newgold™ Rainy River Project

APPENDIX H

HYDROGEOLOGY BASELINE

RAINY RIVER PROJECT
Final Environmental Assessment Report

amec

RAINY RIVER GOLD PROJECT
HYDROGEOLOGY BASELINE REPORT

Submitted by:

AMEC Environment & Infrastructure,
a Division of AMEC Americas Limited
160 Traders Blvd., Suite 110
Mississauga, Ontario
L4Z 3K7

On behalf of:

Rainy River Resources Ltd.
1111 Victoria Avenue East
Thunder Bay, Ontario
P7C 1B7

March 2013
TC111504

March 22, 2013
TC111504

Mr. Kyle Stanfield, P.Eng
Vice President, Environment & Sustainability
Rainy River Resources Ltd.
1111 Victoria Avenue East
Thunder Bay, Ontario
P7C 1B7

Dear Mr. Stanfield,

AMEC Environment & Infrastructure is pleased to submit the attached Hydrogeology Baseline Report for the Rainy River Gold Project.

This Hydrogeology Baseline Study was prepared to describe the current groundwater conditions and update existing hydrogeology information. The report summarizes the hydrogeology baseline data collected by AMEC, which comprises a large groundwater level monitoring network and further hydraulic testing of the overburden material and bedrock. These data have been used to update and improve the previous hydrogeological information.

We greatly appreciate the opportunity to provide support for your Rainy River Gold Project. Should you have any questions regarding the study, please do not hesitate to contact us.

Yours Sincerely,

AMEC Environment & Infrastructure,
a division of AMEC Americas Limited

Simon Gautrey, M.Sc. M.B.A. P.Geo.
Associate Hydrogeologist

Sheila Daniel, M.Sc. P.Geo.
Head, Environmental Management
Senior Associate Geoscientist

AMEC Environment & Infrastructure,
a division of AMEC Americas Limited
160 Traders Blvd. East, Suite 110
Mississauga, Ontario
Canada L4Z 3K7
Tel (905) 568-2929
Fax (905) 568-1686
www.amec.com

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Glossary

BP	before present
˚C	degrees Celsius
CEQG	Canadian Environmental Quality Guidelines
EC	Environment Canada
EFLT	Eastern Fault
GPS	Global Positioning System
km	kilometres
masl	metres above sea level
mbgs	metres below ground surface
mbbs	metres below bedrock surface
m	metres
MOE	Ontario Ministry of the Environment
m/s	metres per second
m^3/s	cubic metres per second
mm	millimetres
mm/year	millimetres per year
PLGD	Pleistocene lower granular deposits
PWQO	Provincial Water Quality Objectives
RRGP	Rainy River Gold Project
RQD	rock quality designation
RRR	Rainy River Resources Ltd.
UTM	Universal Transverse Mercator
WSC	Water Survey of Canada
WWR	water well record

1.0 INTRODUCTION

AMEC Environment & Infrastructure (AMEC) was retained by Rainy River Resources Ltd. (RRR) to describe the current groundwater conditions and update existing information for the Rainy River Gold Project (RRGP) located in northwestern Ontario. RRR is planning to develop and operate an open pit and underground mine, the RRGP, in the Township of Chapple located approximately 65 kilometres (km) by road, northwest of Fort Frances, Ontario in northwestern Ontario (Figure 1-1). The proposed mine and project site area defined for the purposes of this report, is positioned within the upper portion of the Pinewood River watershed (Figures 1-2 and 1-3).

1.1 General Approach

Hydrogeological and relevant other environmental information is available for a localized area relating to the RRGP site as part of previous baseline investigations initiated in 2008 (Klohn Crippen Berger 2011). AMEC conducted a comprehensive gap analysis to determine the extent and quality of existing relevant environmental data in the winter of 2011 to support future mine development. This report focuses on the new information collected by AMEC subsequent to the gap analysis. Previous data have been included to provide a broader context where appropriate.

Baseline data were gathered by AMEC using the standard approaches of literature review, observation and sample collection, data analysis and discussions with people having specific knowledge of the area. Where appropriate, an ecosystem perspective has been used to integrate other baseline data collected for the RRGP into functional relationships with the hydrogeology. It is recognized that the entire physical, chemical and biological system (i.e., the ecosystem) is interconnected. For example, surface water systems are connected to groundwater systems, which are in turn affected by climate, geology, soils and general terrain aspects.

While environmental baseline investigations typically describe environmental conditions as they exist at the time of the investigation, AMEC has found that hydrogeological baseline reports are most useful if a numerical, three-dimensional groundwater flow model is developed of existing conditions. Investigations completed by AMEC have been designed to support the development of such a model. This model can then be used subsequently to support future project design and determination of potential environmental impacts. The previous baseline report (Klohn Crippen Berger 2011) did not produce a groundwater flow model.

1.2 Secondary Sources - Previous Studies / Documentation

A number of investigations were completed in the project area prior to 2011 when AMEC initiated this study. This includes the following sources that provide significant data and information to this report:

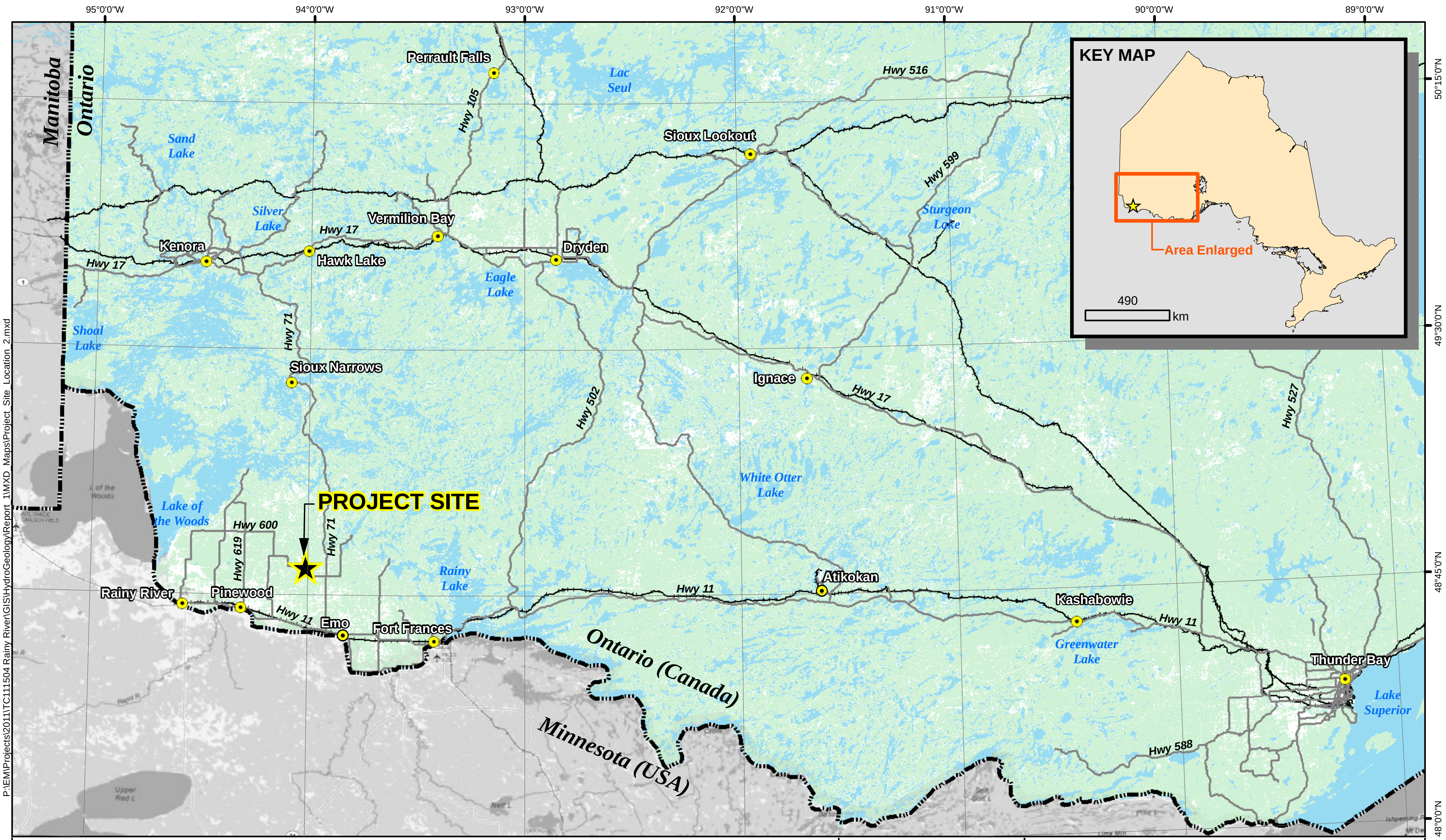
- Report 286 of the Ontario Geological Survey produced by A.F. Bajc in 2001, which provides a thorough description of the Quaternary Geology of the Fort Frances-Rainy River Area.

- Rainy River Gold Project Baseline Report 2008 to 2010 produced by Klohn Crippen Berger (KCB) in 2011. This report documents the first groundwater investigation at the Project site and installation of an initial dedicated groundwater level piezometer network.

- Independent Technical Report for the Rainy River Property produced by Caracle Creek in 2008. This document is a primary source of information for the bedrock geology although the detailed geologic interpretations of the project area are being progressively updated by RRR and these interpretations are included in this report.

- Work Report of the 1997 Reverse Circulation Drill Data produced by Nuinsco Resources Limited, which documents an extensive drilling campaign in the overburden. This provides additional information on the bulk overburden stratigraphy, particularly to the west of the proposed open pit. The drilling and cross sections from this report cover south and east of Richardson (Chapple Township); south-eastern corner of Sifton (Morley Township) and the north-western part of Tait (Morley Township) (Figure 1-3).

- Flow gauging data from two of the Environment Canada (EC) Water Survey of Canada (WSC) gauging stations for the Pinewood River.



P:\EMProjects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\Project_Site_Location_2.mxd

LEGEND

- ★ Project Site
- ◉ Regional Communities
- Provincial / National Border
- Regional Road / Highway
- Railway

NOTES:
- Ontario base data extracted from Land Information Ontario (MNR) data warehouse.
- Base data outside of Ontario extracted from ESRI DeLorme World Basemap

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

Project Location

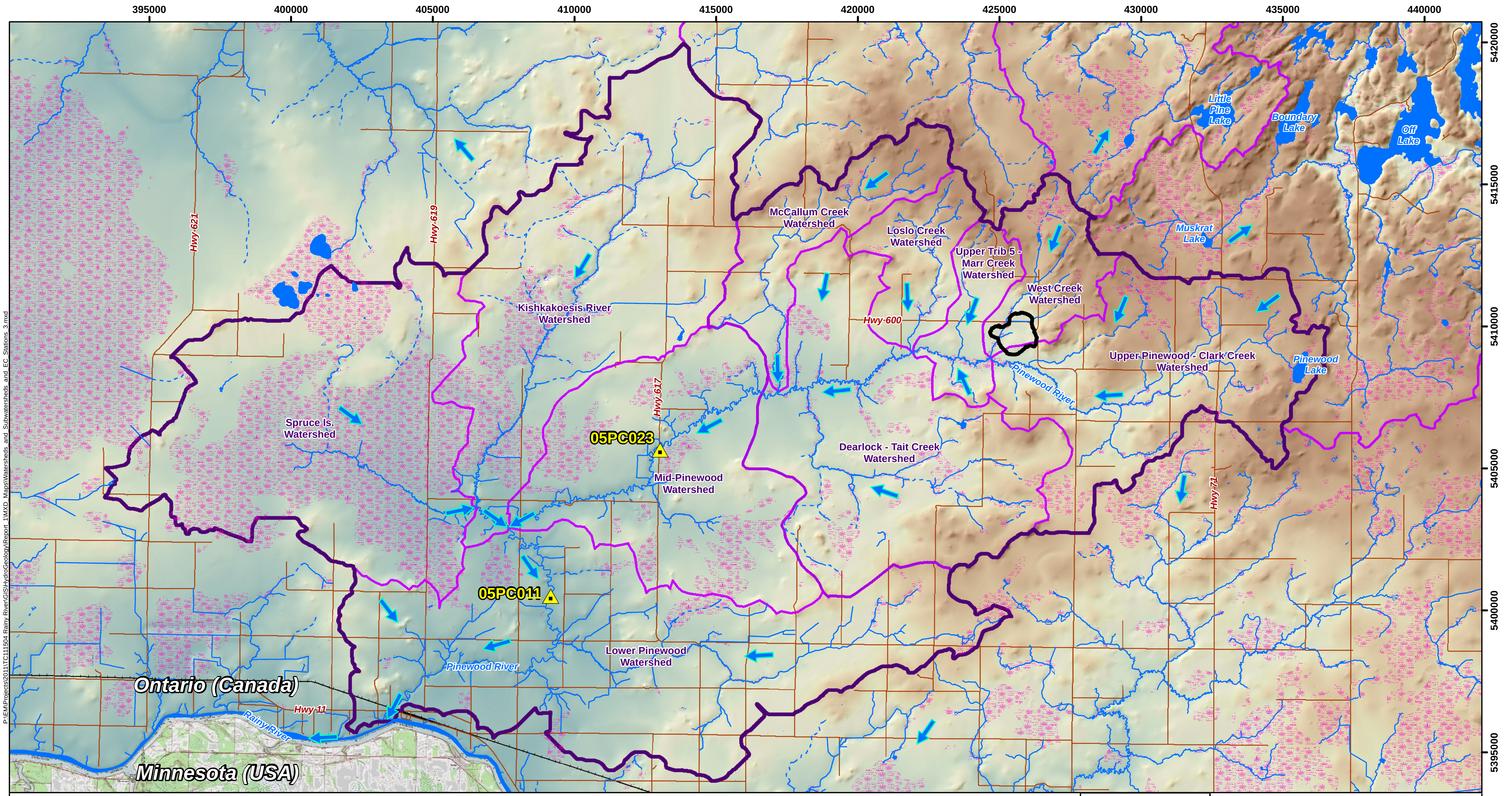
Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

PROJECT N^{o}: TC111504	FIGURE: 1-1
SCALE: 1:1,800,000	DATE: March 2013

0 25 50 100 150 200 250 Kilometres

P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report 1\MXD Maps\Watersheds and Subwatersheds and EC Stations 3.mxd



LEGEND

- Approximate Open Pit Outline
- 05PC011 WSC Station
- Regional Road / Highway
- Railway
- Waterbody
- Low-Lying Wetland Area
- Permanent Watercourse
- Intermittent Watercourse
- General Surface Flow Direction

Elevation Colour Ramp
- High ground
- Low ground

- Pinewood River Watershed (approx. 57,450 ha)
- Main Project Area Watershed (approx. 20,700 ha)
- Subwatershed Areas (labelled on map)

-Upper Trib 5 - Marr Cr. approx. 1,230 ha
-Loslo Cr. approx. 1,620 ha
-West Cr. approx. 1,635 ha
-McCallum Cr. approx. 2,490 ha
-Upper Pinewood - Clark Cr. approx. 6,130 ha
-Mid-Pinewood approx. 6,530 ha
-Dearlock - Tait Cr. approx. 7,600 ha
-Kishkakoesis R. approx. 9,200 ha
-Spruce Is. approx. 9,580 ha
-Lower Pinewood approx. 11,435 ha

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR
- Ontario base data extracted from Land Information Ontario (MNR) data warehouse.
- Base data outside of Ontario extracted from ESRI USGS Topographic maps
- Watershed delineations are approximate and are derived from MNR Ontario Digital Elevation Model and Quaternary Watershed boundaries

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

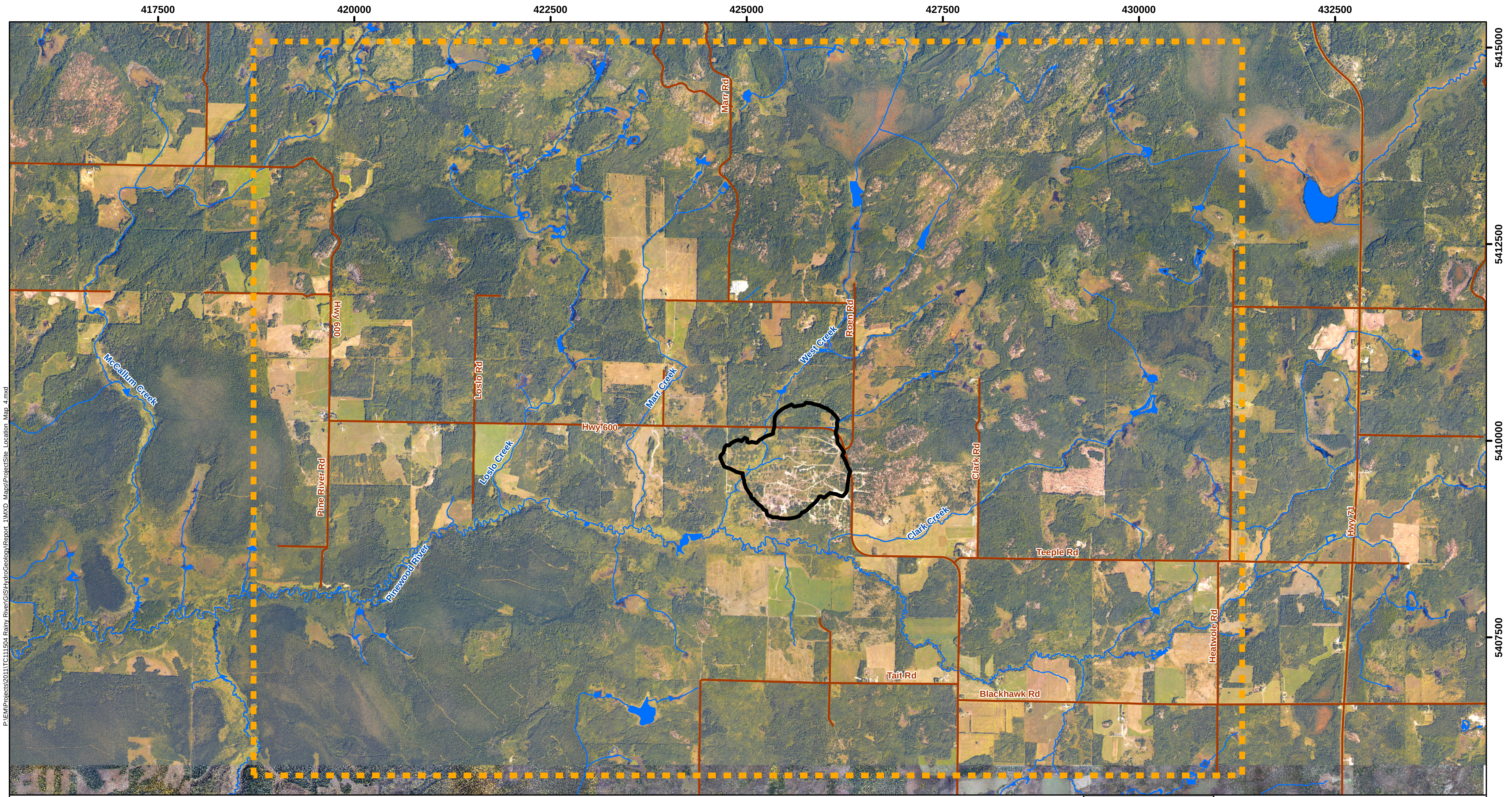
0 3.5 7 14 21 28 35
Kilometres

RAINY RIVER
amec

RAINY RIVER GOLD PROJECT

Regional Topography, Watershed and Subwatershed Boundaries

PROJECT N^{o}: TC111504
FIGURE: 1-2
SCALE: 1:127,000
DATE: March 2013



P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\ProjectSite_Location_Map_4.mxd

LEGEND

- ▨ General Project Area
- ⬡ Approximate Open Pit Outline
- Roads
- Watercourses

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR
- Township and watercourse data extracted from Land Information Ontario, MNR
- Aerial photos provided by Rainy River Resources, taken in summer 2011

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

0 1 2 4 6 8 10
Kilometres

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

General Project Area

PROJECT N^o: TC111504	**FIGURE: 1-3**
SCALE: 1:46,000	DATE: March 2013

2.0 ENVIRONMENTAL SETTING

2.1 Physiography

The RRGP site occurs within the Severn Upland Physiographic Subregion of the James Bay Physiographic Region (Bostock 1970) which is generally characterized by gently undulating topography. Topography has been strongly influenced by glaciation, which on higher ground has left bedrock exposed (or with limited overburden cover) and in lower lying areas has thicker sedimentary deposits primarily of glacial origin (till). The final phases of glaciation overrode pro-glacial lake sediments, which has resulted in the upper parts of the overburden being dominated by clay sediments in the low lying areas, particularly in the southern and western part of the region associated with the widespread glaciolacustrine deposits of Lake Agassiz. Organic deposits (peat) are also common at surface and are associated with the poor drainage in the lower areas where clay deposits dominate the upper overburden. Organic deposits are particularly prevalent in the area west of the proposed open pit.

The project area can be divided into two general physiographic types based on topography and frequency of bedrock outcrops. The north and eastern portions of the project area have numerous bedrock outcrops, with variable overburden cover, which generally occur at elevations above 380 metres above sea level (masl). The southwest and central portions of the project area have thicker and more extensive overburden, with isolated bedrock outcrops. The area of the proposed open pit is largely low lying and is at an elevation of approximately 350 masl, while some small bedrock knolls occur close to the centre of the pit at approximately 360 masl.

2.2 Geology

2.2.1 Regional Overburden Geology

The current understanding of the regional overburden geology was determined by the Ontario Geological Survey (OGS) from a series of field programs started in 1986 to assess the mineral potential of the Rainy River District. This is documented by Bajc (2001), which provides an overview of previous work, including the reports produced by the OGS from their field programs (many of which were authored or co-authored by Bajc). A regional surface geology map of the project area is presented in Figure 2-1.

The overburden (Quaternary) geology can be divided into two general ages: Pleistocene which includes the glacial deposits from >10,000 years before present (BP); and Holocene which is post-glacial and includes deposits from 9,000 to 10,000 years BP. The overburden is typically in the range of 10 to 20 metres (m) thick, with some areas exceeding 40 m and others with no overburden, where bedrock is exposed.

The region has a complex Pleistocene history with multiple glacial advances from two dominant directions resulting in two sets of tills of different origins, with glacial lakes, such as Lake Agassiz, occupying the area in the periods between glaciations. The sediments deposited by the two ice sheets can be distinguished by the mineralogy of the sediments and lithology of the bedrock clasts within the glacial deposits (Bajc 2001) as summarized below.

The center of the Labradorean ice sheet was situated to the northeast of the project area and advanced into the project area from this direction. The bedrock to the northeast of site is of Precambrian age consisting of granitic and metamorphic rocks, with the nearest carbonate and clastic rocks in this direction located approximately 700 km away, in the Paleozoic- to Mesozoic-era bedrock near Hudson Bay. As a result, the tills deposited during advances of the Labradorean ice sheet tend to reflect the predominantly Precambrian source with relatively low carbonate content in tills, generally less than 5%. The Precambrian source is also reflected by the local clay mineralogy, which is generally inactive clays such as illite, chlorite and kaolinite.

The center of the Keewatin ice sheet was situated to the northwest of the project area. It advanced into the project area from the west, where carbonates and clastic rocks of the Williston Basin are located within 200 km from the site. The Keewatin ice sheets traveled over large areas of carbonate rocks and the resulting sediments contain relatively high amounts of carbonate debris. The Keewatin-derived tills generally contain pebbles that are 50 to 60% carbonate pebbles and 20 to 40% carbonate in the matrix. Shales of the Williston basin generally have high amounts of swelling clays, which is reflected by the abundance of smectite, vermiculite and montmorillonite in Keewatin-derived clays.

2.2.2 Pleistocene Glacial History

The earliest Pleistocene sediments in the region are of pre-Late Wisconsinan age and include both Labradorean and Keewatin tills and glaciolacustrine deposits. These deposits are uncommon as they have been largely removed by subsequent glacial advances. The majority of the Pleistocene deposits are of Late Wisconsinan age.

The Late Wisconsinan geological history and associated deposits has been summarized as follows (Bajc 2001):

- An advance by the Labradorean ice sheet from the northeast deposited a silty sand till known as the Whiteshell Till. As the Labradorean ice retreated, glaciofluvial sediments, consisting of sand, gravel and boulders were deposited in some areas.

- Glacial Lake Agassiz occupied much of the area following the retreat of the ice sheet, depositing glaciolacustrine clay, silt and sand of the Wylie Formation.

- The Keewatin ice sheet then advanced over the area from the west resulting in the clay-rich Whitemouth Lake Till being deposited. Several depositional facies including sub-glacial till and sub-aqueous flow till, have been recognized regionally within the Whitemouth Lake Till. These facies indicate a glacial advance and retreat across a lake bed with respective retreat and advance of lacustrine conditions (Bajc 2001). The sub-glacial till is massive, firm to stiff, with features such as strong pebble fabric and ice thrusts, which indicate deposition under grounded active ice possibly by lodgement processes. The flow tills are generally softer, often containing faint stratification and small clasts of glaciolacustrine clay. The flow tills were likely deposited in water at the margin of the ice sheet.

- The sequence of glacial retreat with subsequent glaciofluvial and glaciolacustrine environments and associated deposits was repeated. The sediments deposited from this stage of Lake Agassiz are known as the Brenna Formation and formed on the Lake bottom (clay and silt) and along shorelines and bars (sand, silt and minor gravel). The water level in Lake Agassiz at this time is thought to have been at approximately 370 masl. The beach ridge/bar identified to the east of the proposed open pit (Figure 2-1) is considered to part of this phase of sedimentation (Bajc 2001).

- The Keewatin ice sheet subsequently re-advanced to within 25 km of the project area depositing the Marchand Till to the southwest of the area. Approximately 11,000 years BP Lake Agassiz was partially drained and water levels dropped, leaving the project area subaerially exposed.

- At approximately 10,000 years BP, the water level in Lake Agassiz rose again to approximately 350 to 355 masl depositing the glaciolacustrine deposits of the Sherack Formation. The shore bluff at Deerlock to the west of the open pit is considered part of this phase of sedimentation (Figure 2-1; Bajc 2001). The Sherack Formation consists of highly calcareous clay and silt, with minor sand and includes a distinctive thin red clay bed in the region. At some locations the Sherack Formation contains expansive clays such as smectite.

The Pleistocene sediments are overlain by more recent deposits of Holocene age, such as peat and organic deposits in low-lying wetland areas. Other Holocene sediments include alluvial sand, silt and clay deposited by individual watercourses.

2.2.3 Project Area Overburden Geology

The project area overburden geology is dominated by two formations, the Whiteshell Till and Whitemouth Lake Till of Labradorean and Keewatin origin, respectively. A summary is given in Table 2-1 of the overburden units that occur within the vicinity of the project area briefly described below in order from oldest to youngest. The description of the units is based primarily on Bajc (2001) and the results of AMEC's 2011/2012 geotechnical drilling program (AMEC 2012a). The predominance of the Whiteshell Till and Whitemouth Lake Till is confirmed by the cross sections developed by Nuinsco (1997), particularly in the southern part of Richardson

Township to the west of the proposed open pit. Figure 2-2 shows a refinement of the regional geology map with respect to the overburden within the project area based on site data.

Pre-Late Wisconsinan Deposits

Although these deposits have not been encountered at site to date, it is possible that some older tills and glaciolacustrine deposits may occur locally in places. They could include deposits of both Labradorean and Keewatin origin of variable composition. If present, they would occur above the bedrock and below the younger glacial deposits described below.

Whiteshell Till

The Whiteshell Till is of Labradorean origin and appears throughout the project area below younger units, with the exception of on bedrock topographic highs, where it appears absent. The Whiteshell Till is a predominantly silty sand till, with some gravel and cobbles, trace clay and some boulders. Where observed in an excavation in the proposed open pit area, the till contained numerous angular gravel and cobbles consisting of what appeared to be locally derived metavolcanics. In some places the deposit appears to be crudely bedded. Nuinsco (1997) report sandy till of Labradorean origin in 90% of the boreholes drilled. There is little, if any direct evidence to suggest that this till is exposed at surface in the project area (where present, it is always overlain by Keewatin-derived sediments). There are groundwater level data that support the lack of outcrop of the Whiteshell Till; however, it may be possible in that some locations Labradorean glaciofluvial deposits connect the Whiteshell Till to the surface.

Labradorean Glaciofluvial

A glaciofluvial deposit identified as Labradorean (Bajc 2001) occurs on site approximately 1.2 km north of the proposed open pit area (Figure 2-2). A sand and gravel pit was developed during the 1950's / 1960's at this location. It is likely that the deposit is associated with the Whiteshell Till and it occurs stratigraphically immediately above, below, or within the Whiteshell Till. Boreholes immediately to the north and west of proposed the pit (BH11-12, BH11-17, BH11-20, BH11-35 and BH11-40) do not support an extensive and thick body (>5 m) of Labradorean sand/gravel connecting the Whiteshell Till to this glaciofluvial deposit. Exceptions are BH10-04 (KCB 2011) which has close to 12 m of fine to medium sand and gravel beneath the Keewatin sediment; and Borehole BH11-11 (Appendix A) which has an appreciable thickness of glaciofluvial sand (approximately 14.5 m), but this is interpreted as being at a higher stratigraphic level above the Whitemouth Lake Till. The Labradorean glaciofluvial deposits at the gravel pit are more likely to be an isolated deposit exposed at surface at this location due to shallow bedrock with the younger, overlying Keewatin deposits being thin or non-existent. It is possible that similar Labradorean glaciofluvial deposits occur in the sub-surface where the overlying Keewatin sediments are thicker. Regionally the Labradorean glaciofluvial deposits range from fine-grained sand to boulder gravel.

Wylie Formation

The Wylie Formation is glaciolacustrine clay, silt and fine sand which occurs between, and is gradational with, the Whiteshell Till and Whitemouth Lake Till. The Wylie Formation likely contains material derived from both Labradorean and Keewatin sources, with the upper portions being more clay-rich and Keewatin in origin. The Wylie Formation is generally less than 2.5 m thick, is not as extensive as the near surface glaciolacustrine deposits of the Brenna Formation and is more common at lower elevations. Regional studies have indicated the clay contains swelling clays such as smectite and vermiculite. Nuinsco (1997) cross sections show these glaciolacustrine clays to be discontinuous. They are nevertheless relatively widespread and are possibly an important component of the hydraulic resistance required to generate the artesian conditions and strong upward vertical groundwater gradients from the Whiteshell Till and shallow bedrock.

Whitemouth Lake Till

The Whitemouth Lake Till is of Keewatin origin and appears to be one of the most widespread and thickest Quaternary units in the project area. This till is thickest in low-lying areas. Nuinsco (1997) reported from their extensive drill campaigns that this till is typically greater than 50% of the overburden material above the Labradorean sediments. The Whitemouth Lake Till is a silty clay with trace to some sand and trace gravel, and is high to medium plastic. It is suspected that the Whitemouth Lake Till contains swelling clays such as smectite, given the Keewatin origin of the clay. The depositional environment of this till has not been established for the project area. The till varies from soft to very stiff (AMEC 2012a), which may be an indication of different depositional environments. The softer material may be flow tills and similar material deposited into water. The stiff to very stiff tills are likely sub-glacial and may include lodgement till.

Keewatin Glaciofluvial

Glaciofluvial deposits of Keewatin origin are relatively uncommon in the area, but may have been encountered in a few boreholes from the 2011/2012 geotechnical drilling program (Figure 2-2). BH11-28 located south of the Pinewood River encountered 5.5 m of sand and gravel, including some sandy clayey gravel above the Whitemouth Lake Till at a depth of 8.2 m. The other occurrence was in BH11-11, where 14.5 m of silty sand was encountered at a depth of 2.3 m overlying the Whitemouth Lake Till. The extent of these deposits is unknown, but they are not expected to be widespread.

Brenna Formation

The Brenna Formation is a glacial Lake Agassiz clay of Keewatin origin which occurs stratigraphically above the Whitemouth Lake Till and is widespread throughout low-lying areas. It is assumed that most or all of the near surface, upper glaciolacustrine deposits encountered by the 2011/12 geotechnical drilling program (AMEC 2012a) are Brenna Formation, although some may belong to the Poplar River or Sherack Formations described below. It is varved in places and contains sand lenses and gravel at some locations. Regionally the Brenna Formation is rich in swelling clay minerals such as smectite and vermiculite, with slickensides; however, the clay mineralogy or presence of slickensides has not been confirmed within the project area.

The shoreline of Lake Agassiz at the time of deposition of the Brenna Formation was in the range of 370 to 375 masl and the Brenna Formation is not likely to occur above this elevation. An analysis of air photos has indicated some sandier glaciolacustrine deposits noted as unit GLc on the surficial geology map (Figure 2-2). It is possible that these sandy sediments could have been deposited in beach or near-shore environments of Lake Agassiz, similar to those mapped on Figure 2-1. Alternatively these deposits may be fluvial in origin and belong to the Poplar River Formation.

Poplar River Formation

It is unknown if the Poplar River Formation which formed in the Lake Agassiz basin during a time of low water levels occurs within the project area. Regionally these deposits are fluvial in nature composed of sand and gravel, but may also include boulder lags, channel fills, palaeosols and organic remains. The Poplar River deposits are not believed to be widespread and would occur in low lying areas, within the glaciolacustrine deposits of the Brenna Formation and Sherack Formation. There is a possibility that the near surface sand encountered in boreholes at the open pit site and in the vicinity of the Pinewood River may be Poplar River Formation.

Sherack Formation

The Sherack Formation is a glaciolacustrine deposit from Lake Agassiz which has not been identified in the project area, but is likely to occur in low lying areas below 355 masl elevation in the southwest corner of the project area and along the Pinewood River. It would represent the uppermost Pleistocene unit in the area. The Sherack Formation consists of clay, silt, sand, minor gravel and organics where it occurs regionally and often includes a distinctive red clay bed. Regional studies indicate the clay contains swelling clays such as smectite and vermiculite.

Recent Deposits

Recent sediments have been deposited since Lake Agassiz retreated from the area, approximately 9,000 years BP. Deposits of peat occur in low lying areas and along some watercourses and are fairly common within the project area. The most extensive area of peat is located in the southwest corner of the project area. The thickness of peat is expected to be variable ranging from thin veneers to greater than 2 m thickness in places.

Recent alluvial deposits are expected to occur along the Pinewood River and its tributaries. The alluvium likely consists of silt, clay, sand and some organics. It is possible that some colluvium may occur at the base of and along lower portions of slopes; however this is not expected to be extensive due to the limited topographic variability. These deposits would have formed by the erosion and gravity driven transport of materials such as clay, silt, sand and pieces of bedrock.

2.2.4 Regional Bedrock Geology

An overview of the regional bedrock geology is provided by Caracle Creek (2008) and SRK (2011) and summarized herein. The project area lies within the Rainy River Greenstone Belt which is part of the Achaean Wabigoon Subprovince and the Superior Province of the Precambrian Shield. The Rainy River Greenstone Belt is a 900 km long, east-west trending metavolcanic and metasedimentary domain, bordered and intruded by numerous granitoid batholiths. The supracrustal rocks of the Wabigoon Subprovince have a synformal structure that is associated with the emplacement of the granitoid batholiths. The Quetico Fault forms the southern boundary of the Wabigoon Subprovince, but departs from the boundary towards the west. The Rainy River Greenstone Belt to the south of the proposed open pit is believed to be intersected by the Quetico Fault; however, the surface trace of the fault is only conjectured. The Rainy River Greenstone Belt is bounded by the Sabaskong Batholith to the north and extends into Minnesota to the south (Figure 2-3).

2.2.5 Project Area Bedrock Geology

The bedrock geology in the project area was considerably refined by Nuinsco, which is described by Caracle Creek (2008) and slightly modified by SRK (2011). The main meta-volcanic units are a mafic-intermediate volcanic succession which lies immediately to the north and south of the proposed open pit; and an intermediate-felsic volcanic succession located in between. The latter comprises a diverse and complex sequence and is also the host for the gold mineralization. A detailed description of the main bedrock units is given in Table 2-2, along with the main intrusive bodies, such as the Black Hawk Stock. The metamorphic grade of the meta-volcanics is greenschist to lower-amphibolite facies.

2.2.6 Project Area Structural Geology

The structural geology of the project area is complex; interpretation and mapping of major structures can be difficult. The current interpretation of the major structures is shown on Figure 2-3. Two main phases of deformation and associated folding are currently recognized in the project area (D/F1 and D/F2). Deformation associated with faulting is predominantly in the mode of ductile shear zones (i.e., well-annealed) rather than brittle faulting and associated development of more permeable zones, such as fault breccia.

The structure at the project area is dominated by a south plunging F2 antiform. The contact of the Mafic-Intermediate Volcanic Succession with the Sabaskong granite is also interpreted to be deformed by this fold and the former is considered an early tectonic granite. On the eastern limb of the antiform the strike is approximately 050°N to 060°N; the western limb is interpreted to have a strike of approximately 100° to 110°N. Bedding dip is approximately 70° to the south, but may be shallower near the antiform hinge (~50°). A foliation occurs that is generally parallel or closely parallel to bedding in the metavolcanics associated with early (D/F1) deformation broadly striking east-west, but is not well-developed in the intrusive rocks. The regional foliation diverges around the Black Hawk Stock, which has been interpreted as a late-tectonic granite.

The major faults shown on Figure 2-3 are interpreted based mainly on aeromagnetic data (SRK 2011). A set of reactivated D1/D2 thrust faults are interpreted to run through the proposed open pit locally separating the lower Mafic-Intermediate Volcanic Succession from the Intermediate-Felsic Volcanic Succession. To the south the boundary of the Intermediate-Felsic Volcanic Succession is interpreted to be a fault striking 100°N to 110°N, which may be the western extension of the Quetico Fault. This fault is interpreted to possibly have some splays, one of which runs through the bottom part of the proposed open pit. To date, exploration drilling performed by RRR around and within the footprint of the proposed open pit has not confirmed the existence of these reactivated D1/D2 thrust faults or splays of the Quetico Fault (Macdonald 2012). Consequently all previously interpreted major faults/shear zones in the vicinity of the proposed open pit are considered conjecture.

Exploration drilling has revealed one brittle fault (the Eastern Fault; EFLT) that can be correlated across the proposed open pit (Figure 2-3). This is a north-south striking structure that dips at approximately 50° and is an approximately 50 to 100 m thick zone, comprising a relatively thin central zone of fault gouge with brittle deformation either side. This fault can be traced 2.3 km to the north of centre of the proposed open pit and 1.8 km to the south. It does not have a large displacement as the mineralized gold-bearing zones are not notably offset.

The 210°N to 230°N striking faults found to the west of the project area are interpreted to displace all structures and are likely the final major tectonic activity in the area (Figure 2-3). It is possible that the EFLT is contemporaneous with these late south-southwest - north-northeast trending faults.

2.3 Climate

2.3.1 Background

The summary of baseline climatic conditions provided herein, is based on published government sources, on-site studies conducted by KCB, and data from an onsite climate station monitored by RRR. Published sources of climatic information provide the best longer term record for planning and design purposes (Environment Canada 2012).

2.3.2 Temperature

The mean annual temperature and precipitation in the area of the RRGP site are best described by the 1971 to 2000 Canadian Climate Normals. Several climate stations are located within 30 km of the RRGP site; however, the Barwick, Ontario meteorological station (Station 6020559; Environment Canada 2012) has established Canadian Climate Normals and is currently active. The Barwick, Ontario Station is located approximately 20 km south of the RRGP site near Rainy River, Ontario.

The average daily temperature (from Canadian Climate Normals) at the Barwick station is 18.8°C in July, -15.9°C in January and 3.2°C annually.

KCB (2011) found daily average temperatures at the RRGP site from June, 2009 to January, 2011 closely approximated temperatures at the Barwick station 20 km to the south (correlation coefficient of 0.98). Barwick station was typically warmer than the site by 1°C to 2°C (KCB 2011).

2.3.3 Precipitation

On average, 695 mm of precipitation occurs annually, with 552 mm of this total falling as rain. Most precipitation occurs in the summer months and the Canadian Climate Normals show an extreme precipitation event of 152 mm of daily rainfall. The monthly mean precipitation is shown in Table 2-3.

2.3.4 Evapotranspiration

The Hydrological Atlas of Canada (1978) estimates the RRGP region experiences 600 to 700 mm/year of lake evaporation and 500 to 600 mm/year of evapotranspiration. KCB (2011) predicted average evapotranspiration in the RRGP area of likely between 315 and 560 mm/yr (45% to 80% of average annual precipitation). The KCB prediction was based upon regional information (National Resources of Canada Evaporation Atlas and streamflow stations) and data from the temporary climate station. Evapotranspiration varies temporally throughout the year, and spatially as surface water, soil, and vegetation conditions change across the Project area (KCB 2011).

The most applicable evaporation data for the RRGP site is available from the Atikokan Climate Station (Station 6020379) located approximately 175 km east of the RRGP. Annual lake evaporation recorded at this station is 560 mm/year.

2.4 Hydrology

The RRGP is located in the Rainy Lake drainage sub-basin (19,400 km^2) of the Rainy River watershed which covers an area of 55,100 km^2. The Pinewood River is a tributary of the Rainy

River which drains into Lake of the Woods and eventually into Hudson Bay. The Pinewood River is typically meandering and has an average channel slope of less than 0.1%. The proposed open pit is located approximately 43 km upstream along the Pinewood River from the confluence of the Pinewood River and Rainy River (Figure 1-2).

Local drainage systems are characterized by numerous small creeks draining to the Pinewood River. The creeks generally originate in rocky uplands, but also frequently originate from or pass through headwater wetland systems. Much of the area has been cleared for agricultural development, except where rock outcrop and wetlands occur. The natural drainage systems have been altered near the RRGP site through the development of agricultural drains (including the Cowser Drain and Teeple Drain) and ongoing beaver activities.

Regional hydrological data are available from four WSC stations: two on the Pinewood River and two on the much larger Rainy River. Additional Project flow data are also available for a number of the local creek systems. In addition to the WSC data, water level / flow data are being collected periodically by RRR from local creek systems.

The Rainy River WSC stations cover areas that are too large to derive flow condition data which could be applied to the RRGP site, other than for comparisons of long term, per unit area annual averages (i.e., mean annual runoff data) which are not affected by watershed catchment size, or whether or not the station exhibits regulated or natural flow. Data from the downstream Pinewood River station near Pinewood (station 05PC011) are more helpful, especially given the long term record for this station; but the data are limited by the fact that there are no winter data for this station and that the station was discontinued in 1998. The higher mean annual runoff values for this station (270 mm) compared with those of the other three stations is a reflection of the lack of winter measurements.

Data from the upstream Pinewood River station at Highway 617 (station 05PC023) are particularly relevant to the project area because they are on the same river system (the Pinewood River); data are collected year-round; the station is currently still active; and the watershed is comparatively small allowing for direct prorated data derivations for other site area watersheds (Figure 2-4). The only limitation to data records for this station is the comparatively short timeframe for data collection, from 2007 to present.

As with all of northern Ontario, peak stream flows occur in the spring, with a secondary smaller peak flow in the fall. Low flows occur in the winter under ice cover, and also vary, depending on the year, in the late summer or early fall. The average annual runoff for the region is approximately 230 mm, reflecting the progressively drier conditions towards the western portion of the province.

From the information available from the WSC EC gauging stations, the Pinewood River would be considered runoff dominated; however, there is an apparent attenuation to smaller precipitation events (KCB 2011). This indicates a short to medium term flow response to precipitation (interflow) related to a storage process associated with soils and near-surface deposits (peat, alluvium), but also obstructions to river flow such as beaver dams and elevated culverts. This interflow response is considered part of the Near-surface System (Section 3.4.2).

Overall the Pinewood River has very low flows under dry conditions, which has been approximately assessed by averaging gauged flow outside of clear recessions from runoff events for summer and winter periods. For the years of 2007 to 2010 average low flows have been estimated within the range 0.003 to 0.03 cubic metres per second (m^3/s) for summer conditions (June to September) and 0.01 to 0.1 m^3/s for winter conditions (November to February) for station 05PC023. These values suggest that groundwater recharge on average is very low within the Pinewood River watershed (excluding the Near-surface System) – likely lower than 10 mm/year, assuming an average of 0.03 m^3/s. The low flow conditions have been confirmed through an infield low flow survey (Section 3.4.1).

The downstream Pinewood River station 05PC011 has also gone to zero or near zero flows (monthly averages) in both the late summer/fall (about 10% of years), and in the late winter (about 25% of the years) for records spanning 1952 to 1998. The vast majority of the recorded zero flows for this station were prior to 1983, and may reflect, in part, the seasonal operating constraints of the system.

2.5 Aquatic Studies

As part of AMEC's aquatic baseline study (AMEC 2012b) for RRR, a physio-chemical and habitat characterisation was performed for the Pinewood River and its tributaries. Sediment grain size was consistently dominated by smaller particles (clay and silt) with some sample locations showing a greater proportion of sand and in some cases gravel. Larger particles (cobble and boulder) were atypical for the Project area, but were present at those locations exhibiting higher gradients.

Aquatic habitat was found to support a variety of small-bodied forage fish species. The tributaries of the Pinewood River support warm water fish communities and habitats, while the lower reaches of these tributaries at their confluence with the Pinewood River as well as the Pinewood River itself, support a warm / cool water fish community. These habitats are consistently affected by beaver activity and water temperatures are influenced in many locations, specifically in Clark and Marr Creeks, where watercourses have been manipulated to provide water sources for livestock. In these areas riparian vegetation had been reduced to grass and sedge species in lower densities which provide little cover for thermal refuge.

The creeks and streams that are present in the Project area do not support a commercial or recreational fishery, and a number including Marr Creek and Clark Creek are agricultural drains.

Overall the information from the aquatic studies is consistent with limited groundwater discharge occurring to the Pinewood River and its tributaries.

2.6 Water Wells

An assessment has been made of the occurrence of private water wells within a 10 km radius of the proposed open pit using the geographic location data from the Ministry of the Environment (MOE) water well information system and cross-referenced against more detailed water well records (WWR) requested and obtained from the MOE. Well locations were recorded by the MOE using Global Positioning Systems (GPS) after 2003 and are considered accurate. For wells recorded prior to 2003, schematics of the well location are only available. AMEC conducted a private well survey in 2012 which located 68 private wells within approximately 10 km of the proposed open pit.

The majority of the private wells were drilled to the base of a coarse granular material, presumed to be the Whiteshell Till located above the bedrock surface. These wells are usually in the range of 10 to 30 m below ground surface (mbgs). Where the Whiteshell Till is absent, the wells are completed in the bedrock and are much deeper, approaching 100 m depth. This indicates that the specific capacity of bedrock wells is much lower than those sourcing water predominantly from the Whiteshell Till.

Figure 2-5 shows the locations of the wells, with an indication of accuracy on a scale of one to three, with one being accurate (GPS/well survey), two moderately accurate (reasonable well location diagram in WWR) and three inaccurate (poor well location diagram in WWR). It is likely that these underestimate of the total number of wells as buildings within the 10 km buffer number approximately 130; the majority of these may be assumed to have a well for water supply. However, most of the well locations and buildings correspond with the main roads, particularly the Trans Canada Highway (71), which is 6 km east of the open pit. To the south and north of the proposed pit there are few roads and correspondingly few wells/buildings.

The majority of wells/buildings in close proximity to the open pit are located along Highway 600. Within a radius of approximately two km of the margins of the proposed open pit there are a possible 21 wells of which 18 have associated well records; the other are three buildings with no located well record nearby. The majority of these 21 wells are on RRR lands.

