
BH09-4A	16.46 to 21.95	5.7 x 10^{-8}	<1 x 10^{-8}	Queenston/ Carlsbad Contact	hydraulic conductivity from packer testing is an estimate based on no observed take
BH09-4B	1.83 to 7.62	2.4 x 10^{-6}	3.0 x 10^{-6}	Queenston	- -
BH09-5	18.9 to 25.60	1.3 x 10^{-6}	<1 x 10^{-8}	Carlsbad	hydraulic conductivity from packer testing is an estimate based on no observed take
BH09-6A	16.46 to 22.56	9.7 x 10^{-7}	1.3 x 10^{-8}	Carlsbad	- -
BH09-6B	4.88 to 10.36	6.0 x 10^{-8}	<1 x 10^{-8}	Queenston/ Carlsbad Contact	hydraulic conductivity from packer testing is an estimate based on no observed take
BH09-7A	26.16 to 33.53	7.8 x 10^{-7}	- -	Queenston	- -
BH09-7B	18.29 to 24.23	2.5 x 10^{-6}	- -	Queenston	- -
BH09-7C	6.71 to 11.89	5.3 x 10^{-7}	- -	Queenston	- -
BH09-8A	24.38 to 30.48	2.0 x 10^{-8}	- -	Queenston/ Carlsbad Contact	- -
BH09-8B	14.02 to 21.34	3.6 x 10^{-9}	- -	Queenston	- -
BH09-8C	3.96 to 8.23	>1.0 x 10^{-2}	- -	Queenston	hydraulic conductivity from rising-head test is an estimate because recovery was too fast to complete the test

Notes:

No hydraulic testing was completed in open holes BH08-1 and BH08-2.

* The screened interval refers to the entire gravel pack area – not just the length of the slotted screen.

** The approximate corresponding packer testing interval may not be identical to the interval tested during the rising-head test.

For the above table, if there was more than one packer testing interval included with the rising-head test interval, the higher of the two packer testing results was reported. It was assumed the more conductive feature would dominate the hydraulic conductivity within the screened interval. Overall, the packer testing and rising-head test results are similar, with the exception of BH09-5 where the results differ by approximately two orders of magnitude.

Based on the results of the *in-situ* hydraulic conductivity testing completed at the NRR Site (packer testing and rising-head tests), the following ranges in hydraulic conductivities were observed in the bedrock formations at the NRR Site:

- Queenston Formation: 3.6×10^{-9} m/sec to $>1.0 \times 10^{-2}$ m/sec;
- Carlsbad Formation: $<1 \times 10^{-8}$ m/sec to 1.3×10^{-6} m/sec; and
- Queenston Formation/Carlsbad Formation Contact: $<1 \times 10^{-8}$ m/sec to 1.7×10^{-7} m/sec.

Overall, the majority of the Queenston Formation and the Carlsbad Formation is tight; however, at some locations there is enhanced permeability in the upper portion of the Queenston Formation (observed at BH09-3 and BH09-4). There does not appear to be a zone of enhanced permeability at the contact between the Queenston Formation and the Carlsbad Formation.

2.1.4.7 Water Level Monitoring Program

A groundwater level monitoring program was conducted to provide information on hydraulic gradients, the range in groundwater levels observed at the NRR Site over time and the groundwater flow direction(s). Groundwater levels were measured 36 times in the on-Site monitoring wells between January 8, 2010 and December 6, 2012. In addition to the groundwater level measurements, the elevation of the water level in the quarry was measured 16 times between May 20, 2011 and October 29, 2012. The groundwater and quarry level elevation data collected to date are provided in Table TSD#1-B-5-1 in Attachment TSD#1-B-5.

2.1.4.7.1 Groundwater Elevations

Graphs showing the trends in groundwater levels over time for the monitoring locations are shown on Figure TSD#1-B-5-1 through Figure TSD#1-B-5-7 in Attachment TSD#1-B-5. The following provides general observations about the groundwater elevations measured at the NRR Site:

- All groundwater monitoring locations at the NRR Site display seasonal variations. In general, water levels are highest during the spring freshet, which is followed by a decline in water levels during the late spring and summer. Groundwater levels typically rise during the fall, and decline again during the winter;
- At locations BH09-4, BH09-6 and BH09-8, the shallow installations typically display slightly greater seasonal variations than observed in the deeper installation(s);
- Locations BH09-3 (A and B), BH09-6 (A and B) and BH09-7 (A, B and C) typically have the highest groundwater elevations at the NRR Site and have ranged between 79.5 and 83.7 masl between January 8, 2010 and December 6, 2012. These monitoring well locations are found on the western and southern boundaries of the NRR Site;

- On June 29, 2010, location BH08-1 was developed and sampled (see Figure TSD#1-B-5-1). Due to the low hydraulic conductivity bedrock in the vicinity of this monitoring well, it required over two months for the groundwater level to return to static; and

- The erratic groundwater levels observed for locations BH09-8A and BH09-8B between January 8, 2010 and October 23, 2011 on Figure TSD#1-B-5-7 are a result of well development on January 8, 2010, and sampling events completed on February 12, 2010, June 29, 2010 and September 7, 2010. Following the October 3, 2011 sampling event, groundwater levels gradually returned to static levels over the next six to eight months. The slow recovery in water levels at these locations is a result of the low hydraulic conductivity bedrock in the vicinity of the monitoring intervals.

2.1.4.7.2 Quarry Water Elevations

The elevation of the water level in the quarry was measured 16 times between May 20, 2011 and October 29, 2012. Figure TSD#1-B-5-8 in Attachment TSD#1-B-5 displays the trend in quarry water levels over time. The water level in the quarry was measured using staff gauge SG-1 between May 20, 2011 and May 30, 2012. The top of SG-1 was surveyed, and the elevation of the quarry water was measured relative to the known top of gauge elevation. Based on the measurements at SG-1, the water level in the quarry gradually declined approximately 0.12 metres during the summer of 2011. This was followed by an increase of approximately 0.15 metres during the fall rains in 2011.

There were no staff gauge measurements in January and February 2012 because the water in the quarry was frozen. Following the spring melt in March 2012, the quarry water level increased by approximately 0.5 metres. Based on the measurements at SG-2, the water level in the quarry continued to increase through the spring of 2012 to a maximum elevation of 78.07 in May 2012. At that time, staff gauge SG-1 was almost under water, so a new staff gauge (SG-2) was installed and surveyed. The water level in the quarry gradually declined between May 2012 and September 2012. A slight increase in the water level in the quarry was observed in October 2012. The increase in water levels observed in October 2012 is interpreted to be associated with the fall rains.

2.1.4.7.3 Vertical Gradients

The following table provides a summary of the direction of vertical gradients observed at the NRR Site.

Table 2.1-6: NRR Site Direction of Vertical Gradient

Locations	Interpreted Direction of Vertical Gradient/Comments
BH09-3A and BH09-3B	no significant vertical gradient observed
BH09-4A and BH09-4B	downward vertical gradient
BH09-6A and BH09-6B	typically downward vertical gradient; however, the gradient tends to switch to upward during periods of low groundwater levels at BH09-6B (i.e., during summer)
BH09-7A, BH09-7B and BH09-7C	no significant vertical gradient observed between BH09-7A and BH09-7B; an upward gradient is typically observed between BH09-7B and BH09-7C; however, the gradient has been downward between these monitors since September 2012
BH09-8A, BH09-8B and BH09-8C	During the period of stabilized groundwater levels at BH09-8A and BH09-8B (i.e., between July 2011 and December 2012), the vertical gradient between the intermediate/deep groundwater (BH09-8B and BH09-8A) and the shallow groundwater (BH09-8C) was typically downward. However, the gradient switched to upward during the summer of 2012 (i.e., during a period of low water levels at BH09-8C)

Based on the groundwater elevation data collected to date, vertical gradients at the NRR Site are typically downward, or absent, for most of the year; however, the gradient may switch to upward at some locations during the summer (i.e., BH09-6 and BH09-8). BH09-7 is the only monitoring location at the NRR Site that consistently has an upward gradient.

2.1.4.7.4 Continuous Groundwater Level Monitoring

Pressure transducers and data loggers were installed on May 20, 2010 at BH09-4 (A and B) and BH09-7 (A and C) to provide an ongoing record of groundwater levels. The results of the continuous groundwater level monitoring are presented on Figure TSD#1-B-5-9 and Figure TSD#1-B-5-10 in Attachment TSD#1-B-5. A selection of manual readings is plotted on the continuous groundwater level plots to confirm that the data loggers are collecting reliable data. The manual readings agree with the continuous data logger data. The data loggers measured a groundwater level every six hours (i.e., four readings per day), and provide a detailed record of seasonal variations in groundwater levels at the NRR Site.

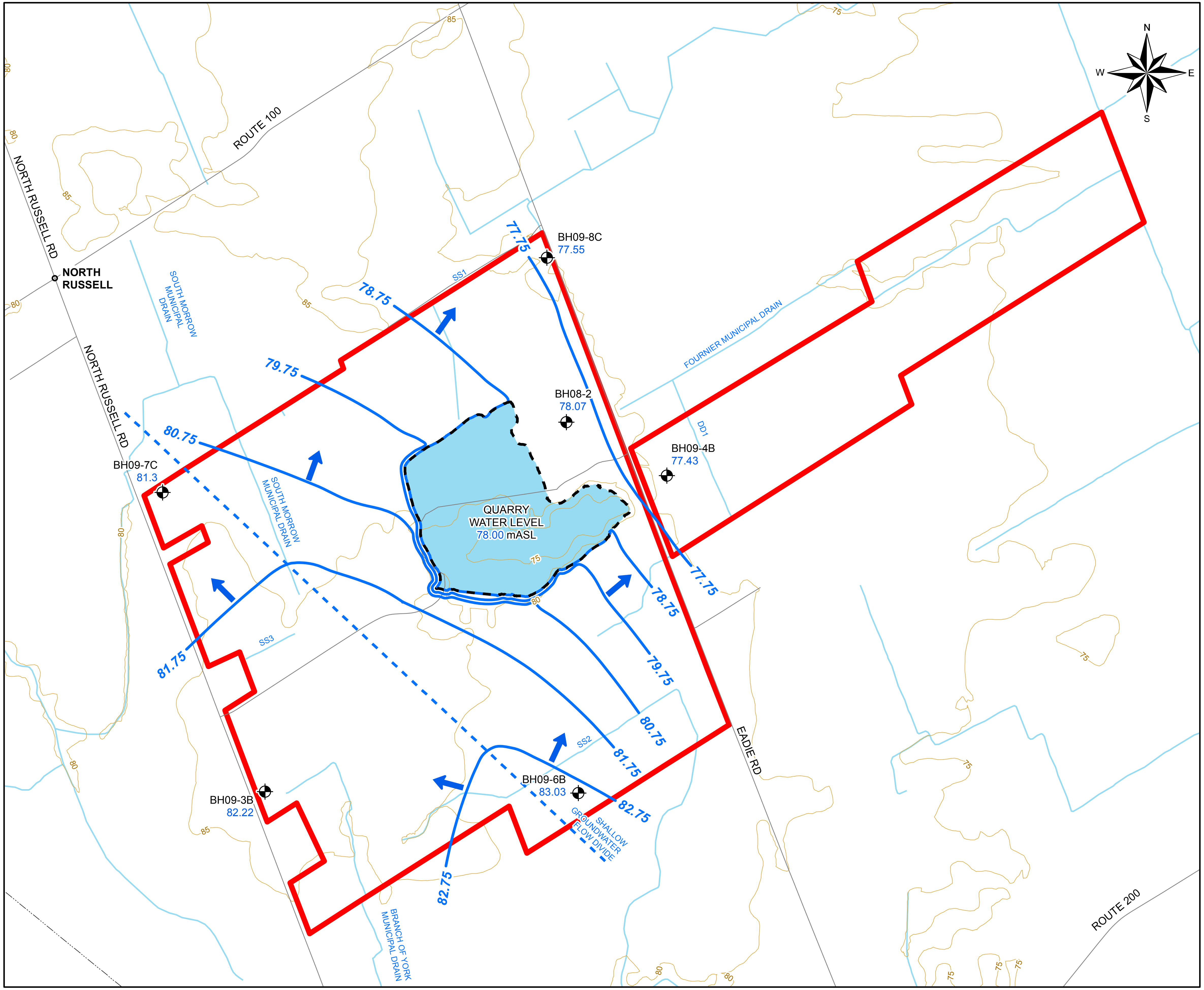
2.1.4.7.5 Groundwater Flow Direction

An estimate of the groundwater flow direction for the shallow and intermediate bedrock at the NRR Site was obtained using appropriately positioned (vertically) on-Site monitoring intervals. The following locations were used to provide an estimate of the shallow groundwater flow direction: BH08-2; BH09-3B; BH09-4B; BH09-6B; BH09-7C; and, BH09-8C. The groundwater levels collected from these locations on June 28, 2012, and October 29, 2012, were used to produce the groundwater contours shown on Figure 2.1-5 and Figure 2.1-6, respectively. As shown on Figure 2.1-5 and Figure 2.1-6 the groundwater contours are used to interpret the shallow groundwater flow direction in the bedrock at the NRR Site.

Based on the groundwater levels collected on June 28, 2012, the shallow groundwater flow direction for the majority of the NRR Site is interpreted to be towards the northeast; however, a shallow groundwater flow divide is interpreted to be present in the southwestern portion of the NRR Site. Shallow groundwater to the west of this divide is interpreted to be flowing towards the northwest. Based on the groundwater contour spacing shown on Figure 2.1-5, the hydraulic gradient (i.e., potential for groundwater flow) is greater on the east side of the divide than on the west side. As such, groundwater on the east side of the divide is interpreted to have a higher average linear groundwater velocity.

Based on the groundwater levels collected on October 29, 2012, the shallow groundwater flow direction for the entire NRR Site is interpreted to be towards the northeast. The shallow groundwater flow divide in the southwestern portion of the NRR Site observed based on the groundwater levels collected on June 28, 2012, is not apparent. The presence/absence of the shallow groundwater flow divide is primarily controlled by the groundwater levels at BH09-6B and BH09-3B. The shallow groundwater flow divide is interpreted to be a seasonal feature that is present during periods of high water levels at the Site and when groundwater levels are higher at BH09-6B than at BH09-3B.

As shown on Figure 2.1-5 and Figure 2.1-6, the shallow groundwater flow contours are influenced by the presence of the quarry at the NRR Site. The elevation of the water in the quarry on June 28, 2012, and October 29, 2012, was 78.00 and 77.90 masl, respectively. Based on the contours plotted on Figure 2.1-5 and Figure 2.1-6, the water level in the quarry is depressed relative to the surrounding shallow groundwater levels.



LEGEND

○ POPULATED PLACENAME

⊕ BOREHOLE/MONITORING WELL LOCATION

— ROAD

-··- UTILITY LINE

— CONTOUR LINE, (5m)

— SURFACE WATER FEATURE

▨ WATER AREA

▭ APPROXIMATE EXTENT OF EXISTING QUARRY EXCAVATION

🟥 PROPERTY BOUNDARY

➡ INTERPRETED GROUNDWATER FLOW DIRECTION

- - SHALLOW GROUNDWATER FLOW DIVIDE

— INTERPRETED GROUNDWATER CONTOUR

77.43 GROUNDWATER ELEVATION (JUNE 28, 2012)

200 100 0 200

SCALE 1:10,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

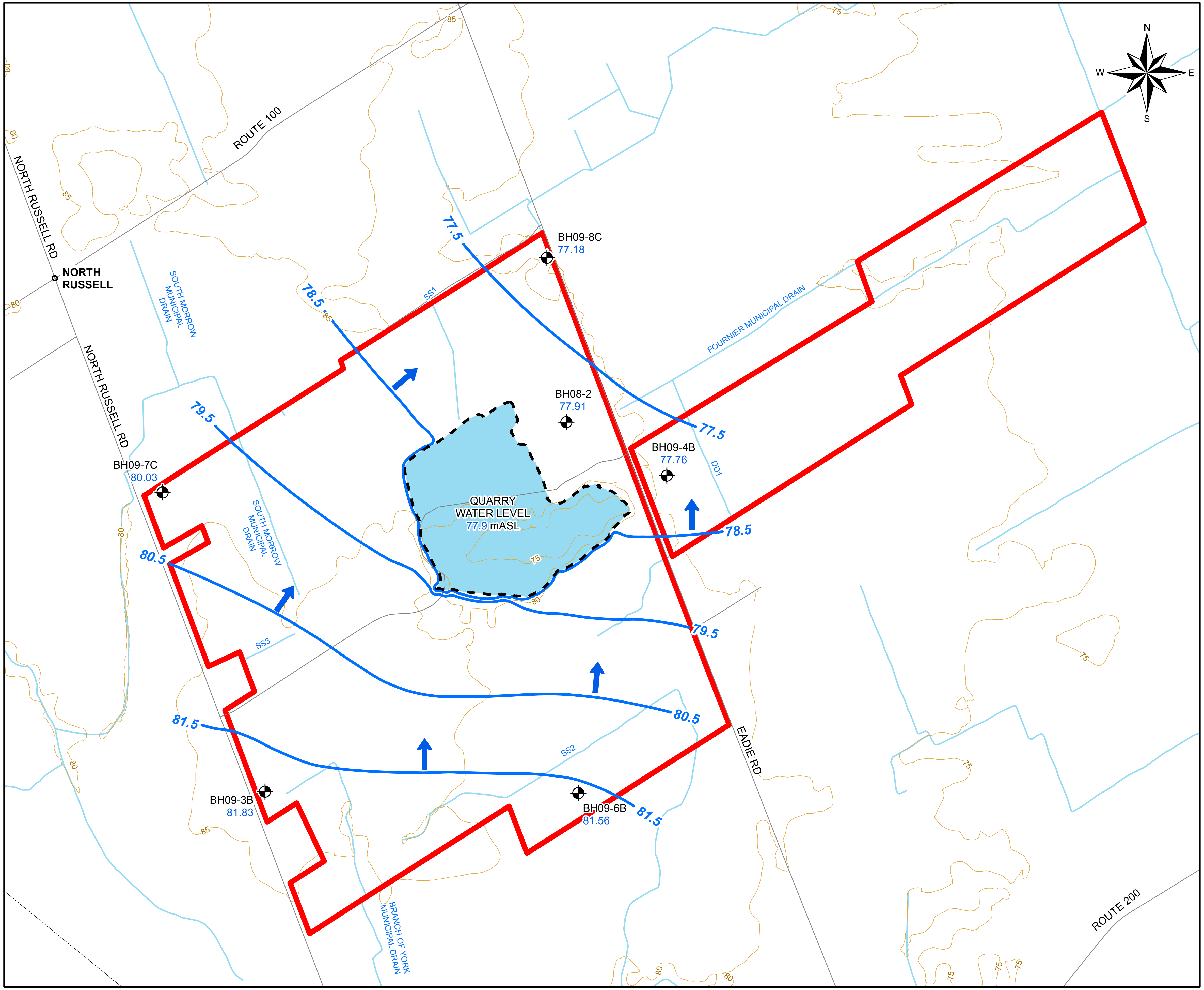
TITLE

NRR SITE
SHALLOW BEDROCK GROUNDWATER FLOW
(JUNE 28, 2012)

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	JAN. 2013	**FIGURE 2.1-5**	
GIS	BR	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0120_GHandG\1211250045-2.1-5-ShallowBedGWFlow.mxd



LEGEND

○	POPULATED PLACENAME
⊕	BOREHOLE/MONITORING WELL LOCATION
—	ROAD
-··-	UTILITY LINE
—	CONTOUR LINE, (5m)
—	SURFACE WATER FEATURE
■	WATER AREA
▭	APPROXIMATE EXTENT OF EXISTING QUARRY EXCAVATION
🟥	PROPERTY BOUNDARY
➡	INTERPRETED GROUNDWATER FLOW DIRECTION
—	INTERPRETED GROUNDWATER CONTOUR
77.76	GROUNDWATER ELEVATION (OCTOBER 29, 2012)

200 100 0 200

SCALE 1:10,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

NRR SITE
SHALLOW BEDROCK GROUNDWATER FLOW
(OCTOBER 29, 2012)

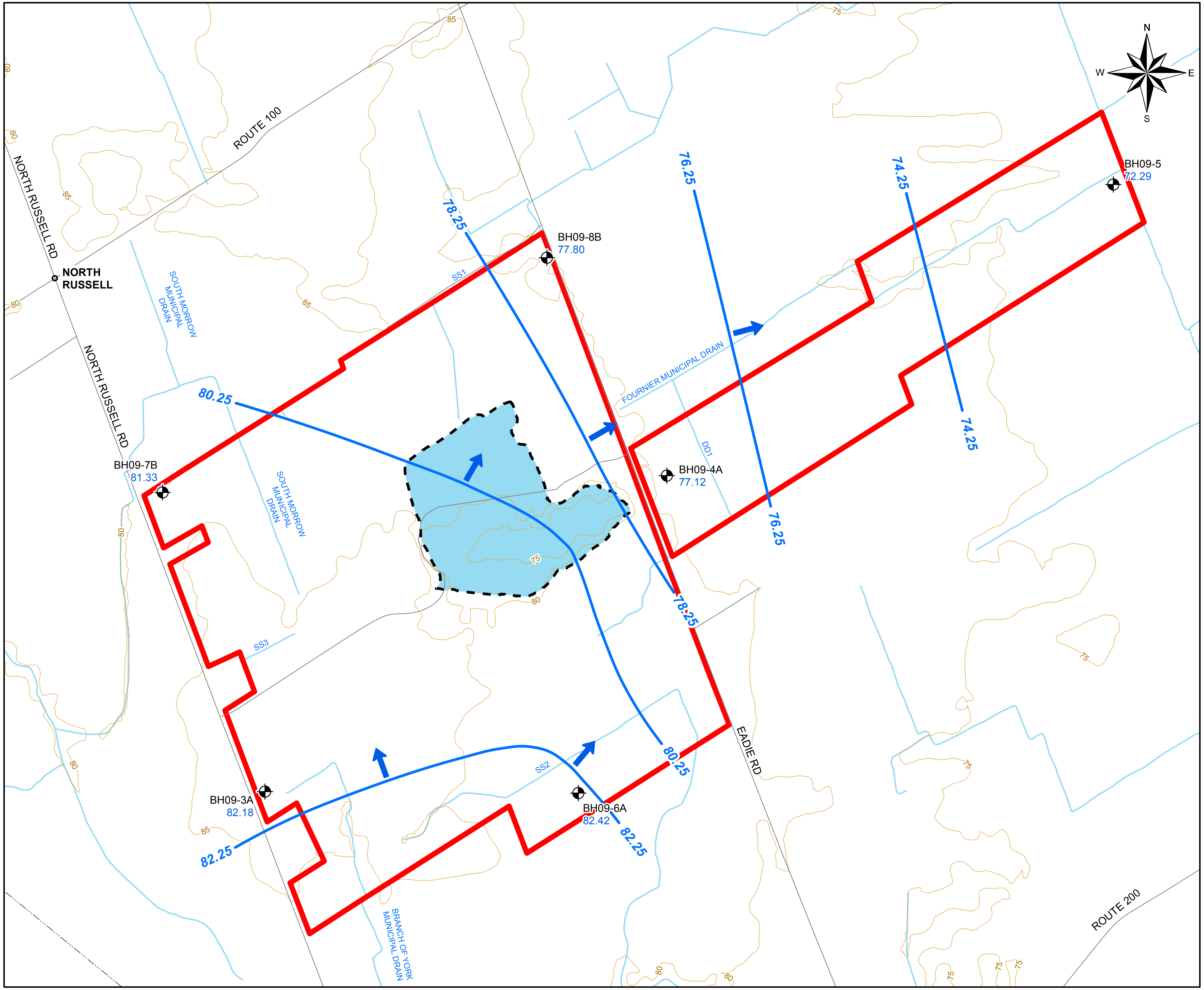
Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	JAN. 2013	**FIGURE 2.1-6**	
GIS	BR	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0120_GHandG\1211250045-2.1-6-ShallowBedGWFlow.mxd

An estimate of the groundwater flow direction for the intermediate bedrock zone at the NRR Site (i.e., between approximately 16 and 25 mbgs) was obtained using appropriately positioned (vertically) on-Site monitoring intervals. The following locations were used to provide an estimate of the intermediate groundwater flow direction: BH09-3A; BH09-4A; BH09-5; BH09-6A; BH09-7B and BH09-8B. The groundwater levels collected from these locations on June 28, 2012, and October 29, 2012, were used to produce the groundwater contours shown on Figure 2.1-7 and Figure 2.1-8, respectively. As shown on Figure 2.1-7 and Figure 2.1-8, the groundwater contours are used to interpret the groundwater flow direction in the intermediate bedrock at the NRR Site.

Based on the groundwater levels collected on June 28, 2012 and October 29, 2012, the intermediate groundwater flow direction for the NRR Site is interpreted to be towards the northeast on the portion of the Site west of Eadie Road, and towards the east on the portion of the Site east of Eadie Road. The top of the monitoring well intervals used to estimate the intermediate groundwater flow direction are completed at least 3.5 metres below the deepest portion of the former quarry at the Site, and it is interpreted that the groundwater flow direction in the intermediate bedrock at the Site is not influenced by the presence of the quarry.



LEGEND

○ POPULATED PLACENAME

⊕ BOREHOLE/MONITORING WELL LOCATION

— ROAD

-·-·- UTILITY LINE

— CONTOUR LINE, (5m)

— SURFACE WATER FEATURE

▨ WATER AREA

▭ APPROXIMATE EXTENT OF EXISTING QUARRY EXCAVATION

🟥 PROPERTY BOUNDARY

➡ INTERPRETED GROUNDWATER FLOW DIRECTION

— INTERPRETED GROUNDWATER CONTOUR

77.76 GROUNDWATER ELEVATION (JUNE 28, 2012)

200 100 0 200

SCALE 1:10,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

NRR SITE
INTERMEDIATE BEDROCK GROUNDWATER FLOW
(JUNE 28, 2012)

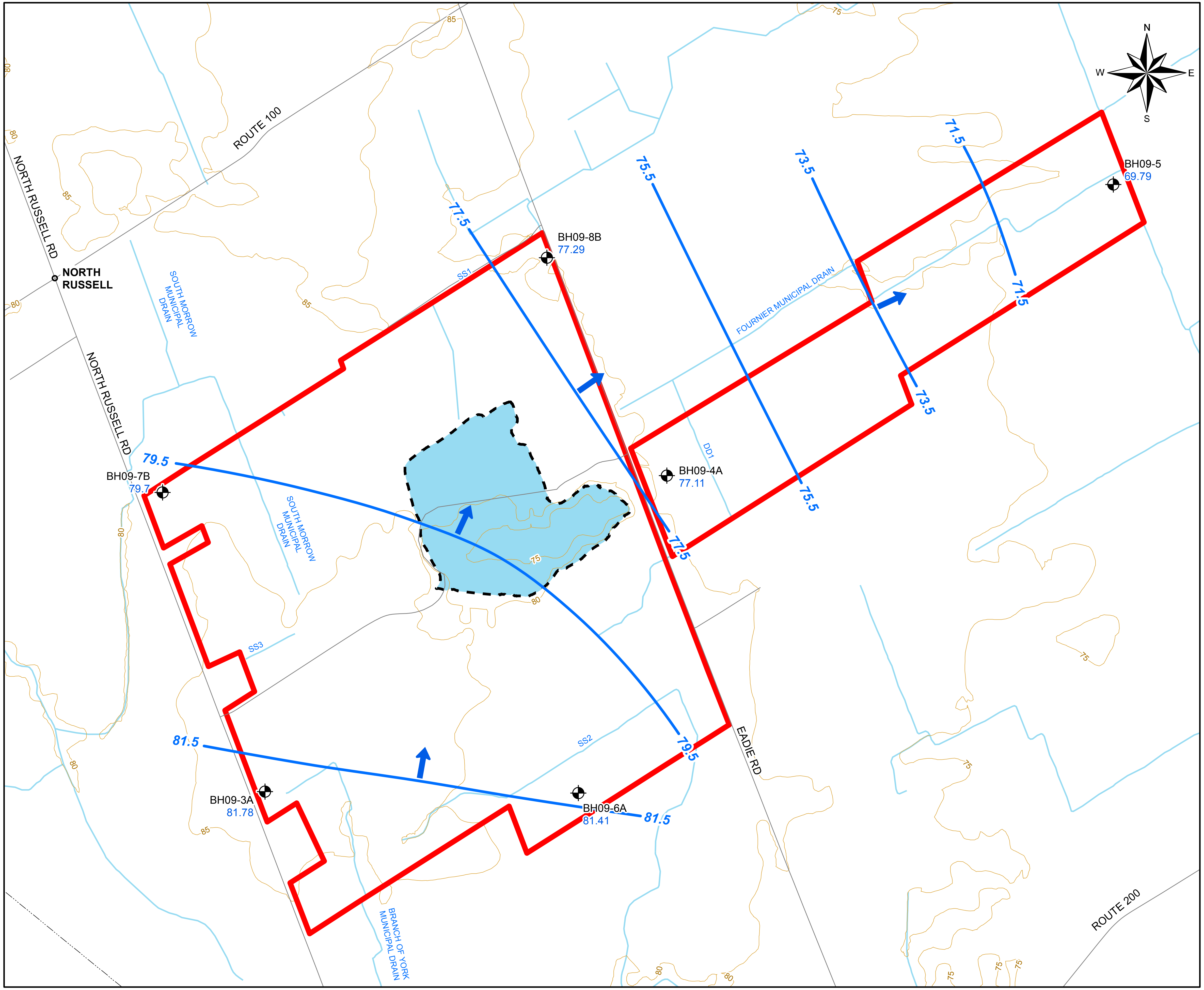
Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045		
DESIGN	JPAO	JAN. 2013
GIS	BR	JAN. 2013
CHECK	PLE	AUG. 2014
REVIEW	PAS	AUG. 2014

SCALE AS SHOWN REV. 0

FIGURE 2.1-7

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0120_GHandG\1211250045-2.1-7-InterBedGWFlow.mxd



LEGEND

- ○ POPULATED PLACENAME
- ⌖ BOREHOLE/MONITORING WELL LOCATION
- — ROAD
- -·- UTILITY LINE
- — CONTOUR LINE, (5m)
- — SURFACE WATER FEATURE
- ▨ WATER AREA
- ┅ APPROXIMATE EXTENT OF EXISTING QUARRY EXCAVATION
- 🟥 PROPERTY BOUNDARY
- ➡ INTERPRETED GROUNDWATER FLOW DIRECTION
- — INTERPRETED GROUNDWATER CONTOUR
- 77.76 GROUNDWATER ELEVATION (OCTOBER 29, 2012)

200 100 0 200

SCALE 1:10,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
NRR SITE
INTERMEDIATE BEDROCK GROUNDWATER FLOW
(OCTOBER 29, 2012)

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045		
DESIGN	JPAO	JAN. 2013
GIS	BR	JAN. 2013
CHECK	PLE	AUG. 2014
REVIEW	PAS	AUG. 2014

SCALE AS SHOWN REV. 0

FIGURE 2.1-8

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0120_GHandG\1211250045-2.1-8-InterBedGWFlow.mxd

2.1.4.8 Groundwater Quality Sampling Program

2.1.4.8.1 On-Site Monitoring Well Sampling Program

The on-Site groundwater quality sampling program involved collecting samples from the monitoring wells installed in BH09-3 through BH09-8 (i.e., the open hole locations BH08-1 and BH08-2 were not included in the groundwater monitoring program). A total of three rounds of groundwater quality sampling were completed at the NRR Site. The groundwater sampling dates are summarized below:

- Session 1 – between February 11 and 12, 2010 (all sample locations except BH09-4B which was frozen and subsequently sampled on March 11, 2010);
- Session 2 – between June 23 and 29, 2010; and
- Session 3 – between September 3 and 7, 2010.

The groundwater samples were analyzed for the parameters specified in *Ontario Regulation 232/98* (except for total suspended solids), which lists generic parameters that should be monitored at landfill sites. Total suspended solids were not measured in the samples collected from the monitoring wells because the analysis would be measuring material in the well that has accumulated over time, and was then re-suspended during the sampling process.

The groundwater quality results for the on-Site monitoring wells are provided in Table TSD#1-B-6-1-1 in Attachment TSD#1-B-6-1. For reference, the Ontario Drinking Water Quality Standards (ODWQS) health based standards and aesthetic objectives are provided on Table TSD#1-B-6-1. Based on the results of the groundwater quality sampling, locations BH09-5, BH09-8A and BH09-8B displayed groundwater quality that was different than what was observed elsewhere on the NRR Site. The following table provides a list of the parameters at BH09-5, BH09-8A and BH09-8B that were elevated relative to most sampling locations at the NRR Site.

Table 2.1-7: NRR Site Elevated Parameters - BH09-5, BH09-8A and BH09-8B

Location	Elevated Parameters
BH09-5	calcium, sodium, COD, ammonia, TKN, TDS, total phosphorus, conductivity, barium and chloride
BH09-8A	calcium, sodium, TDS, conductivity, chloride and sulphate
BH09-8B	calcium, sodium, TDS, conductivity, nitrite, nitrate, chloride and sulphate

Notes: COD – chemical oxygen demand; TKN – total kjeldahl nitrogen; and TDS – total dissolved solids

In addition to the above, elevated sulphate and TDS concentrations were measured at BH09-4A. The elevated concentrations measured at BH09-4A, BH09-5, BH09-8A and BH09-8B are interpreted to be naturally occurring.

Overall, the shallow bedrock groundwater is indicated to be relatively fresh; with depth, in both the Queenston and Carlsbad Formations, the groundwater quality deteriorates with elevated concentrations of chloride, sodium, TDS, iron, manganese and occasionally sulphate, arsenic and barium compared to the ODWQS.

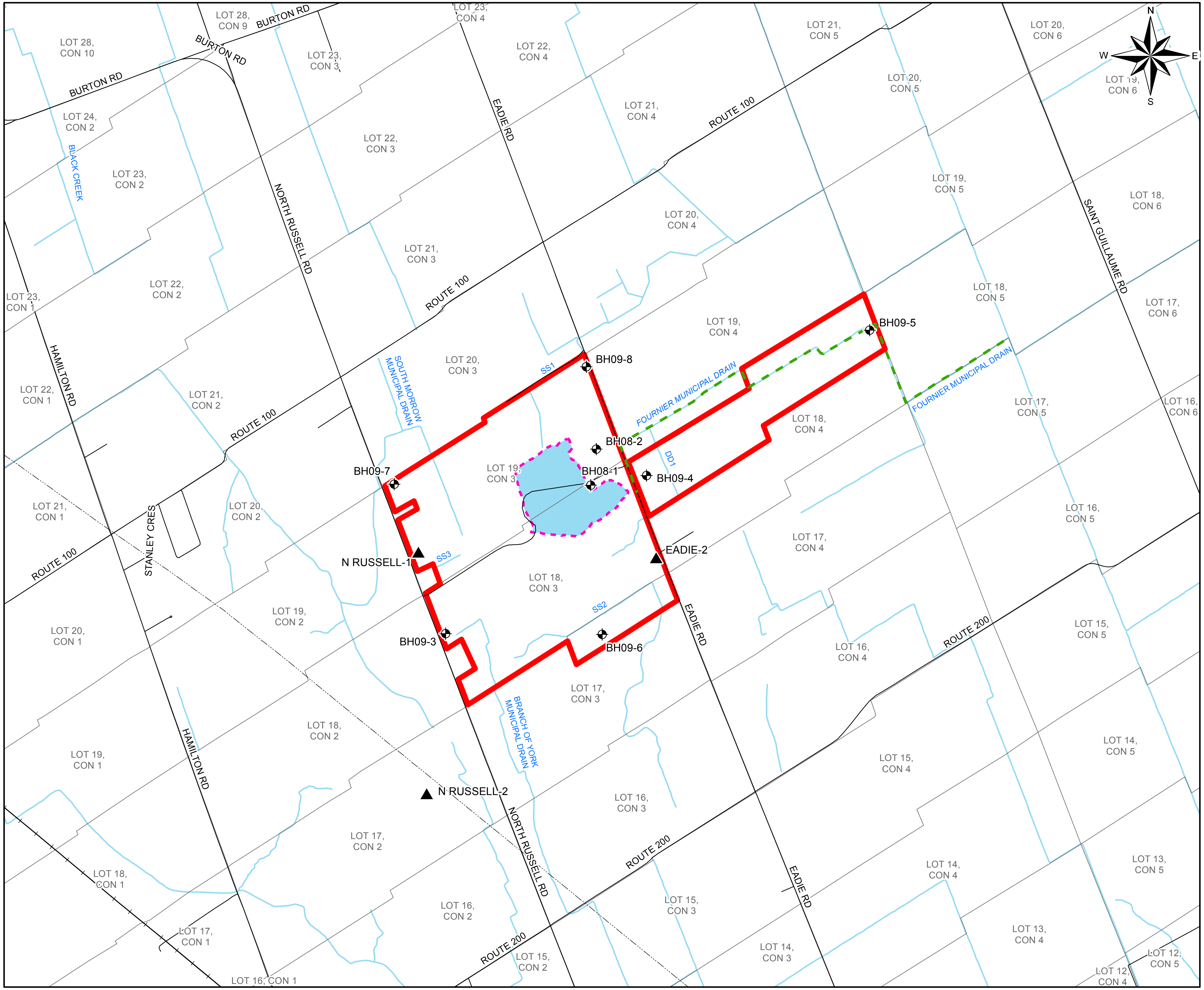
2.1.4.8.2 Residential Well Sampling Program

The residential water supply well sampling program involved collecting groundwater samples from supply wells in the immediate vicinity of the NRR Site to characterize background groundwater quality for typical organic and inorganic landfill leachate parameters. Prior to sampling, Golder staff completed a survey with the homeowners to gather information about their water supply. Copies of the completed surveys are provided in Attachment TSD#1-B-7-1.

A total of four residential water supply wells were sampled between January 17 and 18, 2013. Residential water supply wells are situated along North Russell Road within the western limit (N Russell-1) and just southwest (N Russell-2) of the NRR Site, and along Eadie Road at the northern (Eadie-1) and southeastern extent (Eadie-2) of the NRR Site. The locations of N Russell-1, N Russell-2 and Eadie-2 are shown in Figure 2.1-9. Residential water supply wells N Russell-1 and Eadie-1 are drilled and completed in the bedrock (shale) and N Russell-2 and Eadie-2 are dug wells are completed in the overburden.

The groundwater quality results for the residential water supply wells are provided in Table TSD#1-B-7-1-1 in Attachment TSD#1-B-7-1. The results of residential water supply sampling program indicate that all parameters analyzed were below the respective ODWQS for which health based standards and aesthetic objectives have been established, with the exception of a few parameters at residential water supply wells Eadie-1, Eadie-2 and N Russell-2. Parameters exceeding the ODWQS include TDS and sodium at water supply wells Eadie-1 and Eadie-2 and nitrate at N Russell-2 only. Elevated concentrations of nitrate were also observed at N Russell-1.

The results of the residential water supply wells sampling program indicate that groundwater quality at the private well locations is consistent with the groundwater quality observed at all on-Site monitoring wells at the NRR Site, with the exception of monitoring wells BH09-5, BH09-8A and BH09-8B that generally had elevated parameters compared to other monitoring wells.



LEGEND

⊕ BOREHOLE/MONITORING WELL LOCATION
▲ RESIDENTIAL WATER SUPPLY WELL LOCATION
— ROAD
—+— RAIL ROAD
-·-·- UTILITY LINE
- - FOURNIER MUNICIPAL DRAIN
— SURFACE WATER FEATURE
🟦 WATER AREA
☐ LOT/CONCESSION
⬚ APPROXIMATE EXTENT OF EXISTING QUARRY EXCAVATION
🟥 PROPERTY BOUNDARY

390 195 0 390

SCALE 1:20,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

NRR SITE
RESIDENTIAL WATER SUPPLY
WELL LOCATIONS

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	JAN. 2013	**FIGURE 2.1-9**	
GIS	BR	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0120_GHandG\1211250045-2.1-9-ResidentialWaterSupplyWellLocations.mxd

2.1.5 Summary of Conditions at North Russell Road Site

Table 2.1-8: Summary of NRR Site Considerations

Environmental Component	Summary of Site Considerations
Geology, Hydrogeology & Geotechnical	Geological Setting: ■ NRR Site is on a local bedrock high with the bedrock surface declining in elevation, and the overburden thickness overlying the bedrock increasing in all directions away from the Site. ■ The overburden at the NRR Site is typically less than two metres thick. The central portion of the NRR Site has various thicknesses of completely weathered shale overlying the shale bedrock. In the northwestern and southwestern portions of the NRR Site, the bedrock is typically overlain by glacial till. At some locations, the glacial till is overlain by a thin layer of silty clay or silty sand. On the eastern half of the Concession IV portion of the property, the bedrock surface is deeper resulting in significant thicknesses of overlying silty clay and glacial till. ■ The majority of the NRR Site is underlain by the Queenston Formation shale bedrock followed by the Carlsbad Formation limestone and shale. The Queenston Formation varies in thickness from zero at the eastern extent of the property to 28 metres in the northwestern portion of the NRR Site. ■ Overall, the majority of the Queenston Formation and the Carlsbad Formation at the NRR Site have a low hydraulic conductivity (i.e., less than 2.5 x 10^{-8}m/sec); however, at some locations there is enhanced permeability in the upper portion of the Queenston Formation (observed at BH09-8). The hydraulic conductivity of the upper bedrock generally ranges from 10^{-8} m/sec to 10^{-2} m /sec; below the upper bedrock zone, the hydraulic conductivity is typically 10^{-8} m/sec or less. There does not appear to be a zone of enhanced permeability at the contact between the Queenston Formation and the Carlsbad Formation. ■ In the unlikely event of an unmitigated leachate release from the proposed landfill to the shallow on-Site groundwater system, leachate-impacted groundwater would enter the bedrock and migrate downward and then in an easterly direction.
	Type and thickness of any natural on-Site attenuation layer: ■ The on-Site natural attenuation layer for vertical groundwater flow would rely on hydraulic properties of the shale bedrock. ■ The thickness of the shale bedrock is highly variable across the Site. ■ The shale is indicated to have an overall low hydraulic conductivity; however the hydraulic conductivity of the upper bedrock is variable, with the presence of zones of enhanced permeability due to fracturing and weathering.

Environmental Component	Summary of Site Considerations
	Presence and quality of groundwater resources on-Site and in Site-vicinity: ■ The on-Site shallow bedrock groundwater is indicated to be relatively fresh; with depth, in both the Queenston and Carlsbad Formations, the groundwater quality deteriorates with elevated concentrations of chloride, sodium, TDS, iron, manganese and occasionally sulphate, arsenic and barium compared to the ODWQS. ■ The results of a limited residential water supply sampling program indicate that all parameters analyzed were below the respective ODWQS for which health based standards and aesthetic objectives have been established, with the exception of a few parameters at residential water supply wells Eadie-1, Eadie-2 and N Russel-2. Parameters exceeding the ODWQS include TDS and sodium at water supply wells Eadie-1 and Eadie-2 and nitrate at N Russel-2 only. Elevated concentrations of nitrate were also observed at N Russel-1. ■ The results of the limited residential water supply wells sampling program indicate that groundwater quality at the private well locations is consistent with the groundwater quality observed at all on-Site monitoring wells at the NRR Site, with the exception of monitoring wells BH09-5, BH09-8A and BH09-8B that generally had elevated parameters compared to other monitoring wells. ■ In the unlikely event of an unmitigated release of leachate from the proposed landfill to the shallow groundwater system, leachate-impacted groundwater would enter the bedrock and migrate downward and eastward.
	Interpreted direction of vertical groundwater flow on-Site and in Site-vicinity (i.e., area of groundwater recharge, transitional flow, or groundwater discharge): ■ Based on the groundwater elevation data collected to date, vertical gradients at the NRR Site are typically downward, or absent, for most of the year. ■ The NRR Site is interpreted to be located within a large regional groundwater recharge area for the bedrock flow system. As such, in the event of a leachate release, leachate-impacted groundwater would move downward in the bedrock flow system. ■ Predictive modelling would be required to assess the potential for development of the CRRRC on the NRR Site to affect the availability of groundwater for off-Site users. However, in view of the relatively small portion of the overall recharge ridge area occupied by the CRRRC project, and the relatively low overall water demand from the bedrock in the area, it is not expected that it would have a noticeable effect on off-Site availability.

2.2 Boundary Road Site

2.2.1 Introduction

This report summarizes the results of the preliminary subsurface investigation and hydrogeological assessment of the BR Site located on the east side of Boundary Road on Lots 23 to 25, Concession XI, Township of Cumberland, Ontario. The general location of the BR Site is shown on Figure 2.1-1. A preliminary subsurface investigation was completed by Golder to obtain Site-specific geological, hydrogeological and geotechnical information.

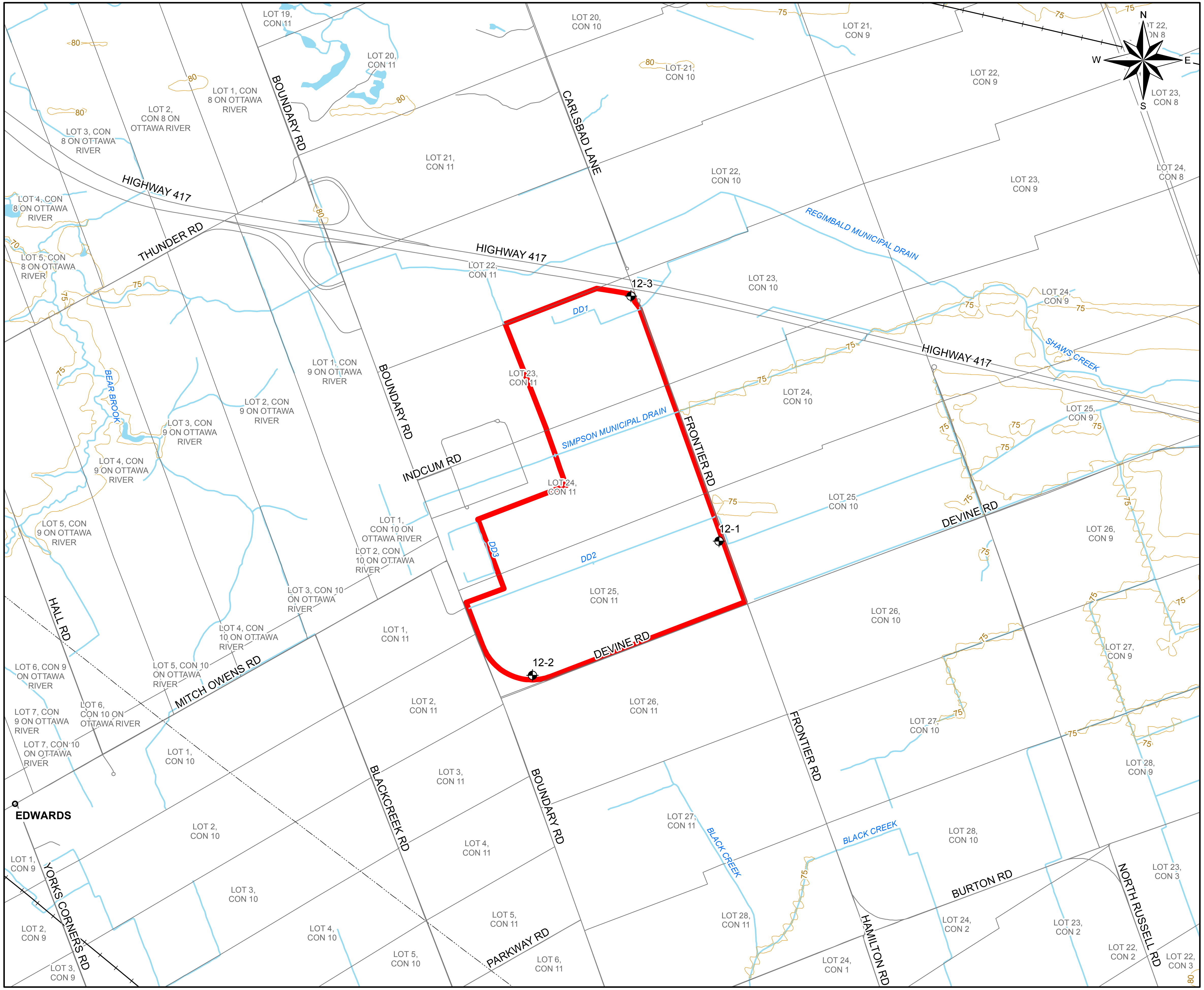
2.2.1.1 Site Description

The boundary of the BR Site at the time of this evaluation is shown on Figure 2.2-1. The BR Site is located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road and totals about 175 hectares (430 acres) of land. Part of the northern portion of the BR Site is used for agricultural purposes, and the remainder of the BR Site is heavily vegetated.

The land use surrounding the BR Site is primarily a mix of commercial/light industrial and agricultural. The agricultural land use is found immediately east of the BR Site, as well as to the southeast, south and southwest; however, areas of undeveloped (heavily vegetated) land generally exist between the BR Site and the agricultural lands in these directions. The industrial land use is found to the west of the northern portion of the BR Site. Residential development in the vicinity of the BR Site is limited to some homes near the northern end of Frontier Road (on the BR Site and to be removed once facility construction commences), and some homes mixed in with the commercial/industrial uses along Boundary Road.

2.2.2 Local Setting

The following sections provide general information on the local geology, hydrogeology and geotechnical conditions in the vicinity of the BR Site taken from published sources and findings and interpretations of previous subsurface investigations. This information was gathered as part of a review of background information completed prior to beginning the subsurface investigation at the BR Site.



LEGEND

⌖ BOREHOLE/MONITORING WELL LOCATION
— ROAD
┼ RAIL ROAD
— CONTOUR LINE, (5m)
-··- UTILITY LINE
— SURFACE WATER FEATURE
▨ WATER AREA
☐ LOT/CONCESSION
🟥 PROPERTY BOUNDARY

490 245 0 490
SCALE 1:20,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
BR SITE PLAN

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN
DESIGN	JPAO	JAN. 2013	REV. 0
GIS	BR	JAN. 2013	
CHECK	PLE	AUG. 2014	
REVIEW	PAS	AUG. 2014	

FIGURE 2.2-1

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase4000\TSD1\1211250045-4000-2.2-1-SitePlan.mxd

2.2.2.1 Surficial Geology

The surficial geology in the vicinity of the BR Site is shown on Figure 2.1-3. The BR Site and surrounding areas are underlain by an extensive and thick deposit of silty clay soil of marine origin (unit 3 on Figure 2.1-3). Based on published mapping, the marine clay in the western portion of the BR Site is overlain by deltaic and estuary deposits consisting of medium to fine grained sand. As shown on Figure 2.1-3, an extensive deposit of medium to fine grained sand overlying the marine clay is shown to the north of the BR Site. Based on previous investigations completed in the vicinity of the BR Site, the surficial sand material is discontinuous and is underlain by weathered silty clay (Golder, 1974a; WESA, 1986). The surficial sand and weathered clay typically do not extend beyond two to three metres depth. Below the weathered clay is the remainder of the silty clay deposit with an estimated thickness of 30 to 35 metres in the vicinity of the BR Site. The clay deposit is in turn underlain by approximately 1.5 to 5 metres of basal gravelly glacial till, followed by bedrock (Golder, 1974a; WESA, 1986).

From previous geotechnical investigations in the vicinity of the BR Site, it is reported that below the upper weathered zone, the clay deposit has a relatively soft consistency to a depth of about 10 metres, below which its shear strength gradually increases with depth and becomes stiff. The silty clay is a high plasticity soil with high natural water content, which is typical of the marine clay deposit in the Ottawa area (Golder, 1974a; Golder, 1974b, MTO, 1968; MTO 1969).

2.2.2.2 Bedrock Geology

The bedrock geology in the vicinity of the BR Site is illustrated on Figure 2.1-4. This figure shows the mapped uppermost bedrock unit beneath the soil cover. The area in the vicinity of the BR Site is underlain by interbedded shale, siltstone and limestone of the Carlsbad Formation. The shales are dark grey in colour and calcareous to non-calcareous. The siltstones and limestones are very thinly to medium bedded, medium grey to greenish grey in colour, and weathering a buff to reddish brown colour (Williams, 1991). Based on previous investigations in the Ottawa area, the total thickness of the Carlsbad Formation in the vicinity of the BR Site is reported to range between approximately 115 to 150 metres (Williams, 1991).

To the south of the BR Site, the uppermost bedrock unit is mapped as the shale of the Queenston Formation, which is indicated to exist in a west-east oriented band. The Queenston Formation to the south of the BR Site is underlain by the Carlsbad Formation. The Queenston Formation is the youngest formation of sedimentary rock in eastern Ontario and is described as a red, laminated to thickly bedded calcareous siltstone/mudstone and shale (Williams, 1991). The contacts between bedrock formations are typically caused by a series of near-vertical faults, which caused downthrowing of adjacent blocks of bedrock.

2.2.2.3 Hydrogeology

Water supply to residences, farms and commercial/industrial properties in the area of the BR Site utilizes individual wells. Drilled wells in this area typically obtain their water supply from the basal till/bedrock contact zone or from within the upper part of the bedrock. The yield of water from this zone is usually adequate for domestic use, with well yields reported to typically range from 15 to 25 litres/minute, and up to 45 to 65 litres/minute in certain wells. In the immediate vicinity of the BR Site, there are few wells registered in the MOE WWIS; these wells are completed in the basal till/bedrock contact zone and are indicated to yield enough water for domestic use. However, the groundwater quality in the immediate vicinity of the BR Site is reported as salty, sulphurous or mineralized; the presence of methane gas in the groundwater is also reported (WESA, 1986). For this reason, it is understood that most residents in the vicinity of the BR Site use shallow dug wells to provide a water supply from the upper sand layer and weathered clay zone. The groundwater quality problems in the basal till/bedrock contact zone are known to exist as far as three or four kilometres to the north of the BR Site to the area of Carlsbad Springs and also to the west. The City of Ottawa extended the municipal water supply to a portion of the Carlsbad Springs area to address these water supply issues. Further to the southwest and southeast, drilled wells are also completed in the basal till and the groundwater quality is reported as fresh (Charron, 1978; WESA, 1986; WESA and Earthfx, 2006).

In the absence of effective drainage in this flat lying terrain, the groundwater level in this fine grained soil is at or near ground surface throughout much of the year. In view of its low permeability characteristic, there is limited horizontal or vertical groundwater flow in the silty clay deposit; groundwater movement in the silty clay deposit would be very locally influenced adjacent to ditches or other watercourses. The silty clay deposit is an aquitard and does not allow recharge of the basal till and bedrock. Groundwater flow occurs in the basal till and bedrock; the direction of regional groundwater flow in these zones is indicated to be towards the northeast (Charron, 1978; WESA and Earthfx, 2006; WESA, 2010).

Based on a review of the City of Ottawa Official Plan, and the Source Water Protection work completed for the Rideau Valley Source Protection Area and the South Nation Source Protection Area, the BR Site is not located within a groundwater protection zone, or within a significant groundwater recharge area.

2.2.3 Study Methodology

To allow for a preliminary assessment of the suitability of the BR Site for use as a waste management facility, a work plan was develop to gather Site-specific geological, hydrogeological and geotechnical data to supplement the available published information. The methodology applied during the subsurface investigation and hydrogeological assessment is briefly described below.

2.2.3.1 Borehole Drilling

The field program for the BR Site includes the drilling of multiple test holes at three locations across the BR Site (numbered BH12-1, BH12-2 and BH12-3, inclusive). The approximate positions of the three investigation locations are shown on the attached, Site Plan, Figure 2.2-1. These locations correspond to locations E, A and Y as shown on Figure C-2.2-1 of the approved TOR. The test holes were advanced using a track-mounted drill rig supplied and operated by Marathon Drilling Company Ltd. of Ottawa, Ontario.

At each location, the following drilling program was typically carried out:

- Cone Penetration Testing (CPT) – CPTs were advanced at each location and are identified as CPT12-1-1, CPT12-2-1 and CPT12-3-1. The CPT consists of a probe with a cone shaped tip that is equipped with electronic sensing elements to continuously measure tip resistance, local side friction on a sleeve behind the tip, and porewater pressure. The cone is pushed at a constant rate into the ground using a drill rig. A continuous stratigraphic profile together with engineering properties, such as strength, stress history and density, can be interpreted from the results of the CPT. The CPTs were advanced to a depth of about 25 metres.
- Nilcon Vane Testing – Nilcon *in-situ* vane test boreholes were also advanced at each location and are identified as BH12-1-2, BH12-2-2 and BH12-3-2. In each boring, soil sampling and standard penetration tests were first carried out in the surficial native sand deposits and upper silty clay to depths of between about 1.8 and 2.1 metres, to reach the native unweathered silty clay. Below that depth, the boreholes were advanced using an electric Nilcon *in-situ* vane testing apparatus, with measurements taken at 1.0-metre

depth intervals. This vane testing was carried out under conditions of a constant rate of strain/rotation. The undrained shear strength of remoulded silty clay was also measured (to thereby measure the sensitivity) for about one out of every three to five test intervals. The boreholes were advanced within the silty clay deposit to depths between about 26.8 and 31.1 metres below the existing ground surface.

- Monitoring Well Installations – Monitoring wells were installed in four boreholes at each location and those boreholes are identified as BH12-1-3 to BH12-1-6, inclusive; BH12-2-3 to BH12-2-6, inclusive; and BH12-3-3 to BH12-3-6, inclusive, as well as BH12-1-3.1. These boreholes included installations within the bedrock, glacial till, silty clay and surficial sandy deposits, for measurement of the groundwater level, hydraulic conductivity testing and/or future 'down hole' geophysical testing. Standard penetration tests and 'split-barrel' soil sampling were carried in the lower portion of the silty clay at BH12-1-3 and within the glacial till at BH12-1-3, BH12-2-3 and BH12-3-3. In addition, 73-millimetre diameter thin-walled Shelby tube samples of the silty clay were obtained using a fixed piston sampler in BH12-1-3, BH12-2-3, BH12-3-3 and BH12-3-5. The boreholes were advanced up to maximum depths between about 36.7 and 40.6 metres where the bedrock surface was encountered.
- Once the bedrock was encountered at BH12-1-3, BH12-2-3, BH12-3-3 and BH12-1-3.1, the boreholes were extended between about 5 and 6 metres into the bedrock using rotary diamond drilling equipment while retrieving HQ size bedrock core.

The drilling was coordinated and observed by a Golder technician who located the test holes, monitored the drilling operations, logged the test holes, monitored the *in-situ* testing, and took custody of the soil samples retrieved.

Upon completion of the drilling operations, samples of the soils and rock core encountered in the boreholes were transported to our laboratory for examination by the project engineer and a geologist, and for laboratory testing.

2.2.3.2 Monitoring Well Installation and Elevation Surveying Program

Combined bedrock monitoring well and vertical seismic profiling (VSP) casing installations were constructed (as a single pipe) in BH12-2-3 and BH12-3-3. However, the VSP casing and bedrock monitoring well at location 12-1 were installed in two separate boreholes (i.e., BH12-1-3 and BH12-1-3.1, respectively) due to construction difficulties encountered with having a dual-purpose installation in a single borehole. The installations in BH12-2-3 and BH12-3-3 were constructed of 0.063-metre diameter, threaded, PVC slot #10 screen and solid risers. The VSP installation at BH12-1-3 was constructed of 0.076-metre diameter PVC solid risers. The bedrock monitoring well at BH12-1-3.1 was constructed of 0.050-metre diameter, threaded, PVC slot #10 screen and solid risers. Silica sand backfill was placed in the boreholes around the screened portion within the bedrock and then a combination of peltonite and bentonite-cement grout was used to seal the boreholes up to the ground surface.

Within the overburden soils, multi-level groundwater monitoring wells within the glacial till and silty clay were installed in BH12-1-4, BH12-1-5, BH12-2-5, BH12-3-4 and BH12-3-5. Single monitoring wells were installed within the sandy surficial deposits at BH12-1-6, BH12-2-6 and BH12-3-6 as well as within the deep silty clay at BH12-2-4. The monitoring wells were installed at specific depths to allow for the measurement of groundwater levels and to obtain estimates of horizontal hydraulic conductivity and gradients within the various soils and bedrock encountered at the BR Site. The preferred locations for the screened intervals of the monitoring wells were determined based on observations during the drilling program and on the results of the CPT and Nilcon vane testing. These monitoring wells were constructed of either 0.025-metre, 0.032-metre or 0.050-metre diameter, threaded, PVC slot #10 screen and solid risers.

Silica sand backfill was placed in the boreholes around the screened portions of the monitors. A combination of bentonite, peltonite and/or bentonite-cement grout was used to provide seals between the screened intervals and to seal the borehole up to ground surface.

Each monitoring well is protected at surface by a steel casing with a lockable cap. A survey of the ground surface and top of casing elevation for the monitoring wells was completed by Golder.

Where dual/multi-level wells were installed in single boreholes, the deepest monitoring well installation at each borehole is designated as monitoring well “A”, with each successively shallower monitoring well at each borehole designated as “B”, “C”, etc., where appropriate.

The monitoring wells were developed following their installation and prior to undertaking hydraulic conductivity testing, groundwater level measurements and groundwater sampling.

2.2.3.3 Hydraulic Conductivity Testing

Well response tests were carried out in the monitoring intervals. The well response testing was undertaken to provide information on the *in-situ* horizontal hydraulic conductivity of the overburden and bedrock adjacent to the monitoring well intervals. The falling-head/rising-head tests consisted of inserting or removing a slug of known volume into each of the monitoring wells, followed by monitoring the groundwater level dissipation/recovery within the monitor. Before the start of the hydraulic testing, static water levels were measured at all locations. Each hydraulic test was deemed complete when the monitoring well recovered to approximately 95% of the original static water level, or after two hours of monitoring for locations having slow recovery.

The intervals for response testing were defined as the sand pack interval (i.e., the zone filled with sand surrounding the screens) between the bentonite seals. The water level recovery data were analyzed using the Hvorslev method (Hvorslev, 1951) to provide an estimate of the horizontal hydraulic conductivity.

2.2.3.4 Groundwater Level Monitoring Program

A groundwater level monitoring program was conducted to provide information on hydraulic gradients and the groundwater flow direction(s) at the BR Site. The depth to groundwater was measured relative to the surveyed top of PVC pipes for the monitoring wells. The water elevations in the monitoring wells were calculated by subtracting the measured depth to water from the top of pipe reference elevations.

2.2.3.5 Groundwater Quality Sampling Program

The water quality sampling program at the BR Site was divided into two programs, which included the on-Site monitoring well sampling program and the residential water supply well sampling program.

2.2.3.5.1 On-Site Monitoring Well Sampling Program

The on-Site monitoring well water quality sampling program involved collecting groundwater samples from the depth-specific monitoring wells installed in BH12-1, BH12-2 and BH12-3. The primary objective of the water quality monitoring program is to define existing background groundwater quality at the BR Site. The groundwater samples were analyzed for the parameters specified in *Ontario Regulation 232/98* (except for total suspended solids), which relates to the construction and expansion of landfill sites. All samples were entered on Chain of Custody forms and delivered to Maxxam for the required analysis.

2.2.3.5.2 Residential Well Sampling Program

The limited residential water supply well sampling program involved collecting groundwater samples from supply wells in the immediate vicinity of the BR Site to characterize background groundwater quality for typical organic and inorganic landfill leachate parameters. The parameters analyzed for the residential wells were the same as the on-Site monitoring wells. Prior to sampling, Golder staff completed a survey with the homeowners to gather information about their water supply (i.e., well type, depth, location, satisfaction with water quality and quantity, etc.). If the water supply is treated (i.e., water softener), the water sample was collected from an untreated location, or the treatment system was bypassed. All samples were entered on Chain of Custody forms and delivered to Maxxam for the required analysis.

2.2.4 Results and Discussion

In the following discussion, the borehole locations are generally referred to only by the designation of each group of boreholes (i.e., 12-1, 12-2 and 12-3) without reference to the individual test holes at each location.

2.2.4.1 Borehole Drilling Program

The CPT profiles for normalized cone resistance, sleeve friction, and porewater pressure during pushing together with an interpreted profile of the stratigraphy are presented in Attachment TSD#1-B-2-2. The subsurface conditions encountered in the boreholes along with the results of the Nilcon vane testing are shown on the Record of Borehole and Drillhole Sheets in Attachment TSD#1-B-2-2. The results of the water content and Atterberg limit testing are indicated on the Record of Borehole sheets. The results of grain size distribution testing of the surficial sandy deposits and glacial till are also provided in Attachment TSD#1-B-2-2.

The following presents a summarized overview of the subsurface conditions encountered within the test holes.

2.2.4.1.1 Topsoil

About 200 to 250 millimetres of topsoil was encountered at ground surface at all of the test hole locations.

2.2.4.1.2 Sandy Deposit

The topsoil is underlain by about 0.3 to 1.3 metres of silty sand, sand, and/or sandy silt. Standard penetration tests carried out within the sandy soils gave ‘N’ values of between 2 and 10 blows per 0.3 metres of penetration indicating a very loose to compact state of packing.

The measured natural water contents of two samples of the sandy deposit were about 19% and 23%. The results of grain size distribution testing of two samples of this deposit are shown on the figure in Attachment TSD#1-B-2-2.

2.2.4.1.3 Clay to Silty Clay

The surficial sandy deposits are underlain by a thick deposit of clay to silty clay. The clay to silty clay was fully penetrated to depths between about 34.1 and 35.8 metres below the existing ground surface at BH12-1, BH12-2 and BH12-3. The thickness of this deposit ranges from about 32 to 35 metres.

The upper 0.7 metres of the silty clay at BH12-1 have been weathered to a red brown crust. One standard penetration test carried out in the weathered material gave an ‘N’ value of four blows per 0.3 metres of penetration indicating a stiff consistency (based on local experience with the correlation to undrained shear strength). No similar weathering was encountered at BH12-2 and BH12-3.

The clay to silty clay below the sandy deposit or weathering (where present) is unweathered. The results of *in-situ* Nilcon vane testing in this unweathered material gave undrained shear strengths ranging from about 14 to greater than 100 kilopascals, generally increasing with depth. These results indicate a generally soft consistency to about 9 to 10 metres depth, followed by a firm consistency to about 15 to 18 metres depth, and stiff to very stiff below that.

The results of Atterberg limit testing carried out on four samples of the unweathered clay to silty clay gave plasticity index values ranging between about 44% and 80%, and liquid limits values between about 75% and 114%. These results indicate a relatively high plasticity soil. The measured water contents of the samples were between about 71% and 87%.

The results of the CPT testing indicate the variable occurrence of sand and silt seams within the upper portion of the clay to silty clay. These seams were encountered at depths between about 1.8 and 6.6 metres and are interpreted to vary in thickness from about 0.1 to 0.3 metres. Information to be obtained from the remainder of the drilling and testing program will be used to assess the presence, characteristics and continuity of these seams.

2.2.4.1.4 Glacial Till

The silty clay is underlain by a deposit of glacial till. Based on the retrieved samples and observations of the sampler/drilling resistance, the glacial till is considered to generally consist of a heterogeneous mixture of gravel, cobbles and boulders in a matrix of sand and silt with a trace to some clay. This deposit was fully penetrated to depths between about 36.7 and 40.6 metres below the existing ground surface. The thickness ranges from about 2 to 6 metres.

Standard penetration tests carried out within the glacial till gave ‘N’ values of between 16 and 97 blows per 0.3 metres of penetration indicating a compact to very dense state of packing. Sampler ‘refusal’ was also encountered for one sample attempt, likely reflecting the cobble/boulder content.

The measured natural water contents of two samples of the glacial till were about 9% and 10%. The results of grain size distribution testing of two samples of this deposit are shown on the figure in Attachment TSD#1-B-2-2. It should be noted, however, that the samples were retrieved using a 35-millimetre inside diameter sampler and therefore the results don’t reflect the boulder, cobble or full gravel content.

2.2.4.1.5 Bedrock

Coring of the bedrock was carried out in four of the boreholes (i.e., BH12-1-3, 12-1-3.1, 12-2-3 and 12-3-3). The following table provides details of the cored boreholes.

Table 2.2-1: BR Site Cored Hole Drilling Details – BH12-1-3, BH12-1-3.1, BH12-2-3 and BH12-3-3

Location	Date Drilled	Ground Surface Elevation (masl)	Depth to Bedrock (m)	Bedrock Surface Elevation (masl)	Total Depth Cored (m)
BH12-1-3	November 15 to 19, 2012	76.01	40.61	35.40	5.86
BH12-1-3.1	November 23, 2012	76.10	39.78	36.32	5.59
BH12-2-3	January 11 and 14, 2013	76.94	36.74	40.20	5.21
BH12-3-3	December 3 to 5, 2012	76.22	39.84	36.38	5.58

The bedrock encountered in the boreholes typically consists of fresh, laminated to thinly bedded, grey to black, fine to coarse grained, moderately porous interbedded limestone and shale bedrock of the Carlsbad Formation.

The Rock Quality Designation (RQD) values measured on recovered bedrock core samples typically range from about 59% to 100%, indicating a fair to excellent quality rock. However, two lower RQD values of 12% and 29% were measured within the upper portion of the bedrock at BH12-3-3 and BH12-2-3, respectively, indicating poorer quality bedrock.

2.2.4.2 Monitoring Well Installation and Elevation Surveying Program

Groundwater monitoring wells were constructed to allow for the measurement of groundwater levels and to obtain estimates of horizontal hydraulic conductivity and gradients within the soil and bedrock encountered at the BR Site. Combined bedrock monitoring wells and VSP casing installations were installed in BH12-2-3 and BH12-3-3. However, the VSP casing and bedrock monitoring well at location BH12-1 were installed in separate boreholes (i.e., BH12-1-3 and BH12-1-3.1, respectively). Multi-level groundwater monitoring wells within the glacial till and silty clay were installed in BH12-1-4, BH12-1-5, BH12-2-5, BH12-3-4 and BH12-3-5. Single monitoring wells were installed within the surficial sandy deposits at BH12-1-6, BH12-2-6 and BH12-3-6 as well as within the deep silty clay at BH12-2-4. The preferred locations for the screened intervals of the monitoring wells were determined based on observations during the drilling program and on the results of the CPT and Nilcon vane testing. The screened locations within the shallow monitoring wells in the silty clay deposit were selected based on the presence of sand and silt layers inferred from the results of the CPT.

The following table summarizes the monitoring well completion details for the monitoring wells constructed in boreholes. The monitoring well installations are shown on the borehole/drillhole logs in Attachment TSD#1-B-2-2.

Table 2.2-2: BR Site Monitoring Well Completion Details

Location	Ground Surface Elevation (masl)	TOP Elevation (masl)	Screened Interval* (mbgs)	
			Top	Bottom
BH12-1-3.1	76.10	76.84	40.1	45.4
BH12-1-4A	76.08	77.03	36.0	39.5
BH12-1-4B	76.08	77.01	27.0	31.0
BH12-1-5A	76.06	76.87	12.8	15.3
BH12-1-5B	76.06	76.84	4.0	6.0
BH12-1-6	76.06	76.82	0.3	1.5
BH12-2-3	76.94	77.77	37.0	42.0
BH12-2-4	77.09	77.95	30.0	32.2
BH12-2-5A	76.99	77.82	18.6	20.7
BH12-2-5B	76.99	77.77	3.8	7.6
BH12-2-6	77.13	78.07	0.4	2.3
BH12-3-3	76.22	77.00	40.1	45.4
BH12-3-4A	76.23	77.20	35.1	38.7
BH12-3-4B	76.23	77.20	28.0	30.5
BH12-3-5A	76.23	77.18	13.8	15.8
BH12-3-5B	76.23	77.21	4.0	6.1
BH12-3-6	76.27	77.09	0.3	1.5

Notes: TOP – top of pipe.
* The screened interval refers to the entire sand pack area – not just the length of the slotted screen.

2.2.4.3 *Hydraulic Conductivity Testing*

Well response tests were carried out in the 12 monitoring intervals installed within the on-Site boreholes using the rising-head and/or falling-head methods. The results of the *in-situ* hydraulic conductivity testing are summarized in the following table. The depth of the screened interval and comments relating to the interval tested are provided.

Table 2.2-3: BR Site Hydraulic Conductivity Results

Location	Screened Interval* (mbgs)	Hydraulic Conductivity (m/sec)	Formation Monitored	Comments
BH12-1-3.1	40.1 to 45.4	3×10^{-7}	Carlsbad Bedrock	--
BH12-1-4A	36.0 to 39.5	4×10^{-6}	Glacial Till	--
BH12-1-5B	4.0 to 6.0	1×10^{-7}	Shallow Clay	Sand/silt seam between 5.1 and 5.2 mbgs
BH12-1-6	0.3 to 1.5	1×10^{-7}	Shallow sand, silt and clay (Sandy Deposit)	--
BH12-2-3	37.0 to 42.0	2×10^{-5}	Carlsbad Bedrock	--
BH12-2-5B	3.8 to 7.6	5×10^{-7}	Shallow Clay	Sand/silt seam between 6.3 and 6.6 mbgs
BH12-2-6	0.4 to 2.3	3×10^{-5}	Shallow sand, silt and clay (Sandy Deposit)	--
BH12-3-3	40.1 to 45.4	4×10^{-6}	Carlsbad Bedrock	--
BH12-3-4A	35.1 to 38.7	1×10^{-6}	Glacial Till	--
BH12-3-5B	4.0 to 6.1	3×10^{-7}	Shallow Clay	Sand/silt seam between 4.6 and 4.9 mbgs
BH12-3-6	0.3 to 1.5	6×10^{-6}	Shallow sand, silt and clay (Sandy Deposit)	--

Note: * The screened interval refers to the entire sand pack area – not just the length of the slotted screen.

Based on the results of the *in-situ* hydraulic conductivity testing completed at the Site (falling and rising-head tests), the following ranges in hydraulic conductivities were observed in the various overburden and bedrock formations at the Site:

- Shallow sand, silt and clay (Sandy Deposit): 1×10^{-7} m/sec to 3×10^{-5} m/sec;
- Shallow clay with sand/silt seam: 1×10^{-7} m/sec to 5×10^{-7} m/sec;
- Glacial Till: 1×10^{-6} m/sec to 4×10^{-6} m/sec; and
- Carlsbad Formation: 3×10^{-7} m/sec to 2×10^{-5} m/sec.

2.2.4.4 Groundwater Level Monitoring Program

A groundwater level monitoring program was conducted to provide information on hydraulic gradients, the range in water levels observed at the BR Site and the groundwater flow direction(s).

2.2.4.4.1 Groundwater Elevations

Groundwater levels were collected at the on-Site monitoring wells following well development from January 14 (BH12-1 and BH12-3 only) to January 22, 2013 and are presented in Table 2.2-4 below. Monitoring well installations were completed in borehole location BH12-2 following the completion of the drill program on January 14, 2013; therefore groundwater elevation data are limited to only one monitoring event at this location at this time.

Table 2.2-4: BR Site Groundwater Elevations

Location	Ground Surface Elevation (masl)	TOP Elevation (masl)	January 14, 2013	January 22, 2013
			Groundwater Depth (masl)	Groundwater Depth (masl)
BH12-1-3.1	76.10	76.84	74.52	75.56
BH12-1-4A	76.08	77.03	74.41	74.42
BH12-1-4B	76.08	77.01	74.46	74.47
BH12-1-5A	76.06	76.87	Frozen	Frozen
BH12-1-5B	76.06	76.84	75.64	75.68
BH12-1-6	76.06	76.82	75.85	Frozen
BH12-2-3	76.94	77.77	—	75.11
BH12-2-4	77.09	77.95	—	(76.56)/65.06*
BH12-2-5A	76.99	77.82	—	Frozen
BH12-2-5B	76.99	77.77	—	(76.05)/76.07*
BH12-2-6	77.13	78.07	—	76.64
BH12-3-3	76.22	77.00	74.47	74.53
BH12-3-4A	76.23	77.20	74.41	74.59
BH12-3-4B	76.23	77.20	75.70	75.66
BH12-3-5A	76.23	77.18	Frozen	Frozen
BH12-3-5B	76.23	77.21	75.75	75.78
BH12-3-6	76.27	77.09	76.22	Frozen

Notes: — Monitoring well location not yet established
( ) Groundwater elevation prior to well development on January 21, 2013
* Non-stabilized groundwater elevation following well development

The water levels at BH12-2-4 and BH12-2-5B are interpreted to be influenced by on-Site data collection activities. The water level recovery in these wells is slow. The decrease in the groundwater elevation at these locations shown in Table 2.2-4 is interpreted to be a result of monitoring well development and groundwater sampling completed on January 21, 2013. The groundwater levels in BH12-2-4 and BH12-2-5B are expected to gradually increase over time until the stabilized static water levels are reached. If the BR Site is identified as the preferred Site for the Undertaking, a groundwater monitoring program for on-Site monitoring wells at the BR Site will be established in order to further characterize the long-term hydrogeological conditions present at the BR Site.

2.2.4.4.2 Vertical Gradients

Table 2.2-5 provides a summary of the direction of vertical gradients observed at the Site.

Table 2.2-5: BR Site Direction of Vertical Gradient

Locations	Interpreted Direction of Vertical Gradient/Comments
BH12-1-3.1, BH12-1-4A, BH12-1-4B, BH12-1-5B and BH12-1-6	Typical downward vertical gradient in overburden between BH12-1-6 through to BH12-1-4A; and, slight upward gradient observed between BH12-1-3.1 (bedrock) and BH12-1-4A
BH12-2-4, BH12-2-5B and BH12-2-6	Typical downward vertical gradient in overburden between BH12-2-6 and BH12-2-5B; and slight upward gradient observed between BH12-2-4 and BH12-02-5B, likely the result of non-stabilized groundwater levels in the deep and shallow clay
BH12-3-3, BH12-3-4A, BH12-3-4B, BH12-3-5A, BH12-2-5B and BH12-3-6	Typical downward vertical gradient in overburden between BH12-3-6 through to BH12-3-4A; and negligible upwards vertical gradient between BH12-3-3 (bedrock) and BH12-3-4A

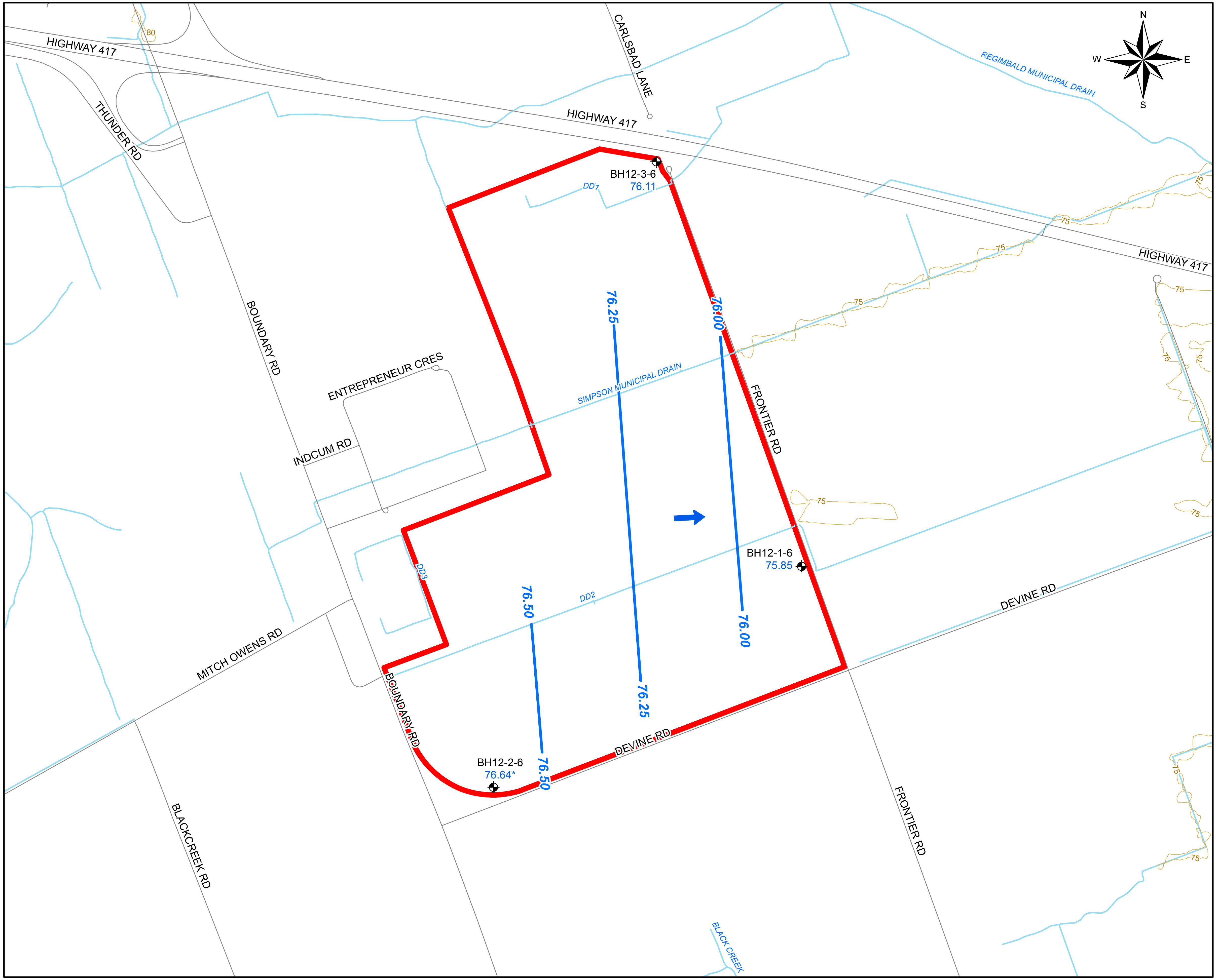
Based on the groundwater elevation data collected to date, vertical gradients at the Site are typically weakly downward, or absent, with the exception of a slight upward vertical gradient between BH12-1-3.1 and BH12-1-4A and possibly BH12-2-4 and BH12-2-5B based on the available groundwater data (likely non-stabilized). Vertical gradients could not be adequately assessed between the deep clay (BH12-1-4B, BH12-2-4 and BH12-3-4B) and middle clay (BH12-1-5A, BH12-2-5A and BH12-3-5A) due to the groundwater in the monitoring wells screened within the middle clay deposit being consistently frozen, however downward gradients are assumed based on these observations. If the BR Site is identified as the preferred Site for the Undertaking, as additional groundwater level data are collected in 2013, the variation in magnitude and direction of the vertical gradients associated with seasonal variations in groundwater levels will be assessed.

2.2.4.4.3 Groundwater Flow Direction

An estimate of the groundwater flow direction for the shallow overburden (sand, silt and clay), shallow clay (with sand/silt seam), and shallow bedrock at the BR Site was obtained using appropriately positioned (vertically) on-Site monitoring intervals.

The following locations were used to provide an estimate of the shallow groundwater flow direction in the shallow overburden: BH12-1-6; BH12-2-6 and BH12-3-6. The groundwater levels collected from these locations on January 14 (BH12-1-6 and BH12-3-6) and January 22 (BH12-2-6 only), 2013 were used to produce the groundwater contours shown on Figure 2.2-2. Monitoring well BH12-2-6 was not installed during the January 14, 2013 monitoring session, while groundwater in monitoring wells BH12-1-6 and BH12-3-6 was frozen during the January 22, 2013 monitoring event; therefore the available data was combined to estimate groundwater flow direction. Based on the available groundwater levels collected in January 2013 at BH12-1-6, BH12-2-6 and BH12-3-6, the groundwater flow in the shallow overburden for the BR Site is interpreted to be towards the east.

Groundwater flow direction in the shallow clay was estimated using monitoring well locations BH12-1-5B, BH12-2-5B and BH12-3-5B. The groundwater levels collected from these locations on January 22, 2013 were used to produce the groundwater contours and interpret the groundwater flow direction in the shallow clay as shown on Figure 2.2-3. The groundwater flow direction in the shallow clay is interpreted to be towards the east at the BR Site.



LEGEND

- ⊕ BOREHOLE/MONITORING WELL LOCATION
- — ROAD
- — CONTOUR LINE, (5m)
- — SURFACE WATER FEATURE
- ▨ WATER AREA
- ▭ PROPERTY BOUNDARY
- ➡ INTERPRETED GROUNDWATER FLOW DIRECTION
- — INTERPRETED GROUNDWATER CONTOUR
- 76.61 GROUNDWATER ELEVATION (JANUARY 14, 2013)
- 76.64* GROUNDWATER ELEVATION (JANUARY 22, 2013)

200 100 0 200

SCALE 1:12,000 METRES

NOTE

1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B.
2. MONITORING WELLS BH 12-1-6 AND BH 12-3-6 FROZEN ON JANUARY 22, 2013.

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

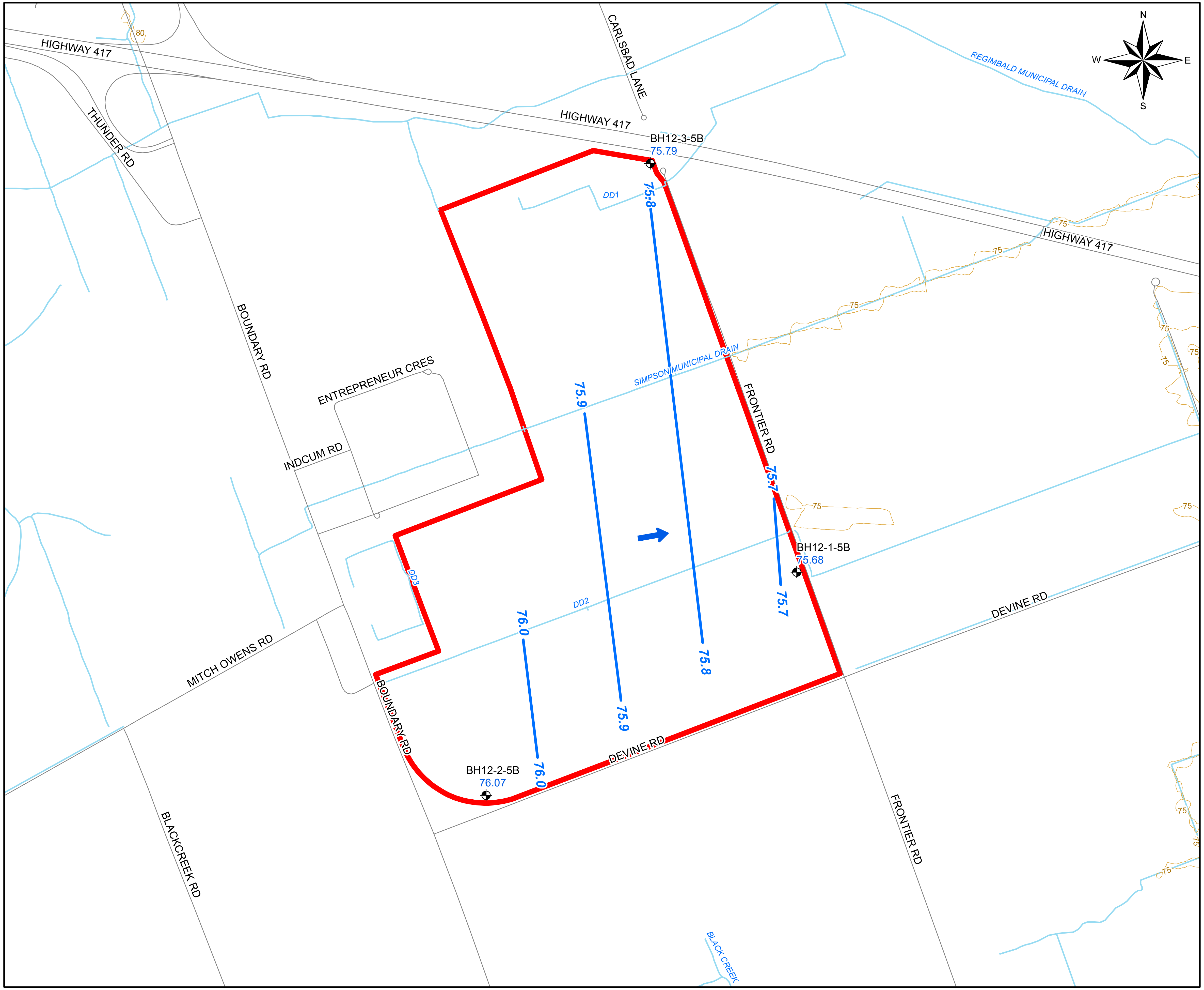
PROJECT
ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
BR SITE
SHALLOW OVERBURDEN GROUNDWATER FLOW
(JANUARY 14 AND 22, 2013)

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	JAN. 2013	FIGURE 2.2-2	
GIS	BR	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase4000\TSD1\1211250045-4000-2-2-2-WaterTableGWFlow.mxd



LEGEND

- ⊕ BOREHOLE/MONITORING WELL LOCATION
- — ROAD
- — CONTOUR LINE, (5m)
- — SURFACE WATER FEATURE
- ▭ WATER AREA
- ▭ PROPERTY BOUNDARY
- ➡ INTERPRETED GROUNDWATER FLOW DIRECTION
- — INTERPRETED GROUNDWATER CONTOUR
- 75.79 GROUNDWATER ELEVATION (JANUARY 22, 2013)

190 95 0 190

SCALE 1:12,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
BR SITE
SHALLOW CLAY GROUNDWATER FLOW
(JANUARY 22, 2013)

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045		
DESIGN	JPAO	JAN. 2013
GIS	BR	JAN. 2013
CHECK	PLE	AUG. 2014
REVIEW	PAS	AUG. 2014

SCALE AS SHOWN REV. 0

FIGURE 2.2-3

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase4000\TSD1\1211250045-4000-2-2-3-ShallowClayGWFlow.mxd

Monitoring wells were installed within the glacial till at borehole locations BH12-1 and BH12-3 only; therefore it was not possible to estimate the groundwater flow direction within this unit. However, given the general understanding of the surficial geology at the Site, the glacial till layer trends towards the east and it's likely that the groundwater flow direction is consistent with the slope of the glacial fill surface and towards the east.

The following locations were used to provide an estimate of the shallow bedrock groundwater flow direction (i.e., between approximately 37 and 45.4 mbgs): BH12-1-3.1; BH12-2-3 and BH12-3-3. The groundwater levels collected from these locations on January 22, 2013 were used to produce the groundwater contours shown on Figure 2.2-4, which indicates that groundwater flow in the shallow bedrock is interpreted to be towards the east at the BR Site.

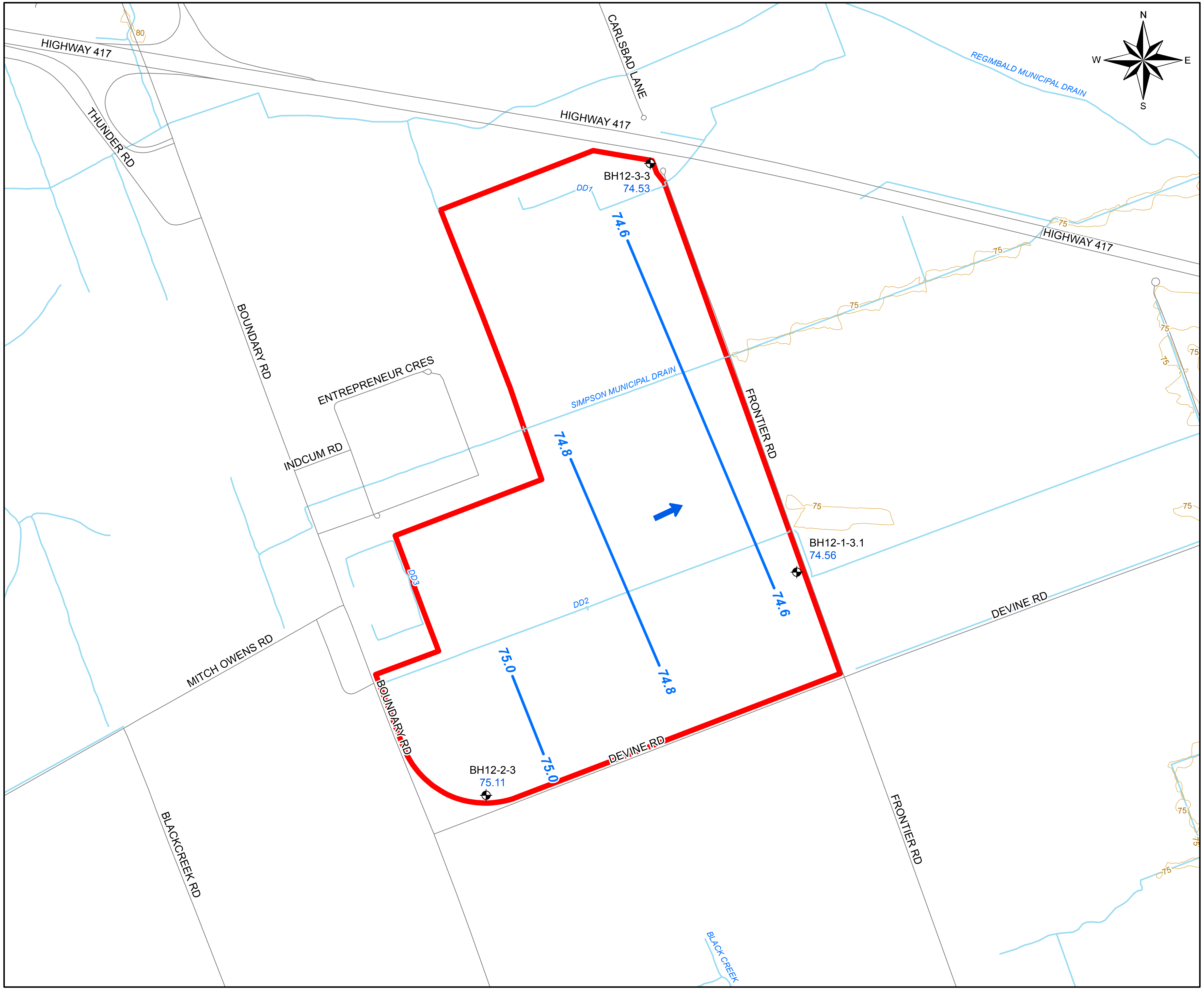
Based on the groundwater levels collected on January 14 and 22, 2013, groundwater flow direction for the BR Site is interpreted to be towards the east within all layers, consistent with the dip direction of the respective units. Based on the groundwater contour spacing shown on Figures 2.2-2, 2.2-3 and 2.2-4, the horizontal hydraulic gradient (i.e., potential for horizontal groundwater flow) appears to be consistent across the Site due to the relatively level topography in each stratigraphic unit.

2.2.4.5 Groundwater Quality Sampling Program

2.2.4.5.1 Monitoring Well Sampling Program

The groundwater quality sampling program involved collecting samples from selected on-Site monitoring wells installed in BH12-1 through BH12-3 (standpipe locations BH12-1-4B, 12-1-5A, BH12-2-4B, BH12-2-5A, BH12-3-4B and BH12-3-5A were not included in the groundwater monitoring program). To date, one round of groundwater quality sampling has been completed. Groundwater samples were collected from the selected monitoring locations on January 11 (BH12-1 and BH12-3) and January 21 (BH12-2), 2013. The groundwater samples were analyzed for the parameters specified in *Ontario Regulation 232/98* (except for total suspended solids), which lists generic parameters that should be monitored at landfill sites. Total suspended solids were not measured in the samples collected from the monitoring wells because the analysis would be measuring material in the well that has accumulated, and was then re-suspended during the sampling process. All groundwater samples collected were odourless, very light brown to dark brown in colour and had little to high sediment loading (BH12-1-5B, BH12-2-5B, BH12-2-6 and BH12-3-5B only).

The groundwater quality results for the on-Site monitoring wells are provided in Table TSD#1-B-6-2-1 in Attachment TSD#1-B-6-2. Based on the results of the first round of groundwater quality sampling, groundwater quality was variable across the BR Site. Table 2.2-6 provides a list of the parameters at monitoring wells that were elevated relative to most sampling locations at the BR Site.



LEGEND

⊕ BOREHOLE/MONITORING WELL LOCATION
— ROAD
— CONTOUR LINE, (5m)
— SURFACE WATER FEATURE
▨ WATER AREA
▭ PROPERTY BOUNDARY
➡ INTERPRETED GROUNDWATER FLOW DIRECTION
— INTERPRETED GROUNDWATER CONTOUR
74.53 GROUNDWATER ELEVATION (JANUARY 22, 2013)

190 95 0 190

SCALE 1:12,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

BR SITE
SHALLOW BEDROCK GROUNDWATER FLOW
(JANUARY 22, 2013)

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	JAN. 2013	FIGURE 2.2-4	
GIS	BR	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

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Table 2.2-6: BR Site Elevated Parameters at On-Site Monitoring Wells

Location	Elevated Parameters
BH12-1-3.1	ammonia, BOD, chloride, conductivity, TDS, barium, boron, magnesium, potassium, sodium, methane
BH12-1-4A	ammonia, BOD, chloride, conductivity, TDS, barium, boron, magnesium, potassium, sodium
BH12-1-5B	COD, chloride, total phosphorus, magnesium, sodium
BH12-1-6	sulfate, calcium
BH12-2-3	chloride, conductivity, sulfate, boron, potassium, sodium
BH12-2-5B	COD, DOC, total phosphorus
BH12-2-6	total phosphorus
BH12-3-3	ammonia, chloride, conductivity, TDS, barium, boron, magnesium, potassium, sodium, benzene, toluene, methane
BH12-3-4A	ammonia, chloride, conductivity, TDS, barium, boron, magnesium, potassium, sodium
BH12-3-5B	BOD, COD, DOC, total phosphorus, sulfate, calcium, manganese, benzene, toluene, vinyl chloride
BH12-3-6	calcium

Notes: BOD – biological oxygen demand; COD – chemical oxygen demand; and TDS – total dissolved solids

Elevated concentrations of total phosphorus observed at all shallow clay monitoring wells (BH12-1-5B, BH12-2-5B and BH12-3-5B) and the shallow overburden monitoring well BH12-2-6 are likely due to the samples having high sediment loadings. A minimum of 5 purge volumes were removed as part of the monitoring well development program prior to groundwater sampling.

The elevated concentrations measured at monitoring wells presented in Table 2.2-6 are interpreted to be naturally occurring, with the exception of benzene and toluene at monitoring well BH12-3-3 (0.0072 and 0.0027 mg/L, respectively) and BH12-3-5B (0.0043 and 0.0011 mg/L, respectively) and vinyl chloride at monitoring well BH12-3-5B (0.0013 mg/L) only. Groundwater samples collected at BH12-3-3 and BH12-3-5B were re-analyzed for volatile organic compounds (VOCs) and the results indicate that concentrations of benzene and toluene in BH12-3-3 and benzene, toluene and vinyl chloride at BH12-3-5B remain elevated, but within the applicable ODWQS. Elevated concentrations of these parameters were not anticipated given there is no known source of contaminants near the monitoring well, especially in regards to the monitoring well screened within the shallow bedrock (BH12-3-3) which is overlain by approximately 5.8 metres of moderately permeable glacial till and 32.5 metres of low permeability clay. Additional groundwater quality sampling at BH12-3-5B and BH12-3-3 scheduled as part of the on-going characterizing of background conditions at the BR Site (if the BR Site is identified as the preferred Site) will confirm the presence of VOC contaminants at these locations.

Groundwater quality results obtained at the BR Site consistently exceeded ODWQS for the following parameters: TDS (all locations), chloride and sodium (all locations, with the exception of BH12-2-6) and DOC (all locations, with the exception of BH12-1-6 and BH12-3-6). Based on the available information, groundwater quality at the BR Site varies from fresh to brackish and deteriorates with depth, where elevated concentrations of barium, chloride, sodium and TDS and occasionally manganese are observed in the shallow bedrock and glacial till, compared to the applicable ODWQS. Groundwater quality samples collected in the shallow bedrock were also analyzed for dissolved methane, which exceeded the ODWQS at monitoring wells BH12-1-3.1 and BH12-3.3.

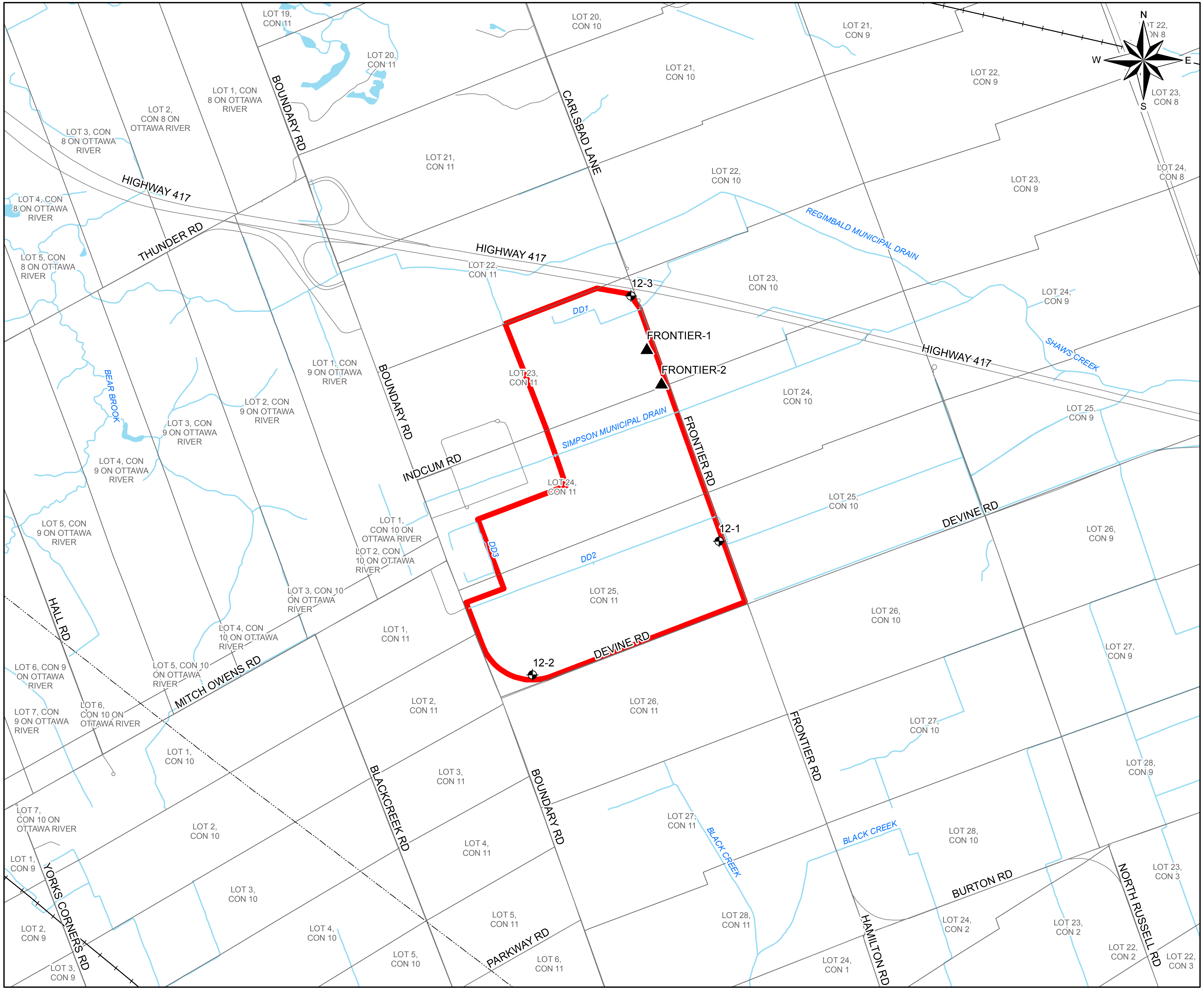
2.2.4.5.2 Residential Water Supply Well Sampling Program

The limited residential water supply well sampling program involved collecting groundwater samples from accessible supply wells in the immediate vicinity of the BR Site to characterize background groundwater quality for typical organic and inorganic landfill leachate parameters. Prior to sampling, Golder staff completed a survey with the homeowners to gather information about their water supply. Copies of the completed surveys are provided in Attachment TSD#1-B-7-2.

Two residential water supply wells and one commercial water supply well were sampled between January 17 and January 18, 2013. Residential water supply wells are situated along Frontier Road (two: Frontier-1 and Frontier-2) within the northeast limits of the BR Site, and one commercial supply well (Boundary-1) is situated west of the BR Site. The residential water supply wells are shown on Figure 2.2-5. The water supply well survey completed at location Boundary-1 identified the supply well operates at a commercial property and is primarily used for washing equipment. All water supply wells sampled during this program are completed to an approximate depth of 3.7 to 6.1 metres (unknown well depth at Frontier-2) in the overburden and consist of dug wells.

The groundwater quality results for the residential and commercial water supply wells are provided in Table TSD#1-B-7-2-1 in Attachment TSD#1-B-7-2. The results of the water supply sampling program indicate that all parameters analyzed were below the respective ODWQS with the exception of a few parameters at all water supply wells. Parameters exceeding the ODWQS include DOC and manganese at all three water supply locations, along with TDS and iron at the commercial water supply well only (Boundary-1).

The results of the residential water supply wells sampling program indicate that groundwater quality at the private well locations differs significantly from the groundwater quality observed at on-Site monitoring wells at the BR Site. Groundwater quality at on-Site monitoring wells appears to be of poor quality compared to the residential and commercial water supply dug wells sampled, as evidenced by elevated concentrations of parameters at a majority of the groundwater monitoring locations.



LEGEND

⌖ BOREHOLE/MONITORING WELL LOCATION

WATER SUPPLY WELL LOCATION

▲ RESIDENTIAL WATER SUPPLY WELL

— ROAD

┼ RAIL ROAD

-··- UTILITY LINE

— SURFACE WATER FEATURE

🟦 WATER AREA

🟥 PROPERTY BOUNDARY

☐ LOT/CONCESSION

500 250 0 500

SCALE 1:20,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-B

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

BR SITE
RESIDENTIAL WATER SUPPLY WELL LOCATIONS

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	JAN. 2013	**FIGURE 2.2-5**	
GIS	BR	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

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2.2.5 Summary of Conditions at Boundary Road Site

Table 2.2-7: Summary of BR Site Considerations

Environmental Component	Summary of Site Considerations
Geology, Hydrogeology & Geotechnical	Geological Setting: ▪ Variable thickness of surficial silty sand up to 1.5 m thick overlying about 30 m of clay to silty clay. ▪ The results of the CPT testing indicate the variable presence of sand and silt seams within the upper portion of the clay to silty clay, encountered at depths between about 1.8 and 6.6 metres and interpreted to vary in thickness from about 0.1 to 0.3 metres. ▪ Surficial geological mapping indicates that the surficial sand layer pinches out (or is of minimal thickness) to the east of the BR Site and on the northern part of the BR Site. ▪ Based on the available groundwater levels, the groundwater flow in the shallow overburden, shallow clay, glacial till and shallow bedrock is interpreted to be towards the east at the BR Site (i.e., away from off-Site groundwater users). ▪ The horizontal/hydraulic gradient is quite small, mirroring the flat terrain in the area of the BR Site. ▪ In the unlikely event of an unmitigated leachate release to the shallow on-Site groundwater system, leachate-impacted groundwater would migrate easterly primarily through the surficial silty sand layer unless intercepted.
	Type and thickness of any natural on-Site attenuation layer: ▪ An on-Site natural attenuation (containment) layer for flow in the vertical direction is present (about 30 m of clay to silty clay). ▪ Upper surficial silty sand layer has a moderate horizontal hydraulic conductivity of between 10^{-7} m/sec to 10^{-5} m/sec.
	Presence and quality of groundwater resources on-Site and in Site-vicinity: ▪ Off-Site groundwater users typically obtain water from dug wells completed in the upper 3 to 7 m of overburden. ▪ Based on the available information from the monitoring wells, groundwater quality at the BR Site varies from fresh to brackish and deteriorates with depth, where elevated concentrations of barium, chloride, sodium and TDS and occasionally manganese are observed in the shallow bedrock and glacial till, compared to the applicable ODWQS. Groundwater quality samples collected in the shallow bedrock were also analyzed for dissolved methane, which exceeded the ODWQS at monitoring wells BH12-1-3.1 and BH12-3.3. ▪ The results of the limited well water supply sampling program indicate that all water quality parameters analyzed were below the respective ODWQS with the exception of a few parameters at all water supply wells. Parameters exceeding the ODWQS include DOC and manganese at all three water supply locations, along with TDS and iron only at the one commercial water supply well on Boundary Road. ▪ In the unlikely event of an unmitigated potential release of leachate to the shallow groundwater system, leachate would enter the surficial sand layer and migrate in the direction of groundwater flow (i.e., to the east, away from groundwater users). ▪ In the surficial sand layer, the moderate horizontal hydraulic conductivity and low hydraulic gradient result in a relatively slow groundwater flow velocity through this unit. ▪ The presence of the thick clay to silty clay unit restricts the downward migration of leachate-impacted groundwater regardless of vertical gradients.

Environmental Component	Summary of Site Considerations
	Interpreted direction of vertical groundwater flow on-Site and in Site-vicinity (i.e., area of groundwater recharge, transitional flow, or groundwater discharge): ▪ Based on the groundwater elevation data collected to date, vertical gradients at the Site are indicated to be typically weakly downward, or absent. ▪ The BR Site is not part of a regional groundwater recharge system to the basal glacial till and bedrock. ▪ The shallow overburden used locally for dug wells is recharged locally by precipitation; therefore development of the BR Site will not affect off-Site groundwater availability.

3.0 SITE COMPARISON – GEOLOGY, HYDROGEOLOGY & GEOTECHNICAL

3.1 Comparison of Sites

For the purpose of selecting the preferred Site based on the geology, hydrogeology and geotechnical disciplines, the assessment criteria is “Which Site is preferred for protection of groundwater?” The associated indicators considered are geological setting; type and thickness of natural on-Site attenuation layer; presence and quality of groundwater resources on-Site and in Site-vicinity; and, interpreted direction of vertical groundwater flow on-Site and in Site-vicinity (i.e., area of groundwater recharge, transitional flow, or groundwater discharge). The technical factors considered in applying these indicators are associated with the geological and hydrogeological setting; the geotechnical characteristics are related to design of the facilities on the preferred Site.

The BR Site is not part of a regional groundwater recharge system to the basal glacial till and bedrock. The shallow overburden used locally off-Site for dug wells is recharged locally by precipitation; therefore development of the BR Site is not expected to affect off-Site groundwater availability. The NRR Site is interpreted to be located within a large regional groundwater recharge area; however, in view of the relatively small portion of the recharge ridge area occupied by the Undertaking and the relatively low overall water demand, it is not expected there would be noticeable effects on off-Site groundwater availability.

The BR Site and its associated thick natural low permeability silty clay attenuation layer offers more favourable natural containment properties (i.e., natural backup to an engineered system, etc.) compared to the NRR Site in the unlikely event of an unmitigated release of leachate from the engineered containment components of the waste management facility.

Based on the assessment criteria for the geology, hydrogeology and geotechnical disciplines and the associated indicators, the preferred site from the perspective of the protection of groundwater is clearly the BR Site.

3.2 Results of Site Comparison

The preferred site based on the geology, hydrogeology and geotechnical disciplines is the BR Site.

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ATTACHMENT TSD#1-B-1

Records of Test Pits and Augerholes and Grain Size Distribution (NRR Site)

February 2013

Record of Augerholes and Test Pits

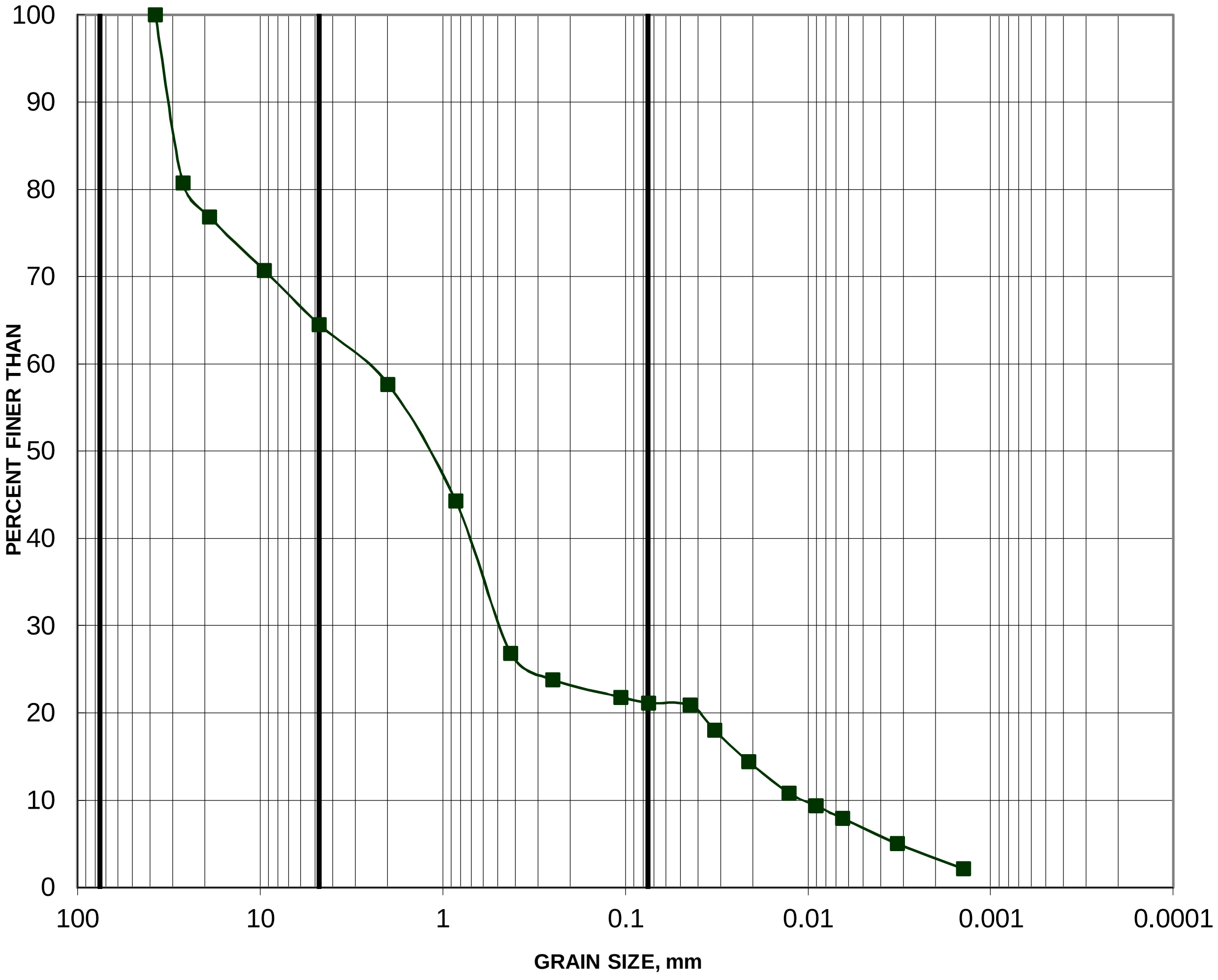
AUGERHOLE (AH)/ TEST PIT (TP) NUMBER (ground surface elevation, masl)	DEPTH (mbgs)	DESCRIPTION
AH09-1 (82.16)	0.00 – 0.22	Dark brown TOPSOIL
	0.22 – 0.78	Grey brown SILTY CLAY with clayey silt and fine sand seams
	0.78 – 2.7	Red brown silty sand and gravel to sandy silt and gravel (GLACIAL TILL)
	2.70 to 3.00	Weathered red brown shale BEDROCK, effective auger refusal
		Water encountered at 1.00 mbgs
AH09-2 (83.40)	0.00 – 0.20	Dark brown and red brown TOPSOIL
	0.20 – 1.50	Red brown SILTY SAND and SANDY SILT with gravel, some cobbles (GLACIAL TILL)
	1.50 – 1.70	Weathered red brown shale BEDROCK, effective auger refusal
		Water encountered at 0.50 mbgs
AH09-3 (80.76)	0.00 – 0.25	Dark brown TOPSOIL
	0.25 – 2.20	Weathered red brown shale BEDROCK, effective auger refusal
		Augerhole dry to 2.20 mbgs
AH09-4 (84.51)	0.00 – 0.20	Dark brown to red brown TOPSOIL
	0.20 – 0.80	Red brown SANDY SILT with gravel (completely weathered shale)
	0.80 – 1.40	Moderately weathered red brown and greenish grey shale (BEDROCK)
	1.40 to 1.50	Slightly weathered red brown shale BEDROCK
		Augerhole dry to 1.5 mbgs
AH09-5 (85.31)	0.00 – 0.20	Dark brown TOPSOIL
	0.20 – 0.96	Red brown SANDY SILT with shaley gravel (completely weathered shale)
	0.96 – 1.40	Moderately to slightly weathered red brown shale (BEDROCK)
	1.40	Fresh shale BEDROCK
		Augerhole dry to 1.4 mbgs
TP09-1 (87.36)	0.00 – 0.15	Dark brown TOPSOIL
	0.15 – 2.50	Red brown silty sand and gravel, some cobbles (GLACIAL TILL)
	2.50	Red and greenish grey shale BEDROCK
		Test pit dry at 2.50 mbgs
TP09-2 (85.33)	0.00 – 0.30	Dark brown TOPSOIL
	0.30 – 1.50	Red brown, occasional green-grey pocket, SILTY CLAY with shaley gravel (completely weathered shale)
	1.50	Slightly weathered shale BEDROCK
		Water seepage at 1.5 mbgs
		19% water content in sample collected from 1.0 mbgs

AUGERHOLE (AH)/ TEST PIT (TP) NUMBER (ground surface elevation, masl)	DEPTH (mbgs)	DESCRIPTION
TP09-3	0.00 – 0.22	Dark brown TOPSOIL
(87.05)	0.22 – 1.50	Red brown, occasional green-grey pocket, SILTY CLAY with shaley gravel (completely weathered shale)
	1.50 – 2.30	Weathered shale (BEDROCK)
	2.30	Fresh red brown shale BEDROCK
		Water seepage at 2.00 mbgs
		14.6% water content in sample collected from 0.5 mbgs
		Atterberg Limits: W_L = 22.2 W_P = N/P
TP09-4	0.00 – 0.20	Dark brown TOPSOIL
(84.69)	0.20 – 0.60	Red brown, occasional green-grey pocket, SILTY CLAY with shaley gravel (completely weathered shale)
	0.60 – 1.20	Weathered red brown and greenish grey shale (BEDROCK)
	1.20	Becoming fresh shale BEDROCK
		Test pit dry at 1.20 mbgs
TP09-5	0.00 – 0.20	Dark brown TOPSOIL
(85.06)	0.20 – 2.10	Red brown SANDY SILT and CLAYEY SILT with shaley gravel
	2.10 – 2.60	Grey brown and red brown silty sand and gravel and cobbles (GLACIAL TILL)
	2.60 – 2.80	Fresh shale BEDROCK (some green seams)
		Water seepage at 1.90 mbgs
TP09-6	0.00 – 0.22	Dark brown TOPSOIL
(85.28)	0.22 – 1.20	Red brown CLAYEY SILT with shaley gravel
	1.20 – 2.20	Highly weathered shale
	2.20 – 3.00	Moderately to slightly weathered red brown and green grey shale (BEDROCK)
	3.00	Fresh shale BEDROCK
		Water seepage at 1.30 mbgs
		9.1% water content in sample collected from 0.70-0.80 mbgs
TP09-7	0.00 – 0.25	Dark brown TOPSOIL and root material
(81.99)	0.25 – 1.10	Red brown SILTY CLAY with shaley gravel (completely weathered shale)
	1.10 – 2.00	Weathered red brown and green grey shale (BEDROCK)
	2.00	Fresh shale BEDROCK
		Water seepage at 1.60 mbgs
TP09-8	0.00 – 0.25	Dark brown TOPSOIL
(82.27)	0.25 – 1.30	Red brown, SILTY CLAY, some shaley gravel (completely weathered shale)
	1.30 – 2.00	Highly to moderately weathered red brown shale (BEDROCK)
		Fresh shale BEDROCK
	2.00	Water seepage at 0.95 mbgs

AUGERHOLE (AH)/ TEST PIT (TP) NUMBER **(ground surface elevation, masl)**	**DEPTH (mbgs)**	**DESCRIPTION**
TP09-9	0.00 – 0.95	Red brown sandy silt and clayey silt with shaley gravel (FILL)
(81.93)		Dark brown TOPSOIL
	0.95 – 1.10	Greenish grey CLAYEY SILT
	1.10 – 1.40	Red brown CLAYEY SILT with shaley gravel
	1.40 – 2.10	moderate to slightly weathered shale BEDROCK
	2.10 – 3.00	Test pit dry at 3.00 mbgs
	3.00	
TP09-10	0.00 – 0.22	Dark brown TOPSOIL
(83.81)	0.22 – 1.00	Red brown SANDY SILT and SILTY CLAY with shaley gravel (completely weathered shale)
	1.00 – 2.20	Moderately weathered shale (BEDROCK)
	2.20	Slightly weathered shale BEDROCK
		Test pit dry at 2.20 mbgs
TP09-11	0.00 – 0.20	Dark brown TOPSOIL
(80.28)	0.20 – 0.75	Red brown SILT with shaley gravel (completely weathered shale)
	0.75 – 1.20	Moderately weathered shale (BEDROCK)
	1.20 – 1.60	Slightly weathered to fresh with depth red brown shale BEDROCK
		Test pit dry at 1.60 mbgs
TP09-12	0.00 – 0.14	Dark brown TOPSOIL and sod
(80.15)	0.14 – 0.80	Red brown SILTY CLAY with shaley gravel (completely weathered shale)
	0.80 – 1.20	Red brown slightly weathered shale (BEDROCK)
	1.20	Fresh shale BEDROCK
		Test pit dry at 1.20 mbgs
TP09-13	0.00 – 0.28	Dark brown TOPSOIL
(77.27)	0.28 – 1.30	Red brown SILTY CLAY with shaley gravel (completely weathered shale)
	1.30 – 2.30	Moderately to slightly weathered with depth, red brown and greenish grey shale (BEDROCK)
	2.30	Fresh shale BEDROCK
		Water seepage at 1.00 mbgs and Water inflow at 2.20 mbgs
TP09-14	0.00 – 0.25	Dark brown TOPSOIL with organics (wet)
(75.49)	0.25 – 0.35	Yellow brown SILTY FINE SAND
	0.35 – 0.90	Grey brown and red brown silty clay (WEATHERED CRUST)
	0.90 – 4.50	Red brown and red grey sandy silt and gravel, some cobbles/boulders (GLACIAL TILL)
	4.50	Fresh green grey siltstone/limestone BEDROCK
		Water seepage at 0.70 mbgs
		Water inflow at 1.00 mbgs
		25.7% water content in sample collected from 0.45-0.70 mbgs
		Atterberg Limits: W_L = 46.9 W_P = 22.6 LI = 0.1 PI = 24.3

AUGERHOLE (AH)/ TEST PIT (TP) NUMBER (ground surface elevation, masl)	**DEPTH (mbgs)**	**DESCRIPTION**
TP09-15	0.00 – 0.28	Dark brown TOPSOIL (wet)
(74.16)	0.28 – 3.00	Grey brown and red brown silty clay (WEATHERED CRUST)
	3.00 – 6.20	Grey SILTY CLAY
	6.20	Grey sandy silt with gravel (GLACIAL TILL)
		Some water seepage at 1.5 mbgs
		36.4% water content in sample collected from 0.6 mbgs
		36.3% water content in sample collected from 1.20 mbgs
		Atterberg Limits: W_L = 52.5 W_P = 25.7 LI = 0.4 PI = 26.8
		39.1% water content in sample collected from 1.70 mbgs
		69.0% water content in sample collected from 2.20 mbgs
		65.8% water content in sample collected from 2.70 mbgs
		71.3% water content in sample collected from 3.20 mbgs
		87.8% water content in sample collected from 4.50 mbgs
TP09-16	0.00 – 0.18	Dark brown TOPSOIL
(74.88)	0.18 – 0.60	Yellow brown silty fine sand
	0.60 – 2.30	Grey brown and red brown silty clay (WEATHERED CRUST)
	2.30 – 3.30	Grey SILTY CLAY
	3.30 – 6.00	Grey and red brown sandy silt and gravel, some cobbles (GLACIAL TILL)
		Some water at 1.5 mbgs and Water inflow at 3.5 mbgs

GRAIN SIZE DISTRIBUTION



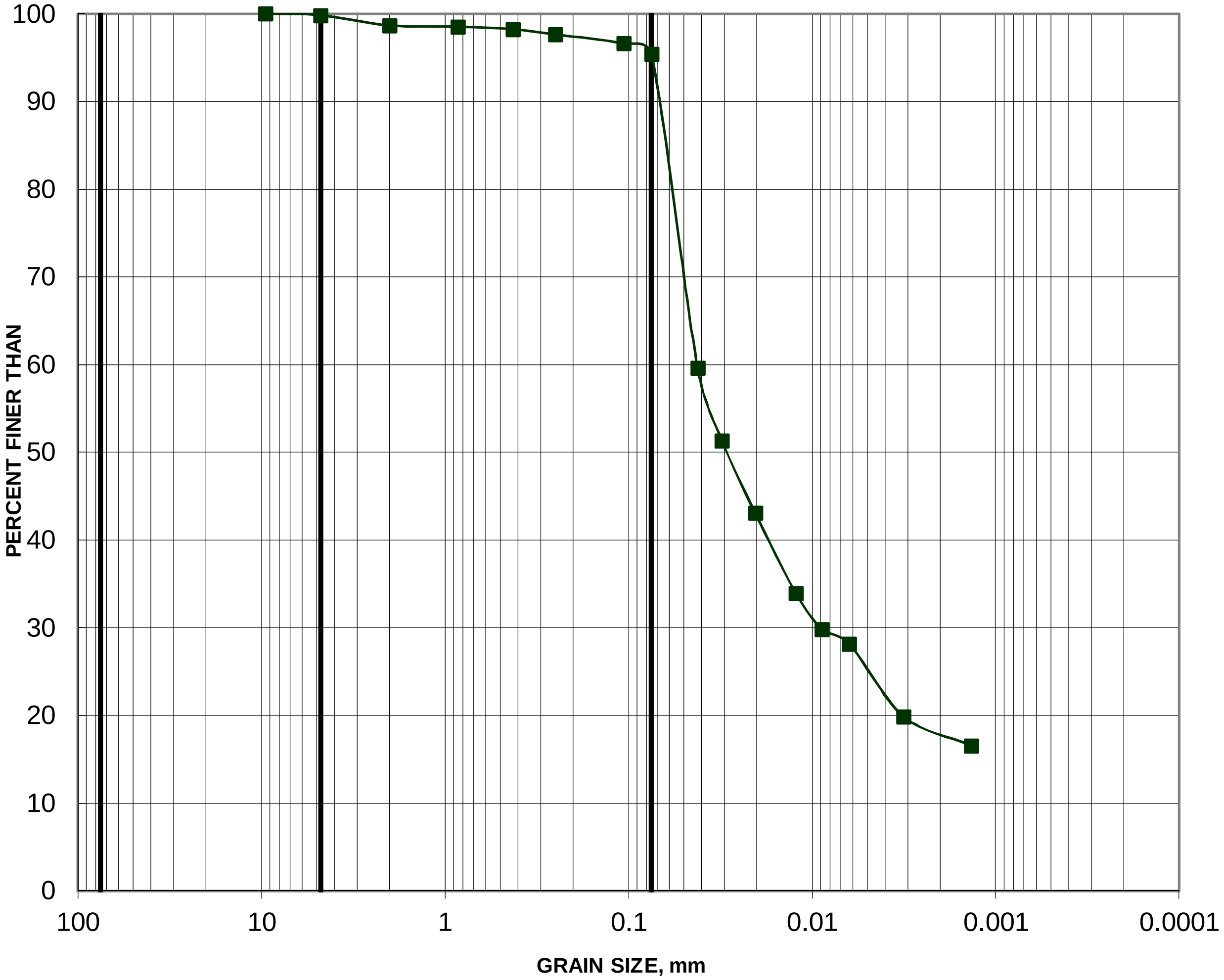
Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Test Pit	Sample	Depth (m)
■ 09-3	1	0.50

Created by: CW
Checked by: CNM

Project: 12-1125-0045 **Golder Associates**

GRAIN SIZE DISTRIBUTION



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Test Pit	Sample	Depth (m)
■ 09-14	1	0.45-0.70

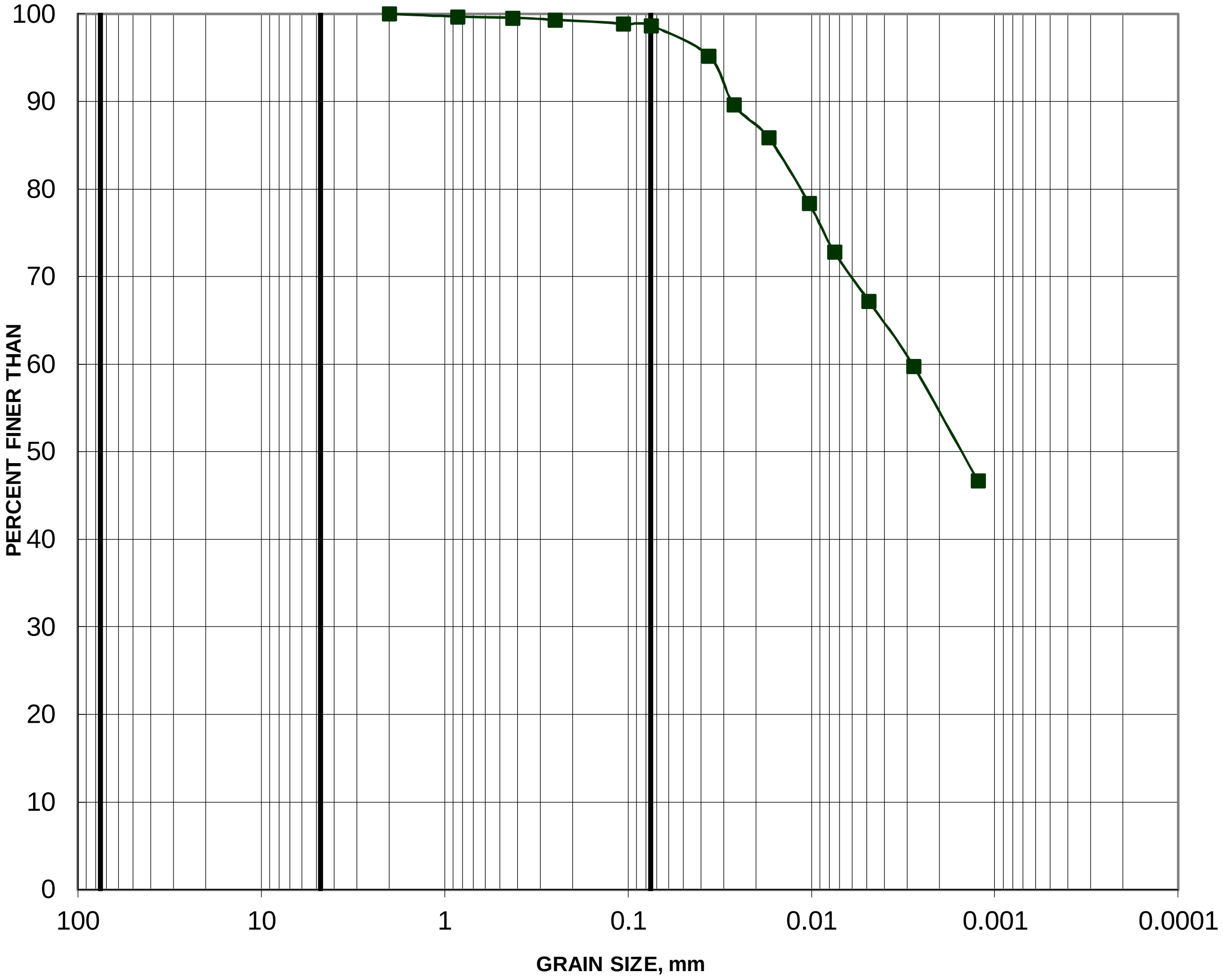
Project: 12-1125-0045

Golder Associates

Created by: CW

Checked by: CNM

GRAIN SIZE DISTRIBUTION



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Test Pit	Sample	Depth (m)
■ 09-15	2	1.20

Created by: CW
Checked by: CNM

Project: 12-1125-0045

Golder Associates

ATTACHMENT TSD#1-B-2

Borehole/Drillhole Logs and MOE Water Well Records

TSD#1-B-2-1 – NRR Site

TSD#1-B-2-2 – BR Site

February 2013

ATTACHMENT TSD#1-B-2-1

Borehole/Drillhole Logs and MOE Water Well Records (NRR Site)

February 2013

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample
DT	Dual Tube sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open Sampler for a distance of 300 mm (12 in.)

DD- Diamond Drilling

Dynamic Penetration Resistance; N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive Uncased a 50 mm (2 in.) diameter, 60^0 cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

Peizo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60^0 conical tip and a projected end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded Electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	**N** Blows/300 mm Or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	**C_u or S_u**	
	Kpa	Psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	Over 200	Over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limited
w_l	liquid limit
C	consolidaiton (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	modified Proctor compaction test
SPC	standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane test (LV-laboratory vane test)
γ	unit weight

Note:

1. Tests which are anisotropically consolidated prior shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	= 3.1416
ln x, natural logarithm of x	
$\log_{10}$ x or log x, logarithm of x to base 10	
g	Acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma'$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma''$-u)
σ'_{vo}	initial effective overburden stress
$\sigma_1\sigma_2\sigma_3$	principal stresses (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1+\sigma_2+\sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma'=\gamma-\gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R= p_s/p_w$) formerly (G_s)
e	void ratio
n	porosity
S	degree of saturation
*	Density symbol is p. Unit weight symbol is γ where γ=pg(i.e. mass density x acceleration due to gravity)

(a) Index Properties (cont'd.)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity Index=(w_l-w_p)
w_s	shrinkage limit
I_L	liquidity index=$(w-w_p)/I_p$
I_c	consistency index=$(w_l-w)/I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index-$(e_{max}-e)/(e_{max}-e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	Overconsolidation ratio=σ'_p/σ'_{vo}

(d) Shear Strength

$\tau_p\tau_r$	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction=tan δ
c'	effective cohesion
$c_{u,}s_u$	undrained shear strength (ϕ=0 analysis)
p	mean total stress $(\sigma_1+\sigma_3)/2$
p'	mean effective stress $(\sigma'_1+\sigma'_3)/2$
q	$(\sigma_1-\sigma_3)/2$ or $(\sigma'_1-\sigma_3)/2$
q_u	compressive strength $(\sigma_1-\sigma_3)$
S_t	sensitivity

Notes: 1. $\tau=c'\sigma' \tan |'$
2. Shear strength=(Compressive strength)/2

PROJECT: 09-1125-1008

RECORD OF BOREHOLE: 08-1

SHEET 1 OF 1

LOCATION: N 5018490.0 ;E 393506.0

BORING DATE: Apr. 24, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		82.57							
0	Rotary Drill Steel Casing	Overburden	▨	0.00							
1		Queenston Formation 1.0 m to 9.1 m	☰	81.57 1.00							
5	Rotary Drill Open Hole										▽
9		End of Borehole		73.47 9.10							W.L. in open hole at Elev. 77.37 m on May 20, 2010

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: P.A.H.

CHECKED:

MIS-BHS 001 0911251008-3000-3090.GPJ GAL-MIS.GDT 5/28/10 JM

PROJECT: 09-1125-1008

RECORD OF BOREHOLE: 08-2

SHEET 1 OF 1

LOCATION: N 5018679.0 ;E 393531.0

BORING DATE: Apr. 24, 2008

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		80.77							
0	Rotary Drill Steel Casing	Overburden	▩	0.00							
1											
	Rotary Drill Open Hole	Queenston Formation 1.5 m to 9.1 m	▤	79.27 1.50							
2											
3											∇
4											
5											
6											
7											
8											
9				71.67							
		End of Borehole		9.10							W.L. in open hole at Elev. 78.05 m on May 20, 2010
10											
11											
12											
13											
14											
15											

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: P.A.H.

CHECKED:

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-3

SHEET 1 OF 3

LOCATION: N 5017702.0 ;E 392764.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Nov. 17-18, 2009

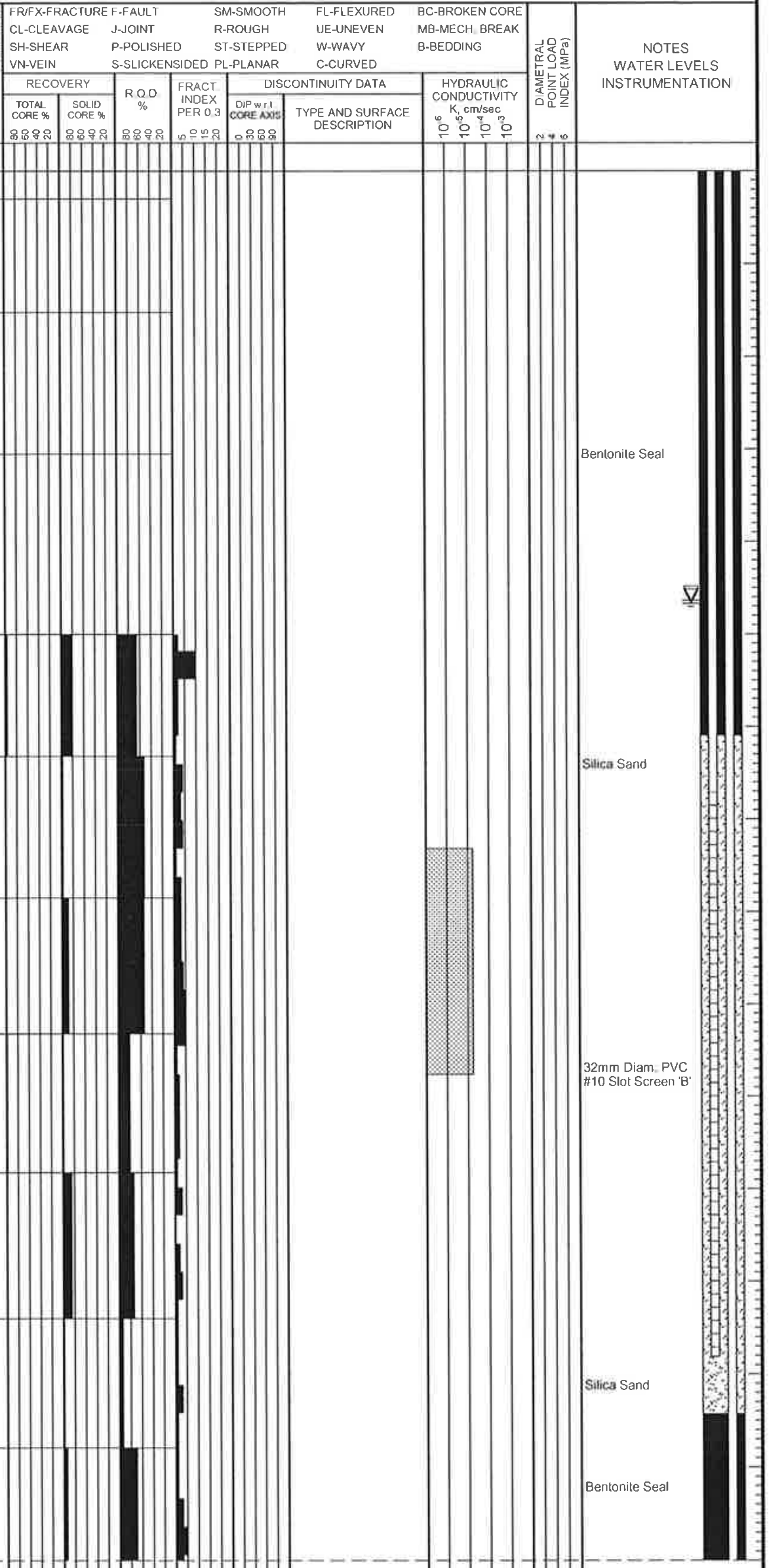
DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.
		GROUND SURFACE	86.30	
0		TOPSOIL	0.00	
	Rotary Drill HW Casing	Red brown SANDY SILT/CLAYEY SILT, with gravel and cobbles (GLACIAL TILL)	0.24	1 2 3
5	Rotary Drill HQ Core	Queenston Formation 5.00 m to 10.52 m Fresh, medium to dark reddish brown, fine grained thin to medium bedded calcareous MUDSTONE interbedded with medium grey, thin to medium bedded LIMESTONE beds. Mudstone slakes on exposure to wetting and drying. Marker Bed occurs between 7.17 m and 7.55 m comprised of reddish grey bioclastic calcarenitic limestone with numerous mollusk and brachiopod fossils and lithoclastic fragments. Mudstone becomes dark grey and shaley from 9.33 m to 10.55 m.	81.30 5.00	C1 C2 C3 C4
10.52		Carlsbad Formation 10.52 m to 30.56 m Fresh, medium to dark grey, fine to medium grained, thin to medium bedded LIMESTONE with bioclastic sections, burrow casts, thin lithoclastic limestone beds, occasional stylolites and dark grey to black shale partings.	75.78 10.52	C5 C6 C7
15		CONTINUED NEXT PAGE		



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: P.A.H.