Table 2-1: Summary of Expected Project Area Overburden Geology

Age	Deposit*	Description*	Expected Occurrence in Project Area / Comments
Holocene	Muskeg	Peat and organic muck	Swamps, bogs, drainages
	Alluvium	Sand, silt, clay and organics	Along Pinewood River and tributaries
	Colluvium	Clay, silt, sand; blocks of bedrock	Isolated, at base of slopes
Late Wisconsinan	Sherack glaciolacustrine	Clay, silt and sand; minor gravel	May occur in areas below 355 masl
	Poplar River fluvial	Sand and gravel	Unknown
	Brenna glaciolacustrine	Clay, silt and sand; minor gravel	Widespread in areas below 375 masl
	Glaciofluvial (Keewatin)	Sand and silt; minor gravel	Isolated
	Whitemouth Lake Till (Keewatin)	Silty clay: silty, trace gravel, high plastic, carbonate in matrix, the gravel is mostly rounded and consists of limestone, shale and siltstone with minor shield rocks	Widespread / Should be the uppermost till in the area
	Wylie glaciolacustrine	Sand, silt and clay; often laminated or varved	Common / Often occurs between the two tills
	Glaciofluvial (Labradorean)	Sand, gravel and boulders; minor silt and till	Isolated / Exposed in gravel pit north of proposed open pit
	Whiteshell Till (Labradorean)	Silty to sandy till: low clay content, some cobbles which are mainly locally derived (volcanics)	Widespread sheet / Generally is the first till to occur above bedrock, with other glacial deposits occurring above
Pre-late Wisconsinan	Older Keewatin till	Sandy, clayey silt till	Not present to isolated / May occur in isolated bedrock lows, directly above bedrock
	Older Labradorean till	Sandy silt till	
	Old glaciolacustrine / glaciofluvial deposits	Sand, silt and clay; minor gravel	

* Modified from Bajc (2001)

Table 2-2: Summary of Project Area Bedrock Geology

Lithologic Units	Description	Structural relationships
Metasedimentary Rock	Containing graphite and sulphides, occurs above the Intermediate-Felsic Volcanic Succession in the project area	Highest unit in sequence
Intermediate-Felsic Volcanic Succession	Mixed Succession: intermediate (dacite-andesite) tuff horizons succeeded by mafic metavolcanics	Above Upper Felsic Succession
	Upper Felsic Succession – quartz-pyrhic rhyolite	Above Intermediate Succession
	Intermediate Succession - complex and heterogeneous unit comprising predominantly fine-grained pyroclastic deposits; composed of quartz eye dacite (crystal ash tuff), with subordinate ash horizons; lapilli tuffs, tuff breccias occur locally	Above Mafic-Intermediate Volcanic Succession
Mafic-Intermediate Volcanic Succession	Subaqueously deposited, fine to medium grained, massive and pillowed flows and flow breccias, with subordinate tuff-hyaloclastite and graphitic sediments, conformably overlying medium to coarse grained, massive flows (probably in part intrusive); a pyritic, heavy metal bearing graphitic horizon is often present at contact with overlying Intermediate-Felsic Volcanic Succession	Above Sabaskong batholith
Intrusives		
Diabase Dyke	Proterozoic diabase dyke, approximately 10 m thick with sub-vertical dip	Cross-cutting all units across the project site, striking at N135°
Felsic-Intermediate Intrusions	Abundant, anastomosing felsic-intermediate dykes transect the Mafic-Intermediate Volcanic Succession at oblique angles; the dykes range in thickness from decimeter to decameter-scale	Generally strike at N30°
Mafic-Ultra Mafic Intrusions	Narrow (sub-metre) mafic and possibly ultramafic intrusions have been frequently intersected in drill holes; in general, these bodies are aphanitic to fine grained and massive to weakly feldspar-phyric; lithologies identified include gabbro, pyroxene-phyric gabbro, pyroxenite and dunite	Concordant and discordant contacts occur and shearing at contacts is quite common
Blackhawk Stock	The marginal zone comprises coarse grained, unfoliated, pink-gray monzonite; the interior zone comprises grey, porphyritic granodiorite with significant positive topographic relief. Contact with metavolcanic rocks is generally unexposed – in the SE observed to be sharp and non-mineralized	Post dating main deformation events (D/F1, D/F2)

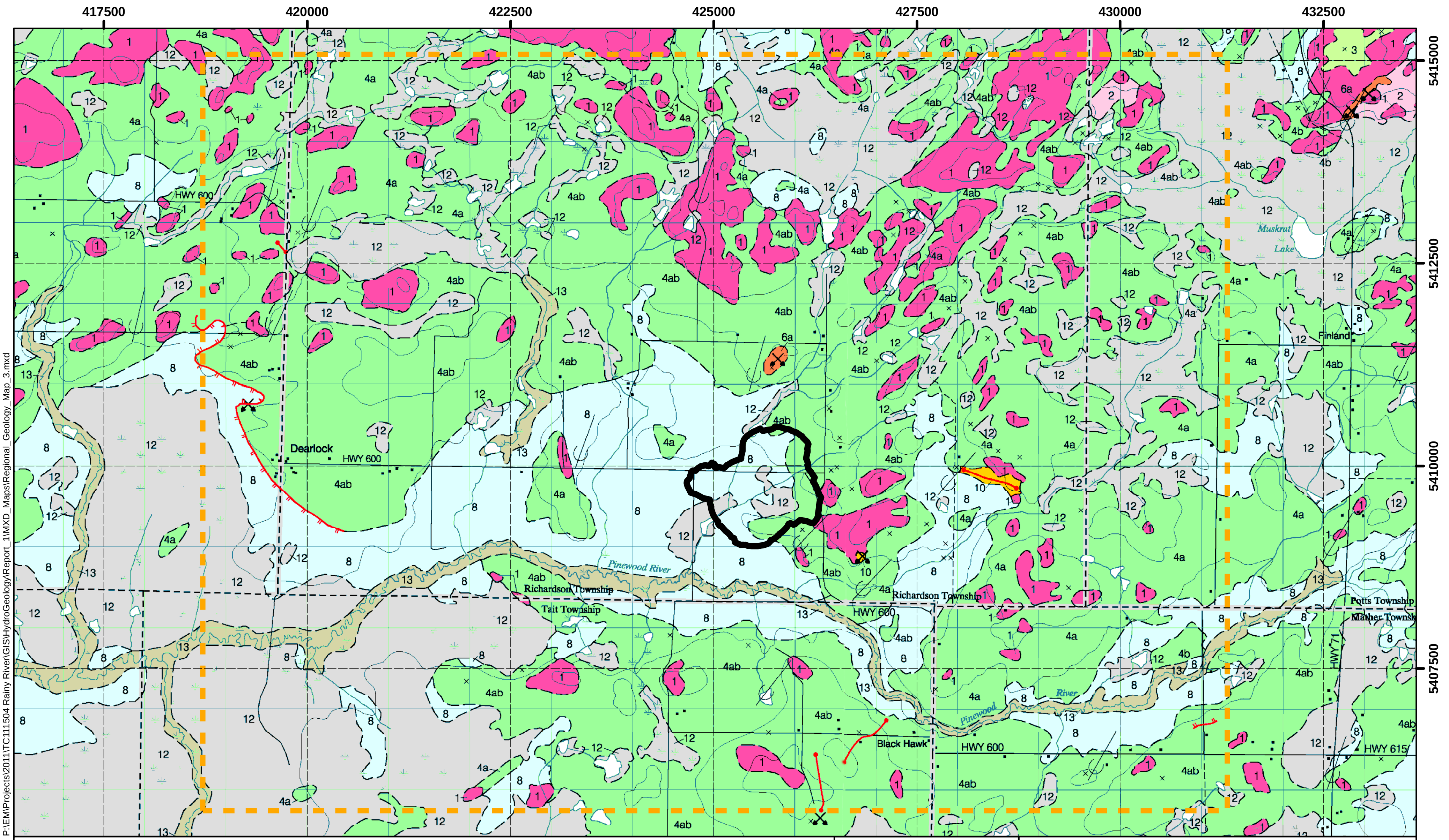
Summarized from Caracle Creek (2008) and SRK (2011)

Table 2-3: Environment Canada Station

Station	Location		Data Range	Catchment Area (km^2)	Derived Runoff (mm)*
	Easting	Northing			
05PC011	409290	5400720	1952-1998	461	215
05PC023	413017	5405653	2007-2010	229	200

*from AMEC (2012d)

P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\Regional_Geology_Map_3.mxd



LEGEND

PHANEROZOIC

CENOZOIC

QUATERNARY

RECENT

14	**Modern Beach and Eolian Deposits:** fine to very fine sand
13	**Modern Alluvial Deposits:** fine sand, silt and clay with detrital organic remains
12	**Swamp and Organic Deposits:** peat and muck

PLEISTOCENE

11	**Older Alluvial Deposits:** gravelly to pebbly, fine and medium sand, may contain organic remains; occurs in terrace remnants
10	**Glaciolacustrine Beach, Bar and Nearshore Deposits:** sand and gravel 10a Mainly sand 10b Mainly gravel
9	**Glaciolacustrine Coarse-Grained Deposits:** fine to very fine sand, minor silt and clay
8	**Glaciolacustrine Fine-Grained Deposits:** silt and clay, minor sand
7	**Glaciofluvial Outwash Deposits:** sand and gravel; noncalcareous^b 7a Fine to medium sand 7b Sandy gravel and gravel
6	**Glaciofluvial Ice-Contact Stratified Deposits:** sand, gravel and boulders, minor till 6a Noncalcareous deposits^b 6b Calcareous deposits^c
5	**Marchand Till^c:** pebbly, silty sand to sandy silt till; contains predominantly distally derived rock types and high matrix carbonate 5a Subcompact to compact, massive till 5b Substratified, gritty, pebbly silt till interbedded with glaciolacustrine silt and clay
4	**Whitemouth Lake Till^c:** clast-poor, silty clay to clayey silt till; contains predominantly distally derived rock types and high matrix carbonate 4a Subcompact to compact, massive till 4b Substratified, gritty, pebbly silt till interbedded with glaciolacustrine silt and clay
3	**Whiteshell Till^b:** silty sand to sandy silt till; contains predominantly local and semi-local rock types and low matrix carbonate
2	**Bedrock–Drift Complex:** thin, discontinuous drift cover; contains areas of drift greater than 1 m in thickness, although not large enough to delineate at the scale of this map

PRECAMBRIAN

1	**Bedrock:** exposed or with very thin drift cover

Wave-cut notch or shore bluff

Beach ridge or bar

General Project Area

Approximate Open Pit Outline

0 1 2 4 6 8 Kilometres

NOTES:
-This image was extracted from the Quaternary Geology Fort Frances-Rainy River Area report, published by the Ontario Geological Survey, 2001

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

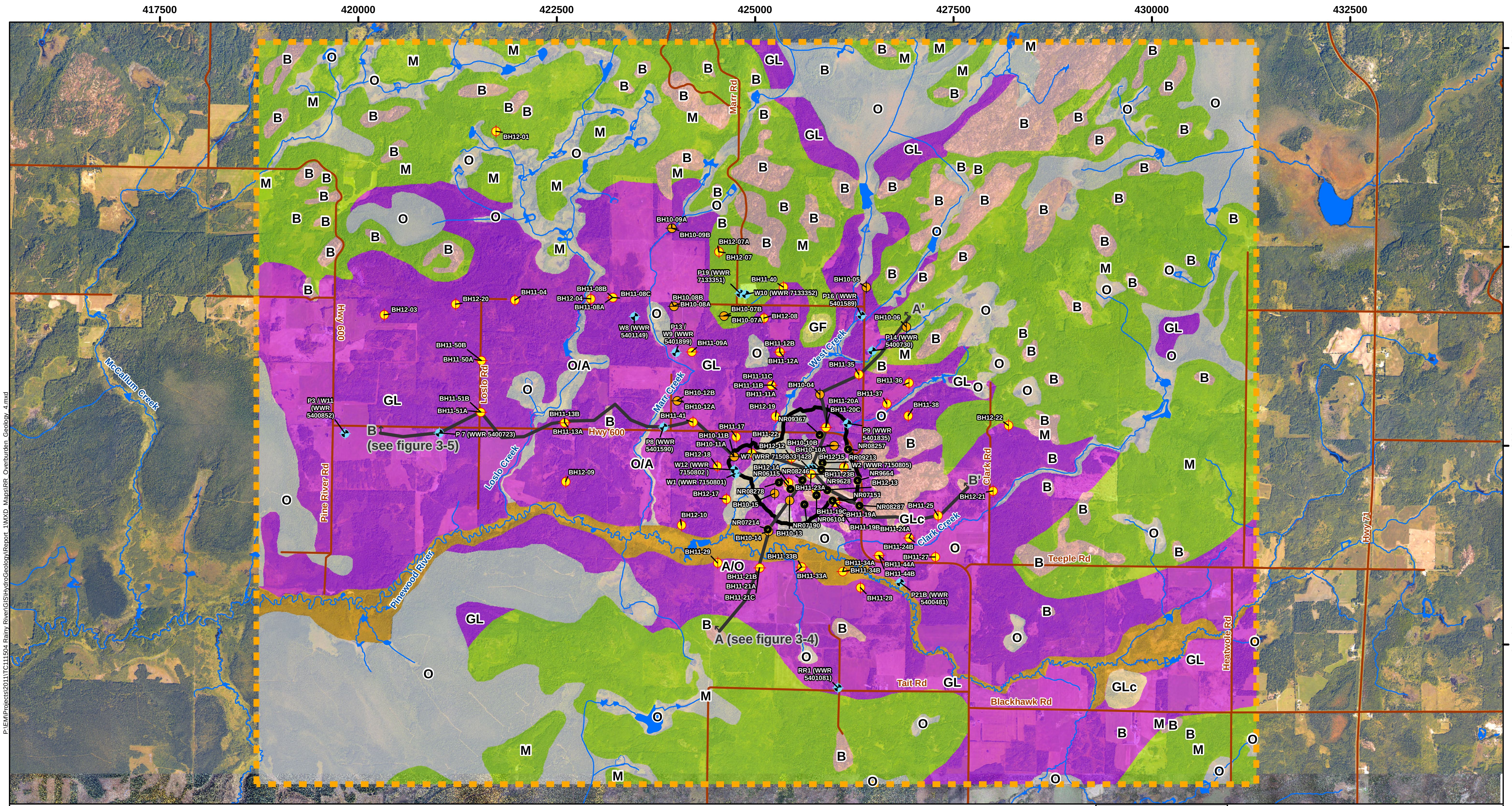
Regional Geology Map

PROJECT N^o: TC111504

FIGURE: 2-1

SCALE: 1:65,000

DATE: March 2013



P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\RR_Overburden_Geology_4.mxd

LEGEND

- ▭ General Project Area
- ⬭ Approximate Open Pit Outline
- ╱╲ Cross Section
- ╱╲ Roads
- ∼ Watercourses

Monitoring Wells (Labelled with ID on map)

- ● RRR Long Term Monitoring Wells (open bedrock holes)
- ⊕ KCB 2010 Single Piezometer
- ⊕ KCB 2010 Nested Piezometer
- ⊕ AMEC Single Piezometer
- ⊕ AMEC Nested Piezometer
- ⊕ Private Wells on RRR Property

Quaternary Geology

O	Organic: peat and organic clay; includes bogs, fens, marsh, ponds and standing water along poorly defined creeks.
A	Alluvium: fine sand, silt, and clay; deposits of Pinewood River and tributaries
B	Bedrock: exposures or with very thin cover
GL	Glaciolacustrine: clay, silt, and minor sand; glacial lake bottom
GLc	Glaciolacustrine Coarse Grained: sand and gravel; beach, bar and, near-shore deposits
GF	Glaciofluvial: sand, gravel, and boulders, minor till; deposited from glacial meltwater in ice-contact environment.
M	Moraine: glacial till with some interbedded glaciolacustrine clay and silt; inferred to mostly Whitemouth Lake Till, clay rich with carbonate rocks and matrix.

0 1 2 4 6 8 10 Kilometres

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR
- Township and watercourse data extracted from Land Information Ontario, MNR
- Surficial geology based on air photo analysis and review of published geology maps. Surficial materials may vary from those indicated

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

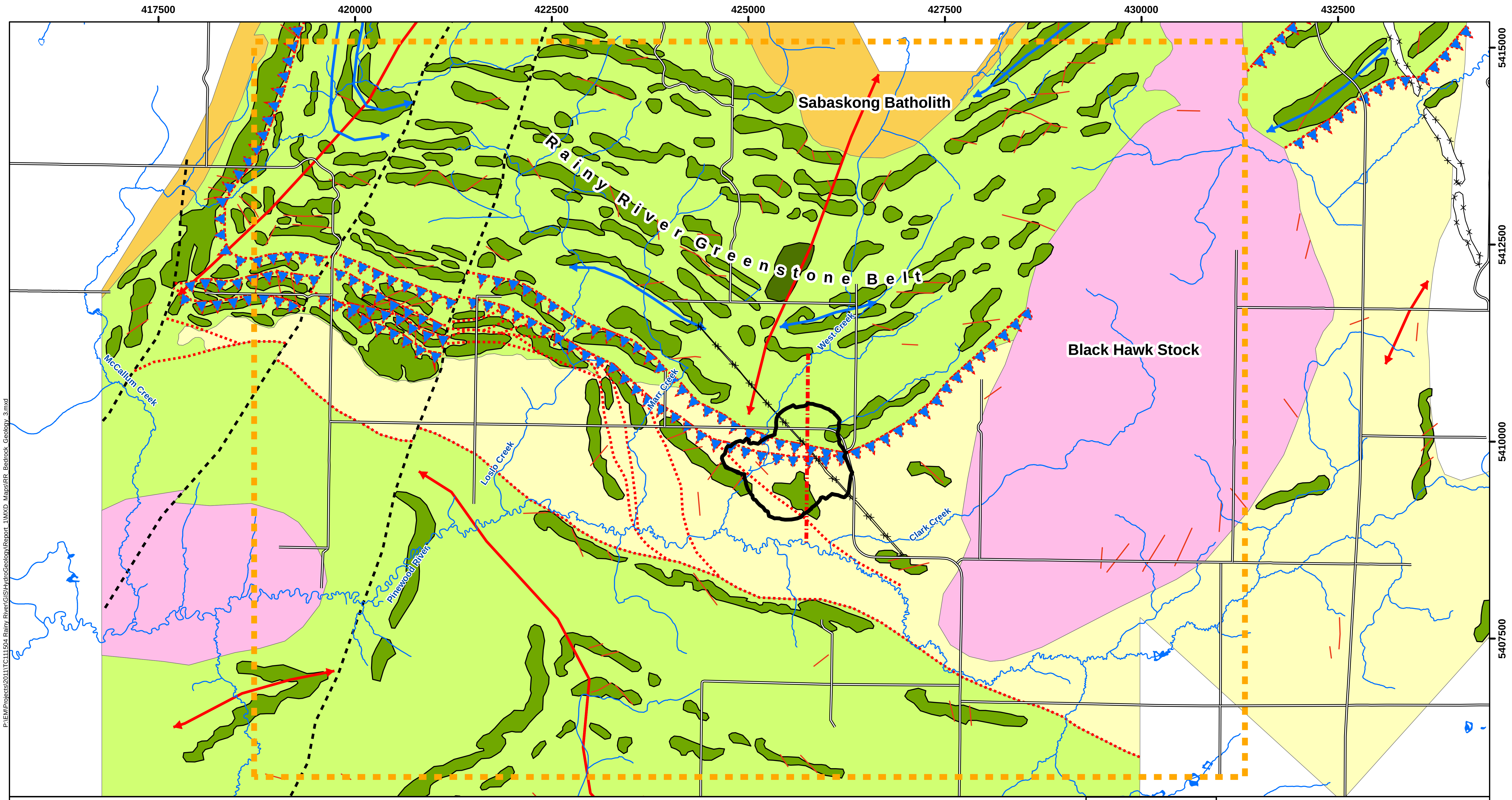
Regional Overburden Geology

PROJECT N^{o}: TC111504

FIGURE: 2-2

SCALE: 1:46,000

DATE: March 2013



P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\RR_Bedrock_Geology_3.mxd

LEGEND

- General Project Area
- Approximate Open Pit Outline
- Roads
- Watercourses

Regional Structures

- Dyke
- F1 fold axis
- F2 fold axis
- Conjectural Faults
- Reactivated D1/D2 Thrust
- Late Faults
- Minor Faults
- EFLT Fault

Regional Lithology

- Gabbro
- Early tectonic granite
- Interflow Iron Formation & mafic flows
- Mafic-Intermediate volcanics
- Intermediate-Felsic volcanics
- Late tectonic granite
- No Data

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR

Datum: NAD83
Projection: UTM Zone 15N

0 1 2 4 6 8 10 Kilometres

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

Regional Bedrock Geology

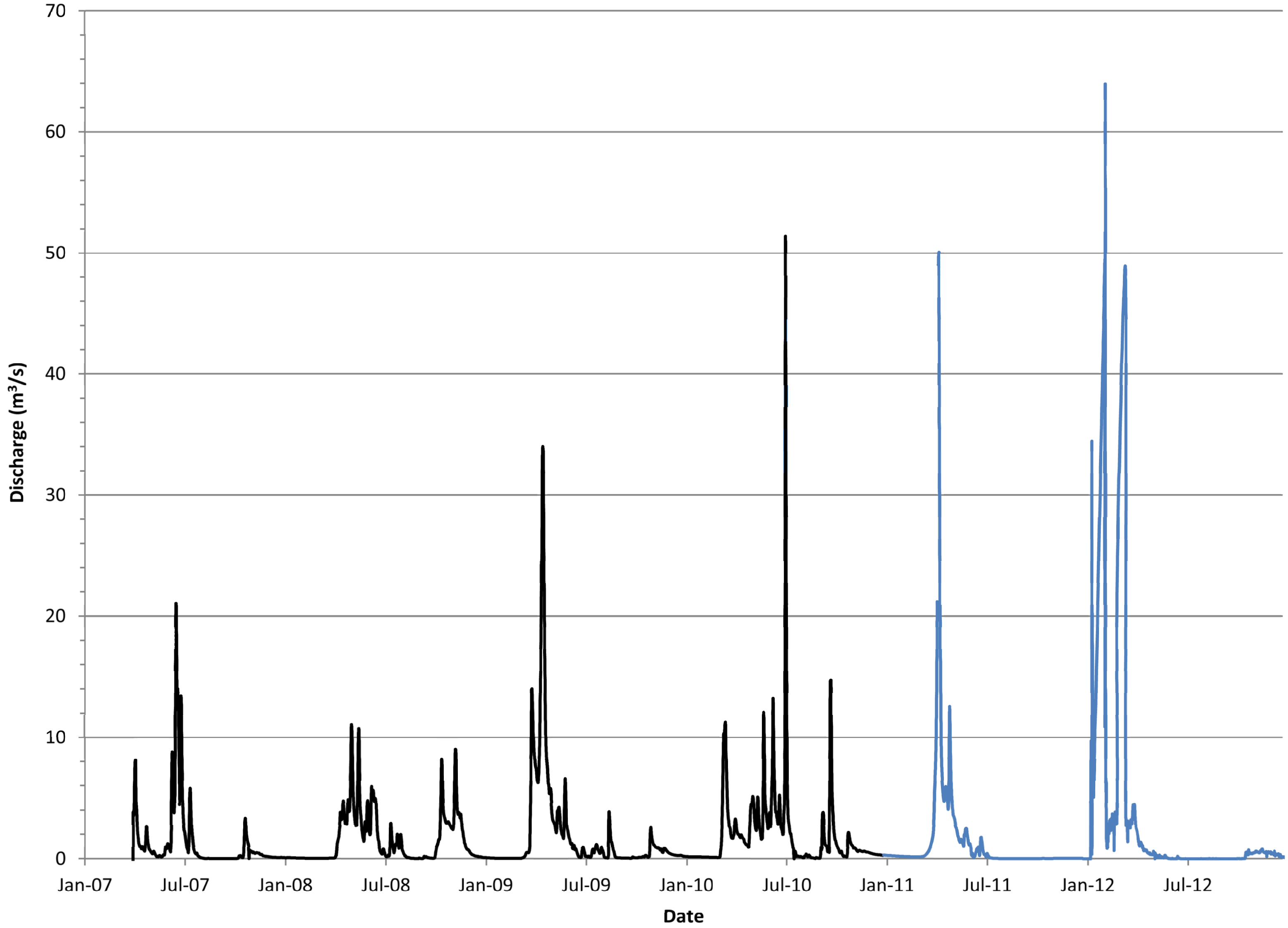
PROJECT N°: TC111504

FIGURE: 2-3

SCALE: 1:46,000

DATE: March 2013

P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\Daily_Flow_PinewoodR_EC_05PC023_4.mxd



LEGEND

— 05PCO23 - Daily Discharge Rate (m3/s)

— 05PCO23 - Provisional Daily Discharge Rate (m3/s)

NOTES:
-

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

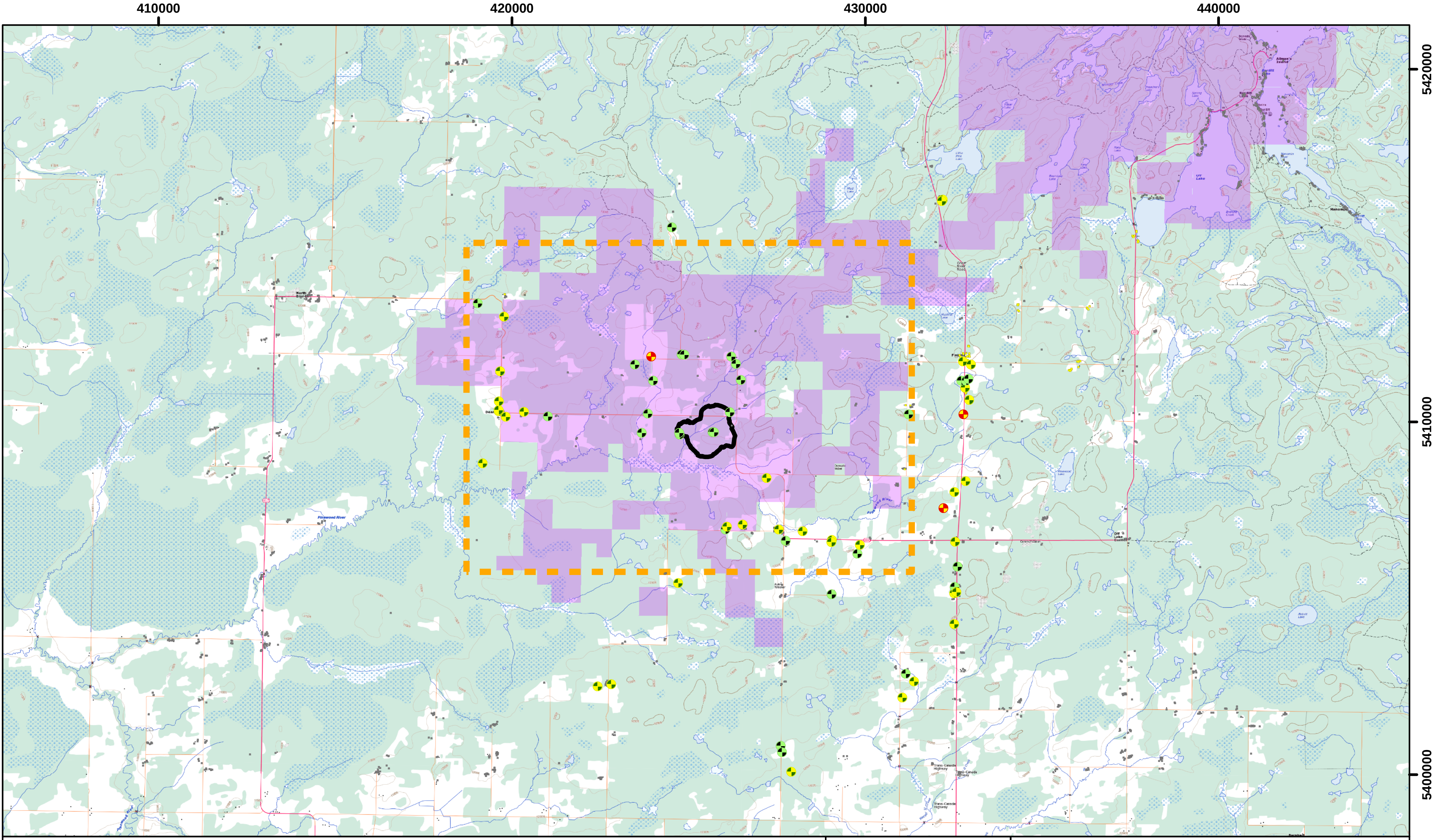
Daily Flow in the Pinewood River at Environment Canada Station 05PC023

PROJECT N^o: TC111504

FIGURE: 2-4

SCALE:

DATE: March 2013



P:\EMProjects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\PrivateWater_Wells_6.mxd

LEGEND

- ▭ **General Project Area**
- ○ **Approximate Open Pit Outline**
- 🟪 **RRR Active Dispositions/Claims**

- · Residence-House
- · Building - Unknown Use

Private Well Locations

- ● **Very accurate location (GPS/private well survey)**
- ● **Moderately accurate (accurate MOE WWR location map)**
- ● **Not accurate (inaccurate MOE WWR location map)**

NOTES:
- Land tenure information derived from MNDM Claimap service, data extracted on May 8, 2012
- RRR land current as of Aug. 2012
- Background topographic map extracted from Topograma, Geogratis, NRCan 1:50k DRG

Datum: NAD83
Projection: UTM Zone 15N

0 2.5 5 10 15 20 Kilometres

N W E S

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

Private Water Wells

PROJECT N^{o}: TC111504

FIGURE: 2-5

SCALE: 1:150,000

DATE: March 2013

3.0 HYDROGEOLOGICAL ENVIRONMENTAL BASELINE

3.1 Background and Approach

The hydrogeological environmental baseline condition for the RRGP has been determined through a number of investigations and including most recently those completed by AMEC in 2011 to 2012. Data collected prior to 2011 (KCB 2011) are summarized herein as relevant. Data collected by AMEC are described in more detail with detailed data and/or analyses catalogued in the appendices.

Six hydrostratigraphic units, consisting of overburden and bedrock units have previously been identified in the project area: peat, recent alluvium, Whitemouth Lake Till (Keewatin origin) and glaciolacustrine sediments (Lake Agassiz Sediments), Whiteshell Till (Labradorean origin), competent bedrock and fractured bedrock (KCB 2011). These hydrostratigraphic units have been reorganized into a set of units that are relevant to explaining the groundwater - surface water interaction in the Pinewood River watershed, the artesian conditions that occur at lower elevations and how discharge will occur to the proposed open pit. The proposed hydrostratigraphic units are shown in Table 3-1 listed according to increasing depth. The rational for this hydrostratigraphic subdivision is developed over Sections 3.2 to 3.4 and summarised in Section 3.6, where the hydrogeological conceptual model is outlined.

3.2 Hydrogeological Investigations and Testing for the RRGP

Shallow (overburden and the Shallow Bedrock; AMEC 2012a) and deep (bedrock; AMEC 2012c) investigations have been conducted by AMEC within the project area. These two AMEC investigations are described separately below as they consider largely different hydrostratigraphic units (i.e., different parts of the groundwater flow system) and also different methods of testing (mainly slug testing in shallow piezometers for the overburden and Shallow Bedrock as opposed to packer testing in boreholes for the bedrock), which may produce some systematic bias in the data. There is some overlap as both programmes have undertaken testing on the Shallow Bedrock. Where relevant, data are summarised from KCB (2011) to give a comprehensive understanding of the hydraulic character of the proposed hydrostratigraphic units for the project area.

3.2.1 Overburden and Shallow Bedrock

As part of the geotechnical and hydrogeological site investigations for the RRGP, 51 boreholes were drilled between December 2011 and April 2012 (AMEC 2012a). Boreholes associated with this investigation are all named BH11-XX. Piezometers were installed at 30 of these locations for groundwater level monitoring. These are in addition to the holes / tests completed previously by KCB. The locations of the boreholes with piezometers are shown on Figure 2-2.

The piezometers were constructed with 2.54 cm inner diameter PVC piping and generally had 1.5 m long screens. Up to two piezometers were installed at each borehole location with injected grout seals between installations and offset holes used for additional piezometer installations. The piezometers are identified by the borehole number and the suffix A, B or C (deepest through shallowest, respectively). Piezometers were typically installed in one of three geological units which included the Shallow Bedrock, the Whiteshell Till and the Whitelake Mouth Till. Lithological logs and construction details for these piezometers are provided in Appendix A.

Slug testing of the AMEC piezometers was conducted between June 8 and 16, 2012. Not all the sites were accessible due to access timing limitations, flooded conditions, or in some cases, wells had been damaged since establishment and were not amenable to testing. In total hydraulic conductivity was estimated for 29 piezometers by slug testing. A further three piezometers were tested, but proved to be too conductive for a reliable estimate using a slug testing methodology.

Where it was possible to do so, rising-head slug tests were conducted by removing water using a Waterra Inertia Pump with 13 millimetre (mm) diameter tubing. Changes in groundwater levels were recorded using a transducer and manual water levels at regular intervals. These slug tests were analyzed using the Bouwer and Rice (1976) method. The results of the slug testing are summarized in Table B-1 (Appendix B). Print outs of the analyses using AQTESOLV software (Duffield 2007) are also presented in Appendix B.

Where artesian conditions existed, an extension was placed onto to the well casing in order to measure the height of the water column above grade. The hydraulic conductivity in these flowing artesian wells was calculated using a constant head test analysis (Powers et al. 2007), by measuring the head difference between the static water level and the height of the point of discharge and the flow rate. The latter was calculated by noting the time required to fill a container of known volume. The results of these tests are also presented in Table B-1, with the basic data for these tests presented in a following table in Appendix B (Table B-2).

Summary statistics of the results from the AMEC piezometers, along with those of KCB (2011) are provided in Table 3-2 according to the proposed hydrostratigraphic units used in the groundwater model. These results are considered below according to these hydrostratigraphic units.

Near-surface System

The Near-surface System comprises a heterogeneous assemblage of sediments that includes peat, fine to coarser-grained material associated with the Pinewood River alluvial sediments and weathered clay/till and sand at the top of the Pleistocene Aquitard.

There is one AMEC data point for the Near-surface System, which comprised silty sand and gave a hydraulic conductivity result of 1.4E-06 meters per second (m/s). KCB (2011) undertook slug testing on seven piezometers that were all within 0.5 m of surface and described as being in top soil. These gave a geometric mean of 3.6E-07 m/s with a minimum of 5.6E-08 m/s and a maximum of 3.6E-06 m/s. The data provided above give an indication of the hydraulic conductivity of the finer-grained material (weathered silt, clay and sand from either the Whitemouth Lake Till or Brenna Formation) associated with the Near-surface System.

The hydraulic properties of the other near-surface strata have been assessed by reference to project area geology data and literature. Peat can have very high hydraulic conductivities in the range 1E-04 to 1E-02 m/s, but this is generally only in the top 10 to 20 cm where it is highly weathered. Below this depth it decreases rapidly to within the approximate range of 5E-06 to 5E-05 m/s as indicated by the research of Quinton et al. (2008) on peat hydraulics in Canadian boreal conditions.

Alluvium deposits can be very heterogeneous with grain sizes varying from silt/clay to gravel. The current indications are that the Pinewood River alluvium is relatively fine grained as indicated by borehole data (Appendix A; logs of BH11-29, BH11-21, BH11-33 and BH11-24). Stream bed sediment samples of the Pinewood River are predominantly of clay and silt with some sands in locations (AMEC 2012b). Assuming that grain sizes are predominantly silt to fine sand, hydraulic conductivities in the range of 1E-08 to 1E-04 m/s are expected (Freeze and Cherry 1979).

Whitemouth Lake Till (Pleistocene Aquitard)

All of the AMEC data from the Pleistocene Aquitard are for strata interpreted as Whitemouth Lake Till (10 results), which largely fall within the range 1E-08 to 5E-07 m/s. There is one anomalous high value at 1.8E-05 m/s (BH11-24B), which suggests possibly a faulty completion of the piezometer. This data point is excluded from the statistics shown in Table 3-2. Overall the data collected by AMEC are very consistent in terms of geometric mean and range with the data collected by KCB (Table 3-2). The geometric mean of the combined data is 3.4E-08 m/s.

Overall the vertical hydraulic conductivity of the Pleistocene Aquitard would be expected to be on the order of 1E-08 m/s or possibly lower, particularly where there are glaciolacustrine clays from the Wylie Formation below and Brenna Formation above the Whitemouth Lake Till.

In addition to the slug testing, KCB (2011) also undertook dissipation tests in cone penetration test holes, which give an estimate of the horizontal hydraulic conductivity. These are predominantly for the Pleistocene Aquitard and have been summarized in Table 3-2 to allow comparison with the slug testing data. The results of the dissipation tests are systematically an order of magnitude lower than the slug test results. There is possibly a sampling bias as most of the cone penetration test results are from the upper glaciolacustrine clay (likely the Brenna Formation). Nevertheless KCB (2011) report that only 18 of the 60 tests undertaken reached the

50% dissipation of excess pressure required to produce an order of magnitude estimate of hydraulic conductivity. The others did not produce a meaningful result because of very low dissipation rates (i.e., likely very low hydraulic conductivity). Given the very small-scale nature of the dissipation tests cone penetration test holes it also possible that these could underestimate the bulk hydraulic conductivity by not taking account of layers of coarser material within the Pleistocene Aquitard.

Whiteshell Till (Pleistocene Lower Granular Deposits)

The geometric mean of the hydraulic conductivity of the Whiteshell Till is 8.8E-06 m/s based on the AMEC slug testing data (five results). This is consistent with the slug testing data from KCB (2011), which gave a geometric mean of 1.7E-05 m/s (Table 3-2). There are no systematic spatial variations in hydraulic conductivity notable from these data.

KCB (2011) also performed five pumping tests, which gave results that overall are approximately one half an order of magnitude higher based on the geometric mean of slug test results (Table 3-2). The difference between these two data sources is likely systematic associated with the scale of measurement. Slug tests are likely to be biased by smaller scale heterogeneity and are not an effective test when more permeable units are encountered (the response is too fast to effectively analyse the test, which was the case for one piezometer; BH11-38). The pumping tests are likely to sample the larger-scale hydraulic behaviour of the unit. For the purposes of this study, where the effects of large-scale dewatering is considered, a best estimate value of 5E-05 m/s is considered most appropriate for the Pleistocene lower granular deposits (PLGD) which is consistent with the pumping test data from KCB (2011).

Shallow Bedrock

The AMEC slug testing was performed on bedrock piezometers located within 10 m of the bedrock surface, with the exception of BH11-34A, for which the piezometer was located within 20 m of the bedrock surface. These piezometers can all be reliably considered as measuring groundwater conditions in the Shallow Bedrock, where elevated hydraulic conductivities may be expected due to fracturing and possibly weathering. Highly fractured and sometimes weathered bedrock has been recorded close to the bedrock surface in a number of boreholes (Appendix A; logs of BH11-04, BH11-12, BH11-16, BH11-17, BH11-20, BH11-21, BH11-33, BH11-34, BH11-36, BH11-37, BH11-38, BH11-41, BH11-44, BH11-49 and BH11-51).

The geometric mean of the Shallow Bedrock based on thirteen results is 4.1E-07 m/s, but the minimum and maximum estimated values span five orders of magnitude. The variability of the hydraulic conductivity is most likely associated with the heterogeneity (degree of weathering and fracturing) although there could be some bias associated with the testing methodology, particularly at the extremes where the test results are harder to interpret. There are no systematic spatial variations in hydraulic conductivity notable from these data. Two of the tests could not be analyzed because of a very fast response due to increased permeability. If these values are assumed 1E-04 m/s, the geometric mean of the AMEC data would be 8.6E-07 m/s.

KCB (2011) also performed slug-testing on the bedrock, but the majority were in open holes with borehole depths ranging from 80 to 760 m which had overburden cased. Although these boreholes are deep, they are of relevance to the Shallow Bedrock as it may be expected that the hydraulic conductivity would be dominated by the fractured / weathered Shallow Bedrock. The geometric mean of the data from open holes is 4.4E-08 m/s, which is an order of magnitude lower and has a much narrower range than the slug testing data obtained by AMEC from dedicated Shallow Bedrock piezometers. As the estimated hydraulic conductivity is averaged over the full length of the borehole, two observations can be made relating to the differences between these two data sets:

- The lower hydraulic conductivities in the deep open holes suggest there is a decrease overall with hydraulic conductivity with depth; and

- The much narrower range of hydraulic conductivities suggests that the influences of discrete transmissive fractures are averaged out for estimates of hydraulic conductivity over larger length-scales.

3.2.2 The Intermediate and Deep Bedrock

The physical characteristics of the intermediate and deeper groundwater flow system has been assessed as part of the AMEC (2012c) geomechanical field program completed between January and April 2012. This program consisted of:

- Seven inclined NQ-sized holes (300 to 400 m long) totaling 2,405 m of drilling to assess the proposed open pit; and

- Three inclined NQ-sized holes (500 to 750 m long), totaling 1,990 m of drilling to assess the proposed underground mine beneath the open pit (Figure 3-1).

The data collected by the geomechanical program provide information on the local geological structure around the proposed pit and underground mine that is of relevance to the hydrogeological assessment of the bedrock. The cores of all these boreholes were oriented and geomechanically logged (AMEC 2012c). A summary of the boreholes is provided in Table 3-3, including the main lithotypes identified.

The rock mass quality based on the rock quality designation (RQD) was assessed to be good to excellent and dominantly above 90%. The intervals with rock identified as shear, breccia or fault zone (SHR in Table 3-3; <1% overall of rock encountered) sometimes have low RQD. The main example is BH12-UG-02, which has values as low as 10% close to bedrock surface (0 to 8 m below bedrock surface (mbbs; approximately 55 to 63 m depth down hole). At greater depths these zones of deformation tend to have RQDs above 90%, the main exception being the intersection of the EFLT in BH12-OP-07, which is discussed further below.

The hydraulic conductivity has been assessed with 61 packer tests performed in six of the 2012 inclined and NQ-sized geomechanical holes. Rising head tests were performed in four open pit holes (BH12-OP-01, BH12-OP-03, BH12-OP-05 and BH12-OP-07), as well as constant head and falling head tests in two underground holes (BH12-UG-02 and BH12-UG-03, respectively) using single packer equipment. Packer testing was undertaken at the bottom of the boreholes during its advance. The intervals usually ranged from 18 to 21 m. The main exception is one underground hole (BH12-UG-03), where below 300 mbgs packer intervals ranging from 60 to 201 m were used. The Hvorslev solution was used to estimate hydraulic conductivity of all rising and falling tests. The results for most tests produced linear curves. Where this was not the case, curves were fitted within the recommended normalized head range for the Hvorslev solution (0.2 to 0.3; Butler 1998). Constant head tests were analysed using an equation outlined in Power et al. (2007). The analysis and detailed results of these tests are given in Appendix C.

Figure 3-2 summarizes the packer test results, which are plotted according to the depth below the bedrock surface. Based on the packer tests performed, rock hydraulic conductivity values range from 2.4E-10 m/s to 1.6E-06 m/s. The highest hydraulic conductivity value was found in BH12-OP-03 for the packer interval between 9 and 29 mbbs; the overburden at this hole is approximately 8 m thick.

There is an overall decrease in hydraulic conductivity with depth relative to top of bedrock (Table 3-4; Figure 3-2). This is demonstrated by calculating the geometric mean for depth intervals relative to bedrock surface based on the centre point of the packer interval. The depth intervals overlap to avoid significant bias associated with the choice of interval boundary. The four measurements where the centre of the packer interval is within 25 mbbs has a geometric mean of 1.5E-07; i.e., approaching one order magnitude lower than the determinations from slug testing of the Shallow Bedrock, which were mostly within 10 mbbs (Section 3.2.1). With depth below bedrock surface the geometric mean of the hydraulic conductivity becomes progressively lower until it remains more or less constant at just below 2E-08 m/s below 50 mbbs.

The comparison between the packer testing data and slug testing data suggests that the highest hydraulic conductivities are associated with fractured/weathered bedrock within 10 to 20 mbbs. Between 20 and 50 mbbs, the hydraulic conductivity drops rapidly and approaches 1E-08 m/s at depths greater than 50 mbbs. This is consistent with the data obtained from slug testing deep open boreholes reported in KCB (2011; summarized in Table 3-2).

It should be noted that the geometric mean can underestimate the bulk hydraulic conductivity, particularly if transmissive fractures occur over length scales significantly greater than the typical testing interval (i.e., hundreds to thousands of metres rather than tens of metres) and are well connected. This is illustrated by a comparison with the arithmetic mean (Table 3-4), which would equally weight all measurements implying larger length scales and a higher degree of connectivity for the more transmissive fractures. Overall, the arithmetic means are generally half an order of magnitude higher. There is a similar trend of decreasing hydraulic conductivity with depth, with the exception of the intervals below 100 mbbs, which is influenced by some relatively high hydraulic conductivities (greater than 1E-07 m/s) at depth (greater than 150 mbbs) estimated for two boreholes:

- BH12-UG-02, one interval: 5.5E-07 m/s between 196 and 214 mbbs (approximately 257 to 276 m down hole), lithology within, above and below interval comprises mafic metavolcanics with RQDs at 94% or greater; and

- BH12-OP-05, two intervals: 2.3E-07 m/s between 172 and 191 mbbs (approximately 226 to 247 m down hole), lithology within, above and below interval consists of felsic tuff with RQDs at 97% or greater; and 2.2E-07 m/s between 210 and 239 mbbs (approximately 268 to 300 m down hole), lithology at the top consists of a mafic dyke, but otherwise within, above and below interval consists of felsic tuff with RQDs at 98% or greater.

In summary, these elevated estimates of hydraulic conductivity do not occur within zones of notable fracturing or faulting and it is assumed that they are relatively localized. They may occur where the effective apertures of the joints are slightly larger than normal.

The north-south striking, eastward dipping EFLT has been mapped across the proposed open pit with a strike length of at least 4 km (Section 2.2.6). BH12-OP-07 (Figure 3-1) was drilled inclined towards the south-southwest to intersect the EFLT to assess rock conditions and the hydraulic conductivity across this fault. Two fault zones were identified in this borehole at 33 and 83 mbbs, respectively (approximately 115 and 183 m down hole with RQDs at 60 to 83% and 67%, respectively) and a marginal increase in hydraulic conductivity was estimated with depth (Figure 3-2). The hydraulic conductivity along BH12-OP-07 does not however, exceed 3E-08 m/s and would not be regarded as unusually high for the project area.

KCB (2011) performed two packer tests at boreholes for intervals that were noted to be fractured that are located within the footprint of the proposed open pit, but away from the EFLT (Figure 3-1):

- KCBL-101, one interval: 3.3E-07 m/s between 43 and 63 mbbs (approximately 56 to 76 m down hole), lithology within, above and below interval comprises metavolcanics with RQDs in the range 55 to 92; and

- KCBL-104, one interval: 3.3E-06 m/s between 20 and 22 mbbs (approximately 59 to 61 m down hole) – lithology within, above and below interval comprises metavolcanics with an RQD of 70.

These data are at relatively shallow depths below the bedrock surface. The elevated hydraulic conductivities are consistent with increased weathering and fracturing that is expected to occur closer to the bedrock surface, as indicated by the AMEC slug and packer testing data.

In summary, the slug and packer testing undertaken by AMEC on the bedrock has found no consistent relationship between the degree of brittle deformation and hydraulic conductivity. The only major fault structure (EFLT) that can be correlated across the proposed open pit does not have estimated hydraulic conductivities that are above average based on measurements to date. In the absence of data identifying any significant transmissive features with length scales of over hundreds to thousands of metres, the slug and packer testing data of the bedrock support a decrease of hydraulic conductivity with depth as indicated by the geometric mean of the data. This provides the rational for the threefold subdivision of the bedrock, based approximately on depth below bedrock surface (Section 3.6).

3.3 Groundwater Level and Flow Conditions

3.3.1 Overview of Groundwater Level Monitoring

There has been ongoing groundwater monitoring within the project area since August, 2009. Open bedrock boreholes have been monitored since August 2009 and geotechnical boreholes with piezometer installations constructed by KCB have been monitored since September, 2010. A total of 26 locations are being monitored, 6 of which have multilevel piezometers (deepest - labelled A to shallowest - labelled B, with some exceptions though). Monitoring has been conducted weekly to monthly by RRR, although monitoring at some of the open bedrock boreholes monitoring has been discontinued. Twenty-one locations continue to be monitored at present. Appendix A (Table A-1) presents the piezometer details and a representative range of measured groundwater levels in the open bedrock holes and KCB piezometers. Hydrographs for these monitoring installations are presented in Appendix D.

As discussed in Section 3.2.1, AMEC has added 30 piezometer sites to the groundwater level monitoring network of which 14 are nested piezometers (Appendix A, Table A-1). As monitoring has only recently started on these piezometers, no hydrographs are presented. In addition to these sites, AMEC has also started monitoring at 16 existing private wells on RRR lands. Appendix A (Table A-1) presents data for all monitoring sites for a survey undertaken in June, 2012, which provides the most extensive data set spatially for the project area.

Appendix A, Table A-1 also shows data for September, 2009, 2010 and 2011 and March, 2011 as a comparison, which shows that groundwater levels during the June, 2012 survey are low. This is also evident from the groundwater level hydrographs (Appendix D), which show a notable decline during 2011 into 2012 (see Section 3.3.4 for a fuller discussion of these data). Given the wide coverage of the June, 2012 data, these provide the best available data set for the analysis of the regional and local, groundwater level and flow conditions (Section 3.3.2), including the patterns of artesian conditions and vertical gradients (Section 3.3.3). The climate conditions of 2012 have, however, been taken into account when interpreting these data.

3.3.2 Regional and Local Groundwater Flow Directions

The regional groundwater flow has been previously described by KCB (2011; Figure 6.2). Groundwater flow approximately follows topography with a groundwater divide to the northwest, approximately coincident with the watershed boundary of the Pinewood River. Groundwater flow is generally towards the west in the Pinewood River watershed.

There are some variations from the groundwater level data collated from previous studies (KCB 2011) and ongoing groundwater level monitoring by RRR, and the new piezometers installed and monitored by AMEC. Figure 3-3 shows a contour map of the groundwater levels from the bedrock and/or the PLGD for June, 2012. Groundwater flow is from the higher ground towards the Pinewood River corridor. It should be noted that two of the private wells (P14 and P16) are thought to be being pumped and do not adhere to the contours.

Horizontal gradients are relatively steep on higher ground approaching 0.01, but become more subdued in the lower lying areas decreasing to around 0.003 in the area. It is particularly notable as this pattern has prevailed during the dry conditions encountered in 2011 and 2012. The change in horizontal gradient is a strong indication that as the groundwater flows from the higher ground to lower elevations there is flow from the Shallow Bedrock to a more permeable hydrostratigraphic unit. The most likely explanation is that recharge water flows into overlapping and more permeable Whiteshell Till or other granular material (i.e., the PLGD). The pattern is consistent with the results from hydraulic testing, which shows the Whiteshell Till having at least an order of magnitude higher hydraulic conductivity overall than the Shallow Bedrock (Section 3.2.1). This is an indirect, but reasonable indication that the PLGD do not have significant exposure at surface and direct access to recharge water, either from precipitation or any surface water.

3.3.3 Vertical Gradients

Artesian conditions as demonstrated by flowing wells occur in the area and particularly for boreholes completed in the bedrock and/or the Whiteshell Till. This is shown from north to south and east to west in cross section on Figures 3-4 and 3-5, respectively. Artesian conditions are most prevalent during the freshet when groundwater levels are high, but many piezometers occur that appear to be permanently artesian. The piezometers with artesian conditions (either apparently permanent or periodic) are indicated on Figure 3-6 for the groundwater levels measured in the deepest piezometers (Shallow Bedrock, Whiteshell Till; or the deeper piezometers of the Whitemouth Lake Till at greater than 10 mbgs). The occurrence of artesian conditions is systematic. Most artesian piezometers occur below the 350 masl contour in the lower lying areas of the Pinewood River corridor in the vicinity and to the west of the proposed open pit. The higher areas immediately to the south, east and north of the proposed open pit are largely free of artesian conditions, coincident with the bedrock outcrop or limited overburden thickness.

The distribution of the artesian conditions in the bedrock and Whiteshell Till is a consequence of the general groundwater flow in the Pinewood River watershed in the immediate vicinity of the proposed open pit. Groundwater is mainly recharged in the higher areas where there is bedrock outcrop (or with minimal overburden cover). Groundwater flows towards the Pinewood River corridor and subsequently becomes confined in the Shallow Bedrock and Whiteshell Till beneath the lower permeability silty clays of the Whitemouth Lake Till and glaciolacustrine deposits that largely sandwich this till (i.e., the Pleistocene Aquitard). The steeper horizontal gradients shown in Figure 3-3 are likely where flow is predominantly through the Shallow Bedrock. These gradients become shallower in the lower lying areas where the bedrock is overlain by the Whiteshell Till and other granular deposits (the PLGD), which is then the main unit for horizontal groundwater flow.

The vertical gradients are plotted in Figure 3-6 for June, 2012 for the locations where there are nested piezometers with a piezometer in the Shallow Bedrock and/or Whiteshell Till to a piezometer in the Whitemouth Till or the shallow overburden above. The average piezometer spacing (from middle of screen) of the nests is just less than 20 m. The gradients tend to be of the order of 0.03 to 0.1 and are upwards (indicated as negative) along the stream corridors and downwards in the higher areas between the streams. The consistent upward gradients across the Whitemouth Lake Till along the Pinewood River corridor are shown by four nested piezometers (BH-11-21, BH-11-33, BH-11-34 and BH-11-44), which are all located within about 500 m of the Pinewood River. This is an indicator of groundwater discharge in the Pinewood River corridor from the Shallow Bedrock and PLGD.

There is one location where a very strong downward gradient occurs between the Shallow Bedrock and the Whitemouth Lake Till (approximately 0.58 at BH-11-50). This is a location where the measured groundwater level of the bedrock (5.9 mbgs) is below the screened interval in the Whitemouth Lake Till (4.5 mbgs) and is an indication that perched conditions in the Whitemouth Lake Till could occur above the bedrock outside of the stream corridors. It is also an indication that some recharge to the PLGD and bedrock is possible through the Whitemouth Lake Till on higher ground, particularly where it is not overlain by glaciolacustrine clays.

3.3.4 Temporal Groundwater Level Responses

Groundwater levels have been regularly monitored in the overburden and the bedrock since the summer of 2009. Some of the piezometers have artesian conditions and the records may be limited because the groundwater level is above stick-up and/or the piezometer pipe has been frozen during winter conditions. The main characteristic of most hydrographs where records are continuous, is that they show a regression that starts at the end of 2010 and continues through 2011 into 2012. This is largely due to the low amount of precipitation throughout 2011, which was below 60% of the 1971 to 2000 climate normal annual value. In 2012 there has been relatively limited, if any recovery, because the precipitation has remained below average.

3.3.4.1 Whitemouth Lake Till and Near-surface System

There are seven sites with piezometers with groundwater level hydrographs with measurements in overburden interpreted as Whitemouth Lake Till or sediments above. At five of these there are nested piezometers with a piezometer at two levels within the Whitemouth Lake Till (three sites) or with a piezometer in the Whitemouth Lake Till and the Whiteshell Lake Till or bedrock below (two sites). There are two additional sites that have piezometers straddling the contact with the Whitemouth Lake Till and the Whiteshell Till and are more likely representative of the latter.

In most cases the full annual variation in groundwater levels in the Whitemouth Till could not be measured due to the practical limits of measuring artesian heads above the top of the well casings (or potential breaks in the casings near ground level) (Figure 3-8). Most of the piezometers with artesian conditions have screens that are at least 10 m below surface. The main exception is BH10-06, which has a shallow piezometer within 5 m of the surface and had artesian conditions in 2011, which subsequently dropped 3 m in 2012. The log of this borehole (KCB 2011) shows gravel immediately beneath the piezometer screen and the groundwater level measured could actually be more representative of conditions in the Whiteshell Till. The recession observed in this hydrograph could be explained by the relatively thin amount of silty clay above and proximity to a possible discharge boundary (tributary of the West Creek; Figure 2-2).

The responsive shallow piezometers are more likely representative of the Near-surface System where local precipitation recharge and resulting shallow groundwater discharge occurs, possibly over a time-scale of several months after a precipitation event. The less responsive and mostly deeper artesian piezometers, are an indicator of a confining system (i.e., caused by the Pleistocene Aquitard) with upward groundwater gradients. The groundwater level variation in these piezometers is expected to be largely influenced by groundwater head variations at the base of the Pleistocene Aquitard, rather than by any precipitation recharge infiltrating in the immediate vicinity of the piezometer.

3.3.4.2 Whiteshell Till and Deeper Overburden

There are seven sites with piezometers with groundwater level hydrographs with measurements in overburden interpreted as Whiteshell Till. As noted above, two of these sites have piezometers that straddle the contact with the Whitemouth Lake Till above, but are most likely representative of Whiteshell Till conditions.

Similar to the deeper piezometers in the Whitemouth Lake Till, the groundwater level variations shown by Whiteshell Till piezometers are fairly subdued (less than 1 m) as exemplified by

BH10-11A (Figure 3-8). It is also noteworthy that where artesian conditions occur (BH10-11A, BH10-12A and BH10-14), they are persistent throughout the dry period from 2011 through 2012.

There is one nested piezometer that has separate completions in the Shallow Bedrock and Whiteshell Till (BH10-09; Figure 3-9). Given the very similar groundwater levels, it would appear that there is a good hydraulic connection between Whiteshell Till and the Shallow Bedrock.

3.3.4.3 Bedrock

There are no dedicated monitoring installations in the Intermediate and Deep Bedrock, but monitoring has been undertaken on a regular basis in eleven deep open boreholes since 2009. These may provide some indication of groundwater conditions at depth in the bedrock, although the interpretation of data from open boreholes is less certain, because the borehole itself is a flow conduit.

The hydrographs from the deep open boreholes all show climatic responses, including reasonably rapid responses to rainfall, freshet conditions and dry periods. For example, the majority of the deep boreholes show the strong groundwater level decline in 2012, the main exception being the strongly artesian boreholes, where due to practicalities there is no detailed groundwater level record (nevertheless the water pressure may have declined in these boreholes). In general the climatic response is of the order of 1 to 2 m across a year, although one borehole (NR08287; Figure 3-10) shows an annual variation of up to 5 m, which may be considered unusual. The occurrence of the clear climatic signals can be explained by a proximal confined response in the Shallow Bedrock, given the likely hydraulic diffusivity of the Shallow Bedrock.

Rushton (2003) provides a simple assessment for the time necessary for a signal at a boundary (in this case recharge at the bedrock outcrop) to cover distance (L) to a particular point (in this case a deep borehole), where t equals approximately L^2/D. D is the unit hydraulic diffusivity (hydraulic conductivity divided by specific storage). Assuming a typical fractured bedrock specific storage of 1E-06 to 5E-06 1/m (Anderson and Woessner 1992) and a Shallow Bedrock hydraulic conductivity of 1E-06 m/s, it would take of the order of 10 to 60 days for a recharge signal from bedrock outcrop to reach a borehole at 1 km distance. It can be concluded that most of the deep boreholes have a record that are consistent with a confined response in Shallow Bedrock given the typical Shallow Bedrock hydraulic conductivity estimated from hydraulic testing undertaken.

With lower hydraulic conductivities more typical of Intermediate and Deep Bedrock (1E-07 m/s and less) a more attenuated climatic response in the groundwater level record may be expected. It is possible that persistent artesian conditions with no climatic signature (such as NR07214; Appendix D) are representative of very tight bedrock, Shallow Bedrock that is not weathered or fractured. This would appear atypical considering it concerns only 2 of 13 records.

3.4 Groundwater - Surface Water Interaction

3.4.1 Pinewood River Low-flow Conditions

Spot flow gauging has also been completed since 2008 within the Pinewood River watershed and adjacent watersheds. Nine locations were gauged by KCB; seven in the Pinewood River watershed and two immediately to the northeast of this watershed (Table 3-5, Figure 3-11). Five of the sites were equipped with level loggers and spot gaugings were undertaken for the purpose of establishing stage-discharge rating curves. Flow hydrographs were not generated at these sites because of anomalous relationships between stage and discharge, potentially related to changes in backwater conditions (beaver dams, debris in culverts etc.) and inaccuracy of measurements at very low velocities (KCB 2011).

AMEC completed a stream flow monitoring program in late August to early September, 2011 with the objective of characterizing stream flows in the vicinity of the project area under low-flow conditions (Appendix E). Twenty-five sites were selected for flow measurements. The survey was performed over three days and provides a basis to assess the downstream accumulation of groundwater discharge within the Pinewood River watershed.

The encountered flow conditions in 2011 were lower than typical for the months of August and September based on comparisons with the baseline study completed by KCB (2011) and conversations with local individuals. The dry conditions in 2011 are also evident in the groundwater level hydrographs (Section 3.3.4). Beaver activity and culverts placed higher than the stream bed (Appendix E) were also apparent at some locations impeding the flow. A summary of the survey is provided in Table 3-5 together with summer measurements previously undertaken by KCB at overlapping sites for comparison. Figure 3-11 plots the results of the 2011 monitoring program, indicating the flow conditions and average discharge rate at each of the sites.

In summary, most locations had no noticeable flow, as these either had: large volumes of standing water with no flow, disconnected ponds of standing water, or dry stream beds. Given the results of this survey, it can be concluded that under dry conditions there is effectively no or minimal flow in the Pinewood River watershed upstream of the current Environment Canada gauging station (05PC023).

3.4.2 Synthesis of Surface Water Flow and Groundwater Level Data

Overall it appears that groundwater - surface water interaction in the Pinewood River watershed is largely governed under current conditions by the occurrence of the Pleistocene Aquitard, in particular the glaciolacustrine sediments in the lower areas below 350 masl. The upward vertical hydraulic gradients in the lower areas mean there is no local recharge infiltrating to the Whiteshell Till and Shallow Bedrock through the Pleistocene Aquitard. Any precipitation that occurs in the low areas either: becomes runoff (particularly during higher rainfall events of more than 20 mm/d); evaporates; infiltrates locally in the shallow sediments and peat that occur above the Pleistocene Aquitard; or is held up by beaver dams or other obstructions such as elevated culverts. The infiltration into shallow sediments and peat (the Near-surface System) is expected to produce discharge over the short to medium term and in the order of months to the Pinewood River and its tributaries, which is hereafter referred to as interflow. The attenuation that is noted in the gauging records of the Pinewood River (Section 2.4) is likely a combination of water stored in the Near-surface System and surface obstructions. As discussed in Section 3.3.4.1, there are groundwater level hydrographs obtained from shallow piezometers (<5 m deep) that are consistent with a Near-surface System that supports flow in the Pinewood River watershed over the short to medium term.

Under persistent dry conditions such as those encountered through 2011/2012 and monitored in August and September 2011; however, the interflow discharge from the Near-surface System more or less ceases (i.e., the groundwater levels in the shallow sediments and peat drop to such an extent that any significant flow past obstructions, either high culverts or beaver dams is simply not possible. It should be noted across small (over less than 100’s of metres) reaches of the creek more complex interactions could occur particularly associated with near-surface Pleistocene sand deposits. These still may discharge through dry periods, but the flow from these is not evident because it is obscured by obstructions (particularly beaver dams).

The absence of any significant flow during August and September 2011 is indicative of very limited groundwater - surface water interaction between the PLGD and Pleistocene Aquitard and creeks within the Pinewood River watershed. This is consistent with the low amounts of flow recorded in the Pinewood River watershed during dry conditions (Section 2.4). Although overall the pattern of horizontal and vertical groundwater levels and gradients is indicative of groundwater discharge in the Pinewood River corridor, the quantities are very limited. This indicates that relatively little water infiltrates through the Shallow Bedrock or Whitemouth Lake Till into the Whiteshell Till under present conditions. The discharge that does occur is over a wide area and this concerns relatively small quantities, which do not give rise to notable downstream accumulation of flow in the Pinewood River and tributaries during very dry conditions.

3.5 Groundwater Quality

Groundwater sampling was completed during 2007 and 2009 to 2012. The baseline study completed by KCB (2011) reported extensively on the groundwater quality of the overburden and the bedrock with data up to 2010, including piper diagrams. In general it was found that the groundwater comprised typical calcium-magnesium-bicarbonate type water with the majority of sampling points having total dissolved solids exceeding 500 mg/L. The following dissolved metal concentrations were noted to exceed or met the Ontario Provincial Water Quality Objectives (PWQO) for the Protection of Aquatic Life at one or more of the twenty monitoring wells that were sampled: aluminum (one site), cadmium (one site), cobalt (six sites), copper (one site), iron (14 sites), mercury (one site), molybdenum (one site), uranium (four sites) and zinc (one site). It should be noted that groundwater cannot be directly compared to the PWQO, but the objectives can nevertheless be used for description purposes. Exceedances of the PWQO were also observed in surface water body samples for aluminum, cobalt, copper and iron.

KCB (2011) also reviewed a municipal groundwater study for the Township of Chapple and noted that the raw water quality of samples collected from four municipal water supply wells completed in bedrock at the Village of Barwick, located approximately 23 km south of the site, frequently exceeded the Ontario Drinking Water Standards for aluminum, iron and manganese. They also indicated the frequent occurrence of higher iron concentrations in the project area.

Subsequent groundwater sampling by RRR of monitoring wells for 2011 to 2012 is summarised in Appendix F. This sampling has found dissolved metal exceedances of the PWQO for some of the metals reported by KCB (2011) at one or more wells. The groundwater was found to contain metal contents which exceeded the PWQO on one or more sampling occasion include: arsenic (six sites), cobalt (four sites), iron (four sites), molybdenum (two sites), tungsten (four sites) and uranium (two sites). Groundwater was also found to exceed the Canadian Environmental Quality Guidelines (CEQG) for the protection of aquatic freshwater life for similar metals including: arsenic (six sites), cadmium (one site), iron (four sites), mercury (one site) and uranium (one site)

There is no strongly discernable difference between groundwater quality in individual hydrostratigraphic units with regards to metals for which there are PWQO/CEQG, save uranium. As had been noted by KCB (2011) exceedances in uranium concentrations are only observed in wells screened in the Pleistocene Aquitard, a trend that was also observed in subsequent sampling efforts.

3.6 Conceptual Model Summary

Five hydrostratigraphic units have been identified that are key to explaining: the groundwater - surface water interaction in the Pinewood River watershed; the artesian conditions that occur; and in predicting the groundwater level drawdown and surface water flow depletion associated with the proposed open pit:

- Near-surface Flow System: This unit consists of all the Holocene sediments (alluvium, peat) and hydrologically is the unit in combination with surface storage from beaver dams etc., that is responsible for the attenuation of moderate runoff events in the Pinewood River watershed that produces the short to medium-term interflow response in the river (Sections 2.4 and 3.4). Locally, this may also include more granular and weathered units of the younger Pleistocene deposits where they lie immediately beneath the Holocene deposits, likely to be mainly from the Brenna Formation.

- Pleistocene Aquitard: This unit consists mainly of Whitemouth Lake Till, but also includes the upper and lower glaciolacustrine deposits that sandwich the Whitemouth Lake Till (the Wylie Formation beneath and the Brenna Formation above). Overall this is a reasonably heterogeneous unit that contains some sand lenses that locally may provide some horizontal groundwater flow, otherwise the vertical flow is likely to dominate. The glaciolacustrine sediments at the top and the bottom of this unit probably have the lowest hydraulic conductivity; however, neither of these units are as continuous as the Whitemouth Lake Till. Nevertheless, the Pleistocene Aquitard overall is of low enough hydraulic conductivity to give rise to artesian conditions in the low lying areas within the project area to the west along the Pinewood River and tributaries, particularly below 350 masl.

- PLGD: This unit consists of predominantly the Whiteshell Till and possibly also glaciofluvial deposits of Labradorean origin beneath the Pleistocene Aquitard. It is purposely not referred to as an aquifer because of its overall modest hydraulic conductivity.

- Shallow Bedrock: This unit includes bedrock within 10 to 20 m of the upper bedrock surface and is often weathered and fractured. It is expected to have a moderate hydraulic conductivity overall at least one order of magnitude lower than the Whiteshell Till. Hydraulically it has a reasonable connection with the PLGD.

- Intermediate and Deep Bedrock: Overall a decreasing hydraulic conductivity can be observed with depth. The distinction between intermediate and deep is made to approximately replicate the observed data and is taken at approximately 200 to 300 mbgs.

A summary of the estimated hydraulic conductivities is provided in Table 3-6 based primarily on hydraulic testing undertaken around the project area. The hydrostratigraphy in the bedrock may be different, particularly at depth, if elevated hydraulic conductivities occur in relation to brittle deformation. The EFLT is the only fault identified that has been mapped across the proposed open pit. Conservatively this has been assumed a zone of more enhanced hydraulic conductivity at depth (Intermediate and Deep Bedrock) 100 m wide, although the hydraulic data collected to date does not consistently suggest this is a zone of enhanced transmissivity.

The pattern of groundwater flow at the site is illustrated schematically in a conceptual cross section shown on Figure 3-12. Most of the effective precipitation is either runoff or infiltrates in shallow soils (mainly weathered silts and clays) peat and alluvium. The latter is expected to discharge relatively quickly over the short to medium term as interflow and is interpreted as part of a near-surface flow system (including beaver dams and other obstructions) that gives rise to the characteristic attenuated response of the Pinewood River system to smaller-scale precipitation events.

Limited groundwater recharge to the deeper groundwater system (Shallow Bedrock and PLGD) is expected to occur, primarily where the bedrock is at surface or has limited cover of overburden. Very limited recharge to the deeper groundwater system is probable through the Whitemouth Lake Till on higher ground as downward groundwater gradients are likely. Sand and gravel pits located within the project area may act as localized areas of high recharge rates, although geological data suggest these occur above the Pleistocene Aquitard. Where glaciolacustrine clays and peat are close to surface within the project area, recharge to the deeper groundwater system is minimal (effectively zero), particularly where artesian conditions prevail (below 350 masl). When averaged over the entire project area, recharge to the deeper groundwater system is considered less than 5% (<10 mm) of the total effective precipitation.

Groundwater discharge from the deeper groundwater system to the Pinewood River and its tributaries does occur, but this is very distributed and overall the flows are very low. Given this conceptual model, the majority of watercourses and wetlands are considered weak discharge areas for the deep groundwater system. On higher ground and particularly around 4 km to the north of the proposed open pit, there are wetlands and lakes that may act as groundwater discharge points.

Groundwater withdrawal from the proposed open pit is expected to increase the overall recharge rates in the proximity of the pit due to: altering the direction of vertical gradients from the upward to the downward ones; and increasing the moisture penetration ability / capacity of soil(s) by lowering the water table due to the dewatering operations.

Table 3-1: Summary of Hydrostratigraphic Units

Hydrostratigraphic Units	Geologic Units
Near-surface System	Mainly the Holocene sediments, including the peat and alluvial deposits of the Pinewood River. May also include locally small amounts of Whitemouth Lake Till and and/or Brenna Formation near surface where these comprise fine sand and coarser material or are highly weathered.
Pleistocene Aquitard	The dominant unit is the Whitemouth Lake Till, but also includes the various glaciolacustrine deposits (primarily the Wylie and Brenna Formations)
PLGD	The dominant unit is the Whiteshell Till, but also includes Labradorean glaciofluvial deposits. Coarser (fine sand and above) parts of the Wylie Formation may be included where this sits immediately above the Whiteshell Till or bedrock
Shallow Bedrock	Weathered and/or fractured undifferentiated bedrock, occurring within 10 to 20 m of the bedrock surface
Intermediate and Deep bedrock	Undifferentiated bedrock

Table 3-2: Summary Statistics of Hydraulic Conductivity Data for Overburden and Shallow Bedrock Hydrostratigraphic Units Based on Slug Testing and Pumping Tests

	Number	Geometric Mean (m/s)	Minimum (m/s)	Maximum (m/s)
AMEC slug testing				
Near-surface System	1	1.4E-06	1.4E-06	1.4E-06
Pleistocene Aquitard	9	4.5E-08	8.6E-10	5.0E-07
PLGD	5	8.8E-06	1.6E-06	1.0E-04
Shallow Bedrock	13	4.1E-07	1.8E-11	1.7E-05
Slug testing and pumping tests (KCB 2011)				
Near-surface System	7	3.6E-07	5.6E-08	3.6E-06
Pleistocene Aquitard	8	2.5E-08	1.9E-09	2.5E-07
PLGD	7	1.7E-05	4.0E-07	1.8E-04
PLGD - PT*	4	8.8E-05	4.8E-05	2.1E-04
Shallow Bedrock	2	1.1E-06	7.7E-07	1.7E-06
Bedrock (open borehole 80 to 760 m deep)	11	4.4E-08	2.1E-09	2.9E-07
Cone penetration testing (KCB 2011)				
Near-surface System	1	1.8E-09	1.8E-09	1.8E-09
Pleistocene Aquitard	14	3.6E-09	3.5E-11	1.4E-07
PLGD	3	1.2E-07	1.6E-08	5.2E-07
Combined slug testing				
Near-surface System	8	4.3E-07	5.6E-08	3.6E-06
Pleistocene Aquitard	17	3.4E-08	8.6E-10	5.0E-07
PLGD **	12	1.3E-05	4.0E-07	1.8E-04
Shallow Bedrock***	15	4.7E-07	1.8E-11	1.7E-05

* Pumping test results from KCB (2011)
** Excluding pumping test results from KCB (2011)
*** Excluding open holes tested by KCB (2011)

Table 3-3: Summary of Deep Geomechanical / Hydrogeological Boreholes

Borehole	Easting	Northing	Surface Elevation (masl)	Dip (°)	UTM Azimuth (°)	Overburden Depth* (m)	Completion Length (m)	Major Rock Type Encountered (ratio based on the core geology)
BH12-UG-01	425213	5409209	349	80	25	37	739	FLS (31%), MSD (67%), MMV (2%)
BH12-UG-02	425625	5409102	348	75	25	55	750	MMV (63%), FLS (27%), IMV (8%), SHR (2%)
BH12-UG-03	426224	5409421	360	70	25	8.8	501	IMV (65%), FLS (35%)
BH12-OP-01	425057	5409436	347	65	220	58	402	FLS (82%), MMV (17%), MIN (1%)
BH12-OP-02	425809	5409377	351	65	120	45	402	IMV (65%), MMV (27%), FLS (8%)
BH12-OP-03	425018	5409873	349	65	320	30	400	FLS (89%), MMV (10%), SHR (1%)
BH12-OP-04	425555	5410117	349	65	250	42	300	FLS (96%), FIN (6%), SHR (1%)
BH12-OP-05	425745	5410254	350	65	45	36	301	FLS (77%), MSD (21%), MIN (2%)
BH12-OP-06	425889	5410057	349	65	135	48	300	FLS (85%), MIN (9%), IMV (6%)
BH12-OP-07	425900	5409801	349	45	225	68	300	FLS (95%), SHR (4%), MIN (1%)
KCBL-101	425482	5409624	355	80	180	12	383	-
KCBL-104	425950	5409600	355	70	130	38	400	-

* Depths are measured along the borehole and have been determined based on the borehole log geological descriptions

** Felsic (FLS), Intermediate Volcanics (IMV) and Mafic Metavolcanics (MMV), Metasediments (MSD), Felsic (FIN), Mafic (MIN) Intrusives and Shear (SHR). AMEC (2012c) provides detailed descriptions

Table 3-4: Hydraulic Conductivity Data for Shallow, Intermediate and Deep Bedrock Based on Single Packer Testing

Interval (mbbs) *	Number	Geometric mean (m/s)	Arithmetic Mean (m/s)	Minimum (m/s)	Maximum (m/s)
0 to 25	4	1.5E-07	7.0E-07	7.9E-09	1.6E-06
0 to 50	10	1.3E-07	4.1E-07	4.9E-09	1.6E-06
25 to 75	11	4.4E-08	2.8E-07	3.8E-09	1.4E-06
50 to 100	13	1.6E-08	1.3E-07	3.8E-09	7.9E-08
75 to 150	18	1.8E-08	2.7E-08	1.4E-09	1.1E-07
100 to 250	30	1.7E-08	7.7E-08	1.8E-10	7.6E-07
>200	17	1.5E-08	7.8E-08	1.1E-09	5.5E-07

* metres below bedrock surface - taken as the centre of the packer interval

Table 3-5 Summer Spot Flow Gauging, Pinewood River and Adjacent Watersheds

Station	Easting	Northing	KCB (2011) Surveys		AMEC Survey		
			June / July 2009	June / July 2010	Aug/Sept 2011		
			Average Discharge (m^3/s)		Average Discharge (m^3/s)	Comments on Flow Conditions	Beaver Activity
05PC023	413028	5405669			0	Disconnected pools in creek	Not evident
Clark 1*	427957	5409191			0.0062	Visible flow	Not evident
Jones 1	416578	5411821			0	Disconnected pools in creek	Not evident
Jones 2	418847	5413450			0	Creek bed dry	Not evident
Loslo 1	422912	5412040			0	No Flow	Yes
Marr 1	423675	5410238			0	Disconnected pools in creek	Possible
Marr 2	423689	5411785			0	Creek bed dry	No
Pine 1*	429234	5406712			0.002	Water in creek, no visible flow	Likely
Pine 2	430090	5408419			0	Creek bed dry	No
Pine 3	425546	5408124			0	Creek bed dry	No
Pine 4	430951	5407634			0	No visible flow	Likely
SW1	426312	5408490	0.03		0	No visible flow	Yes
SW1A	426150	5408768		0.1	0	No visible flow	Yes
SW2	425267	5410115	0.12		0	Disconnected pools in creek	No
SW3	419494	5408096	0	1.36	0	Disconnected pools in creek	No
SW4	432799	5413361	0		0	No visible flow	Yes
SW5*	424634	5416586	0		0.0019	Water in creek, no visible flow	Yes
SW10	427823	5407034			0	Water in creek, too shallow	No
SW13	422184	5410152		0.006	0	Water in creek, too shallow	No
SW14**	426283	5411689		0.07	0.01	Visible flow	No
Tait 1	423669	5403689			0	Creek bed dry	No
Tait 2	418420	5405321			0	No visible flow	Yes
West 1	426433	5411095			0	Creek bed dry	Likely
West 2	426432	5411616			0	Creek bed dry	No
West 3*	426430	5410321			0.0013	Water in creek, no visible flow	No

* August / September 2011; although a flow measurement was taken the methodology due to poor conditions impacted measurement and this is not a representative record

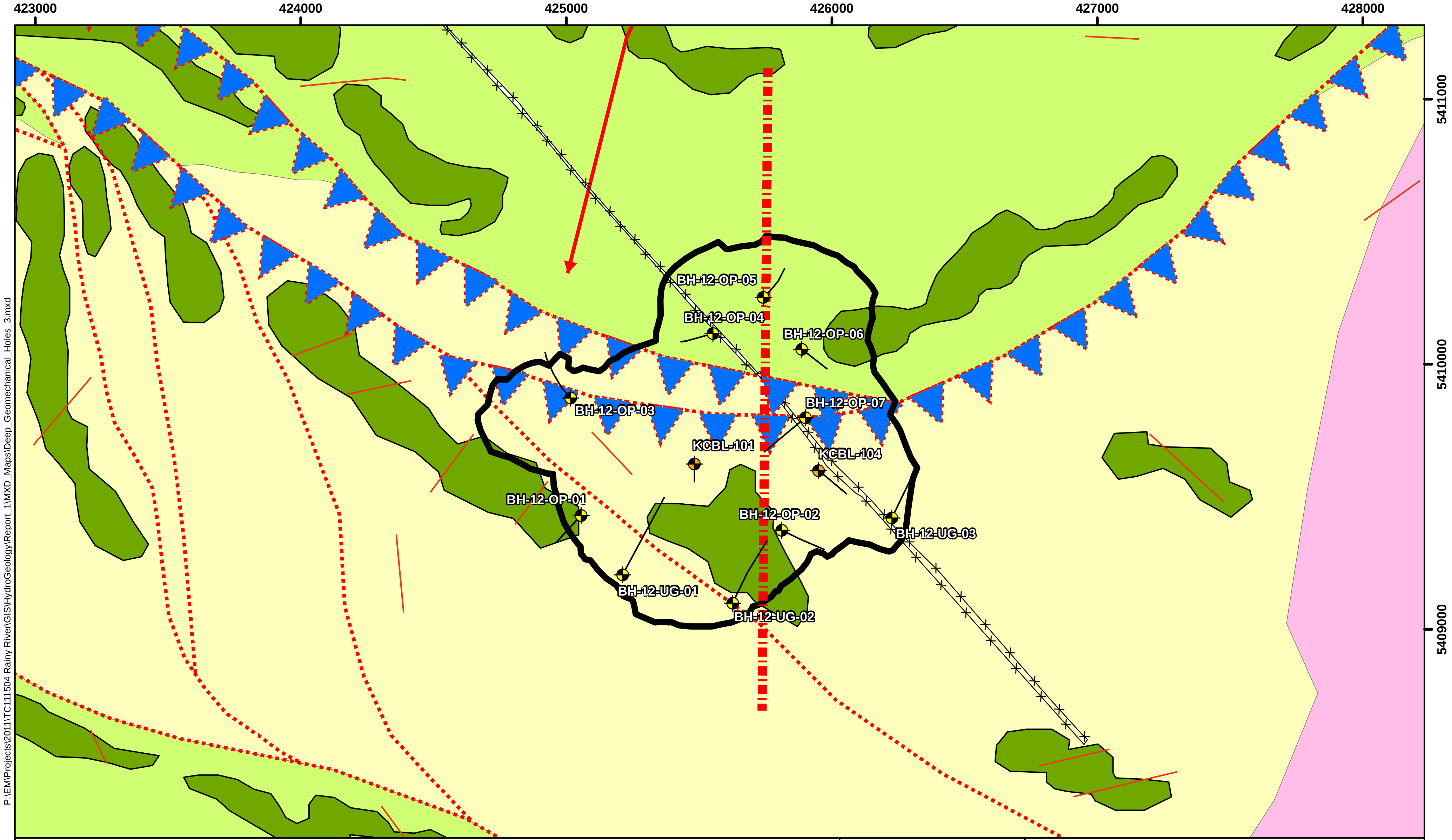
** August / September 2011; estimate of flow based on visual observations comparable to other watercourses in the area

Table 3-6: Initial Estimates of Hydraulic Properties for Hydrostratigraphic Units

Hydrostratigraphic Unit	Geology	Hydraulic Conductivity Estimate	
		Range (m/s)	Initial Estimate (m/s)
Near-surface System	Peat	5E-06 - 5E-05*	1E-05
	Pinewood River alluvium	1E-08 - 1E-04**	1E-06
Pleistocene Aquitard	Brenna (glaciolacustrine)	1E-10 - 1E-08***	1E-08
	Whitemouth Lake Till (Keewatin derived)	1E-09 - 1E-06****	5E-08
	Wylie (glaciolacustrine)	1E-10 - 1E-08***	1E-08
Pleistocene Lower Granular Deposits (PLGD)	Whiteshell Till (Labradorean derived)	1E-06 - 1E-04*****	5E-05
	Glaciofluvial sands		
Shallow Bedrock (10 to 20 mbbs)	Undifferentiated Rainy River Greenstone Belt intermediate and felsic volcanics and intrusives	1E-07 - 1E-05******	1E-06
Intermediate Bedrock (to approximately 200 to 300 mbgs)	Undifferentiated Rainy River Greenstone Belt intermediate and felsic volcanics and intrusives	1E-09 - 1E-07*******	1E-08
Deep Bedrock (greater than approximately 200 to 300 mbgs)	Undifferentiated Rainy River Greenstone Belt Intermediate and felsic volcanics and intrusives	1E-10 - 1E-08*******	1E-09
EFLT	Shallow Bedrock	1E-8 - 1E-06	1E-06
	Intermediate Bedrock		1E-07
	Deep bedrock		1E-08

Recharge	
Wetlands/peat and near-surface glaciolacustrine clay (Brenna Formation)	Expected to negligible
Areas without near-surface glaciolacustrine clay	Expected to be small
Abandoned sand and gravel pits	Expected to be relatively high
Bedrock, near surface PLGD	In the range of 10 - 50 mm/year

*	Based on literature values for peat for boreal Canadian conditions (Quinton et al. 2008)
**	Based on literature values (Freeze and Cherry 1979) for sediments that are predominantly silt to fine sand in grain size
***	Based on literature values (Freeze and Cherry 1979) for glacial till that is likely to comprise predominantly clay
*****	Based on slug testing data and pumping test data summarised in Table 3-2
******	Based on slug testing data summarised in Table 3-2 and packer testing data summarized in Table 3-4
*******	Based on packer testing data summarized in Table 3-4



NOTES:
-

Datum: NAD83
Projection: UTM Zone 15N

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

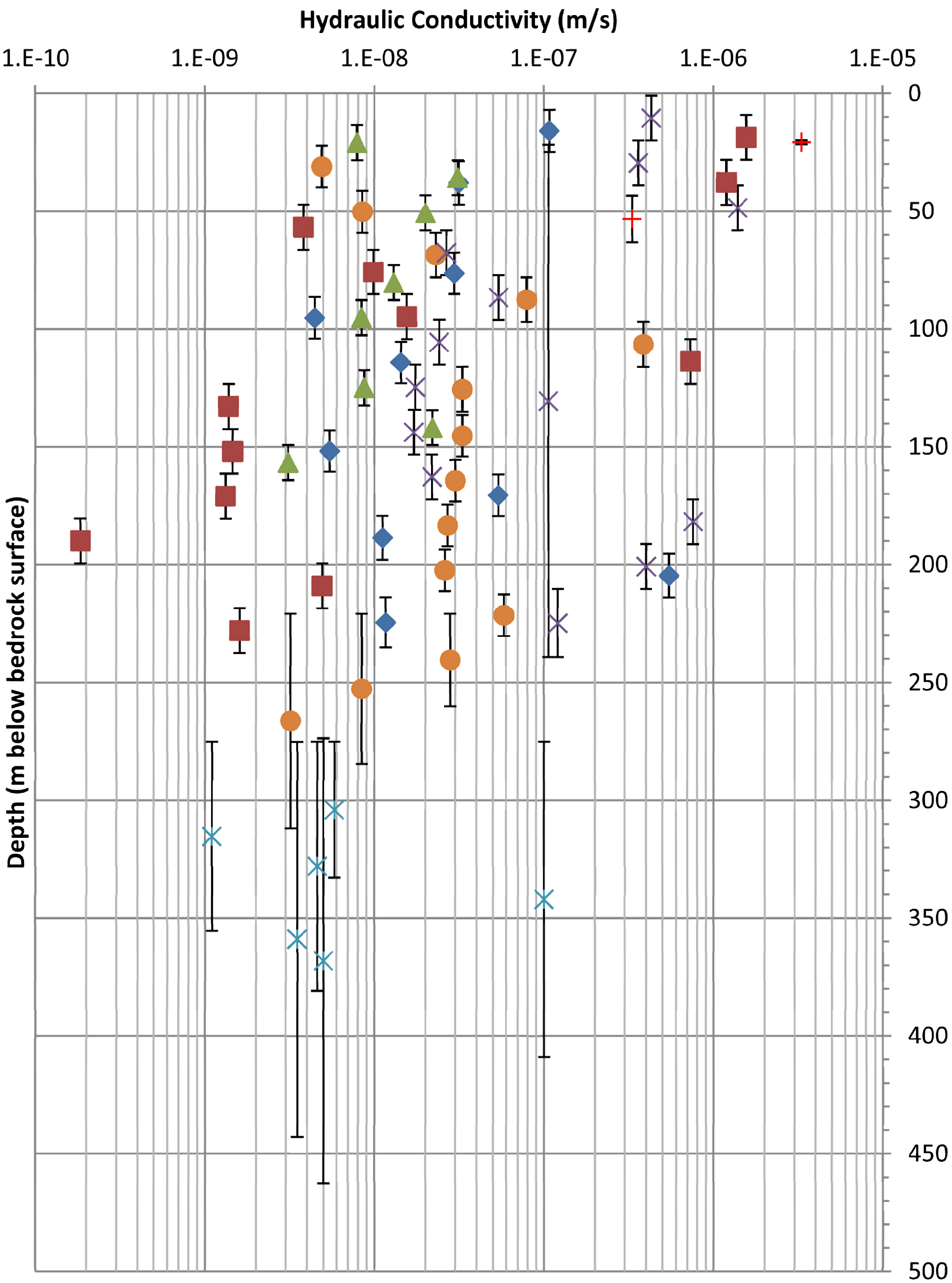
Location of Deep Geomechanical Holes at Proposed Open Pit

PROJECT N^{o}: TC111504

FIGURE: 3-1

SCALE: 1:20,000

DATE: March 2013



LEGEND

- ◆ BH12-UG-02
- ✳ BH12-UG-03
- ● BH12-OP-01
- ■ BH12-OP-03
- × BH12-OP-05
- ▲ BH12-OP-07
- + KCB

NOTES:

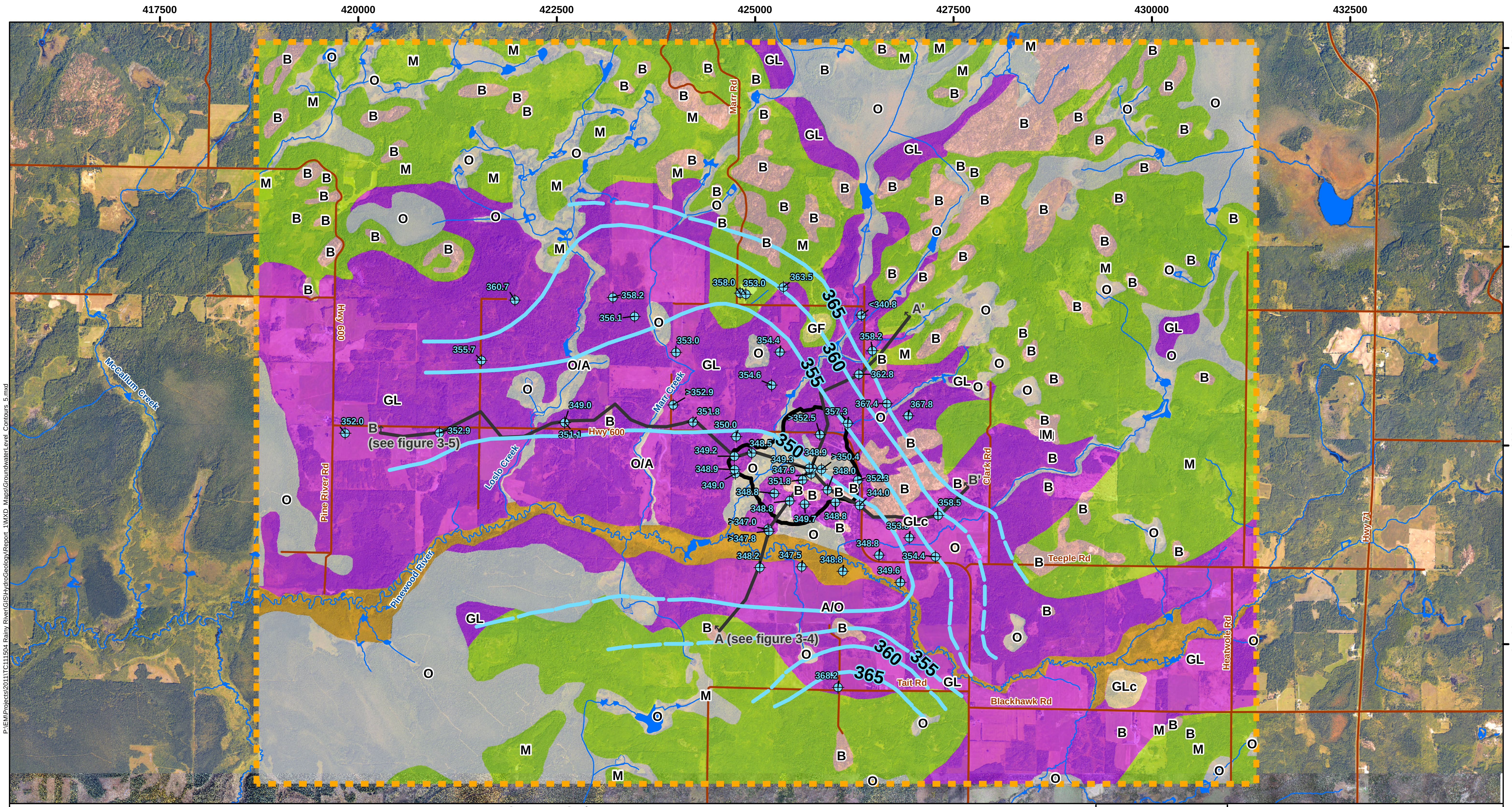
RAINY RIVER amec

RAINY RIVER GOLD PROJECT

Summary of AMEC Packer Test Results According to Depth and Length of Test Interval

PROJECT N^{o}: TC111504	**FIGURE: 3-2**
SCALE:	DATE: March 2013

P:\EMProjects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\Summary_of_PackerTest_Results_3.mxd



LEGEND

- General Project Area
- Approximate Open Pit Outline
- Cross Section
- Roads
- Watercourses
- ⌖ Borehole Used in Groundwater Contour Interpolation labelled with Groundwater level (masl)
- 360 Groundwater Level Contours

Quaternary Geology

O	Organic: peat and organic clay; includes bogs, fens, marsh, ponds and standing water along poorly defined creeks.
A	Alluvium: fine sand, silt, and clay; deposits of Pinewood River and tributaries
B	Bedrock: exposures or with very thin cover
GL	Glaciolacustrine: clay, silt, and minor sand; glacial lake bottom
GLc	Glaciolacustrine Coarse Grained: sand and gravel; beach, bar and, near-shore deposits
GF	Glaciofluvial: sand, gravel, and boulders, minor till; deposited from glacial meltwater in ice-contact environment.
M	Moraine: glacial till with some interbedded glaciolacustrine clay and silt; inferred to mostly Whitemouth Lake Till, clay rich with carbonate rocks and matrix.

0 1 2 4 6 8 10 Kilometres

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR
- Township and watercourse data extracted from Land Information Ontario, MNR
- Surficial geology based on air photo analysis and review of published geology maps. Surficial materials may vary from those indicated

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

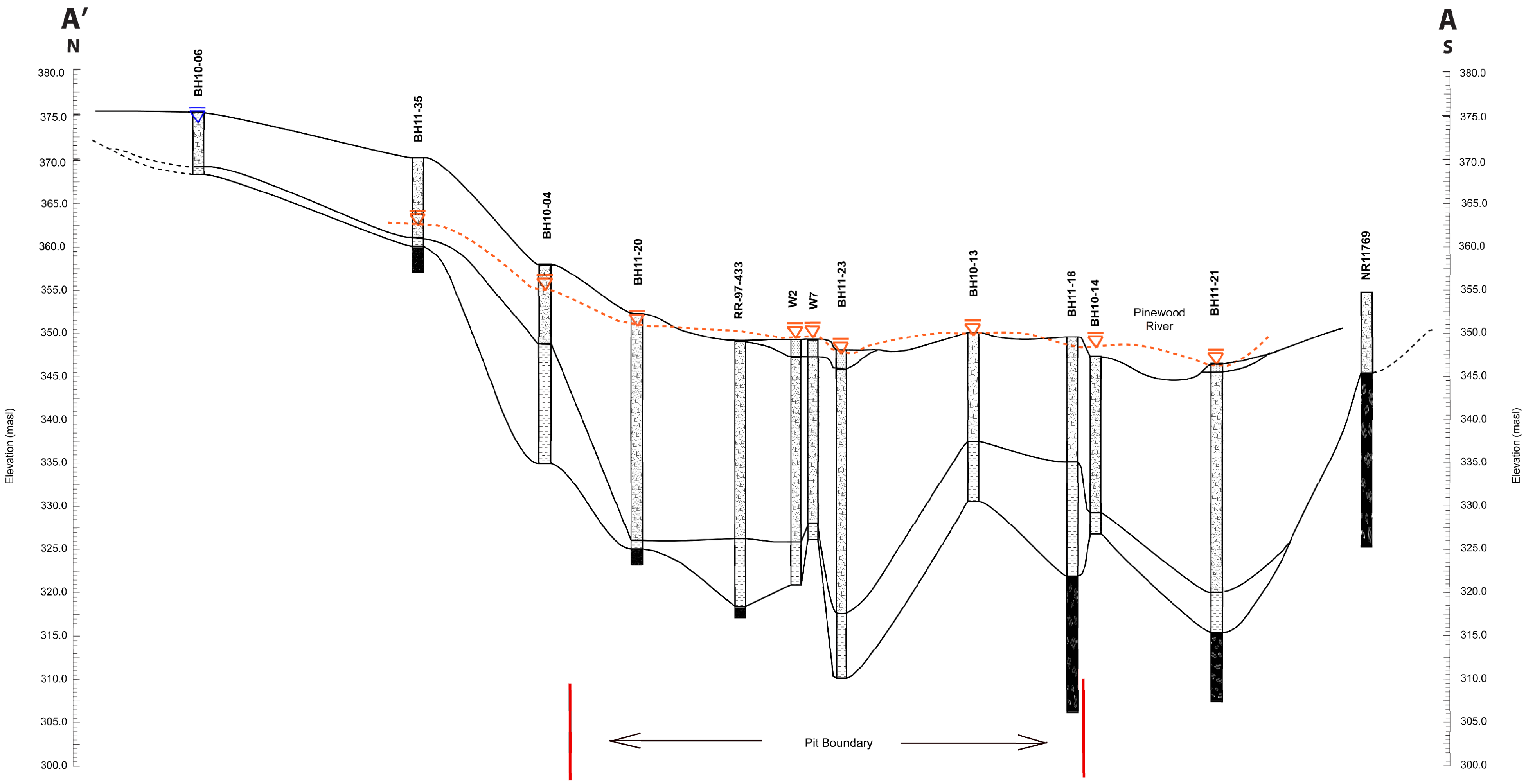
Groundwater Level Contour Map for June 2012 for Whiteshell Till and Shallow Bedrock

PROJECT N^{o}: TC111504

FIGURE: 3-3

SCALE: 1:46,000

DATE: March 2013



P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\NorthSouth_XSection_2.mxd

LEGEND

- ░ Top soil/shallow sediments
- ▨ Predominantly Whitemouth Lake Till, (Pleistocene Aquitard)
- ▤ Predominantly Whiteshell Till, (Pleistocene Lower Granular Deposits)
- ■ Bedrock
- ▽ Groundwater level (withiin Whitemouth Lake Till)
- ▽ Groundwater level (within Whiteshell Till and bedrock)
- - - - - - - - Interpreted contact
- - - - - - - - Interpreted groundwater level (within Whitesehll Till and shallow bedrock)

NOTES:
- RR-97 Data sourced from Nuinsco (1997)

RAINYRIVER

amec

RAINY RIVER GOLD PROJECT

Cross Section of Overburden and Shallow Bedrock (North-South)

Datum: NAD83
Projection: UTM Zone 15N

N S

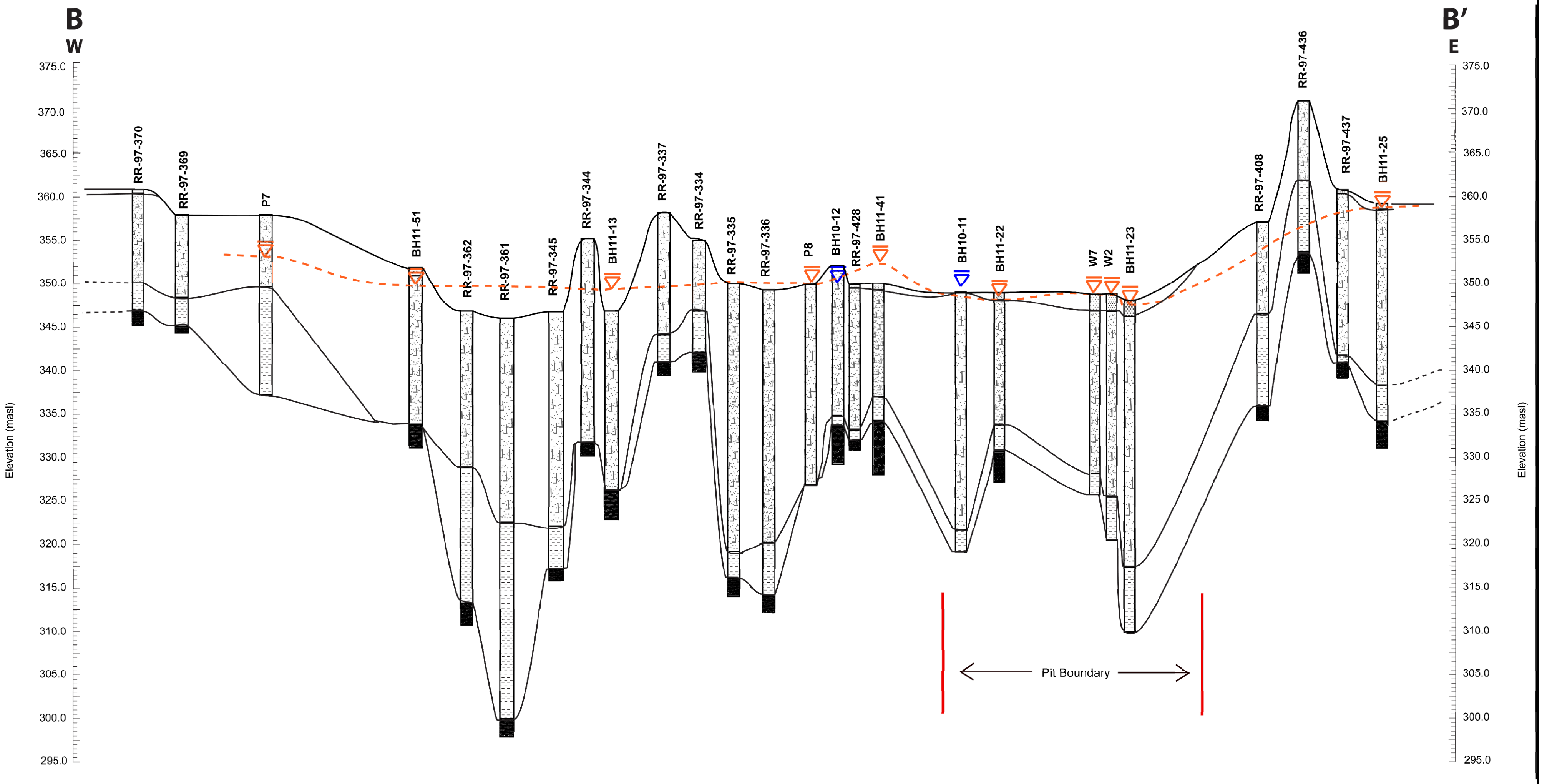
PROJECT N^{o}: TC111504

FIGURE: 3-4

SCALE: As Shown

DATE: March 2013

P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\EastWest_XSection_2.mxd



LEGEND

- ░ Top soil/shallow sediments
- ▨ Predominantly Whitemouth Lake Till, (Pleistocene Aquitard)
- ▤ Predominantly Whiteshell Till, (Pleistocene Lower Granular Deposits)
- ■ Bedrock
- ▽ Groundwater level (withiin Whitemouth Lake Till)
- ▽ Groundwater level (within Whiteshell Till and bedrock)
- - - - - - - - Interpreted contact
- – – – – – Interpreted groundwater level (within Whitesehll Till and shallow bedrock)

NOTES:
- RR-97 Data sourced from Nuinsco (1997)

Datum: NAD83
Projection: UTM Zone 15N

W E

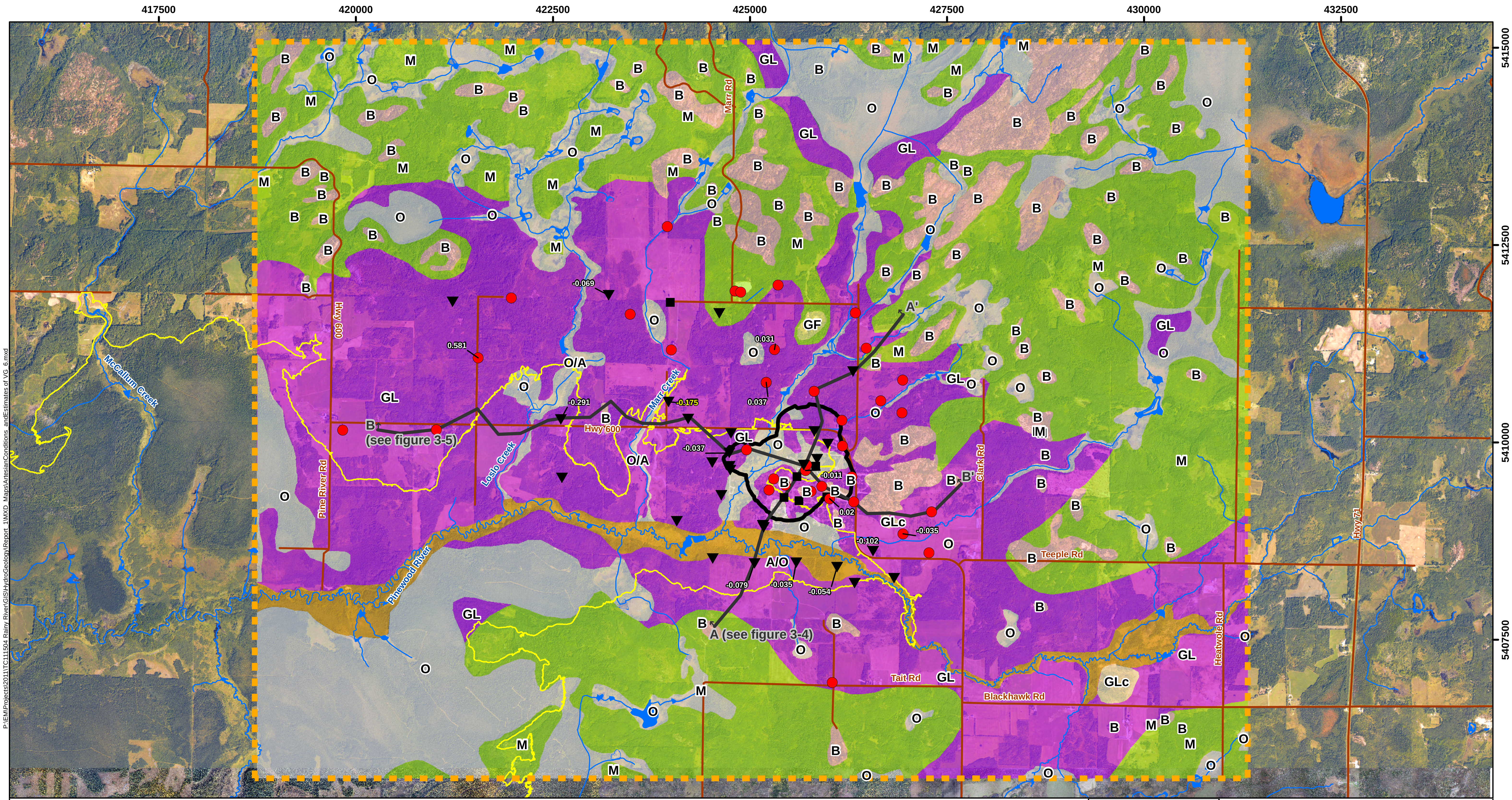
RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

Cross Section of Overburden and Shallow Bedrock (West-East)

PROJECT N^{o}: TC111504	**FIGURE: 3-5**
SCALE: As Shown	DATE: March 2013



P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\ArtesianConditions_andEstimates of VG_6.mxd

LEGEND

- General Project Area
- Approximate Open Pit Outline
- Cross Section
- Roads
- Watercourses
- 350 masl Elevation Contour (LiDAR Survey 2010)

Boreholes

- ▼ Artesian
- ■ Artesian, periodic
- ● Not Artesian

Label Key:

-0.054 ← Vertical Gradient, June 2012 (not shown at every borehole location, negative value indicates upward vertical gradient). Yellow label indicates minimum estimate (groundwater level for bottom piezometer above standpipe).