CHECKED:

MIS-RCK 001 0911251008-3000-3090.GPJ GAL-MISS.GDT 5/28/10 JM

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-3

SHEET 2 OF 3

LOCATION: N 5017702.0 ;E 392764.0

INCLINATION: -90° AZIMUTH: ---

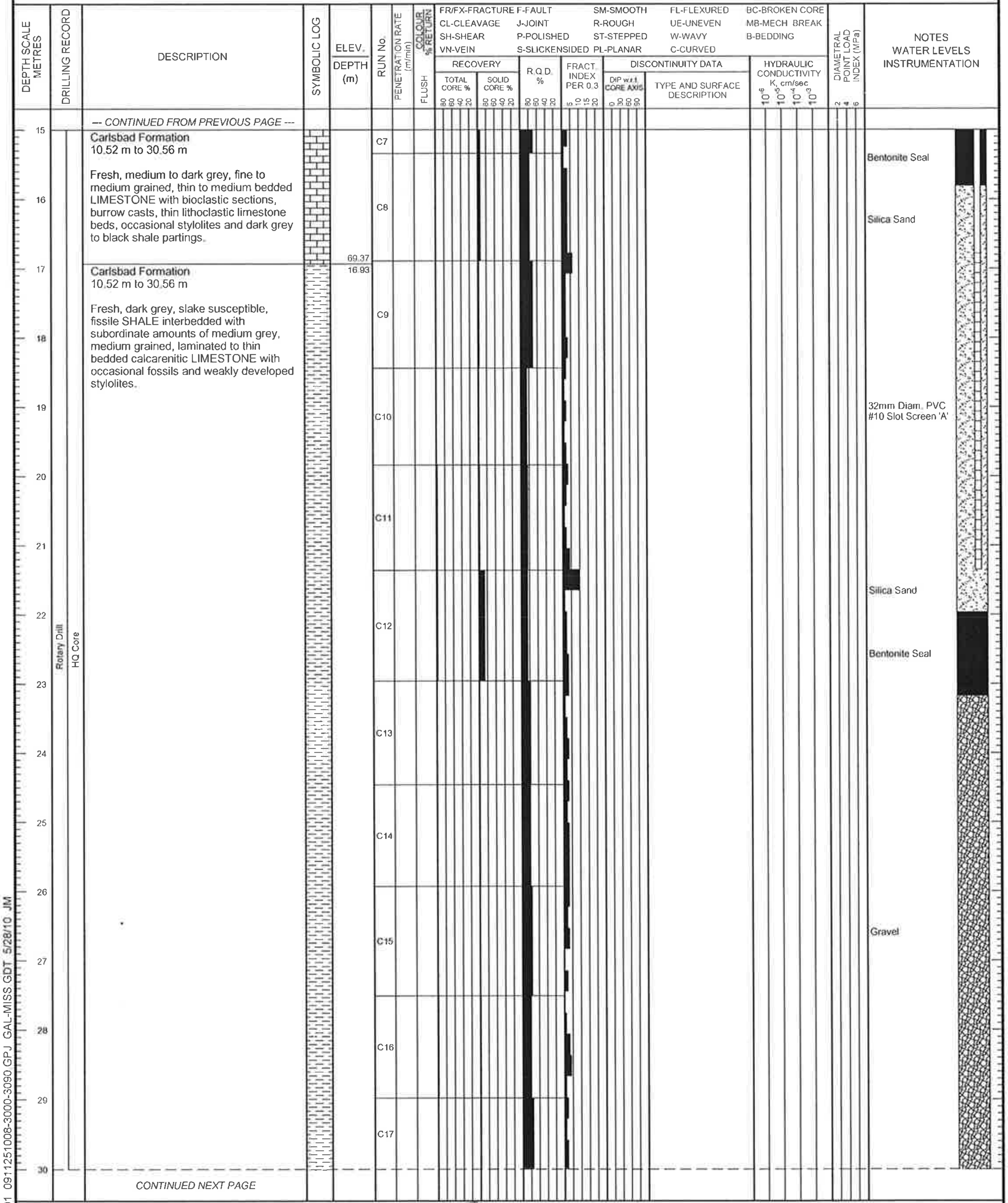
DRILLING DATE: Nov. 17-18, 2009

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE	F-FAULT	SM-SMOOTH	FL-FLEXURED	BC-BROKEN CORE
CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH BREAK
SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY	B-BEDDING
VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED	



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Carlsbad Formation
10.52 m to 30.56 m

Fresh, medium to dark grey, fine to medium grained, thin to medium bedded LIMESTONE with bioclastic sections, burrow casts, thin lithoclastic limestone beds, occasional stylolites and dark grey to black shale partings.

Carlsbad Formation
10.52 m to 30.56 m

Fresh, dark grey, slake susceptible, fissile SHALE interbedded with subordinate amounts of medium grey, medium grained, laminated to thin bedded calcarenitic LIMESTONE with occasional fossils and weakly developed stylolites.

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED: JM

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-3

SHEET 3 OF 3

LOCATION: N 5017702.0 ;E 392764.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Nov. 17-18, 2009
DRILL RIG: CME 850
DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.3 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	DIAMETRAL POINT LOAD INDEX (MPa) 2 4 6	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---														
30	HQ Core			55.74	C17					■	▌					Gravel ▨
		End of Drillhole		30.56												
31																W.L. in screen 'A' at Elev. 81.63 m on May 20, 2010
32																W.L. in screen 'B' at Elev. 81.66 m on May 20, 2010
33																
34																
35																
36																
37																
38																
39																
40																
41																
42																
43																
44																
45																

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED:

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-4

SHEET 1 OF 3

LOCATION: N 5018544.0 ;E 393796.0

DRILLING DATE: Nov. 3-9, 2009

DATUM: Geodetic

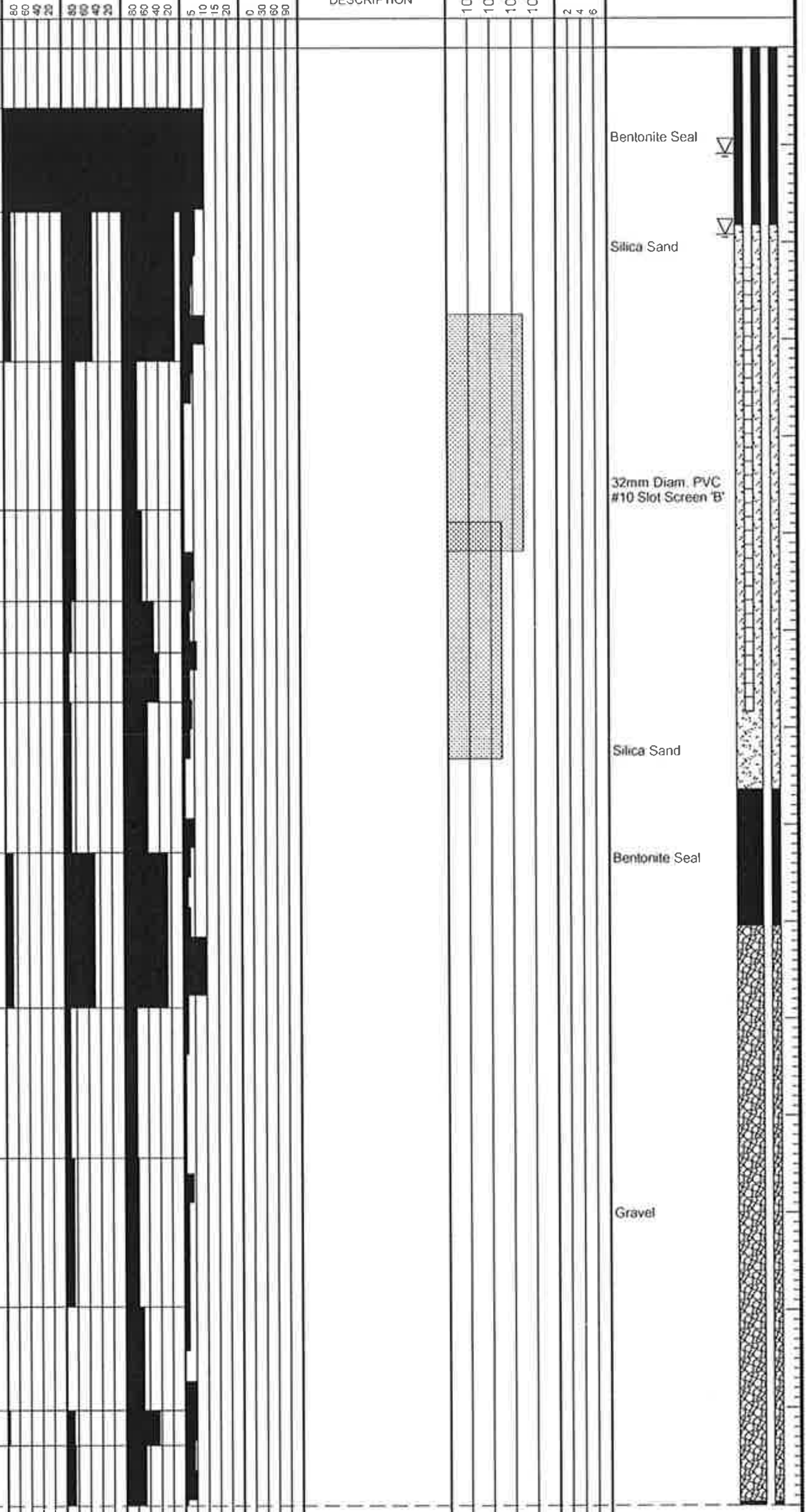
INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA DIP w.r.t. CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		79.05												
0		Completely weathered, dark reddish brown MUDSTONE		0.00												
	Rotary Drill HW Casing	Queenston Formation 0.61 m to 21.27 m Fresh, dark reddish brown, thin to medium bedded, slake susceptible calcareous MUDSTONE with occasional thin interbeds of greenish grey siltstone and mudstone. Mudstone becomes greyish with thin limestone beds below 16.39 m. Marker Bed occurs between 18.09 m and 18.83 m comprised of reddish grey bioclastic calcarenitic limestone with numerous mollusk and brachiopod fossils and lithoclastic fragments.		78.44 0.61	C1 C2 C3 C4 C5 C6 C7											
	Rotary Drill HQ Core				C8 C9 C10 C11 C12 C13											
15		CONTINUED NEXT PAGE														



DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED:

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-4

SHEET 2 OF 3

LOCATION: N 5018544.0 ;E 393796.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Nov. 3-9, 2009
DRILL RIG: CME 850
DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DRILLING RECORD: Rotary Drill, HQ Core

--- CONTINUED FROM PREVIOUS PAGE ---

Queenston Formation
0.61 m to 21.27 m

Fresh, dark reddish brown, thin to medium bedded, slake susceptible calcareous MUDSTONE with occasional thin interbeds of greenish grey siltstone and mudstone. Mudstone becomes greyish with thin limestone beds below 16.39 m. Marker Bed occurs between 18.09 m and 18.83 m comprised of reddish grey bioclastic calcarenitic limestone with numerous mollusk and brachiopod fossils and lithoclastic fragments.

Carlsbad Formation
21.27 m to 30.84 m

Fresh, medium to dark grey, fine to medium grained, thin to medium bedded LIMESTONE with bioclastic sections, burrow casts, thin lithoclastic limestone beds, occasional stylolites and dark grey to black shale partings and thin to medium shale beds.

Carlsbad Formation
21.27 m to 30.84 m

Fresh, dark grey, slake susceptible, fissile SHALE interbedded with subordinate amounts of medium grey, medium grained, laminated to thin

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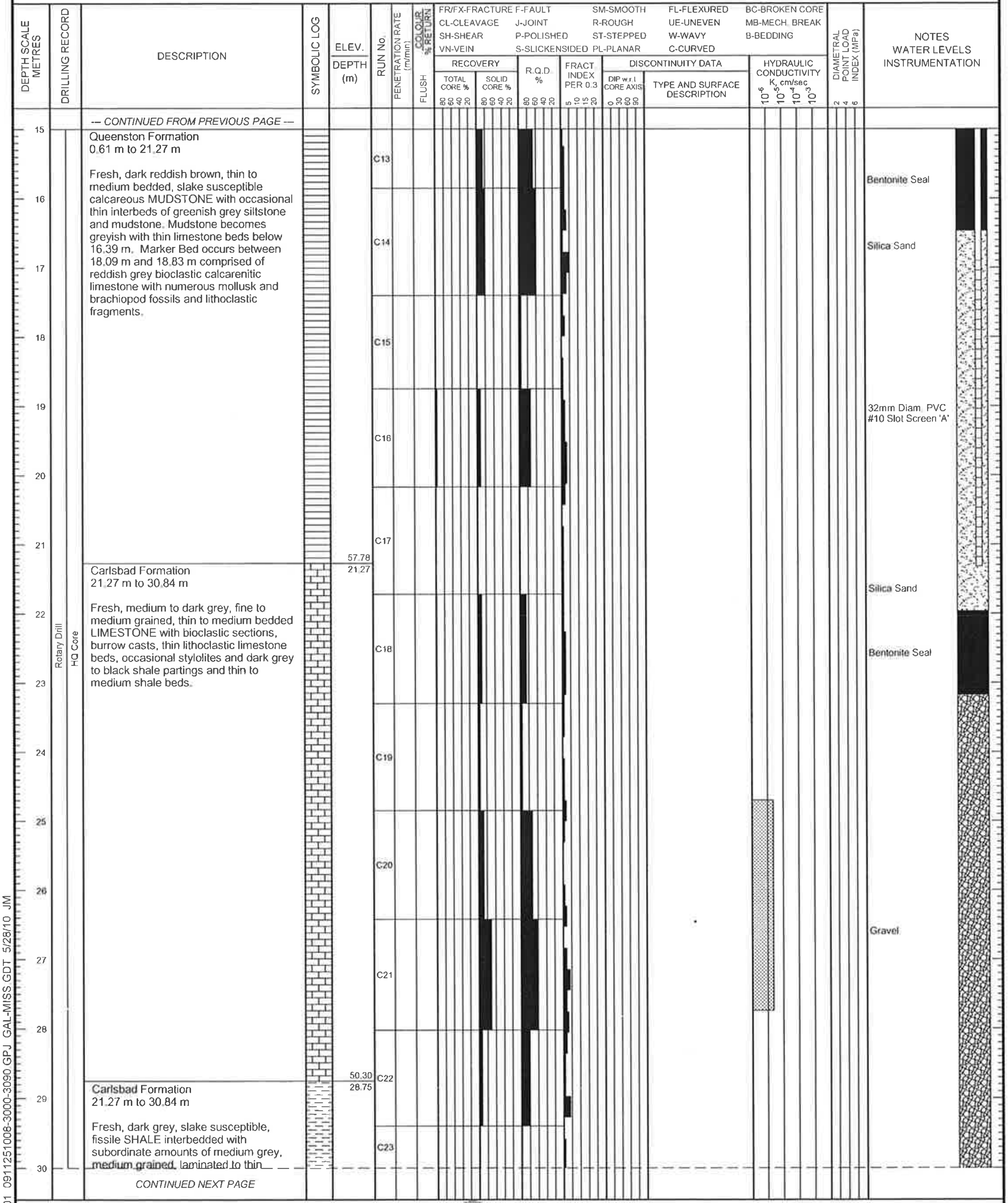


DEPTH SCALE
1 : 75

LOGGED: P.A.H.
CHECKED:

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-4

SHEET 3 OF 3

LOCATION: N 5018544.0 ;E 393796.0

INCLINATION: -90° AZIMUTH: --

DRILLING DATE: Nov. 3-9, 2009

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No	PENETRATION RATE (m/min)	FLUSH	COLOUR % RETURN	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.3 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	DIAMETRAL POINT LOAD INDEX (MPa) 2 4 6	NOTES WATER LEVELS INSTRUMENTATION
		— CONTINUED FROM PREVIOUS PAGE —															
30	Rotary Drill HQ Core	bedded micritic to partly crystalline calcarenitic LIMESTONE with occasional fossils and weakly developed stylolites.		48.21	C23												Gravel
31		End of Drillhole		30.84													W.L. in screen 'A' at Elev. 77.13 m on May 20, 2010
32																	W.L. in screen 'B' at Elev. 77.96 m on May 20, 2010
33																	
34																	
35																	
36																	
37																	
38																	
39																	
40																	
41																	
42																	
43																	
44																	
45																	

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED:

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-5

SHEET 1 OF 2

LOCATION: N 5019324.0 ;E 394945.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Nov. 11-16, 2009

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.3 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	DIAMETRAL POINT LOAD INDEX (MPa) 2 4 6	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		73.93													
0		TOPSOIL		0.00													
		Grey brown SILTY CLAY (Weathered Crust)		0.25													Bentonite Seal
1																	∇
					1												
2																	
					2												
3																	
		Grey SILTY CLAY		70.58 3.35													
4					3												
5																	
6																	
7	Rotary Drill NQ Core / HW Casing				4												
8		GLACIAL TILL		66.00 7.93													Silica Sand
					5												
9																	
10					6												
11																	
12																	
					7												
13																	
14					8												
					9												
15																	

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.

CHECKED:

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-5

SHEET 2 OF 2

LOCATION: N 5019324.0 ;E 394945.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Nov. 11-16, 2009

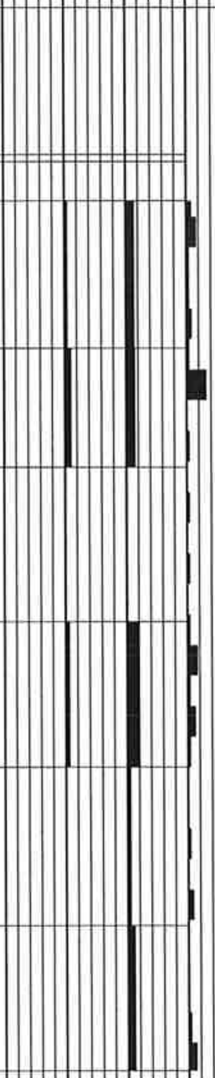
DRILL RIG: CME 850

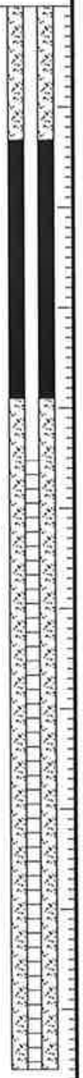
DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT INDEX PER 0.3 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	DIAMETRAL POINT LOAD INDEX (MPa) 2 4 6	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---															
15	Rotary Drill NQ Core / HW Casing	GLACIAL TILL															
16					9												Silica Sand
				57.47 16.46													
		SAND and GRAVEL, with cobbles		57.01 16.92	10												
17		Carlsbad Formation 16.92 m to 25.6 m Fresh, dark grey, slake susceptible, fissile SHALE interbedded with subordinate amounts of medium grey, medium grained, laminated to thin bedded micritic to partly crystalline calcarenitic LIMESTONE with occasional fossils and weakly developed stylolites.			C1												Bentonite Seal
18																	
19	Rotary Drill NQ Core				C2												Silica Sand
20					C3												
21																	
22					C4												32mm Diam. PVC #10 Slot Screen
23					C5												
24																	
25					C6												
		End of Drillhole		48.33 25.60													
26																	W.L. in screen at Elev. 72.71 m on May 20, 2010
27																	
28																	
29																	
30																	





DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED: JMD

MIS-RCK 001 091125100 8-3000-3090.GPJ GAL-MISS.GDT 5/28/10 JM

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-6

SHEET 1 OF 3

LOCATION: N 5017714.0 ;E 393580.0

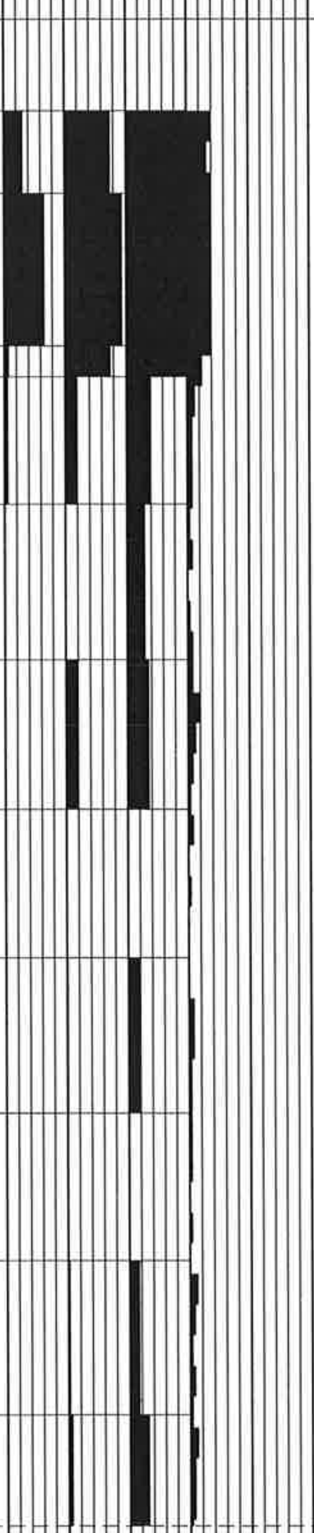
INCLINATION: -90° AZIMUTH: ---

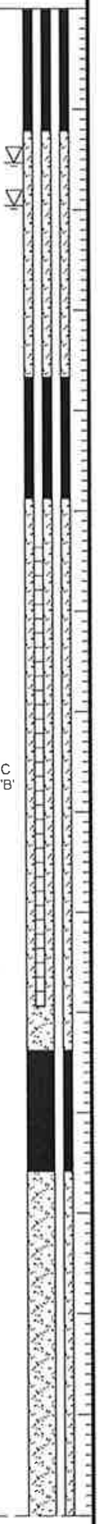
DRILLING DATE: Nov. 24-26, 2009
DRILL RIG: CME 850
DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	NOTES WATER LEVELS INSTRUMENTATION
0		GROUND SURFACE	84.94		
		TOPSOIL	0.00		
		Red brown SANDY SILT, with shaley gravel	0.20		Bentonite Seal
1	Rotary Drill HW Casing	Moderately to completely weathered, dark reddish brown MUDSTONE	84.03 0.91	C1	
2				C2	Silica Sand
3				C3	
4	Rotary Drill HQ Core	Queenston Formation 3.56 m to 7.63 m Fresh, dark reddish brown, thin to medium bedded, slake susceptible calcareous MUDSTONE with occasional thin interbeds of greenish grey siltstone and mudstone. Mudstone becomes greyish with thin limestone beds below 6.71 m. Marker Bed occurs between 5.70 m and 6.02 m comprised of reddish grey bioclastic calcarenitic limestone with numerous mollusk and brachiopod fossils and lithoclastic fragments.	81.38 3.56	C4	Bentonite Seal
5				C5	Silica Sand
6–7				C6	32mm Diam. PVC #10 Slot Screen 'B'
8		Carlsbad Formation 7.63 m to 30.51 m Fresh, medium to dark grey to black, fine to medium grained, thin to medium bedded LIMESTONE with bioclastic sections, burrow casts, thin lithoclastic limestone beds, occasional stylolites and dark grey to black shale partings and thin to medium shale beds.	77.31 7.63	C7	
9					
10				C8	Silica Sand
11				C9	Bentonite Seal
12–13				C10	Silica Sand
14				C11	
15		CONTINUED NEXT PAGE			





DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED: JMD

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-6

SHEET 2 OF 3

LOCATION: N 5017714.0 ;E 393580.0

INCLINATION: -90° AZIMUTH: ---

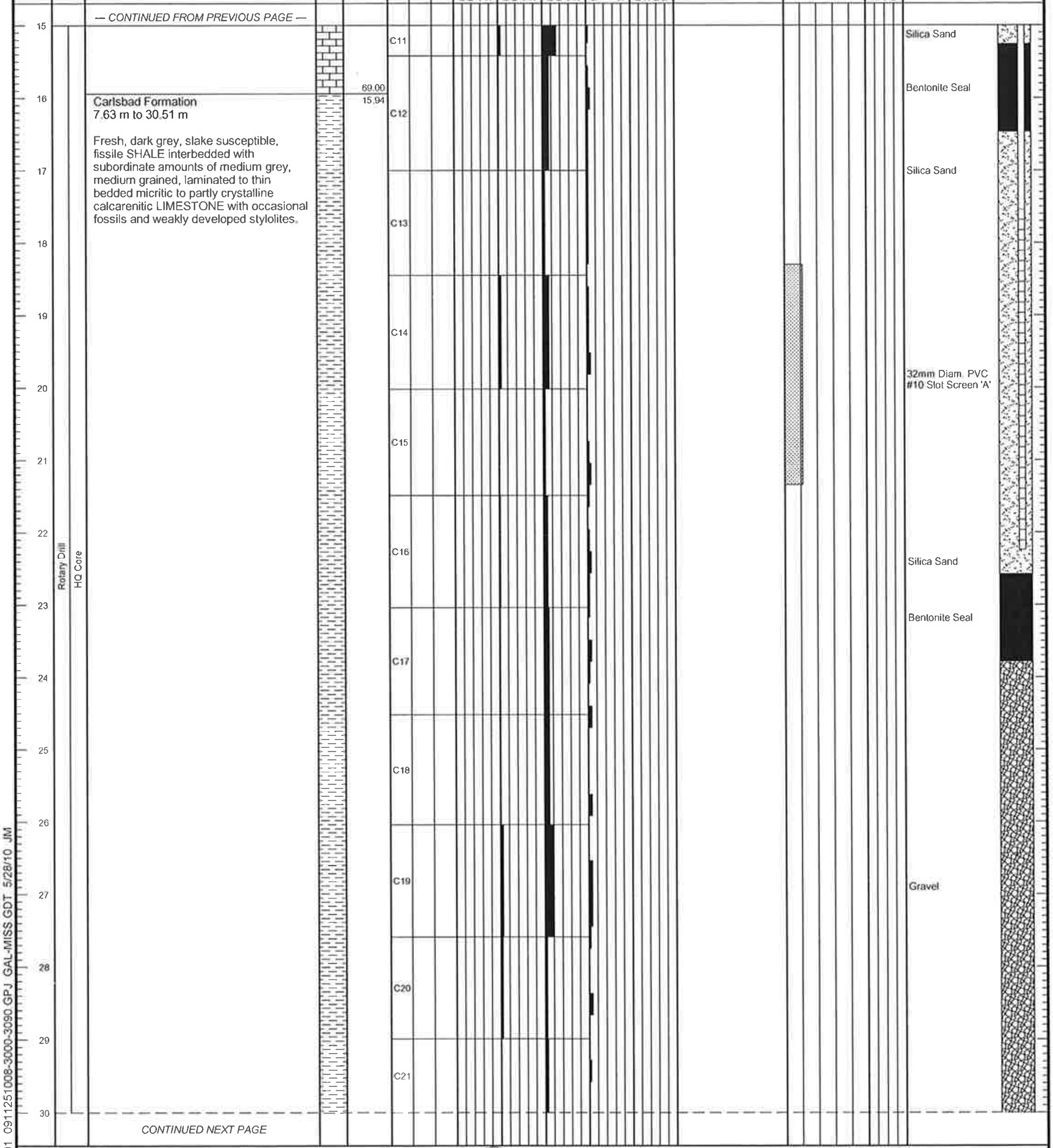
DRILLING DATE: Nov. 24-26, 2009
DRILL RIG: CME 850
DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE	F-FAULT	SM-SMOOTH	FL-FLEXURED	BC-BROKEN CORE
CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK
SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY	B-BEDDING
VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED	

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.3 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	DIAMETRAL POINT LOAD INDEX (MPa) 2 4 6	NOTES WATER LEVELS INSTRUMENTATION

— CONTINUED FROM PREVIOUS PAGE —



Carlsbad Formation
7.63 m to 30.51 m

Fresh, dark grey, slake susceptible, fissile SHALE interbedded with subordinate amounts of medium grey, medium grained, laminated to thin bedded micritic to partly crystalline calcarenitic LIMESTONE with occasional fossils and weakly developed stylolites.

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED:

PROJECT: 09-1125-1008

RECORD OF DRILLHOLE: 09-6

SHEET 3 OF 3

LOCATION: N 5017714.0 ;E 393580.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Nov. 24-26, 2009

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.3 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	DIAMETRAL POINT LOAD INDEX (MPa) 2 4 6	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---															
30					C21												Gravel ▨
		End of Drillhole		54.43 30.51													
31																	W.L. in screen 'A' at Elev. 82.98 m on May 20, 2010
32																	W.L. in screen 'B' at Elev. 83.41 m on May 20, 2010
33																	
34																	
35																	
36																	
37																	
38																	
39																	
40																	
41																	
42																	
43																	
44																	
45																	

MIS-RCK 001 091125100830003090.GPJ GAL-MISS.GDT 5/28/10 JM

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.

CHECKED:

PROJECT: 09-1125-1008

RECORD OF BOREHOLE: 09-7

SHEET 1 OF 3

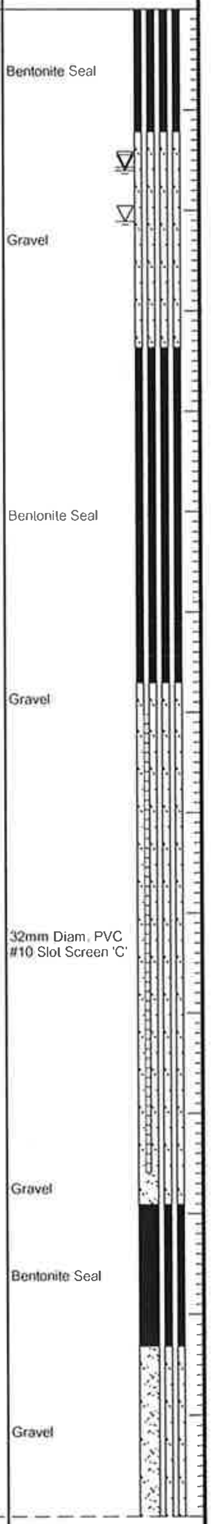
LOCATION: N 5018476.0 ;E 392482.0

BORING DATE: Nov. 20, 2010

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - O 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—O W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING
		GROUND SURFACE		83.52						
0	Rotary Drill Steel Casing	Overburden	▨	0.00						
5		Queenston Formation 4.88 m to 33.55 m	▤	78.64 4.88						
6	Rotary Drill Open Hole									
15		CONTINUED NEXT PAGE								

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED:

PROJECT: 09-1125-1008

RECORD OF BOREHOLE: 09-7

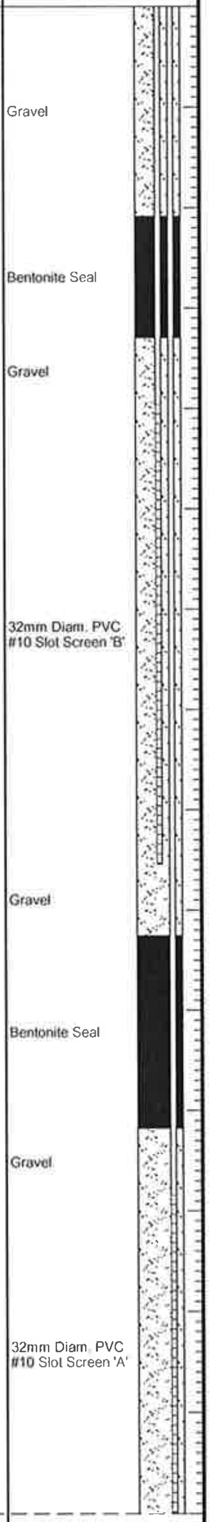
SHEET 2 OF 3

LOCATION: N 5018476.0 ;E 392482.0

BORING DATE: Nov. 20, 2010

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
15	Rotary Drill Open Hole	Queenston Formation 4.88 m to 33.55 m									
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
		CONTINUED NEXT PAGE									



DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED:

MIS-BHS 001 0911251008-3000-3090.GPJ GAL-MIS.GDT 5/28/10 JM

PROJECT: 09-1125-1008

RECORD OF BOREHOLE: 09-7

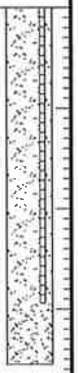
SHEET 3 OF 3

LOCATION: N 5018476.0 ;E 392482.0

BORING DATE: Nov. 20, 2010

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ├─○W─┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
30	Rotary Drill Open Hole	Queenston Formation 4.88 m to 33.55 m									
31											32mm Diam. PVC #10 Slot Screen 'A'
32											
33				49.97 33.55							Gravel
		End of Drillhole									
34											W.L. in screen 'A' at Elev. 81.92 m on May 20, 2010
35											W.L. in screen 'B' at Elev. 81.95 m on May 20, 2010
36											W.L. in screen 'C' at Elev. 81.41 m on May 20, 2010
37											
38											
39											
40											
41											
42											
43											
44											
45											



DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED:

PROJECT: 09-1125-1008

RECORD OF BOREHOLE: 09-8

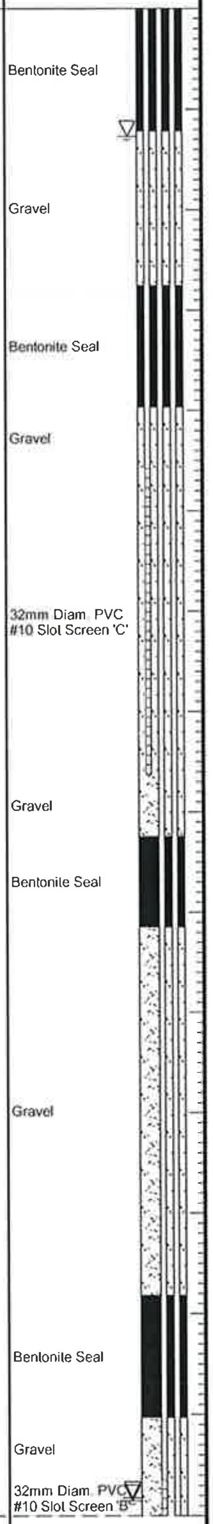
SHEET 1 OF 3

LOCATION: N 5019106.0 ;E 393472.0

BORING DATE: Nov. 30, 2010

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		79.38							
0	Rotary Drill Steel Casing	Overburden		0.00							Bentonite Seal
2		Queenston Formation 2.13 m to 25.76 m		77.25 2.13							Gravel
3	Rotary Drill Open Hole										
15		CONTINUED NEXT PAGE									



DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED:

PROJECT: 09-1125-1008

RECORD OF BOREHOLE: 09-8

SHEET 2 OF 3

LOCATION: N 5019106.0 ;E 393472.0

BORING DATE: Nov. 30, 2010

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		— CONTINUED FROM PREVIOUS PAGE —									
15	Rotary Drill Open Hole	Queenston Formation 2.13 m to 25.76 m									
16											
17											
18											32mm Diam. PVC #10 Slot Screen 'B'
19											
20											
21											Gravel
22											
23											Bentonite Seal
24											
25											Gravel
26		Carlsbad Formation 25.76 m to 30.50 m		53.62 25.76							
27											
28											32mm Diam. PVC #10 Slot Screen 'A'
29											
30											

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED: JDB

PROJECT: 09-1125-1008

RECORD OF BOREHOLE: 09-8

SHEET 3 OF 3

LOCATION: N 5019106.0 ;E 393472.0

BORING DATE: Nov. 30, 2010

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m				
		--- CONTINUED FROM PREVIOUS PAGE ---									
30		Carlsbad Formation 25.76 m to 30.50 m	▨	48.88 30.50						Gravel ▨
		End of Drillhole									
31											W.L. in screen 'A' at Elev. 64.56 m on May 20, 2010
32											W.L. in screen 'B' at Elev. 64.53 m on May 20, 2010
33											W.L. in screen 'C' at Elev. 78.11 m on May 20, 2010
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
45											

MIS-BHS 001 0911251008-3000-3090.GPJ GAL-MIS.GDT 5/28/10 JM

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED:

Ontario Ministry of the Environment

Well Tag No. (Place Sticker and/or Print Below)
A 057512
A057512

MW-1

BH08-1

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

#1

Well Owner's Information

First Name: 2122063
Last Name: Ontario Inc.
E-mail Address:
☐ Well Constructed by Well Owner
Mailing Address (Street Number/Name, RR): 708-225 Metcalfe st
~~Municipality~~: Ottawa
Province: Ontario
Postal Code: K2A1A9
Telephone No. (inc. area code): 6135929600

Part A Construction and/or Major Alteration of a Well

Address of Well Location (Street Number/Name, RR): 19 Eadie RD
Township: Russell
Lot: 19
Concession: 3
County/District/Municipality: Russell
City/Town/Village: Russell
Province: Ontario
Postal Code: K0A3B0
UTM Coordinates Zone Easting Northing: NAD 83 18 472107 5016434
GPS Unit Make:
Model:
Mode of Operation: ☐ Undifferentiated ☑ Averaged
☐ Differentiated, specify ________

Overburden and Bedrock Materials (see instructions on the back of this form)

General Colour	Most Common Material	Other Materials	General Description	Depth (Metres) From	To
Red	Clay		Soft	0	1
Red	Shale		Layered	1	9.1

Annular Space/Abandonment Sealing Record

Depth Set at (Metres) From	To	Type of Sealant Used (Material and Type)	Volume Placed (Cubic Metres)
0	1.5	ciment grout	1 Bag

Results of Well Yield Testing

Check box if after test of well yield, water was:
☐ Clear and sand free
☐ Cannot develop to sand-free state
If pumping discontinued, give reason:
Pumping test method
Pump intake set at (Metres)
Pumping rate (Litres/min)
Duration of pumping ____ hrs + ____ min
Final water level end of pumping (Metres)
Recommended pump type ☐ Shallow ☐ Deep
Recommended pump depth ____ Metres
Recommended pump rate (Litres/min)
If flowing give rate (Litres/min)

NA

Draw Down Time (Min)	Water Level (Metres)	Recovery Time (Min)	Water Level (Metres)
Static Level		Static Level	
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Method of Construction

☐ Cable Tool
☐ Rotary (Conventional)
☐ Rotary (Reverse)
☑ Rotary (Air)
☐ Air percussion
☐ Other, specify ________
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging
☐ Boring

Water Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, specify ________
☐ Commercial
☐ Municipal
☑ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☐ Monitoring

Status of Well

☐ Water Supply
☐ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☑ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Other, specify ________

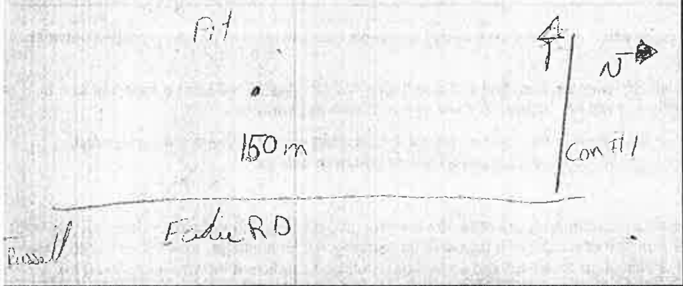
Water Details

Water found at Depth ____ Metres ☐ Gas — Kind of Water ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals
Water found at Depth ____ Metres ☐ Gas — Kind of Water ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals
Water found at Depth ____ Metres ☐ Gas — Kind of Water ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals

NA

Location of Well

Please provide a map below showing:
- all property boundaries, and measurements sufficient to locate the well in relation to fixed points,
- an arrow indicating the North direction
- detailed drawings can be provided as attachments no larger than legal size (8.5" by 14")
- vidigital pictures of inside of well can also be provided



Casing Used

☐ Galvanized
☑ Steel
☐ Fibreglass
☐ Plastic
☐ Concrete

Screen Used

☐ Galvanized
☐ Steel
☐ Fibreglass
☐ Plastic
☐ Concrete

No Casing and Screen Used

☑ Open Hole
Disinfected? ☐ Yes ☑ No

Casing and Well Details

Diameter of the Hole (Centimetres): 15.55
Depth of the Hole (Metres): 9.1
Wall Thickness (Metres): 0.48
Inside Diameter of the Casing (Metres): 15.55
Depth of the Casing (Metres): 1.5

Date Well Completed (yyyy/mm/dd): 2008/01/24
Was the well owner's information package delivered? ☐ Yes ☑ No
Date the Well Record and Package Delivered to Well Owner (yyyy/mm/dd):

Well Contractor and Well Technician Information

Business Name of Well Contractor: Bourgeois Well Drilling
Well Contractor's Licence No.: 1414
Business Address (Street No./Name, number, RR): 1182 100 East
Municipality: Nation
Province: Ontario
Postal Code: K0A3C0
Business E-mail Address: NA
Bus. Telephone No. (inc. area code): 6139875291
Name of Well Technician (Last Name, First Name): Alain Bourgeois
Well Technician's Licence No.: 2710
Signature of Technician: Alain Bourgeois
Date Submitted (yyyy/mm/dd): 2008/01/24

Ministry Use Only

Audit No. Z 79805
Well Contractor No.
Date Received (yyyy/mm/dd)
Date of Inspection (yyyy/mm/dd)
Remarks

0506E (11/2006)

Well Owner's Copy

BH08-2

MW-2

Ontario Ministry of the Environment

#2

Well Tag No. *(Place Sticker and/or Print Below)*

A 057520

A 057520

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Well Owner's Information

First Name: 2122063

Last Name: Ontario Inc.

E-mail Address: NA

☐ Well Constructed by Well Owner

Mailing Address (Street Number/Name, RR):

Municipality:

Province: Ontario

Postal Code:

Telephone No. *(inc. area code)*:

Part A Construction and/or Major Alteration of a Well

Address of Well Location (Street Number/Name, RR): LOT 14 Eadie RD

Township: Russell

Lot: 19

Concession: 3

County/District/Municipality: Russell

City/Town/Village: Russell

Province: **Ontario**

Postal Code:

UTM Coordinates NAD 8 3 | Zone 1 8 | Easting 4 2 1 1 0 3 5 0 | Northing 1 6 6 1 1 7

GPS Unit Make: Magellan

Model: UTM

Mode of Operation: ☐ Undifferentiated ☑ Averaged ☐ Differentiated, specify ______

Overburden and Bedrock Materials *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth *(Metres)* From	To
Red			Soft	0	1.5
Red	shale		layered	1.5	9.1

Annular Space/Abandonment Sealing Record

Depth Set at *(Metres)* From	To	Type of Sealant Used *(Material and Type)*	Volume Placed *(Cubic Metres)*
0	2.1	Ciment grout	3 Bag

Results of Well Yield Testing

Check box if after test of well yield, water was:
☐ Clear and sand free
☐ Cannot develop to sand-free state

If pumping discontinued, give reason:

Pumping test method

Pump intake set at *(Metres)*

Pumping rate *(Litres/min)*

Duration of pumping ____ hrs + ____ min

Final water level end of pumping *(Metres)*

Recommended pump type ☐ Shallow ☐ Deep

Recommended pump depth ______ Metres

Recommended pump rate *(Litres/min)*

If flowing give rate *(Litres/min)*

NA

Draw Down Time *(Min)*	Water Level *(Metres)*	Recovery Time *(Min)*	Water Level *(Metres)*
Static Level		Static Level	
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Method of Construction

☐ Cable Tool
☐ Rotary (Conventional)
☐ Rotary (Reverse)
☑ Rotary (Air)
☐ Air percussion
☐ Other, specify ______
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging
☐ Boring

Water Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, specify ______
☐ Commercial
☐ Municipal
☐ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☐ Monitoring

Status of Well

☐ Water Supply
☐ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify ______
☑ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Other, specify ______

Water Details

Water found at Depth ____ Metres ☐ Gas — Kind of Water ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals

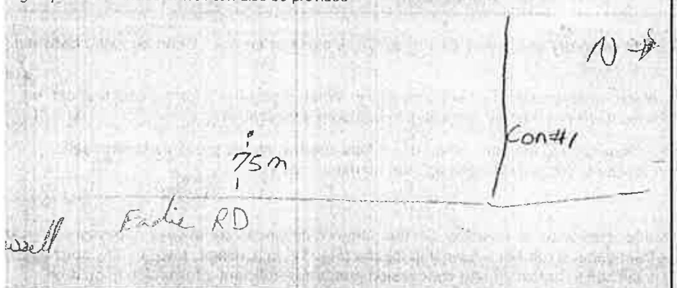
Water found at Depth ____ Metres ☐ Gas — Kind of Water ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals

Water found at Depth ____ Metres ☐ Gas — Kind of Water ☐ Fresh ☐ Salty ☐ Sulphur ☐ Minerals

NA

Location of Well

ease provide a map below showing:
ll property boundaries, and measurements sufficient to locate the well in relation to fixed points,
n arrow indicating the North direction
letailed drawings can be provided as attachments no larger than legal size (8.5" by 14")
digital pictures of inside of well can also be provided



Casing Used

☐ Galvanized
☑ Steel
☐ Fibreglass
☐ Plastic
☐ Concrete

Screen Used

☐ Galvanized
☐ Steel
☐ Fibreglass
☐ Plastic
☐ Concrete

Casing and Well Details

Diameter of the Hole *(Centimetres)*: 15.55

Depth of the Hole *(Metres)*: 9.1

Wall Thickness *(Metres)*: 0.48

Inside Diameter of the Casing *(Metres)*: 15.55

Depth of the Casing *(Metres)*: 2.1

No Casing and Screen Used

☑ Open Hole

Disinfected? ☐ Yes ☑ No

ate Well Completed *(yyyy/mm/dd)*: 08/04/24

Was the well owner's information package delivered? ☐ Yes ☑ No

Date the Well Record and Package Delivered to Well Owner *(yyyy/mm/dd)*:

Well Contractor and Well Technician Information

siness Name of Well Contractor: Bourgeois Well Drilling

Well Contractor's Licence No.: 1 4 1 4

siness Address (Street No./Name, number, RR): 82 900 East

Municipality: Nation

ovince: nt.

Postal Code: K0A3C0

Business E-mail Address: NA

s.Telephone No. *(inc. area code)*: 1 3 9 8 7 5 2 9 1

Name of Well Technician (Last Name, First Name): Alain Bourgeois

ll Technician's Licence No.: 2 7 1 0

Signature of Technician: Alain Bourgeois

Date Submitted *(yyyy/mm/dd)*: 2008/04/24

Ministry Use Only

Audit No. z79806

Well Contractor No.

Date Received *(yyyy/mm/dd)*

Date of Inspection *(yyyy/mm/dd)*

Remarks

6E (11/2006)

#1 / BH09-7

Ontario Ministry of the Environment

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Measurements recorded in: ☑ Metric ☐ Imperial

Well Tag No. (Place Sticker and/or Print Below) A088095

Well Owner's Information

First Name: 2122063
Last Name / Organization: Ontario INC.
E-mail Address:
☐ Well Constructed by Well Owner
Mailing Address (Street Number/Name): 708-225 Metcalfe St.
Municipality: Ottawa
Province: Ontario
Postal Code: K2P1P9
Telephone No. (inc. area code):

Well Location

Address of Well Location (Street Number/Name): Russell RD
Township: Russell
Lot: 19
Concession: 3
County/District/Municipality: Prescott Russell
City/Town/Village: Russell
Province: **Ontario**
Postal Code:
UTM Coordinates NAD 83 Zone 18 Easting 470058 Northing 5016421
Municipal Plan and Sublot Number:
Other:

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Red	clay	silt	Hard	0	4.8
Red	shale		layered	48	29.8
grey	limestone		layered	29.8	~~[illegible]~~ 33.5

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	6	Cement grout	1 Bag

Method of Construction

☐ Cable Tool ☐ Diamond
☐ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☐ Boring ☐ Digging
☐ Air percussion
☑ Other, specify Rotary Air

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☑ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, specify

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
15.55	Steel	.48	+.6	6
15.55	Open Hole		6	~~[illegible]~~ 33.5

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To

Status of Well

☐ Water Supply
☐ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Water Details

Water found at Depth 23 (m/ft) ☐ Gas — Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas — Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas — Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6	21.23
6	~~[illegible]~~ 33.5	15.55

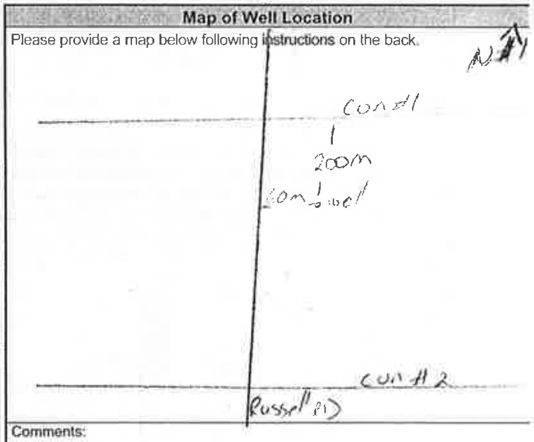
Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, specify
If pumping discontinued, give reason:
Pump intake set at (m/ft)
Pumping rate (l/min / GPM)
Duration of pumping ____ hrs + ____ min
Final water level end of pumping (m/ft)
If flowing give rate (l/min / GPM)
Recommended pump depth (m/ft) N/A
Recommended pump rate (l/min / GPM)
Well production (l/min / GPM)
Disinfected? ☐ Yes ☑ No

Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor: Bourgeois Well Drilling
Well Contractor's Licence No.: 74117
Business Address (Street Number/Name): 151 Montée D'Aoust
Municipality: Nation
Province: Ontario
Postal Code: K093K0
Business E-mail Address: NA
Bus. Telephone No. (inc. area code): 613987 5[illegible]91
Name of Well Technician (Last Name, First Name): Michael Greier
Well Technician's Licence No.: 3494
Signature of Technician and/or Contractor:
Date Submitted: 20091130

Well owner's information package delivered ☐ Yes ☑ No
Date Package Delivered: Y Y Y Y M M D D
Date Work Completed: 20091130

Ministry Use Only
Audit No. Z108068
Received

0506E (12/2007)

Well Owner's Copy

BH09-8

Ontario Ministry of the Environment

Well Tag No. *(Place Sticker and/or Print Below)*
A 088103

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Measurements recorded in: ☑ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	
2122063	Ontario inc		☐ Well Constructed by Well Owner

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
208-225 Metcalfe St.	Ottawa	Ontario	K2P1P9	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Eadie RD	Russell	19	3

County/District/Municipality	City/Town/Village	Province	Postal Code
Prescott Russell	Russell	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	471042	5017030		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	To
Red	clay	shale	Hard	0	2.1
Red	shale		layered	2.1	22.8
Grey	limestone		layered	22.8	30.48

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	3	Bentonite	2 Bag

Method of Construction

☐ Cable Tool
☐ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☑ Other, specify Air Rotary
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, specify
☐ Commercial
☐ Municipal
☑ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☐ Monitoring

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
15.55	Steel	.48	+.6	3
15.55	Open Hole		3	30.48

Status of Well

☐ Water Supply
☐ Replacement Well
☑ Test Hole
☐ Recharge Well
☐ Dewatering Well
☐ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To

Water Details

Water found at Depth 8 (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	3	21.23
3	30.48	15.55

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ____ hrs + ____ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min / GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min / GPM)

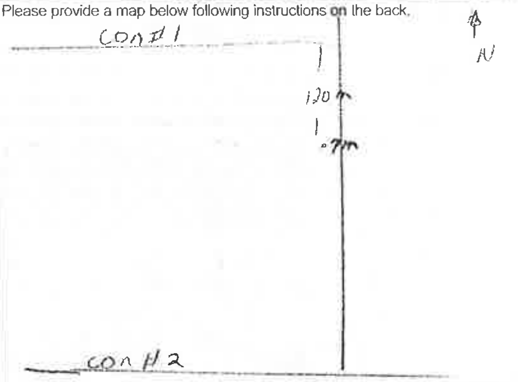
Well production (l/min / GPM)

Disinfected? ☐ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15	N/A	15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Bourgeois Well Drilling	3417

Business Address (Street Number/Name)	Municipality
151 Montée D'Aoust	Nation

Province	Postal Code	Business E-mail Address
Ontario	K0A3C0	NA

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6139875291	Michael genier

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3494		[illegible]

Well owner's information package delivered ☐ Yes ☑ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed [illegible]

Ministry Use Only
Audit No. Z108066
Received

0506E (12/2007)

Well Owner's Copy

ATTACHMENT TSD#1-B-2-2

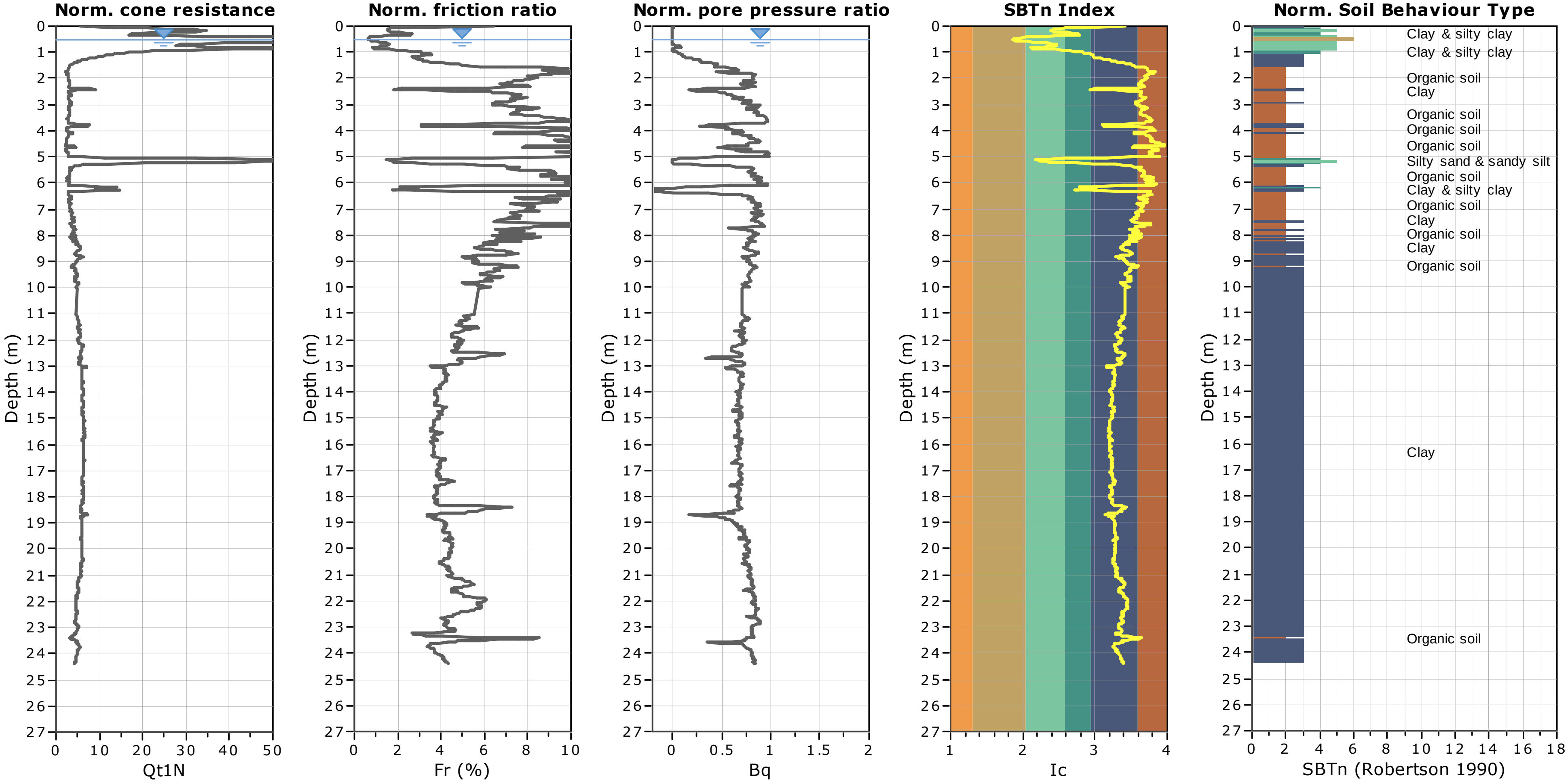
CPT Logs, Borehole Logs and Grain Size Distribution (BR Site)

February 2013

Golder Associates
Ottawa, ON
www.golder.com

CPT: 12-1-1 Rev 1
Total depth: 24.38 m, Date: 11/14/2012
Surface Elevation: 75.99 m
Coords: X:467130.45, Y:5020302.87
Cone Type: 10 cm2, (4039)
Cone Operator: Golder (D. Grylls)

Project: **12-1125-0045 - CRRRC EA Eastern Ontario**
Location: **Boundary Road Site**



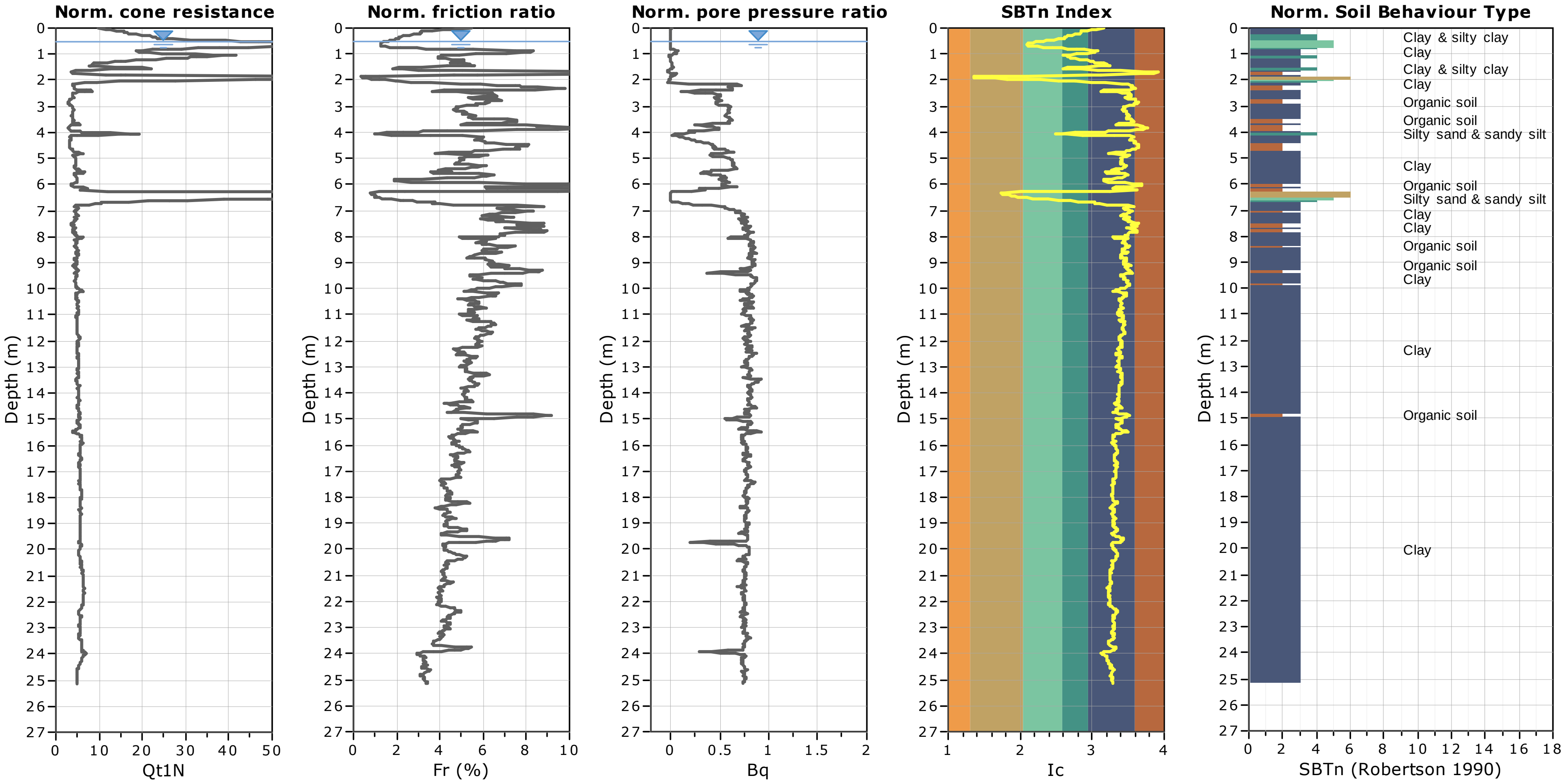
SBTn legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty clay
- 🟩 5. Silty sand to sandy silt
- 🟫 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to clayey sand
- ⬜ 9. Very stiff fine grained

Golder Associates
Ottawa, ON
www.golder.com

CPT: 12-2-1 Rev 1
Total depth: 25.14 m, Date: 12/20/2012
Surface Elevation: 77.02 m
Coords: X:466155.63, Y:5019599.37
Cone Type: 10 cm2, u2, (4039)
Cone Operator: Golder (D. Grylls)

Project: **12-1125-0045 - CRRRC EA Eastern Ontario**
Location: **Boundary Road Site**



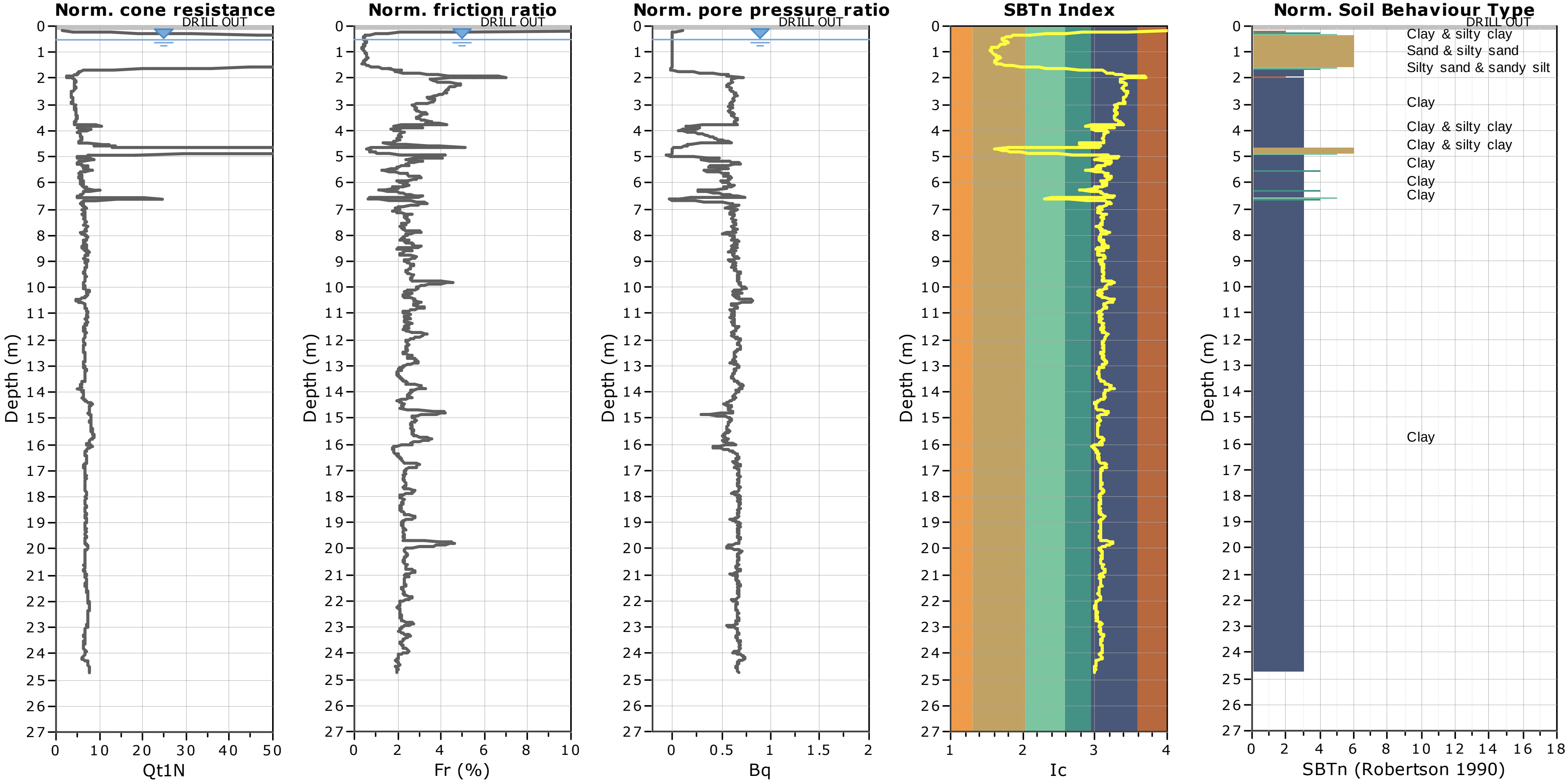
SBTn legend

🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to clayey sand
⬜ 9. Very stiff fine grained

Golder Associates
Ottawa, ON
www.golder.com

CPT: 12-3-1 Rev 1
Total depth: 24.76 m, Date: 11/29/2012
Surface Elevation: 76.16 m
Coords: X:466663.45, Y:5021575.17
Cone Type: 10 cm2, u2, (4039)
Cone Operator: Golder (D. Grylls)

Project: **12-1125-0045 - CRRRC EA Eastern Ontario**
Location: **Boundary Road Site**



SBTn legend

🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to clayey sand
⬜ 9. Very stiff fine grained

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-2

SHEET 1 OF 2

LOCATION: N 5020298.57 ;E 467132.84

BORING DATE: November 13-14, 2012

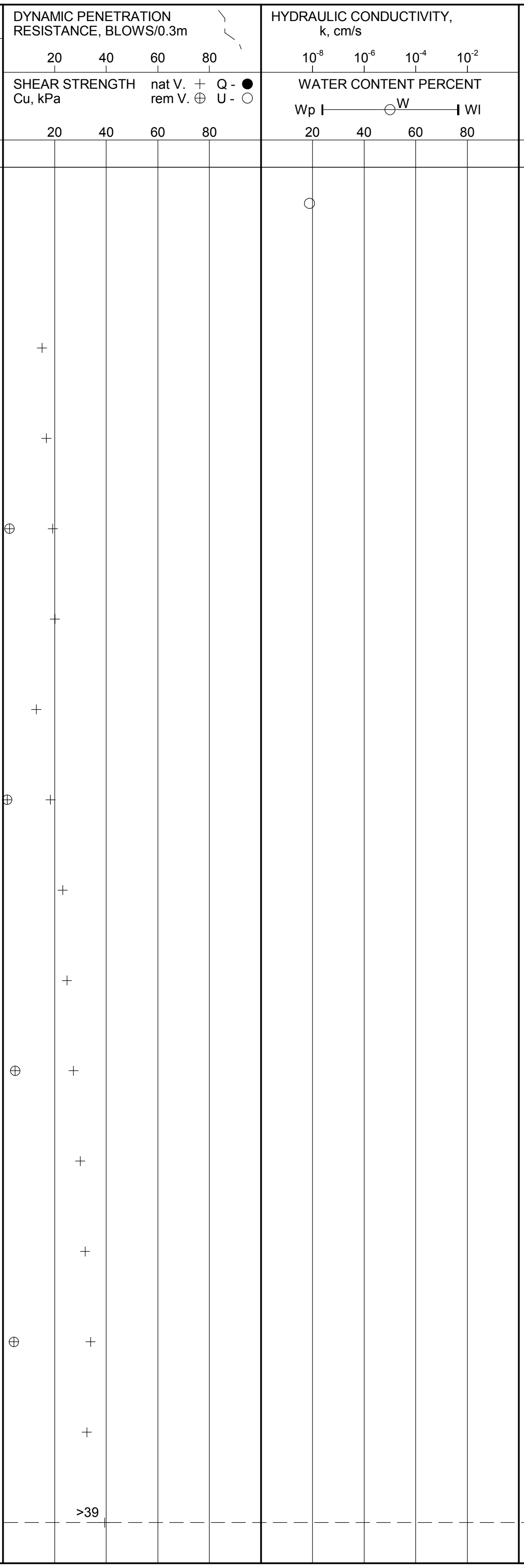
DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
		GROUND SURFACE	75.95				
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00				
		Very loose brown SILTY SAND to SAND, some silt and clay	0.25	1	50 DO	3	MH
		Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	75.40 0.55	2	50 DO	4	
1		Grey brown SAND, some silt, trace clay	74.88				
		Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	1.22	3	50 DO	1	
		Soft grey to red grey SILTY CLAY					
2	Electric Nilcon	Grey CLAYEY SILT, some sand	73.89				
		Soft grey to red grey CLAY to SILTY CLAY, with silt seams	2.15				
3							
4		- Grey silt layer from 3.72 m to 3.76 m					
		Grey SANDY SILT, with black staining	71.20 4.75				
5		Grey SILT, some clay	4.99				
		Soft to firm red grey CLAY to SILTY CLAY, with black staining and sandy silt and sand seams - Grey sandy silt layer from 5.28 m to 5.32 m	5.13				
6							
7		- Grey silt layer from 7.16 m to 7.24 m					
8							
9		- Grey clayey silt layer from 8.94 m to 9.07 m					
10							
11							
12		Stiff grey and red CLAY to SILTY CLAY, with black staining	63.76 12.19				
13							
14							
15		*CONTINUED NEXT PAGE*					



PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-2

SHEET 2 OF 2

LOCATION: N 5020298.57 ;E 467132.84

BORING DATE: November 13-14, 2012

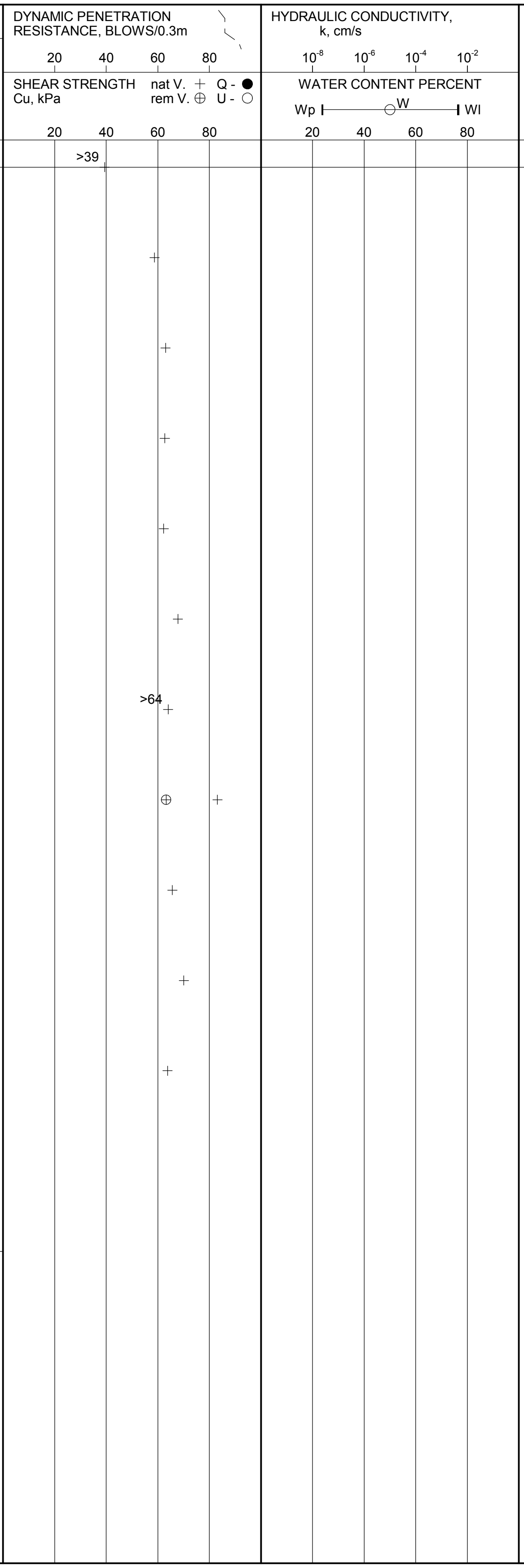
DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---							
15	Electric Nilcon	Stiff grey and red CLAY to SILTY CLAY, with black staining	▨						
23		Stiff to very stiff grey CLAY to SILTY CLAY, with black staining	▨	53.09 22.86					
27		End of Borehole Note: 1. Soil stratigraphy inferred from various soil sampling methods and CPT. 2. Vane pushed to 27 m depth. Rod friction too high to carry out test.		48.95 27.00					



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-3

SHEET 1 OF 3

LOCATION: N 5020302.44 ;E 467125.21

INCLINATION: -90° AZIMUTH: ---

BORING DATE: November 15-19, 2012

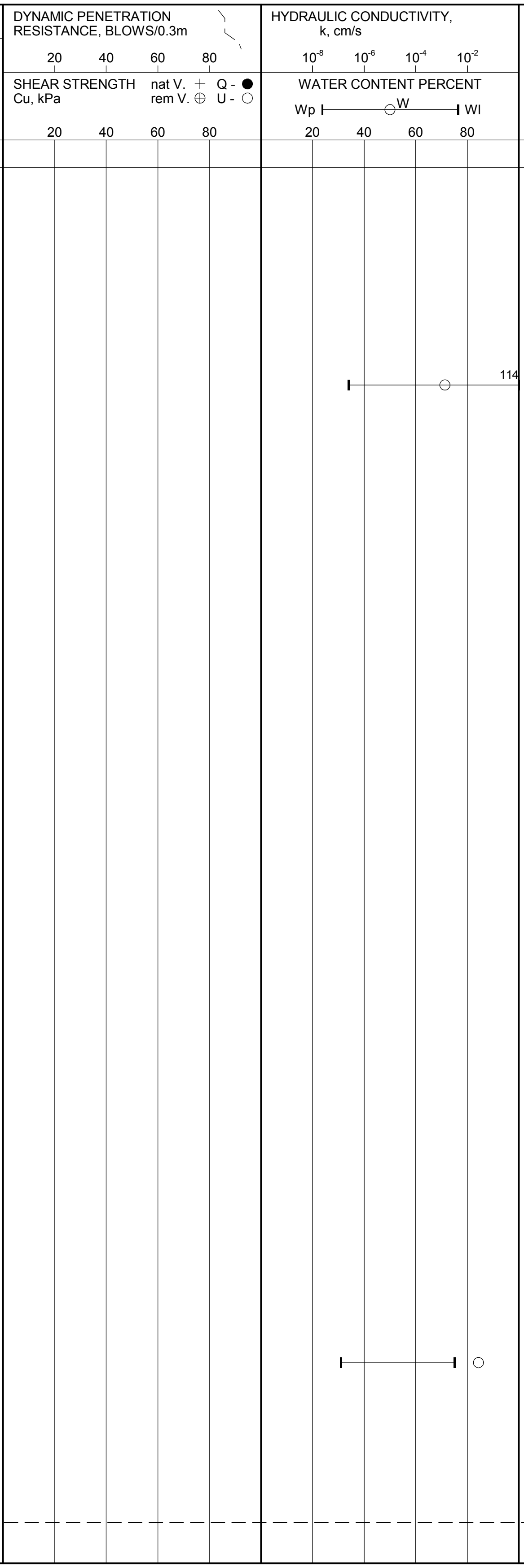
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Wash Boring, HW Casing

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	76.01			
TOPSOIL	0.00			
Very loose brown SILTY SAND to SAND, some silt and clay	0.25 75.46			
Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	0.55 74.94			
Grey brown SAND, some silt, trace clay				
Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	1.22			
Soft grey to red grey SILTY CLAY	73.95			
Grey CLAYEY SILT, some sand	2.15			
Soft grey to red grey CLAY to SILTY CLAY, with silt seams		1	73 TP	PH
- Grey silt layer from 3.72 m to 3.76 m	71.26			
Grey SANDY SILT, with black staining	4.75			
Grey SILT, some clay	4.99 5.13			
Soft to firm red grey CLAY to SILTY CLAY, with black staining and sandy silt and sand seams - Grey sandy silt layer from 5.28 m to 5.32 m		2	73 TP	PH
- Grey silt layer from 7.16 m to 7.24 m				
- Grey clayey silt layer from 8.94 m to 9.07 m		3	73 TP	PH
	63.82			
Stiff grey and red CLAY to SILTY CLAY, with black staining	12.19	4	73 TP	PH



PIEZOMETER OR STANDPIPE INSTALLATION:
Protective Casing
76 mm Diam. PVC Casing
Bentonite-Cement Grout

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 75

LOGGED: DG
CHECKED: SAT

CRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-3

SHEET 2 OF 3

LOCATION: N 5020302.44 ;E 467125.21

BORING DATE: November 15-19, 2012

DATUM: Geodetic

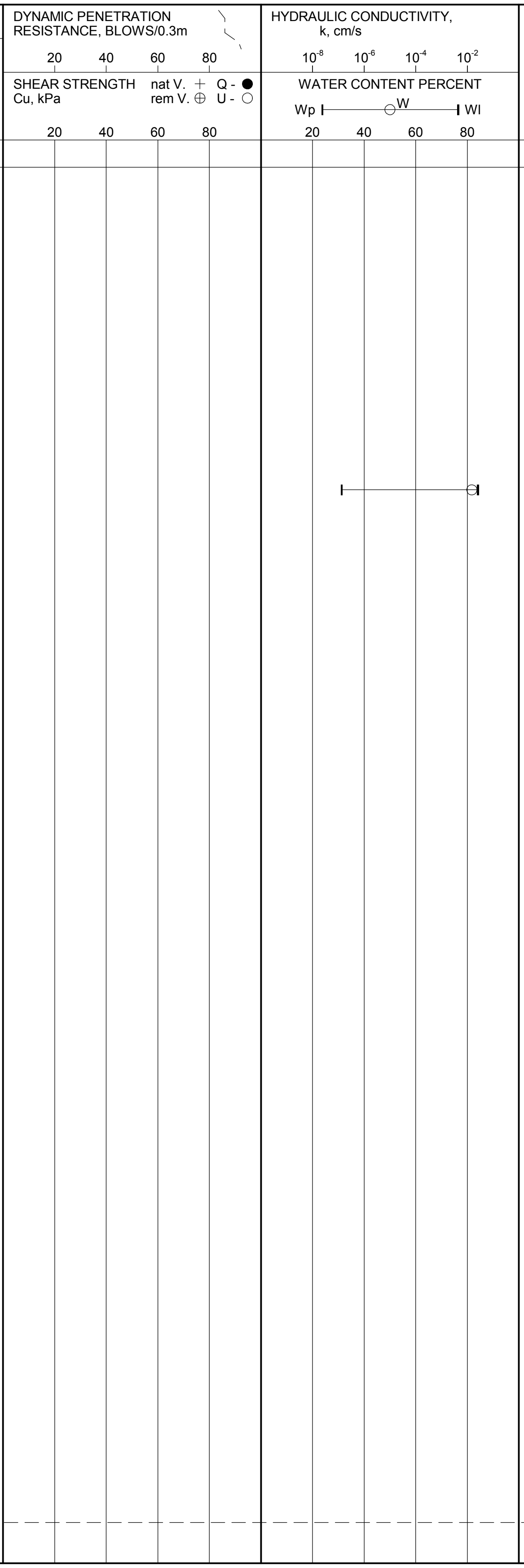
INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	PIEZOMETER OR STANDPIPE INSTALLATION
		--- *CONTINUED FROM PREVIOUS PAGE* ---			
15	Wash Boring HW Casing	Stiff grey and red CLAY to SILTY CLAY, with black staining	▨		76 mm Diam. PVC Casing Bentonite-Cement Grout
23		Stiff to very stiff grey CLAY to SILTY CLAY, with black staining	▨	53.15 22.86	
30		*CONTINUED NEXT PAGE*			

SAMPLES NUMBER	TYPE	BLOWS/0.3m
5	73 TP	PH
6	73 TP	PH
7	50 DO	WH
8	50 DO	WR
9	50 DO	WR
10	50 DO	WR
11	50 DO	WR
12	50 DO	WR
13	50 DO	WR
14	50 DO	WR



ADDITIONAL LAB. TESTING

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-3

SHEET 3 OF 3

LOCATION: N 5020302.44 ;E 467125.21

BORING DATE: November 15-19, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- *CONTINUED FROM PREVIOUS PAGE* ---							
30	Wash Boring HW Casing	Stiff to very stiff grey CLAY to SILTY CLAY, with black staining		14	50 DO	WR			
				15	50 DO	WR			
31				16	50 DO	WR			
32				17	50 DO	WR			
33				18	50 DO	WR			
34				19	50 DO	WR			
				20	50 DO	WR			
35				21	50 DO	WR			
			40.20 35.81						
36		Dense to very dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		22	50 DO	52			
				23	50 DO	67			
37				24	50 DO	36	○	MH	76 mm Diam. PVC Casing Bentonite-Cement Grout
38				25	50 DO	33			
				26	50 DO	>50			
				27	HQ RC	DD			
39				28	50 DO	>50			
40			35.40						
41		Borehole continued on RECORD OF DRILLHOLE 12-1-3 Note: 1. Soil stratigraphy inferred from various soil sampling methods and CPT. 2. Different stratigraphy relative to borehole 12-1-7.							
42									
43									
44									
45									

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-1-3

SHEET 1 OF 3

LOCATION: N 5020302.44 ;E 467125.21

DRILLING DATE: November 15-19, 2012

DATUM: Geodetic

DRILL RIG: CME 850

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint
FLT - Fault
SH - Shear
VN - Vein
CJ - Conjugate

BD - Bedding
FO - Foliation
CO - Contact
OR - Orthogonal
CL - Clean

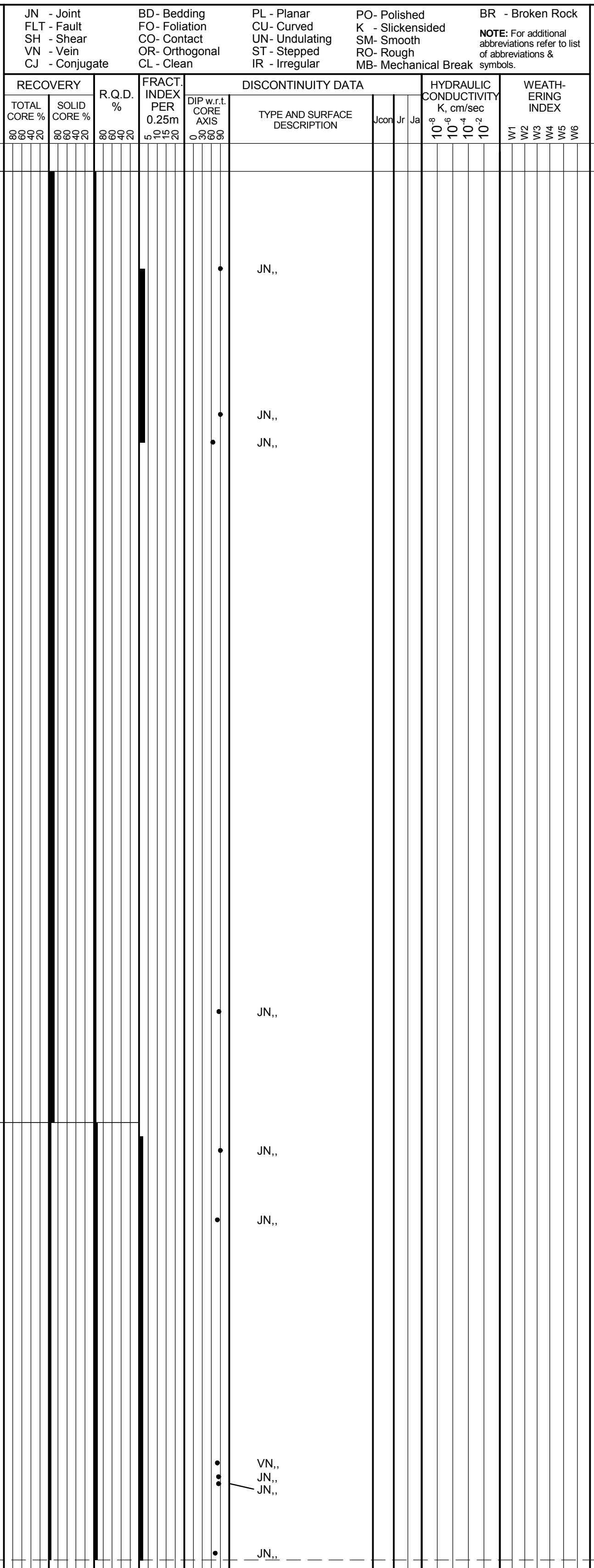
PL - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

PO - Polished
K - Slickensided
SM - Smooth
RO - Rough
MB - Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	NOTES
		BEDROCK SURFACE		35.40		
	Rotary Drill HQ Core	**CARLSBAD FORMATION, 40.61 m to 46.47 m** Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible **SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE** with occasional bioclastic limestone beds.		40.61	1	76 mm Diam. PVC Casing Bentonite-Cement Grout
				35.26 40.75		
41						
				34.27 41.74		
				41.76		
				34.10 41.91		
				41.94		
42					2	
				33.91 42.10		
				33.83 42.18		
				33.58 42.43		
				33.54 42.47		
				33.50 42.51		
				33.44 42.57		



CONTINUED NEXT PAGE

DEPTH SCALE
1 : 10

Golder Associates

LOGGED: DG
CHECKED: SAT

CRRRC-ROCK 1211250045.GPJ GAL-MISS.GDT 09/04/14 JM

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-1-3

SHEET 2 OF 3

LOCATION: N 5020302.44 ;E 467125.21

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 15-19, 2012

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

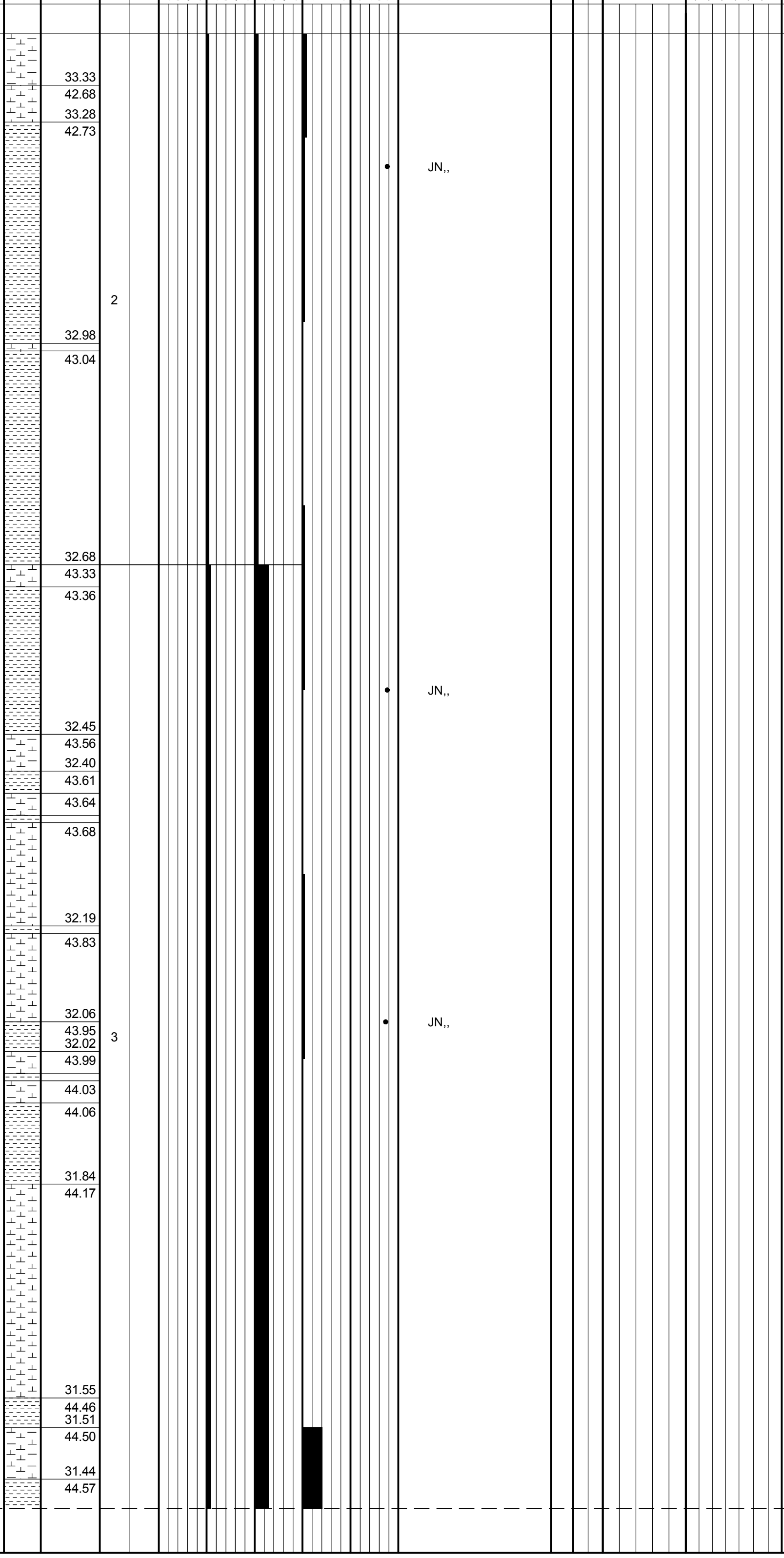
DATUM: Geodetic

JN - Joint	BD - Bedding	PL - Planar	PO - Polished	BR - Broken Rock
FLT - Fault	FO - Foliation	CU - Curved	K - Slickensided	**NOTE:** For additional abbreviations refer to list of abbreviations & symbols.
SH - Shear	CO - Contact	UN - Undulating	SM - Smooth	
VN - Vein	OR - Orthogonal	ST - Stepped	RO - Rough	
CJ - Conjugate	CL - Clean	IR - Irregular	MB - Mechanical Break	

--- *CONTINUED FROM PREVIOUS PAGE* ---

DEPTH SCALE METRES | DRILLING RECORD: Rotary Drill, HQ Core | DESCRIPTION

CARLSBAD FORMATION, 40.61 m to 46.47 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible **SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE** with occasional bioclastic limestone beds.



DEPTH SCALE METRES	ELEV.	DEPTH (m)	RUN No.	DISCONTINUITY DATA
	33.33	42.68		
	33.28	42.73		
				JN,,
			2	
43	32.98	43.04		
	32.68	43.33		
		43.36		
				JN,,
	32.45	43.56		
	32.40	43.61		
		43.64		
		43.68		
	32.19	43.83		
				JN,,
	32.06	43.95	3	
	32.02	43.99		
44		44.03		
		44.06		
	31.84	44.17		
	31.55	44.46		
	31.51	44.50		
	31.44	44.57		

NOTES

76 mm Diam. PVC Casing

Bentonite-Cement Grout

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 10

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-1-3

SHEET 3 OF 3

LOCATION: N 5020302.44 ;E 467125.21

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 15-19, 2012

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SH - Shear
VN - Vein
CJ - Conjugate

BD - Bedding
FO - Foliation
CO - Contact
OR - Orthogonal
CL - Clean

PL - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

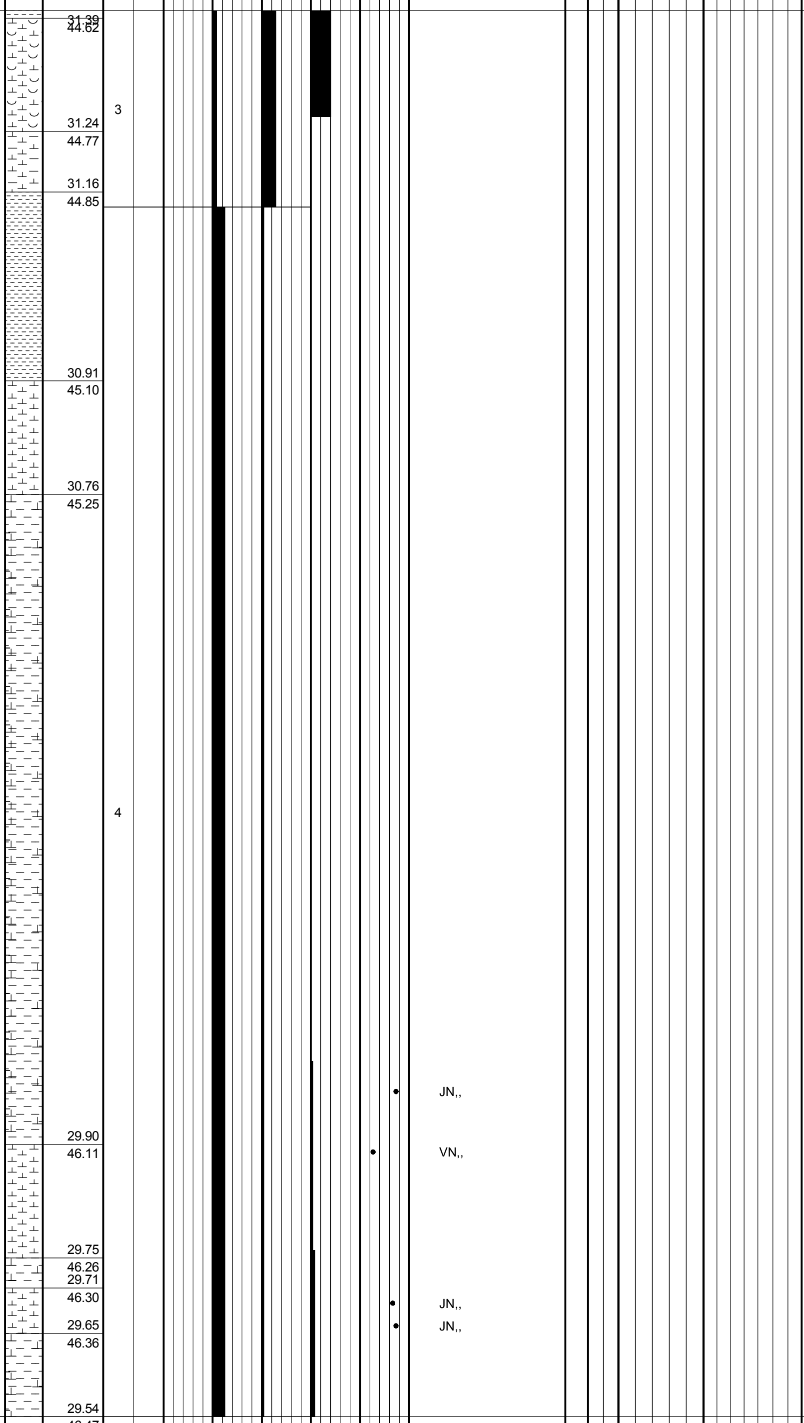
PO - Polished
K - Slickensided
SM - Smooth
RO - Rough
MB - Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | FLUSH RETURN | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25m (5 10 15 20) | DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jcon, Jr, Ja | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-8} 10^{-6} 10^{-4} 10^{-2}) | WEATHERING INDEX (W1 W2 W3 W4 W5 W6) | NOTES

--- CONTINUED FROM PREVIOUS PAGE ---



Drilling record: Rotary Drill, HQ Core

CARLSBAD FORMATION, 40.61 m to 46.47 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible **SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE** with occasional bioclastic limestone beds.

ELEV.	DEPTH (m)
31.39	44.62
31.24	44.77
31.16	44.85
30.91	45.10
30.76	45.25
29.90	46.11
29.75	46.26
29.71	46.30
29.65	46.36
29.54	46.47

Run No.: 3, 4

Depth scale: 45, 46

TYPE AND SURFACE DESCRIPTION
JN,,
VN,,
JN,,
JN,,

End of Drillhole

NOTES:

76 mm Diam. PVC Casing

Bentonite-Cement Grout

DEPTH SCALE
1 : 10

Golder Associates

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-3-1

SHEET 1 OF 3

LOCATION: N 5020300.53 ;E 467124.43

INCLINATION: -90° AZIMUTH: ---

BORING DATE: November 23, 2012

DATUM: Geodetic

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | SAMPLES (NUMBER, TYPE, BLOWS/0.3m) | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

BORING METHOD: Rotary Drill, HQ Core

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	76.10
TOPSOIL	0.00
Very loose brown SILTY SAND to SAND, some silt and clay	0.25 75.55
Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	0.55 75.03
Grey brown SAND, some silt, trace clay	
Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	1.22
Soft grey to red grey SILTY CLAY	74.04
Grey CLAYEY SILT, some sand	2.15
Soft grey to red grey CLAY to SILTY CLAY, with silt seams - Grey silt layer from 3.72 m to 3.76 m	71.35
Grey SANDY SILT, with black staining	4.75
Grey SILT, some clay	4.99 5.13
Soft to firm red grey CLAY to SILTY CLAY, with black staining and sandy silt and sand seams - Grey sandy silt layer from 5.28 m to 5.32 m - Grey silt layer from 7.16 m to 7.24 m - Grey clayey silt layer from 8.94 m to 9.07 m	63.91
Stiff grey and red CLAY to SILTY CLAY, with black staining	12.19

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

MON. WELL

Protective Casing

Bentonite-Cement Grout

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-3-1

SHEET 2 OF 3

LOCATION: N 5020300.53 ;E 467124.43

INCLINATION: -90° AZIMUTH: ---

BORING DATE: November 23, 2012

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m				
		--- CONTINUED FROM PREVIOUS PAGE ---									MON. WELL
15	Rotary Drill HQ Core	Stiff grey and red CLAY to SILTY CLAY, with black staining	▨								
16			▨								
17			▨								
18			▨								
19			▨								
20			▨								
21			▨								
22			▨								Bentonite-Cement Grout
23		Stiff to very stiff grey CLAY to SILTY CLAY, with black staining	▨	53.24 22.86							
24			▨								
25			▨								
26			▨								
27			▨								
28			▨								
29			▨								
30											
		CONTINUED NEXT PAGE									

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-3-1

SHEET 3 OF 3

LOCATION: N 5020300.53 ;E 467124.43

BORING DATE: November 23, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2}; WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									MON. WELL
30	Rotary Drill HQ Core	Stiff to very stiff grey CLAY to SILTY CLAY, with black staining	▨								Bentonite-Cement Grout
36		Dense to very dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)		40.29 35.81							
40		Borehole continued on RECORD OF DRILLHOLE 12-1-3.1 Note: 1. Soil stratigraphy inferred from various soil sampling methods and CPT. 2. Different stratigraphy relative to borehole 12-1-7.		36.32							

Depth scale: 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-1-3-1

SHEET 1 OF 3

LOCATION: N 5020300.53 ;E 467124.43

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 23, 2012

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

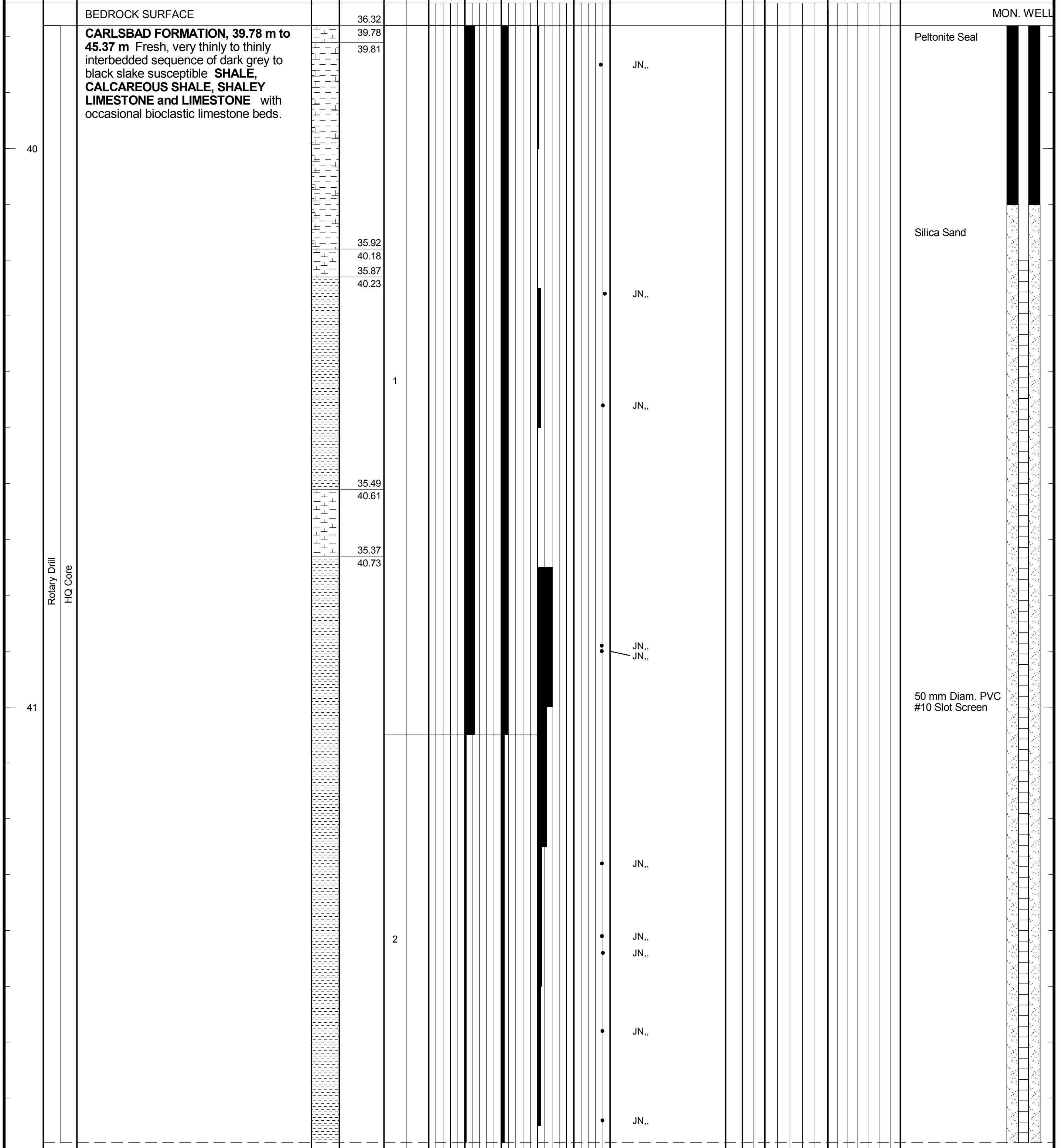
JN - Joint
FLT - Fault
SH - Shear
VN - Vein
CJ - Conjugate
BD - Bedding
FO - Foliation
CO - Contact
OR - Orthogonal
CL - Clean
PL - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular
PO - Polished
K - Slickensided
SM - Smooth
RO - Rough
MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | FLUSH RETURN | RECOVERY: TOTAL CORE %, SOLID CORE % | R.Q.D. % | FRACT. INDEX PER 0.25m | DISCONTINUITY DATA: DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jcon, Jr, Ja | HYDRAULIC CONDUCTIVITY K, cm/sec | WEATHERING INDEX | NOTES

BEDROCK SURFACE

CARLSBAD FORMATION, 39.78 m to 45.37 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible **SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE** with occasional bioclastic limestone beds.



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DEPTH SCALE

1 : 10

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-1-3-1

LOCATION: N 5020300.53 ;E 467124.43

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 23, 2012

DRILL RIG: CME 850

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint	BD - Bedding	PL - Planar	PO - Polished	BR - Broken Rock
FLT - Fault	FO - Foliation	CU - Curved	K - Slickensided	**NOTE:** For additional abbreviations refer to list of abbreviations & symbols.
SH - Shear	CO - Contact	UN - Undulating	SM - Smooth	
VN - Vein	OR - Orthogonal	ST - Stepped	RO - Rough	
CJ - Conjugate	CL - Clean	IR - Irregular	MB - Mechanical Break	

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | FLUSH RETURN | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25m 5 10 15 20 | DISCONTINUITY DATA (DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jcon Jr Ja) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-8} 10^{-6} 10^{-4} 10^{-2} | WEATH-ERING INDEX W1 W2 W3 W4 W5 W6 | NOTES

--- CONTINUED FROM PREVIOUS PAGE ---

MON. WELL

CARLSBAD FORMATION, 39.78 m to 45.37 m Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible **SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE** with occasional bioclastic limestone beds.

Depth scale: 42, 43

Drilling record: Rotary Drill, HQ Core

Run No.: 2, 3

ELEV.	DEPTH (m)	TYPE AND SURFACE DESCRIPTION
33.59	42.51	
33.55	42.55	JN,,
33.49	42.61	
33.40	42.70	
33.34	42.76	
33.23	42.87	
33.14	42.96	
33.05	43.05	JN,,
33.01	43.09	
32.86	43.24	
32.73	43.37	
32.55	43.55	
32.40	43.70	JN,,

NOTES: 50 mm Diam. PVC #10 Slot Screen

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 10

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-1-3-1

SHEET 3 OF 3

LOCATION: N 5020300.53 ;E 467124.43

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 23, 2012
DRILL RIG: CME 850
DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SH - Shear
VN - Vein
CJ - Conjugate
BD - Bedding
FO - Foliation
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CL - Clean
PL - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular
PO - Polished
K - Slickensided
SM - Smooth
RO - Rough
MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	NOTES
		--- CONTINUED FROM PREVIOUS PAGE ---				MON. WELL
	Rotary Drill HQ Core	**CARLSBAD FORMATION, 39.78 m to 45.37 m** Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible **SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE** with occasional bioclastic limestone beds.	32.23 43.87 43.90 32.15 43.95	3		
44			32.08 44.02 32.03 44.07		JN,,	
						50 mm Diam. PVC #10 Slot Screen
					JN,,	
				4		
					JN,,	
45						Silica Sand
			30.85 45.25 30.75 30.73 45.35			
		End of Drillhole	45.37			

Column headings: RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.25m 5 10 15 20; DIP w.r.t. CORE AXIS 0 30 60 90; Jcon Jr Ja; HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-8} 10^{-6} 10^{-4} 10^{-2}; WEATH-ERING INDEX W1 W2 W3 W4 W5 W6; SYMBOLIC LOG; FLUSH RETURN

DEPTH SCALE
1 : 10

Golder Associates

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-4

SHEET 1 OF 3

LOCATION: N 5020299.81 ;E 467126.00

INCLINATION: -90° AZIMUTH: ---

BORING DATE: November 26, 2012

DATUM: Geodetic

SAMPLES: NUMBER, TYPE, BLOWS/0.3m

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl — 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	76.08	'B' 'A'
0	Wash Boring HW Casing	TOPSOIL	0.00	Protective Casing
		Very loose brown SILTY SAND to SAND, some silt and clay	0.25	Bentonite Seal
		Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	75.53 0.55	
1		Grey brown SAND, some silt, trace clay	75.01	
		Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	1.22	
		Soft grey to red grey SILTY CLAY		
2		Grey CLAYEY SILT, some sand	74.02	
		Soft grey to red grey CLAY to SILTY CLAY, with silt seams	2.15	
3				
4		- Grey silt layer from 3.72 m to 3.76 m		
		Grey SANDY SILT, with black staining	71.33 4.75	
5		Grey SILT, some clay	4.99	
		Soft to firm red grey CLAY to SILTY CLAY, with black staining and sandy silt and sand seams - Grey sandy silt layer from 5.28 m to 5.32 m	5.13	
6				
7		- Grey silt layer from 7.16 m to 7.24 m		
8				Bentonite-Cement Grout
9		- Grey clayey silt layer from 8.94 m to 9.07 m		
10				
11				
12		Stiff grey and red CLAY to SILTY CLAY, with black staining	63.89 12.19	
13				
14				
15				

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-4

SHEET 2 OF 3

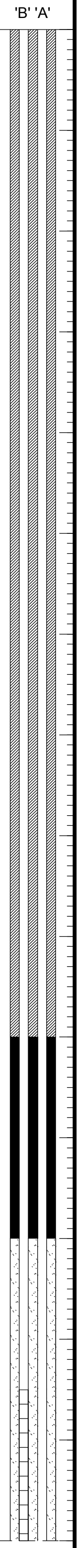
LOCATION: N 5020299.81 ;E 467126.00

INCLINATION: -90° AZIMUTH: ---

BORING DATE: November 26, 2012

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} / WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									'B' 'A'
15	Wash Boring HW Casing	Stiff grey and red CLAY to SILTY CLAY, with black staining	▨								
20											Bentonite-Cement Grout
22.86		Stiff to very stiff grey CLAY to SILTY CLAY, with black staining	▨	53.22 22.86							
26											Peltonite
27.7											Silica Sand
29.2											25 mm Diam. PVC #10 Slot Screen 'B'
30		*CONTINUED NEXT PAGE*									



DEPTH SCALE
1 : 75

Golder Associates

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-4

SHEET 3 OF 3

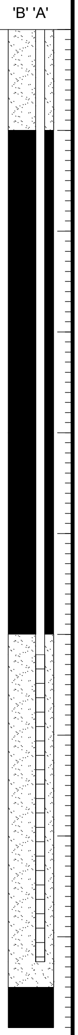
LOCATION: N 5020299.81 ;E 467126.00

INCLINATION: -90° AZIMUTH: ---

BORING DATE: November 26, 2012

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---								'B' 'A'
30	Wash Boring HW Casing	Stiff to very stiff grey CLAY to SILTY CLAY, with black staining								Silica Sand
31										
32										Bentonite Seal
33										
34										
35										Peltonite
36		Dense to very dense grey SILTY SAND, some gravel, trace clay, with cobbles and boulders (GLACIAL TILL)	40.27 35.81							Silica Sand
37										
38										32 mm Diam. PVC #10 Slot Screen 'A'
39										Silica Sand Peltonite
40		End of Borehole Note: 1. Soil stratigraphy inferred from various soil sampling methods and CPT. 2. Different stratigraphy relative to borehole 12-1-7.	36.18 39.90							
41										
42										
43										
44										
45										



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-5

SHEET 1 OF 2

LOCATION: N 5020301.64 ;E 467122.27

INCLINATION: -90° AZIMUTH: ---

BORING DATE: November 19, 2012

DATUM: Geodetic

DEPTH SCALE METRES | BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SAMPLES: NUMBER | TYPE | BLOWS/0.3m

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	76.06
TOPSOIL	0.00
Very loose brown SILTY SAND to SAND, some silt and clay	0.25
Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	75.51 0.55
Grey brown SAND, some silt, trace clay	74.99
Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)	1.22
Soft grey to red grey SILTY CLAY	
Grey CLAYEY SILT, some sand	74.00
Soft grey to red grey CLAY to SILTY CLAY, with silt seams - Grey silt layer from 3.72 m to 3.76 m	2.15
Grey SANDY SILT, with black staining	71.31 4.75
Grey SILT, some clay	4.99
Soft to firm red grey CLAY to SILTY CLAY, with black staining and sandy silt and sand seams - Grey sandy silt layer from 5.28 m to 5.32 m - Grey silt layer from 7.16 m to 7.24 m - Grey clayey silt layer from 8.94 m to 9.07 m	5.13
Stiff grey and red CLAY to SILTY CLAY, with black staining	63.87 12.19

CONTINUED NEXT PAGE

'B' 'A'

Protective Casing

Bentonite Seal

Silica Sand

32 mm Diam. PVC
#10 Slot Screen 'B'

Silica Sand

Bentonite Seal

Silica Sand

25 mm Diam. PVC
#10 Slot Screen 'A'

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-5

SHEET 2 OF 2

LOCATION: N 5020301.64 ;E 467122.27

INCLINATION: -90° AZIMUTH: ---

BORING DATE: November 19, 2012

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									'B' 'A'
15			▨	60.81 15.25							Silica Sand
		End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.									
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-1-6

SHEET 1 OF 1

LOCATION: N 5020298.76 ;E 467123.21

INCLINATION: -90° AZIMUTH: ---

BORING DATE: November 19, 2012

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		76.06							MON. WELL
0	Power Auger 200 mm Diam. (HS)	TOPSOIL		0.00							
		Very loose brown SILTY SAND to SAND, some silt and clay		0.25 75.51							
1		Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)		0.55 74.99							
		Grey brown SAND, some silt, trace clay									
		Stiff red brown SILTY CLAY, with sand seams (Weathered Crust)		1.22 74.56							
		Soft grey to red grey SILTY CLAY		1.50							
2		End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.									
3											
4											
5											
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8											
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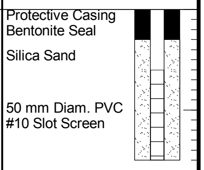
14											
15											



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-2

SHEET 1 OF 2

LOCATION: N 5019601.24 ;E 466150.44

BORING DATE: December 19, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE	77.12			
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL/PEAT	0.00			
		Very loose to loose grey brown SILTY SAND	0.23	1	50 DO	2
1				2	50 DO	6
		Red brown SILTY CLAY, with sand seams (Weathered Crust)	75.90 1.22			
		CLAY to SILTY CLAY	1.37	3	50 DO	WH
2	Electric Nilcon	Grey brown SANDY SILT, trace to some clay	75.01 2.11			
		Firm red grey SILTY CLAY, with sand seams - Sand layer from 2.41 m to 2.46 m	2.29			
3		Grey SAND, some silt, trace clay, with black staining	74.32 2.80			
		Soft to firm red grey CLAY to SILTY CLAY, with silt seams - Grey silt layer from 4.47 m to 4.50 m - Silt layer from 6.53 m to 6.61 m - Silt layer from 6.65 m to 6.68 m	3.02			
7		SILTY SAND, trace clay, with black staining	70.19 7.03			
		Grey CLAYEY SILT	69.73 7.39			
8		Soft to firm red grey to grey CLAY to SILTY CLAY, with black staining and silt seams				
15		*CONTINUED NEXT PAGE*				

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

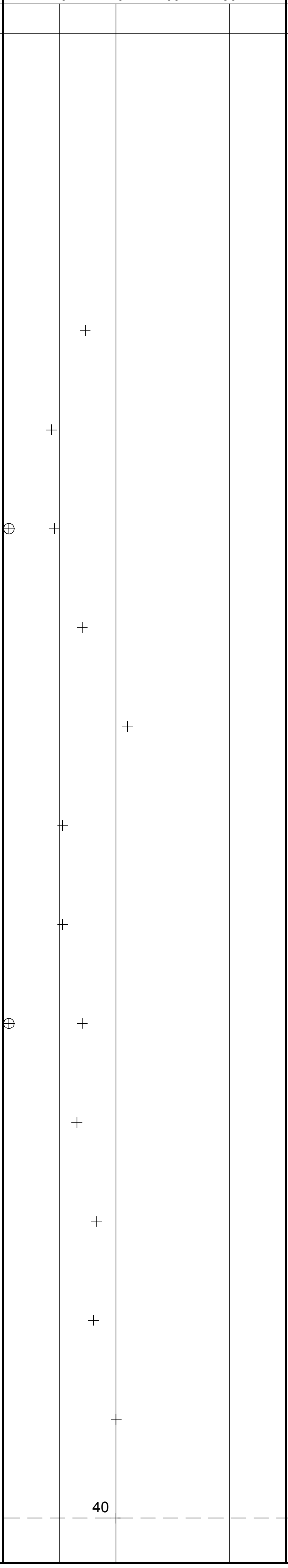
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl; 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 75

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-2

SHEET 2 OF 2

LOCATION: N 5019601.24 ;E 466150.44

BORING DATE: December 19, 2012

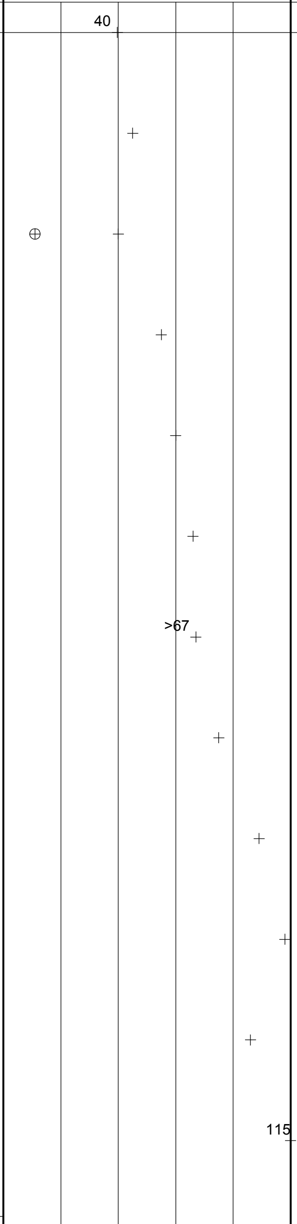
DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
15	Electric Nilcon	Soft to firm red grey to grey CLAY to SILTY CLAY, with black staining and silt seams	▨								
16			▨	60.51 16.61							
17		Firm to stiff grey CLAY to SILTY CLAY, with black staining	▨								
18–25			▨	51.36 25.76							
26		Very stiff dark grey CLAY to SILTY CLAY, with black staining	▨	50.37 26.75							
27		End of Borehole Note: 1. Soil stratigraphy inferred from various soil sampling methods and CPT. 2. Vane pushed to 26.75 m depth.									
28											
29											
30											



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-3

SHEET 1 OF 3

LOCATION: N 5019604.15 ;E 466157.12

BORING DATE: January 7-14, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

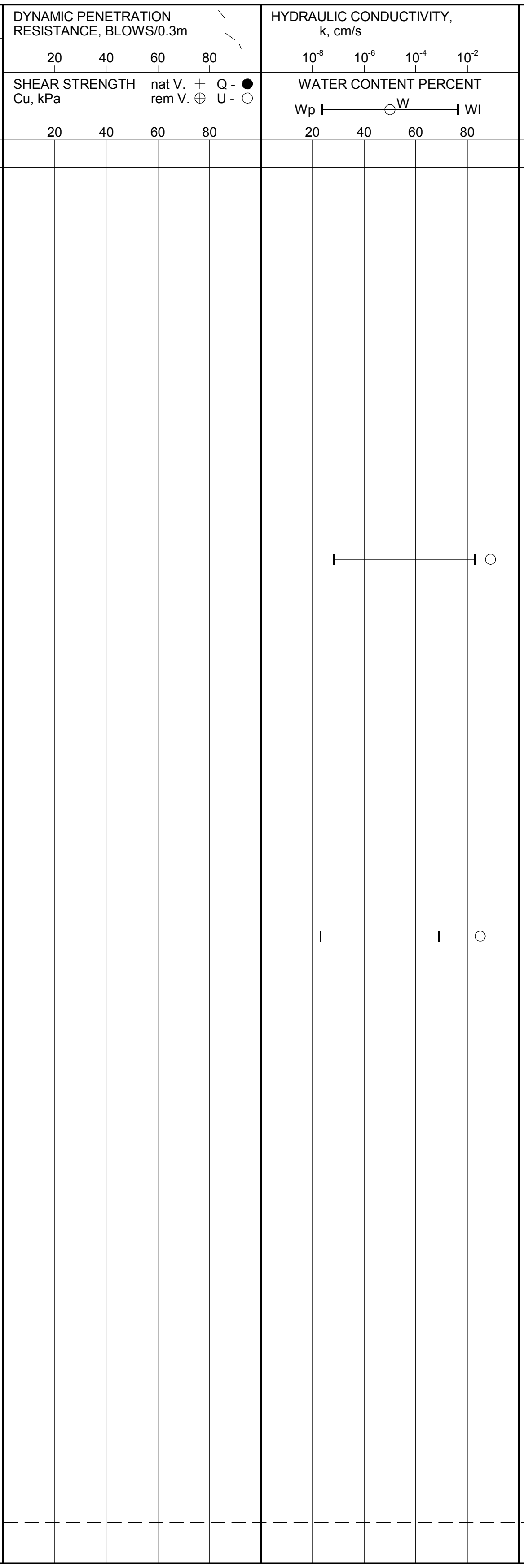
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Wash Boring, HW Casing

ELEV. / DEPTH (m)	SOIL PROFILE DESCRIPTION
76.94	GROUND SURFACE
0.00	TOPSOIL/PEAT
0.23	Very loose to loose grey brown SILTY SAND
75.72 1.22	Red brown SILTY CLAY, with sand seams (Weathered Crust)
1.37	CLAY to SILTY CLAY
74.83 2.11	Grey brown SANDY SILT, trace to some clay
2.29	Firm red grey SILTY CLAY, with sand seams - Sand layer from 2.41 m to 2.46 m
74.14 2.80	Grey SAND, some silt, trace clay, with black staining
3.02	Soft to firm red grey CLAY to SILTY CLAY, with silt seams - Grey silt layer from 4.47 m to 4.50 m - Silt layer from 6.53 m to 6.61 m - Silt layer from 6.65 m to 6.68 m
70.01 7.03	SILTY SAND, trace clay, with black staining
69.55 7.39	Grey CLAYEY SILT
	Soft to firm red grey to grey CLAY to SILTY CLAY, with black staining and silt seams

SAMPLES

NUMBER	TYPE	BLOWS/0.3m
1	73 TP	PH
2	73 TP	PH
3	73 TP	PH
4	73 TP	PH



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION: MON. WELL

Protective Casing

Bentonite-Cement Grout

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DEPTH SCALE 1 : 75

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-3

SHEET 2 OF 3

LOCATION: N 5019604.15 ;E 466157.12

BORING DATE: January 7-14, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

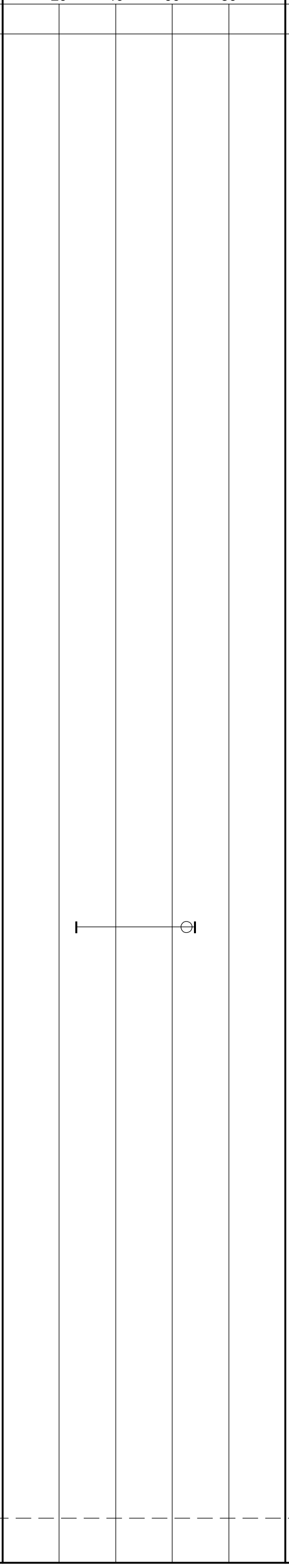
PIEZOMETER OR STANDPIPE INSTALLATION: MON. WELL

BORING METHOD: Wash Boring, HW Casing

--- *CONTINUED FROM PREVIOUS PAGE* ---

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
15	Soft to firm red grey to grey CLAY to SILTY CLAY, with black staining and silt seams	
16.61	Firm to stiff grey CLAY to SILTY CLAY, with black staining	60.33 16.61
25.76	Very stiff dark grey CLAY to SILTY CLAY, with black staining	51.18 25.76

SAMPLES NUMBER	TYPE	BLOWS/0.3m
5	73 TP	PH
6	73 TP	PH
7	50 DO	4



Bentonite-Cement Grout

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DEPTH SCALE

1 : 75

LOGGED: DG

CHECKED: SAT

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-3

SHEET 3 OF 3

LOCATION: N 5019604.15 ;E 466157.12

BORING DATE: January 7-14, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- *CONTINUED FROM PREVIOUS PAGE* ---									MON. WELL
30	Wash Boring HW Casing	Very stiff dark grey CLAY to SILTY CLAY, with black staining									
31					8	73 TP	PH				
32											
33					9	50 DO	2				Bentonite-Cement Grout
				43.16							
34		Grey brown SILTY SAND		33.78							
		Grey SANDY SILT		33.91 42.65							
		Dark grey and brown SILTY CLAY		34.29 42.35							
35		Compact to very dense grey SAND and SILT, some gravel, trace clay (GLACIAL TILL)		34.59	10	50 DO	71				
					11	50 DO	16				
36					12	50 DO	73				Peltonite
				40.20							
37		Borehole continued on RECORD OF DRILLHOLE 12-2-3 Note: Soil stratigraphy inferred from various soil sampling methods and CPT.									
38											
39											
40											
41											
42											
43											
44											
45											

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-2-3

SHEET 1 OF 3

LOCATION: N 5019604.15 ;E 466157.12

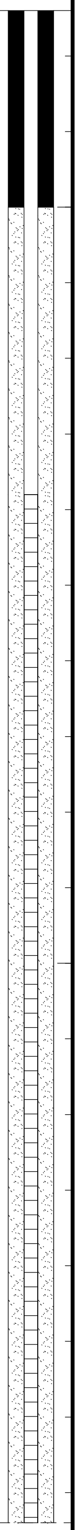
INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: January 7-14, 2013
DRILL RIG: CME 55
DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint	BD - Bedding	PL - Planar	PO - Polished	BR - Broken Rock
FLT - Fault	FO - Foliation	CU - Curved	K - Slickensided	**NOTE:** For additional abbreviations refer to list of abbreviations & symbols.
SH - Shear	CO - Contact	UN - Undulating	SM - Smooth	
VN - Vein	OR - Orthogonal	ST - Stepped	RO - Rough	
CJ - Conjugate	CL - Clean	IR - Irregular	MB - Mechanical Break	

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25m (5 10 15 20)	DISCONTINUITY DATA DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-8} 10^{-6} 10^{-4} 10^{-2})	WEATHERING INDEX (W1 W2 W3 W4 W5 W6)	NOTES
		BEDROCK SURFACE		40.20														MON. WELL
	Rotary Drill HQ Core	**CARLSBAD FORMATION, 36.74 m to 41.95 m** Fresh, medium grey, fine to medium grained crystalline, non-porous, thinly to medium bedded **LIMESTONE** with fine argillaceous partings, occasional bioclastic and lithoclastic beds and black slake susceptible shale partings 0.5-5.0 cm thick. Shale and calcareous shale comprises approximately 10% of section.		36.74														
				40.07 36.87								JN,,						Peltonite
												BD,,						
37												BD,,						
												BD,,						
					1													
				39.77 37.17														Silica Sand
				37.20														
												BD,,						
				39.44 37.51								BD,,						
												BD,,						
				39.24 37.70														
				39.17 37.77														
				39.03 37.91														
38				38.94 38.01								JN,,						63 mm Diam. PVC #10 Slot Screen
				38.83 38.11								BD,,						
					2													
												JN,,						
				38.44 38.50														
												BD,,						
												BD,,						



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DEPTH SCALE
1 : 10

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-2-3

SHEET 2 OF 3

LOCATION: N 5019604.15 ;E 466157.12

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: January 7-14, 2013

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SH - Shear
VN - Vein
CJ - Conjugate

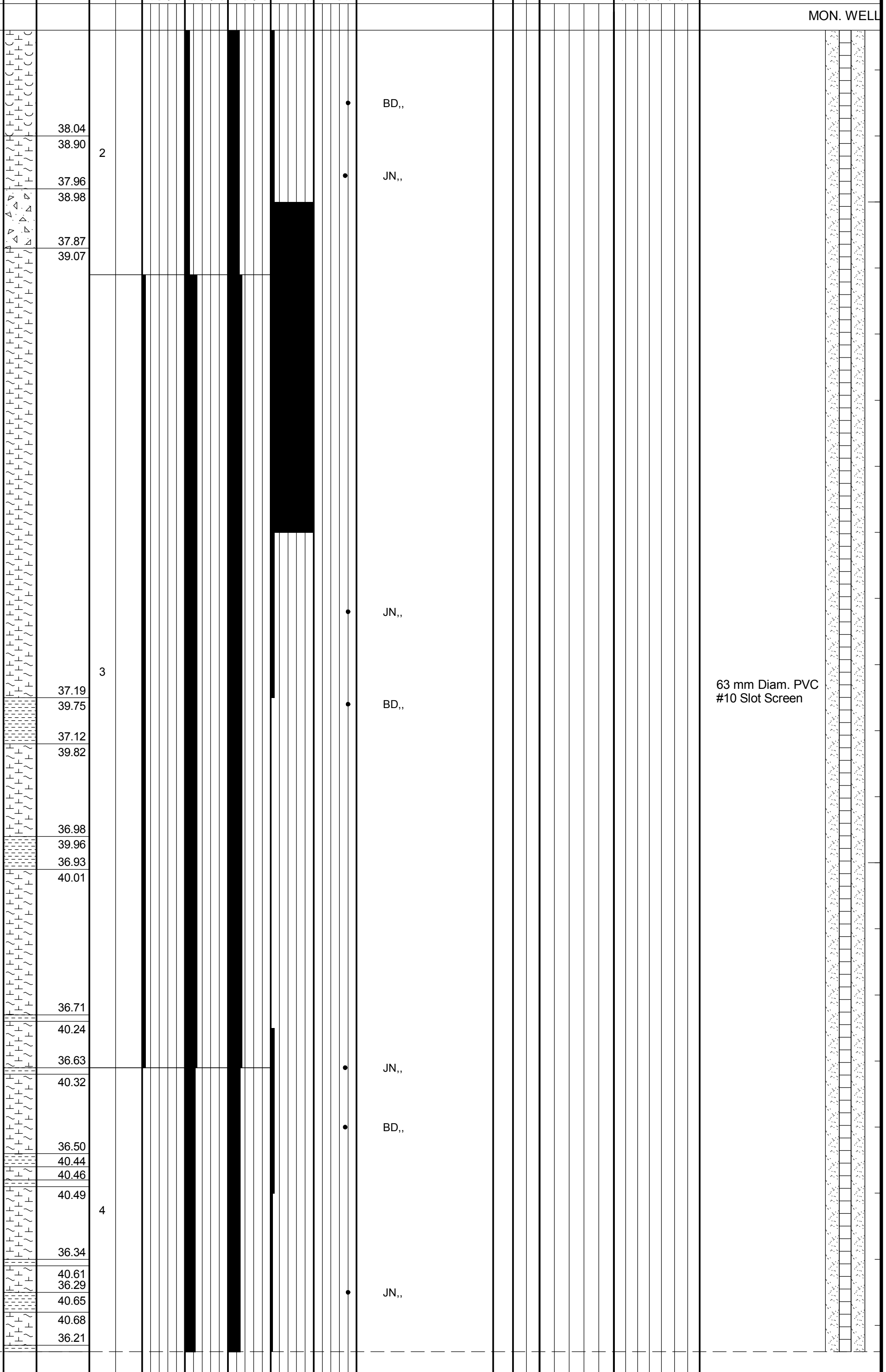
BD - Bedding
FO - Foliation
CO - Contact
OR - Orthogonal
CL - Clean

PL - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

PO - Polished
K - Slickensided
SM - Smooth
RO - Rough
MB - Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	NOTES
		--- CONTINUED FROM PREVIOUS PAGE ---				
	Rotary Drill HQ Core	**CARLSBAD FORMATION, 36.74 m to 41.95 m** Fresh, medium grey, fine to medium grained crystalline, non-porous, thinly to medium bedded **LIMESTONE** with fine argillaceous partings, occasional bioclastic and lithoclastic beds and black slake susceptible shale partings 0.5-5.0 cm thick. Shale and calcareous shale comprises approximately 10% of section.			BD,,	
			38.04 38.90	2	JN,,	
39			37.96 38.98			
			37.87 39.07			
				3	JN,,	
			37.19 39.75		BD,,	63 mm Diam. PVC #10 Slot Screen
			37.12 39.82			
			36.98 39.96			
40			36.93 40.01			
			36.71 40.24			
			36.63 40.32		JN,,	
					BD,,	
			36.50 40.44 40.46 40.49	4		
			36.34 40.61 36.29 40.65		JN,,	
			40.68 36.21			
		CONTINUED NEXT PAGE				

DEPTH SCALE
1 : 10

Golder Associates

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-2-3

SHEET 3 OF 3

LOCATION: N 5019604.15 ;E 466157.12

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: January 7-14, 2013

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint	BD - Bedding	PL - Planar	PO - Polished	BR - Broken Rock
FLT - Fault	FO - Foliation	CU - Curved	K - Slickensided	**NOTE:** For additional abbreviations refer to list of abbreviations & symbols.
SH - Shear	CO - Contact	UN - Undulating	SM - Smooth	
VN - Vein	OR - Orthogonal	ST - Stepped	RO - Rough	
CJ - Conjugate	CL - Clean	IR - Irregular	MB - Mechanical Break	

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	NOTES / MON. WELL
		--- CONTINUED FROM PREVIOUS PAGE ---					
	Rotary Drill HQ Core	**CARLSBAD FORMATION, 36.74 m to 41.95 m** Fresh, medium grey, fine to medium grained crystalline, non-porous, thinly to medium bedded **LIMESTONE** with fine argillaceous partings, occasional bioclastic and lithoclastic beds and black slake susceptible shale partings 0.5-5.0 cm thick. Shale and calcareous shale comprises approximately 10% of section.	40.74 36.05			BD,,	
			40.89 36.01			BD,,	
			40.93 35.95			BD,,	
41			40.99 35.76			VN,,	
			41.18 35.72				
			41.22 35.67				
			41.27 35.59	4		BD,, BD,,	63 mm Diam. PVC #10 Slot Screen
			41.35 35.54				
			41.40 35.42				
			41.52 35.29				
			41.65 35.23				
			41.71 35.19			BD,,	
			41.75 35.08				
			41.86 35.04				
			41.90 34.99				
		End of Drillhole	41.95				
42							

CRRC-ROCK 1211250045.GPJ GAL-MISS.GDT 09/04/14 JM

DEPTH SCALE

1 : 10

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-4

SHEET 1 OF 3

LOCATION: N 5019605.34 ;E 466154.28

INCLINATION: -90° AZIMUTH: ---

BORING DATE: January 15-17, 2013

DATUM: Geodetic

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | SAMPLES | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 | SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80 | HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} | WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80 | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

Boring method: Wash Boring, HW Casing (0 to 15 m)

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	77.09
TOPSOIL/PEAT	0.00
Very loose to loose grey brown SILTY SAND	0.23
Red brown SILTY CLAY, with sand seams (Weathered Crust)	75.87 1.22
CLAY to SILTY CLAY	1.37
Grey brown SANDY SILT, trace to some clay	74.98 2.11
Firm red grey SILTY CLAY, with sand seams - Sand layer from 2.41 m to 2.46 m	2.29
Grey SAND, some silt, trace clay, with black staining	74.29 2.80
Soft to firm red grey CLAY to SILTY CLAY, with silt seams - Grey silt layer from 4.47 m to 4.50 m - Silt layer from 6.53 m to 6.61 m - Silt layer from 6.65 m to 6.68 m	3.02
SILTY SAND, trace clay, with black staining	70.16 7.03
Grey CLAYEY SILT	69.70 7.39
Soft to firm red grey to grey CLAY to SILTY CLAY, with black staining and silt seams	

MON. WELL

Protective Casing

Bentonite Seal

Bentonite-Cement Grout

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-4

SHEET 2 OF 3

LOCATION: N 5019605.34 ;E 466154.28

BORING DATE: January 15-17, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ ; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl ; 20 40 60 80

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---							MON. WELL
15	Wash Boring HW Casing	Soft to firm red grey to grey CLAY to SILTY CLAY, with black staining and silt seams	▨						
16									
		Firm to stiff grey CLAY to SILTY CLAY, with black staining	▨	60.48 16.61					
17									
18									
19									
20									
21									
22									Bentonite-Cement Grout
23									
24									
25									
		Very stiff dark grey CLAY to SILTY CLAY, with black staining	▨	51.33 25.76					
26									
27									
28									
29									Bentonite Seal
30									

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 75

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-4

SHEET 3 OF 3

LOCATION: N 5019605.34 ;E 466154.28

INCLINATION: -90° AZIMUTH: ---

BORING DATE: January 15-17, 2013

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									MON. WELL
30	Wash Boring HW Casing	Very stiff dark grey CLAY to SILTY CLAY, with black staining									Silica Sand
31											25 mm Diam. PVC #10 Slot Screen
32											Silica Sand
33											Peltonite
		Grey brown SILTY SAND		43.31 33.78							
34		Grey SANDY SILT		33.91 42.80							
		Dark grey and brown SILTY CLAY		34.29 42.50							
35		Compact to very dense grey SAND and SILT, some gravel, trace clay (GLACIAL TILL)		34.59 41.43							Cave
36		End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.		35.66							
37											
38											
39											
40											
41											
42											
43											
44											
45											

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-5

SHEET 1 OF 2

LOCATION: N 5019606.89 ;E 466157.75
INCLINATION: -90° AZIMUTH: ---

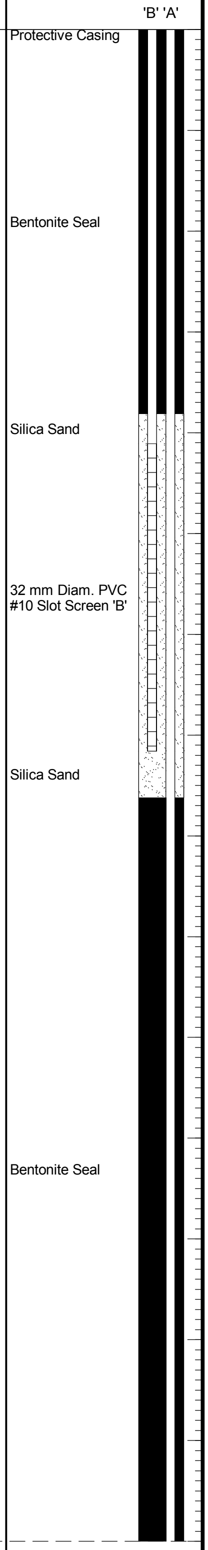
BORING DATE: January 17-18, 2013

DATUM: Geodetic

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | SAMPLES | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20, 40, 60, 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8}, 10^{-6}, 10^{-4}, 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20, 40, 60, 80) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

Boring method (0–15 m): Wash Boring, HW Casing

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	76.99
TOPSOIL/PEAT	0.00
Very loose to loose grey brown SILTY SAND	0.23
Red brown SILTY CLAY, with sand seams (Weathered Crust)	75.77 1.22
CLAY to SILTY CLAY	1.37
Grey brown SANDY SILT, trace to some clay	74.88 2.11
Firm red grey SILTY CLAY, with sand seams - Sand layer from 2.41 m to 2.46 m	2.29
Grey SAND, some silt, trace clay, with black staining	74.19 2.80
Soft to firm red grey CLAY to SILTY CLAY, with silt seams - Grey silt layer from 4.47 m to 4.50 m - Silt layer from 6.53 m to 6.61 m - Silt layer from 6.65 m to 6.68 m	3.02
SILTY SAND, trace clay, with black staining	70.06 7.03
Grey CLAYEY SILT	69.60 7.39
Soft to firm red grey to grey CLAY to SILTY CLAY, with black staining and silt seams	



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DEPTH SCALE
1 : 75

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-5

SHEET 2 OF 2

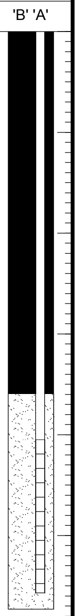
LOCATION: N 5019606.89 ;E 466157.75

BORING DATE: January 17-18, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
15	Wash Boring HW Casing	Soft to firm red grey to grey CLAY to SILTY CLAY, with black staining and silt seams	▨								
16				60.38 16.61							
17		Firm to stiff grey CLAY to SILTY CLAY, with black staining	▨								Bentonite Seal
18											
19											Silica Sand
20				56.26 20.73							25 mm Diam. PVC #10 Slot Screen 'A'
21		End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.									
22											
23											
24											
25											
26											
27											
28											
29											
30											



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-2-6

SHEET 1 OF 1

LOCATION: N 5019607.98 ;E 466154.98

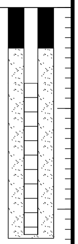
INCLINATION: -90° AZIMUTH: ---

BORING DATE: January 19, 2013

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	77.13							MON. WELL
0		TOPSOIL/PEAT	0.00							Protective Casing Bentonite Seal
	Power Auger 200 mm Diam. (Hollow Stem)	Very loose to loose grey brown SILTY SAND	0.23							Silica Sand
1		Red brown SILTY CLAY, with sand seams (Weathered Crust)	75.91 1.22							50 mm Diam. PVC #10 Slot Screen
		CLAY to SILTY CLAY	1.37							
2		Grey brown SANDY SILT, trace to some clay	75.02 2.11							
		End of Borehole	2.29							

Note:
Soil stratigraphy inferred from various soil sampling methods and CPT.



DEPTH SCALE

1 : 75

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-2

SHEET 1 OF 3

LOCATION: N 5021570.68 ;E 466665.61

BORING DATE: November 27-28, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	76.24					
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00					
		Loose to compact grey brown to grey SILTY SAND, trace clay	0.20	1	50 DO	9		
1				2	50 DO	10	MH	
		Grey SANDY SILT, trace clay	75.10 1.14					
		Soft grey and red brown CLAY to SILTY CLAY, with silt seams	74.72 1.52	3	50 DO	WH		
2	Electric Nilcon							
3								
4								
5		Grey SILT, trace clay	71.36 4.88					
		Grey SILTY SAND	5.03					
		Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams	5.15					
6								
		Grey SILT	69.84 6.46					
		Soft grey and red brown CLAY to SILTY CLAY, with black staining	69.35 6.95					
7		Grey SILT						
		Soft grey and red brown CLAY to SILTY CLAY, with black staining and clayey silt seams						
8								
		Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining	67.65 8.59					
9								
10								
11								
12								
13								
14								
15								

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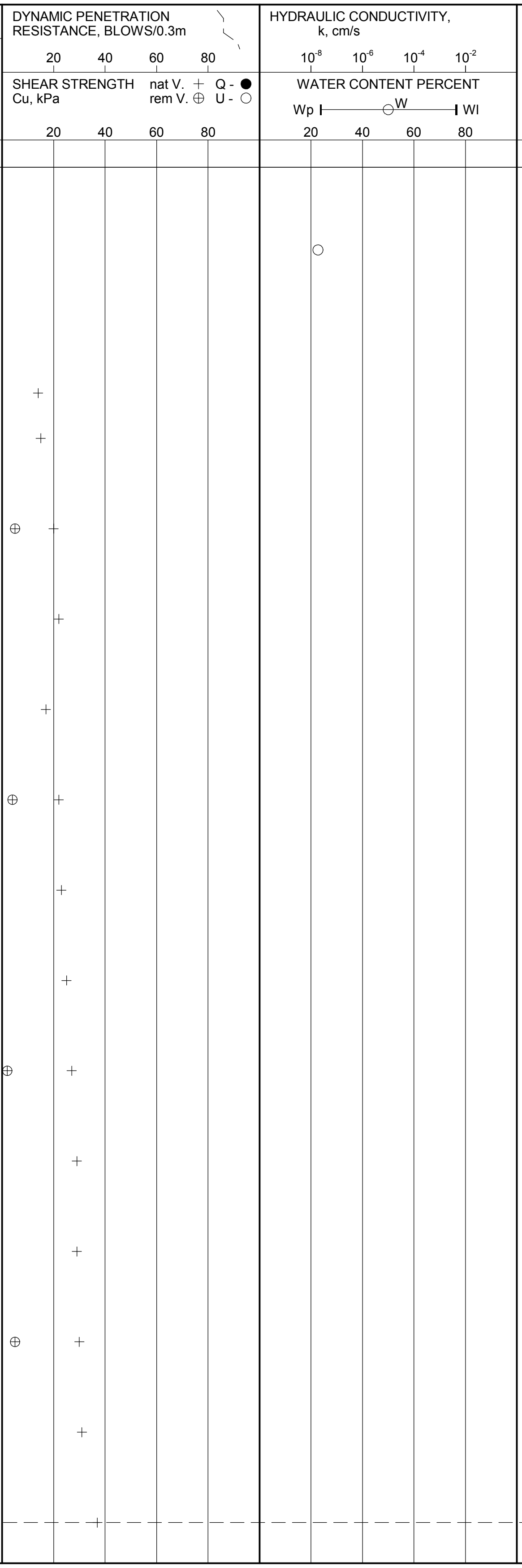


DEPTH SCALE

1 : 75

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-2

SHEET 2 OF 3

LOCATION: N 5021570.68 ;E 466665.61

INCLINATION: -90° AZIMUTH: ---

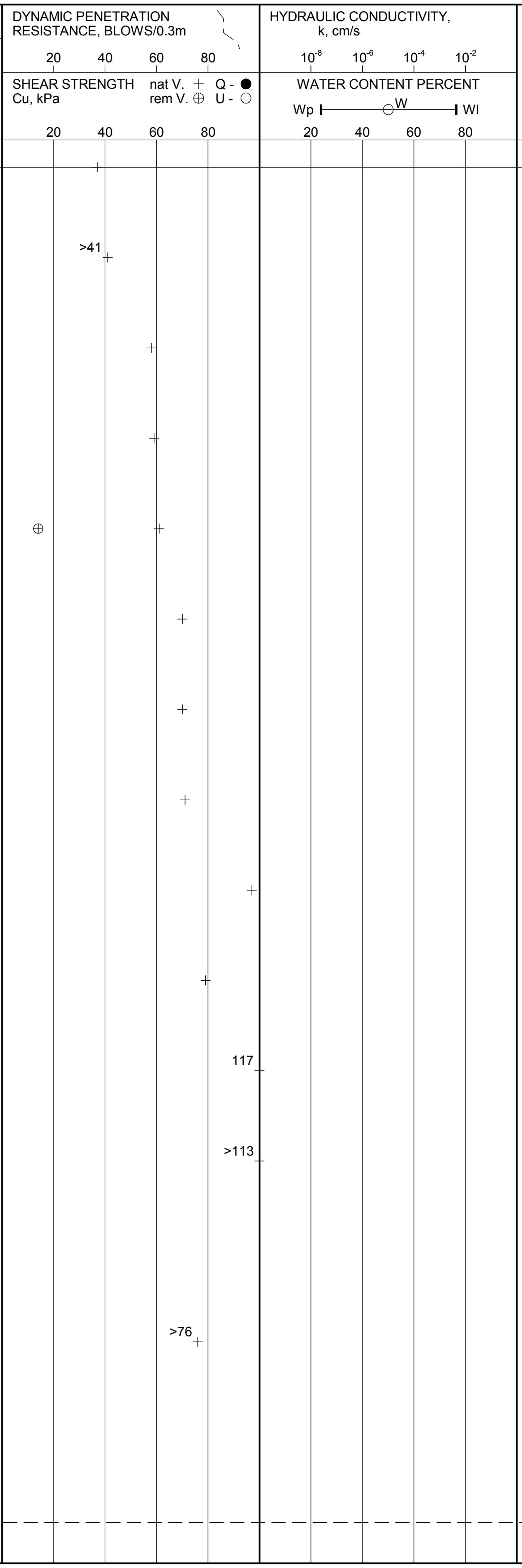
BORING DATE: November 27-28, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---							
15	Electric Nilcon	Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining							
		Stiff grey and red brown CLAY to SILTY CLAY, with black staining		53.63 22.61					
		Grey CLAYEY SILT, some sand		50.58 25.66					
		Very stiff grey CLAY to SILTY CLAY, with black staining		50.24 26.00					
		Grey SILTY fine SAND		49.05 27.30					
		Grey SANDY SILT, some clay							
		Very stiff grey CLAY to SILTY CLAY, with black staining							
30		*CONTINUED NEXT PAGE*							



DEPTH SCALE

1 : 75

LOGGED: DG

CHECKED: SAT

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-2

SHEET 3 OF 3

LOCATION: N 5021570.68 ;E 466665.61

BORING DATE: November 27-28, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
30	Electric Nilcon		▨	45.94 30.33							
		Brown SILTY SAND Very stiff grey CLAY to SILTY CLAY, with black staining	▨								
31			▨	45.11 31.13				>76 +			
		End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.									
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
45											

DEPTH SCALE

1 : 75

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-3

SHEET 1 OF 3

LOCATION: N 5021578.47 ;E 466670.90

BORING DATE: December 3-5, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	76.22							
0	Wash Boring HW Casing	TOPSOIL	0.00							Protective Casing Bentonite Seal
		Loose to compact grey brown to grey SILTY SAND, trace clay	0.20							
1		Grey SANDY SILT, trace clay	75.08 1.14							
		Soft grey and red brown CLAY to SILTY CLAY, with silt seams	74.70 1.52							
2				1	73 TP	PH				
3										
4										
5		Grey SILT, trace clay	71.34 4.88							
		Grey SILTY SAND	5.03							
		Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams	5.15							
6				2	73 TP	PH				
		Grey SILT	69.82 6.46							
		Soft grey and red brown CLAY to SILTY CLAY, with black staining								
7		Grey SILT	69.33 6.95							
		Soft grey and red brown CLAY to SILTY CLAY, with black staining and clayey silt seams								Bentonite-Cement Grout
8										
		Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining	67.63 8.59							
9										
10										
11										
12				3	73 TP	PH				
13										
14										
15										

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DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-3

SHEET 2 OF 3

LOCATION: N 5021578.47 ;E 466670.90

BORING DATE: December 3-5, 2012

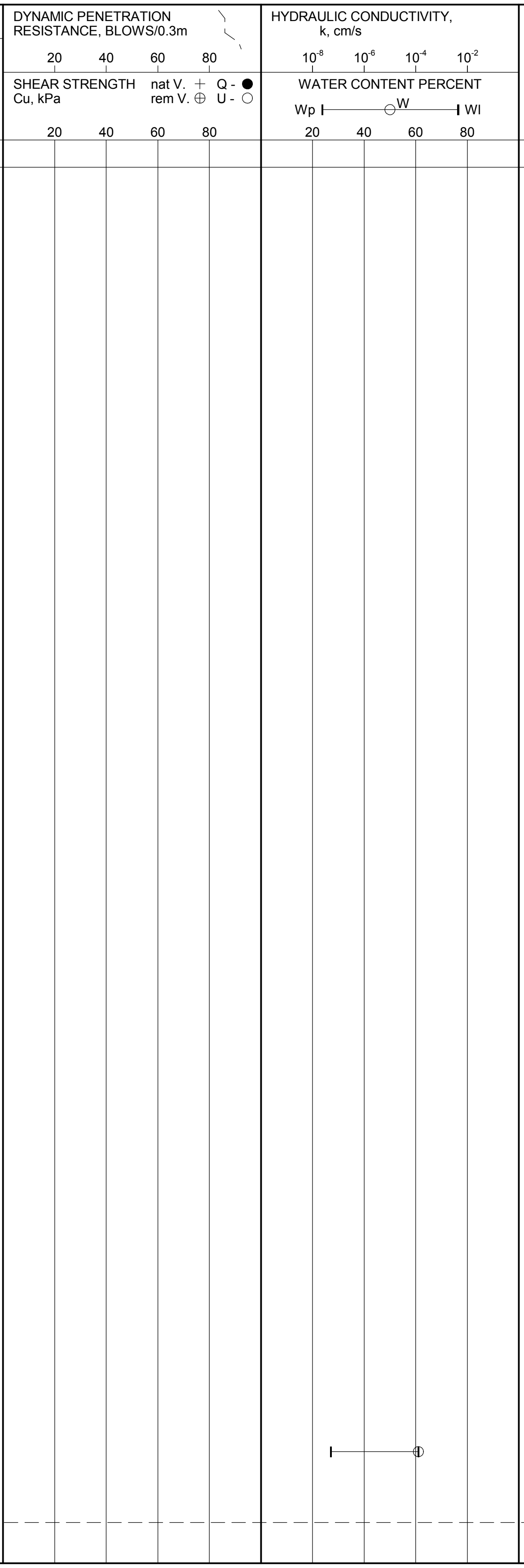
DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---						
15	Wash Boring HW Casing	Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining	▨					
16					4	73 TP	PH	
21					5	73 TP	PH	
22		Stiff grey and red brown CLAY to SILTY CLAY, with black staining	▨	53.61 22.61				Bentonite-Cement Grout
25		Grey CLAYEY SILT, some sand	▨	50.56 25.66				
26		Very stiff grey CLAY to SILTY CLAY, with black staining	▨	50.22 26.00				
27		Grey SILTY fine SAND		49.03				
		Grey SANDY SILT, some clay		27.30				
		Very stiff grey CLAY to SILTY CLAY, with black staining	▨					
29					6	73 TP	PH	
30		*CONTINUED NEXT PAGE*						



ADDITIONAL LAB. TESTING

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-3

SHEET 3 OF 3

LOCATION: N 5021578.47 ;E 466670.90

INCLINATION: -90° AZIMUTH: ---

BORING DATE: December 3-5, 2012

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---							
30	Wash Boring HW Casing								
		Brown SILTY SAND	45.92 30.33						
		Very stiff grey CLAY to SILTY CLAY, with black staining							
31									
		Very stiff grey SILTY CLAY, some sand	44.37 31.85						
32		Very stiff grey and red CLAY to SILTY CLAY	32.10						
33		Compact to very dense grey SILTY SAND to SANDY SILT, some gravel, trace to some clay, with cobbles and boulders (GLACIAL TILL)	43.15 33.07						
				7	50 DO	6			
34	Rotary Drill HQ Core								
				8	50 DO	20			Bentonite-Cement Grout
35				9	50 DO	21			
				10	50 DO	44			
36				11	50 DO	55			
37				12	50 DO	97			
				13	50 DO	88	○	MH	
38				14	50 DO	>50			
				15	50 DO	90			
39				16	50 DO	90			Peltonite
			36.38						
40		Borehole continued on RECORD OF DRILLHOLE 12-3-3 Note: Soil stratigraphy inferred from various soil sampling methods and CPT.							
41									
42									
43									
44									
45									

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-3-3

SHEET 1 OF 3

LOCATION: N 5021578.47 ;E 466670.90

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: December 3-5, 2012

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling

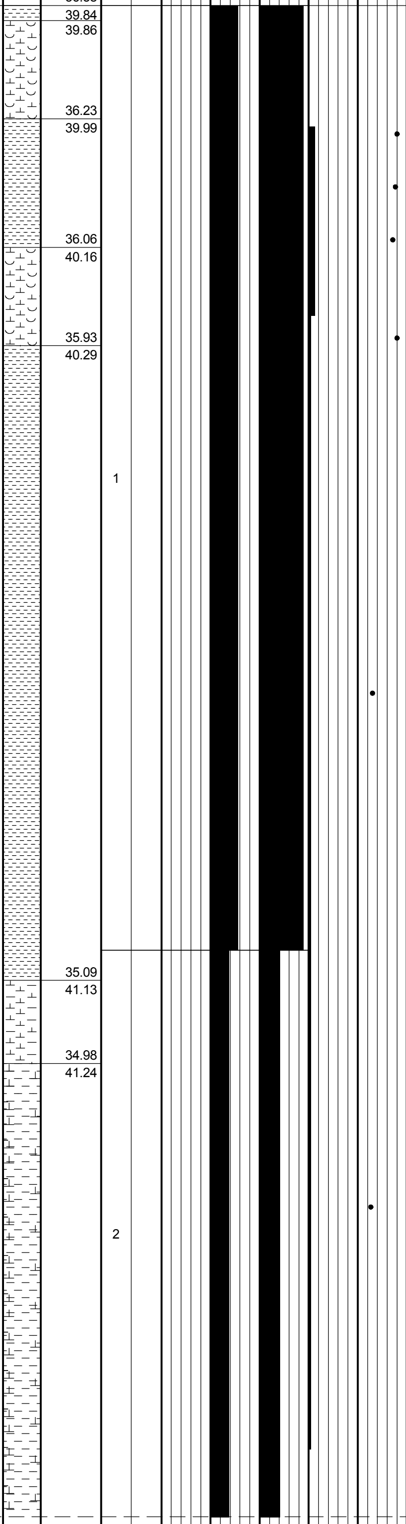
DATUM: Geodetic

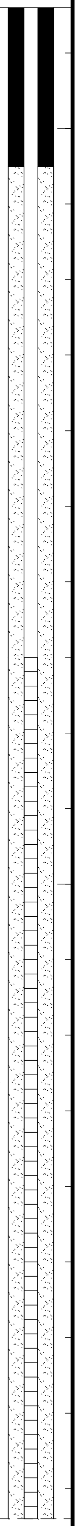
JN - Joint
FLT - Fault
SH - Shear
VN - Vein
CJ - Conjugate
BD - Bedding
FO - Foliation
CO - Contact
OR - Orthogonal
CL - Clean
PL - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular
PO - Polished
K - Slickensided
SM - Smooth
RO - Rough
MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	NOTES
		BEDROCK SURFACE	36.38			
	Rotary Drill HQ Core	**CARLSBAD FORMATION, 39.84 m to 45.42 m** Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible **SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE** with occasional bioclastic limestone beds.	39.84 39.86	1		Peltonite
40			36.23 39.99		JN,, JN,, JN,,	
			36.06 40.16			
			35.93 40.29		JN,,	Silica Sand
					VN,,	
41			35.09 41.13	2		
			34.98 41.24		VN,,	63 mm Diam. PVC #10 Slot Screen

RECOVERY: TOTAL CORE % / SOLID CORE %; R.Q.D. %; FRACT. INDEX PER 0.25m; DIP w.r.t. CORE AXIS; Jcon Jr Ja; HYDRAULIC CONDUCTIVITY K, cm/sec; WEATHERING INDEX W1 W2 W3 W4 W5 W6; FLUSH RETURN; SYMBOLIC LOG





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DEPTH SCALE
1 : 10

Golder Associates

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF DRILLHOLE: 12-3-3

SHEET 2 OF 3

LOCATION: N 5021578.47 ;E 466670.90

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: December 3-5, 2012

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SH - Shear
VN - Vein
CJ - Conjugate

BD - Bedding
FO - Foliation
CO - Contact
OR - Orthogonal
CL - Clean

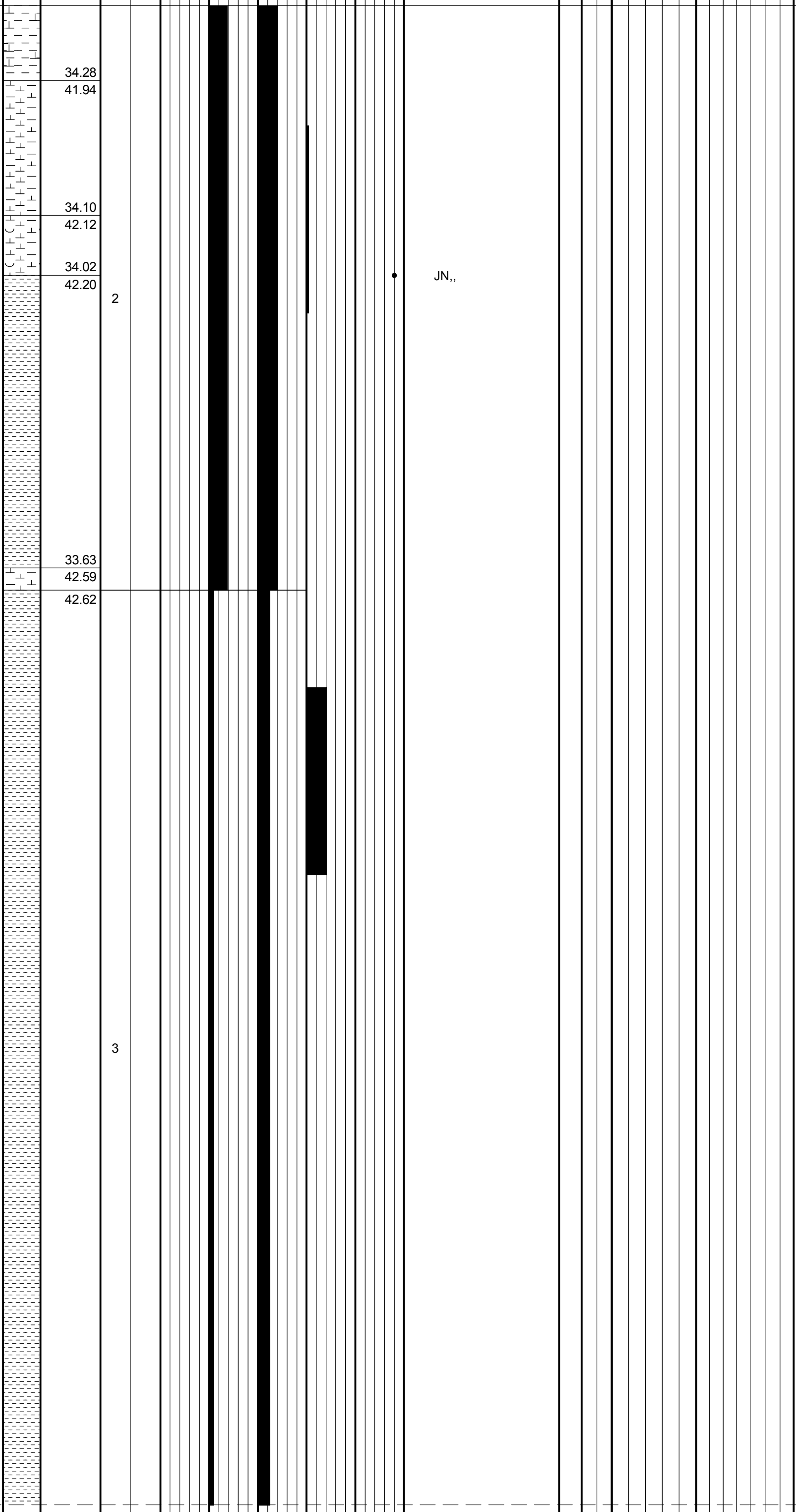
PL - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

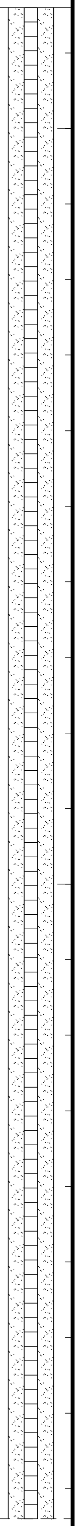
PO - Polished
K - Slickensided
SM - Smooth
RO - Rough
MB - Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25m 5 10 15 20	DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-8} 10^{-6} 10^{-4} 10^{-2}	WEATHERING INDEX W1 W2 W3 W4 W5 W6	NOTES
		--- CONTINUED FROM PREVIOUS PAGE ---																
	Rotary Drill HQ Core	**CARLSBAD FORMATION, 39.84 m to 45.42 m** Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible **SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE** with occasional bioclastic limestone beds.		34.28 41.94														
42																		
				34.10 42.12														
				34.02 42.20	2						●	JN,,						
				33.63 42.59														
				42.62														
																		63 mm Diam. PVC #10 Slot Screen
43																		
					3													
		CONTINUED NEXT PAGE																





DEPTH SCALE

1 : 10

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

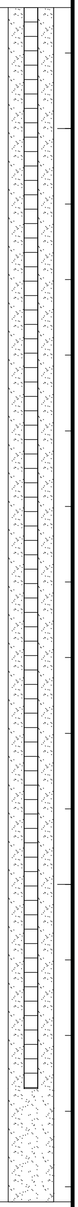
RECORD OF DRILLHOLE: 12-3-3

LOCATION: N 5021578.47 ;E 466670.90
DRILLING DATE: December 3-5, 2012
DATUM: Geodetic
INCLINATION: -90° AZIMUTH: ---
DRILL RIG: CME 55
DRILLING CONTRACTOR: Marathon Drilling

JN - Joint
FLT - Fault
SH - Shear
VN - Vein
CJ - Conjugate
BD - Bedding
FO - Foliation
CO - Contact
OR - Orthogonal
CL - Clean
PL - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular
PO - Polished
K - Slickensided
SM - Smooth
RO - Rough
MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25m 5 10 15 20	DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-8} 10^{-6} 10^{-4} 10^{-2}	WEATHERING INDEX W1 W2 W3 W4 W5 W6	NOTES
		--- CONTINUED FROM PREVIOUS PAGE ---															
44	Rotary Drill HQ Core	**CARLSBAD FORMATION, 39.84 m to 45.42 m** Fresh, very thinly to thinly interbedded sequence of dark grey to black slake susceptible **SHALE, CALCAREOUS SHALE, SHALEY LIMESTONE and LIMESTONE** with occasional bioclastic limestone beds.		3													
			32.07 44.15														
			44.17														
										●	VN,,						
			31.69 44.53														63 mm Diam. PVC #10 Slot Screen
			31.63 44.59														
			31.54 44.68														
			31.50 44.72	4													
45																	
			31.06 45.16														
			30.85 45.37														Silica Sand
			30.80 45.42														
		End of Drillhole															



DEPTH SCALE
1 : 10

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-4

SHEET 1 OF 3

LOCATION: N 5021576.05 ;E 466672.49

INCLINATION: -90° AZIMUTH: ---

BORING DATE: December 11-14, 2012

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 'B' 'A'
		GROUND SURFACE		76.23							
0	Wash Boring HW Casing	TOPSOIL		0.00							Protective Casing
		Loose to compact grey brown to grey SILTY SAND, trace clay		0.20							
1		Grey SANDY SILT, trace clay		75.09 1.14							
		Soft grey and red brown CLAY to SILTY CLAY, with silt seams		74.71 1.52							
5		Grey SILT, trace clay		71.35 4.88							
		Grey SILTY SAND		5.03							
		Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams		5.15							
		Grey SILT		69.83 6.46							
		Soft grey and red brown CLAY to SILTY CLAY, with black staining									
7		Grey SILT		69.34 6.95							
		Soft grey and red brown CLAY to SILTY CLAY, with black staining and clayey silt seams									Bentonite-Cement Grout
		Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining		67.64 8.59							
15											

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 75

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-4

SHEET 2 OF 3

LOCATION: N 5021576.05 ;E 466672.49

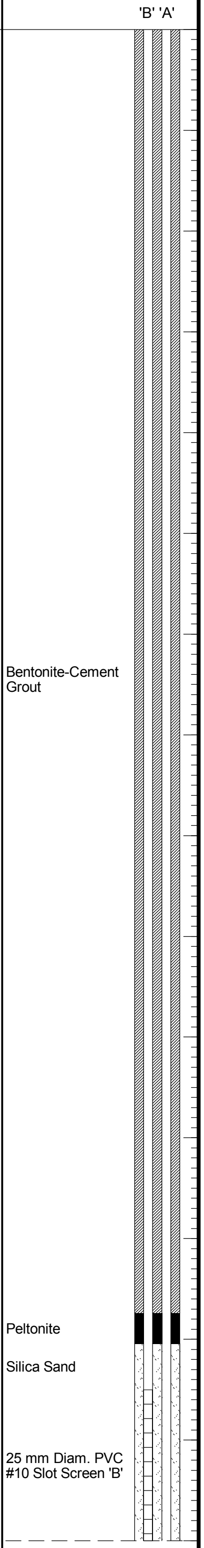
INCLINATION: -90° AZIMUTH: ---

BORING DATE: December 11-14, 2012

DATUM: Geodetic

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | SAMPLES | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) | SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-8} 10^{-6} 10^{-4} 10^{-2}) | WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
		--- CONTINUED FROM PREVIOUS PAGE ---					
15	Wash Boring HW Casing	Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining	▨				
22		Stiff grey and red brown CLAY to SILTY CLAY, with black staining	▨	53.62 22.61			
25		Grey CLAYEY SILT, some sand		50.57 25.66			
26		Very stiff grey CLAY to SILTY CLAY, with black staining	▨	50.23 26.00			
27		Grey SILTY fine SAND		49.04			
		Grey SANDY SILT, some clay		27.30			
28		Very stiff grey CLAY to SILTY CLAY, with black staining	▨				
30		*CONTINUED NEXT PAGE*					



DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-4

SHEET 3 OF 3

LOCATION: N 5021576.05 ;E 466672.49

INCLINATION: -90° AZIMUTH: ---

BORING DATE: December 11-14, 2012

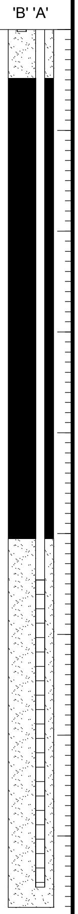
DATUM: Geodetic

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE: DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m) | SAMPLES: NUMBER, TYPE, BLOWS/0.3m | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 | SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80 | HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} | WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80 | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

Boring method: Wash Boring, HW Casing

Description	Elev. / Depth (m)
--- CONTINUED FROM PREVIOUS PAGE ---	
Brown SILTY SAND	45.93 30.33
Very stiff grey CLAY to SILTY CLAY, with black staining	
Very stiff grey SILTY CLAY, some sand	44.38 31.85
Very stiff grey and red CLAY to SILTY CLAY	32.10
Compact to very dense grey SILTY SAND to SANDY SILT, some gravel, trace to some clay, with cobbles and boulders (GLACIAL TILL)	43.16 33.07
End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.	37.52 38.71

Depth scale: 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45



Silica Sand

Peltonite

Silica Sand

38 mm Diam. PVC #10 Slot Screen 'A'

Silica Sand

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-5

SHEET 1 OF 2

LOCATION: N 5021577.15 ;E 466668.45

BORING DATE: December 7, 2012

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	76.23			
TOPSOIL	0.00			
Loose to compact grey brown to grey SILTY SAND, trace clay	0.20			
Grey SANDY SILT, trace clay	75.09 1.14			
Soft grey and red brown CLAY to SILTY CLAY, with silt seams	74.71 1.52			
Grey SILT, trace clay	71.35 4.88			
Grey SILTY SAND	5.03			
Soft grey and red brown CLAY to SILTY CLAY, with black staining and silt seams	5.15	1	73 TP	PH
Grey SILT	69.83 6.46			
Soft grey and red brown CLAY to SILTY CLAY, with black staining				
Grey SILT	69.34 6.95			
Soft grey and red brown CLAY to SILTY CLAY, with black staining and clayey silt seams				
Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining	67.64 8.59			

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

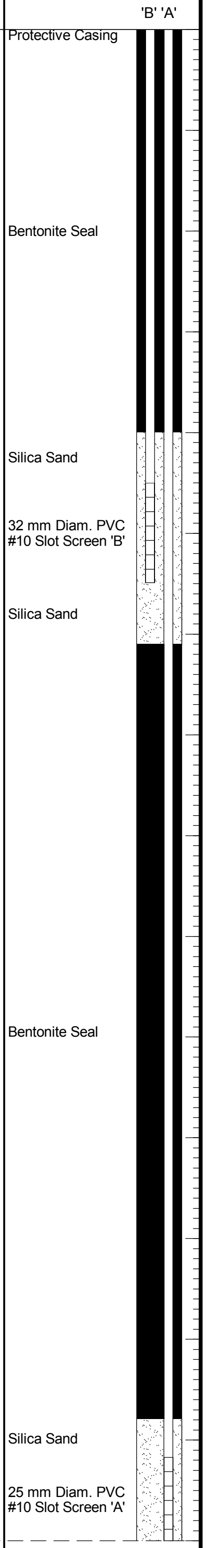
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-8} 10^{-6} 10^{-4} 10^{-2}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



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DEPTH SCALE

1 : 75

LOGGED: DG

CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-5

SHEET 2 OF 2

LOCATION: N 5021577.15 ;E 466668.45
INCLINATION: -90° AZIMUTH: ---
SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: December 7, 2012

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									'B' 'A'
15	Power Auger	Soft to stiff grey and grey brown CLAY to SILTY CLAY, with black staining	▨	60.43	2	73 TP	PH				25 mm Diam. PVC #10 Slot Screen 'A' Silica Sand
16		End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.		15.80							
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											

CRRRC-SOIL 1211250045.GPJ GAL-MIS.GDT 09/04/14 JM

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: DG
CHECKED: SAT

PROJECT: 12-1125-0045

RECORD OF BOREHOLE: 12-3-6

SHEET 1 OF 1

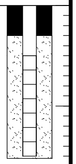
LOCATION: N 5021574.40 ;E 466669.89

INCLINATION: -90° AZIMUTH: ---

BORING DATE: December 7, 2012

DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-8} 10^{-6} 10^{-4} 10^{-2} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		76.27							MON. WELL
0	Power Auger 200 mm Diam. (HS)	TOPSOIL		0.00							Protective Casing Bentonite Seal
		Loose to compact grey brown to grey SILTY SAND, trace clay		0.20							Silica Sand
1		Grey SANDY SILT, trace clay		75.13 1.14							50 mm Diam. PVC #10 Slot Screen
		End of Borehole Note: Soil stratigraphy inferred from various soil sampling methods and CPT.		74.75 1.52							
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											



DEPTH SCALE

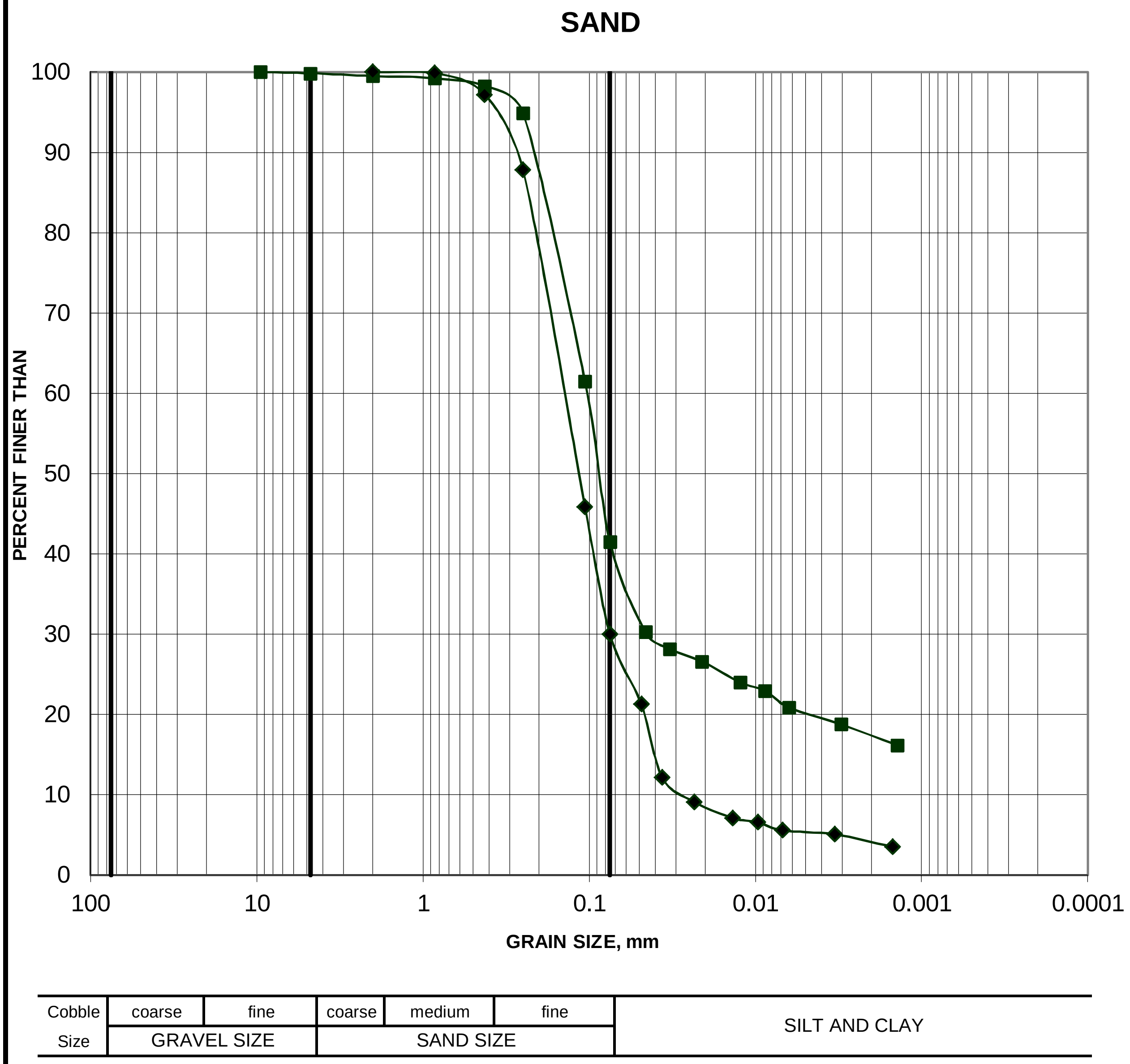
1 : 75

Golder Associates

LOGGED: DG

CHECKED: SAT

GRAIN SIZE DISTRIBUTION



Borehole	Sample	Depth (m)
■ 12-1-2	1B	0.25-0.55
◆ 12-3-2	2	0.61-1.22

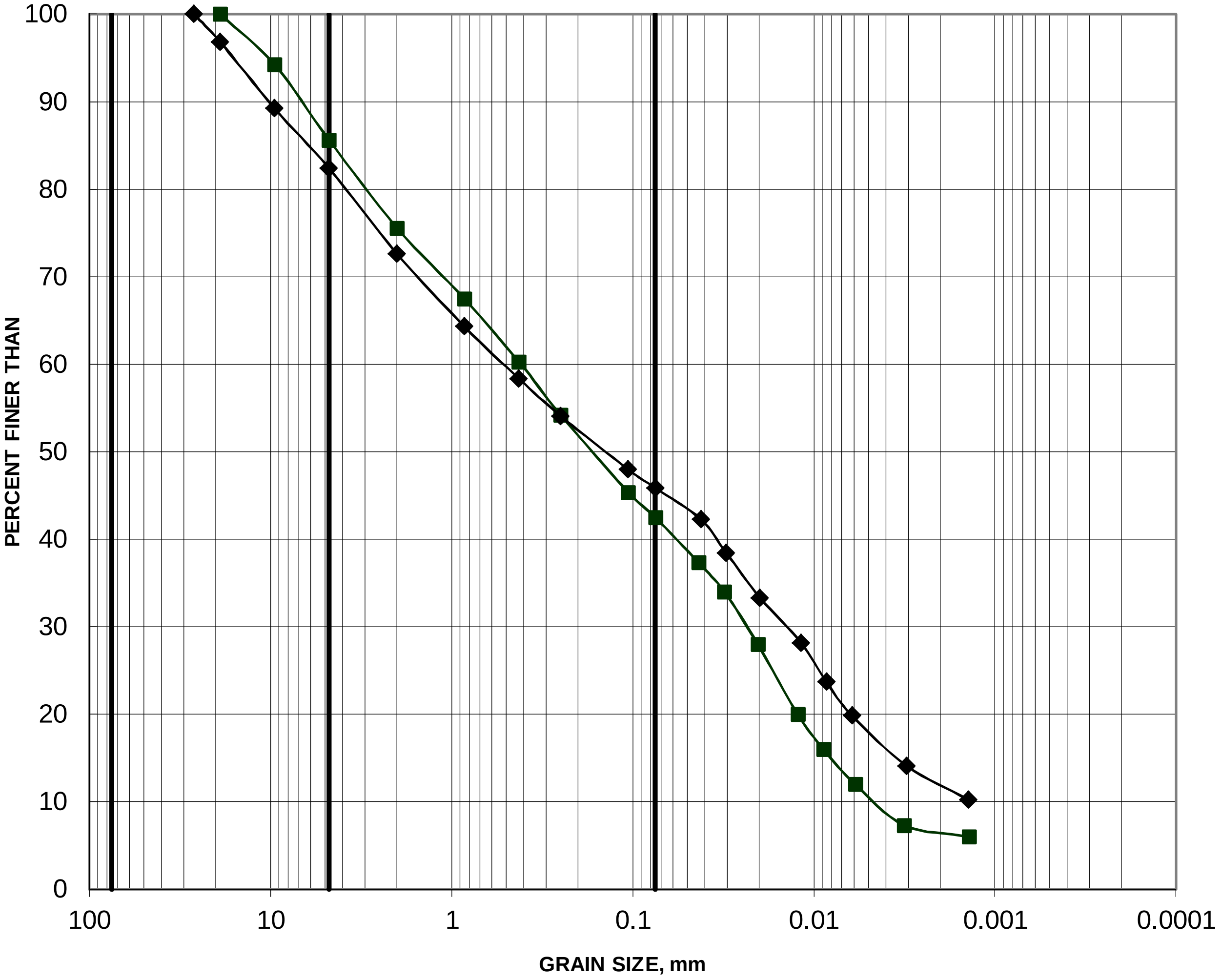
Created by: CW
Checked by: CNM

Project: 12-1125-0045/1000

Golder Associates

GRAIN SIZE DISTRIBUTION

GLACIAL TILL



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
■ 12-1-3	24	37.03-37.64
◆ 12-3-3	13	37.19-37.80

Created by: CW
Checked by: CNM

Project: 12-1125-0045/1000

Golder Associates

ATTACHMENT TSD#1-B-3

Packer Testing Results – BH09-3 through BH09-6 (NRR Site)

February 2013

Table TSD#1-B-3-1
Packer Test Results
NRR Site, CRRRC Project

BH No.	Range depth (feet)		Pressure (psi)	k (m/sec)
BH09-3	20.0	28.0	5.0	no take
BH09-3	20.0	28.0	10.0	no take
BH09-3	20.0	28.0	15.0	no take
BH09-3	20.0	28.0	20.0	no take
			Average	**No take**
BH09-3	24.0	32.0	10.0	no take
BH09-3	24.0	32.0	15.0	no take
BH09-3	24.0	32.0	20.0	1.7E-07
BH09-3	24.0	32.0	15.0	no take
BH09-3	24.0	32.0	10.0	no take
			Average	**1.7E-07**
BH09-3	32.0	40.0	15.0	no take
BH09-3	32.0	40.0	20.0	no take
BH09-3	32.0	40.0	25.0	no take
			Average	**no take**
BH09-3	40.0	48.0	20.0	no take
BH09-3	40.0	48.0	25.0	no take
BH09-3	40.0	48.0	30.0	no take
			Average	**no take**
BH09-3	48.0	56.0	25.0	no take
BH09-3	48.0	56.0	30.0	no take
BH09-3	48.0	56.0	35.0	no take
			Average	**no take**
BH09-3	56.0	64.0	30.0	no take
BH09-3	56.0	64.0	35.0	no take
BH09-3	56.0	64.0	40.0	no take
			Average	**no take**
BH09-3	64.0	72.0	35.0	no take
BH09-3	64.0	72.0	40.0	no take
BH09-3	64.0	72.0	45.0	no take
			Average	**no take**
BH09-3	72.0	80.0	40.0	no take
BH09-3	72.0	80.0	45.0	no take
BH09-3	72.0	80.0	50.0	no take
			Average	**no take**
BH09-3	80.0	100.0	100.0	no take
BH09-3	80.0	100.0	100.0	no take
BH09-3	80.0	100.0	100.0	no take
			Average	**no take**

Notes:
No leak was noted from 24'-32'
Based on test ranges 20'-28' and 24'-32', range 28'-32' may have a k of 1.7E-7 m/sec at 20 PSI

Entered: PH
Checked: JPAO

Table TSD#1-B-3-1
Packer Test Results
NRR Site, CRRRC Project

BH No.	Range depth (feet)		Pressure (psi)	k (m/sec)
BH09-4	9.0	17.0	5.0	3.0E-06
BH09-4	9.0	17.0	10.0	2.7E-06
BH09-4	9.0	17.0	15.0	3.2E-06
BH09-4	9.0	17.0	5 (check)	3.3E-06
			Average	**3.0E-06**
BH09-4	16.0	24.0	5.0	1.7E-07
BH09-4	16.0	24.0	10.0	4.8E-08
BH09-4	16.0	24.0	15.0	6.9E-07
BH09-4	16.0	24.0	5 (check)	see notes
			Average	**3.0E-07**
BH09-4	24.0	32.0	10.0	no take
BH09-4	24.0	32.0	15.0	no take
BH09-4	24.0	32.0	20.0	no take
			Average	**no take**
BH09-4	32.0	40.0	16.0	no take
BH09-4	32.0	40.0	22.0	no take
BH09-4	32.0	40.0	28.0	no take
			Average	**no take**
BH09-4	40.0	48.0	25.0	no take
BH09-4	40.0	48.0	30.0	no take
BH09-4	40.0	48.0	35.0	no take
			Average	**no take**
BH09-4	48.0	56.0	26.0	no take
BH09-4	48.0	56.0	32.0	no take
BH09-4	48.0	56.0	38.0	no take
BH09-4	48.0	56.0	26 (check)	no take
			Average	**no take**
BH09-4	56.0	64.0	26.0	no take
BH09-4	56.0	64.0	33.0	no take
BH09-4	56.0	64.0	40.0	no take
BH09-4	56.0	64.0	26 (check)	no take
			Average	**no take**
BH09-4	61.0	101.1	40.0	no take
BH09-4	61.0	101.1	50.0	no take
BH09-4	61.0	101.1	60.0	no take
BH09-4	61.0	101.1	40 (check)	no take
			Average	**no take**
BH09-4	71.0	101.1	40.0	no take
BH09-4	71.0	101.1	50.0	no take
BH09-4	71.0	101.1	60.0	no take
BH09-4	71.0	101.1	40 (check)	no take
			Average	**no take**
BH09-4	81.0	101.1	50.0	no take
BH09-4	81.0	101.1	60.0	1.3E-08
BH09-4	81.0	101.1	70.0	3.0E-08
BH09-4	81.0	101.1	50 (check)	2.6E-08
			Average	**2.3E-08**
BH09-4	91.0	101.1	50.0	no take
BH09-4	91.0	101.1	60.0	no take
BH09-4	91.0	101.1	70.0	no take
BH09-4	91.0	101.1	50.0	no take
			Average	**no take**

Notes:
A slight backpressure and reverse flow was noted for the second 5 PSI test (check test) from Range 16-24'

Entered: PH
Checked: JPAO

Table TSD#1-B-3-1
Packer Test Results
NRR Site, CRRRC Project

BH No.	Range depth (feet)		Pressure (psi)	k (m/sec)
BH09-5	62.0	84.0	36.0	no take
BH09-5	62.0	84.0	42.0	no take
BH09-5	62.0	84.0	48.0	no take
			Average	**No take**
BH09-5	69.0	84.0	40.0	no take
BH09-5	69.0	84.0	46.0	no take
BH09-5	69.0	84.0	52.0	no take
			Average	**No take**
BH09-5	74.0	84.0	40.0	no take
BH09-5	74.0	84.0	45.0	no take
BH09-5	74.0	84.0	55.0	no take
			Average	**no take**

BH No.	Range depth (feet)		Pressure (psi)	k (m/sec)
BH09-6	16.0	27.0	10.0	no take
BH09-6	16.0	27.0	15.0	no take
BH09-6	16.0	27.0	20.0	no take
			Average	**no take**
BH09-6	27.0	38.0	15.0	no take
BH09-6	27.0	38.0	20.0	no take
BH09-6	27.0	38.0	25.0	no take
			Average	**no take**
BH09-6	38.0	49.0	20.0	no take
BH09-6	38.0	49.0	25.0	no take
BH09-6	38.0	49.0	30.0	no take
			Average	**no take**
BH09-6	49.0	60.0	25.0	no take
BH09-6	49.0	60.0	30.0	no take
BH09-6	49.0	60.0	40.0	no take
			Average	**no take**
BH09-6	60.0	100.0	45.0	no take
BH09-6	60.0	100.0	50.0	9.7E-09
BH09-6	60.0	100.0	60.0	1.6E-08
BH09-6	60.0	100.0	45.0	no take
			Average	**1.3E-08**
BH09-6	70.0	100.0	50.0	no take
BH09-6	70.0	100.0	55.0	no take
BH09-6	70.0	100.0	60.0	no take
			Average	**no take**

Notes:

Based on test ranges 70'-100' and 60'-100', range 60'-70' may have a k of 1.3x10-8 m/sec

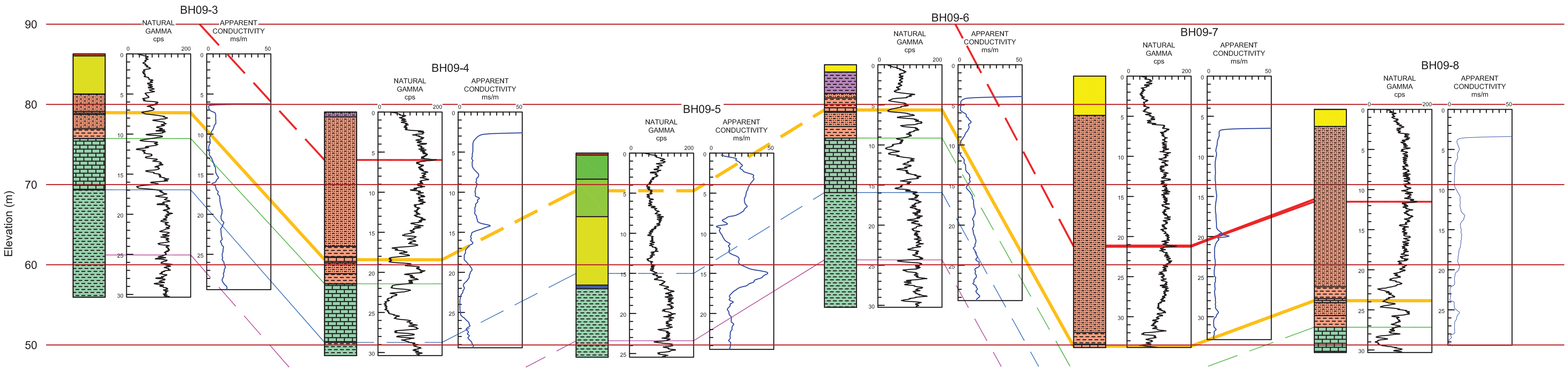
ATTACHMENT TSD#1-B-4

Geophysical Logging Results
(NRR Site)

ATTACHMENT TSD#1-B-4-1

Stratigraphic Correlation Figures

February 2013



CORRELATION LINES

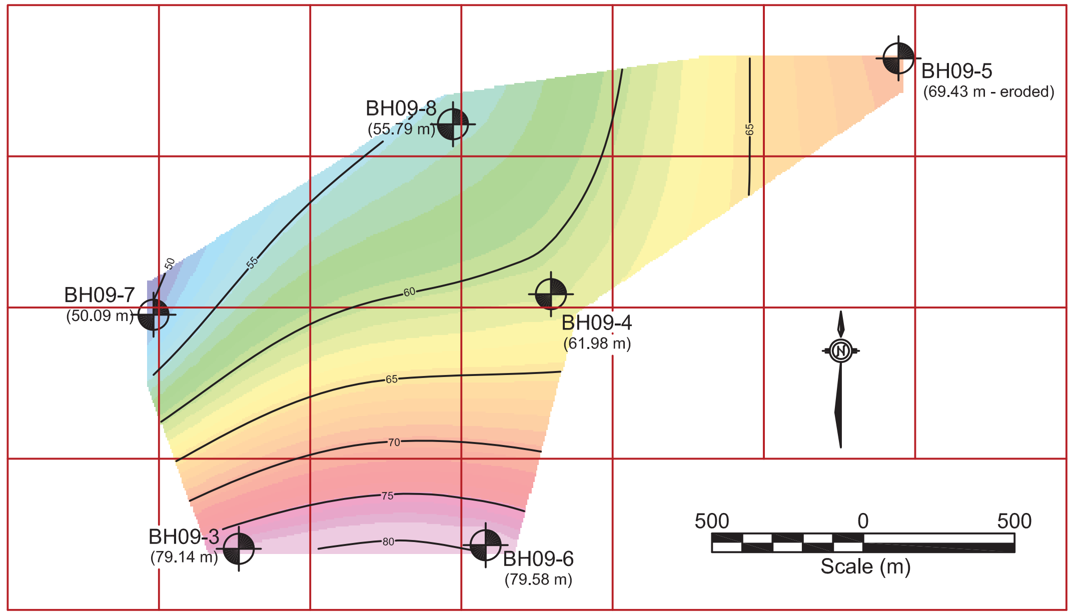
(dashed lines indicate extrapolated correlation)

- 🟥 Gamma Spike in Queenston Fm.
- 🟨 Marker Bed - Lower Queenston Fm.
- 🟩 Queenston Fm./Carlsbad Fm. Contact
- 🟦 Carbonate to Shale Transition (Carlsbad Fm.)
- 🟪 Gamma Response (Carlsbad Fm.)

LOGGED STRATIGRAPHY

Overburden
- 🟥 Topsoil
- 🟨 Overburden / Sandy Silt
- 🟩 Silty Clay / weathered crust
- 🟩 Grey Silty Clay
- 🟦 Sand / Gravel / Cobbles
- 🟨 Glacial Till

Bedrock
- 🟪 Weathered Shale
- 🟧 Queenston Fm.
- 🟩 Carlsbad Fm.



CONTOUR SURFACE - TOP OF MARKER - LOWER QUEENSTON Fm.

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Mississauga, Ontario, Canada

FILE No. 09-1125-1008 nG-aC Logs.dwg
PROJECT No. 12-1125-0045 REV.

SCALE AS SHOWN
DATE May. 23, 2010
DESIGN TF
CAD TF/MMW
CHECK MMW
REVIEW PAS

TITLE

BOREHOLE GEOPHYSICS NATURAL GAMMA AND APPARENT CONDUCTIVITY RESPONSES

CAPTIAL REGION RESOURCE RECOVERY CENTRE
ENVIRONMENTAL ASSESSMENT

FIGURE
TSD#1-B-4-1-1

PLOT DATE: May 24, 2010
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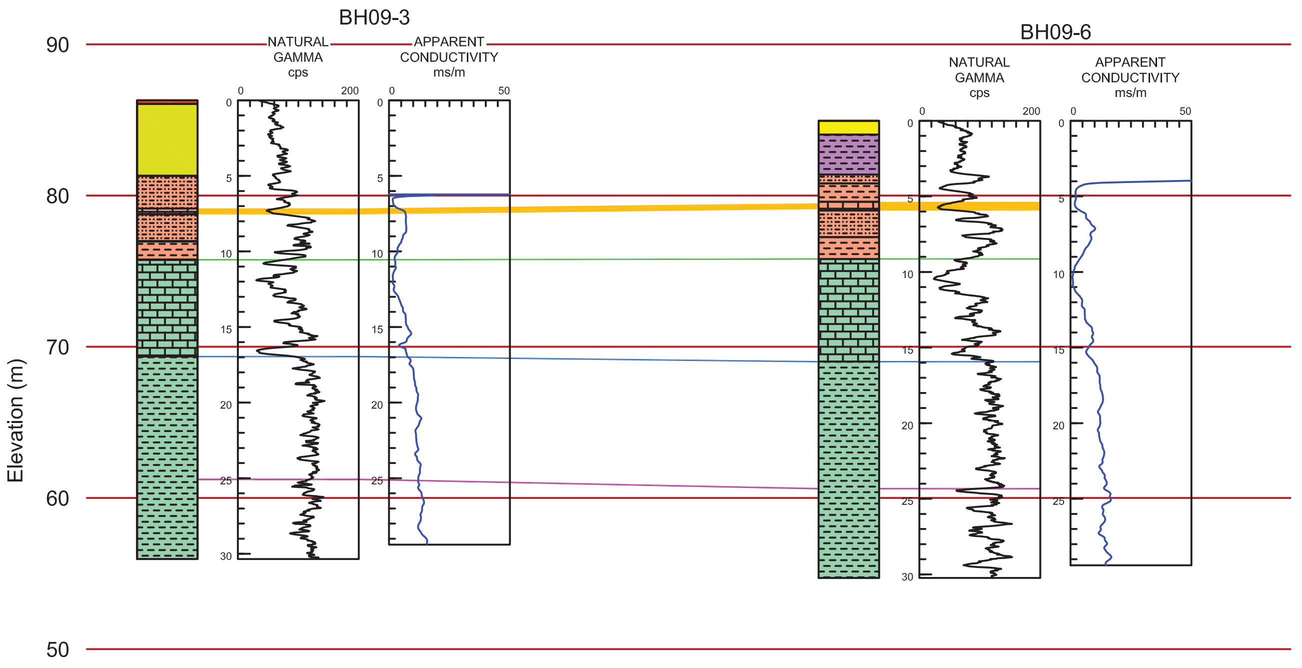

CORRELATION LINES

(dashed lines indicate extrapolated correlation)

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- 🟩 Queenston Fm./Carlsbad Fm. Contact
- 🟦 Carbonate to Shale Transition (Carlsbad Fm.)
- 🟪 Gamma Response (Carlsbad Fm.)

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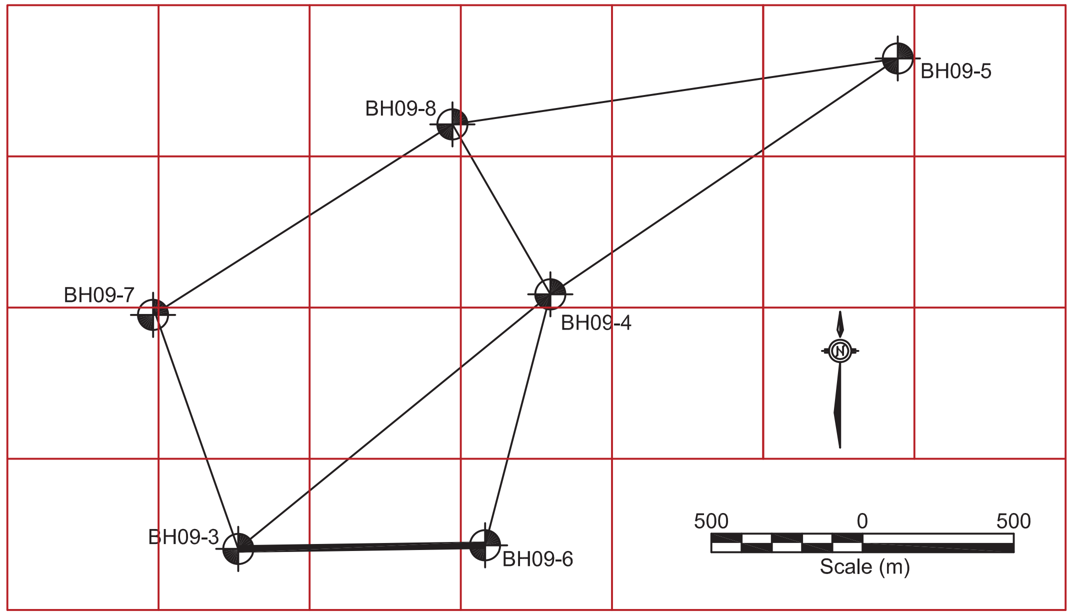
- 🟨 Glacial Till

Bedrock
- 🟪 Weathered Shale
- 🟧 Queenston Fm.
- 🟩 Carlsbad Fm.



▬ SECTION LINE

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PROJECT No. 12-1125-0045 REV.

TITLE

BOREHOLE SECTION BH09-3 TO BH09-6

CAPTIAL REGION RESOURCE RECOVERY CENTRE
ENVIRONMENTAL ASSESSMENT

FIGURE
TSD#1-B-4-1-2

PLOT DATE: May 24, 2010
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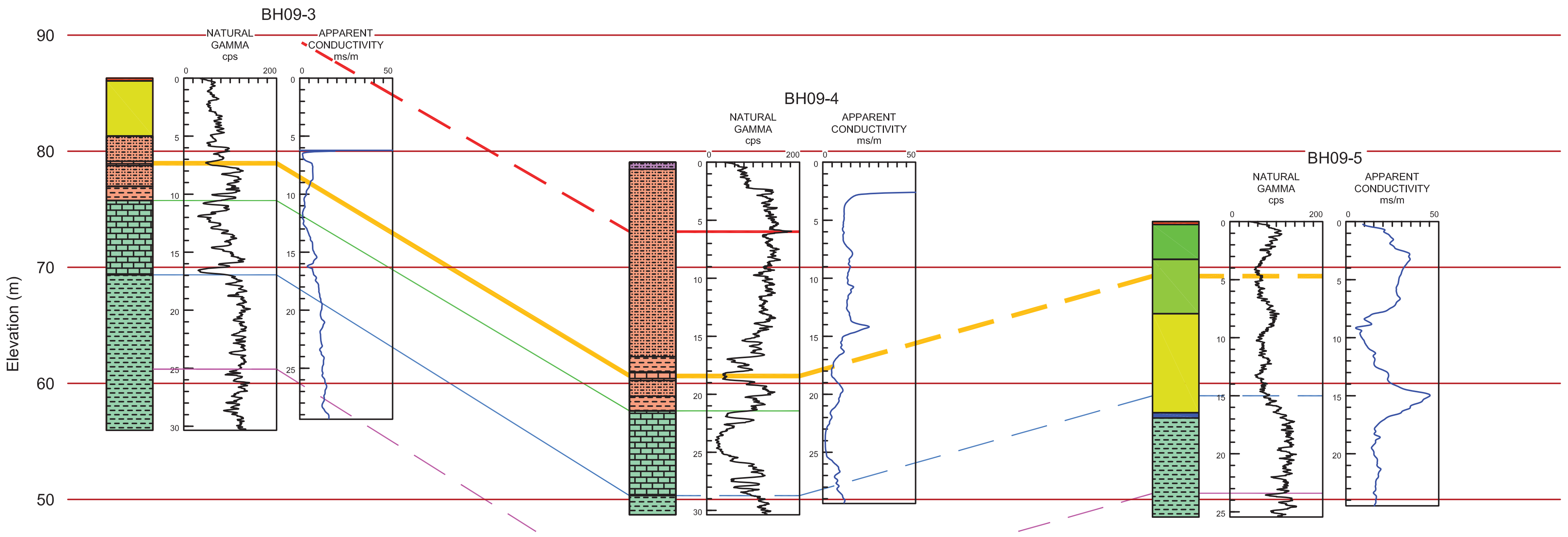

CORRELATION LINES

(dashed lines indicate extrapolated correlation)

- ━ Gamma Spike in Queenston Fm.
- ━ Marker Bed - Lower Queenston Fm.
- ━ Queenston Fm./Carlsbad Fm. Contact
- ━ Carbonate to Shale Transition (Carlsbad Fm.)
- ━ Gamma Response (Carlsbad Fm.)

LOGGED STRATIGRAPHY

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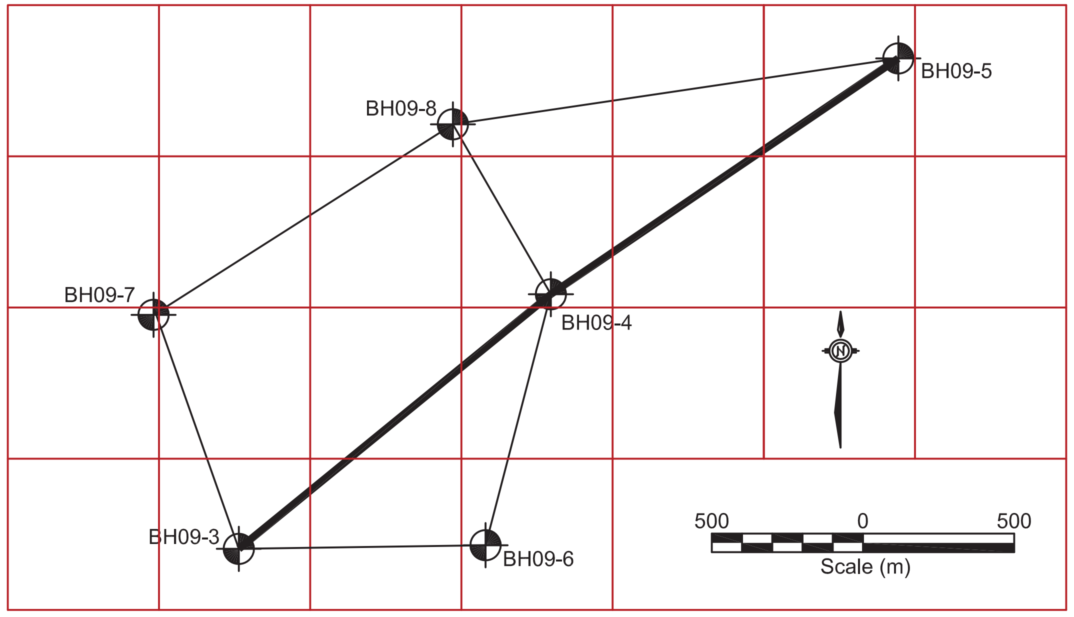
Bedrock
- 🟪 Weathered Shale
- 🟧 Queenston Fm.
- 🟩 Carlsbad Fm.



━ SECTION LINE

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PROJECT No. 12-1125-0045
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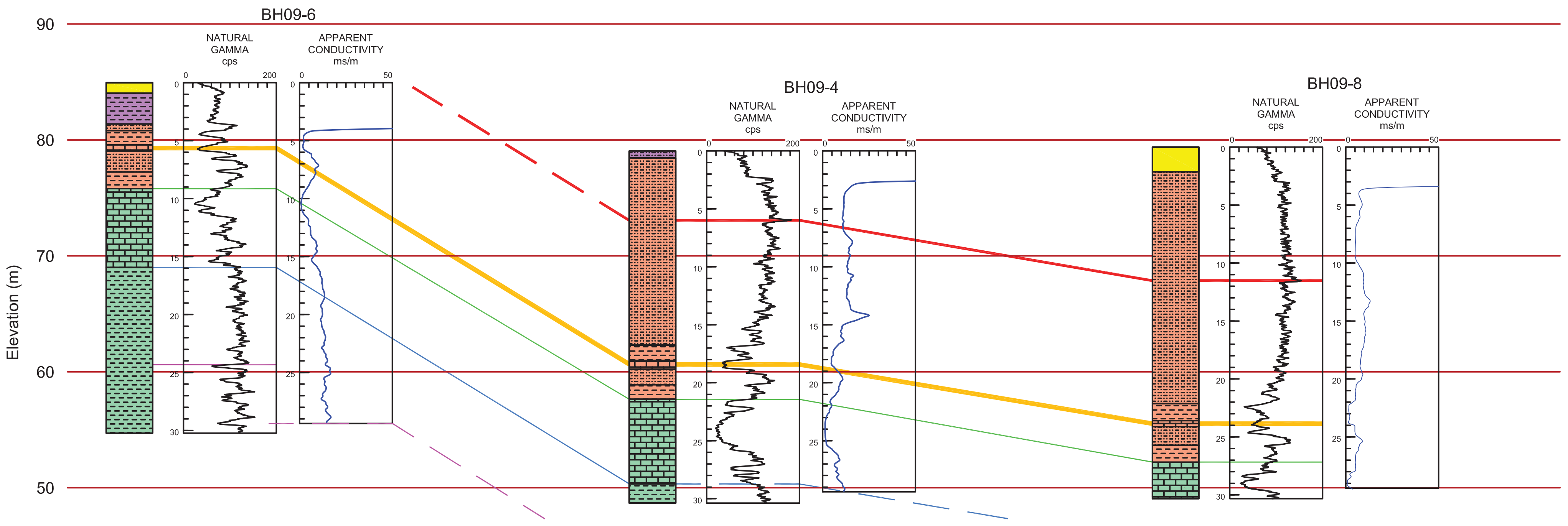
TITLE

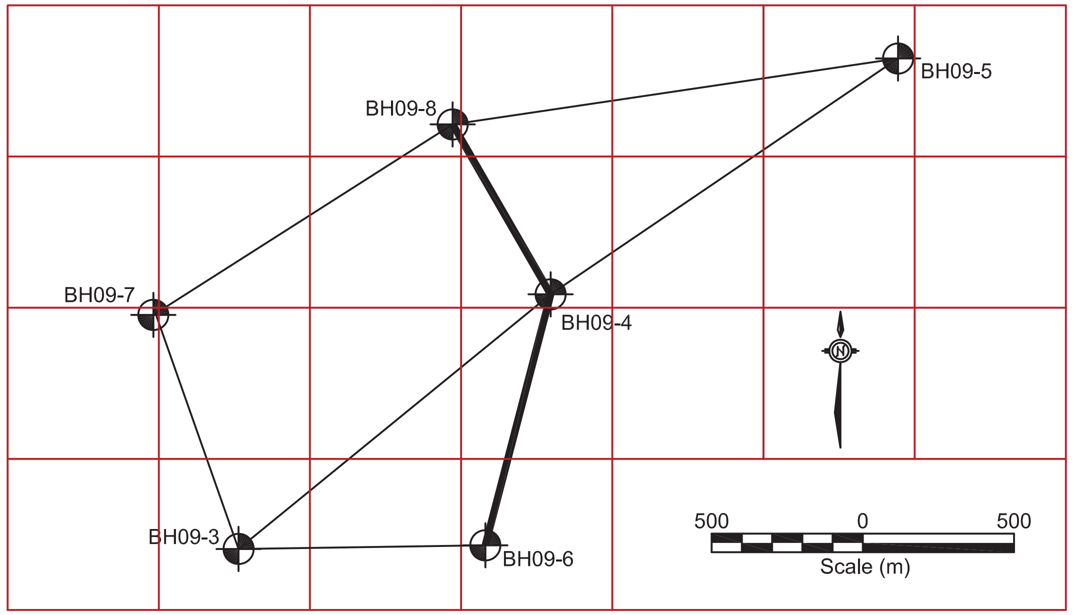
BOREHOLE SECTION BH09-3 TO BH09-4 TO BH09-5

CAPTIAL REGION RESOURCE RECOVERY CENTRE
ENVIRONMENTAL ASSESSMENT

FIGURE
TSD#1-B-4-1-3

PLOT DATE: May 24, 2010
FILENAME: C:\Documents and Settings\mmonier-williams\My Documents\09-Projects\09-1125-1008(3000) Green Project - Geophysics - Ottawa\09-1125-1008 nG-aC Logs.dwg





SECTION LINE

CORRELATION LINES

(dashed lines indicate extrapolated correlation)

- 🟥 Gamma Spike in Queenston Fm.
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LOGGED STRATIGRAPHY

Overburden
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- 🟨 Glacial Till

Bedrock
- ▨ Weathered Shale
- ▨ Queenston Fm.
- ▨ Carlsbad Fm.

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PROJECT No. 12-1125-0045 REV.

TITLE

BOREHOLE SECTION
BH09-6 TO BH09-4 TO BH09-8

CAPTIAL REGION RESOURCE RECOVERY CENTRE
ENVIRONMENTAL ASSESSMENT

FIGURE **TSD#1-B-4-1-4**

PLOT DATE: May 24, 2010
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PLOT DATE: May 24, 2010
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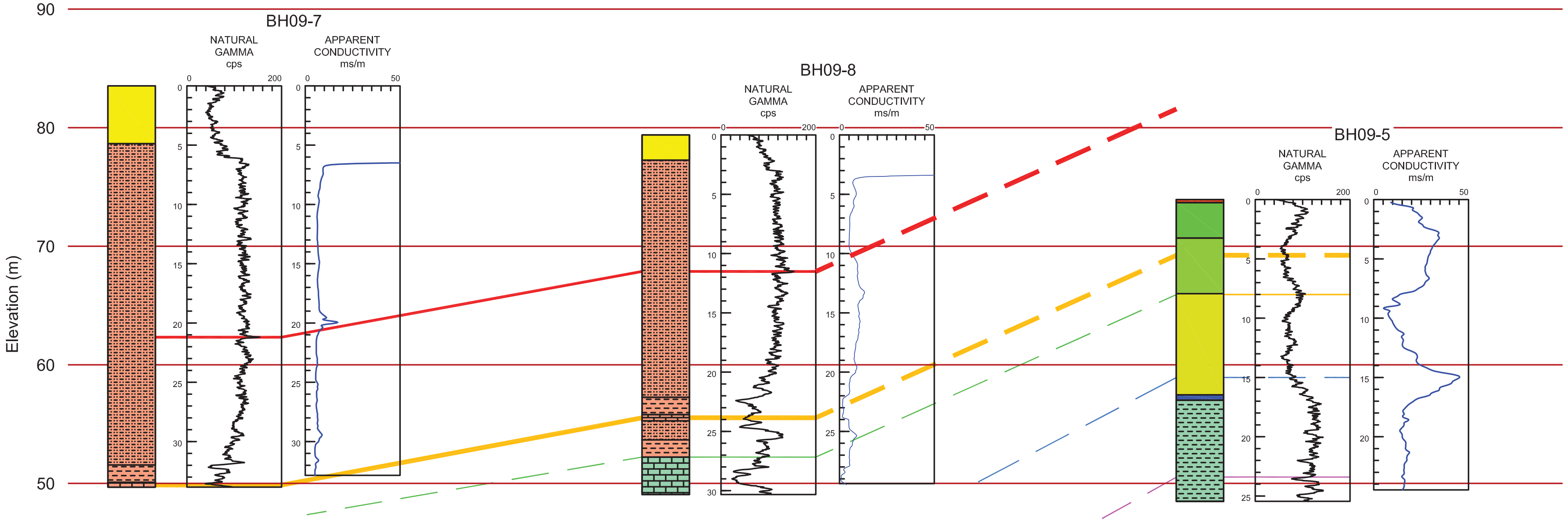

CORRELATION LINES

(dashed lines indicate extrapolated correlation)

- — Gamma Spike in Queenston Fm.
- — Marker Bed - Lower Queenston Fm.
- — Queenston Fm./Carlsbad Fm. Contact
- — Carbonate to Shale Transition (Carlsbad Fm.)
- — Gamma Response (Carlsbad Fm.)

LOGGED STRATIGRAPHY

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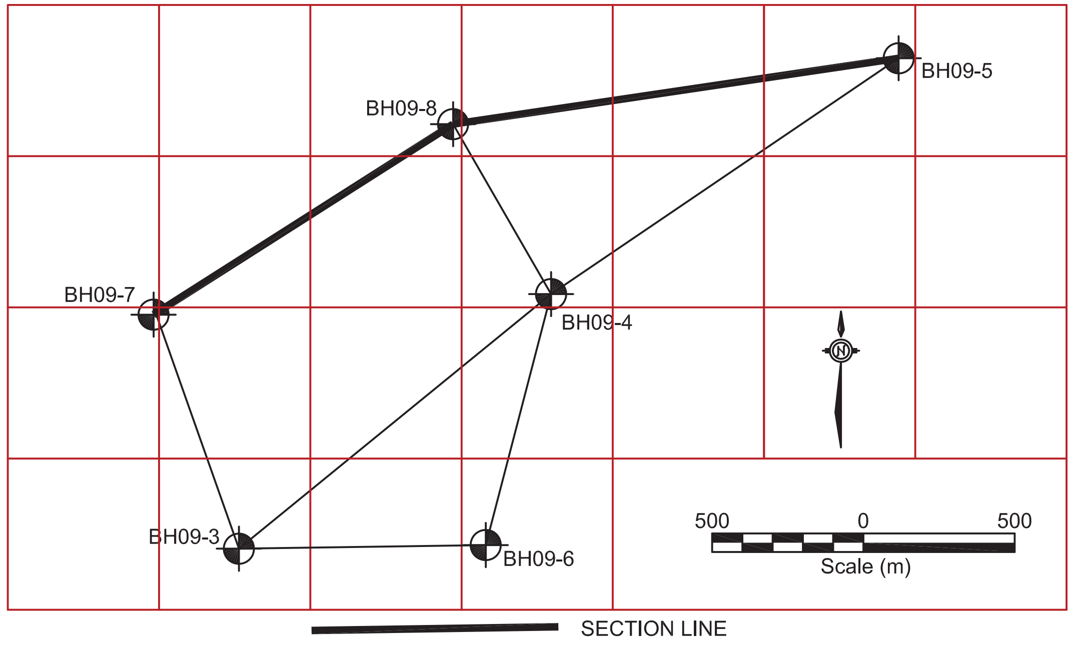

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SCALE	AS SHOWN	TITLE
DATE	May. 23, 2010	
DESIGN	TF	
CAD	TF/MMW	
CHECK	MMW	
REVIEW	PAS	

BOREHOLE SECTION
BH09-7 TO BH09-8 TO BH09-5

FILE No. 09-1125-1008 nG-aC Logs.dwg
PROJECT No. 12-1125-0045 REV.

CAPTIAL REGION RESOURCE RECOVERY CENTRE
ENVIRONMENTAL ASSESSMENT

FIGURE
TSD#1-B-4-1-5

ATTACHMENT TSD#1-B-4-2

Geophysical Logging Results for BH09-4

February 2013

Static Heat Pulse Flow Meter Results - BH09-4

Borehole BH09-4

Dynamic Heat Pulse Flow Meter Testing

Pipe Stick Up = 0.92 (m)

Static Water Level = 0.92 (m - btop)

Depth (m)	Acq. Time Day/Time	Pick Time (sec)	Flow USGal/min.	Comment
1.11	3/12/2009 16:43	4.00	-0.12	possible good test
	3/12/2009 16:46	-	no flow	non-stable curve
2.10	3/12/2009 16:50	-	no flow	non-stable curve
	3/12/2009 16:51	-	no flow	non-stable curve
	3/12/2009 16:53	-	no flow	non-stable curve
4.12	3/12/2009 16:56	14.38	-0.03	possible good test
	3/12/2009 16:57	-	no flow	non-stable curve
	3/12/2009 16:59	-	no flow	non-stable curve
	3/12/2009 17:00	-	no flow	non-stable curve
6.61	3/12/2009 17:02	-	no flow	non-stable curve
	3/12/2009 17:03	-	no flow	non-stable curve
9.10	3/12/2009 17:05	-	no flow	non-stable curve
	3/12/2009 17:06	-	no flow	non-stable curve
14.10	3/12/2009 17:09	-	no flow	non-stable curve
	3/12/2009 17:11	-	no flow	non-stable curve
19.10	3/12/2009 17:12	-	no flow	non-stable curve
	3/12/2009 17:13	-	no flow	non-stable curve
24.12	3/12/2009 17:16	-	no flow	non-stable curve
	3/12/2009 17:17	-	no flow	non-stable curve
29.15	3/12/2009 17:20	-	no flow	non-stable curve
	3/12/2009 17:21	-	no flow	non-stable curve

Dynamic Heat Pulse Flow Meter Results - BH09-4

Borehole BH09-4

Dynamic Heat Pulse Flow Meter Testing

Pipe Stick Up = 0.92 (m)

Static Water Level = 0.92 (m - btop)

					Pump Rate				
Depth (m)	Acq. Time Day/Time	Pick Time (sec)	Flow (USGal/min)	Average (USGal/min) or Comment	Volume (USGal)	Time (min)	Rate USGal/min	Water Level (m - btop)	Draw Down (m)
2.09	3/12/2009 18:11	0.74	0.71	0.89	4.50	3.08	1.46	1.72	0.80
	3/12/2009 18:13	0.69	1.13						
	3/12/2009 18:15	0.71	0.85						
2.58	3/12/2009 18:05	1.10	0.37	0.37	4.50	3.08	1.46	1.72	0.80
	3/12/2009 18:07	1.20	0.32						
	3/12/2009 18:08	1.05	0.40						
	3/12/2009 18:09	1.05	0.40						
3.06	3/12/2009 17:58	2.50	0.08	0.07	4.50	3.08	1.46	1.72	0.80
	3/12/2009 17:59	2.60	0.08						
	3/12/2009 18:01	3.00	0.06						
	3/12/2009 18:02	2.90	0.07						
4.08	3/12/2009 17:54	-	no flow	non-stable curve					
	3/12/2009 17:55	-	no flow	non-stable curve					
	3/12/2009 17:56	-	no flow	non-stable curve					
6.59	3/12/2009 17:52	-	no flow	non-stable curve					
	3/12/2009 17:53	-	no flow	non-stable curve					
9.08	3/12/2009 17:49	-	no flow	non-stable curve					
	3/12/2009 17:50	-	no flow	non-stable curve					
14.08	3/12/2009 17:47	-	no flow	non-stable curve					
	3/12/2009 17:48	-	no flow	non-stable curve					
19.08	3/12/2009 17:41	-	no flow	non-stable curve					
	3/12/2009 17:42	-	no flow	non-stable curve					
	3/12/2009 17:44	-	no flow	non-stable curve	4.50	3.08	1.46	1.73	0.81
24.09	3/12/2009 17:37	-	no flow	non-stable curve					
	3/12/2009 17:38	-	no flow	non-stable curve					
24.58	3/12/2009 17:35	-	no flow	non-stable curve					
26.58	3/12/2009 17:33	-	no flow	non-stable curve					
	3/12/2009 17:34	-	no flow	non-stable curve	4.50	2.98	1.51	1.72	0.80
29.09	3/12/2009 17:26	-	no flow	non-stable curve					
	3/12/2009 17:28	-	no flow	non-stable curve	4.50	3.08	1.46	1.72	0.80

GEOPHYSICAL RECORD OF BOREHOLE: BH09-4

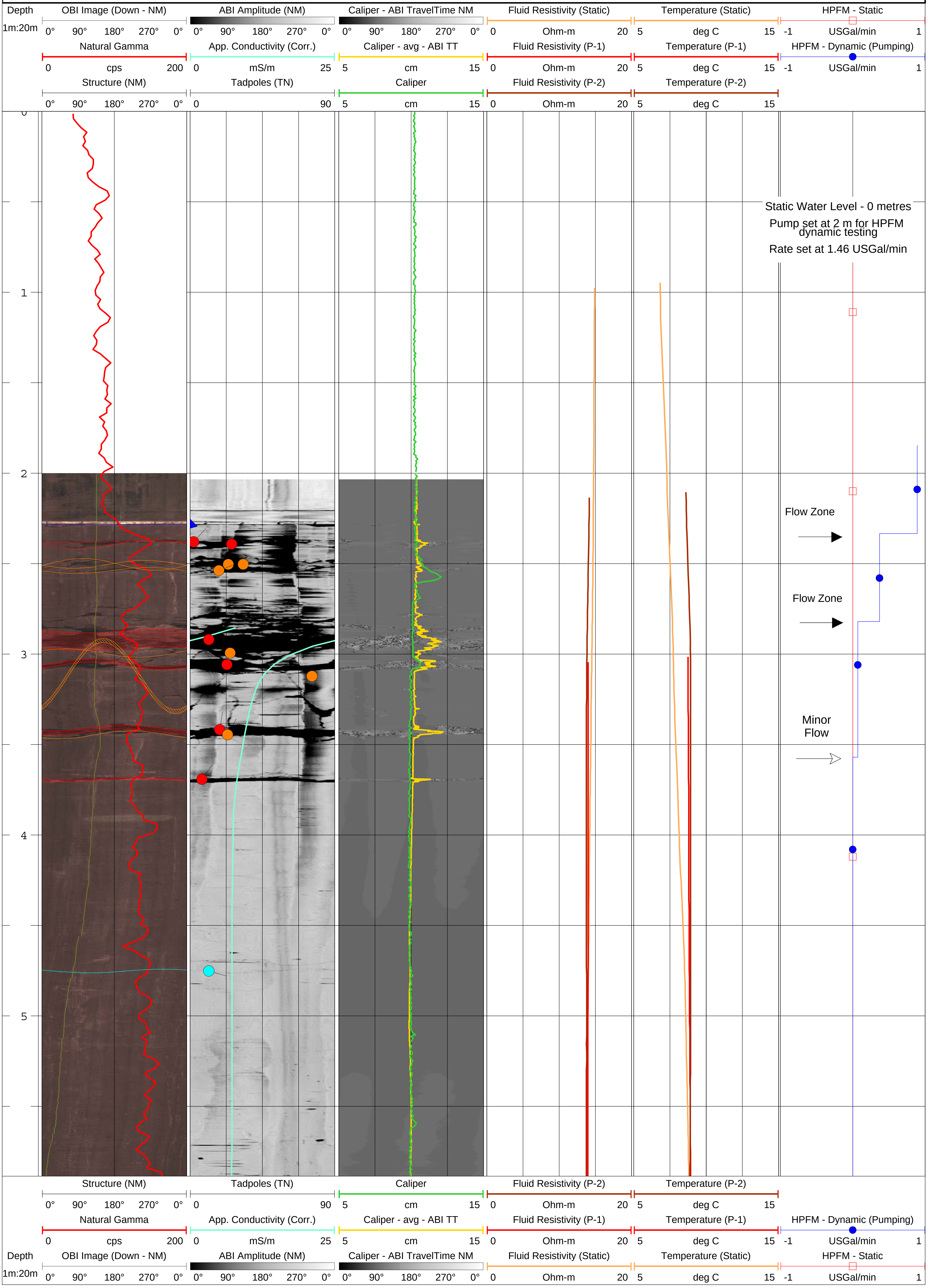
Borehole Geophysics

Confidential

Project Number: 09-1125-1008(3000)

Date: April, 2010

Datum:	MTM NAD83						
Easting:	393,796 E	Depth Reference:	'0' at Ground Surface	Borehole Diameter:	HQ - 96 mm	Location:	North Russel, Ontario
Northing:	5,018,544 N	Drilling Method:	HQ Core	Casing Diameter:	HW - 101 mm	Log Date:	Nov. 30 / Dec. 3, 2009
Elevation:	79.05 m - asl	Drilled Depth:	30.84 m	Casing Depth:	2.28 m	Logged By:	MM-W

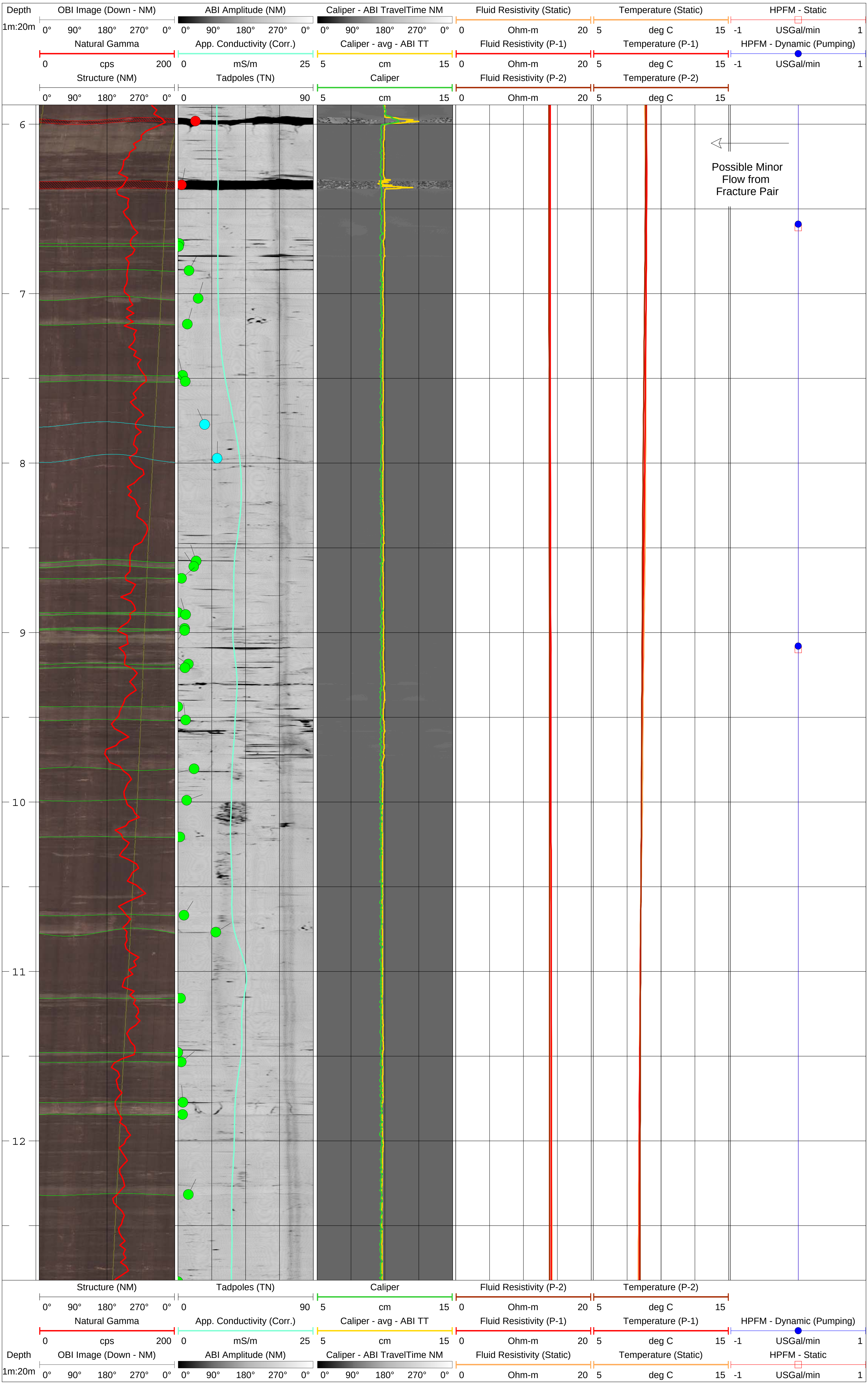


Static Water Level - 0 metres

Pump set at 2 m for HPFM dynamic testing

Rate set at 1.46 USGal/min

BH09-4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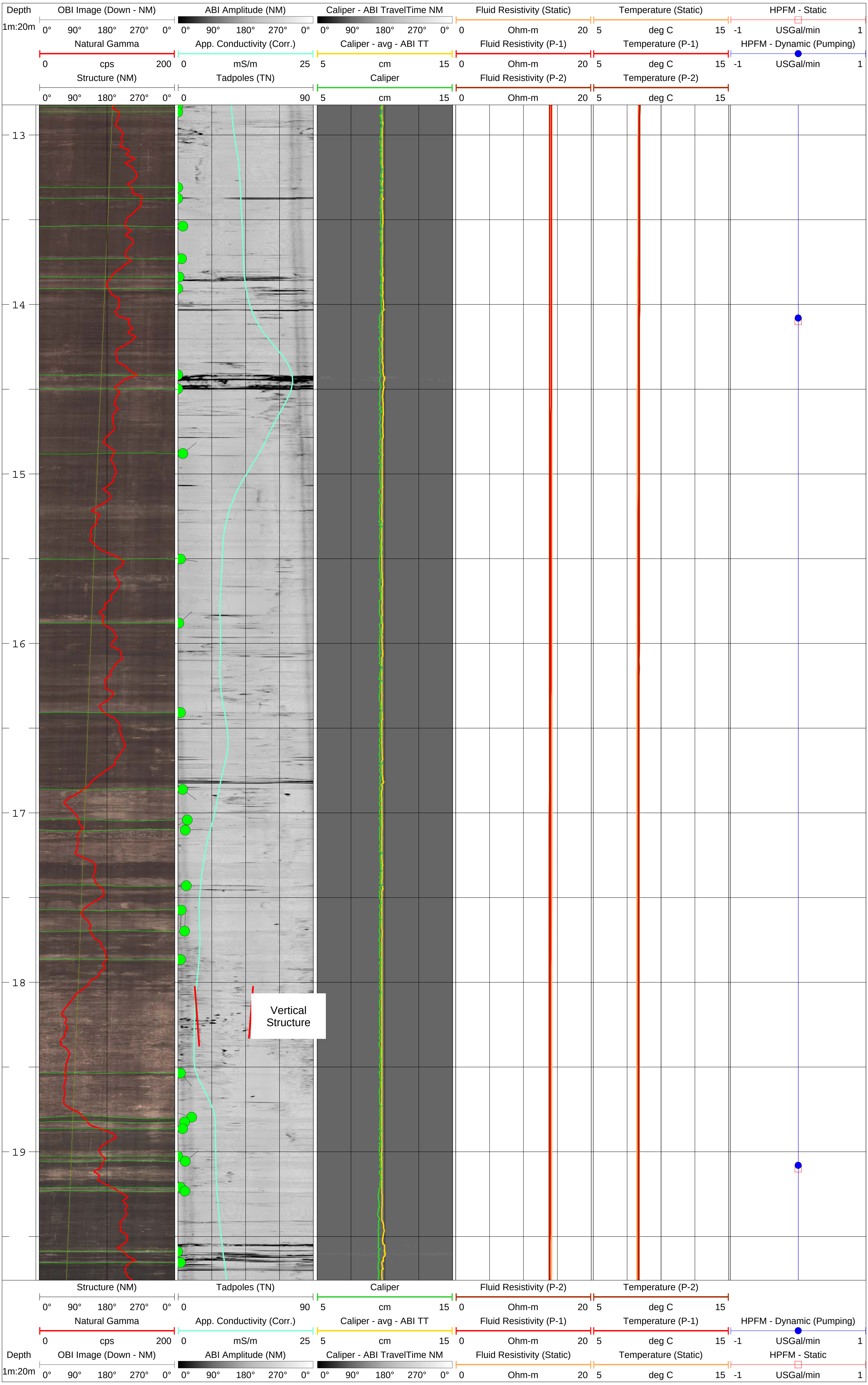
1m:20m
OBI Image (Down - NM)
0° 90° 180° 270° 0°
ABI Amplitude (NM)
0° 90° 180° 270° 0°
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Fluid Resistivity (Static)
0 Ohm-m 20
Temperature (Static)
5 deg C 15
HPFM - Static
-1 USGal/min 1
Natural Gamma
0 cps 200
App. Conductivity (Corr.)
0 mS/m 25
Caliper - avg - ABI TT
5 cm 15
Fluid Resistivity (P-1)
0 Ohm-m 20
Temperature (P-1)
5 deg C 15
HPFM - Dynamic (Pumping)
-1 USGal/min 1
Structure (NM)
0° 90° 180° 270° 0°
Tadpoles (TN)
0 90
Caliper
5 cm 15
Fluid Resistivity (P-2)
0 Ohm-m 20
Temperature (P-2)
5 deg C 15
6
7
8
9
10
11
12
Possible Minor Flow from Fracture Pair

BH09-4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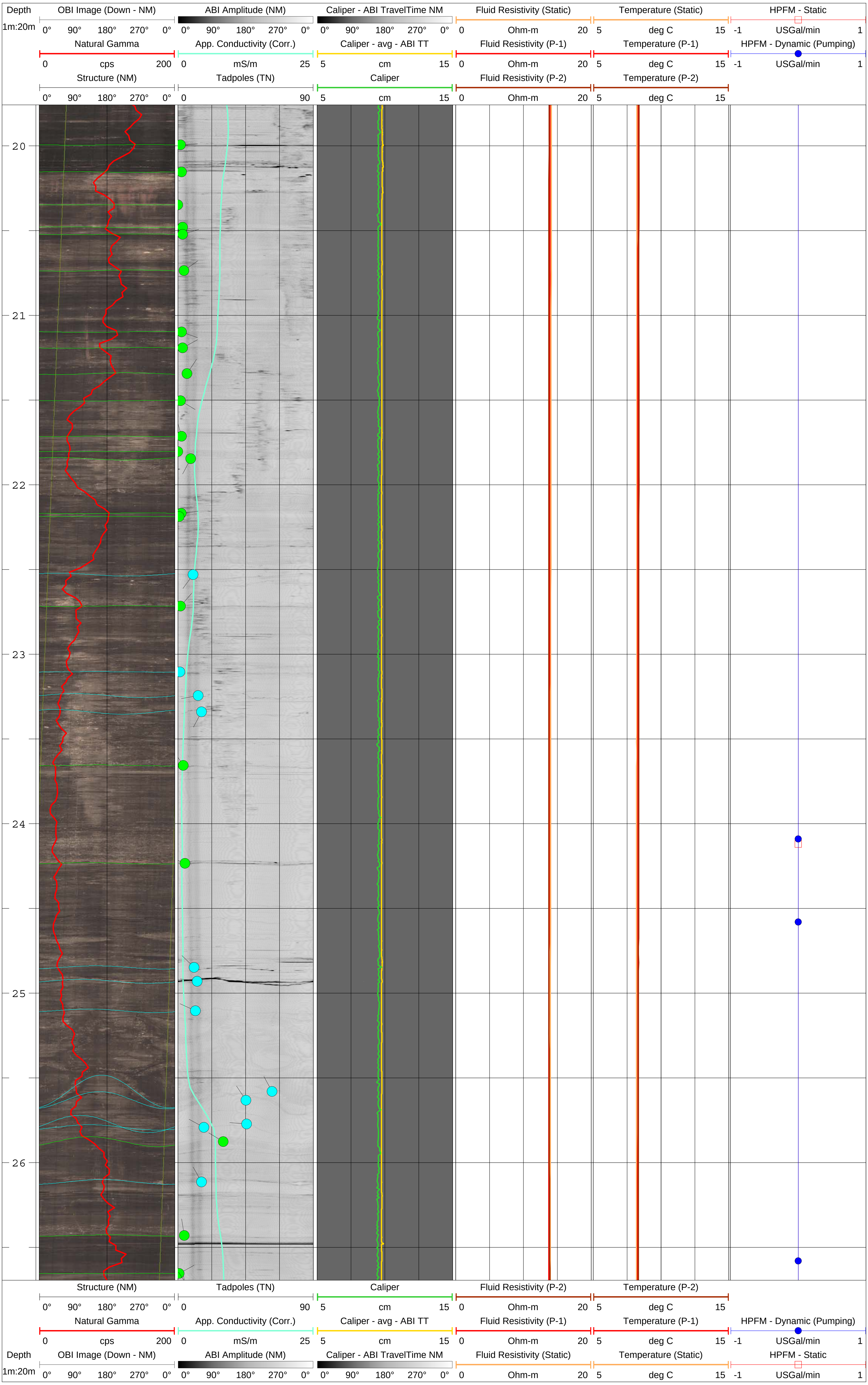
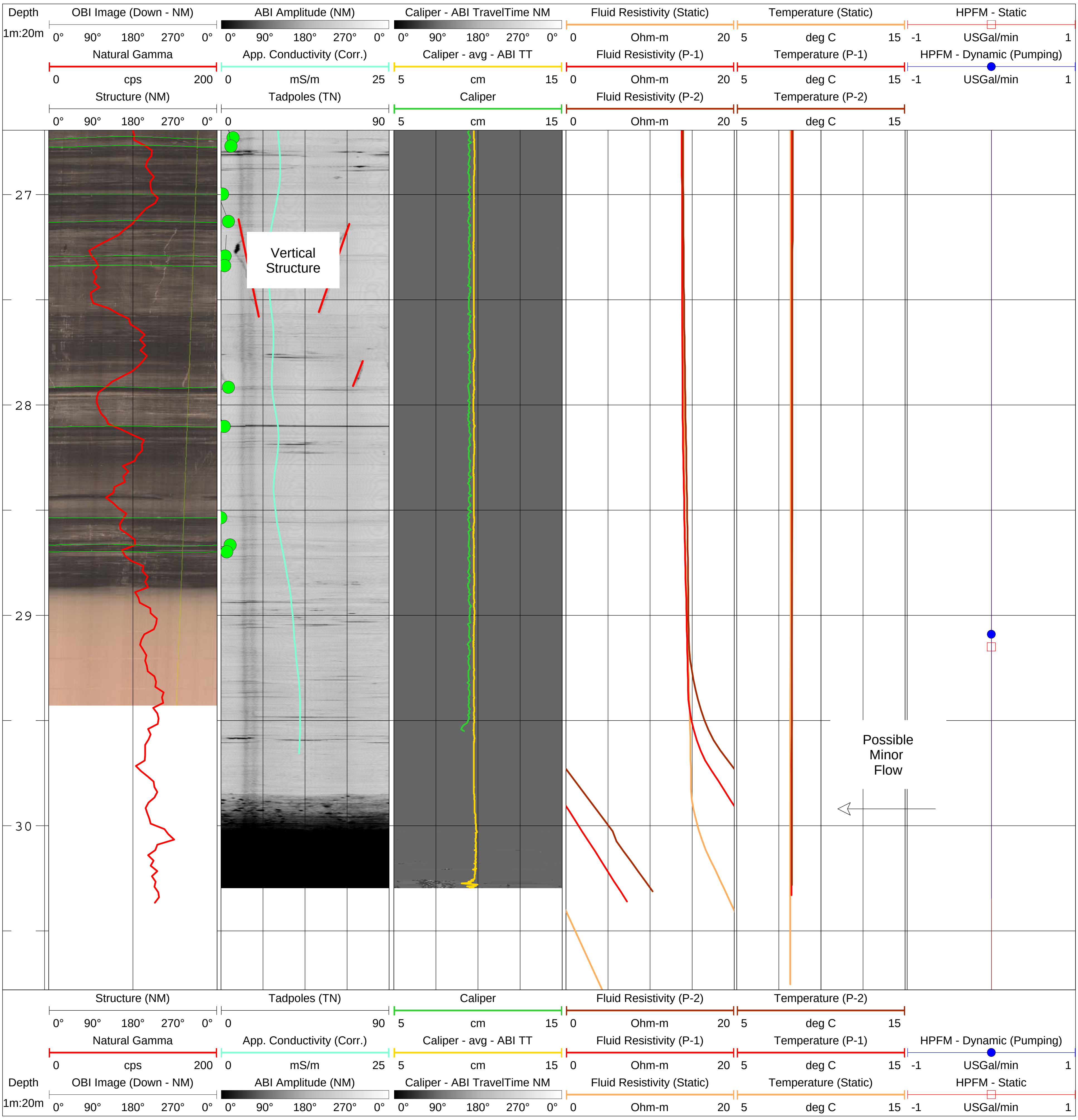
1m:20m
OBI Image (Down - NM)
0° 90° 180° 270° 0°
Natural Gamma
0 cps 200
Structure (NM)
0° 90° 180° 270° 0°
ABI Amplitude (NM)
0° 90° 180° 270° 0°
App. Conductivity (Corr.)
0 mS/m 25
Tadpoles (TN)
0 90
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Caliper - avg - ABI TT
5 cm 15
Caliper
5 cm 15
Fluid Resistivity (Static)
0 Ohm-m 20
Fluid Resistivity (P-1)
0 Ohm-m 20
Fluid Resistivity (P-2)
0 Ohm-m 20
Temperature (Static)
5 deg C 15
Temperature (P-1)
5 deg C 15
Temperature (P-2)
5 deg C 15
HPFM - Static
-1 USGal/min 1
HPFM - Dynamic (Pumping)
-1 USGal/min 1
13
14
15
16
17
18
19
Vertical Structure

BH09-4


Depth
1m:20m
OBI Image (Down - NM)
0° 90° 180° 270° 0°
Natural Gamma
0 cps 200
Structure (NM)
0° 90° 180° 270° 0°
ABI Amplitude (NM)
0° 90° 180° 270° 0°
App. Conductivity (Corr.)
0 mS/m 25
Tadpoles (TN)
0 90
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Caliper - avg - ABI TT
5 cm 15
Caliper
5 cm 15
Fluid Resistivity (Static)
0 Ohm-m 20
Fluid Resistivity (P-1)
0 Ohm-m 20
Fluid Resistivity (P-2)
0 Ohm-m 20
Temperature (Static)
5 deg C 15
Temperature (P-1)
5 deg C 15
Temperature (P-2)
5 deg C 15
HPFM - Static
-1 USGal/min 1
HPFM - Dynamic (Pumping)
-1 USGal/min 1
20
21
22
23
24
25
26
Structure (NM)
0° 90° 180° 270° 0°
Tadpoles (TN)
0 90
Caliper
5 cm 15
Fluid Resistivity (P-2)
0 Ohm-m 20
Temperature (P-2)
5 deg C 15
Natural Gamma
0 cps 200
App. Conductivity (Corr.)
0 mS/m 25
Caliper - avg - ABI TT
5 cm 15
Fluid Resistivity (P-1)
0 Ohm-m 20
Temperature (P-1)
5 deg C 15
HPFM - Dynamic (Pumping)
-1 USGal/min 1
Depth
1m:20m
OBI Image (Down - NM)
0° 90° 180° 270° 0°
ABI Amplitude (NM)
0° 90° 180° 270° 0°
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Fluid Resistivity (Static)
0 Ohm-m 20
Temperature (Static)
5 deg C 15
HPFM - Static
-1 USGal/min 1

BH09-4



Depth
1m:20m
OBI Image (Down - NM)
0° 90° 180° 270° 0°
ABI Amplitude (NM)
Caliper - ABI TravelTime NM
Fluid Resistivity (Static)
0 Ohm-m 20
Temperature (Static)
5 deg C 15
HPFM - Static
-1 USGal/min 1
Natural Gamma
0 cps 200
App. Conductivity (Corr.)
0 mS/m 25
Caliper - avg - ABI TT
5 cm 15
Fluid Resistivity (P-1)
Temperature (P-1)
HPFM - Dynamic (Pumping)
Structure (NM)
Tadpoles (TN)
0 90
Caliper
Fluid Resistivity (P-2)
Temperature (P-2)
27
28
29
30
Vertical Structure
Possible Minor Flow

GEOPHYSICAL RECORD OF BOREHOLE: BH09-4

Borehole Geophysics

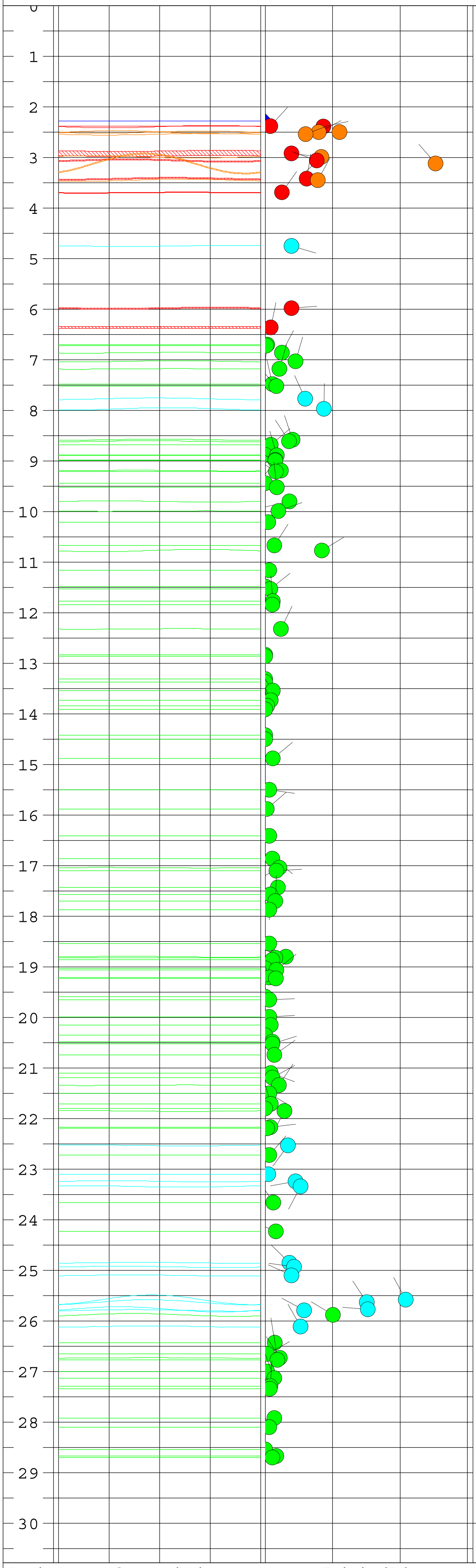
Confidential

Project Number: 09-1125-1008(3000)

Date: April, 2010

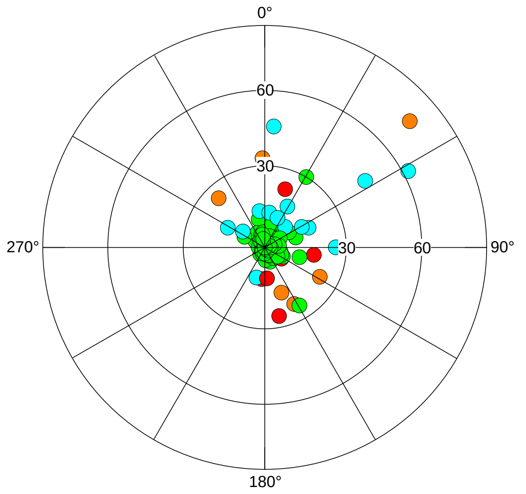
Datum:	MTM NAD83						
Easting:	393,796 E	Depth Reference:	'0' at Ground Surface	Borehole Diameter:	HQ - 96 mm	Location:	North Russel, Ontario
Northing:	5,018,544 N	Drilling Method:	HQ Core	Casing Diameter:	HW - 101 mm	Log Date:	Nov. 30 / Dec. 3, 2009
Elevation:	79.05 m - asl	Drilled Depth:	30.84 m	Casing Depth:	2.28 m	Logged By:	MM-W

Depth	Structure (NM)	Tadpoles (TN)	Strike from Tadpoles (TN)	Azimuth from Tadpoles (TN)
1:100	0° 90° 180° 270° 0°	0 90	Schmidt Plot (Strike) - LH - Type	Azimuth - Percent Interval (Count)



Schmidt Plot (Strike) - LH - Type

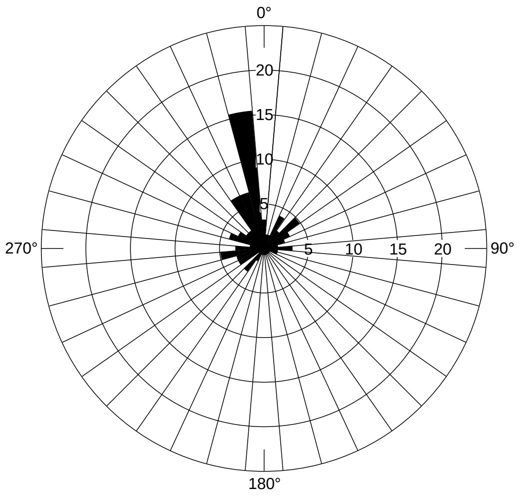
Depth: 0.00 [m] to 30.00 [m]



	Counts	Dip[deg]	Strike[deg]
Mean	121	7.80	249.32
🔴	8	12.86	311.78
🟠	6	32.53	266.98
🔵	15	20.92	210.83
🟢	92	3.84	250.18

Azimuth - Percent Interval (Count)

Depth: 0.00 [m] to 30.00 [m]



Counts:	121.00
Mean:	339.32
Std.Dev.:	74.76
Min:	0.59
Max:	356.08

Depth	Structure (NM)	Tadpoles (TN)	Strike from Tadpoles (TN)	Azimuth from Tadpoles (TN)
1:100	0° 90° 180° 270° 0°	0 90	Schmidt Plot (Strike) - LH - Type	Azimuth - Percent Interval (Count)

ATTACHMENT TSD#1-B-4-3

Geophysical Logging Results for BH09-7

February 2013

Dynamic Heat Pulse Flow Meter Results - BH09-7

Borehole BH09-7
Dynamic Heat Pulse Flow Meter Testing
Pipe Stick Up = 0.87 (m)
Static Water Level = 2.13 (m - btop)

					Pump Rate				
Depth (m)	Acq. Time Day/Time	Pick Time (sec)	Flow (USGal/min)	Average (USGal/min) or Comment	Volume (USGal)	Time (min)	Rate USGal/min	Water Level (m - btop)	Draw Down (m)
5.48	4/12/2009 22:56	1.60	0.185						
	4/12/2009 22:57	1.55	0.197					3.74	1.61
	4/12/2009 22:58	1.52	0.203						
	4/12/2009 22:58	1.52	0.203						
	4/12/2009 22:59			0.20					
	4/12/2009 23:00	1.55	0.197					3.80	1.67
	4/12/2009 23:01	1.50	0.209						
	4/12/2009 23:02	1.50	0.209						
	4/12/2009 23:04	1.55	0.197						
	4/12/2009 23:05	1.55	0.197		4.5	8.5	0.53	3.85	1.72
7.48	4/12/2009 22:47	2.70	0.074						
	4/12/2009 22:48	2.80	0.069						
	4/12/2009 22:50	3.25	0.054	0.06		Note - Pump Stopped			
	4/12/2009 22:52	3.30	0.053						
	4/12/2009 22:53	2.90	0.065					3.50	1.37
	4/12/2009 22:54	2.70	0.074						
9.91	4/12/2009 22:45	1.90	0.137						
	4/12/2009 22:46	1.85	0.143	0.14					
12.49	4/12/2009 22:44	1.80	0.150						
	4/12/2009 22:44	1.80	0.150	0.15					
14.98	4/12/2009 22:42	1.70	0.167						
	4/12/2009 22:43	1.70	0.167	0.17					
17.48	4/12/2009 22:38	1.83	0.146					3.87	1.74
	4/12/2009 22:39	1.80	0.150	0.15					
	4/12/2009 22:40	1.83	0.146						
19.99	4/12/2009 22:36	1.80	0.150					3.87	1.74
	4/12/2009 22:36	1.80	0.150	0.15					
	4/12/2009 22:37	1.80	0.150						
22.46	4/12/2009 22:33	7.70	0.014						
	4/12/2009 22:33	7.43	0.015	0.01					
	4/12/2009 22:34	7.35	0.015						
24.99	4/12/2009 22:11	12.31	0.007						
	4/12/2009 22:13	12.30	0.007						
	4/12/2009 22:15	13.20	0.006	0.01					
	4/12/2009 22:17	13.57	0.006					3.73	1.6
27.49	4/12/2009 22:19	10.44	0.009						
	4/12/2009 22:20	10.33	0.009						
	4/12/2009 22:21	9.55	0.010	0.01					
	4/12/2009 22:22	9.60	0.010						
27.89	4/12/2009 22:30	10.09	0.009						
	4/12/2009 22:30	11.65	0.008	0.01					
	4/12/2009 22:31	12.33	0.007						
28.99	4/12/2009 22:27	19.15	0.004	no flow				3.86	1.73
	4/12/2009 22:28	0.40	-2.237	no flow					
29.99	4/12/2009 22:24	19.10	0.004	no flow	4.5	9	0.50	3.83	1.7
	4/12/2009 22:25	0.40	-2.237	no flow					

Static Heat Pulse Flow Meter Results - BH09-7

Borehole BH09-7

Static Heat Pulse Flow Meter Testing

Pipe Stick Up = 0.87 (m)

Static Water Level = 2.13 (m - btop)

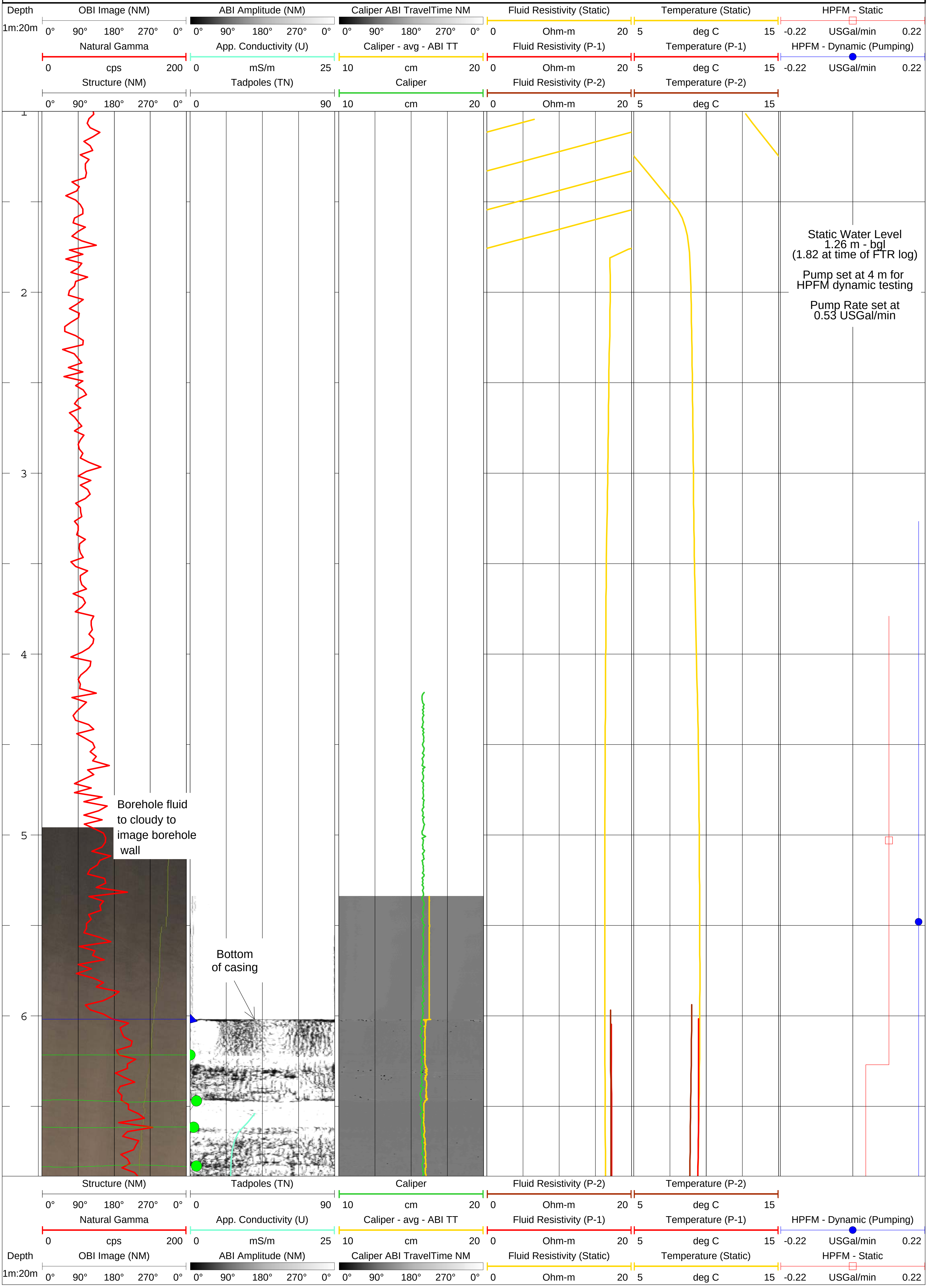
Depth (m)	Acq. Time Day/Time	Pick Time (sec)	Flow USGal/min.	Average (USGal/min) or Comment
5.03	4/12/2009 21:35	2.15	0.11	
	4/12/2009 21:35	2.17	0.11	0.11
7.51	4/12/2009 21:38	3.64	0.04	
	4/12/2009 21:39	3.82	0.04	0.04
10.04	4/12/2009 21:41	3.25	0.05	
	4/12/2009 21:43	3.40	0.05	0.05
12.51	4/12/2009 21:45	3.80	0.04	
	4/12/2009 21:46	3.85	0.04	0.04
15.01	4/12/2009 21:47	3.75	0.04	
	4/12/2009 21:48	3.90	0.04	0.04
17.57	4/12/2009 21:50	4.00	0.04	
	4/12/2009 21:50	4.00	0.04	0.04
20.04	4/12/2009 21:52	4.00	0.04	
	4/12/2009 21:53	3.00	0.06	
	4/12/2009 21:54	4.35	0.03	
	4/12/2009 21:55	4.50	0.03	0.04
22.51	4/12/2009 21:56	-	no flow	non-stable curve
	4/12/2009 21:58	-	no flow	non-stable curve
25.02	4/12/2009 22:00	-	no flow	non-stable curve
	4/12/2009 22:01	-	no flow	non-stable curve
	4/12/2009 22:03	-	no flow	non-stable curve

GEOPHYSICAL RECORD OF BOREHOLE: BH09-7

Borehole Geophysics
Confidential

Project Number: 09-1125-1008(3000)
Date: April, 2010

Datum:	MTM - NAD83						
Easting:	392,482 E	Depth Reference:	'0' at Ground Surface	Borehole Diameter:	6" (152.4 mm)	Location:	North Russel, Ontario
Northing:	5,018,476 N	Drilling Method:	Air Rotary	Casing Diameter:	158 mm	Log Date:	Dec. 4, 2009
Elevation:	83.52 m - asl	Drilled Depth:	33.55 m	Casing Depth:	6.02 m	Logged By:	MM-W



Static Water Level
1.26 m - bgl
(1.82 at time of FTR log)

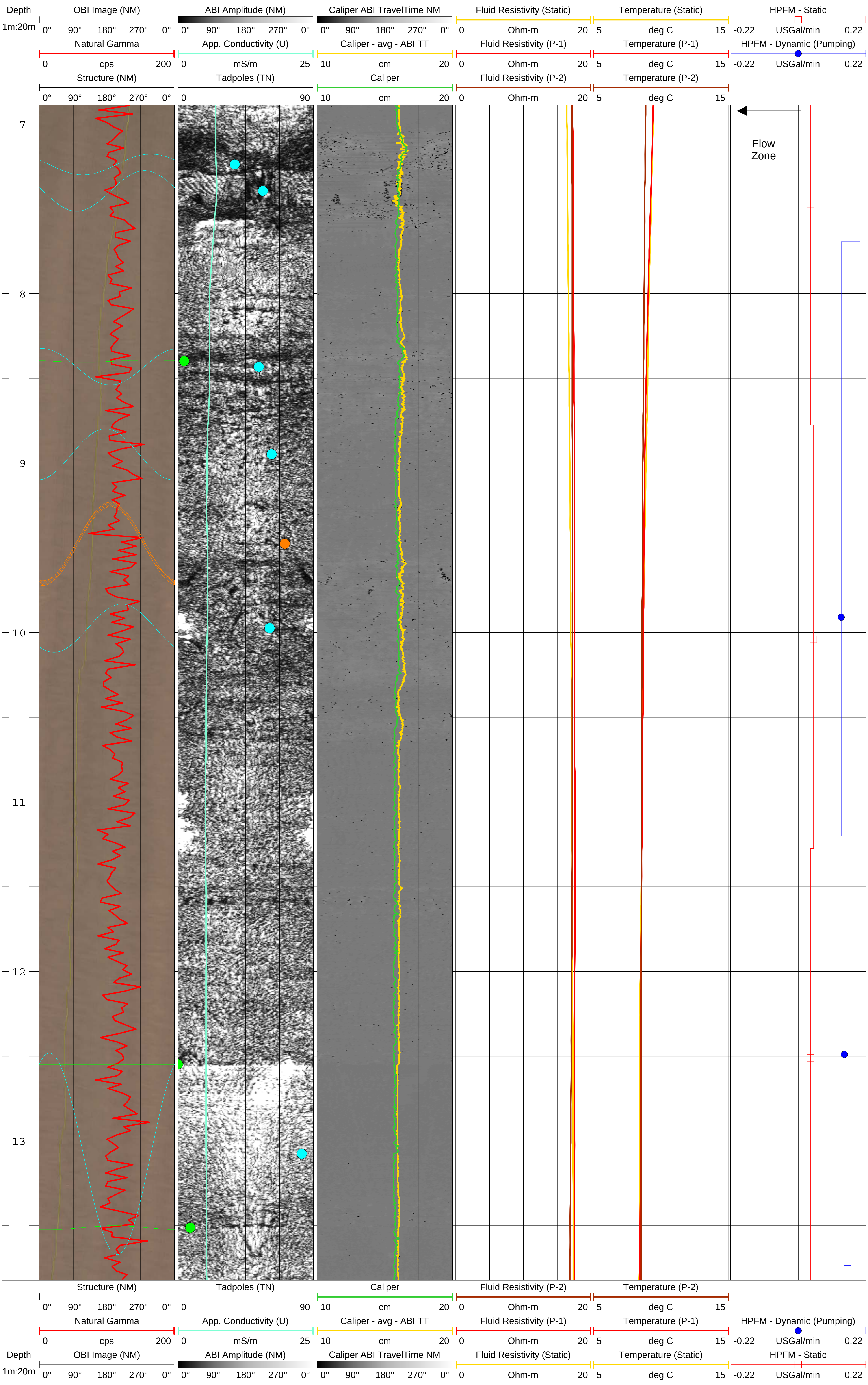
Pump set at 4 m for
HPFM dynamic testing

Pump Rate set at
0.53 USGal/min

Borehole fluid
to cloudy to
image borehole
wall

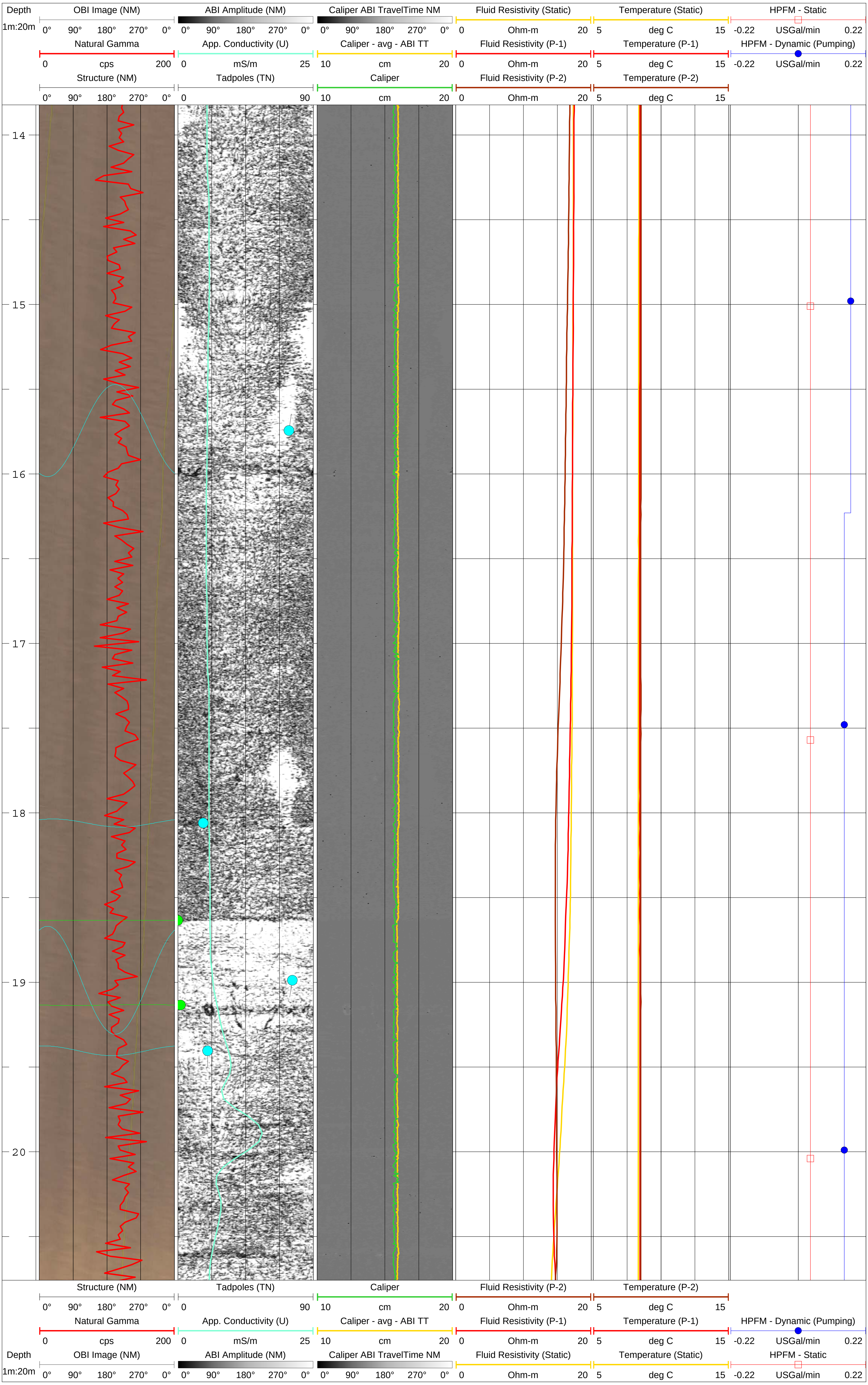
Bottom
of casing

BH09-7

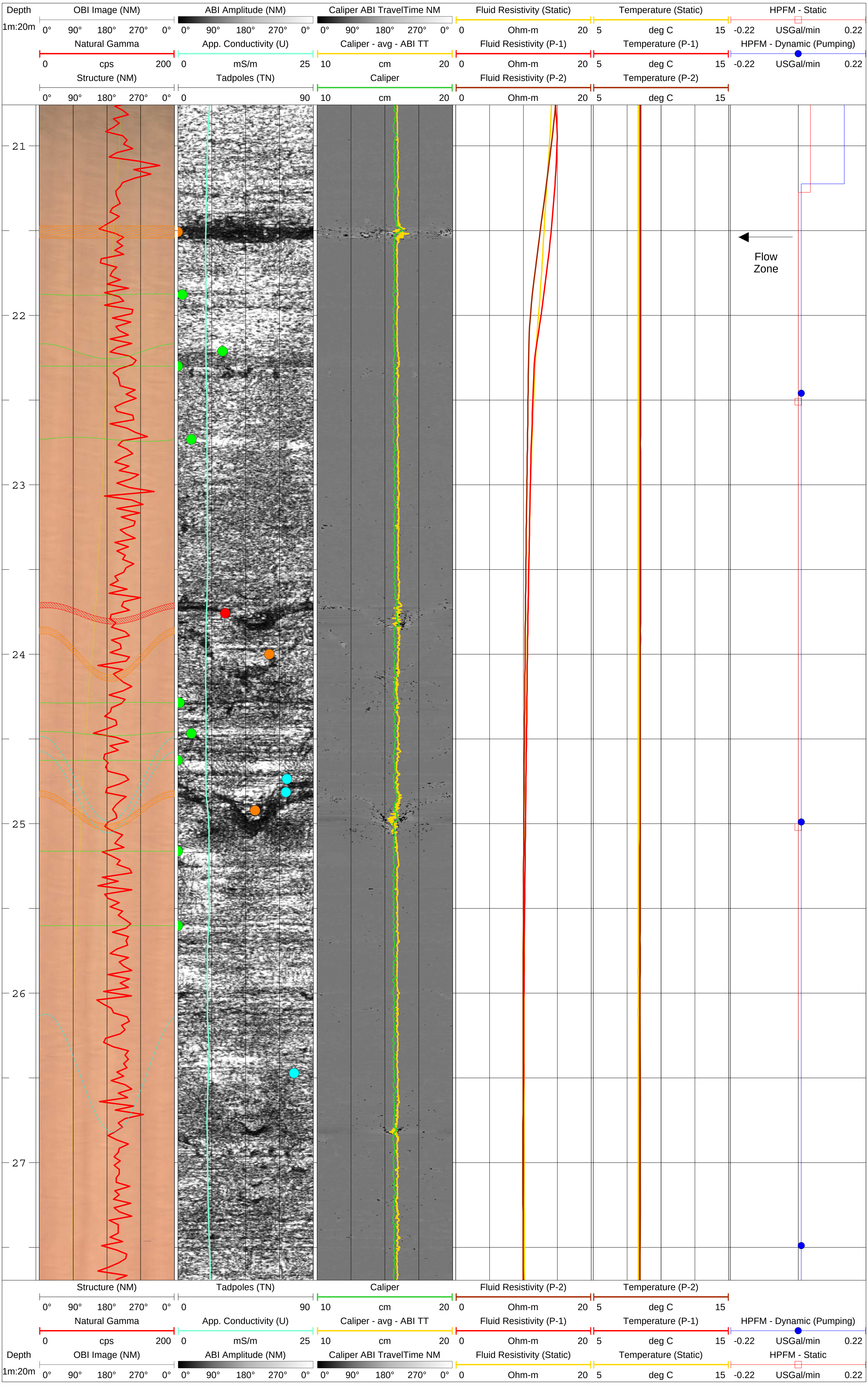


Depth
1m:20m
OBI Image (NM)
0° 90° 180° 270° 0°
ABI Amplitude (NM)
0° 90° 180° 270° 0°
Caliper ABI TravelTime NM
0° 90° 180° 270° 0°
Fluid Resistivity (Static)
0 Ohm-m 20
Temperature (Static)
5 deg C 15
HPFM - Static
-0.22 USGal/min 0.22
Natural Gamma
0 cps 200
App. Conductivity (U)
0 mS/m 25
Caliper - avg - ABI TT
10 cm 20
Fluid Resistivity (P-1)
0 Ohm-m 20
Temperature (P-1)
5 deg C 15
HPFM - Dynamic (Pumping)
-0.22 USGal/min 0.22
Structure (NM)
0° 90° 180° 270° 0°
Tadpoles (TN)
0 90
Caliper
10 cm 20
Fluid Resistivity (P-2)
0 Ohm-m 20
Temperature (P-2)
5 deg C 15
7
8
9
10
11
12
13
Flow
Zone

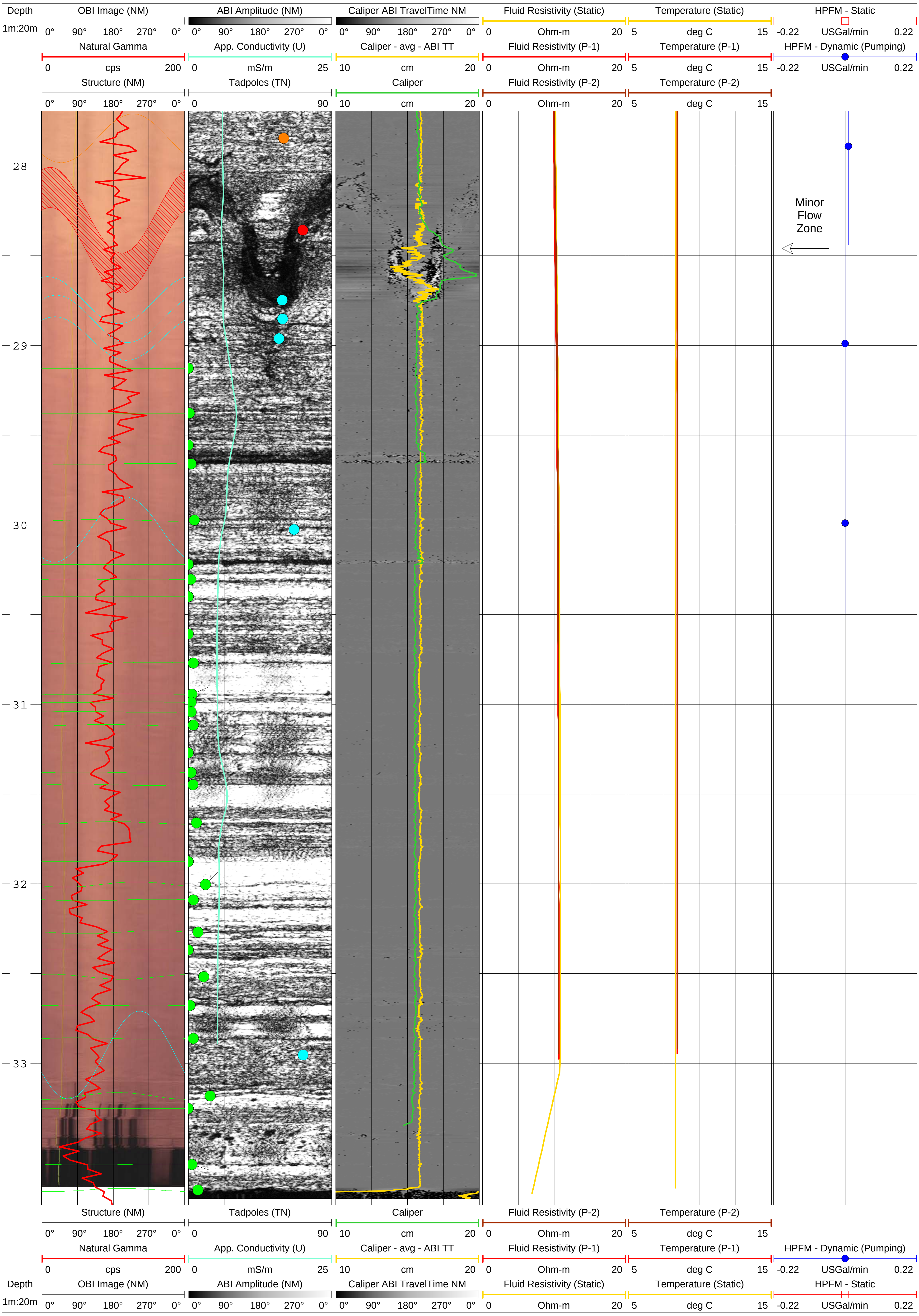
BH09-7


Depth
1m:20m
OBI Image (NM) 0° 90° 180° 270° 0°
Natural Gamma 0 cps 200
Structure (NM) 0° 90° 180° 270° 0°
ABI Amplitude (NM) 0° 90° 180° 270° 0°
App. Conductivity (U) 0 mS/m 25
Tadpoles (TN) 0 90
Caliper ABI TravelTime NM 0° 90° 180° 270° 0°
Caliper - avg - ABI TT 10 cm 20
Caliper 10 cm 20
Fluid Resistivity (Static) 0 Ohm-m 20
Fluid Resistivity (P-1) 0 Ohm-m 20
Fluid Resistivity (P-2) 0 Ohm-m 20
Temperature (Static) 5 deg C 15
Temperature (P-1) 5 deg C 15
Temperature (P-2) 5 deg C 15
HPFM - Static -0.22 USGal/min 0.22
HPFM - Dynamic (Pumping) -0.22 USGal/min 0.22
14
15
16
17
18
19
20

BH09-7


Depth
1m:20m
OBI Image (NM)
0° 90° 180° 270° 0°
Natural Gamma
0 cps 200
Structure (NM)
0° 90° 180° 270° 0°
ABI Amplitude (NM)
0° 90° 180° 270° 0°
App. Conductivity (U)
0 mS/m 25
Tadpoles (TN)
0 90
Caliper ABI TravelTime NM
0° 90° 180° 270° 0°
Caliper - avg - ABI TT
10 cm 20
Caliper
10 cm 20
Fluid Resistivity (Static)
0 Ohm-m 20
Fluid Resistivity (P-1)
0 Ohm-m 20
Fluid Resistivity (P-2)
0 Ohm-m 20
Temperature (Static)
5 deg C 15
Temperature (P-1)
5 deg C 15
Temperature (P-2)
5 deg C 15
HPFM - Static
-0.22 USGal/min 0.22
HPFM - Dynamic (Pumping)
-0.22 USGal/min 0.22
21
22
23
24
25
26
27
Flow Zone

BH09-7


Depth
1m:20m
OBI Image (NM)
0° 90° 180° 270° 0°
Natural Gamma
0 cps 200
Structure (NM)
0° 90° 180° 270° 0°
ABI Amplitude (NM)
0° 90° 180° 270° 0°
App. Conductivity (U)
0 mS/m 25
Tadpoles (TN)
0 90
Caliper ABI TravelTime NM
0° 90° 180° 270° 0°
Caliper - avg - ABI TT
10 cm 20
Caliper
10 cm 20
Fluid Resistivity (Static)
0 Ohm-m 20
Fluid Resistivity (P-1)
0 Ohm-m 20
Fluid Resistivity (P-2)
0 Ohm-m 20
Temperature (Static)
5 deg C 15
Temperature (P-1)
5 deg C 15
Temperature (P-2)
5 deg C 15
HPFM - Static
-0.22 USGal/min 0.22
HPFM - Dynamic (Pumping)
-0.22 USGal/min 0.22
28
29
30
31
32
33
Minor
Flow
Zone
Structure (NM)
0° 90° 180° 270° 0°
Tadpoles (TN)
0 90
Caliper
10 cm 20
Fluid Resistivity (P-2)
0 Ohm-m 20
Temperature (P-2)
5 deg C 15
Natural Gamma
0 cps 200
App. Conductivity (U)
0 mS/m 25
Caliper - avg - ABI TT
10 cm 20
Fluid Resistivity (P-1)
0 Ohm-m 20
Temperature (P-1)
5 deg C 15
HPFM - Dynamic (Pumping)
-0.22 USGal/min 0.22
Depth
1m:20m
OBI Image (NM)
0° 90° 180° 270° 0°
ABI Amplitude (NM)
0° 90° 180° 270° 0°
Caliper ABI TravelTime NM
0° 90° 180° 270° 0°
Fluid Resistivity (Static)
0 Ohm-m 20
Temperature (Static)
5 deg C 15
HPFM - Static
-0.22 USGal/min 0.22

GEOPHYSICAL RECORD OF BOREHOLE: BH09-7

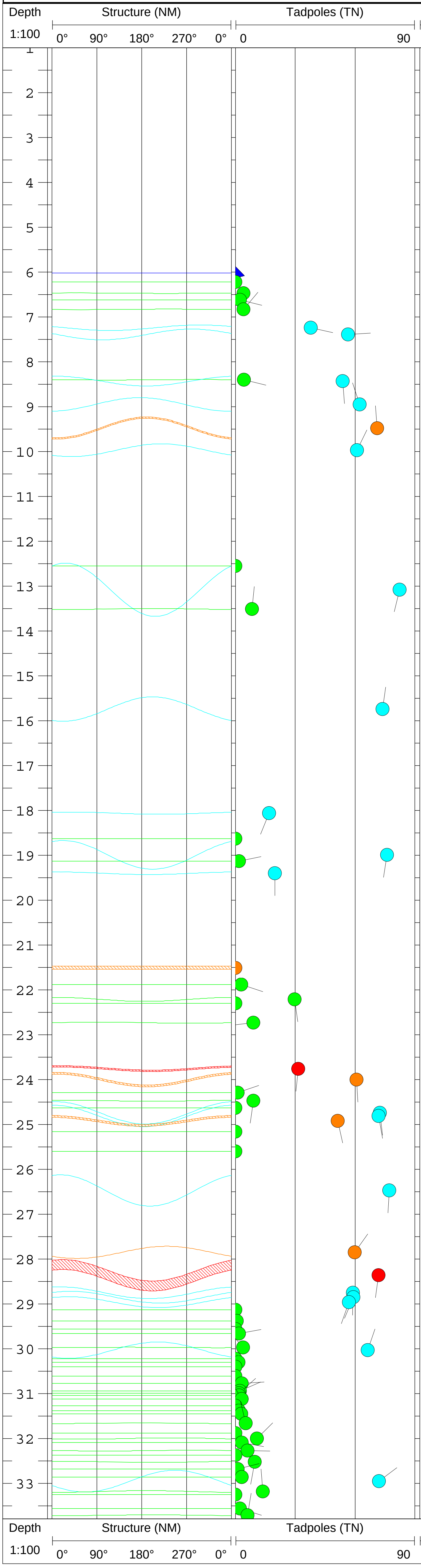
Borehole Geophysics

Confidential

Project Number: 09-1125-1008(3000)

Date: April, 2010

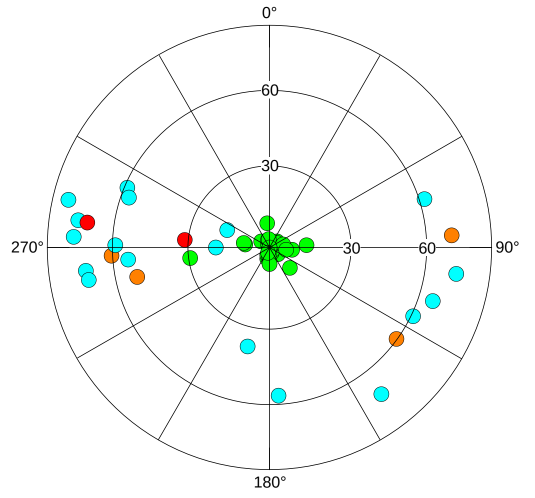
Datum:	MTM - NAD83						
Easting:	392,482 E	Depth Reference:	'0' at Ground Surface	Borehole Diameter:	6" (152.4 mm)	Location:	North Russel, Ontario
Northing:	5,018,476 N	Drilling Method:	Air Rotary	Casing Diameter:	158 mm	Log Date:	Dec. 4, 2009
Elevation:	83.52 m - asl	Drilled Depth:	33.55 m	Casing Depth:	6.02 m	Logged By:	MM-W



Strike From Tadpoles

Schmidt Plot (Strike) - LH - Type

Schmidt Plot (Strike) - LH - Type
Depth: 0.00 [m] to 35.00 [m]

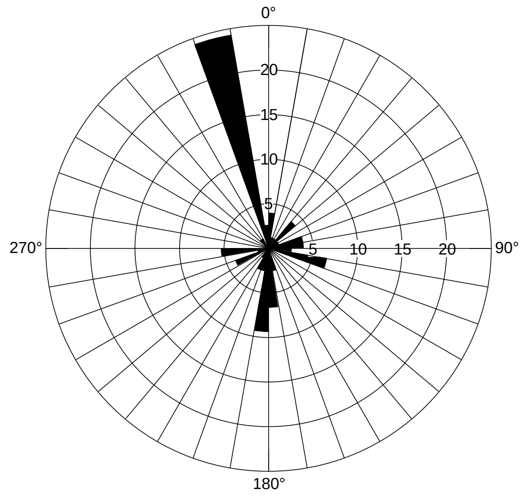


	Counts	Dip[deg]	Strike[deg]
Mean	73	20.52	289.11
🟢	48	3.37	272.02
🔵	18	60.09	71.21
🟠	5	49.67	304.48
🔴	2	51.60	96.60

Azimuth From Tadpoles (TN)

Azimuth - Percent Interval (Count)

Azimuth - Percent Interval (Count)
Depth: 0.00 [m] to 35.00 [m]



Counts:	73.00
Mean:	19.11
Std.Dev.:	115.66
Min:	6.12
Max:	356.15

Depth 1:100 | Structure (NM) 0° 90° 180° 270° 0° | Tadpoles (TN) 0 90 | Strike From Tadpoles Schmidt Plot (Strike) - LH - Type | Azimuth From Tadpoles (TN) Azimuth - Percent Interval (Count)

ATTACHMENT TSD#1-B-4-4

Geophysical Logging Results for BH09-8

Dynamic Heat Pulse Flow Meter Results - BH09-8

Borehole BH09-8

Dynamic Heat Pulse Flow Meter Testing

Pipe Stick Up = 0.76 (m)

Static Water Level = 1.57 (m - btop)

					Pump Rate				
Depth (m)	Acq. Time Day/Time	Pick Time (sec)	Flow (USGal/min)	Average (USGal/min) or Comment	Volume (USGal)	Time (min)	Rate USGal/min	Water Level (m - btop)	Draw Down (m)
2.65	4/12/2009 15:50	0.75	0.76	0.76					
	4/12/2009 15:51	0.75	0.76						
	4/12/2009 15:52	0.75	0.76						
2.99	4/12/2009 15:45	4.05	0.04	0.54	4.50	2.78	1.62	1.63	0.06
	4/12/2009 15:47	0.75	0.76						
	4/12/2009 15:49	0.80	0.67						
	4/12/2009 15:49	0.80	0.67						
3.99	4/12/2009 15:41	0.95	0.49	0.47					
	4/12/2009 15:42	1.00	0.44						
	4/12/2009 15:43	0.95	0.49						
4.97	4/12/2009 15:35	16.36	0.005	0.01					
	4/12/2009 15:36	16.36	0.005						
	4/12/2009 15:37	13.68	0.006						
	4/12/2009 15:39	14.26	0.006						
	4/12/2009 15:40	14.49	0.006						
7.48	4/12/2009 15:33	-	no flow	non-stable curve					
	4/12/2009 15:34	-	no flow	non-stable curve					
9.98	4/12/2009 15:29	-	no flow	non-stable curve					
	4/12/2009 15:31	-	no flow	non-stable curve					
14.99	4/12/2009 15:25	-	no flow	non-stable curve	4.50	1.47	3.07	1.63	0.06
	4/12/2009 15:26	12.25	0.007	possible very minor upward flow					
	4/12/2009 15:28	20.00	0.004	possible very minor upward flow					
19.99	4/12/2009 15:20	-	no flow	non-stable curve					
	4/12/2009 15:22	-	no flow	non-stable curve					
24.97	4/12/2009 15:16	20.00	0.004	possible very minor upward flow	4.50	1.48	3.03	1.63	0.06
	4/12/2009 15:18	20.00	0.004	possible very minor upward flow					

Static Heat Pulse Flow Meter Results - BH09-8

Borehole BH09-8

Static Heat Pulse Flow Meter Testing

Pipe Stick Up = 0.76 (m)

Static Water Level = 1.57 (m - btop)

Depth (m)	Acq. Time Day/Time	Pick Time (sec)	Flow USGal/min.	Average (USGal/min) or Comment
2.60	4/12/2009 14:51	-	no flow	non-stable curve
3.01	4/12/2009 14:52	-	no flow	non-stable curve
	4/12/2009 14:53	-	no flow	non-stable curve
5.01	4/12/2009 14:55	-	no flow	non-stable curve
	4/12/2009 14:56	-	no flow	non-stable curve
10.02	4/12/2009 15:00	-	no flow	non-stable curve
	4/12/2009 15:00	-	no flow	non-stable curve
20.04	4/12/2009 15:04	-	no flow	non-stable curve
	4/12/2009 15:04	-	no flow	non-stable curve
	4/12/2009 15:06	-	no flow	non-stable curve
25.01	4/12/2009 15:07	19.20	0.004	possible very minor upward flow
	4/12/2009 15:08	20.00	0.004	possible very minor upward flow