Quaternary Geology

O	Organic: peat and organic clay; includes bogs, fens, marsh, ponds and standing water along poorly defined creeks.
A	Alluvium: fine sand, silt, and clay; deposits of Pinewood River and tributaries
B	Bedrock: exposures or with very thin cover
GL	Glaciolacustrine: clay, silt, and minor sand; glacial lake bottom
GLc	Glaciolacustrine Coarse Grained: sand and gravel; beach, bar and, near-shore deposits
GF	Glaciofluvial: sand, gravel, and boulders, minor till; deposited from glacial meltwater in ice-contact environment.
M	Moraine: glacial till with some interbedded glaciolacustrine clay and silt; inferred to mostly Whitemouth Lake Till, clay rich with carbonate rocks and matrix.

0 1 2 4 6 8 10
Kilometres

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR
- Township and watercourse data extracted from Land Information Ontario, MNR
- Surficial geology based on air photo analysis and review of published geology maps. Surficial materials may vary from those indicated

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

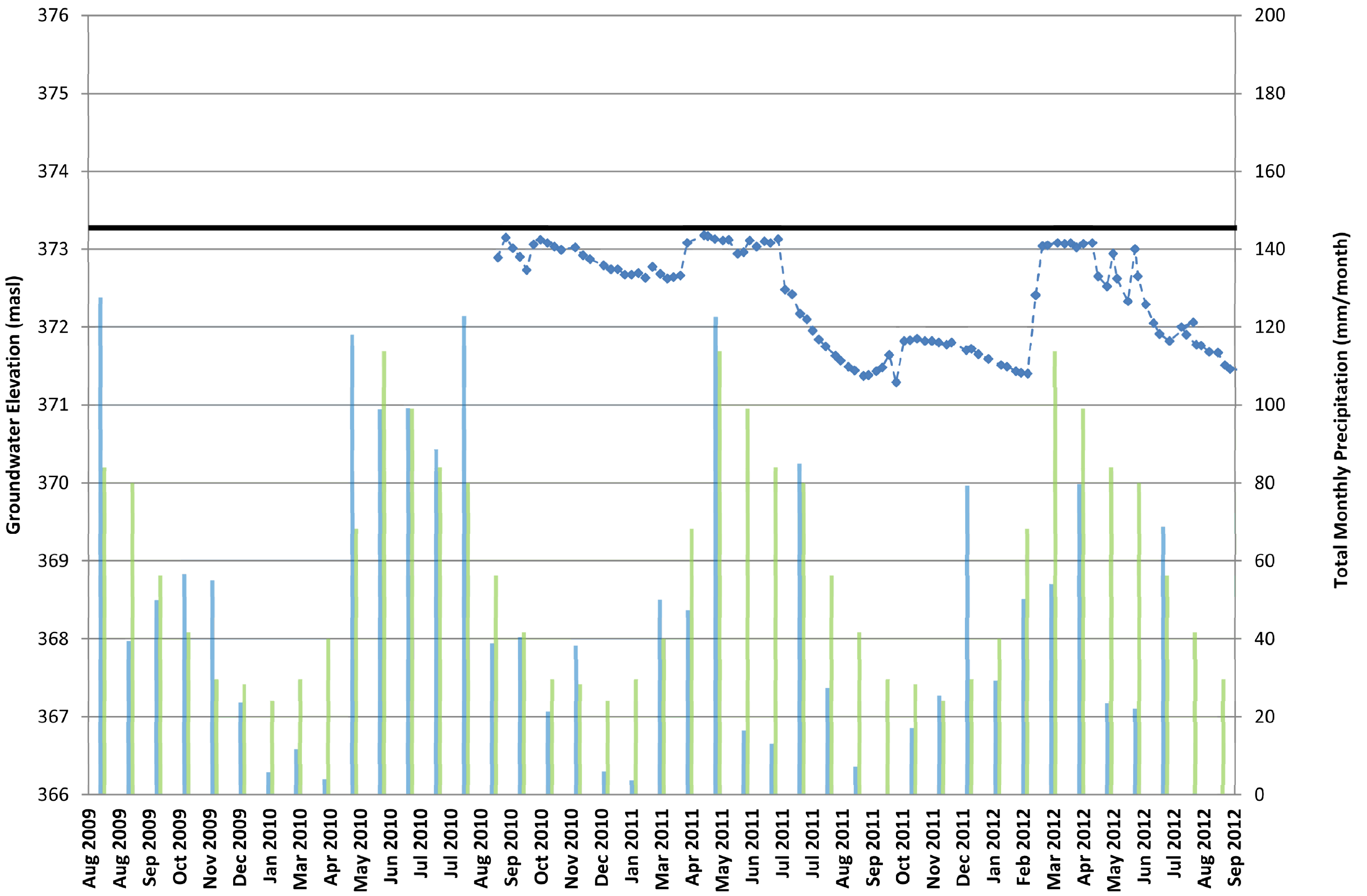
Location of Artesian Conditions and Estimates of Vertical Gradient

PROJECT N^{o}: TC111504

FIGURE: 3-6

SCALE: 1:46,000

DATE: March 2013



LEGEND

🟦 Precipitation (Barwick)

🟩 Climate Normal (1971-2000)

— Ground surface

- -◆- - Water Level

NOTES:
- 2009 - 2012
- screen interval: 370.3 - 367.3 masl (silty clay)

RAINY RIVER

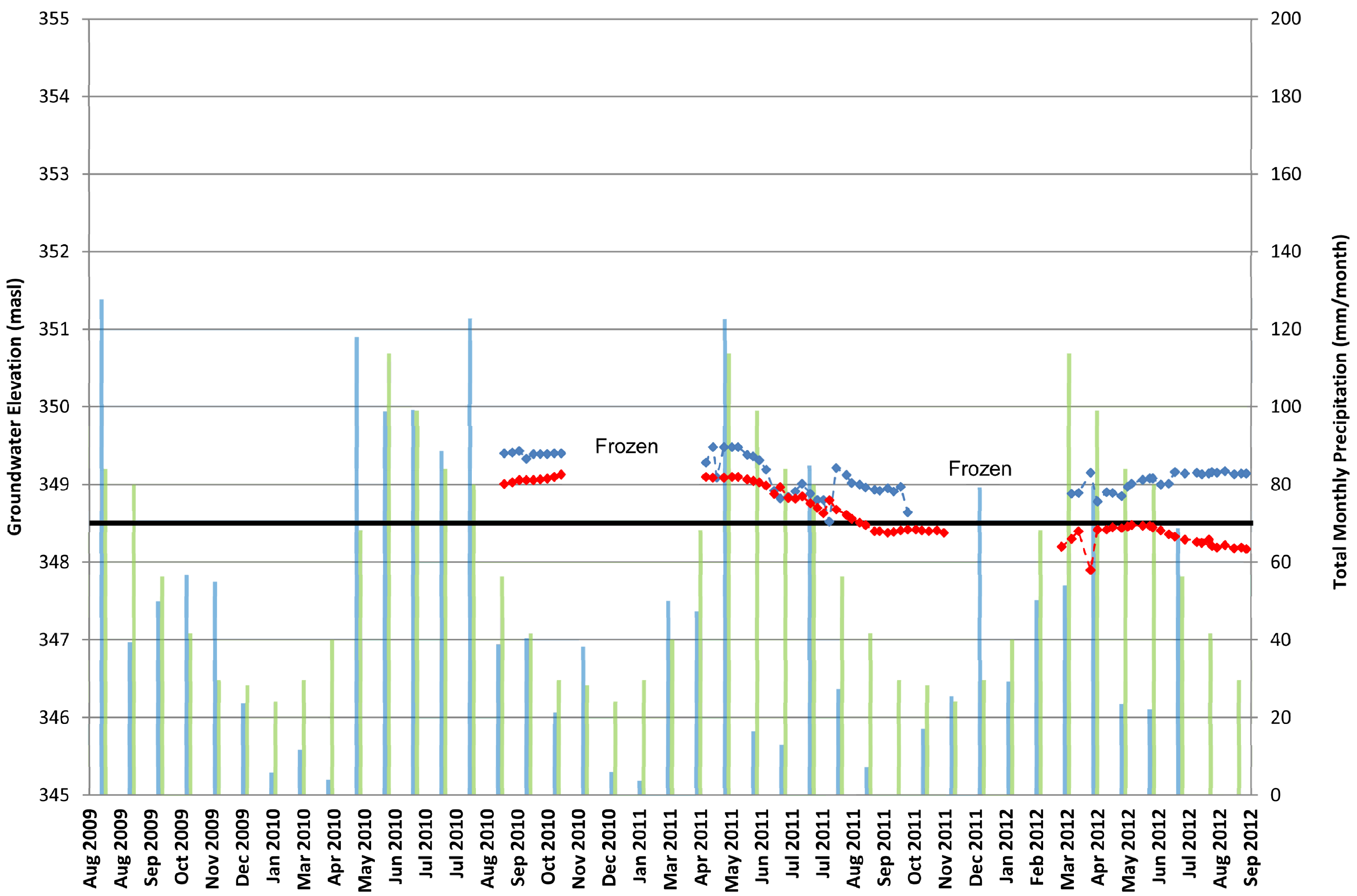
amec

RAINY RIVER GOLD PROJECT

Groundwater Level Hydrograph for BH10-05 with Shallow Piezometer in Whitemouth Lake Till

PROJECT N^{o}: TC111504	**FIGURE: 3-7**
SCALE:	DATE: March 2013

P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\GW_Hydrograph_BH10-11_Nested_4.mxd



LEGEND

🟦 Precipitation (Barwick)
🟩 Climate Normal (1971-2000)
▬ Ground surface
- -◆- - Water Level Casing A
- -◆- - Water Level Casing B

NOTES:
- 2009 - 2012
- Casing A = Whiteshell Till
- Casing B = Whitemouth Lake Till
- Screen interval: Casing A 321.8-318.8 masl silty sand and sand gravel)
- Screen interval: Casing B 339.1-336.1 masl (silty clay)

RAINY RIVER

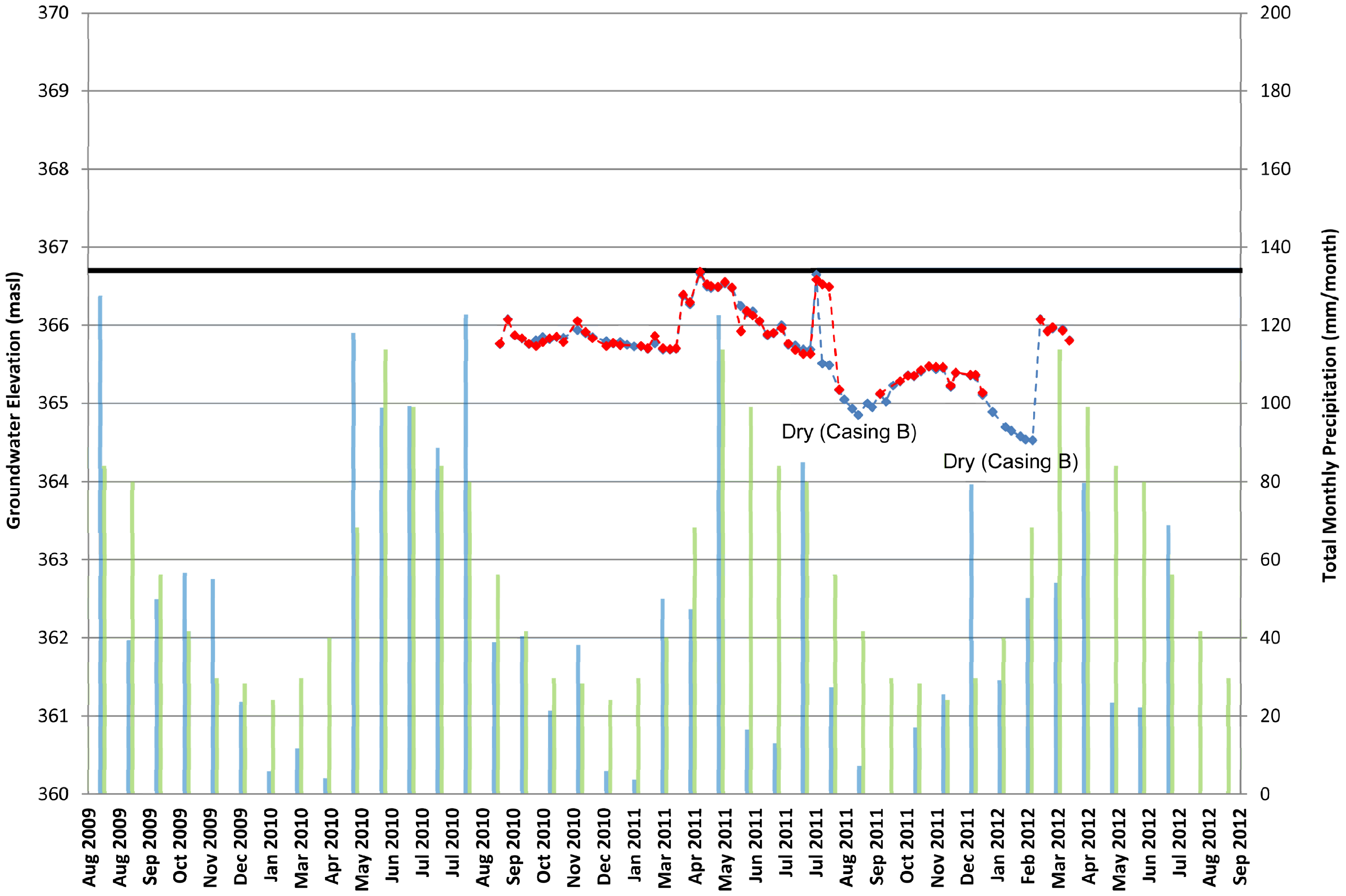
amec

RAINY RIVER GOLD PROJECT

Groundwater Level Hydrograph for BH10-11 with Nested Piezometer in Whitemouth Lake Till and Whiteshell Till

PROJECT N^{o}: TC111504	**FIGURE: 3-8**
SCALE:	DATE: March 2013

P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\GW_Hydrograph_BH10-09_Nested_4.mxd



LEGEND

- 🟦 Precipitation (Barwick)
- 🟩 Climate Normal (1971-2000)
- ━ Ground surface
- -◆- Water Level Casing A
- -◆- Water Level Casing B

NOTES:
- 2009 - 2012
- Casing A =Bedrock
- Casing B = Whiteshell Till
- Screen interval: Casing A
  364.5-363 masl (Bedrock)
- Screen interval: Casing B
  366.2-364.7 masl (Sandy Gravel)

RAINY RIVER

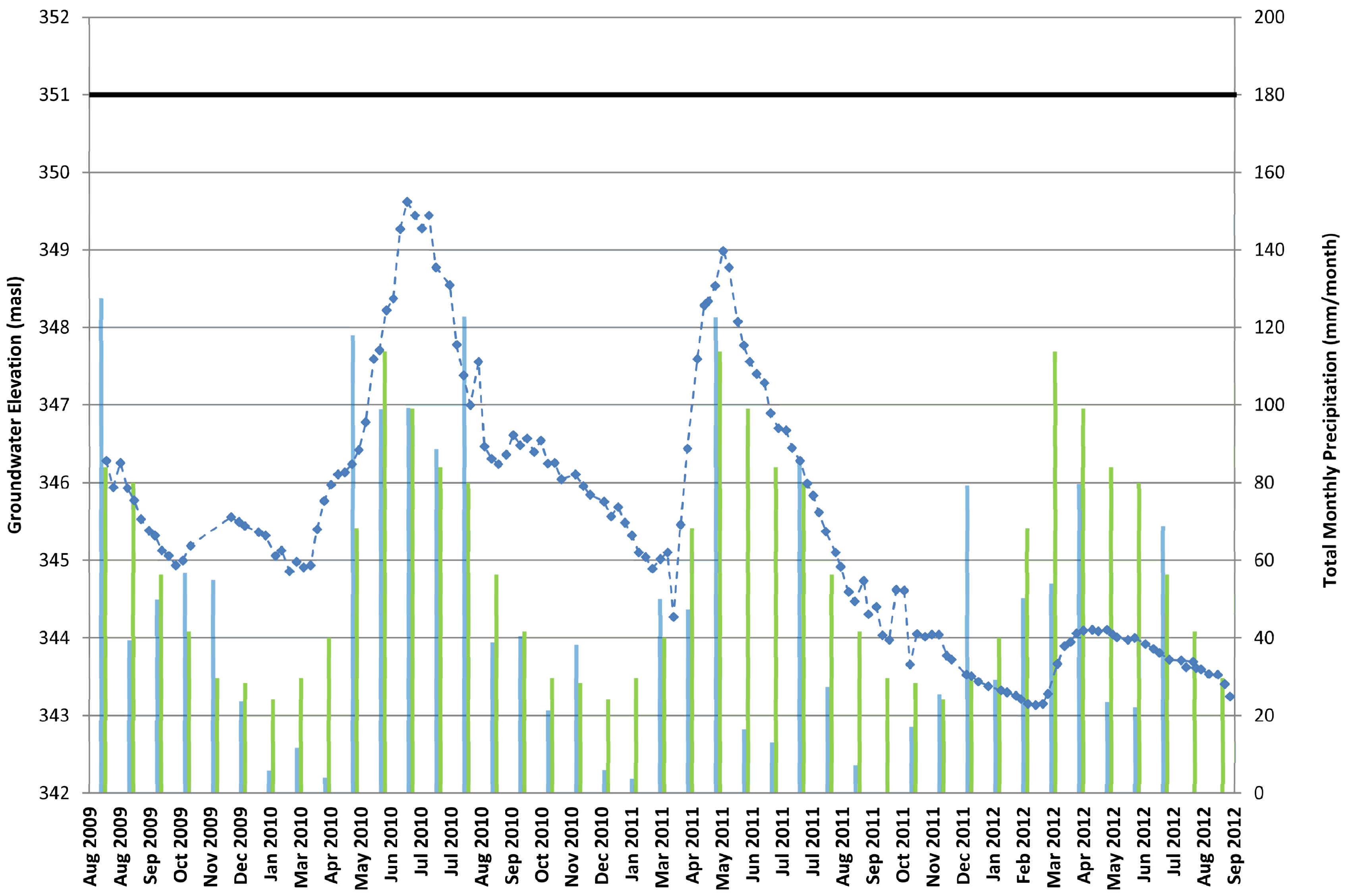
amec

RAINY RIVER GOLD PROJECT

Groundwater Level Hydrograph for BH-10-09 with Nested Piezometer in Whiteshell Till and Shallow Bedrock

PROJECT N^{o}: TC111504	**FIGURE: 3-9**
SCALE:	DATE: March 2013

P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\GW_Hydrograph_NR08287_BedrockWell_4.mxd



LEGEND

- 🟦 Precipitation (Barwick)
- 🟩 Climate Normal (1971-2000)
- ━ Ground surface
- --◆-- Water Level

NOTES:
- 2009 - 2012

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

Groundwater Level Hydrograph for NR08287 (Open Hole Well in Bedrock; 548 m Length; Dip Angle of -61^{o})

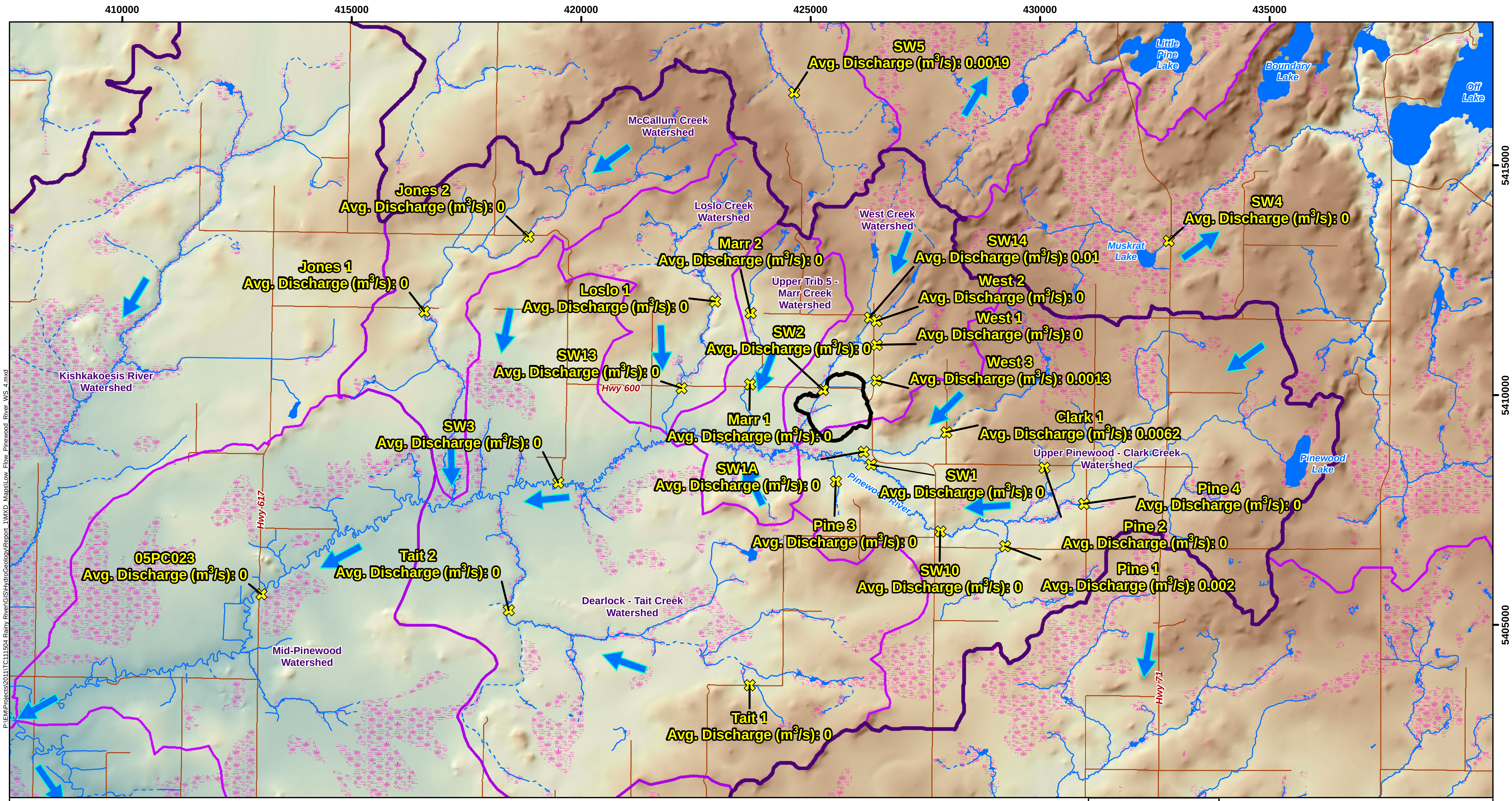
PROJECT N^{o}: TC111504

FIGURE: 3-10

SCALE:

DATE: March 2013

P:\EM\Projects\2011\TC111504 Rainy River\GIS\HydroGeology\Report_1\MXD_Maps\Low_Flow_Pinewood_River_WS_4.mxd



LEGEND

- ⬠ Approximate Open Pit Outline
- ✕ Spot Flow Measurement (Aug/Sept 2011)
- Regional Road / Highway
- Railway
- Waterbody
- Low-Lying Wetland Area
- Predominantly Perennial Watercourse
- Intermittent Watercourse
- ↖ General Surface Flow Direction

Elevation Colour Ramp
- High ground
- Low ground

- Pinewood River Watershed (approx. 57,450 ha)
- Main Project Area Watershed (approx. 20,700 ha)
- Subwatershed Areas (labelled on map)

-Upper Trib 5 - Marr Cr. approx. 1,230 ha
-Loslo Cr. approx. 1,620 ha
-West Cr. approx. 1,635 ha
-McCallum Cr. approx. 2,490 ha
-Upper Pinewood - Clark Cr. approx. 6,130 ha
-Mid-Pinewood approx. 6,530 ha
-Dearlock - Tait Cr. approx. 7,600 ha
-Kishkakoesis R. approx. 9,200 ha
-Spruce Is. approx. 9,580 ha
-Lower Pinewood approx. 11,435 ha

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR
- Ontario base data extracted from Land Information Ontario (MNR) data warehouse.
- Base data outside of Ontario extracted from ESRI USGS Topographic maps
- Watershed delineations are approximate and are derived from MNR Ontario Digital Elevation Model and Quaternary Watershed boundaries

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

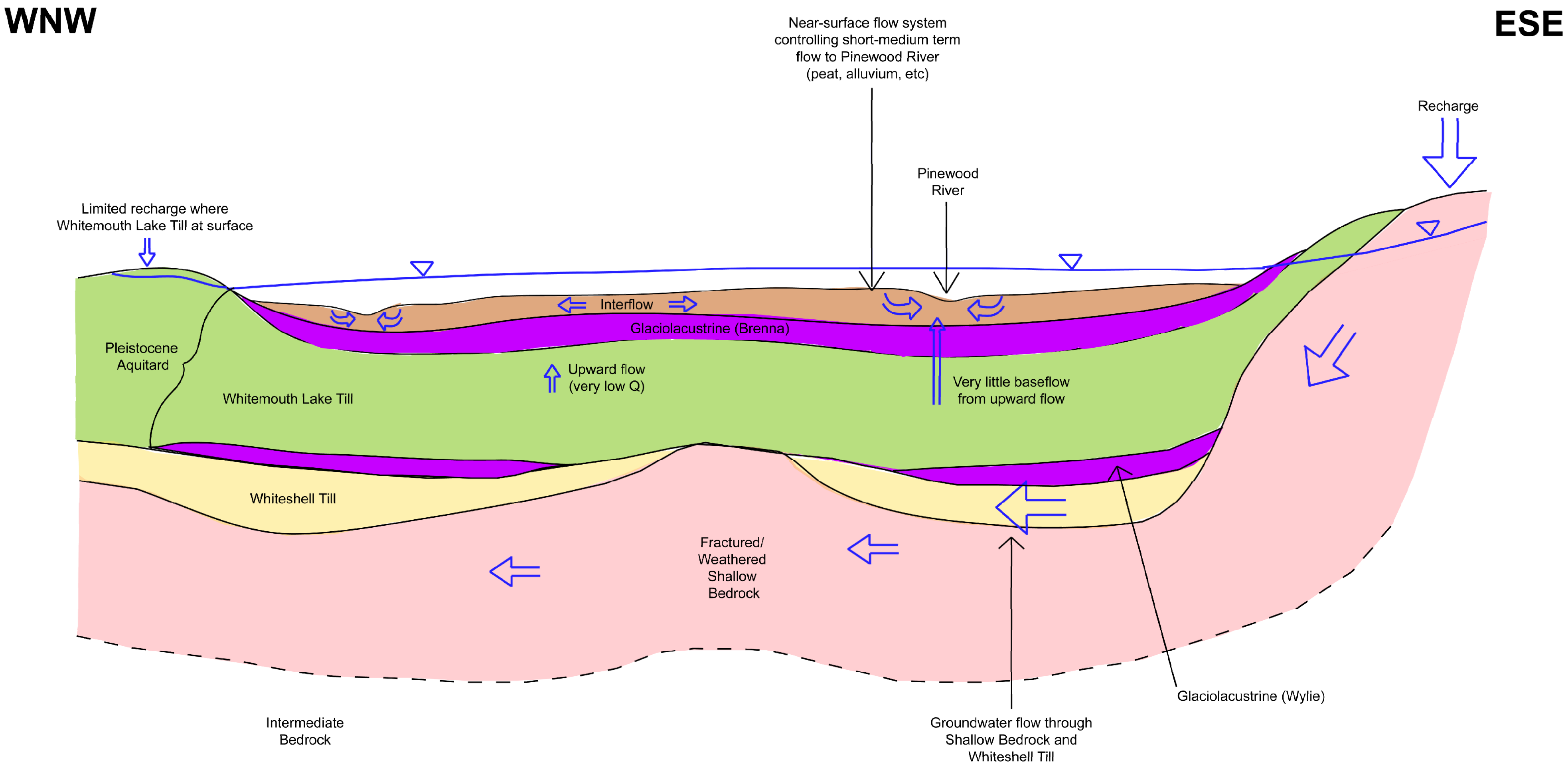
RAINY RIVER
amec

RAINY RIVER GOLD PROJECT

Low-Flow Spot Gauging, End of August, Beginning of September 2011, Pinewood River Watershed

PROJECT N°: TC111504
FIGURE: 3-11
SCALE: 1:79,000
DATE: March 2013

0 2 4 8 12 16 20
Kilometres



LEGEND

🟩	Whitemouth Lake Till (Keewatin)	🟫	Peat/alluvium	— — —	Approximate limit of fractured/weathered bedrock (10-20 m below bedrock surface)
🟨	Predominantly Whiteshell Till (Lower Pleistocene Granular Deposits)	▨	Shallow Bedrock		
🟪	Glaciolacustrine Brenna/Wylie	▽	Piezometric level (Whiteshell/ Shallow Bedrock)		

NOTES:
-

Datum: NAD83
Projection: UTM Zone 15N

WNW ESE

RAINY RIVER

amec

RAINY RIVER GOLD PROJECT

Cross Section, Conceptual Hydrogeological Model of Groundwater Flow, Pre-mining Conditions

PROJECT N^o: TC111504

FIGURE: 3-12

SCALE: As Shown

DATE: March 2013

4.0 REFERENCES

AMEC. 2012a. Rainy River Gold Project, Geotechnical and Hydrogeological Site Investigations, Rainy River, Ontario.

AMEC. 2012b. Rainy River Gold Project, Aquatic Resources 2011 Baseline Investigation.

AMEC. 2012c. Rainy River Gold Project, Rock Mass Characterization and Summary of Geomechanical Site Investigation Program 2012.

Anderson, MP and WW Woessner. 1992. Applied Groundwater Modeling. Academic Press, Inc, San Diego, CA, 381 pp.

Bajc AF. 2001. Quaternary Geology, Fort Frances – Rainy River Area. Ontario Geological Survey, Report No. 286: 52 pp.

Bostock, HS. 1970. Physiographic subdivisions of Canada. In: Geology and Economic Minerals of Canada, Geological Survey of Canada, Economic Geology Report No. 1, Part A: 9-30.

Bouwer, H and RC Rice. 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. Water Resources Research 12: 423-428.

Butler, JJ. 1998. The Design, Performance and Analysis of Slug Tests. Lewis Publishers, Boca Raton: 252 pp.

Caracle Creek International Consulting Inc.. 2008. Independent Technical Report, Rain River Property.

Duffield, GM. 2007. AQTESOLV for Windows Version 4.5 User's Guide. HydroSOLVE Inc., Reston, VA.

Environment Canada. 2012. National Climatic Data and Information Archive. http://climate.weatheroffice.gc.ca/climate_normals/index_e.html. Accessed April 2012.

Freeze, RA and JA Cherry. 1979. Groundwater. Prentice-Hall, Englewood Cliffs, New Jersey: 604 pp.

Klohn Crippen Berger. 2011. Rainy River Gold Project Baseline Report 2008-2010.

Macdonald, G. Rainy River Resources Ltd. Email communication. September 2012.

Nuinsco Resources Limited. 1997. Work Report, 1997 Reverse Circulation Drill Data.

Powers, JP, AB Corwin, PC Schmall, WE Kaeck and HC Morris. 2007. Construction Dewatering and Groundwater Control. John Wiley and Sons, Hoboken, New Jersey: 177 pp.

Rushton, KR. 2003. Groundwater Hydrology, Conceptual and Computational Models. John Wiley and Sons, Chichester, UK: 416 pp.

Quinton, WL, M Hayashi and SK Carey. 2008. Peat hydraulic conductivity in cold regions and its relation to pore size and geometry. Hydrological Processes 22: 2829-2837.

SRK Consulting. 2011. Mineral Resource Evaluation, Rainy River Gold Project, Western Ontario, Canada.

APPENDIX A

AMEC MONITORING WELL LOGS

Table A-1 Summary Details of All Monitoring Wells/Piezometers and Groundwater Level Measurements for Selected Periods

Borehole ID	UTM 15		Ground Surface Elevation (masl)	Unit	Screen (mbgs)		Water Level (masl)						Comments
	Easting	Northing			top	bottom	Sept.22nd, 2009	Sept.18th 2010	March 8th 2011	Sept.22nd, 2011	June, 2012	Oct./Nov., 2012	
Existing piezometers and open boreholes with hydrographs monitored by RRR													
NR9628	425909.4	5409444.7	353.60	BR	8.0	203.1	348.61	348.63	348.59	347.47	348.03	347.48	June 25th, 2012
NR9664	426291.5	5409563.7	365.09	BR	3.9	182.5	353.20	352.91	353.30	351.74	352.30	348.06	June 15th, 2012
NR06104	425774.0	5409380.8	353.07	BR	2.8	398.3	349.86	NA	NA	NA	NA	---	Stopped monitoring Fall of the 2009
NR06115	425446.0	5409458.0	355.00	BR	4.6	680.3	347.70	NA	NA	NA	NA	---	Stopped monitoring Fall of the 2009
NR07151	425977.0	5409314.0	352.00	BR	23.2	417.8	351.44	NA	NA	NA	NA	---	Stopped monitoring Fall of the 2009
NR07190	425622.9	5409265.0	350.42	BR	16.8	350.4	349.71	349.49	349.06	348.51	349.69	348.97	June 25th, 2012
RR09213	425850.0	5409786.0	350.00	BR	3.5	46.5	>350.27	>350.27	>350.27	>350.27	>350.27	>350.27	Bore hole dimensions taken from Klohn-Crippen-Beger Table 6.1, artesian (waterlevel higher than casing 0.27 m above ground),
NR07214	425160.0	5408952.0	347.00	BR	25.3	940.2	>347.00	>347.00	>347.00	>347.00	>347.00	>347.00	Artesian (waterlevel higher than 0 m above ground, no casing height information)
NR08246	425597.0	5409569.0	352.00	BR	28.5	542.5	---	352.38	---	351.66	351.83	350.97	Well located near a pumping station, water level in September 2009 affected by pumping, Frozen in March 2011, June 25th,
NR08257	426174.0	5409956.0	363.00	BR	12.9	729.3	357.52	356.58	NA	NA	NA	---	September 11th instead of September 18th, 2010 as this was the last reading,
NR08278	425300.0	5409540.0	351.00	BR	7.7	514.8	349.36	348.87	NA	NA	NA	---	September 11th instead of September 18th, 2010 as this was the last reading,
NR08287	426316.0	5409249.0	351.00	BR	22.5	451.7	345.53	346.24	345.10	344.73	343.97	342.11	June 15th, 2012
NR09367	425814.0	5410139.0	352.00	BR	23.5	322.1	---	---	---	>352.50	>352.50	>352.50	Artesian (waterlevel higher than 0 m above ground, no casing height information), not monitored prior to June 28th, 2011,
NR09428	425835.0	5409700.0	350.00	BR	21.5	409.5	---	---	---	>350.38	>350.38	>350.38	Artesian (waterlevel higher than casing 0.38 m above ground), not monitored prior to June 28th, 2011,
BH10-04	425813.5	5410648.6	358.14	WS	18.5	21.5	---	355.44	---	354.83	---	---	Monitoring begins on September 18th, 2010, no access to site in March 2011, no access to site after March 31st 2012,
BH10-05	426397.3	5411994.8	373.28	WML	3.0	6.0	---	372.89	372.62	371.37	372.33	---	Monitoring begins on September 18th, 2010, June 15, 2012,
BH10-06	426901.3	5411494.2	375.50	WML	3.6	6.6	---	374.76	---	374.14	---	373.48	Monitoring begins on September 18th, 2010, Frozen in March of 2011, no access after March 31st, 2012, October 29th, 2012
BH10-07A	424608.6	5411634.2	353.27	WML	22.0	25.0	---	>354.21	>354.21	>354.21	>354.21	353.41	Artesian (waterlevel higher than casing 0.93 m above ground), monitoring begins on September 18th, 2010, October 31st, 2012
BH10-07B	424608.5	5411634.2	353.27	WML	1.4	4.4	---	>354.33	---	>354.33	>354.33	355.12	Artesian (waterlevel higher than casing 1.04 m above ground), monitoring begins on September 18th, 2010, Frozen in March of 2011, October 31st, 2012, Artesian conditions above well stick up, measured with an extention
BH10-08A	423987.7	5411777.5	358.14	WML	3.7	6.7	---	357.95	357.12	356.46	357.43	357.41	Monitoring begins on September 18th, 2010, June 15, 2012, October 29th, 2012
BH10-08B	423987.7	5411777.5	358.14	A	11.7	14.7	---	358.23	---	357.96	357.32	356.82	Monitoring begins on September 18th, 2010, March 1st (frozen March 8th), June 15th, 2012, October 29th, 2012
BH10-09A	423949.4	5412734.9	366.70	BR	2.2	3.7	---	365.96	365.89	365.20	---	365.67	Monitoring begins on September 18th, 2010, no site access, October 31st, 2012
BH10-09B	423949.5	5412734.9	366.70	WS	0.5	2.0	---	365.97	365.90	DRY	---	365.69	Monitoring begins on September 18th, 2010, no measurement on record in June 2012, October 31st, 2012
BH10-10A	425986.5	5409979.8	350.15	WML	27.2	30.2	---	351.06	---	>351.07	>351.07	351.01	Artesian (waterlevel higher than casing 0.86 m above ground), Monitoring begins on September 18th, 2010, Frozen in March of 2011, October 30th, 2012
BH10-10B	425986.5	5409980.0	350.15	WML	9.8	12.8	---	351.21	---	350.52	351.22	350.19	Monitoring begins on September 18th, 2010, Frozen in March of 2011, June 25th, 2012, October 30th, 2012
BH10-11A	424736.3	5409865.5	348.50	WS	26.7	29.7	---	349.55	---	349.08	349.23	349.28	Monitoring begins on September 18th, 2010, Frozen in March of 2011, June 15th, 2012, October 29th, 2012
BH10-11B	424736.3	5409865.5	348.50	WML	9.4	12.4	---	349.16	---	348.55	348.60	348.29	Monitoring begins on September 18th, 2010, Frozen in March of 2011, June 15th, 2012, October 29th, 2012
BH10-12A	423964.1	5410512.2	351.94	WS/BR	16.5	19.5	---	>352.89	>352.89	>352.89	>352.89	352.79	Artesian (waterlevel higher than casing 0.85 m above ground), Monitoring begins on September 18th, 2010, Frozen in March of 2011, October 29th, 2012
BH10-12B	423964.0	5410512.2	351.94	WML	6.0	9.0	---	350.40	350.47	350.64	350.95	349.63	Monitoring begins on September 18th, 2010, June 15, 2012, October 29th, 2012
BH10-13	425432.6	5409306.5	349.47	WS	16.3	19.3	---	349.15	349.21	348.63	348.75	348.52	Monitoring begins on September 18th, 2010, June 15, 2012, October 30th, 2012

Borehole ID	UTM 15		Ground Surface Elevation (masl)	Unit	Screen (mbgs)		Water Level (masl)						Comments
	Easting	Northing			top	bottom	Sept.22nd, 2009	Sept.18th 2010	March 8th 2011	Sept.22nd, 2011	June, 2012	Oct./Nov., 2012	
BH10-14	425173.1	5408923.5	346.84	WML/WS	16.5	19.5	---	>347.81	---	>347.81	>347.81	>347.81	Artesian (waterlevel higher than casing 0.85 m above ground), Monitoring begins on September 18th, 2010, Frozen in March of 2011, June 25th, 2012, October 31st, 2012, Artesian conditions above well stick up.
BH10-15	425241.2	5409399.8	349.65	WML/WS	15.5	18.5	---	348.64	---	348.40	348.79	348.75	Monitoring begins on September 18th, 2010, broken casing in March of 2011, June 25th, 2012, October 30th, 2012
Piezometers installed by AMEC 2011/2012													
BH11-04	421970.3	5411831.8	365.477	BR	13.4	16.5	---	---	---	---	360.71	359.74	June 8th, 2012, October 30th, 2012
BH11-08A	423205.2	5411863.4	356.564	BR	24.0	25.5	---	---	---	---	358.20	357.04	June 16th, 2012, October 31st, 2012
BH11-08B	423205.2	5411863.4	356.564	WS	19.8	21.3	---	---	---	---	356.77	---	June 16th, 2012, October 31st, 2012, Well under the influence of surface water
BH11-08C	423205.2	5411863.4	356.564	WML	4.6	6.1	---	---	---	---	356.86	---	June 16th, 2012, October 31st, 2012, Water level at top of casing
BH11-09A	424201.0	5411181.8	351.277	WML	4.6	6.1	---	---	---	---	350.29	---	June 11th, 2012
BH11-11A	425205.3	5410762.9	360.00	BR	36.3	37.8	---	---	---	---	354.58	354.41	June 10th, 2012, October 30th, 2012
BH11-11B	425205.3	5410762.9	360.00	WS	32.8	34.3	---	---	---	---	354.57	354.43	June 10th, 2012, October 30th, 2012
BH11-11C	425205.3	5410762.9	360.00	GS	6.1	7.6	---	---	---	---	355.71	354.84	June 10th, 2012, October 30th, 2012
BH11-12A	425311.2	5411177.9	355.723	BR	22.5	27.0	---	---	---	---	354.37	354.08	June 11th, 2012, October 29th, 2012
BH11-12B	425311.2	5411177.9	355.723	WML	4.6	6.1	---	---	---	---	354.98	355.30	June 11th, 2012, October 29th, 2012
BH11-13A	422597.1	5410290.3	347.063	LGL/BR	19.8	22.8	---	---	---	---	351.06	350.38	June 11th, 2012, October 30th, 2012
BH11-13B	422597.1	5410290.3	347.063	WML	13.4	14.9	---	---	---	---	348.98	347.62	June 11th, 2012, November 1st, 2012
BH11-17	424758.1	5410114.4	349.346	WML	10.7	12.2	---	---	---	---	349.96	349.84	June 11th, 2012, October 29th, 2012
BH11-19A	426009.5	5409287.1	350.323	BR	28.5	30.1	---	---	---	---	348.79	348.91	June 11th, 2012, October 30th, 2012
BH11-19B	426009.5	5409287.1	350.323	LGL/WS	22.8	24.3	---	---	---	---	348.79	348.91	June 11th, 2012, October 30th, 2013
BH11-19C	426009.5	5409287.1	350.323	WML	4.6	6.1	---	---	---	---	349.27	348.84	June 11th, 2012, October 30th, 2014
BH11-20A	425891.5	5410232.5	352.093	LGL/WS	25.0	26.5	---	---	---	---	---	352.31	October 30th, 2015 - Water Level measured on several days, but is very variable
BH11-20C	425891.5	5410232.5	352.093	UG	1.5	3.0	---	---	---	---	351.42	---	June 8th, 2012
BH11-21A	425054.7	5408465.6	346.495	BR	37.8	39.3	---	---	---	---	348.18	---	June 14th, 2012 Water Level inconsistent between two measurements with no explanation, October 31st, 2012, Frozen
BH11-21B	425054.7	5408465.6	346.495	WML	16.8	18.3	---	---	---	---	348.10	---	June 14th, 2012, October 31st, 2012, Well under the influence of surface water
BH11-21C	425054.7	5408465.6	346.495	WML	7.6	9.1	---	---	---	---	345.80	---	June 13th, 2012, October 31st, 2012, Frozen
BH11-22	424953.5	5409907.9	348.996	BR	20.0	21.5	---	---	---	---	348.48	348.59	June 14th, 2012, October 30th, 2012
BH11-23A	425704.3	5409645.2	348.143	WS	36.3	37.8	---	---	---	---	347.92	348.02	June 14th, 2012, October 30th, 2012
BH11-23B	425704.3	5409645.2	348.143	UG	2.8	4.2	---	---	---	---	347.55	347.57	June 14th, 2012, October 30th, 2012
BH11-24A	426940.0	5408843.0	354.00	BR	18.3	22.8	---	---	---	---	353.78	353.04	June 8th, 2012, October 29th, 2012
BH11-24B	426940.0	5408843.0	354.00	WML	10.7	12.2	---	---	---	---	353.46	352.97	June 8th, 2012, October 29th, 2012
BH11-25	427302.2	5409121.8	358.780	WS	23.6	25.1	---	---	---	---	358.51	358.32	June 15th, 2012, October 29th, 2012
BH11-27	427268.7	5408603.3	355.103	WS	25.9	28.9	---	---	---	---	354.40	353.80	June 8th, 2012, November 1st, 2012
BH11-28	426325.2	5408217.7	349.444	WML	15.2	16.7	---	---	---	---	351.99	352.02	June 13th, 2012, October 31st, 2012
BH11-29	424525.6	5408528.1	345.784	WML	24.4	25.9	---	---	---	---	346.44	>345.78	June 15th, 2012, October 31st, 2012, Water level at top of casing
BH11-33A	425585.7	5408476.3	346.707	BR	42.4	43.9	---	---	---	---	347.55	348.04	June 13th, 2012, October 31st, 2012
BH11-33B	425585.7	5408476.3	346.707	WML	12.2	13.7	---	---	---	---	346.48	---	June 14th, 2012, Well under the influence of surface waterWater level at top of casing
BH11-34A	426102.3	5408419.0	347.648	BR	35.1	36.6	---	---	---	---	348.81	347.80	June 14th, 2012, October 31st, 2012
BH11-34B	426102.3	5408419.0	347.648	WML	9.2	10.6	---	---	---	---	347.40	347.53	June 14th, 2012, October 31st, 2012
BH11-35	426305.8	5410895.8	370.255	BR	11.8	13.3	---	---	---	---	362.85	361.60	June 11th, 2012, October 29th, 2012
BH11-36	426935.6	5410792.0	374.669	WS	5.2	6.7	---	---	---	---	---	---	Dry , October 29th, 2012, Dry
BH11-37	426657.8	5410527.7	369.991	BR	1.2	2.8	---	---	---	---	367.38	367.29	June 13th, 2012, October 29th, 2012
BH11-38	426927.5	5410377.4	371.593	WS	19.2	20.7	---	---	---	---	367.80	367.43	June 11th, 2012, October 29th, 2012
BH11-40	425356.1	5411994.4	370.100	BR	10.0	11.6	---	---	---	---	363.53	363.20	June 12th, 2012, October 29th, 2012
BH11-41	424215.0	5410296.0	350.444	WS	14.8	16.3	---	---	---	---	351.83	350.63	June 9th, 2012, October 30th, 2012
BH11-44A	426559.7	5408621.6	348.812	BR	16.2	17.7	---	---	---	---	348.82	349.41	June 9th, 2012, November 1st, 2012
BH11-44B	426559.7	5408621.6	348.812	UG	5.6	6.1	---	---	---	---	347.69	347.22	June 9th, 2012, October 29th, 2012