GEOPHYSICAL RECORD OF BOREHOLE: BH09-8

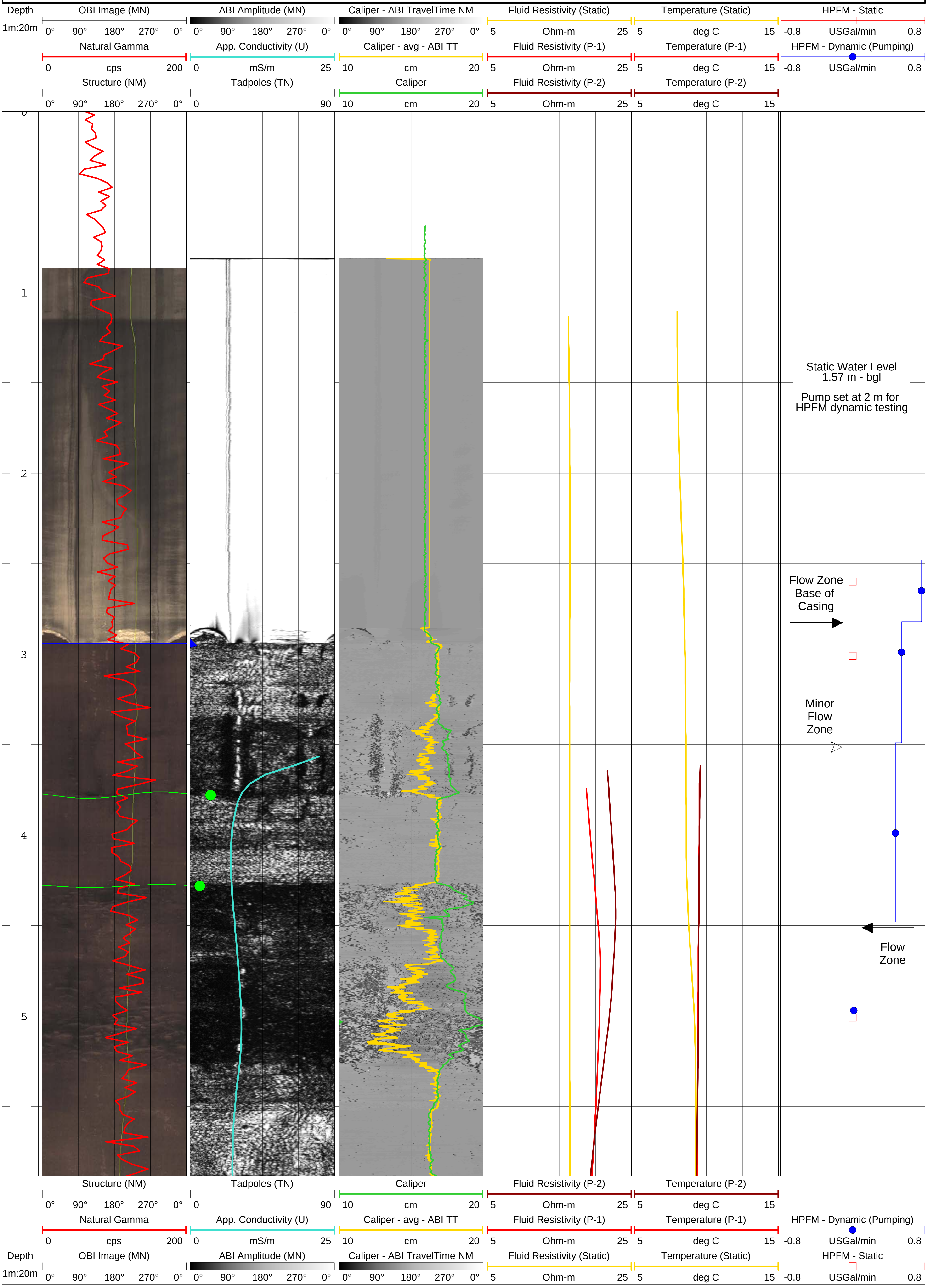
Borehole Geophysics

Confidential

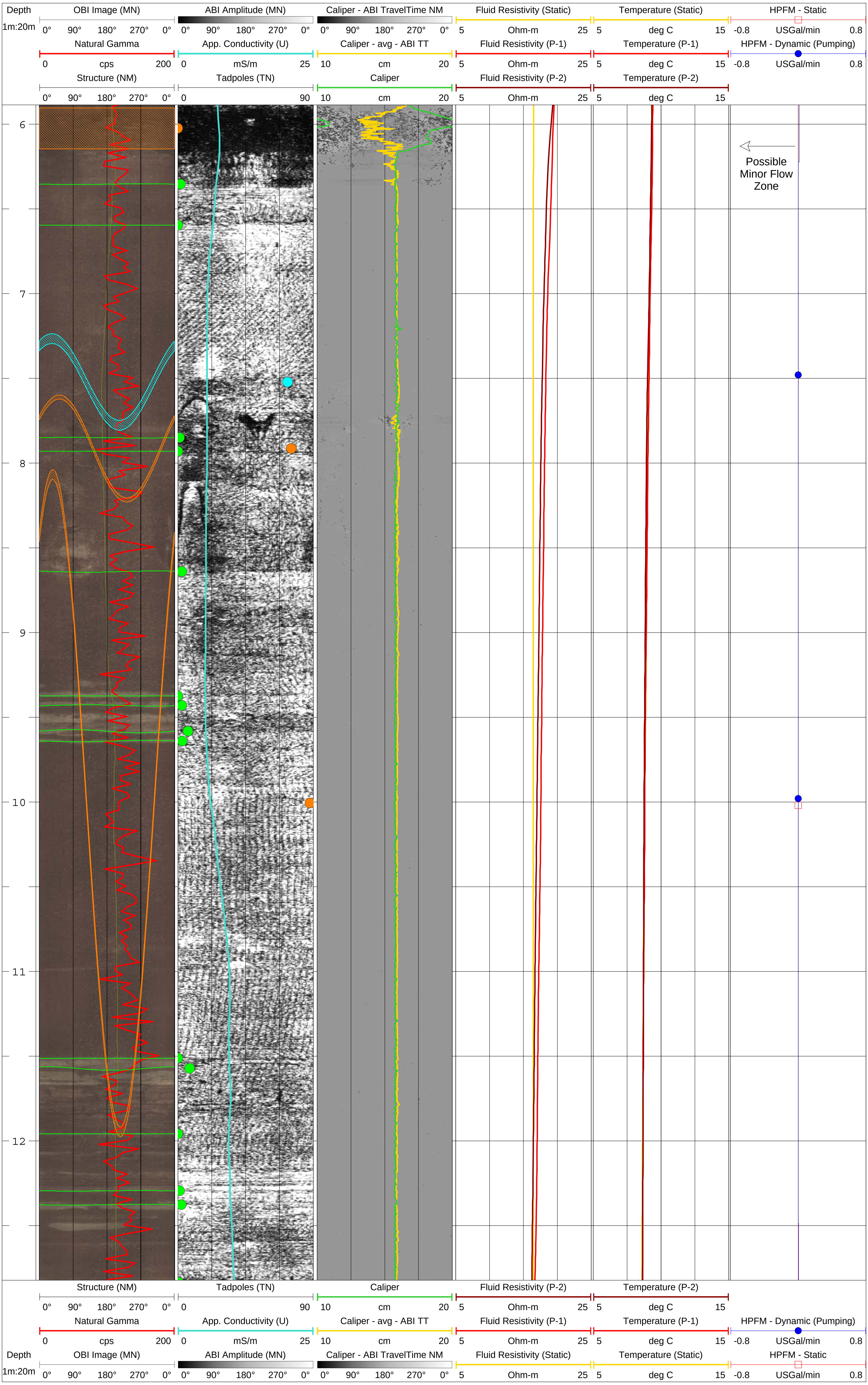
Project Number: 09-1125-1008 (3000)

Date: April, 2010

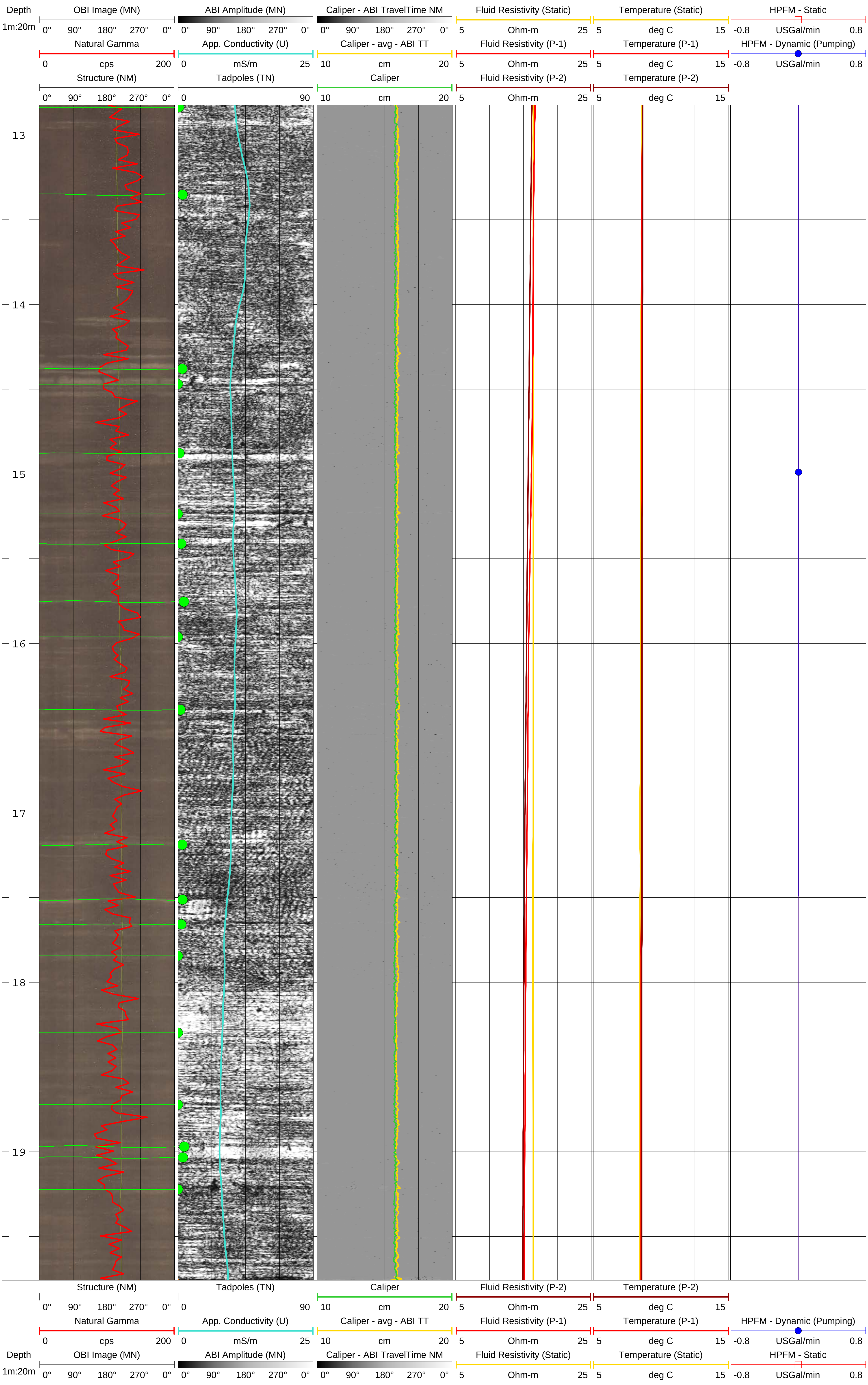
Datum:	MTM NAD83						
Easting:	393,472 E	Depth Reference:	'0' at Ground Surface	Borehole Diameter:	6" (152.4 mm)	Location:	North Russel, Ontario
Northing:	5,019,106 N	Drilling Method:	Air Rotary	Casing Diameter:	158 mm	Log Date:	December 4, 2009
Elevation:	79.38 m asl	Drilled Depth:	~30.5 m	Casing Depth:	2.94 m	Logged By:	MM-W



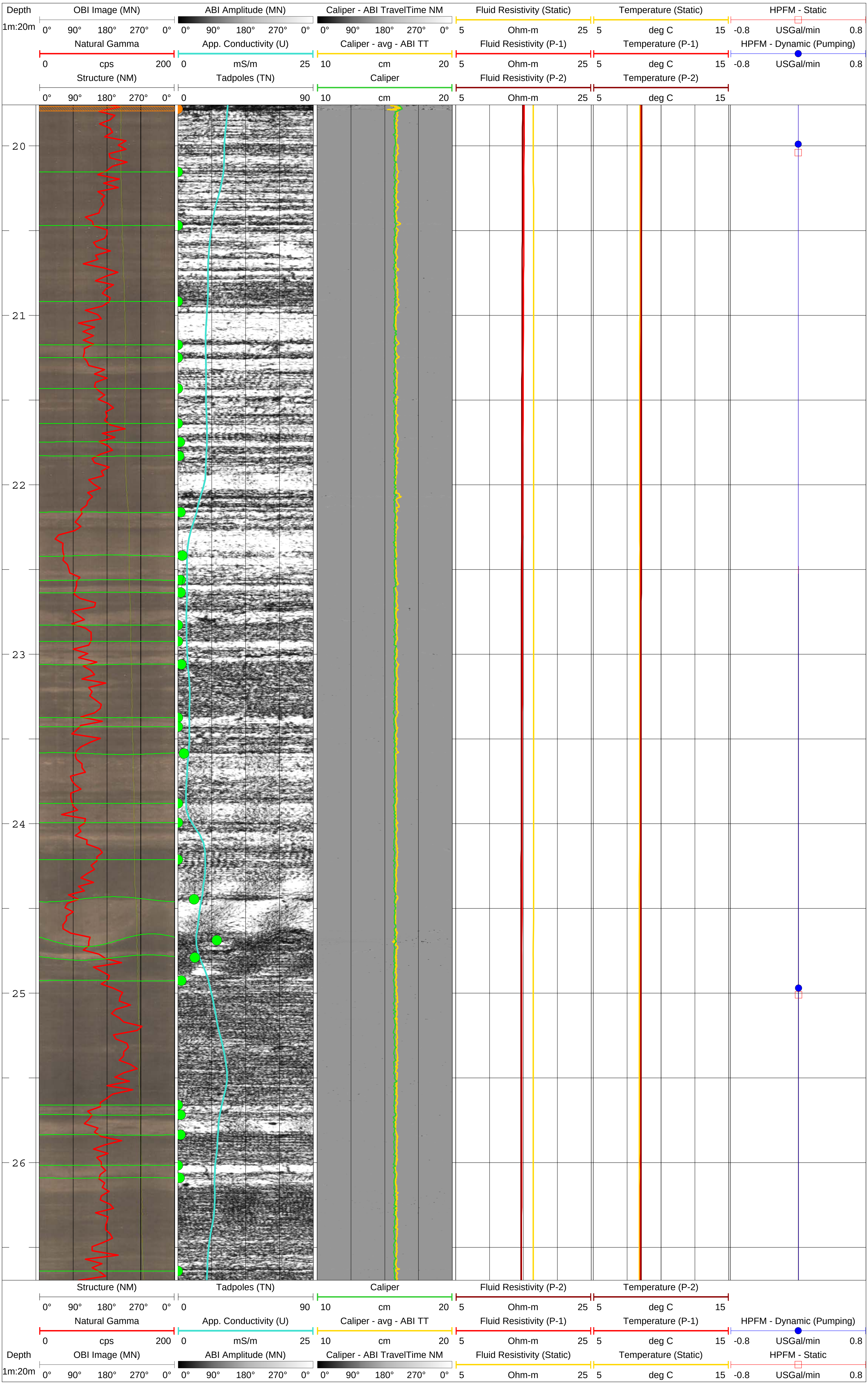
BH09-8


Depth
1m:20m
OBI Image (MN)
0° 90° 180° 270° 0°
Natural Gamma
0 cps 200
Structure (NM)
0° 90° 180° 270° 0°
ABI Amplitude (MN)
0° 90° 180° 270° 0°
App. Conductivity (U)
0 mS/m 25
Tadpoles (TN)
0 90
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Caliper - avg - ABI TT
10 cm 20
Caliper
10 cm 20
Fluid Resistivity (Static)
5 Ohm-m 25
Fluid Resistivity (P-1)
5 Ohm-m 25
Fluid Resistivity (P-2)
5 Ohm-m 25
Temperature (Static)
5 deg C 15
Temperature (P-1)
5 deg C 15
Temperature (P-2)
5 deg C 15
HPFM - Static
-0.8 USGal/min 0.8
HPFM - Dynamic (Pumping)
-0.8 USGal/min 0.8
6
7
8
9
10
11
12
Possible Minor Flow Zone
Structure (NM)
0° 90° 180° 270° 0°
Tadpoles (TN)
0 90
Caliper
10 cm 20
Fluid Resistivity (P-2)
5 Ohm-m 25
Temperature (P-2)
5 deg C 15
Natural Gamma
0 cps 200
App. Conductivity (U)
0 mS/m 25
Caliper - avg - ABI TT
10 cm 20
Fluid Resistivity (P-1)
5 Ohm-m 25
Temperature (P-1)
5 deg C 15
HPFM - Dynamic (Pumping)
-0.8 USGal/min 0.8
Depth
1m:20m
OBI Image (MN)
0° 90° 180° 270° 0°
ABI Amplitude (MN)
0° 90° 180° 270° 0°
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Fluid Resistivity (Static)
5 Ohm-m 25
Temperature (Static)
5 deg C 15
HPFM - Static
-0.8 USGal/min 0.8

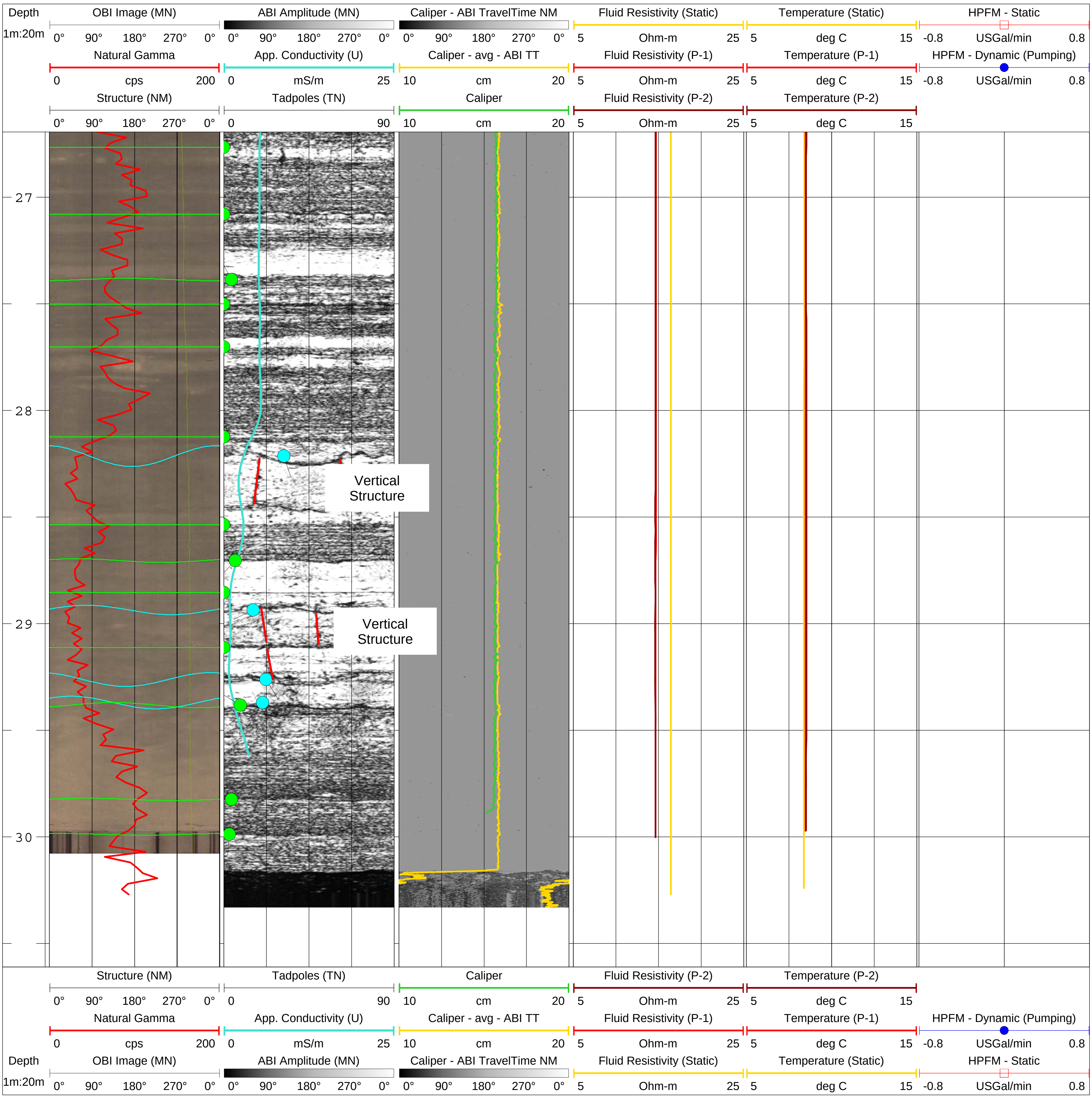
BH09-8


Depth
1m:20m
OBI Image (MN)
0° 90° 180° 270° 0°
Natural Gamma
0 cps 200
Structure (NM)
0° 90° 180° 270° 0°
ABI Amplitude (MN)
0° 90° 180° 270° 0°
App. Conductivity (U)
0 mS/m 25
Tadpoles (TN)
0 90
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Caliper - avg - ABI TT
10 cm 20
Caliper
10 cm 20
Fluid Resistivity (Static)
5 Ohm-m 25
Fluid Resistivity (P-1)
5 Ohm-m 25
Fluid Resistivity (P-2)
5 Ohm-m 25
Temperature (Static)
5 deg C 15
Temperature (P-1)
5 deg C 15
Temperature (P-2)
5 deg C 15
HPFM - Static
-0.8 USGal/min 0.8
HPFM - Dynamic (Pumping)
-0.8 USGal/min 0.8
13
14
15
16
17
18
19
Structure (NM)
0° 90° 180° 270° 0°
Tadpoles (TN)
0 90
Caliper
10 cm 20
Fluid Resistivity (P-2)
5 Ohm-m 25
Temperature (P-2)
5 deg C 15
Natural Gamma
0 cps 200
App. Conductivity (U)
0 mS/m 25
Caliper - avg - ABI TT
10 cm 20
Fluid Resistivity (P-1)
5 Ohm-m 25
Temperature (P-1)
5 deg C 15
HPFM - Dynamic (Pumping)
-0.8 USGal/min 0.8
Depth
1m:20m
OBI Image (MN)
0° 90° 180° 270° 0°
ABI Amplitude (MN)
0° 90° 180° 270° 0°
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Fluid Resistivity (Static)
5 Ohm-m 25
Temperature (Static)
5 deg C 15
HPFM - Static
-0.8 USGal/min 0.8

BH09-8


Depth
1m:20m
OBI Image (MN)
0° 90° 180° 270° 0°
Natural Gamma
0 cps 200
Structure (NM)
0° 90° 180° 270° 0°
ABI Amplitude (MN)
0° 90° 180° 270° 0°
App. Conductivity (U)
0 mS/m 25
Tadpoles (TN)
0 90
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Caliper - avg - ABI TT
10 cm 20
Caliper
10 cm 20
Fluid Resistivity (Static)
5 Ohm-m 25
Fluid Resistivity (P-1)
5 Ohm-m 25
Fluid Resistivity (P-2)
5 Ohm-m 25
Temperature (Static)
5 deg C 15
Temperature (P-1)
5 deg C 15
Temperature (P-2)
5 deg C 15
HPFM - Static
-0.8 USGal/min 0.8
HPFM - Dynamic (Pumping)
-0.8 USGal/min 0.8
20
21
22
23
24
25
26

BH09-8



Depth
1m:20m
OBI Image (MN)
0° 90° 180° 270° 0°
Natural Gamma
0 cps 200
Structure (NM)
0° 90° 180° 270° 0°
ABI Amplitude (MN)
0° 90° 180° 270° 0°
App. Conductivity (U)
0 mS/m 25
Tadpoles (TN)
0 90
Caliper - ABI TravelTime NM
0° 90° 180° 270° 0°
Caliper - avg - ABI TT
10 cm 20
Caliper
10 cm 20
Fluid Resistivity (Static)
5 Ohm-m 25
Fluid Resistivity (P-1)
5 Ohm-m 25
Fluid Resistivity (P-2)
5 Ohm-m 25
Temperature (Static)
5 deg C 15
Temperature (P-1)
5 deg C 15
Temperature (P-2)
5 deg C 15
HPFM - Static
-0.8 USGal/min 0.8
HPFM - Dynamic (Pumping)
-0.8 USGal/min 0.8
27
28
29
30
Vertical Structure
Vertical Structure

GEOPHYSICAL RECORD OF BOREHOLE: BH09-8

Borehole Geophysics

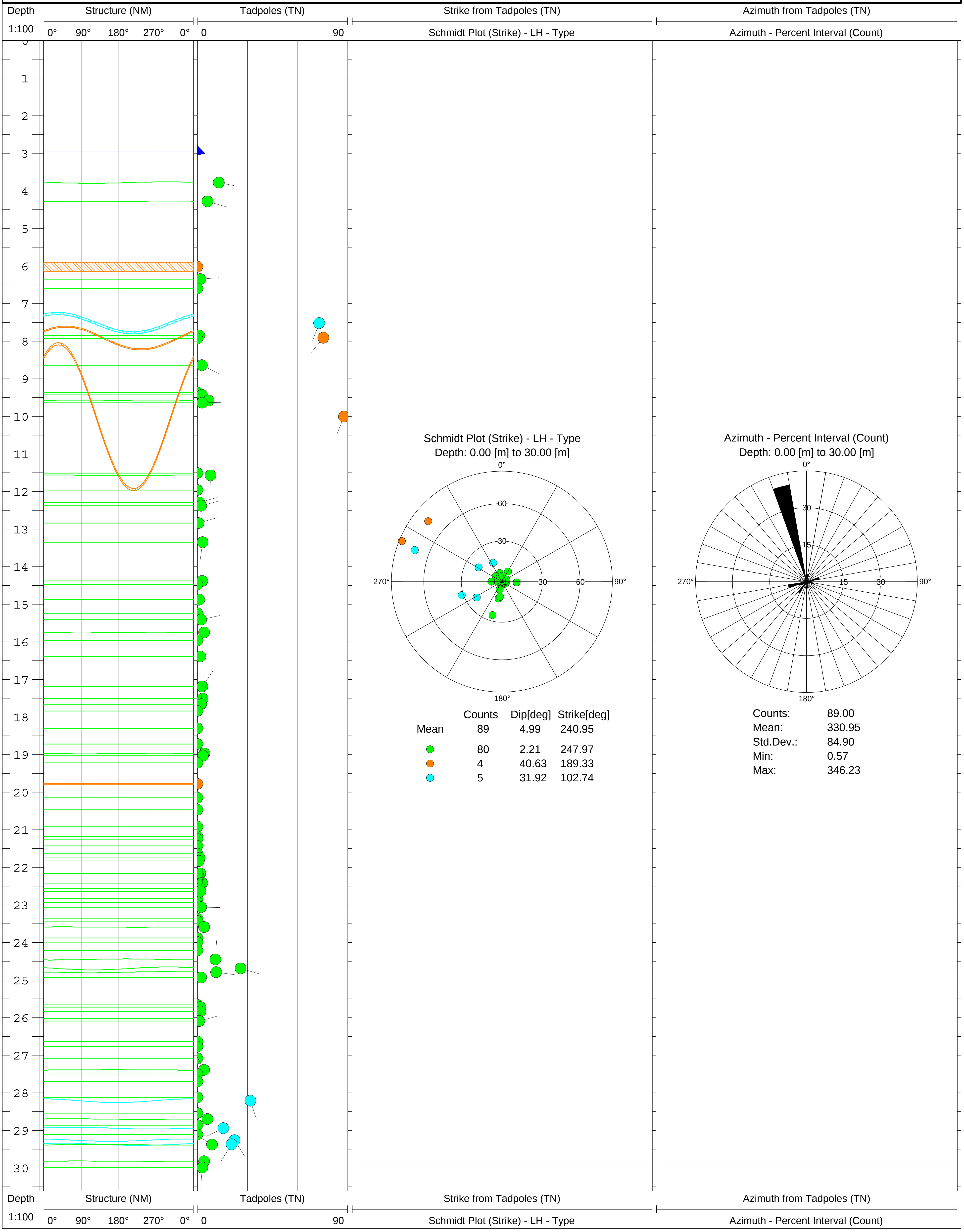
Confidential

Golder Associates

Project Number: 09-1125-1008 (3000)

Date: April, 2010

Datum:	MTM NAD83						
Easting:	393,472 E	Depth Reference:	'0' at Ground Surface	Borehole Diameter:	6" (152.4 mm)	Location:	North Russel, Ontario
Northing:	5,019,106 N	Drilling Method:	Air Rotary	Casing Diameter:	158 mm	Log Date:	December 4, 2009
Elevation:	79.38 m asl	Drilled Depth:	~30.5 m	Casing Depth:	2.94 m	Logged By:	MM-W



	Counts	Dip[deg]	Strike[deg]
Mean	89	4.99	240.95
🟢	80	2.21	247.97
🟠	4	40.63	189.33
🔵	5	31.92	102.74

Counts:	89.00
Mean:	330.95
Std.Dev.:	84.90
Min:	0.57
Max:	346.23

ATTACHMENT TSD#1-B-5

Groundwater and Quarry Water Elevation Data (NRR Site)

February 2013

TABLE TSD#1-B-5-1
GROUNDWATER ELEVATION DATA
NRR SITE, CRRRC PROJECT

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	Screened Interval Elevation (mASL)		8-Jan-10		11-Feb-10		11-Mar-10		17-Mar-10	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		- -	- -	5.63	77.54	5.25	77.92	5.34	77.83
BH08-2	80.77	81.44	- -		- -	- -	3.05	78.39	1.85	79.59	2.05	79.39
BH09-3A	86.30	87.13	70.50	64.35	4.28	82.85	4.70	82.43	4.18	82.95	4.05	83.08
BH09-3B	86.30	87.13	80.20	72.89	4.25	82.88	4.69	82.44	4.15	82.98	4.02	83.11
BH09-4A	79.05	79.94	62.59	57.10	2.27	77.67	frozen	- -	2.20	77.74	2.27	77.67
BH09-4B	79.05	79.96	77.22	71.43	1.58	78.38	2.43	77.53	0.85	79.11	0.93	79.03
BH09-5	73.93	74.69	55.03	48.33	1.85	72.84	1.86	72.83	1.96	72.73	1.93	72.76
BH09-6A	84.94	85.06	68.48	62.38	2.11	82.95	1.97	83.09	2.14	82.92	2.10	82.96
BH09-6B	84.94	85.09	80.06	74.58	1.34	83.75	1.56	83.53	1.48	83.61	1.47	83.62
BH09-7A	83.52	84.29	57.36	49.99	2.10	82.19	2.15	82.14	1.68	82.61	1.81	82.48
BH09-7B	83.52	84.31	65.23	59.29	2.12	82.19	2.17	82.14	1.68	82.63	1.81	82.50
BH09-7C	83.52	84.31	76.81	71.63	2.63	81.68	2.56	81.75	2.08	82.23	2.07	82.24
BH09-8A	79.38	80.27	55.00	48.90	14.81	65.46	17.54	62.73	21.74	58.53	19.63	60.64
BH09-8B	79.38	80.31	65.36	58.04	14.82	65.49	17.60	62.71	20.83	59.48	19.70	60.61
BH09-8C	79.38	80.33	75.42	71.15	1.83	78.50	1.92	78.41	1.47	78.86	1.46	78.87
SG-1	- -	78.18	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SG-2	- -	79.29	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	ened Interval Elevation (m		4-Aug-10		3-Sep-10		23-Oct-10		26-Nov-10	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		8.97	74.20	7.41	75.76	5.68	77.49	5.34	77.83
BH08-2	80.77	81.44	- -		4.28	77.16	4.22	77.22	3.24	78.20	2.55	78.89
BH09-3A	86.30	87.13	70.50	64.35	5.46	81.67	5.48	81.65	4.72	82.41	4.08	83.05
BH09-3B	86.30	87.13	80.20	72.89	5.41	81.72	5.52	81.61	5.09	82.04	4.03	83.10
BH09-4A	79.05	79.94	62.59	57.10	3.47	76.47	3.31	76.63	2.37	77.57	1.94	78.00
BH09-4B	79.05	79.96	77.22	71.43	2.58	77.38	2.62	77.34	1.63	78.33	1.05	78.91
BH09-5	73.93	74.69	55.03	48.33	3.28	71.41	3.03	71.66	2.71	71.98	2.42	72.27
BH09-6A	84.94	85.06	68.48	62.38	2.53	82.53	3.11	81.95	2.78	82.28	2.44	82.62
BH09-6B	84.94	85.09	80.06	74.58	3.09	82.00	3.17	81.92	2.10	82.99	1.84	83.25
BH09-7A	83.52	84.29	57.36	49.99	3.82	80.47	3.96	80.33	2.43	81.86	1.74	82.55
BH09-7B	83.52	84.31	65.23	59.29	3.84	80.47	3.99	80.32	2.43	81.88	1.74	82.57
BH09-7C	83.52	84.31	76.81	71.63	3.83	80.48	3.93	80.38	2.80	81.51	2.30	82.01
BH09-8A	79.38	80.27	55.00	48.90	19.10	61.17	17.53	62.74	23.89	56.38	18.66	61.61
BH09-8B	79.38	80.31	65.36	58.04	19.20	61.11	17.62	62.69	19.83	60.48	18.01	62.30
BH09-8C	79.38	80.33	75.42	71.15	3.83	76.50	3.20	77.13	2.02	78.31	1.62	78.71
SG-1	- -	78.18	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SG-2	- -	79.29	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

TABLE TSD#1-B-5-1
GROUNDWATER ELEVATION DATA
NRR SITE, CRRRC PROJECT

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	Screened Interval Elevation (mASL)		30-Mar-10		20-May-10		23-Jun-10		4-Mar-11	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		5.49	77.68	5.80	77.37	5.79	77.38	5.81	77.36
BH08-2	80.77	81.44	- -		2.32	79.12	3.39	78.05	3.87	77.57	3.48	77.96
BH09-3A	86.30	87.13	70.50	64.35	4.46	82.67	5.50	81.63	5.29	81.84	4.73	82.40
BH09-3B	86.30	87.13	80.20	72.89	4.43	82.70	5.47	81.66	5.19	81.94	4.68	82.45
BH09-4A	79.05	79.94	62.59	57.10	2.22	77.72	2.81	77.13	3.29	76.65	2.62	77.32
BH09-4B	79.05	79.96	77.22	71.43	0.95	79.01	2.00	77.96	2.29	77.67	1.99	77.97
BH09-5	73.93	74.69	55.03	48.33	1.89	72.80	1.98	72.71	2.32	72.37	2.15	72.54
BH09-6A	84.94	85.06	68.48	62.38	2.08	82.98	2.08	82.98	2.24	82.82	2.12	82.94
BH09-6B	84.94	85.09	80.06	74.58	1.55	83.54	1.68	83.41	2.00	83.09	1.58	83.51
BH09-7A	83.52	84.29	57.36	49.99	1.69	82.60	2.37	81.92	3.10	81.19	2.61	81.68
BH09-7B	83.52	84.31	65.23	59.29	1.67	82.64	2.36	81.95	3.07	81.24	2.62	81.69
BH09-7C	83.52	84.31	76.81	71.63	2.22	82.09	2.90	81.41	3.29	81.02	2.89	81.42
BH09-8A	79.38	80.27	55.00	48.90	18.73	61.54	15.71	64.56	11.12	69.15	8.89	71.38
BH09-8B	79.38	80.31	65.36	58.04	18.82	61.49	15.78	64.53	11.21	69.10	8.97	71.34
BH09-8C	79.38	80.33	75.42	71.15	1.47	78.86	2.22	78.11	2.76	77.57	2.16	78.17
SG-1	- -	78.18	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SG-2	- -	79.29	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	ened Interval Elevation (m		9-Dec-10		7-Jan-11		16-Feb-11		17-Oct-11	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		5.42	77.75	5.63	77.54	5.89	77.28	5.75	77.42
BH08-2	80.77	81.44	- -		2.52	78.92	2.95	78.49	3.69	77.75	4.24	77.20
BH09-3A	86.30	87.13	70.50	64.35	3.91	83.22	4.15	82.98	4.89	82.24	5.71	81.42
BH09-3B	86.30	87.13	80.20	72.89	3.78	83.35	4.14	82.99	4.86	82.27	5.62	81.51
BH09-4A	79.05	79.94	62.59	57.10	1.91	78.03	1.95	77.99	2.49	77.45	3.10	76.84
BH09-4B	79.05	79.96	77.22	71.43	1.20	78.76	1.47	78.49	2.11	77.85	2.73	77.23
BH09-5	73.93	74.69	55.03	48.33	2.18	72.51	2.04	72.65	2.23	72.46	4.04	70.65
BH09-6A	84.94	85.06	68.48	62.38	2.26	82.80	1.97	83.09	2.29	82.77	3.35	81.71
BH09-6B	84.94	85.09	80.06	74.58	1.71	83.38	1.39	83.70	1.65	83.44	3.66	81.43
BH09-7A	83.52	84.29	57.36	49.99	1.93	82.36	1.93	82.36	2.70	81.59	4.51	79.78
BH09-7B	83.52	84.31	65.23	59.29	1.93	82.38	1.90	82.41	2.70	81.61	4.62	79.69
BH09-7C	83.52	84.31	76.81	71.63	2.34	81.97	2.57	81.74	2.94	81.37	4.47	79.84
BH09-8A	79.38	80.27	55.00	48.90	18.31	61.96	16.38	63.89	10.85	69.42	3.70	76.57
BH09-8B	79.38	80.31	65.36	58.04	17.63	62.68	16.37	63.94	10.91	69.40	3.70	76.61
BH09-8C	79.38	80.33	75.42	71.15	1.73	78.60	1.85	78.48	2.19	78.14	3.53	76.80
SG-1	- -	78.18	- -	- -	- -	- -	- -	- -	- -	- -	0.94	77.24
SG-2	- -	79.29	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

TABLE TSD#1-B-5-1
GROUNDWATER ELEVATION DATA
NRR SITE, CRRRC PROJECT

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	Screened Interval Elevation (mASL)		25-Apr-11		20-May-11		7-Jun-11		20-Jul-11	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		5.24	77.93	4.93	78.24	5.30	77.87	5.71	77.46
BH08-2	80.77	81.44	- -		1.99	79.45	2.28	79.16	2.76	78.68	3.76	77.68
BH09-3A	86.30	87.13	70.50	64.35	3.56	83.57	4.06	83.07	4.61	82.52	5.58	81.55
BH09-3B	86.30	87.13	80.20	72.89	3.47	83.66	3.99	83.14	4.58	82.55	5.56	81.57
BH09-4A	79.05	79.94	62.59	57.10	2.34	77.60	2.42	77.52	2.63	77.31	3.27	76.67
BH09-4B	79.05	79.96	77.22	71.43	1.95	78.01	0.99	78.97	1.77	78.19	2.73	77.23
BH09-5	73.93	74.69	55.03	48.33	1.96	72.73	1.92	72.77	1.99	72.70	2.60	72.09
BH09-6A	84.94	85.06	68.48	62.38	2.03	83.03	1.99	83.07	1.96	83.10	2.89	82.17
BH09-6B	84.94	85.09	80.06	74.58	1.31	83.78	1.32	83.77	1.47	83.62	3.54	81.55
BH09-7A	83.52	84.29	57.36	49.99	1.70	82.59	1.64	82.65	2.12	82.17	3.37	80.92
BH09-7B	83.52	84.31	65.23	59.29	1.76	82.55	1.61	82.70	2.10	82.21	3.37	80.94
BH09-7C	83.52	84.31	76.81	71.63	2.11	82.20	2.36	81.95	2.78	81.53	3.55	80.76
BH09-8A	79.38	80.27	55.00	48.90	5.28	74.99	4.38	75.89	4.01	76.26	3.48	76.79
BH09-8B	79.38	80.31	65.36	58.04	5.33	74.98	4.43	75.88	4.01	76.30	3.51	76.80
BH09-8C	79.38	80.33	75.42	71.15	1.44	78.89	1.42	78.91	1.84	78.49	2.99	77.34
SG-1	- -	78.18	- -	- -	- -	- -	0.86	77.32	0.82	77.36	0.885	77.30
SG-2	- -	79.29	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	ened Interval Elevation (m		24-Nov-11		13-Dec-11		12-Jan-12		28-Feb-12	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		5.80	77.37	5.30	77.87	5.54	77.63	4.92	78.25
BH08-2	80.77	81.44	- -		4.07	77.37	3.04	78.40	3.29	78.15	2.85	78.59
BH09-3A	86.30	87.13	70.50	64.35	5.65	81.48	4.85	82.28	4.73	82.40	4.50	82.63
BH09-3B	86.30	87.13	80.20	72.89	5.53	81.60	4.80	82.33	4.69	82.44	4.46	82.67
BH09-4A	79.05	79.94	62.59	57.10	2.65	77.29	2.27	77.67	1.98	77.96	2.20	77.74
BH09-4B	79.05	79.96	77.22	71.43	2.60	77.36	1.46	78.50	1.81	78.15	1.51	78.45
BH09-5	73.93	74.69	55.03	48.33	4.06	70.63	3.82	70.87	3.56	71.13	3.16	71.53
BH09-6A	84.94	85.06	68.48	62.38	3.62	81.44	3.40	81.66	2.84	82.22	2.76	82.30
BH09-6B	84.94	85.09	80.06	74.58	3.52	81.57	2.45	82.64	1.82	83.27	1.69	83.40
BH09-7A	83.52	84.29	57.36	49.99	4.24	80.05	3.10	81.19	2.78	81.51	2.49	81.80
BH09-7B	83.52	84.31	65.23	59.29	4.26	80.05	3.10	81.21	2.76	81.55	2.49	81.82
BH09-7C	83.52	84.31	76.81	71.63	4.20	80.11	3.22	81.09	2.93	81.38	2.72	81.59
BH09-8A	79.38	80.27	55.00	48.90	3.81	76.46	3.75	76.52	3.74	76.53	3.37	76.90
BH09-8B	79.38	80.31	65.36	58.04	3.83	76.48	3.83	76.48	3.73	76.58	3.41	76.90
BH09-8C	79.38	80.33	75.42	71.15	3.20	77.13	2.02	78.31	2.14	78.19	1.82	78.51
SG-1	- -	78.18	- -	- -	0.89	77.29	0.80	77.39	frozen	- -	frozen	- -
SG-2	- -	79.29	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

TABLE TSD#1-B-5-1
GROUNDWATER ELEVATION DATA
NRR SITE, CRRRC PROJECT

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	Screened Interval Elevation (mASL)		30-Aug-11		16-Sep-11		30-May-12		28-Jun-12	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		5.75	77.42	5.78	77.39	5.01	78.16	5.02	78.15
BH08-2	80.77	81.44	- -		4.16	77.28	4.13	77.31	3.09	78.35	3.37	78.07
BH09-3A	86.30	87.13	70.50	64.35	5.64	81.49	5.67	81.46	4.78	82.35	4.95	82.18
BH09-3B	86.30	87.13	80.20	72.89	5.59	81.54	5.62	81.51	4.66	82.47	4.91	82.22
BH09-4A	79.05	79.94	62.59	57.10	3.50	76.44	3.32	76.62	2.42	77.52	2.82	77.12
BH09-4B	79.05	79.96	77.22	71.43	2.81	77.15	2.61	77.35	1.98	77.98	2.53	77.43
BH09-5	73.93	74.69	55.03	48.33	3.34	71.35	3.63	71.06	2.20	72.49	2.40	72.29
BH09-6A	84.94	85.06	68.48	62.38	2.99	82.07	3.28	81.78	2.22	82.84	2.64	82.42
BH09-6B	84.94	85.09	80.06	74.58	3.64	81.45	3.60	81.49	1.84	83.25	2.06	83.03
BH09-7A	83.52	84.29	57.36	49.99	4.31	79.98	4.40	79.89	2.38	81.91	2.31	81.98
BH09-7B	83.52	84.31	65.23	59.29	4.34	79.97	4.42	79.89	2.52	81.79	2.98	81.33
BH09-7C	83.52	84.31	76.81	71.63	4.26	80.05	4.30	80.01	2.93	81.38	3.01	81.30
BH09-8A	79.38	80.27	55.00	48.90	3.45	76.82	3.50	76.77	2.62	77.65	2.50	77.77
BH09-8B	79.38	80.31	65.36	58.04	3.50	76.81	3.56	76.75	2.61	77.70	2.51	77.80
BH09-8C	79.38	80.33	75.42	71.15	3.58	76.75	3.44	76.89	2.18	78.15	2.78	77.55
SG-1	- -	78.18	- -	- -	0.94	77.24	0.91	77.27	0.11	78.07	- -	- -
SG-2	- -	79.29	- -	- -	- -	- -	- -	- -	- -	- -	1.29	78.00

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	ened Interval Elevation (m		29-Mar-12		9-Apr-12		6-Dec-12	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		5.05	78.12	5.10	78.07	5.13	78.04
BH08-2	80.77	81.44	- -		2.40	79.04	2.67	78.77	3.44	78.00
BH09-3A	86.30	87.13	70.50	64.35	3.73	83.40	4.16	82.97	5.45	81.68
BH09-3B	86.30	87.13	80.20	72.89	3.67	83.46	4.12	83.01	5.40	81.73
BH09-4A	79.05	79.94	62.59	57.10	2.05	77.89	2.24	77.70	2.45	77.49
BH09-4B	79.05	79.96	77.22	71.43	1.05	78.91	1.40	78.56	1.98	77.98
BH09-5	73.93	74.69	55.03	48.33	2.39	72.30	2.46	72.23	4.94	69.75
BH09-6A	84.94	85.06	68.48	62.38	2.36	82.70	2.20	82.86	3.73	81.33
BH09-6B	84.94	85.09	80.06	74.58	1.51	83.58	1.51	83.58	3.44	81.65
BH09-7A	83.52	84.29	57.36	49.99	1.88	82.41	1.97	82.32	4.46	79.83
BH09-7B	83.52	84.31	65.23	59.29	1.82	82.49	1.91	82.40	4.68	79.63
BH09-7C	83.52	84.31	76.81	71.63	2.35	81.96	2.55	81.76	4.05	80.26
BH09-8A	79.38	80.27	55.00	48.90	3.09	77.18	2.94	77.33	3.19	77.08
BH09-8B	79.38	80.31	65.36	58.04	3.12	77.19	2.99	77.32	3.21	77.10
BH09-8C	79.38	80.33	75.42	71.15	1.56	78.77	1.69	78.64	2.93	77.40
SG-1	- -	78.18	- -	- -	0.27	77.91	0.26	77.92	- -	- -
SG-2	- -	79.29	- -	- -	- -	- -	- -	- -	- -	- -

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

TABLE TSD#1-B-5-1
GROUNDWATER ELEVATION DATA
NRR SITE, CRRRC PROJECT

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	Screened Interval Elevation (mASL)		16-Jul-12		20-Aug-12		24-Sep-12		29-Oct-12	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		5.13	78.04	5.17	78.00	5.11	78.06	5.18	77.99
BH08-2	80.77	81.44	- -		3.53	77.91	3.68	77.76	3.64	77.80	3.53	77.91
BH09-3A	86.30	87.13	70.50	64.35	5.06	82.07	5.56	81.57	5.66	81.47	5.35	81.78
BH09-3B	86.30	87.13	80.20	72.89	5.02	82.11	5.52	81.61	5.61	81.52	5.30	81.83
BH09-4A	79.05	79.94	62.59	57.10	3.40	76.54	3.39	76.55	3.16	76.78	2.83	77.11
BH09-4B	79.05	79.96	77.22	71.43	2.76	77.20	2.85	77.11	2.51	77.45	2.20	77.76
BH09-5	73.93	74.69	55.03	48.33	2.70	71.99	3.55	71.14	4.55	70.14	4.90	69.79
BH09-6A	84.94	85.06	68.48	62.38	2.58	82.48	3.26	81.80	3.18	81.88	3.65	81.41
BH09-6B	84.94	85.09	80.06	74.58	3.01	82.08	3.54	81.55	3.30	81.79	3.53	81.56
BH09-7A	83.52	84.29	57.36	49.99	3.66	80.63	4.53	79.76	4.82	79.47	4.53	79.76
BH09-7B	83.52	84.31	65.23	59.29	3.65	80.66	4.55	79.76	4.87	79.44	4.61	79.70
BH09-7C	83.52	84.31	76.81	71.63	3.77	80.54	4.58	79.73	4.75	79.56	4.28	80.03
BH09-8A	79.38	80.27	55.00	48.90	2.44	77.83	2.56	77.71	2.77	77.50	2.99	77.28
BH09-8B	79.38	80.31	65.36	58.04	2.48	77.83	2.60	77.71	2.81	77.50	3.02	77.29
BH09-8C	79.38	80.33	75.42	71.15	3.28	77.05	3.70	76.63	3.65	76.68	3.15	77.18
SG-1	- -	78.18	- -	- -	0.25	77.93	- -	- -	- -	- -	- -	- -
SG-2	- -	79.29	- -	- -	1.36	77.93	1.41	77.88	1.41	77.88	1.39	77.90

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

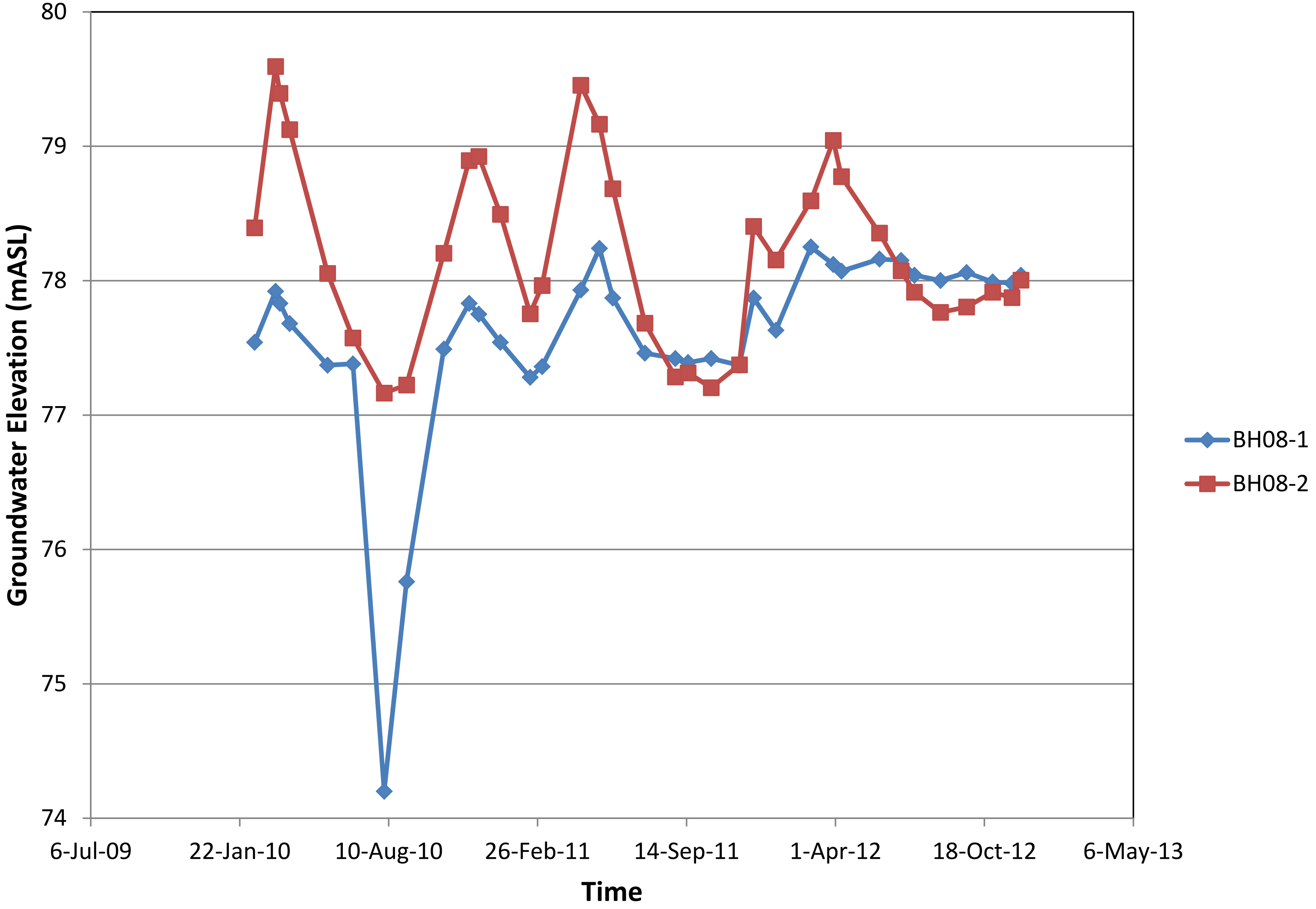
TABLE TSD#1-B-5-1
GROUNDWATER ELEVATION DATA
NRR SITE, CRRRC PROJECT

Monitoring Intervals	Ground Surface Elevation (mASL)	TOP Elevation (mASL)	Screened Interval Elevation (mASL)		24-Nov-12	
			Top	Bottom	GW Depth (m)	GW Elev. (mASL)
BH08-1	82.57	83.17	- -		5.19	77.98
BH08-2	80.77	81.44	- -		3.57	77.87
BH09-3A	86.30	87.13	70.50	64.35	5.35	81.78
BH09-3B	86.30	87.13	80.20	72.89	5.31	81.82
BH09-4A	79.05	79.94	62.59	57.10	2.50	77.44
BH09-4B	79.05	79.96	77.22	71.43	2.37	77.59
BH09-5	73.93	74.69	55.03	48.33	4.85	69.84
BH09-6A	84.94	85.06	68.48	62.38	3.56	81.50
BH09-6B	84.94	85.09	80.06	74.58	3.33	81.76
BH09-7A	83.52	84.29	57.36	49.99	4.45	79.84
BH09-7B	83.52	84.31	65.23	59.29	4.52	79.79
BH09-7C	83.52	84.31	76.81	71.63	4.20	80.11
BH09-8A	79.38	80.27	55.00	48.90	3.18	77.09
BH09-8B	79.38	80.31	65.36	58.04	3.15	77.16
BH09-8C	79.38	80.33	75.42	71.15	3.10	77.23
SG-1	- -	78.18	- -	- -	- -	- -
SG-2	- -	79.29	- -	- -	- -	- -

* - includes entire length of gravel pack for monitoring well installations

TOP - top of pipe

SG-2 was installed in June 2012 and was surveyed on July 16, 2012

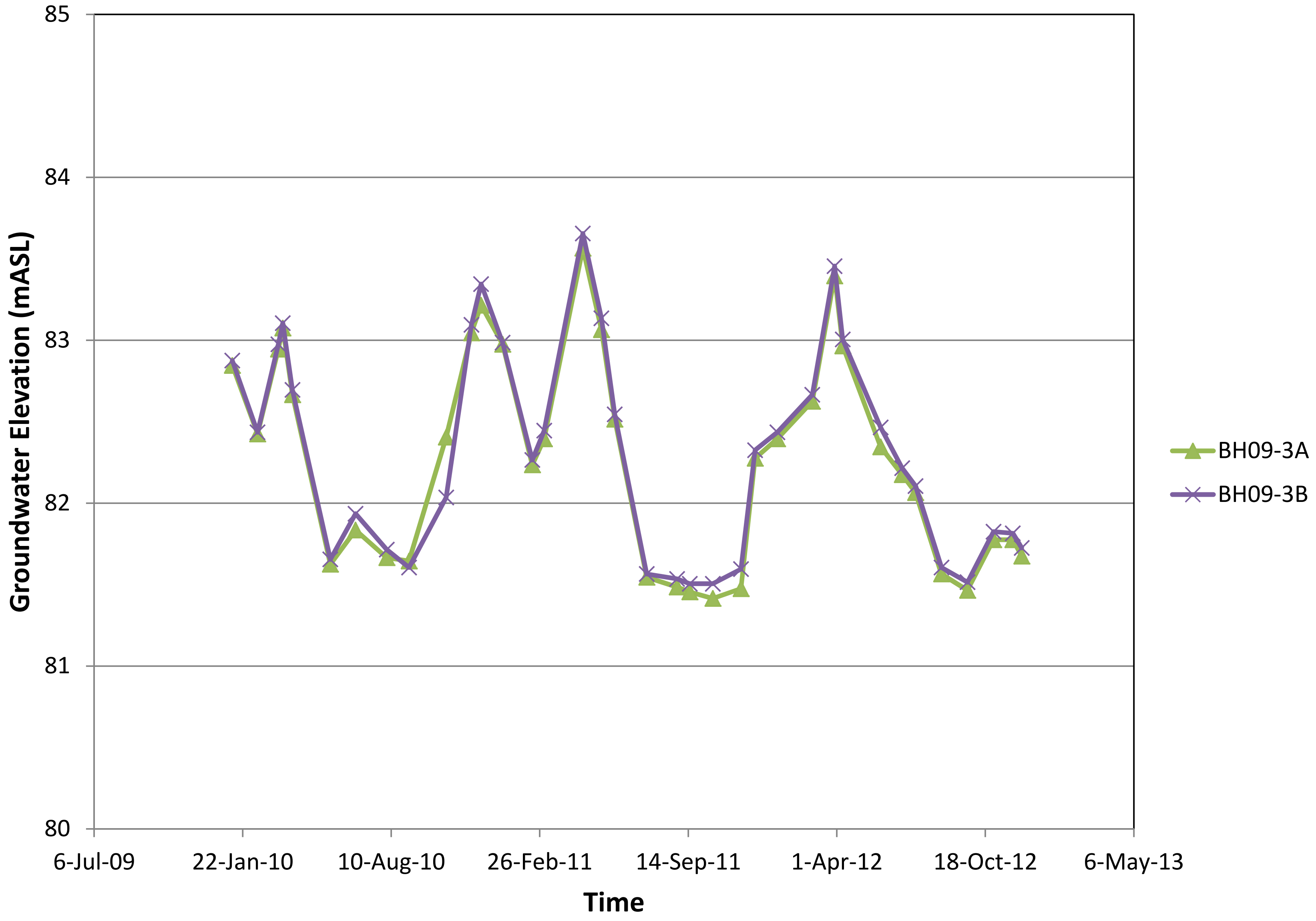


Golder Associates

Date: January 2013 Drawn: JPAO

Project: 12-1125-0045 Checked: KAM

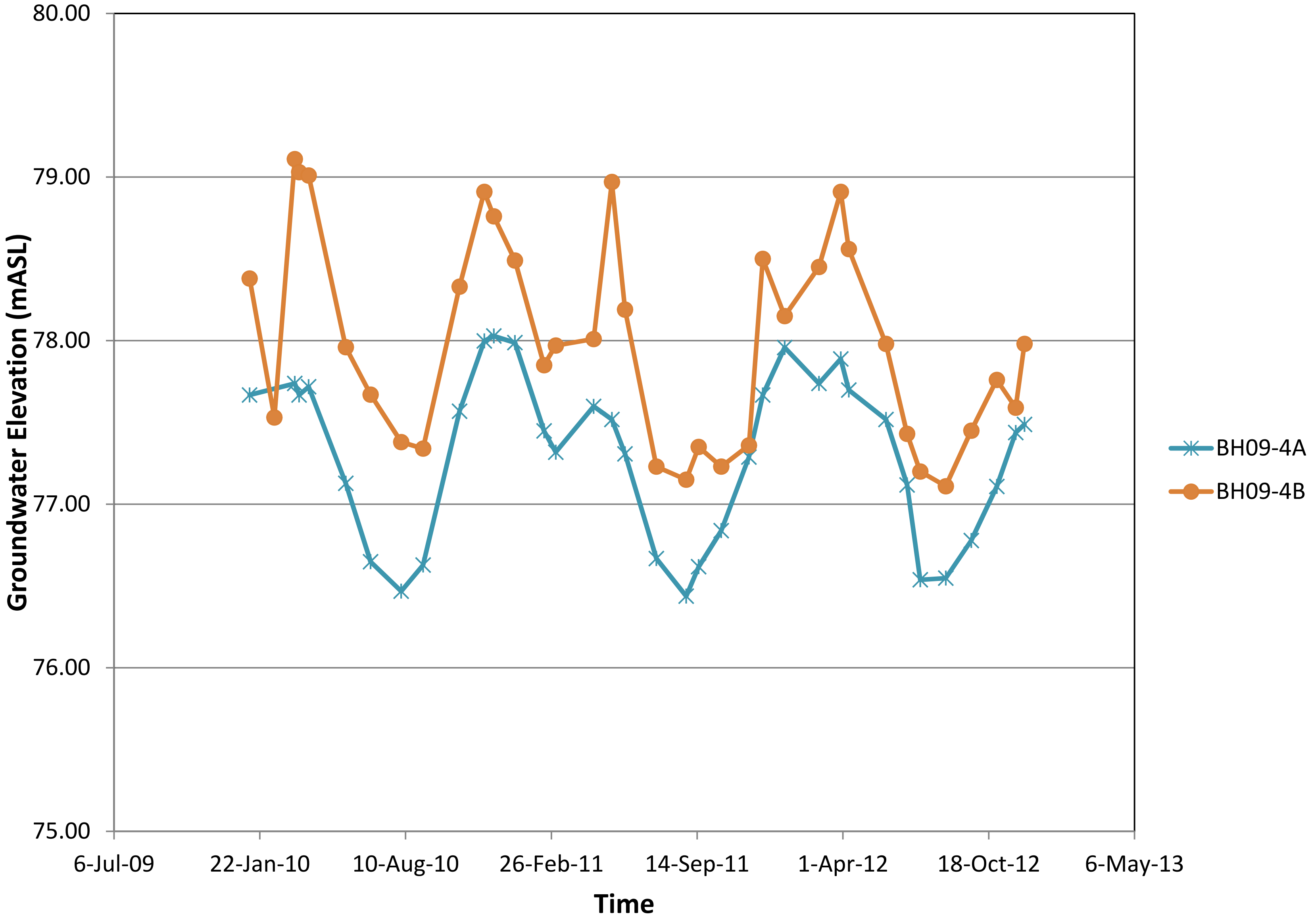
FIGURE TSD#1-B-5-1: GROUNDWATER ELEVATION DATA FOR BH08-1 and BH08-2



Date: January 2013 Drawn: JPAO

Project: 12-1125-0045 Checked: KAM

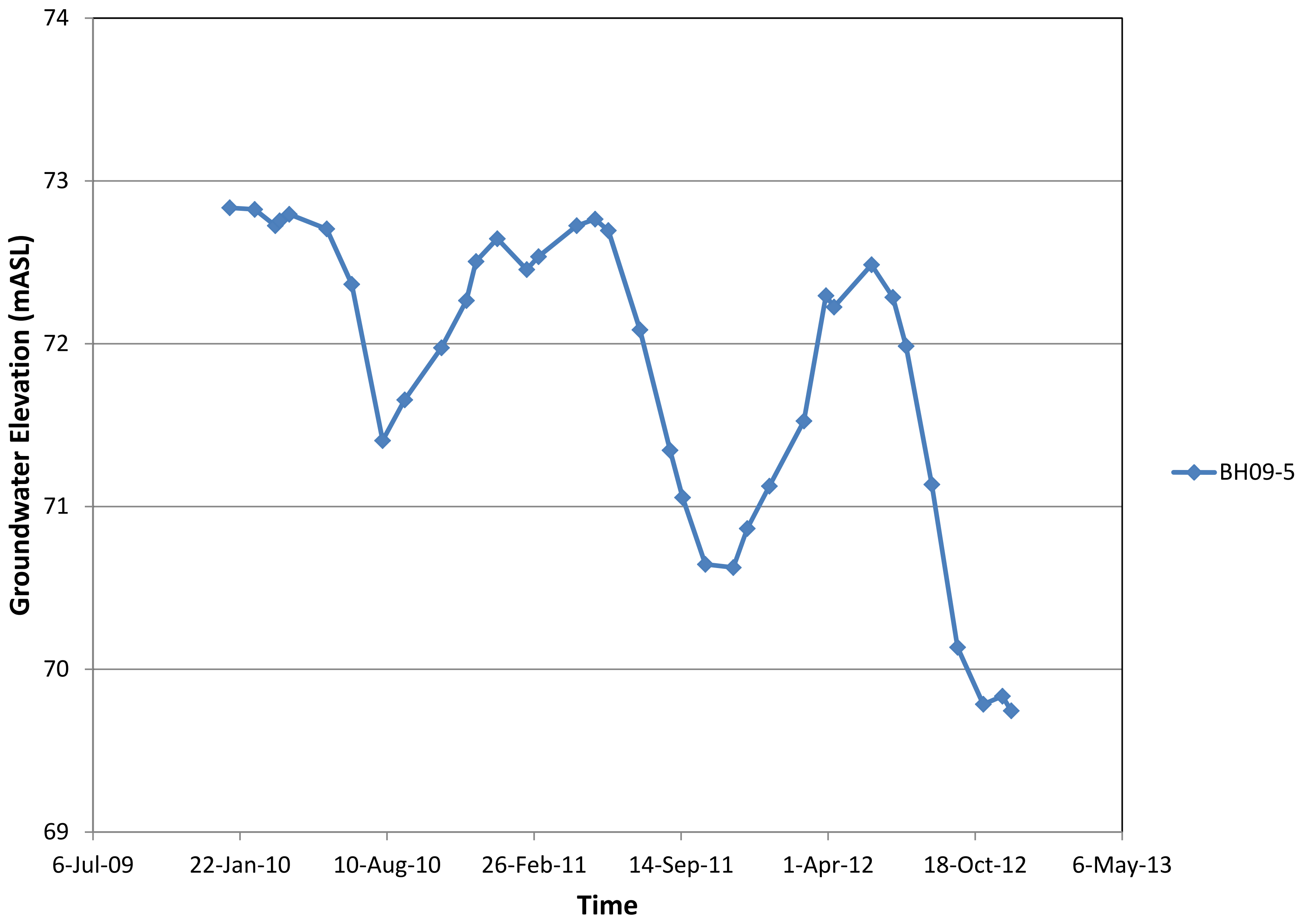
FIGURE TSD#1-B-5-2: GROUNDWATER ELEVATION DATA FOR BH09-3



Date: January 2013 Drawn: JPAO

Project: 12-1125-0045 Checked: KAM

FIGURE TSD#1-B-5-3: GROUNDWATER ELEVATION DATA FOR BH09-4



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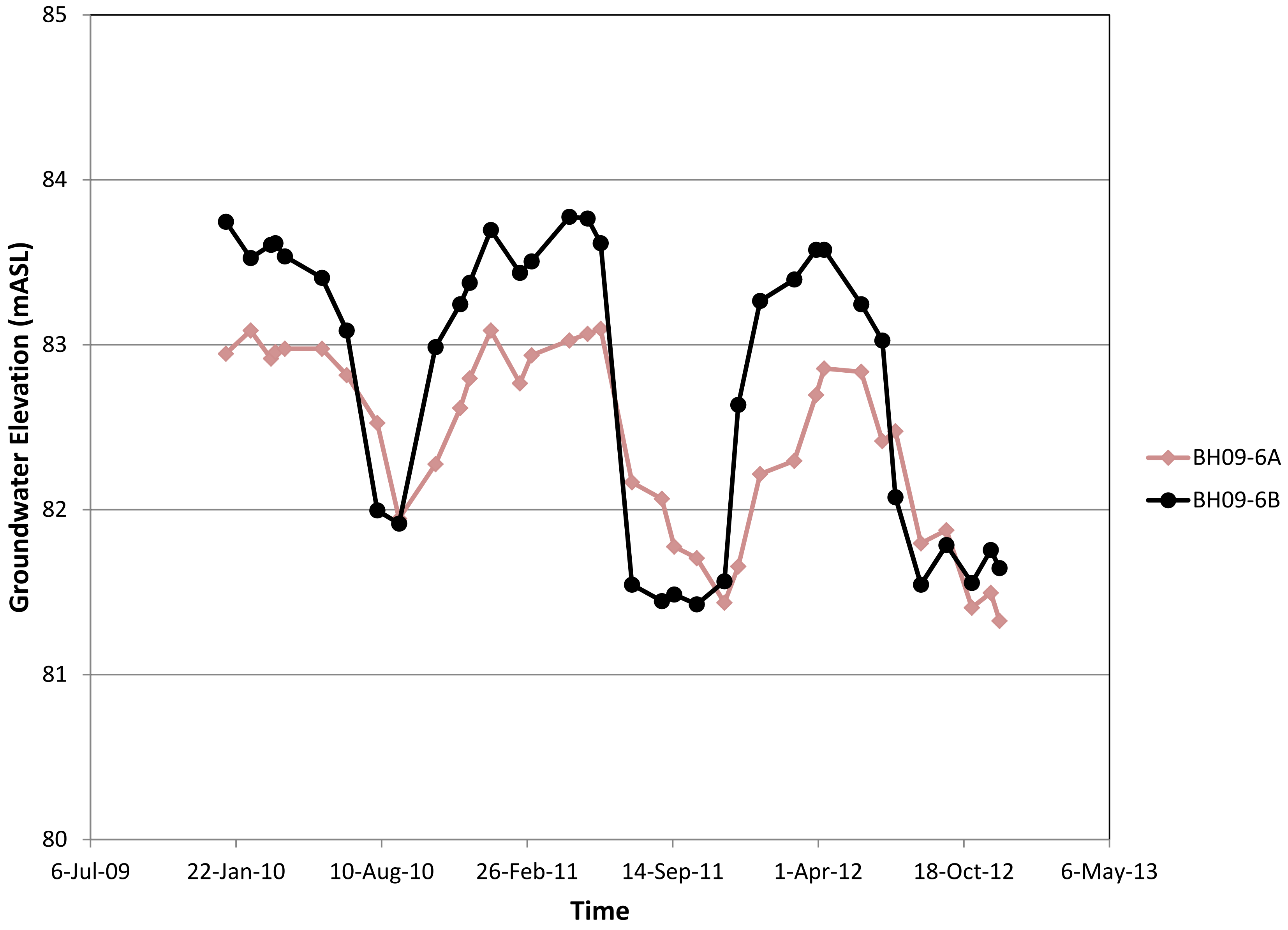
Date: January 2013 Drawn: JPAO

Project: 12-1125-0045 Checked: KAM

FIGURE TSD#1-B-5-4: GROUNDWATER ELEVATION DATA FOR BH09-5



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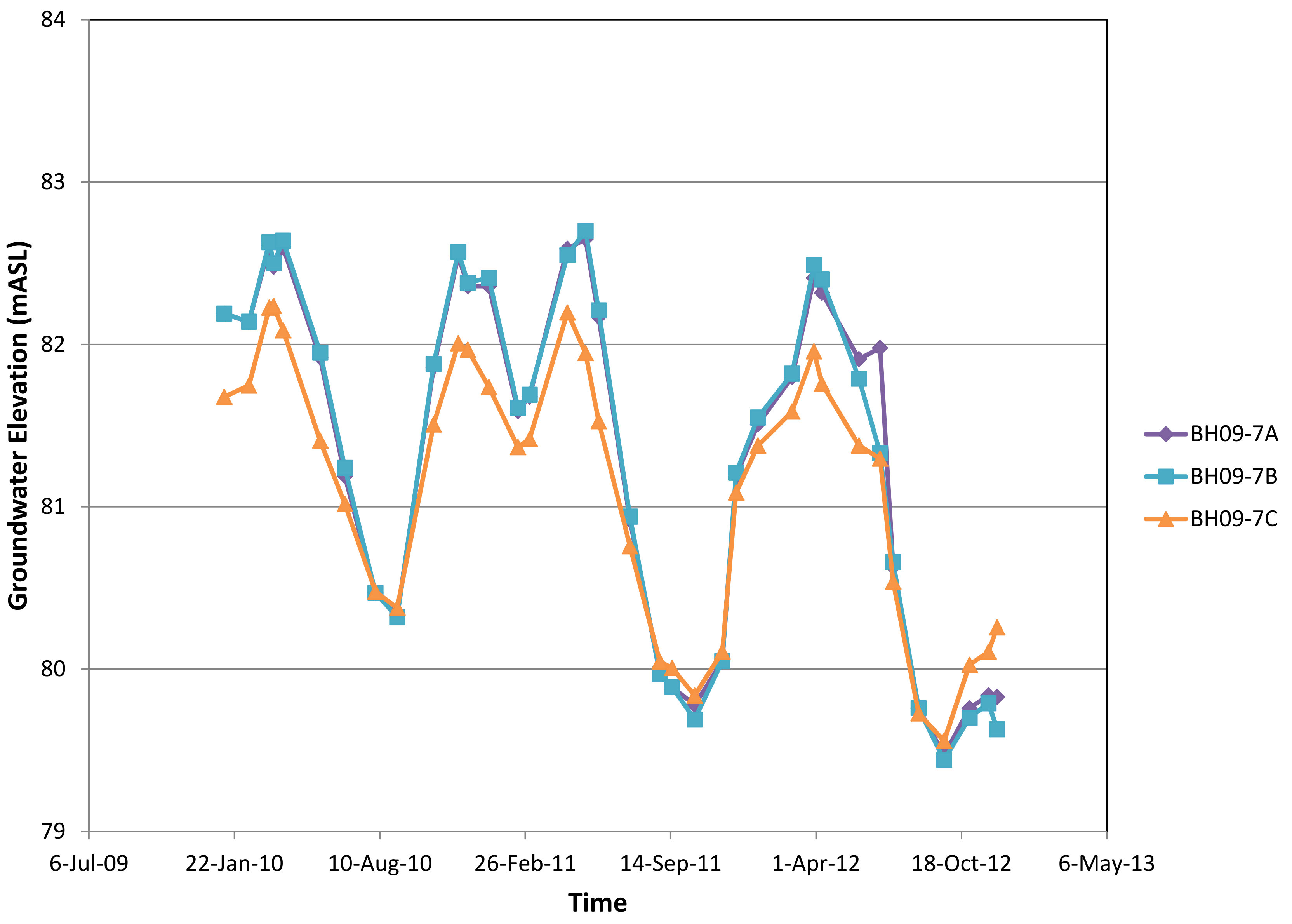
Date: January 2013 Drawn: JPAO
Project: 12-1125-0045 Checked: KAM

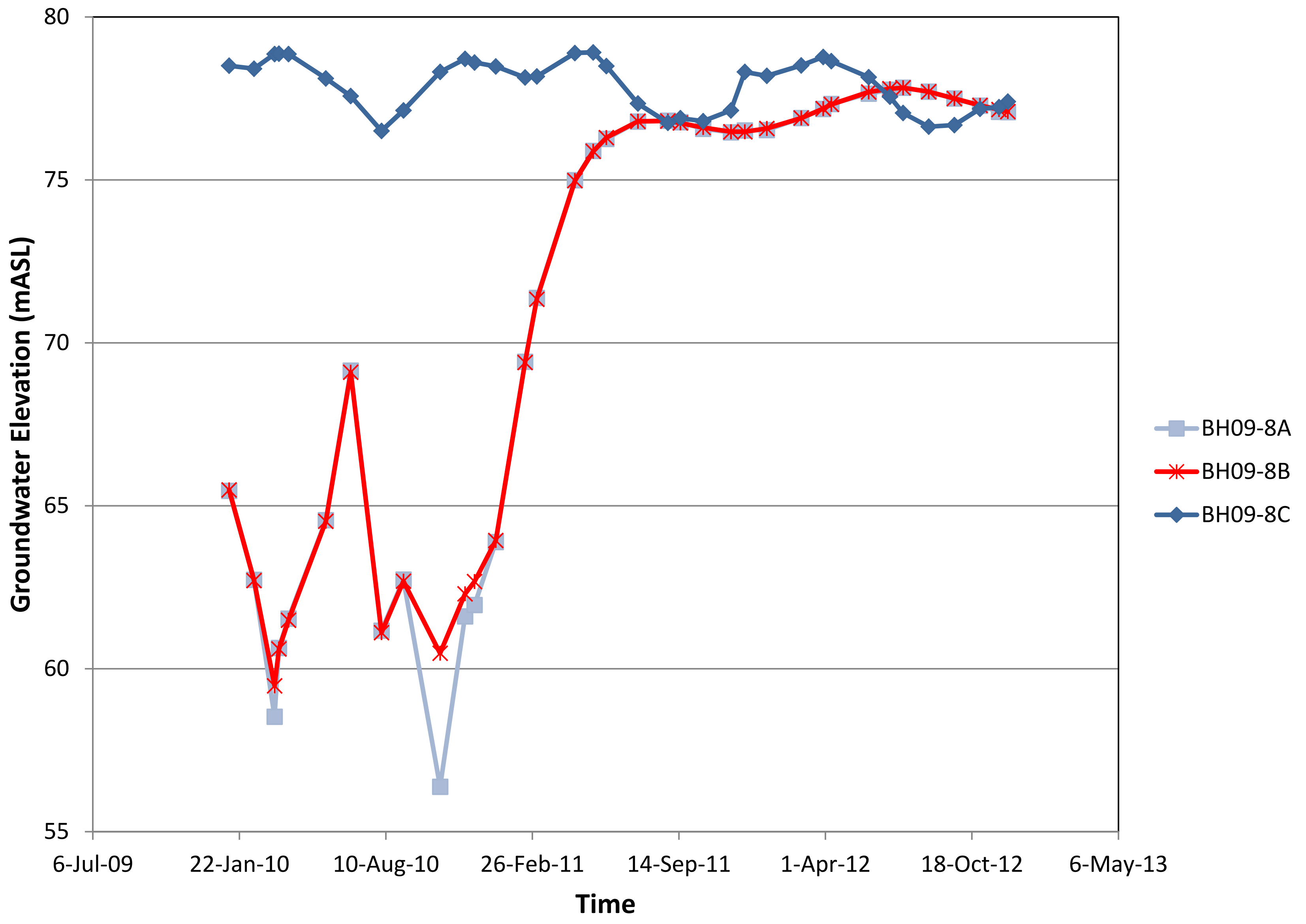
FIGURE TSD#1-B-5-5: GROUNDWATER ELEVATION DATA FOR BH09-6



Date: January 2013 Drawn: JPAO

Project: 12-1125-0045 Checked: KAM

FIGURE TSD#1-B-5-6: GROUNDWATER ELEVATION DATA FOR BH09-7



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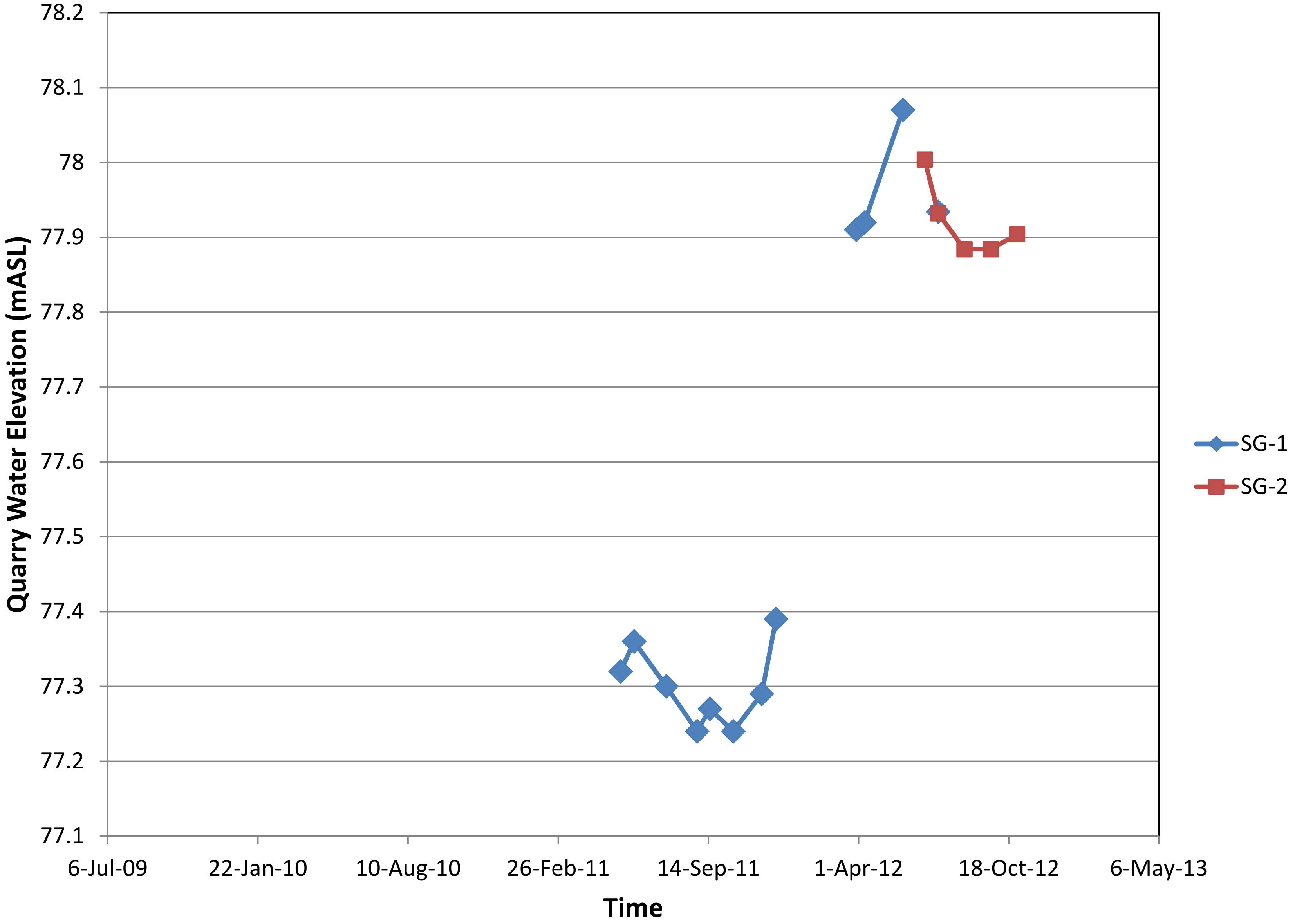
Date: January 2013
Drawn: JPAO
Project: 12-1125-0045
Checked: KAM

FIGURE TSD#1-B-5-7: GROUNDWATER ELEVATION DATA FOR BH09-8

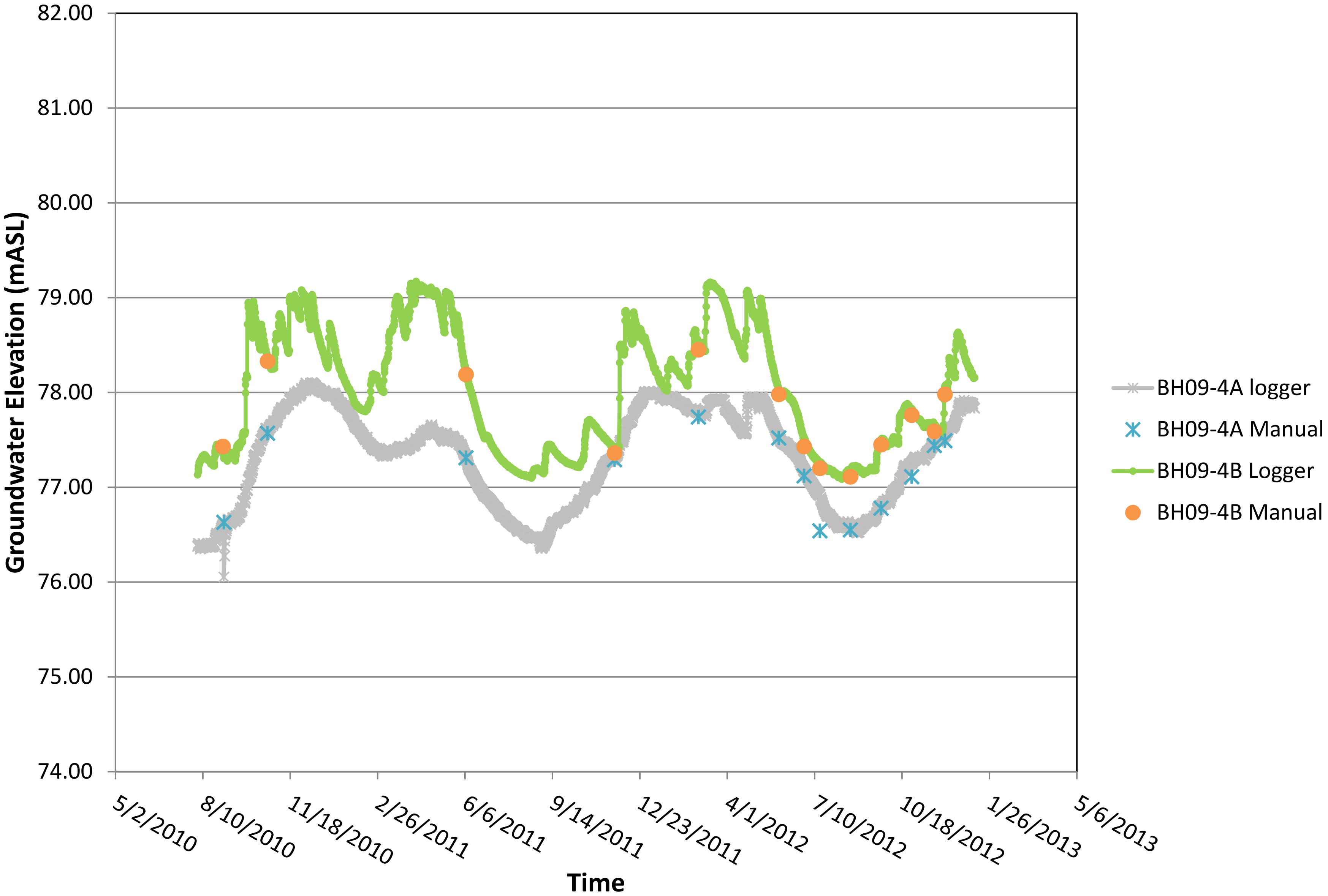


Golder Associates

Date: January 2013 Drawn: JPAO

Project: 12-1125-0045 Checked: KAM

FIGURE TSD#1-B-5-8: QUARRY WATER ELEVATION DATA FOR SG-1 and SG-2

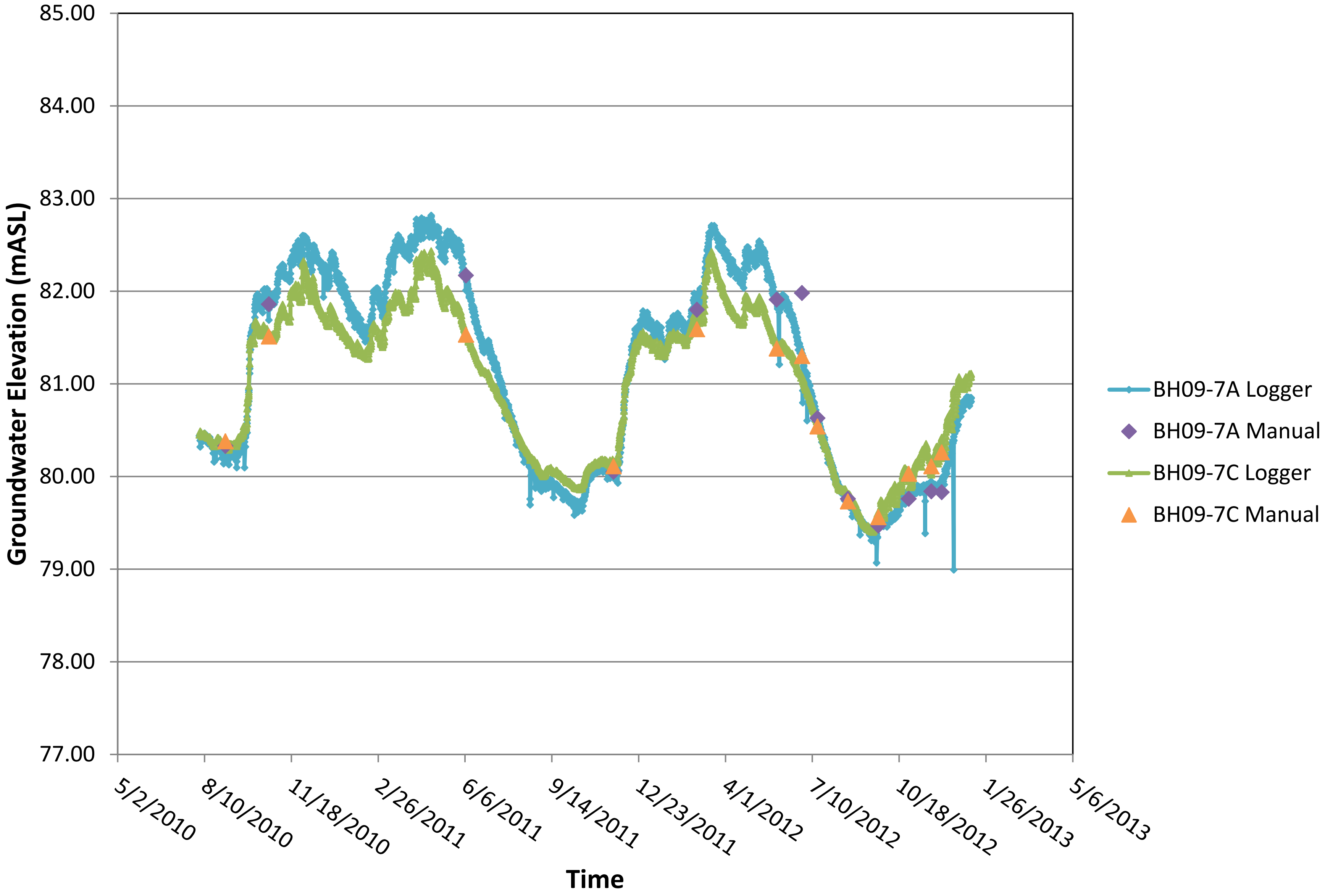


Golder Associates

Date: January 2013 Drawn: DH

Project: 12-1125-0045 Checked: KAM

FIGURE TSD#1-B-5-9: CONTINUOUS GROUNDWATER ELEVATION DATA FOR BH09-4



Golder Associates

Date: January 2013 Drawn: DH

Project: 12-1125-0045 Checked: KAM

FIGURE TSD#1-B-5-10: CONTINUOUS GROUNDWATER ELEVATION DATA FOR BH09-7

ATTACHMENT TSD#1-B-6

On-Site Groundwater Quality Results

TSD#1-B-6-1 – NRR Site

TSD#1-B-6-2 – BR Site

ATTACHMENT TSD#1-B-6-1

On-Site Groundwater Quality Results (NRR Site)

February 2013

TABLE TSD#1-B-6-1-1
ON-SITE GROUNDWATER QUALITY RESULTS
NRR SITE

Parameter	Unit	(2) (1) ODWQS(169/03)-Health	(4) (3) ODWQS-AO	08-1	08-2	09-3A	09-3A	09-3A	09-3B	09-3B	09-3B
				29-Jun-2010 (5)	29-Jun-2010	12-Feb-2010	23-Jun-2010 (5)	03-Sep-2010 (5)	11-Feb-2010	23-Jun-2010 (5)	03-Sep-2010 (5)
				T-6	T-5	G-3	G-4	G-5	S-6	G-5	G-6
General Chemistry											
Alkalinity, Carbonate as CaCO3	mg/L	--	--	185	208	421	369	338	241	262	260
Ammonia Nitrogen	mg/L	--	--	<0.02	<0.02	0.42	0.35	0.34	0.41	0.11	0.09
Biologic Oxygen Demand, Five Day	mg/l	--	--	2	<1	13	11	17	3	2	3
Chemical Oxygen Demand	mg/l	--	--	8	10	120	10	15	45	10	10
Chloride	mg/l	--	250	3	3	25	21	16	7	6	7
Conductivity	uS/cm	--	--	424	425	966	870	788	757	630	647
Conductivity (Field)	uS/cm	--	--	381	400	1278	811	683	635	602	569
Dissolved Organic Carbon	mg/l	--	5	1.4	3.3	2.3	1.4	1.4	2.3	1.3	1.2
Nitrate as N	mg/l	10	--	6.57	2.01	0.24	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrite as N	mg/l	1	--	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrogen, Total Kjeldahl	mg/l	--	--	<0.10	<0.10	0.43	0.56	0.57	0.52	0.46	0.30
pH	-	--	--	8.34	7.99	8.49	8.36	8.30	8.02	8.01	8.15
pH (Field)	-	--	--	8.17	7.43	9.06	8.28	7.71	7.6	7.72	7.48
Phosphorus	mg/l	--	--	0.18	0.02	2.71	0.60	1.51	3.13	1.33	2.34
Sulfate	mg/l	--	500 (13)	14	8	78	67	65	151	68	85
Temperature (Field)	deg c	--	15	12.2	12.1	6.8	16.0	18.6	6.9	14.6	19.9
Total Dissolved Solids	mg/l	--	500	276	276	628	565	512	492	410	421
Metals											
Arsenic, Dissolved	mg/l	0.025	--	<0.01	<0.001	0.002	<0.01	<0.01	0.002	<0.01	<0.01
Barium, Dissolved	mg/l	1	--	0.05	0.25	0.05	0.05	0.07	0.03	0.04	0.05
Boron, Dissolved	mg/l	5	--	0.22	0.08	0.43	0.54	0.43	0.38	0.14	0.15
Cadmium, Dissolved	mg/l	0.005	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Calcium, Dissolved	mg/l	--	--	11	51	29	31	40	57	53	56
Chromium, Dissolved	mg/l	0.05	--	0.003	0.005	0.002	0.001	0.003	<0.001	<0.001	0.002
Copper, Dissolved	mg/l	--	1	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.001	<0.001
Iron, Dissolved	mg/l	--	0.3	<0.03	<0.03	<0.03	0.18	0.11	0.62	0.45	0.15
Lead, Dissolved	mg/l	0.01	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium, Dissolved	mg/l	--	--	3	7	16	20	26	29	38	37
Manganese, Dissolved	mg/l	--	0.05	<0.01	<0.01	0.04	0.03	0.04	0.05	0.09	0.06
Mercury, Dissolved	mg/l	0.001	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Potassium, Dissolved	mg/l	--	--	7	4	5	4	4	6	5	4
Sodium, Dissolved	mg/l	--	200 (14)	87	27	168	128	97	50	16	16
Zinc, Dissolved	mg/l	--	5	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.02
Phenols											
Phenolics, Total Recoverable	mg/l	--	--	<0.001	<0.001	0.001	0.003	0.002	<0.001	<0.001	<0.001
VOCs											
1,4-Dichlorobenzene	mg/l	0.005	0.001	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Methylene Chloride	mg/l	0.05	--	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	mg/l	0.002	--	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Benzene	mg/l	0.005	--	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Toluene	mg/l	--	0.024	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

TABLE TSD#1-B-6-1-1
ON-SITE GROUNDWATER QUALITY RESULTS
NRR SITE

Parameter	Unit	[2] [1] ODWQS(169/03)-Health	[4] [3] ODWQS-AO	09-4A	09-4A	09-4A	09-4B	09-4B	09-4B	09-5	09-5	09-5
				11-Feb-2010	29-Jun-2010	03-Sep-2010	11-Mar-2010	29-Jun-2010	03-Sep-2010	11-Feb-2010 [6][7]	23-Jun-2010 [7]	07-Sep-2010 [6][7][8]
				S-2	T-3	G-4	G-1	T-4	G-3	S-1	G-1	T-7
General Chemistry												
Alkalinity, Carbonate as CaCO3	mg/L	--	--	220	248	193	210	244	245	138	126	98
Ammonia Nitrogen	mg/L	--	--	0.25	0.21	0.79	0.07	0.09	0.09	5.33	4.80	6.01
Biologic Oxygen Demand, Five Day	mg/l	--	--	16	4	4	4	11	5	159	4	16
Chemical Oxygen Demand	mg/l	--	--	75	53	13	13	80	10	300	145	325
Chloride	mg/l	--	250	72	98	102	78	82	94	4310	4950	6200
Conductivity	uS/cm	--	--	1470	1010	2910	695	812	835	14100	15200	19400
Conductivity (Field)	uS/cm	--	--	1200	900	2497	646	720	749	4825	>3999	>3999
Dissolved Organic Carbon	mg/l	--	5	3.8	4.2	3.3	4.1	4.7	2.8	1.9	1.1	3.9
Nitrate as N	mg/l	10	--	0.64	<0.10	<0.10	0.89	0.26	<0.10	<0.10	<0.10	<0.50
Nitrite as N	mg/l	1	--	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrogen, Total Kjeldahl	mg/l	--	--	0.21	0.42	1.01	0.29	0.13	0.21	5.0	4.82	8.1
pH	-	--	--	7.86	7.98	8.08	7.71	7.79	8.06	7.74	7.75	7.60
pH (Field)	-	--	--	8.7	7.46	7.99	6.62	7.19	6.91	7.62	7.13	7.22
Phosphorus	mg/l	--	--	0.48	0.35	0.18	1.18	2.51	1.03	6.06	8.96	7.68
Sulfate	mg/l	--	500 [13]	407	113	1200	37	40	43	6	24	46
Temperature (Field)	deg c	--	15	7.2	11.4	14.8	7.1	12.3	21.5	7.3	13.7	12.7
Total Dissolved Solids	mg/l	--	500	1030	657	2330	452	528	543	9170	9880	12600
Metals												
Arsenic, Dissolved	mg/l	0.025	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.05**	<0.1	<0.1
Barium, Dissolved	mg/l	1	--	0.14	0.26	0.10	0.55	0.56	0.76	**4.0**	**4.7**	**5.1**
Boron, Dissolved	mg/l	5	--	0.20	0.14	0.42	0.11	0.10	0.19	0.7	0.9	0.7
Cadmium, Dissolved	mg/l	0.005	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.001
Calcium, Dissolved	mg/l	--	--	80	64	106	79	92	86	229	249	576
Chromium, Dissolved	mg/l	0.05	--	0.003	0.005	0.003	0.006	0.005	0.005	0.01	<0.01	<0.01
Copper, Dissolved	mg/l	--	1	<0.001	<0.001	0.003	0.002	0.001	0.002	<0.01	<0.01	<0.01
Iron, Dissolved	mg/l	--	0.3	<0.03	0.06	0.06	<0.03	0.18	0.06	<0.3	0.8	1.8
Lead, Dissolved	mg/l	0.01	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01
Magnesium, Dissolved	mg/l	--	--	18	12	23	11	13	13	115	132	175
Manganese, Dissolved	mg/l	--	0.05	0.04	0.06	0.07	0.07	0.18	0.19	0.2	0.2	0.4
Mercury, Dissolved	mg/l	0.001	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Potassium, Dissolved	mg/l	--	--	7	5	8	4	4	4	34	42	48
Sodium, Dissolved	mg/l	--	200 [14]	212	127	502	50	56	53	2310	2730	2730
Zinc, Dissolved	mg/l	--	5	<0.01	<0.01	0.02	0.01	<0.01	<0.01	<0.1	<0.1	<0.1
Phenols												
Phenolics, Total Recoverable	mg/l	--	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VOCs												
1,4-Dichlorobenzene	mg/l	0.005	0.001	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Methylene Chloride	mg/l	0.05	--	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	mg/l	0.002	--	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Benzene	mg/l	0.005	--	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Toluene	mg/l	--	0.024	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

TABLE TSD#1-B-6-1-1
ON-SITE GROUNDWATER QUALITY RESULTS
NRR SITE

Parameter	Unit	[2] [1] ODWQS(169/03)-Health	[4] [3] ODWQS-AO	09-6A	09-6A	09-6A	09-6B	09-6B	09-6B	09-7A	09-7A	09-7A
				11-Feb-2010	23-Jun-2010 [5]	03-Sep-2010 [5]	11-Feb-2010	23-Jun-2010 [5]	03-Sep-2010 [5]	12-Feb-2010 [8]	29-Jun-2010 [5]	07-Sep-2010 [9][10]
				S-3	G-3	G-1	S-4	G-2	G-2	G-4	T-8	T-4
General Chemistry												
Alkalinity, Carbonate as CaCO3	mg/L	--	--	497	479	498	386	345	757	284	302	294
Ammonia Nitrogen	mg/L	--	--	0.49	0.50	0.72	0.47	0.48	0.67	0.18	0.24	0.31
Biologic Oxygen Demand, Five Day	mg/l	--	--	23	23	36	4	2	16	1	<1	2
Chemical Oxygen Demand	mg/l	--	--	53	15	25	40	13	15	10	8	15
Chloride	mg/l	--	250	56	289	546	7	8	122	86	70	47
Conductivity	uS/cm	--	--	1170	1960	2730	811	792	1820	1160	1080	991
Conductivity (Field)	uS/cm	--	--	1200	1892	2458	780	784	1578	1135	983	986
Dissolved Organic Carbon	mg/l	--	5	4.0	3.5	4.2	2.9	4.5	1.9	2.0	1.1	1.3
Nitrate as N	mg/l	10	--	<0.10	<0.10	<0.10	<0.10	0.56	<0.10	<1	<0.10	<0.10
Nitrite as N	mg/l	1	--	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<1	<0.10	<0.10
Nitrogen, Total Kjeldahl	mg/l	--	--	0.49	0.63	0.98	0.45	0.83	0.82	0.22	0.33	0.30
pH	-	--	--	8.37	8.35	8.33	8.03	8.09	8.37	8.47	8.58	8.45
pH (Field)	-	--	--	8.7	8.53	7.72	8.0	7.82	7.82	9.11	9.87	8.73
Phosphorus	mg/l	--	--	1.90	2.14	1.38	0.50	0.66	0.56	0.29	0.17	0.17
Sulfate	mg/l	--	500 [13]	63	46	32	57	69	36	162	114	117
Temperature (Field)	deg c	--	15	7.2	12.8	14.4	7	13.6	15.4	7.9	12.9	18.1
Total Dissolved Solids	mg/l	--	500	761	1270	1770	527	515	1180	754	702	644
Metals												
Arsenic, Dissolved	mg/l	0.025	--	0.002	<0.01	<0.01	0.002	<0.01	<0.01	0.004	<0.01	<0.01
Barium, Dissolved	mg/l	1	--	0.10	0.14	0.20	0.07	0.05	0.04	0.03	0.02	0.02
Boron, Dissolved	mg/l	5	--	0.40	0.58	0.47	0.20	0.25	0.63	0.95	1.16	1.3
Cadmium, Dissolved	mg/l	0.005	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Calcium, Dissolved	mg/l	--	--	14	9	9	45	35	19	7	4	5
Chromium, Dissolved	mg/l	0.05	--	0.003	<0.005	0.007	0.001	0.001	0.007	0.004	0.005	<0.001
Copper, Dissolved	mg/l	--	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron, Dissolved	mg/l	--	0.3	0.03	0.11	0.23	0.23	0.08	<0.03	<0.03	<0.03	<0.03
Lead, Dissolved	mg/l	0.01	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium, Dissolved	mg/l	--	--	5	3	3	16	14	7	4	2	2
Manganese, Dissolved	mg/l	--	0.05	0.02	0.02	0.02	0.10	0.06	0.03	<0.01	<0.01	<0.01
Mercury, Dissolved	mg/l	0.001	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Potassium, Dissolved	mg/l	--	--	6	5	6	3	4	4	4	3	3
Sodium, Dissolved	mg/l	--	200 [14]	255	411	556	114	129	371	236	212	202
Zinc, Dissolved	mg/l	--	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenols												
Phenolics, Total Recoverable	mg/l	--	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VOCs												
1,4-Dichlorobenzene	mg/l	0.005	0.001	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.003
Methylene Chloride	mg/l	0.05	--	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.032
Vinyl Chloride	mg/l	0.002	--	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.002
Benzene	mg/l	0.005	--	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.004
Toluene	mg/l	--	0.024	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.004

TABLE TSD#1-B-6-1-1
ON-SITE GROUNDWATER QUALITY RESULTS
NRR SITE

Parameter	Unit	[2] [1] ODWQS(169/ 03)-Health	[4] [3] ODWQS-AO	09-7B	09-7B	09-7B	09-7C	09-7C	09-7C	09-8A	09-8A	09-8A
				12-Feb-2010	29-Jun-2010	07-Sep-2010	11-Feb-2010	29-Jun-2010	07-Sep-2010 [5][10]	12-Feb-2010	29-Jun-2010 [6][11]	07-Sep-2010 [6][7]
				G-5	T-7	T-5	S-7	T-9	T-6	G-1	T-10	T-1
General Chemistry												
Alkalinity, Carbonate as CaCO3	mg/L	--	--	264	255	249	323	290	283	287	221	200
Ammonia Nitrogen	mg/L	--	--	0.26	0.30	0.33	0.23	0.28	0.36	0.75	2.71	2.77
Biologic Oxygen Demand, Five Day	mg/l	--	--	<1	1	1	3	5	5	8	9	17
Chemical Oxygen Demand	mg/l	--	--	75	58	13	120	375	10	15	160	425
Chloride	mg/l	--	250	16	12	11	26	29	18	1100	6140	7410
Conductivity	uS/cm	--	--	674	651	674	730	828	755	4600	19500	24600
Conductivity (Field)	uS/cm	--	--	684	571	632	370	718	712	>5000	>3999	>3999
Dissolved Organic Carbon	mg/l	--	5	1.7	1.1	1.3	2.6	3.9	1.8	3.3	2.1	3.8
Nitrate as N	mg/l	10	--	<0.10	<0.10	<0.10	<0.10	<0.10	0.12	<0.10	1.46	2.35
Nitrite as N	mg/l	1	--	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.37	0.42
Nitrogen, Total Kjeldahl	mg/l	--	--	0.25	0.39	0.35	0.47	0.62	0.38	1.06	4.4	4.9
pH	-	--	--	8.59	8.67	8.58	8.50	8.38	8.28	7.79	7.70	7.59
pH (Field)	-	--	--	9.07	8.88	8.72	8.8	8.56	8.24	7.92	7.05	6.22
Phosphorus	mg/l	--	--	2.88	2.68	2.14	2.59	<0.01	1.24	0.01	0.03	0.17
Sulfate	mg/l	--	500 [13]	58	59	75	71	94	86	361	1230	1630
Temperature (Field)	deg c	--	15	6.4	14.0	14.4	7.4	14.7	12.9	6.8	16.1	13.0
Total Dissolved Solids	mg/l	--	500	438	423	438	475	538	491	3220	15600	19700
Metals												
Arsenic, Dissolved	mg/l	0.025	--	<0.001	<0.001	<0.001	0.002	0.001	<0.01	0.014	**0.032**	<0.1
Barium, Dissolved	mg/l	1	--	0.02	0.01	<0.01	0.03	0.02	0.07	0.11	0.04	<0.1
Boron, Dissolved	mg/l	5	--	0.64	0.69	0.76	0.73	0.89	0.83	0.33	0.27	0.7
Cadmium, Dissolved	mg/l	0.005	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001
Calcium, Dissolved	mg/l	--	--	5	8	4	26	9	11	143	999	1010
Chromium, Dissolved	mg/l	0.05	--	0.002	0.006	0.002	0.002	0.004	0.007	0.008	0.004	<0.01
Copper, Dissolved	mg/l	--	1	<0.001	0.001	<0.001	<0.001	<0.001	0.002	0.002	0.005	<0.01
Iron, Dissolved	mg/l	--	0.3	<0.03	1.20	<0.03	<0.03	<0.03	3.82	<0.03	<0.03	<0.3
Lead, Dissolved	mg/l	0.01	--	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.01
Magnesium, Dissolved	mg/l	--	--	8	1	<1	4	4	4	57	230	278
Manganese, Dissolved	mg/l	--	0.05	<0.01	0.04	<0.01	<0.01	<0.01	0.07	0.08	0.32	0.4
Mercury, Dissolved	mg/l	0.001	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Potassium, Dissolved	mg/l	--	--	16	3	2	4	4	4	21	67	46
Sodium, Dissolved	mg/l	--	200 [14]	143	128	151	158	157	162	765	2650	3830
Zinc, Dissolved	mg/l	--	5	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.1
Phenols												
Phenolics, Total Recoverable	mg/l	--	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VOCs												
1,4-Dichlorobenzene	mg/l	0.005	0.001	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.003	<0.0004	<0.0004	<0.0004
Methylene Chloride	mg/l	0.05	--	<0.004	<0.004	<0.004	<0.004	<0.004	<0.032	<0.004	<0.004	<0.004
Vinyl Chloride	mg/l	0.002	--	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.002	<0.0002	<0.0002	<0.0002
Benzene	mg/l	0.005	--	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.004	<0.0005	<0.0005	<0.0005
Toluene	mg/l	--	0.024	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.004	<0.0005	<0.0005	<0.0005

TABLE TSD#1-B-6-1-1
ON-SITE GROUNDWATER QUALITY RESULTS
NRR SITE

Parameter	Unit	(2) (1) ODWQS(169/03)-Health	(4) (3) ODWQS-AO	09-8B	09-8B	09-8B	09-8C	09-8C	09-8C
				12-Feb-2010 (7)	29-Jun-2010 (6)(11)	07-Sep-2010 (6)(7)(12)	11-Feb-2010	29-Jun-2010 (5)	07-Sep-2010 (5)
				G-2	T-1	T-2	S-5	T-2	T-3
General Chemistry									
Alkalinity, Carbonate as CaCO3	mg/L	--	--	181	145	158	271	332	276
Ammonia Nitrogen	mg/L	--	--	1.10	1.88	0.63	0.08	0.07	0.07
Biologic Oxygen Demand, Five Day	mg/l	--	--	8	5	17	2	3	1
Chemical Oxygen Demand	mg/l	--	--	65	450	700	30	50	15
Chloride	mg/l	--	250	4270	8760	8700	2	2	7
Conductivity	uS/cm	--	--	14700	26400	28300	501	619	546
Conductivity (Field)	uS/cm	--	--	>5000	>3999	>3999	500	702	708
Dissolved Organic Carbon	mg/l	--	5	1.4	0.7	0.9	3.5	5.9	4.2
Nitrate as N	mg/l	10	--	2.05	<0.10	**12.6**	<0.10	<0.10	<0.10
Nitrite as N	mg/l	1	--	**1.97**	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrogen, Total Kjeldahl	mg/l	--	--	1.08	3.3	2.6	<0.10	<0.10	0.13
pH	-	--	--	7.48	7.59	7.68	7.82	7.67	7.72
pH (Field)	-	--	--	8.04	6.62	6.43	7.7	7.19	7.55
Phosphorus	mg/l	--	--	0.02	0.18	0.09	0.75	0.86	0.72
Sulfate	mg/l	--	500 (13)	1280	1930	2340	6	8	10
Temperature (Field)	deg c	--	15	7.2	11.4	21.3	7.3	10.8	13.5
Total Dissolved Solids	mg/l	--	500	11800	21100	22600	326	402	355
Metals									
Arsenic, Dissolved	mg/l	0.025	--	**0.05**	**0.042**	<0.1	0.002	<0.01	<0.01
Barium, Dissolved	mg/l	1	--	<0.1	0.04	<0.1	**1.11**	**1.3**	**1.3**
Boron, Dissolved	mg/l	5	--	0.4	0.35	0.9	0.07	0.05	0.11
Cadmium, Dissolved	mg/l	0.005	--	<0.001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001
Calcium, Dissolved	mg/l	--	--	655	1060	1270	78	98	83
Chromium, Dissolved	mg/l	0.05	--	0.01	0.003	<0.01	<0.001	<0.005	0.001
Copper, Dissolved	mg/l	--	1	<0.01	0.005	<0.01	<0.001	0.001	0.001
Iron, Dissolved	mg/l	--	0.3	<0.3	<0.03	<0.3	0.05	0.41	0.24
Lead, Dissolved	mg/l	0.01	--	<0.01	<0.001	<0.01	<0.001	<0.001	<0.001
Magnesium, Dissolved	mg/l	--	--	193	233	245	10	13	10
Manganese, Dissolved	mg/l	--	0.05	0.2	0.44	0.3	0.35	0.53	0.45
Mercury, Dissolved	mg/l	0.001	--	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Potassium, Dissolved	mg/l	--	--	40	55	46	2	2	2
Sodium, Dissolved	mg/l	--	200 (14)	2260	4860	4620	10	7	12
Zinc, Dissolved	mg/l	--	5	<0.1	<0.01	<0.1	<0.01	<0.01	<0.01
Phenols									
Phenolics, Total Recoverable	mg/l	--	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VOCs									
1,4-Dichlorobenzene	mg/l	0.005	0.001	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Methylene Chloride	mg/l	0.05	--	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Vinyl Chloride	mg/l	0.002	--	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Benzene	mg/l	0.005	--	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Toluene	mg/l	--	0.024	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

TABLE TSD#1-B-6-1-1
ON-SITE GROUNDWATER QUALITY RESULTS
NRR SITE

Footnotes:

Tables should be read in conjunction with the accompanying document.

< value = Indicates parameter not detected above laboratory method detection limit

> value = Indicates parameter detected above equipment analytical range

-- Chemical not analyzed or criteria not defined

(1) Ontario Drinking Water Quality Standards - Health Based Standards

(2) Bold = Parameter concentration greater than ODWQS(169/03)-Health

(3) Ontario Drinking Water Quality Standards - Aesthetic Objectives. Aesthetic Objectives are established for parameters that may impair the taste, odour or colour of water or which may interfere with good water quality control practices. For certain parameters, both aesthetic objectives and health-related MACs have been derived.

(4) Underline = Parameter concentration greater than ODWQS-AO

(5) Arsenic MRL elevated due to matrix interference.

(6) TKN MRL elevated due to matrix interference. TKN results may be biased low due to elevated dissolved salt content.

(7) Metals MRL elevated due to matrix interference.

(8) N-NO2 and N-NO3 MRL elevated due to matrix interference.

(9) Arsenic and TP MRL elevated due to matrix interference.

(10) VOC MRL elevated due to matrix interference.

(11) Arsenic was analsyed at Exova Pointe Claire.

(12) COD results may be biased high due to elevated dissolved salt content.

(13) There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L.

(14) The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets.

ATTACHMENT TSD#1-B-6-2

On-Site Groundwater Quality Results (BR Site)

February 2013

TABLE TSD#1-B-6-2-1
ON-SITE GROUNDWATER QUALITY RESULTS
BR SITE

Parameter	Unit	(2) (1) ODWQS(169/03)-Health	(4) (3) ODWQS-AO	BH12-1-3.1	BH12-1-4A	BH12-1-5B	BH12-1-6	BH12-2-3	BH12-2-5B	BH12-2-6	BH12-3-3	BH12-3-4A	BH12-3-5B	BH12-3-6
				11-Jan-2013 (5)	11-Jan-2013	11-Jan-2013 (5)	11-Jan-2013	21-Jan-2013	21-Jan-2013	21-Jan-2013	11-Jan-2013 (6)	11-Jan-2013 (5)	11-Jan-2013	11-Jan-2013
				A-1	A-2	A-3	A-5	12-02-3	12-02-5B	12-02-6	B-1	B-2	B-3	B-4
General Chemistry														
Alkalinity, Carbonate as CaCO3	mg/l	--	--	510	490	710	660	590	200	390	680	620	340	320
Ammonia Nitrogen	mg/l	--	--	12 (7)	12	3.4	0.26	6.9	2.3	0.37	9.7	8.7 (7)	1.7	0.22
Biologic Oxygen Demand, Five Day	mg/l	--	--	17	15	<2.0	<2.0	4	68	5	<40	8.0	20	<2.0
Chemical Oxygen Demand	mg/l	--	--	140	110	220	51	56	740	140	100	85	380	26
Chloride	mg/l	--	250	7300	7100	1600	360	2800	350	71	6000	6100	900	950
Conductivity	uS/cm	--	--	23000	22000	6400	2700	10000	1700	1000	21000	19000	3900	3900
Conductivity (Field)	uS/cm	--	--	>3999	>3999	>3999	2564	>3999	1507	920	>3999	>3999	3364	3108
Dissolved Organic Carbon	mg/l	--	5	8.5	8.6	6.2	4.8	5.6	45	5.7	8.1	9.4	21	4.5
Nitrate as N	mg/l	10	--	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrite as N	mg/l	1	--	<0.010	<0.010	<0.010	0.022	<0.010	0.056	<0.010	<0.010	<0.010	<0.010	<0.010
Nitrogen, Total Kjeldahl	mg/l	--	--	12 (7)	14	11	3.0	7.4	19	4.0	9.8	8.3 (7)	14	1.9
pH (Field)	-	--	--	7.69	7.86	7.82	7.75	7.73	7.37	7.72	7.88	8.12	7.71	7.81
Phosphorus	mg/l	--	--	0.23	6.9	130	1.5	0.087	78	25	0.23	0.37	48	6.3
Sulfate	mg/l	--	500 (8)	6	10	38	160	250	32	55	4	18	130	83
Temperature (Field)	deg c	--	15	6.5	6.1	6.4	2.5	3.6	5.0	3.4	6.9	6.8	6.8	3.5
Total Dissolved Solids	mg/l	--	500	12700	12500	3460	1540	5560	958	570	11600	10400	2170	2270
Metals														
Arsenic, Dissolved	mg/l	0.025	--	<0.01	<0.01	0.0022	<0.0010	<0.0050 (9)	0.0021	<0.0010	<0.01	<0.01	0.0021 (9)	<0.0020 (9)
Barium, Dissolved	mg/l	1	--	**16**	**15**	0.2	0.079	0.09	0.044	0.058	**17**	**14**	0.2	0.36
Boron, Dissolved	mg/l	5	--	1.7	1.7	0.34	0.067	1.5	0.13	0.042	1.7	1.5	0.18	0.017
Cadmium, Dissolved	mg/l	0.005	--	<0.0010	<0.0010	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.0010	<0.0010	<0.00010	<0.00010
Calcium, Dissolved	mg/l	--	--	67	71	67	130	27	19	76	62	57	120	240
Chromium, Dissolved	mg/l	0.05	--	<0.05	<0.05	<0.02	0.0072	<0.025 (9)	<0.0050	<0.0050	<0.05	<0.05	<0.01 (9)	0.011 (9)
Copper, Dissolved	mg/l	--	1	<0.01	<0.01	<0.0020	0.0011	<0.0010	<0.0010	<0.0010	<0.01	<0.01	<0.0010	0.0016
Iron, Dissolved	mg/l	--	0.3	<1	<1	<0.2	<0.1	<0.1	<0.1	<0.1	<1	<1	<0.1	<0.1
Lead, Dissolved	mg/l	0.01	--	<0.0050	<0.0050	<0.0010	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	<0.0050	<0.00050	<0.00050
Magnesium, Dissolved	mg/l	--	--	330	330	130	88	93	12	35	240	210	34	56
Manganese, Dissolved	mg/l	--	0.05	0.082	0.12	0.064	0.33	0.018	0.044	0.25	0.031	0.05	1.4	0.51
Mercury, Dissolved	mg/l	0.001	--	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Potassium, Dissolved	mg/l	--	--	90	91	26	6.2	50	5.2	4.7	81	74	12	6
Sodium, Dissolved	mg/l	--	200 (10)	4800	4900	1200	380	2000	350	87	4300	4000	690	530
Zinc, Dissolved	mg/l	--	5	<0.05	<0.05	<0.01	<0.0050	<0.0050	<0.0050	<0.0050	<0.05	<0.05	<0.0050	<0.0050
Phenols														
Phenolics, Total Recoverable	mg/l	--	--	<0.0010	<0.0010	<0.0010	<0.0010	0.0029	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
VOCs														
1,4-Dichlorobenzene	mg/l	0.005	0.001	<0.00050	<0.00050	<0.00040	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00050	<0.00050	<0.00020
Methane	l/m3	--	3	16	--	--	--	0.46	--	--	39	--	--	--
Methylene Chloride	mg/l	0.05	--	<0.0013	<0.0013	<0.0010	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0013	<0.0013	<0.00050
Vinyl Chloride	mg/l	0.002	--	<0.00050	<0.00050	<0.00040	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00050	0.0013	<0.00020
Benzene	mg/l	0.005	--	<0.00025	<0.00025	<0.00020	<0.00010	<0.00010	0.00061	<0.00010	0.00072	<0.00025	0.0043	<0.00010
Toluene	mg/l	--	0.024	<0.00050	<0.00050	<0.00040	<0.00020	<0.00020	0.00035	<0.00020	0.00027	<0.00050	0.0011	<0.00020

Created by: DH
Checked by: KAM

TABLE TSD#1-B-6-2-1
ON-SITE GROUNDWATER QUALITY RESULTS
BR SITE

Footnotes:

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< value = Indicates parameter not detected above laboratory method detection limit

> value = Indicates parameter detected above equipment analytical range

-- Chemical not analyzed or criteria not defined

(1) Ontario Drinking Water Quality Standards - Health Based Standards

(2) Bold = Parameter concentration greater than ODWQS(169/03)-Health

(3) Ontario Drinking Water Quality Standards - Aesthetic Objectives. Aesthetic Objectives are established for parameters that may impair the taste, odour or colour of water or which may interfere with good water quality control practices. For certain parameters, both aesthetic objectives and health-related MACs have been derived.

(4) Underline = Parameter concentration greater than ODWQS-AO

(5) Metal analysis: Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly.

(6) Metal analysis: Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly. BOD Analysis: BOD was reported as ND due to unknown matrix interference

(7) TKN < NH4: Both values fall within acceptable RPD limits for duplicates and are likely equivalent.

(8) There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L.

(9) Metal analysis: Detection Limit was raised due to matrix interferences.

(10) The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets.

Created by: DH
Checked by: KAM

ATTACHMENT TSD#1-B-7

Residential Water Quality Results and Completed Water Supply Surveys

TSD#1-B-7-1 – NRR Site

TSD#1-B-7-2 – BR Site

February 2013

ATTACHMENT TSD#1-B-7-1

Residential Water Quality Results and Completed Water Supply Surveys (NRR Site)

February 2013

TABLE TSD#1-B-7-1-1
RESIDENTIAL WATER SUPPLY WELL PROGRAM SAMPLING RESULTS
NRR SITE

Parameter	Unit	(2) (1) ODWQS(169/03)-Health	(4) (3) ODWQS-AO	EADIE-1	EADIE-2	N RUSSELL-1	N RUSSELL-2
				18-Jan-2013	17-Jan-2013	17-Jan-2013	17-Jan-2013
General Chemistry							
Alkalinity, Carbonate as CaCO3	mg/l	--	--	180	320	99	230
Ammonia Nitrogen	mg/l	--	--	0.46	0.15	0.12	<0.050
Biologic Oxygen Demand, Five Day	mg/l	--	--	<2.0	13	<2.0	<2.0
Chemical Oxygen Demand	mg/l	--	--	4.6	18	23	<4.0
Chloride	mg/l	--	250	110	170	6	20
Conductivity	uS/cm	--	--	1600	1600	300	710
Dissolved Organic Carbon	mg/l	--	5	0.44	1.7	2.5	0.89
Nitrate as N	mg/l	10	--	<0.10	0.26	9.1	**15**
Nitrite as N	mg/l	1	--	<0.010	0.054	<0.010	<0.010
Nitrogen, Total Kjeldahl	mg/l	--	--	0.93	0.63	0.13	0.15
pH	-	--	--	8.00	8.23	7.25	7.68
Phosphorus	mg/l	--	--	<0.020	<0.020	0.026	<0.020
Sulfate	mg/l	--	500 (5)	410	170	7	44
Total Dissolved Solids	mg/l	--	500	892	960	208	424
Metals							
Arsenic	mg/l	0.025	--	0.011	<0.0010	<0.0010	<0.0010
Barium	mg/l	1	--	0.02	0.28	0.14	0.095
Boron	mg/l	5	--	0.6	0.61	0.025	0.038
Cadmium	mg/l	0.005	--	<0.00010	<0.00010	<0.00010	0.00012
Calcium	mg/l	--	--	49	33	42	100
Chromium	mg/l	0.05	--	<0.0050	<0.0050	<0.0050	<0.0050
Copper	mg/l	--	1	0.0038	0.018	0.043	0.014
Iron	mg/l	--	0.3	<0.1	<0.1	<0.1	<0.1
Lead	mg/l	0.01	--	<0.00050	<0.00050	<0.00050	0.0022
Magnesium	mg/l	--	--	18	5.8	7.4	22
Manganese	mg/l	--	0.05	0.042	0.021	0.0025	0.0042
Mercury	mg/l	0.001	--	<0.00010	<0.00010	<0.00010	<0.00010
Potassium	mg/l	--	--	6	3.4	1.2	2.4
Sodium	mg/l	--	200 (6)	290	260	6.8	4
Zinc	mg/l	--	5	<0.0050	0.0097	0.0091	0.12
Phenols							
Phenolics, Total Recoverable	mg/l	--	--	<0.0010	<0.0010	<0.0010	<0.0010
VOCs							
1,4-Dichlorobenzene	mg/l	0.005	0.001	<0.00020	<0.00020	<0.00020	<0.00020
Methylene Chloride	mg/l	0.05	--	<0.00050	<0.00050	<0.00050	<0.00050
Vinyl Chloride	mg/l	0.002	--	<0.00020	<0.00020	<0.00020	<0.00020
Benzene	mg/l	0.005	--	<0.00010	<0.00010	<0.00010	<0.00010
Toluene	mg/l	--	0.024	<0.00020	<0.00020	<0.00020	<0.00020

Footnotes:

Tables should be read in conjunction with the accompanying document.

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(5) There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L.

(6) The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets.

Created by: DH
Checked by: KAM

[redacted]

CRRRC PROJECT
WATER WELL AND SEWAGE DISPOSAL SYSTEM
SURVEY QUESTIONNAIRE

Eadie-1

PROPERTY IDENTIFICATION NUMBER (PIN): [redacted] Eadie

TYPE OF DWELLING: ☒ Residential ☐ Commercial ☐ Institutional ☐ Other

I. OWNER / OCCUPANT INFORMATION AND GENERAL QUESTIONS:

OWNER:

Name: [redacted]

Address: [redacted] Eadie

Number of Bedrooms 3

Telephone No. (business)

Telephone No. (home) [redacted]

Number of Occupants 6

OCCUPANT (if other than Owner):

Name:

Address:

Number of Bedrooms

Telephone No. (business)

Telephone No. (home)

Number of Occupants

GENERAL QUESTIONS

How long have you owned/occupied this dwelling? 8 yrs

Is well water used for drinking water supply? Yes ☑ No ☐

If no, why not?

If no, how long has it been since well water was used for drinking?

If no, what is origin of drinking water?

II. WATER WELL

A. WELL CONSTRUCTION DETAILS:

Date or Year Constructed 30 +/- year ago Contractor –

Type of Well: Drilled ☒ Dug ☐ Well Diameter (inches) 5"

Present Well Depth: 48 +/- Original Well Depth ☐ Same as Present

Is Well Vented and How?:

PIN: [redacted] Eadie

Eadie-1

Top of Well Casing is:

1) Above ground surface ☒ 2) Buried inside a well pit ☐ 3) Buried, but not in a well pit ☐

The accurate location of well is known ☒ Unknown ☐

Type of pump: Submersible ☒ Jet pump ☐ Depth of Pump Intake (if known) ....

Well completed into: Bedrock ✓ shale Overburden (Soil) .... Both ....

Do you have a copy of the MOE Water Well Record? ☐ Yes ☐ No

ATTACH A COPY OF WATER WELL RECORD, IF POSSIBLE (WELL RECORD NO. ....)

B. WELL WATER LEVELS:

Indicate whether measured from ☐ ground level or ☐ from top of casing

Original water level depth .... metres on (date) ....

Subsequent water level measurements (give depths in metres and dates)................................

....

C. WATER QUANTITY

Does your well supply enough water for your use? Yes ☑ No ☐

If no, is this the case: All the time ☑ Some of the time ☐ Seasonally ☐ Other ....

Use: Domestic: No ☐ Yes ☑ No. of persons using water from well 6

Livestock: No ☒ Yes ☐ Lawn Watering: No ☒ Yes ☐

Other Uses .... Daily Usage (if known) ....

Have you ever experienced any problems with your well? redish colour in water

If so, when? When quarry is pumped down

What was the cause of the problem? ☐ Drought ☐ Pump Failure ☐ Plugging

☐ Increased Usage ☐ Interference ☐ Other (Please Specify) ....

Did you ever have your well deepened or cleaned, or a new well constructed? No

If so, why? ....

PIN: [redacted] Eadie

Eadie-1

D. WATER QUALITY

Water Treatment (if any) softner

Has your well recently been chlorinated and, if so, when? No

How would you describe quality of your water? ☐Poor ☐Good ☒Excellent

Has your water quality previously been tested? No ☐ Yes ☒

If yes, for what and how often? (bacteriological, chemical analyses, etc.) Bacti every year

ATTACH COPY OF ANY PREVIOUS CHEMICAL AND/OR BACTERIOLOGICAL ANALYSIS RESULTS ON THE WELL WATER, IF AVAILABLE

E. WATER SAMPLING INFORMATION

Water Quality Field Observations:

Appearance (clear, cloudy) Clear Odour none

Field Measured Parameters:

Temperature 6 °C pH

Conductivity H_2S

Other Comments no sediments no colour

Water Sample Collected No ☐ Yes ☒ If no, why?

Note: Collect Sample of "Untreated" Water only

Duplicate Water Sample Collected (10% of Locations for Project QA/QC) No ☒ Yes ☐

III. SEWAGE DISPOSAL SYSTEM

SYSTEM DETAILS

What type of sewage disposal system do you have:

☐ Holding Tank

☒ Septic Tank and Inground Leaching Bed

☐ Septic Tank and Raised or Partially Raised Leaching Bed

☐ Other Treatment System (e.g. peat bed, peat filter, etc.) If so, specify

☐ Don't know

Date or year Constructed — Contractor —

PIN: [redacted] Eadie

How often do you have the holding tank or septic tank pumped out? 2012 - summer Eadie-1

When was the last time? ✓

Is the septic tank comprised of ☐ one chamber ☐ 2 chambers ☒ don't know

Have you ever had any problems with your sewage disposal systems? (e.g. leaks from holding tank, failure of septic system including surficial release of sewage, visibly stained areas, unusual odours, soft ground, etc.) None

Technician Signature

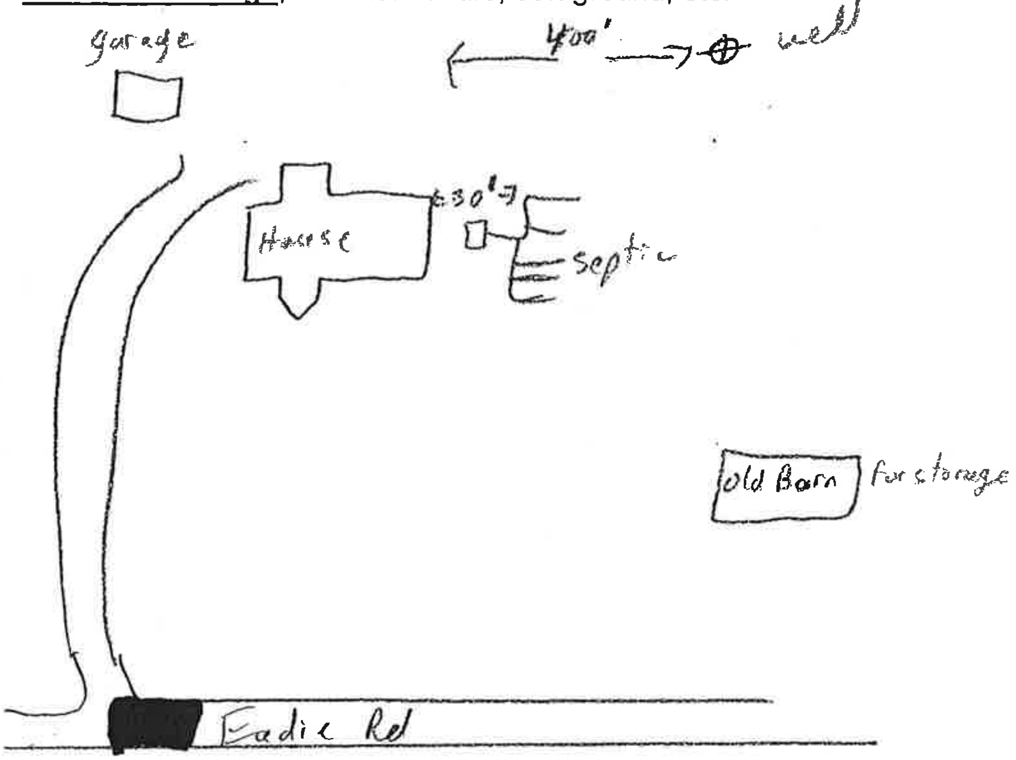
Date Jan 17/13

PIN: [redacted] Eadie.

Eadie-1

IV. PROPERTY SKETCH

Sketch the location of the septic system (including approximate leaching bed area), the well and the house, giving the best approximated distance between each of them. Include any indication of soil types (e.g. gravel, sand, silt, clay); overburden thickness, and slope (in degrees or percentage). Note any indications of septic system failure such as stained areas, **surficial release of sewage**, unusual odours, soft ground, etc.



Indicate all dimensions in metres

Note distance between well and septic system(s), if possible

Was there any existing evidence of a surficial release of sewage? ☐ No ☐ Yes

---

Other Symbols - Please Specify

Drilled Well

Dug Well

Septic Field

Septic Tank

Holding Tank

Bedrock Outcrop

Break of Slope

Minor

Steep

House

Road

Shed

Tree

Underground Line

Drainage

Ditch

Lot Line

Sidewalk

Fence

[redacted]

CRRRC PROJECT
WATER WELL AND SEWAGE DISPOSAL SYSTEM
SURVEY QUESTIONNAIRE

PROPERTY IDENTIFICATION NUMBER (PIN): [redacted] Eadie Eadie-2

TYPE OF DWELLING: ☒ Residential ☐ Commercial ☐ Institutional ☐ Other

I. OWNER / OCCUPANT INFORMATION AND GENERAL QUESTIONS:

OWNER:

Name: ....
Telephone No. (business) ....
Address: ....
Telephone No. (home) ....
Number of Bedrooms ....
Number of Occupants ....

OCCUPANT (if other than Owner):

Name: [redacted]
Telephone No. (business) ....
Address: [redacted] Eadie Rd
Telephone No. (home) [redacted]
Number of Bedrooms 3
Number of Occupants 1

GENERAL QUESTIONS

How long have you owned/occupied this dwelling? 2010

Is well water used for drinking water supply? Yes ☐ No ☒

If no, why not? ....

If no, how long has it been since well water was used for drinking? Since moving in

If no, what is origin of drinking water? bottles of water

II. WATER WELL

A. WELL CONSTRUCTION DETAILS:

Date or Year Constructed [illegible] +/-
Contractor ....

Type of Well: Drilled ☐ Dug ☒
Well Diameter (inches) N/A

Present Well Depth: —
Original Well Depth —
☐ Same as Present

Is Well Vented and How?: ....

PIN: [redacted] Eadie

Eadie-2

Top of Well Casing is:

1) Above ground surface ☐ 2) Buried inside a well pit ☒ 3) Buried, but not in a well pit ☐

The accurate location of well is known ☒ Unknown ☐

Type of pump: Submersible ☒ Jet pump ☐ Depth of Pump Intake (if known) —

Well completed into: Bedrock — Overburden (Soil) ✓ Both ....

Do you have a copy of the MOE Water Well Record? ☐ Yes ☒ No

ATTACH A COPY OF WATER WELL RECORD, IF POSSIBLE (WELL RECORD NO. ....)

B. WELL WATER LEVELS:

Indicate whether measured from ☐ ground level or ☐ from top of casing

Original water level depth .... metres on (date) ....

Subsequent water level measurements (give depths in metres and dates) ....

C. WATER QUANTITY

Does your well supply enough water for your use? Yes ☐ No ☒

If no, is this the case: All the time ☐ Some of the time ☒ Seasonally ☐ Other ....

Use: Domestic: No ☐ Yes ☒ No. of persons using water from well 1 yrs

Livestock: No ☑ Yes ☐ Lawn Watering: No ☒ Yes ☐

Other Uses .... Daily Usage (if known) ....

Have you ever experienced any problems with your well? Well will go dry if over used.

If so, when? The owner Has to be carefull to do 1 load of laundry of [illegible]

What was the cause of the problem? ☐ Drought ☐ Pump Failure ☐ Plugging

☐ Increased Usage ☐ Interference ☐ Other (Please Specify) ....

Did you ever have your well deepened or cleaned, or a new well constructed? NO

If so, why? ....

PIN [redacted] Eadie
Eadie -2

D. WATER QUALITY

Water Treatment (if any) Hydrogen Peroxide 35% make Anprox 35

Has your well recently been chlorinated and, if so, when? Sulphur -

How would you describe quality of your water? ☐Poor ☑Good ☐Excellent

Has your water quality previously been tested? No ☐ Yes ☐ dk biege, summer no odor

If yes, for what and how often? (bacteriological, chemical analyses, etc.)

ATTACH COPY OF ANY PREVIOUS CHEMICAL AND/OR BACTERIOLOGICAL ANALYSIS RESULTS ON THE WELL WATER, IF AVAILABLE

E. WATER SAMPLING INFORMATION

Water Quality Field Observations:

Appearance (clear, cloudy) clear Odour none

Field Measured Parameters:

Temperature 7°C pH

Conductivity H_2S

Other Comments no colour, no sediments

Water Sample Collected No ☐ Yes ☒ If no, why?

Note: Collect Sample of "Untreated" Water only

Duplicate Water Sample Collected (10% of Locations for Project QA/QC) No ☒ Yes ☐

III. SEWAGE DISPOSAL SYSTEM

SYSTEM DETAILS

What type of sewage disposal system do you have:

☐ Holding Tank

☒ Septic Tank and Inground Leaching Bed

☐ Septic Tank and Raised or Partially Raised Leaching Bed

☐ Other Treatment System (e.g. peat bed, peat filter, etc.) If so, specify

☐ Don't know

Date or year Constructed — Contractor —

PIN [redacted] Eadie
Eadie-2

How often do you have the holding tank or septic tank pumped out? –

When was the last time? Not yet since living there.

Is the septic tank comprised of ☐ one chamber ☐ 2 chambers ☒ don't know

Have you ever had any problems with your sewage disposal systems? (e.g. leaks from holding tank, failure of septic system including surficial release of sewage, visibly stained areas, unusual odours, soft ground, etc.) No.

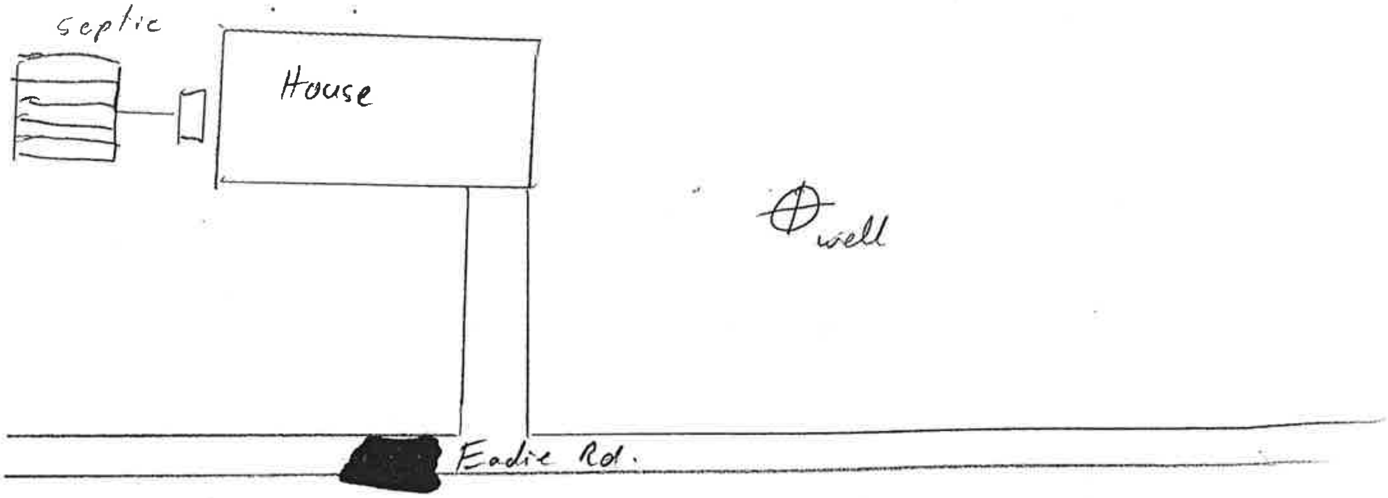
Technician Signature

Date Jan /13

PIN: [redacted] Eadie Eadie-2

IV. PROPERTY SKETCH

Sketch the location of the septic system (including approximate leaching bed area), the well and the house, giving the best approximated distance between each of them. Include any indication of soil types (e.g. gravel, sand, silt, clay); overburden thickness, and slope (in degrees or percentage). Note any indications of septic system failure such as stained areas, **surficial release of sewage**, unusual odours, soft ground, etc.



Indicate all dimensions in metres

Note distance between well and septic system(s), if possible

Was there any existing evidence of a surficial release of sewage? ☒ No ☐ Yes

---

Other Symbols - Please Specify

- Drilled Well
- Dug Well
- Septic Field
- Septic Tank
- Holding Tank
- Bedrock Outcrop
- Break of Slope
- Minor
- Steep
- House
- Road
- Shed
- Tree
- Underground Line
- Drainage
- Ditch
- Lot Line
- Sidewalk
- Fence

[redacted]

CRRRC PROJECT
WATER WELL AND SEWAGE DISPOSAL SYSTEM
SURVEY QUESTIONNAIRE

PROPERTY IDENTIFICATION NUMBER (PIN): [redacted] N. Russell N Russell-1

TYPE OF DWELLING: ☒ Residential ☐ Commercial ☐ Institutional ☐ Other

I. OWNER / OCCUPANT INFORMATION AND GENERAL QUESTIONS:

OWNER:

Name: [redacted] Telephone No. (business)
Address: [redacted] N. Russell Rd Telephone No. (home) [redacted]
Number of Bedrooms 3 Number of Occupants 4

OCCUPANT (if other than Owner):

Name: Telephone No. (business)
Address: Telephone No. (home)
Number of Bedrooms 3 Number of Occupants 4

GENERAL QUESTIONS

How long have you owned/occupied this dwelling? 2000
Is well water used for drinking water supply? Yes ☑ No ☐
If no, why not?
If no, how long has it been since well water was used for drinking?
If no, what is origin of drinking water?

II. WATER WELL

A. WELL CONSTRUCTION DETAILS:

Date or Year Constructed 30'+/- in shale Contractor —
Type of Well: Drilled ☒ Dug ☐ Well Diameter (inches) 4"-5"
Present Well Depth: Original Well Depth 45' ☐ Same as Present
Is Well Vented and How?:

PIN: [redacted] N. Russell

N Russell-1

Top of Well Casing is:

1) Above ground surface ☑ 2) Buried inside a well pit ☐ 3) Buried, but not in a well pit ☐

The accurate location of well is known ☒ Unknown ☐

Type of pump: Submersible ☑ Jet pump ☐ Depth of Pump Intake (if known) ....

Well completed into: Bedrock Shale .... Overburden (Soil) .... Both ....

Do you have a copy of the MOE Water Well Record? ☐ Yes ☒ No

ATTACH A COPY OF WATER WELL RECORD, IF POSSIBLE (WELL RECORD NO. ....)

B. WELL WATER LEVELS:

Indicate whether measured from ☐ ground level or ☐ from top of casing

Original water level depth .... metres on (date) ....

Subsequent water level measurements (give depths in metres and dates)..................................

....

C. WATER QUANTITY

Does your well supply enough water for your use? Yes ☑ No ☐

If no, is this the case: All the time ☐ Some of the time ☐ Seasonally ☐ Other ....

Use: Domestic: No ☐ Yes ☑ No. of persons using water from well ....

Livestock: No ☐ Yes ☑ Lawn Watering: No ☑ Yes ☐

Other Uses .... Daily Usage (if known) ....

Have you ever experienced any problems with your well? ......No......................................

If so, when? ....

What was the cause of the problem? ☐ Drought ☐ Pump Failure ☐ Plugging

☐ Increased Usage ☐ Interference ☐ Other (Please Specify) ....

Did you ever have your well deepened or cleaned, or a new well constructed? ....No..............

If so, why? ....

PIN: [redacted] N. Russell N Russell-1

D. WATER QUALITY

Water Treatment (if any) Hydrogen Peroxide

Has your well recently been chlorinated and, if so, when? No

How would you describe quality of your water? ☐Poor ☒Good ☐Excellent

Has your water quality previously been tested? No ☐ Yes ☒

If yes, for what and how often? (bacteriological, chemical analyses, etc.) Bacti every year

ATTACH COPY OF ANY PREVIOUS CHEMICAL AND/OR BACTERIOLOGICAL ANALYSIS RESULTS ON THE WELL WATER, IF AVAILABLE

E. WATER SAMPLING INFORMATION

Water Quality Field Observations:

Appearance (clear, cloudy) clear Odour none

Field Measured Parameters:

Temperature .... pH ....

Conductivity .... H_2S ....

Other Comments no sediments, no colour

Water Sample Collected No ☐ Yes ☒ If no, why? ....

Note: Collect Sample of "Untreated" Water only

Duplicate Water Sample Collected (10% of Locations for Project QA/QC) No ☒ Yes ☐

III. SEWAGE DISPOSAL SYSTEM

SYSTEM DETAILS

What type of sewage disposal system do you have:

- ☐ Holding Tank
- ☐ Septic Tank and Inground Leaching Bed
- ☑ Septic Tank and Raised or Partially Raised Leaching Bed
- ☐ Other Treatment System (e.g. peat bed, peat filter, etc.) If so, specify ....
- ☐ Don't know

Date or year Constructed 1992 Contractor –

PIN: [redacted] N. Russell

N Russell-1

How often do you have the holding tank or septic tank pumped out? 3 yrs ago ✓

When was the last time?

Is the septic tank comprised of ☐ one chamber ☐ 2 chambers ☐ don't know

Have you ever had any problems with your sewage disposal systems? (e.g. leaks from holding tank, failure of septic system including surficial release of sewage, visibly stained areas, unusual odours, soft ground, etc.) None

Technician Signature

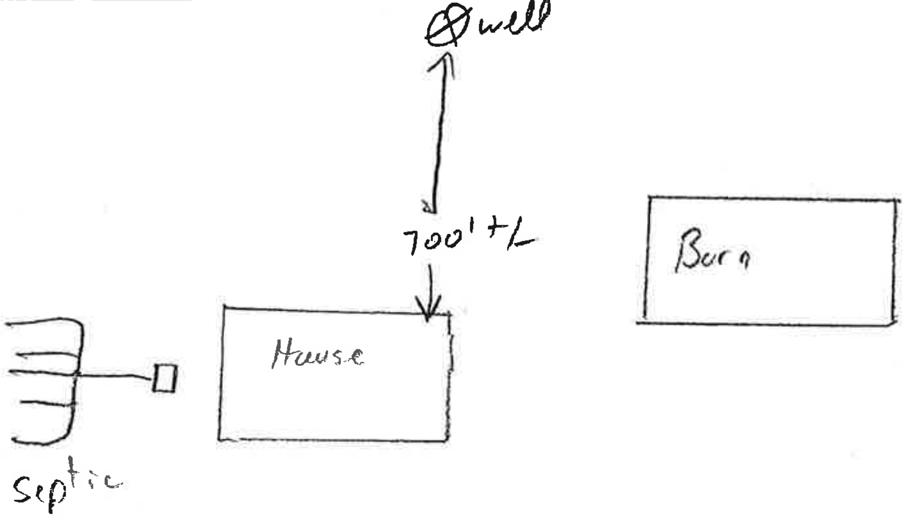
Date Jun 17/13

PIN: [redacted] N Russell

N Russell -1

IV. PROPERTY SKETCH

Sketch the location of the septic system (including approximate leaching bed area), the well and the house, giving the best approximated distance between each of them. Include any indication of soil types (e.g. gravel, sand, silt, clay); overburden thickness, and slope (in degrees or percentage). Note any indications of septic system failure such as stained areas, **surficial release of sewage**, unusual odours, soft ground, etc.



Indicate all dimensions in metres

Note distance between well and septic system(s), if possible

Was there any existing evidence of a surficial release of sewage? ☒ No ☐ Yes

---

Other Symbols - Please Specify

- Drilled Well
- Dug Well
- Septic Field
- Septic Tank
- Holding Tank
- Bedrock Outcrop
- Break of Slope
- Minor
- Steep
- House
- Road
- Shed
- Tree
- Underground Line
- Drainage
- Ditch
- Lot Line
- Sidewalk
- Fence

[redacted]

CRRRC PROJECT
WATER WELL AND SEWAGE DISPOSAL SYSTEM
SURVEY QUESTIONNAIRE

N Russell-2

PROPERTY IDENTIFICATION NUMBER (PIN): [redacted] N. Russell

TYPE OF DWELLING: ☒ Residential ☐ Commercial ☐ Institutional ☐ Other

I. OWNER / OCCUPANT INFORMATION AND GENERAL QUESTIONS:

OWNER:

Name: [redacted]

Telephone No. (business) [redacted]

Address: [redacted] N. Russell

Telephone No. (home) ....

Number of Bedrooms........

Number of Occupants........

OCCUPANT (if other than Owner):

Name: ....

Telephone No. (business) ....

Address: ....

Telephone No. (home) ....

Number of Bedrooms........

Number of Occupants........

GENERAL QUESTIONS

How long have you owned/occupied this dwelling? House 3-4 yrs old

Is well water used for drinking water supply? Yes ☐ No ☐

If no, why not? possibly at house

If no, how long has it been since well water was used for drinking? ....

If no, what is origin of drinking water? ....

II. WATER WELL

A. WELL CONSTRUCTION DETAILS:

Date or Year Constructed 10 yrs +

Contractor ....

Type of Well: Drilled ☐ Dug ☒

Well Diameter (inches) 24" - originally dugged and then drilled deep for more capacity

Present Well Depth: ....

Original Well Depth .... ☐ Same as Present

Is Well Vented and How?: .... still think they are in overburden

X Note Home owner gone South for winter talked to his employee. ([redacted])

PIN: [redacted] N Russell

N Russell -2

Top of Well Casing is:

1) Above ground surface ☒ 2) Buried inside a well pit ☐ 3) Buried, but not in a well pit ☐

The accurate location of well is known ☒ Unknown ☐

Type of pump: Submersible ☒ Jet pump ☐ Depth of Pump Intake (if known) ....

Well completed into: Bedrock .... Overburden (Soil) ....✓.... Both ....

Do you have a copy of the MOE Water Well Record? ☐ Yes ☒ No

ATTACH A COPY OF WATER WELL RECORD, IF POSSIBLE (WELL RECORD NO. ....)

B. WELL WATER LEVELS:

Indicate whether measured from ☐ ground level or ☐ from top of casing

Original water level depth .... metres on (date) ....

Subsequent water level measurements (give depths in metres and dates)..............................

....

C. WATER QUANTITY

Does your well supply enough water for your use? Yes ☒ No ☐

If no, is this the case: All the time ☒ Some of the time ☐ Seasonally ☐ Other ....

Use: Domestic: No ☐ Yes ☒ No. of persons using water from well —

Livestock: No ☒ Yes ☐ Lawn Watering: No ☒ Yes ☐

Other Uses .... Daily Usage (if known) ....

Have you ever experienced any problems with your well? No

If so, when? ....

What was the cause of the problem? ☐ Drought ☐ Pump Failure ☐ Plugging

☐ Increased Usage ☐ Interference ☐ Other (Please Specify) ....

Did you ever have your well deepened or cleaned, or a new well constructed? ....

If so, why? Not lately

PIN: [redacted] N Russell

N Russell -2

D. WATER QUALITY

Water Treatment (if any) None in garage maybe at house

Has your well recently been chlorinated and, if so, when? N/A

How would you describe quality of your water? ☐Poor ☒Good ☐Excellent

Has your water quality previously been tested? No ☐ Yes ☐

If yes, for what and how often? (bacteriological, chemical analyses, etc.)

ATTACH COPY OF ANY PREVIOUS CHEMICAL AND/OR BACTERIOLOGICAL ANALYSIS RESULTS ON THE WELL WATER, IF AVAILABLE

E. WATER SAMPLING INFORMATION

Water Quality Field Observations:

Appearance (clear, cloudy) clear Odour none

Field Measured Parameters:

Temperature 7 °C pH

Conductivity H_2S

Other Comments no sediments, no colour

Water Sample Collected No ☐ Yes ☒ If no, why?

Note: Collect Sample of "Untreated" Water only

Duplicate Water Sample Collected (10% of Locations for Project QA/QC) No ☒ Yes ☐

III. SEWAGE DISPOSAL SYSTEM

SYSTEM DETAILS

What type of sewage disposal system do you have:

☐ Holding Tank

☑ Septic Tank and Inground Leaching Bed

☐ Septic Tank and Raised or Partially Raised Leaching Bed

☐ Other Treatment System (e.g. peat bed, peat filter, etc.) If so, specify

☐ Don't know

Date or year Constructed 3-4yrs Contractor —

PIN: [redacted] N Russell
N Russell-2

How often do you have the holding tank or septic tank pumped out? not yet

When was the last time? have not done it yet

Is the septic tank comprised of ☐ one chamber ☐ 2 chambers ☐ don't know

Have you ever had any problems with your sewage disposal systems? (e.g. leaks from holding tank, failure of septic system including surficial release of sewage, visibly stained areas, unusual odours, soft ground, etc.) None

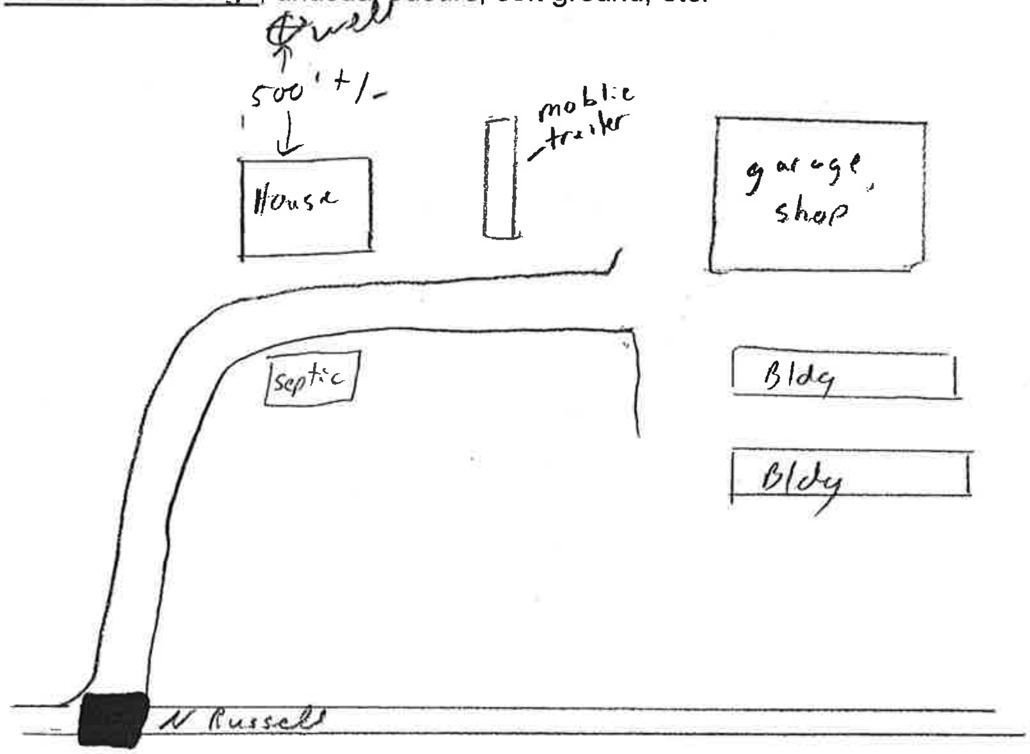
Technician Signature Date Jan 17/13

PIN: [redacted] N Russell

N Russell-2

IV. PROPERTY SKETCH

Sketch the location of the septic system (including approximate leaching bed area), the well and the house, giving the best approximated distance between each of them. Include any indication of soil types (e.g. gravel, sand, silt, clay); overburden thickness, and slope (in degrees or percentage). Note any indications of septic system failure such as stained areas, **surficial release of sewage**, unusual odours, soft ground, etc.



Indicate all dimensions in metres

Note distance between well and septic system(s), if possible

Was there any existing evidence of a surficial release of sewage? ☒ No ☐ Yes

Other Symbols - Please Specify

Drilled Well
Dug Well
Septic Field
Septic Tank
Holding Tank
Bedrock Outcrop

Break of Slope
Minor
Steep
House
Road
Shed

Tree
Underground Line
Drainage
Ditch
Lot Line
Sidewalk
Fence

ATTACHMENT TSD#1-B-7-2

Residential Water Quality Results and Completed Water Supply Surveys (BR Site)

February 2013

TABLE TSD#1-B-7-2-1
RESIDENTIAL AND COMMERCIAL WATER SUPPLY WELL PROGRAM SAMPLING RESULTS
BR SITE

Parameter	Unit	(2) (1) ODWQS(169/03)-Health	(4) (3) ODWQS-AO	BOUNDARY-1 (7)	FRONTIER-1	FRONTIER-2
				17-Jan-2013	18-Jan-2013	17-Jan-2013
General Chemistry						
Alkalinity, Carbonate as CaCO3	mg/l	--	--	370	220	220
Ammonia Nitrogen	mg/l	--	--	0.40	<0.050	<0.050
Biologic Oxygen Demand, Five Day	mg/l	--	--	<2.0	<2.0	<2.0
Chemical Oxygen Demand	mg/l	--	--	18	15	11
Chloride	mg/l	--	250	130	71	60
Conductivity	uS/cm	--	--	1200	830	690
Dissolved Organic Carbon	mg/l	--	5	7.4	5.4	5.6
Nitrate as N	mg/l	10	--	<0.10	2.5	<0.10
Nitrite as N	mg/l	1	--	<0.010	<0.010	<0.010
Nitrogen, Total Kjeldahl	mg/l	--	--	0.93	0.68	0.69
pH	-	--	--	7.83	7.65	7.73
Phosphorus	mg/l	--	--	0.058	<0.020	<0.020
Sulfate	mg/l	--	500 (5)	74	81	37
Total Dissolved Solids	mg/l	--	500	720	374	422
Metals						
Arsenic	mg/l	0.025	--	<0.0010	<0.0010	<0.0010
Barium	mg/l	1	--	0.048	0.069	0.04
Boron	mg/l	5	--	0.11	0.18	0.016
Cadmium	mg/l	0.005	--	<0.00010	<0.00010	<0.00010
Calcium	mg/l	--	--	99	89	85
Chromium	mg/l	0.05	--	<0.0050	<0.0050	<0.0050
Copper	mg/l	--	1	0.0015	0.018	0.073
Iron	mg/l	--	0.3	0.65	<0.1	0.23
Lead	mg/l	0.01	--	<0.00050	<0.00050	<0.00050
Magnesium	mg/l	--	--	40	25	15
Manganese	mg/l	--	0.05	1.2	0.13	0.094
Mercury	mg/l	0.001	--	<0.00010	<0.00010	<0.00010
Potassium	mg/l	--	--	7.7	6.3	2.3
Sodium	mg/l	--	200 (6)	100	55	30
Zinc	mg/l	--	5	<0.0050	0.019	0.0092
Phenols						
Phenolics, Total Recoverable	mg/l	--	--	<0.0010	<0.0010	<0.0010
VOCs						
1,4-Dichlorobenzene	mg/l	0.005	0.001	<0.00020	<0.00020	<0.00020
Methylene Chloride	mg/l	0.05	--	<0.00050	<0.00050	<0.00050
Vinyl Chloride	mg/l	0.002	--	<0.00020	<0.00020	<0.00020
Benzene	mg/l	0.005	--	<0.00010	<0.00010	<0.00010
Toluene	mg/l	--	0.024	<0.00020	<0.00020	<0.00020

Footnotes:

Tables should be read in conjunction with the accompanying document.

< value = Indicates parameter not detected above laboratory method detection limit

> value = Indicates parameter detected above equipment analytical range

-- Chemical not analyzed or criteria not defined

(1) Ontario Drinking Water Quality Standards - Health Based Standards

(2) Bold = Parameter concentration greater than ODWQS(169/03)-Health

(3) Ontario Drinking Water Quality Standards - Aesthetic Objectives. Aesthetic Objectives are established for parameters that may impair the taste, odour or colour of water or which may interfere with good water quality control practices. For certain parameters, both aesthetic objectives and health-related MACs have been derived.

(4) Underline = Parameter concentration greater than ODWQS-AO

(5) There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L.

(6) The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets.

(7) Commercial water supply well.

[redacted]

CRRRC PROJECT
WATER WELL AND SEWAGE DISPOSAL SYSTEM
SURVEY QUESTIONNAIRE

PROPERTY IDENTIFICATION NUMBER (PIN): Boundary - 1

TYPE OF DWELLING: ☐ Residential ☒ Commercial ☐ Institutional ☐ Other

I. OWNER / OCCUPANT INFORMATION AND GENERAL QUESTIONS:

OWNER:

Name: [redacted]
Telephone No. (business) [redacted]
Address: [redacted] Boundry Rd.
Telephone No. (home)
Number of Bedrooms —
Number of Occupants —

OCCUPANT (if other than Owner):

Name:
Telephone No. (business)
Address:
Telephone No. (home)
Number of Bedrooms
Number of Occupants

GENERAL QUESTIONS

How long have you owned/occupied this dwelling? 77 years
Is well water used for drinking water supply? Yes ☐ No ☒
If no, why not? just to be safe
If no, how long has it been since well water was used for drinking? never
If no, what is origin of drinking water?

II. WATER WELL

A. WELL CONSTRUCTION DETAILS:

Date or Year Constructed 50+ yrs
Contractor Themselves
Type of Well: Drilled ☐ Dug ☒
Well Diameter (inches) 36" +/-
Present Well Depth:
Original Well Depth 18-20'
☐ Same as Present
Is Well Vented and How?:

PIN: [redacted] Boundary
Boundary - 1

Top of Well Casing is:

1) Above ground surface ☒ 2) Buried inside a well pit ☐ 3) Buried, but not in a well pit ☐

The accurate location of well is known ☒ Unknown ☐

Type of pump: Submersible ☒ Jet pump ☐ Depth of Pump Intake (if known) ....

Well completed into: Bedrock .... Overburden (Soil) ..X....... Both ....

Do you have a copy of the MOE Water Well Record? ☐ Yes ☒ No

ATTACH A COPY OF WATER WELL RECORD, IF POSSIBLE (WELL RECORD NO. ....)

B. WELL WATER LEVELS:

Indicate whether measured from ☐ ground level or ☐ from top of casing

Original water level depth .... metres on (date) ....

Subsequent water level measurements (give depths in metres and dates)...............................

....

C. WATER QUANTITY

Does your well supply enough water for your use? Yes ☒ No ☐

If no, is this the case: All the time ☒ Some of the time ☐ Seasonally ☐ Other ....

Use: Domestic: No ☐ Yes ☒ No. of persons using water from well —..........

Livestock: No ☐ Yes ☐ Lawn Watering: No ☒ Yes ☐

Other Uses washing equipment Daily Usage (if known) ....

Have you ever experienced any problems with your well? None

If so, when? ....

What was the cause of the problem? ☐ Drought ☐ Pump Failure ☐ Plugging

☐ Increased Usage ☐ Interference ☐ Other (Please Specify) ....

Did you ever have your well deepened or cleaned, or a new well constructed? not that

If so, why? .... they cald remeber

PIN: [redacted] Boundary.

Boundary -1

D. WATER QUALITY

Water Treatment (if any)............none

Has your well recently been chlorinated and, if so, when?........No

How would you describe quality of your water? ☐Poor ☒Good ☐Excellent

Has your water quality previously been tested? No ☐ Yes ☒

If yes, for what and how often? (bacteriological, chemical analyses, etc.) ....Bacti, awhile ago

ATTACH COPY OF ANY PREVIOUS CHEMICAL AND/OR BACTERIOLOGICAL ANALYSIS RESULTS ON THE WELL WATER, IF AVAILABLE

E. WATER SAMPLING INFORMATION

Water Quality Field Observations:

Appearance (clear, cloudy)..Clear.......... Odour ...None

Field Measured Parameters:

Temperature ....6°C.......... pH ....

Conductivity .... H_2S ....

Other Comments ....no sediments, no colour

Water Sample Collected No ☐ Yes ☒ If no, why?..........

Note: Collect Sample of "Untreated" Water only

Duplicate Water Sample Collected (10% of Locations for Project QA/QC) No ☒ Yes ☐

III. SEWAGE DISPOSAL SYSTEM

SYSTEM DETAILS

What type of sewage disposal system do you have:

☐ Holding Tank

☒ Septic Tank and Inground Leaching Bed

☐ Septic Tank and Raised or Partially Raised Leaching Bed

☐ Other Treatment System (e.g. peat bed, peat filter, etc.) If so, specify ....

☐ Don't know

Date or year Constructed ..30 yrs +/-.......... Contractor ....Themselves

PIN: [redacted] Boundry

Boundary -1

How often do you have the holding tank or septic tank pumped out? N/A

When was the last time? N/A

Is the septic tank comprised of ☒ one chamber ☐ 2 chambers ☐ don't know

Have you ever had any problems with your sewage disposal systems? (e.g. leaks from holding tank, failure of septic system including surficial release of sewage, visibly stained areas, unusual odours, soft ground, etc.) None

Technician Signature

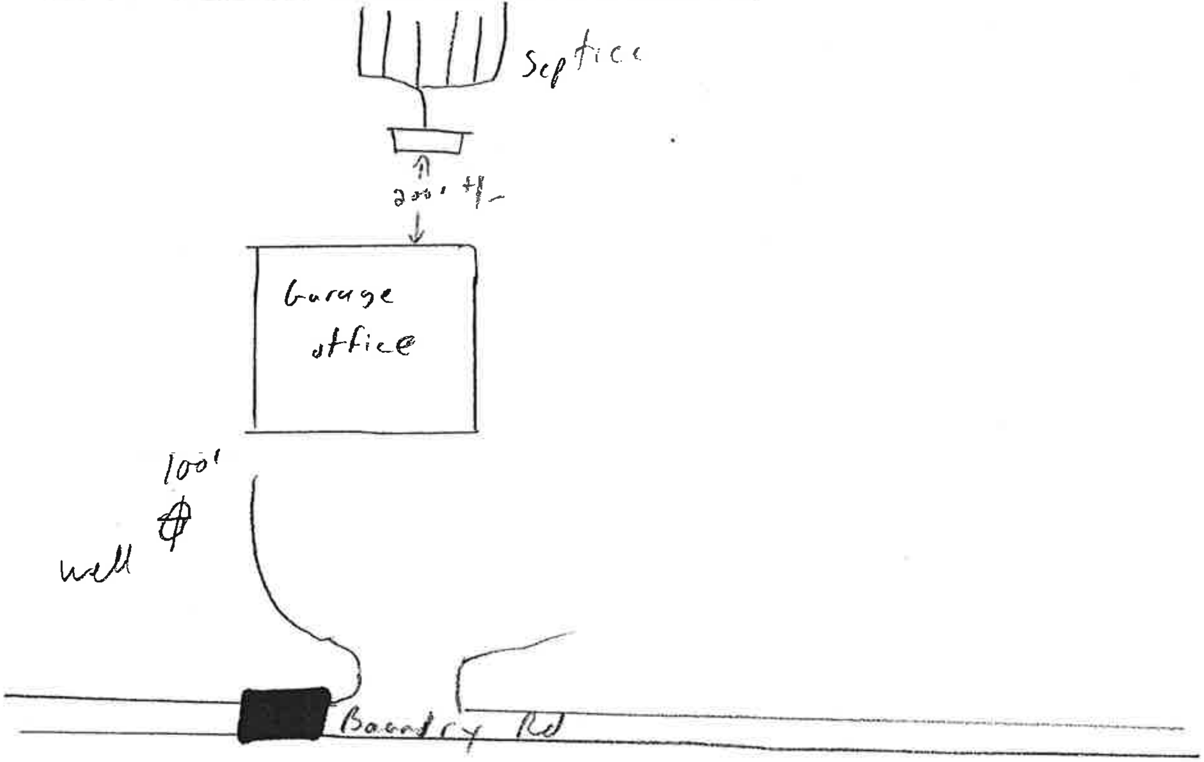
Date Jan /13

PIN: [redacted] Boundry

Boundary - 1

IV. PROPERTY SKETCH

Sketch the location of the septic system (including approximate leaching bed area), the well and the house, giving the best approximated distance between each of them. Include any indication of soil types (e.g. gravel, sand, silt, clay); overburden thickness, and slope (in degrees or percentage). Note any indications of septic system failure such as stained areas, **surficial release of sewage**, unusual odours, soft ground, etc.



Indicate all dimensions in metres

Note distance between well and septic system(s), if possible

Was there any existing evidence of a surficial release of sewage? ☐ No ☐ Yes

---

Other Symbols - Please Specify

Drilled Well

Dug Well

Septic Field

Septic Tank

Holding Tank

Bedrock Outcrop

Break of Slope

Minor

Steep

House

Road

Shed

Tree

Underground Line

Drainage

Ditch

Lot Line

Sidewalk

Fence

[redacted]

CRRRC PROJECT
WATER WELL AND SEWAGE DISPOSAL SYSTEM
SURVEY QUESTIONNAIRE

Frontier -1

PROPERTY IDENTIFICATION NUMBER (PIN): [redacted] Frontier Rd

TYPE OF DWELLING: ☒ Residential ☐ Commercial ☐ Institutional ☐ Other

I. OWNER / OCCUPANT INFORMATION AND GENERAL QUESTIONS:

~~OWNER:~~ Renters

Name: [redacted]
Address: [redacted] Frontier Rd
Number of Bedrooms 3
Telephone No. (business)
Telephone No. (home) [redacted]
Number of Occupants 3

OCCUPANT (if other than Owner):

Name:
Address:
Number of Bedrooms
Telephone No. (business)
Telephone No. (home)
Number of Occupants

GENERAL QUESTIONS

How long have you owned/occupied this dwelling? 18 years
Is well water used for drinking water supply? Yes ☐ No ☒
If no, why not? To be safe
If no, how long has it been since well water was used for drinking?
If no, what is origin of drinking water?

II. WATER WELL

A. WELL CONSTRUCTION DETAILS: house is 110 yrs old

Date or Year Constructed 20yrs+
Contractor
Type of Well: Drilled ☐ Dug ☒
Well Diameter (inches) 36"
Present Well Depth: 12'
Original Well Depth
☐ Same as Present
Is Well Vented and How?

PIN: [redacted]ontier Rd
Frontier - 1

Top of Well Casing is:

1) Above ground surface ☒ 2) Buried inside a well pit ☐ 3) Buried, but not in a well pit ☐

The accurate location of well is known ☒ Unknown ☐

Type of pump: Submersible ☐ Jet pump ☐ Depth of Pump Intake (if known) ....

Well completed into: Bedrock .... Overburden (Soil) ✓ Both ....

Do you have a copy of the MOE Water Well Record? ☐ Yes ☒ No

ATTACH A COPY OF WATER WELL RECORD, IF POSSIBLE (WELL RECORD NO. ....)

B. WELL WATER LEVELS:

Indicate whether measured from ☐ ground level or ☐ from top of casing

Original water level depth .... metres on (date) ....

Subsequent water level measurements (give depths in metres and dates)................................

....

C. WATER QUANTITY

Does your well supply enough water for your use? Yes ☒ No ☐ This summer went dry once but usually lots of water

If no, is this the case: All the time ☐ Some of the time ☐ Seasonally ☐ Other ....

Use: Domestic: No ☐ Yes ☒ No. of persons using water from well .....3.........

Livestock: No ☒ Yes ☐ Lawn Watering: No ☒ Yes ☐

Other Uses .... Daily Usage (if known) ....

Have you ever experienced any problems with your well? ....No..

If so, when? ....

What was the cause of the problem? ☐ Drought ☐ Pump Failure ☐ Plugging

☐ Increased Usage ☐ Interference ☐ Other (Please Specify) ....

Did you ever have your well deepened or cleaned, or a new well constructed? .....No...........

If so, why? ....

PIN: [redacted] Frontier Rd

Frontier - 1

D. WATER QUALITY

Water Treatment (if any) None

Has your well recently been chlorinated and, if so, when? No

How would you describe quality of your water? ☐Poor ☒Good ☐Excellent

Has your water quality previously been tested? No ☒ Yes ☐

If yes, for what and how often? (bacteriological, chemical analyses, etc.)

ATTACH COPY OF ANY PREVIOUS CHEMICAL AND/OR BACTERIOLOGICAL ANALYSIS RESULTS ON THE WELL WATER, IF AVAILABLE

E. WATER SAMPLING INFORMATION

Water Quality Field Observations:

Appearance (clear, cloudy) clear Odour none

Field Measured Parameters:

Temperature pH

Conductivity H_2S

Other Comments no sediments, no colour

Water Sample Collected No ☐ Yes ☒ If no, why?

Note: Collect Sample of "Untreated" Water only

Duplicate Water Sample Collected (10% of Locations for Project QA/QC) No ☒ Yes ☐

III. SEWAGE DISPOSAL SYSTEM

SYSTEM DETAILS

What type of sewage disposal system do you have:

☐ Holding Tank

☒ Septic Tank and Inground Leaching Bed

☐ Septic Tank and Raised or Partially Raised Leaching Bed

☐ Other Treatment System (e.g. peat bed, peat filter, etc.) If so, specify

☐ Don't know

Date or year Constructed N/A Contractor N/A

PIN: [redacted] Frontier Rd

Frontier-1

How often do you have the holding tank or septic tank pumped out? 4yrs

When was the last time? 4yrs

Is the septic tank comprised of ☐ one chamber ☐ 2 chambers ☐ don't know

Have you ever had any problems with your sewage disposal systems? (e.g. leaks from holding tank, failure of septic system including surficial release of sewage, visibly stained areas, unusual odours, soft ground, etc.) None

Technician Signature Date Jan 18/13

* Note

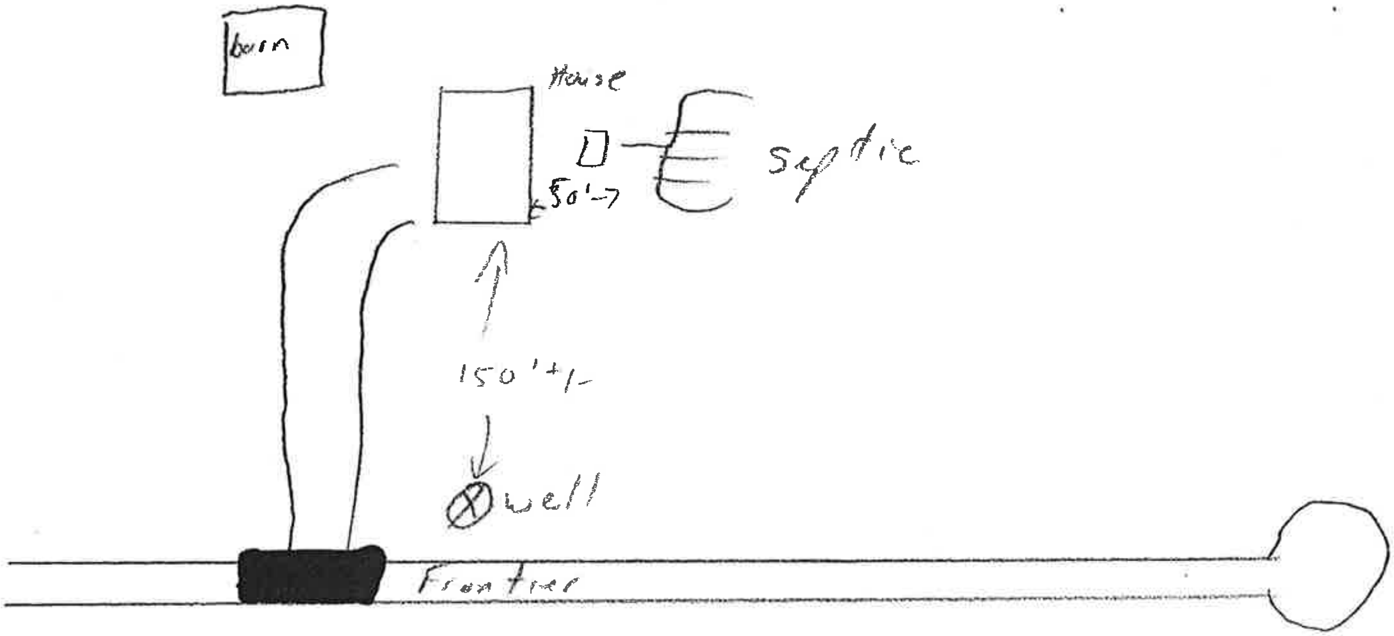
- Home owner mentions sulphur odor sometimes iron staining & some sediment periodically

PIN: [redacted] Frontier

Frontier -1

IV. PROPERTY SKETCH

Sketch the location of the septic system (including approximate leaching bed area), the well and the house, giving the best approximated distance between each of them. Include any indication of soil types (e.g. gravel, sand, silt, clay); overburden thickness, and slope (in degrees or percentage). Note any indications of septic system failure such as stained areas, **surficial release of sewage**, unusual odours, soft ground, etc.



Indicate all dimensions in metres

Note distance between well and septic system(s), if possible

Was there any existing evidence of a surficial release of sewage? ☒ No ☐ Yes

Other Symbols - Please Specify

Drilled Well
Dug Well
Septic Field
Septic Tank
Holding Tank
Bedrock Outcrop

Break of Slope
Minor
Steep
House
Road
Shed

Tree
Underground Line
Drainage
Ditch
Lot Line
Sidewalk
Fence

[redacted]

CRRRC PROJECT
WATER WELL AND SEWAGE DISPOSAL SYSTEM
SURVEY QUESTIONNAIRE

Frontier -2

PROPERTY IDENTIFICATION NUMBER (PIN): [redacted] Frontier Rd

TYPE OF DWELLING: ☒ Residential ☐ Commercial ☐ Institutional ☐ Other

---

I. OWNER / OCCUPANT INFORMATION AND GENERAL QUESTIONS:

OWNER:

Name: [redacted]

Address: [redacted] Frontier Rd.

Number of Bedrooms 3

Telephone No. (business)

Telephone No. (home) [redacted]

Number of Occupants 4

OCCUPANT (if other than Owner):

Name:

Address:

Number of Bedrooms

Telephone No. (business)

Telephone No. (home)

Number of Occupants

GENERAL QUESTIONS

How long have you owned/occupied this dwelling? 4 yrs

Is well water used for drinking water supply? Yes ☑ No ☐

If no, why not?

If no, how long has it been since well water was used for drinking?

If no, what is origin of drinking water?

II. WATER WELL

A. WELL CONSTRUCTION DETAILS: house built in late 70's well too.

Date or Year Constructed late 70's

Contractor –

Type of Well: Drilled ☐ Dug ☑ Well Diameter (inches) –

Present Well Depth: – Original Well Depth – ☐ Same as Present

Is Well Vented and How?:

PIN: [redacted] Frontier

Frontier - 2

Top of Well Casing is:

1) Above ground surface ☐ 2) Buried inside a well pit ☑ 3) Buried, but not in a well pit ☐

The accurate location of well is known ☒ Unknown ☐

Type of pump: Submersible ☒ Jet pump ☐ Depth of Pump Intake (if known) ....

Well completed into: Bedrock .... Overburden (Soil) ....✓.... Both ....

Do you have a copy of the MOE Water Well Record? ☐ Yes ☒ No

ATTACH A COPY OF WATER WELL RECORD, IF POSSIBLE (WELL RECORD NO. ....)

B. WELL WATER LEVELS:

Indicate whether measured from ☐ ground level or ☐ from top of casing

Original water level depth .... metres on (date) ....

Subsequent water level measurements (give depths in metres and dates)..................

....

C. WATER QUANTITY

Does your well supply enough water for your use? Yes ☑ No ☐

If no, is this the case: All the time ☐ Some of the time ☐ Seasonally ☐ Other ....

Use: Domestic: No ☐ Yes ☑ No. of persons using water from well ....4....

Livestock: No ☒ Yes ☐ Lawn Watering: No ☑ Yes ☐

Other Uses .... Daily Usage (if known) —

Have you ever experienced any problems with your well? ....No....

If so, when? ....

What was the cause of the problem? ☐ Drought ☐ Pump Failure ☐ Plugging

☐ Increased Usage ☐ Interference ☐ Other (Please Specify) ....

Did you ever have your well deepened or cleaned, or a new well constructed? ..No..

If so, why? ....

PIN: [redacted] Frontier

Frontier-2

D. WATER QUALITY

Water Treatment (if any) None

Has your well recently been chlorinated and, if so, when? possible iron & hardness in sinks toilets stained

How would you describe quality of your water? ☐Poor ☐Good ☐Excellent

Has your water quality previously been tested? No ☒ Yes ☐

If yes, for what and how often? (bacteriological, chemical analyses, etc.) —

ATTACH COPY OF ANY PREVIOUS CHEMICAL AND/OR BACTERIOLOGICAL ANALYSIS RESULTS ON THE WELL WATER, IF AVAILABLE

E. WATER SAMPLING INFORMATION

Water Quality Field Observations:

Appearance (clear, cloudy) clear Odour none

Field Measured Parameters:

Temperature 7°C pH

Conductivity H_2S

Other Comments no sediments, no colour

Water Sample Collected No ☐ Yes ☒ If no, why?

Note: Collect Sample of "Untreated" Water only

Duplicate Water Sample Collected (10% of Locations for Project QA/QC) No ☒ Yes ☐

III. SEWAGE DISPOSAL SYSTEM

SYSTEM DETAILS

What type of sewage disposal system do you have:

☐ Holding Tank

☑ Septic Tank and Inground Leaching Bed

☐ Septic Tank and Raised or Partially Raised Leaching Bed

☐ Other Treatment System (e.g. peat bed, peat filter, etc.) If so, specify

☐ Don't know

Date or year Constructed N/A Contractor —

PIN: [redacted] Frontier
Frontier-2

How often do you have the holding tank or septic tank pumped out? 4 yrs

When was the last time? no yet

Is the septic tank comprised of ☐ one chamber ☐ 2 chambers ☐ don't know

Have you ever had any problems with your sewage disposal systems? (e.g. leaks from holding tank, failure of septic system including surficial release of sewage, visibly stained areas, unusual odours, soft ground, etc.) None

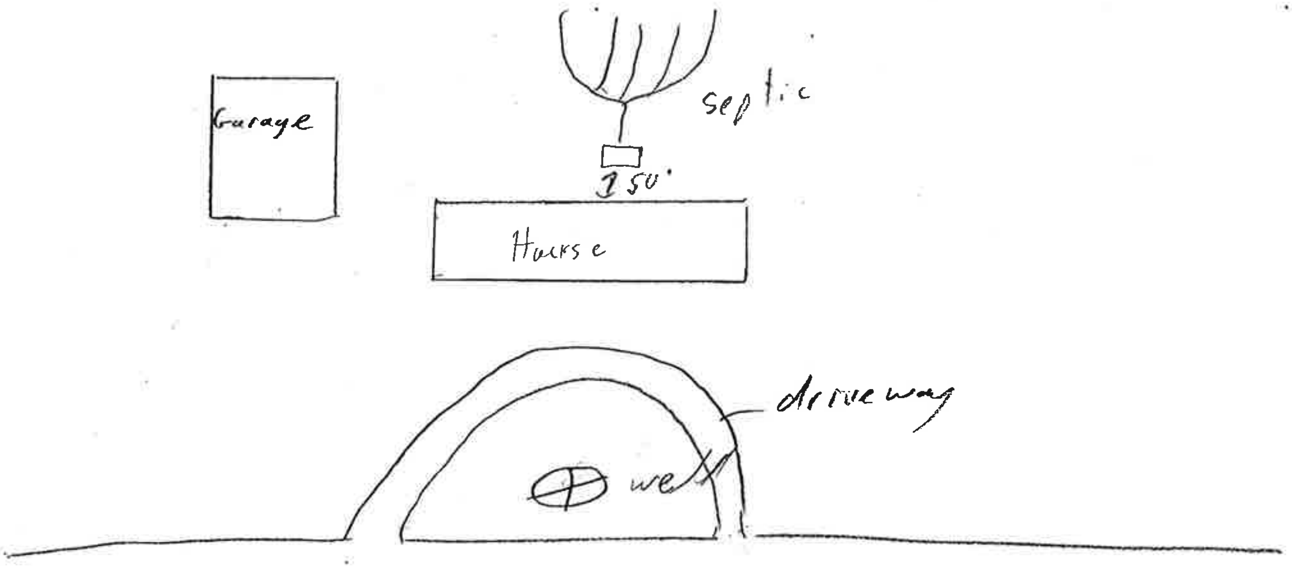
Technician Signature

Date Jun 17th/13

PIN: [redacted] Frontier
Frontier-2

IV. PROPERTY SKETCH

Sketch the location of the septic system (including approximate leaching bed area), the well and the house, giving the best approximated distance between each of them. Include any indication of soil types (e.g. gravel, sand, silt, clay); overburden thickness, and slope (in degrees or percentage). Note any indications of septic system failure such as stained areas, **surficial release of sewage**, unusual odours, soft ground, etc.



Indicate all dimensions in metres

Note distance between well and septic system(s), if possible

Was there any existing evidence of a surficial release of sewage? ☒ No ☐ Yes

---

Other Symbols - Please Specify

Drilled Well
Dug Well
Septic Field
Septic Tank
Holding Tank
Bedrock Outcrop

Break of Slope
Minor
Steep
House
Road
Shed

Tree
Underground Line
Drainage
Ditch
Lot Line
Sidewalk
Fence

APPENDIX TSD#1-C

Surface Water Component

February 2013

February 2013

Surface Water Component
Appendix TSD#1-C

COMPARATIVE EVALUATION OF ALTERNATIVE SITES

TAGGART
GROUP OF COMPANIES

miller
THE MILLER GROUP

Table of Contents

TABLES

FIGURES

ATTACHMENTS

INTRODUCTION

Two properties that are owned or have been optioned by Taggart Miller have been identified for the proposed Capital Region Resource Recovery Centre CRRRC (the Alternative Sites). The Alternative Sites are described below:

- **North Russell Road Site (NRR Site)** – located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell.
- **Boundary Road Site (BR Site)** – located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, Township of Cumberland.

The CRRRC is proposed to provide facilities and capacity for recovery of resources and diversion of material from disposal generated by the industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sectors primarily in Ottawa and secondarily a portion of eastern Ontario, for management and utilization of surplus and contaminated soils, as well as landfill disposal capacity for material that is not diverted.

1.0 ASSESSMENT CRITERIA, INDICATORS AND DATA SOURCES

The surface water component compared the Alternative Sites using the following criterion:

- Which site is preferred for protection of surface water quality?

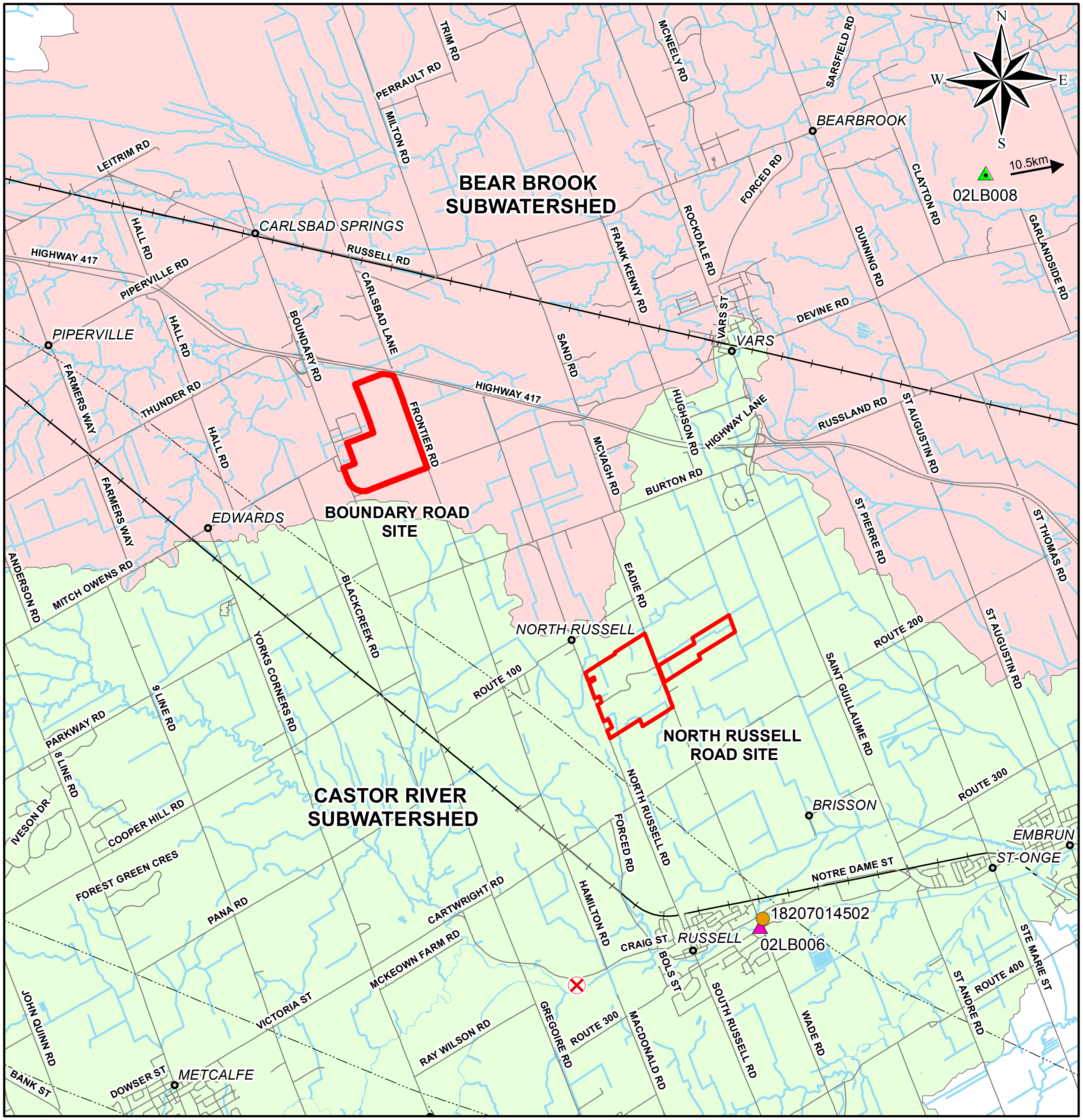
The indicators are:

- Number of existing surface water outlet points;
- Distance to nearest continuously flowing water course; and
- Characteristics of downstream surface water system and usage.

The data sources used are topographic maps, air photos, discussions with municipalities and conservations authorities, published water quality and flow information, site reconnaissance, and surface water flow and water quality monitoring stations.

2.0 PRELIMINARY DESCRIPTION OF EXISTING ENVIRONMENT

The following sections describe the existing environmental conditions for the surface water component at each of the Alternative Sites based on the preliminary investigations and assessments. Refer to Figure 2-1 for a study area and watershed divide map. Water quality sampling sessions were conducted by Golder Associates Ltd. (Golder) in the spring and fall of 2009 for the NRR Site and the early winter of 2012 for the BR Site, to establish baselines and acquire more recent data. The NRR Site surface water sampling locations were dry during the early winter 2012 sampling session. The sample results were compared to the Ontario Provincial Water Quality Objectives (PWQO) for surface water.



LEGEND

●	POPULATED PLACE NAME
☒	CITY OF OTTAWA WEPP SAMPLING STATION
▲	ENVIRONMENT CANADA HYDAT STATION
▲	ENVIRONMENT CANADA HYDAT STATION (SITE OFF MAP)
●	PROVINCIAL WATER QUALITY MONITORING NETWORK STATION
—	ROAD
—+—	RAILWAY
-·-·-	UTILITY LINE
—	SURFACE WATER FEATURE
▨	WATER AREA
☐	PROPERTY BOUNDARY
🟥	BEAR BROOK SUBWATERSHED
🟩	CASTOR RIVER SUBWATERSHED

2,000 1,000 0 2,000

SCALE 1:100,000 METRES

NOTE

THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-C.

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, ©QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
STUDY AREA MAP AND WATERSHED DIVIDE

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0.0
DESIGN	DH	JAN. 2014	FIGURE 2-1	
GIS	BR	FEB. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Working\Phase0500\Task0130\1211250045-0500-0130-2-1.mxd

2.1 North Russell Road Site

The NRR Site is located in the Castor River Subwatershed in the Lower Ottawa – South Nation Watershed and is bisected by Eadie Road. Surface drainage is generally by sheet flow, ditches and road side ditches to municipal drains that eventually discharge into the Castor River. A quarry, with standing water, is present on the property. Land use in the vicinity is generally agricultural.

2.1.1 Natural Watercourses

There are three notable natural watercourses within 5 kilometres (km) of the NRR Site. The Castor River is located approximately 4.5 km south of the NRR Site. The North Castor River, which is a tributary of the Castor River, is approximately 5 km to the south west of the NRR Site. Black Creek is located 3.5 km to the west of the NRR Site and eventually flows into the Castor River. Black Creek does not receive runoff from the NRR Site. The Castor River is one of two major tributaries of the South Nation River. The South Nation River eventually discharges into the Ottawa River near the community of Plantagenet.

The municipalities of Russell, Embrun and Limoges discharge wastewater into the Castor River between Russell and the Village of Casselman. Embrun is approximately 6.7 km to the east of Russell, while Limoges is 6.8 km to the north east of Embrun. The only municipality with a municipal surface water intake is the Village of Casselman just downstream of the confluence of the Castor and South Nation Rivers.

Water quality monitoring information is available from the Provincial (Stream) Water Quality Monitoring Network (PWQMN), as well as the City of Ottawa Water Environment Protection Program (WEPP) for portions of the Castor River which lie within the City of Ottawa. Flow information is available from the Environment Canada Hydrometric Database (HYDAT).

The PWQMN station (ID: 18207014502) is located off Wade Road at 45°15'44" N, 75°20'37" W, upstream of Russell’s sewage lagoon discharge. The HYDAT station (No. 02LB006) is located nearby at 45°25'33" N, 75°09'11" W. The WEPP sampling locations are throughout the Castor River watershed, but include sampling points at the confluence of the North Castor River and Castor River.

Phosphorus, *Escherichia coli* (*E. coli*), copper and zinc are key indicators of water quality. The PWQMN does not monitor for *E.coli*. The WEPP data from 1998 to 2006 has been used to provide the results for the key indicators and for comparison purposes. It was evaluated by the City of Ottawa against the PWQO, the Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life, and the Canadian Council of Ministers of the Environment (CCME) Water Quality Index. The PWQO was used for the evaluation of the raw PWQMN water quality results.

The water quality in the Castor River is reflective of the rural, agricultural population in its vicinity. Generally, 0% to 44% of the phosphorus water quality samples meet provincial and federal targets, 45% to 64% for E. coli samples, 80% to 94% for copper samples, and 95% to 100% for zinc samples (City of Ottawa, 2006).

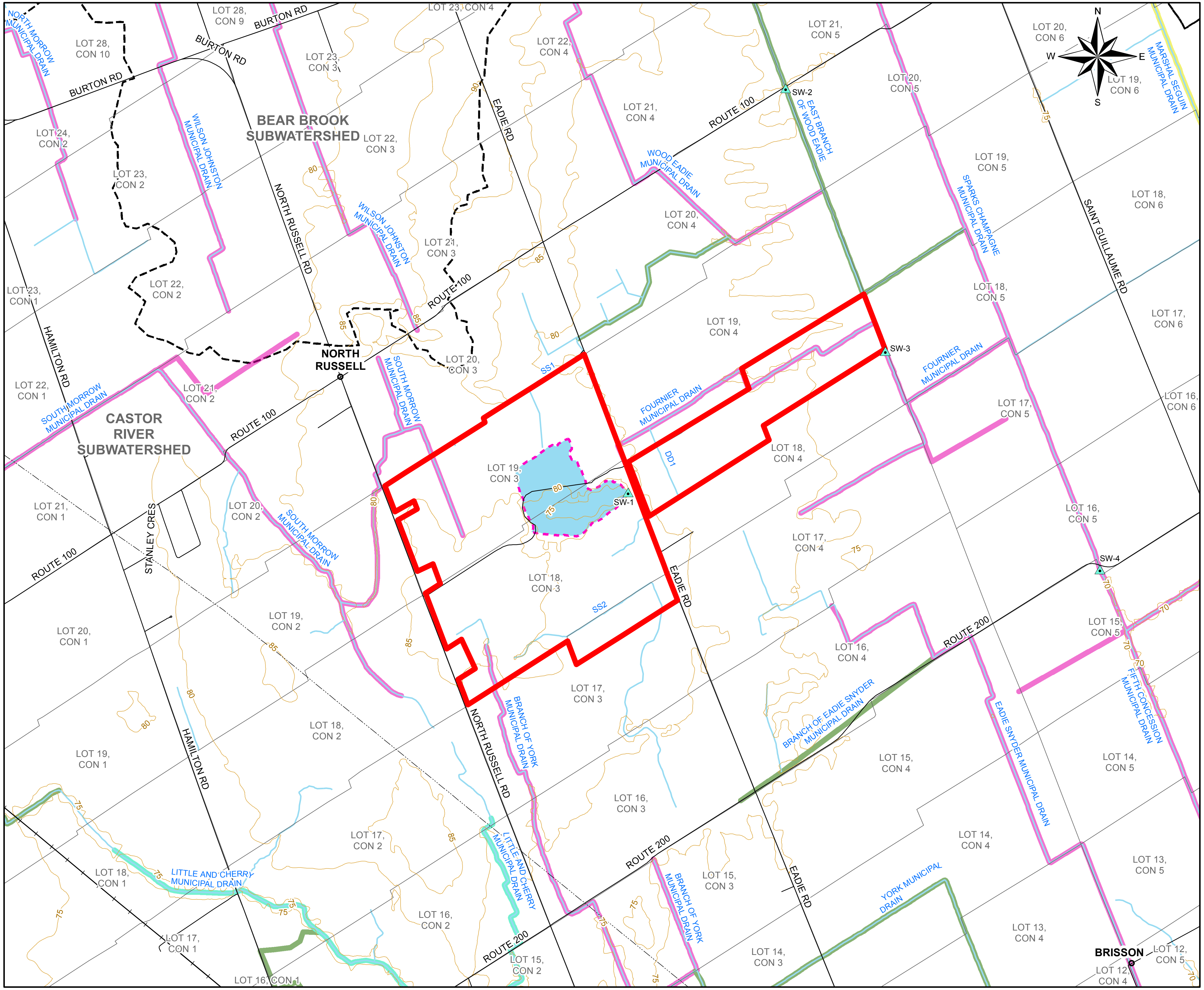
The average daily discharge at the Castor River at HYDAT station 02LB006 for 2001 to 2010 is 5.48 cubic metres per second (m^3/s). This represents seven years of data as the records were incomplete for 2006, 2007 and 2008.

2.1.2 Constructed Watercourses

Watercourses in the form of ditches are present on the NRR Site. In general, these are extensions of municipal drains in the vicinity of the property, or of municipal drains and their branches that originate from the property. Refer to Figure 2.1-1 for a site plan including surface water sampling locations and constructed watercourses and their Department of Fisheries and Oceans (DFO) classifications. Municipal drain classifications from the DFO define the flow conditions, water temperature, species classification and the terms and conditions for work.

The primary water courses on the NRR Site are as follows:

- SS1 – Originates within the NRR Site. It is a ditch on a southeast to northwest alignment on the northeast portion of the property. Its direction changes to the north east at the northern Site boundary. It then connects with the Wood Eadie Municipal Drain and travels through a ditch and municipal drain network that eventually discharges into the Castor River at a location about 2.7 km east of Embrun. The streamflow distance from the property boundary to the discharge point at the Castor is approximately 13.5 km.
- SS2 – Originates within the NRR Site. It is a ditch on a southwest to northeast alignment on the southeast portion of the property. Based on Site visits, there is an unmapped ditch which continues to direct drainage along this route to Eadie Road, where it joins DD1. The mapped section of SS2 winds south for about 1.3 km and drains the properties to the south of the NRR Site. It eventually directs water via smaller unmapped drains to a Branch of the York Municipal Drain.
- Branch of York Municipal Drain – Originates within the NRR Site and is a constructed branch of the York Municipal Drain on a northwest to southeast alignment on the southwest portion of the property. SS2 does not connect directly to this branch of the York Municipal Drain. This branch travels south for approximately 1.8 km, eventually joins the York Municipal Drain to the south and then discharges into the Castor River. The total streamflow distance from the property boundary to the discharge point of the York Municipal Drain into the Castor, 700 metres (m) west of Embrun, is approximately 9.4 km.
- DD1 – Originates within the NRR Site and is a tributary on a southwest to northeast alignment on the east portion of the property east of Eadie Road. It extends on the same alignment for about 200 metres east of Eadie Road before travelling northwest for approximately 330 metres to join the Fournier Municipal Drain.
- South Morrow Municipal Drain – Originates within the NRR Site and is a constructed drain on a southeast to northwest alignment located on the northwestern portion of the property. It flows north for approximately 600 m, turns west, crosses North Russell Road, turns south before continuing north and west and outlets to the North Castor River. The total streamflow distance from the property boundary to the discharge to the North Castor is approximately 5.4 km. The total streamflow distance from the property boundary to the confluence of the North Castor and South Castor Rivers, to form the Castor River is about 12 km.
- Fournier Municipal Drain – Originates at Eadie Road and flows in a north to east direction and crosses the far eastern portion of the NRR Site for approximately 2 km, then south through the Sparks Champagne Municipal Drain and east, connecting to the Marshall Seguin Municipal Drain to outlet at the Castor River 6.1 km to the southeast.



LEGEND

○	POPULATED PLACENAME
▲	SURFACE WATER SAMPLING LOCATION
—	ROAD
┼	RAIL ROAD
-·-	UTILITY LINE
—	CONTOUR LINE, (5m)
—	MUNICIPAL DRAIN, CLASS B
—	MUNICIPAL DRAIN, CLASS C
—	MUNICIPAL DRAIN, CLASS F
—	MUNICIPAL DRAIN, NO CLASSIFICATION
—	SURFACE WATER FEATURE
■	WATER AREA
⬚	SUBWATERSHED DIVIDE
☐	LOT/CONCESSION
⬚	APPROXIMATE EXTENT OF EXISTING QUARRY EXCAVATION
☐	PROPERTY BOUNDARY

390 195 0 390

SCALE 1:20,000 METRES

NOTE

THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-C.

REFERENCE

MUNICIPAL DRAIN CLASSIFICATIONS PROVIDED BY DEPARTMENT OF FISHERIES AND OCEANS (DFO).
LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE
ENVIRONMENTAL ASSESSMENT

TITLE
NORTH RUSSELL ROAD SITE PLAN

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	JAN. 2013	FIGURE 2.1-1	
GIS	BR	FEB. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Task0130\Phase0500\Task0130\1211250045-0500-0130-2.1-1-NorthRussellRoadSitePlan.mxd

The Little and Cherry Municipal Drain is approximately 300 metre map distance to the southwest of the NRR Site, on the west side of Russell Road. The Little and Cherry Municipal Drain is of potential interest to this evaluation due to the drain's proximity to the NRR Site, and the permanent flow in the drain. However, it is parallel to the Branch of York Municipal Drain and does not receive drainage directly from the NRR Site. The Little and Cherry Municipal Drain discharges 3.3 km to the south into the Castor River.

The Marshall Seguin Municipal Drain is approximately 2 km map distance to the east of the NRR Site. It runs on a north to south alignment and is of interest to this evaluation due to the drain's permanent flow and connections to the on-Site municipal drains. The Fournier Municipal Drain discharges into the Marshall Seguin Municipal Drain after travelling approximately 4.9 km streamflow distance from the NRR Site's farthest east property boundary.

The DFO classifications for the drains are presented in Table 2.1-1.

Table 2.1-1: Municipal Drain Details for the NRR Site

Municipal Drain Name	Flow	DFO Classification Type
South Morrow	Intermittent	F
Fournier	Intermittent	F
Branch of York	Intermittent	F
Branch of Wood Eadie	Intermittent	F
Little and Cherry	Permanent	B
Marshall Seguin	Permanent	C

All municipal drains on the NRR Site are intermittent and DFO Class F. This class of municipal drain does not require authorization from the DFO for work, on the condition that all work must be conducted in dry conditions, and disturbed soils are stabilized upon completion (DFO, 2010).

The Little and Cherry Municipal Drain is a permanent flow, Class B constructed drain. This class of municipal drain has warm waters and sensitive species or communities present. All work must be conducted in-water only, but not in elevated flow situations and riparian vegetation must be re-established if they are removed. Timing restrictions designed to protect fish during critical life stages must be adhered to, and a site specific review may be required if a Species at Risk has been identified in the drain.

The Sparks Champagne Municipal Drain is a permanent flow, Class C constructed drain. This class of municipal drain has warm waters and no sensitive species present. All work must be conducted in-water only, but not in elevated flow situations. Riparian vegetation can be removed from either bank but not both. Timing restrictions designed to protect fish during critical life stages must be adhered to.

Surface water quality samples for the NRR Site were collected by Golder in July of 2009 and November of 2009 at four water monitoring stations. The surface water sampling stations are described below. Sampling stations were dry during a separate sampling session conducted in the early winter of 2012.

- SW-1 – discharge from the quarry sump;
- SW-2 – upstream sample location at culvert along Route 100 on Branch of Wood Eadie Municipal Drain;
- SW-3 – downstream sample location where the Fournier Municipal Drain exits the eastern extent of the NRR Site; and
- SW-4 – downstream sample location at culvert along Route 200 on the Sparks Champagne Municipal Drain.

The results of the two sampling sessions are provided in Attachment TSD#1-C.1.

Based on the July 2009 results, total phosphorus was exceeded at all sampling locations. The pH value for the quarry discharge (SW-1) and the iron concentration at SW-4 exceeded the PWQO. All other test results were below their respective PWQO criteria for the July 2009 sampling session.

Based on the November 2009 results, total phosphorus was exceeded at all sampling locations except SW-1. Boron concentrations at SW-1 and iron concentrations at SW-4 exceeded the PWQO. All other test results were below their respective PWQO criteria for the November 2009 sampling session.

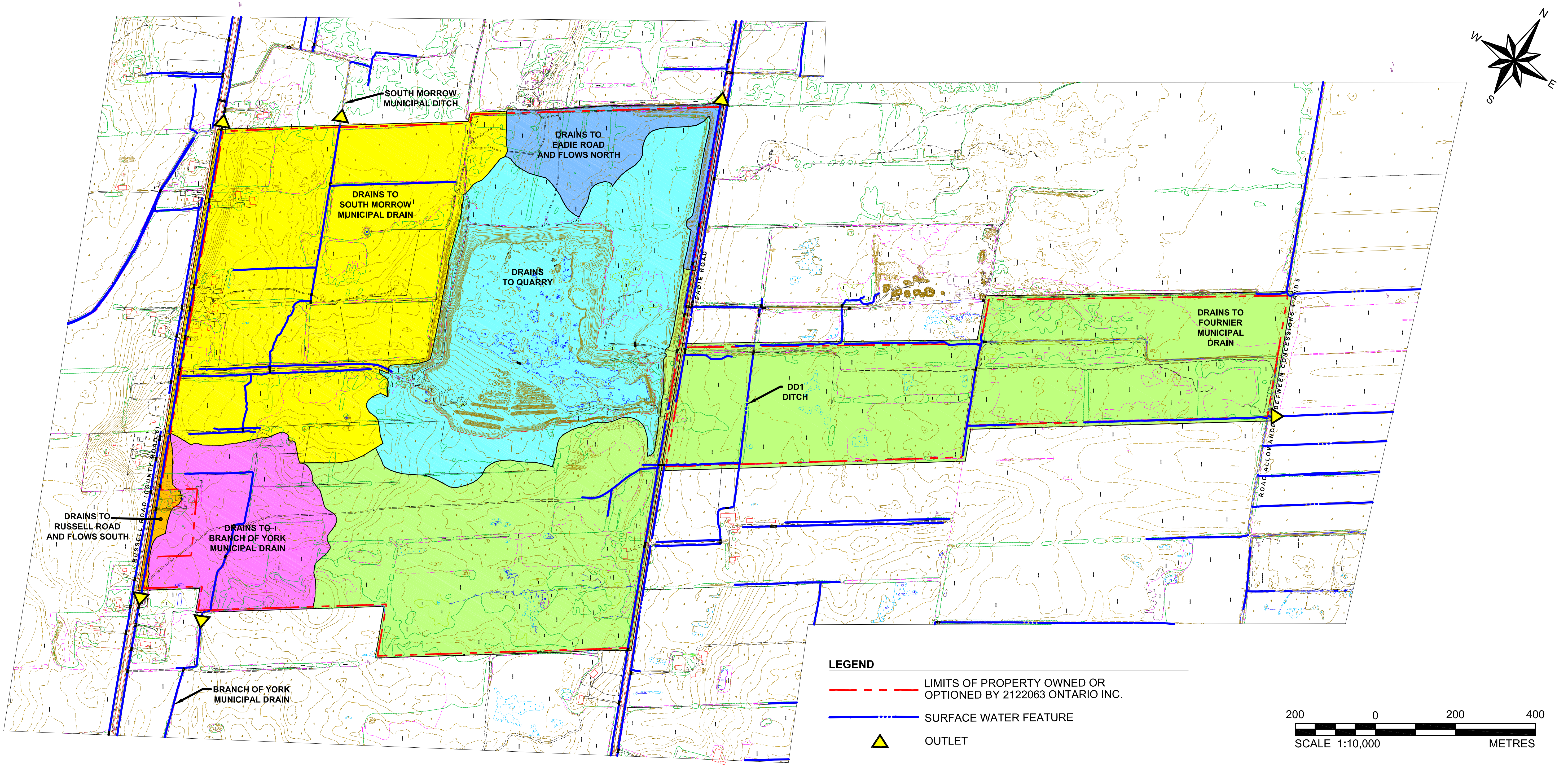
2.1.3 Existing Surface Water Outlet Points

Six drainage areas were delineated for the NRR Site and are presented in Figure 2.1-2.

Surface water generally flows into ditches and channels or sheet flows to six outlets.

- The South Morrow Municipal Drain is the outlet for the northwest portion of the NRR Site. Surface water from this section may leave the property at the South Morrow Municipal Drain or the roadside ditch by Russell Road. This roadside ditch drainage will eventually connect with the municipal drain, before being directed to the North Castor River.
- The Fournier Municipal Drain is the outlet for the east and far east portions of the NRR Site. These portions of the Site are drained by DD1 and SS2.
- A branch of the York Municipal Drain is the outlet for the south west portion.
- A sliver of property in the southwest corner drains to the road side ditches on Russell Road and flows south before eventually connecting to the York Municipal Drain and downstream to the Castor River.
- A small portion to the northwest drains to Eadie Road via SS1 and flows north to a branch of the Wood Eadie Municipal Drain.

The majority of the central portion of the NRR Site, located around the quarry, does not typically discharge as it drains directly to the quarry.



LEGEND

🟥 - · -	LIMITS OF PROPERTY OWNED OR OPTIONED BY 2122063 ONTARIO INC.
🟦 — · · · —	SURFACE WATER FEATURE
△	OUTLET

NOTE

1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-C.

REFERENCES

1. THE PROPERTY LINES PROVIDED BY STANTEC GEOMATICS LTD. FOR PART OF LOTS 17, 18, & 19, CONCESSION 3 FROM JOB No. 16169900-100, DATED JANUARY 31, 2008.
2. BASE DRAWING PROVIDED IN A DIGITAL FORMAT BY: BASE MAPPING CO. LTD., CONTRACT No. 2250-08, PHOTO DATE: NOVEMBER 2 2009.
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: MTM ZONE 9

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW
△						

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

NORTH RUSSELL ROAD SITE
EXISTING SITE DRAINAGE

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045
DESIGN	D.H.	22 Jan, 2013
CAD	M.L.F.	23 Jan. 2013
CHECK	P.L.E.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

FILE No.1211250045-0500-0130-2.1-2.dwg
SCALE AS SHOWN REV. 0
FIGURE No.
2.1-2

PLOT DATE: August 6, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Phase 0500\Task 0130\1211250045-0500-0130-2.1-2.dwg

2.1.4 Summary of Considerations at North Russell Road Site

Component	Summary of Site Considerations
Surface Water	**General Information** ▪ Located in the Castor River Subwatershed. **Surface Water Outlets** ▪ Drainage generally conveyed by ditches to four intermittently flowing municipal drains. ▪ Six drainage outlet points from the Site. **Map & Streamflow Distance to Nearest Continuous Flow Watercourse** ▪ Little and Cherry Municipal Drain, a permanent flow, Class B drain is 300 m map distance from the NRR Site (parallel to Branch of York Municipal Drain); drainage not directly connected to Site. ▪ A 2 km map distance from Marshall Seguin Municipal Drain, a permanent flow, Class C drain; this is a receiver of NRR Site drainage. Actually, 4.9 km streamflow distance from NRR Site to Marshall Seguin Municipal Drain (following Fournier Municipal Drain). ▪ A 5.4 km streamflow length from NRR Site to North Castor River discharge point, and 12 km streamflow length to the Castor River (following Branch of York Municipal Drain). **Castor River Water System Characteristics** ▪ Meets phosphorus water quality target in 0% to 44% of samples. ▪ Meets *E.coli* water quality target in 45% to 64% of samples. ▪ Meets copper water quality target in 80% to 94% of samples. ▪ Meets zinc water quality target in 95% to 100% of samples. ▪ Average discharge (flow) of 5.48 m^3/s. ▪ Three communities discharge wastewater into the Castor River, one community draws surface water from confluence of Castor and South Nation Rivers. ▪ Water in ditches at or near the Site exhibit exceedances of PWQO for pH, total phosphorus, boron and iron.

2.2 Boundary Road Site

The BR Site is located in the Bear Brook Subwatershed in the Lower Ottawa – South Nation Watershed (refer to Figure 2-1). Surface drainage of water is generally by sheet flow, ditches and road side ditches to municipal drains that eventually discharge into Bear Brook. Land use in the vicinity is generally agricultural and industrial. The closest end of Grey Hawk Golf Club is about 600 metres to the north, on the north side of Highway 417, and contains a number of man-made ponds. The closest point of the Mer Bleue bog is about 3.7 km to the north/northwest of the BR Site boundaries.

2.2.1 Natural Watercourses

There are four natural watercourses within 5 km of the BR Site. Bear Brook Creek is 3.4 km map distance to the northwest of the property boundaries and Shaw's Creek is 1.6 km map distance to the east. Bear Brook Creek is another major tributary of the South Nation River. The North Castor River is 4.7 km map distance to the southwest of the property, while Black Creek is approximately 2.5 km map distance to the southeast. Both the North Castor River and Black Creek are part of the Castor River subwatershed and, as such, are not part of the subwatershed receiving potential drainage from the BR Site.

The communities of Edwards, Carlsbad Springs, Bearbrook, Cheney and Bourget are located along tributaries or sections of Bear Brook Creek. There are no municipal surface water intakes, with these communities primarily relying on groundwater or municipal systems for their water supply (South Nation Conservation Authority, 2012). The two closest of these communities are Edwards and Carlsbad Springs, located about 2 km west and 3 km north, respectively, from the BR Site. The other three communities are more than 10 km east of Carlsbad Springs.

Water quality monitoring information for Bear Brook Creek is available from the City of Ottawa WEPP. Water level information is available from the HYDAT.

The City of Ottawa WEPP sampled in various locations of the Bear Brook Creek Watershed, including a location near Carlsbad Springs; just north of the BR Site. The HYDAT station (No. 02LB008) is located near Bourget at 45°25'33" N, 75°9'11" W.

The water quality in the Bear Brook Creek is also reflective of the rural, agricultural population in its vicinity. According to the City of Ottawa WEPP, 0% to 44% of the phosphorus water quality samples meet provincial and federal targets, 45% to 64% for E. coli samples, 45% to 64% for copper samples and 80% to 94% for zinc samples.

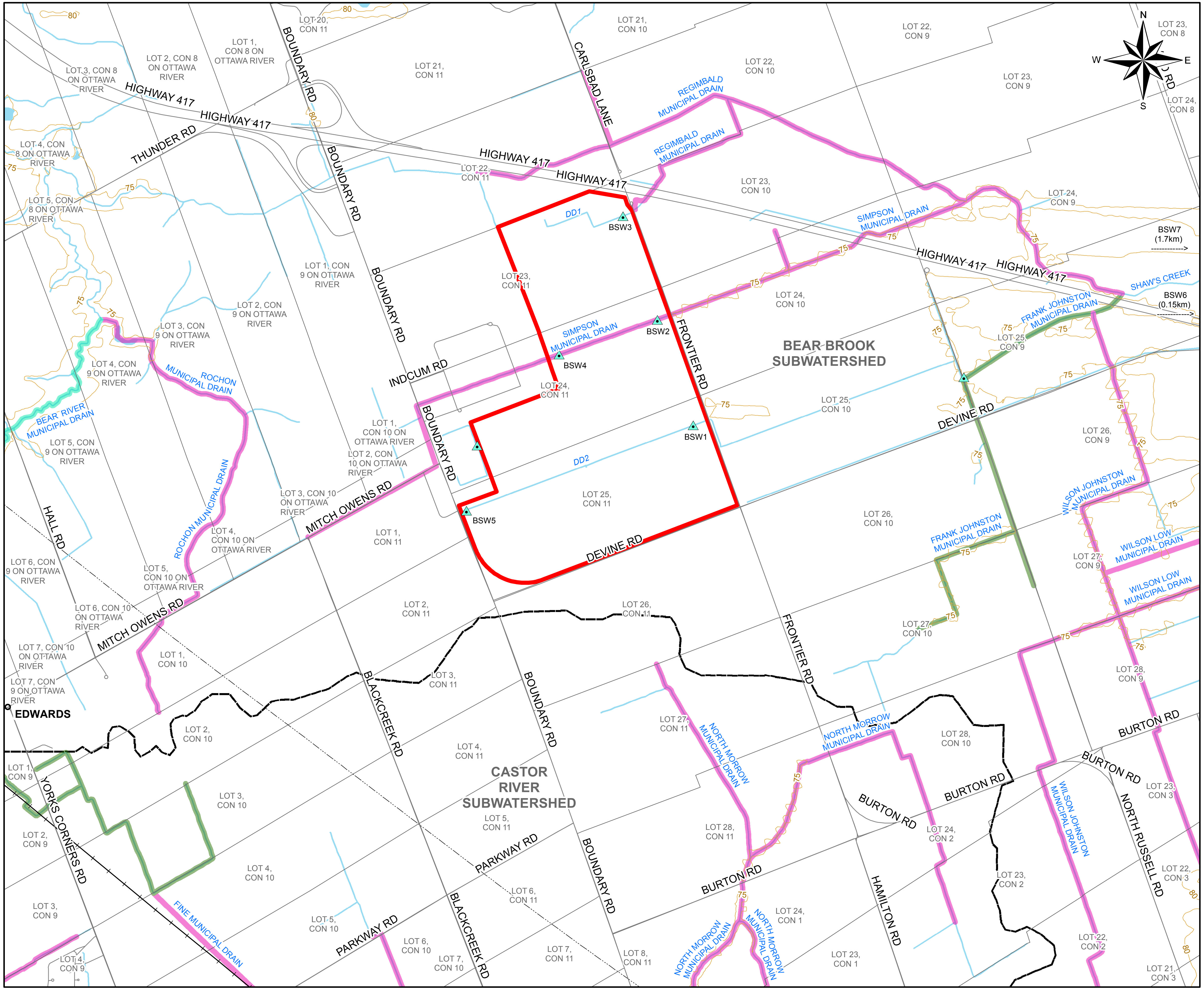
The average daily discharge at HYDAT station 02LB008 for 2001 to 2010 is 7.42 m^3/s. This represents seven years of data as the records were incomplete for 2001, 2004 and 2007.

The Bear Brook Creek also appears on the DFO Drain Classification Database as a Class E drain. This class is defined as having permanent warm water flow, and the presence of sensitive species or communities. Projects involving the Bear Brook Creek are assessed on a project specific basis.

Surface water stations for seven locations were established in December of 2012 (Refer to Figure 2.2-1). Two stations are along Shaw’s Creek at Sand Road (BSW-6) and Frank Kenny Road (BSW-7). Samples were collected for baseline data and are presented in Attachment TSD#1-C.2. Both sampling locations were observed to have elevated total phosphorus and iron levels above the PWQO criteria.

2.2.2 Constructed Watercourses

Water courses in the form of ditches and drains are present on the BR Site. In general, these are extensions of municipal drains in the vicinity of the property, or of municipal drains and their branches that originate from the property. Refer to Figure 2.2-1 for a site plan including sampling locations and constructed watercourses and their classifications.



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SCALE 1:20,000 METRES

LEGEND

- ○ POPULATED PLACENAME
- ▲ SURFACE WATER SAMPLING LOCATION
- ROAD
- RAIL ROAD
- CONTOUR LINE, (5m)
- UTILITY LINE
- 🟩 MUNICIPAL DRAIN, CLASS B
- 🟪 MUNICIPAL DRAIN, CLASS F
- 🟩 MUNICIPAL DRAIN, NO CLASSIFICATION
- SURFACE WATER FEATURE
- 🟦 WATER AREA
- ☐ SUBWATERSHED DIVIDE
- ☐ LOT/CONCESSION
- 🟥 PROPERTY BOUNDARY

NOTE

THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-C.

REFERENCE

MUNICIPAL DRAIN CLASSIFICATIONS PROVIDED BY DEPARTMENT OF FISHERIES AND OCEANS (DFO).
LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

BOUNDARY ROAD SITE PLAN

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	Jan. 2013	FIGURE 2.2-1	
GIS	BR	FEB. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Working\Phase0500\Task0130\1211250045-0500-0130-2.2-1-BoundaryRoadSitePlan.mxd

The primary water courses that are on or near the BR Site are as follows:

- DD1 – Originates within the BR Site. It is an extension of the Regimbald Municipal Drain and is on a west to east orientation. It is located on the northern portion of the BR Site.
- Simpson Municipal Drain – Crosses the BR Site, entering from the west and exiting on the east. The municipal drain is on a west to east alignment and travels approximately 1.8 km from the east boundary of the property, eastward under Highway 417 before turning southeast, continues as Shaws Creek which eventually feeds Bear Brook Creek. The streamflow distance from the Simpson Municipal Drain at the BR Site east boundary to Bear Brook Creek is approximately 11.4 km.
- DD2 – Originates within the BR Site. It is an extension of the Frank Johnston Municipal Drain and is on a west to east orientation. It is located on the southern half of the BR Site. Surface drainage from the BR Site boundary will travel approximately 1.3 km before reaching the Frank Johnston Municipal Drain, which travels another 820 m, crosses under Highway 417 and joins the Simpson Municipal Drain at Shaw's Creek. The streamflow distance from the BR Site boundary to Shaw's Creek is approximately 2.1 km.
- Regimbald Municipal Drain – Another extension of the Regimbald Municipal Drain is located near the northwest boundary of the BR Site on the north side of Highway 417. Initially aligned in a southeast to northwest direction, then runs east, and flows southeast to join the Simpson Municipal Drain. Little or no drainage from the Site flows to this extension of the Regimbald Municipal Drain.

As noted above, all drainage discharge from the BR Site eventually combines in the Simpson Municipal Drain, continues as Shaw's Creek and eventually discharges to Bear Brook Creek.

The Bear River Municipal Drain is located approximately 1.4 km map distance to the west of the BR Site. It is a municipal drain with permanent flow that eventually makes its way north for approximately 5.1 km and discharges into Bear Brook Creek. The Bear River Municipal Drain does not receive drainage directly from the BR Site.

Municipal drain details from the Fisheries and Oceans Canada (DFO) Drain Classification Database are presented in Table 2.2-1.

Table 2.2-1: Municipal Drain Details for the BR Site

Municipal Drain Name	Flow	DFO Classification Type
Regimbald	Intermittent	F
Simpson	Intermittent	F
Frank Johnston	Intermittent	F
Bear River	Permanent	B

All municipal drains on the BR Site are intermittent and DFO Class F. However, the Bear River Municipal Drain has permanent flow and is DFO Class B; as described above, this does not receive drainage from the Site.

Surface water sampling was conducted at five stations at the BR Site in December of 2012. The stations are as follows:

- BSW1 – discharge of DD2;
- BSW2 – discharge of Simpson Municipal Drain at BR Site boundary;
- BSW3 – discharge at DD1;
- BSW4 – upstream, beginning of Simpson Municipal Drain as it enters BR Site; and
- BSW5 – upstream, beginning of DD2.

BSW5 was dry during the sampling session and was not sampled. Total phosphorus was exceeded for BSW1 and BSW2. Copper was above PWQO levels for BSW3, while exceedances in iron were observed for all sampling locations. Dissolved oxygen was below the PWQO at BSW1.

2.2.3 Existing Surface Water Outlet Points

Three drainage areas were delineated for the BR Site and are presented in Figure 2.2-2.

Surface water generally flows into ditches and channels or sheet flows to three outlets.

- Surface drainage from the northeast portion of the site is collected by DD1, and directed to the Regimbald Municipal Drain on the northeast border of the property.
- The central portion of the BR Site is drained by the Simpson Municipal Drain, which exits out the east border and is eventually joined by the drainage from the northeast portion.
- The south portion of the site drains to DD2, exits out the east property boundary and continues to flow until it reaches the Frank Johnston Municipal Drain, which also eventually connects to the Simpson Municipal Drain at Shaw’s Creek.

PLOT DATE: September 5, 2014
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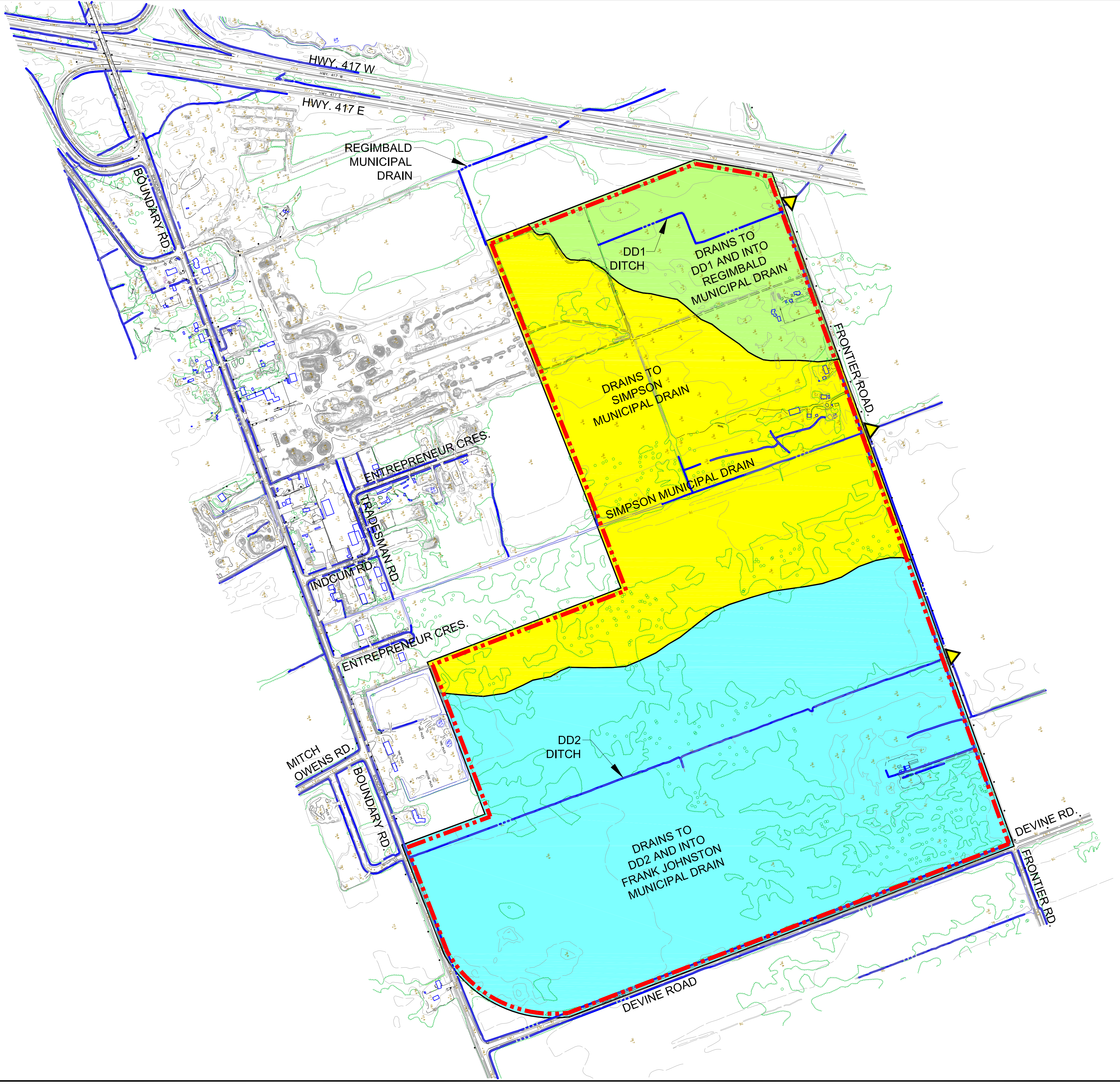

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LEGEND:

🟥 ▬ · · ▬	LIMITS OF PROPERTY OWNED OR OPTIONED BY 2122063 ONTARIO INC.
▬ · · ▬	SURFACE WATER FEATURE
△	OUTLET

NOTE

1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-C.

REFERENCES:

1. BASE DRAWING PROVIDED IN A DIGITAL FORMAT BY BASE MAPPING CO. LTD., CONTRACT No. 2517-12, PHOTO DATE: NOVEMBER 7, 2012, DATE RECEIVED: JANUARY 9, 2013.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

200 0 200 400
SCALE 1:10,000 METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW
△						

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

BOUNDARY ROAD SITE
EXISTING SITE DRAINAGE

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045
DESIGN	D.H.	22 Jan. 2013
CAD	M.L.F.	23 Jan. 2013
CHECK	P.L.E.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

FILE No.1211250045-0500-0130-2.2-2.dwg
SCALE AS SHOWN REV. 0
FIGURE No.
2.2-2

2.2.4 Summary of Considerations at Boundary Road Site

Component	Summary of Site Considerations
Surface Water	**General Information** ▪ Located in the Bear Brook Creek subwatershed. **Surface Water Outlets** ▪ Drainage generally conveyed by ditches to three intermittently flowing municipal drains which combine east of the Site. ▪ Three drainage outlet points. **Map & Streamflow Distance to Nearest Continuous Flow Watercourse** ▪ Bear River Municipal Drain, a permanent flow, Class B waterway is 1.4 km map distance from the BR Site (drainage not directly connected to BR Site). ▪ 1.6 km map distance from Shaw's Creek (downstream of Site). Streamflow distance from BR Site boundary to Shaw's Creek is approximately 2.1 km (following DD2 and Frank Johnston Municipal Drain), and approximately 2.2 km streamflow distance following the Simpson Drain. ▪ 11.4 km streamflow distance from BR Site to Bear Brook Creek discharge point, via Simpson Drain and Shaw's Creek. **Bear Brook Creek Water System Characteristics** ▪ Meets phosphorus water quality target in 0% to 44% of samples. ▪ Meets *E.coli* water quality target in 45% to 64% of samples. ▪ Meets copper water quality target in 45% to 64% of samples. ▪ Meets zinc water quality target in 80% to 94% of samples. ▪ Average discharge (flow) of 7.42 m^3/s. ▪ Ditches at or near the site exhibit PWQO exceedances for total phosphorus, copper and iron and were below the PWQO for dissolved oxygen.

3.0 SITE COMPARISON – SURFACE WATER

3.1 Comparison of Sites

Sites are compared based on the aforementioned indicators. Under usual circumstances, engineered systems following industry standard best-practices involve the collection and treatment of any impacted surface water, as well as the use of stormwater mitigation systems to maintain pre-existing drainage conditions for downstream receivers. Disruption to sensitive and downstream water courses such as changes to watershed boundaries should be mitigated as much as possible regardless of the preferred Site. The comparison and choice of a Site for the surface water component is based on perceived risks to the environment in the event of substandard performance or unexpected failure of engineered control systems.

3.1.1 Surface Water Outlets

The number of surface water outlets indicates routes by which drainage can be conveyed off each Site. A greater number of outlets increase the number of pathways for potentially impacted surface water to affect surrounding and downstream environmental receivers. It also suggests that there are more water courses that may be subject to potential impacts. The increased number of outlets will generally correspond to more complex on-Site engineered systems to mitigate the potential impacts of the proposed development.

In general, sites with fewer surface water outlets are preferable as any potential impacts caused by the development will be restricted to fewer watercourse receivers.

The NRR Site has six outlets to four municipal drains that flow in different directions before discharging to the Castor River. The BR Site has three outlets that combine into a single municipal drain, not far from the Site. For this indicator, the BR Site is preferred.

3.1.2 Distance to Nearest Continuously Flowing Watercourse

The proximity of a continuously flowing watercourse to the Alternate Sites is important to assess the risk of environmental degradation to habitats associated with the potential release of contaminants. Intermittently flowing or dry watercourses provide poorer quality habitat and their lower flow velocities would assist with the removal of suspended solids through settling and increasing overall flow travel time.

Continuously flowing watercourses may contain sensitive aquatic habitats, convey contaminants further downstream quicker, and may expose the contaminants to individuals using the watercourse for recreation or as a water source. The assessment favours the site that is further away from a downstream continuously flowing watercourse.

The nearest continuously flowing watercourse to the NRR Site is the Little and Cherry Municipal Drain, approximately 300 metre map distance to the southwest; however, since the NRR Site does not drain to this watercourse, it has not been included into the assessment. The Marshall Seguin Municipal Drain is a receiver of the NRR Site drainage and is the nearest permanent flowing watercourse. The shortest streamflow distance from the NRR Site to the Marshall Seguin Municipal Drain is approximately 4.9 km.

The nearest continuously flowing watercourse for the BR Site is the Bear River Municipal Drain at 1.4 km map distance to the northwest; however since the BR Site does not drain to this watercourse, it has not been included in the assessment. Shaw’s Creek is located approximately 1.6 km map distance to the east and is a receiver of the BR Site drainage. The shortest streamflow distance from the BR Site to Shaw’s Creek is approximately 2.1 km.

The NRR Site is marginally preferred due to its farther streamflow distance to the nearest continuously flowing, downstream watercourse.

3.1.3 Characteristics of Downstream Surface Water System

Water quality and flow characteristics of downstream surface water systems are important in assessing the risk posed to the environment. A healthier water system would be better suited to withstand a release of potentially contaminated water in the event of a significant storm event or the substandard performance or unexpected failure of engineered systems. In addition, the uses of downstream surface water systems by humans need to be assessed, particularly if there are surface water intakes. A watercourse with greater flow is less likely to be significantly affected by small variations in water quality. High flows in water courses can result in erosion and damage to riparian habitats; however, through appropriate stormwater management systems, the CRRRC development is not expected to increase external flows significantly enough to change flow regimes.

Based on the water quality data available, the site within the water system with the best quality and limited human consumption use would be preferred.

The NRR Site ultimately discharges runoff into the Castor River, which exhibits poor phosphorus levels, moderately poor *E. coli* levels, good copper levels and excellent zinc levels. The average discharge is approximately 5.48 m^3/s. One community's surface water source (Casselman) could be impacted by changes to the Castor River's water quality.

The BR Site ultimately discharges runoff into Bear Brook Creek, which exhibits poor phosphorus levels, moderately poor *E. coli* levels, moderately poor copper levels, and good zinc levels. The average discharge is approximately 7.42 m^3/s, which is greater than the Castor River.

The Bear Brook Creek exhibits slightly poorer water quality than the Castor River, however, its discharge is generally greater, and there is no indication of significant surface water taking for human consumption from Bear Brook Creek. As a result, the BR Site is preferred for this indicator.

3.2 Results of Site Comparison

The BR Site was preferred over the NRR Site for two of the three surface water indicators. As such, the BR Site is the preferred choice of the surface water component.

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ATTACHMENT TSD#1-C.1

North Russell Road Site
Surface Water Sampling Results

North Russell Road Site Surface Water Sampling Results
Environmental Assessment of The Capital Region Resource Recovery Centre, Township of Russell, Ontario

Sampling Date			7/29/2009				11/23/2009			
Sample Location			**SW-1**	**SW-2**	**SW-3**	**SW-4**	**SW-1**	**SW-2**	**SW-3**	**SW-4**
INORGANICS	**Units**	**PWQO**								
Chloride	mg/L	- -	4	12	16	83	4	21	15	26
Conductivity	uS/cm	- -	303	378	502	886	517	590	499	662
Total Ammonia-N	mg/L	- -	0.07	0.08	0.02	0.09	0.1	0.05	0.06	0.05
Nitrite	mg/L	- -	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrate	mg/L	- -	0.15	0.31	1.44	1.89	2.29	1.98	0.82	2.84
Sulphate	mg/L	- -	11	15	15	44	77	37	44	30
Total Dissolved Solids (TDS)	mg/L	- -	197	246	326	576	336	384	324	430
Total Kjeldahl Nitrogen (TKN)	mg/L	- -	0.83	0.75	0.55	0.56	0.32	0.25	0.33	0.32
Total Phosphorus	mg/L	0.03	0.44	0.42	0.2	0.11	0.02	0.07	0.04	0.1
Total Suspended Solids	mg/L	- -	8	7	6	25	8	21	4	36
Hardness as $CaCO_3$	mg/L	- -	109	142	203	311	157	224	185	258
Silicon	mg/L	- -	1.4	2.1	4.3	7.3	1.9	3.9	3.2	5.6
unionized ammonia(1)	mg/L	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
FIELD PARAMETERS										
pH	pH units	6.5-8.5	9.0	8.2	8.3	8.2	8.4	8.0	8.2	8.1
conductivity	us/cm	- -	386	560	470	550	460	420	475	490
temperature	°C	- -	23	21	24	20	4.4	4.4	4.9	4.2
METALS										
Total Aluminum	mg/L	- -	0.12	0.19	0.2	0.51	- -	- -	- -	- -
Dissolved (0.2u) Aluminum	mg/L	0.075	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	mg/L	- -	0.16	0.14	0.1	0.07	0.18	0.11	0.13	0.08
Beryllium	mg/L	1.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.2	0.19	0.17	0.13	0.13	0.21	0.08	0.09	0.06
Calcium	mg/L	- -	32	42	60	95	48	65	56	72
Cadmium	mg/L	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	- -	<0.001	<0.001	0.001	0.003	0.001	0.001	0.001	0.003
Cobalt	mg/L	0.0009	<0.0002	<0.0002	<0.0002	0.0004	<0.0002	0.0002	0.0002	0.0004
Copper	mg/L	0.005	<0.001	<0.001	<0.001	0.001	0.003	0.001	0.001	0.002
Iron	mg/L	0.3	0.1	0.24	0.23	0.42	0.16	0.28	0.22	0.40
Lead	mg/L	0.025	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium	mg/L	- -	7	9	13	18	9	15	11	19
Manganese	mg/L	- -	0.03	0.04	0.02	0.1	0.02	0.08	0.11	0.05
Molybdenum	mg/L	0.04	0.015	0.014	0.006	<0.005	0.026	<0.005	0.007	<0.005
Nickel	mg/L	0.025	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Potassium	mg/L	- -	7	7	5	3	6	3	4	3
Silver	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Sodium	mg/L	- -	19	24	23	55	34	22	24	24
Strontium	mg/L	- -	1.01	1.02	0.684	0.82	1.89	0.699	0.856	0.428
Thallium	mg/L	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Titanium	mg/L	- -	<0.01	0.01	0.01	0.02	<0.01	0.01	<0.01	0.01
Vanadium	mg/L	0.006	0.003	0.003	0.004	0.005	0.002	0.002	0.001	0.004
Zinc	mg/L	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

🟩 exceeds PWQO

(1) unionized ammonia result calculated using the methodology stipulated in "Ontario's Provincial Water Quality Objectives" dated July 1994

ATTACHMENT TSD#1-C.2

Boundary Road Site
Surface Water Sampling Results

February 2013

Boundary Road Site Surface Water Sampling Results
Environmental Assessment of The Capital Region Resource Recovery Centre, City of Ottawa, Ontario

Sampling Date			**12/5/2012**						
Sample Location			**BSW1**	**BSW2**	**BSW3**	**BSW4**	**BSW5**	**BSW6**	**BSW7**
INORGANICS	**Units**	**PWQO**							
Chloride	mg/L	- -	47	250	270	210	-	160	220
Conductivity	uS/cm	- -	430	1800	1300	1500	-	1200	1400
Total Ammonia-N	mg/L	- -	0.24	0.054	<0.050	0.050	-	<0.050	0.066
Nitrite	mg/L	- -	0.058	<0.010	<0.010	<0.010	-	<0.010	<0.010
Nitrate	mg/L	- -	1.2	<0.10	<0.10	0.22	-	3.5	3.0
Sulphate	mg/L	- -	17	200	63	170	-	75	83
Total Dissolved Solids (TDS)	mg/L	- -	246	966	750	796	-	670	736
Total Kjeldahl Nitrogen (TKN)	mg/L	- -	1.1	1.2	2.2	0.77	-	0.79	0.81
Total Phosphorus	mg/L	0.03	0.061	0.037	0.13	0.026	-	0.042	0.042
Total Suspended Solids	mg/L	- -	1	7	8	6	-	4	12
							-		
GENERAL PARAMETERS							-		
pH	pH units	6.5-8.5	7.06	7.76	6.94	7.66	-	7.97	7.93
conductivity	us/cm	- -	430	1800	1300	1500	-	1200	1400
							-		
METALS							-		
Barium	mg/L	- -	0.018	0.068	0.061	0.051	-	0.1	0.12
Boron	mg/L	0.2	0.017	0.063	<0.001	0.065	-	0.054	0.041
Cadmium	mg/L	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001
Chromium	mg/L	- -	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01
Copper	mg/L	0.005	0.002	0.003	0.007	0.003	-	0.005	0.003
Iron	mg/L	0.3	0.79	0.68	0.31	0.64	-	0.74	0.86
Lead	mg/L	0.025	<0.01	0.01	<0.01	0.01	-	<0.01	<0.01
Zinc	mg/L	0.03	0.02	0.01	0.01	0.02	-	<0.01	<0.01

Notes:

🟩 exceeds PWQO

APPENDIX TSD#1-D

Biology Component

February 2013

February 2013

Biology Component
Appendix TSD#1-D

COMPARATIVE EVALUATIONS OF ALTERNATIVE SITES

TAGGART
GROUP OF COMPANIES

THE MILLER GROUP

Table of Contents

TABLES

FIGURES

ATTACHMENTS

INTRODUCTION

Two properties that are owned or have been optioned by Taggart Miller have been identified for the proposed Capital Region Resource Recovery Centre (CRRRC) (the Alternative Sites). The Alternative Sites are described below:

- **North Russell Road Site (NRR Site)** – located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell.
- **Boundary Road Site (BR Site)** – located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, Township of Cumberland.

The CRRRC is proposed to provide facilities and capacity for recovery of resources and diversion of material from disposal generated by the industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sectors primarily in Ottawa and secondarily a portion of eastern Ontario, for management and utilization of surplus and contaminated soils, as well as landfill disposal capacity for material that is not diverted.

1.0 ASSESSMENT CRITERIA, INDICATORS AND DATA SOURCES

The biology component compared the Sites using the following criterion:

- Which Site is preferred for protection of terrestrial and aquatic biological systems?

The indicator is:

- Amount of, quality of and impact on biological systems on-Site, including protected biological systems:
  - Class 1 to 3 wetlands;
  - Life science ANSIs;
  - Wooded areas;
  - Species at risk and endangered species and associated habitat; and
  - Waterbodies and water courses.

The wetlands portion of the assessment was undertaken using the current classification of “provincially significant” versus “not provincially significant”, which replaced the Class 1 to 7 rankings.

The data sources used are Site reconnaissance and preliminary field surveys and published data sources including: Ontario Ministry of Natural Resources (MNR) Natural Heritage Information Centre (NHIC) database (NHIC 2013); MNR fisheries data; Conservation Authority information and mapping; past natural feature surveys and regulatory requirements; Atlas of the Breeding Birds of Ontario (Cadman et al. 2007); Atlas of the Mammals of Ontario (Dobbyn 1994); Ontario Herpetofaunal Summary Atlas (Oldham and Weller 2000); Ontario Odonata Atlas (NHIC 2005); Bird Studies Canada and other similar organizations; Royal Ontario Museum SAR mapping (2010); *Species at Risk Act* (SARA) (Canada 2002) and *Endangered Species Act* (ESA) (Ontario 2007); the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); Municipal Official Plans; Ontario Base Maps; Natural Resource Values Information System mapping and Land Information System mapping and Land Information Ontario (MNR 2012); and aerial photography. A BioBlitz (Hanrahan et al. 2011), which is a 24-hour survey of the biological diversity of a selected area, was conducted in 2011 on parts of the NRR Site and the general area of the Site. As part of the desktop assessment, the BioBlitz report was used as background information (Hanrahan et al. 2011).

2.0 METHODS

2.1 Screening for Species at Risk (SAR)

Species at Risk (SAR) considered in this evaluation include those species listed under the ESA and SARA, as well as species ranked S1 to S3 (NHIC) and regionally rare species. An assessment was conducted to determine which Species at Risk (SAR) had potential habitat in the general area of the Site.

A screening of all SAR that have the potential to be found on the NRR Site and within the general area of the NRR Site and on the BR Site and within the general area of the BR Site was conducted first as a desktop exercise. Species with ranges overlapping the Sites, or recent occurrence records in the vicinity, were screened by comparing their habitat requirements to habitat conditions on the Sites. Following the field surveys, the screening was updated to reflect the assessment of habitats in the NRR Site and the general area of the Site and in the BR Site and the general area of the Site, and survey data collected in the field. Range mapping for species listed as threatened or endangered under the ESA (Ontario 2007) are available on-line through the Royal Ontario Museum (2010) and from the Species at Risk Public Registry (Canada 2012). These range maps were referenced to determine if the Sites coincide with the known ranges of endangered or threatened species listed under the ESA. Only habitat for species designated as endangered or threatened under the ESA is afforded direct protection under the Act.

The potential for a SAR to occur within the Alternative Site and the general area of the Site was determined through a probability of occurrence, where a low-high ranking is applied based on considerations of habitat suitability and availability. A ranking of low indicates no suitable habitat availability for that species on the Site and no specimens identified. Moderate probability indicates more potential for the species to occur, as suitable habitat appeared to be present on the Site, but no occurrence of the species observed. High potential indicates a known species record on the Site (including during field surveys or background data review) and good quality habitat is present.

2.2 Site Investigations

A number of field surveys were conducted as part of the baseline data collection for the Alternative Sites evaluation.

The following field surveys were conducted on the NRR Site:

May 29, 2008	Site reconnaissance, Ecological Land Classification (ELC), vegetation, amphibian surveys
June 18, 2008	Breeding birds and wildlife area searches
July 25, 2008	Aquatic habitat and fish community surveys
August 1, 2008	Aquatic habitat and fish community surveys
November 29, 2011	Aquatic habitat and fish community surveys
September 20, 2012	Aquatic habitat and fish community surveys
September 26, 2012	ELC, vegetation and wildlife area searches
October 2, 2012	ELC, vegetation and wildlife area searches

The following field surveys were conducted on the BR Site:

May 10, 2012	Site reconnaissance, incidental wildlife and vegetation surveys
September 20, 2012	ELC, vegetation, herpetiles and wildlife area search, incidental birds, aquatic habitat and fish community surveys
October 2, 2012	ELC, vegetation, wildlife area search, incidental birds, aquatic habitat and fish community surveys
October 11, 2012	Aquatic habitat and fish community surveys

2.2.1 Aquatic Surveys

Surface water features were mapped using Land Information Ontario (LIO) data. Prepared mapping was ground-truthed through field surveys. Aquatic habitat assessments were conducted on all surface water features at both Sites.

The existing flooded quarry at NRR Site was visually inspected for aquatic vegetation and two baited Gee Minnow traps were set for a fish presence/absence assessment. The assessment of the surface water features on the remainder of the NRR Site and the general area of the Site was limited to qualitative visual inspections and aquatic habitat assessments.

Electrofishing, using a Smith-Root LR 24 Backpack electroshocker, was conducted in the ditches and streams on the BR Site, where there was sufficient water for fish collection.

2.2.2 Vegetation Communities

ELC, following the methods and terminology developed by Lee et al. (1998) for naturally-occurring plant communities of southern Ontario, was completed on both Sites. Vegetation community polygons were first delineated at a desktop level using existing aerial imagery and then ground-truthed in the field. Data collected included information on plant community structure and composition. Although all plant species observed were recorded, a complete botanical inventory was not conducted.

At both Sites, the vegetation surveys were conducted in the spring and/or fall, and not during the core of the growing season (i.e., summer). Sufficient data was collected to complete a preliminary ELC map and plant species list, but because of the timing of the surveys, the plant lists are not complete. The vegetation data collected at the NRR Site in 2008 was only used as background information, and not relied upon for ELC.

2.2.3 Wildlife Surveys

Species-specific wildlife surveys were not conducted as part of this evaluation. Inventories of wildlife were based on direct observations, distinctive calls and signs (e.g., tracks, scat, hair, etc.) observed during field surveys. Suitable habitats for SAR with a moderate or high potential to be found on the NRR or BR Site were assessed, where possible (depending on the season of the field surveys) and sightings or signs of any individuals were recorded (e.g., snake surveys involved flipping logs and observing piles of rocks for snakes).

Incidental wildlife surveys provide information on species using the Sites at specific periods of time or specific features of the Site. Additional surveys will be carried out to consider seasonal variations and complete the inventory of species potentially using the preferred Site.

2.3 Evaluation of Sites

A qualitative assessment of existing natural features, based on the indicators listed in Section 1.0, was undertaken. As it is assumed that the disturbance and the footprint of the CRRRC will include the entire land holdings of the Sites, the magnitude and scale of the source of disturbance, and the persistence of the disturbance (i.e., permanent versus temporary) was not considered. Where possible, the potential for minimizing residual effects through mitigation or avoidance was considered. Information used was derived from formal designations (i.e. local, provincial or national significance), preliminary baseline data collection and professional opinion.

Municipal planning documents were referenced to determine if any woodlands occurring on the Sites or within the general area of the Sites held designated significance under the respective planning context. Woodlands without a formal designation were assessed against the criteria of a municipality (i.e., City of Ottawa), or the Natural Heritage Reference Manual (NHRM) (MNR 2010) was used to determine if they could be considered significant.

The Ontario ESA takes precedence over the Canada SARA on private lands. Subsequently, because both of the Sites are located on private lands, the Ontario ESA takes precedence over the Canada SARA, and species ranked as S1 to S3 provincially (imperiled or rare in the NHIC database). For this evaluation, species listed as ‘threatened’ or ‘endangered’ under the ESA were considered more of a constraint (or the CRRRC would have more of an impact on these species) than those listed as ‘special concern’, or those listed under SARA or as S1 to S3.

3.0 PRELIMINARY DESCRIPTION OF EXISTING ENVIRONMENT

3.1 North Russell Road Site

3.1.1 Surface Water Resources and Aquatic Habitat

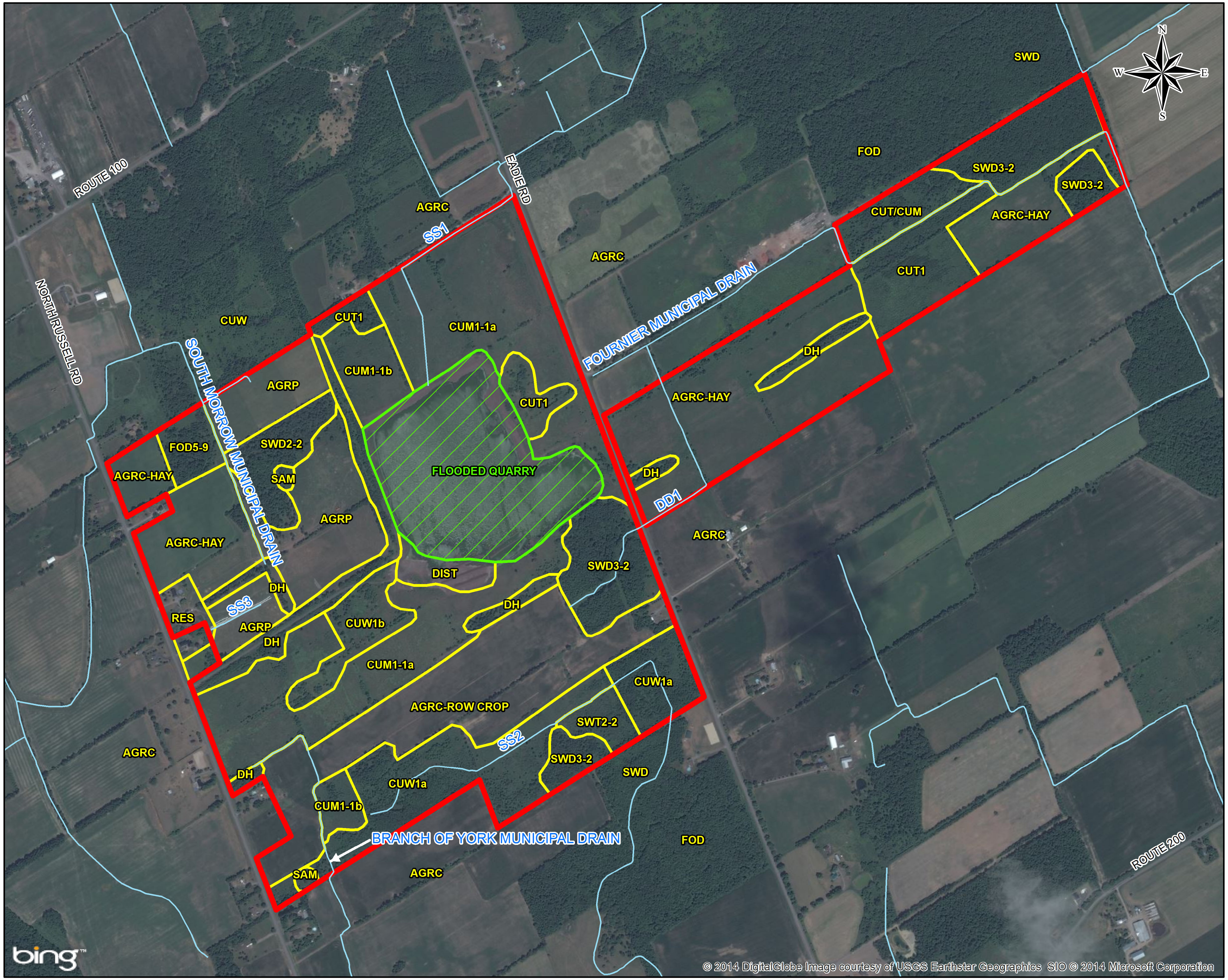
Based on the desktop assessment and the reconnaissance, there are five seasonal surface water features on the NRR Site: South Morrow Municipal Drain near the northeast corner of the NRR Site; Fournier Municipal Drain, east of Eadie Road; and three unnamed features: SS1, SS2 and SS3 (Figure 3.1-1). It was determined through three separate Site visits that all features are ephemeral (have intermittent flow). During all visits, SS1 and SS3 were dry, with only wet sediment present. South Morrow Municipal Drain and SS2 held water with no visible flow and were thick with algae and emergent grasses and sedges during the summer months, but were dry in September.

There are also two constructed drainage ditches within the general area of the Site: a drainage ditch located southeast of the property (DD1), along Eadie Road, and a branch of York Municipal Drain located in the southwest corner parallel to North Russell Road (Figure 3.1-1). During all surveys, there was minimal (0.5 metres) to no water in DD1, except when accumulated water in the quarry was pumped in 2008, suggesting that it likely acts only as a discharge conveyance for the quarry. Common cattail (*Typha latifolia*) and tall grasses and forbs were established along the channel edges and were bordered by riparian grasses. The branch of York Municipal Drain drains through a hedgerow separating agricultural fields.

No fish were observed or captured in any of the seasonal surface water features or drainage ditches during the surveys.

Three additional surface water features were identified during field surveys. These included two constructed shallow farm ponds, near the northwest and the southwest corners of the NRR Site (labelled SAM on Figure 3.1-1), and the quarry that, during the 2012 surveys, was flooded. Although some aquatic and emergent vegetation was present in the southwest pond, water was shallow, stagnant, and there was evidence that it dries up during periods of low water. The northwestern pond is currently used by cattle and is heavily disturbed. No fish species were caught or observed in either of these ponds, or in the flooded quarry. There were algae on the surface and sediment, as well some aquatic vegetation just beginning to become established (e.g., water naiad; *Najas flexilis*) in the water contained within the quarry.

The surface water features on the NRR Site and in the general area of the Site are not coldwater, so likely not as sensitive as coldwater systems.



LEGEND

- ━ SURFACE WATER FEATURE
- 🟨 ECOLOGICAL LAND CLASSIFICATION; RES; DIST
- 🟩 FLOODED QUARRY
- 🟥 PROPERTY BOUNDARY

ECOLOGICAL LAND CLASSIFICATION:

AGRC-AGRICULTURAL FIELDS
AGRC-ROW CROP : ROW CROP
AGRC-HAY : HAYFIELD
AGRP : HORSE PASTURE
CUM1-1A : MIXED MEADOW
CUM1-1B : FORB MEADOW
CUT1 : DECIDUOUS THICKET
CUT/CUM : DECIDUOUS THICKET/MIXED MEADOW COMPLEX
CUW1A : WHITE ELM DECIDUOUS OPEN WOODLAND
CUW1B : MANITOBA MAPLE DECIDUOUS OPEN WOODLAND
DH : DECIDUOUS HEDGEROW
DIST : DISTURBED
DD1-3 : DRAINAGE DITCHES
FOD-DICIDUOUS FOREST
FOD5-9 : MOIST RED MAPLE DECIDUOUS FOREST
RES : RESIDENTIAL
SAM : MIXED SHALLOW AQUATIC
SS1-4 : SEASONAL STREAMS
SWD2-2 : GREEN ASH-POPLAR MINERAL DECIDUOUS SWAMP
SWD3-2 : SILVER MAPLE MINERAL DECIDUOUS SWAMP
SWT2-2:WILLOW MINERAL THICKET SWAMP

200 100 0 200
SCALE 1:10,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-D

REFERENCE

BACKGROUND IMAGERY - BING MAPS AERIAL (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
NORTH RUSSELL ROAD SITE
ECOLOGICAL LAND CLASSIFICATION

Golder Associates
Ottawa, Ontario

PROJECT NO. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	FN	DEC. 2012	**FIGURE 3.1-1**	
GIS	BR	JAN. 2013		
CHECK	HM	AUG. 2014		
REVIEW	PLE	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0140_Biology\1211250045-0500-0140-3.1-1_RussellRdSite.mxd

3.1.2 Vegetation Communities

Vegetation communities on the NRR Site include meadows, pasture and hayfields, forest, swamp and thicket areas. A total of 155 species of plants have been observed on the NRR Site during field surveys completed to date. In some parts of the NRR Site there is weathered shale at surface; elsewhere the soil on the NRR Site generally consists of glacial till consisting of sandy silt to silty sand with gravel. All vegetation communities observed on the NRR Site and in the general area of the Site are common and widespread in the region.

The vegetation communities on the NRR Site are delineated on Figure 3.1-1 and a brief description of the communities are included in Attachment D-1 (Table 1). A list of the plant species observed on the NRR Site is included in Attachment D-2 (Table 1).

3.1.3 Wildlife

Seven insect, four herpetile, 34 bird and 10 mammal species were observed during the field surveys conducted in 2012 (Table 1, Attachment D-3). All species observed on the NRR Site are common and widespread in the region.

Common species observed included black swallowtail (*Papilio polyxenes*), meadow vole (*Microtus pennsylvanicus*), grey tree frog (*Hyla versicolor*) and American robin (*Turdus migratorius).* Based on the data collected to date, the wildlife community on the NRR Site and in the general area of the Site appears to be typical of the region, and consistent with the observed habitats.

3.1.4 Species at Risk

No sensitive or significant aquatic species were identified through the desktop assessment as occurring or having potential to occur on the NRR Site based on the data referenced during the 2012 SAR screening (Table 1, Attachment D-4). Also, none were identified during field surveys to date.

One significant plant species, butternut (*Juglans cinera*), was assessed through the desktop screening and preliminary habitat assessment as having a moderate to high likelihood of occurrence on the NRR Site and within the general area of the Site. This species is present on adjacent lands, and although no species were observed on the NRR Site in 2012, there is a possibility that it could occur, as the conditions are suitable.

A number of wildlife SAR were assessed as having potential to occur on the Site or in the general area of the Site (Table 3.1-1).

Table 3.1-1: Species at Risk with Potential to Occur on the NRR Site or in the General Area of the Site

Species	Potential to be found on the NRR Site or in the General area of the Site	*Endangered Species Act*	*Species at Risk Act*	Provincial Rank (SRank)
Western chorus frog (*Pseudacris triseriata*)	Low – Moderate	Not Listed	Threatened	S3
Barn swallow (*Hirundo rustica*)	Low – Moderate	Threatened	Not Listed	S4B
Eastern meadowlark (*Sturnella magna*)	Low – Moderate	Threatened	Not Listed	S4B
Short-eared owl (*Asio flammeus*)	Low – Moderate	Special Concern	Not Listed	S2N, S4B
Monarch (*Danaus plexippus*)	Moderate	Special Concern	Special Concern	S2N, S4B
Milksnake (*Lampropeltis triangulum*)	Moderate	Special Concern	Special Concern	S3
Little brown myotis (*Myotis lucifugus*)	Moderate – High	Endangered	Not Listed	S4
Butternut (*Juglans cinerea*)	Moderate – High	Endangered	Endangered	S3?
Bobolink (*Dolichonyx orizivorus*)	High	Threatened	Not Listed	S4B

Notes:
S = Provincial; Ranks 1-3 are considered imperiled or rare; Ranks 4 and 5 are considered secure
N = Native
B = Breeding
S3? = Rank Uncertain

Although none of the species listed in Table 3.1-1 were observed on the NRR Site during field surveys in 2012, there are records from previous Golder surveys of bobolink, and butternut being present or observed on the Site or in the general area of the Site. Although the BioBlitz also recorded these two species, as well as barn swallow in their study area (Hanrahan et al. 2011), it is not known if any of the observations were actually on the NRR Site or were observed off-Site within the general area of the Site.

3.1.5 Indicator Natural Heritage System Components

The indicator natural features or natural heritage system components on the NRR Site and general area of the Site are discussed further in the following sections.

3.1.5.1 Significant Wetlands

Based on the desktop assessment, there are no PSWs on the NRR Site or within the general area of the Site.

3.1.5.2 Significant Habitat of Endangered or Threatened Species

Nine SAR (eight provincially listed SAR and one federally threatened species) were identified, through the desktop screening and preliminary habitat assessment, with some potential to occur on the NRR Site and/or in the general area of the Site (see Section 3.1.4 for more details on these species). Four of these species have a Low-Moderate potential to occur, two have Moderate potential to occur, two species have Moderate-High potential to occur and one species has High potential to occur on the NRR Site and/or in the general area of the Site.

3.1.5.3 Significant Areas of Natural and Scientific Interest (ANSI)

Based on the desktop assessment, there are no provincially significant ANSIs on, or overlapping with, the NRR Site or within the general area of the Site.

3.1.5.4 Woodlands

There is a woodlot at the eastern extent of the NRR Site, east of Eadie Road that is contiguous with a larger woodland off-Site. This woodlot is not designated significant in the Township of Russell Official Plan (OP 2010). Based on mapping delineation, the woodland is approximately 108 hectares (ha) in size. In the United Counties of Prescott Russell, 25.7% of the landscape is vegetated in woodlands (Riley and Mohr 1994). According to the NHRM (MNR 2010), if woodlands cover 15 to 30% of the landscape in a region, woodlands 20 ha in size or larger should be considered significant. The woodland that encroaches on this portion of the NRR Site meets the criteria for significance using provincial guidelines.

3.1.6 Summary

A summary of the existing natural features on the NRR Site, related to the indicators of the Alternative Site evaluation, is provided in Table 3.1-2.

Table 3.1-2: Summary of Site Considerations on the NRR Site

Component	Summary of Site Considerations
Biology	**<u>Class 1-3 Wetlands</u>** ■ There are no Provincially Significant Wetlands (Class 1 to3 Wetlands) on the NRR Site, or in the general area of the Site. **<u>Life Science ANSIs</u>** ■ There are no Life Science ANSIs on the NRR Site, or in the general area of the Site. **<u>Wooded Areas</u>** ■ Although not officially designated, there is a woodlot on the east corner of the NRR Site that meets the NHRM criteria for a significant woodland. **<u>SAR and Associated Habitats</u>** ■ There are two species (barn swallow and eastern meadowlark), designated as threatened under the ESA which have a Low-Moderate potential to occur on the NRR Site and/or general area of the Site; ■ There are two species (little brown myotis and butternut), designated endangered under the ESA which have a Moderate-High potential to occur on the NRR Site and/or in the general area of the Site ; ■ There is one species (bobolink), designated as threatened under the ESA which has a High potential to occur on the NRR Site and/or in the general area of the Site; and, ■ There are four species either designated special concern under the ESA (short-eared owl, monarch, milksnake), or threatened under SARA (western chorus frog) which have some potential to occur on the NRR Site and/or in the general area of the Site. **<u>Watercourses and Waterbodies</u>** ■ There are five seasonal surface water features and two drainage ditches on the NRR Site and in the general area of the Site; ■ There are two dug agricultural ponds and a flooded quarry on the NRR Site; and, ■ The surface water features on the NRR Site are not coldwater, so likely not as sensitive as coldwater systems.

3.2 Boundary Road Site

3.2.1 Surface Water Resources and Aquatic Habitat

Three surface water features were identified on the BR Site: DD1 flows across several agricultural fields in the northern portion of the BR Site, Simpson Drain in the central portion of the BR Site, and DD2 which flows west to east in the southern portion of the BR Site (Figure 3.2-1).

DD1 was dry during the survey conducted in September 2012 with established growth of tall grasses and sparse cattail stands within the channel depression. It is likely that this feature only conveys flow during periods of high water (i.e., following storm events or spring freshet).

Simpson Drain is a shallow, narrow channel approximately 290 metres in length that flows easterly through a corrugated steel pipe culvert under Frontier Road. At the time of the survey (September 2012), water depth ranged from 0.02 to 0.08 metres and the wetted width was 0.73 to 0.78 metres. There is some contribution to the Simpson Drain from several small defined and undefined drainage areas from the north. A beaver dam (approximately 4 by 0.7 metres) at the upstream reach of Simpson Drain impounds water, resulting in a flooded area approximately 170 metres long with a generally uniform width (average wetted width of 5 metres) and depth (approximately 0.8 metres). Access could not be gained further upstream of Simpson Drain due to property ownership.

Ten fish representing four species (creek chub – *Semotilus atromaculatus*, brook stickleback – *Culaea inconstans*, central mudminnow – *Umbra limi* and pumpkinseed – *Lepomis gibbosus*) were captured in the Simpson Drain during the fish community survey (Attachment D-4, Table 2).

Fisheries and Oceans Canada (DFO) has classified municipal drains with regard to flow characteristics, which relates to the potential quality of fish habitat. Based on mapping that was updated in 2010, the Simpson Drain is classified as ‘F’, meaning it has intermittent flow and therefore likely to provide relatively low quality fish habitat.

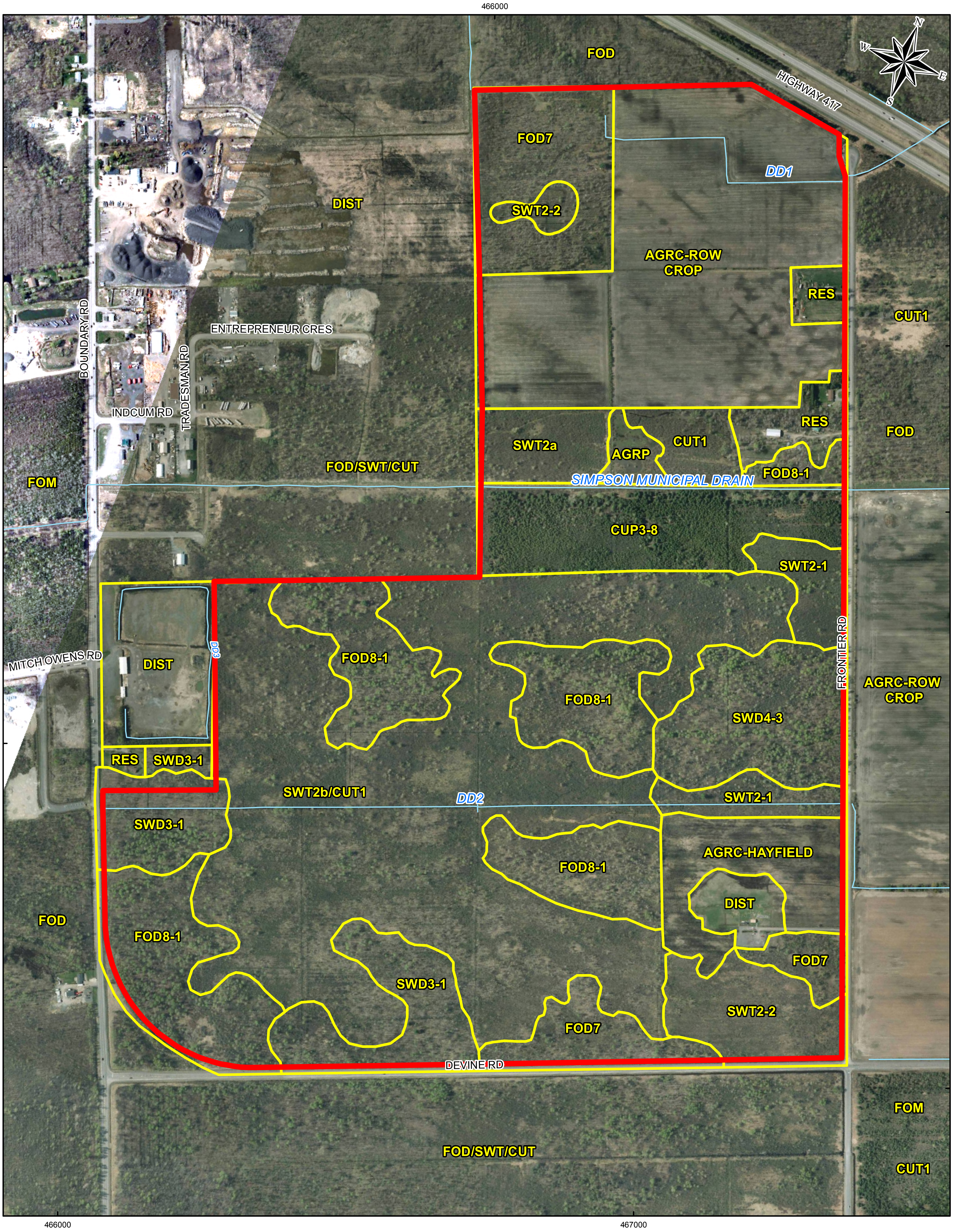
Most of DD2 was dry during the fish community survey conducted in September 2012, with the exception of the central reach. The water in the central reach of DD2 (length of approximately 100 metres) was stagnant. The water depth in this reach ranged from approximately 0.15 to 0.3 m, and the wetted width ranged from 0.75 to 1.0 metres. No fish were captured in DD2 during the fish community survey.

The surface water features on the BR Site are not coldwater, so likely not as sensitive as coldwater systems.

3.2.2 Vegetation Communities

Vegetation communities on the BR Site (Figure 3.2-1) include immature deciduous forest and swamp, deciduous thickets and thicket swamp, plantation, agricultural fields and small residential properties. A total of 115 species of plants have been observed on the BR Site during field surveys to date. The soil underlying the BR Site consists of a silty sand layer over deep clays. Flooding occurs throughout the BR Site during periods of high water (i.e., storm events and spring freshet), and the soil remains saturated in several areas for much of the year. A large proportion of the BR Site consists of mineral thicket swamp.

A brief description of the plant communities on the BR Site is included on Figure 3.2-1 and in Attachment D-1 (Table 2). A list of the plant species observed on the BR Site is included in Attachment D-2 (Table 2).



200 100 0 200

SCALE 1:7,000 METRES

LEGEND

- SURFACE WATER FEATURE
- 🟥 PROPERTY BOUNDARY
- 🟨 ECOLOGICAL LAND CLASSIFICATION

ECOLOGICAL LAND CLASSIFICATION:

AGRC : ROW CROP
AGRC : HAYFIELD
AGRP : HORSE PASTURE
CUP3-8 : WHITE SPRUCE PLANTATION
CUT1 : DECIDUOUS THICKET
DD-1-2 : DRAINAGE DITCHES
DIST : DISTURBED LANDS FOR VARIOUS USES
FOD : DECIDUOUS FOREST
FOD7 : MOIST EUROPEAN WHITE BIRCH - POPLAR DECIDUOUS FOREST
FOD8-1 : FREST-MOIST POPLAR - RED MAPLE - EUROPEAN WHITE BIRCH DECIDUOUS FOREST
FOM : MIXED FOREST
RES : RESIDENTIAL
SWD3-1 : RED MAPLE MINERAL DECIDUOUS SWAMP
SWD4-3 : POPLAR-EUROPEAN WHITE BIRCH MINERAL DECIDUOUS SWAMP
SWT2A : ALDER-WILLOW-GLOSSY BUCKTHORN MINERAL THICKET SWAMP
SWT2B/CUT1 : GLOSSY BUCKTHORN MINERAL THICKET SWAMP/DECIDUOUS THICKET COMPLEX
SWT2-1 : SPECKLED ALDER-GLOSSY BUCKTHORN MINERAL THICKET SWAMP
SWT2-2 : WILLOW MINERAL THICKET SWAMP
SWT – MINERAL THICKET SWAMP

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING APPENDIX TSD1-D

REFERENCE

BACKGROUND IMAGERY - BING MAPS AERIAL (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
AERIAL PHOTOGRAPHS PURCHASED FROM THE CITY OF OTTAWA.
LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

BOUNDARY ROAD SITE
ECOLOGICAL LAND CLASSIFICATION

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0.0
DESIGN	FN	DEC. 2012	FIGURE 3.2-1	
GIS	BR	JAN. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase0500\Task0140_Biology\1211250045-0500-0140-3.2-1_BoundaryRdSite.mxd

3.2.3 Wildlife

Nine insect, two herpetile, 32 bird, and 10 mammal species have been observed during all field surveys to date (Table 2, Attachment D-3).

Common species observed included common whitetail (*Plathemis lydia*), grey tree frog (*Hyla versicolor*), white-tailed deer (*Odocoileus virginianus*) and rose-breasted grosbeak (*Pheucticus ludovicianus*). Based on the data collected to date, the wildlife community on the BR Site appears to be typical of the region, and consistent with the observed habitats.

3.2.4 Species at Risk

No sensitive or significant aquatic or plant species were identified through the desktop assessment to exist or have potential to exist on the BR Site at the time of the assessment (Table 2, Attachment D-4). Also, none were identified during field surveys to date.

A number of wildlife SAR were assessed as having potential to occur on the BR Site or in the general area of the Site (Table 3.2-1).

Table 3.2-1: Species at Risk with Potential to Occur on the BR Site or in the General Area of the Site

Species	Potential to be Found on the BR Site or in the General Area of the Site	*Endangered Species Act*	*Species at Risk Act*	Provincial Rank (SRank)
Monarch	Low – Moderate	Special Concern	Special Concern	S2N, S4B
Eastern meadowlark	Low – Moderate	Threatened	Not Listed	S4B
Western chorus frog	Moderate	Not Listed	Threatened	S3
Barn swallow	Moderate	Threatened	Not Listed	S4B
Little brown myotis	Moderate	Endangered	Not Listed	S4
Milksnake	Moderate	Special Concern	Special Concern	S3

Notes:
S = Provincial; Ranks 1-3 are considered imperiled or rare; Ranks 4 and 5 are considered secure.
N = Native
B = Breeding

3.2.5 Indicator Natural Heritage System Components

The indicator natural features or natural heritage system components on the BR Site and in the general area of the Site are discussed further in the following sections.

3.2.5.1 Significant Wetlands

Based on the desktop assessment, there are no PSWs on the BR Site, or in the general area of the Site.

3.2.5.2 Significant Habitat of Endangered or Threatened Species

Six SAR (five provincially listed SAR and one federally threatened species) were identified, through the desktop screening and preliminary habitat assessment, with some potential to occur on the BR Site and/or in the general area of the Site (see Section 3.2.4 for more details on these species). Two of these species have a Low-Moderate potential to occur on the BR Site and/or in the general area of the Site, and four have Moderate potential to occur on the BR Site and/or in the general area of the Site.

3.2.5.3 Significant Areas of Natural and Scientific Interest (ANSI)

Based on the desktop assessment, there are no provincially significant ANSIs on, or overlapping with, the BR Site.

3.2.5.4 Woodlands

A large proportion of the BR Site is deciduous and swamp forest. Annex 14 of the City of Ottawa's Official Plan Amendment (OPA) 76 shows areas of the BR Site as potentially significant woodlands. However an Ontario Municipal Board Decision from mid-2011 deleted Annex 14 from OPA 76. The City has advised that as a part of an initial re-assessment of the Forest Resource Inventory (FRI), the BR Site lands will not be included as significant woodland in the revised mapping.

Although there are no significant woodlands on the BR Site, the woodland to the south of Devine Road (within the general area of the Site) has been identified as potentially significant based on the criteria in the City of Ottawa Official Plan (OP) (2003). This woodland also meets the NHRM criteria of a significant woodland (MNR 2010). This woodland has been identified as a Life Science area by the MNR (NHIC 2013). A Life Science area has no protection, nor are there any development restrictions or setbacks associated with a Life Science area. The BR Site and the general area of the Site is designated a general rural area on Schedule A of the City of Ottawa OP, and the woodland to the south of the BR Site is also included in the natural heritage system feature overlay (Schedule L1) (Ottawa 2003).

3.2.6 Summary

A summary of the existing natural features on the BR Site is provided in Table 3.2-2.

Table 3.2-2: Summary of Site Considerations on the BR Site

Component	Summary of Site Considerations
Biology	**Class 1-3 Wetlands** ■ There are no PSWs (Class 1 to 3 Wetlands) on the BR Site, or in the general area of the Site. **Life Science ANSIs** ■ There are no Life Science ANSIs on the BR Site, or in the general area of the Site. **Wooded Areas** ■ There is a potentially significant woodland off-Site, to the south of the BR Site, south of Devine Road; and, ■ The BR Site contains deciduous and swamp wooded areas. **SAR and Associated Habitats** ■ There is one species (eastern meadowlark) designated threatened under the ESA which has a Low-Moderate potential to occur on the BR Site and/or in the general area of the Site; ■ There are two species (barn swallow – designated threatened under the ESA; and little brown myotis – designated endangered under the ESA) which have Moderate potential to occur on the BR Site and/or in the general area of the Site; ■ There are three other species either designated special concern under the ESA and SARA (milksnake and monarch) or threatened under SARA (western chorus frog) with some potential to occur on the BR Site and/or in the general area of the Site; and, ■ At the time of assessment, there were no SAR with a High potential to occur on the BR Site and/or in the general area of the Site. **Watercourses and Waterbodies** ■ There are three surface features on the BR Site – a Municipal Drain and two drainage ditches; ■ A large proportion of the BR Site is mineral thicket swamp; and, ■ The surface water features on the BR Site are not coldwater, so likely not as sensitive as coldwater systems.

4.0 SITE COMPARISON – BIOLOGY

4.1 Comparison of Sites

As described in Section 2.3, a qualitative assessment of existing natural features, based on the indicators listed in Section 1.0, was undertaken.

Using the potential of impact of the CRRRC to the indicators, the two Sites were compared, with the rationale provided in Table 4.1-1.

Table 4.1-1: Comparison of Sites Based on Indicators

Indicator	Rationale	Rationale
PSWs (Class 1 to 3 Wetlands)	There are no PSWs on the NRR Site	There are no PSWs on the BR Site
Life Science ANSIs	There are no Life Science ANSIs on the NRR Site	There are no Life Science ANSIs on the BR Site
Wooded Areas (Significant Woodlands)	There is a woodlot on the east part of the NRR Site to the east of Eadie Road (SWD3-2 on Figure 3.1-1) that is contiguous with an off-Site woodland that meets NHRM criteria for significant woodlands. If required, Site planning would allow for the protection of this treed feature and the provision of a buffer.	The Site contains young deciduous and treed swamp components that are not significant. There is an off-Site woodlot to the south of the BR Site, across Devine Road (in the general area of the Site – FOD/SWT/CUT on Figure 3.2-1) which is shown as significant woodland in the City of Ottawa OP and is currently under review. It also meets the NHRM criteria for significant woodlands. The existing separation of Devine Road represents a physical separation between the BR Site and the woodlot that prevents on-Site activities from interfering with the woodlot and other off-Site vegetation.
SAR and Associated Habitat	There are two SAR species, designated threatened under the ESA which have a Low-Moderate potential to occur on the NRR Site and/or in the general area of the Site. There are three species, designated threatened or endangered under the ESA, which have a Moderate-High or a High potential to occur on the NRR Site and/or in the general area of the Site.	There are three SAR species, designated either threatened or endangered under the ESA, which have a Low-Moderate or a Moderate potential to occur on the BR Site and/or in the general area of the Site. There are no SAR species designated under the ESA or SARA which have a High potential to occur on the BR Site and/or in the general area of the Site.

Indicator	Rationale	Rationale
Waterbodies/ Watercourses	There are five seasonal surface water features and two constructed drainage features on the NRR Site which may provide some direct or indirect aquatic habitat. There is also a flooded quarry on the NRR Site. None of these surface water features are coldwater. It is possible that as part of the CRRRC, surface water features on the NRR will be removed, resulting in alteration of the surface water drainage patterns on the Site. The level of impact that the CRRRC will have on these systems depends on a number of factors, including how the features will be re-aligned. It is understood that the objective of stormwater management design is to maintain off-Site post-development flows similar to pre-development flows.	There are three drainage features which may provide some direct or indirect aquatic habitat on the BR Site. None of these surface water features are coldwater. In addition, a large proportion of the BR Site is mineral thicket swamp. It is possible that as part of the CRRRC, surface water features on the BR will be removed resulting in alteration of the surface water drainage patterns on the Site. The level of impact that the CRRRC will have on these systems depends on a number of factors including how the features will be re-aligned. It is understood that the objective of stormwater management design is to maintain off-Site post-development flows similar to pre-development flows.

As part of this evaluation, it was considered that the CRRRC would have more of an impact on the SAR on the Site than on wooded areas, particularly if the wooded areas were not designated as significant. In the assessment, the presence, or potential of occurrence of SAR on the Site was given a heavier weighting than wooded areas.

4.2 Results of Site Comparison

Based on biology data collected for the two Sites, the amount, quality and potential for impact with regard to PSWs, Life Science ANSIs, wooded areas and waterbodies was comparable for the two sites. There are more SAR and associated habitat at the NRR Site. Therefore, the BR Site is the preferred option for the proposed CRRRC.

More detailed field and background data will be collected for the Site that is chosen as preferred overall for the Environmental Assessment.

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ATTACHMENT D-1

Ecological Land Classification

February 2013

Table 1: Preliminary Ecological Land Classification on the North Russell Road Site

Vegetation Unit	Description
AGRC: Agricultural Fields	Agricultural Fields – Various uses
AGRC: Row Crop	Row crops (planted corn in 2012) near the southern edge of the NRR Site.
AGRC: Hayfield	Hayfields in the north western corner of the Site, and east across Eadie road. The hayfields appeared to be dominated by graminoid species such as Timothy (*Phleum pratense*) and smooth brome (*Bromus inermis*), but also included forbs such as white sweet clover (*Melilotus alba*).
AGRP: Pasture	This actively grazed cattle pasture was near the northwest corner of the NRR Site. Grazing appeared to be heavy, with vegetation cut low. Dominant plant species included grasses such as smooth brome, as well as various herbaceous plants including common dandelion (*Taraxacum officinale*).
CUM1-1A: Mixed Meadow	Old field habitat included large meadow areas throughout the NRR Site. Plant dominance varied between graminoids and forbs, with common plants such as Timothy, quack grass (*Elymus repens)* and wild carrot (*Daucus carota*).
CUM1-1B: Forb Meadow	Two small areas in the northern and southern portions of the NRR Site. The plant community was similar to that of the CUM1-1A, but with a higher proportion of forbs such as Canada goldenrod (*Solidago canadensis*) and New England Aster (*Symphyotrichum novae-angliae*).
CUT1: Deciduous Thicket	Three late successional field habitats near the north east corner and the east end of the NRR Site across Eadie Road. Common plants included immature trees such as trembling aspen, shrubs such as willows (*Salix* spp.) and red raspberry (*Rubus idaeus*), and groundcover such as parsnip (*Pastinaca sativa*) and Canada goldenrod.
CUT/CUM: Deciduous Thicket/Mixed Meadow Complex	Late successional field area near the eastern edge of the NRR Site, east of Eadie Road. A mosaic of mixed meadow, tall and short deciduous thickets and scattered larger trees. Plant species included trees and shrubs such as white elm (*Ulmus americana*), and glossy buckthorn (*Rhamnus frangula*), and red raspberry; as well as grasses and forbs such as reed canary grass (*Phalaris arundinacea*) and calico aster (*Symphyotrichum lateriflorum*).

Vegetation Unit	Description
CUW1A: White Elm Deciduous Open Woodland	Open woodland at the southern edge of the NRR Site. It appeared to be late successional fields that have a disturbance history that included grazing at some point. The canopy was open, with patches of trees interspersed with open areas and thickets. The plant community was fairly diverse and included trees and shrubs such as white elm, European white birch (*Betula papyrifera*), and Canada plum (*Prunus nigra*); as well as grasses and forbs such as Kentucky bluegrass (*Poa pratensis*) and common strawberry (*Fragaria virginiana*)
CUW1B: Manitoba Maple Deciduous Open Woodland	Open woodland in the middle of a meadow area south west of the flooded quarry. The canopy was open and dominated by Manitoba maple (*Acer negundo*). Other common plants included horseweed (*Conyza canadensis*), Canada thistle (*Cirsium arvense*) and smooth brome.
DH: Deciduous Hedgerows	Hedgerows throughout the NRR Site. Species dominance and plant structure varied, but common species included Manitoba maple, white ash (*Fraxinus americana*) and riverbank grape (*Vitis riparia*).
FOD5-9: Moist Red Maple Deciduous Forest	Small immature woodlot near the north east corner of the NRR Site. The soil appeared to be fairly moist, and may receive some flooding in early spring. Disturbance was moderate to heavy within this woodlot, due to current cattle activity and grazing. The canopy was partially open with a moderate understory and ground cover. Red maple (*Acer rubrum*) appeared dominant in the canopy with associates such as green ash (*Fraxinus pennsylvanica*). Understory and ground cover included species such as common buckthorn (*Rhamnus frangula*), white clover (*Trifolium repens*) and Canada mayflower (*Maianthemum canadense*).
SAM: Mixed Shallow Aquatic	Two small dug farm ponds, near the north west and south west corners of the site. Both appeared to have been used for livestock watering, and it was evident that the northern pond was used heavily by cattle at the time of the assessment. Water depth was primarily shallow (under 1 m), and likely dries up, at least in part, during some summers. Plant species include common cattail (*Typha latifolia*), duckweed (*Lemna minor*), and slender naiad (*Najas flexilis*). These ponds appeared fairly stagnant, and are not likely fish habitat.