Borehole ID	UTM 15		Ground Surface Elevation (masl)	Unit	Screen (mbgs)		Water Level (masl)						Comments
	Easting	Northing			top	bottom	Sept.22nd, 2009	Sept.18th 2010	March 8th 2011	Sept.22nd, 2011	June, 2012	Oct./Nov., 2012	
BH11-50A	421550.9	5411071.0	361.591	BR	11.9	12.4	---	---	---	---	355.69	352.34	June 8th, 2012, October 30th, 2012
BH11-50B	421550.9	5411071.0	361.591	WML	3.0	4.5	---	---	---	---	360.57	359.52	June 8th, 2012, October 30th, 2012
BH11-51A	421543.2	5410423.4	351.539	BR	17.4	18.9	---	---	---	---	---	351.81	Water Level measured on several days, but is very variable, October 30th, 2012
BH11-51B	421543.2	5410423.4	351.539	WML	10.7	12.2	---	---	---	---	350.44	351.32	June 16th, 2012, October 30th, 2012
Monitored Private Wells (RRR Property)													
P3 / W11 (WWR 5400852)	419831	5410156	356.00	BR	15.2	32.3	---	---	---	---	351.97	351.62	June, 2012, Broken small shack
P7 (WWR 5400723)	421018	5410160	358.00	WS	21.3	21.3	---	---	---	---	352.87	352.04	June, 2012, WWR 5400723*
P8 (WWR 5401590)	423846	5410238	350.00	WS	23.5	23.5	---	---	---	---	---	---	June, 2012, Artesian, underground drain build into well casing to keep it from overflowing, Well under artesian pressure, but WL controlled by underground
P9 (WWR 5401835)	426165	5410281	363.00	WS	9.8	9.8	---	---	---	---	357.33	357.36	June, 2012, Two wells on the property (P9 and W5). Notes for the drilled well. WWR 5401835*
P13 / W9 (WWR 5401899)	424000	5411174	354.00	WS	10.4	10.4	---	---	---	---	353.01	352.64	June, 2012, WWR 5401899*
P14 (WWR 5400730)	426476	5411194	366.00	WS	18.9	18.9	---	---	---	---	358.15	357.83	June, 2012, WWR 5400730
P16 (WWR 5401589)	426336	5411643	371.00	BR	6.7	62.8	---	---	---	---	<340.77	338.17	June, 2012, Water level deeper than length of water level tape (30.60m). WWR 5401589* (60m tape used in Oct/Nov)
P19 (WWR 7133351)	424808	5411918	365.00	BR	7.6	38.1	---	---	---	---	358.00	357.49	June, 2012, RR core storage well. A070581. WWR 7133351*
P21B (WWR 5400481)	426828	5408280	349.00	WS	12.2	12.2	---	---	---	---	349.56	---	June, 2012, Artesian - flowing through outlet on side of concrete well casing outlet at 0.56 mabgs
RR1 (WWR 5401081)	426042	5406960	373.00	BR	3.4	31.7	---	---	---	---	368.22	367.21	June, 2012, RRR student house. WWR 5401079 or 5401081*
W1 (WWR 7150801)	424748	5409649	348.00	WS/BR	31.4	32.3	---	---	---	---	348.99	349.10	June, 2012, TW10-04. A091516
W2 (WWR 7150805)	425717	5409717	349.00	WS/BR	28.0	28.3	---	---	---	---	348.92	349.02	June, 2012, TW10-01. A091513
W7 (WRR 7150803)	425680	5409713	349.00	WS	23.5	23.5	---	---	---	---	349.29	349.38	June, 2012, TW10-02 A091514
W8 (WWR 5401149)	423479	5411625	358.00	WS	13.1	13.1	---	---	---	---	356.06	355.62	June, 2012, WWR 5401149
W10 (WWR 7133352)	424881	5411906	364.00	BR	8.5	74.7	---	---	---	---	352.99	356.09	June, 2012, RR core storage well. A070580*. WWR 7133352* Likley under influence of core shack operations.
W12 (WWR 7150802)	424738	5409697	348.00	WS	28.0	28.7	---	---	---	---	348.93	---	June, 2012
Piezometers installed by AMEC 2012													
BH12-01	421733	5413954	374.73	WS	6.3	11.9	---	---	---	---	---	---	
BH12-03	420323	5411646	362.57	WML/WS/BR	7.6	12.8	---	---	---	---	---	361.87	October 30th, 2012
BH12-04	422926	5411848	357.35	WS/BR	24.7	29.7	---	---	---	---	---	356.11	October 31st, 2012
BH12-07	424542	5412438	371.54	WML/LGL/WS	10.4	15.7	---	---	---	---	---	360.60	October 31st, 2012
BH12-08	425109	5411603	359.50	WML/LGL/WS/BR	15.2	19.8	---	---	---	---	---	354.49	October 29th, 2012
BH12-09	422612	5409548	347.42	WML/LGL/WS	21.2	24.7	---	---	---	---	---	---	October 30th, 2012, Frozen
BH12-10	424069	5409003	345.23	WML	21.7	25.1	---	---	---	---	---	---	October 31st, 2012, Frozen
BH12-13	425767	5409437	353.63	WML/WS	7.1	10.7	---	---	---	---	---	350.62	October 30th, 2012
BH12-14	425420	5409536	354.13	WML/WS/BR	4.9	10.2	---	---	---	---	---	348.72	October 30th, 2012
BH12-15	426116	5409732	351.34	WML/WS	36.1	40.1	---	---	---	---	---	350.33	October 30th, 2012
BH12-17	424634	5409329	346.59	LGL/WS	25.8	32.0	---	---	---	---	---	348.90	October 30th, 2012
BH12-18	424521	5409745	348.38	WS	28.9	33.7	---	---	---	---	---	348.87	October 30th, 2012

Borehole ID	UTM 15		Ground Surface Elevation (masl)	Unit	Screen (mbgs)		Water Level (masl)						Comments
	Easting	Northing			top	bottom	Sept.22nd, 2009	Sept.18th 2010	March 8th 2011	Sept.22nd, 2011	June, 2012	Oct./Nov., 2012	
BH12-19	425255	5410368	351.19	BR	31.2	34.3	---	---	---	---	---	351.20	October 30th, 2012
BH12-20	421225	5411780	362.40	WS/BR	21.3	28.4	---	---	---	---	---	363.19	October 30th, 2012
BH12-21	427995	5409431	372.77	UG/WS/BR	4.6	8.2	---	---	---	---	---	---	
BH12-22	428190	5410257	379.37	WML/LGL/WS/BR	11.3	16.1	---	---	---	---	---	---	
BBAF-BH-2002	426778	5410217	369.76	UG/WML/BR	1.2	6.3	---	---	---	---	---	---	
BBAF-BH-2015	426591	5410507	368.45	UG/WS/BR	1.2	6.1	---	---	---	---	---	---	
BBAF-BH-2051	426591	5410538	368.51	UG/WS/BR	0.5	4.0	---	---	---	---	---	---	
BBAF-BH-2054	426572	5410874	372.20	WS/BR	3.7	8.5	---	---	---	---	---	---	
BBAF-BH-2061	426687	5411001	374.06	LGL/BR	6.4	11.2	---	---	---	---	---	---	
BBAF-BH-2063	426562	5411008	372.40	UG/BR	0.6	4.3	---	---	---	---	---	---	
BBAF-BH-2065	426758	5411099	375.94	WML/WS/BR	4.3	9.2	---	---	---	---	---	---	
BBAF-BH-2069	426442	5411089	363.24	WML/WS/BR	22.0	27.1	---	---	---	---	---	---	
BBAF-BH-2073	426547	5411158	367.51	WML/BR	11.6	16.9	---	---	---	---	---	---	
BBAF-BH-2076	426698	5410335	365.06	WS/BR	13.4	19.1	---	---	---	---	---	---	
BH-04	426759	5410181	369.08	WS/BR	15.3	18.4	---	---	---	---	---	---	
BH-05	426804	5410210	371.00	WS/BR	5.0	8.0	---	---	---	---	---	---	
BH-07	426807	5410185	369.49	WS/BR	13.6	20.0	---	---	---	---	---	---	

*** Interpreted stratigraphic units for the piezometer interval**
GL = Glaciolacustrine sediments, either from the Wylie or the Brenna Formations
GS = Glacial sand, most likely from the Brenna Formation
WML = Whitelake Mouth Till
WS = Whiteshell Till
BR = Bedrock

**** Hydrostratigraphic units for which the groundwater conditions at the piezometer interval are considered representative**
NSS = Near-surface system
PA = Pleistocene aquitard (in this case all Whitemouth Lake Till)
PLGD = Pleistocene lower granular deposits; in this case all Whiteshell Till, with the exception of BH11-21A which is interpreted as glacial sand; always assumed to be more dominant than shallow bedrock, when screen overlaps both
SBR = Shallow Bedrock
BR = Undifferentated bedrock

RECORD OF BOREHOLE No. BH11-01

PAGE 1 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	SM
ELEVATION	362.945 m	COORD.	N 5,413,209 E 420,171	BORING DATE	Start: Apr 12, 12 End: Apr 13, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

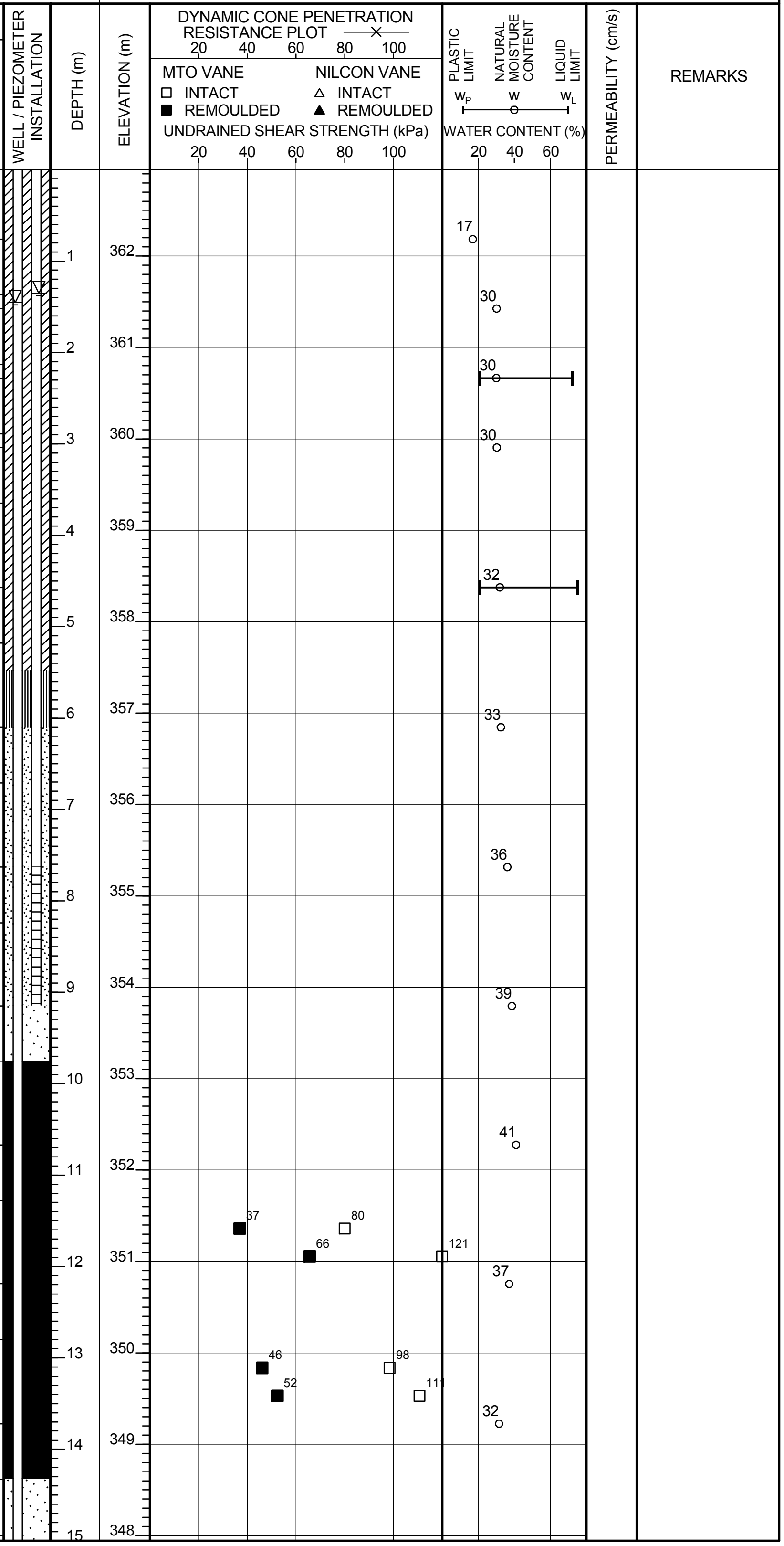
ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
362.9	Ground surface
0.0	**Silty CLAY** Light Brown silty clay, trace to some sand, trace gravel, low to medium plasticity, stiff, moist [Upper Glaciolacustrine]
359.9 3.0	**Silty CLAY** Dark brown silty clay, trace gravel, medium plasticity, stiff, moist [WML Till] ...becoming firm at 7.6m
348.9 14.0	**SILTY CLAY**
348.6 14.3	Dark grey silty clay, varved, low plastic, firm, moist [Lower Glaciolacustrine]

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
2	SS	67	9
3	SS		12
4	SS	100	12
5	SS	100	11
8	SS	100	11
11	SS	100	10
14	SS	100	8
17	SS	100	8
18	SS	100	7
21	SS	100	6
24	SS	100	8
25	RC	95	63



Continued on Next Page

RECORD OF BOREHOLE No. BH11-01

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Tailings Management Area
COMPILED BY SM
ELEVATION 362.945 m
COORD. N 5,413,209 E 420,171
BORING DATE Start: Apr 12, 12 End: Apr 13, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger
BU	Bulk
DC	Dynamic Cone
RC	Rock Core
SS	Split Spoon
TW	Thin Walled Open (Shelby)
WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer
U.W.	Wet Unit Weight
PT	Standard Proctor Test
P.L.	Point Load Strength Index (I_{50})
RQD	Rock Quality Designation
SCR	Solid Core Recovery
k	Permeability
C	Consolidation
DS	Direct Shear
GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
	BEDROCK												
								16	347				
			26	RC	100	88		17	346				
344.7			27	RC	100	80		18	345				
18.2	**End of Borehole** at 18.2m Standpipes installed with flush mounted steel casing Water level (b.g.s): For Piezometer A (bottom sensing zone) at 0.3m on April 13/12 For Piezometer B (top sensing zone) at surface on April 13/12												

RECORD OF BOREHOLE No. BH11-04

PAGE 1 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring
				LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area	COMPILED BY	SM
ELEVATION	365.477 m	COORD.	N 5,411,832 E 421,970	BORING DATE	Start: Mar 20, 12 End: Mar 20, 12
				CHECKED BY	DGR

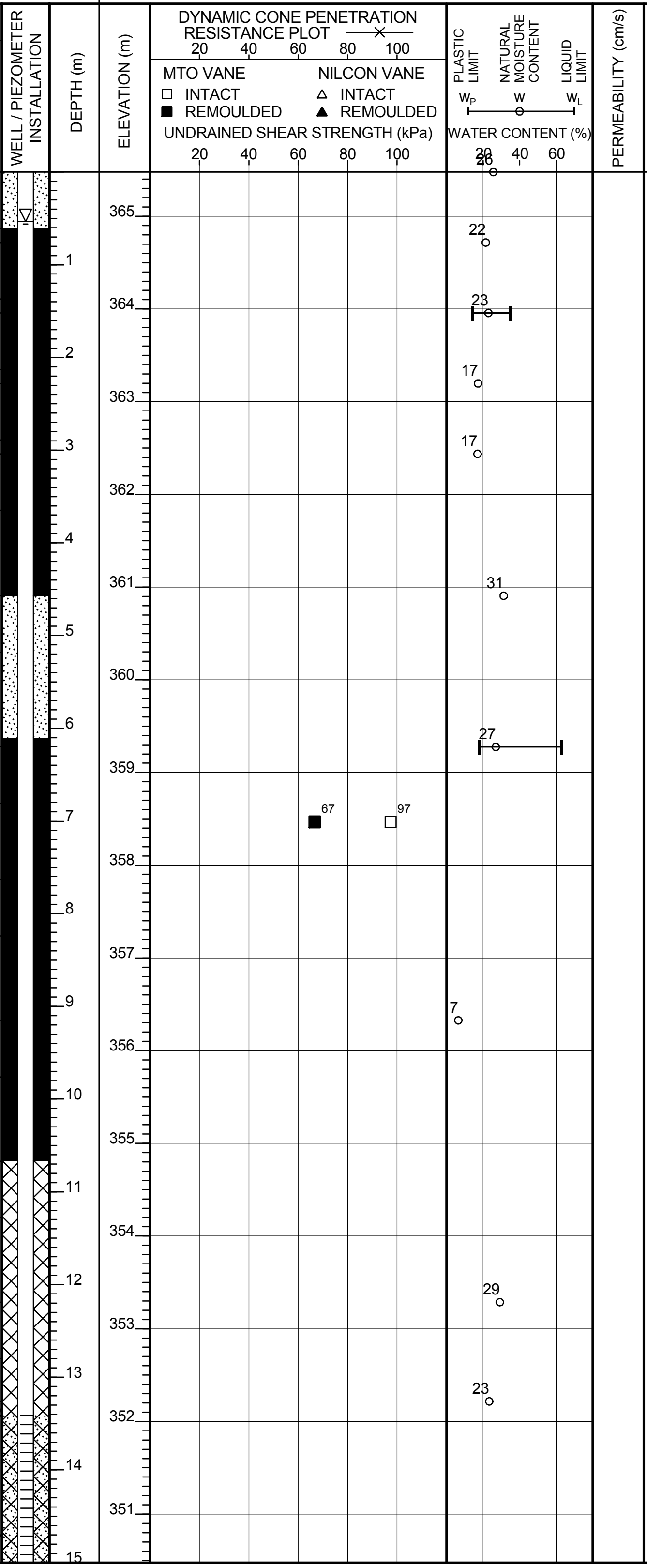
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
365.5	Ground surface					
365.5 0.0 365.3 0.2	**TOPSOIL** Dark brown organics, fibrous, rootlets	1	SS	63	4	
	CLAYEY SILT Light Brown to brown clayey silt, some sand and gravel, varved, low to medium plasticity, stiff, damp to moist [Upper Glaciolacustrine] ...at 0.76 m becoming sandy , grey clay lenses ...at 2.3m , trace mottled brown lenses	2	SS	63	10	
		3	SS	100	10	
		4	SS	100	10	
		5	SS	100	11	
360.9 4.6	**Silty CLAY** Dark grey silty clay, trace sand, high plasticity, firm, moist [WML Till]	6	SS	100	8	
		8	SS	92	8	...at 6.4m PP=49-61 kPa TV=20 KPa
357.9 7.6	**SILTY CLAY** Greenish grey silty clay , varved [Lower Glaciolacustrine]	11	TW	91		
356.3 9.1	**SAND & GRAVEL** Greenish grey sand and gravel, silty, angular to subangular (black, grey and brown, granite pebbles), dense, wet ...below 12.2m greenish silt, trace gravel, no plasticity, firm, moist	13	SS	63	39	...at 9.1 m switched to washboring
		14	SS	0	67	
		15	SS	54	15	
		16	SS	58	50/0.15	
352.1 13.4	**BEDROCK** Greenish grey , highly fractured and weathered	17	RC	35	44	...at 13.7 m switched to NQ coring



Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-04

PAGE 2 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	SM
ELEVATION	365.477 m	COORD.	N 5,411,832 E 421,970	BORING DATE	Start: Mar 20, 12 End: Mar 20, 12	CHECKED BY	DGR

SAMPLE TYPES
- AU Auger
- BU Bulk
- DC Dynamic Cone
- RC Rock Core
- SS Split Spoon
- TW Thin Walled Open (Shelby)
- WS Wash Sample

ABBREVIATIONS
- P.P. Pocket Penetrometer
- U.W. Wet Unit Weight
- PT Standard Proctor Test
- P.L. Point Load Strength Index (I_{50})
- RQD Rock Quality Designation
- SCR Solid Core Recovery
- k Permeability
- C Consolidation
- DS Direct Shear
- GS Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
349.2	... very mushy bellow 14.7 m, possible infill	▨	18	RC	60	0	▨	16	350				
16.2	**End of Borehole** at 16.2 m Standpipe installed with flush mounted steel casing Water level (b.g.s): at 0.48 m on Mar 20/12												

amec

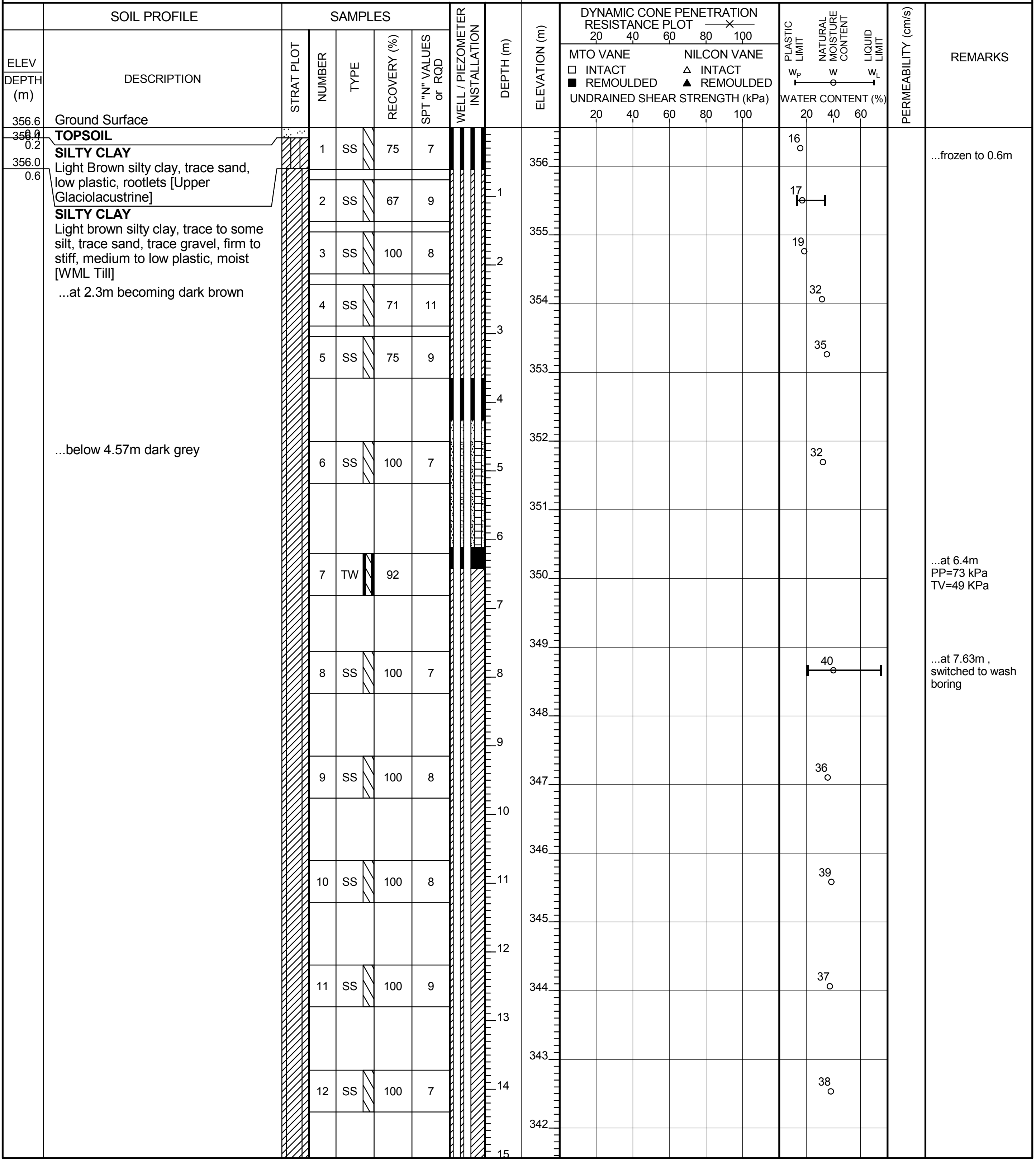
RECORD OF BOREHOLE No. BH11-08

PAGE 1 OF 2

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Flotation Tailings
COMPILED BY SM
ELEVATION 356.564 m
COORD. N 5,411,863 E 423,205
BORING DATE Start: Dec 13, 11 End: Dec 16, 11
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis



ELEV DEPTH (m)	DESCRIPTION
356.6	Ground Surface
356.4 0.0	**TOPSOIL**
0.2	**SILTY CLAY** Light Brown silty clay, trace sand, low plastic, rootlets [Upper Glaciolacustrine]
356.0 0.6	**SILTY CLAY** Light brown silty clay, trace to some silt, trace sand, trace gravel, firm to stiff, medium to low plastic, moist [WML Till] ...at 2.3m becoming dark brown ...below 4.57m dark grey

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
1	SS	75	7	16	...frozen to 0.6m
2	SS	67	9	17	
3	SS	100	8	19	
4	SS	71	11	32	
5	SS	75	9	35	
6	SS	100	7	32	
7	TW	92			...at 6.4m PP=73 kPa TV=49 KPa
8	SS	100	7	40	...at 7.63m , switched to wash boring
9	SS	100	8	36	
10	SS	100	8	39	
11	SS	100	9	37	
12	SS	100	7	38	

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-08

PAGE 2 OF 2

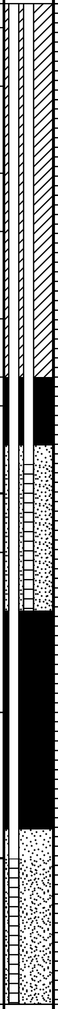
PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD 200 mm HSA, NQ Coring	LOGGED BY PDR
CLIENT	Rainy River Resources.	LOCATION	Flotation Tailings		COMPILED BY SM
ELEVATION	356.564 m	COORD.	N 5,411,863 E 423,205	BORING DATE Start: Dec 13, 11 End: Dec 16, 11	CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE □ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
		13	TW	100			341			...at 15.25m TV=78 kPa PP=98 kPa
						16	340			
	...At 16.77m , sandy lenses/laminate	14	SS	100	9	17		28		
338.3						18	339			
18.3	**Varved SILTY CLAY** Grey silty clay , moist to wet, varved, medium plastic, very stiff [Lower Glaciolacustrine]	15	SS	100	15		338	37		GS on SS15
337.4 19.2	**Gravelly SAND** Sand boulders, some cobbles in silty sand, very wet [WS Till, inferred]	16	RC	67		19	337			...switched to NQ coring at 19.2m
		17	RC	67		20	336			
334.6		18	RC	47	88	21	335			
22.0	**BEDROCK**	19	RC	100	97	22 23	334 333			
331.1		20	RC	97	95	24 25	332			
25.5	**End of Borehole** at 25.5m Standpipes installed with flush mounted steel casing Water level (b.g.s): For Piezometer A (bottom sensing zone) at surface on Dec 16/11 For Piezometer B (middle sensing zone) Artesian condition on Dec 16/11 For Piezometer C (top sensing zone) 3.05 m on Dec 16/11									



Format: AMEC GEO MWSK File: TC113921_BHLOGS_20120405.GPJ Date: 7/10/2012 1:29:00 PM

RECORD OF BOREHOLE No. BH11-09

PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD 200 mm HSA, NQ Coring	LOGGED BY SM
CLIENT	Rainy River Resources.	LOCATION	Flotation Tailings	COMPILED BY	SM
ELEVATION	351.277 m	COORD.	N 5,411,182 E 424,201	BORING DATE Start: Dec 10, 11 End: Dec 11, 11	CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

SOIL PROFILE

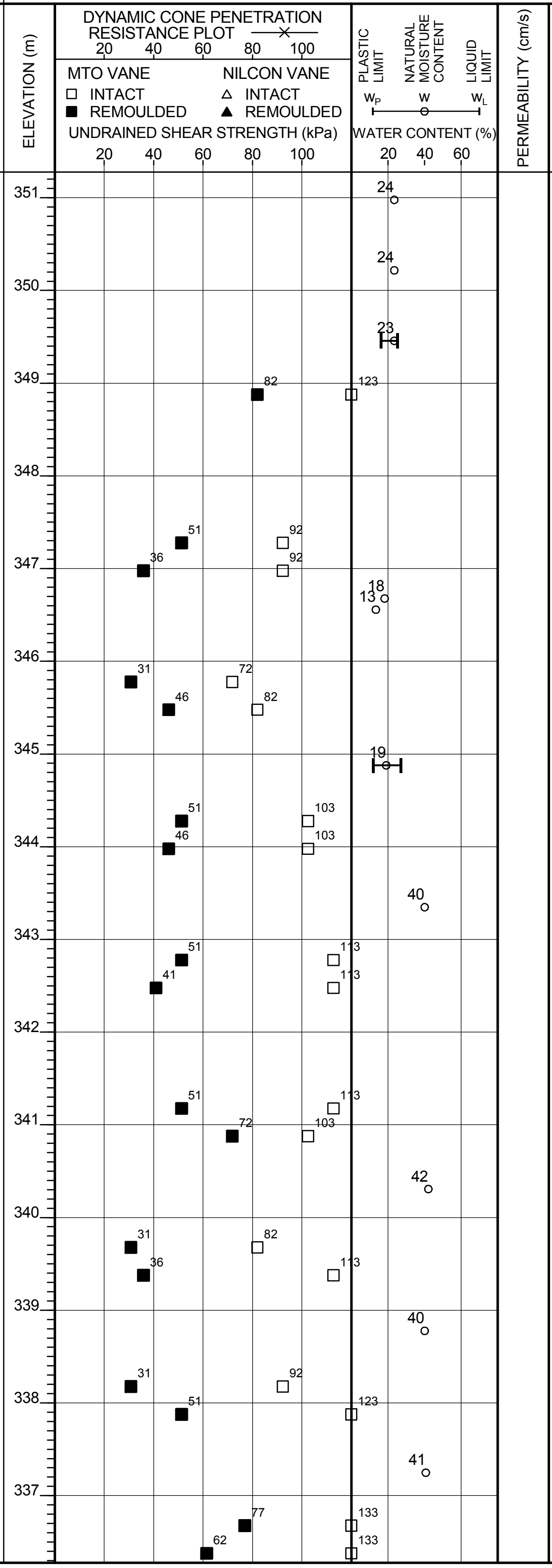
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT
351.3	Ground Surface	
0.0	**TOP SOIL** Dark brown silty clay, trace muskeg, rootlets, plastic, firm	░
350.5 0.8	**SILTY CLAY** Light brown silty clay (grey clay in lenses), low to medium plasticity, firm to stiff, moist [Upper Glaciolacustrine] ...at 1.52m becoming firm, trace clay	▨
348.2 3.0	**SILTY CLAY** Dark grey silty clay, trace sand and gravel, firm to stiff, medium to high plasticity, moist [WML Till] ...Sand and Gravel layer between 4.64m to 4.8m	▨

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	AU		
2	SS	79	10
3	SS	100	6
6	TW	63	
8 (A&B)	SS	100	5
9	SS	100	5
12	SS	100	5
15	TW	88	
18	SS	100	6
20	SS	100	6
23	SS	100	5

WELL / PIEZOMETER INSTALLATION

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15



REMARKS
...frozen to 1.4m
...at 3.35m PP=61 KPa TV=49 KPa
...at 9.45m PP=61 KPa TV=69 KPa

Continued on Next Page

RECORD OF BOREHOLE No. BH11-09

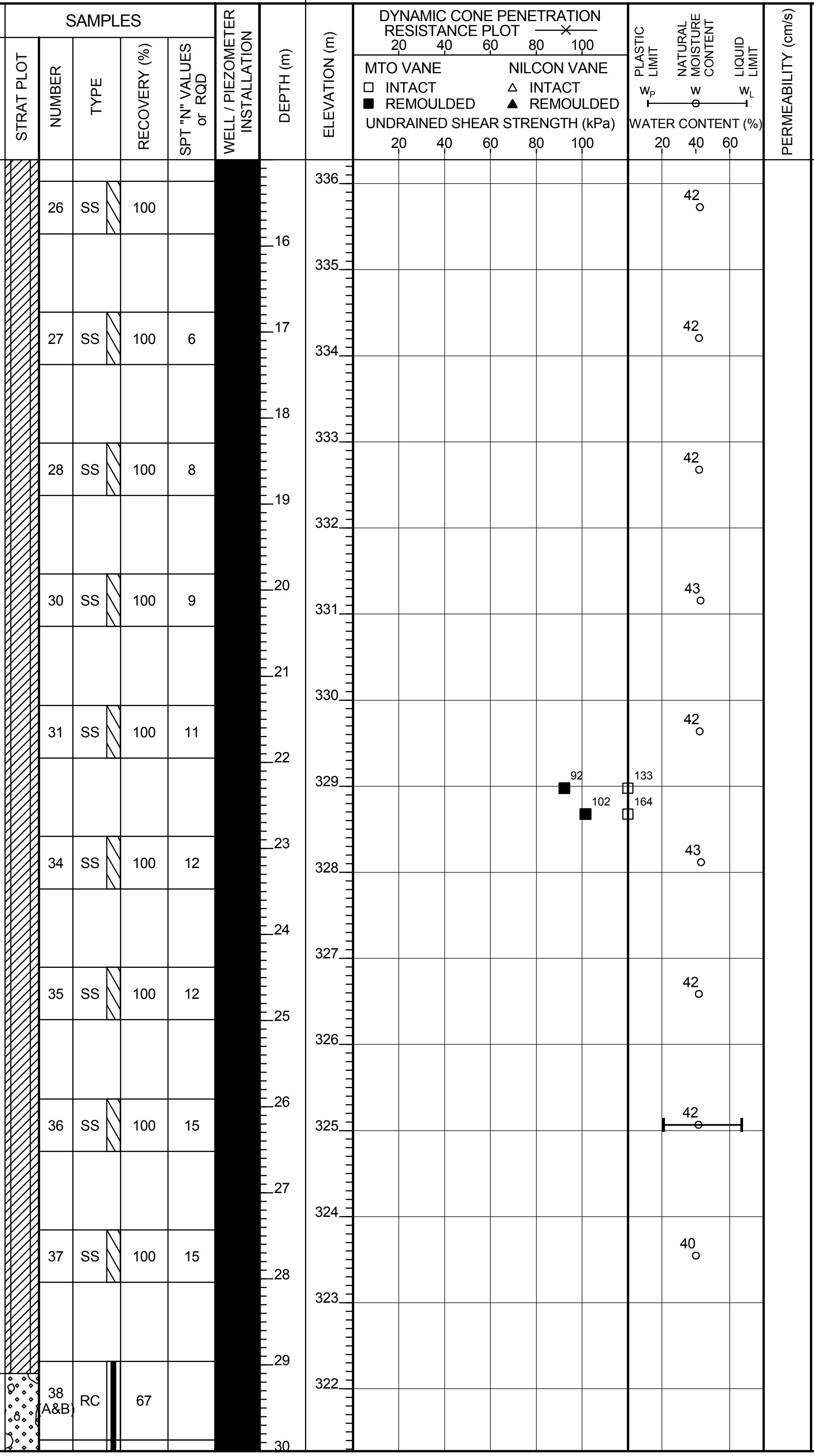
PAGE 2 OF 3

PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD 200 mm HSA, NQ Coring	LOGGED BY SM
CLIENT	Rainy River Resources.	LOCATION	Flotation Tailings		COMPILED BY SM
ELEVATION	351.277 m	COORD.	N 5,411,182 E 424,201	BORING DATE Start: Dec 10, 11 End: Dec 11, 11	CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	NATURAL MOISTURE CONTENT w (%)	REMARKS
		26	SS	100		42	
		27	SS	100	6	42	
	...at 18.3m small brown sandy pockets	28	SS	100	8	42	
	...at 19.8m small silty pockets	30	SS	100	9	43	
		31	SS	100	11	42	
		34	SS	100	12	43	
	..at 24.4m trace to some gravel, angular to subangular	35	SS	100	12	42	
		36	SS	100	15	42	
		37	SS	100	15	40	
322.2 29.1	... at 29m becoming firm, low to medium plastic, some gravel **GRAVELLY SAND** Greyish blue boulders and gravel,	38 (A&B)	RC	67			...at 29m, switched to NQ coring.



Continued on Next Page

RECORD OF BOREHOLE No. BH11-09

PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring
				LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Flotation Tailings	COMPILED BY	SM
ELEVATION	351.277 m	COORD.	N 5,411,182 E 424,201	BORING DATE	Start: Dec 10, 11 End: Dec 11, 11
				CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100

MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	PERMEABILITY (cm/s)	REMARKS
	trace clay and sand, angular to subangular [WS Till, inferred]		39	RC	92				321		...at 30.17m, encountered artesian pressure up to 2.85m above ground level
			40	RC				31	320		
319.6 31.7	**End of Borehole** at 31.7m Standpipe installed with 0.9m stick up Water Level (bgs): at 2.23m on Dec 13/12 at 1.36m on Dec 18/12										

amec

RECORD OF BOREHOLE No. BH11-11 A&B

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	MM
CLIENT	Rainy River Resources.	LOCATION	Flotation Tailings			COMPILED BY	NH
ELEVATION	374.744 m	COORD.	N 5,410,763 E 425,205	BORING DATE	Start: Jan 30, 12 End: Feb 2, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
374.7	Ground surface							
0.0	**TOP SOIL** Dark brown organics, silty, fibrous, rootlets	1	SS	54	10	24		
374.6 0.2	**Silty CLAY** Light brown silty clay, trace sand, trace gravel, varved, moist, low to medium plasticity, stiff [Upper Glaciolacustrine]	2	SS	67	11	14		
	...at 1.52m, occasional sand lenses	3	SS	100	10	22		
372.5 2.3	**Silty SAND** Light brown silty sand, trace clay, well graded, loose to compact, occasional silt lenses, moist [Glacial sand]	4	SS	100	11	17		
		5	SS	100	8	21		
	...below 4.57m, very loose to loose, wet	6	SS	83	6	20		
		7	SS	100	7	22		
		8	SS	83	2	23		
		9	SS	83	3	19		
		10	SS	75		21		...at 10.8m SPT sampler sank under its own weight
		11	SS	92	4	21		
361.0 13.7		12	SS	96	5	21		

Continued on Next Page

RECORD OF BOREHOLE No. BH11-11 A&B

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	MM
CLIENT	Rainy River Resources.	LOCATION	Flotation Tailings			COMPILED BY	NH
ELEVATION	374.744 m	COORD.	N 5,410,763 E 425,205	BORING DATE	Start: Jan 30, 12 End: Feb 2, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT ——×—— 20 40 60 80 100
MTO VANE: ☐ INTACT ■ REMOULDED
NILCON VANE: △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60
PERMEABILITY (cm/s)

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
		15	SS	100	6	22	
	Silty CLAY Grey silty clay, trace gravel, trace sand, high plasticity, stiff, moist [WML Till] ...at 17m, sand pocket/layer.	18	SS	100	11	29	
		19	SS	100	11	35	...at 18.3m, 75 mm of heaving sand.
		20	SS	100	10	38	
		21	SS	100	6	23	
351.9 22.9	**Silty SAND** Dark grey silty sand, trace clay, gravel, compact to dense, saturated [WS Till] ...below 23.5m, frequent cobles and boulders	24	SS	46	24	21	
		25	SS	25	24	8	
		26	SS	0.04	50/0.1	9	...at 25.9m- SPT refusal on possible cobbles and boulders; switched to coring.

DEPTH (m): 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

ELEVATION (m): 359 358 357 356 355 354 353 352 351 350 349 348 347 346 345

Continued on Next Page

RECORD OF BOREHOLE No. BH11-11 A&B

PAGE 3 OF 3

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	MM
CLIENT	Rainy River Resources.	LOCATION	Flotation Tailings			COMPILED BY	NH
ELEVATION	374.744 m	COORD.	N 5,410,763 E 425,205	BORING DATE	Start: Jan 30, 12 End: Feb 2, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

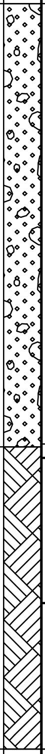
DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100

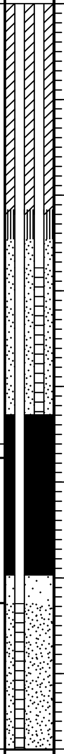
MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	PERMEABILITY (cm/s)	REMARKS
								31	344		
								32	343		
								33	342		
								34	341		
340.1 34.6	**BEDROCK**		27	RC	83	67		35	340		
			28	RC	98	70		36	339		
			29	RC	100	93		37	338		
337.0 37.8	**End of Borehole** at 37.8m. Standpipe A and B installed with flush mounted casing Water Level (bgs): For Piezometer A (bottom sensing zone) at 4.7m on Feb 02/12 For Piezometer B (middle sensing zone) at 5.6 m on Feb 02/12								337		





RECORD OF BOREHOLE No. BH11-11C

PAGE 1 OF 1

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD		LOGGED BY	MM
CLIENT	Rainy River Resources.	LOCATION	Flotation Tailings			COMPILED BY	SM
ELEVATION	374.744 m	COORD.	N 5,410,763 E 425,205	BORING DATE	Start: Feb 2, 12 End: Feb 2, 12	CHECKED BY	DGR

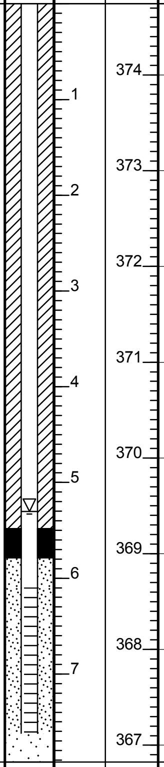
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
374.7	Ground surface												
0.0	BH11-11C shows installation details of shallow standpipe piezometer BH11-11C Refer to BH11-11 for stratigraphic Information												
366.8 7.9	**End of Borehole** Standpipes installed with flush mounted steel casing Water Level (b.g.s): At 5.25m on Feb 02/12												



RECORD OF BOREHOLE No. BH11-12

PAGE 1 OF 2

PROJECT Rainy River - Geotechnical Investigation 2011/2012 ENGINEER MS
PROJECT NO. TC113921 DRILLER Marathon Drilling BORING METHOD 200 mm HSA, NQ Coring LOGGED BY PDR
CLIENT Rainy River Resources. LOCATION Flotation Tailings COMPILED BY SM
ELEVATION 355.723 m COORD. N 5,411,178 E 425,311 BORING DATE Start: Mar 17, 12 End: Mar 17, 12 CHECKED BY DGR

SAMPLE TYPES

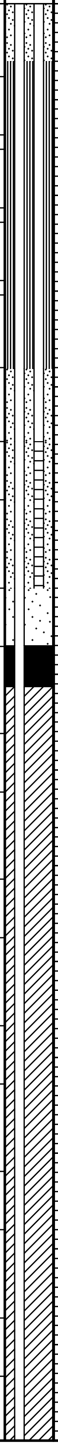
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

SOIL PROFILE — SAMPLES — WELL / PIEZOMETER INSTALLATION — DEPTH (m) — ELEVATION (m) — DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100 — PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60 — PERMEABILITY (cm/s) — REMARKS

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
355.7	Ground surface						
0.0	**TOPSOIL** Dark brown peat and clay, some rootlets	1	AS			42	...frozen to 0.8m
355.0 0.8	**SILTY CLAY** Greyish brown silty clay, trace to some sand, some lensing and oxidation, varved, firm to stiff, low to medium plasticity, moist [Upper Glaciolacustrine] ...at 1.5 m trace gravel ...at 2.3 m trace rootlets	2	SS	67	8	39	
		3	SS	92	14	19	
		4	SS	100	8	35	
		5	TW	100			...at 3.04m TV=64 KPa
351.2 4.6	**Silty CLAY** Dark brown to grey silty clay, trace sand, trace gravel, occasional silt pockets, medium plasticity, stiff, moist [WML Till]	6	SS	87	10	19	
		7	SS	100	10	35	
		8	SS	100	9	36	
		9	SS	100	14	36	
		10	SS	100	14	35	
		11	SS	100	13	36	
		12	SS	100	7	36	



Continued on Next Page

RECORD OF BOREHOLE No. BH11-12

PAGE 2 OF 2

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Flotation Tailings
COMPILED BY SM
ELEVATION 355.723 m
COORD. N 5,411,178 E 425,311
BORING DATE Start: Mar 17, 12 End: Mar 17, 12
CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT ——×—— 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
		13	SS	100	10	38	
	... at 16.8 m sand lenses/laminae, firm	14	SS	100	8	20	
337.4 18.3	**SILTY CLAY** Dark grey silty clay and gravel, varved, low plasticity, stiff, moist [Lower Glaciolacustrine]	15	SS	100	10	34	
						19	
335.9 19.8	**Gravelly SAND** Grey sand, some silt and gravel, well graded, boulders, compact, wet [inferred WS Till]	17	SS	25	11		
		18	RC				
333.3 22.4	**BEDROCK** highly fractured and weathered, bluish green	19	RC	63	0		...at 22.4 m switched to NQ
		20	RC	92	0		
		21	RC	82	0		
328.8 27.0	**End of Borehole** at 27m Standpipes installed with flush mounted steel casing Water level (b.g.s): For Piezometer A (bottom sensing zone) at 1.1 m on Mar 18/12 For Piezometer B (top sensing zone) 0.65 m on Mar 18/12						

RECORD OF BOREHOLE No. BH11-13

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Overburden stockpile
COMPILED BY NH
ELEVATION 347.063 m
COORD. N 5,410,290 E 422,597
BORING DATE Start: Mar 3, 12 End: Mar 5, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

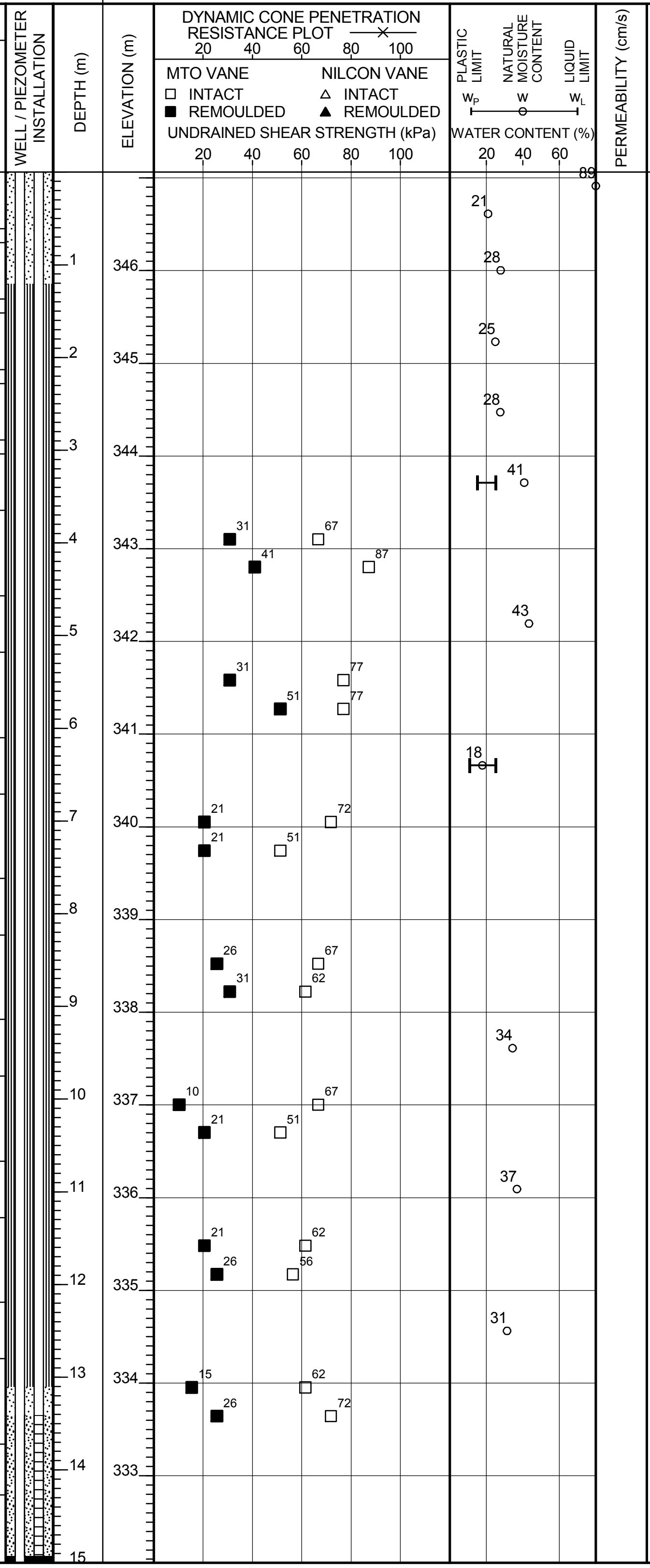
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
347.1	Ground surface
0.0	**TOPSOIL** Woody, fibrous organics
346.8 0.3	**Sandy SILT** Dark brown to light brown sandy silt, trace clay, rootlets, trace organics, soft, low plasticity, damp [Upper Glaciolacustrine]
344.8 2.3	**Clayey SILT** Grey clayey silt, trace sand, no to low plasticity, moist, soft ...30cm thick silty clay at the top ...at 4.49m, brown oxidised pockets
342.5 4.6	**Silty CLAY** Dark grey silty clay, trace sand, trace subangular gravel, limestone, high plasticity, moist, firm [WMLTill] ...from 6.25m to 9.14m, medium plasticity

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	87.5	4
2	SS	29.2	7
3	SS	92	4
4	SS	83	7
5	SS	92	3
8	SS	100	7
11	SS	92	5
14	TW	100	
17	SS	92	5
20	SS	88	6
23	SS	96	5
26	TW	100	