Vegetation Unit	**Description**
SWD2-2: Green Ash - Poplar Mineral Deciduous Swamp	Two degraded forested swamps near the northeast corner and near the southeast corner of the NRR Site. These swamps had been heavily disturbed by cattle grazing and usage at the time of the assessment. The canopy ranged from closed to partially open, and the understory and ground cover was moderate to sparse. Tree species were variable, but green ash appeared dominant throughout, with balsam poplar and red maple as associates. Understory and ground cover included species such as dwarf raspberry (*Rubus pubescens*), northern water-horehound (*Lycopus uniflorus*) and sedges (*Carex* spp.)
SWD3-2: Silver Maple Mineral Deciduous Swamp	One woodlot near the southern edge and two near the eastern edge of the NRR Site, east across Eadie road. All three of these swamps appeared semi-mature, with the northeastern most being the most mature. No permanent open water was observed, however signs of flooding and vernal pools during high water were observed throughout. There was a small amount of disturbance in the form of past tree cutting, trail blazing and garbage dumping. The canopy ranged from closed to partially open, and the understory and ground cover was sparse overall. Silver maple was dominant in the canopy, with associates such as green ash and white elm. Understory and ground cover included species such as swamp red currant (*Ribes triste*), sensitive fern (*Onaclea sensibilis*), American water-horehound (*Lycopus americanus*) and bladder sedge (*Carex intumescens*).
SWT2-2: Willow Mineral Thicket Swamp	Thicket swamp adjacent to the silver maple swamp at the southern edge of the NRR Site, and is contiguous south of the NRR Site. Although no large areas of open water were observed, some small channels and areas of flooding appeared to occur. Willow species (e.g. Slender willow; *Salix petiolaris*) were dominant, with several other plant species such as glossy buckthorn, wool grass (*Scirpus cyperinus*) and water parsnip (*Sium suave*).

Table 2: Preliminary Ecological Land Classification on the Boundary Road Site

Vegetation Unit	Description
AGRC: Hayfields	A small hayfield adjacent to a model airplane club near the eastern boundary of the BR Site. Hay fields were dormant or already cut at the time of surveys, but included graminoid species such as Timothy (*Phleum pratense*) and smooth brome (*Bromus inermis*), as well as herbaceous species such as red clover (*Trifolium pratense*).
AGRC: Agricultural Row Crop	Row crops (planted soya in 2012) in the northern portion of the BR Site.
AGRP: Horse Pasture	Small moist meadow area currently used by a small herd of horses in the north central portion of the BR Site. Grazing appeared moderate to heavy and dominant plant species included grasses such as smooth brome, as well as sedges (*Carex* spp., *Scirpus* spp.) and rush (*Juncus* sp.).
CUP 3-8: White Spruce Plantation	A band of naturalized plantation that runs east-west through the north central portion of the BR Site. The canopy was partially opened, with a moderate to dense understory and ground cover. White spruce was dominant in the canopy, with the occasional other tree species such as trembling aspen (*Populus tremuloides*). The understory and ground cover was comprised of sapling trees, shrubs such as willows (Salix spp.), and forbs such as common strawberry (*Fragaria virginiana*). It appeared that some of this area experiences flooding during periods of high water (i.e., during storm events or spring freshet).
CUT1: Deciduous Thicket	Small thicket area between the horse pasture and residential areas. Moderately disturbed due to residential use, and included an open trail area. Common plants included immature trees such as trembling aspen and black walnut (*Juglans nigra*), shrubs such as willows and red raspberry (Rubus idaeus), and groundcover such as smooth brome and Canada goldenrod (*Solidago canadensis*).
FOD	Deciduous Forest

Vegetation Unit	Description
FOD 7: Moist European White Birch - Poplar Deciduous Forest	Two patches of immature lowland forest community: near the southeast corner, and a small woodlot at the northern edge of the BR Site. The canopy was partially open, with a moderate understory and ground cover. European white birch (*Betula pendula*), trembling aspen, and red maple (*Acer rubrum*) were common tree species, and varied in dominance throughout. Understory and ground cover vegetation included saplings and seedlings of the various tree species, as well as shrubs and forbs such as glossy buckthorn (*Rhamnus frangula*) and flat-topped aster (*Doellingeria umbellata*). Low lying wet spots included water tolerant vegetation such as red osier dogwood (*Cornus stolonifera*) and sedges (*Carex* and *Scirpus* spp).
FOD 8-1: Fresh-Moist Poplar - Red Maple - European White Birch Deciduous Forest	Two areas of immature moist forest community in the central portion, and in the southeast corner of the BR Site. It had a similar plant community and structure to that of FOD 7, except red maple and poplar species appeared more dominant in the canopy.
FOM	Mixed Forest
SWD 3-1: Red Maple Mineral Deciduous Swamp	Two areas of immature swamp community near the southwest corner of the BR Site. It had a similar plant community to FOD 7 and FOD 8-1, although it appeared to receive more flooding, had soil that is saturated longer, and a higher proportion of water tolerant plants. The canopy was partially closed to closed with a moderate understory and groundcover. Red maple was dominant in the canopy with associates such as balsam poplar (*Populus balsamifera*) and green ash (*Fraxinus pennsylvanica*). Understory and ground cover included species such as speckled alder (*Alnus incana*), royal fern (*Osmunda regalis*), Canada mayflower (*Maianthemum canadense*), and bladder sedge (*Carex intumescens*). No permanent areas of open water were observed in 2012; however there were old dry ditches with terrestrial vegetation and low pool areas throughout that appeared to hold water during periods of flooding.
SWD 4-3: Poplar - European White Birch Mineral Deciduous Swamp	Immature swamp community at the east-central edge of the BR Site. The canopy was partially open, with a moderate to dense understory and groundcover. Balsam poplar and European white birch appeared dominant in the canopy with associates such as red maple and trembling aspen. Understory and ground cover included species such as glossy buckthorn, shining willow (*Salix lucida*), northern water-horehound (*Lycopus uniflorus*), and woolgrass (*Scirpus cyperinus*).
SWT	Mineral Thicket Swamp

Vegetation Unit	**Description**
SWT2B/CUT1: Mineral Thicket Swamp/Deciduous Thicket Complex	This large area is the core of the southern half of the BR Site. Due to the microtopography of this area, it was a mosaic of thicket swamp, and drier deciduous thicket areas. Within these areas were scattered trees, and small patches of marsh-like communities. Species dominance varied throughout, but overall it included patches of shrubs such as speckled alder, glossy buckthorn, common buckthorn (*Rhamnus cathartica*), slender willow (*Salix petiolaris*), and meadowsweet (*Spiraea alba*). Understory and ground cover as diverse, and included species such as sensitive fern (*Onaclea sensibilis*), spinulose wood fern (*Dryopteris carthusiana*), dwarf raspberry (*Rubus pubescens*), Canada goldenrod, Calico aster (*Symphyotrichum lateriflorum*), reed canary grass (*Phalaris arundinacea*), soft-stemmed bulrush (*Schoenoplectus tabernaemontani*), and cyperus-like sedge (*Carex pseudocyperus*). No permanent areas of open water were observed in 2012; however there were old dry ditches with terrestrial vegetation and low pool areas throughout that appeared to hold water during periods of flooding, particularly in areas with beaver (*Castor canadensis*) activity.
SWT2a: Glossy Buckthorn Mineral Thicket Swamp	Small thicket swamp at the western edge of the north-central portion of the BR Site. It appeared to be dominated by glossy buckthorn and willows (Salix spp.). Ground cover included water tolerant species such as swamp dewberry (*Rubus hispidus*), soft-stemmed bulrush, and fringed sedge (*Carex crinita*).
SWT 2-1: Speckled Alder-Glossy Buckthorn Mineral Thicket Swamp	Thicket swamp at the eastern edge of the central portion of the BR Site. It appeared to be dominated by fairly mature speckled alder, with a dense understory of glossy buckthorn seedlings and saplings in many areas. Other common plants included American water-horehound (*Lycopus americanus*), blue flag (*Iris versicolor*), sensitive fern, and fowl bluegrass (*Poa palustris*).
SWT 2-2: Willow Mineral Thicket Swamp	Thicket swamp in the small woodlot at the far northern portion of the BR Site. It appeared to be dominated by willow species (*Salix* spp.), with other shrubs such as glossy buckthorn common. Ground cover included species such as northern water-horehound, black bulrush (*Scirpus atrovirens*), sedges (*Carex* spp.) and rush (*Juncus* sp).

ATTACHMENT D-2

Plants Observed on the NRR and BR Sites

Table 1: Plant Species Observed on the North Russell Road Site and in the Site-vicinity

Scientific Name	Common Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Locations[e]
Acer negundo	Manitoba maple	(N)	G5	S5	--	--	1,2,3
Acer rubrum	Red maple	N	G5	S5	--	--	2,3
Acer saccharinum	Silver maple	N	G5	S5	--	--	3
Acer saccharum	Sugar maple	N	G5	S5	--	--	1,2
Achillea millefolium	Common yarrow	I	G5T5?	SNA	--	--	1
Agrimonia gryposepala	Common agrimony	N	G5	S5	--	--	1,2
Alisma triviale	Small-flowered water plantain	N	G5	S5	--	--	3
Amaranthus retroflexus	Redroot pigweed	I	GNR	SNA	--	--	1
Ambrosia artemisiifolia	Ragweed	N	G5	S5	--	--	1,2
Arctium minus	Common burdock	I	GNR	SNA	--	--	1,3
Asclepias incarnata	Swamp milkweed	N	G5	S5	--	--	3
Asclepias syriaca	Common milkweed	N	G5	S5	--	--	1
Athyrium filix-femina	Lady fern	N	G5T5	S5	--	--	2,3
Barbarea vulgaris	Winter cress	I	GNR	SNA	--	--	1,3
Betula papyrifera	White birch	N	G5	S5	--	--	2
Betula pendula	European white birch	I	GNR	SNA	--	--	1,2
Bidens cernua	Beggar-ticks	N	G5	S5	--	--	1,3
Bidens frondosa	Beggar-ticks	N	G5	S5	--	--	3
Brassica napus	Turnip	I	GNR	SNA	--	--	1
Bromus inermis	Smooth brome	I	GNR	SNA	--	--	1,2
Calamagrostis canadensis	Canada blue-joint	N	G5	S5	--	--	3
Carex arctata	Compressed sedge	N	G5?	S5	--	--	2,3
Carex communis	Common sedge	N	G5	S5	--	--	2,3
Carex crinita	Fringed sedge	N	G5	S5	--	--	3
Carex intumescens	Bladder sedge	N	G5	S5	--	--	3
Carex spp.	Sedge species	N	?	?	--	--	2,3
Carex vulpinoidea	Fox sedge	N	G5	S5	--	--	1,3
Cerastium fontanum	Mouse-ear chickweed	I	GNR	SNA	--	--	1
Chara sp.	Stonewort	N	?	?	--	--	3
Chelidonium majus	Celandine	I	GNR	SNA	--	--	3
Cichorium intybus	Chicory	I	GNR	SNA	--	--	1
Cicuta bulbifera	Bulb-bearing water-hemlock	N	G5	S5	--	--	3
Cirsium arvense	Canada thistle	I	GNR	SNA	--	--	1,2
Cirsium vulgare	Bull thistle	I	GNR	SNA	--	--	1

Design by: FN December 2012
Checked by: HM

Scientific Name	Common Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Locations[e]
Conyza canadensis	Horseweed	N	G5	S5	--	--	1
Cornus rugosa	Round-leaved dogwood	N	G5	S5	--	--	1,2
Cornus stolonifera	Red osier dogwood	N	G5	S5	--	--	1,3
Dactylis glomerata	Orchard grass	I	GNR	SNA	--	--	1,2
Daucus carota	Wild carrot	I	GNR	SNA	--	--	1
Doellingeria umbellata	Flat-topped aster	N	G5T5	S5	--	--	1,2,3
Dryopteris carthusiana	Spinulose woodfern	N	G5	S5	--	--	2,3
Echinochloa crusgalli	Barnyard grass	I	GNR	SNA	--	--	1,3
Elodea canadensis	Common waterweed	N	G5	S5	--	--	3
Elymus repens	Quack grass	I	GNR	SNA	--	--	1
Epipactis helleborine	Helleborine	I	GNR	SNA	--	--	2,3
Erigeron philadelphicus	Philadelphia fleabane	N	G5	S5	--	--	1
Erysimum cheiranthoides	Wormseed mustard	I	G5	SNA	--	--	1
Euthamia graminifolia	Grass-leaved goldenrod	N	G5	S5	--	--	1
Fragaria virginiana	Common strawberry	N	G5	S5	--	--	1,2,3
Fraxinus americana	White ash	N	G5	S5	--	--	1,2
Fraxinus pennsylvanica	Green ash	N	G5	S5	--	--	2,3
Galium asprellum	Rough bedstraw	N	G5	S5	--	--	2
Galium mollugo	White bedstraw	I	GNR	SNA	--	--	1,2
Geum aleppicum	Yellow avens	N	G5	S5	--	--	1,2,3
Glyceria grandis	Tall manna grass	N	G5	S4S5	--	--	1,3
Hemerocallis fulva	Orange daylily	I	GNA	SNA	--	--	1,3
Hydrocharis morsus-ranae	Frogbit	I	GNR	SNA	--	--	3
Hypericum perforatum	Common St. John's-wort	I	GNR	SNA	--	--	1
Impatiens capensis	Spotted jewelweed	N	G5	S5	--	--	3
Juglans nigra	Black walnut	(N)	G5	S4	--	--	2
Juncus effusus	Soft rush	N	G5	S5	--	--	1,3
Juncus sp.	Rush species	N	?	?	--	--	1,3
Lactuca biennis	Tall blue lettuce	N	G5	S5	--	--	1,2
Leersia oryzoides	Rice cut-grass	N	G5	S5	--	--	3
Lemna minor	Duckweed	N	G5	S5	--	--	3
Leonurus cardiaca	Common motherwort	I	GNR	SNA	--	--	1,2
Leucanthemum vulgare	Ox-eye daisy	I	GNR	SNA	--	--	1
Linaria vulgaris	Butter-and-eggs	I	GNR	SNA	--	--	1

Table 1: Plant Species Observed on the North Russell Road Site and in the Site-vicinity

Scientific Name	Common Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Locations[e]
Lonicera tatarica	Tartarian honeysuckle	I	GNR	SNA	--	--	1,2
Lotus corniculatus	Bird’s-foot trefoil	I	GNR	SNA	--	--	1
Lycopus americanus	American water-horehound	N	G5	S5	--	--	3
Lycopus uniflorus	Northern water-horehound	N	G5	S5	--	--	1,3
Lythrum salicaria	Purple loosestrife	I	G5	SNA	--	--	1,3
Maianthemum canadense	Canada mayflower	N	G5	S5	--	--	2,3
Maianthemum racemosum	False Solomon's-seal	N	G5	S5	--	--	3
Malus pumila	Apple	I	G5	SNA	--	--	1,2
Medicago lupulina	Black medick	I	GNR	S5	--	--	1
Medicago sativa	Alfalfa	I	GNR	S5	--	--	1
Melilotus alba	White sweet clover	I	G5	SNA	--	--	1,2
Melilotus officinalis	Yellow sweet-clover	I	GNR	SNA	--	--	1
Najas flexilis	Slender naiad	N	G5	S5	--	--	3
Nepeta cataria	Catnip	I	GNR	SNA	--	--	1
Onoclea sensibilis	Sensitive fern	N	G5	S5	--	--	3
Osmunda cinnamomea	Cinnamon fern	N	G5	S5	--	--	3
Oxalis stricta	Yellow wood-sorrel	N	G5	S5	--	--	1,2
Panicum capillare	Witch grass	N	G5	S5	--	--	1
Parthenocissus inserta	Virginia creeper	N	G5	S5	--	--	1,2,3
Pastinaca sativa	Parsnip	I	GNR	SNA	--	--	1
Phalaris arundinacea	Reed canary grass	N	G5	S5	--	--	1,3
Phleum pratense	Timothy	I	GNR	SNA	--	--	1,2
Picea glauca	White spruce	N	G5	S5	--	--	2
Pinus strobus	White pine	N	G5	S5	--	--	2
Pinus sylvestris	Scots pine	I	GNR	SNA	--	--	1,2
Plantago major	Common plantain	I	G5	SNA	--	--	1,2
Poa palustris	Fowl bluegrass	N	G5	S5	--	--	1,3
Poa pratensis	Kentucky bluegrass	I	G5T5?	SNA	--	--	1,2
Pontederia cordata	Pickerelweed	N	G5	S5	--	--	3
Populus balsamifera	Balsam poplar	N	G5	S5	--	--	1,3
Populus deltoides	Eastern cottonwood	N	G5T5	S5	--	--	1,2
Populus tremuloides	Trembling aspen	N	G5	S5	--	--	1,2,3
Potentilla argentea	Silvery cinquefoil	I	GNR	SNA	--	--	1
Potentilla norvegica	Rough cinquefoil	I	G5	S5	--	--	1,2

Table 1: Plant Species Observed on the North Russell Road Site and in the Site-vicinity

Scientific Name	Common Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Locations[e]
Prunus nigra	Canada plum	N	G4G5	S4	--	--	1,2
Prunus pensylvanica	Pin cherry	N	G5	S5	--	--	1,2
Prunus virginiana	Choke cherry	N	G5	S5	--	--	1,3
Quercus macrocarpa	Bur oak	N	G5	S5	--	--	1,2
Quercus rubra	Red oak	N	G5	S5	--	--	2
Ranunculus abortivus	Kidney-leaf buttercup	N	G5	S5	--	--	3
Ranunculus acris	Common buttercup	I	G5	SNA	--	--	1,2
Rhamnus cathartica	Common buckthorn	I	GNR	SNA	--	--	1,2
Rhamnus frangula	Glossy buckthorn	I	GNR	SNA	--	--	1,2,3
Rhus radicans	Poison-ivy	N	G5T5	S5	--	--	1,2,3
Rhus typhina	Staghorn sumac	N	G5	S5	--	--	1
Ribes cynosbati	Prickly gooseberry	N	G5	S5	--	--	2,3
Ribes triste	Swamp red currant	N	G5	S5	--	--	3
Rorippa palustris	Marsh yellow-cress	N	G5T5	S5	--	--	1,3
Rosa rubiginosa	Sweetbriar	I	GNR	SNA	--	--	1
Rubus allegheniensis	Mountain blackberry	N	G5	S5	--	--	1
Rubus idaeus	Red raspberry	N	G5T5	S5	--	--	1,2,3
Rubus odoratus	Purple-flowering raspberry	N	G5	S5	--	--	1,2
Rubus pubescens	Dwarf raspberry	N	G5	S5	--	--	2,3
Rudbeckia hirta	Black-eyed susan	N	G5	S5	--	--	1
Rumex crispus	Curled dock	I	GNR	SNA	--	--	1
Salix bebbiana	Beaked willow	N	G5	S5	--	--	1,3
Salix discolor	Pussy willow	N	G5	S5	--	--	1
Salix lucida	Shining willow	N	G5	S5	--	--	1,3
Salix petiolaris	Slender willow	N	G5	S5	--	--	3
Salix x fragilis	Crack willow	I	GNR	SNA	--	--	1
Scirpus cyperinus	Wool-grass	N	G5	S5	--	--	3
Scirpus hattorianus	Mosquito bulrush	N	G5	S4	--	--	1,3
Setaria pumila	Yellow foxtail	I	GNR	SNA	--	--	1
Silene vulgaris	Bladder campion	I	GNR	SNA	--	--	1
Sium suave	Water parsnip	N	G5	S5	--	--	3
Solanum dulcamara	Climbing nightshade	I	GNR	SNA	--	--	1,2,3
Solanum ptycanthum	Eastern black nightshade	N	G5	S5	--	--	1
Solidago canadensis	Canada goldenrod	N	G5T5	S5	--	--	1,2

Table 1: Plant Species Observed on the North Russell Road Site and in the Site-vicinity

Scientific Name	Common Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Locations[e]
Solidago rugosa	Rough goldenrod	N	G5	S5	--	--	1,2,3
Sonchus arvensis	Common sow-thistle	I	GNR	SNA	--	--	1
Spiraea alba	Meadowsweet	N	G5	S5	--	--	1,3
Spiraea tomentosa	Hardhack	N	G5	S4S5	--	--	3
Symphyotrichum cordifolium	Heart-leaved aster	N	G5	S5	--	--	1,2
Symphyotrichum lanceolatum	Panicled aster	N	G5T5	S5	--	--	1,2
Symphyotrichum lateriflorum	Calico aster	N	G5T?	S5	--	--	1,3
Symphyotrichum novae-angliae	New England aster	N	G5	S5	--	--	1,2
Symphyotrichum puniceum	Red-stemmed aster	N	G5	S5	--	--	3
Syringa vulgaris	Lilac	I	GNR	SNA	--	--	1,2
Taraxacum officinale	Common dandelion	I	G5	SNA	--	--	1,2
Thuja occidentalis	Eastern white cedar	N	G5	S5	--	--	1,3
Tilia americana	Basswood	N	G5	S5	--	--	1,2,3
Trifolium pratense	Red clover	I	GNR	SNA	--	--	1
Trifolium repens	White clover	I	GNR	SNA	--	--	1,2
Typha latifolia	Common cattail	N	G5	S5	--	--	1,3
Ulmus americana	White elm	N	G5?	S5	--	--	1,2,3
Viburnum lentago	Nannyberry	N	G5	S5	--	--	1,2
Viburnum trilobum	Highbush cranberry	N	G5T5	S5	--	--	1,3
Vicia cracca	Cow-vetch	I	GNR	SNA	--	--	1
Vitis riparia	Riverbank grape	N	G5	S5	--	--	1,2,3

[a] Origin: N = Native; (N) = Native but not in study area region; I = Introduced.

[b] Ranks based upon determinations made by the Ontario Natural Heritage Information Centre (2012).

[c] Canada *Species at Risk Act* (Schedule 1; checked September 2012).

[d] Ontario *Endangered Species Act* (O. Reg. 4/12 amending O.Reg.230/08; checked September 2012).

[e] Locations: 1: Thickets, Meadows, Agricultural Fields, Roadside, and Habitat edges; 2: Upland Forests and Woodlands 3: Swamps and Ditches/Water features.

G = Global; S = Provincial; Ranks 1-3 are considered imperiled or rare; Ranks 4 and 5 are considered secure.

SNA = Not applicable for Ontario Ranking (e.g. Exotic species).

Table 2: Plant Species Observed on the Boundary Road Site and in the Site-vicinity

Scientific Name	Common Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Locations[e]
Acer negundo	Manitoba maple	(N)	G5	S5	--	--	1,2
Acer rubrum	Red maple	N	G5	S5	--	--	1,2,3
Alnus incana	Speckled alder	N	G5	S5	--	--	1,2,3
Amaranthus retroflexus	Redroot pigweed	I	GNR	SNA	--	--	1
Ambrosia artemisiifolia	Ragweed	N	G5	S5	--	--	1
Aralia nudicaulis	Wild sarsaparilla	N	G5	S5	--	--	2,3
Asclepias syriaca	Common milkweed	N	G5	S5	--	--	1
Athyrium filix-femina	Lady fern	N	G5T5	S5	--	--	2,3
Betula pendula	European white birch	I	GNR	SNA	--	--	1,2,3
Bromus inermis	Smooth brome	I	GNR	SNA	--	--	1
Calamagrostis canadensis	Canada blue-joint	N	G5	S5	--	--	3
Carex crinita	Fringed sedge	N	G5	S5	--	--	2,3
Carex intumescens	Bladder sedge	N	G5	S5	--	--	3
Carex lacustris	Lake sedge	N	G5	S5	--	--	3
Carex pseudocyperus	Cyperus-like sedge	N	G5	S5	--	--	3
Carex spp.	Sedges	N	?	?	--	--	1,2,3
Carex vulpinoidea	Fox sedge	N	G5	S5	--	--	1,3
Circaea lutetiana	Enchanter’s nightshade	N	G5	S5	--	--	2,3
Cicuta bulbifera	Bulb-bearing water-hemlock	N	G5	S5	--	--	1,3
Cirsium arvense	Canada thistle	I	GNR	SNA	--	--	1
Cirsium vulgare	Bull thistle	I	GNR	SNA	--	--	1
Clematis virginiana	Virgin's-bower	N	G5	S5	--	--	1,2,3
Conyza canadensis	Horseweed	N	G5	S5	--	--	1
Cornus stolonifera	Red osier dogwood	N	G5	S5	--	--	1,3
Dactylis glomerata	Orchard grass	I	GNR	SNA	--	--	1
Daucus carota	Wild carrot	I	GNR	SNA	--	--	1
Digitaria ischaemum	Smooth crab-grass	I	GNR	SNA	--	--	1
Doellingeria umbellata	Flat-topped aster	N	G5T5	S5	--	--	1,3
Dryopteris carthusiana	Spinulose woodfern	N	G5	S5	--	--	2,3
Echinochloa crusgalli	Barnyard grass	I	GNR	SNA	--	--	1
Elodea canadensis	Common waterweed	N	G5	S5	--	--	3
Equisetum arvense	Field horsetail	N	G5	S5	--	--	1,2,3
Erigeron philadelphicus	Philadelphia fleabane	N	G5	S5	--	--	1
Eupatorium perfoliatum	Boneset	N	G5	S5	--	--	1,3
Euthamia graminifolia	Grass-leaved goldenrod	N	G5	S5	--	--	1

Table 2: Plant Species Observed on the Boundary Road Site and in the Site-vicinity

Scientific Name	Common Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Locations[e]
Eutrochium maculatum	Joe-pye weed	N	G5TNR	S5	--	--	3
Fragaria virginiana	Common strawberry	N	G5	S5	--	--	1,2,3
Fraxinus americana	White ash	N	G5	S5	--	--	1,2
Fraxinus nigra	Black ash	N	G5	S5	--	--	3
Fraxinus pennsylvanica	Green ash	N	G5	S5	--	--	2,3
Geum sp.	Avens species	N	G5	?	--	--	2,3
Glyceria grandis	Tall manna grass	N	G5	S4S5	--	--	1,3
Glyceria striata	Fowl manna grass	N	G5T5	S4S5	--	--	3
Impatiens capensis	Spotted jewelweed	N	G5	S5	--	--	2,3
Iris versicolor	Blue-flag	N	G5	S5	--	--	3
Juglans nigra	Black walnut	(N)	G5	S4	--	--	1,2
Juncus spp.	Rushes	N	?	?	--	--	1,3
Larix laricina	Tamarack	N	G5	S5	--	--	2
Lemna minor	Duckweed	N	G5	S5	--	--	3
Lonicera tatarica	Tartarian honeysuckle	I	GNR	SNA	--	--	1
Lycopus americanus	American water-horehound	N	G5	S5	--	--	3
Lycopus uniflorus	Northern water-horehound	N	G5	S5	--	--	1,3
Lythrum salicaria	Purple loosestrife	I	G5	SNA	--	--	1,3
Maianthemum canadense	Canada mayflower	N	G5	S5	--	--	2,3
Medicago sativa	Alfalfa	I	GNR	S5	--	--	1
Oenothera biennis	Common evening-primrose	N	G5	S5	--	--	1
Onoclea sensibilis	Sensitive fern	N	G5	S5	--	--	2,3
Osmunda claytoniana	Interrupted fern	N	G5	S5	--	--	1,2,3
Osmunda regalis	Royal fern	N	G5	S5	--	--	3
Panicum capillare	Witch grass	N	G5	S5	--	--	1
Parthenocissus inserta	Virginia creeper	N	G5	S5	--	--	1,2,3
Persicaria sp.	Lady's thumb species	?	?	?	--	--	3
Phalaris arundinacea	Reed canary grass	N	G5	S5	--	--	1,3
Phleum pratense	Timothy	I	GNR	SNA	--	--	1
Picea glauca	White spruce	N	G5	S5	--	--	2
Pinus sylvestris	Scots pine	I	GNR	SNA	--	--	1
Plantago major	Common plantain	I	G5	SNA	--	--	1
Poa palustris	Fowl bluegrass	N	G5	S5	--	--	3
Poa pratensis	Kentucky bluegrass	I	G5T5?	SNA	--	--	1,2
Populus balsamifera	Balsam poplar	N	G5	S5	--	--	1,2,3

Table 2: Plant Species Observed on the Boundary Road Site and in the Site-vicinity

Scientific Name	Common Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Locations[e]
Populus deltoides	Eastern cottonwood	N	G5T5	S5	--	--	2
Populus tremuloides	Trembling aspen	N	G5	S5	--	--	1,2,3
Potomogeton sp.	Pondweed species	N	?	?	--	--	3
Lactuca serriola	Prickly lettuce	I	GNR	SNA	--	--	1
Prunus virginiana	Choke cherry	N	G5	S5	--	--	1
Rhamnus cathartica	Common buckthorn	I	GNR	SNA	--	--	1,2
Rhamnus frangula	Glossy buckthorn	I	GNR	SNA	--	--	1,2,3
Rhododendron groenlandicum	Labrador-tea	N	G5	S5	--	--	3
Rhus radicans	Poison-ivy	N	G5T5	S5	--	--	1,2,3
Ribes cynosbati	Prickly gooseberry	N	G5	S5	--	--	1,2,3
Ribes triste	Swamp red currant	N	G5	S5	--	--	3
Rubus allegheniensis	Mountain blackberry	N	G5	S5	--	--	1,2
Rubus hispidus	Swamp dewberry	N	G5	S4S5	--	--	3
Rubus idaeus	Red raspberry	N	G5T5	S5	--	--	1,2
Rubus pubescens	Dwarf raspberry	N	G5	S5	--	--	2,3
Salix amygdaloides	Peach-leaved willow	N	G5	S5	--	--	1,3
Salix discolor	Pussy willow	N	G5	S5	--	--	1,3
Salix lucida	Shining willow	N	G5	S5	--	--	3
Salix petiolaris	Slender willow	N	G5	S5	--	--	3
Salix x fragilis	Crack willow	I	GNR	SNA	--	--	1,2
Sambucus canadensis	Common elderberry	N	G5	S5	--	--	1,3
Schoenoplectus tabernaemontani	Softstem bulrush	N	G5	S5	--	--	3
Scirpus atrovirens	Black bulrush	N	G5?	S5	--	--	3
Scirpus cyperinus	Wool-grass	N	G5	S5	--	--	1,3
Scirpus hattorianus	Mosquito bulrush	N	G5	S4	--	--	1,3
Setaria pumila	Yellow foxtail	I	GNR	SNA	--	--	1
Solanum dulcamara	Climbing nightshade	I	GNR	SNA	--	--	1,2,3
Solidago canadensis	Canada goldenrod	N	G5T5	S5	--	--	1,2
Solidago rugosa	Rough goldenrod	N	G5	S5	--	--	2,3
Spiraea alba	Meadowsweet	N	G5	S5	--	--	3
Symphyotrichum lanceolatum	Panicled aster	N	G5T5	S5	--	--	1,3
Symphyotrichum lateriflorum	Calico aster	N	G5T?	S5	--	--	1,2
Symphyotrichum novae-angliae	New England aster	N	G5	S5	--	--	1
Syringa vulgaris	Lilac	I	GNR	SNA	--	--	1
Taraxacum officinale	Common dandelion	I	G5	SNA	--	--	1

Table 2: Plant Species Observed on the Boundary Road Site and in the Site-vicinity

Scientific Name	Common Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Locations[e]
Trifolium pratense	Red clover	I	GNR	SNA			
Typha latifolia	Common cattail	N	G5	S5	--	--	1,3
Ulmus americana	White elm	N	G5?	S5	--	--	1,2,3
Urtica dioica	Stinging nettle	N	G5T?	S5	--	--	3
Verbascum thapsus	Common mullein	I	GNR	SNA	--	--	1
Viburnum lentago	Nannyberry	N	G5	S5	--	--	1,3
Vicia cracca	Cow-vetch	I	GNR	SNA	--	--	1
Viola renifolia	Kidney-leaved violet	N	G5	S5	--	--	3
Vitis riparia	Riverbank grape	N	G5	S5	--	--	1,2,3

[a] Origin: N = Native; (N) = Native but not in study area region; I = Introduced.

[b] Ranks based upon determinations made by the Ontario Natural Heritage Information Centre (2012).

[c] Canada *Species at Risk Act* (Schedule 1; checked September 2012)

[d] Ontario *Endangered Species Act* (O. Reg. 4/12 amending O.Reg.230/08; checked September 2012)

[e] Locations: 1: Thickets, Agricultural Fields, Roadside, and Habitat edges; 2: Deciduous Forests, and Plantation 3: Swamps and Ditches/Water features

G = Global; S = Provincial; Ranks 1-3 are considered imperiled or rare; Ranks 4 and 5 are considered secure.

SNA = Not applicable for Ontario Ranking (e.g. Exotic species)

ATTACHMENT D-3

Wildlife Observed on the NRR and BR Sites

Table 1: Wildlife Species Observed on the North Russell Road Site and in the Site-vicinity

Common Name	Scientific Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Remarks
Butterflies and Dragonflies							
Black swallowtail	*Papilio polyxenes*	N	G5	S5	--	--	Likely Resident
Cabbage white	*Pieris rapae*	I	G5	SNA	--	--	Likely Resident
Clouded sulphur	*Colias philodice*	N	G5	S5	--	--	Likely Resident
Eastern comma	*Polygonia comma*	N	G5	S5	--	--	Likely Resident
Marsh bluet	*Enallagma ebrium*	N	G5	S5	--	--	Likely Resident
Spreadwing species	*Lestes* sp.	N	?	?	--	--	Likely Resident
White-faced meadowhawk	*Sympetrum obtrusum*	N	S5	G5	--	--	Likely Resident
Herpetiles							
Eastern garter snake	*Thamnophis sirtalis*	N	S5	G5	--	--	Likely Resident
Green frog	*Rana clamitans*	N	S5	G5	--	--	Likely Resident
Grey tree frog	*Hyla versicolor*	N	S5	G5	--	--	Likely Resident
Spring peeper	*Pseudacris crucifer*	N	S5	G5	--	--	Likely Resident
Birds							
American black duck	*Anas rubripes*	N	G5	S5	--	--	Likely Migrant
American crow	*Corvus brachyrhynchos*	N	G5	S5	--	--	Possible Breeder
American goldfinch	*Carduelis tristis*	N	G5	S5B	--	--	Possible Breeder
American robin	*Turdus migratorius*	N	G5	S5	--	--	Possible Breeder
belted kingfisher	*Ceryle alcyon*	N	G5	S5	--	--	Possible Breeder
black-capped chickadee	*Poecile atricapillus*	N	G5	S5	--	--	Possible Breeder
blue jay	*Cyanocitta cristata*	N	G5	S5	--	--	Possible Breeder
brown-headed cowbird	*Molothrus ater*	N	G5	S4B	--	--	Possible Breeder
bufflehead	*Bucephala albeola*	N	G5	S4	--	--	Likely Migrant
Canada goose	*Branta canadensis*	N	G5	S5	--	--	Likely Migrant
dark-eyed junco	*Junco hyemalis*	N	G5	S5	--	--	Likely Migrant
golden-crowned kinglet	*Regulus satrapa*	N	G5	S5B	--	--	Likely Migrant
mallard	*Anas platyrhynchos*	N	G5	S5	--	--	Possible Breeder
northern harrier	*Circus cyaneus*	N	G5	S4B	--	--	Possible Breeder
white-throated sparrow	*Zonotrichia albicollis*	N	G5	S5B	--	--	Possible Breeder
brown thrasher	*Toxostoma rufum*	N	G5	S4B	--	--	Possible Breeder
chipping sparrow	*Spizella passerine*	N	G5	S5B	--	--	Possible Breeder
common grackle	*Quiscalus quiscula*	N	G5	S5B	--	--	Possible Breeder
downy woodpecker	*Picoides pubescens*	N	G5	S5	--	--	Possible Breeder
European starling	*Sturnus vulgaris*	I	G5	SNA	--	--	Possible Breeder
greater yellowlegs	*Tringa melanoleuca*	N	G5	S4B,S4N	--	--	Likely Migrant

Table 1: Wildlife Species Observed on the North Russell Road Site and in the Site-vicinity

Common Name	Scientific Name	Origin[a]	Global Rarity Status[b]	Ontario Rarity Status[b]	SARA[c]	ESA[d]	Remarks
hooded merganser	*Lophodytes cucullatus*	N	G5	S5B.S5N	--	--	Likely Migrant
house sparrow	*Passer domesticus*	I	G5	SNA	--	--	Possible Breeder
killdeer	*Charadrius vociferus*	N	G5	S5B, S5N	--	--	Possible Breeder
least sandpiper	*Calidris minutilla*	N	G5	S4B,S5N	--	--	Likely Migrant
magnolia warbler	*Dendroica magnolia*	N	G5	S5B	--	--	Likely Migrant
palm warbler	*Setophaga palmarum*	N	G5T5	S5B	--	--	Likely Migrant
red-winged blackbird	*Agelaius phoeniceus*	N	G5	S4	--	--	Possible Breeder
rose-breasted grosbeak	*Pheucticus ludovicianus*	N	G5	S4B	--	--	Possible Breeder
ruby-crowned kinglet	*Regulus calendula*	N	G5	S4B	--	--	Likely Migrant
savannah sparrow	*Passerculus sandwichensis*	N	G5	S4B	--	--	Possible Breeder
solitary sandpiper	*Tringa solitaria*	N	G5	S4B	--	--	Likely Migrant
song sparrow	*Melospiza melodia*	N	G5	S5B	--	--	Possible Breeder
spotted sandpiper	*Actitis macularius*	N	G5	S5	--	--	Possible Breeder
Mammals							
Beaver	*Castor canadensis*	N	G5	S5	--	--	Likely Resident
Deer mouse	*Peromyscus sp.*	N	G5	S5	--	--	Likely Resident
Eastern chipmunk	*Tamias striatus*	N	G5	S5	--	--	Likely Resident
Grey squirrel	*Sciurus carolinensis*	N	G5	S5	--	--	Likely Resident
Meadow vole	*Microtus pennsylvanicus*	N	G5	S5	--	--	Likely Resident
Raccoon	*Procyon lotor*	N	G5	S5	--	--	Likely Resident
Red fox	*Vulpes vulpes*	N	G5	S5	--	--	Likely Resident
Striped skunk	*Memphitis memphitis*	N	G5	S5	--	--	Likely Resident
White-tailed deer	*Odocoileus virginianus*	N	G5	S5	--	--	Likely Resident
Woodchuck	*Marmota monax*	N	G5	S5	--	--	Likely Resident

[a] Origin: N = Native; (N) = Native but not in study area region; I = Introduced.

[b] Ranks based upon determinations made by the Ontario Natural Heritage Information Centre (2012).

[c] Canada *Species at Risk Act* (Schedule 1; checked September 2012)

[d] Ontario *Endangered Species Act* (O. Reg. 4/12 amending O.Reg.230/08; checked September 2012)

G = Global; S = Provincial; Ranks 1-3 are considered imperiled or rare; Ranks 4 and 5 are considered secure.

SNA = Not applicable for Ontario Ranking (e.g. Exotic species)

Design by: FN December2012
Checked by: HM

Table 2: Wildlife Species Observed on the Boundary Road Site and in the Site-vicinity

Common Name	Scientific Name	Origin[a]	Global (GRank)[b]	Ontario (SRank)[b]	SARA[c]	ESA[d]	Comments
Butterflies and Dragonflies							
Black swallowtail	*Papilio polyxenes*	N	G5	S5	--	--	--
Cabbage white	*Pieris rapae*	I	G5	SNA	--	--	--
Clouded sulphur	*Colias philodice*	N	G5	S5	--	--	--
Common whitetail	*Plathemis lydia*	N	G5	S5	--	--	--
Marsh bluet	*Enallagma ebrium*	N	G5	S5	--	--	--
Red admiral	*Vanessa atalanta*	N	G5	S5	--	--	--
Spreadwing species	*Lestes* sp.	N	?	?	--	--	--
Viceroy	*Limenitis archippus*	N	S5	G5	--	--	--
White-faced meadowhawk	*Sympetrum obtrusum*	N	S5	G5	--	--	--
Herpetiles							
Grey tree frog	*Hyla versicolor*	N	S5	G5	--	--	--
Spring peeper	*Pseudacris crucifer*	N	S5	G5	--	--	--
Birds							
American crow	*Corvus brachyrhynchos*	N	G5	S5	--	--	Possible Breeder
American goldfinch	*Carduelis tristis*	N	G5	S5B	--	--	Possible Breeder
American robin	*Turdus migratorius*	N	G5	S5	--	--	Possible Breeder
black-capped chickadee	*Poecile atricapillus*	N	G5	S5	--	--	Possible Breeder
blue-headed vireo	*Vireo solitarius*	N	G5	S5B	--	--	Likely Migrant
blue jay	*Cyanocitta cristata*	N	G5	S5	--	--	Possible Breeder
dark-eyed junco	*Junco hyemalis*	N	G5	S5	--	--	Possible Breeder
golden-crowned kinglet	*Regulus satrapa*	N	G5	S5B	--	--	Likely Migrant
mallard	*Anas platyrhynchos*	N	G5	S5	--	--	Possible Breeder
northern harrier	*Circus cyaneus*	N	G5	S4B	--	--	Possible Breeder
white-throated sparrow	*Zonotrichia albicollis*	N	G5	S5B	--	--	Possible Breeder
brown thrasher	*Toxostoma rufum*	N	G5	S4B	--	--	Possible Breeder
chipping sparrow	*Spizella passerine*	N	G5	S5B	--	--	Possible Breeder
common grackle	*Quiscalus quiscula*	N	G5	S5B	--	--	Possible Breeder
downy woodpecker	*Picoides pubescens*	N	G5	S5	--	--	Possible Breeder
European starling	*Sturnus vulgaris*	I	G5	SNA	--	--	Possible Breeder
house sparrow	*Passer domesticus*	I	G5	SNA	--	--	Possible Breeder
killdeer	*Charadrius vociferus*	N	G5	S5B, S5N	--	--	Possible Breeder
magnolia warbler	*Setophaga magnolia*	N	G5	S5B	--	--	Likely Migrant
red-eyed vireo	*Vireo olivaceus*	N	G5	S5B	--	--	Possible Breeder
red-winged blackbird	*Agelaius phoeniceus*	N	G5	S4	--	--	Possible Breeder

Design by: FN December2012
Checked by: HM

Table 2: Wildlife Species Observed on the Boundary Road Site and in the Site-vicinity

Common Name	Scientific Name	Origin[a]	Global (GRank)[b]	Ontario (SRank)[b]	SARA[c]	ESA[d]	Comments
rose-breasted grosbeak	*Pheucticus ludovicianus*	N	G5	S4B	--	--	Possible Breeder
ruby-crowned kinglet	*Regulus calendula*	N	G5	S4B	--	--	Likely Migrant
ruffed grouse	*Bonasa umbellus*	N	G5	S4	--	--	Possible Breeder
savannah sparrow	*Passerculus sandwichensis*	N	G5	S4B	--	--	Possible Breeder
solitary sandpiper	*Tringa solitaria*	N	G5	S4B	--	--	Likely Migrant
song sparrow	*Melospiza melodia*	N	G5	S5B	--	--	Possible Breeder
sora	*Porzana Carolina*	N	G5	S4B	--	--	Possible Breeder
spotted sandpiper	*Actitis macularius*	N	G5	S5	--	--	Possible Breeder
swamp sparrow	*Melospiza Georgiana*	N	G5	S5B	--	--	Possible Breeder
Wilson's snipe	*Gallinago delicate*	N	G5	S5	--	--	Possible Breeder
yellow-rumped warbler	*Setophaga coronata*	N	G5	S5B	--	--	Likely Migrant
Mammals							
Beaver	*Castor canadensis*	N	G5	S5	--	--	--
Coyote	*Canis latrans*	N	G5	S5	--	--	--
Deer mouse	*Peromyscus sp.*	N	G5	S5	--	--	--
Eastern cottontail	*Sylvilagus floridanus*	N	G5	S5	--	--	--
Grey squirrel	*Sciurus carolinensis*	N	G5	S5	--	--	--
Meadow vole	*Microtus pennsylvanicus*	N	G5	S5	--	--	--
Raccoon	*Procyon lotor*	N	G5	S5	--	--	--
Striped skunk	*Memphitis memphitis*	N	G5	S5	--	--	--
Snowshoe hare	*Lepus americanus*	N	G5	S5	--	--	--
White-tailed deer	*Odocoileus virginianus*	N	G5	S5	--	--	--
Fish							
Creek chub	*Semotilus atromaculatus*		G5	S5	--	--	--
Brook stickleback	*Culaea inconstans*		G5	S5	--	--	--
Central mudminnow	*Umbra limi*		G5	S5	--	--	--
Pumpkinseed	*Lepomis gibbosus*		G5	S5	--	--	--

[a] Origin: N = Native; (N) = Native but not in study area region; I = Introduced.

[b] Ranks based upon determinations made by the Ontario Natural Heritage Information Centre (2012).

[c] Canada *Species at Risk Act* (Schedule 1; checked September 2012)

[d] Ontario *Endangered Species Act* (O. Reg. 4/12 amending O.Reg.230/08; checked September 2012)

G = Global; S = Provincial; Ranks 1-3 are considered imperiled or rare; Ranks 4 and 5 are considered secure.

SNA = Not applicable for Ontario Ranking (e.g. Exotic species)

Design by: FN December2012
Checked by: HM

ATTACHMENT D-4

Species at Risk Screening for the NRR and BR Sites

Table 1: Preliminary Species at Risk Screening for the North Russell Road Site and Within the General Area of the Site

Taxon	Common Name	Scientific Name	Global (GRank)[a]	Provincial (SRank)[a]	SARA[b]	ESA[c]	Potential to Occur on, or within 120 m of the Site
Amphibian	Western chorus frog - Great Lakes St. Lawrence/Canadian Shield Pop'n	*Pseudacris triseriata*	G5TNR	S3	Threatened		**Low-Moderate** Some suitable habitat for Western chorus frog available in onsite swamps. There are records in the area for this species in the Ontario Herpetofaunal Summary Atlas for area, but no observations onsite during past Golder amphibian surveys (2008).
Arthropod	West Virginia white	*Pieris virginiensis*	G3G4	S3	Not Listed	Special Concern	**Low** No food sources for West Virginia white were identified on the site, and there is no suitable habitat onsite.
Arthropod	Monarch	*Danaus plexippus*	G5	S2N, S4B	Special Concern	Special Concern	**Moderate** The open fields on the site provide suitable habitat for monarch, and there is a food source (Asclepias spp) on the site.
Bird	Eastern Whip-poor-will	*Caprimulgus vociferus*	G5	S4B	Threatened	Threatened	**Low** No habitat
Bird	Eastern Wood-Pewee	*Contopus virens*	G5	S4B	Not Listed	To be assessed in January 2013	**High** The Semi-mature forested swamps on the site provide suitable habitat for eastern wood-pewee. There are also records in the OBBA square including the site, and the species has been identified on the site during past Golder breeding bird surveys (2008).
Bird	Bank Swallow	*Riparia riparia*	G5	S4B	Not Listed	To be assessed in January 2013	**Low** There is no nesting habitat for bank swallow on, or within 120 m of, the site.
Bird	Barn swallow	*Hirundo rustica*	G5	S4B	Not Listed	Threatened	**Low-Moderate** Suitable nesting and foraging habitat for barn swallow is available on the site. Although there are records in the OBBA square including the site, this species has not been identified on the site during past Golder breeding bird surveys (2008).

Design by: FN December2012
Checked by: HM

Table 1: Preliminary Species at Risk Screening for the North Russell Road Site and Within the General Area of the Site

Taxon	Common Name	Scientific Name	Global (GRank)[a]	Provincial (SRank)[a]	SARA[b]	ESA[c]	Potential to Occur on, or within 120 m of the Site
Bird	Wood Thrush	*Hylocichla mustelina*	G5	S4B	Not Listed	To be assessed in January 2013	**Low-Moderate** The onsite forested swamps provide suitable habitat. Although there are records in the OBBA square including the site, this species has not been identified on the site during past Golder breeding bird surveys (2008).
Bird	Bobolink	*Dolichonyx orizivorus*	G5	S4B	Not Listed	Threatened	**High** The onsite meadows and hayfields provide suitable habitat for bobolink. In addition, there are records in the OBBA square including the site, and has been identified within 120 m of the site during past Golder breeding bird surveys (2008).
Bird	Eastern meadowlark	*Sturnella magna*	G5	S4B	Not Listed	Threatened	**Low-Moderate** The onsite meadows and hayfields provide suitable habitat for eastern meadowlark. Although there are records in the OBBA square including the site, this species has not been identified on the site during past Golder breeding bird surveys (2008).
Bird	Henslow's sparrow	*Ammodramus henslowii*	G4	SHB	Endangered	Endangered	**Low** There is some suitable habitat for Henlow's sparrow available on the site, and there are some old OBBA records for this species in the area. This species is now very rare in Ontario, and there are no recent records for the region or the area of the site (OBBA).
Bird	Peregrine falcon (anatum subspecies)	*Falco peregrinus anatum*	G4	S3B	Threatened	Special Concern (status in effect Jan 24/2013)	**Low** There is no nesting habitat for peregrine on, or within 120 m of, the site.
Bird	Black tern	*Chlidonias niger*	G4	S3B	Not Listed	Special Concern	**Low** There is no nesting habitat for black tern on, or within 120 m of, the site.
Bird	Short-eared owl	*Asio flammeus*	G5	S2N,S4B	Special Concern	Special Concern	**Low-Moderate** There is some suitable habitat for short-eared owl on the site, but there are no records for this species in the area (OBBA).

Design by: FN December2012
Checked by: HM

Table 1: Preliminary Species at Risk Screening for the North Russell Road Site and Within the General Area of the Site

Taxon	Common Name	Scientific Name	Global (GRank)[a]	Provincial (SRank)[a]	SARA[b]	ESA[c]	Potential to Occur on, or within 120 m of the Site
Bird	Cerulean warbler	*Setophaga cerulea*	G4	S3B	Special Concern	Threatened	**Low** No habitat
Bird	Common nighthawk	*Chordeiles minor*	G5	S4B	Threatened	Special Concern	**Low** No habitat
Bird	Chimney swift	*Chaetura pelagica*	G5	S4B, S4N	Threatened	Threatened	Low No nesting habitat.
Bird	Least bittern	*Ixobrychus exilis*	G5	S4B	Threatened	Threatened	**Low** No habitat
Bird	Red-headed woodpecker	*Melanerpes erythrocephalus*	G5	S4B	Threatened	Special Concern	**Low** There is some suitable habitat on the site, but no records in area in the OBBA, and this species was not identified on the site during past Golder breeding bird surveys (2008)
Fish	American eel	*Anguilla rostrata*	G4	S1?	Not Listed	Endangered	**Low** No habitat
Fish	Lake sturgeon - Great Lakes / upper St. Lawrence Pop'n	*Acipenser fulvescens*	G3G4TNR	S2	Not Listed	Threatened	**Low** No habitat
Mammal	Grey fox	*Urocyon cinereoargenteus*	G5	S1	Threatened	Threatened	**Low** There is suitable habitat for grey fox on, and within 120 m of, the site, but current records in Ontario for this species are only known in extreme southwestern Ontario. The possibility for this species to be found near the site is unlikely.
Mammal	Eastern cougar	*Puma concolor couguar*	G5	SU	Not Listed	Endangered	**Low** There is suitable habitat for eastern cougar on, and within 120 m of, the site. Occurrence of this species in Ontario is unknown, but there are very few recent confirmed records, and none for the area of the site.
Mammal	Little Brown Myotis	*Myotis lucifugus*	G5	S4	Not Listed	Endangered (status in effect Jan 24/2013)	**Moderate-High** The combination of forests and swamps, farm buildings, fields, and water in the flooded quarry on the site provides suitable habitat for little brown myotis. In addition, there are records in the area in the Ontario Mammal Atlas.

Table 1: Preliminary Species at Risk Screening for the North Russell Road Site and Within the General Area of the Site

Taxon	Common Name	Scientific Name	Global (GRank)[a]	Provincial (SRank)[a]	SARA[b]	ESA[c]	Potential to Occur on, or within 120 m of the Site
Mammal	Northern Myotis	*Myotis septentrionalis*	G4	S3	Not Listed	Endangered (status in effect Jan 24/2013)	**Low** No habitat
Reptile	Blanding's turtle - Great Lakes/ St. Lawrence population	*Emydoidea blandingii*	G4	S3	Threatened	Threatened	**Low** No habitat
Reptile	Eastern ribbonsnake - Great Lakes population	*Thamnophis sauritius*	G5	S3	Special Concern	Special Concern	**Low** No habitat
Reptile	Snapping turtle	*Chelydra serpentina*	G5	S3	Special Concern	Special Concern	**Low** There is likely no habitat for snapping turtle on the site, as the number and size of fish in the flooded quarry would be limiting as a food source.
Reptile	Milksnake	*Lampropeltis triangulum*	G5	S3	Special Concern	Special Concern	**Moderate** Although there is suitable habitat for milksnake on the site, there are no records for this species in the area in the Ontario Herpetofaunal Summary Atlas.
Vascular plant	American ginseng	*Panax quinquefolius*	G3G4	S2	Endangered	Endangered	**Low**
Vascular plant	Butternut	*Juglans cinerea*	G4	S3?	Endangered	Endangered	**Moderate-High** Butternut has been identified been identified within 120 m of the site. Although it was not identified on the site in 2012, additional surveys are required to confirm presence or absence.
Vascular plant	Eastern prairie fringed-orchid	*Platanthera leucophaea*	G2G3	S2	Endangered	Endangered	**Low** No habitat

[a] Ranks based upon determinations made by the Ontario Natural Heritage Information Centre (2012)

[b] *Species at Risk Act* (Schedule 1; checked September 2012)

[c] Ontario *Endangered Species Act* (O. Reg. 4/12 amending O.Reg.230/08; checked September 2012)

S1 – Critically imperiled in Ontario
S2 – Imperiled in Ontario
S3 – Vulnerable in Ontario
S4 – Apparently secure in Ontario
S5 – Secure in Ontario
SU – Species unrankable
G = Global; S = Provincial; Ranks 1-3 are considered imperiled or rare; Ranks 4 and 5 are considered secure.
SNA = Not applicable for Ontario Ranking (e.g. Exotic species)

Design by: FN December2012
Checked by: HM

Table 2: Preliminary Species at Risk Screening for the Boundary Road Site and Within the General Area of the Site

Taxon	Common Name	Scientific Name	Global (GRank)[a]	Provincial (SRank)[a]	SARA[b]	ESA[c]	Potential to Occur on, or within 120 m of the Site
Amphibian	Western chorus frog - Great Lakes St. Lawrence/Canadian Shield Pop'n	*Pseudacris triseriata*	G5TNR	S3	Threatened	Not Listed	**Moderate** Thicket swamps on the site provide potential suitable habitat. There are records for Western chorus frog in this area in the Ontario Herpetofaunal Atlas.
Arthropod	Monarch	*Danaus plexippus*	G5	S2N, S4B	Special Concern	Special Concern	**Low-Moderate** the field edges on the site provide some suitable habitat.
Arthropod	West Virginia white	*Pieris virginiensis*	G3G4	S3	Not Listed	Special Concern	**Low** No habitat
Bird	Henslow's sparrow	*Ammodramus henslowii*	G4	SHB	Endangered	Endangered	**Low** No habitat
Bird	Chimney swift	*Chaetura pelagica*	G5	S4B, S4N	Threatened	Threatened	**Low** No habitat
Bird	Eastern Wood-Pewee	*Contopus virens*	G5	S4B	Not Listed	*To be assessed in January 2013*	**Low** No habitat
Bird	Bank Swallow	*Riparia riparia*	G5	S4B	Not Listed	*To be assessed in January 2013*	**Low** No habitat
Bird	Barn swallow	*Hirundo rustica*	G5	S4B	Not Listed	Threatened	**Moderate** Barns and buildings on the site may provide suitable nesting sites. There are records of barn swallow in the OBBA square which includes the site.
Bird	Wood Thrush	*Hylocichla mustelina*	G5	S4B	Not Listed	*To be assessed in January 2013*	**Low-Moderate** The forests and thicket swamps on the site may provide limited suitable nesting habitat. There are records of wood thrush in the OBBA square which includes the site.
Bird	Bobolink	*Dolichonyx orizivorus*	G5	S4B	Not Listed	Threatened	**Low** The hayfield on the site is likely too small and there is too much forest edge on the site to provide suitable habitat for bobolink.

Design by: FN
Checked by: HM

Table 2: Preliminary Species at Risk Screening for the Boundary Road Site and Within the General Area of the Site

Taxon	Common Name	Scientific Name	Global (GRank)[a]	Provincial (SRank)[a]	SARA[b]	ESA[c]	Potential to Occur on, or within 120 m of the Site
Bird	Eastern meadowlark	*Sturnella magna*	G5	S4B	Not Listed	Threatened	**Low-Moderate** The onsite hayfield is likely too small to provide ideal habitat for eastern meadowlark, but there is a possibility that it could provide enough suitable habitat for 1 or 2 pairs. There are also records of eastern meadowlark in the OBBA square which includes the site.
Bird	Short-eared owl	*Asio flammeus*	G5	S2N,S4B	Special concern	Special Concern	**Low** No habitat
Bird	Common nighthawk	*Chordeiles minor*	G5	S4B	Threatened	Special Concern	**Low** No habitat
Bird	Black tern	*Chlidonias niger*	G4	S3B	Not Listed	Special Concern	**Low** No habitat
Bird	Peregrine falcon (anatum subspecies)	*Falco peregrinus anatum*	G4	S3B	Threatened	*Special Concern (status in effect Jan 24/2013)*	**Low** No habitat
Bird	Cerulean warbler	*Setophaga cerulea*	G4	S3B	Special Concern	Threatened	**Low** No habitat
Bird	Red knot - rufa subspecies	*Calidris canutus rufa*	G4T2	S1N	Not Listed	Endangered	**Low** No habitat
Bird	Eastern Whip-poor-will	*Caprimulgus vociferus*	G5	S4B	Threatened	Threatened	**Low** No habitat
Bird	Least bittern	*Ixobrychus exilis*	G5	S4B	Threatened	Threatened	**Low** No habitat
Bird	Red-headed woodpecker	*Melanerpes erythrocephalus*	G5	S4B	Threatened	Special Concern	**Low** No habitat
Fish	Lake sturgeon - Great Lakes / upper St. Lawrence Pop'n	*Acipenser fulvescens*	G3G4TNR	S2	Not Listed	Threatened	**Low** No habitat
Fish	American eel	*Anguilla rostrata*	G4	S1?	Not Listed	Endangered	**Low** No habitat

Design by: FN
Checked by: HM

Table 2: Preliminary Species at Risk Screening for the Boundary Road Site and Within the General Area of the Site

Taxon	Common Name	Scientific Name	Global (GRank)[a]	Provincial (SRank)[a]	SARA[b]	ESA[c]	Potential to Occur on, or within 120 m of the Site
Mammal	Eastern cougar	*Puma concolor couguar*	G5	SU	Not Listed	Endangered	**Low** There is suitable habitat for eastern cougar on, and within 120 m of, the site. Occurrence of this species in Ontario is unknown, but there are very few recent confirmed records, and none for the area of the site.
Mammal	Grey fox	*Urocyon cinereoargenteus*	G5	S1	Threatened	Threatened	**Low** There is suitable habitat for grey fox on, and within 120 m of, the site, but current records in Ontario for this species are only known in extreme southwestern Ontario. The possibility for this species to be found near the site is unlikely.
Mammal	Little Brown Myotis	*Myotis lucifugus*	G5	S4	Not Listed	*Endangered (status in effect Jan 24/2013)*	**Moderate** The barns, and other old buildings adjacent to agricultural fields may provide suitable maternity roosting habitat for little brown myotis. There are records for this species in the area of the site in the Ontario Mammal Atlas.
Mammal	Northern Myotis	*Myotis septentrionalis*	G4	S3	Not Listed	*Endangered (status in effect Jan 24/2013)*	**Low** Habitat unlikely
Reptile	Blanding's turtle - Great Lakes/ St. Lawrence population	*Emydoidea blandingii*	G4	S3	Threatened	Threatened	**Low** No habitat
Reptile	Snapping turtle	*Chelydra serpentina*	G5	S3	Special Concern	Special Concern	**Low** No habitat
Reptile	Spotted turtle	*Clemmys guttata*	G5	S3	Endangered	Endangered	**Low** No habitat
Reptile	Eastern ribbonsnake - Great Lakes population	*Thamnophis sauritius*	G5	S3	Special Concern	Special Concern	**Low** Habitat is limited, and no occurrence records in the area.

Design by: FN
Checked by: HM

Table 2: Preliminary Species at Risk Screening for the Boundary Road Site and Within the General Area of the Site

Taxon	Common Name	Scientific Name	Global (GRank)[a]	Provincial (SRank)[a]	SARA[b]	ESA[c]	Potential to Occur on, or within 120 m of the Site
Reptile	Milksnake	*Lampropeltis triangulum*	G5	S3	Special Concern	Special Concern	**Moderate** Mosaic of farm fields, thickets, swamps and forests provides habitat for this species, and there are records in the area for the Ontario Herp Atlas.
Vascular plant	American ginseng	*Panax quinquefolius*	G3G4	S2	Endangered	Endangered	**Low** No habitat
Vascular plant	Butternut	*Juglans cinerea*	G4	S3?	Endangered	Endangered	**Low** Suitable habitat for butternut on the site is restricted to edges of farm fields. The site has been thoroughly searched for buttenut, and none were found.
Vascular plant	Eastern prairie fringed-orchid	*Platanthera leucophaea*	G2G3	S2	Endangered	Endangered	**Low** No habitat

[a] Ranks based upon determinations made by the Ontario Natural Heritage Information Centre (2012)

[b] *Species at Risk Act* (Schedule 1; checked September 2012)

[c] Ontario *Endangered Species Act* (O. Reg. 4/12 amending O.Reg.230/08; checked September 2012)

S1 – Critically imperiled in Ontario

S2 – Imperiled in Ontario

S3 – Vulnerable in Ontario

S4 – Apparently secure in Ontario

S5 – Secure in Ontario

SU – Species unrankable

G = Global; S = Provincial; Ranks 1-3 are considered imperiled or rare; Ranks 4 and 5 are considered secure.

SNA = Not applicable for Ontario Ranking (e.g. Exotic species)

APPENDIX TSD#1-E

Land Use & Socio-Economic Component

February 2013

February 2013

Land Use & Socio-Economic Component Appendix TSD#1-E

COMPARATIVE EVALUATION OF ALTERNATIVE SITES

TAGGART
GROUP OF COMPANIES

THE MILLER GROUP

Table of Contents

TABLES

FIGURES

INTRODUCTION

Two properties that are owned or have been optioned by Taggart Miller have been identified for the proposed Capital Region Resource Recovery Centre (CRRRC) (the Alternative Sites). The Alternative Sites are described below:

- **North Russell Road Site (NRR Site)** – located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell.
- **Boundary Road Site (BR Site)** – located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, Township of Cumberland.

The CRRRC is proposed to provide facilities and capacity for recovery of resources and diversion of material from disposal generated by the industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sectors primarily in Ottawa and secondarily a portion of eastern Ontario, for management and utilization of surplus and contaminated soils, as well as landfill disposal capacity for material that is not diverted.

1.0 ASSESSMENT CRITERIA, INDICATORS AND DATA SOURCES

The land use & socio-economic component compared the Alternative Sites using the following criteria:

- Which Site is more compatible with current and proposed planned future land uses in the Site-vicinity?
- Which Site is preferred for the protection of mineral aggregate resources?

The indicators for the first criterion are:

- Current land use within 1,000 metres of the Site; and
- Certain and probable planned future land use within 1,000 metres of the Site.

The indicator for the second criterion is:

- Known and probable type and quality of mineral aggregate resources on Site and within 500 metres.

The data sources used for the first criterion were aerial photographic and topographic mapping and field reconnaissance, published data on public recreational facilities/activities, Provincial Policy Statement, 2005 and ongoing review, Eastern Ontario Smart Growth Panel recommendations, discussions with municipality and institutions and Municipal Official Plans and Zoning. The data sources used for the second criterion were published reports (i.e., Ministry of Natural Resources (MNR), Ontario Geologic Survey (OGS), Ministry of Northern Development and Mines (MNDM) Aggregate Resources Inventory Papers (ARIPs)), existing quarry aggregate license, Municipal Official Plans and Zoning and findings of on-Site investigations completed for this project or otherwise available.

2.0 PRELIMINARY DESCRIPTION OF EXISTING ENVIRONMENT

The following sections describe the existing conditions for the land use & socio-economic component at each of the Alternative Sites based on the preliminary investigations and assessments.

2.1 North Russell Road Site

The NRR Site is located within the Township of Russell, which is a part of the United Counties of Prescott and Russell (UCPR). The land use planning policy is determined by the Official Plan (OP) of the United Counties. The Township has policy for only the Villages, not the rural area. The Zoning By-law for the lands is approved by the Township of Russell.

There is limited residential development in the study area and a single institutional use, being the cemetery on North Russell Road, identified within 1,000 metres of the site.

Provincial Policy Statement (PPS), 2005

The PPS provides the Provincial Objectives for land use in the province. The Province is currently undertaking a review of the PPS and released a first draft for comment in late 2012. It is unknown when this review will be complete, but if an application(s) is filed after the review is complete then the new policies would apply to the approval of the application(s).

The relevant policies that deal with Resources in the PPS include both Agricultural and Aggregates. Neither of the two is given primacy over the other, but it is the province's goal to protect both for the long term.

Planning policies for Agricultural lands are addressed in Section 2.3 of the PPS. Prime Agricultural Land is defined by the PPS as land that includes specialty crop areas and/or Canada Land Inventory Classes 1, 2 and 3 soils, in this order of priority for protection. Prime agricultural areas are areas where prime agricultural lands predominate.

The Provincial mandate for prime agricultural areas is that they shall be protected for long-term use for agriculture. Specialty crop areas shall be given the highest priority for protection, followed by Classes 1, 2 and 3 soils, in this order of priority.

Permitted Uses within prime agricultural areas are agricultural uses, secondary uses and agriculture-related uses. In prime agricultural areas, all types, sizes and intensities of agricultural uses and normal farm practices shall be promoted and protected in accordance with provincial standards.

Planning authorities may only exclude land from prime agricultural areas for expansions identified for settlement areas; extraction of minerals, petroleum resources and mineral aggregate resources; and limited non-residential uses are only allowed under strict conditions.

The PPS also states that impacts from any new or expanding non-agricultural uses on surrounding agricultural operations and lands should also be mitigated to the extent feasible.

Any proposal to amend the lands designated Agricultural under the UCPR OP to permit a use that is not considered as agricultural will have to be evaluated against the potential of the land to serve the long term needs of both the Province and the community for agricultural purposes. Any such application will have to be supported by agricultural technical studies that could include soil analysis, a review of existing uses that limit the potential for long-term use of the land for agriculture and a comprehensive planning analysis that examines the change to the new use.

Planning policies for Mineral Aggregate Resources are addressed in Section 2.5 of the PPS. Mineral Aggregate Resources are defined as gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, rock or other material prescribed under the *Aggregate Resources Act* suitable for construction, industrial, manufacturing and maintenance purposes but does not include metallic ores, asbestos, graphite, kyanite, mica, nepheline syenite, salt, talc, wollastonite, mine tailings or other material prescribed under the *Mining Act*.

The Provincial mandate for mineral aggregate resources is that they shall be protected for long-term use. Mineral aggregate operations shall be protected from development and activities that would preclude or hinder their expansion or continued use or which would be incompatible for reasons of public health, public safety or environmental impact.

In areas adjacent to or in known deposits of mineral aggregate resources, development and activities which would preclude or hinder the establishment of new operations or access to the resources shall only be permitted if:

a) Resource use would not be feasible; or

b) The proposed land use or development serves a greater long-term public interest; and

c) Issues of public health, public safety and environmental impact are addressed.

To rezone the NRR Site, there will also have to be an analysis of the potential impact upon the aggregate resource. This would include a planning rationale as to the impacts upon the uses for shale in the area, along with supporting analysis from engineering specialists about the shale and its role in the Provincial and community context.

Shape the Future: Eastern Ontario Smart Growth Panel, 2003

In 2002, the government appointed a Smart Growth Panel for eastern Ontario to develop recommendations for bringing growth and prosperity to eastern Ontario.

When the Eastern Panel was established, the Minister of Municipal Affairs and Housing challenged panel members to think creatively and to come up with a bold new strategy to guide eastern Ontario’s growth over the next 30 years.

In Section 2 of the Panel’s final report, recommendations were made for enhancing environmental stewardship. Section 2.3 dealt with waste management where they noted:

> “The panel has recognized that waste management is a significant issue now and will continue to be in the future. Disposing of waste has become a costly exercise, financially and environmentally. Co-operation among provincial and municipal governments, and stakeholders must exist in order to develop a more comprehensive, integrated waste management plan for the zone. Eastern Ontario must strive to embrace alternative technologies, and the re-use and reduction of waste when considering waste disposal.”

The proposed CRRRC would be a step in assisting eastern Ontario to deliver on the Panel’s recommendations.

United Counties of Prescott and Russell Official Plan 1999

The OP for the UCPR was adopted in 1999 and was last updated in June 2006. That update did not affect the subject lands.

The lands that are presently licensed as a quarry are designated as Aggregate Extraction, while the balance of the lands are designated as Agricultural Resource as shown in Figure 2.1-1. The general Background information used to develop the UCPR OP identifies the western portion of the site land as Class 1 for agriculture, and the eastern portion as Class 2 according to the published information from the Canada Land Inventory for Soils. A preliminary Site-specific evaluation of the soil capability on the NRR Site in Appendix TSD#1-G provides information that identifies the actual soil capability as Class 3 and 4.

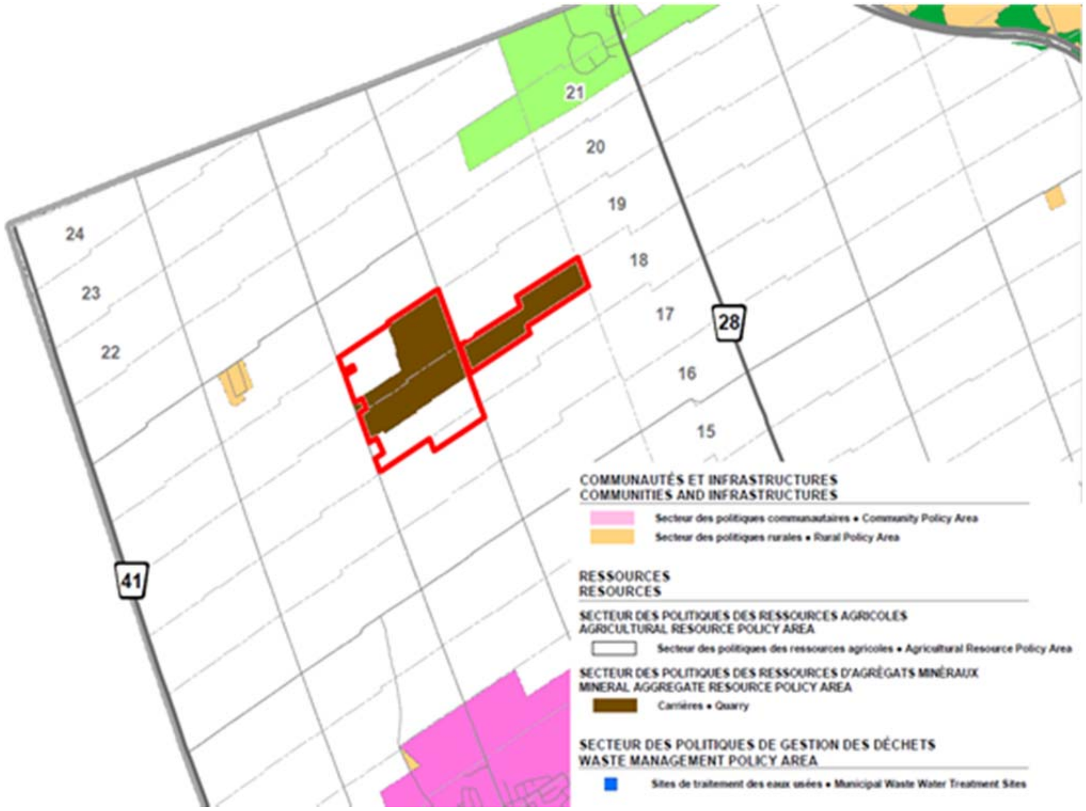


Figure 2.1-1: United Counties of Prescott and Russell Official Plan 2006-25 – Schedule A

The UCPR are presently completing a study regarding the Aggregate Resources within the Township. The draft report is expected to be released in February or March of 2013. Through discussions with Counties and Township staff, they have identified that no changes to the Mineral Aggregate Resource Policy Area are expected around the subject lands.

The Township is also presently undertaking a review of its policy for the development of the Villages. The Village of Russell is south of the NRR Site. The conclusion of the draft report on growth is that there are no needs for additional residential lands, but there are some needs to ensure the supply of recreational and employment lands. It is proposed that this be provided by expansion of the Village boundaries with the addition of Commercial lands to the east of Russell towards Embrun. These lands are currently designated as 'Rural' within the UCPR OP.

The Township has entered into an agreement with the City of Ottawa to purchase water to supply the villages of Russell, Embrun and Marionville. This water supply extends from the urban area of the City of Ottawa to the Russell Reservoir. The feeder main extends along Eadie Road, which runs between the west and east portions of the NRR Site. This water is not considered potable until it is treated at the reservoir; therefore it is not expected that this water supply would be available to the NRR Site.

Changes to the OP of the UCPR would be required to redevelop the NRR Site lands. When evaluating the opportunities and constraints associated with changes to the OP, it is necessary to examine the Provincial Policy Statement (PPS) of 2005 to ensure changes are consistent with Provincial Policy.

Agricultural Resource Policy Area

Section 4.2 of the UCPR OP outlines the development policies for lands designated Agricultural Resource Policy Area. The intent of this designation is to promote agricultural uses and to control non-agricultural uses.

The following uses are permitted in the Agricultural Resource Policy Area:

1) Agricultural uses and normal farm practices. Agricultural uses means crop cultivation, including nursery and horticultural crops; raising of livestock (including dairy or beef cattle, poultry, swine, sheep, fish and non-traditional livestock such as deer, bison, emu, pheasant etc.); raising of other animals for food, fur or fibre, including poultry and fish; aquaculture, apiaries, agroforestry, orchards, maple syrup production, and associated on-farm buildings and structures;

2) Uses which are secondary to a principal agricultural use and which add value to agricultural products or support the agricultural resource use;

3) Uses secondary to the principal use of the property such as home-based work, bed and breakfast establishments, domestic industries and uses that produce agricultural products;

4) Forestry;

5) Uses related to the conservation or management of the natural environment;

6) Small scale industrial and commercial uses that are directly related to agriculture which of necessity must locate close to farm operations, including such uses as livestock assembly points, grain drying, storage for farm produce, and custom machinery operators. Wherever possible, these uses shall be located on land that is of low capability for agriculture. Furthermore they shall not adversely affect agricultural operations in the general vicinity;

7) Wayside pits and quarries which, if established on land that is of high capability for agriculture, shall be subject to a rehabilitation plan showing how the site will be rehabilitated for productive agricultural use;

8) Public utility corridors and communications facilities;

9) Private communications facilities subject to local zoning and development controls;

10) Wind and or solar energy facilities; and

11) Limited Residential development.

Mineral Aggregate Resource Policy Area

Section 4.3 of the UCPR OP outlines the development policies for lands designated Mineral Aggregate Resource Policy Area. The intent of this designation is to protect existing extraction operations as the primary source of future supplies.

The following uses are permitted in the Mineral Aggregate Resource Policy Area:

1) Pits and quarries;

2) Wayside pits and quarries;

3) Portable asphalt plants and concrete plants;

4) Agricultural uses excluding any accessory building or structure;

5) Forestry uses excluding any accessory building or structure;

6) Conservation and natural resource management uses excluding any accessory building or structure; and

7) Uses accessory to an aggregate extraction operation such as crushing and screening operations, machinery storage facilities and office space.

Development, including changes in land use and the creation of new lots for residential, commercial, institutional, recreational or industrial development that has the potential to preclude or hinder future aggregate extraction or the expansion of existing extraction operations or resource use shall be prohibited within the Mineral Aggregate Resource Policy Area.

Waste Management Policy Area

The UCPR OP also has specific policies in Section 3.5 which deal with Waste Management Policy Areas. The UCPR will require an Official Plan Amendment (OPA) for the establishment of any new Solid Waste Disposal Site. Policies for the development of a Waste Management Site include:

1) Development shall be reviewed to ensure that appropriate solid waste disposal services can be provided in a manner which is consistent with environmental considerations;

2) Waste water and solid waste disposal sites are identified as Waste Management Policy Area on Schedule A. The establishment of new sites or the enlargement of existing sites shall be in accordance with Ministry of the Environment guidelines and regulations and shall require an amendment to the OP;

3) Waste water and solid waste disposal sites shall be appropriately zoned in local zoning by-laws;

4) Uses permitted in individual Waste Management Policy Area designations shall be in accordance with the individual Certificate of Approval issued by the Ministry of the Environment and the local municipal Zoning By-law;

5) Waste water and solid waste disposal sites may be managed by the local municipality or may be transferred to the upper tier without amendment to this Plan; and

6) Septage disposal sites (i.e., sites required for the disposal of waste removed from private septic systems, holding tanks and similar facilities) shall require an amendment to this OP. The amendment shall be justified and supported by appropriate environmental studies in accordance with the guidelines of the Ministry of the Environment's (MOE) permit process. Where OPAs are granted, such sites shall be appropriately zoned and must operate in accordance with a MOE license. The location of septage disposal sites shall generally be a minimum of 500 metres from any adjacent residential, institutional or commercial use and development of the site shall be subject to site plan control. There is one septage disposal site in the United Counties. It is located in part of Lot 18, Concession XIV in the former Township of South Plantagenet, now part of Nation Municipality. It is identified on Schedule A as a Waste Disposal Site and the use is permitted in accordance with MOE Certificate of Authorization No. KG-97-008.

Development within 500 metres (or less where approved in a secondary plan or local OP) of existing waste water or solid waste management sites shall generally be discouraged unless supported by an appropriate study or studies which confirm that there will be no negative impacts on the proposed development related to the adjacent waste water or waste disposal site.

Local zoning by-laws shall zone adjacent lands appropriately, prohibiting new incompatible uses which cannot be reasonably mitigated.

It is clear that the UCPR has strong policies related to the preservation of Agricultural lands. The NRR Site itself is a large area, and it is within an even larger area of agriculturally designated lands. The aggregate is also identified and the UCPR does recognize that there is an opportunity to amend the OP when a licence is surrendered. This does provide for an opportunity to examine the appropriate land use for the future, in a localized context.

A change in Official Plan Designation would be required for the redevelopment of these lands. The context of this change would be evaluated against the:

- Resources;
- Appropriateness of the new use against the agricultural land base;
- Remaining aggregate; and
- With respect to community impact.

Transportation

The NRR Site is located along both a local road and a local collector as shown in Figure 2.1-2. Section 3.3.6 of the UCPR OP outlines that access to local collectors shall generally be minimized in order to ensure that the main function of the roadway as an efficient transportation artery is maintained.

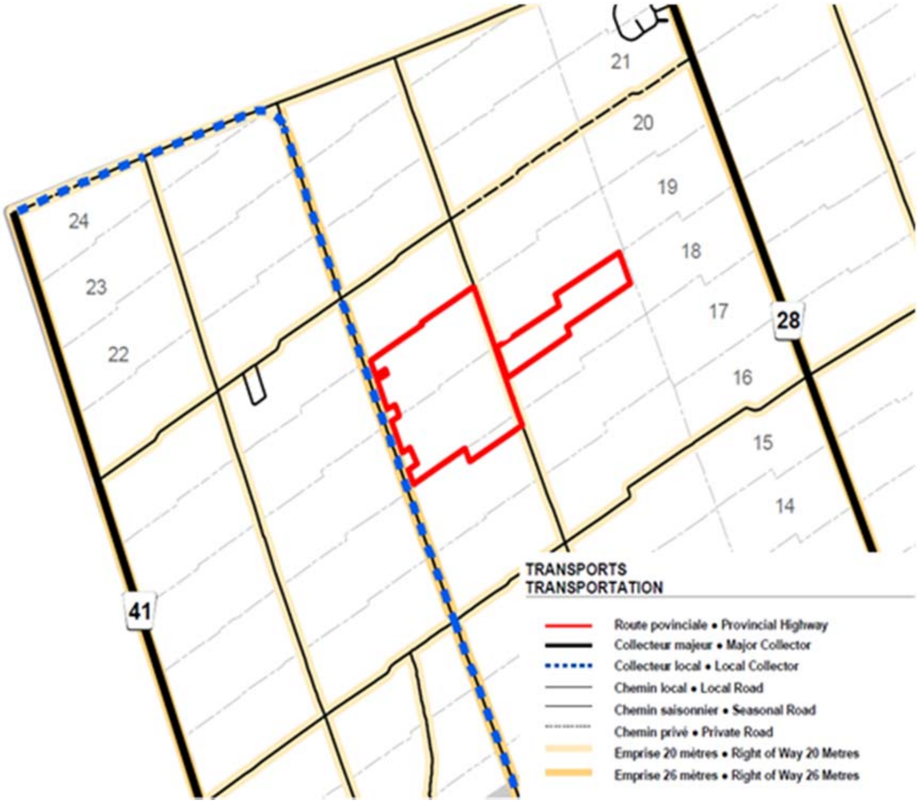


Figure 2.1-2 United Counties of Prescott and Russell Official Plan 2006-25 - Schedule D

Any use changes will have to be evaluated against these issues in order to substantiate a change to the policies. In addition, noise, traffic and similar topics with potential for impact will also have to be evaluated.

Groundwater

Section 5.5.8 of the UCPR OP outlines policy for groundwater protection and enhancement. It is the intent of the UCPR OP policies rebated to groundwater to consider the impact of development and land use on groundwater in order to ensure the long term viability of this resource.

The following policies shall apply:

1) The United Counties of Prescott and Russell will work in partnership with senior and local levels of government, environmental agencies and the private sector to develop a water resources data base which identifies sensitive groundwater recharge areas, sensitive hydro-geological areas and areas with known groundwater quality and quantity constraints.

2) Council will proceed with an amendment to this OP in order to implement site specific groundwater protection or improvement land use policies based on the detailed data base developed through the implementation of policy 3.3.8.2 (1)1 above and will identify these areas as Natural Heritage Policy Area on Schedule B.

3) The United Counties of Prescott and Russell will work in partnership with senior and local levels of government, environmental agencies and the private sector to enforce provincial regulations on private septic field and water well construction.

4) Industrial or commercial developments which require large amounts of groundwater will be required to undertake a hydrogeology study conducted by qualified hydrogeology engineers which addresses the impact of the proposed development on the quantity and quality of the water supply for existing development in the general area of the development site.

5) New commercial and/or industrial operations which take and bottle water for commercial purposes are prohibited. Existing operations are recognized as legal non-conforming uses. Any expansion of such operations will require an amendment to this Plan.

6) The United Counties of Prescott and Russell will work in partnership with senior and local levels of government and environmental agencies to develop an education program aimed at reducing groundwater consumption and pollution.

Discussions with UCPR

Through discussion with Mr. Louis Prévost, the Director of Planning with the UCPR, it was determined that UCPR are scheduled to release in February – March 2013 an Aggregate Resources Review that has been underway for the past few years. He stated that no changes to the aggregate boundary are expected to be modified on the NRR Site or surrounding area. The recommendations of this report will be incorporated into the UCPR OP five-year review which is expected to start public meetings in late spring or early summer 2013.

The UCPR is not currently planning any review of their agricultural lands or policies.

Mr. Prévost also stated the Counties' intention to add additional Commercial lands to the east of Russell towards Embrun. These lands are currently designated as 'Rural' within the UCPR.

The UCPR has no intention to designate additional Trade and Industry Lands through its review.

There are no significant designation changes expected surrounding the NRR Site during the five-year review. A few individual land owners on currently designated agricultural lands have requested their property be changed to rural.

Russell Township Zoning By-law, 46-2011

The subject lands are currently zoned Mineral Aggregate-Quarry (MAQ), General Agricultural (A2), General Agricultural Special Exception 52 (A2-52) and General Agricultural Special Exception 63 (A2-63) in the Russell Township Zoning By-law 2011, as shown in Figure 2.1-3. Development of the NRR Site lands will require amendments to this By-law.

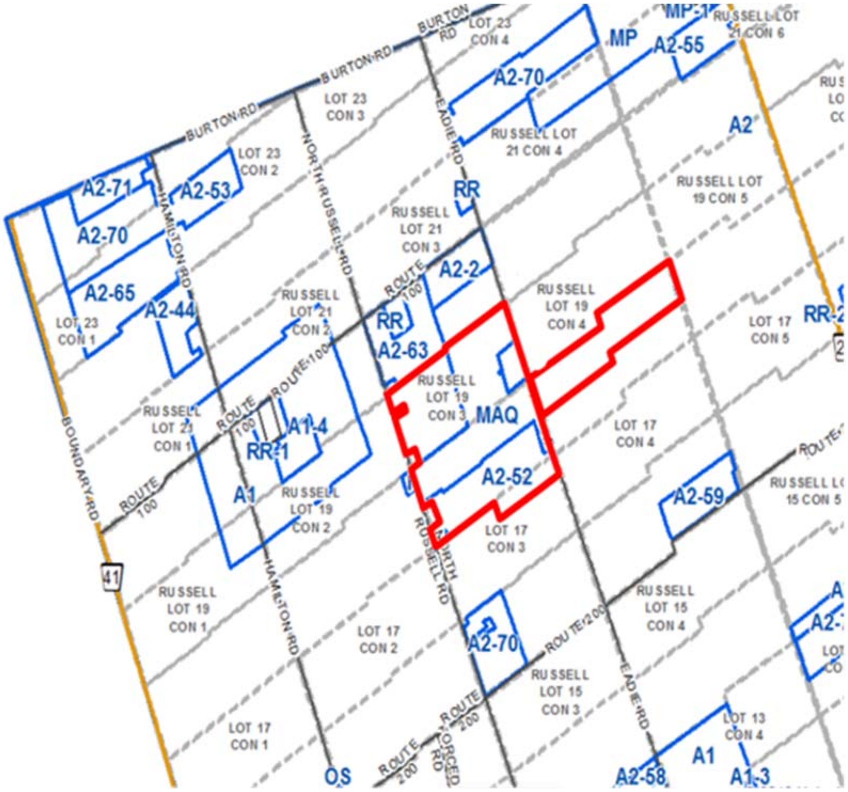


Figure 2.1-3: Russell Township Zoning By-law, 2011

Discussions with Township Staff

Through discussion with Ms. Dominique Tremblay, Planning Director with Russell Township, it was determined that no zoning or site plan applications have been applied for, or are active in January of 2013, with the Township in the Site-vicinity of the NRR Site.

Four building permits have been issued in the area surrounding the NRR Site, three south of the Site and one to the north. Two of the permits are for new residential dwellings: one is to replace a dwelling and garage destroyed by fire and one is to build a farm structure.

Aggregate Resources

The central and eastern portions of the NRR Site consist of a quarry with a Class A license #5881 (quarry below the water table) licensed under the Aggregate Resources Act (ARA) for the extraction of Queenston Formation shale. The extracted shale has been used in the manufacture of brick. The Official Plan of the UCPR designates this licensed quarry as Aggregate Extraction. The 110 ha licensed quarry has been operated since around the turn of the 19th century until 2006 when Hanson Brick, the owner of the quarry and an off-site brick manufacturing plant in Ottawa, closed up their Ottawa area operations and consolidated their operations at their southern Ontario facility. The existing quarry occupies a footprint of about 15 ha; it is estimated that about 1 million cubic metres of shale has been extracted.

In Ontario, brick manufacturing is predominantly carried out at two major facilities in southern Ontario by Hanson Canada Brick and Brampton Brick. These are located closer to the much larger deposits of Queenston shale in the province, and close to the major markets for manufactured brick, the two key economic factors in this business. It is understood (personal communication) that Hanson Brick decided to close their business in eastern Ontario because it was no longer economically viable. In addition to being farther from major markets, it is further understood (personal communication) that the chemical-physical properties of the Queenston Shale in Russell Township are less favourable than those of the Queenston Formation in southern Ontario, making the manufacture of brick comparatively more expensive.

The Clay and Shale Industry of Ontario (Guillet and Joyce, 1987) provides an overview of Queenston Shale deposits in Ontario, as well as their general uses. The report shows that the majority of the Queenston shale deposits are present in the Toronto-Hamilton area. Assuming a shale thickness of 7.6 metres, the report estimates that the Queenston shale deposit in the Russell Township area is about 7 % of the total resources in Ontario (by land area or tonnage). Using these estimates, the 110 ha licenced area on the North Russell Road Site represents less than 1 % of the provincial shale reserve and about 10 % of the reserves in Russell Township.

The Aggregate Resources Inventory of the United Counties of Prescott and Russell (Rowell, 1997) provides estimated quantities of aggregate reserves, based on interpretation of published geological data and a number of assumptions. The report states that the total land area with less than 8 metres of soil cover where Queenston shale is mapped as being the uppermost bedrock formation, excluding licensed sites under the ARA, i.e., excluding the licensed area on the North Russell Road Site, is estimated to be 1259.2 ha, with an estimated possible resource area of 1014.4 ha. Assuming a workable thickness of 18 metres, this corresponds to a possible bedrock resource of 483.7 million tonnes. The ARA licensed area of 110 ha would correspond to about 10% of the possible resource area in Russell Township.

The publication Shale Resources of Southern Ontario: An Update [Rowell, 2012] confirms that the Queenston shale is the main raw material used in brick manufacturing, and that shale extraction in Ontario has been fairly consistent at about 2 million tonnes per year. Updated estimates of shale reserves in Ontario are not provided.

The estimates of shale reserves in the province, and in Russell Township, provided in the above documents are based on broad assumptions and limited site-specific information. The preliminary drilling program carried out on the North Russell Road Site for the proposed CRRRC project provides a greater amount of site-specific factual information on the occurrence and distribution of shale thickness that underlies both the licensed area and the overall Site. The drilling indicates that beneath the portion of the licensed area between North Russell and Eadie Roads, the thickness of the shale increases from south to north. Beneath the portion of the licensed area east of Eadie Road, the base of the shale rises towards the east and is not indicated to be present about halfway across this part of the property. Using the elevation and horizontal extent to which quarrying has been completed to date, the licensed quarry base elevations and interpretation of the on-Site borehole and test pit information, it is estimated that there is about 3 to 3.2 million cubic metres of shale that remains for possible extraction under the existing ARA licence.

The published geological mapping shows the areal extent of the north-south till ridge, which represents an area of relatively shallow soil cover over the bedrock. Based on the above assumption that 8 metres of soil cover is acceptable for establishing a quarry operation, the interpreted extent of the east-west band of Queenston shale that overlies the till ridge is considered to represent an area that could be considered in future as possible shale reserve beyond the limits of the currently licensed site. Based on the findings of the preliminary on-Site drilling, the Queenston shale is indicated to not extend as far east as shown on the published bedrock mapping; as such, it is interpreted that the possible shale reserve is present mostly to the north, south and west beyond the existing licensed quarry, extending a distance of perhaps 1 to 1.5 km.

In 2009/2010 the United Counties of Prescott and Russell undertook a survey and review of aggregate resources in the County, for the purpose of updating the aggregate section of their Official Plan. As described previously, although this review is still in progress, from discussion with the County Planner in early 2013, it is understood that there are should be no changes in terms of designation of aggregate resources around the existing quarry site because of the large area of shale within which the quarry is located and because a large area is already licenced.

Table 2.1-1: Summary of NRR Site Considerations

Component	Summary of Site Considerations
Land Use & Socio-economic	■ Use does not conform to the intent of the OP; ■ Official Plan Amendment required; ■ OPA would need to review consistency with PPS; ■ Limited incompatible land uses and a single institutional use, being a cemetery; and ■ North Russell Road is a Collector Road.
	■ It is known that a portion of the NRR Site is underlain by a licensed quarry. The quarried material is Queenston shale that is a mineral aggregate resource used in the manufacture of brick in Ontario. It is understood that the quality of the shale at this location is not as economically favourable for brick manufacturing as the much larger Queenston shale deposits in southern Ontario; ■ It is likely that this shale deposit extends beyond the licensed quarry and the NRR Site limits, mainly to the north, south and west; and ■ There are no other known or probable aggregate resources on the Site or within 500 metres.

2.2 Boundary Road Site

The BR Site is located within the Rural Area of the City of Ottawa. The land use planning policy for this area is determined by the City of Ottawa's OP and Zoning By-law.

There is limited residential development in the study area and no institutional uses were identified.

Provincial Policy Statement (PPS), 2005

Planning policies for Rural Areas within Municipalities are addressed in Section 1.1.4 of the PPS. In rural areas located in municipalities permitted uses and activities shall relate to the management or use of resources, resource-based recreational activities, limited residential development and other rural land uses.

Development of these lands shall be appropriate to the infrastructure which is planned or available, and avoid the need for the unjustified and/or uneconomical expansion of this infrastructure. Development that is compatible with the rural landscape and can be sustained by rural service levels should also be promoted.

Locally-important agricultural and resource areas should be designated and protected by directing non-related development to areas where it will not constrain these uses.

Opportunities should be retained to locate new or expanding land uses that require separation from other uses; and recreational, tourism and other economic opportunities should be promoted.

Waste Management Systems are defined by the PPS as sites and facilities to accommodate solid waste from one or more municipalities and includes landfill sites, recycling facilities, transfer stations, processing sites and hazardous waste depots. Section 1.6.8 of the PPS lays out policies for Waste Management Systems. It states that "Waste management systems need to be provided that are of an appropriate size and type to accommodate present and future requirements, and facilitate, encourage and promote reduction, reuse and recycling objectives."

Shape the Future: Eastern Ontario Smart Growth Panel, 2003

As noted previously, in 2002 the government appointed a Smart Growth panel for eastern Ontario to develop recommendations for bringing growth and prosperity to eastern Ontario.

When the eastern panel was established, the Minister of Municipal Affairs and Housing challenged panel members to think creatively and to come up with a bold new strategy to guide eastern Ontario's growth over the next 30 years.

In Section 2 of the Panel's final report, recommendations were made for enhancing environmental stewardship. Section 2.3 dealt with waste management.

"The panel has recognized that waste management is a significant issue now and will continue to be in the future. Disposing of waste has become a costly exercise, financially and environmentally. Co-operation among provincial and municipal governments and stakeholders must exist in order to develop a more comprehensive, integrated waste management plan for the zone. Eastern Ontario must strive to embrace alternative technologies, and the re-use and reduction of waste when considering waste disposal."

The proposed CRRRC would be a step in assisting eastern Ontario to deliver on the Panel's recommendations.

City of Ottawa Official Plan, 2003-203

The City completed a five-year review in 2008 of its OP. The subject lands are designated as General Rural Area on Schedule A of the City of Ottawa's OP. As shown in Figure 2.2-1, the lands immediately to the west and south of the Site are also designated General Rural Area, while the lands to the north, separated from the site by Highway 417, are designated Natural Features Area. The lands to the south east of the site are designated Agricultural Resource Area.

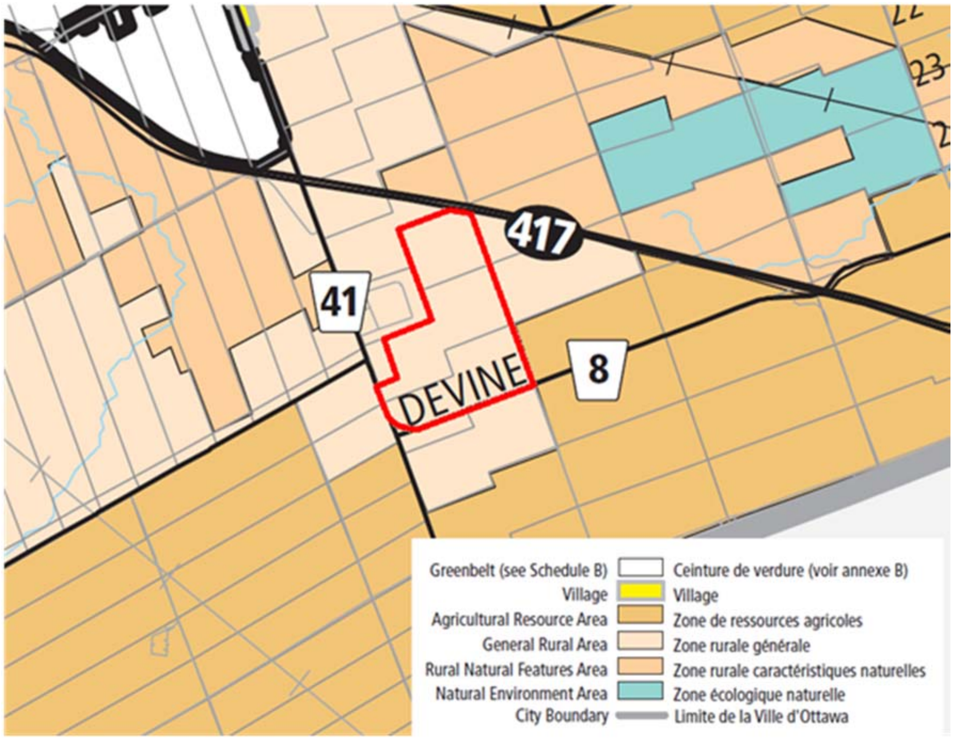


Figure 2.2-1: City of Ottawa Official Plan 2003-203 Schedule A

The City is currently undertaking the next five-year review of their OP which includes a Land Evaluation and Area Review for Agriculture areas. A draft report was issued in 2012, which identified various calculation options for mapping agriculture parcels and areas throughout rural Ottawa. The subject Site was not included in those lands that were being recommended to be added to the City`s Agricultural lands as part of the background report.

Section 3.7.2 of the City's OP outlines the development policies for lands designated General Rural Area. The intent of this designation is to accommodate a variety of land uses that are appropriate for a rural location and a limited amount of residential development where such development will not preclude continued agricultural and non-residential uses.

General Rural Area

General Rural Areas are designated on Schedule A with the intent to provide a location for agriculture uses and for those non-agricultural uses that, due to their land requirements or the nature of their operation would not be more appropriately located within urban or Village location.

Policy 4 of section 3.7.2 states that: A zoning by-law amendment will be required where any of the following uses are proposed in General Rural Areas:

a) New industrial and commercial uses, such as farm equipment and supply centers, machine and truck repair shops, building products yards, landscape contractors, and nurseries; and

b) Uses that are noxious by virtue of their noise, odour, dust or other emissions or that have potential for impact on air quality or surface water or groundwater, such as salvage or recycling yards, composting or transfer facilities; concrete plants; the treatment of aggregate products; and abattoirs.

The evaluation criteria for rezoning identified in Policy 4 are as follows:

a) The use would not be better located in a Village or the urban area;

b) If the use is to be located on a local road, it must be demonstrated that the volume and pattern of traffic flow anticipated from the development will not interfere with the proper functioning of the local road network;

c) The privacy of adjacent landowners or the amelioration of potential adverse impacts from lighting, noise, odour, dust or traffic can be achieved by separating the land uses, buffering or other measures as part of the development;

d) The potential for reducing possible impacts on neighboring agricultural uses or nearby rural residential or Village communities, where relevant;

e) The development is in keeping with the surrounding rural character and landscape;

f) All those requirements of Sections 2 and 4 related to transportation, servicing, design and compatibility and environmental protection;

g) Noxious uses will only be considered where suitable screening and buffering can be provided and generally these uses will not be considered in locations within groundwater recharge areas or immediately adjacent to residential areas, Scenic-Entry Routes, or waterfront areas; and

h) The impact that the development will have on the protection of tree cover and local wildlife movement, as result of proposed site clearing and grading, fencing, security lighting, and other similar site plan matters.

Solid Waste Disposal

The City's OP also has specific policies in Section 3.8 which deal with Solid Waste Disposal. Solid Waste Disposal sites are identified on Schedule A with a solid dot: "●"

Operating and non-operating Solid Waste Disposal Sites are landfills, dumps, incinerators and any other facilities providing for the long-term storage or destruction of municipal solid waste. Composting, recycling and transfer facilities are considered processing operations.

The City will require an OP amendment for the establishment of any new Solid Waste Disposal Site. The City will evaluate applications based on the following:

a) The proponent has completed an Environmental Assessment or an Environmental screening Report under the *Environmental Assessment Act*;

b) Compliance with a Terms of Reference for the Environmental Assessment, as approved by the Minister of the Environment under the *Environment Assessment Act;* or in the case of a project using the Environmental Screening Process, the submission of a Notice of Completion to the Ministry of the Environment; and

c) Does not duplicate the requirements of the *Environmental Assessment Act.*

Human health and safety may be affected within the area of influence of an operating or non-operating solid waste disposal site. The most significant contaminant discharges and visual problems normally occur within 500 metres of the perimeter of the fill area.

Land within 500 metres of an operating or non-operating solid waste disposal site boundary is considered to be the influence area of the site. However, where the City or the owner of the site, has determined through an Environmental Assessment, Hydrogeological analysis or similar study that significant ground, surface or air-borne impacts occur at a distance greater than 500 metres, the greater distance will establish the influence area.

Transportation

Schedule G of the OP as shown in Figure 2.2-2 identifies Boundary Road, Devine Road and Regional Road 8 as Arterial Roads. Section 2.3.1 (48) outlines policy related to the movement of goods throughout the City. It notes that “The City will minimize the impact of truck traffic on residential neighborhoods caused by the presence of these vehicles and their noise, vibration and emissions by ensuring the availability of a comprehensive truck route network based on the arterial road system”.

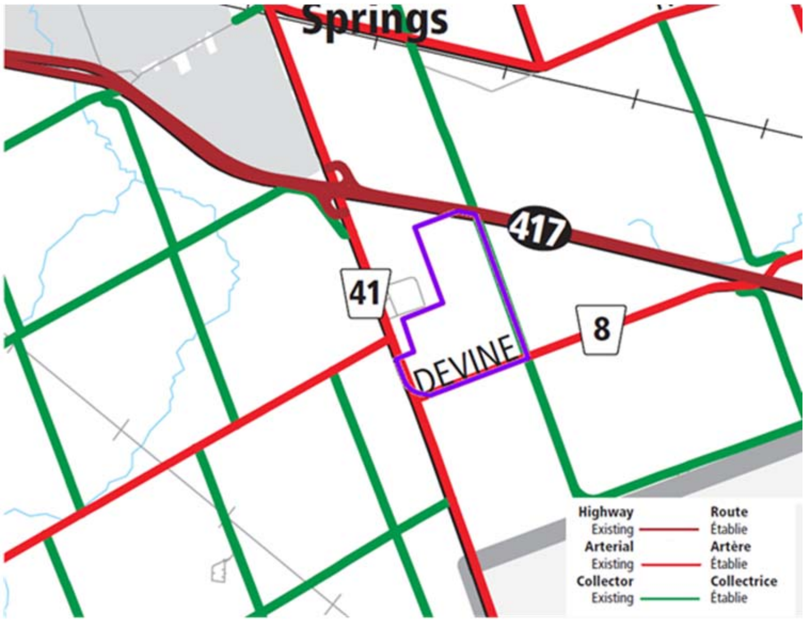


Figure 2.2-2: City of Ottawa Official Plan 2003-203 Schedule G

The City's Transportation Master Plan further details the City's objectives for Transportation. Section 6.10 Goods Movements notes that:

"While efficient goods movement by truck, rail and air supports Ottawa's economic livelihood and competitiveness, trucks remain the primary mode of local freight transportation. Ottawa's truck route system is generally represented by arterial roads that can withstand use by heavy trucks, the sizes of which are legislated by the Province of Ontario."

Groundwater

Section 2.4.4 of the City`s OP outlines policy for groundwater management. It is the responsibility of the City for the regulation of land use and development that impacts groundwater resources; the operation of public drinking water systems including public communal wells and the delivery of public health programs and educational materials.

The following policies shall apply:

1) Where monitoring and characterization of the groundwater resource has indicated degradation of the resource function, the zoning by-law will restrict uses to prevent further impacts on that function; and

2) Where monitoring and characterization of the groundwater resource has indicated that a significant resource function exists, the zoning by-law will restrict uses to protect that function.

The City will:

1) Investigate, identify, record and analyze the extent and characteristics of the groundwater resources;

2) Identify and evaluate potential sources of groundwater contamination which arise from a variety of land-use practices and industrial activities;

3) Develop and maintain a database, which will provide ready access to, and manipulation of, groundwater data, including geological, hydrogeological and water quality information and make database information available to the public;

4) Ensure that there are current best management practices, protection policies and regulations to guide development so that reliable use and functions of groundwater resources can be maintained;

5) Use the information gained through investigation and analysis when reviewing development and building applications under the *Planning Act*; and

6) Ensure that programs to inform the community about best practices related to groundwater resource issues are developed and that the community is involved in collective decision-making regarding the protection, preservation and stewardship of groundwater resources and in making wise individual decisions regarding private well and septic matters.

Additional Official Plan Policy

The site is located more than one kilometre from the Village Boundary of Carlsbad Springs and from the City's Boundary. Edwards is no longer identified as a Village in the OP.

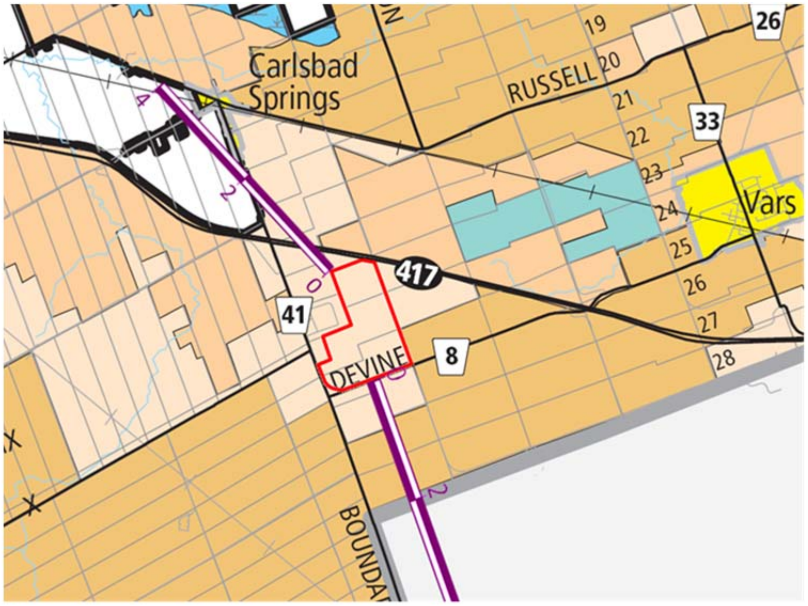


Figure 2.2-3: City of Ottawa 2003-203 - Distance from Subject Site to Village and City Boundary (kilometres)

The City does not identify any Environmental Constraints or Natural Features on the BR Site lands as shown on Schedule K (Figure 2.2-4) and Schedule L1 (Figure 2.2-5) of the OP.

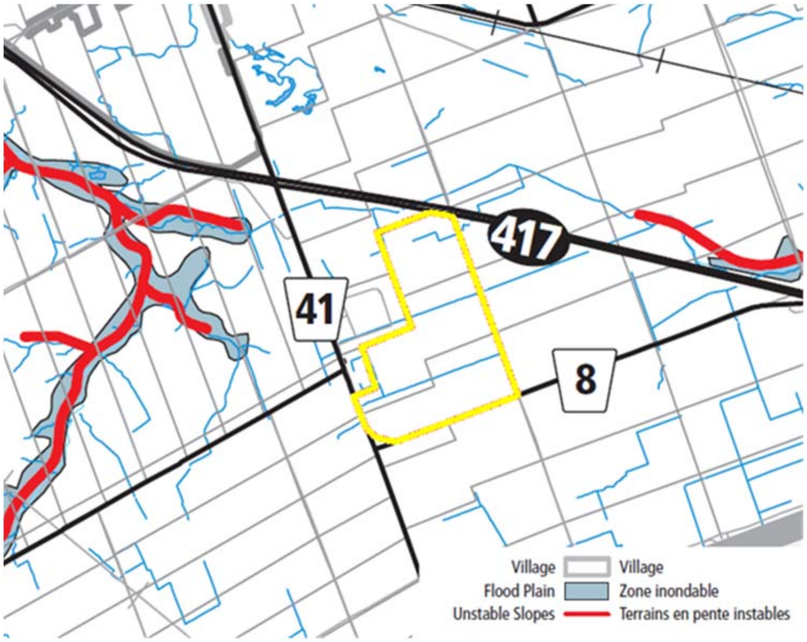


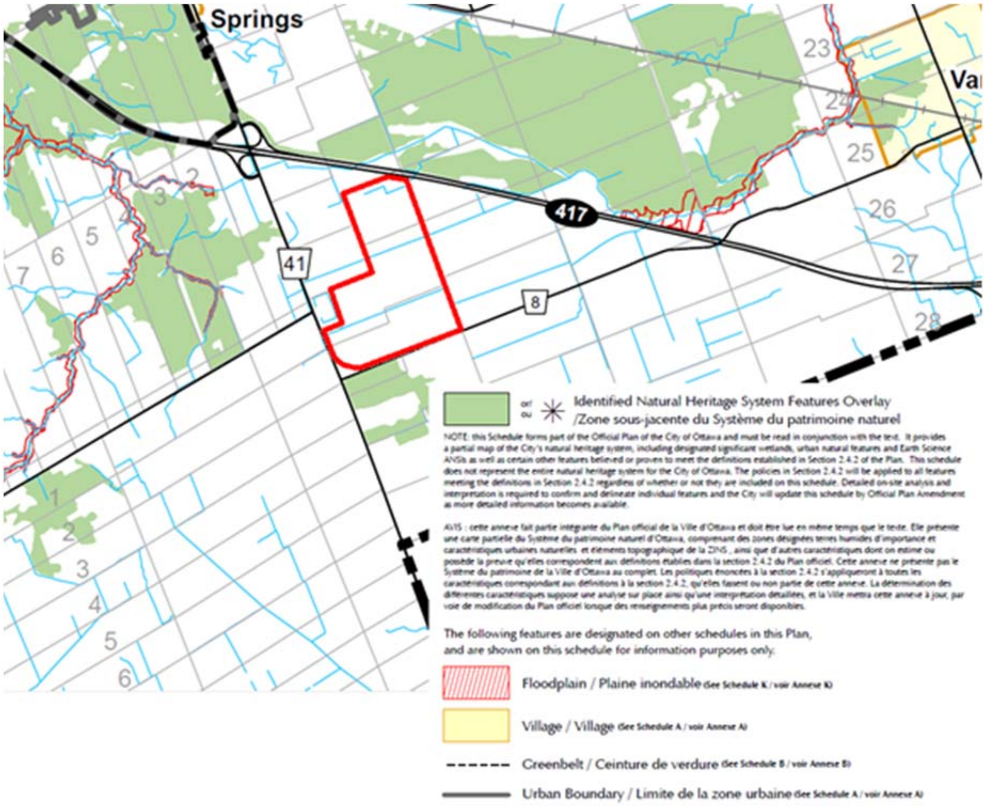
Figure 2.2-4: City of Ottawa Official Plan 2003-203 - Schedule K

As part of OPA 76 (five year review of the OP) the City approved Annex 14 which identified Natural Heritage System Features. As the result of an appeal, Annex 14 was not accepted by the Ontario Municipal Board (OMB) for inclusion in the OP.

On October 24th of 2012, Ottawa City Council approved and adopted an amendment to the Official Plan which amended policy and mapping changes to the Official Plan in order to update the Natural Heritage System.

This amendment included changes to policies related to the Natural Features and Functions, Environmental Impact Statement and Implementation as well as including new Natural Heritage System Overlay maps, labelled as Schedules L1, L2 and L3.

As a result of this amendment, the area on BR Site that were previously identified as significant woodlands in Annex 14 of the Official Plan were removed as being identified as a natural heritage feature overlay. These changes were the result of the City's re-evaluation of documentation.



NOTE: this Schedule forms part of the Official Plan of the City of Ottawa and must be read in conjunction with the text. It provides a partial map of the City's natural heritage system, including designated significant wetlands, urban natural features and Earth Science ANSIs as well as certain other features believed or proven to meet the definitions established in Section 2.4.2 of the Plan. This schedule does not represent the entire natural heritage system for the City of Ottawa. The policies in Section 2.4.2 will be applied to all features meeting the definitions in Section 2.4.2 regardless of whether or not they are included on this schedule. Detailed on-site analysis and interpretation is required to confirm and delineate individual features and the City will update this schedule by Official Plan Amendment as more detailed information becomes available.

AVIS : cette annexe fait partie intégrante du Plan officiel de la Ville d'Ottawa et doit être lue en même temps que le texte. Elle présente une carte partielle du Système du patrimoine naturel d'Ottawa, comprenant des zones désignées terres humides d'importance et caractéristiques urbaines naturelles et éléments topographique de la ZINS , ainsi que d'autres caractéristiques dont on estime ou possède la preuve qu'elles correspondent aux définitions établies dans la section 2.4.2 du Plan officiel. Cette annexe ne présente pas le Système du patrimoine de la Ville d'Ottawa au complet. Les politiques énoncées à la section 2.4.2 s'appliqueront à toutes les caractéristiques correspondant aux définitions à la section 2.4.2, qu'elles fassent ou non partie de cette annexe. La détermination des différentes caractéristiques suppose une analyse sur place ainsi qu'une interprétation détaillées, et la Ville mettra cette annexe à jour, par voie de modification du Plan officiel lorsque des renseignements plus précis seront disponibles.

The following features are designated on other schedules in this Plan, and are shown on this schedule for information purposes only.

Figure 2.2-5: City of Ottawa Official Plan 2003-203 - Schedule L1

Discussions with City of Ottawa Staff

Through discussion with Mr. Jeff McEwen, Rural Services (Wards 5, portion of Ward 19 within Rural Area 20, 21) Acting Program Manager it was determined that the City is currently undertaking a review of Agricultural lands as well as Mineral-Aggregate Resources throughout the City. The draft released for the review of Agricultural lands has not identified the BR Site as being included within additional lands to designate agricultural. The Mineral Aggregate study is still under review and is not yet available to the public.

The City is also currently undertaking an Infrastructure Master Plan Review for the Rural Area.

City staff is currently unaware of when these reviews will be finalized, but once they are completed their recommendations will be incorporated into the City's Official Plan Update. The City is expected to begin its review of the Official Plan in 2013.

There are currently no OPAs applied for with the City of Ottawa in the Site-vicinity of the BR Site.

City of Ottawa Zoning By-law (2008-250)

The majority of the subject lands are currently zoned Rural (RU) in the City of Ottawa's Zoning By-law, with the balance zoned Rural Heavy Industrial (RH) as shown in Figure 2.2-6. The development of these lands will require an amendment to this By-law.

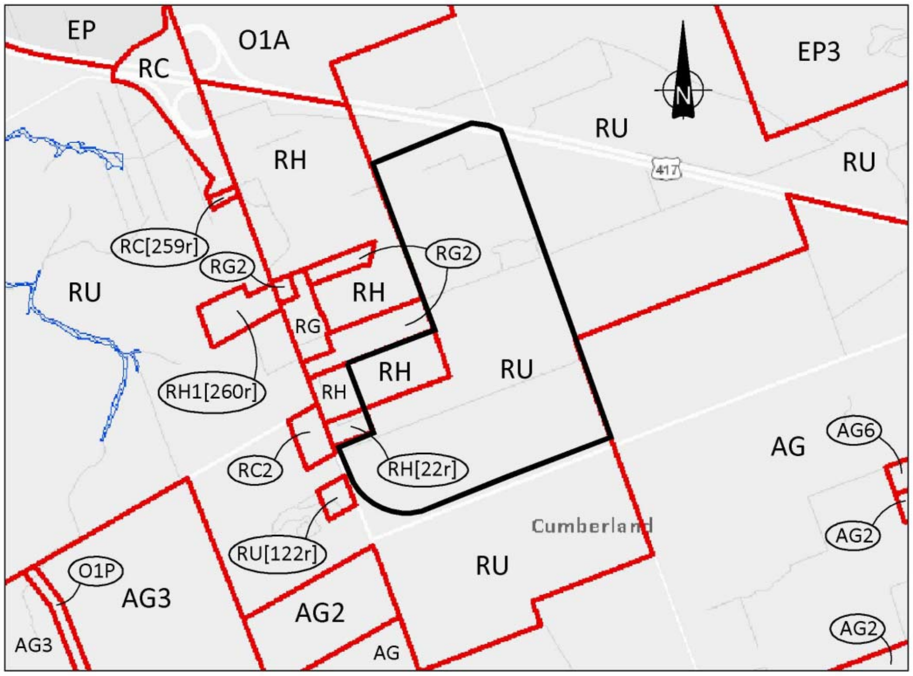


Figure 2.2-6: City of Ottawa Zoning By-law 2008-250

Discussions with City of Ottawa Staff

Through discussion with Mr. Jeff McEwen, Rural Services (Wards 5, portion of Ward 19 within Rural Area 20, 21) Acting Program Manager it was determined no zoning or site plan applications have been applied for with the City in the Site-vicinity of the BR Site.

Aggregate Resources

Previous subsurface investigation on and in the area of the Boundary Road Site (WESA, 1986), as well as current preliminary on-Site investigation indicates that the Site is underlain by a surficial sand layer followed by an extensive and thick deposit of silty clay. The surficial sand layer generally consists of silty sand having a thickness generally ranging from about 0.6 to 1.2 metres.

Because of its fine grained nature, this surficial sand layer is not of high quality as a potential aggregate material. Also, the layer is relatively thin compared to what would typically be considered for an aggregate resource operation, i.e., Aggregate Resource Industry Reports (ARIP) consider 6 m as a minimum thickness for identification as an aggregate resource, and there are already sand resources within the City that are known and reasonably plentiful, even within the existing licensed pits

From review of the 1995 study regarding aggregate supply in the Region of Ottawa-Carleton, which includes sand, gravel, crushed stone, shale and clay, there are no aggregate resources at or within 500 metres of the BR Site (MHBC, 1995). Additionally the Ministry of Northern Development and Mines prepared the first Aggregate Resource Inventory Paper (ARIP) for the Ottawa Region in 2013 and it does not show any aggregate resource at or within 500 metres of the BR Site (MNDM, 2013).

Table 2.2-1: Summary of BR Site Considerations

Component	Summary of Site Considerations
Land Use & Socio-economic	■ PPS does not identify lands of Provincial Interest; ■ OP states that CRRRC use may be permitted in designation; ■ OP Amendment needed; ■ Generally compatible with adjacent land uses and there are no institutional uses; ■ On an Arterial Road.
	■ There are no known or probable aggregate resources on the Site or within 500 m.

3.0 SITE COMPARISON – LAND USE & SOCIO-ECONOMIC

3.1 Comparison of Sites

3.1.1 Current and Planned Future Land Use

Both the NRR Site and the BR Site would require OPAs and Zoning By-law Amendments in order to permit the development of the CRRRC.

The re-designation of the NRR Site would extend beyond the aggregate designation and include Agricultural lands.

Even with all of the appropriate technical and planning studies, it is expected that this OP amendment will be subjected to considerable scrutiny due to the NRR Site being located in an area of mineral aggregate and agricultural resources.

The Provincial direction is to preserve large agricultural areas for the long-term benefit of the Province. Areas with large or significant mineral aggregate deposits are also intended to be protected. This would mean that an amendment to the UCPR to remove both the agricultural and mineral aggregate lands could be appealed to the Ontario Municipal Board (OMB) on the grounds that the amendment is not consistent with the PPS.

No material planning constraints have been identified to re-designation of the BR Site by the City of Ottawa.

The BR Site is clearly preferable to the NRR Site in terms of compatibility of the CRRRC with adjacent land uses. There is an existing industrial park adjacent to the BR Site, as well as a soil handling business visible from Boundary Road. Highway 417 borders the BR Site to the north.

Both Sites have road networks that identify the importance of the roads for use by a wide range of vehicle types, and in large volumes.

3.1.2 Mineral Aggregate Resources

A portion of the NRR Site is underlain by a licensed quarry. The quarried material is Queenston shale that has been a mineral aggregate resource used in the manufacture of brick in Ontario. It is understood that the quality of the shale at this location is not as economically favourable for brick manufacturing as the much larger Queenston shale deposits in southern Ontario. It is likely that this shale deposit extends beyond the licensed quarry and the NRR Site limits, mainly to the north, south and west. There are no other known or probable aggregate resources on the NRR Site or within 500 metres.

There are no known or probable aggregate resources on the BR Site or within 500 m.

3.2 Results of Site Comparison

After analysis of both land use and socio-economic factors for both sites, the preferred site for the CRRRC with respect to current and proposed planned future land uses is clearly the BR Site.

With respect to protection of mineral aggregate resources, the BR Site is also clearly preferred.

REFERENCES

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City of Ottawa (June 25, 2008) By-law 2008-250, The Zoning By-law for the City of Ottawa

Guillet, G.R. and Joyce, I.H. (1987). *The Clay and Shale Industries of Ontario.* Ontario Ministry of Natural Resources.

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APPENDIX TSD#1-F

Cultural & Heritage Resources Component

February 2013

February 2013

Cultural & Heritage Resources Component Appendix TSD#1-F

COMPARATIVE EVALUATION OF ALTERNATIVE SITES

TAGGART
GROUP OF COMPANIES

THE MILLER GROUP

Table of Contents

TABLES

ATTACHMENTS

INTRODUCTION

Two properties that are owned or have been optioned by Taggart Miller have been identified for the proposed Capital Region Resource Recovery Centre (CRRRC) (the Alternative Sites). The Alternative Sites are described below:

- **North Russell Road Site (NRR Site)** – located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell.
- **Boundary Road Site (BR Site)** – located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, Township of Cumberland.

The CRRRC is proposed to provide facilities and capacity for recovery of resources and diversion of material from disposal generated by the industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sectors primarily in Ottawa and secondarily a portion of eastern Ontario, for management and utilization of surplus and contaminated soils, as well as landfill disposal capacity for material that is not diverted.

1.0 ASSESSMENT CRITERIA, INDICATORS AND DATA SOURCES

The cultural & heritage resources component compared the Alternative Sites using the following criterion:

- Which Site is preferred for the protection of archaeological and heritage resources, and cultural heritage landscapes?

The indicators for the criterion are:

- Number and significance of known archaeological and heritage features, and cultural heritage landscapes on-Site; and
- Area of on-Site lands with moderate to high potential for undiscovered archaeological sites.

The data sources used were published data sources including: literature; historic maps, land registry data, assessment rolls and census records; Local Architectural Conservation Advisory Committee and/or municipal heritage building/district listings; review of the Ministry of Tourism, Culture and Sport's (MTCS) updated database; Site reconnaissance, Stage 1 archaeological and cultural/heritage assessments; consultation with Aboriginal communities and organizations, historical societies and institutes (all unresponsive); consultation with other government agencies as appropriate; and applicable provincial guidance documents.

For the Cultural Heritage Overview Report, the following heritage inventories and registers were examined:

- Parks Canada – Historic Sites and Monuments Board of Canada (HSMBC)
- Parks Canada – Federal Heritage Buildings Review Office (FHBRO)
- Infrastructure Ontario (IO)
- Ontario Heritage Trust
- City of Ottawa
- United Counties of Prescott Russell
- Township of Russell

The relevant heritage planning policies from the following agencies were also examined:

- National Capital Commission (NCC)
- City of Ottawa
- United Counties of Prescott Russell
- Township of Russell

This research was augmented by air photo analysis to determine any pre-1973 resources as per MTCS requirements for the identification of any structures older than 40 years. Two Site visits were carried out to document identified and potential cultural heritage resources.

2.0 PRELIMINARY DESCRIPTION OF EXISTING ENVIRONMENT

The following sections describe the existing environmental conditions for the cultural & heritage resources component at each of the Alternative Sites based on the preliminary investigations and assessments.

2.1 North Russell Road Site

The section below contains a synopsis of the Archaeological Assessment conducted on the NRR Site; details are provided in the complete report in Attachment TSD#1-F-1. This section also includes a synopsis of the findings of the Cultural Heritage Overview report conducted for the NRR Site. A description of the existing cultural heritage environment is provided in the complete report in Attachment TSD#1-F-3.

There is evidence of human occupation in Eastern Ontario dating at least 9,000 Before Present (B.P.) following the retreat of the Champlain Sea. Although open to habitation at this time, Russell Township would have been very sparsely populated throughout the Paleo-Indian period before experiencing a gradual increase in population during the subsequent Archaic and Woodland periods. Even with this increase, the highly mobile and seasonal nature of habitation ensured that the region would remain lightly populated until European colonization and agricultural intensification during the early nineteenth century.

Significant European settlement of the region did not occur until the nineteenth century. The Township of Russell was first surveyed in 1821 in preparation for eventual settlement, with the western half of the township attracting settlers of British decent, and then of eastern French and Irish decent. The closest rural community to the study area was the village of Russell, itself formed in 1900 by the amalgamation of two earlier mid-nineteenth century villages of Duncanville and Luxemburg.

A search of the MTCS *Archaeological Sites Database* indicates that the NRR Site does not contain any known or registered archaeological Sites, nor are there any registered archaeological Sites within a three-kilometre radius of the Site (study area).

Based upon the criteria laid out in the 2011 *Standards and Guidelines for Consulting Archaeologists*, there is a moderate potential for pre-contact archaeological resources within the NRR Site based upon the prevalence of wet areas and watercourses within the study area. This would have been ideal hunting grounds but not necessary desirable for lengthy habitation by pre-contact populations due to seasonal flooding.

There is a moderate to high potential for post-contact archaeological resources within the NRR Site based upon documentary evidence from land registry records, census records and historic mapping. Crown Patents were issued for the various Lots within the study area between 1834 and 1841. It is likely that the study area was first settled by between 1840 and 1860. Historical mapping indicates the presence of five houses within the study area by 1862. School House No3 was located in close proximity to the southwest corner the study area, and a pioneer cemetery was established within an adjacent concession.

Air photography indicates that by 1945 buildings possibly related to at least two of these early homes had disappeared from the landscape, and that quarrying had already begun in the site of the present day quarry. It is anticipated that the remains of these early farmsteads would be identified by further detailed archaeological assessment of the NRR Site, possibly leading to further archaeological work to fully assess the heritage value of these resources.

As part of the Cultural Heritage Overview report, in conjunction with the NRR Site, a total of 29 identified and potential cultural heritage resources (including both individual properties and cultural landscapes) were identified. There are no properties within the NRR Site or within the area around it that was studied that have been identified as possessing cultural heritage value or interest by either the Township of Russell or the United Counties of Prescott Russell. These 29 potential heritage resources were identified as pre-1973 structures as per MTCS guidelines; 20 of these potential heritage resources are current or former farmsteads with multiple buildings and landscape features. These properties will need to be treated as potential cultural heritage landscapes. In addition, the quarry itself (which predates 1945) is a potential industrial heritage Site, and would need to be examined as such. In addition, there is an active historic cemetery, a former school located at 456 North Russell Road and a former church located at 587 Route 100. There is also a brick building located at 499 North Russell Road whose original purpose could not be determined. There are four properties which are being used only as residences. Lastly, the area studied surrounding the NRR study area is a potential cultural heritage landscape. These potential cultural heritage resources, including a former cemetery, church and school, would need to be further assessed to determine if there is cultural heritage value as a larger landscape unit.

2.1.1 Summary of Conditions at NRR Site

Table 2.1-1: Summary of Site Considerations on the NRR Site

Environmental Component	Summary of Site Considerations
Cultural & Heritage Resources	▪ No registered archaeological Sites within study area. ▪ Based on the 2011 *Standards and Guidelines for Consulting Archaeologists*, approximately 90% of on-Site lands are of medium to high archaeological potential, with the remaining 10% having low or no archaeological potential. ▪ The NRR Site and area around it that was studied was found to have 29 identified and potential cultural heritage resources, including 20 potential cultural heritage landscapes, a potential industrial heritage Site (the quarry), a cemetery, a former school and a former church. Because of these features, further assessment is required to determine if the area as a whole is potentially a larger scale cultural heritage landscape unit.

2.2 Boundary Road Site

The section below contains a synopsis of the Archaeological Assessment conducted on the BR Site; details are provided in the complete report in Attachment TSD#1-F-2. This section also includes a synopsis of the findings of the Cultural Heritage Overview report conducted for the BR Site. A description of the existing cultural heritage environment is provided in the complete report in Attachment TSD#1-F-3.

There is evidence of human occupation in Eastern Ontario dating at least 9,000 B.P. following the retreat of the Champlain Sea. Although open to habitation at this time, Cumberland Township would have been very sparsely populated throughout the Paleo-Indian period before experiencing a gradual increase in population during the subsequent Archaic and Woodland periods. Even with this increase, the highly mobile and seasonal nature of habitation ensured that the region would remain lightly populated until European colonization and agricultural intensification during the early nineteenth century.

The Township of Cumberland was first surveyed in 1791 in advance of settlement; although a large number of Lots were granted at an early date to United Empire Loyalists, only a small number adjacent to the Ottawa River were occupied. The lack of interior access roads proved to be a hindrance to settlement of the area well into the early twentieth century, especially towards the south of the Township away from the Ottawa River. The arrival of the Grand Trunk Railway in 1882, and Canadian National Railway in 1899 helped open up the final areas of the Township for settlement.

A search of the MTCS *Archaeological Sites Database* indicates that the BR Site does not contain any known or registered archaeological Sites, nor are there any registered archaeological Sites within a three-kilometre radius of the Site.

Due to the flat topography, poorly drained soils and lack of natural water courses, the study area contains low pre-contact archaeological potential.

The area studied also contains low historic archaeological potential. This is based upon documentary records indicating that the Crown patent for the land within the study area were issued relatively late in the 19th century, with no settlement indicated on historical mapping until the 20th century. Despite the arrival of the railways at the end of the 19th century, the area within which the BR Site is located remained partially isolated until the construction of Frontier Road in 1923. Air photography indicated that all suitable land had mostly been cleared for agricultural purposes by 1945, though cultivation has since declined and the majority of the Site has reverted to secondary growth.

No further archaeological assessment would be required prior to development.

As part of the Cultural Heritage Overview report, in relation to the BR Site, a total of four cultural heritage resources (including both individual properties and cultural landscapes) were identified. Near the BR Site, there were three properties identified as having cultural heritage value: the NCC Greenbelt (identified by NCC), 6086 Frontier Road (identified by the City of Ottawa) and 9341 Mitch Owens Road (identified by the City of Ottawa). All three properties are in excess of 500 metres from the study property and are not included in the report inventory.

A total of four potential heritage resources (identified as pre-1973 structures as per MTCS guidelines) were identified. Only one, the farmstead located at 5508 Frontier Road, is a potential cultural heritage landscape. The other three properties are located in an area of transition, and are often already isolated by recent land-use changes. Two of the properties include mixed uses including residential and commercial components (5409 Boundary Road and 5329 Boundary Road). The property located at 5329 Boundary Road appears to be residential use only, but it shares a civic address with a commercial business (Alpine Auto Parts) immediately adjacent. The specific use of what appears to be a former farmhouse located at 5507 Boundary Road (Inventory O-08) could not be determined, although it is located in an area dominated by industrial uses.

2.2.1 Summary of Conditions at BR Site

Table 2.2-1: Summary of Site Considerations on the BR Site

Environmental Component	Summary of Site Considerations
Cultural & Heritage Resources	▪ No registered archaeological Sites within study area. ▪ All of the on-Site lands contain no or low archaeological potential. ▪ Four potential cultural heritage resources (identified as pre-1973 structures as per MTCS guidelines) were identified.

3.0 SITE COMPARISON – CULTURAL & HERITAGE RESOURCES

3.1 Comparison of Sites

The NRR Site and the BR Site do not contain any registered archaeological Sites, although in both cases this is in part due to a lack of previous archaeological assessment and/or recent development within the respective study areas. In the absence of any registered archaeological Sites, archaeological potential is used as an indicator for the presence of undiscovered archaeological Sites.

Only the NRR Site contains areas of archaeological potential that would trigger further Archaeological assessment in advance of any development. These areas of archaeological potential are identified using criteria outlined by the 2011 *Standards and Guidelines for Consulting Archaeologists* and are based upon physical attributes such as water courses and landforms, in addition to documentary and historical research.

The NRR Site contains areas of high archaeological potential, primarily associated with the documented locations of early historic homesteads, in addition to moderate archaeological potential associated with watercourses and wet areas that may have been utilized by pre-contact populations.

The BR Site does not possess any archaeological potential regarding historic homesteads. The area within which the BR Site is located does not possess any archaeological potential regarding pre-contact populations.

The BR Site is preferred from a Cultural & Heritage Resources perspective due to the lack of archaeological potential compared to the NRR Site. The absence of registered archaeological Sites does not favour one Site over the other.

As part of the Cultural Heritage Overview Report process, in reviewing the identified and potential properties (based on the review of inventories, Site visits, and air photo analysis) at both locations, the area with which the NRR Site is located was found to have approximately seven times the number of potential cultural heritage resources.[1] The heritage resources within the area of the NRR Site also appear to be more complex, as illustrated by the number of farmsteads present. Further, the area of the NRR location could be a potential cultural heritage landscape. In contrast, the potential cultural heritage resources at the BR Site location are located in an area that has already been heavily modified by commercial and industrial activities. Further, the majority of the potential cultural heritage resources near the Boundary Road Site are single buildings. Some of the potential heritage resources have already isolated by previous interventions, such as the house located at 5507 Boundary Road.

3.2 Results of Site Comparison

Following a comparison of the two Sites, it is considered that the BR Site is preferred overall for the protection of archeological and cultural heritage resources. The BR Site has low archaeological potential and therefore a much smaller possibility of impacting any undiscovered resources. It also has fewer potential cultural heritage resources that, in general, are already located within an area that has seen significant interventions.

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[1] The BR area has 4 identified or potential cultural heritage resources, while the NRR area has 29 identified or potential cultural heritage resources.

ATTACHMENT TSD#1-F-1

Archaeological Assessment, North Russell Road Site

February 6, 2013

REPORT ON

Archaeological Assessment
Capital Region Resource Recovery Centre
North Russell Road Site
Lots 18-19, Concessions 3 and 4
Geographic Township of Russell
Prescott and Russell County, Ontario

PIF Number P366-025-2013

Submitted to:
Taggart Miller Environmental Services
P.O. Box 4080
Markham, Ontario

Report Number: 12-1125-0045/4500/0160-1

REPORT

Golder
Associates

Executive Summary

The Executive Summary highlights key points from the report only; for complete information and findings, as well as the limitations, the reader should examine the complete report.

Golder Associates Ltd. (Golder) was contracted by Taggart Miller Environmental Services (Taggart Miller) to undertake a preliminary archaeological assessment of the properties located on Lots 18-19, Concessions 3 and Lot 18 Concession 4, in the Geographic Township of Russell. The overall study area is approximately 193 Ha of continuous lands. The archaeological assessment is one part of an overall assessment of the existing quarry site and adjoining lands located from North Russell Road on the west and extending east of Eadie Road. This study area, known as the North Russell Road Site (NRR), is being assessed as a possible location for the Capital Region Resource Recovery Centre (CRRRC). The objective of the archaeological investigation was to identify known archaeological sites within and in the vicinity of the study area and to assess its archaeological potential.

There is evidence of human occupation in Eastern Ontario dating at least 9,000 Before Present (B.P.) following the retreat of the Champlain Sea. Although open at this time, Russell Township would have been sparsely populated through the Palaeo-Indian period but would have had an increase in population during the Archaic and Woodland periods. The region of the study area would remain sparsely populated until European colonization during the early nineteenth century. The first Euro-Canadian settlement in the vicinity of the study area was the village of Russell.

The Crown patents granted for the three lots were: Lot 18 Concession 3 to William Hamilton in 1841, Lot 19 Concession 3 to Thomas Gillespie in 1840, and Lot 18 Concession 4 to William McDonell in 1834. It is likely that the area was first settled between 1840-1860.

There are no archaeological sites in the study area or within a three kilometre radius. Due to the presence of wetlands there is a moderate potential for pre-contact archaeological resources within the study area. Historical records and maps indicate that there was moderate to high potential for post contact archaeological resources based upon locations of early settlement.

This investigation has provided the basis for the following recommendations:

1) That further detailed archaeological assessment be undertaken of any areas of archaeological potential that are to be affected by future development within the study area. This further detailed assessment will be required over the majority of the lands that comprise the North Russell Road Site (Map 5).

Project Personnel

Client Contact	Jeff Parkes, Taggart Miller Environmental Services
Project Director	Paul Smolkin P.Eng.
Senior Report Review	Hugh Daechsel M.A. (P051)
Licensed Archaeologist	Erin Wilson M.A. (P366)
Project Manager	Trish Edmond P.Eng
Report Preparation	Dan Goss B.A., Tim Rangecroft M.Sc. (R383)
Spatial Imaging	Bojan Radojevic, Jamie McKenzie
Administrative Support	Candice Butler

Abbreviations

MTCS	Ministry of Tourism, Culture and Sport (Ontario)
ASDB	Archaeological Sites Database
CRRRC	Capital Region Resource Recovery Centre
NRR	North Russell Road
PIF	Project Information Form
B.P.	Before Present (Taken to be 1950)
C14	Carbon 14 dating technique

Table of Contents

IMAGES

MAPS

APPENDICES

1.0 PROJECT CONTEXT

1.1 Objectives

This archaeological assessment was completed to identify known archaeological resources in the study area as well as to determine if additional archaeological investigations are required. The objectives of the assessment are based on principles outlined in the *Ontario Heritage Act* (Consolidated 2007) and the Ministry of Tourism, Culture and Sport's *Standards and Guidelines for Consultant Archaeologists* (2011). More specifically, studies were completed with the following objectives:

- To provide information about the property's geography, history, previous archaeological fieldwork and current land condition;
- To evaluate in detail the property's archaeological potential, which will support recommendations for further detailed surveys for all or parts of the property; and
- To recommend appropriate strategies for further detailed surveys, if required.

1.2 Development Context

Golder Associates Ltd. (Golder) was contracted by Taggart Miller Environmental Services (Taggart Miller) to undertake an archaeological assessment of the properties located on Lots 18-19, Concession 3 and Lot 18, Concession 4, in the Geographic Township of Russell. This study area, known as the North Russell Road Site (NRR) is being assessed as a possible location for the Capital Region Resource Recovery Centre (CRRRC). The archaeological assessment is one part of an overall assessment of the existing quarry site and adjoining lands located between North Russell Road on the west and extending east of Eadie Road. The study area is indicated by the boundaries on Map 1 & Map 2; these are the physical limits of any proposed development. A wider study area of 3km was used to investigate the Ministry of Tourism, Culture and Sports' (MTCS) *Archaeological Sites Database* (ASDB) in accordance with the *Standards and Guidelines for Consulting Archaeologists (2011)* and professional standards of due diligence.

This assessment was undertaken in advance of any pre-development permitting process, and for the purposes of the MTCS was triggered by the need to identify any potential impacts to archaeological resources as considered under the *Canadian Environmental Assessment Act*. The CRRRC project has an approved Terms of Reference and the provincial Environmental Assessment process activities have commenced.

Permission to access the study area for the purpose of archaeological assessment was provided by Taggart Miller in consultation with local landowners.

1.3 Historical Context

Our understanding of the local sequence of human activity in the study area following the recession of the last ice sheet and the Champlain Sea is incomplete. It is possible, however, to provide a general outline of prehistoric occupation in the Ottawa region based on the archaeological investigations conducted throughout eastern Ontario.

Pre-Contact Overview

Human occupation of southern Ontario dates back approximately 10,000 years B.P. These first peoples, known as Palaeo-Indians to archaeologists, moved into Ontario as the last of the glaciers retreated northward. The former shores of the vast glacial lakes such as Lake Algonquin in the area that is now southern Georgian Bay, and along the north shore of present day Lake Ontario, contain remnants of some of their sites. Isolated finds of the distinctive, parallel-flaked Palaeo-Indian spear points have been recorded in the Rideau Lakes and north of Kingston (Watson 1982). Although there is limited information on the lifestyle of the Palaeo-Indians, the little evidence that is available suggests that they were highly mobile hunters and gatherers relying on caribou, small game, fish and wild plants found in the sub-arctic environment.

The Ottawa Valley remained very much on the fringe of occupation at this time. The ridges and old shorelines of the Champlain Sea and early Ottawa River channels would be the areas most likely to contain evidence of Palaeo-Indian occupation in this region. What is believed by some to be late Palaeo-Indian material has been found in several locations within the City of Ottawa including a site in Honey Gables as well as in general proximity to the study area, near Albion Road and Rideau Road, Innes Road, and north of the Mer Bleue close to the intersection of Navan Road and Page Road (Swayze 2001, 2003 & 2004).

It was not until the succeeding Archaic Period (ca. 9,000 to 3,000 B.P.), that the environment of southern Ontario approached modern conditions. While more land became available for occupation as the glacial lakes drained, Archaic populations continued as hunter-gatherers, however they appear to have focused more on local food resources, abandoning the highly mobile lifestyle of their predecessors. Although Palaeo-Indian workmanship of stone tools was also lost, the archaic tool kit became more diversified, reflecting the change to a temperate forest environment. Ground stone tools such as adzes and gouges first appeared and may indicate the construction of the dug-out canoes or other heavy wood working activities. Extensive trade networks had developed by the middle to late Archaic Period. Items such as copper from the north shore of Lake Superior were exchanged during this time.

The first significant evidence for occupation in the Ottawa Valley appears at this time. Archaic sites have been identified on Allumettes and Morrison Islands on the Ottawa River near Pembroke, and within the boundaries of Leamy Lake Park within the City of Gatineau (Pilon 1999: 43-53, 64). Late Archaic sites have also been identified to the west in the Rideau Lakes, and the east at Jessup Falls and Pendleton along the South Nation River (Daechsel 1980). A few other poorly documented finds of Archaic artifacts have been made within the City limits (Jamieson 1989).

The Woodland Period (ca. 3,000 to 400 B.P.) is distinguished by the introduction of ceramics. Early Woodland groups continued to live as hunters, gatherers and fishers in much the same way as earlier populations had done. They also shared an elaborate burial ceremonialism evidenced by the inclusion of exotic artifacts within graves (Spence et. al. 1990: 129). Extensive trade networks continued through the early part of this period and Early Woodland populations in Ontario appear to have been heavily influenced by groups to the south, particularly the Adena people of the Ohio Valley. By 1,700 B.P., the trade networks had reached their peak and covered much of North America.

Through the Middle Woodland Period (ca. 2,400 to 1,100 B.P.) there was an increase in the decorative styles found on ceramics and changes in the shapes and types of tools used. For the first time, it is possible to identify regional cultural traditions within the province, with 'Point Peninsula' being the distinctive variant found in eastern and south-central Ontario. A greater number of known sites from this period have allowed archaeologists to develop a better picture of the seasonal round followed in order to exploit a variety of resources within a home territory. Through the late fall and winter, small groups would occupy an inland 'family' hunting area. In the spring, these dispersed families would congregate at specific lakeshore sites to fish, hunt in the surrounding forest, and socialize. This gathering would last through to the late summer when large quantities of food would be stored for the approaching winter. The proliferation of sites suggests an increase in the population of Eastern Ontario, although the Ottawa area has yet to yield as many sites as other parts of south-eastern Ontario. Middle Woodland sites have been noted in the South Nation Drainage Basin and along the Ottawa River including the northwest end of Ottawa at Marshall's and Sawdust Bays (Daechsel 1980; Daechsel 1981).

Another significant development of the Woodland period was the appearance of domesticated plants ca. 1,450 B.P. Initially only a minor addition to the diet, the cultivation of corn, beans, squash, sunflowers and tobacco gained economic importance for Late Woodland peoples. Along with this shift in subsistence, settlements located adjacent to the corn fields began to take on greater permanency as sites with easily tillable farmland became more important. Eventually, semi-permanent and permanent villages were built, many of which were surrounded by palisades, evidence of growing hostilities between neighbouring groups. By the end of the Late Woodland Period, distinct regional populations occupied specific areas of southern Ontario separated by vast stretches of largely unoccupied land, including the Huron along the north shore of Lake Ontario, and the St. Lawrence Iroquois along the St. Lawrence River.

While there is clear evidence of these latter developments in much of southern Ontario, the Ottawa Valley remained a sparsely occupied region utilized by mobile hunter-gatherers. In part, this was because the terrain was less than suitable for early agriculture. It was also a reflection of the increased pressure on hunting territories and conflict over trade routes at the end of the Woodland Period. Facing persistent hostilities with Iroquoian populations based in what is now New York State, the Huron moved from their traditional lands on the north shore of Lake Ontario to the Lake Simcoe and Georgian Bay region. Algonquin groups, who had occupied the lands north of the Huron, also appear to have retreated further northward in order to place greater distance between themselves and the Iroquois.

Woodland sites have been recorded throughout the Ottawa Valley. Two small Late Woodland sites were recently located on a property near the Village of Cumberland to the east of the study area (Ferris, 2002). A significant Woodland occupation has also been identified at the Leamy Lake site (Pilon 1999: 76-80). Finally, an ossuary burial identified near the Chaudière Falls in the 1840s dates to this period. Although ossuaries are a burial practice normally associated with Iroquoian speaking populations, especially the Huron, this internment may have been Algonquin. Once again, a number of poorly documented Woodland find spots are known for the general study area (Jamieson 1989).

At the time of initial contact, the French documented three Algonquin groups residing in the vicinity of the study area (Heidenreich & Wright 1987: Plate 18). These included the Matouweskarini along the Madawaska River to the west, the Onontchataronon in the Gananoque River basin to the southwest, and the largest of the three, the Weskarini, situated in the Petite Nation River basin north of the study area. While prolonged occupation of the region may have been avoided as a result of hostilities with Iroquoian speaking populations to the south, at least the northern reaches of the South Nation River basin were undoubtedly used as hunting territories by the Algonquin at this time.

Post-Contact Overview

Étienne Brûlé is reported to be the first European in the region; having travelled up the Ottawa River in 1610, three years before Samuel de Champlain. For the next two centuries, the Ottawa River served as a major route for explorers, traders and missionaries from the St. Lawrence into the interior, and throughout the seventeenth and eighteenth centuries this route remained an important link in the French fur trade. A seigneury was established at L'Orignal, east of the study area, in 1674 and granted to Nathaniel Hazard Treadwell but there was little permanent European settlement at this early date. The recovery of European trade goods (i.e., iron axes, copper kettle pieces and glass beads) from Native sites throughout the Ottawa River drainage basin has provided evidence of the extent of contact between Natives and the fur traders during this period. The English, upon assuming possession of New France, continued to use the Ottawa River as an important transportation corridor.

A French trading post was built near the mouth of Le Lievre River, near the present community of Buckingham, Quebec, sometime in the eighteenth century. This post had been abandoned by the time Alexander Henry travelled up the Ottawa River in 1761 (Voorhis 1930:62). Independent trading posts at Buckingham and in the Rockland area were reportedly operated by Gabriel Foubert in the late eighteenth century (Beaulieu n.d.). Gabriel was the father of Amable Foubert, one of the first recorded settlers in Cumberland Township.

Significant European settlement of the region did not occur until United Empire Loyalists and other immigrants began to move to lands along the Ottawa River in the late eighteenth and early nineteenth centuries. The need for land on which to settle the Loyalists led the British government into hasty negotiations with their indigenous military allies, the Mississauga, who were assumed, erroneously, to be the only Native peoples inhabiting eastern Ontario. Captain William Redford Crawford, who enjoyed the trust of the Mississauga chiefs living in the Bay of Quinte region, negotiated on behalf of the British government. In the so-called 'Crawford Purchase,' the Mississauga were cajoled into giving up Native title to most of eastern Ontario, including what would become the counties of Stormont, Dundas, Glengarry, Prescott, Russell, Leeds, Grenville and Prince Edward, as well as the front Townships of Frontenac, Lennox, Addington and Hastings and much of what is now the City of Ottawa (including the Geographic Townships of Gloucester, Nepean, Osgoode, Marlborough and North Gower) (Lockwood 1996: 24). Two years after the 1791 division of the Province of Quebec into Upper and Lower Canada, John Stegmann, the Deputy Surveyor for the Province of Upper Canada, undertook an initial survey of four Townships (Nepean, Gloucester, North Gower and Osgoode) on both sides of the Rideau River near its junction with the Ottawa River.

Russell Township

The Township was first surveyed in 1821 to mark out lots for the settlers that would soon follow. The colonization of Russell Township began in the early nineteenth century as land was granted to United Empire Loyalists. The western half of the township was initially settled as the soils were more favourable for farming, while the eastern half would be settled later by people emigrating from Québec in the mid nineteenth century.

The United Empire Loyalists were people of different cultural backgrounds who remained loyal to the British during their conflicts with the United States. They were primarily of English, Scottish, or Irish descent but there were also people of Dutch, German and French backgrounds who fought for the British and as a result lost their properties in the United States. The British governors in Canada realized it would benefit them to grant lands to the Loyalists in Canada as it would provide foundation for a small but loyal militia who would fight for their lands should the Americans ever invade north of the border.

The western half of the township was made up of small farming communities and was sparsely populated. New immigrants would add to the local population later in the nineteenth century with people of British descent emigrating to the western half of the township while people of French and Irish descent emigrated to the eastern half of the township.

The town of Duncanville shows up as early as 1862 on the Walling map (Walling 1862). The largest town close to the study area was the village of Russell which was formed when the villages of Duncanville and Luxemburg were amalgamated around 1900.

Brick Works

There were three brick manufacturing companies in the township during the nineteenth century. The clay and shale in the area was used for making bricks. The Russell Brick and Tile Company started the pit on Lot 18 Concession 3 in 1907 in order to provide more construction material they expanded their operations by buying out two other brick factories in the region. The Russell Shale Bricks Ltd. Company was formed in 1911 and it bought the holdings of the Russell Brick and Tile Company. This company had one of the most modern factories at the time in the area and they brought in skilled workmen from Europe to run it. The pit on Lot 18, Concession 3 was expanded and a narrow gage railroad was built to move aggregate from the pit to the factory in the village of Russell. Most of the brick houses in the area were constructed with local brick from this factory. During World War One there was less demand for building material so the plant and shale pit were closed. The shale pit would later reopen in 1927 with new owners and remained a reliable local source for brick manufacturing material for the rest of the twentieth century (Stanley 1988).

Present Land Use

The study area is currently a mixture of agricultural fields, wetlands, woodlot and scrub. The centre of the study area is dominated by a flooded quarry and access road. A number of single residential buildings are located around the periphery of the study area within proximity to roadways.

Property History

Historic evidence including land registry documents and census records provide a history of the ownership and development of the study area. The Walling historical map from 1862 (Walling 1862) and the Belden historical map from 1881 (Belden 1881) also help to provide information on who was living on the properties, how the properties were divided and where the houses and farm buildings were located.

Lot 18 Concession 3 Russell Township

The land registry documents indicate that the patent for the 200 acre lot was granted to William Hamilton in 1841. Hamilton sold 100 acres to David Harrison in 1849 (Inst. 4760). Harrison sold part of the land to Susan Harrington in 1851 (Inst. 5016). John Harrington sold his property to Adam Baker in 1854 (Inst. 6421) who in turn sold the property back to William Hamilton in 1857 (Inst. 6812). David Harrison sold the rest of his property to Richard Wilson in 1876 (Inst. 1236). William Hamilton sold his land to his son Thomas in 1879 (Inst. 2094). The last property transfer on the lot during the 1800's occurred in 1882 when Richard Wilson sold his property his son Andrew (Inst. 2684).

The 1871 census returns (C-10012) provide information for two families living on the lot. David Harrison was listed as a 62 year old farmer of English descent. He lived with his wife Ann (age 59) and had four children still living at home: Matilda (age 25), Peter (age 17), William (age 15), and Margaret (age 13). Both David and Ann were born in England while all the children were born in Ontario. Peter listed his occupation as a farmer like his father while the two youngest children were listed as attending school. The family identified their religious faith as Church of England.

The family owned a total of 160 acres with 60 acres improved. They divided their property into 15 acres for pasture, one acre for garden/orchard, four acres for wheat, two acres for potatoes, and 16 acres for hay. The family owned one house on the property which shows up on the 1862 Walling map (Map 3) in the northwest corner of the lot (Walling 1862). The family also owned three barns/stables, two carriages/sleighs, one cart/wagon/sled, three ploughs/cultivators, one reaper/mower, one horse rake, one thrashing machine, and one fanning mill. The farm produced 40 bushels of spring wheat, six bushels of fall wheat, 35 bushels of barely, 300 bushels of oats, 10 bushels of peas, 12 bushels of corn, 200 bushels of potatoes, 15 tonnes of hay, 20 bushels of apples, 400 pounds of butter, 56 pounds of wool, and 25 cords of wood. The family also owned two horses and one colt/filly, four milk cows, three horned cattle, 12 sheep, three swine and one beehive. There were three sheep and three swine killed or sold that year.

The 1871 census returns (C-10012) also provide information on the Hamilton family. William Hamilton was listed as a 61 year old farmer of Irish descent. He was married to Jane (age 62) and they had two sons still living at home: Thomas (age 26) and George (age 22). William and Jane were born in Ireland while their sons were born in Ontario. Thomas listed his occupation as a farmer while his younger brother George was identified as a clerk. The family listed their religious faith as Methodist.

The family owned a total of 102 acres with 75 acres improved. They divided their land into 25 acres for pasture, one acre for garden/orchard, five acres for wheat, one acre for potatoes, and 15 acres for hay. They had one house on the property which was located in the centre of the western boundary of the lot according to the 1862 Walling map (Map 3). The family also owned three barns/stables, four carriages/sleighs, three carts/wagons/sleds, two ploughs/cultivators, one reaper/mower, and one fanning mill. The farm produced 85 bushels of spring wheat, 500 bushels of oats, 80 bushels of peas, 10 bushels of buckwheat, 12 bushels of corn, 250 bushels of potatoes, 16 tonnes of hay, 10 bushels of apples, 10 bushels of grapes, 450 pounds of butter, 30 pounds of honey, 20 pounds of wool, 32 yards of cloth, and 27 cords of firewood. The family owned four horses, six milk cows, six horned cattle, six sheep, four swine and three beehives. They had one cow and three swine killed or sold that year.

The 1881 census returns (C-13229) provide information on two families living on the lot. First, Thomas Hamilton had taken over the land from his father. He lived with his wife Matilda (age 25) and their two children William (age 2) and Robert (age 8 months). Unlike her husband and children who were Methodists, Matilda listed her religious faith as Presbyterian.

Richard Wilson is listed in the 1881 census as a 61 year old farmer of Irish descent. He purchased the property in 1876 from David Harrison. Richard lived with his wife Marian (age 51) and they had five children still living at home: Anne (age 25), Andrew (age 23), Harris (age 21), Marian (age 16) and Elizabeth (age 15). Andrew was identified as a farmer and the youngest two children were attending school. It should be mentioned that on the 1881 Belden historical map, only the Wilson family shows up on the property (Map 3). This is possibly a result of the mapping process relying upon financial subscription.

The 1891 census returns (T-6367) only lists the Hamilton family. The change was that the family lived in wooden two storey house with three rooms.

Lot 19 Concession 3 Russell Township

The land registry documents indicate that the patent for the 200 acres lot was given to Thomas Gillespie in 1840. He sold the lot to Henry Hitsman in 1844 for 200 pounds (Inst. 3829). Hitsman sold 50 acres of the property to John Shelp for 25 pounds in 1853 (Inst. 4258). Henry would later sell the rest of the property to his two sons: John in 1865 (Inst. 10428) and Thomas in 1873 (Inst. 726). The last property transaction on the lot in the 19th century took place in 1895 when John Shelp sold his property to his son Thomas (Inst. 5750).

The 1871 census returns (C-10012) listed Henry Hitsman as a 72 year old farmer of German descent. He lived with his wife Lilia (age 60) and had one son still living at home: Thomas (age 27). The family listed their religious faith as Methodist.

The family owned a total of 155 acres with 60 of the acres being improved. They divided their land into 12 acres for pasture, eight acres for wheat, two acres for potatoes, and 20 acres for hay. They owned one house that according to the 1862 Walling map (Map 3) was located in the southern corner of the western boundary of the Lot. The family also owned two barns/stables, a carriage/sleigh, a cart/wagon/sled, a plough/cultivator, a reaper/mower, a horse rake, a thrashing machine, and a fanning mill. The farm produced 30 bushels of spring wheat, 40 bushels of fall wheat, 40 bushels of barley, 10 bushels of oats, 200 bushels of rye, 40 bushels of peas, seven bushels of corn, 600 bushels of potatoes, 15 tonnes of hay, 400 pounds of butter, 200 pounds of honey, 80 pounds of wool, 25 cords of firewood, and had 15 pine logs. The family also owned four horses, one colt/filly, eight milk cows, six horned cattle, 24 sheep, three swine, and 13 beehives. The also had six swine killed or sold.

John Hitsman was listed in the 1871 census as a 35 year old farmer of German descent. He lived with his wife Jane (age 20) and they both identified their religious faith as Methodist.

They owned 50 acres of land with 20 of those acres improved. They divided their land into two acres for wheat, one acre for potatoes, and 15 acres for hay. They owned a house on the property as well as one barn/stable, and one plough/cultivator. Their farm produced 20 bushels of spring wheat, 20 bushels of fall wheat, 50 bushels of oats, 40 bushels of peas, 100 bushels of potatoes, eight tonnes of hay, 18 pounds of wool, 18 yards of cloth, and five cords of firewood. They also owned one horse, one milk cow, five sheep, two swine, and one beehive.

The 1881 census returns (C-13229) provided information on three families living on the lot. First, John Hitsman and his wife Jane had added five children to their family: Samuel (age 9), Emma (age 7), Aaron (age 5), Sarah (age 4) and George (age 7 months). Only Samuel was listed as attending school.

Thomas Hitsman took possession of his father's farm in 1873. He lived with his wife Anne (age 25) who was born in Wales. They had two children: Thomas (age 1) and Sarah (age 0). The family listed their religious faith as Methodist.

The third family that the 1881 census returns (C-13229) provided information for was for the Shelp family. John Shelp was a 61 year old farmer of German Descent. He was married to Rebecca (age 53). Their 26 year old widowed son Thomas lived with them as did their one month old grandson Alexander. Thomas also listed his occupation as a farmer and the family listed their religious faith as Methodist.

The 1891 census returns (T-6367) provided additional information on the Hitsman and Shelp families. First, John and Jane Hitsman had three new children: Ford (age 7), Jessica (age 5), and Annie (age 2). Their eldest son Samuel was listed as student for his occupation while the next oldest son Aaron was listed as a farmer. The family lived in a wooden two storey house with five rooms.

The 1891 census indicated that the Shelp family lived in a wooden two storey house with seven rooms.

Lot 18 Concession 4 Russell Township

The patent for the 200 acre lot was granted by the Crown to William McDonell in 1834. He sold the lot to Angus McDonell in 1844 (Inst. 3860) who in turn sold the lot to George Jarvis that same year (Inst. 3859). Jarvis sold the lot in 1853 to Charles Purney in 1853 (Inst. 6285). Purney sold the north 100 acres to William Hayes in 1862 (Inst. 7658) who sold his portion of the lot to Robert Armstrong four years later (Inst. 10540). Purney sold the south 100 acres to William Eadie in 1869 (Inst. 130). Armstrong sold the north half of the lot to William Hayes in 1879 for $400 (Inst. 2191). The last land transaction on the lot during this century was when William Eadie sold the southern 100 acres to his son John for $1,000 in 1881 (Inst. 2514).

The 1871 census only provided data for the Hays family. William Hays was a 43 year old farmer of Irish descent. He lived with his wife Rebecca (age 42) and had eight children living at home: William (age 19), Margaret (age 17), Mary Ellen (age 15), Elizabeth (age 13), Rebecca (age 11), Mary Ann (age 7), Matilda (age 4), and John (age 2). William and Rebecca were born in Ireland while all of their children were born in Ontario. Their eldest son listed his occupation as a farmer and Rebecca and Mary Ann are listed as going to school. The family listed their religious faith as Church of England.

The family was listed as tenant farmers. They initially owned the property and then had to sell it to Robert Armstrong in 1866, perhaps due to financial troubles. They have some property listed but it is unclear whether they owned it at this time or whether they were renting the farm buildings and house on the property. They would eventually re-buy the north half of the lot from Robert Armstrong in 1879. The Hays family operated

100 acres of land with 12 acres improved. They allotted one acre for potatoes and four acres for hay. They lived in a house on the property which was listed as the Purney house on the 1862 Walling map (Map 3) which was located in the southwest corner of the lot. They used one barn/stable, one cart/wagon/sled, and one plough/cultivator. The farm produced 20 bushels of oats, 100 bushels of potatoes, four tonnes of hay, 50 pounds of butter, 20 pounds of wool, 30 yards of cloth, and 15 cords of firewood. The family had two oxen, two milk cows, six sheep, one swine and had two sheep and one swine killed or sold.

The 1881 census returns (C-13229) provide information about both the Hays and Eadie families. First, there was no new information about the Hays family except that two of the children, Margaret and Matilda, are no longer living at home.

Regarding the Eadie family, William Eadie was a 64 year old farmer of Scottish descent. He lived with his wife Sarah (age 50) and their eight children: John (age 26), Sarah (age 21), Joseph (age 18), Mary (age 16), James (age 14), Archibald (age 12), Robert (age 10), and Maggie (age 8). William was born in Scotland while the rest were born in Ontario. The two eldest sons, John and Joseph, listed their occupation as farmer while the four youngest children are listed as going to school. The family listed their religious faith as being Presbyterian.

The 1891 census returns (T-6367) only provide information on the Eadie family. John took over the family farm in 1881. He lived with his wife Margaret (age 32) and their four children: Margaret (age 8), William (age 5), John (age 2), and Sarah (age 5 months). The family listed their faith as Presbyterian and they lived in a wooden two storey house with three rooms.

Historic Maps and Air Photos

A review of available historic maps was undertaken to identify the locations of any early historic structures within the study area. The earliest map available for this part of the township is the 1862 Walling map, this shows a total of four homesteads within the study area (Map 3). The map attributes the building at the northern border of the study area to be that of J. Shelp, while the three buildings on the western border belong to H. Hitsman, D Harrison and William Hamilton respectively. Schoolhouse No. 3, located in the southwestern corner of the Lot, is located just outside the study area. The concession roads appear to form the focus of the earliest settlement within the study area, however the presence of initial shantys and cabins associated with sources of water rather than infrastructure cannot be discounted.

The 1881 Belden map (Map 3) does not show any buildings within the study area, aside from a church located adjacent to the study area in concession 2. Buildings are clearly visible to the north, however only the name of Richard Wilson appears with the study area itself. It is possible that inclusion on the 1881 map was by subscription, therefore removing a large segment of the population that were unwilling to pay. Census records illustrate the continued settlement of the study area and the continued presence of families identified on the 1862 Walling Map.

A review of air photography for the study area was undertaken to determine how it has developed through the Twentieth Century. A 1945 air photo indicates that the J. Shelp farmstead had been abandoned, though its field boundaries remained to show its location. Similarly, the D. Harrison farmstead had disappeared from the landscape by this time. The farmsteads of H. Hitsman and W. Hamilton are still present. An area of resource extraction is visible in the vicinity of the present-day quarry. The majority of the study area is cleared for agricultural purposes, with a very small woodlot remaining at the eastern edge of the study area

1.4 Archaeological Context

Previous Environmental Conditions

The study area began to emerge from the Wisconsin Ice Cap during the onset of the Holocene, roughly 12,000 years B.P. Immediately adjacent to the retreating ice sheets, melt water lakes formed within the low lying Ottawa Valley; itself having been depressed by the great weight of the ice cap. Around 11,000 to 11,500 B.P. the ice had sufficiently melted to allow sea water from the Atlantic Ocean access to the glacially lowered lands of eastern Ontario via the St. Lawrence (Cronin et al 2008). This marine inundation formed the Champlain Sea, briefly extending as far west as parts of Renfrew County, and is represented within the sedimentary record by a change from laminated glaciolacustrine clays to marine deposited clays.

Isostatic rebound gradually raised the Ottawa Valley, resulting in the shrinkage of the Champlain Sea eastwards. Large amounts of meltwater from the retreating ice sheets to the northwest flowed down through the Ottawa Valley, resulting in the freshwater mixing with the saline Champlain Sea providing for a brackish environment, eventually producing the smaller freshwater Lake Lampsilis by around 9,800 B.P. By this period an extensive sand delta had formed over the region as the large amounts of sediment transported downstream entered into the less turbulent and slower waters of the Lake and subsequently dropped from suspension. This resulted in the draping of the existing deep water marine clays with a thick layer of fluvial sands and silts across the entire deltaic fan. Following the further draining of Lake Lampsilis, the Ottawa River remained as a drainage route to the Atlantic for larger glacial lakes and water bodies to the west, with occasional large release episodes.

“The most significant alterations to the landscape following the withdrawal of the Champlain Sea are related to the shifting channels of the Ottawa River. A series of terraces and abandoned channels in the vicinity of Ottawa indicates that the Ancestral Ottawa River was much larger than present. Isostatic adjustment and the erosion of a lower channel upstream from Ottawa gradually caused the river to abandon the southern channel and shift to the north, to occupy the pre-glacial valley and what is now the Ottawa River channel. Terraces at various levels in the clay mark successive periods of downcutting by the Pre-Ottawa River. The south channel east of Ottawa has several cross channels separated by elongated islands underlain by marine clay and covered by fluvial sands” (Marshall et al 1979:14).

The study area is located due south of the southern bank of this ancestral channel, with most of the channel at this location currently occupied by the Mer Bleue Bog. A carbon date obtained from the peat (GSC-681, 7650+- 120 years BP) indicates this bog to be at least 7,700 years old (ibid:15). The development of the bog indicates that the channel must have been abandoned by the Ottawa River by this time, and that potentially it existed earlier as an open lake before reverting to a peat forming marsh.

Pollen cores taken from the Mer Bleue, immediately north of the study area (Anderson 1988), and Ramsay Lake, 50 km to the northwest (Rocheleau et al 2008) provide a record of paleoflora at the time of the emergence of the study area from the Champlain Sea (9,800 B.P.). Pollen cores indicate the existence of a tundra that gave way to coniferous tree cover, likely spruce, pine and willow, later supplanted with oak and birch at the expense of the spruce. These forests increased in density and remained dominant between 10,600 and 7,500 B.P. A more mixed forest, characterised as Great Lakes Forest began to be established with the onset of a warmer and more humid environment between 7,500 and 4,700 B.P. with the predominance of pine giving way to hemlock. A cooling of the climate and the decimation of the hemlock by disease led to a massive increase in the birch composition of the tree cover between 4,700 and 3,000 B.P. This birch, pine and hemlock tree cover remained established until 200 B.P. with lumbering and agriculture clearing the area (Ibid: 2008)

Study Area Characteristics

The study area is located in the Russell and Prescott Sand Plains (Chapman 1966). This area is characterized by large deposits of sand and fine sand with smaller deposits of shale till. The study area has a level to slightly undulating topography.

There were four soil types shown as located within the study area. The largest concentration of soil within the study area is Vars gravelly sand; it consists of slightly stony, gravelly loam soils with reddish gravel or shale parent material with good drainage (Image 11). The second soil type was Rubicon fine sand located in the northwest corner of the study area. It consists of light grey depressions and reddish brown hummocks of sandy soils with sorted sand parent material and had imperfect drainage. The other two soil types were only located in the eastern part of the study area. The first was Bearbrook clay, which consists of stone free dark grey clay soils with non-calcareous layered red and grey clay with poor drainage. The last soil type potentially found within the study area was Bainsville silt loam. It consists of stone free fine sandy loam soils with layered silt and fine sand with poor drainage (Wicklund 1962).

The study area is located within the Upper St. Lawrence Sub-region of the Great Lakes-St. Lawrence Forest Region (Rowe 1977). Forests in this sub-region include sugar maple, beech, red maple, yellow birch, white ash, basswood, largetooth aspen, and red and burr oaks. Most of the study area consists of open cultivated farm fields with occasional wood lots. Most of the old growth forest would have been cut down during the nineteenth century and the trees that can be found within the study area would be secondary or tertiary growth (Images 5, 14 and 20).

There are three large wet areas located within the study area. The first is located in the northwest corner (Image 14) while the second was located below the southeast corner of the quarry (Image 5). The third wet area was located in the southeast corner itself (Image 6). Drainage with the study area was provided by the larger Fournier Municipal Drain (Image 21), South Morrow Municipal Drain and York Municipal Drain, in addition to numerous smaller drainage ditches. The eastern arm of the study area was also notably more saturated due to the poor soil drainage (Image 17).

There were moderate limitations to agricultural production, moderate limitations to ungulate production (Brassard 1971), and severe limitations to waterfowl production (Arsenault 1970), for the area.

Property Inspection

A property inspection was conducted on November 24th 2009. Photographs were taken of the existing conditions and a field log maintained. Visibility was excellent and conformed to the stipulations laid out in the *Standards and Guidelines for Consulting Archaeologists (2011)*.

Registered Archaeological Sites

The primary source of information regarding known archaeological sites in the study area is the Ontario Ministry of Tourism, Culture and Sport’s archaeological sites database. A current version of this database was consulted and, at present, there are no documented or registered archaeological sites either within the study area or a 3 kilometre radius (Von Bitter per comms, January 13, 2012).

Previous Research and Fieldwork

There are a number of publications regarding the history and development of Russell Township. *From Swamp to Shanty* (Wendell 1987) discusses the historic development of the western half of the township while *Histoire d'Embrun* (Bourgie 1980) describes early settlers' lives in the eastern half of the township. *The Illustrated Historical Atlas of Prescott and Russell* (Belden 1881) provides historical maps and specific information about people and places within Russell Township. Other historical accounts include *The History of the Ottawa Valley* (Gourlay 1896) and *Histoire de Comtes unis de Prescott et de Russell* (Brault 1965).

M. Emard (1974) and Donald Cartwright (1973) did statistical studies of settlement patterns in Eastern Ontario, including Russell Township according to linguistic groups.

There has been very little archaeological assessment work done in Russell Township. Some archaeological work that has been done in the area includes an overview of the archaeology and inventory of known archaeological sites as well as an assessment of archaeological potential of the Township was provided by Heritage Quest in 2004 (Daechsel & Bauer 2004). A Stage 1 archaeological assessment was undertaken for the expansion of Embrun and Russell Lagoons in 2006 (Daechsel 2007) and the Stage 2 assessment on the same properties was undertaken in 2007 and 2008 (Golder 2009; PIF P302-038-2008). More recently, Golder undertook assessments for lands located directly north of the study area and to the northwest (Golder 2011; PIF P311-049-2011 and P311-080-2011, respectively).

2.0 FIELD METHODS

A property inspection was conducted on the study area on November 24, 2009. This inspection was undertaken to determine if there were any areas of disturbance which would have affected the archaeological potential, and what assessment strategies would be appropriate for further detailed assessment should it be required.

The weather was overcast, 11 degrees with a strong NW wind.

Field notes and photographs of the property were taken during the inspection. The photograph locations and directions were noted and all photographs were catalogued (see Appendix A). All photograph locations and directions referenced in this report have been shown on Map 2. No archaeological remains were identified during the course of the property inspection. Areas of disturbance related to the quarry and residential areas were noted.

The following documents were generated in the field and will be kept with the licensee at Golder until an appropriate repository can be identified:

- Field notes (in 1 note book)
- Digital photographs
- GPS points
- Sketch maps

3.0 ANALYSIS AND CONCLUSIONS

There are no registered archaeological sites within a significant proximity to the study area. The area does however contain areas of archaeological potential that may indicate the presence of undiscovered archaeological resources.

Archaeological potential

There are a number of criteria employed in the assessment of archaeological site potential. For pre-contact or prehistoric sites, these criteria are principally focused on the topographical features of the landscape including ridges, knolls and eskers, and the type of soils found within the area being assessed. For post-contact or historic sites, documentary evidence such as maps and census records may indicate areas of settlement and activity. These criteria were formulated in close consultation with the *Ministry of Tourism, Culture and Sport's set guidelines* for archaeological resource potential mapping (2011).

The following assessment of archaeological potential has also been formulated in consultation with the Archaeological Resource Potential Mapping Study of the Regional Municipality of Ottawa-Carleton: Technical Report (Archaeological Services Inc. & Geomatics International Inc. 1999). Hereafter referred to as the Archaeological Master Plan, this report identifies areas of archaeological potential within the now amalgamated City of Ottawa and sets out guidelines for requiring testing. These guidelines also follow the *Checklist for Determining Archaeological Potential* developed by the Ontario Ministry of Tourism and Culture (1993) for archaeological assessments. The NRR Site falls just outside the City of Ottawa municipal boundaries and is therefore not actively mapped within the City of Ottawa Archaeological Master Plan; however, the criteria used for the generation of the Master Plan may be applied additional lands.

According to the Archaeological Master Plan modelling criteria, lands within 300 metres of 'two-line' rivers, watercourses with mapped floodplains and wetlands (as shown on 1:10 000 topographic maps) are considered to have pre-contact site potential, while lands with moderate or well drained soils within 200 metres of 'one-line' watercourses also have potential. Further, areas up to 300 metres from abandoned Ottawa and Rideau River terrace scarps have pre-contact site potential. In the case of drumlins and eskers, the entire feature has pre-contact potential. Areas near historical schools, churches, commercial buildings, industrial sites and early settlement roads are considered to have potential within 100 metres of the structure, known structure location or settlement road, the last with the object of locating early pioneer homes. Areas within 50 metres of historical railways are also considered to have site potential and, finally, any area within 100 metres of a registered or unregistered archaeological site.

There is moderate potential for pre-contact archaeological resources in the study area due to the high percentage of wet areas within the study area (Map 5). This would have formed an ideal hunting ground but not necessarily ideal for pre-contact habitation due to seasonal flooding.

There is moderate to high potential for post-contact archaeological resources within the study area. Historical records from the land registry office indicate that sections of the study area were first granted by the Crown as early as 1834. It is likely that settlement within the study area occurred between 1840 and 1860. The Walling historical map (Map 3) indicates that there was at least one house on each Lot by 1862 and in some cases there were multiple houses. 1871 census records (C10012) indicate that many of the property owners had several farm buildings and rapidly expanding families. A comparison of historical mapping and air photography indicates than a number of these early farmsteads had been abandoned prior to 1945. It is possible that foundations, garbage dumps, or artifact scatters relating to these sites remain within the study area.

Map 5 indicates all of the areas that have archaeological potential and are recommended for a further detailed archaeological assessment in advance of any future development. These areas of potential are a composite of pre-contact potential attributed to wet areas and watercourses, combined with the historic potential associated with early homesteads, roads and resource areas.

4.0 RECOMMENDATIONS

Based on the historic research and results of the property inspection, portions of the study area are considered to have archaeological potential and a further detailed assessment is required prior to development on any areas of archaeological potential.

The further detailed assessment should be undertaken by a licenced archaeologist and follow the *Standards and Guidelines for Consultant Archaeologists* (MTCS 2011, p. 31- p.32). Fallow fields, areas with mature trees and shrubs, and fields which are not actively being cultivated should undergo a further detailed assessment by way of test pit survey. It should include the excavation of test pits to subsoil by hand in a 5 m grid pattern throughout areas of archaeological potential, with test pits measuring 30 cm in diameter and all back-dirt to be screened through a minimum of 6 mm mesh. Actively cultivated land possessing archaeological potential should undergo further detailed assessment by pedestrian survey. The fields should be cultivated and allowed to weather before being field-walked at 5 m intervals.

This investigation has provided the basis for the following recommendations:

1) That a further detailed archaeological assessment be undertaken of any areas of archaeological potential that are to be affected by future development within the study area.

5.0 ADVICE ON COMPLIANCE WITH LEGISLATION

This report is submitted to the Minister of Tourism Culture and Sport as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism Culture and Sport, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeological Reports referred to in Section 65.1 of the *Ontario Heritage Act*.

Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.

The *Cemeteries Act* R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

6.0 IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the archaeological profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

This report has been prepared for the specific site, design objective, developments and purpose described to Golder by Taggart Miller Environmental Services (Taggart Miller- the Client). The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges the electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project.

Special risks occur whenever archaeological investigations are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain archaeological resources. The sampling strategies incorporated in this study comply with those identified in the *Ministry of Tourism Culture and Sport's Standards and Guidelines for Consulting Archaeologists* (2011).

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8.0 IMAGES

Please See Map 2 for photo locations and direction.

Image 1: Open agricultural land, facing east.

Image 2: Scrub and bush, east of the fields in Image 1, facing east.

Image 3: Bush and scrub, facing east.

Image 4: Open agricultural land, facing east.

Image 5: Wet area and woodlot southeast of quarry, facing east.

Image 6: Wet area located in southeast corner of study area, looking south east.

Image 7: Woodlot and wet area in the south east corner of the study area, looking south east.

Image 8: View across existing quarry in centre study area, looking north.

Image 9: Scrubland in the vicinity of existing quarry, looking west.

Image 10: Open scrubland on western edge of study area, facing north west.

Image 11: Agricultural fields immediately west of existing quarry, facing west.

Image 12: View from northeast of quarry facing south.

Image 13: Existing pasture, western edge of study area, facing east.

Image 14: Woodlot and wet area associated with South Morrow Municipal Drain, looking east.

Image 15: Open fields between the woodlot and wet area associated with South Morrow Municipal Drain and existing quarry, looking north west.

Image 16: Scrub and marsh grass in vicinity of DD1 (arm of Fournier Municipal Drain), looking east.

Image 17: Marsh grass and seasonal wet area east of Eadie Road, looking east.

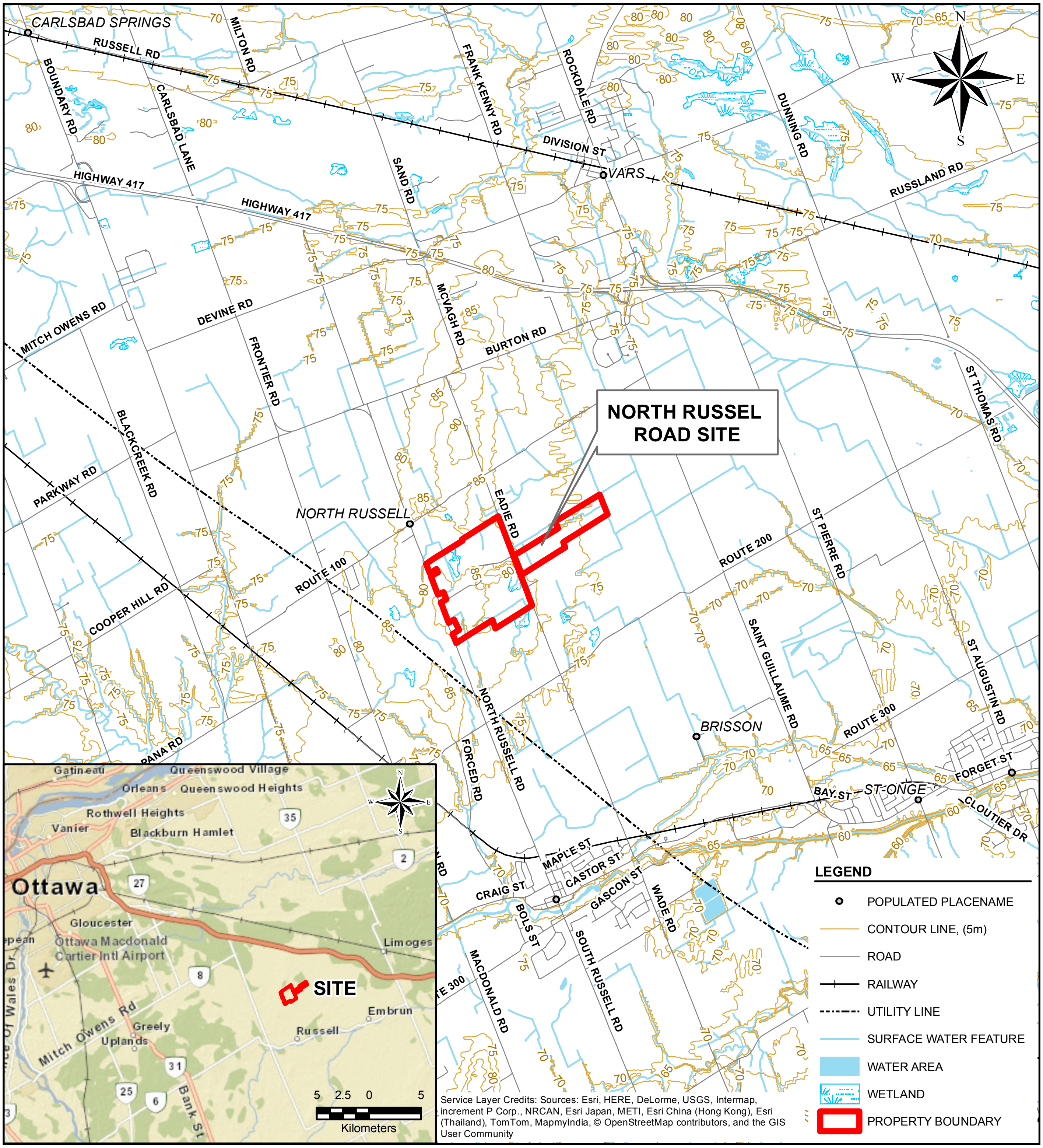
Image 18: Marsh grass and scrubland east of DD1, looking east.

Image 19: Scrubland east of DD1, looking south east.

Image 20: Woodlot at the eastern end of the study area, looking north east.

Image 21: Fournier Municipal Drain, eastern end of study area, looking north.

9.0 MAPS



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

1,600 800 0 1,600

SCALE 1:80,000 METRES

Golder Associates
Ottawa, Ontario

DATE FEB. 2013
DESIGN TR
GIS BR
CHECK EW
REVIEW HJD

PROJECT No. 12-1125-0045
SCALE AS SHOWN
REV. 0

TITLE

KEY PLAN

PROJECT ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

MAP 1

Path: \\golder.gds\gal\Ottawa\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Working\Phase0500\Task0160_CultureAndHeritage\1211250045-0500-0160-NRussellRd-01.mxd

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N
W
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LEGEND

- ● PHOTO LOCATION AND DIRECTION
- ○ POPULATED PLACENAME
- — ROAD
- — CONTOUR LINE, (5m)
- -·-· UTILITY LINE
- — SURFACE WATER FEATURE
- ▭ APPROXIMATE EXTENT OF EXISTING QUARRY EXCAVATION
- 🟥 PROPERTY BOUNDARY

200 100 0 200

SCALE 1:12,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT

REFERENCE

BING MAPS AERIAL, SEPT. 2010, PROVIDED BY ARCGIS ONLINE, ESRI, 2012.
SOURCE: (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF
THE CAPITAL REGION RESOURCE RECOVERY CENTRE

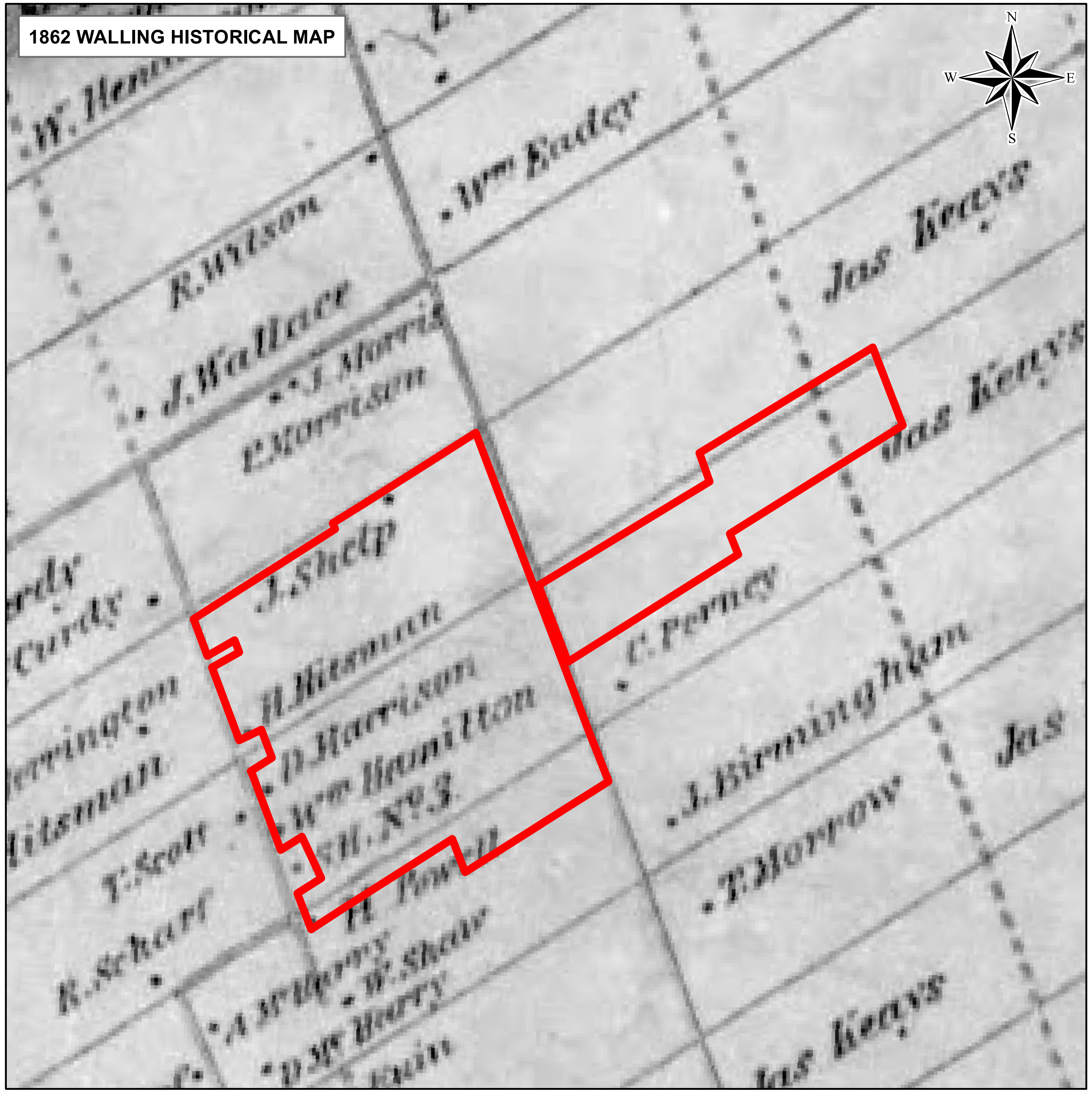
TITLE

SITE PLAN

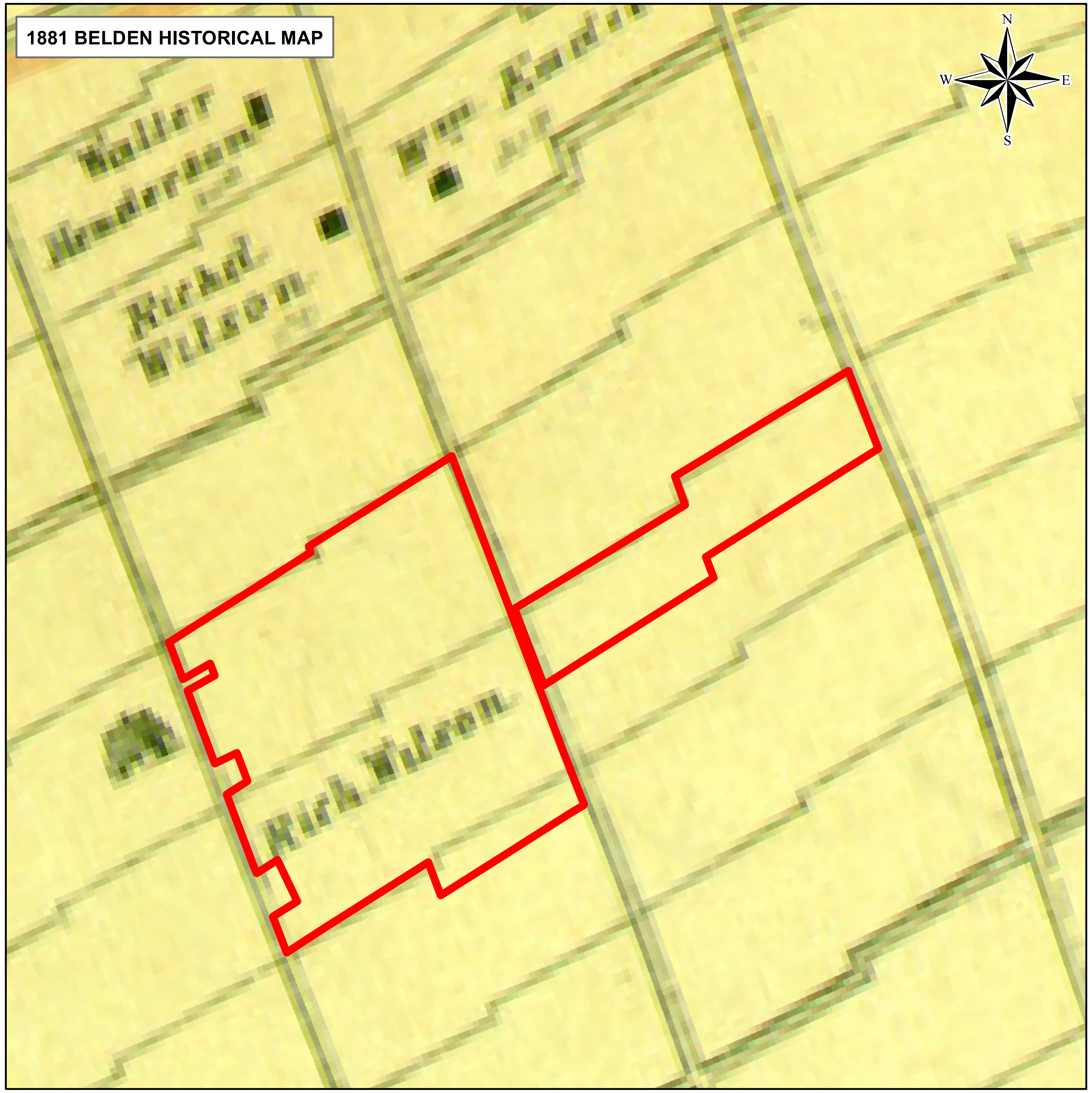
Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	TR	JAN. 2013	MAP 2	
GIS	BR	AUG. 2014		
CHECK	EW	AUG. 2014		
REVIEW	HJD	AUG. 2014		

1862 WALLING HISTORICAL MAP



1881 BELDEN HISTORICAL MAP



LEGEND

🟥 PROPERTY BOUNDARY

400 200 0 400

SCALE 1:20,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT

REFERENCE

1862 WALLING HISTORICAL MAP - RUSSELL COUNTY.
1881 BELDEN HISTORICAL MAP - EAST GLOUCESTER.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF
THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

HISTORIC MAPS

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0.0
DESIGN	TR	JAN. 2013	MAP 3	
GIS	BR	AUG. 2014		
CHECK	EW	AUG. 2014		
REVIEW	HJD	AUG. 2014		

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LEGEND

🟥 PROPERTY BOUNDARY

280 140 0 280

SCALE 1:14,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT

REFERENCE

1945 AIR PHOTOS - A9557-128 AND A9557-130, NAPL.
1985 AIR PHOTO - A31402-05, NAPL.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF
THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

AIR PHOTOS

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0.0
DESIGN	TR	JAN. 2013	**MAP 4**	
GIS	BR	AUG. 2014		
CHECK	EW	AUG. 2014		
REVIEW	HJD	AUG. 2014		

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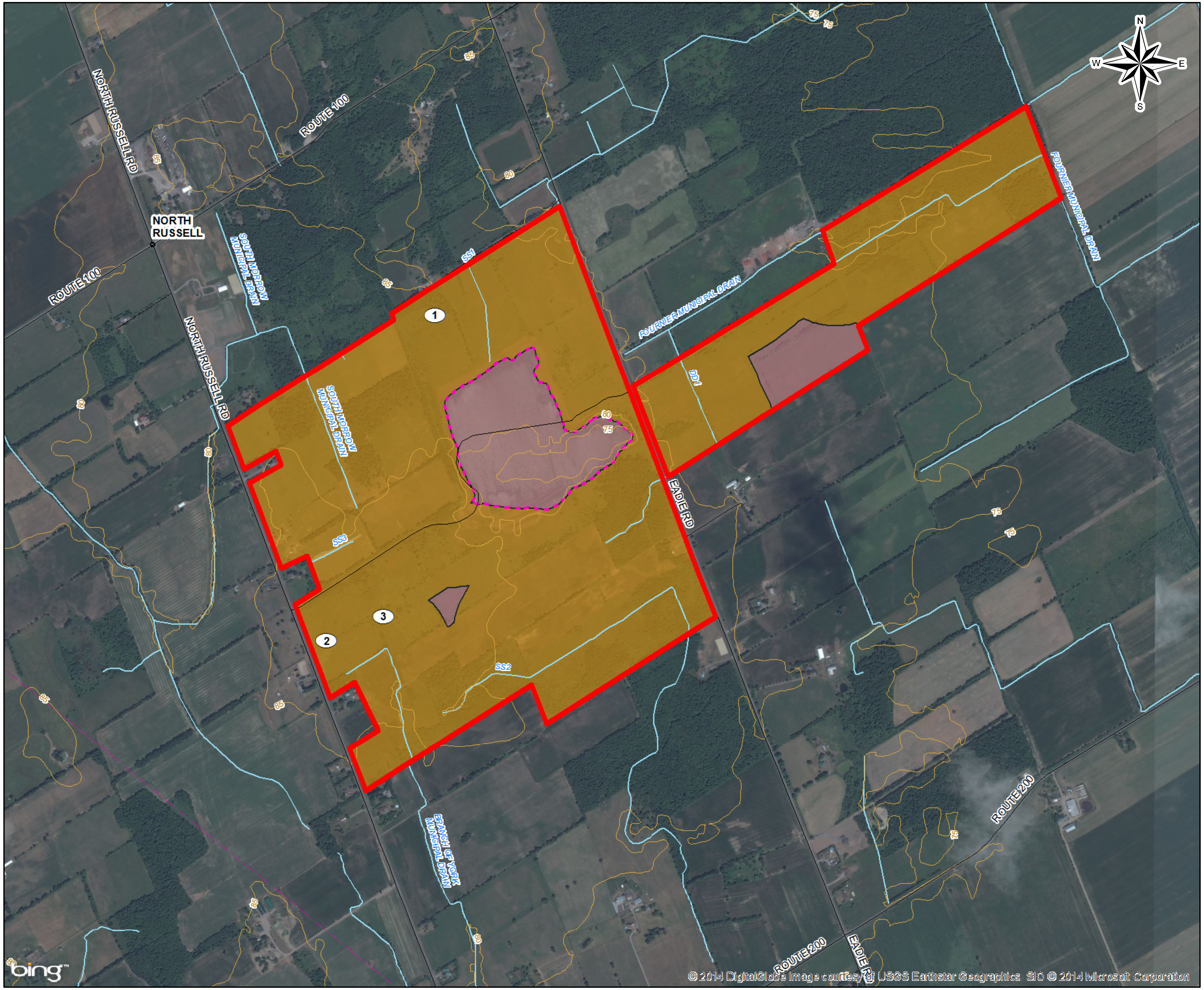

LEGEND

- ○ POPULATED PLACENAME
- — ROAD
- — CONTOUR LINE, (5m)
- -·-· UTILITY LINE
- — SURFACE WATER FEATURE
- ▭ APPROXIMATE EXTENT OF EXISTING QUARRY EXCAVATION
- ▨ ARCHAEOLOGICAL POTENTIAL
- ▨ LOW/NO ARCHAEOLOGICAL POTENTIAL
- ▭ PROPERTY BOUNDARY

① PROBABLE 19th CENTURY FARMSTED LOCATION

② PROBABLE 19th CENTURY FARMSTED LOCATION

③ PROBABLE 20th CENTURY FARMSTED LOCATION

200 100 0 200

SCALE 1:12,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT

REFERENCE

BING MAPS AERIAL, SEPT. 2010, PROVIDED BY ARCGIS ONLINE, ESRI, 2012. SOURCE: (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF
THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

AREAS OF ARCHAEOLOGICAL POTENTIAL

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	TR	JAN. 2013	MAP 5	
GIS	BR	AUG. 2014		
CHECK	EW	AUG. 2014		
REVIEW	HJD	AUG. 2014		

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Report Signature Page

GOLDER ASSOCIATES LTD.

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TR/PAS/HJD/clb/sg
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APPENDIX A

Photographic Catalogue

Catalogue No.	Description	Photographer	Date	Direction
0911251008-6000-D001	Southwest corner of study area	DG	24/11/09	NE
0911251008-6000-D002	Southwest corner of study area	DG	24/11/09	E
0911251008-6000-D003	Southwest corner of study area	DG	24/11/09	SE
0911251008-6000-D004	Drainage ditch in southwest corner	DG	24/11/09	S
0911251008-6000-D005	Drainage ditch in southwest corner	DG	24/11/09	E
0911251008-6000-D006	Drainage ditch in southwest corner	DG	24/11/09	NE
0911251008-6000-D007	Area adjacent to drainage ditch	DG	24/11/09	S
0911251008-6000-D008	Area adjacent to drainage ditch	DG	24/11/09	SE
0911251008-6000-D009	Area adjacent to drainage ditch	DG	24/11/09	E
0911251008-6000-D010	Area adjacent to drainage ditch	DG	24/11/09	NE
0911251008-6000-D011	Area adjacent to drainage ditch	DG	24/11/09	N
0911251008-6000-D012	Area adjacent to drainage ditch	DG	24/11/09	NW
0911251008-6000-D013	Area adjacent to drainage ditch	DG	24/11/09	W
0911251008-6000-D014	Area adjacent to drainage ditch	DG	24/11/09	SW
0911251008-6000-D015	Southern boundary of study area	DG	24/11/09	S
0911251008-6000-D016	Southern boundary of study area	DG	24/11/09	SE
0911251008-6000-D017	Southern drainage ditch west end	DG	24/11/09	S
0911251008-6000-D018	Southern drainage ditch west end	DG	24/11/09	SE
0911251008-6000-D019	Fields / scrub south west of quarry	DG	24/11/09	S
0911251008-6000-D020	Fields / scrub south west of quarry	DG	24/11/09	W
0911251008-6000-D021	Fields / scrub south west of quarry	DG	24/11/09	N
0911251008-6000-D022	Fields / scrub south west of quarry	DG	24/11/09	E
0911251008-6000-D023	Open fields south of quarry	DG	24/11/09	NE
0911251008-6000-D024	Open fields south of quarry	DG	24/11/09	E

Catalogue No.	Description	Photographer	Date	Direction
0911251008-6000-D025	Open fields south of quarry	DG	24/11/09	SE
0911251008-6000-D026	Open fields south of quarry	DG	24/11/09	S
0911251008-6000-D027	Field north of York Municipal Drain	DG	24/11/09	W
0911251008-6000-D028	Field north of York Municipal Drain	DG	24/11/09	NW
0911251008-6000-D029	Field north of York Municipal Drain	DG	24/11/09	N
0911251008-6000-D030	Field north of York Municipal Drain	DG	24/11/09	NE
0911251008-6000-D031	Field north of York Municipal Drain	DG	24/11/09	E
0911251008-6000-D032	Drainage ditch with open space	DG	24/11/09	SE
0911251008-6000-D033	South east corner of study area	DG	24/11/09	N
0911251008-6000-D034	South east corner of study area	DG	24/11/09	NE
0911251008-6000-D035	South east corner of study area	DG	24/11/09	E
0911251008-6000-D036	South east corner of study area	DG	24/11/09	SE
0911251008-6000-D037	South east corner of study area	DG	24/11/09	S
0911251008-6000-D038	South east corner of study area	DG	24/11/09	SW
0911251008-6000-D039	South east corner of study area	DG	24/11/09	W
0911251008-6000-D040	South east corner of study area	DG	24/11/09	NW
0911251008-6000-D041	South east woodlot	DG	24/11/09	E
0911251008-6000-D042	South east woodlot	DG	24/11/09	SE
0911251008-6000-D043	South east woodlot	DG	24/11/09	S
0911251008-6000-D044	South east woodlot	DG	24/11/09	SW
0911251008-6000-D045	Eastern boundary of south ditch	DG	24/11/09	SW
0911251008-6000-D046	Wet area along Eadie road, south east corner	DG	24/11/09	E
0911251008-6000-D047	Wet area along Eadie road, south east corner	DG	24/11/09	E
0911251008-6000-D048	Wet area along Eadie road, south east corner	DG	24/11/09	N

Catalogue No.	Description	Photographer	Date	Direction
0911251008-6000-D049	Wet area along Eadie road, south east corner	DG	24/11/09	W
0911251008-6000-D050	Wet area along Eadie road, south east corner	DG	24/11/09	S
0911251008-6000-D051	Southern edge of quarry	DG	24/11/09	E
0911251008-6000-D052	Southern edge of quarry	DG	24/11/09	NE
0911251008-6000-D053	Southern edge of quarry	DG	24/11/09	N
0911251008-6000-D054	Southern edge of quarry	DG	24/11/09	NW
0911251008-6000-D055	Southern edge of quarry	DG	24/11/09	W
0911251008-6000-D056	quarry / extraction area	DG	24/11/09	NW
0911251008-6000-D057	quarry / extraction area	DG	24/11/09	N
0911251008-6000-D058	quarry / extraction area	DG	24/11/09	NE
0911251008-6000-D059	quarry extraction area	DG	24/11/09	N
0911251008-6000-D060	Wet area south east of quarry	DG	24/11/09	NE
0911251008-6000-D061	Wet area south east of quarry	DG	24/11/09	E
0911251008-6000-D062	Wet area south east of quarry	DG	24/11/09	S
0911251008-6000-D063	Wet area south east of quarry	DG	24/11/09	W
0911251008-6000-D064	Southeast corner of quarry	DG	24/11/09	N
0911251008-6000-D065	Pipe at eastern boundary	DG	24/11/09	E
0911251008-6000-D066	Eastern boundary of study area	DG	24/11/09	SW
0911251008-6000-D067	Eastern boundary of study area	DG	24/11/09	W
0911251008-6000-D068	Eastern boundary of study area	DG	24/11/09	NW
0911251008-6000-D069	Eastern boundary of study area	DG	24/11/09	N
0911251008-6000-D070	From eastern boundary of quarry	DG	24/11/09	W
0911251008-6000-D071	From eastern boundary of quarry	DG	24/11/09	NE
0911251008-6000-D072	From eastern boundary of quarry	DG	24/11/09	E

Catalogue No.	Description	Photographer	Date	Direction
0911251008-6000-D073	From eastern boundary of quarry	DG	24/11/09	SE
0911251008-6000-D074	From eastern boundary of quarry	DG	24/11/09	S
0911251008-6000-D075	From northeast boundary of study area	DG	24/11/09	N
0911251008-6000-D076	From northeast boundary of study area	DG	24/11/09	NE
0911251008-6000-D077	From northeast boundary of study area	DG	24/11/09	E
0911251008-6000-D078	From northeast boundary of study area	DG	24/11/09	SE
0911251008-6000-D079	From northeast boundary of study area	DG	24/11/09	S
0911251008-6000-D080	From northeast boundary of study area	DG	24/11/09	SW
0911251008-6000-D081	From northeast boundary of study area	DG	24/11/09	W
0911251008-6000-D082	From northeast boundary of study area	DG	24/11/09	NW
0911251008-6000-D083	From area adjacent to Russell Road	DG	24/11/09	W
0911251008-6000-D084	From area adjacent to Russell Road	DG	24/11/09	N
0911251008-6000-D085	From area adjacent to Russell Road	DG	24/11/09	E
0911251008-6000-D086	From area adjacent to Russell Road	DG	24/11/09	S
0911251008-6000-D087	From area adjacent to Russell Road	DG	24/11/09	S
0911251008-6000-D088	From area adjacent to Russell Road	DG	24/11/09	W
0911251008-6000-D089	From area adjacent to Russell Road	DG	24/11/09	N
0911251008-6000-D090	From area adjacent to Russell Road	DG	24/11/09	E
0911251008-6000-D091	West boundary from north west corner	DG	24/11/09	E
0911251008-6000-D092	West boundary from north west corner	DG	24/11/09	S
0911251008-6000-D093	West boundary from north west corner	DG	24/11/09	W
0911251008-6000-D094	West boundary from north west corner	DG	24/11/09	N
0911251008-6000-D095	Wet area in north west of study area	DG	24/11/09	N
0911251008-6000-D096	Wet area in north west of study area	DG	24/11/09	NE

Catalogue No.	Description	Photographer	Date	Direction
0911251008-6000-D097	Wet area in north west of study area	DG	24/11/09	E
0911251008-6000-D098	Wet area in north west of study area	DG	24/11/09	SE
0911251008-6000-D099	Wet area in north west of study area	DG	24/11/09	S
0911251008-6000-D100	Wet area in north west of study area	DG	24/11/09	SW
0911251008-6000-D101	Wet area in north west of study area	DG	24/11/09	W
0911251008-6000-D102	Wet area in north west of study area	DG	24/11/09	NW
0911251008-6000-D103	Drainage Ditch in north west portion	DG	24/11/09	S
0911251008-6000-D104	Drainage Ditch in north west portion	DG	24/11/09	N
0911251008-6000-D105	Waterlogged area around drainage ditch	DG	24/11/09	E
0911251008-6000-D106	Waterlogged area around drainage ditch	DG	24/11/09	SE
0911251008-6000-D107	Waterlogged area around drainage ditch	DG	24/11/09	E
0911251008-6000-D108	From eastern edge of wet area	DG	24/11/09	NE
0911251008-6000-D109	From eastern edge of wet area	DG	24/11/09	E
0911251008-6000-D110	From eastern edge of wet area	DG	24/11/09	SE
0911251008-6000-D111	From northern edge of wet area	DG	24/11/09	NE
0911251008-6000-D112	From northern edge of wet area	DG	24/11/09	N
0911251008-6000-D113	From northern edge of wet area	DG	24/11/09	NW
0911251008-6000-D114	Adjacent to North Russell Road	DG	24/11/09	S
0911251008-6000-D115	Adjacent to North Russell Road	DG	24/11/09	SE
0911251008-6000-D116	Adjacent to North Russell Road	DG	24/11/09	SW
0911251008-6000-D117	Study area east of existing quarry	DG	12/04/2009	N
0911251008-6000-D118	Study area east of existing quarry	DG	12/04/2009	NE
0911251008-6000-D119	Study area east of existing quarry	DG	12/04/2009	E
0911251008-6000-D120	Study area east of existing quarry	DG	12/04/2009	S

Catalogue No.	Description	Photographer	Date	Direction
0911251008-6000-D121	Study area east of existing quarry	DG	12/04/2009	W
0911251008-6000-D122	Study area east of existing quarry	DG	12/04/2009	N
0911251008-6000-D123	Study area east of existing quarry	DG	12/04/2009	NE
0911251008-6000-D124	Study area east of existing quarry	DG	12/04/2009	E
0911251008-6000-D125	Study area east of existing quarry	DG	12/04/2009	SE
0911251008-6000-D126	Study area east of existing quarry	DG	12/04/2009	S
0911251008-6000-D127	Study area east of existing quarry	DG	12/04/2009	SW
0911251008-6000-D128	Study area east of existing quarry	DG	12/04/2009	W
0911251008-6000-D129	Study area east of existing quarry	DG	12/04/2009	NW
0911251008-6000-D130	Area of Fournier Municipal Drain	DG	12/04/2009	NW
0911251008-6000-D131	Area of Fournier Municipal Drain	DG	12/04/2009	SE
0911251008-6000-D132	Area of Fournier Municipal Drain	DG	12/04/2009	NE
0911251008-6000-D133	Area of Fournier Municipal Drain	DG	12/04/2009	E
0911251008-6000-D134	Wet area east of Fournier Municipal Drain	DG	12/04/2009	SE
0911251008-6000-D135	From centre of western arm of study area	DG	12/04/2009	N
0911251008-6000-D136	From centre of western arm of study area	DG	12/04/2009	E
0911251008-6000-D137	From centre of western arm of study area	DG	12/04/2009	S
0911251008-6000-D138	From centre of western arm of study area	DG	12/04/2009	W
0911251008-6000-D139	From centre of western arm of study area	DG	12/04/2009	N
0911251008-6000-D140	From centre of western arm of study area	DG	12/04/2009	NE
0911251008-6000-D141	From centre of western arm of study area	DG	12/04/2009	E
0911251008-6000-D142	From centre of western arm of study area	DG	12/04/2009	SE
0911251008-6000-D143	From centre of western arm of study area	DG	12/04/2009	S
0911251008-6000-D144	From centre of western arm of study area	DG	12/04/2009	SW

Catalogue No.	Description	Photographer	Date	Direction
0911251008-6000-D145	From centre of western arm of study area	DG	12/04/2009	W
0911251008-6000-D146	From centre of western arm of study area	DG	12/04/2009	NW
0911251008-6000-D147	Drainage ditch feeding Fournier Drain	DG	12/04/2009	S
0911251008-6000-D148	Drainage ditch feeding Fournier Drain	DG	12/04/2009	N
0911251008-6000-D149	Roadway along field boundary	DG	12/04/2009	N
0911251008-6000-D150	Roadway along field boundary	DG	12/04/2009	E
0911251008-6000-D151	Roadway along field boundary	DG	12/04/2009	S
0911251008-6000-D152	Roadway along field boundary	DG	12/04/2009	W
0911251008-6000-D153	Scrub and bush at eastern boundary	DG	12/04/2009	N
0911251008-6000-D154	Scrub and bush at eastern boundary	DG	12/04/2009	NE
0911251008-6000-D155	Scrub and bush at eastern boundary	DG	12/04/2009	E
0911251008-6000-D156	Scrub and bush at eastern boundary	DG	12/04/2009	SE
0911251008-6000-D157	Scrub and bush at eastern boundary	DG	12/04/2009	S
0911251008-6000-D158	Scrub and bush at eastern boundary	DG	12/04/2009	SW
0911251008-6000-D159	Scrub and bush at eastern boundary	DG	12/04/2009	W
0911251008-6000-D160	Scrub and bush at eastern boundary	DG	12/04/2009	NW
0911251008-6000-D161	Area south of Fournier Drain at east end	DG	12/04/2009	N
0911251008-6000-D162	Area south of Fournier Drain at east end	DG	12/04/2009	NE
0911251008-6000-D163	Area south of Fournier Drain at east end	DG	12/04/2009	E
0911251008-6000-D164	Area south of Fournier Drain at east end	DG	12/04/2009	SE
0911251008-6000-D165	Area south of Fournier Drain at east end	DG	12/04/2009	S
0911251008-6000-D166	Area south of Fournier Drain at east end	DG	12/04/2009	SW
0911251008-6000-D167	Area south of Fournier Drain at east end	DG	12/04/2009	W
0911251008-6000-D168	Area south of Fournier Drain at east end	DG	12/04/2009	NW

Catalogue No.	Description	Photographer	Date	Direction
0911251008-6000-D169	Fournier Dain east/west	DG	12/04/2009	E
0911251008-6000-D170	Fournier Drain east/west	DG	12/04/2009	W
0911251008-6000-D171	Wet area and woodlot in proximity to Drain	DG	12/04/2009	N
0911251008-6000-D172	From centre of eastern boundary	DG	12/04/2009	N
0911251008-6000-D173	From centre of eastern boundary	DG	12/04/2009	NE
0911251008-6000-D174	From centre of eastern boundary	DG	12/04/2009	E
0911251008-6000-D175	From centre of eastern boundary	DG	12/04/2009	SE
0911251008-6000-D176	From centre of eastern boundary	DG	12/04/2009	S
0911251008-6000-D177	From centre of eastern boundary	DG	12/04/2009	SW
0911251008-6000-D178	From centre of eastern boundary	DG	12/04/2009	W
0911251008-6000-D179	From centre of eastern boundary	DG	12/04/2009	NW

DG = Dan Goss

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ATTACHMENT TSD#1-F-2

Archaeological Assessment, Boundary Road Site

February 2013

February 6, 2013

REPORT ON

Archaeological Assessment
Capital Region Resource Recovery Centre
Boundary Road Site
Part Lots 23-25, Concession 11
Cumberland Township
City of Ottawa

PIF Number: P366-026-2013

Submitted to:
Taggart Miller Environmental Services
P.O. Box 4080
Markham, Ontario

REPORT

Report Number: 12-1125-0045/4500/0160-2

Golder Associates

Executive Summary

The Executive Summary highlights key points from the report only; for complete information and findings, as well as the limitations, the reader should examine the complete report.

Golder Associates Ltd. (Golder) completed a preliminary archaeological assessment of the lands located on Lots 23 - 25, Concession 11, Cumberland Township, Ontario. The archaeological assessment is part of an overall assessment of lands located between Boundary Road and Frontier Road and south of Highway 417. This study area, known as the Boundary Road Site (BR), is being assessed as a possible location for the Capital Region Resource Recovery Centre (CRRRC). The objective of the archaeological investigation was to identify known heritage and archaeological sites within and in the vicinity of the study area and to assess its archaeological potential.

The study area consisted of 3 part lots totalling 175 hectares. The study area was composed primarily of overgrown agricultural fields with a smaller component of actively cultivated fields. The study area is bounded to the north by Highway 417, to the west by the Boundary Road Industrial Park and Boundary Road, to the east by Frontier Road and to the south by a Devine Road and a mix of wood lots and agricultural fields.

There is evidence of human occupation in Eastern Ontario dating at least 9,000 Before Present (B.P.) following the retreat of the Champlain Sea. Although open at this time, Cumberland Township would have been very sparsely populated through the Palaeo-Indian period but would have experienced a gradual increase in population during the subsequent Archaic and Woodland periods. Even with this increase, the highly mobile and seasonal nature of habitation ensured that the region would remain sparsely populated until European colonization and agricultural intensification during the early nineteenth century.

Settlement on Lots 23 – 25 did not occur until the late nineteenth century and early twentieth century. Crown patents for Lots 23 & 24 were granted in 1865, while patents for Lot 25 were granted in 1874. According to the available historic maps, no structures were located within the study area in 1825, 1840, 1861 or 1881. Furthermore, the first roads to border the study area do not appear until 1923, and at the time it was only a small section of Frontier Road, south of Devine Road that was in use (Prescott and Russell Counties Map, 1923).

There are no registered archaeological sites in the study area or within a three kilometre radius. Due to the flat topography, poorly drained soils, and relatively late settlement date, the study area contains low archaeological potential for both pre-contact and historic resources.

This investigation has provided the basis for the following recommendations:

1) That the CRRRC Boundary Road study area does not require further archaeological assessment.

Project Personnel

Client Contact	Jeff Parkes; Taggart Miller Environmental Services
Project Director	Paul Smolkin P.Eng.
Senior Report Review	Hugh Daechsel M.A. (P051)
Licensed Archaeologist	Erin Wilson M.A. (P366)
Project Manager	Trish Edmond P.Eng
Report Preparation	Bradley Drouin M.A. (P311), Tim Rangecroft M.Sc. (R383)
Spatial Imaging	Bojan Radojevic, Jamie McKenzie
Administrative Support	Candice Butler

Abbreviations

MTCS	Ministry of Tourism, Culture and Sport (Ontario)
ASDB	Archaeological Sites Database
CRRRC	Capital Region Resource Recovery Centre
NRR	North Russell Road
PIF	Project Information Form
B.P.	Before Present (Taken to be 1950)
C14	Carbon 14 dating technique

Table of Contents

IMAGES

MAPS

APPENDICES

1.0 PROJECT CONTEXT

1.1 Objectives

This archaeological assessment was completed to identify known archaeological resources on and in the vicinity of the study area as well as assess the archaeological potential of the subject property. The assessment will determine if any additional archaeological investigations are required. The objectives of this assessment are based on principles outlined in the *Ontario Heritage Act* (Consolidated 2007), and comply with the Ministry of Tourism, Culture and Sport's *Standards and Guidelines for Consulting Archaeologists* (2011). More specifically, studies were completed with the following objectives:

- To provide information about the property's geography, history, previous archaeological fieldwork and current land condition;
- To evaluate in detail the property's archaeological potential, which will support recommendations for further detailed surveys for all or parts of the property; and,
- To recommend appropriate strategies for further detailed surveys, if required.

1.2 Development Context

Golder Associates Ltd. (Golder) was contracted by Taggart Miller Environmental Services (Taggart Miller) to undertake an Archaeological assessment of the properties located on Part Lots 23 - 25, Concession 11, Geographic Township of Cumberland, Ontario. This study area is being assessed as a possible location for the Capital Region Resource Recovery Centre (CRRRC). The objective of the study was to identify known archaeological sites within and in the vicinity of the study area and to assess its archaeological potential.

The study area consisted of 3 separate lots totalling approximately 175 hectares. The study area consists predominantly of overgrown agricultural fields with a smaller component of active fields. The study area, known as the Boundary Road Site (BR), is bounded to the north by Highway 417, to the west by the Boundary Road Industrial Park and Boundary Road, to the east by Frontier Road and to the south by Devine Road and a mix of wood lots and agricultural land. The study area is indicated by the boundaries on Maps 1 & 2; these are the physical limits of any proposed development. A wider study area of 3 km was used to investigate the Ministry of Tourism, Culture and Sports' (MTCS) *Archaeological Sites Database* (ASDB) in accordance with the *Standards and Guidelines for Consulting Archaeologists (2011)* and professional standards of due diligence.

This assessment was undertaken in advance of the pre-development permitting process, and for the purposes of the MTCS was triggered by the need to identify any potential impacts to archaeological resources as considered under the *Canadian Environmental Assessment Act*. The CRRRC project has an approved Terms of Reference and the provincial Environmental Assessment activities have commenced.

Permission to access the study area for the purpose of archaeological assessment was provided by Taggart Miller in consultation with local landowners.

1.3 Historical Context

Our understanding of the local sequence of human activity in the study area following the recession of the last ice sheet and the Champlain Sea is incomplete. It is possible, however, to provide a general outline of prehistoric occupation in the Ottawa region based on the archaeological investigations conducted throughout eastern Ontario.

1.3.1 Pre-Contact Occupation

Human occupation of southern Ontario dates back approximately 10,000 years B.P. These first peoples, known as Palaeo-Indians to archaeologists, moved into Ontario as the last of the glaciers retreated northward. The former shores of the vast glacial lakes such as Lake Algonquin in the area that is now southern Georgian Bay, and along the north shore of present day Lake Ontario, contain remnants of some of their sites. Isolated finds of the distinctive, parallel-flaked Palaeo-Indian spear points have been recorded in the Rideau Lakes and north of Kingston (Watson 1982). Although there is limited information on the lifestyle of the Palaeo-Indians, the little evidence that is available suggests that they were highly mobile hunters and gatherers relying on caribou, small game, fish and wild plants found in the sub-arctic environment.

The Ottawa Valley remained very much on the fringe of occupation at this time. The ridges and old shorelines of the Champlain Sea and early Ottawa River channels would be the areas most likely to contain evidence of Palaeo-Indian occupation in this region. What is believed by some to be late Palaeo-Indian material has been found in several locations within the City of Ottawa including a site in Honey Gables as well as in general proximity to the study area, near Albion Road and Rideau Road, Innes Road, and north of the Mer Bleue close to the intersection of Navan Road and Page Road (Swayze 2001, 2003 & 2004).

It was not until the succeeding Archaic Period (ca. 9,000 to 3,000 B.P.), that the environment of southern Ontario approached modern conditions. While more land became available for occupation as the glacial lakes drained, Archaic populations continued as hunter-gatherers, however they appear to have focused more on local food resources, abandoning the highly mobile lifestyle of their predecessors. Although Palaeo-Indian workmanship of stone tools was also lost, the Archaic Period tool kit became more diversified, reflecting the adaptation to a temperate forest environment. Ground stone tools such as adzes and gouges first appeared and may indicate the construction of the dug-out canoes or other heavy wood working activities. Extensive trade networks had developed by the middle to late Archaic Period. Items such as copper from the north shore of Lake Superior were exchanged during this time.

The first significant evidence for occupation in the Ottawa Valley appears at this time. Archaic sites have been identified on Allumettes and Morrison Islands on the Ottawa River near Pembroke, and within the boundaries of Leamy Lake Park within the City of Gatineau (Pilon 1999: 43-53, 64). Late Archaic sites have also been identified to the west in the Rideau Lakes, and the east at Jessup Falls and Pendleton along the South Nation River (Daechsel 1980). A few other poorly documented finds of Archaic artifacts have been made within the City limits (Jamieson 1989).

The Woodland Period (ca. 3,000 to 400 B.P.) is distinguished by the introduction of ceramics. Early Woodland groups continued to live as hunters, gatherers and fishers in much the same way as earlier populations had done. They also shared an elaborate burial ceremonialism evidenced by the inclusion of exotic artifacts within graves (Spence et. al. 1990: 129). Extensive trade networks continued through the early part of this period and Early Woodland populations in Ontario appear to have been heavily influenced by groups to the south, particularly the Adena people of the Ohio Valley. By 1,700 B.P., the trade networks had reached their peak and covered much of North America.

Through the Middle Woodland Period (ca. 2,400 to 1,100 B.P.) there was an increase in the decorative styles found on ceramic pots and changes in the shapes and types of tools used. For the first time, it is possible to identify regional cultural traditions within the province, with 'Point Peninsula' being the distinctive variant found in eastern and south-central Ontario. A greater number of known sites from this period have allowed archaeologists to develop a better picture of the seasonal round followed in order to exploit a variety of resources within a home territory. Through the late fall and winter, small groups would occupy an inland 'family' hunting area. In the spring, these dispersed families would congregate at specific lakeshore sites to fish, hunt in the surrounding forest, and socialize. This gathering would last through to the late summer when large quantities of food would be stored for the approaching winter. The proliferation of sites suggests an increase in the population of Eastern Ontario, although the Ottawa area has yet to yield as many sites as other parts of south-eastern Ontario. Middle Woodland sites have been noted in the South Nation Drainage Basin and along the Ottawa River including the northwest end of Ottawa at Marshall's and Sawdust Bays (Daechsel 1980; Daechsel 1981).

Another significant development of the Woodland Period was the appearance of domesticated plants ca. 1,450 B.P. Initially only a minor addition to the diet, the cultivation of corn, beans, squash, sunflowers and tobacco gained economic importance for Late Woodland peoples. Along with this shift in subsistence, settlements located adjacent to the corn fields began to take on greater permanency as sites with easily tillable farmland became more important. Eventually, semi-permanent and permanent villages were built, many of which were surrounded by palisades, evidence of growing hostilities between neighbouring groups. By the end of the Late Woodland Period, distinct regional populations occupied specific areas of southern Ontario separated by vast stretches of largely unoccupied land, including the Huron along the north shore of Lake Ontario, and the St. Lawrence Iroquois along the St. Lawrence River.

While there is clear evidence of these latter developments in much of southern Ontario, the Ottawa Valley remained a sparsely occupied region utilized by mobile hunter-gatherers. In part, this was because the terrain was less than suitable for early agriculture. It was also a reflection of the increased pressure on hunting territories and conflict over trade routes at the end of the Woodland Period. Facing persistent hostilities with Iroquoian populations based in what is now New York State, the Huron moved from their traditional lands on the north shore of Lake Ontario to the Lake Simcoe and Georgian Bay region. Algonquin groups, who had occupied the lands north of the Huron, also appear to have retreated further northward in order to place greater distance between themselves and the Iroquois.

Woodland sites have been recorded throughout the Ottawa Valley. Two small Late Woodland sites were recently located on a property near the Village of Cumberland to the east of the study area (Ferris, 2002). A significant Woodland occupation has also been identified at the Leamy Lake site (Pilon 1999: 76-80). Finally, an ossuary burial identified near the Chaudière Falls in the 1840s dates to this period. Although ossuaries are a burial practice normally associated with Iroquoian speaking populations, especially the Huron, this internment may have been Algonquin. Once again, a number of poorly documented Woodland find spots are known for the general study area (Jamieson 1989).

At the time of initial contact, the French documented three Algonquin groups residing in the vicinity of the study area (Heidenreich & Wright 1987: Plate 18). These included the Matouweskarini along the Madawaska River to the west, the Onontchataronon in the Gananoque River basin to the southwest, and the largest of the three, the Weskarini, situated in the Petite Nation River basin north of the study area. While prolonged occupation of the region may have been avoided as a result of hostilities with Iroquoian speaking populations to the south, at least the northern reaches of the South Nation River basin were undoubtedly used as hunting territories by the Algonquin at this time.

1.3.2 Post-Contact Occupation

Étienne Brûlé is reported to be the first European in the region; having travelled up the Ottawa River in 1610, three years before Samuel de Champlain. For the next two centuries, the Ottawa River served as a major route for explorers, traders and missionaries from the St. Lawrence into the interior, and throughout the seventeenth and eighteenth centuries this route remained an important link in the French fur trade. A seigneury was established at L'Orignal, east of the study area, in 1674 and granted to Nathaniel Hazard Treadwell but there was little permanent European settlement at this early date. The recovery of European trade goods (i.e., iron axes, copper kettle pieces and glass beads) from Native sites throughout the Ottawa River drainage basin has provided evidence of the extent of contact between Natives and the fur traders during this period. The English, upon assuming possession of New France, continued to use the Ottawa River as an important transportation corridor.

A French trading post was built near the mouth of Le Lievre River, near the present community of Buckingham, Quebec, sometime in the eighteenth century. This post had been abandoned by the time Alexander Henry travelled up the Ottawa River in 1761 (Voorhis 1930:62). Independent trading posts at Buckingham and in the Rockland area were reportedly operated by Gabriel Foubert in the late eighteenth century (Beaulieu n.d.). Gabriel was the father of Amable Foubert, one of the first recorded settlers in Cumberland Township.

Significant European settlement of the region did not occur until United Empire Loyalists and other immigrants began to move to lands along the Ottawa River in the late eighteenth and early nineteenth centuries. The need for land on which to settle the Loyalists led the British government into hasty negotiations with their indigenous military allies, the Mississauga, who were assumed, erroneously, to be the only Native peoples inhabiting eastern Ontario. Captain William Redford Crawford, who enjoyed the trust of the Mississauga chiefs living in the Bay of Quinte region, negotiated on behalf of the British government. In the so-called 'Crawford Purchase,' the Mississauga were cajoled into giving up Native title to most of eastern Ontario, including what would become the counties of Stormont, Dundas, Glengarry, Prescott, Russell, Leeds, Grenville and Prince Edward, as well as the front Townships of Frontenac, Lennox, Addington and Hastings and much of what is now the City of Ottawa (including the Geographic Townships of Gloucester, Nepean, Osgoode, Marlborough and North Gower) (Lockwood 1996: 24). Two years after the 1791 division of the Province of Quebec into Upper and Lower

Canada, John Stegmann, the Deputy Surveyor for the Province of Upper Canada, undertook an initial survey of four Townships (Nepean, Gloucester, North Gower and Osgoode) on both sides of the Rideau River near its junction with the Ottawa River.

1.3.3 Cumberland Township

The Ottawa River was an important transportation route during the early trading days of settlement in the area. Fur trading posts were erected along the Ottawa River where the Algonquin traded with the Europeans. A French trading post was situated across the river from Cumberland in modern day Buckingham in 1761. This area was controlled by France until 1763 when the British gained control of the region following the completion of the Seven Year War. The Township of Cumberland still has a large French population to this day.

The first official survey of the Township of Cumberland was conducted in 1791 (CTHS n.d.) in order to divide the land into individual lots for settlement. Although many of the lots were granted at an early date to Loyalists, very few were settled. Many of the Loyalists had already settled on properties along the St. Lawrence River and remained absentee landowners of their Cumberland lots. Another hindrance to early settlement of Cumberland was the lack of roads to the interior (Belden 1881). The first major road, Montreal Road (originally called L'Orignal-Bytown Rd.) was not built until 1850; this road ran directly through Concession 1 along the Ottawa River (CTHS n.d.; McGilvray 2005).

The first settlers of the Township of Cumberland were Abijah Dunning and Amable Faubert (also written Foubert), both arriving in 1801. Abijah Dunning originally obtained 800 acres of land in Cumberland from the Crown and continued to acquire land, eventually coming to own 3,000 acres throughout Cumberland, Buckingham and Onslow Townships. Amable Faubert opened up a trading post along the river in 1807. Cumberland Township was used for trading mostly fur, potash and lumber through the nineteenth century. The Foubert and Dunning families continued to have a large presence in the Township throughout the nineteenth century.

By 1858 the Village of Cumberland had a population of over 1,000 with an additional 2,000 residents in the rural parts of the Township. Cumberland became a major seasonal forwarding center along the Ottawa River in the 1870's, where two wharves were built and several forwarding companies were established, including one owned by the Faubert brothers. This helped facilitate a small ship building industry in the Township during the mid-nineteenth century (CTHS n.d.).

In 1882, the Grand Trunk Railway was built through the community of Vars which provided the first rail transportation route through the Township. Another railway, the Canadian National Railway (CNR), was built through Cumberland Township in 1899 and was extended in 1907 to run through Concession 1 along the river (CTHS n.d.). The CNR was closed during the depression and in 1952 the old line was replaced by the current Highway 417.

Present Land Use

The study area is currently a mix of agricultural fields and secondary growth. Three residential buildings, one associated with a farming operation, are also present along Frontier Road at the eastern edge of the study area.

Property History

Land registry documents were examined to provide a history of ownership and development within the study area. The documents indicated that Lots 23-24 in Concession 11 were granted by Crown Patent to Andrew F. Gault in 1865, with both Lots subsequently bought by James Boyd in 1872. The block transfer of large amounts of land is usually indicative of speculative holding rather than settlement. Both Lots are sold concurrently between O.N. Schnei, N. Smith, J. Bond, R. Scott and E. Keays during the period between 1875 and 1885 before returning to the possession of A. Gault. The Lots continued to be frequently traded well into the 1890's and early 1900's. It is highly unlikely that the Lots were settled prior to 1872, with the land registry suggesting that the area was settled possibly after 1880.

Lots 25, Concession 11 was granted by Crown Patent to William, F. Powell in 1874, and subsequently sold to John Nicholas in 1880. Ownership appears to have reverted to the Crown later in 1880, a series of entries involving the Ontario Bank occur, the net result of which is that the Lot was obtained from the Chancery by Martin O'Gara in 1885. The Lot was sold immediately by O'Gara and bought and sold with frequency over the next 10 years. The Lot appears to be split in the late 1890's. It is unlikely that the Lot was settled prior to 1880, possibly even the 1890's.

1.3.4 Historic Maps and Air Photos

A review of available historic maps was undertaken to identify the locations of any early historic structures within the study area. The earliest map referenced was the 1825 Coffin Map (Map 3) which showed no structures present within the 3 lots of the study area. Similarly, the 1841 census map, the 1861 Walling Map and the 1881 Belden map (Map 3) showed no structures present in any of the lots. Interestingly, the first roads in the study area do not appear until the 1923 Prescott and Russell Counties Map. At this stage a portion of what is now Frontier Road, south of Devine Road, was the only road present. The lack of roads in and around the study area was likely one reason why this area was not settled until the late nineteenth to early twentieth century; this corresponds with documentary evidence obtained from land registry records.

A review of six air photos was undertaken to determine how the study area has developed over time and to identify any previous water sources or features that might indicate archaeological potential. The air photos that were targeted were 1945 (NAPL A9611-84), 1955 (NAPL A14755-65), 1964 (NAPL A18649-23), 1975 (NAPL A31016-122), 1984 (NAPL 26469-227) and 1998 (A28361-202). These show that in 1945 the study area had been primarily used for agricultural purposes, with over 90% of the study area having been cleared and turned into agricultural fields. Slowly over time the fields were abandoned and have now become overgrown with the majority of the study area composed of secondary woodlot and bush with only a small portion at the north end remaining as agricultural land.

One building present within the 1945 air photo (Map 4) has disappeared from the landscape by 1965; it appears to have been destroyed by the re-alignment of the junction between Boundary Road and Devine Road. Due to the relatively late settlement of the area and the existence of buildings till the mid-twentieth century, this location is deemed to possess low archaeological potential.

There is no evidence of any active creeks or streams within the study area, only man made channels and ditches.

1.4 Archaeological Context

Previous Environmental Conditions

The study area began to emerge from the Wisconsin Ice Cap during the onset of the Holocene, roughly 12,000 years B.P. Immediately adjacent to the retreating ice sheets, melt water lakes formed within the low lying Ottawa Valley; itself having been depressed by the great weight of the ice cap. Around 11,000 to 11,500 B.P. the ice had sufficiently melted to allow sea water from the Atlantic Ocean access to the glacially lowered lands of eastern Ontario via the St. Lawrence (Cronin et al 2008). This marine inundation formed the Champlain Sea, briefly extending as far west as parts of Renfrew County, and is represented within the sedimentary record by a change from laminated glaciolacustrine clays to marine deposited clays.

Isostatic rebound gradually raised the Ottawa Valley, resulting in the shrinkage of the Champlain Sea eastwards. Large amounts of meltwater from the retreating ice sheets to the northwest flowed down through the Ottawa Valley, resulting in the freshwater mixing with the saline Champlain Sea resulting in a brackish environment, eventually producing the smaller freshwater Lake Lampsilis by around 9,800 B.P. By this period an extensive sand delta had formed over the study area as the large amounts of sediment transported downstream entered into the less turbulent and slower waters of the Lake and subsequently dropped from suspension. This resulted in the draping of the existing deep water marine clays with a thick layer of fluvial sands and silts across the entire deltaic fan. Following the further draining of Lake Lampsilis, the Ottawa River remained as a drainage route to the Atlantic for larger glacial lakes and water bodies to the west, with occasional large release episodes. The study area would have been uncovered from the draining waters shortly after 9,800 B.P.

> “The most significant alterations to the landscape following the withdrawal of the Champlain Sea are related to the shifting channels of the Ottawa River. A series of terraces and abandoned channels in the vicinity of Ottawa indicates that the Ancestral Ottawa River was much larger than present. Isostatic adjustment and the erosion of a lower channel upstream from Ottawa gradually caused the river to abandon the southern channel and shift to the north, to occupy the pre-glacial valley and what is now the Ottawa River channel. Terraces at various levels in the clay mark successive periods of downcutting by the Pre-Ottawa River. The south channel east of Ottawa has several cross channels separated by elongated islands underlain by marine clay and covered by fluvial sands” (Marshall et al 1979:14).

The study area is located in close proximity to the southern bank of this ancestral channel, with most of the channel at this location currently occupied by the Mer Bleue Bog. A carbon date obtained from the peat (GSC-681, 7650+- 120 years BP) indicates this bog to be at least 7,700 years old (ibid:15). The development of the bog indicates that the channel must have been abandoned by the Ottawa River by this time, and that potentially it existed earlier as an open lake before reverting to a peat forming marsh.

Pollen cores taken from the Mer Bleue, immediately north of the study area (Anderson 1988), and Ramsay Lake, 50 km to the northwest (Rocheleau et al 2008) provide a record of paleoflora at the time of the emergence of the study area from the Champlain Sea (9,800 B.P.). Pollen cores indicate the existence of a tundra that gave way to coniferous tree cover, likely spruce, pine and willow, later supplanted with oak and birch at the expense of the spruce. These forests increased in density and remained dominant between 10,600 and 7,500 B.P. A more mixed forest, characterised as Great Lakes Forest began to be established with the onset of a warmer and more humid environment between 7,500 and 4,700 B.P. with the predominance of pine giving way to hemlock.

A cooling of the climate and the decimation of the hemlock by disease led to a massive increase in the birch composition of the tree cover between 4,700 and 3,000 B.P. This birch, pine and hemlock tree cover remained established until 200 B.P. with lumbering and agriculture clearing the area (Ibid: 2008).

Study Area Characteristics

The study area falls within the Upper St. Lawrence sub-region of the Great Lakes - St. Lawrence Forest Region (Kershaw 2001). On the acidic soils of the area, a representation of conifers is usually found, particularly the eastern hemlock, eastern white pine, white spruce and balsam fir. The more coarse textured soils commonly support stands of eastern white pine and red pine, with wetter sites supporting black spruce and eastern white cedar. After large fires, largetooth aspen and white birch, along with balsam fir and white spruce play a prominent role in the pioneer forest stands (Rowe 1977). Bogs, such as Mer Bleue, tend to be dominated by willows, poplars and alders at the fringe, with tamarack and black spruce invading the centre (Marshal et al 1979). Extensive clearance of the land through settling, farming and lumbering has greatly reduced tree cover and altered is composition, with the Great Fire of 1870 resulting in almost total devastation of Carleton County, although the study area was probably spared (Currie 2009); as a consequence no old growth tree cover is expected to remain within the study area. Recent abandonment of cleared agricultural land has resulted in the gradual re-growth of immature forest cover within the study area.

The overall geology of the study area consists of Ordovician bedrock of the Lorraine-Carlsbad formation, comprised of grey shale, sandy shale and occasional dolomitic layers, covered with Pleistocene fluvial gravels and subsequently overlain by sand and clay soils that characterize the Prescott and Russell Sand Plains physiographic region (Chapman & Putnam 1984).

The coarse sand plains of the study area have mature Podzol soils with thin ash-grey horizons, modified to Ground-Water Podzols in areas with a high or fluctuating water table, indicated by the development of iron and humus hardpans. These soils are classed as low fertility, being deficient in lime, nitrogen, potash, phosphorus and manganese (Chapman and Putnam 1984).

Specifically, the study area contains three distinct soil types. The north half of the study area consists of poorly drained fine sandy loam, either fluvial or eolian in origin. The soils in the majority of the southern half of the study area consists of poorly drained fluvial or marine fine sandy loam over clay loam, silty clay loam, silty clay or clay marine material. Portions of the southern boundary of the study area are located in the poorly drained fine sandy loam with similar underlying clay deposits (Cumberland Township Soils Map, Soils Survey Report No. 58, 1987).

Primary drainage within the study area is provided by the Simpson Municipal Drain; this traverses the centre-north of the study area parallel to, and well north of Devine Road. Minor drainage is also provided by the Regimbald Municipal Drain and an old farm ditch across the southern part of the study area. All of these outlet to Shaws Creek, which connects to Bear Brook and eventually with the South Nation River, that in turn drains into the Ottawa River.

The study area possesses a moderate limitation to the production of Ungulates, due to a lack of nutrients in the soil to facilitate optimum plant growth for deer grazing (Brassard & Bouchard 1971). It also possesses such severe limitations that almost no waterfowl are produced; however, the Mer Bleue bog, to the north and west possesses only moderate limitations (Arsenault & Johnson 1970). The majority of the study area has severe limitations to agricultural production due to low soil fertility and poor drainage.

Property Inspection

A property inspection was conducted on November 22nd 2012. Photographs were taken of the existing conditions and a field log maintained. Visibility was excellent and conformed to the stipulations laid out in the *Standards and Guidelines for Consulting Archaeologists (2011)*.

Registered Archaeological Sites

The primary source of information regarding known archaeological sites in the study area is the Ontario Ministry of Tourism, Culture and Sport's archaeological sites database. A current version of this database was consulted and, at present, there are no documented or registered archaeological sites either within the study area or a 3 kilometre radius (Von Bitter per comms, January 13, 2012).

Previous research and fieldwork

There are a number of publications regarding the history and development of portions of Russell County. *From Swamp to Shanty* (Wendell 1987) discusses the historic development of the western half of neighbouring Russell Township while Histoire d'Embrun (Bourgie 1980) describes early settlers' lives in the eastern half of Russell Township. *The Illustrated Historical Atlas of Prescott and Russell* (Belden 1881) provides historical maps and specific information about people and places within Cumberland Township. Other historical accounts include *The History of the Ottawa Valley* (Gourlay 1896) and *Histoire de Comtes unis de Prescott et de Russell* (Brault 1965).

M. Emard (1974) and Donald Cartwright (1973) did statistical studies of settlement patterns in Eastern Ontario, including Russell County according to linguistic groups.

There has been very little archaeological assessment work done close to the study area. Some archaeological work that has been done in the area includes an overview of the archaeology and inventory of known archaeological sites, as well as an assessment of archaeological potential of the adjacent Russell Township was provided by Heritage Quest in 2004 (Daechsel & Bauer 2004; PIF P051-P051-33-2004). A Stage 1 archaeological assessment was undertaken for the expansion of Embrun and Russell Lagoons in 2006 (Daechsel 2007; PIF P051-109-2006;), a Stage 2 assessment on the same properties was undertaken in 2007 and 2008 (Golder 2009; PIF P302-038-2008). More recently, Golder undertook assessments for lands located directly north of the study area and to the northwest (Golder 2011; PIF P311-049-2011 and P311-080-2011, respectively).

The study area is covered by the Archaeological Resource Potential Mapping Study of the Regional Municipality of Ottawa-Carleton (ASI 1999).

2.0 FIELD METHODS

A property inspection was conducted on the study area on November 22, 2012. This inspection was undertaken to determine if there were any areas of disturbance which would have affected the archaeological potential, and what assessment strategies would be appropriate for a further detailed assessment, should it be required.

The weather was clear, 7 degrees Celsius with a SW wind.

Field notes and photographs of the property were taken during the inspection. The photograph locations and directions were noted and all photographs were catalogued (see Appendix A). All photograph locations and directions referenced in this report have been shown on Map 2. No archaeological remains were noted during the course of the property inspection.

The following documents were generated in the field and will be kept with the licensee at Golder until an appropriate repository can be identified:

- Field notes (in 1 note book)
- Digital photographs
- GPS points
- Sketch maps

3.0 ANALYSIS AND CONCLUSIONS

There are no registered archaeological sites within a significant proximity to the study area.

Archaeological potential

There are a number of criteria employed in the assessment of archaeological site potential. For pre-contact or prehistoric sites, these criteria are principally focused on the topographical features of the landscape including ridges, knolls and eskers, and the type of soils found within the area being assessed. For post-contact or historic sites, documentary evidence such as maps and census records may indicate areas of settlement and activity. These criteria were formulated in close consultation with the *Ministry of Tourism, Culture and Sport's set guidelines* for archaeological resource potential mapping (2011).

The following assessment of archaeological potential has also been formulated in consultation with the Archaeological Resource Potential Mapping Study of the Regional Municipality of Ottawa-Carleton: Technical Report (Archaeological Services Inc. & Geomatics International Inc. 1999). Hereafter referred to as the Archaeological Master Plan, this report identifies areas of archaeological potential within the now amalgamated City of Ottawa and sets out guidelines for requiring testing. These guidelines also follow the *Checklist for Determining Archaeological Potential* developed by the Ontario Ministry of Tourism and Culture (1993) for archaeological assessments.

According to the Archaeological Master Plan modelling criteria, lands within 300 metres of 'two-line' rivers, watercourses with mapped floodplains and wetlands (as shown on 1:10 000 topographic maps) are considered to have pre-contact site potential, while lands with moderate or well drained soils within 200 metres of 'one-line' watercourses also have potential. Further, areas up to 300 metres from abandoned Ottawa and Rideau River terrace scarps have pre-contact site potential. In the case of drumlins and eskers, the entire feature has pre-contact potential. Areas near historical schools, churches, commercial buildings, industrial sites and early settlement roads are considered to have potential within 100 metres of the structure, known structure location or settlement road, the last with the object of locating early pioneer homes. Areas within 50 metres of historical railways are also considered to have site potential and, finally, any area within 100 metres of a registered or unregistered archaeological site.

The Archaeological Master Plan Does not indicate any archaeological potential within the study area.

Pre-contact archaeological potential

Pre-contact potential for the study area is low (Map 5). The site has very limited potential for pre-contact resources as it is poorly drained, low lying and a significant distance from any permanent or ancient source of water. In addition, there are no raised glacial or geological features that might be considered areas of pre-contact focus. As such, there is no direct evidence that would suggest that the study area would have been an area of focus or habitation for pre-contact populations in the Ottawa Valley.

Historic archaeological potential

The available historic information (historic maps, land records) indicate that this area of Cumberland Township was settled relatively late compared to other areas of the Township. The roads that border the study area have not been considered significant historic corridors as they do not appear on any maps until 1923. In addition, there is no evidence of historic structures present in the study area in any of the historic maps. As such, the potential for historic archaeological resources within the study area is very low.

4.0 RECOMMENDATIONS

No registered archaeological sites and no areas of archaeological potential were identified by the Archaeological Assessment.

This investigation has provided the basis for the following recommendations:

1) That the CRRRC Boundary Road study area does not require further archaeological assessment.

5.0 ADVICE ON COMPLIANCE WITH LEGISLATION

This report is submitted to the Minister of Tourism, Culture and Sport as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism and Culture, a letter will be issued by the Ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act*.

Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.

The Cemeteries Act, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

Reports recommending further archaeological fieldwork or protection for one or more archaeological sites must include the following standard statement: “Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48 (1) of *the Ontario Heritage Act* and may not be altered, or have artifacts removed from them, except by a person holding an archaeological licence.”

6.0 IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the archaeological profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

This report has been prepared for the specific site, design objective, developments and purpose described to Golder by Taggart Miller Environmental Services (Taggart Miller - the Client). The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges the electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project.

Special risks occur whenever archaeological investigations are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain archaeological resources. The sampling strategies incorporated in this study comply with those identified in the Ministry of Tourism, Culture and Sport's Standards and Guidelines for Consultant Archaeologists (2011).

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A14755-65	1955
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M-7735. 1840 Census Map of Cumberland Township, Russell County.

8.0 IMAGES

Image 1: View across area of archaeological potential, Highway 417 is located behind woods on the right, looking north west.

Image 2: View along drainage channel, looking west.

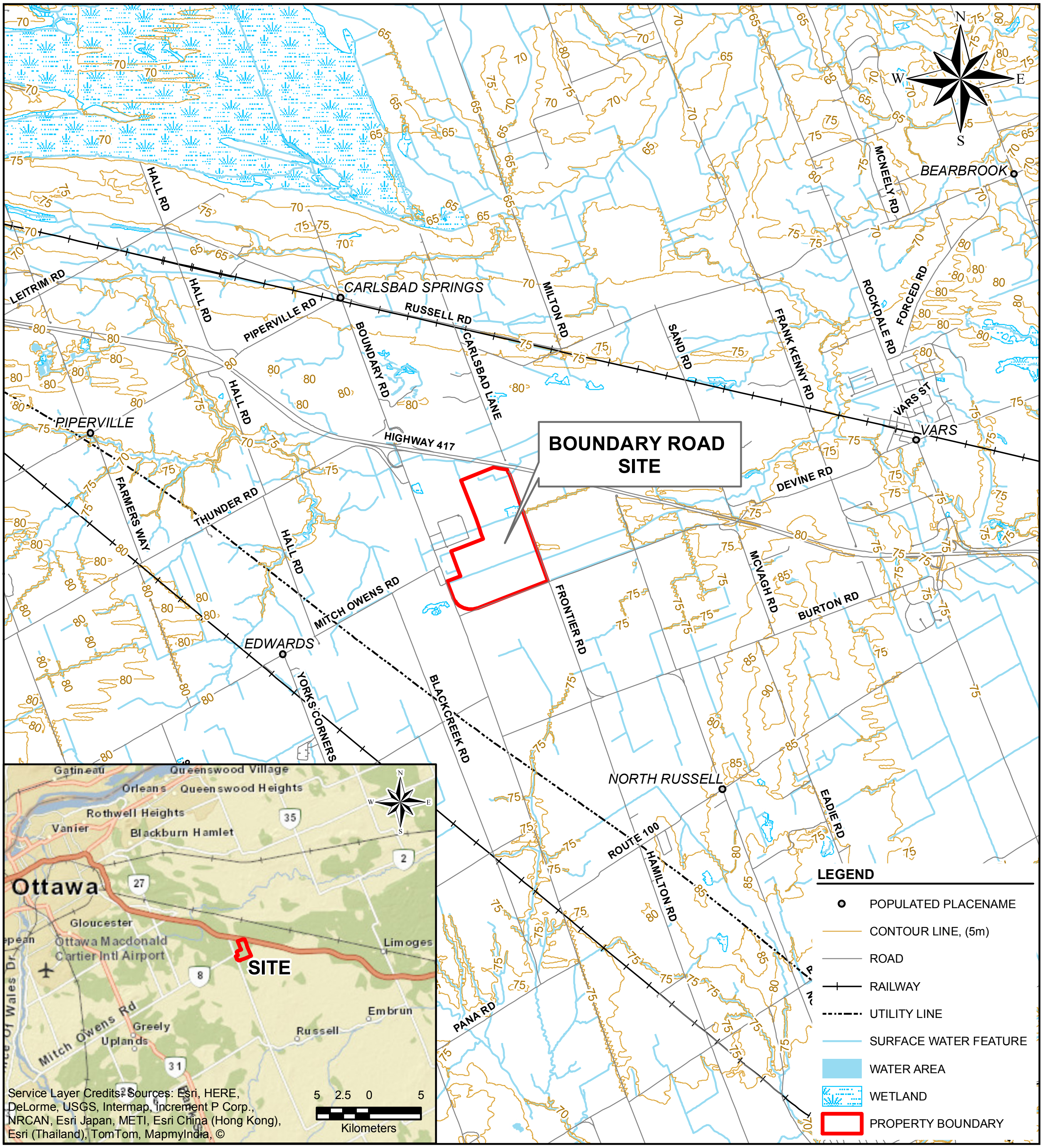
Image 3: Typical area of woodlot at the northern end of the study area, looking west.

Image 4: Typical area of scrubland at the eastern edge of the study area, looking west.

Image 5: Man-made drainage and culvert flowing through the study area, looking west.

Image 6: Typical scrubland at the southern end of the study area, looking north.

9.0 MAPS



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DATE	FEB. 2013	TITLE	
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PROJECT No.	12-1125-0045	CHECK	EW
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PROJECT	ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE	**MAP 1**	

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LEGEND

●	PHOTO LOCATION AND DIRECTION
—	ROAD
—	CONTOUR LINE, (5m)
—	SURFACE WATER FEATURE
🟥	PROPERTY BOUNDARY

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SCALE 1:10,000 METRES

NOTE

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PROJECT

ENVIRONMENTAL ASSESSMENT OF
THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

SITE PLAN

Golder Associates
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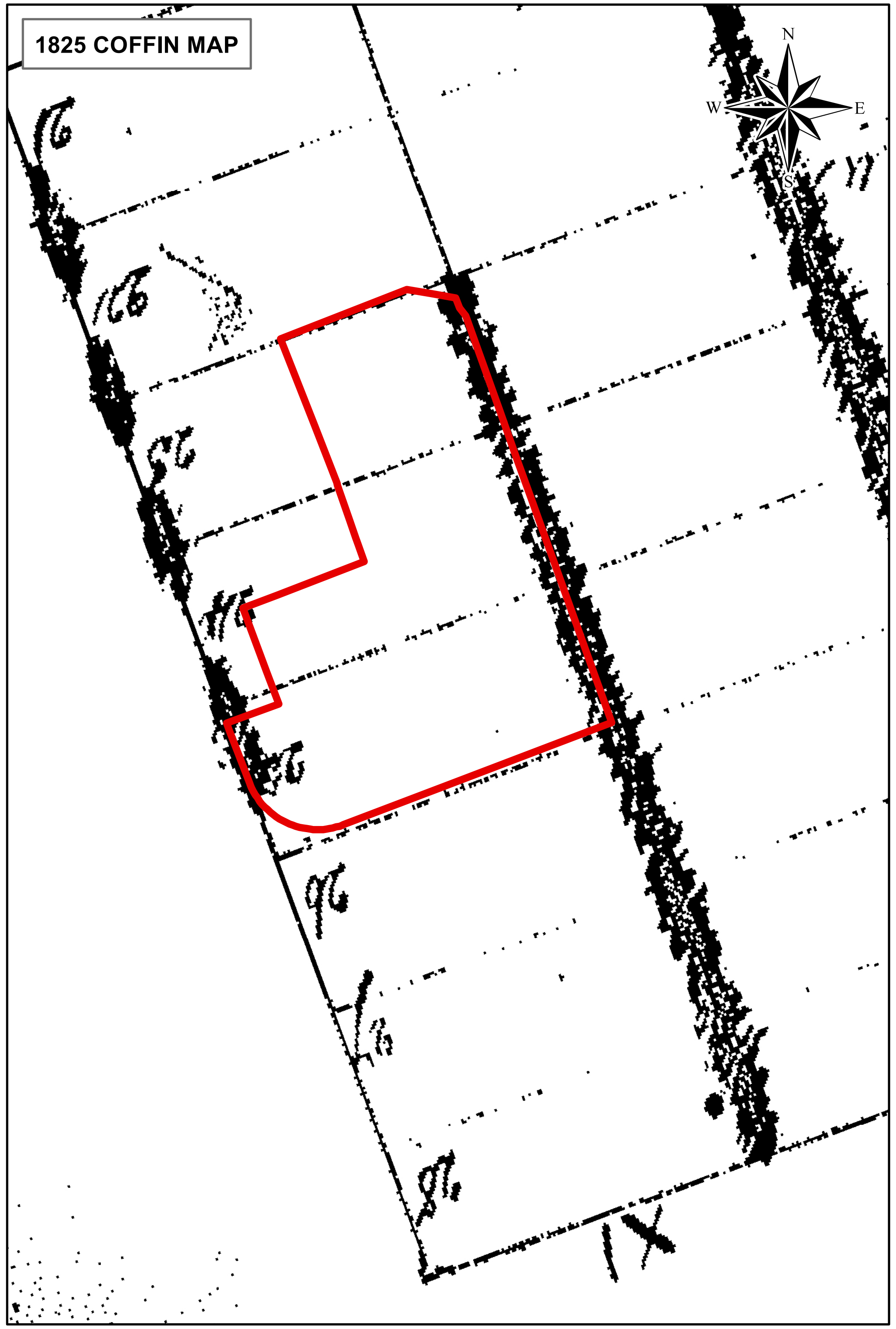

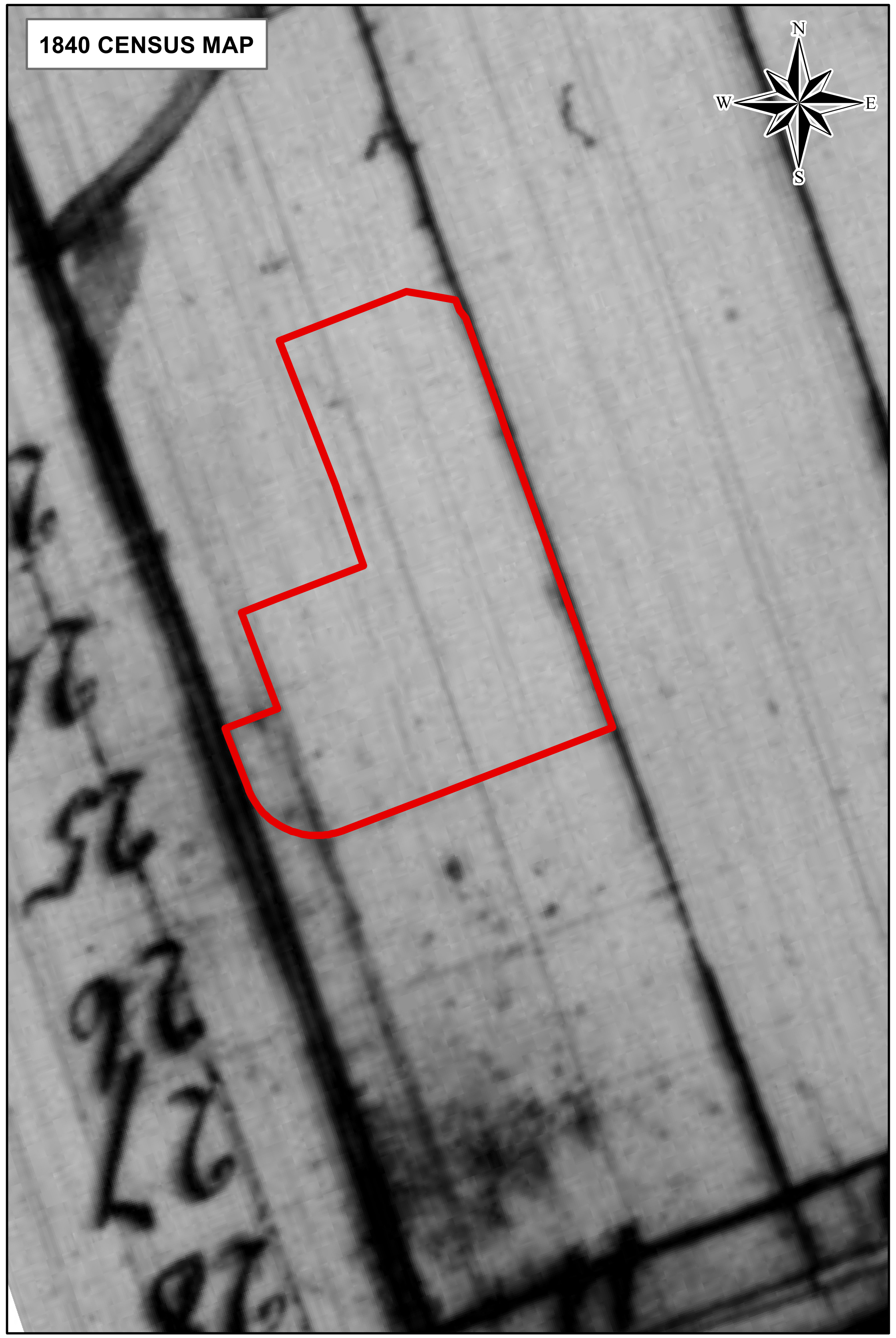

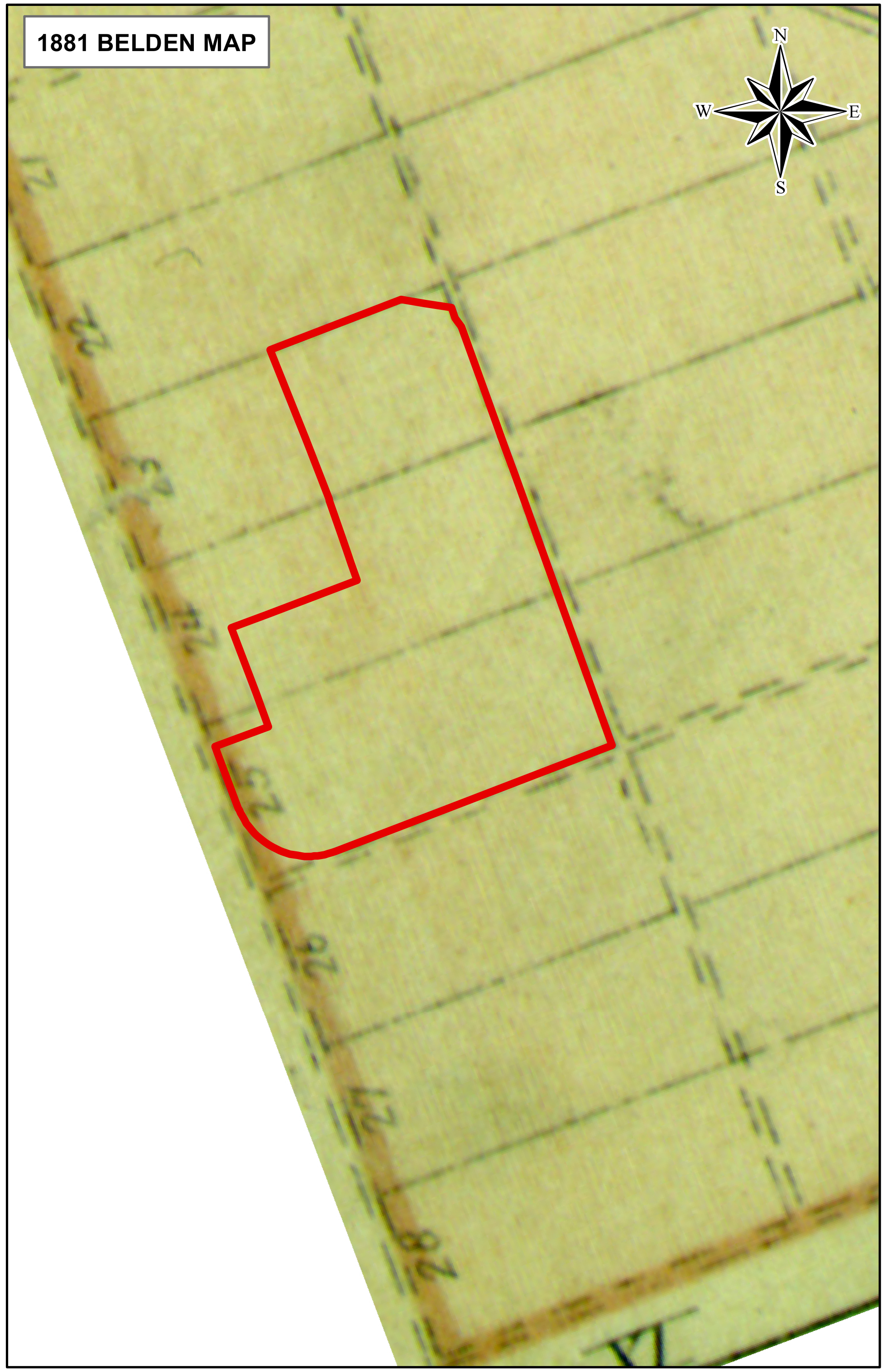

LEGEND

🟥 PROPERTY BOUNDARY

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1826 COFFIN MAP - CUMBERLAND TOWNSHIP (RUSSELL COUNTY).
1840 CENSUS MAP - CUMBERLAND TOWNSHIP (RUSSELL COUNTY) -NATIONAL ARCHIVES OF CANADA, REEL NUMBER M-7735.
1881 BELDEN MAP - CUMBERLAND TOWNSHIP (RUSSELL COUNTY).
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PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

HISTORIC MAPS

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REVIEW	HJD	AUG. 2014

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MAP 3

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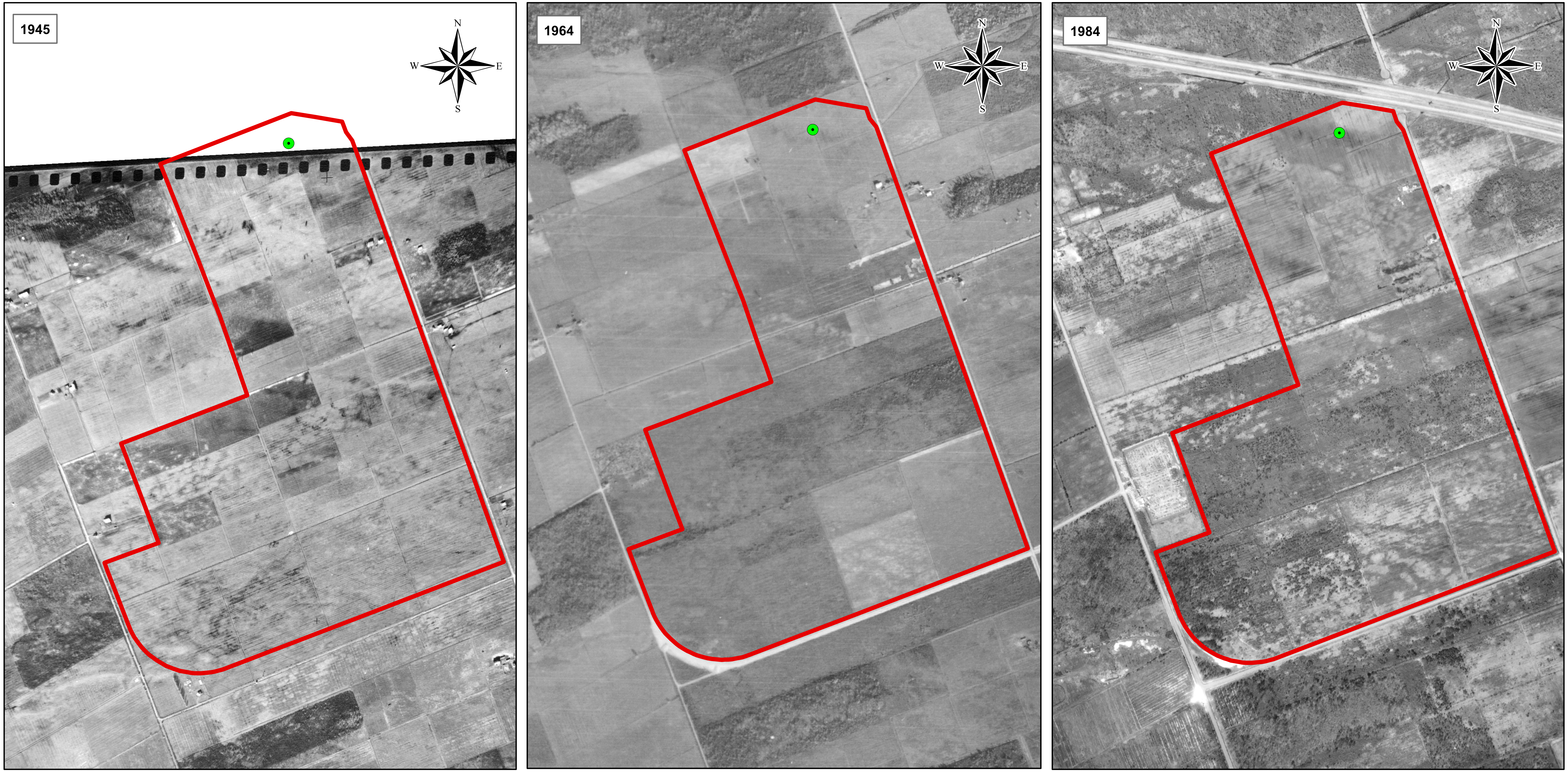

LEGEND

● EVIDENCE OF ABANDONED BEAR BROOK CREEK

🟥 PROPERTY BOUNDARY

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SCALE 1:14,000 METRES

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PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

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LEGEND

—	ROAD
—	CONTOUR LINE, (5m)
—	SURFACE WATER FEATURE
🟥	PROPERTY BOUNDARY
▨	LOW/NO ARCHAEOLOGICAL POTENTIAL
①	DESTROYED 19th/20th CENTURY FARMSTEAD

200 100 0 200

SCALE 1:10,000 METRES

NOTE

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PROJECT

ENVIRONMENTAL ASSESSMENT OF
THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

AREA OF
ARCHAEOLOGICAL POTENTIAL

Golder Associates
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Report Signature Page

GOLDER ASSOCIATES LTD.

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BD/PAS/HJD/clb/sg
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APPENDIX A

Photographic Catalogue

APPENDIX A
Photographic Catalogue

ID-number	Description	Photographer	Date	Direction
P1020228	View across northern boundary of study area	TR	22nd Nov 12	W
P1020229	View along Regimbald Municipal Drain	TR	22nd Nov 12	W
P1020230	View of existing farm from mid-point of Regimbald Municipal Drain	TR	22nd Nov 12	SE
P1020231	Open agricultural fields north of Regimbalnd Municipal Drain	TR	22nd Nov 12	W
P1020232	Dogleg in Regimbald Municipal Drain	TR	22nd Nov 12	N
P1020233	Agricultural fields	TR	22nd Nov 12	W
P1020234	View along Regimbald Municipal Drain back towards Frontier Road	TR	22nd Nov 12	SE
P1020235	Agricultural fields	TR	22nd Nov 12	SE
P1020236	Scrubland at western edge of agricultural fields	TR	22nd Nov 12	W
P1020237	Secondary growth at western edge of agricultural fields	TR	22nd Nov 12	NW
P1020238	View across agricultural fields towards exisiting farm	TR	22nd Nov 12	SW
P1020239	Trackway at field boundary marking southern edge of agricultural fields	TR	22nd Nov 12	W
P1020240	Field boundary leading back to exisiting farm	TR	22nd Nov 12	E
P1020241	View along Simpson Municipal Drain	TR	22nd Nov 12	W
P1020242	View of Simpson Municiapal Drain and Culvert	TR	22nd Nov 12	SW
P1020243	Driveway and exisiting property at south-west corner of study area	TR	22nd Nov 12	W
P1020244	Open fields in south western corner of study area	TR	22nd Nov 12	NW
P1020245	Scrubland and secondary growth at southern edge of study area	TR	22nd Nov 12	N

TR = Tim Rangecroft

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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ATTACHMENT TSD#1-F-3

Cultural Heritage Overview Report, Capital Regional Resource Recovery Centre Environmental Assessment (EA)

February 2013

February 2013

REPORT

Cultural Heritage Overview Report Capital Region Resource Recovery Centre Environmental Assessment (EA)

Submitted to:
Jeff Parkes
Taggart Miller Environmental Services
225 Metcalfe Street, Suite 708
Ottawa, Ontario K2P 1P9

Report Number: 12-1125-0045/4500/0160

REPORT

Golder Associates

Executive Summary

The Executive Summary highlights key points from the report only; for complete information and findings, as well as the limitations, the reader should examine the complete report.

Golder Associates Ltd. ("Golder") was retained by Taggart Miller Environmental Services (Taggart Miller) to conduct a Cultural Heritage Overview Report on two Alternative Site locations for the proposed Capital Region Resource Recovery Centre (CRRRC):

- **North Russell Road Site**: located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell; and,
- **Boundary Road Site**: located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, Township of Cumberland.

This report was prepared to provide initial guidance on the cultural heritage aspects to the project. The objective of the study was to identify the existing heritage policy framework related to the two sites, to examine known inventories, to determine identified cultural heritage resources, and to identify potential cultural heritage resources (identified by the Ministry of Tourism, Culture and Sport (MTCS) as any resources older than 40 years) that would need to be assessed. It will need to be supplemented by a Cultural Heritage Impact Statement (CHIS)/Heritage Impact Assessment (HIA) once the preferred option is determined.[1] The scope of this report is limited to a review of existing inventories, legislation, policies, published information, and maps. A site visit to spot-check properties related to both sites was undertaken. The City of Ottawa, the United Counties of Prescott-Russell, the Township of Russell, as well as Infrastructure Ontario were contacted. The online inventories from Parks Canada and the Ontario Heritage Trust were examined. From this assessment, a total of four properties were noted as being either an identified or potential cultural heritage resource at the Boundary Road Site; a total of 29 properties were noted as being either an identified or potential cultural heritage resource at the North Russell Road Site.

A heritage policy review for both sites was undertaken as part of this report. The review of the policies relating to the Boundary Road Site identified no policies from a cultural heritage perspective within the City of Ottawa *Official Plan* or the City of Ottawa *Heritage Plan* that would prohibit the project. The lands that are part of the National Capital Commission (NCC) Greenbelt, and fall under the auspices of the NCC, are located on the opposite (north) side Highway 417, which separates the Greenbelt from the Boundary Road Site.

A review of the policies relating to the North Russell Road Site identified no policies from a cultural heritage perspective within the United Counties of Prescott-Russell *Official Plan* or the Township of Russell *Official Plan* that would prohibit the project.

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[1] The City of Ottawa and the Township of Russell use the term Cultural Heritage Impact Statement (CHIS), whereas the United Counties of Prescott and Russell use the term Heritage Impact Assessment (HIA). Regardless of the difference of language, it is understood that these CHIS/HIA reports refer to the same type of heritage evaluation.

While the legislation/policy review revealed no heritage policies that would prohibit the construction of the CRRRC at either location, there were clear policy statements that cultural heritage resources need to be protected during the process of change. Near the Boundary Road site, there were three properties identified as having cultural heritage value: the NCC Greenbelt (identified by NCC), 6086 Frontier Road (identified by the City of Ottawa), and 9341 Mitch Owens Road (identified by the City of Ottawa). All three properties are in excess of 500 metres from the subject property. There were no properties within the North Russell Road study area previously identified as possessing cultural heritage value. In reviewing the potential properties (based on the review of inventories, site visits, and air photo analysis), the North Russell Road Site was found to have 29 potential cultural heritage resources and the Boundary Road Site was found to have four potential cultural heritage resources.

In terms of next steps, the following will need to be undertaken for the site chosen as the preferred site:

1) Each of the potential cultural heritage resources will need to be assessed against Regulation 9/06 of the *Ontario Heritage Act* to determine if they possess cultural heritage value. These assessments should be reviewed and approved by the local municipal approval agency. If no properties are identified in a study area as having cultural heritage value, a CHIS/HIA will not need to be prepared; and,

2) If a CHIS/HIA needs to be prepared, it must draw upon the foregoing Regulation 9/06 to determine what, if any impacts, will occur and to provide recommendations for any necessary mitigative work. This assessment should be prepared early in the design process to ensure that any recommendations can be integrated into the detailed designs.

If the Boundary Road Study Area is identified as the preferred site:

1) The property located at 5508 Frontier Road (Inventory O-04) should be assessed as a cultural heritage landscape. This should be reviewed and approved by the municipal approval agency;

2) The City of Ottawa's *A Guide to Preparing Cultural Heritage Impact Statements* will need to be reviewed and integrated into any CHIS prepared for the project; and,

3) The detailed design for the project will need to be evaluated against the City of Ottawa Council-adopted *Standards and Guidelines for the Conservation of Historic Places in Canada* as part of any CHIS prepared for the project; and,

If the North Russell Road Study Area is identified as the preferred site:

1) Twenty of the 29 properties identified as potential cultural heritage landscapes will need to be assessed to determine if they have cultural heritage value. These should be reviewed and approved by the municipal approval agency;

2) The overall area will need to be assessed to determine if it is a larger scale cultural heritage landscape. This should be reviewed and approved by the municipal approval agency; and,

3) Any local or provincial guidelines for the preparation of CHIS/HIA will need to be reviewed and integrated in any CHIS/HIA prepared for the project. It will need to be determined if the United Counties of Prescott-Russell would require a separate submission from the Township of Russell.

Project Personnel

Proponent Contact	Jeff Parkes, Taggart Miller Environmental Services
Project Manager	Trish Edmond, M.E.Sc., P.Eng.
Project Director	Paul Smolkin, B.A.Sc, P. Eng.
Senior Cultural Heritage Specialist	Marcus Létourneau, PhD, MCIP, RPP, CAHP
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	Kyle Gonyou, M.Pl
	Tim Rangecroft, MSc.
Graphics Production	Paul McDowell
Senior Review	Hugh J. Daechsel, MA
Administration	Lois Breadner, B.A.

Table of Contents

FIGURES

PLATES

APPENDICES

APPENDIX A
Boundary Road Site-Potential Cultural Heritage Inventory

APPENDIX B
North Russell Road Site-Potential Cultural Heritage Resources Inventory

1.0 STUDY PURPOSE

Golder Associates Ltd. (“Golder”) was retained by Taggart Miller Environmental Services (Taggart Miller) to conduct a Cultural Heritage Overview Report on two alternative site locations for the proposed Capital Region Resource Recovery Centre (CRRRC):

- **North Russell Road Site** located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell; and,
- **Boundary Road Site** located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, Township of Cumberland.

This report was prepared to provide initial guidance for the project on cultural heritage issues. The objective of the study was to identify the existing heritage policy framework related to the two sites, to examine known inventories to determine known cultural heritage resources, and to identify potential cultural heritage resources (identified by the Ministry of Tourism, Culture and Sport as any resources older than 40 years) that would need to be further assessed. This report will need to be supplemented by a Cultural Heritage Impact Statement (CHIS)/Heritage Impact Assessment (HIA) once the preferred site is identified. The scope of this report is limited to a review of existing inventories, legislation, policies, published information, and maps.

2.0 STUDY APPROACH

2.1 Definitions

Cultural Heritage Landscape: A defined geographical area of heritage significance that has been modified by human activities and is valued by a community. It involves a grouping(s) of heritage features such as structures, spaces, archaeological sites and natural elements, which together form a significant type of heritage form, distinctive from its constituent elements or parts. Examples include, but are not limited to, heritage conservation districts (HCD) designated under the *Ontario Heritage Act*, villages, parks, gardens, battlefields, main streets and neighbourhoods, cemeteries, trailways, and industrial complexes of cultural heritage value. In the context of this report, the definitions found in local municipal *Official Plans* and at the National Capital Commission (NCC) will be considered as they relate to resources under each organization's jurisdiction.

Cultural Heritage Resource: A human work or a place that gives evidence of human activity or has spiritual or cultural meaning, and which has been determined to have historic value. Cultural heritage resources can include both physical and intangible heritage resources, heritage properties, built heritage resources, cultural heritage landscapes, archaeological resources, paleontological resources, and both documentary and material heritage.

Cultural Heritage Value: The aesthetic, historic, scientific, cultural, social or spiritual importance or significance for past, present and future generations. The cultural heritage value of a cultural heritage resource is embodied in its character-defining elements, including its materials, forms, location, spatial configurations, uses and cultural associations or meanings.

Governmental Approval Body: This refers to any agency or division of a level of government that has the authority to approve works on a cultural heritage resource. This includes a Municipal Council, the Ontario Heritage Trust, Federal Heritage Building Review Office (FHBRO), and National Historic Sites and Monuments Board of Canada (HSMBC).

Heritage Attributes: The materials, forms, location, spatial configurations, uses and cultural associations or meanings that contribute to the cultural heritage value of a cultural heritage resource, which must be retained to conserve its cultural heritage value. These are defined by a governmental approval body. For properties protected under Part IV of the *Ontario Heritage Act*, the heritage attributes are "in relation to real property, and to the buildings and structures on the real property, the attributes of the property, buildings and structures that contribute to their cultural heritage value or interest" (*Ontario Heritage Act*, Section 1).

2.2 Cultural Heritage Overview Report Framework

A Heritage Overview Report focuses on the identification of potential cultural heritage issues or readily apparent impacts. Like a CHIS/HIA, a Heritage Overview Report is based on an understanding of a project, the cultural heritage resources that may be affected by that project, and best practices to mitigate any recognized impacts. As stated, this Heritage Overview Report should be supplemented by a CHIS/HIA, once a preferred site has been chosen.

2.3 Study Area Boundaries

The location of the two subject properties, known as the North Russell Road Site and the Boundary Road Site, is described in Section 1.0, and shown on Figure 1, p. 4.

2.4 Detailed Study Approach

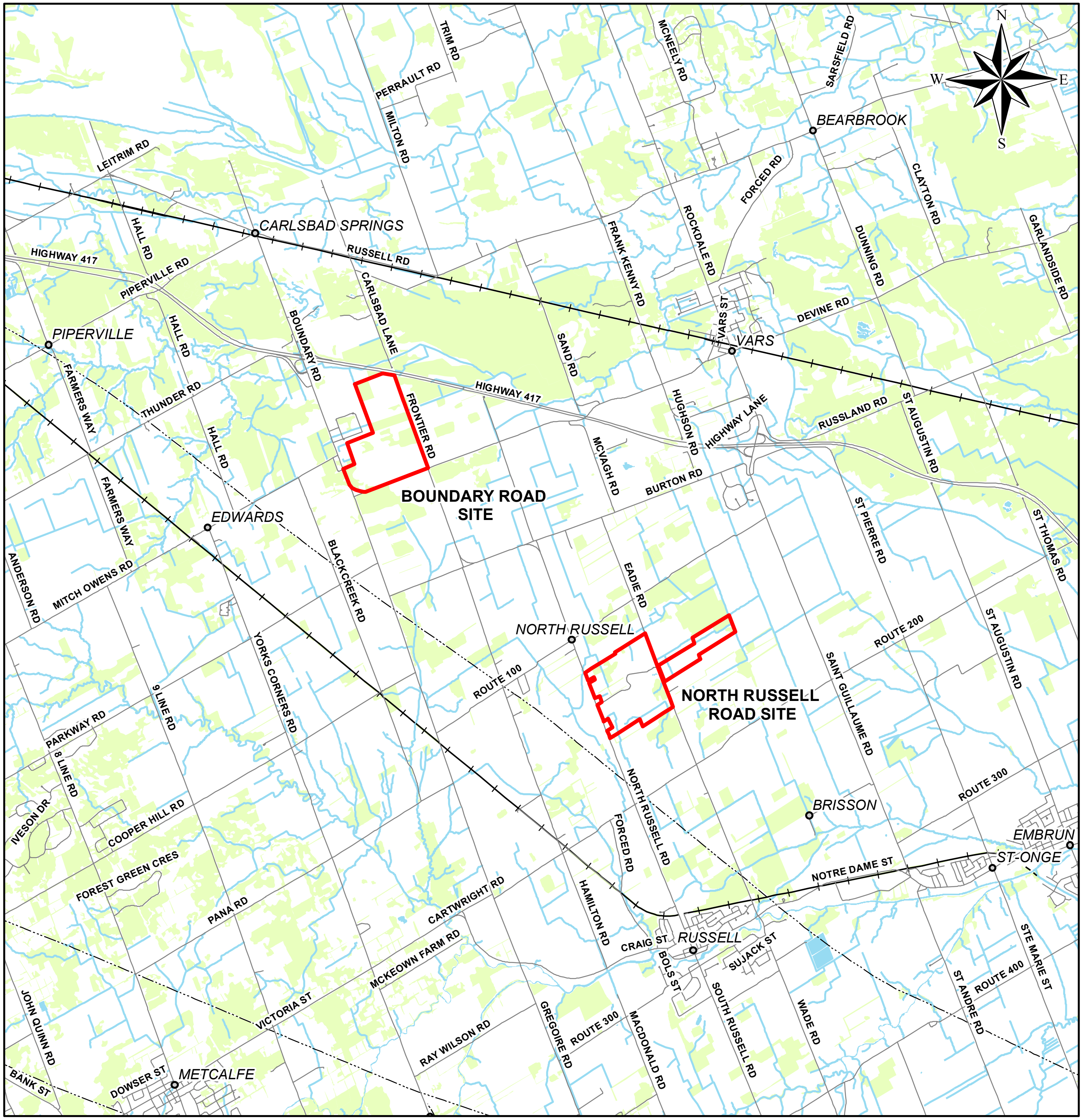
In order to identify any potential issues, three steps must be undertaken:

- The scope, scale, and nature of the cultural heritage resources must be adequately understood;
- Planning must take into consideration the cultural heritage resources while be flexible enough to allow for the unexpected; and,
- Interventions must respect and protect the heritage attributes (as defined by a government approval body) of the cultural heritage resources.

As discussed, this report examines a proposed project to ensure that cultural heritage resources are adequately understood. As a result, it addresses the first two steps of appropriate heritage conservation: understanding and planning.

2.4.1 Review of Policy and Legislative Context

A review of applicable legislation and policy is provided in Section 3.0 of this report. The analysis considered provincial legislation/policy and municipal policies/by-laws. This review does not address all policies/legislation, but is instead focused on the applicable policies/legislation as they apply to heritage conservation. The review included Federal policy documents, the *Provincial Policy Statement* (2005), applicable provincial legislation, the City of Ottawa *Official Plan*, the City of Ottawa *Heritage Plan* (2003), the United Counties of Prescott-Russell *Official Plan* (2006), and the Township of North Russell *Official Plan* (2010). This was done to make certain that the heritage planning and policy requirements are made clear, to determine if any of these documents specifically identifies any cultural heritage resources, and in order to ensure that the project will not violate any heritage planning requirements.



LEGEND

- ● POPULATED PLACE NAME
- ROAD
- RAILWAY
- UTILITY LINE
- SURFACE WATER FEATURE
- 🟦 WATER AREA
- 🟩 WOODED AREA
- 🟥 PROPERTY BOUNDARY

2 1 0 2

SCALE 1:100,000 METRES

NOTE

CULTURAL & HERITAGE RESOURCES COMPONENT
APPENDIX TSD1-F
COMPARATIVE EVALUATION OF ALTERNATIVE SITES
CAPITAL REGION RESOURCE RECOVERY CENTRE

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, ©QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
STUDY AREA MAP

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0.0
DESIGN	DH	JAN. 2013		
GIS	PJM	FEB. 2013		
CHECK	ML	AUG. 2014		
REVIEW	HJD	AUG. 2014		

FIGURE 1

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase4000\TSD1\12-1125-00045-4000-160-01-StudyArea.mxd

2.4.2 Identification of Cultural Heritage Resources

There are several different types of cultural heritage resources and these resources are identified by a variety of governmental approval bodies. For the purpose of this report, "real property" within 500 metres of the subject properties was examined.[2] Properties owned or leased by the provincial government and prescribed public bodies (as defined in Regulation 157/10 of the *Ontario Heritage Act*) were not considered in this report. There is no master list maintained of provincial heritage properties (or properties of potential). However, Infrastructure Ontario (IO) was consulted, and there were no properties identified to be of interest at either site. The categories of sites assessed in this report may include the following:

Historic Sites and Monuments Board of Canada (HSMBC): Through the HSMBC, the Minister of Environment, responsible for Parks Canada, has the authority to designate National Historic Sites (pertaining to a defined area), Events (pertaining to an idea or concept with spatial boundaries), and Persons. These designations are generally well documented. In addition to having "Reasons for Designation", National Historic Sites often have Commemorative Integrity Statements and/or Management Plans. Events or persons designations are not included in this study.

Federal Heritage Building Review Office (FHBRO): FHBRO, part of Parks Canada, evaluates the cultural heritage value of federally owned and occupied buildings and maintains a "Register of the Government of Canada Heritage Buildings". Unlike many other heritage programs, FHBRO is focused strictly on buildings. FHBRO's jurisdiction does not apply to Crown Corporations such as railway stations.

National Capital Commission (NCC): The NCC manages federal improvements to the National Capital Region. Currently, the NCC acts as a steward for many federally-owned buildings and open lands in the National Capital Region. NCC maintains a list of heritage structures and Heritage Conservation Districts (HCD), and has identified cultural landscapes in the document *Definition and Assessment of Cultural Landscapes of Heritage Value on NCC Lands* (2004).

Ontario Heritage Trust Easement: The Ontario Heritage Trust, an agency of the Government of Ontario, has the authority to enter into easement agreements to conserve cultural heritage resources. Changes to these resources require Ontario Heritage Trust approval.

Ontario Heritage Act: Heritage properties within a municipality may be designated under Part IV of the *Ontario Heritage Act*. These properties must have a "Statement of Significance" or "Reasons for Designation". In addition, heritage easements and/or maintenance agreements under the Act can be put in place. Under Section 27 of the *Ontario Heritage Act*, Ottawa has also "listed" additional properties that are of interest to the municipality; while not considered the same as a Part IV property, these properties nonetheless require a Council resolution to add them to its Register of Heritage Properties and there is a 60-day demolition delay. These properties do not always have descriptions, as there is no consistent format for the content required to add these properties to a Register of Heritage Properties.

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[2] Due to difficulties in determining the precise location of real property boundaries, there may be some properties included in the inventory which are located just outside the 500-metre zone. Further, two properties, R-023 and P-022, at the North Russell Road site were also included although they are technically just outside the 500-metre zone. One is a former church and the other is an old farmhouse that may be associated with the church. These were included as there will likely be community interest in them.