REMARKS

...at 7.9m
PP=37 KPa
Torvane=49 KPa

...at 14m
PP=61-85 KPa
Torvane=44 KPa

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-13

PAGE 2 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Overburden stockpile			COMPILED BY	NH
ELEVATION	347.063 m	COORD.	N 5,410,290 E 422,597	BORING DATE	Start: Mar 3, 12 End: Mar 5, 12	CHECKED BY	DGR

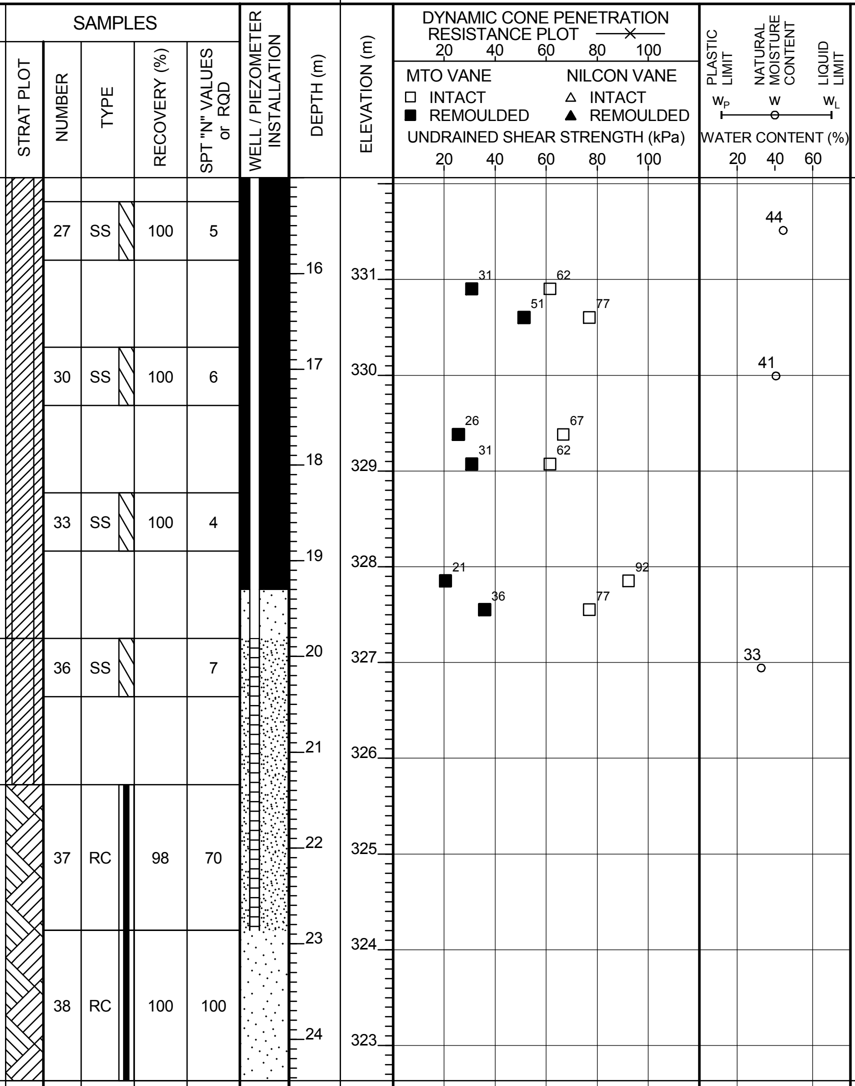
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
		27	SS	100	5	Artesian pressure up to 1.06m encountered after installing the second standpipe.
		30	SS	100	6	
		33	SS	100	4	
327.3 19.8	**Sandy SILT** Greyish green sandy silt, trace clay, grey clay lamination, no plasticity, wet, soft to firm [Lower Glaciolacustrine]	36	SS		7	
325.7 21.3	**BEDROCK**	37	RC	98	70	
		38	RC	100	100	
322.6 24.4	**End of Borehole** at 24.4m Two standpipes, BH11-13A and BH11-13B (orange spray) installed with flush mounted steel casing Water level (b.g.s): For Piezometer A (bottom sensing zone) at surface on Mar 5/12 For Piezometer B (top sensing zone) surface on Mar 5/12					



RECORD OF BOREHOLE No. BH11-16 A&B

PROJECT Rainy River - Geotechnical Investigation 2011/2012 ENGINEER MS
PROJECT NO. TC113921 DRILLER Marathon Drilling BORING METHOD 200 mm HSA, NQ Coring LOGGED BY SM
CLIENT Rainy River Resources. LOCATION Overburden stockpile COMPILED BY NH
ELEVATION 348.843 m COORD. N 5,409,752 E 423,785 BORING DATE Start: Feb 29, 12 End: Mar 2, 12 CHECKED BY DGR

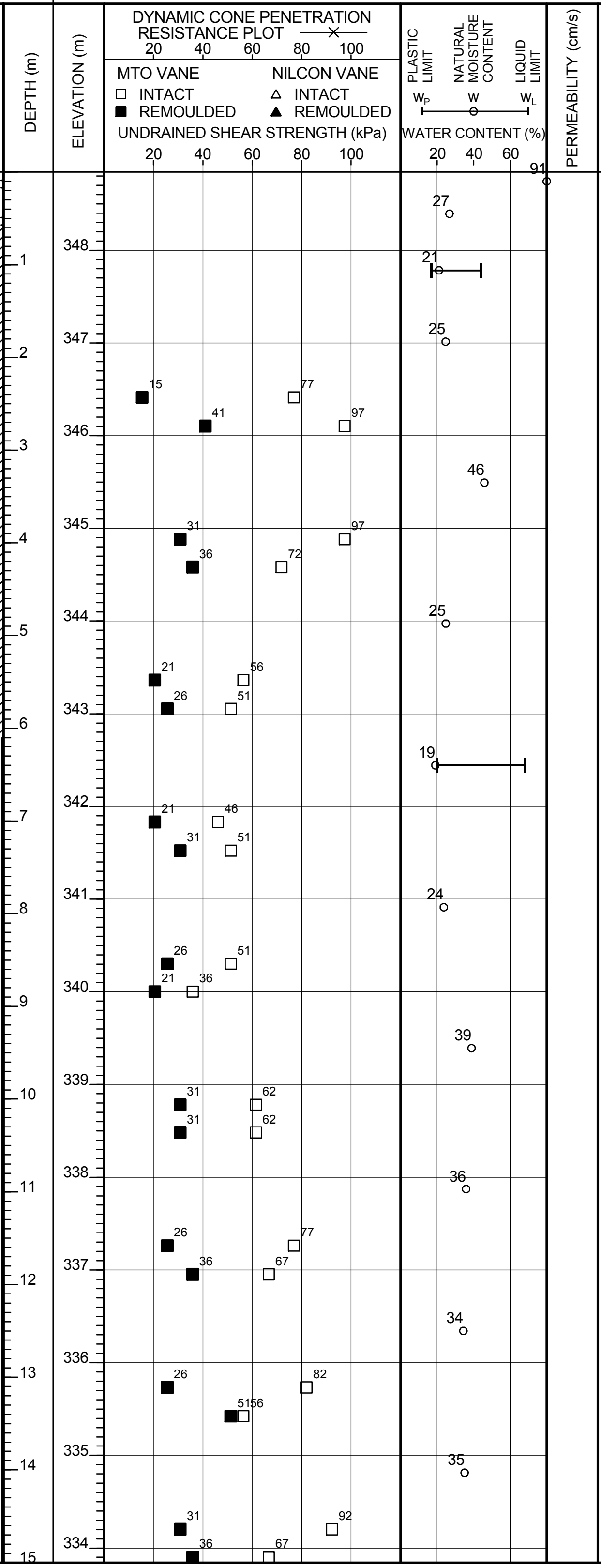
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
348.8	Ground surface					
348.8 0.0 348.7 0.1	**TOPSOIL** Dark brown organics, fibrous rootlets	1	SS	100	15	...frozen to 0.8m
	Clayey SILT Brown clayey silt, trace sand, grey clay laminations, varved, low plasticity, damp, organics [Upper Glaciolacustrine]	2	SS	100	6	
	...below 1.5m mottled brown lenses, no to low plasticity, firm, damp	3	SS	100	6	
345.8 3.0	**Silty CLAY** Dark grey silty clay, medium to high plasticity, soft to firm, damp to moist [WML Till]	6	SS	100	6	
	...at 4.57m, some sand, subangular to subrounded gravel, damp to moist, soft to firm, sand lenses	9	SS	100	3	
	...sandy lense between 6.3 and 6.35m	12	SS	100	4	
	...between 7.6m to 9.5m - clayey silt, soft, no to low plasticity, wet	15	SS	71		...at 7.6m SPT sampler sank under its own weight
		18	SS	100	4	
		21	SS	100	5	
		24	SS	100	5	
		27	SS	100	6	



Continued on Next Page

RECORD OF BOREHOLE No. BH11-16 A&B

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Overburden stockpile			COMPILED BY	NH
ELEVATION	348.843 m	COORD.	N 5,409,752 E 423,785	BORING DATE	Start: Feb 29, 12 End: Mar 2, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

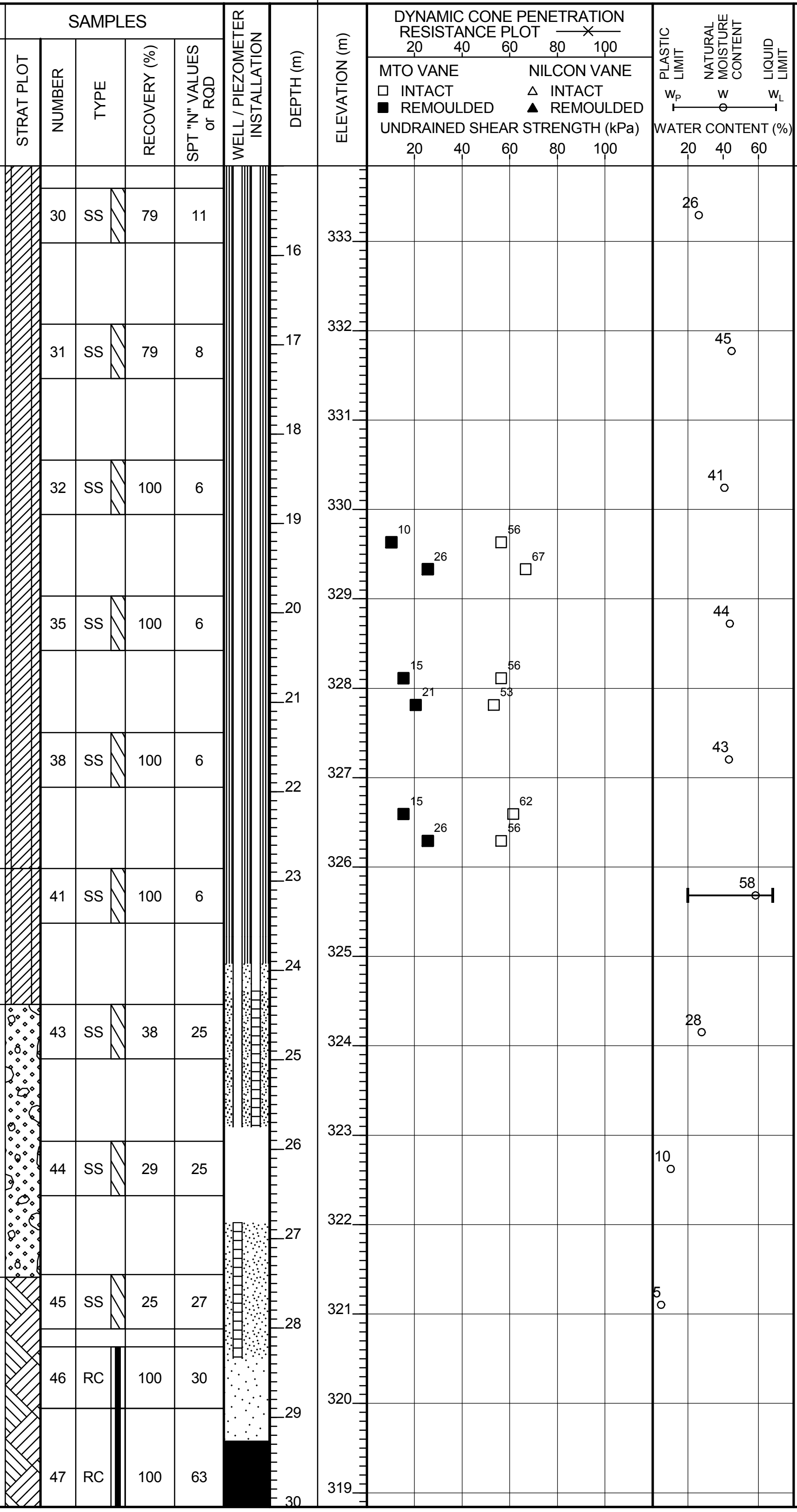
ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
	...sand and gravel lense between 15.75 m and 15.85m
	...sand and gravel lense between 17.3 m and 17.4m
326.0 22.9	**Silty CLAY** Silty clay, medium plasticity, varved, firm, moist to wet [Lower Glaciolacustrine]
324.5 24.4	**Silty SAND and GRAVEL** Silty sand and white brown angular to subangular gravel, trace clay, compact, moist to wet [WS Till]
321.4 27.4	**BEDROCK** Fractured at the top

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
30	SS	79	11
31	SS	79	8
32	SS	100	6
35	SS	100	6
38	SS	100	6
41	SS	100	6
43	SS	38	25
44	SS	29	25
45	SS	25	27
46	RC	100	30
47	RC	100	63



PERMEABILITY (cm/s)

REMARKS

Format: AMEC GEO MWSK File: TC113921_BHLOGS_20120405.GPJ Date: 7/10/2012 1:29:17 PM

Continued on Next Page

RECORD OF BOREHOLE No. BH11-16 A&B

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Overburden stockpile
COMPILED BY NH
ELEVATION 348.843 m
COORD. N 5,409,752 E 423,785
BORING DATE Start: Feb 29, 12 End: Mar 2, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION / UNDRAINED SHEAR STRENGTH (kPa)	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
			48	RC	100	83		31	318				
317.2 31.6	**End of Borehole** at 31.65m Two standpipes, BH11-16A and BH11-16B (orange spray) installed with flush mounted steel casing Water level (b.g.s): For Piezometer A (bottom sensing zone) at surface on Mar 3/12 For Piezometer B (middle sensing zone) surface on Mar 3/12												

RECORD OF BOREHOLE No. BH11-16C

PAGE 1 OF 2

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Overburden stockpile
COMPILED BY SM
ELEVATION 348.431 m
COORD. N 5,409,753 E 423,785
BORING DATE Start: Mar 3, 12 End: Mar 3, 12
CHECKED BY DGR

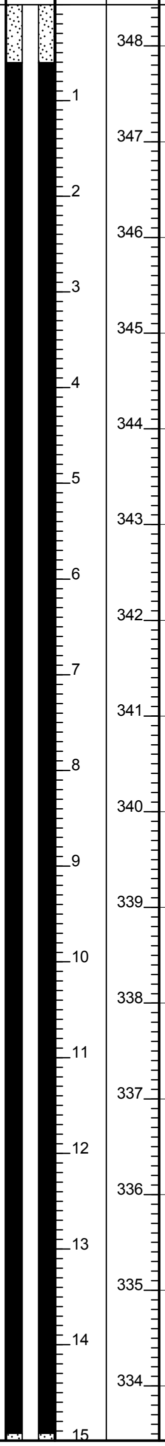
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
348.4	Ground surface												
0.0	BH11-16C shows installation details of shallow standpipe piezometer BH11-16C Refer to BH11-16 for stratigraphic Information												



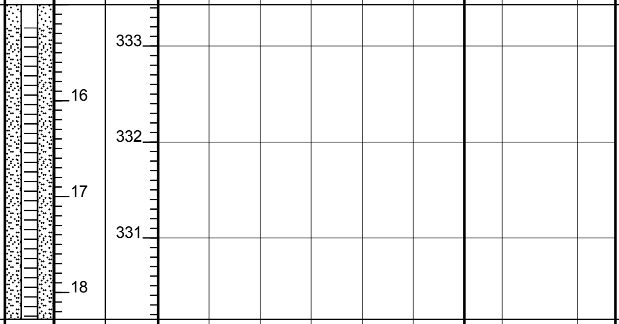
Continued on Next Page

RECORD OF BOREHOLE No. BH11-16C

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Overburden stockpile
COMPILED BY SM
ELEVATION 348.431 m
COORD. N 5,409,753 E 423,785
BORING DATE Start: Mar 3, 12 End: Mar 3, 12
CHECKED BY DGR

SAMPLE TYPES				ABBREVIATIONS			
AU	Auger	RC	Rock Core	P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})
BU	Bulk	SS	Split Spoon	U.W.	Wet Unit Weight	RQD	Rock Quality Designation
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)	PT	Standard Proctor Test	SCR	Solid Core Recovery
		WS	Wash Sample			k	Permeability
				C	Consolidation	DS	Direct Shear
				GS	Grain Size Analysis		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
330.1 18.3	**End of Borehole** at 16.3m Standpipes installed with flush mounted steel casing Water Level (b.g.s): At surface on March 03/12												



RECORD OF BOREHOLE No. BH11-17

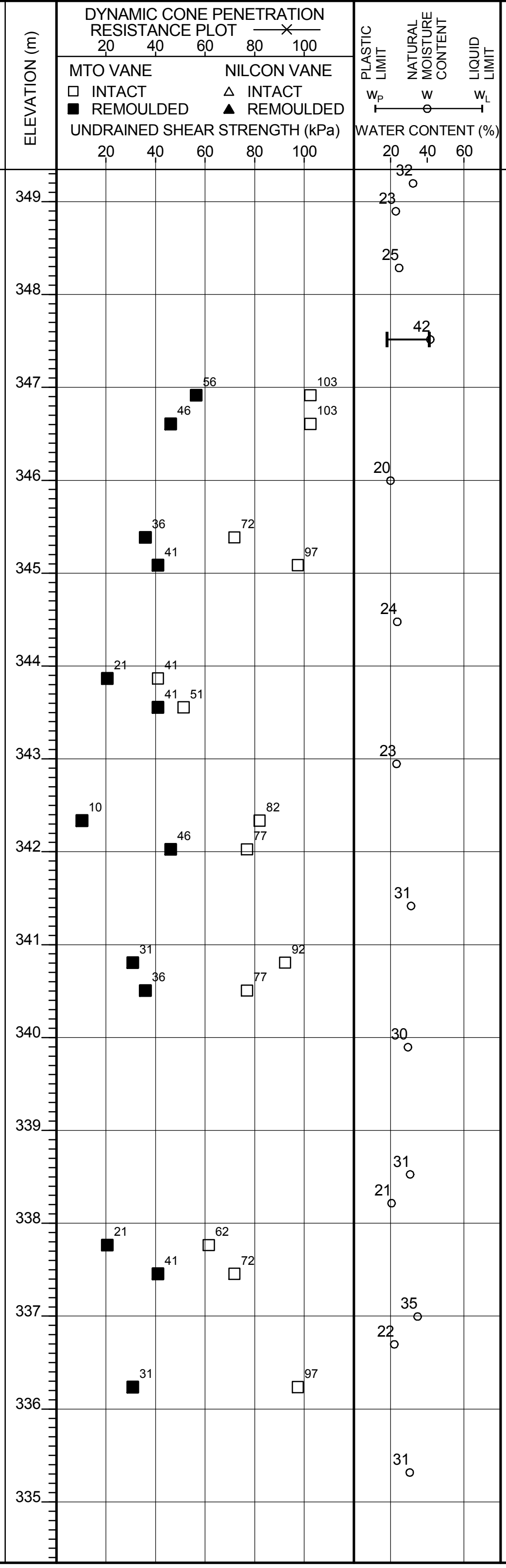
PAGE 1 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD 200 mm HSA, NQ Coring	LOGGED BY SM
CLIENT	Rainy River Resources.	LOCATION	Pit diversion	COMPILED BY	NH
ELEVATION	349.346 m	COORD.	N 5,410,114 E 424,758	BORING DATE Start: Feb 27, 12 End: Feb 28, 12	CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
349.3	Ground surface					
349.0 0.0	**TOPSOIL** Dark brown, fibrous, rootlets	1	SS	100	29	...frozen to 0.8m
0.3 348.6	**SILT** Light brown silt, trace clay, some sand, trace organics					
0.8	**Clayey SILT to Silty CLAY** Light brown clayey silt, trace gravel, trace sand, rootlets, mottled brown lenses, low to medium plasticity, firm, damp [Upper Glaciolacustrine]	2	SS	96	8	
		3	SS	88	4	
	..at 1.7m brown silty clay, medium to high plasticity, firm to stiff, damp					
346.3 3.0	**Silty CLAY** Brown silty clay, trace sand and gravel, medium to high plasticity, soft to firm, damp to moist [WML Till]	6	SS	100	4	
		9	SS	100	3	
	...at 6.1m grey silty, low plasticity	12	SS	100	3	
	... below 7.6m becoming dark grey	15	SS	100	6	
		18	SS	100	5	
		20A&B	SS		3	
	...from 10.7m to 14.3m occasional dark grey silty sand and gravel lamination	23	SS		5	...at 11.89m, heaving sands; switched to wash boring.
		26	SS	100	5	



PERMEABILITY (cm/s)

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

WELL / PIEZOMETER INSTALLATION

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-17

PAGE 2 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Pit diversion			COMPILED BY	NH
ELEVATION	349.346 m	COORD.	N 5,410,114 E 424,758	BORING DATE	Start: Feb 27, 12 End: Feb 28, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100

MTO VANE: □ INTACT ■ REMOULDED; NILCON VANE: △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

PERMEABILITY (cm/s)

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
		27	SS	92	5	38	
		28	SS	100	6	37	
	...at 18.29m, silty pockets.	29	SS	100	6	31	
329.4 20.0	**Silty CLAY** Greyish green silty clay(silt as 3-4mm lamintions) medium plasticity, varved, firm, moist [Lower Glaciolacustrine]	30	SS	100	8		
328.0 21.3	**Clayey SAND and GRAVEL** Dark grey clayey sand and gravel, subrounded to angular [WS Till] ...below 22.6m, boulders	34	RC	37	0		
325.0 24.4	**BEDROCK** Highly fractured bedrock	35	RC	100	0		
		36	RC	78	9		Artesian pressure up to 0.7m encountered pulling rods out
		37	RC	100	100		
322.2 27.2	**End of Borehole** at 27.1m Standpipe installed with flush mounted steel casing Water level (b.g.s): at 0.15m on Feb 29/12						

RECORD OF BOREHOLE No. BH11-18

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR/SM
CLIENT	Rainy River Resources.	LOCATION	Open Pit			COMPILED BY	NH
ELEVATION	348.507 m	COORD.	N 5,408,990 E 425,202	BORING DATE	Start: Jan 15, 12	CHECKED BY	DGR

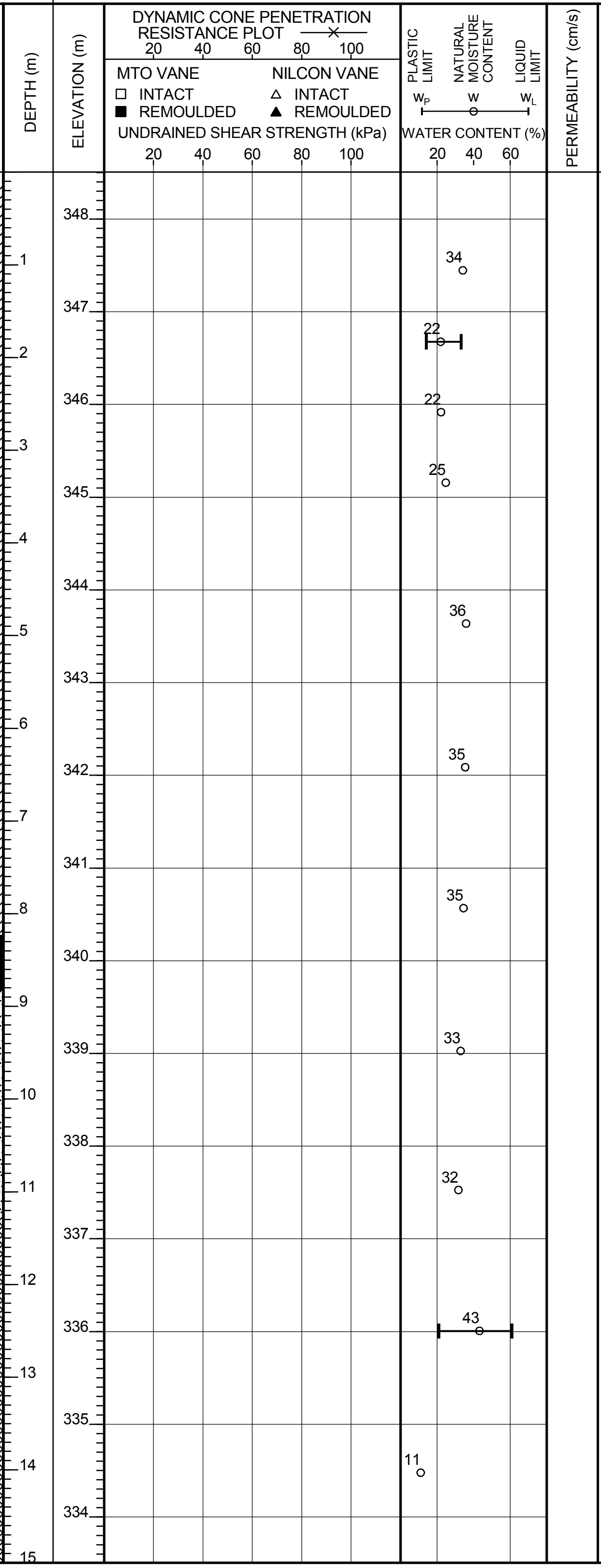
SAMPLE TYPES

AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS

P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	NATURAL MOISTURE CONTENT (%)	REMARKS
348.5	Ground surface						
0.0	**TOPSOIL** Dark brown silty peat, fibrous						
347.7 0.8	**Silty CLAY** Brown silty clay, trace to some sand, trace gravel, varved, low to medium plasticity, stiff, moist, occasional sand laminations [Upper Glaciolacustrine]	2	SS	88	10	34	...frozen to 1.5m
		3	SS	83	11	22	
		4	SS	96	10	22	
		5	SS	96	10	25	
343.9 4.6	**silty CLAY** Dark brown silty clay, trace sand, trace gravel, stiff, medium plasticity, moist [WML Till].	6	SS	100	11	36	
		7	SS	100	10	35	
		8	SS	100	9	35	
	From 9.45m to 9.78m, silty sand, trace clay, compact, wet.	9	SS	100	14	33	
		10	SS	92	9	32	
336.3 12.2	**silty CLAY** Dark grey silty clay, varved (greenish grey silty layers 2-3mm), soft, medium to high plasticity, moist, varved [Glaciolacustrine].	11	SS	100	4	43	
334.8 13.7	**SAND AND GRAVEL** Greenish brown sand and gravel, trace silt, well graded, very dense, angular to subangular, wet [WS Till].	12	SS		69	11	...at 13.72m, heaving sand; switched to wash boring.



Continued on Next Page

RECORD OF BOREHOLE No. BH11-18

PROJECT Rainy River - Geotechnical Investigation 2011/2012 ENGINEER MS
PROJECT NO. TC113921 DRILLER Marathon Drilling BORING METHOD 200 mm HSA, NQ Coring LOGGED BY PDR/SM
CLIENT Rainy River Resources. LOCATION Open Pit COMPILED BY NH
ELEVATION 348.507 m COORD. N 5,408,990 E 425,202 BORING DATE Start: Jan 15, 12 CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60
PERMEABILITY (cm/s)

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
333.3 15.3	**BOULDERS AND COBBLES** Boulders and cobbles, some coarse sand [Inferred WS Till].					...at 15.7m, switched to NQ coring
		13	WS			
		14	WS			
321.6 26.9	**BEDROCK**	16	RC	100	55	
		16	RC	100	93	...at 28.9m to 43.4m, Constant head Packer test carried out; no change in flow noted.

DEPTH (m): 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
ELEVATION (m): 333 332 331 330 329 328 327 326 325 324 323 322 321 320 319

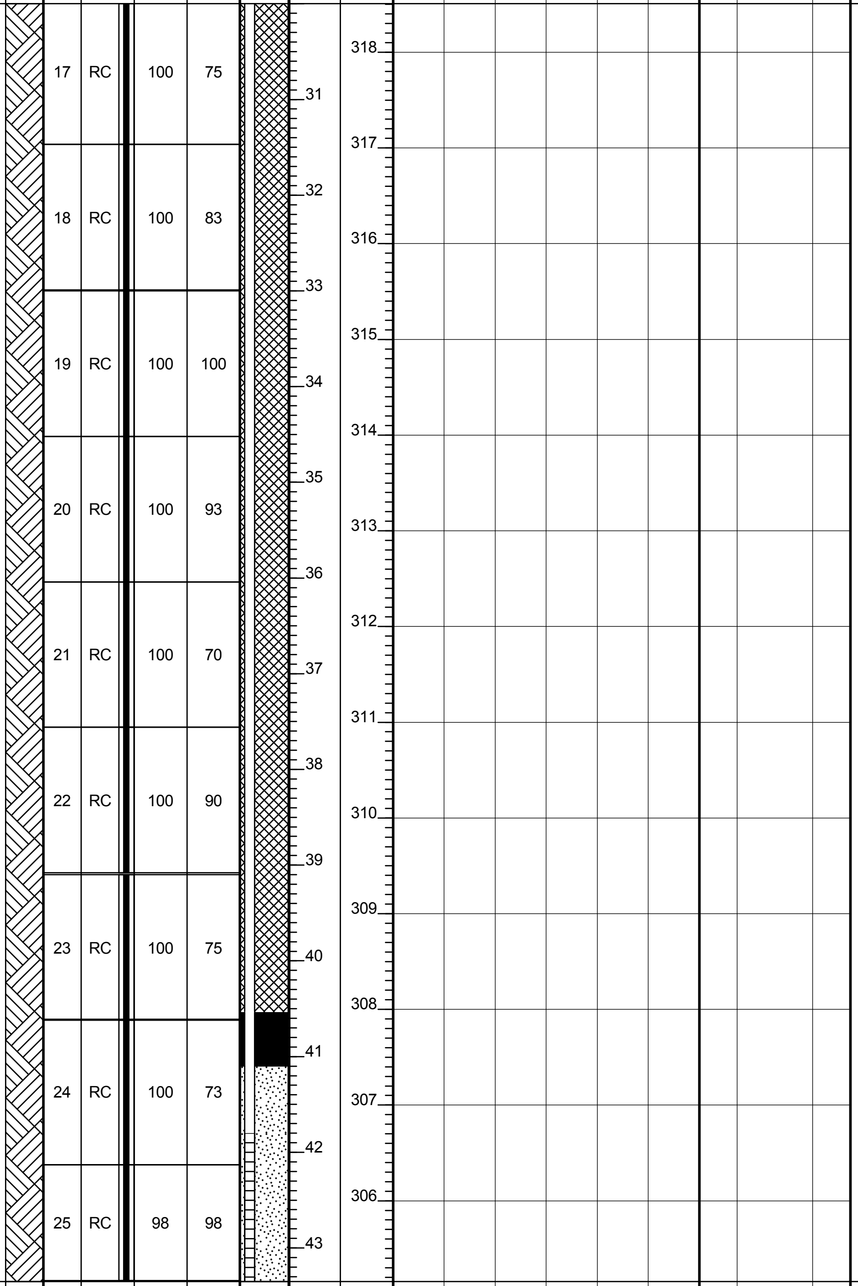
Continued on Next Page

RECORD OF BOREHOLE No. BH11-18

PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD 200 mm HSA, NQ Coring	LOGGED BY PDR/SM
CLIENT	Rainy River Resources.	LOCATION	Open Pit	COMPILED BY	NH
ELEVATION	348.507 m	COORD.	N 5,408,990 E 425,202	BORING DATE Start: Jan 15, 12	CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis



ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
		17	RC	100	75	
		18	RC	100	83	
		19	RC	100	100	
		20	RC	100	93	
		21	RC	100	70	
		22	RC	100	90	
		23	RC	100	75	
		24	RC	100	73	
		25	RC	98	98	
305.2 43.4	**End of Borehole** at 43.35m Standpipe installed with flushmounted steel casing Water Level (bgs): For Piezometer A (bottom sensing					

Continued on Next Page

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR/SM
CLIENT	Rainy River Resources.	LOCATION	Open Pit			COMPILED BY	NH
ELEVATION	348.507 m	COORD.	N 5,408,990 E 425,202	BORING DATE	Start: Jan 15, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
	zone) at 0.76m on Feb 02/12 For Piezometer B (middle sensing zone) at 0.76m on Feb 02/12												

RECORD OF BOREHOLE No. BH11-19 A&B

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Open Pit			COMPILED BY	NH
ELEVATION	350.323 m	COORD.	N 5,409,287 E 426,009	BORING DATE	Start: Jan 3, 12 End: Jan 5, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

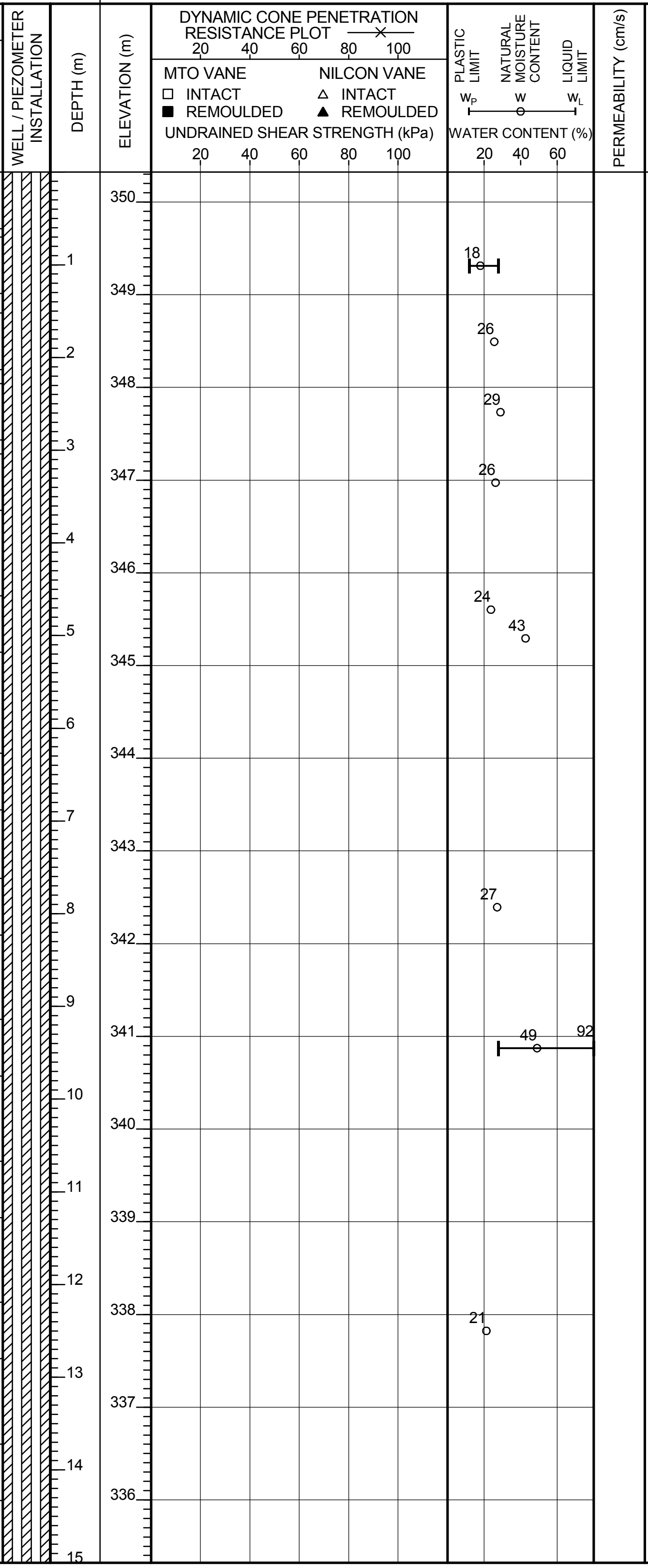
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE

ELEV / DEPTH (m)	DESCRIPTION
350.3	Ground Surface
0.0	**TOPSOIL** dark brown, peat
350.1 0.3	**SILTY CLAY** Light brown silty clay, some sand, varved, soft to firm, low plastic, moist to wet [Upper Glaciolacustrine] ...at 0.8m becoming sandy ...becoming dark brown below 2.2m
345.5 4.9	**SILTY CLAY** Drak grey silty (to trace silt) clay, trace sand, trace gravel, firm to stiff, medium to high plasticity, moist [WML Till]

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
1	SS	83	15	
2	SS	46	5	..frozen to 1.4m
3	SS	100	8	
4	SS	100	3	
5	SS	100	7	
6	SS	100	11	
7	TW	100		...at 6.4m PP=122-134 KPa
8	SS	92	8	
9	SS	100	5	
10	SS	100	13	
11	SS	100	9	
12	SS	100	11	



Continued on Next Page

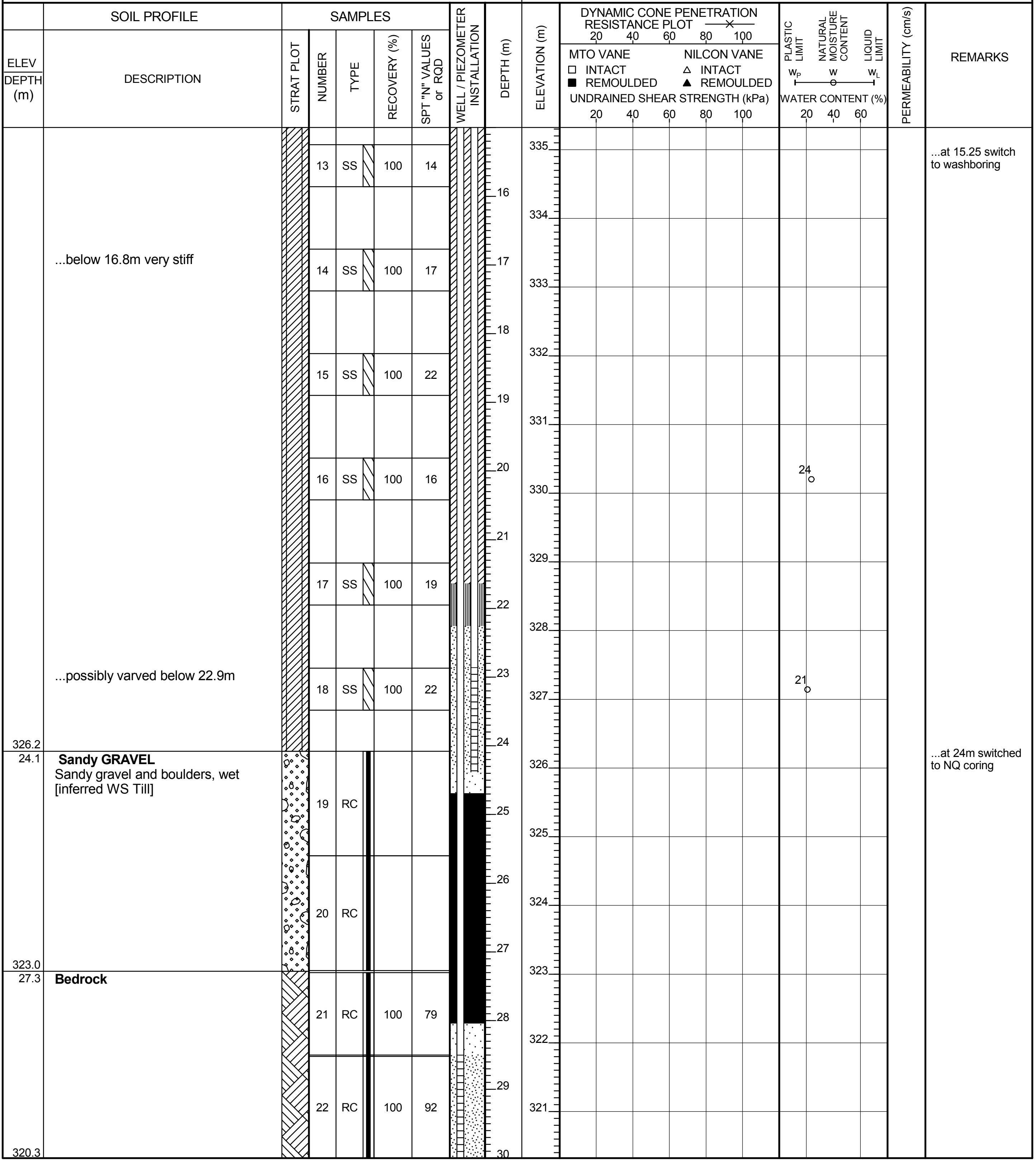
RECORD OF BOREHOLE No. BH11-19 A&B

PAGE 2 OF 3

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Open Pit			COMPILED BY	NH
ELEVATION	350.323 m	COORD.	N 5,409,287 E 426,009	BORING DATE	Start: Jan 3, 12 End: Jan 5, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis



ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
		13	SS	100	14		...at 15.25 switch to washboring
	...below 16.8m very stiff	14	SS	100	17		
		15	SS	100	22		
		16	SS	100	16	24	
		17	SS	100	19		
	...possibly varved below 22.9m	18	SS	100	22	21	
326.2 24.1	**Sandy GRAVEL** Sandy gravel and boulders, wet [inferred WS Till]	19	RC				...at 24m switched to NQ coring
		20	RC				
323.0 27.3	**Bedrock**	21	RC	100	79		
		22	RC	100	92		
320.3							

Continued on Next Page

RECORD OF BOREHOLE No. BH11-19 A&B

PAGE 3 OF 3

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Open Pit
COMPILED BY NH
ELEVATION 350.323 m
COORD. N 5,409,287 E 426,009
BORING DATE Start: Jan 3, 12 End: Jan 5, 12
CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

SOIL PROFILE		SAMPLES											
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
30.0	**End of Borehole** at 30.02m Standpipes installed with A 0.86m, B 0.91m stick up Water Level (b.g.s): For Piezometer A (bottom sensing zone) at 1.83 m on Jan 07/12 at 1.86 m on Jan 14/12 For Piezometer B (middle sensing zone) at 1.83 m on Jan 07/12 at 1.86 m on Jan 14/12								320				

RECORD OF BOREHOLE No. BH11-19C

PAGE 1 OF 1

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD		LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Open Pit			COMPILED BY	NH
ELEVATION	350.453 m	COORD.	N 5,409,285 E 426,011	BORING DATE	Start: Jan 7, 12 End: Jan 7, 12	CHECKED BY	DGR

SAMPLE TYPES

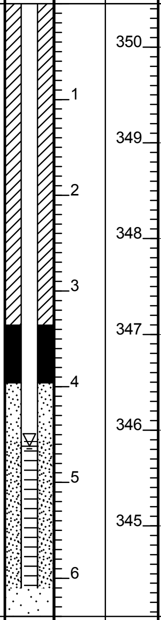
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

SOIL PROFILE | SAMPLES | WELL / PIEZOMETER INSTALLATION | DEPTH (m) | ELEVATION (m) | DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 | MTO VANE ☐ INTACT ■ REMOULDED | NILCON VANE △ INTACT ▲ REMOULDED | UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100 | PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L | WATER CONTENT (%) 20 40 60 | PERMEABILITY (cm/s) | REMARKS

ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
350.5	Ground Surface					
0.0	BH11-19C shows installation details of shallow standpipe piezometer BH11-19C Refer to BH11-19 for stratigraphic Information					
344.1 6.4	**End of Borehole** at 6.4m Stand pipe installed with 0.91m stick up Water Level (b.g.s): At 4.57 m on Jan 07/12 at 1.24 m on Jan 14/12					



amec

RECORD OF BOREHOLE No. BH11-20 A&B

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Open pit
COMPILED BY NH
ELEVATION 352.093 m
COORD. N 5,410,232 E 425,891
BORING DATE Start: Jan 6, 12 End: Jan 9, 12
CHECKED BY DGR

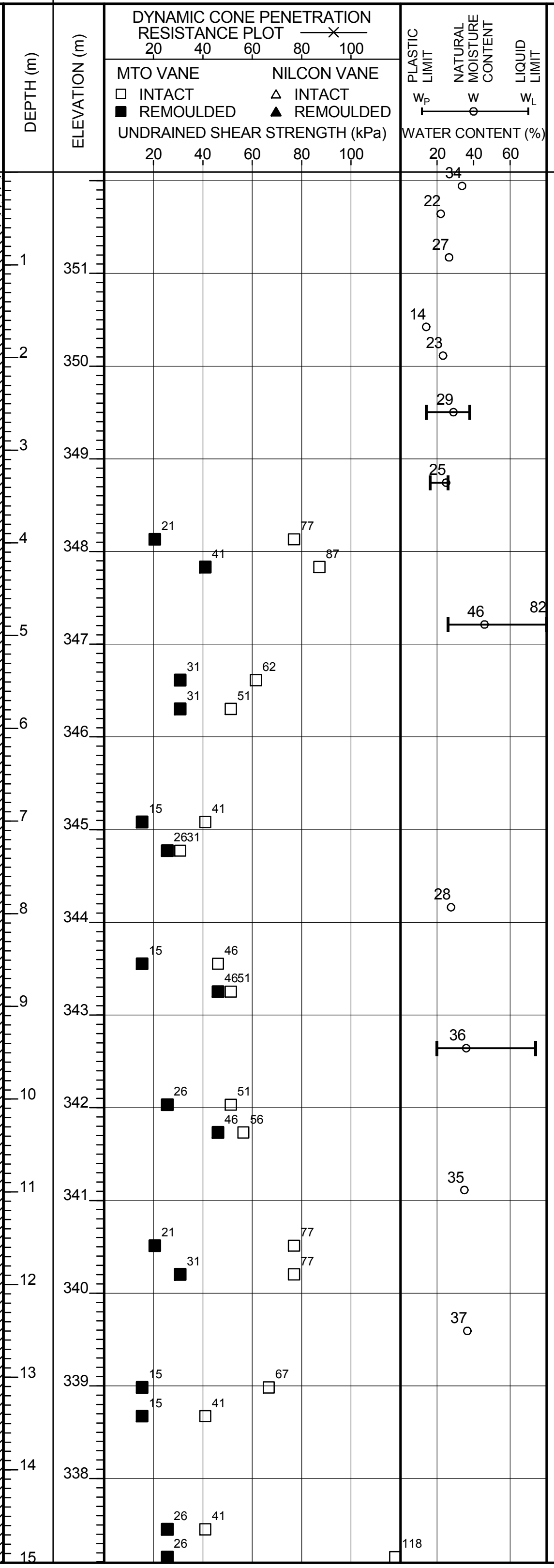
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
352.1	Ground surface					
0.0 351.9 0.2	**TOPSOIL** Dark brown organics, fibrous, rootlets	1	SS	63	10	
	SANDY SILT Brown sandy silt to silty sand, trace clay, trace brown lenses , organics, low to medium plasticity, soft to firm, damp to moist [Glacial Sand??]	2	SS	50	3	
		3	SS	54	5	
349.8 2.3	...below 2.3m - Greyish blue silty clay, trace sand, low to medium plasticity, soft, moist	4	SS	83	4	
	... becoming brown, sandy, low plasticity	5	SS	92	3	
347.5 4.6	**CLAY** Dark grey clay, trace silt, trace sand, trace gravel, firm to stiff, medium to high plasticity, moist [WML Till]	8	SS	100	5	
	...becoming soft	11	TW	100		...at 6.4m PP = 36 KPa TV=44 KPa
	...at 7.62 becoming silty	14	SS	96	5	
	..becoming firm, moist to wet	17	SS	100	5	
		20	SS	100	7	
		23	SS	100	5	
		26	TW	95		...at 14m PP = 49 KPa TV=59 KPa



Continued on Next Page

amec

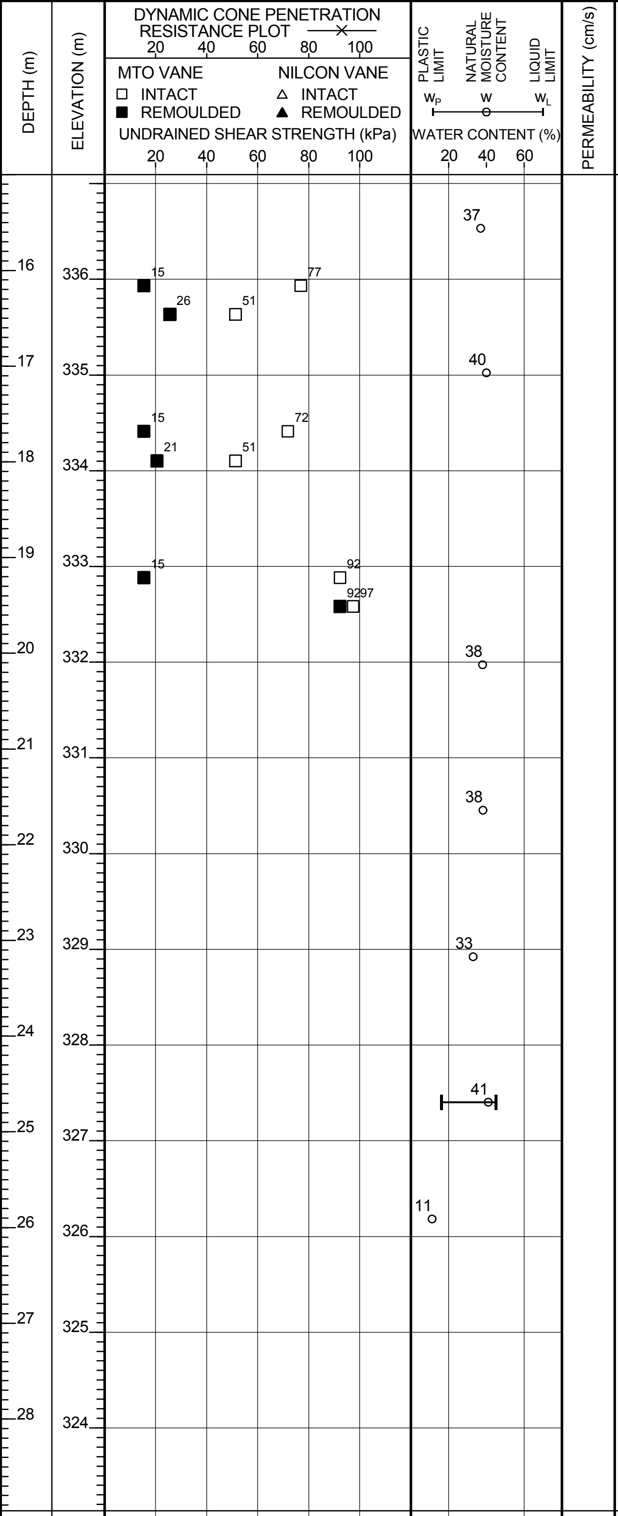
RECORD OF BOREHOLE No. BH11-20 A&B

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Open pit
COMPILED BY NH
ELEVATION 352.093 m
COORD. N 5,410,232 E 425,891
BORING DATE Start: Jan 6, 12 End: Jan 9, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
		29	SS	100	5	
		32	SS	100	6	...at 16.76m switched to washboring
		35	SS	100	7	
		38	SS	100	6	
		40	SS	100	7	
	...At 22.86m occasional sandy pockets, stiff	41	SS	100	9	
327.6 24.5	**SILTY CLAY** Greenish grey silty clay, varved (2-3 mm) dark grey clay , firm, medium plasticity, moist [Lower Glaciolacustrine]	42	SS	100	16	
326.2 25.9	**BOULDERS AND GRAVEL** Dark grey boulders in sand and clay, angular, cm scale [WS Till]	43	SS		/0.08	...at 26m spoon refused switched to NQ coring
		44	RC	67		
325.5 26.6	**BEDROCK** Highly fractured	45	RC	87	23	
		46	RC	100	22	
		47	RC	100	0	
		48	RC	0		
323.1 29.0	**End of Borehole** at 29m due to fractured rock cavin Standpipes installed with flush mounted steel casing Water Level (b.g.s):					



Continued on Next Page

RECORD OF BOREHOLE No. BH11-20 A&B

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Open pit
COMPILED BY NH
ELEVATION 352.093 m
COORD. N 5,410,232 E 425,891
BORING DATE Start: Jan 6, 12 End: Jan 9, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE		SAMPLES											
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
	For Piezometer A (bottom sensing zone) at surface on Jan 09/12 Frozen on Jan 14/12												

RECORD OF BOREHOLE No. BH11-20C

PAGE 1 OF 1

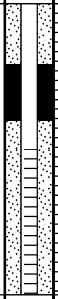
PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Open pit
COMPILED BY SM
ELEVATION 352.093 m
COORD. N 5,410,232 E 425,891
BORING DATE Start: Jan 9, 12 End: Jan 9, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
352.1	Ground surface												
0.0	BH11-20C shows installation details of shallow standpipe piezometer BH11-20C Refer to BH11-20 for stratigraphic Information							1 2 3	351 350				
349.1 3.0	**End of Borehole** at 3.0m Standpipe installed with flushmounted steel casing Water Level (b.g.s): At 0.15m on 09-Jan-12												

RECORD OF BOREHOLE No. BH11-21

PAGE 1 OF 3

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION South of river
COMPILED BY NH
ELEVATION 346.495 m
COORD. N 5,408,466 E 425,055
BORING DATE Start: Feb 25, 12 End: Mar 2, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100)
MTO VANE: □ INTACT, ■ REMOULDED
NILCON VANE: △ INTACT, ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) (20, 40, 60, 80, 100)
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (20, 40, 60)

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
346.5	Ground surface						
0.0	**TOPSOIL** dark brown peat, trace clay.					299	...frozen to 0.8m
345.7 0.8	**Silty SAND** Brownish grey silty sand, trace fine gravel, well graded, loose, wet.	2	SS	29	6	17	
345.0 1.5	**Silty CLAY** Light brown silty clay, trace sand, dark brown lenses, low to medium plasticity, firm, varved, moist [Upper Glaciolacustrine]	3	SS	92	5	26	
		4	SS	100	5	25 42	
		5	SS	100	6	45	
		6	SS	100	5	21	
		7	TW	67			...at 6.1m PP = 73 KPa TV=74 KPa
338.9 7.6	**Silty CLAY** Dark grey silty clay, trace fine gravel, occasional silt pockets, firm, moist [WML Till]	8	SS	100	7	36	
	...below 9.2m, becoming stiff.	9	SS	100	9	35	
		10	SS	100	10	36	
		11	SS		11	35	
		12	SS	100	10	37	

Continued on Next Page

RECORD OF BOREHOLE No. BH11-21

PAGE 2 OF 3

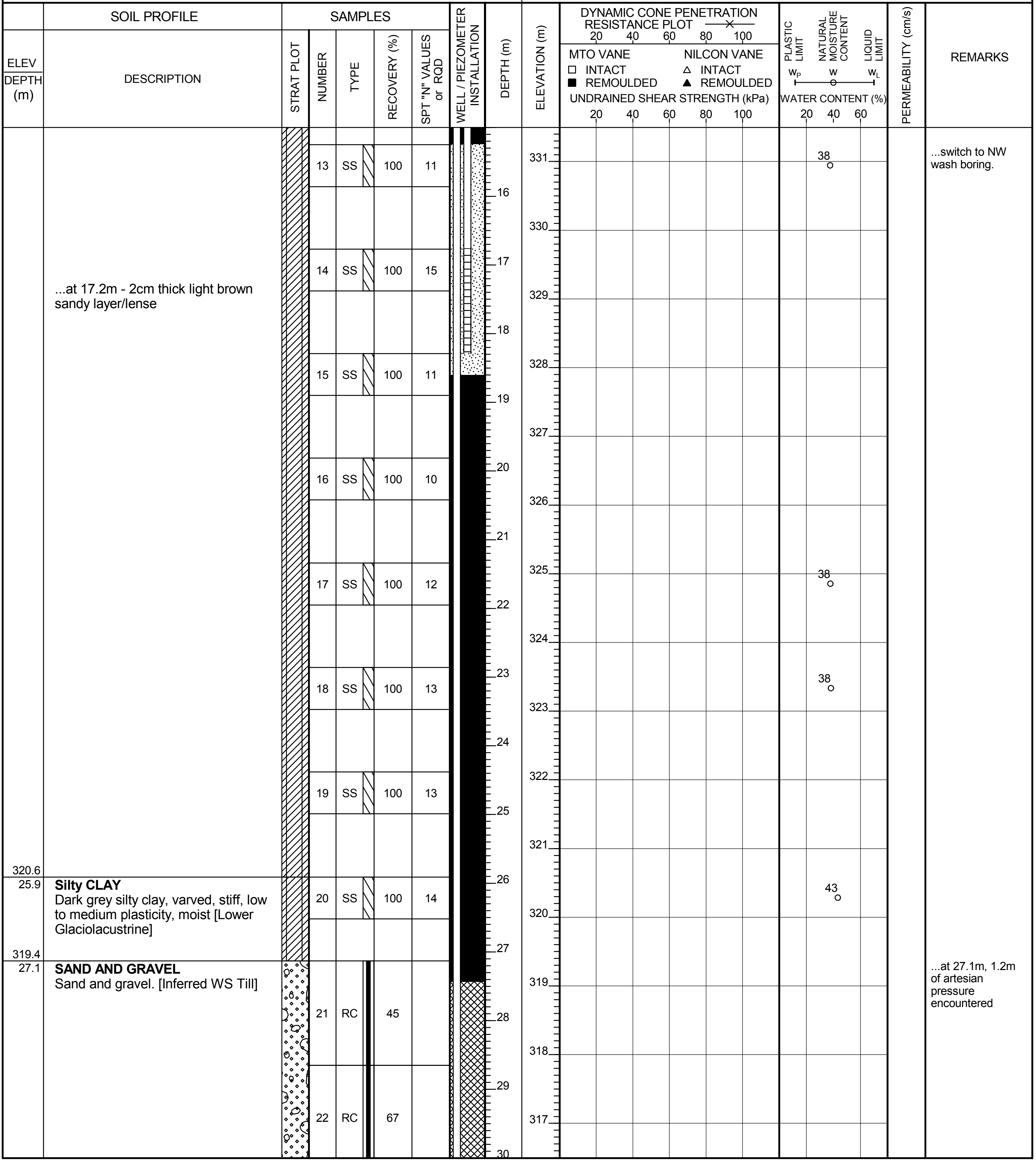
PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION South of river
COMPILED BY NH
ELEVATION 346.495 m
COORD. N 5,408,466 E 425,055
BORING DATE Start: Feb 25, 12 End: Mar 2, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger
BU	Bulk
DC	Dynamic Cone
RC	Rock Core
SS	Split Spoon
TW	Thin Walled Open (Shelby)
WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer
U.W.	Wet Unit Weight
PT	Standard Proctor Test
P.L.	Point Load Strength Index (I_{50})
RQD	Rock Quality Designation
SCR	Solid Core Recovery
k	Permeability
C	Consolidation
DS	Direct Shear
GS	Grain Size Analysis



ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
		13	SS	100	11	38	...switch to NW wash boring.
	...at 17.2m - 2cm thick light brown sandy layer/lense	14	SS	100	15		
		15	SS	100	11		
		16	SS	100	10		
		17	SS	100	12	38	
		18	SS	100	13	38	
		19	SS	100	13		
320.6 25.9	**Silty CLAY** Dark grey silty clay, varved, stiff, low to medium plasticity, moist [Lower Glaciolacustrine]	20	SS	100	14	43	
319.4 27.1	**SAND AND GRAVEL** Sand and gravel. [Inferred WS Till]	21	RC	45			...at 27.1m, 1.2m of artesian pressure encountered
		22	RC	67			

Continued on Next Page

RECORD OF BOREHOLE No. BH11-21

PAGE 3 OF 3

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	South of river			COMPILED BY	NH
ELEVATION	346.495 m	COORD.	N 5,408,466 E 425,055	BORING DATE	Start: Feb 25, 12 End: Mar 2, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100

MTO VANE □ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

PERMEABILITY (cm/s)

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)	REMARKS
		23	RC	45		31	316 315	
314.8 31.7	**BEDROCK** Highly weathered/fractured	24	RC		0	32 33	314	
		25	RC		0	34	313 312	
		26	RC	77	0	35 36	311	
		27	RC	37	0	37	310 309	
		28	RC	60	0	38 39	308	
307.2 39.3	**End of Borehole** at 39.3m Standpipes installed with flushmounted steel casing Water Level (b.g.s): For Piezometer A (bottom sensing zone) at surface on March 02/12 For Piezometer B (middle sensing zone) at surface on March 02/12							...borehole terminated due to dificult drilling condition

amec

RECORD OF BOREHOLE No. BH11-22

PAGE 1 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	MM
CLIENT	Rainy River Resources.	LOCATION	Open Pit			COMPILED BY	NH
ELEVATION	348.996 m	COORD.	N 5,409,908 E 424,953	BORING DATE	Start: Feb 2, 12 End: Feb 3, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

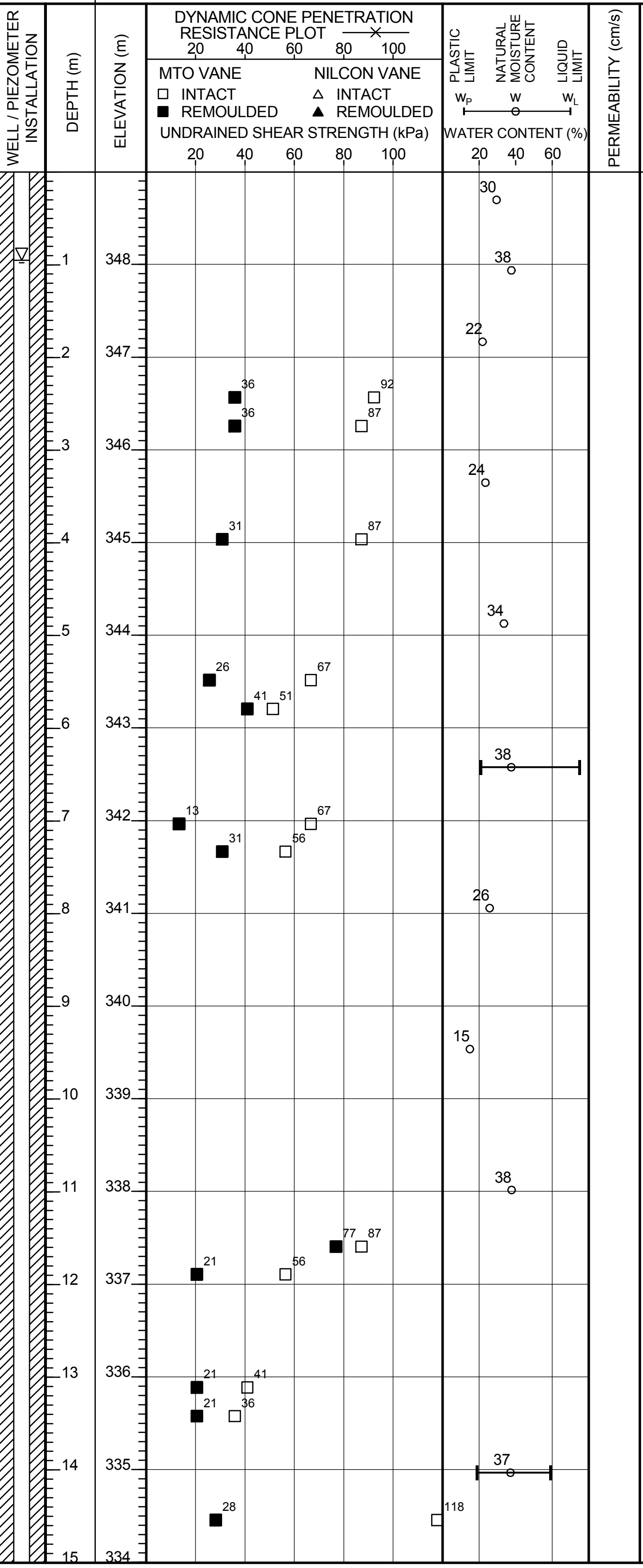
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
349.0	Ground surface
0.0	**TOPSOIL** Light brown silty sand, moist, loose, trace organics.
348.2 0.8	**Silty CLAY** Light brown silty clay, trace sand, varved [Upper Glaciolacustrine]
344.4 4.6	**Silty CLAY** Grey silty clay, trace sand, moist, medium to high plasticity, soft [WML Till] ...at 9.15m, 15cm thick grey silty sand layer, trace gravel, compact, wet
335.3 13.7	**CLAY** Grey clay, trace gravel, trace silt, varved, moist, medium to high plasticity, firm [Lower Glaciolacustrine]
334.3 14.7	

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	96	18
2	SS	83	7
3	SS	100	6
6	SS	100	5
9	SS	100	5
12	SS	100	4
15	SS	100	6
16	SS	50	15
17	SS	100	6
20	TW	95	
23	SS	100	6



REMARKS
...frozen to 1.4m
...at 8.55m, Vane refusal; possible sandy layer
...at 12.19m, TV = 49 KPa
...at 14.65m, heaving sand.

Continued on Next Page

RECORD OF BOREHOLE No. BH11-22

PROJECT: Rainy River - Geotechnical Investigation 2011/2012
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: MM
CLIENT: Rainy River Resources.
LOCATION: Open Pit
COMPILED BY: NH
ELEVATION: 348.996 m
COORD.: N 5,409,908 E 424,953
BORING DATE: Start: Feb 2, 12 End: Feb 3, 12
CHECKED BY: DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
MTO VANE: ☐ INTACT ■ REMOULDED
NILCON VANE: △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa): 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%): 20 40 60

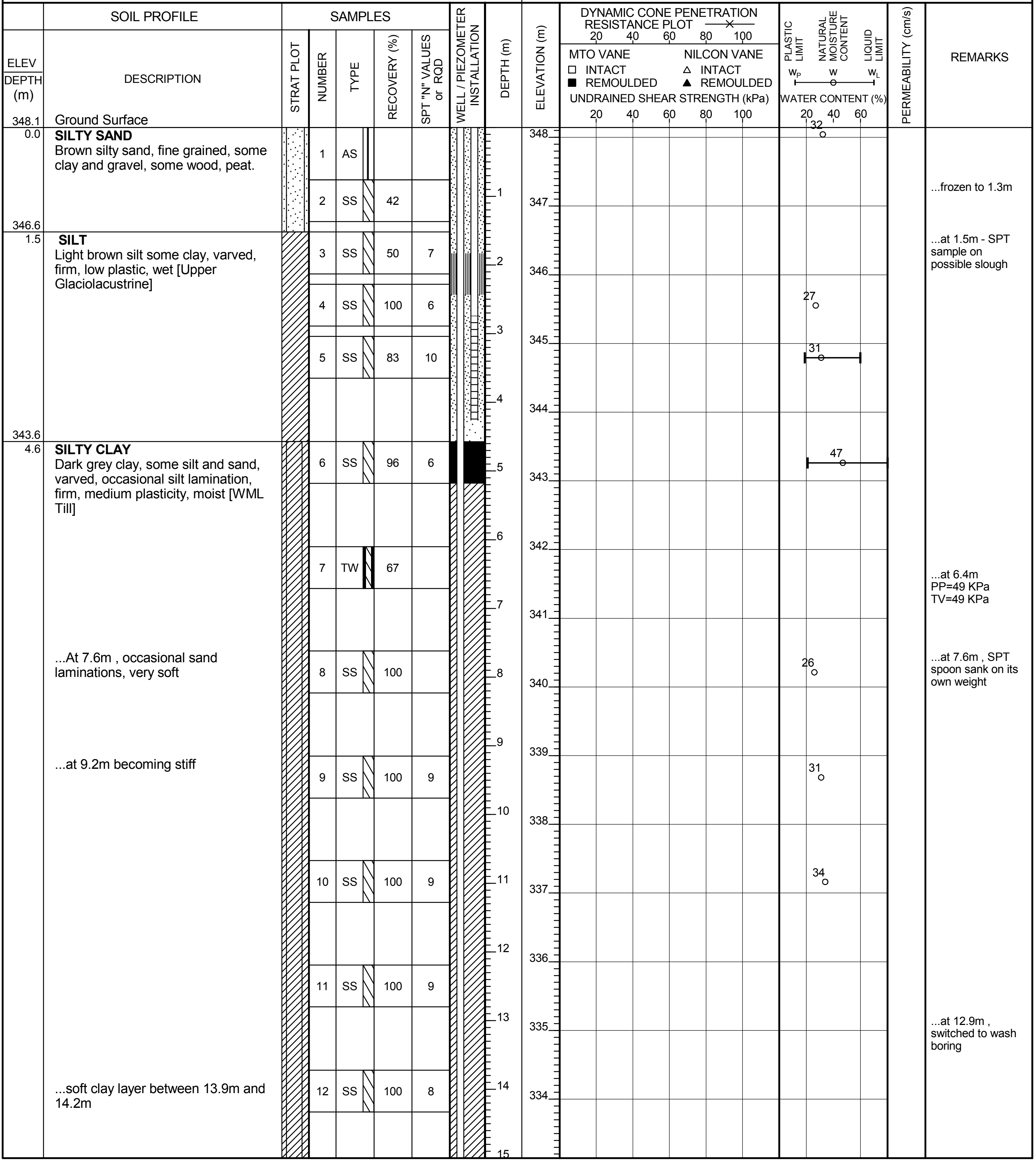
ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
	Silty SAND Grey silty sand, trace gravels, wet, loose [inferred WS Till]					16	333	20		
	...boulders below 16.8m	27	RC			17	332			...at 16.38m; switched to NQ coring.
330.6		28	RC			18	331			
18.4	**BEDROCK**	29	RC	100	22	19	330			
		20	RC	100	97	20 21	329 328			
327.5 21.5	**End of Borehole** at 21.5m Standpipe installed with flush mounted steel casing. Water Level (bgs): at 0.9 m on Feb04/12									

RECORD OF BOREHOLE No. BH11-23

PROJECT: Rainy River - Geotechnical Investigation 2011/2012
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: PDR
CLIENT: Rainy River Resources.
LOCATION: Open Pit
COMPILED BY: NH
ELEVATION: 348.143 m
COORD.: N 5,409,645 E 425,704
BORING DATE: Start: Jan 7, 12 End: Jan 9, 12
CHECKED BY: DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		



ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
348.1	Ground Surface						
0.0	**SILTY SAND** Brown silty sand, fine grained, some clay and gravel, some wood, peat.	1	AS			32	
		2	SS	42			...frozen to 1.3m
346.6 1.5	**SILT** Light brown silt some clay, varved, firm, low plastic, wet [Upper Glaciolacustrine]	3	SS	50	7		...at 1.5m - SPT sample on possible slough
		4	SS	100	6	27	
		5	SS	83	10	31	
343.6 4.6	**SILTY CLAY** Dark grey clay, some silt and sand, varved, occasional silt lamination, firm, medium plasticity, moist [WML Till]	6	SS	96	6	47	
		7	TW	67			...at 6.4m PP=49 KPa TV=49 KPa
	...At 7.6m , occasional sand laminations, very soft	8	SS	100		26	...at 7.6m , SPT spoon sank on its own weight
	...at 9.2m becoming stiff	9	SS	100	9	31	
		10	SS	100	9	34	
		11	SS	100	9		
							...at 12.9m , switched to wash boring
	...soft clay layer between 13.9m and 14.2m	12	SS	100	8		

Continued on Next Page

RECORD OF BOREHOLE No. BH11-23

PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring
				LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Open Pit	COMPILED BY	NH
ELEVATION	348.143 m	COORD.	N 5,409,645 E 425,704	BORING DATE	Start: Jan 7, 12 End: Jan 9, 12
				CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

SOIL PROFILE: ELEV / DEPTH (m); DESCRIPTION; STRAT PLOT
SAMPLES: NUMBER; TYPE; RECOVERY (%); SPT "N" VALUES or RQD
WELL / PIEZOMETER INSTALLATION; DEPTH (m); ELEVATION (m)
DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
MTO VANE □ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P; NATURAL MOISTURE CONTENT W; LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60
PERMEABILITY (cm/s)
REMARKS

Description: ...at 15.25m occasional pockets of sandy silt

DEPTH (m)	ELEVATION (m)	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
15.3	332.8	13	SS	100	11	34	
16.8	331.3	14	TW	100			...at 17.1m PP=73 KPa TV=83 KPa
18.3	329.8	15	SS	100	11	31	
19.8	328.3	16	SS	100	11	29	
21.3	326.8	17	SS	100	13	28	
22.9	325.3	18	SS	100	12	33	
24.4	323.7	19	SS	100	13	40	
25.9	322.2	20	SS	100	13	43	
27.4	320.7	21	SS	100	14	42	
29.0	319.2	22	SS	100	15	51 89	

Continued on Next Page

RECORD OF BOREHOLE No. BH11-23

PAGE 3 OF 3

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Open Pit			COMPILED BY	NH
ELEVATION	348.143 m	COORD.	N 5,409,645 E 425,704	BORING DATE	Start: Jan 7, 12 End: Jan 9, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100

MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
							318			
317.7 30.5	**SANDY GRAVEL Silty** Grey sandy gravel, trace clay, dense to very dense [WS Till]	23	SS		51/0.15	31	317	16		...at 30.6m ,SPT sampler bouncing on possible boulder; switched to NQ coring
						32	316			
						33	315			
						34	314			
	Heaving sands from 34.4m to 35.05m					35	313			
						36	312			
						37	311			
310.0 38.1	**End of Borehole** at 38.1m Standpipes installed with flush mounted steel casing. Water Level (bgs): For piezometer A (bottom sensing zone) at 0.27m on Jan10/12 frozen on Jan14/12 For piezometer B (top sensing zone) at 0.82m on Jan10/12 frozen on Jan14/12					38				

RECORD OF BOREHOLE No. BH11-24

PAGE 1 OF 3

PROJECT: Rainy River - Geotechnical Investigation 2011/2012
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: PDR
CLIENT: Rainy River Resources.
LOCATION: Mine Rock Stockpile
COMPILED BY: SM
ELEVATION: 354 m
COORD.: N 5,408,843 E 426,940
BORING DATE: Start: Mar 13, 12 End: Mar 14, 12
CHECKED BY: DGR

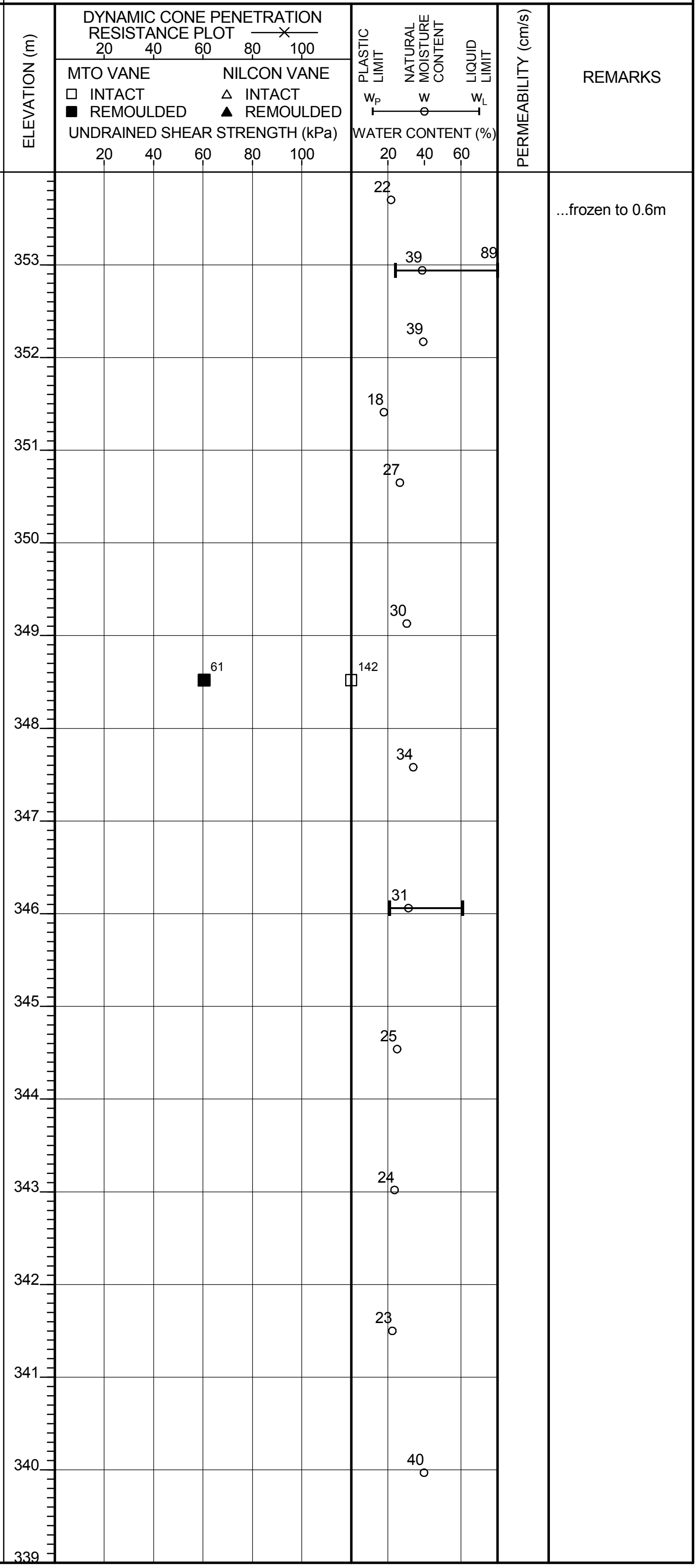
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV / DEPTH (m)	SOIL PROFILE – DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
354.0	Ground Surface					
0.0	**TOPSOIL** Dark brown sandy silt muskeg, occasional rootlets	1	AS			...frozen to 0.6m
353.2 / 0.8	**Silty CLAY** Light brown silty clay, trace sand lensing, varved, firm, medium plasticity, moist [Glaciolacustrine]	2	SS	75	7	
	...at 1.52m trace fine gravel, stiff	3	SS	88	10	
		4	SS	100	13	
		5	SS	100	11	
349.4 / 4.6	**Silty CLAY** Dark greyish brown silty clay, trace to some fine gravel, occasional silt pockets, stiff, medium plasticity, moist [WML Till]	8	SS	100	10	
		11	SS	100	10	
		14	SS	100	9	
		17	SS	100	7	
		20	SS	100	11	
		23	SS	92	12	
		24	SS	100	10	



Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-24

PAGE 2 OF 3

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Mine Rock Stockpile			COMPILED BY	SM
ELEVATION	354 m	COORD.	N 5,408,843 E 426,940	BORING DATE	Start: Mar 13, 12 End: Mar 14, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

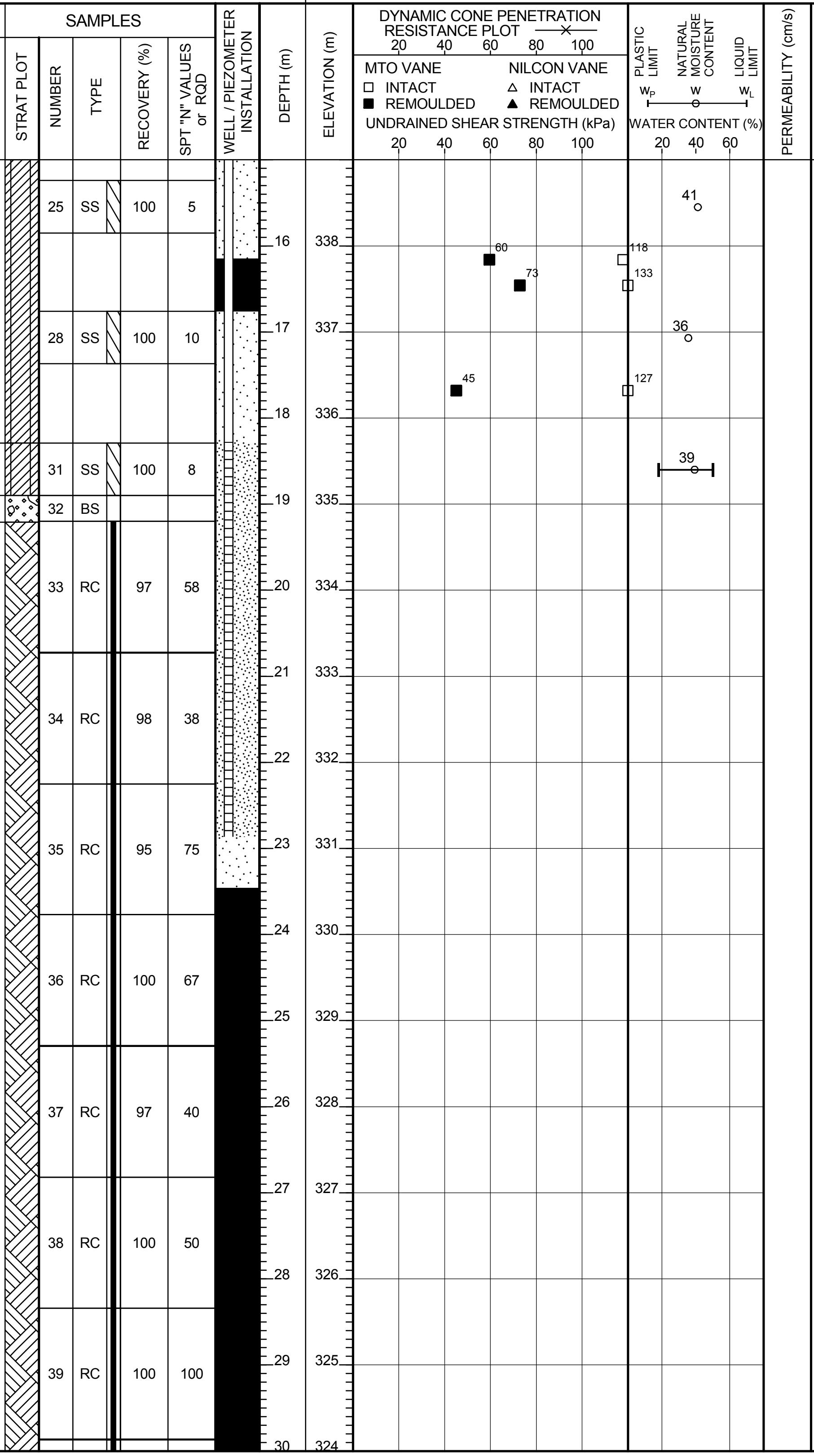
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
	...at 15.25m firm
335.7 18.3	**Silty CLAY** Dark grey clay some light grey silt, varved, firm, low plasticity, moist [Lower Glaciolacustrine]
335.1 18.9	**BOULDERS** [inferred WS Till]
334.8 19.2	**BEDROCK**

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
25	SS	100	5
28	SS	100	10
31	SS	100	8
32	BS		
33	RC	97	58
34	RC	98	38
35	RC	95	75
36	RC	100	67
37	RC	97	40
38	RC	100	50
39	RC	100	100



REMARKS

...at 15.9m switched to washboring

...at 19.2m switched to NQ coring

Continued on Next Page

RECORD OF BOREHOLE No. BH11-24

PROJECT Rainy River - Geotechnical Investigation 2011/2012 ENGINEER MS
PROJECT NO. TC113921 DRILLER Marathon Drilling BORING METHOD 200 mm HSA, NQ Coring LOGGED BY PDR
CLIENT Rainy River Resources. LOCATION Mine Rock Stockpile COMPILED BY SM
ELEVATION 354 m COORD. N 5,408,843 E 426,940 BORING DATE Start: Mar 13, 12 End: Mar 14, 12 CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

SOIL PROFILE		SAMPLES											
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
			40	RC	100	87							
								31	323				
								32	322				
			41	RC	100	52							
								33	321				
			42	RC	100	80							
								34	320				
319.6 34.4	**End of Borehole** at 34.44m Standpipes installed with flush mounted steel casing Water level (b.g.s): For Piezometer A (bottom sensing zone) 1.67m on March 14/12 For Piezometer B (top sensing zone) 0.35 on April 22/12												

RECORD OF BOREHOLE No. BH11-25

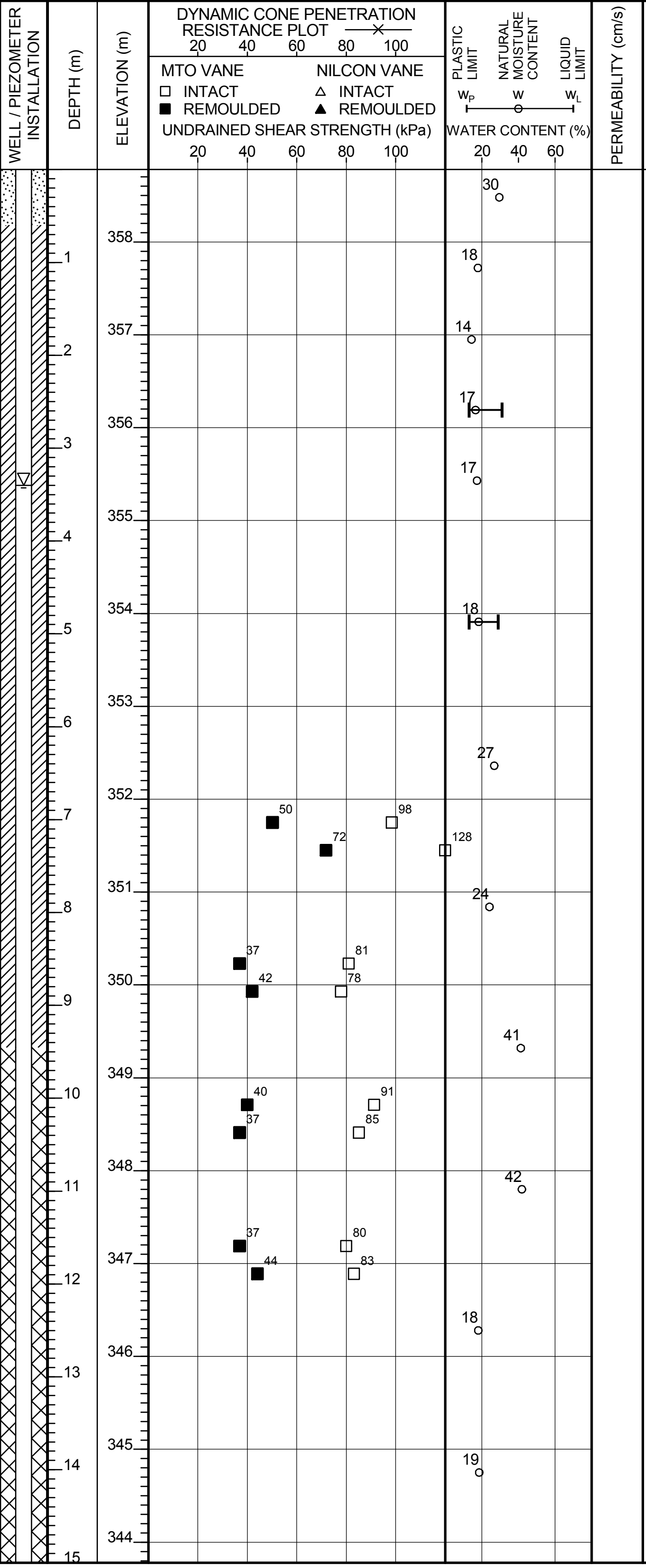
PAGE 1 OF 2

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Mine Rock Stockpile
COMPILED BY SM
ELEVATION 358.780 m
COORD. N 5,409,122 E 427,302
BORING DATE Start: Mar 15, 12 End: Mar 16, 12
CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
358.8	Ground Surface					
0.0	**Silty CLAY** Brown silty clay, some sand, trace fine gravel, low plasticity, occasional rootlets	1	AS			...frozen to 0.8m
358.0 0.8	**Silty CLAY** Light brown silty clay, some sand, trace gravel, varved, very stiff, low plasticity, moist, trace oxidation [Upper Glaciolacustrine]	2	SS	75	18	
		3	SS	96	17	
	...at 2.3m becoming stiff	4	SS	92	14	
		5	SS	96	13	
354.2 4.6	**Silty CLAY** Dark grey silty clay, trace to some sand, trace gravel, occasional silt lenses, stiff, medium plasticity, moist [WML Till]	6	SS	100	12	
	...at 6.1m becoming firm, no gravel	7	SS	100	6	
		10	SS	100	8	
	...at 9.15m trace gravel	13	SS	100	4	
		16	SS	100	4	
	...at 12.2m stiff	19	SS	100	10	
	...at 13.7m very stiff	22	SS	100	20	



Continued on Next Page

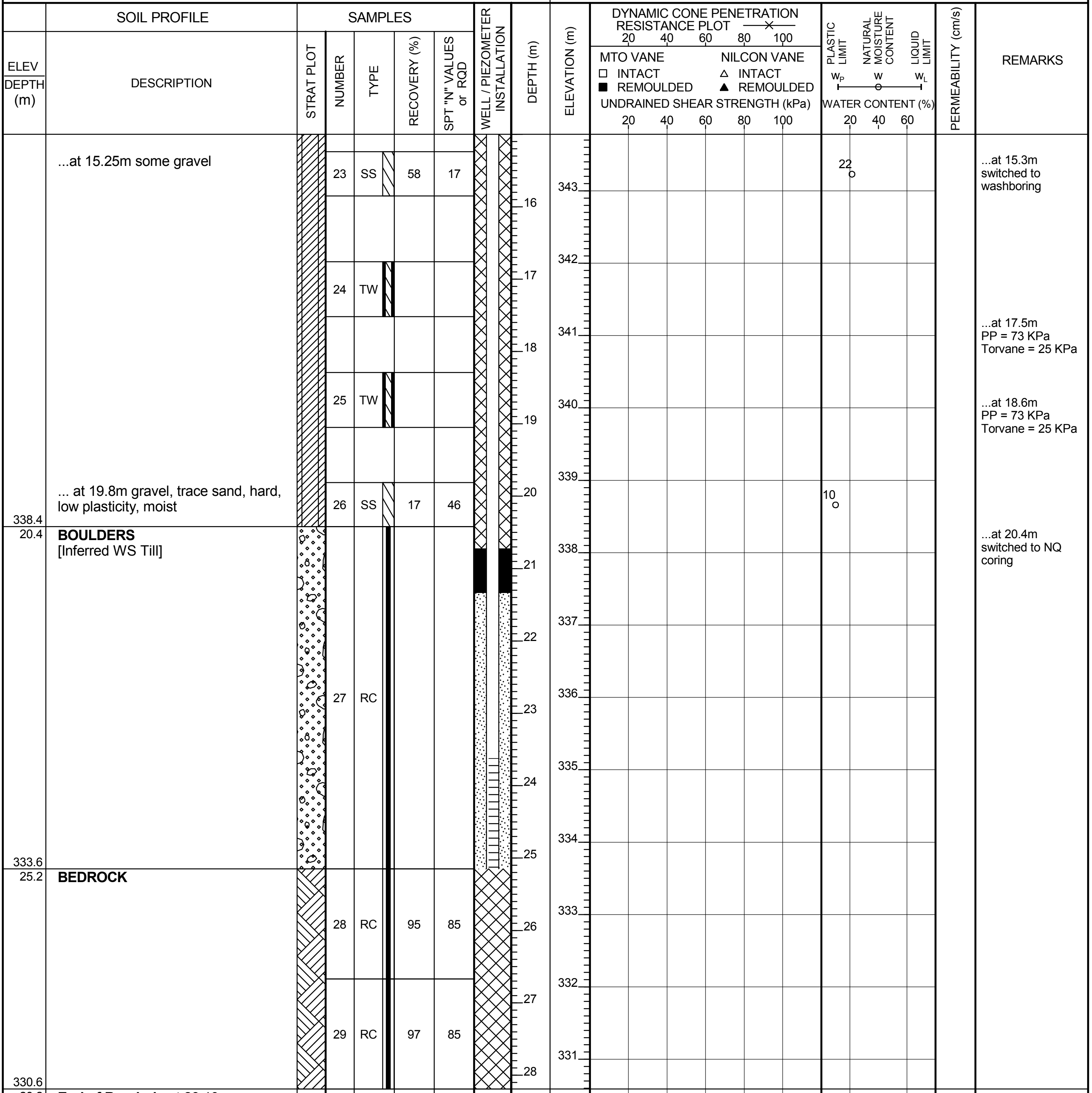
amec

RECORD OF BOREHOLE No. BH11-25

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Mine Rock Stockpile			COMPILED BY	SM
ELEVATION	358.780 m	COORD.	N 5,409,122 E 427,302	BORING DATE	Start: Mar 15, 12 End: Mar 16, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis



ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
	...at 15.25m some gravel	23	SS	58	17	22	...at 15.3m switched to washboring
		24	TW				
							...at 17.5m PP = 73 KPa Torvane = 25 KPa
		25	TW				...at 18.6m PP = 73 KPa Torvane = 25 KPa
	... at 19.8m gravel, trace sand, hard, low plasticity, moist	26	SS	17	46	10	
338.4 20.4	**BOULDERS** [Inferred WS Till]	27	RC				...at 20.4m switched to NQ coring
333.6 25.2	**BEDROCK**	28	RC	95	85		
		29	RC	97	85		
330.6 28.2	**End of Borehole** at 28.19m Standpipes installed with flush mounted steel casing Water level (b.g.s): For Piezometer A at 3.35m on Mar 16/12						

RECORD OF BOREHOLE No. BH11-27

PROJECT Rainy River - Geotechnical Investigation 2011/2012

ENGINEER MS

PROJECT NO. TC113921

DRILLER Marathon Drilling

BORING METHOD 200 mm HSA, NQ Coring

LOGGED BY SM

CLIENT Rainy River Resources.