Cultural Heritage Resources built pre-1973: Both the Ministry of Transportation in its *Environmental Guide for Built Heritage and Cultural Heritage Landscapes (2007)* and the Ministry of Tourism, Culture and Sport, in its *Screening for Impact to Built Heritage and Cultural Heritage Landscapes (2010)* checklist, employ a rolling 40-year rule to identify potential properties of cultural heritage value and interest as part of the environment assessment process. The intent of the 40-year rule is to allow a resource to age sufficiently so that it can be better contextualized and a wider perspective could be applied to it. The following methodology has been adopted for this study:

1) Aerial photos, mapping and published materials will be used to identify pre-1973 resources within and adjacent to the study area; and,

2) Where there could be a potential physical impact on a pre-1973 property or landscape, a further heritage assessment to better understand the cultural heritage values of the resources will be carried out as part of a CHIS/HIA.

Not all of these categories were found to be present near the study areas. All sites were documented based on their vicinity to the study areas.

2.4.3 Consideration of Potential Issues

While certain issues may be identified as part of this report, this report is not intended as a comprehensive CHIS/HIA or to identify all possible impacts. Part of the purpose of this overview report is to identify those properties which have identified (as defined by a governmental approval body) or have potential cultural heritage value so that decisions can be made concerning site options.

2.5 Field Work and Consultation

The field work for the CRRRC project was carried out on January 22, 2013, by Dr. Marcus Létourneau, Senior Cultural Heritage Specialist, and Mr. Kyle Gonyou, Junior Cultural Heritage Specialist. Dr. Létourneau undertook additional field work on January 31, 2013. Consultation was undertaken with the City of Ottawa, the United Counties of Prescott-Russell, the Township of Russell, and Infrastructure Ontario. The North Russell Historical Society and the North Russell Women's Institute were consulted as part of the Archaeological Assessments.

3.0 LEGISLATIVE AND POLICY FRAMEWORK REVIEW

3.1 National Capital Commission (NCC)

The NCC is the federal organization responsible for planning Canada's national capital region and oversees lands in the general area of the Boundary Road Site. *The Plan for Canada's Capital* (1999) sets out the overarching vision for the National Capital Region. The NCC Greenbelt is northwest of the Boundary Road study area on the other (north) side of Highway 417. The National Capital Greenbelt (Figure 2, p. 8) has been identified as part of a medium-scale cultural heritage landscape within the NCC document *Definition and Assessment of Cultural Landscapes of Heritage Value on NCC* (2004).

3.2 Federal Heritage Buildings Review Office (FHBRO)

There are no buildings within either study area that have been either recognized or classified by FHBRO.

3.3 National Historic Sites

There are no sites within either study area that have been recognized by the Historic Sites and Monuments Board of Canada as a National Historic Site.

3.4 Ontario Heritage Trust

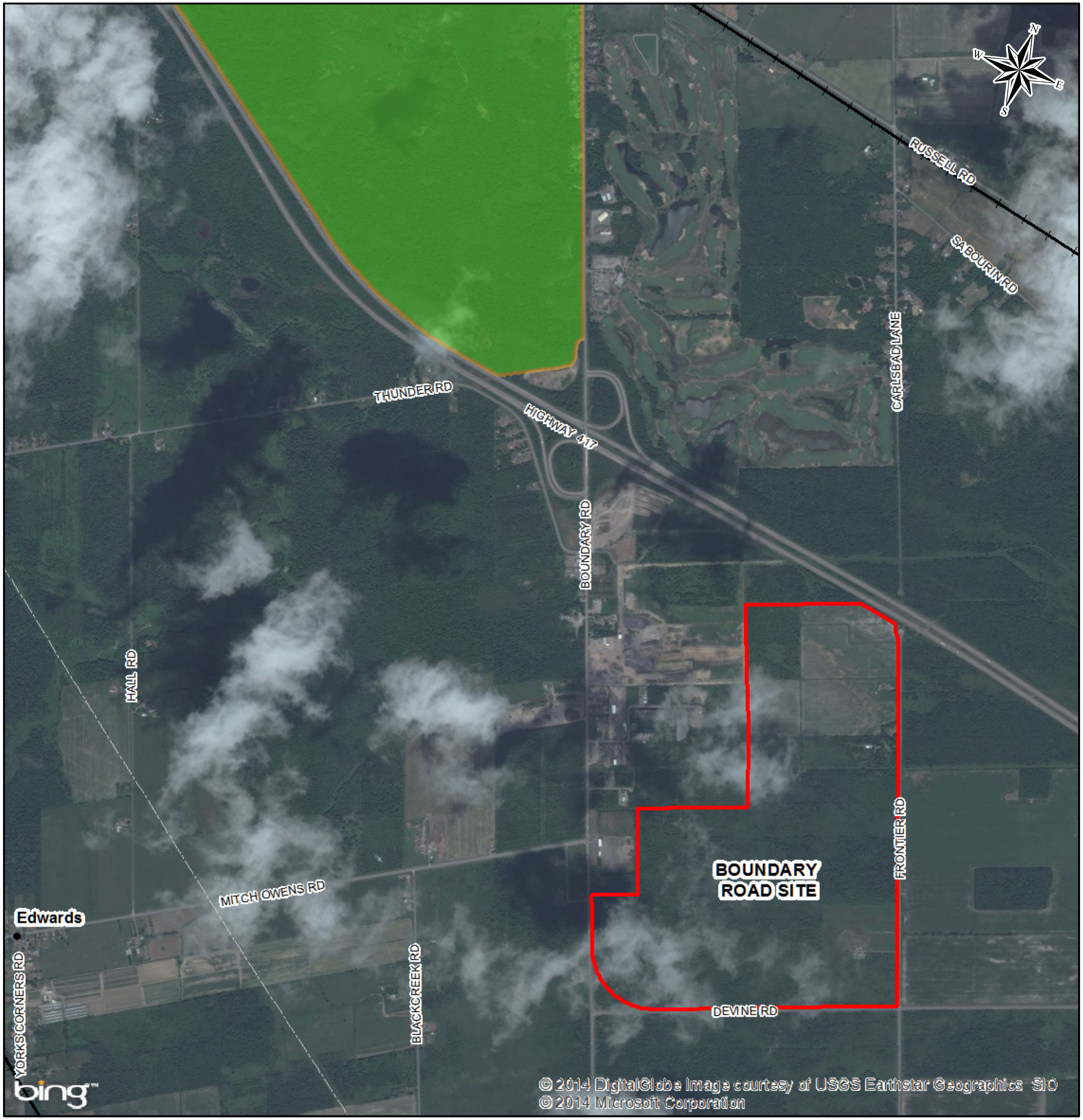
There are no Ontario Heritage Trust Easement Properties within the study areas.

3.5 Ontario Legislation/Policy

Within Ontario, cultural heritage conservation is a matter of provincial interest. This understanding stems from not only the *Ontario Heritage Act* provisions, but also its expression within Section 2 of the *Planning Act* and other Ontario Legislation such as the *Cemeteries Act* and the *Environmental Assessment Act*. Indeed, at both the federal and provincial levels, environmental assessments must now consider cultural heritage as an integrated part of the broader concept of "environment". Further, under the *Provincial Policy Statement* (2005), (which is issued under Section 3 of the *Planning Act),* Sections 2.0 and 2.6 identify the conservation of cultural heritage (including archaeology) as a requirement.

As the *Provincial Policy Statement* (2005) indicates, Ontario's long-term prosperity, environmental health, and social well-being depend on protecting its resources, including its cultural heritage and archaeological resources. All planning decisions as well as any revised/new official plans within Ontario must be consistent with the *Provincial Policy Statement*. In addition, all municipal projects must be consistent with the municipality's *Official Plan*. As a result, provincial heritage policies and legislation must be appropriately considered and integrated as part of any project that may impact cultural heritage resources. However, it must also be noted that the *Provincial Policy Statement* and an official plan must be considered in their entirety, and there is always a balancing of other matters of provincial interest such as transportation and intensification. Nevertheless, as this review is focused on cultural heritage matters, this report will highlight the applicable heritage policies.

For the purpose of this report, Policies 2.6.1 and 2.6.3 of the *Provincial Policy Statement* are applicable. Significant built heritage resources and cultural heritage landscapes will need to be considered and appropriately conserved during this project. In the context of the *Provincial Policy Statement*, heritage significance is understood as being expressed through the formal identification and endorsement by a governmental approval body. The phrase "conserved" is also understood to encompass a range of possible interventions.



LEGEND

🟥 BOUNDARY ROAD SITE

🟩 NATIONAL CAPITAL COMMISSION GREENBELT

0.5 0.25 0 0.5

SCALE 1:25,000 KILOMETRES

NOTE

CULTURAL & HERITAGE RESOURCES COMPONENT
APPENDIX TSD1-F
COMPARATIVE EVALUATION OF ALTERNATIVE SITES
CAPITAL REGION RESOURCE RECOVERY CENTRE

REFERENCE

IMAGERY - BING MAPS AERIAL (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS
DIGITAL NRVIS MNR DATA PRODUCED BY GOLDER ASSOCIATES LTD., USED UNDER LICENSE © QUEEN'S PRINTER OF ONTARIO.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

RELATIONSHIP BETWEEN THE NATIONAL CAPITAL COMMISSION GREENBELT AND THE BOUNDARY ROAD SITE

Golder Associates
Ottawa, Ontario

PROJECT No. 09-1125-1008-9000			SCALE AS SHOWN	REV. 0.0
DESIGN	PLE	OCT. 2012	**FIGURE 2**	
GIS	PJM	FEB. 2013		
CHECK	ML	AUG. 2014		
REVIEW	HJD	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase4000\TSD1\12-1125-00045-4000-160-02-BoundaryRoad.mxd

In addition, the *Provincial Policy Statement* is clear that works on properties adjacent to any cultural heritage resources will need to be evaluated to ensure that the character defining elements (or heritage attributes) of the cultural heritage resource will be protected through the process of changes.

These elements are identified within the formal designation documents for a cultural heritage resource, and can include: an *Ontario Heritage Act* Designation By-law, a FHBRO Report, a HSMBC report, a Commemorative Integrity Statement, a National Historic Site or World Heritage Management Plan, and/or a Heritage Conservation District Plan and Guidelines document.

Any properties protected by the *Ontario Heritage Act* (under Section 27, Part IV, Part V, Part VI, or easement) must be evaluated against the Statement of Significance/Reasons for Designation (*Ontario Heritage Act* Section 29 (4)) for the property, and where required, any interventions on these properties will require municipal approval. Generally, works that will remove or irrevocably alter a character defining element are to be avoided. It should be noted that the *Ontario Heritage Act'*s applicability is limited to either the property or district boundary. The justification for adjacent review stems not from the *Ontario Heritage Act*, but from the *Provincial Policy Statement*.

The *Ontario Environmental Assessment Act* defines heritage resources as follows:

> "environment" means...(c) the social, economic and cultural conditions that influence the life of humans or a community, (d) any building, structure, machine or other device or thing made by humans.

The Ministry of Transportation's *Environmental Guide for Built Heritage and Cultural Heritage Landscape* provides guidance on what issues should be considered. As noted in the document, unless approved through the EA process, there should be no removal or demolition of cultural heritage resources that are:

- Recognized, designated or protected by the *Ontario Heritage Act,* Part IV or V;
- Recognized or protected by:
  - The Ontario Heritage Trust;
  - The Canadian Register of Historic Places;
  - The National Historic Sites and Monuments Board;
  - The Federal Heritage Building Review Office (FHBRO) and/or;
  - Listed on municipal heritage inventories or registers; and,
- Of heritage value and are considered to be important in defining the overall character of an area, but which are not designated, listed or recognized by government.

As stated, in order to assess the last category, the Ministry of Tourism, Culture and Sport uses a rolling age of 40 years as its baseline. For details on the approach, refer to Section 2.4.2.

3.6 City of Ottawa Policies

The Boundary Road site is located within the City of Ottawa. The City of Ottawa has a number of policies that pertain to cultural heritage. For the subject site, these include the City of Ottawa *Official Plan,* the City of Ottawa *Heritage Plan*, and the *Standards and Guidelines for the Conservation of Historic Places in Canada*.

3.6.1 Official Plan

Section 1.3 of the City of Ottawa *Official Plan* states that cultural heritage resources are understood as important to community vitality and local culture. In Section 2.1, the *Official Plan* states that cultural heritage resources are to be protected during the process of change.

The City of Ottawa has identified several studies necessary to support a project where heritage resources many be affected. Section 4.6.1 of the *Official Plan* outlined the requirements for determining if a project adjacent to a heritage resource is appropriate. As the document states:

> "When reviewing applications for zoning amendments, site plan control approval, demolition control, minor variance, or the provision of utilities affecting lands/properties adjacent to a designated heritage resource, the City of Ottawa will ensure that the proposal is compatible by:
>
> - Respecting the massing, profile and character adjacent to or across the street from heritage buildings; [Amendment #76, June 24, 2009];
> - Approximating the width of nearby heritage buildings when constructing new buildings facing the street;
> - Approximating the established setback pattern on the street;
> - Being physically oriented to the street in a similar fashion to existing heritage buildings;
> - Minimizing shadowing on adjacent heritage properties, particularly on landscaped open spaces and outdoor amenity areas;
> - Having minimal impact on the heritage qualities of the street as a public place in heritage areas;
> - Minimizing the loss of landscaped open space;
> - Ensuring that parking facilities (surface lots, residential garages, stand-alone parking and parking components as part of larger developments) are compatibly integrated into heritage areas; and,
> - Requiring local utility companies to place metering equipment, transformer boxes, power lines, conduit equipment boxes, and other utility equipment and devices in locations that do not detract from the visual character or architectural integrity of the heritage resource".

This requirement is extended to properties on the City of Ottawa's Heritage Properties Register. This document also provides a statement that "in undertaking its public works, the City will provide for the conservation of heritage buildings and areas in accordance with these policies".

The Ottawa *Official Plan* does not appear to contain any heritage provision that prohibits the proposed works at the Boundary Road site. However, as indicated above, the critical issue is that any cultural heritage resources are protected through the process of change and that any action undertaken be done in such a way that impacts are mitigated or minimized.

3.6.2 The Ottawa 20/02 Heritage Plan

The Ottawa 20/02 Heritage Plan was developed to provide a 20-year vision for the City of Ottawa's heritage program. A key concept that emerged from this plan was that the City would play a leadership role, and would actively seek to identify and protect the community's cultural heritage resources. Actions supporting this strategic direction include the designation, conservation, and commemoration of cultural heritage resources, encouraging adaptive re-use projects, and recognizing that cultural heritage is a central aspect to the city's tourism and economic development initiatives. Nothing in this document appears, from a heritage planning perspective, to impede the proposed project.

3.6.3 Standards and Guidelines for the Conservation of Historic Places in Canada

The City of Ottawa has adopted the *Standards and Guidelines for the Conservation of Historic Places in Canada* as a tool to help guide change to cultural heritage resources. It provides an overview to the conservation decision-making process; conservation treatments; standards for appropriate conservation, and guidelines for conservation. In the context of the Standards and Guidelines, conservation is understood to embrace several key concepts including preservation, rehabilitation, and restoration. These terms are defined as follows:

- **Conservation:** all actions or processes that are aimed at safeguarding the character-defining elements of an historic place so as to retain its heritage value and extend its physical life. This may involve *Preservation*, *Rehabilitation*, *Restoration*, or a combination of these actions or processes;
- **Preservation:** the action or process of protecting, maintaining, and/or stabilizing the existing materials, form, and integrity of an *historic place*, or of an individual component, while protecting its *heritage value*;
- **Rehabilitation:** the action or process of making possible a continuing or compatible contemporary use of an *historic place*, or an individual component, while protecting its *heritage value*; and,
- **Restoration:** the action or process of accurately revealing, recovering or representing the state of an *historic place,* or of an individual component, as it appeared at a particular period in its history, while protecting its *heritage value* (Parks Canada, 2011).

If the Boundary Road site is chosen as the preferred alternative, the standards and guidelines within this document should be specifically examined as part of a subsequent CHIS/HIA.

3.7 United Counties of Prescott and Russell Policies

The North Russell Road Site is located in the Township of North Russell, in the United Counties of Prescott-Russell. There is both a County *Official Plan* and a Township *Official Plan*.

3.7.1 *Official Plan* of the United Counties of Prescott and Russell

The *Official Plan* of the United Counties of Prescott-Russell contains policies regarding heritage conservation. It outlines heritage conservation as part of development criteria (Section 7.4.5) and community improvement policies (Section 7.4.11). In addition, the Site Plan Control process may be initiated for heritage properties designated under the *Ontario Heritage Act*.

Further, the *Official Plan* directs Council to maintain a “cultural heritage resource database,” consisting of an inventory of significant heritage buildings, heritage districts, cultural heritage landscapes, archaeological sites, and archaeological potential areas located within the County (Section 7.6.3).[3] The heritage-specific policies contained within the *Official Plan* are applicable when:

- Conserving heritage buildings, cultural heritage landscapes, and archaeological resources that are under municipal ownership and/or stewardship;
- Conserving or mitigating impacts to all significant cultural heritage resources, when undertaking public works;
- Respecting the heritage resources, identified, or designated by federal or provincial agencies; and,
- Respecting heritage designations and other heritage conservation efforts by local municipalities.

In general, these policies are in effect for public works on municipally-owned heritage properties designated under the *Ontario Heritage Act*. The policies of the *Official Plan* have limited applicability to privately-owned property, but do support the heritage conservation efforts of lower-tier municipalities.

In addition to these policies, the United Counties of Prescott-Russell has included a policy within the *Official Plan* to enable lower-tier municipalities to request a Heritage Impact Assessment (HIA) in the evaluation of proposed development and site alteration on lands located adjacent to protected heritage property. The *Ontario Heritage Act* may be utilized to conserve, protect, and enhance any significant cultural heritage resources located within the United Counties of Prescott- Russell.

Nothing in this document appears, from a heritage planning perspective, to prevent the project. However, as with the City of Ottawa policies, any cultural heritage resources will need to be protected through the process of change and any action undertaken is to be done in such a way that impacts are mitigated or minimized.

3.7.2 *Official Plan* of the Township of Russell

The *Official Plan* of the Township of Russell is able to enact policy at a local level. As part of the guiding principles for the Township of Russell, the *Official Plan* provides direction to “promote livable and inclusive communities”. Conserving significant built heritage resources and significant cultural heritage landscapes is identified as a critical component (Section 2.2). Conserving significant built heritage is identified as a land use objective (Section 2.3).

Specific policies related to heritage conservation in the Township of Russell include:

7.1 Significant built heritage resources and significant cultural heritage landscapes shall be conserved and protected;

7.2 The Township shall identify potential significant built heritage resources and significant cultural heritage landscapes that should be subject to further protection;

7.3 The Township shall undertake a study to identify significant built heritage resources and significant cultural heritage landscapes;

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[3] The status of this heritage database is unclear. Under the *Ontario Heritage Act*, a municipality may maintain a heritage register under Section 27 (1) of the Act. However, the definition of a municipality as outlined in Section 1 of the *Ontario Heritage Act* states that a municipality is defined as “a local municipality and includes a band under the *Indian Act* (Canada) that is permitted to control, manage and expend its revenue money under Section 69 of that Act.” The *Ontario Heritage Act* does not define “local municipality.” However, under Section 1(1) the *Municipal Act*, “‘local municipality” is defined as a single-tier municipality or a lower-tier municipality. This definition may preclude the database from having any formal status. However, it still can be understood as an expression of community interest.

7.4 Development and site alteration may be permitted on lands adjacent to protected heritage property where the proposed development and site alteration has been evaluated and it has been demonstrated that the heritage attributes of the protected heritage property will be conserved;

7.5 Mitigative measures and/or alternative development approaches may be required in order to conserve the heritage attributes of the protected heritage property affected by the adjacent development or site alteration; and,

7.6 Reference shall be made to the County *Official Plan* for additional heritage policies (Section 7).

Similar to the United Counties of Prescott-Russell, the *Official Plan* for the Township of Russell contains provisions to enable the municipality to request a Cultural Heritage Impact Statement (CHIS) for development and site alteration on lands adjacent to protected heritage property. Additionally, the Site Plan Control process is initiated for heritage properties designated under the *Ontario Heritage Act* (Section 9.3.5) and the development permit by-law shall encourage the protection of heritage resources and landscapes (Section 9.3.4).

Again, nothing in this document appears, from a heritage planning perspective, to prevent the project. As with the County policies, any cultural heritage resources will need to be protected through the process of change and any action undertaken is to be done in such a way that impacts are mitigated or minimized.

4.0 DESCRIPTION OF THE PROJECT

Taggart Miller Environmental Services (Taggart Miller) is undertaking an environmental assessment (EA) under the *Ontario Environmental Assessment Act* for a proposed integrated waste management project to be known as the Capital Region Resource Recovery Centre (CRRRC). In December 2012, the Terms of Reference (TOR) for this environmental assessment were approved by the Minister of the Environment.

The CRRRC, if approved, would provide facilities and capacity for recovery of resources and diversion of materials from disposal that are generated by the Industrial, Commercial and Institutional (IC&I) and the Construction and Demolition (C&D) sectors in Ottawa and Eastern Ontario, as well as disposal capacity for material that is not diverted. The components of the CRRRC will be developed through further consultation during the environmental assessment and are currently proposed to include:

- Material recovery facility;
- Construction and demolition waste processing;
- Organics processing;
- Hydrocarbon contaminated soil treatment;
- Surplus soil management;
- A drop off for separated materials or separation of materials;
- Leaf and yard materials composting (if there is enough material available); and,
- An engineered landfill for residuals disposal.

As set out in the approved TOR, the first step in the EA process is a comparative evaluation of two potential sites being considered for the CRRRC facility. One site is located in the northwest part of the Township of Russell on North Russell Road and the other site is located east of Boundary Road and south of Highway 417 in the City of Ottawa near an existing industrial park.

5.0 STUDY AREA DEVELOPMENT

A brief overview of the general historical background and development of each of the study areas is provided below. For a more comprehensive historical background and development of each of the two study areas, including property histories, refer to the Archaeological Assessments for the two study areas, that are provided attached as Attachment TSD1-F-1 (North Russell Road Site Archaeological Assessment) and Attachment TSD1-F-2 (Boundary Road Site Archaeological Assessment).

5.1 Pre-Contact

Although human occupation of southern Ontario dates back approximately 10,000 years B.P., the Ottawa Valley remained very much on the fringe of occupation at this time. Throughout the Early, Middle, and Late Woodlands Periods, the Ottawa Valley remained a sparsely occupied region utilized by mobile hunter-gatherers. Three Algonquin groups were known to reside in the vicinity of the study area at the point of early European contact.

5.2 Boundary Road Site

The Ottawa River was an important transportation route. Fur trading posts were erected along the Ottawa River where the Algonquin traded with the Europeans. A French trading post was situated across the river from Cumberland in modern-day Buckingham in 1761. This area was controlled by France until 1763 when the British gained control of the region following the completion of the Seven Year War. The Township of Cumberland still has a large French population to this day.

The first official survey of the Township of Cumberland was conducted in 1791 (CTHS, N.D.) in order to divide the land into individual lots for settlement. Although many of the lots were granted to United Empire Loyalists, very few were settled. Many of the Loyalists had already settled on properties along the St. Lawrence River and remained absentee landowners of their Cumberland lots. Another hindrance to early settlement of Cumberland was the lack of roads to the interior (Belden 1881, Plate 1, p. 16). The first major road, Montreal Road (originally called L'Orignal–Bytown Road), was not built until 1850; this road ran directly through Concession 1 along the Ottawa River (CTHS, N.D.; McGilvray 2005).

The first settlers of the Township of Cumberland were Abijah Dunning and Amable Faubert (also written Foubert), both arriving in 1801. Abijah Dunning originally obtained 800 acres of land in the Township of Cumberland from the Crown and continued to acquire land, eventually coming to own 3,000 acres throughout Cumberland, Buckingham, and Onslow Townships. Amable Faubert opened up a trading post along the river in 1807 and traded mostly fur, potash, and lumber throughout the nineteenth century. The Foubert and Dunning families continued to have a large presence in the Township throughout the nineteenth century.

By 1858, the Village of Cumberland had a population of over 1,000 with an additional 2,000 residents in the rural parts of the Township. Cumberland became a major seasonal forwarding centre along the Ottawa River in the 1870s, where two wharves were built and several forwarding companies were established, including one owned by the Faubert brothers. This helped facilitate a small ship building industry during the mid-nineteenth century (CTHS, N.D.).

In 1882, the Grand Trunk Railway was built through the community of Vars which provided the first rail transportation route through the Township. Another railway, the Canadian National Railway (CNR), was built through the Township of Cumberland in 1899 and was extended in 1907 to run through Concession 1 along the river (CTHS, N.D.). The CNR was closed during the Great Depression and the old rail line was replaced by the construction of Highway 417 in the 1960s and 1970s.

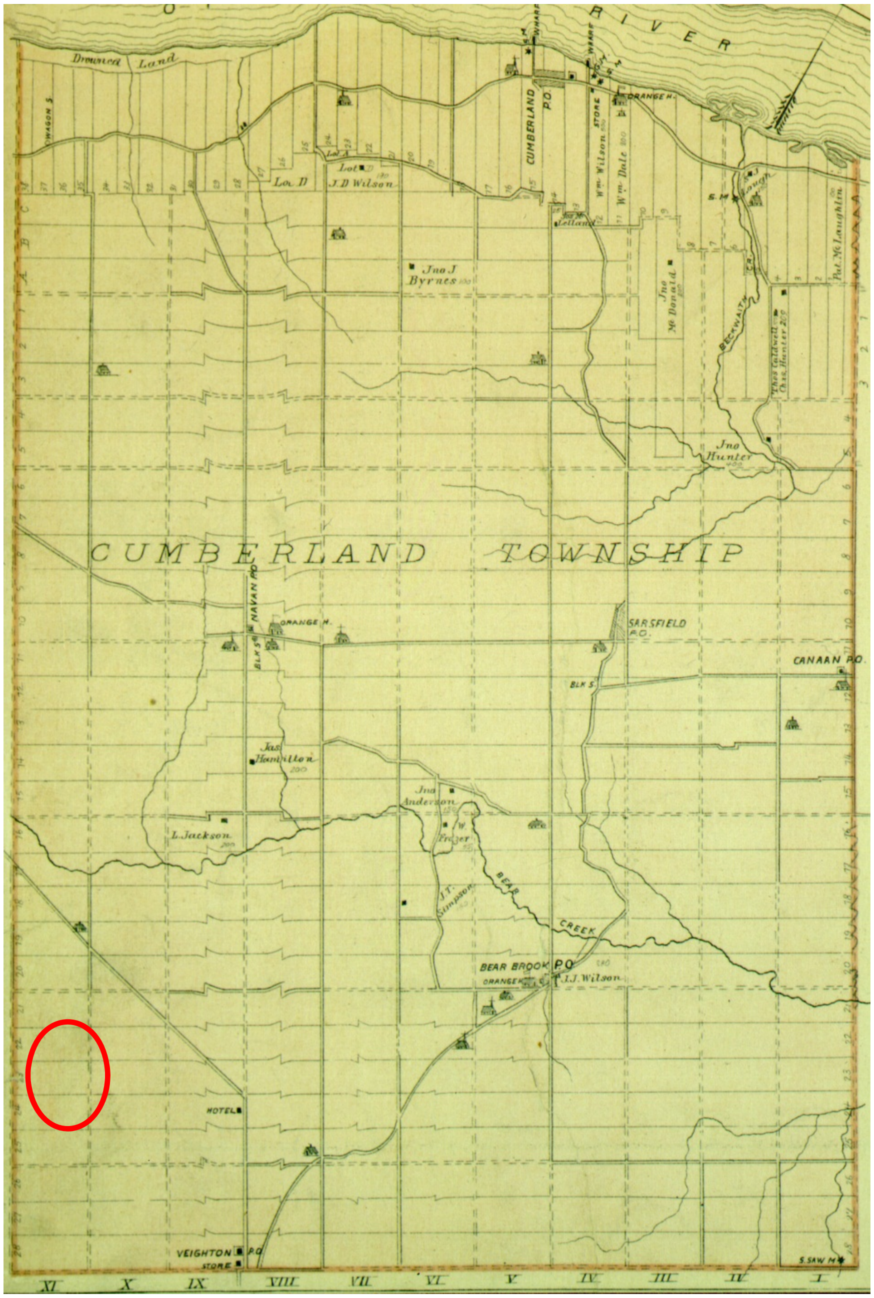

Plate 1: H. Belden & Company's Plan of Cumberland Township in the *Illustrated Historical Atlas of the United Counties of Prescott and Russell* (1881) indicates the lack of roads travelling through Cumberland Township. Dashed lines on the plan indicate road allowances between concessions.

5.3 North Russell Road Site

The earliest recorded European settlement in the Russell area was the establishment of the Seigniory of L'Orignal in 1675, granted by the King of France. It later served as the Ottawa District Seat and today is the County Seat for the United Counties of Prescott-Russell. The founding of Vankleek Hill (1786) and Hawkesbury (1790) followed in the eighteenth century.

Many settlers in the Township of Russell were of Irish origin, with some Scottish and English. However, the majority of landowners were United Empire Loyalist descendants. Land grants to the children of Loyalists were generally located in interior townships, as grants along "the Front", as townships along the St. Lawrence River were called, had already been occupied (Stanley 1988). The Township of Russell was surveyed in 1821–1822 by William MacDonald; survey notes do not indicate any form of settlement in the Township of Russell or any reference to lumbering activities. MacDonald was the first landowner in the Township of Russell, having been granted 2,850 acres in the Township for his services as Surveyor General in 1824 (Stanley 1988). Some of the early patents in the Township of Russell were from the children of Loyalists from Osnabruck Township, including the Mattice and Loucks [*sic*] families. Property transactions in the Township of Russell often took several years to register as absentee ownership was common.

Early settlers were engaged in the lumber trade. Rich with Russell Sand Plain soils, the western half of the Township was initially settled by immigrants of British descent, establishing small farming communities and rural areas. Settlers from Quebec primarily settled in the eastern half of the Township of Russell after 1848, and concentrated in the Embrun area (Stanley 1988). Travel was restricted, which isolated settlers. Due to the difficulty of the terrain, only blazed trails provided access through the swampy brush and forest. It was 1852 before a road was opened to Bytown (later known as Ottawa).

Settlement grew quickly in the period of 1841–1850 with an influx of Irish settlers, although many lots were still available. Most people were still living in log houses or shanties into the mid-nineteenth century. Frame and brick houses would not be constructed until the 1880s and beyond, with few exceptions.

Duncanville, named for William Duncan at the site of an oatmeal mill on the bank of the Castor River, was the earliest settlement in the vicinity of the study area. The mill was constructed in 1846–1847 and attracted subsequent development. A plan of subdivision in 1853 created village lots for development, and the community is shown on the Walling Map (1862). A post office was opened in 1848, with a woolen mill and brickyard soon following. The name transitioned from Duncanville to Russell during the latter half of the nineteenth century, with many discrepancies. In 1898, the conflict was resolved with the passing of a by-law by the County Council of Prescott-Russell to elevate the unincorporated village of Russell into the Police Village of Russell (Stanley 1988, 3). The settlement known as Luxemburg, named for the Loux [*sic*] family, was amalgamated around the same time. Opening in 1898, the Ottawa and New York Railway serviced Russell until 1954 when passenger service ended.

Settlement in North Russell has been recognized continuously by the same name longer than any other part of the Township of Russell (Stanley 1988). Located on red shale lands with sand plain soils at the northern part of the Township of Russell, the area was home to a strong agricultural community. North Russell was the location of the North Russell School (1840–1841) (Plate 2, p. 18), the North Russell Orange Lodge (1850), and the North Russell Methodist Church (1888).

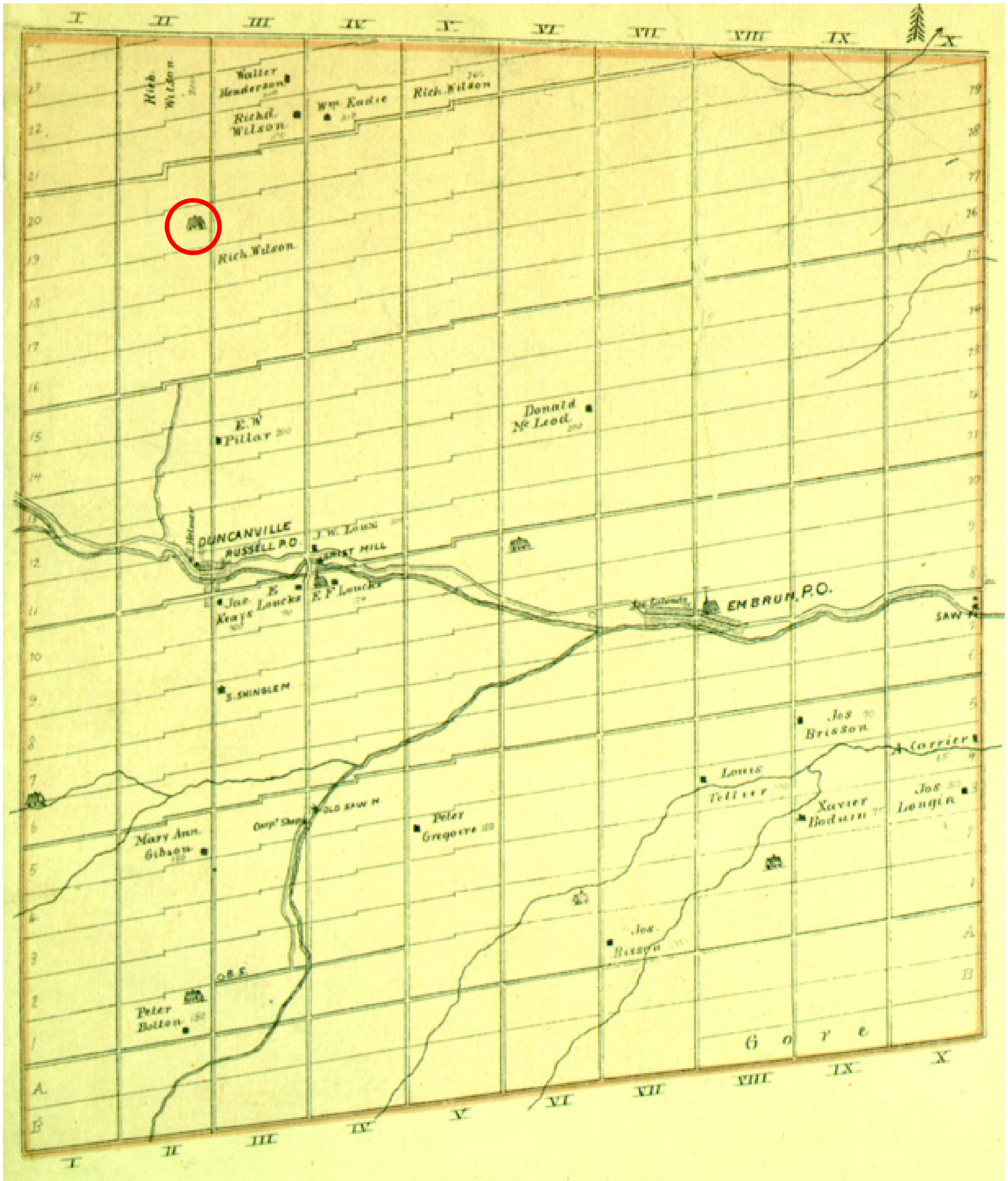

Plate 2: Showing the Township of Russell, H. Belden & Company's *Illustrated Historical Atlas of the United Counties of Prescott and Russell* (1881) marks important social institutions, including the North Russell School, located at Lot 19, Concession II (noted).

6.0 CULTURAL HERITAGE RESOURCES

Identified and potential cultural heritage resources located on, and adjacent to, the two sites have been photographed and listed in Appendix A (Boundary Road Site) and Appendix B (North Russell Road Site). They are also illustrated on Figure 3 (Boundary Road Site), p. 20, and Figure 4 (North Russell Road Site), p. 22.

Identified heritage properties were determined using existing inventories and registers, as outlined in Section 2.4.3. This section also identified how potential heritage properties are determined. As previously stated, these properties will not, at this point, be assessed against Regulation 9/06 of the *Ontario Heritage Act*. Access was not granted to enter onto private property, which would be necessary to undertake a full assessment. However, using e-maps, historic and contemporary mapping, air photos, and site visits, all potential cultural heritage resources adjacent to the proposed project sites were identified.

6.1 Boundary Road Site

In relation to the Boundary Road site, a total of four potential cultural heritage resources (including both individual properties and cultural landscapes) were identified. The location of these identified or potential cultural heritage resources are shown on Figure 3, p. 20, and are described in Appendix A.

6.1.1 Identified Heritage Resources

There are no properties within the Boundary Road study area that have been identified as possessing cultural heritage value or interest by the City of Ottawa. Consultation with the City of Ottawa revealed two properties of cultural heritage value or interest: 6086 Frontier Road and 9341 Mitch Owens Road. However, both of these properties are in excess of 500 metres from the study area. The NCC Greenbelt, which has been identified as a medium-scale cultural landscape by the NCC, is located north of Highway 417 (Inventory O-01).[4] It is also in excess of 500 metres from the study area.

6.1.2 Potential Heritage Resources

A total of four potential heritage resources (identified as pre-1973 structures as per MTCS guidelines) were identified. Only one, the farmstead located at 5508 Frontier Road (Inventory O-04), is a potential cultural heritage landscape.[5] The other three properties are located in an area of transition, and are often already isolated by recent land-use changes. Two of the properties include mixed uses including residential and commercial components (5409 Boundary Road (Inventory O-02)) and (5329 Boundary Road (Inventory O-01)). The property located at 5329 Boundary Road appears to be a residential use only, but it shares a civic address with a commercial business (Alpine Auto Parts) immediately adjacent. The specific use of what appears to be a former farmhouse located at 5507 Boundary Road (Inventory O-03) could not be determined, although it is located in an area dominated by industrial uses.

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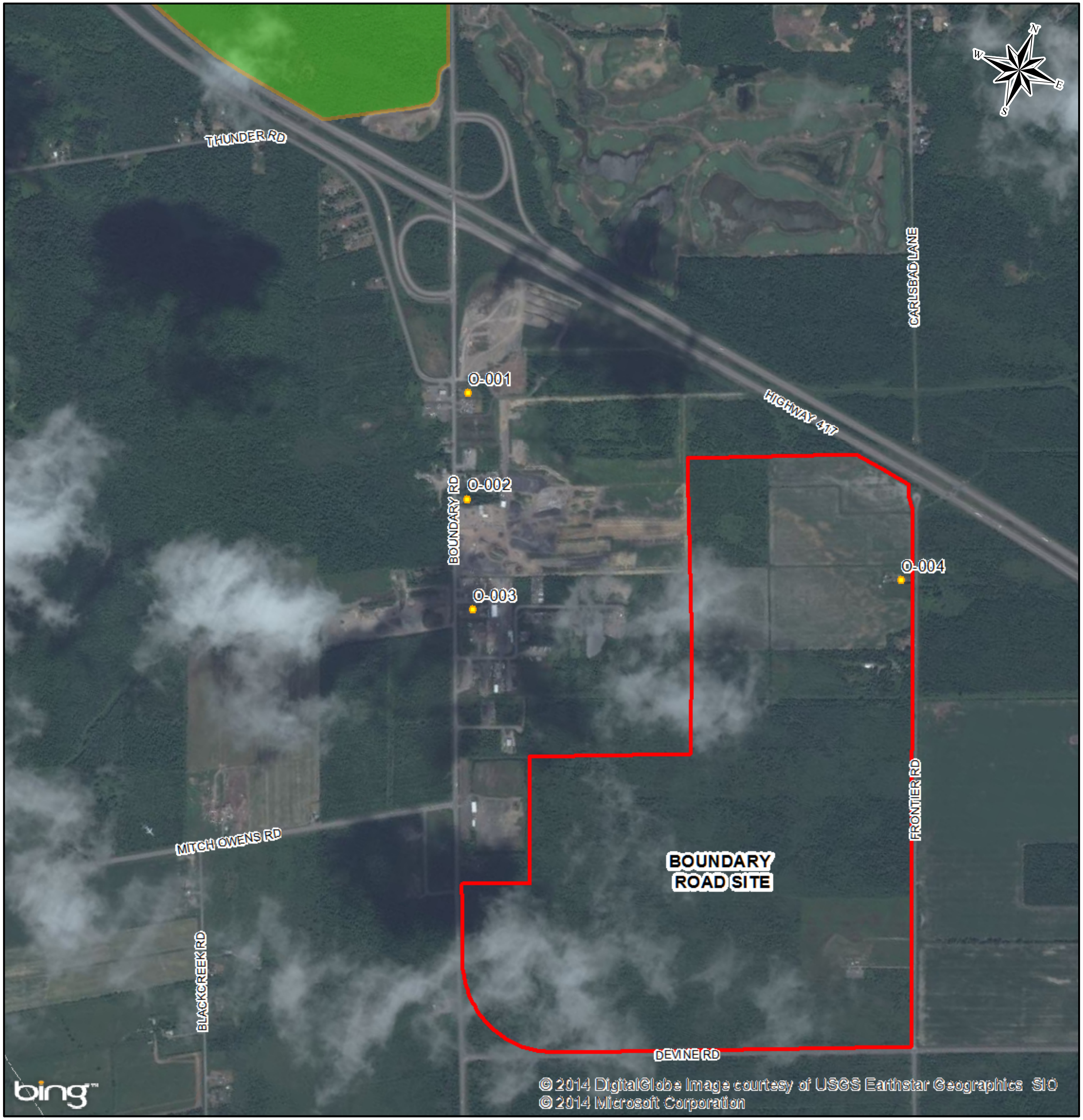
[4] NCC uses the term “cultural landscape” rather than “cultural heritage landscape” used in the PPS (2005) and by MTCS.

[5] As outlined in the definitions, a cultural heritage landscape can be understood as “a grouping(s) of heritage features such as structures, spaces, archaeological sites and natural elements, which together form a significant type of heritage form, distinctive from its constituent elements or parts”. In this instance, the farmstead has been identified as a potential cultural heritage landscape because of the presence of multiple pre-1973 buildings and landscape features. This identification does not mean that the property is of sufficient cultural heritage value to be protected, but has been flagged as such because the assessment process for a cultural heritage landscape is more involved than an assessment based on Regulation 9/06 of the *Ontario Heritage Act*.



LEGEND

●	IDENTIFIED AND POTENTIAL CULTURAL HERITAGE RESOURCES
🟥	BOUNDARY ROAD SITE
🟩	NATIONAL CAPITAL COMMISSION GREEENBELT

0.5 0.25 0 0.5

SCALE 1:17,000 KILOMETRES

NOTE

CULTURAL & HERITAGE RESOURCES COMPONENT
APPENDIX TSD1-F
COMPARATIVE EVALUATION OF ALTERNATIVE SITES
CAPITAL REGION RESOURCE RECOVERY CENTRE

REFERENCE

IMAGERY - BING MAPS AERIAL (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS
DIGITAL NRVIS MNR DATA PRODUCED BY GOLDER ASSOCIATES LTD., USED UNDER LICENSE © QUEEN'S PRINTER OF ONTARIO.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

IDENTIFIED AND POTENTIAL CULTURAL HERITAGE RESOURCES, BOUNDARY ROAD SITE

Golder Associates
Ottawa, Ontario

PROJECT No. 09-1125-1008-9000			SCALE AS SHOWN	REV. 0.0
DESIGN	PLE	OCT. 2012	FIGURE 3	
GIS	PJM	FEB. 2013		
CHECK	ML	AUG. 2014		
REVIEW	HJD	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase4000\TSD1\12-1125-00045-4000-160-03-BoundaryRoad.mxd

6.2 North Russell Road Site

In relation to the North Russell Road site, a total of 29 cultural heritage resources (including both individual properties and cultural landscapes) were identified. The location of these identified or potential cultural heritage resources are shown on Figure 4, p. 22, and are described in Appendix B.

6.2.1 Identified Heritage Resources

There are no properties within the North Russell Road study area that have been identified as possessing cultural heritage value or interest by either the Township of Russell or the United Counties of Prescott-Russell.

6.2.2 Potential Heritage Resources

A total of 29 potential heritage resources (identified as pre-1973 structures as per MTCS guidelines) were identified. Of these potential heritage resources, 20 are current or former farmsteads with multiple structures and landscape features. These properties should be treated as potential cultural heritage landscapes. In addition, the quarry itself (which predates 1945) (Inventory R-17) is a potential industrial heritage site, and would need to be examined as such. There is also an active historic cemetery (Inventory R-06), a former school located at 456 North Russell Road (Inventory R-04), and a former church located at 587 Route 100 (Inventory R-22). There is also a brick building located at 499 North Russell Road whose original purpose could not be determined (Inventory R-05).[6] There are four properties which are primarily being used as residences.[7] Lastly, the North Russell Road study area may be a potential cultural heritage landscape. The number of potential cultural heritage resources, including (but not limited to) the area's landscape features, a cemetery, a former church, and a former school, would need to be assessed *in toto* to determine if there is cultural heritage value as a larger landscape unit.

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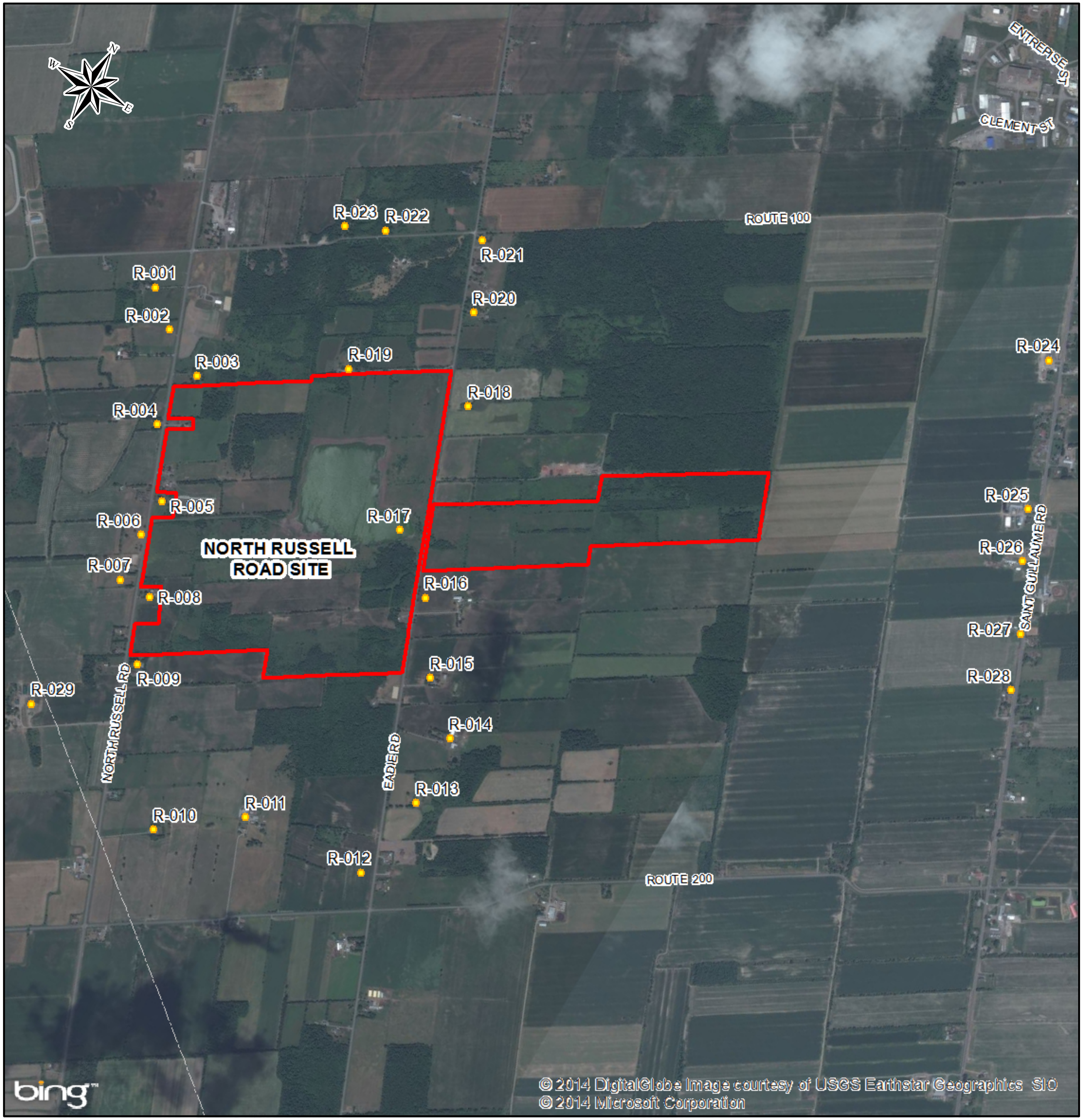
[6] Detailed research would be required for this property to determine its precise history which was not possible as part of this initial survey.

[7] These properties include: 307 Eadie Road (Inventory R-21); 388 Eadie Road (Inventory R-19); 591 Eadie Road (Inventory R-12); and, 476 St. Guillaume Road (Inventory R-28).



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LEGEND

● IDENTIFIED AND POTENTIAL CULTURAL HERITAGE RESOURCES

— · — UTILITY

🟥 NORTH RUSSELL ROAD SITE

0.45 0.225 0 0.45 0.9

SCALE 1:25,000 KILOMETRES

NOTE

CULTURAL & HERITAGE RESOURCES COMPONENT
APPENDIX TSD1-F
COMPARATIVE EVALUATION OF ALTERNATIVE SITES
CAPITAL REGION RESOURCE RECOVERY CENTRE

REFERENCE

IMAGERY - BING MAPS AERIAL (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS
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PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

IDENTIFIED AND POTENTIAL CULTURAL HERITAGE RESOURCES, NORTH RUSSELL ROAD SITE

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-1008-9000			SCALE AS SHOWN	REV. 0.0
DESIGN	PLE	OCT. 2012	FIGURE 4	
GIS	PJM	FEB. 2013		
CHECK	ML	AUG. 2014		
REVIEW	HJD	AUG. 2014		

7.0 SUMMARY AND RECOMMENDATIONS

Golder Associates Ltd. ("Golder") was retained by Taggart Miller Environmental Services (Taggart Miller) to conduct a Cultural Heritage Overview Report on two potential locations for the Capital Region Resource Recovery Centre (CRRRC):

- **North Russell Road Site** consisting of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell; and,
- **Boundary Road Site** consisting of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession 11, Township of Cumberland.

This report was prepared to provide initial guidance on the cultural heritage aspects of the project. The objective of the study was to identify the existing heritage policy framework related to the two potential locations, to examine known inventories to determine known cultural heritage resources, and to identify potential cultural heritage resources (identified by MTCS as any resources older than 40 years) that would need to be further assessed.

As the detailed design work for the project is not complete because a preferred site has not been chosen, it could not be determined in detail how the proposed works may result in direct impacts on identified and potential cultural heritage resources. However, generalized negative impacts on cultural heritage resources, as identified by MTCS, can include the following:

- Destruction of any, or part of any, significant heritage attributes or features;
- Alteration that is not sympathetic, or is incompatible, with the historic fabric and appearance;
- Shadows created that alter the appearance of a heritage attribute or change the visibility of a natural feature or plantings, such as a garden;
- Isolation of a heritage attribute from its surrounding environment, context or a significant relationship;
- Direct or indirect obstruction of significant views or vistas within, from, or of built and natural features;
- A change in land use such as rezoning a battlefield from open space to residential use, allowing new development or site alteration to fill in the formerly open spaces; and,
- Land disturbances such as a change in charge that alters soil, and drainage patterns that adversely affect an archaeological resource.

As a result, further heritage assessment will need to be carried on the site that is identified as the preferred alternative.

While the legislation/policy review revealed no heritage policies that would prohibit the construction of the CRRRC at either location, there were clear policy statements that cultural heritage resources need to be protected during the process of change. There were no properties within the North Russell Road Site study area having been previously identified as possessing cultural heritage value. Near the Boundary Road site, there were three properties identified as having cultural heritage value: the NCC Greenbelt (identified by NCC), 6086 Frontier Road (identified by the City of Ottawa), and 9341 Mitch Owens Road (identified by the City of Ottawa). All three properties are in excess of 500 metres from the study area. In reviewing the potential properties (based on the review of inventories, site visits, and air photo analysis), the North Russell Road Site was found to have 29 potential cultural heritage resources and the Boundary Road Site was found to have four potential cultural heritage resources.

In terms of next steps, the following will need to be undertaken for the site chosen as the preferred site:

1) Each of the potential cultural heritage resources will need to be assessed against Regulation 9/06 of the *Ontario Heritage Act* to determine if they possess cultural heritage value. These assessments should be reviewed and approved by the local municipal approval agency. If no properties are identified in a study area as having cultural heritage value, a CHIS/HIA will not need to be prepared; and,
2) If a CHIS/HIA needs to be prepared, it must draw upon the foregoing Regulation 9/06 to determine what, if any impacts, will occur and to provide recommendations for any necessary mitigative work. This assessment should be prepared early in the design process to ensure that any recommendations can be integrated into the detailed designs;

If the Boundary Road Study Area is identified as the preferred site:

1) The property located at 5508 Frontier Road (Inventory O-04) should be assessed as a cultural heritage landscape. This should be reviewed and approved by the municipal approval agency;
2) The City of Ottawa's *A Guide to Preparing Cultural Heritage Impact Statements* will need to be reviewed and integrated into any CHIS prepared for the project;
3) The detailed design for the project will need to be evaluated against the City of Ottawa Council-adopted *Standards and Guidelines for the Conservation of Historic Places in Canada* as part of any CHIS prepared for the project; and,

If the North Russell Road Study Area is identified as the preferred site:

1) Twenty of the 29 properties identified as potential cultural heritage landscapes will need to be assessed to determine if they have cultural heritage value. These should be reviewed and approved by the municipal approval agency;
2) The overall area will need to be assessed to determine if it is a larger scale cultural heritage landscape. This should be reviewed and approved by the municipal approval agency; and,
3) Any local or provincial guidelines for the preparation of CHIS/HIA will need to be reviewed and integrated in any CHIS/HIA prepared for the project. It will need to be determined if the United Counties of Prescott-Russell would require a separate submission from the Township of Russell.

8.0 IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

This report has been prepared for the specific site, design objective, developments and purpose described to Golder by Taggart Miller Environmental Services (Taggart Miller). The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. The information, recommendations and opinions expressed in this report are for the sole benefit of Taggart Miller. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of Taggart Miller, Golder may authorize in writing the use of this report by the regulatory agency as an approved user for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only Taggart Miller and approved users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. Taggart Miller and approved users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. Golder acknowledges the electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore of Taggart Miller cannot rely upon the electronic media versions of Golder's report or other work products.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of Taggart Miller in the design of the specific project.

This report is also subject to the following limitations:

- This is an overview analysis as detailed construction information was not available;
- Site visits were undertaken during the winter season; there may be some landscape features that were not readily apparent;
- The analysis was focused on tangible post-contact built cultural heritage resources and cultural heritage landscapes. Soundscapes, cultural identity, and sense of place analysis were not integrated into this report; and,
- The review of the policy/legislation was limited to that information directly related to cultural heritage management; it is not a comprehensive planning review and zoning was not examined.

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Walling

1862 **Map of the United Counties of Prescott and Russell.**

Ontario Legislation and Policy

- *Cemeteries Act* (Ontario)
- *Ontario Environmental Assessment Act*
- *Ontario Heritage Act*
- *Municipal Act* (Ontario)
- *Planning Act* (Ontario)
- Provincial Policy Statement (2005)
- Regulation 9/06 of the *Ontario Heritage Act*
- Regulation 157/10 of the *Ontario Heritage Act*

CLOSURE

We trust that this report meets your current needs. If you have any questions, or if we may be of further assistance, please contact the undersigned.

GOLDER ASSOCIATES LTD.

Hugh J Daechsel

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Senior Cultural Heritage Specialist

Hugh J. Daechsel, MA
Principal, Senior Archaeologist

ML/HJD/bh/lrb/sg

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APPENDIX A

Boundary Road Site-Potential Cultural Heritage Inventory

APPENDIX A
Boundary Road Site

This Potential Cultural Heritage Resources Inventory includes identified resources (by a governmental approval body) and potential resources (defined as pre-1973 structures as per Ministry of Tourism, Culture and Sport Guidelines) located within the study area for the Boundary Road site for the Capital Region Resource Recovery Centre (CRRRC).

Cultural heritage features were identified through a review of existing inventories held by Parks Canada, the National Capital Commission, the City of Ottawa, and the Ontario Heritage Trust, as well as a review of pre-1973 air photographs and a field work in the area. All sites were documented based on their vicinity to the study area. The information from this inventory is meant as a first review of identified and potential cultural heritage resources within and adjacent to the study area, and it will be required to be refined following the selection of the preferred site and the preparation of a subsequent CHIS/HIA. This inventory does not include Statements of Significance for the identified properties, but does indicate the type of recognition applied to identified properties. Should it be determined that the intervention activities at the preferred site may impact these resources, the impacted properties will be included in subsequent CHIS/HIA and more details will be provided.

The following is a brief explanation of the terms used within Appendix A:

- **ID**: Identification number associated with an individual resource. “R” indicating Township of Russell; “O” indicating City of Ottawa;
- **Address**: The civic address was determined on site. In situations where an individual address could not be determined, it is noted in the inventory;
- **Description**: A brief description of the use of the structure and particular distinguishing features. Where the structure was named or had a specific purpose, it was also included;
- **Designating Authority**: For identified properties, the authority under which the resource was designated or listed (municipal, provincial, or federal); and,
- **Heritage Recognition**: The current recognized designation of the resource, including those identified as pre-1973. This varies substantially based on the authority which has designated the resource. The following table briefly explains the distinction between each. The *Cemeteries Act* may be applicable where a cemetery has been identified.

Table 1: Description of the Levels of Heritage Designation

Designating Authority	Category	Description
HSMBC (Historic Sites and Monuments Board of Canada)	National Historic Site	■ Designation of Canada's National Historic Sites ■ There are 950 National Historic Sites in Canada
FHBRO (Federal Heritage Building Review Office)	Register of the Government of Canada Heritage Buildings	■ FHBRO assists federal government departments in the protection of their heritage buildings
National Capital Commission	Cultural Landscape	■ Designation of a cultural landscape by the National Capital Commission ■ Small-scale, medium-scale, and large-scale cultural landscape designations
City of Ottawa	Individual Designation	■ Designated under Part IV of the *Ontario Heritage Act*
	Listed	■ A property included on the City of Ottawa Heritage Properties Register under the authorization of Section 27 of the *Ontario Heritage Act* or listed on the City of Ottawa's Heritage Inventory
	Pre-1973	■ Properties older than 40 years, identified in accordance with the Ministry of Tourism, Culture and Sport and the Ministry of Transportation Guidelines
	Other	■ Other types of designations, including cemeteries

Potential Cultural Heritage Resources Inventory						
Boundary Road Site						
ID	**Photograph**	**Address**	**Photograph Direction**	**Description**	**Designating Authority**	**Heritage Recognition**
O-01		Boundary Road 5329	East	- Single-storey brick with stucco residential structure and attached garage - Property includes Alpine Auto Parts, a commercial/industrial complex		Pre-1973 potential cultural heritage resource
O-02		Boundary Road 5409	East	- Single-storey structure with attached garage - Mixed use		Pre-1973 potential cultural heritage resource
O-03		Boundary Road 5507	East	- Two-storey structure with associated outbuildings		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

Boundary Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
O-04		Frontier Road 5508	West	▪ One-and-a-half-storey frame farmhouse and associated farmstead		Pre-1973 potential cultural heritage resource

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APPENDIX B

North Russell Road Site-Potential Cultural Heritage Resources Inventory

APPENDIX B

North Russell Heritage Inventory

This Potential Cultural Heritage Resources Inventory includes identified resources (by a governmental approval body) and potential resources (defined as pre-1973 structures as per Ministry of Tourism, Culture and Sport Guidelines) located within the study area for the North Russell Road site for the Capital Region Resource Recovery Centre (CRRRC).

Cultural heritage features were identified through a review of existing inventories held by Parks Canada, the United Counties of Prescott-Russell, the Township of Russell, and the Ontario Heritage Trust, as well as a review of pre-1973 air photographs and a field work in the area. All sites were documented based on their vicinity to the study area. The information from this inventory is meant as a first review of identified and potential cultural heritage resources within and adjacent to the study area, and it will be required to be refined following the selection of the preferred site and the preparation of a subsequent CHIS/HIA. This inventory does not include Statements of Significance for the identified properties, but does indicate the type of recognition applied to identified properties. Should it be determined that the intervention activities at the preferred site may impact these resources, the impacted properties will be included in subsequent CHIS/HIA and more details will be provided.

The following is a brief explanation of the terms used within Appendix B:

ID: Identification number associated with an individual resource. “R” indicating Township of Russell;

Address: The civic address was determined on site. In situations where an individual address could not be determined, it is noted in the inventory;

Description: A brief description of the use of the structure and particular distinguishing features. Where the structure was named or had a specific purpose, it was also included;

Designating Authority: For identified properties, the authority under which the resource was designated or listed (municipal, provincial, or federal); and,

Heritage Recognition: The current recognized designation of the resource, including those identified as pre-1973. This varies substantially based on the authority which has designated the resource. The following table briefly explains the distinction between each. The Cemeteries Act may be applicable where a cemetery has been identified.

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National Capital Commission	Cultural Landscape	Designation of a cultural landscape by the National Capital Commission Small-scale, medium-scale, and large-scale cultural landscape designations
Township of Russell	Individual Designation	Designated under Part IV of the *Ontario Heritage Act*
	Listed	A property included on the Municipal Register of Heritage Properties under the authorization of Section 27 of the *Ontario Heritage Act*
	Pre-1973	Properties older than 40 years, identified in accordance with the Ministry of Tourism, Culture and Sport and the Ministry of Transportation Guidelines
	Other	Other types of designations, including cemeteries

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-01		North Russell Road 372	West	▪ One-and-a-half-storey red brick residential structure ▪ Large setback, obscured by vegetation ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-02		North Russell Road 412	West	▪ Residential structure ▪ Large setback, obscured by vegetation ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-03		North Russell Road 421	East	▪ One-and-a-half-storey red brick residential structure with a verandah ▪ Brick gate posts at North Russell Road		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-04		North Russell Road 456	West	▪ Former schoolhouse; converted to residential use ▪ Single-storey structure clad in siding		Pre-1973 potential cultural heritage resource
R-05		North Russell Road 499	East	▪ One-and-a-half-storey red brick structure ▪ Contrasting brick voussoirs and quoins		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-06	 	North Russell Road (Lot 18-19, Conc. 2)	West	▪ North Russell Union Cemetery ▪ Associated single-storey brick structure (post-1973)		Pre-1973 potential cultural heritage resource Cemetery

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-07	 	North Russell Road 552	West	▪ Armstrong ▪ One-and-a-half-storey residential structure with two porches ▪ Barn/outbuildings ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-08		North Russell Road 559	East	▪ One-and-a-half-storey frame residential structure with verandah ▪ Barn/coup outbuilding ▪ Tree house ▪ Farmstead		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-09		North Russell Road 591	East	▪ One-and-a-half-storey frame residential structure ▪ Former farmstead		Pre-1973 potential cultural heritage resource
R-10		North Russell Road 699	East	▪ One-and-a-half-storey residential structure with barn and outbuildings ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-11		Route 200 575	North	▪ One-and-a-half-storey residential structure with porch ▪ Barn/outbuildings ▪ Large setback ▪ Farmstead		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-12		Eadie Road 700	West	▪ Large setback, structures obscured by vegetation ▪ Apparent farmstead		Pre-1973 potential cultural heritage resource
R-13		Eadie Road 681	East	▪ One-and-a-half storey residential structure with white cladding, green roof and wrap-around verandah ▪ Barn/outbuildings ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-14		Eadie Road 631	East	▪ One-and-a-half-storey brick residential structure with a verandah and side porch ▪ Barn/outbuildings ▪ Farmstead		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-15		Eadie Road 591	East	▪ One-and-a-half-storey red brick residential structure ▪ Tree house ▪ Barn/outbuildings and silo ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-16		Eadie Road 543	East	▪ One-and-a-half-storey red residential structure ▪ Barns/outbuildings and silos ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-17		Between North Russell Road and Eadie Road	West	▪ Quarry ▪ Quonset hut (prefabricated corrugated galvanized steel structure with semicircular cross-section)		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-18		Eadie Road 415	East	▪ Shed/barn structure ▪ Indicates presence of former farmstead or agricultural activity		Pre-1973 potential cultural heritage resource
R-19		Eadie Road 388	West	▪ Structure obscured by vegetation		Pre-1973 potential cultural heritage resource
R-20		Eadie Road 363	East	▪ Two-storey residential structure clad in white siding ▪ Barn/outbuildings ▪ Farmstead		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
						
R-21		Eadie Road 307	East	▪ Single-storey residential structure clad in vertical blue siding		Pre-1973 potential cultural heritage resource
R-22		Route 100 587	North	▪ Former church; converted into residential use ▪ "The Methodist Church 1888" ▪ Single-storey structure clad in stucco		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-23		Route 100 575	North	▪ One-and-a-half-storey residential structure ▪ Barn/outbuildings (possibly log construction) ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-24		St Guillaume Road 276	West	▪ One-and-a-half-storey residential structure with porch ▪ Outbuildings ▪ Steel silos ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-25		St Guillaume Road 376	West	▪ One-and-a-half-storey frame residential structure ▪ Farmstead ▪ Three concrete silos		Pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-26		St Guillaume Road 440	West	▪ One-and-a-half-storey frame residential structure with verandah ▪ Barn/outbuildings including two concrete silos ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-27		St Guillaume Road 452	West	▪ One-and-a-half-storey residential structure ▪ Outbuildings ▪ Farmstead		Pre-1973 potential cultural heritage resource
R-28		St Guillaume Road 476	West	▪ One-and-a-half storey residential structure		Appears to be pre-1973 potential cultural heritage resource

Potential Cultural Heritage Resources Inventory

North Russell Road Site

ID	Photograph	Address	Photograph Direction	Description	Designating Authority	Heritage Recognition
R-29		North Russell Road 640	West	▪ Single storey residential structure ▪ Farmstead		Appears to be pre-1973 potential cultural heritage resource

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Golder Associates

APPENDIX TDS#1-G

Agriculture Component

February 2013

February 2013

Agriculture Component
Appendix TSD#1-G

COMPARATIVE EVALUATION OF ALTERNATIVE SITES

TAGGART
GROUP OF COMPANIES

THE
MILLER
GROUP

Table of Contents

FIGURES

ATTACHMENTS

INTRODUCTION

Two properties that are owned or have been optioned by Taggart Miller have been identified for the proposed recovery centre.

- **North Russell Road Site (NRR Site)** – located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (470 acres) of contiguous lands on Part of Lots 18 and 19, Concession III and IV, Township of Russell.
- **Boundary Road Site (BR Site)** – located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, geographic Township of Cumberland.

The Capital Region Resource Recovery Centre (CRRRC) is proposed to provide facilities and capacity for recovery of resources and diversion of material from disposal generated by the industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sectors primarily in Ottawa and secondarily a portion of Eastern Ontario, for management and utilization of surplus and contaminated soils, as well as landfill disposal capacity for material that is not diverted.

1.0 ASSESSMENT CRITERIA, INDICATORS AND DATA SOURCES

The agricultural component compared the Alternate Sites using the following criterion:

- Which Site is preferred regarding potential for effects on agriculture?

The indicators for the criterion are:

- Percentage of on-Site lands with soil capability classes 1 to 3.
- Amount, type(s) and quality of on-Site improvements for agricultural purposes (i.e., structures, tile drainage).
- Percentage of on-Site land being used for agricultural purposes.
- Type(s) and extent of agricultural operations on-Site and within 500 metres of the Site boundary, i.e., organic, cash crop, livestock.

Within the approved Terms of Reference (TOR) criterion for off-Site issues for the agriculture component was the requirement to look at 500 metres off-Site (i.e., the Site-vicinity). The data sources used were the Provincial Policy Statement, 2005 and ongoing review, municipal Official Plans, aerial photographic and topographic mapping, available soils mapping, municipal drain mapping, available ownership information based on municipal assessment information and including farm tax credit information, field reconnaissance, Canada Land Inventory (CLI) mapping, Statistics Canada Agricultural Profiles and consultation with the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and the Christian Federation of Farmers.

2.0 PRELIMINARY DESCRIPTION OF EXISTING ENVIRONMENT

The following sections describe the existing environmental conditions for the agricultural component at each Alternative Site based on the preliminary investigations and assessments.

2.1 North Russell Road Site

An aerial photo of the NRR Site and the surrounding area is reproduced as Figure 2.1-1. With the exception of several fields located in the southern part of the rectangular piece of property currently planted with corn using minimum tillage, the lands are not cultivated. The remainder of the NRR Site is used for a variety of uses including pasture/hay and forested areas, as well as the existing shale quarry. The Site-vicinity lands have similarly varied use indicating a low investment in agricultural production. Surface ditching and some stone and boulder removal was evident. The ditches have not been maintained recently and there was no evidence that the fields have been artificially drained. Based on observations of the Site in May, 2012 and January, 2013 in several fields there was evidence that the previous year’s hay crop had not been harvested.

With the exception of the shale quarry, no other concentrations of non-farm uses were evident in the Site-vicinity.

In general the Site-vicinity does not exhibit recent investment in agriculture. The current farming is limited to pasture and several fields of corn.

2.1.1 Soil Capability Classes

Soil Capability Classification of Agriculture is based on characteristics of the soils as determined by soil surveys. The mineral soils are grouped into 7 classes and 13 subclasses according to the potential of each soil for the production of field crops. The classes indicate the degree of limitation imposed by the soil in its use for mechanized agriculture. The subclasses indicate the kinds of limitations that individually, or in combination with others, are affecting agricultural land use. In the Classification system, Class 1 soils have no significant limitations in use for crops. Classes 6 and 7 have very limited capability. Generally, Classes 1 to 3 are capable of cultivation while Class 4 has severe limitations.

An excerpt from the CLI mapping prepared by OMAFRA is reproduced as Figure 2.1-2.

The CLI mapping provides a general soil classification based on the generalized characteristics of the soil types. Within these soil types, there are Site specific variations that were too detailed to map on the County wide scale of the original soils maps. A visit was conducted to the NRR Site in May, 2012 and it generally confirmed the mapped soil types to accurately represent the soils present on the NRR Site. The detailed test pits and visual observations allow a more detailed classification of the soils.

According to the CLI mapping, the following capabilities have been assigned by soil type:

- Rubicon fine sand: 4F (low natural fertility) – over a small area near the northwest corner of the Site
- Vars gravelly sand: 2F (low natural fertility) – over most of the Site west of Eadie Road
- Bearbrook clay: 3WD (W-excess water, D-undesirable structure and/or low permeability) – most of the Site east of Eadie Road

The NRR Site assessment confirmed these general constraints but also found constraints due to P: stoniness; R: shallow rock. Based on the assessment, Figure 2.1-3 was prepared to show results on the NRR Site between North Russell Road and Eadie Road. This area was assessed because it is the portion of the NRR Site that contains lands zoned as Agricultural, and it is the area where the main Site infrastructure and landfill are expected to be located. Test pit logs are provided in Attachment TSD#1-G-1.

The soils on the central and northern portion of the Site are constrained by their shallow, stony nature. The southern portion of the Site has less severe constraints and a significant portion of the southern part of the Site is under cultivation.

The following table provides a breakdown of the soil capability of the land zoned as Agricultural on the NRR Site between North Russell Road and Eadie Road according to the assessment:

Classification	Area	Percentage (%) of Total Area
Class 3	17.15 ha.(42.39 ac)	20.9%
Class 4	61.93 ha.(153.10 ac)	75.4%
Unclassified	3.05 ha (7.54 ac)	3.7%
Total	82.13 ha (203.03 ac)	100.0%

2.1.2 On-Site Improvements for Agricultural Purposes

The on-Site review did not identify any tile drainage improvements. This is confirmed by a review of information available on the Agricultural Information Atlas. There were no agricultural structures on the NRR Site at the time of the Site visit.

2.1.3 Percentage of On-Site Land Being Used for Agricultural Purposes

An agricultural land use survey was conducted of the NRR Site. This survey indicates the following breakdown of land uses on the NRR Site between North Russell Road and Eadie Road:

Land Use	Area	Percentage (%) of Total Area
Cropland	19.6 ha (48.4 ac)	12.6 %
Pasture/Hay	73.2 ha (180.7 ac)	47.1 %
Wooded	31.4 ha (77.6 ac)	20.2 %
Other	31.2 ha (77.1 ac)	20.1 %
Total	155.4 ha (383.9ac)	100.0 %

2.1.4 Agricultural Operations On-Site and in the Site-vicinity

The agricultural operations on-Site were limited to the crops on the southern area and the pasture areas in the northern portion of the land between North Russell Road and Eadie Road.

Within 500 metres of the Site boundary the same pattern is evident. Lands to the south of the NRR Site are being used for crops and there are several active livestock operations. Although there are barns to the east, these barns do not appear to be actively used. The livestock facilities within 500 metres of the NRR Site to the north and west are limited in size and are predominantly used for horses. A hobby farm is located adjacent to the southeast corner of the NRR Site between North Russell Road and Eadie Road.

The following is a breakdown of the land uses within 500 metres of the NRR Site:

Land Use	Area	Percentage (%) of Total Area
Cropland	265.4 ha(674.1 ac)	40.5 %
Pasture/Hay	126.5 ha (321.3 ac)	19.3 %
Wooded	189.2 ha (480.6 ac)	28.9 %
Other	74.2 ha (188.5 ac)	11.3 %
Total	655.3 ha (1,664.5 ac)	100.0 %

2.1.5 Summary of Findings at the NRR Site

Component	Summary of Site Considerations
Agriculture	■ 20.9 % of land zoned Agricultural between North Russell Road and Eadie Road is Class 1-3 agriculture lands; ■ There are no on-Site agricultural improvements; ■ Only 12.6 % of the NRR Site lands are in active agricultural production; ■ Agriculture is not the predominant use on the subject lands and cropland makes up only 40.5 % of the lands in the Site-vicinity area (within 500 m).

2.2 Boundary Road Site

The BR Site is located in the south-east quadrant of the intersection of Boundary Road and Highway 417. Figure 2.2-1 illustrates the property location. The BR Site appears to have been cleared and a substantial portion of the subject lands have been allowed to re-vegetate. The predominant form of vegetation is red maple and European white birch. There are several ditches crossing the BR Site in an east-west orientation. These ditches were full of water at the time of the agriculture component Site visit in May, 2012. Road side culverts were elevated, thereby preventing any effective under-drainage by these features. The BR Site and Site-vicinity give evidence of elevated water table.

2.2.1 Soil Capability Classes

The CLI provides a Capability for Agriculture based upon 7 classes and a series of sub classes related to limitations of soils for agricultural production. The 7 classes rate the soil on severity of limitation to cultivation beginning with Class 1 which has no limitations and progressing to Class 7 which cannot be cultivated. The published capability rating was based upon the Soils Mapping. The Soils Report divides the soils types into landscape units and establishes the following capability classifications associated with the soil landscape units at the BR Site:

Soil Type	CLI Rating
St. Thomas sandy loam (5 & 6)	5FW'
Manotick fine sand (M6)	4FW'

An excerpt from the CLI Mapping has been reproduced as Figure 2.2-2.

The CLI mapping as it applies to the Manotick fine sand landscape unit 6 does not agree with the classification as set out in the Soils Report. This landscape unit is classified as 4W'F. This classification is based on the poor drainage (W') and the low fertility (F) of the soils in this landscape unit. (Refer to Table 9 of the Soils Report).

The assessment carried out at the BR Site confirmed these soil types and also confirmed that the soils throughout the Site are heavily constrained by wetness. Despite the Municipal Drain that crosses the property in an east-west orientation, there is a lack of outlet at sufficient depth to provide under drainage; also, in these relatively fine sands the single Drain has a limited distance of influence.

The following table provides a breakdown of the soil capability according to the assessment:

Classification	Area	Percentage (%) of Total Area
Class 4	114.1 ha (281.8 ac)	65.0%
Class 5	57.2 ha (143.8 ac)	33.2%
Unclassified	3.1 ha (7.7 ac)	1.8%
Total	175.4 ha (433.2 ac)	100.0%

2.2.2 On-Site Improvements for Agricultural Purposes

The on-Site review did not identify any tile drainage improvements. This is confirmed by a review of information available on the Agricultural Information Atlas.

There are no agricultural structures on the BR Site.

2.2.3 On-Site Land Being Used for Agricultural Purposes

An agricultural land use survey was conducted of the BR Site. This survey indicates the following breakdown of land uses on-Site:

Land Use	Area	Percentage (%) of Total Area
Cropland	28.4 ha (70.1 ac)	16.3 %
Pasture/Hay	0 ha (0 ac)	0.0 %
Wooded	140.5 ha (347.0 ac)	80.0 %
Other	6.5 ha (16.1 ac)	3.7 %
Total	175.4 ha (433.2 ac)	100.0 %

2.2.4 Agricultural Operations On-Site and in the Site-vicinity

The only agricultural operation on the BR Site is the cropping in the northern portion. There are extensive croplands to the east. The lands to the south are wooded and the lands to the west are predominantly industrial and commercial in nature.

Within 500 metres of the BR Site boundary the following land use breakdown exists:

Land Use	Area	Percentage (%) of Total Area
Cropland	83.7 ha (212.6 ac)	14.5 %
Pasture/Hay	0 ha (0 ac)	0.0 %
Wooded	436.1 ha (1107.7 ac)	75.6 %
Other	57.4 ha (145.8 ac)	9.9 %
Total	577.2 ha (1466.1 ac)	100.0 %

2.2.5 Summary of Findings at the BR Site

Component	Summary of Site Considerations
Agriculture	■ 0.0% of the land area on the BR Site is Class 1-3 lands; ■ There are no on-Site agricultural improvements on the subject lands; ■ Only 16.3 % of the lands at the BR Site are in active agricultural production (croplands); ■ Agriculture is not the predominant use on the BR Site and cropland makes up only 14.5 % of the lands in the immediate area (within 500 metres).

3.0 SITE COMPARISON – AGRICULTURE

3.1 Comparison of Sites

Both Sites rate poorly from an agricultural perspective and could be justified for the proposed use on the basis that they would have limited impact on adjacent agricultural uses and would not result in the use of significant agricultural lands. The Christian Federation of Farmers provided feedback that any good agricultural land needs to be protected. Based on the evaluation set out above, the BR Site has the lowest percentage of Class 1 – 3 lands (i.e., none). The NRR Site has a slightly lower percentage of active agricultural production than the BR Site. The BR Site has a lower amount of agricultural production in the Site-vicinity.

The evaluation indicates that the BR Site is the preferred Site from an Agricultural perspective.

3.2 Agricultural Policy Considerations

Not part of the comparison but provided here is the Agricultural Policy as set out in the Provincial Policy Statement and the Municipal Official Plans. As described in more detail in Appendix TSD#1-E (Land Use & Socio Economic component), a portion of the NRR Site is designated Prime Agriculture in the County Official Plan. It is considered to be part of a Prime Agricultural Area as defined by the Provincial Policy Statement.

The BR Site does not have an Agricultural designation in the Official Plan of the City of Ottawa.

REFERENCES

Agricultural Information Atlas. GIS Services, Ontario Ministry of Agriculture, Food and Rural Affairs contact: omafra.gis@ontario.ca

Personal communication, Christian Federation of Farmers

Figure 2.1-1 - Agricultural Land Use - North Russell Site
Part of Lots 18 and 19 Concession 3 and Part of Lot 18 Concession 4,
Township of Russell

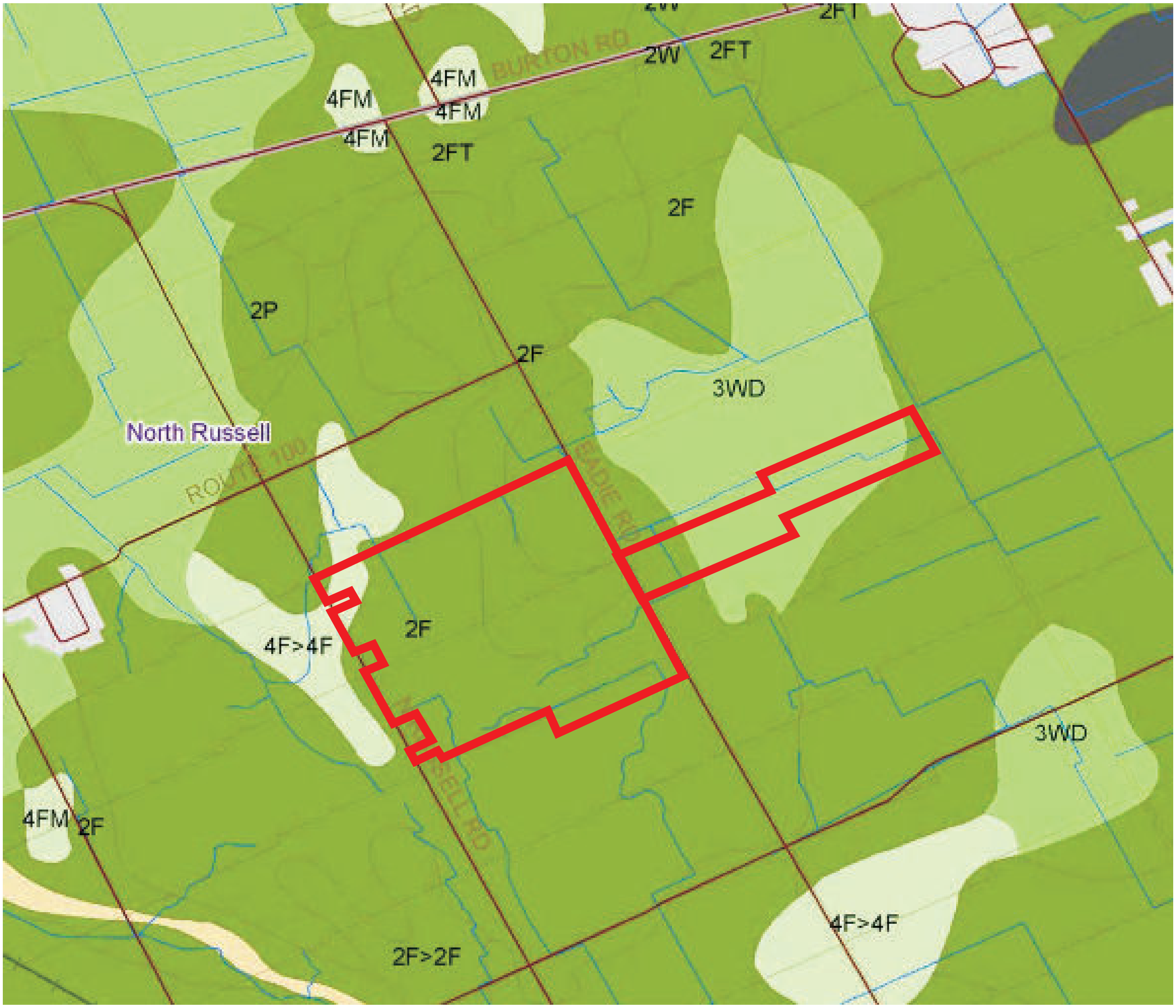
NTS

CLARK
CONSULTING SERVICES

Date: January 2013

z:\1541-CRRRC Ottawa\MDS\Figure 1 - Land Use NR.cdr

Figure 2.1-2 - CLI Map
Part of Lots 18 and 19, Concessions 3 & 4
Township of Russell



Canada Land Inventory Rating

🟩	1	🟧	6
🟩	2	🟨	7
🟩	3	⬛	Organics
🟩	4	⬜	N/A
🟫	5	🟦	Water

- Settlements
- Roads
- Railways
- Waterflow Network
- National Topographic Boundary
- Lot and Concession Boundary
- Municipal Boundaries
- Built Up Areas - circa 2006

Map Symbol Description

1	Soil Capability Class "1"
6TS	Soil Capability Class "6" with SubClass "T" and "S"
1>3T	Soil Capability Class "1" is greater in area than Soil Capability Class "3" with SubClass "T"
3M=5PT	Soil Capability Class "3" with SubClass "M" is equal in Area to Soil Capability Class "5" with SubClass "T" and "P"

In complex soil landscapes the '>' operator indicates a domainate and significant proportionality between the first, second and in some cases a third soilcode.

Examples: 70%>30%, 70%>15%=15%, 50%=50%

N

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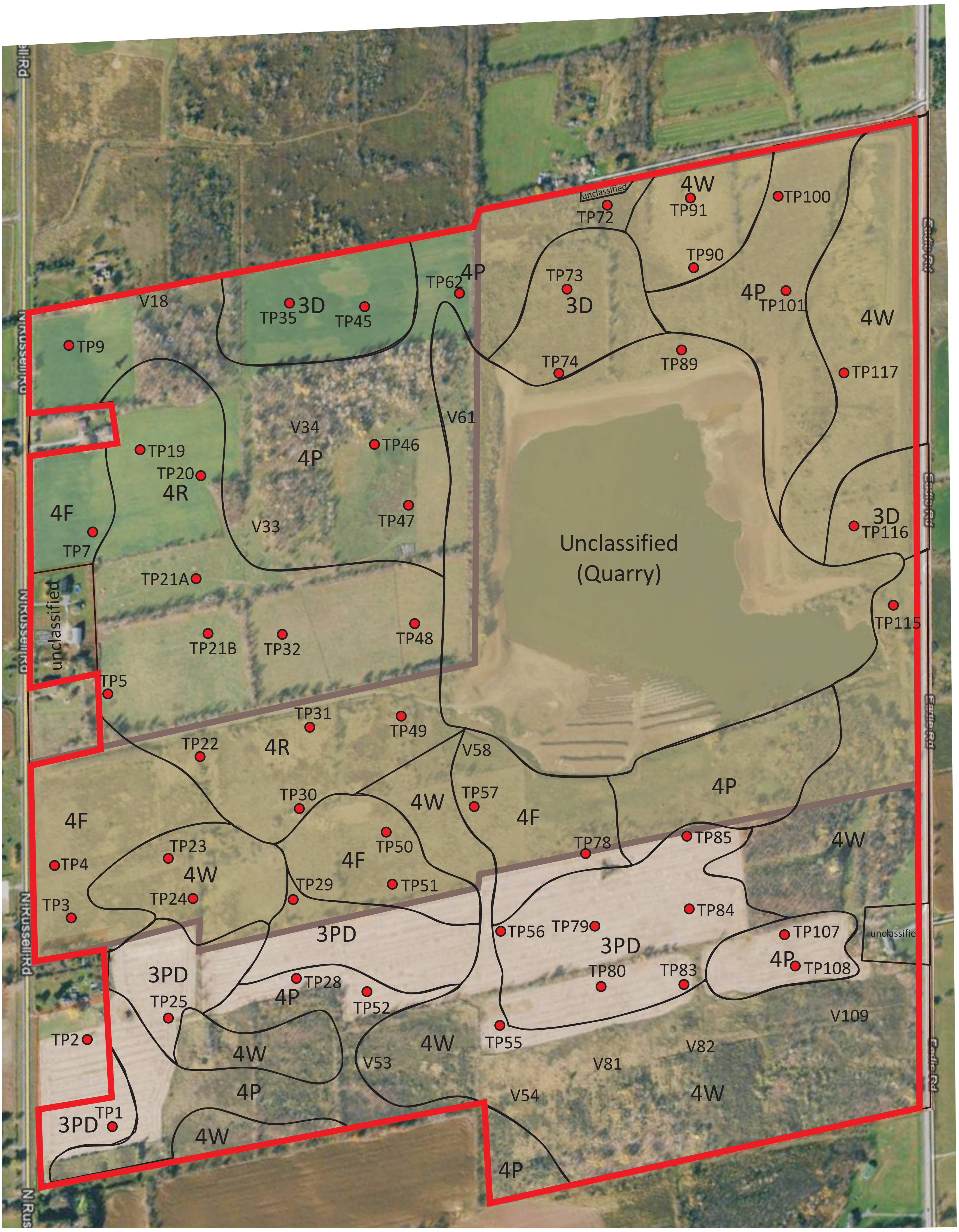
source: Canada Land Inventory Agricultural Capability NTS Map 31G6

Date: November 2012

z:\1541-CRRC Ottawa\Site Visit Oct 2012\Figure 2.1-2 - CLI.cdr

Figure 2.1-3 - Capability Assessment Map
Part of Lots 18 and 19, Concession 3
Township of Russell



	Area (ha)	Percent	Legend
3D	8.61	5.5	Class 3, undesirable
3PD	13.96	9.0	Class 3, stoniness, undesirable
4F	13.50	8.7	Class 4, low fertility
4P	33.30	21.4	Class 4, stoniness
4R	18.81	12.1	Class 4, consolidated bedrock
4W	39.08	25.1	Class 4, excess water
Unclassified	28.18	18.1	
	155.4	100%	

Legend

🟥	Subject Lands
▨	Aggregate designation
● TP #	Test Pit
V#	Visual Test Pit

0 50 100 150 200 250

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Date: January 2013

z:\1541-CRRRC Ottawa\Site Visit Oct 2012\Figure 5a-Capability Assessment Map.cdr

Figure 2.2-1 - Agricultural Land Use - Boundary Road Site
Part of Lots 23, 24 and 25, Concession 11,
Former Township of Cumberland, City of Ottawa

Legend

Dwelling	⌂	Cropland	▨
Barn	🟧	Pasture and Hay	▨
Subject Lands	▬	Wooded Land	🟩
		Residential and Farm Yard	🟧
		Commercial and Industrial	🟨
		Recreational	🟩

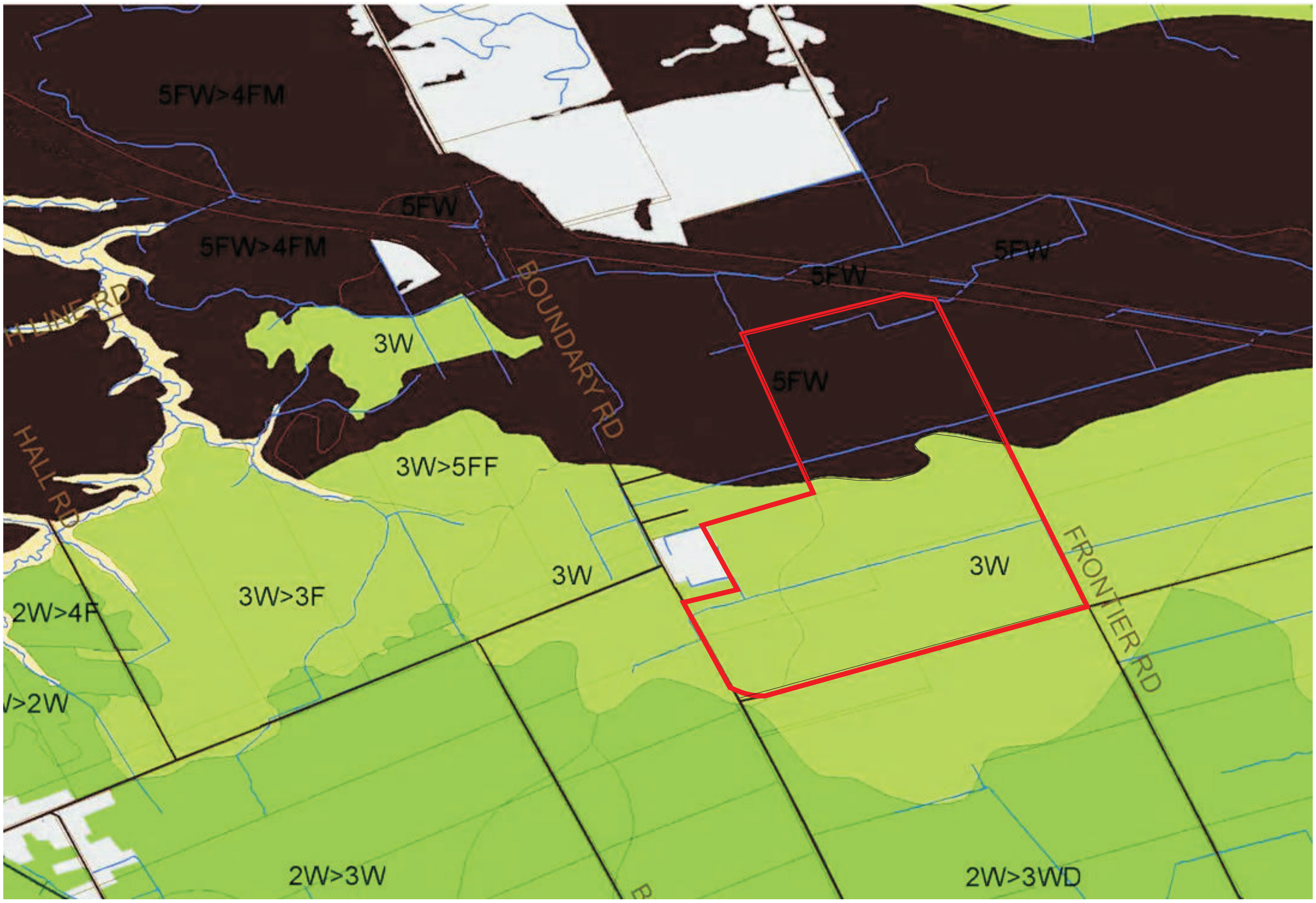
NTS

CLARK

Date: January 2013

z:\1541-CRRRC Ottawa\Figure 2.2-1 - AgLandUseBoundaryRoad.cdr

Figure 2.2-2 - CLI Capability Mapping
Lots 23-25, Concession 11, Boundary Road Property
Former Township of Cumberland, City of Ottawa



Canada Land Inventory Rating

🟩	1	🟧	6
🟩	2	🟨	7
🟩	3	⬛	Organics
🟩	4	⬜	N/A
🟫	5	🟦	Water

▭ **Subject Lands**

NTS

CLARK CONSULTING SERVICES

Date: January, 2013

z:\1541-CRRRC Ottawa\Figure 3 - CLI Capability Mapping.cdr

ATTACHMENT TSD#1-G-1

Test Pit Logs NRR Site

Test Pit Logs for Township of Russell (CRRRC Site)
Part of Lots 17, 18 and 19, Concession 3
CCS Project No. 1541

Soil Dig Date: October 30, 2012
Weather: high cloud, windy, dry

Test Pit No. 1
Surface Condition: cornfield
A Horizon: 0-10" reddish brown clay loam
B Horizon: 10-14" stones
C Horizon: 14-24"+ reddish grey clay
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 2
Surface Condition: cornfield
A Horizon: 0-10" reddish to brown clay loam
B Horizon: 10-12" layer of stone
C Horizon: 12-20"+ grey clay with mottles, some stone throughout
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 3
Surface Condition: old hayfield
A Horizon: 0-12" gravelly, red
B Horizon: 12-18"+ grey gravel
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4F

Test Pit No. 4
Surface Condition: rough grass, gentle slope to North
A Horizon: 0-12" reddish sandy loam, stony and gravelly
B Horizon: 12-16" heavy stone
Notes: Probed to 30"+ into shale
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4F

Test Pit No. 5
Surface Condition: rough pasture
A Horizon: 0-9" brown clay loam, stone layer at 9"
B Horizon: 10-16" reddish brown clay
C Horizon: 20" rock
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4R

Test Pit No. 7
Surface Condition: hayfield
A Horizon: 0-14" red sandy loam, gravelly
Notes: Probed to 30" to stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4F

Test Pit No. 9
Surface Condition: hayfield - 5% slope
A Horizon: 0-12" brown clay loam, very stony
B Horizon: 12" stone layer
Notes: Probed to 30"+
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4P

Test Pit No. 18 - Visual
Surface Condition: hardwood stand, stony & bouldery

Test Pit No. 19
Surface Condition: hayfield
A Horizon: 0-12" red find sandy loam, gravelly
Note: Probed to 20"+
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4R

Test Pit No. 20
Surface Condition: hayfield
A Horizon: 0-12" reddish fine sandy loam, gravelly
B Horizon: 12" stone layer
Notes: Probed to refusal 15"
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4R

Test Pit No. 21A
Surface Condition: rough pasture, surface stones
A Horizon: 0-10" brown gravelly clay loam
B Horizon: 10" stone layer, rock at 16"
C Horizon: 16" rock
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4R

Test Pit No. 22
Surface Condition: Probed 20" to refusal

Test Pit No. 23
Surface Condition: Probed 30" into rock - stopped

Test Pit No. 23
Surface Condition: rough grass, gentle roll
A Horizon: 0-14" reddish stony gravelly sandy loam, dry
B Horizon: 14" heavy stone
Notes: Probed to 30"+ to shale
Soil Type: Vars gravelly sand
Soil Capability for Agriculture: 4W

Test Pit No. 24
Surface Condition: low wet depression
A Horizon: 0-10" red clay
B Horizon: 10" light grey and red clay
C Horizon: 20"+ stone free
Soil Type: Vars gravelly sand
Soil Capability for Agriculture: 4W

Test Pit No. 25
Surface Condition: cornfield
A Horizon: 0-12" black clay loam
B Horizon: 12-24"+ reddish grey clay, some stones and rocks
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 26 - Visual
Surface Condition: scrub area, evidence of wetness (vegetation)

Test Pit No. 27 - Visual
Surface Condition: stone ridge along south edge

Test Pit No. 28
Surface Condition: cornfield edge of overgrown stony ridge, stones on surface
A Horizon: 0-12" reddish clay with small stones
B Horizon: 12-20"+ clay/red clay
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4P

Test Pit No. 28 - Visual
Surface Condition: bush with rocks, depression, wet

Test Pit No. 29
Surface Condition: old hayfield
A Horizon: 0-10" reddish clay with stones
B Horizon: 10-24"+ red gravel
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 30
Surface Condition: in a wooded glade, stones at surface

Test Pit No. 31
Surface Condition: red/brown clay loam, very stony
A Horizon: 20" to shale
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4R

Test Pit No. 32
Surface Condition: pasture, surface stone
A Horizon: 0-10" red sandy loam, same stone
B Horizon: 10" stone
Notes: Refusal at 14"
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4R

Test Pit No. 33 - Visual
Surface Condition: frequent surface boulders (+ rock outcrops)

Test Pit No. 34 - Visual
Surface Condition: hardwood stand, surface stones and boulders

Test Pit No. 35
Surface Condition: rough weedy pasture
A Horizon: 0-12" grey/brown clay loam heavy, few stones
B Horizon: 12"-14" grey blue clay, mottled
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3D

Test Pit No. 45
Surface Condition: rough weedy pasture
A Horizon: 0-10" grey brown clay loam, heavy
B Horizon: 10-12" blue grey clay, very heavy
Soil Type: Vars gravelly loam (Vgl)
Soil Capability for Agriculture: 3D

Test Pit No. 46
Surface Condition: rough pasture
A Horizon: 0-8" brown clay loam, light stone
B Horizon: 8-14" light brown clay, stony
Notes: Probed 20" to stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4P

Test Pit No. 47
Surface Condition: rough cattle pasture, fallow
A Horizon: 0-10" red loam, gravelly, heavy stone at 10"
Notes: Probed to 30"+
Soil Type: Vars gravelly sand
Soil Capability for Agriculture: 4P

Test Pit No. 48
Surface Condition: edge of quarry lands, cattle pasture
A Horizon: 0-10" gravelly red sandy loam
Notes: Probed to 16" refusal
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4R

Test Pit No. 49
Surface Condition: grass-rough, hummocky
A Horizon: 0-10" reddish sandy loam, light stone
B Horizon: 10-15" reddish sandy loam, heavy stone
Notes: Probed to 20" refusal
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture 4R

Test Pit No. 50
Surface Condition: old hayfield
A Horizon: 0-12" red crumbly clay
B Horizon: 12-16" red clay with stone
C Horizon: 16" stones
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4F

Test Pit No. 51
Surface Condition: old hayfield near fence
A Horizon: 0-6" red crumbly clay with stone
B Horizon: 6-14" red gravelly clay with stones
C Horizon: 14" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4F

Test Pit No. 52
Surface Condition: cornfield, some stone
A Horizon: 0-10" reddish clay with stone
B Horizon: 10-12" layer of stone
C Horizon: 12-20"+ grey/red clay
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4P

Test Pit No. 52 - Visual
Surface Condition: bush, low wet area

Test Pit No. 53 - Visual
Surface Condition: bush, low wet area

Test Pit No. 54 - Visual
Surface Condition: cleared area, not planted probably due to wetness, wet area throughout

Test Pit No. 55
Surface Condition: corn field
A Horizon: 0-8" reddish brown clay, some stone
B Horizon: 8-20"+ platy red clay
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4W

Test Pit No. 56
Surface Condition: cornfield
A Horizon: 0-6" boulders clay reddish
B Horizon: 6" stone/rocks
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 57
Surface Condition: old hayfield
A Horizon: 0-10" reddish clay crumbly
B Horizon: 10-16" stones
C Horizon: 16"+ red clay
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4F

Test Pit No. 58 - Visual
Surface Condition: quarry lands, surface scraped of soils

Test Pit No. 61 - Visual
Surface Condition: edge of pit- rough pasture

Test Pit No. 62
Surface Condition: rough weedy pasture
A Horizon: 0-4" brown clay
B Horizon: 4-12"+ red brown loam- stony
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture:

Test Pit No. 72
Surface Condition: rough pasture
A Horizon: 0-12" red gravelly clay
B Horizon: 12-14" stone layer
C Horizon: 14-24" red/grey clay
D Horizon: 24" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4P

Test Pit No. 73
Surface Condition: rough pasture
A Horizon: 0-10" red gravelly clay
B Horizon: 12-30" red stony clay
C Horizon: 30" rock
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3D

Test Pit No. 74
Surface Condition: rough pasture (tall grass)
A Horizon: 0-24" red gravelly clay
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3D

Test Pit No. 78
Surface Condition: edge of cornfield
A Horizon: 0-6" crumbly red clay
B Horizon: 6-12" red clay
C Horizon: 12" stones
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4F

Test Pit No. 79
Surface Condition: cornfield, stones throughout
A Horizon: 0-12" dark brown crumbly clay
B Horizon: 12-16" light grey brown stones
C Horizon: 16"+ stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 80
Surface Condition: cornfield, stones and rocks
A Horizon: 0-14" reddish clay with stone
B Horizon: 14" stone layer
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 81 - Visual
Surface Condition: cleared area - not planted, appears wet area with shrubs

Test Pit No. 82 - Visual
Surface Condition: cleared area - not planted, appears wet area with shrubs

Test Pit No. 83
Surface Condition: cornfield
A Horizon: 0-10" reddish clay
B Horizon: 10-18"+ gritty clay with grey clay, small stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 84
Surface Condition: cornfield
A Horizon: 0-10" reddish brown clay, blocky
B Horizon: 10-18" red clay
C Horizon: 18" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 85
Surface Condition: edge of cornfield
A Horizon: 0-4" reddish brown clay blocky
B Horizon: 4-8" massive red clay
C Horizon: 8" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3PD

Test Pit No. 89
Surface Condition: rough pasture
A Horizon: 0-24" red clay, no stones
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: Unclassified

Test Pit No. 90
Surface Condition: rough pasture, wet area
A Horizon: 0-22" red clay, no stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4W

Test Pit No. 91
Surface Condition: tall grass, wet area
A Horizon: 0-10" brown clay
B Horizon: 10-22" red clay
C Horizon: 22" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4W

Test Pit No. 100
Surface Condition: tall grass
A Horizon: 0-14" red clay
B Horizon: 14" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4P

Test Pit No. 101
Surface Condition: rough pasture
A Horizon: 0-14" red clay
B Horizon: 14" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4P

Test Pit No. 107
Surface Condition: cornfield beside bush
A Horizon: 0-6" reddish clay
B Horizon: 6-8" stony layer
C Horizon: 8"+ gritty grey red clay stones throughout
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4P

Test Pit No. 108
Surface Condition: cornfield
A Horizon: 0-8" reddish clay some stone
B Horizon: 8-18"+ gritty clay, red & grass with stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4P

Test Pit No. 109 - Visual
Surface Condition: bush, low, wet

Test Pit No. 115
Surface Condition: rough pasture
A Horizon: 0-10" brown clay
B Horizon: 10-26" red clay
C Horizon: 26" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4W

Test Pit No. 116
Surface Condition: rough pasture
A Horizon: 0-8" brown clay, no stone
B Horizon: 8-24" red clay
C Horizon: 24" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 3D

Test Pit No. 117
Surface Condition: rough pasture
A Horizon: 0-14" red clay
B Horizon: 14" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4W

Test Pit No. 133 - Visual
Surface Condition: wet bush extending easterly

Test Pit No. 136
Surface Condition: old hayfield
A Horizon: 0-14" dark brown clay loam
B Horizon: 14-36"+ light brown sand
Soil Type: Bearbrook clay (Bc)
Soil Capability for Agriculture: 4W

Test Pit No. 137
Surface Condition: rough hay
A Horizon: 0-14" dark brown clay loam
B Horizon: 14-36"+ light grey sand
Notes: North 137- 5' deep ditch, gravel in the bottom, dry
Soil Type: Bearbrook clay (Bc)
Soil Capability for Agriculture: 4W

Test Pit No. 138
Surface Condition: rough hay
A Horizon: 0-14" brown clay
B Horizon: 14-22" grey/red sand
C Horizon: 22" stone
Soil Type: Bearbrook clay (Bc)
Soil Capability for Agriculture: 4W

Test Pit No. 139
Surface Condition: old hayfield
A Horizon: 0-10" dark brown clay loam
B Horizon: 10-16" light brown sand
C Horizon: 16" stone
Soil Type: Bearbrook clay (Bc)
Soil Capability for Agriculture: 4R

Test Pit No. 142
Surface Condition: rough hay field
A Horizon: 0-16" light brown sand
B Horizon: 16"+ stone
Soil Type: Bearbrook clay (Bc)
Soil Capability for Agriculture: 4R

Test Pit No. 143
Surface Condition: rough hay (cut but left in field)
A Horizon: 0-10" dark brown clay
B Horizon: 10-20" red clay no stones
C Horizon: 20" stone
Soil Type: Bearbrook clay (Bc)
Soil Capability for Agriculture: 4W

Test Pit No. 144 - Visual
Surface Condition: wet bush extending easterly

Test Pit No. 144
Surface Condition: rough hay field
A Horizon: 0-12" dark brown clay loam
B Horizon: 12-16" brown red clay
C Horizon: 16" stone
Soil Type: Bearbrook clay (Bc)
Soil Capability for Agriculture: 4R

Test Pit No. 145
Surface Condition: rough hay field
A Horizon: 0-12" dark brown clay loam
B Horizon: 12-36" red clay
C Horizon: 36" stone
Soil Type: Bearbrook clay (Bc)
Soil Capability for Agriculture: 4R

Test Pit No. 146
Surface Condition: hayfield
A Horizon: 0-10" reddish clay
B Horizon: 10-16" red clay
C Horizon: 16" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4R

Test Pit No. 147
Surface Condition: hay field (rough)
A Horizon: 0-8" reddish brown clay
B Horizon: 8-16" red clay
C Horizon: 16" stone
Soil Type: Bearbrook clay (Bc)
Soil Capability for Agriculture: 4R

Test Pit No. 148
Surface Condition: rough land
A Horizon: 0-8" reddish brown clay
B Horizon: 8-24" red clay
C Horizon: 24" stone
Soil Type: Vars gravelly sand (Vgl)
Soil Capability for Agriculture: 4D

APPENDIX TSD#1-H

Design & Operations Component

February 2013

February 2013

Design & Operations Component
Appendix TSD#1-H

COMPARATIVE EVALUATION OF ALTERNATIVE SITES

TAGGART
GROUP OF COMPANIES

miller
THE
MILLER
GROUP

Table of Contents

INTRODUCTION

Two properties that are owned or have been optioned by Taggart Miller have been identified for the proposed Capital Region Resource Recovery Centre (CRRRC) (the Alternative Sites). The Alternative Sites are described below:

- **North Russell Road Site (NRR Site)** – located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell.
- **Boundary Road Site (BR Site)** – located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, Township of Cumberland.

The CRRRC is proposed to provide facilities and capacity for recovery of resources and diversion of material from disposal generated by the industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sectors primarily in Ottawa and secondarily a portion of eastern Ontario, for management and utilization of surplus and contaminated soils, as well as landfill disposal capacity for material that is not diverted.

1.0 ASSESSMENT CRITERIA, INDICATORS AND DATA SOURCES

The design & operations component compared the Alternative Sites using the following criterion:

- Which Site is preferred regarding the anticipated amount of engineering required to assure Ministry of the Environment (MOE) groundwater quality criteria are met at the property boundary?

The indicator for the criterion is:

- Degree of engineered containment expected to be required for on-Site systems.

The data sources used were Ontario Regulation (O. Reg.) 232/98 and O. Reg. 268/11, published hydrogeological and geotechnical maps and reports, findings of on-Site testing completed for this project or otherwise available to confirm/compare information, preliminary determination of on-Site engineered leachate management system requirements and review of previous knowledge or experience for designs in similar geological settings in Ontario.

2.0 PRELIMINARY DESCRIPTION OF EXISTING ENVIRONMENT

The following sections describe the existing environmental conditions related to the design & operations component at each of the Alternative Sites based on published information and the preliminary investigations and assessments.

A detailed description of the geological, hydrogeological and geotechnical environments is provided in Appendix TSD#1-B. The following provides an overview of key considerations that would affect the degree of engineered containment expected to be required for the proposed on-Site systems.

2.1 North Russell Road Site

2.1.1 Geology and Hydrogeology Environment

The NRR Site lies within a flat lying clay landscape with little topographic relief, interrupted by ridges of glacial till and/or bedrock. The NRR Site is located within an extensive north-south trending deposit of glacial till soil, which typically consists of sandy silt to silty sand, with gravel, a trace of clay and variable cobble and boulder content. The till cover over the bedrock is relatively thin, likely varying from about zero to four metres. Regionally, the till feature protrudes up through, and is surrounded by, an extensive deposit of marine silty clay. The thickness of the clay generally increases with distance from the till ridge feature, to about 30 metres thick; the clay is generally underlain by a basal gravelly till deposit followed by bedrock.

The results of studies completed by the Geological Survey of Canada indicates that there is a continuous, narrow, north-south oriented esker (coarse gravel) feature, extending about 40 kilometres from near the Ottawa River in the north to between Winchester and Chesterville in the south. In the northern portion of the esker and in the portion south of about Morewood, the esker is often exposed at surface and in some locations has been developed as sand and gravel pits. In the central portion, the esker is buried beneath a thick deposit of silty clay and rests on top of the bedrock surface. The studies report that in the area between about Limoges and south of Russell/Embrun, the esker core is an approximately 200-metre wide zone, located just over four kilometres east of Eadie Road (at the intersection of Route 200 and St. Pierre Road) and trending slightly northeast, buried within a 25 to 30 metre thick deposit of silty clay soil. This esker is an important source of existing and potential groundwater supply, currently supplying water to a number of communities, (i.e., Vars, Limoges, Winchester and Chesterville). The majority of recharge to the esker is thought to occur from direct precipitation on areas where the granular esker materials are exposed, although some recharge may also occur via the basal till unit.

In terms of the bedrock geology, the area of the property is shown on published bedrock mapping as underlain by Queenston shale, which is the youngest formation of sedimentary rock in eastern Ontario. Queenston shale is a red, laminated to thickly bedded calcareous siltstone and shale. The property is located near the middle of a band of Queenston shale that is mapped to be approximately 4 kilometres north-south by 15 kilometres west-east. To the south, the uppermost bedrock is mapped to be limestone, while to the north and southwest Carlsbad Formation layered shale and limestone is shown. Preliminary investigations on the NRR Site indicate that shale is absent about half way across the portion of the Site east of Eadie Road (i.e., the shale band is not as extensive in the eastward direction as interpreted and shown on the published geological mapping). The Queenston Formation shale varies in thickness from zero at the eastern extent of the property to 28 metres in the northwestern portion of the NRR Site. Overall, the majority of the Queenston Formation and the Carlsbad Formation at the NRR Site has a low hydraulic conductivity (i.e., less than 1×10^{-8} m/sec); however, at some locations there is slightly higher permeability was measured in the upper portion of the Queenston Formation. There does not appear to be a zone of enhanced permeability at the contact between the Queenston Formation and the Carlsbad Formation.

The overburden at the NRR Site is typically less than two metres thick. The central portion of the NRR Site has various thicknesses of completely weathered shale overlying the shale bedrock. In the northwestern and southwestern portions of the NRR Site, the bedrock is typically overlain by glacial till. At some locations, the glacial till is overlain by a thin layer of silty clay or silty sand. East of Eadie Road on the eastern half of the

Concession IV portion of the property, the bedrock surface is deeper and overlain by a significant thickness of silty clay and glacial till.

In terms of regional hydrogeology, the groundwater flow direction in the bedrock and basal till is generally east to northeast. Based on preliminary investigations and groundwater level monitoring at the NRR Site, shallow groundwater flow on the NRR Site is generally towards the northeast, with a seasonably variable local component of northwesterly flow in the upper bedrock zone indicated in the southwestern portion of the NRR Site. Intermediate bedrock zone groundwater flow directions for the NRR Site are interpreted to be towards the northeast on the portion of the Site west of Eadie Road, and also towards the east on the portion of the Site east of Eadie Road.

Based on the groundwater elevation data collected to date at the NRR Site, vertical gradients are typically downward, or absent, for most of the year, with some local seasonal variations. The NRR Site is interpreted to be in an area of groundwater recharge for the bedrock flow system.

Water supply to homes and farms in the rural area within which the NRR Site is located relies on individual wells. Published information for the general area suggests that most wells obtain their groundwater from zones within the shale and limestone. Where the bedrock is overlain by the clay deposit, wells often obtain their water from a permeable zone at the soil to bedrock contact. In general, water quality gets poorer with depth, associated with the age of the water. Well depths vary considerably due to the changes in geological setting. The majority of the development within the villages of Russell and Embrun were connected to a municipal water supply from the City of Ottawa in 2010, although some locations remain on individual wells.

2.1.2 Geotechnical Considerations

It is anticipated that the diversion and landfill components of the CRRRC would be located on the portion of the Site between North Russell and Eadie Roads. It is envisaged that the landfill and other on-Site facilities would be founded on or within the shale bedrock or on native (primarily glacial till) soils. Considering the NRR Site geology/hydrogeology, significant geotechnical constraints to the design & operations of the NRR Site are not expected.

2.1.3 Conceptual Engineered Containment Requirements

The waste disposal cells at the NRR Site would be situated so as to avoid the existing quarry footprint and would be excavated to approximately four to six metres below the existing ground surface, leaving at least one metre of shale in-place below the base of each cell. Based on the existing Site groundwater level data, this will be below the groundwater elevation in the shale.

The hydraulic conductivity of the shale (generally less than 1×10^{-8} m/sec) is not considered to be sufficiently low to provide long term off-Site groundwater protection (i.e., less than 10^{-9} m/sec is required for a primary or secondary liner layer in O. Reg. 232/98 and the supporting MOE Landfill Standards). Also, based on the available hydraulic conductivity data, the base of the cells may not be below the upper shale zone that is indicated to have higher permeability and underlies some areas of the Site. As such, it is likely that an engineered groundwater protection system would be required for the entire landfill portion of the CRRRC facility if it were to be situated at the NRR Site. Given that the base of the waste disposal cells would be founded in bedrock, it is anticipated that the requirements for the engineered groundwater protection system may be similar to the double composite liner, “Generic Design Option II” from the MOE Landfill Standards, which includes the following, from bottom to top:

- A secondary composite liner consisting of a 0.75-metre thick clayey liner with a maximum hydraulic conductivity of 1 x 10^{-9} m/sec and a high density polyethylene geomembrane liner;
- A secondary leachate collection system designed for a service life of 1,000 years;
- A primary liner consisting of a 0.75-metre thick clayey liner with a maximum hydraulic conductivity of 1 x 10^{-9} m/sec and a high density polyethylene geomembrane liner; and
- A primary leachate collection system designed for a service life of 60 years.

The clayey portions of the primary and secondary liner systems could possibly be replaced with a geosynthetic clay liner (GCL).

For the “Generic Design Option II”, O. Reg. 232/98 requires an attenuation layer with a minimum thickness of one metre below the waste fill zone and groundwater protection system. This layer is required to have a hydraulic conductivity of less than 1 x 10^{-7} m/sec. It is expected that the native shale bedrock that is present below the base elevation of the landfill cells would be acceptable for this layer.

Since the leachate that is generated would be removed for treatment, the leachate level within the disposal cells would be kept near the base of the cell and below the groundwater level outside the cell. As such, the disposal cells would have inward gradients and flow. The exit of leachate would be inhibited not only by the liner system but by the inward groundwater gradient from the shale towards the disposal cells; this is referred to as a hydraulic trap condition.

The diversion facilities at the proposed CRRRC would primarily be within roofed buildings or other contained systems. As such, there would be negligible additional engineered containment requirements for facilities other than the landfill component, with the possible exception of any leachate treatment or holding ponds, which would require an engineered liner system.

Based on the above discussion, the following is a summary of the key considerations affecting the degree of engineered containment expected to be required for the proposed on-Site systems at the NRR Site.

2.1.4 Summary of D&O Considerations at the NRR Site

Component	Summary of Site Considerations
Design & Operations	■ The landfill and any leachate treatment or holding ponds is expected to require an engineered groundwater protection system. It is anticipated that for the landfill, the system would be similar to the “Generic Design Option II” from the MOE Landfill Standards (i.e., double composite liner with primary and secondary leachate collection systems).

2.2 Boundary Road Site

2.2.1 Geology and Hydrogeology Environment

The BR Site and surrounding areas are underlain by an extensive and thick deposit of silty clay soil of marine origin. The upper one to two metre zone is shown to consist of a discontinuous surface sand layer overlying weathered silty clay; this is underlain by the remainder of the silty clay deposit to a total depth of about 30 to 35 metres in the area of the BR Site. The clay deposit is in turn underlain by about 1.5 to 5 metres of a basal gravelly glacial till, followed by bedrock.

Published mapping by the Geological Survey of Canada shows that the bedrock beneath the area of the BR Site consists of interbedded shale and limestone of the Carlsbad Formation; the total thickness of this bedrock unit is reported to be in the range of about 115 to 150 metres.

In the absence of effective drainage in this flat lying terrain, the groundwater level in this fine grained soil is at, near or above the ground surface throughout much of the year. In view of its low permeability characteristic, there is anticipated to be limited horizontal or vertical groundwater flow in the silty clay deposit; groundwater movement in the silty clay deposit would be very locally influenced adjacent to ditches or other watercourses. The silty clay deposit is known to be an aquitard, which would not allow recharge of the basal till and bedrock by water infiltrating from surface. Groundwater flow occurs in the basal till and bedrock; the direction of regional groundwater flow in these zones is indicated to be towards the northeast.

Water supply to residences, farms and industrial properties in the area of the BR Site is from individual wells. Drilled wells in this area are able to obtain their water supply from the basal till/bedrock contact zone or from within the upper part of the bedrock. The yield of water from this zone is usually adequate in quantity for domestic use. In the immediate vicinity of the BR Site, the few wells registered in the MOE Water Well Information System are completed in the basal till/bedrock contact zone and are indicated to yield enough water for domestic use. However, the groundwater quality in the vicinity of the BR Site is reported as salty, sulphurous or mineralized; the presence of methane gas in the groundwater is also reported. Because of this naturally poor water quality at depth, shallow dug wells are typically used to provide water; some residents use bottled water for consumption because of concerns about bacterial contamination in the dug wells. These natural groundwater quality problems are known to exist as far as three or four km to the north of the BR Site to the area of Carlsbad Springs and also to the west. In the mid-1990s the City of Ottawa extended the municipal water supply to portions of the Carlsbad Springs area for this reason. Further to the southwest and southeast, drilled wells completed in the basal till are reported in the MOE well records as providing fresh groundwater quality.

As described in in Appendix TSD#1-B, recent preliminary investigations on the BR Site are consistent with previously published information and indicate that the overburden at the BR Site is comprised of approximately 0.2 metres of topsoil, underlain by 0.3 to 1.3 metres of silty sand, sand and/or sandy silt. Depending on the sand thickness, a discontinuous upper weathered clay zone can be present. These surficial layers are underlain by a thick deposit of sensitive clay to silty clay ranging in thickness from about 32 to 35 metres. The upper portion of the silty clay deposit is indicated to have a soft consistency; the shear strength increases with depth and becomes stiff.

The results of the initial Cone Penetration testing (CPT) indicate the presence of occasional sandy to silty seams within the upper portion of the silty clay. These were indicated at depths between about 1.8 and 6.6 metres below ground surface and are interpreted to vary in thickness from about 0.1 to 0.3 metres.

The silty clay is underlain by a deposit of glacial till ranging from about two to six metres in thickness before encountering the interbedded limestone and shale bedrock of the Carlsbad Formation.

Based on the results of the *in-situ* hydraulic conductivity testing completed at the Site to date, the following ranges in hydraulic conductivities were measured by hydraulic response testing in the overburden and bedrock formations at the Site:

- Shallow sand, silt and clay (Sandy Layer): 1 x 10^{-7} m/sec to 3 x 10^{-5} m/sec;
- Upper clay with sand/silt seam: 1 x 10^{-7} m/sec to 5 x 10^{-7} m/sec;
- Glacial Till: 1 x 10^{-6} m/sec to 4 x 10^{-6} m/sec; and
- Carlsbad Formation Bedrock: 3 x 10^{-7} m/sec to 2 x 10^{-5} m/sec.

Overall, the materials underlying the BR Site vary from tight to moderately permeable. The presence of sand/silt seams in the upper portion of the silty clay results in an increase in hydraulic conductivity, which may be about two orders of magnitude higher compared to typical clay values (1 x 10^{-12} m/sec to 1 x 10^{-9} m/sec) as reported by Freeze and Cherry (1979) (i.e., unweathered marine clay deposits are known to typically have a hydraulic conductivity of about 1 x 10^{-9} to 5 x 10^{-10} m/sec).

Based on groundwater levels collected in January 2013, the groundwater flow direction for the BR Site is interpreted to be towards the east within all of the stratigraphic layers. Based on the groundwater elevation data collected to date, vertical gradients at the Site are variable, but indicated to be typically weakly downward, or absent.

2.2.2 Geotechnical Considerations

The results of in situ vane testing in the unweathered clay to silty clay at the BR Site gave undrained shear strengths ranging from about 14 to greater than 100 kilopascals, generally increasing with depth. These results indicate a generally soft consistency to about 9 to 10 metres depth, followed by a firm consistency to about 15 to 18 metres depth, and stiff to very stiff below that.

The results of Atterberg limit testing carried out on four samples of the unweathered clay to silty clay indicate a high plasticity soil. The measured natural water contents of the samples were between about 71 and 87%.

If the CRRRC were to be located at the BR Site, the undrained shear strength of the upper silty clay zone is expected to govern the design of the landfill geometry (i.e., height and sideslope angles, in order to provide a stable configuration).

2.2.3 Conceptual Engineered Containment Requirements

The waste disposal cells at the BR Site would be excavated into the surficial sandy overburden deposits and/or a limited distance into the underlying silty clay. Based on the existing Site groundwater level data, this may be below the groundwater elevation in the silty clay.

Based on the permeability of the sandy deposit overlying the silty clay deposit, it is expected that an engineered groundwater protection system will be required on the excavated below-ground sideslopes of the waste disposal cells. Given the relatively steep grades of the below-ground sideslopes, it is expected that a single liner (e.g., geomembrane, GCL or compacted clay) that is keyed into the underlying unweathered silty clay would be sufficient.

Additional investigation work, testing and predictive modelling as set out in O. Reg. 223/98 will be required to determine whether a liner system is required on the base of the waste disposal cells. It is expected that the hydraulic conductivity of the unweathered silty clay would meet the recommended minimum hydraulic conductivity of 1 x 10^{-9} m/sec in O. Reg. 232/98 for groundwater protection; however, as noted above the preliminary on-Site testing to date indicates occasional sandy/silty seams in the upper portion of the clay deposit.

If a liner system is determined to be required on the base of the waste disposal cells, it is considered likely that a single liner (e.g., compacted clay or geomembrane) or a single composite liner (e.g., compacted clay or GCL and geomembrane) would be sufficient. Alternatively, incorporation of a vertical engineered cut-off feature around the perimeter of the waste disposal cells (keyed into the unweathered silty clay, below the elevation of the sand/silt seams) that would cut off any potential for leachate migration through the sand/silt seams could be considered. Such a perimeter cut-off would negate the need for a constructed liner system on both the base and the below-ground sideslopes of the waste cells.

A primary leachate collection system would be installed on the base and below-ground sideslopes of the waste disposal cells. Since the leachate that is generated would be removed for treatment, the leachate level within the disposal cells would be kept near the base of the cell and below the groundwater level outside the cell. As such, the disposal cells may have inward groundwater gradients. If this is the case, then the exit of leachate would be inhibited not only by the sideslope (and possibly bottom) liner system (if they are required), but by the inward movement of groundwater from the clay towards the disposal cells.

The diversion facilities at the proposed CRRRC would primarily be within roofed buildings or other contained systems. As such, there would be negligible additional engineered containment requirements for facilities other than the landfill component, with the possible exception of any leachate treatment or holding ponds, which would require an engineered liner system.

Based on the above discussion, the following is a summary of the key considerations affecting the degree of engineered containment expected to be required for the proposed on-Site systems at the BR Site.

2.2.4 Summary of D&O Considerations at the BR Site

Component	Summary of Site Considerations
Design & Operations	■ The landfill portion and any leachate treatment or holding ponds are expected to require: ▪ A single liner on the excavated below-ground sideslopes (e.g., geomembrane, GCL or compacted clay) that is keyed into the underlying unweathered silty clay. ▪ A primary leachate collection system on the base and below-ground sideslopes of the waste disposal cells. ▪ Possibly a single liner or single composite liner on the base of the waste disposal cells or ponds, or a vertical cut-off feature around the landfill perimeter.

3.0 SITE COMPARISON – DESIGN & OPERATIONS

3.1 Comparison of Sites

Based on the design & operations *Summary of D&O Considerations* presented in the tables in Sections 2.1.4 and 2.2.4, the BR Site is likely to require a lower degree of engineered containment for the landfill and leachate treatment/holding pond components of the CRRRC.

Since these components would be founded in shale bedrock at the NRR Site, it is expected that a double composite liner system with both primary and secondary leachate collection systems would be required to provide adequate protection to groundwater.

At the BR Site a thick deposit of native silty clay soils would underlie the landfill and leachate treatment/holding pond components. Depending on 1) the findings of additional hydrogeological investigation work at the BR Site, particularly to investigate the depth and continuity of the sand/silt seams in the upper portion of the silty clay deposit and the hydraulic conductivity of the native silty clay, and 2) predictive modelling, a liner system may not be required on the base of the landfill or leachate treatment/holding pond components. It is expected that a liner system will be required on the below-grade sideslopes of the disposal cells, or as an alternative a vertical perimeter cut-off feature around the waste disposal cells (keyed into the unweathered silty clay, below the elevation of the sand/silt seams) could be constructed instead of any base or below-ground sideslope liner system. A primary leachate collection system will be required below the landfill.

3.2 Results of Site Comparison

Considering the design & operations assessment criteria and the indicator “Degree of engineered containment expected to be required for on-Site systems”, for the reasons described above the BR Site is the preferred Site for the CRRRC.

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APPENDIX TSD#1-I

Traffic Component

February 2013

February 2013

Traffic Component
Appendix TSD#1-I

COMPARATIVE EVALUATION OF ALTERNATIVE SITES

TAGGART
GROUP OF COMPANIES

THE MILLER GROUP

Table of Contents

TABLES

INTRODUCTION

Two properties that are owned or have been optioned by Taggart Miller have been identified for the proposed Capital Region Resource Recovery Centre (CRRRC) (the Alternative Sites). The Alternative Sites are described below:

- **North Russell Road Site (NRR Site)** – located in the northwest part of the Township of Russell about three kilometres east of the boundary with the City of Ottawa, and about five kilometres south of Provincial Highway 417 between the Boundary Road and Vars exits. The property consists of about 193 hectares (476 acres) of contiguous lands on Part of Lots 18 and 19, Concessions III and IV, Township of Russell.
- **Boundary Road Site (BR Site)** – located in the east part of the City of Ottawa, in the former Township of Cumberland and just southeast of the Highway 417/Boundary Road interchange. The property is on the east side of Boundary Road, east of an existing industrial park, north of Devine Road and west of Frontier Road. The property consists of about 175 hectares (430 acres) of land on Lots 23 to 25, Concession XI, Township of Cumberland.

The CRRRC is proposed to provide facilities and capacity for recovery of resources and diversion of material from disposal generated by the industrial, commercial and institutional (IC&I) and construction and demolition (C&D) sectors primarily in Ottawa and secondarily a portion of eastern Ontario, for management and utilization of surplus and contaminated soils, as well as landfill disposal capacity for material that is not diverted.

1.0 ASSESSMENT CRITERIA, INDICATORS AND DATA SOURCES

The traffic component compared the Alternative Sites using the following criterion:

- Which Site is preferred regarding potential effects from Site-related truck traffic?

The indicators for the criterion are:

- Proximity of Site to Highway interchange;
- Characteristics of road network between Highway interchange and Site; and
- Land use from Highway interchange to Site along the main haul route(s).

The data sources used were available road and intersection characteristics, and traffic count information on potential haul routes; historical traffic and collisions, if available; aerial photographic mapping and field reconnaissance; location and nature of potential receptors; and consultation with Russell Township and the City of Ottawa, as appropriate.

2.0 PRELIMINARY DESCRIPTION OF EXISTING ENVIRONMENT

The following sections describe the existing environmental conditions for the traffic component at each of the Alternative Sites based on the preliminary investigations and assessments.

2.1 North Russell Road Site

This Alternative Site for the CRRRC is located approximately three kilometres north of the village of Russell in the Township of Russell. The Site is on the east side of North Russell Road, and a portion of it was formerly the Site of the Hanson Brick quarry operations.

Roads within the vicinity of this Site are North Russell Road to the west of the Site which is a two-lane rural road, and Eadie Road to the east which is a two-lane secondary rural road. Both of these roads are under the jurisdiction of the Township of Russell. Approximately 1.3 kilometres north of the NRR Site is Route 100 which is a rural secondary road under the jurisdiction of the Township of Russell. Burton Road is located approximately three kilometres north of this Site and Frontier Road approximately 4.5 kilometres from the NRR Site. Both Burton Road and Frontier Road are two-lane collector roads under the jurisdiction of the City of Ottawa. During the spring thaw period (approximately six weeks in length), all Township of Russell roads and Frontier Road, which is under the jurisdiction of the City of Ottawa, are subject to seasonal load restrictions.

Further north from the NRR Site, Boundary Road and Devine Road are two-lane rural arterials under the City of Ottawa jurisdiction.

Initial peak hour traffic counts were taken along certain roads as part of obtaining baseline information for the CRRRC project, while other traffic count information was obtained from MTO or the City of Ottawa, as follows:

Table 2.1-1: Peak Hour Traffic Counts – NRR Site

Location	Date & Source	Peak Hourly Traffic (vehicles per hour)	
		A.M. Peak Hour	P.M. Peak Hour
North Russell Road at Burton Road	April 14, 2010 (count)	183 northbound, 36 southbound	40 northbound, 133 southbound
St. Guillaume Road exit 96 at Highway 417	September 20, 2007 (MTO)	704 northbound, 331 southbound	408 northbound, 887 southbound
Boundary Road exit 88 at Highway 417	November 19, 2008 (MTO)	552 northbound, 159 southbound	239 northbound, 752 southbound
Boundary Road at Mitch Owens Road	June 1, 2011 (City of Ottawa)	758 northbound, 196 southbound	163 northbound, 642 southbound
Boundary Road at Devine Road	March 21, 2012 (count)	698 northbound, 104 southbound	171 northbound, 612 southbound
Devine Road at Frontier Road	March 21, 2012 (count)	207 northbound, 36 southbound	46 northbound, 164 southbound

The lands in the proximity of the NRR Site are mainly rural agricultural.

2.1.1 Haul Routes

The haul route analysis has identified five possible haul route alternatives for the NRR Site. The five alternatives are described in the following sections:

<u>Alternative 1</u> – Boundary Road Exit to North Russell Road Access

The first haul route alternative proposes the NRR Site access to be directly onto North Russell Road. The majority of Site traffic would travel from the Boundary Road exit at Highway 417 (Exit 96) to Devine Road, Frontier Road, Burton Road, and then to North Russell Road to enter this Site from the north. Through designation of haul routes, any traffic component of the Site would not travel through the Village of Russell to enter the Site from the south. The distance from the Site access to the Boundary/Highway 417 exit is approximately 10 kilometres. There are currently no signalized intersections.

Land uses along this haul route are mainly agricultural with some commercial/light industrial along Boundary Road between Mitch Owens Road and Highway 417. There are some residential homes/farm houses along North Russell Road between the NRR Site and Burton Road. There are approximately 21 to 30 residences along the haul route between Highway 417 and the Site, depending on the Site access location off North Russell Road. There are approximately 15 commercial/light industrial and 11 agricultural field access points along the haul route between Highway 417 and the Site. Depending on the Site access location, there is a cemetery located along North Russell Road.

Frontier Road and North Russell Road are subject to load restrictions during the spring thaw period.

<u>Alternative 2</u> – Boundary Road Exit to Eadie Road Access

The second haul route alternative proposes the NRR Site entrance to be directly from Eadie Road, with most Site trips travelling from the Boundary Road/Highway 417 exit (Exit 96) to Burton Road and south along Eadie Road to the Site access. The haul route distance from the Highway 417 Exit 96 interchange to the Site is approximately 11.5 kilometres. There are currently no signalized intersections.

Land uses along the haul route are mainly agricultural with some commercial/light industrial along Boundary Road between Mitch Owens Road and Highway 417. There are approximately 14 residential homes/farm houses along Eadie Road between the northeast corner of the NRR Site and Burton Road, many of which are in close proximity to the roadway. There are approximately 30 residences along the haul route between Highway 417 and the Site. Approximately 15 commercial/light industrial and 21 agricultural field access points are located along the haul route between Highway 417 and the Site.

Eadie Road is a rural secondary road which currently does not carry any commercial truck traffic. Further investigation is required to determine if the roadway pavement has the structural capacity to carry the additional traffic from the NRR Site. Frontier Road and Eadie Road are subject to load restrictions during the spring thaw period.

<u>Alternative 3</u> – Vars Exit to North Russell Road Access

The third haul route alternative would have Site trips originating from the east travelling along Burton Road from the Highway 417 exit (Exit 88) at St. Guillaume Road, then south along North Russell Road to the NRR Site. The distance of the haul route from the Highway 417 Exit 88 to the NRR Site access is approximately seven kilometres. There are currently no signalized intersections.

The land uses along the haul route are mainly agricultural with some commercial/light industrial along Burton Road immediately west of St. Guillaume Road. There are approximately 10 to 17 residences along the haul route between Highway 417 Exit 88 and the NRR Site, depending on the Site access location off North Russell Road. Approximately 11 commercial/light industrial and 16 agricultural field access points are located along the haul route between Highway 417 and the Site. Depending on the Site access location, there is a cemetery located along North Russell Road.

North Russell Road is subject to load restrictions during the spring thaw period.

Alternative 4* – *Vars Exit to Eadie Road Access

The fourth alternative proposes the haul route to originate at the Vars exit of Highway 417 (Exit 88), and travel along Burton Road and south along Eadie Road to the NRR Site. The haul route distance from the Highway 417 Exit 88 interchange to the Site is approximately six kilometres. There are currently no signalized intersections.

The land uses along the haul route are mainly agricultural with some commercial/light industrial along Burton Road immediately west of St. Guillaume Road. There are approximately 14 residential homes/farm houses along Eadie Road between the Site and Burton Road, many of which are in close proximity to the roadway. There are approximately 16 residential homes along the haul route between Highway 417 and the NRR Site. Approximately 11 commercial/light industrial and 18 agricultural field access points are located along the haul route between Highway 417 and the Site.

Eadie Road is a rural secondary road which currently does not carry any commercial truck traffic. Further investigation is required to determine if the roadway pavement has the structural capacity to carry the additional traffic from the NRR Site. Eadie Road is subject to load restrictions during the spring thaw period.

Alternative 5* – *Vars Exit to Unopened Road Allowance Access

The fifth alternative proposes the haul route to originate at the Highway 417 exit at Vars (Exit 88), with Site trips travelling along Burton Road and turning south along a new road constructed along an unopened road allowance located approximately 1.5 kilometres east of Eadie Road. The haul route distance from the Highway 417 Exit 88 interchange to the Site is approximately 4.5 kilometres. There are currently no signalized intersections.

The land uses along the haul route are mainly agricultural with some commercial/light industrial along Burton Road immediately west of St. Guillaume Road. There would be no residential houses fronting onto the new road. There are no residences along the haul route between Highway 417 and the Site. Approximately ten commercial/light industrial and two agricultural field access points are located along the haul route between Highway 417 and the Site.

Alternative 5 would require the construction of a new road along the unopened road allowance. The road would be approximately 2.5 kilometres in length and would be constructed to provide the structural capacity for the expected truck traffic.

2.1.2 Summary of NRR Site Traffic Considerations

Table 2.1-2: Summary of NRR Site Traffic Considerations

Component	Summary of Site Considerations
Traffic	1) Five haul route scenarios were examined. Two alternatives assumed traffic to originate from the Boundary Road/Highway 417 interchange, and three alternatives from the Vars/Highway 417 interchange. 2) Alternative 1 – The haul route is 10 km in length with spring thaw load restrictions along the route. There are approximately 21 to 30 residences, 15 commercial/light industrial, 11 agricultural field access points and possibly one cemetery adjacent to the haul route. 3) Alternative 2 – The haul route is 11.5 km in length with spring thaw load restrictions along the route. The structural capacity of Eadie Road must be examined for truck traffic. There are approximately 30 residences, 15 commercial/light industrial and 21 agricultural field access points adjacent to the haul route, many in close proximity to the road. 4) Alternative 3 – The haul route is seven km in length with spring thaw load restrictions along the route. There are approximately 10 to 17 residences, 11 commercial/light industrial, 16 agricultural field access points and possibly one cemetery adjacent to the haul route. 5) Alternative 4 – The haul route is six km in length with spring thaw load restrictions along the route. The structural capacity of Eadie Road must be examined for truck traffic. There are approximately 16 residences, 11 commercial/light industrial and 16 agricultural field access points adjacent to the haul route. 6) Alternative 5 – The haul route is 4.5 km in length. A new 2.5 km-road would be constructed along an unopened road allowance. No residences, ten commercial/light industrial and two agricultural field access points are adjacent to the haul route.

2.2 Boundary Road Site

The BR Site is located at the northeast quadrant of the intersection of Boundary Road and Devine Road. Both Boundary Road (Ottawa Road 41) and Devine Road (Ottawa Road 8) are two-lane rural arterial roads under the jurisdiction of the City of Ottawa. The access to the BR Site could potentially be off Boundary Road on the west side, or from Frontier Road on the east side of the property. Frontier Road is a rural collector road under the jurisdiction of the City of Ottawa.

Initial peak hour traffic counts were taken along certain roads as part of obtaining baseline information for the CRRRC project, while other traffic count information was obtained from MTO or the City of Ottawa, as follows:

Table 2.2-1: Peak Hour Traffic Counts – BR Site

Location	Date & Source	Peak Hourly Traffic (vehicles per hour)	
		A.M. Peak Hour	P.M. Peak Hour
Boundary Road exit 88 at Highway 417	November 19, 2008 (MTO)	552 northbound, 159 southbound	239 northbound, 752 southbound
Boundary Road at Mitch Owens Road	June 1, 2011 (City of Ottawa)	758 northbound, 196 southbound	163 northbound, 642 southbound
Boundary Road at Devine Road	March 21, 2012 (count)	698 northbound, 104 southbound	171 northbound, 612 southbound
Devine Road at Frontier Road	March 21, 2012 (count)	207 northbound, 36 southbound	46 northbound, 164 southbound

The lands in the proximity of the Site are rural agricultural and commercial/light industrial land uses.

2.2.1 Haul Routes

The majority of the Site-related trips would travel to the BR Site along Boundary Road from Highway 417 Exit 96. The distance to the BR Site access will depend on the location of the access, and so could range from around 1 to 2 kilometres if accessed off Boundary Road, to about 3.5 kilometres to the Devine/Frontier Road intersection. There are currently no signal-controlled intersections. Land uses along Boundary Road are mainly commercial/light industrial, with a few houses interspersed. Lands along Devine Road west of Frontier Road are vacant.

Mitch Owens Road intersects Boundary Road from the west opposite the southern portion of the BR Site, approximately 1.8 kilometres from Highway 417. Lands along Mitch Owens Road to the west are mainly vacant or agricultural, with a small amount of commercial and rural residential.

There are approximately nine residences along Boundary Road between Highway 417 (Exit 96) and Devine Road. Approximately 14 commercial/light industrial properties are located along the haul route between Highway 417 and Devine Road.

Both Devine Road and Boundary Road are arterial roads under the jurisdiction of the City of Ottawa. The haul route would not be subject to any spring thaw load restrictions.

2.2.2 Summary of BR Site Traffic Considerations

Table 2.2-2: Summary of BR Site Traffic Considerations

Component	Summary of Site Considerations
Traffic	1) The roads which would form the main haul route for the BR Site-related truck traffic are classified as rural arterial roads. 2) The majority of the Site trips would be from/to Highway 417, which depending on Site access location could correspond to a travel distance of about 1 to 3.5 km from the Boundary Road Exit 96. 3) Land uses along the haul route are mainly commercial/light industrial. Approximately nine residences are along the haul route and 14 commercial/light industrial properties.

3.0 SITE COMPARISON – TRAFFIC

3.1 Comparison of Sites

The Sites were compared following an examination of the length of the haul route, type of roads and possible load restrictions, and impact on residences, commercial properties and agricultural access fronting on the road.

North Russell Road Site

Five alternative scenarios were prepared, which proposed the location of the Site access and the haul route for the majority of Site-related trips. Alternative 3, which proposed the haul route from the Highway 417 Vars exit (Exit 88) to an entrance on North Russell Road, would provide the average haul distance of all the routes, and would have a lower potential impact on the adjacent residential homes than an Eadie Road access which has residential homes in closer proximity to the road. Alternative 3 would not require possible reconstruction of Eadie Road to increase the structural capacity of the road. Alternative 3 has roughly the average number of agricultural land use access points along the haul route. The commercial/light industrial land uses along the proposed haul routes are all comparable. Alternatives 1 to 4 all include roads on which there are spring thaw load restrictions. Alternative 5, which proposes a new road along an unopened road allowance would provide the shortest haul distance and minimal impact on residential homes and agricultural access locations in the area, but would require the construction of a new 2.5-kilometre haul road. Alternative 5 would be the preferred NRR Site alternative due to the shortest haul route from Highway 417 and lowest potential traffic related impact on the surrounding community. Alternative 5 would be expected to be the most expensive alternative due to the construction of the new road.

Boundary Road Site

The BR Site has only one main haul route from Highway 41 using the Boundary Road exit. The haul route from the Highway 417-Boundary Road interchange (Exit 96) has a comparatively short haul distance, with a limited number of residences along the route. The haul route would be along arterial roads, which currently carry truck traffic. There would be no spring thaw load restrictions along the route.

3.2 Results of Site Comparison

Following a comparison of the main haul routes associated with the two Alternative Sites, the BR Site is the clearly preferred Site from a traffic perspective, providing the shortest haul route along roads designated as arterial roads that currently carry truck traffic and with adjacent land uses that are mainly commercial/light industrial or vacant with a limited number of houses.