LOCATION Mine Rock Stockpile

COMPILED BY SM

ELEVATION 355.103 m

COORD. N 5,408,603 E 427,269

BORING DATE Start: Mar 14, 12 End: Mar 17, 12

CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

MTO VANE: □ INTACT ■ REMOULDED; NILCON VANE: △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	UNDRAINED SHEAR STRENGTH (kPa)	WATER CONTENT (%)	REMARKS
355.1	Ground Surface							
0.0	**TOPSOIL** Brown silty clay, trace to some sand, stiff, rootlets and organics	1	SS	100	21		27	...frozen to 1.2m
353.9		2	SS	83	16		31	
1.2	**SILTY CLAY** Greyish brown silty clay, trace sand and gravel, stiff, medium plasticity, damp to moist. [Upper Glaciolacustrine]	3	SS	88	9		39	
	...at 1.5m varved, medium to high plasticity, trace mottled brown lenses	4	SS	100	9		21	
	...at 3.0 m trace to some sand and gravel, rounded to subangular	5	SS	100	9		21	
350.5 4.6	**SILTY CLAY** Greyish brown silty clay, firm to stiff, medium to high plasticity, moist. [WML Till]	6	SS	100	5			
						■ 36 □ 97		
						■ 36 □ 56		
		9	SS	100	6		29	
						■ 31 □ 82		
						■ 41 □ 72		
		12	SS	100	9		18	
	...at 9.1m becoming dark grey, trace to some sand and gravel (subangular)	14	SS	71	9		21	
		15	SS	100	12		22	
	...at 12.6m , 5cm thick sand lense	16	SS	100	9		28	...at 12.2 switched to washboring
	...at 13.7m occasional silty pockets	18	SS	100	9		28	

Continued on Next Page

RECORD OF BOREHOLE No. BH11-27

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Mine Rock Stockpile
COMPILED BY SM
ELEVATION 355.103 m
COORD. N 5,408,603 E 427,269
BORING DATE Start: Mar 14, 12 End: Mar 17, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	UNDRAINED SHEAR STRENGTH (kPa)	WATER CONTENT (%)	REMARKS
		19	SS	100	8		38	
	...at 16.8m becoming firm	21	SS	100	5		39	
						■ 41 ☐ 97		
						■ 56 ☐ 82		
		24	SS	100	8		37	
336.4 18.7	**Silty CLAY** Greyish green silty clay, varved, firm, medium plasticity, moist. [Lower Glaciolacustrine]							
335.3 19.8	**Sandy GRAVEL AND SILT** Grey sandy gravel, trace clay, angular, dense, wet [inferred WS Till]	26	SS	13	36		7	
		27	SS	25	49		1	
	...below 22.3m occasional boulders							
327.2 27.9	**BEDROCK** Grey fractured							...switched to NQ coring at 27.9 m
		28	RC	84	67			

DEPTH (m)	ELEVATION (m)
16	339
17	338
18	337
19	336
20	335
21	334
22	333
23	332
24	331
25	330
26	329
27	328
28	327
29	326
30	

Continued on Next Page

RECORD OF BOREHOLE No. BH11-27

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Mine Rock Stockpile
COMPILED BY SM
ELEVATION 355.103 m
COORD. N 5,408,603 E 427,269
BORING DATE Start: Mar 14, 12 End: Mar 17, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
	...bedrock highly fractured between 29.8m and 31.1m		29	RC	100	50		31	324				
			30	RC	100	68		32	323				
	...slightly fractured below 32.7m		31	RC	100	92		33 34	322 321				
			32	RC	100	93		35	320				
319.4 35.7	**End of Borehole** at 35.7m Standpipe installed with flush mounted steel casing. Water level(b.g.s): at 0.87m on March 17/2012												

RECORD OF BOREHOLE No. BH11-28

PROJECT Rainy River - Geotechnical Investigation 2011/2012 ENGINEER MS

PROJECT NO. TC113921 DRILLER Marathon Drilling BORING METHOD 200 mm HSA, NQ Coring LOGGED BY PDR

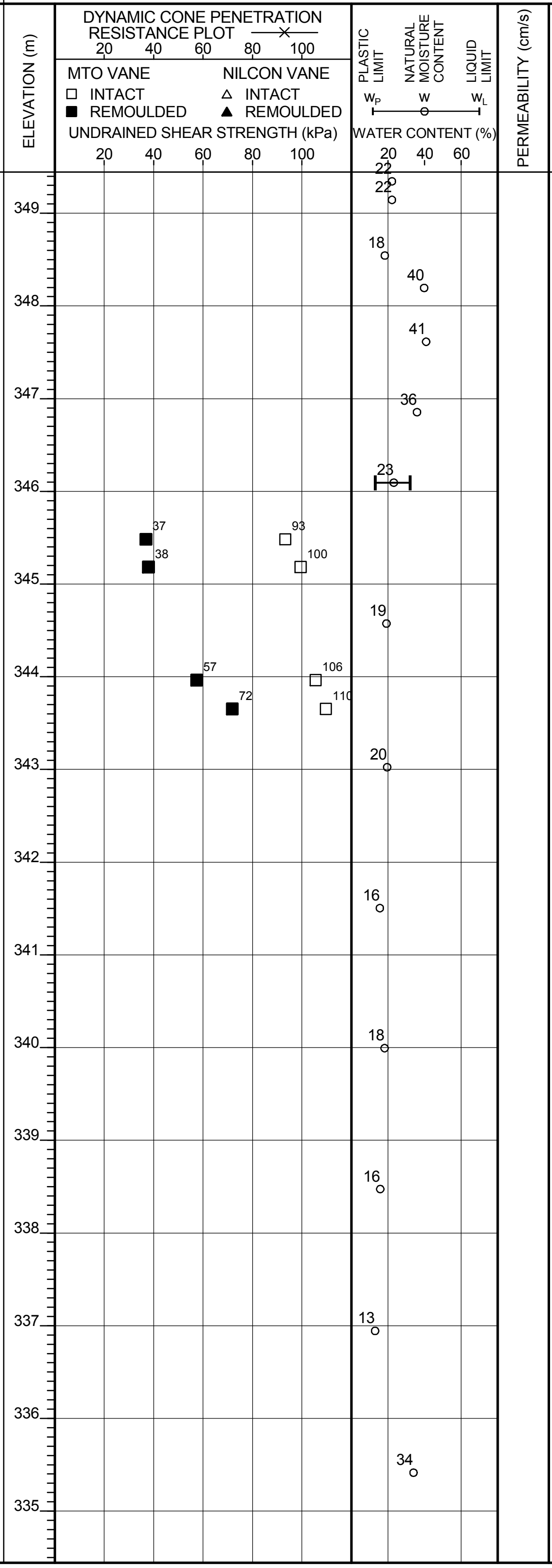
CLIENT Rainy River Resources. LOCATION South of Open Pit COMPILED BY NH

ELEVATION 349.444 m COORD. N 5,408,218 E 426,325 BORING DATE Start: Feb 12, 12 End: Feb 23, 12 CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	REMARKS
349.4	Ground surface						
0.0	**Silty SAND** Light brown silty sand, fine, trace clay, oxidised, woods. ...organics at top.	1	AS				
348.6 0.9	**Silty CLAY** Dark brown silty clay, light brown lenses, medium plasticity, stiff, moist [Upper Glaciolacustrine]	2	SS	83	16	1	...frozen to 1.4m
		3	SS	88	9	2	
		4	SS	96	9	3	
		5	SS	96	7	4	
344.9 4.6	**Silty CLAY** Grey silty clay, trace gravel, trace sand, light grey lenses, medium plasticity, firm, moist [WML Till]	8	SS	100	7	5	
		11	SS	67	10	6	
	...below 7.63m, wet, hard	12	SS	21	27	8	
341.2 8.2	**GRAVELLY SAND** Grey sand and gravel, trace clay, some silt, poorly graded, compact, wet [Glaciofluvial]	13	AS			9	
		14	SS	50	20	10	...heaving sand up to 8.8m
		15	SS	33	34	11	...at 10.67m, switched to wash boring.
		16	SS	54	42	12	
335.7 13.7	**Silty CLAY** Dark grey silty clay, trace light brown lenses, occasional silt pockets, very stiff, medium plasticity [WML Till]	17	SS	100	16	14	



Continued on Next Page

RECORD OF BOREHOLE No. BH11-28

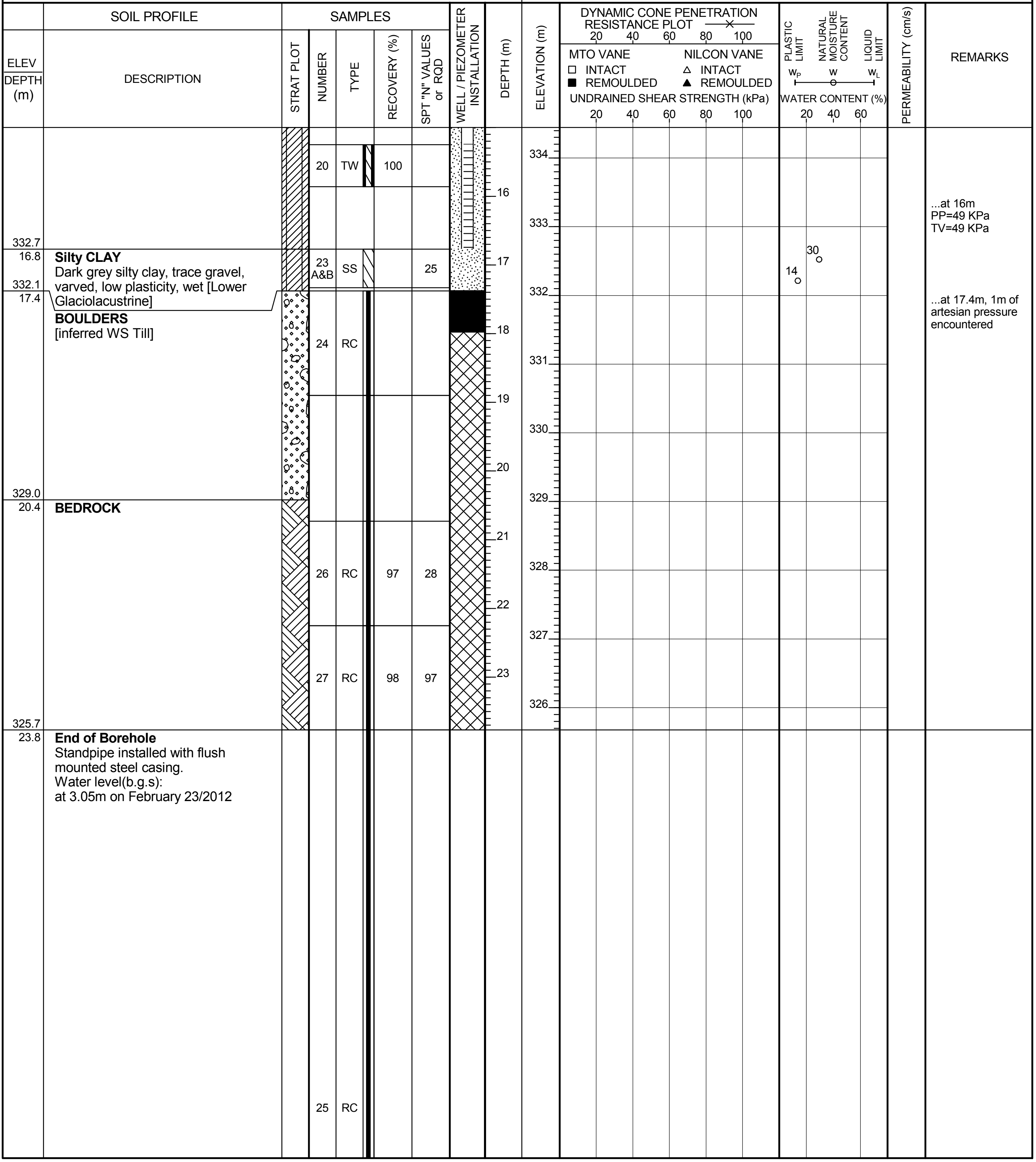
PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring
				LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	South of Open Pit	COMPILED BY	NH
ELEVATION	349.444 m	COORD.	N 5,408,218 E 426,325	BORING DATE	Start: Feb 12, 12 End: Feb 23, 12
				CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		



ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
		20	TW	100		...at 16m PP=49 KPa TV=49 KPa
332.7 16.8	**Silty CLAY** Dark grey silty clay, trace gravel, varved, low plasticity, wet [Lower Glaciolacustrine]	23 A&B	SS		25	
332.1 17.4	**BOULDERS** [inferred WS Till]	24	RC			...at 17.4m, 1m of artesian pressure encountered
329.0 20.4	**BEDROCK**	26	RC	97	28	
		27	RC	98	97	
325.7 23.8	**End of Borehole** Standpipe installed with flush mounted steel casing. Water level(b.g.s): at 3.05m on February 23/2012	25	RC			

Continued on Next Page

RECORD OF BOREHOLE No. BH11-28

PAGE 3 OF 3

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION South of Open Pit
COMPILED BY NH
ELEVATION 349.444 m
COORD. N 5,408,218 E 426,325
BORING DATE Start: Feb 12, 12 End: Feb 23, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

	SOIL PROFILE	SAMPLES								DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60		
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)			PERMEABILITY (cm/s)	REMARKS

RECORD OF BOREHOLE No. BH11-29

PAGE 1 OF 4

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	South of Pinewood River			COMPILED BY	NH
ELEVATION	345.784 m	COORD.	N 5,408,528 E 424,526	BORING DATE	Start: Mar 2, 12 End: Mar 5, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

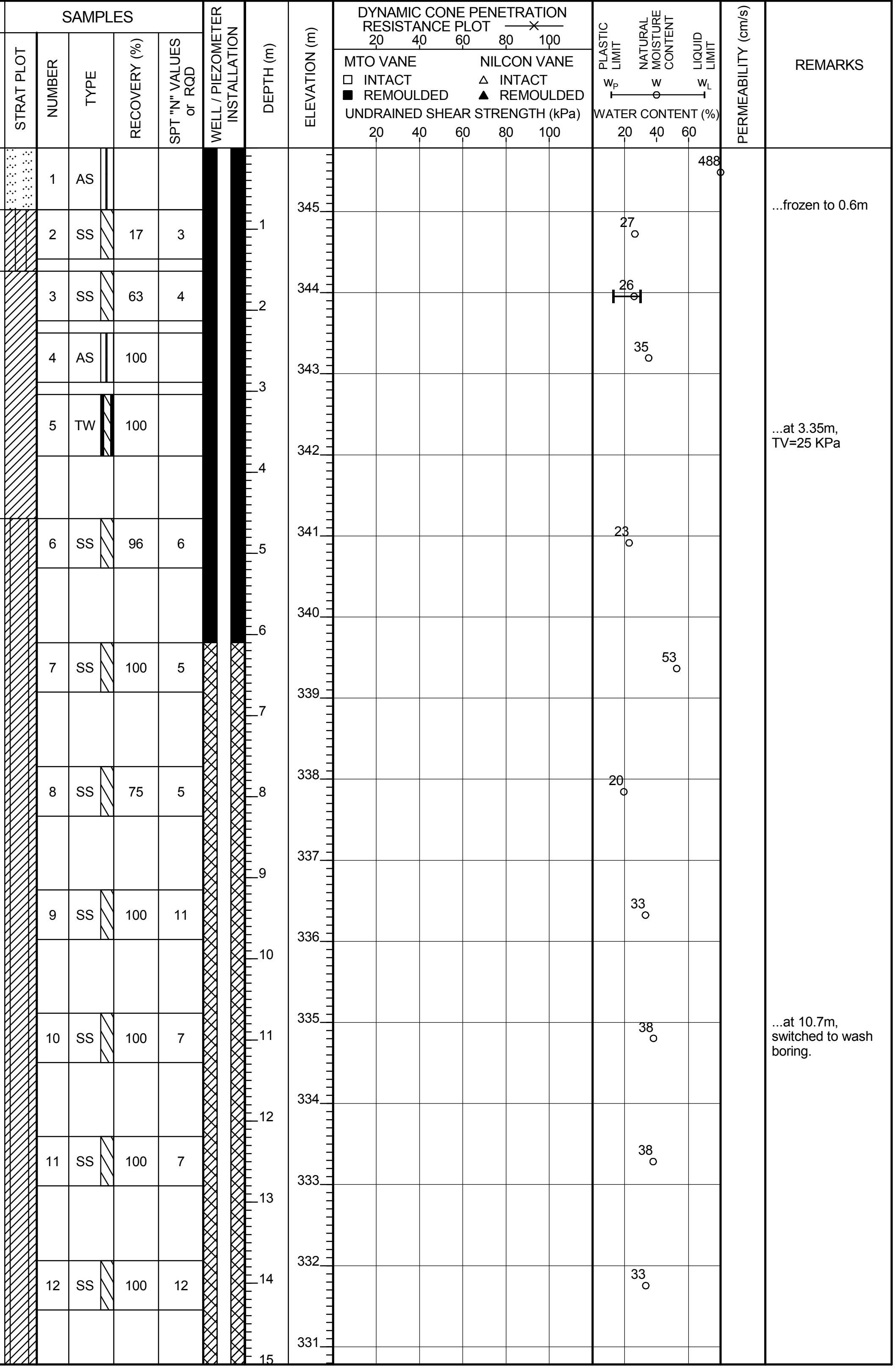
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
345.8	Ground surface
0.0	**TOPSOIL** Dark brown fibrous peat.
345.0 0.8	**Silty CLAY** Light brown silty clay, soft. ...at 0.79m, grey sandy clay, low plasticity, soft.
344.3 1.5	**Silty CLAY** Grey silty clay, some sand, low plasticity, varved, moist, firm, trace oxidised pockets [Upper Glaciolacustrine]
341.2 4.6	**Silty CLAY** Dark grey silty clay, trace sand, medium to high plasticity, stiff, moist. [WML Till] ...below 7.63m, trace fine gravel.

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
1	AS			488	...frozen to 0.6m
2	SS	17	3	27	
3	SS	63	4	26	
4	AS	100		35	
5	TW	100			...at 3.35m, TV=25 KPa
6	SS	96	6	23	
7	SS	100	5	53	
8	SS	75	5	20	
9	SS	100	11	33	
10	SS	100	7	38	...at 10.7m, switched to wash boring.
11	SS	100	7	38	
12	SS	100	12	33	



Continued on Next Page

Format: AMEC GEO MWSK File: TC113921_BHLOGS_20120405.GPJ Date: 7/10/2012 1:30:00 PM

RECORD OF BOREHOLE No. BH11-29

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION South of Pinewood River
COMPILED BY NH
ELEVATION 345.784 m
COORD. N 5,408,528 E 424,526
BORING DATE Start: Mar 2, 12 End: Mar 5, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE: ☐ INTACT ■ REMOULDED
NILCON VANE: △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w ○ — LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
		13	SS	100	10	16	330	35		
		14	SS	100	12	17	329	35		
		15	SS	100	9	18, 19	328, 327	36		
		16	SS	100	9	20	326	35		
		17	SS	100	10	21, 22	325, 324	35		
		18	SS	100	11	23	323	16		
		19	SS	100	13	24, 25	322, 321	25		
	...below 25.9m, stiff to very stiff.	20	SS	100	19	26, 27	320, 319	26		
		21	SS	100	23	28	318	24		
		22	SS	100	14	29, 30	317, 316	37		

Continued on Next Page

RECORD OF BOREHOLE No. BH11-29

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	South of Pinewood River			COMPILED BY	NH
ELEVATION	345.784 m	COORD.	N 5,408,528 E 424,526	BORING DATE	Start: Mar 2, 12 End: Mar 5, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
MTO VANE: ☐ INTACT ■ REMOULDED
NILCON VANE: △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
	...from 30.6m to 30.8m, grey silty sand layer.	23	SS	100	9	23	
		24	SS	100	11		
		25	SS	100	11		
310.7 35.1	**Silty CLAY** Dark grey silty clay, trace sand, trace silt, varved, low to medium plasticity, very stiff [Lower Glaciolacustrine]	26	SS	100	24		
309.8 36.0	**Sandy GRAVEL and BOULDERS** Sandy gravel, silty [inferred WS Till]						...at 36.6m, artesian pressure encountered up to 2.1m
		27	SS	54	45		
306.5 39.3	**BEDROCK**	28	RC	100	20		
		29	RC	100	58		
		30	RC	100	57		
		31	RC	100	77		

DEPTH (m): 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
ELEVATION (m): 315 314 313 312 311 310 309 308 307 306 305 304 303 302 301

Continued on Next Page

RECORD OF BOREHOLE No. BH11-29

PAGE 4 OF 4

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	South of Pinewood River			COMPILED BY	NH
ELEVATION	345.784 m	COORD.	N 5,408,528 E 424,526	BORING DATE	Start: Mar 2, 12 End: Mar 5, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE □ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
		▨					▨		300				
		▨	32	RC	100	72	▨	46	299				
		▨	33	RC	100	50	▨	47 48	298 297				
		▨	34	RC	100	57	▨	49	296				
		▨	35	RC	100	88	▨	50 51	295				
		▨	36	RC	100	10	▨	52	294 293				
291.3		▨	37	RC	100	77	▨	53 54	292				
54.5	**End of Borehole**at 54.35 Standpipe installed with flush mounted steel casing. Water level (b.g.s): at surface on March 05/12												

RECORD OF BOREHOLE No. BH11-33

PAGE 1 OF 3

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	South of River			COMPILED BY	NH
ELEVATION	346.707 m	COORD.	N 5,408,476 E 425,586	BORING DATE	Start: Feb 23, 12 End: Feb 24, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100)
MTO VANE: □ INTACT, ■ REMOULDED
NILCON VANE: △ INTACT, ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) (20, 40, 60, 80, 100)
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (20, 40, 60)
PERMEABILITY (cm/s)

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
346.7	Ground surface
346.6 0.1	**TOPSOIL**
	Silty CLAY Brown silty clay, some sand, slightly oxidised, low plasticity, soft, moist to wet at tip ...at 1.8m grey silty sand, poorly graded, compact, wet
344.4 2.3	**Silty CLAY** Dark brown silty clay, some sand, trace gravel, occasional sand laminations, low plasticity, firm, moist [Upper Glaciolacustrine]
341.8 4.9	**Silty CLAY** Dark grey silty clay, some sand, firm, medium plasticity, moist ...below 6.1m, sand and gravel laminations ...from 12.5 to 13.7m, boulders

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
				49	
2	SS	54	4	26	
3	SS	79	11	28 23	
4	SS	88	6	31	
5	SS	71	4	27	
6 A&B	SS	83	3	30 47 (W_L 83)	
7	SS	100	7	36	
8	SS	100	10	23	
9	SS	100		40	
10	SS	100	10	37	
11	SS		9	34	...at 12.5m, SPT refusal
12	RC	19			
13	RC	7		46	

Continued on Next Page

RECORD OF BOREHOLE No. BH11-33

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION South of River
COMPILED BY NH
ELEVATION 346.707 m
COORD. N 5,408,476 E 425,586
BORING DATE Start: Feb 23, 12 End: Feb 24, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
	...below 15.25m very stiff	14	SS	4	36	37		
		15	SS	100	18	31		
		16	SS	100	18	24		
		17	SS	100	13	22		
	...below 21.34m, occasional silt pockets	18	SS	100	14	35		
		19	SS	100	15	37		
		20	SS	100	14	35		
		21	SS	100	15	25		
319.3 27.4	**Silty CLAY** Grey silty clay, varved, low plasticity, very stiff, moist [Lower Glaciolacustrine]	22	SS	100	17	35		
317.7 29.0	**SAND and GRAVEL** Grey sand and gravel, trace silt, well graded, dense, wet [WS till]	23	SS	100	54			

DEPTH (m): 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30
ELEVATION (m): 331, 330, 329, 328, 327, 326, 325, 324, 323, 322, 321, 320, 319, 318, 317

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-33

PAGE 3 OF 3

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	South of River			COMPILED BY	NH
ELEVATION	346.707 m	COORD.	N 5,408,476 E 425,586	BORING DATE	Start: Feb 23, 12 End: Feb 24, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60
PERMEABILITY (cm/s)
REMARKS

ELEV DEPTH (m)	DESCRIPTION
	...below 36.6m, boulders
308.9 37.8	**BEDROCK** Highly weathered
302.8 43.9	**End of Borehole** Standpipe installed with flush mounted steel casing Water level at ground surface upon installation

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
24	SS	0	76
25	SS	38	41
26	SS	42	19
27	SS	83	38
28	RC	77	0
29	RC	83	0
30	RC	58	0
31	RC	47	0

DEPTH (m): 31 32 33 34 35 36 37 38 39 40 41 42 43

ELEVATION (m): 316 315 314 313 312 311 310 309 308 307 306 305 304 303

amec

RECORD OF BOREHOLE No. BH11-34

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION South of Open Pit
COMPILED BY NH
ELEVATION 347.648 m
COORD. N 5,408,419 E 426,102
BORING DATE Start: Feb 9, 12 End: Feb 11, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

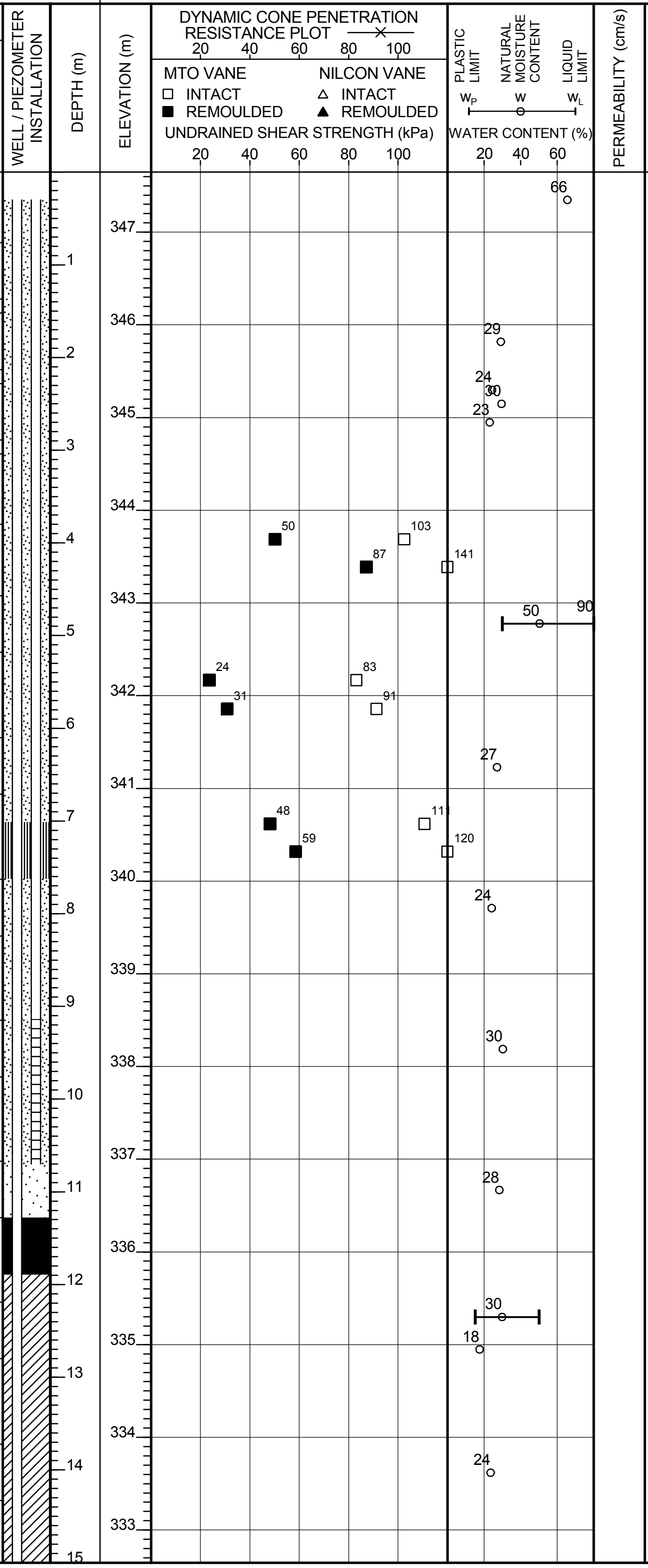
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
347.6	Ground surface
0.0 347.3	**TOPSOIL** Dark brown peat
0.3	**Silty CLAY** Greyish brown silty clay, trace gravel, grey lenses, trace oxidised pockets, medium plasticity, moist [Upper Glaciolacustrine] ...at 1.26m, sand laminations
343.1 4.6	**Silty CLAY** Dark grey silty clay, trace sand, medium plasticity, firm to stiff, moist, light grey silt pockets [WML Till] ...at sandy layer between 12.65 and 12.8m

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	AS		
2A B&C	SS	83	7
3	SS	79	6
4A B C	SS	75	5
5	TW	100	
8	SS	83	7
10	SS	100	6
13	SS	92	6
14	SS	100	10
15	SS	100	11
16A&B	SS	100	17
17	SS	100	9



PERMEABILITY (cm/s)

REMARKS

...frozen to 0.6m

...at 9.15m, switched to wash boring.

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-34

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION South of Open Pit
COMPILED BY NH
ELEVATION 347.648 m
COORD. N 5,408,419 E 426,102
BORING DATE Start: Feb 9, 12 End: Feb 11, 12
CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
		18	SS	100	16		332	38		
						16				
		19	SS	100	12	17	331	37		
						18	330			
		20	SS	100	8		329	26		
328.4 19.2	**Sandy GRAVEL** Boulders [inferred WS Till]					19	328			
						20	327			
326.9 20.7	**BEDROCK**					21				
		22	RC	98	83	22	326			
		23	RC	97	55	23	325			
	...highly fractured					24	324			
		24	RC	95	7	25	323			
		25	RC	98	62	26	322			
						27	321			
		27	RC	95	68	28	320			
		28	RC	98	87	29	319			
						30	318			

Continued on Next Page

RECORD OF BOREHOLE No. BH11-34

PAGE 3 OF 3

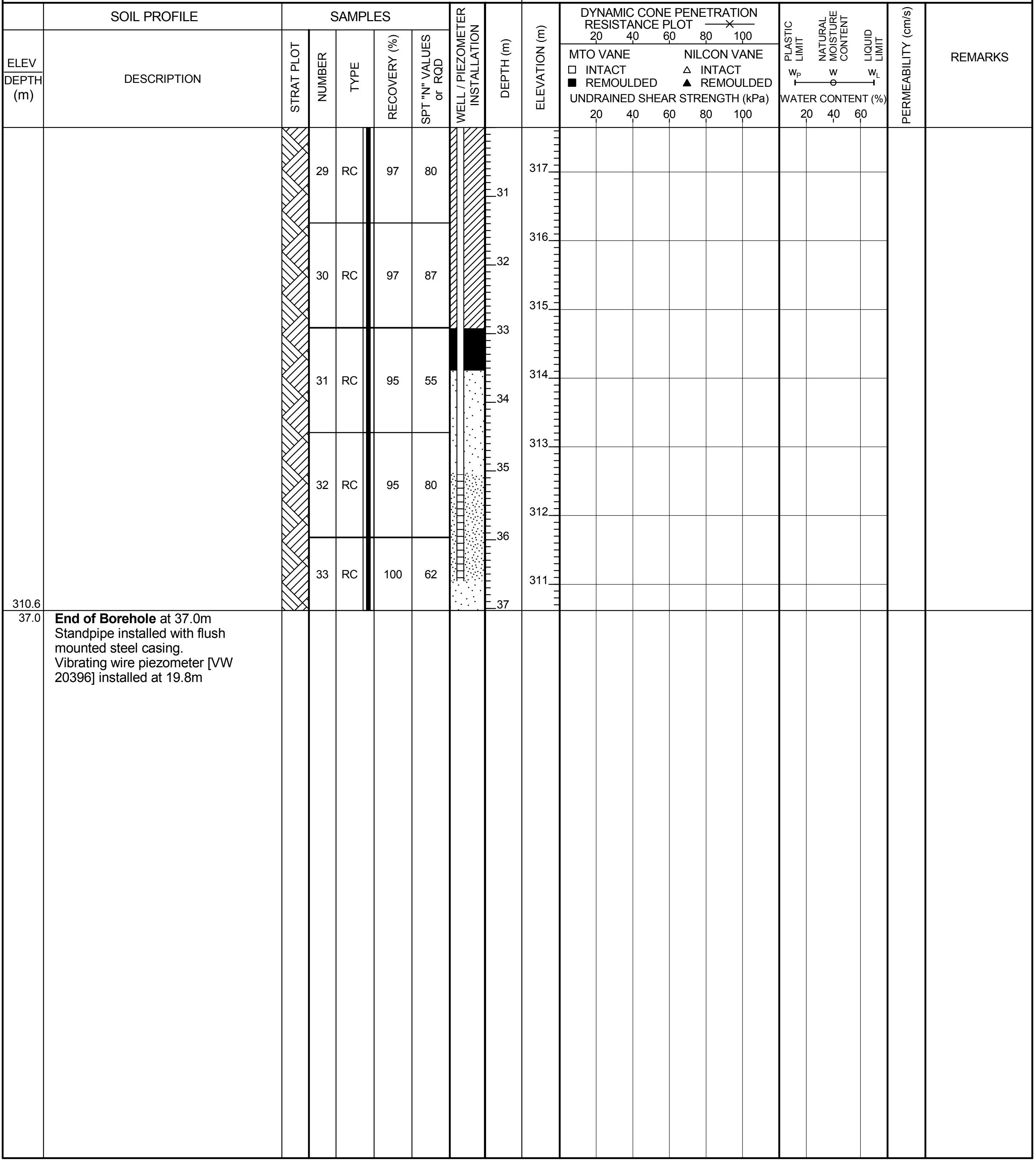
PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	South of Open Pit			COMPILED BY	NH
ELEVATION	347.648 m	COORD.	N 5,408,419 E 426,102	BORING DATE	Start: Feb 9, 12 End: Feb 11, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		



ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
		29	RC	97	80
		30	RC	97	87
		31	RC	95	55
		32	RC	95	80
		33	RC	100	62
310.6 37.0	**End of Borehole** at 37.0m Standpipe installed with flush mounted steel casing. Vibrating wire piezometer [VW 20396] installed at 19.8m				

Format: AMEC GEO MWSK File: TC113921_BHLOGS_20120405.GPJ Date: 7/10/2012 1:30:16 PM

RECORD OF BOREHOLE No. BH11-35

PAGE 1 OF 1

PROJECT: Rainy River - Geotechnical Investigation 2011/2012
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: PDR
CLIENT: Rainy River Resources.
LOCATION: Ore Stockpile
COMPILED BY: NH
ELEVATION: 370.255 m
COORD.: N 5,410,896 E 426,306
BORING DATE: Start: Jan 10, 12 End: Jan 12, 12
CHECKED BY: DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

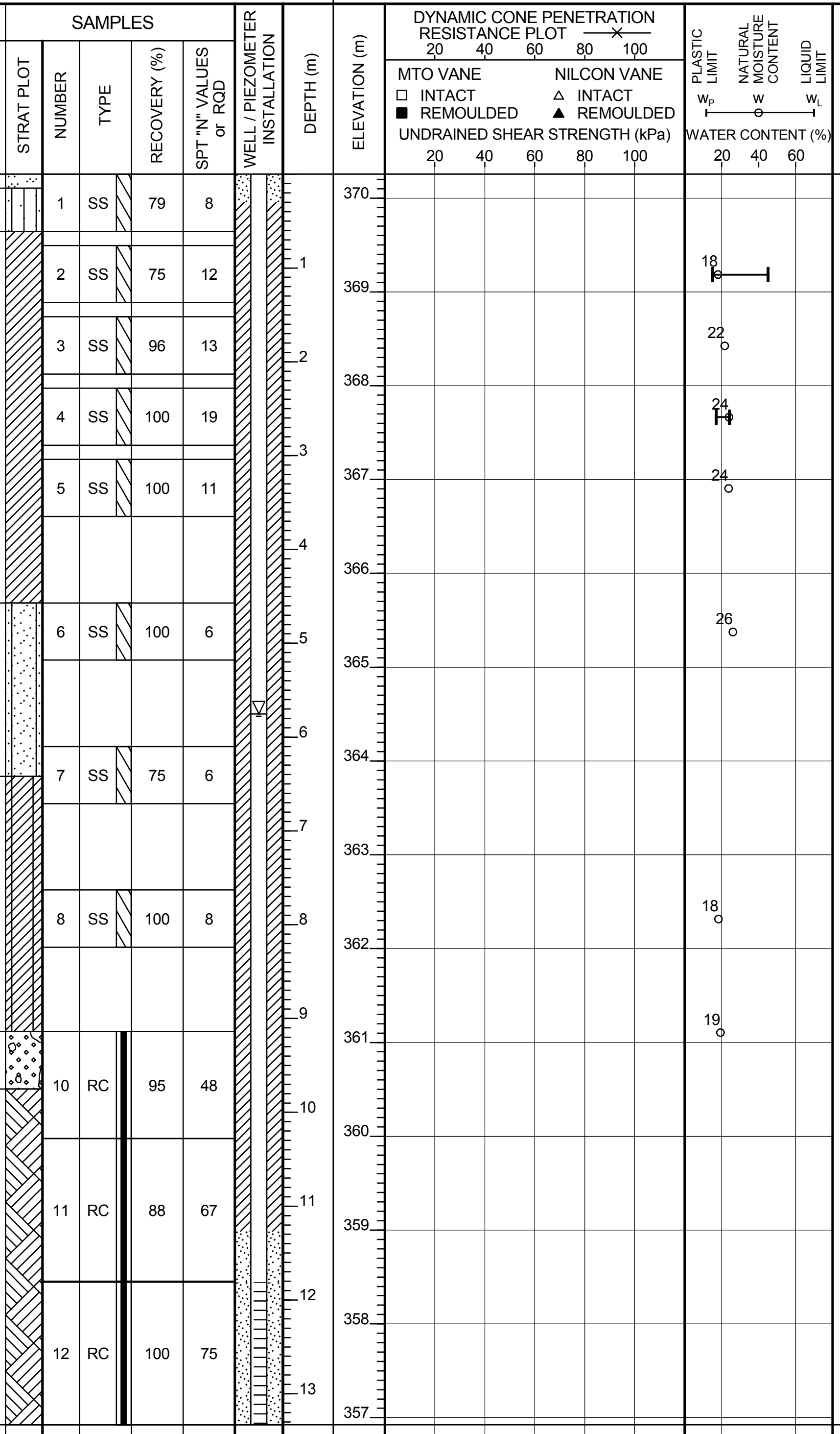
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

SOIL PROFILE

ELEV / DEPTH (m)	DESCRIPTION
370.3	Ground surface
0.0	**TOPSOIL**
370.1 / 0.2	**SANDY SILT** Light brown sandy silt, some clay, some roots, frozen.
369.6 / 0.6	**SANDY SILT** Light brown sandy silt, some clay, trace gravel, some silt laminations, varved, stiff, low to medium plasticity, moist [Upper Glaciolacustrine] ...at 2.3m, some to trace clay, very stiff. ...at 3.04m, becoming stiff, occasional sand laminations.
365.7 / 4.6	**SILTY SAND** Light brown silty sand, some clay, trace gravel, loose, wet [Glacial Sand]
363.8 / 6.4	**CLAY** Dark grey some clay trace to some silt, trace gravel, stiff, medium plasticity, moist, light brown lenses [WML Till] ...occasional 3mm sand laminations noted below 7.6m.
361.1 / 9.1	**SAND AND GRAVEL** Grey sand and gravel, boulders, trace silt, wet [WS Till]
360.5 / 9.8	**BEDROCK**
356.9 / 13.3	**End of Borehole** at 13.3m Standpipe installed with flush mounted steel casing Water level (b.g.s): at 4.24 m on Jan12/12. at 5.70 m on Jan15/12.

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
1	SS	79	8	
2	SS	75	12	...frozen to 1.4 m
3	SS	96	13	
4	SS	100	19	
5	SS	100	11	
6	SS	100	6	
7	SS	75	6	
8	SS	100	8	
10	RC	95	48	
11	RC	88	67	
12	RC	100	75	



RECORD OF BOREHOLE No. BH11-36

PAGE 1 OF 1

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY SM
CLIENT Rainy River Resources.
LOCATION Plant Site
COMPILED BY SM
ELEVATION 374.669 m
COORD. N 5,410,792 E 426,936
BORING DATE Start: Dec 7, 11 End: Dec 9, 11
CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

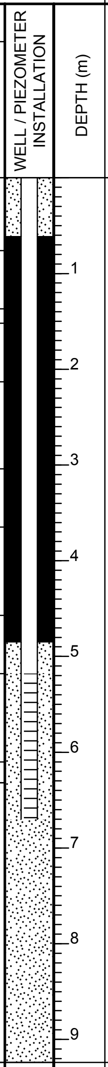
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

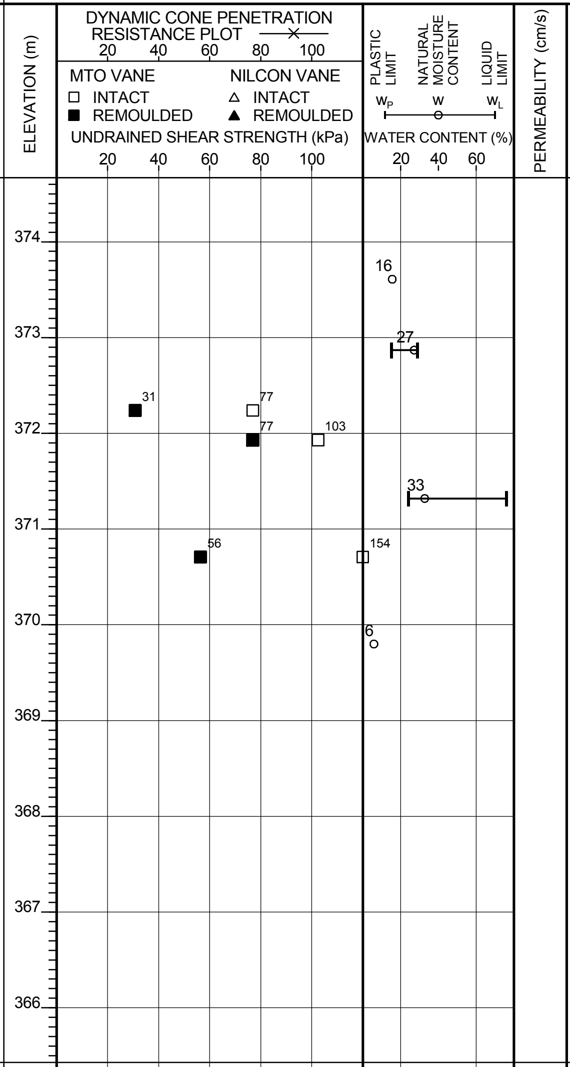
SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
374.7	Ground Surface
0.0 374.4	**TOPSOIL** Dark grey silty clay, trace sand, medium plastic, moist, rootlets
0.3	**SILTY CLAY** Light brown silt, varved (grey clay in laminations), firm, low to medium plasticity, damp to moist [Upper Glaciolacustrine] ...at 0.3m, non-plastic ...at 1.52m, trace mottled brown lenses
371.6 3.1	**SILTY CLAY** Drak grey clay, some silt to silty, trace gravel , stiff to very stiff, medium to high plasticity, occasional sand pockets, moist [WML Till] ...below 4.6m, becoming silty and gravelly (subrounded)
369.8 4.8	**SAND** Dark grey sand, trace silt and gravel (subrounded), fine to medium, poorly graded, compact to dense, damp to moist ...at 6.1 some fine gravel
368.4 6.2	**BEDROCK** Metamorphic, highly fractured
365.4 9.2	**End of Borehole** at 9.2m Stand pipe installed with 0.76m stick up and protected with steel casing; stand pipe pulled up by 0.45m while retrieving auger Water level (bgs): at 5.58m on Dec09/12 No water on De18/12

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	79	8
2	SS	100	13
3	SS	100	12
4	SS	75	21
5	SS	67	8/0.07
6	RC	97	19





REMARKS

amec

RECORD OF BOREHOLE No. BH11-37

PAGE 1 OF 1

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Plant Site			COMPILED BY	SM
ELEVATION	369.991 m	COORD.	N 5,410,528 E 426,658	BORING DATE	Start: Dec 9, 11 End: Dec 13, 11	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

MTO VANE □ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
370.0	Ground Surface							
0.0	**TOP SOIL** Light brown silt, trace gravel and cobbles (angular), mottled brown lenses, firm, no plasticity, dry to moist, rootlets at top	1	SS	83	22	7		
368.5 1.5	**BEDROCK** Bluish grey, metamorphic, weathered ...fractured at the top	2	RC	100	65			
		3	RC	100	56			
		4	RC	100	96			
365.2 4.8	**End of Borehole** at 4.8m Stand pipe installed with 0.91m stick up, protected with steel casing. Water level (bgs): at 1.88m on Dec 14/12 at 1.90m on Dec 18/12							

DEPTH (m)	ELEVATION (m)
1	369
2	368
3	367
4	366

RECORD OF BOREHOLE No. BH11-38

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Plant Site			COMPILED BY	NH
ELEVATION	371.593 m	COORD.	N 5,410,377 E 426,928	BORING DATE	Start: Jan 16, 12	CHECKED BY	DGR

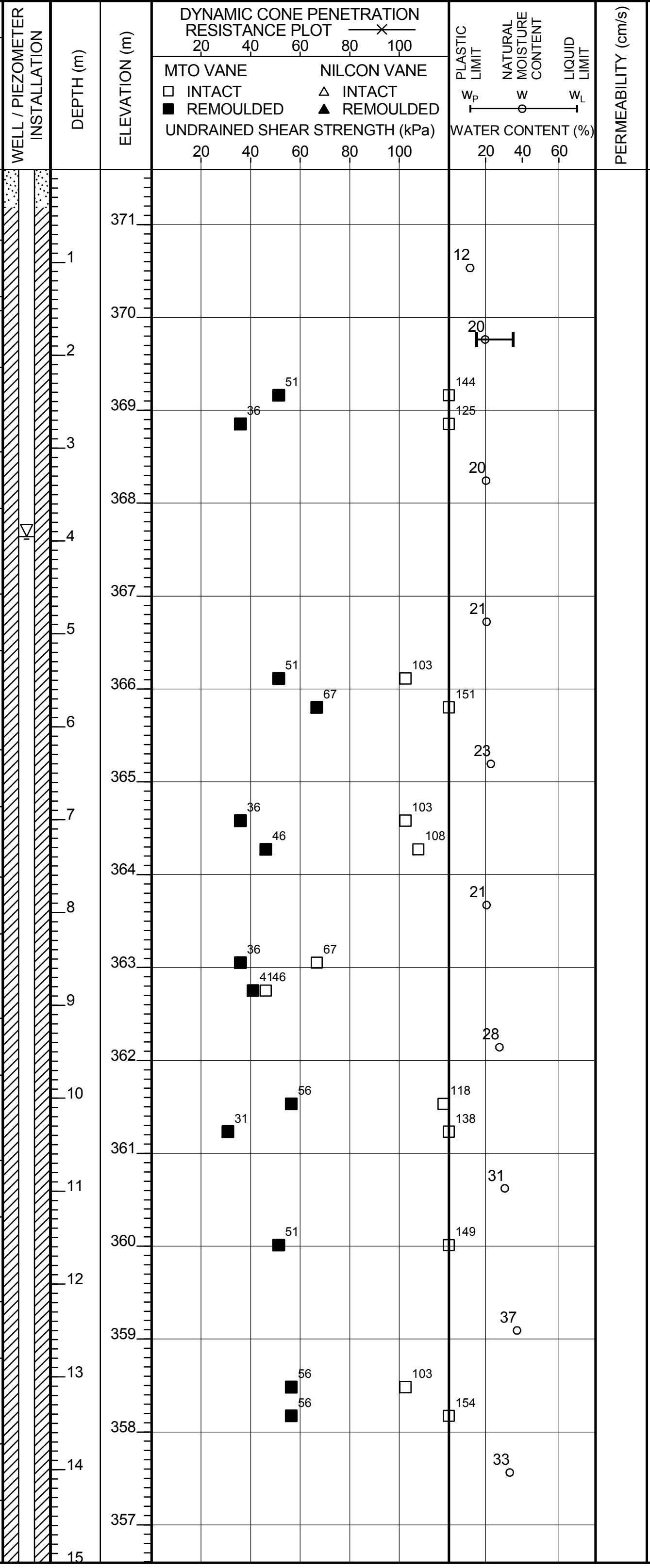
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
371.6	Ground surface				
0.0	**TOP SOIL** brown silty clay , organics, rootlets, trace sand, firm, low plasticity, damp to moist				
370.8 0.8	**SILTY CLAY** Light brown silt, trace sand and gravel, grey clay lenses, low to medium plasticity, stiff, moist, rootlets [Upper Glaciolacustrine] ...at 1.5m, becoming clayey, moist to wet, no rootlets	1	SS	92	13
		2	SS	100	9
		5	SS	100	8
367.0 4.6	**SILTY CLAY** Grey clay, silty, trace sand, trace gravel, occasional silt pocket, stiff , medium to high plasticity, moist [WML Till]	6	SS	100	7
	... becoming silty, firm, low to medium plastic, wet from 6.1m to 9.14m	7	SS	100	6
		12	SS	96	6
		15	SS	100	10
		18	SS		8
		20	SS	100	6
	...at 13.72m, occasional silt pockets, cm scale.	23	SS	100	8



Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-38

PAGE 2 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Plant Site			COMPILED BY	NH
ELEVATION	371.593 m	COORD.	N 5,410,377 E 426,928	BORING DATE	Start: Jan 16, 12	CHECKED BY	DGR

SAMPLE TYPES

AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS

P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION
	...at 16.8m trace sand and gravel angular to subangular, firm.
353.3 18.3	**SANDY GRAVEL** Greenish grey fine gravel, some sand, boulders, well graded ,angular to subangular [WS Till] ...at 18.9m, black greenish grey to light grey boulders, some cobbles, angular to sub angular
350.7 20.9	**BEDROCK** Grey, metamorphic, fractured
348.0 23.6	**End of borehole** at 23.6m Standpipe installed with 0.79m stick up and steel casing Water level (b.g.s): at 3.8m on Dec 19/12 at 3.9m on Jan14/12

SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)
24	SS	100	4	30
25	SS	54	12	31
26	SS	17	15	7
27	RC	33		
28	RC	100		
29	RC	100	65	
30	RC	98	80	
31	RC	100	100	

WELL / PIEZOMETER INSTALLATION

DEPTH (m): 16, 17, 18, 19, 20, 21, 22, 23

ELEVATION (m): 356, 355, 354, 353, 352, 351, 350, 349

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

MTO VANE ☐ INTACT ■ REMOULDED

NILCON VANE △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L

WATER CONTENT (%) 20 40 60

PERMEABILITY (cm/s)

REMARKS

RECORD OF BOREHOLE No. BH11-39

PAGE 1 OF 1

PROJECT	Rainy River - Geotechnical Investigation 2011/2012			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring
				LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Plant Site	COMPILED BY	NH
ELEVATION	373.723 m	COORD.	N 5,409,832 E 426,819	BORING DATE	Start: Jan 5, 12 End: Jan 6, 12
				CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100

MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

PERMEABILITY (cm/s)

ELEV / DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
373.7	Ground Surface						
0.0 373.6 0.2	**TOPSOIL** Dark brown organics, fibrous, rootlets	1	SS	71	7		...frozen to 0.2m
373.0 0.8	**SILT AND SAND** Light brown silt and sand, trace gravel, dark brown pockets of organics, damp, rootlets	2	SS	75	10	16	
	SILTY CLAY Light brown to grey silt, trace sand and gravel, varved (grey clay lamination), firm to stiff, low to medium plasticity, damp to moist, occasional mottled brown lenses [Upper Glaciolacustrine]	3	SS	100	10	17	
		4	SS	100	10	25	
370.9 2.8	**BEDROCK** Fractured, greyish blue	5	RC	100	74		
		6	RC	86	0		
		7	RC	100	93		
		8	RC	87	50		
367.8		9	RC	100	75		
5.9	**End of Borehole** at 5.9m Stand pipe installed with 0.81m stick up and protected with steel casing Water level (b.g.s): at 0.2m on Jan 06/12 at 1.8m on Jan 14/12						

DEPTH (m)	ELEVATION (m)
	373
1	372
2	371
3	370
4	369
5	368

amec

RECORD OF BOREHOLE No. BH11-40

PAGE 1 OF 2

PROJECT: Rainy River - Geotechnical Investigation 2011/2012
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: PDR
CLIENT: Rainy River Resources.
LOCATION: Flotation Tailings
COMPILED BY: NH
ELEVATION: 370.100 m
COORD.: N 5,411,994 E 425,356
BORING DATE: Start: Feb 2, 12 End: Feb 3, 12
CHECKED BY: DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

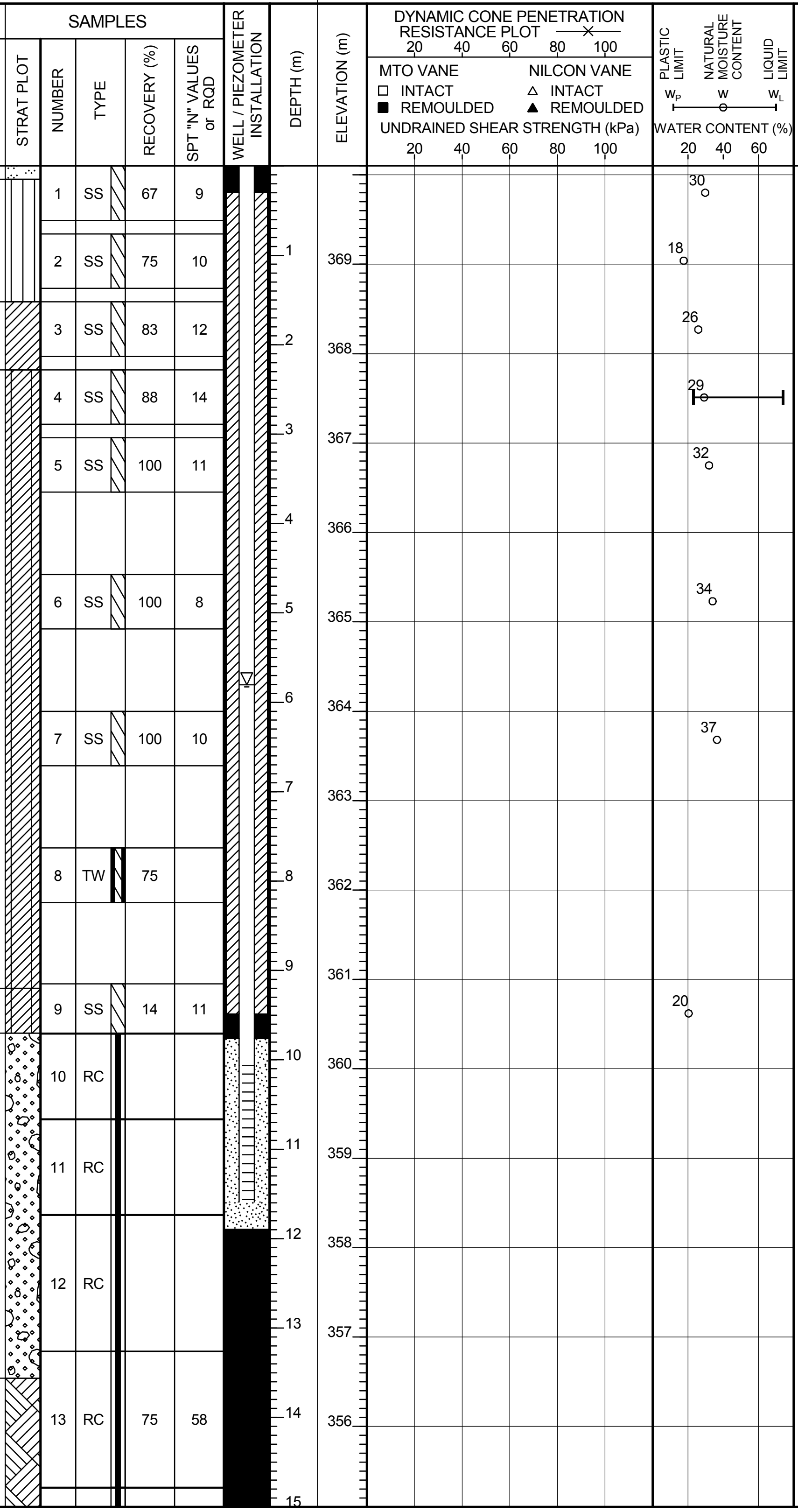
ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
370.1	Ground surface
370.0 0.0	**TOPSOIL**
0.2	**SILT** Brown silt, some clay, trace to some sand, trace gravel, moist, stiff ...at 0.76m, becoming light brown, clayey,
368.6 1.5	**SILTY CLAY** Light brown clay, some silt, trace fine gravel, varved, tiny pockets of silt, low plastic, stiff, moist [Upper Glaciolacustrine]
367.8 2.3	**SILTY CLAY** Dark brown clay, silty, trace gravel, lensed, tiny pockets of silt, medium to high plasticity, stiff [WML Till]
360.9 9.2	**SILTY CLAY** Silty clay, trace sand, medium to high plastic, stiff [Lower Glaciolacustrine]
360.4 9.7	**BOULDERS** between 11.7m and 13.26m, silty sand, some gravel, wet
356.5 13.6	**BEDROCK**

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
1	SS	67	9	30	... frozen to 0.6m
2	SS	75	10	18	
3	SS	83	12	26	
4	SS	88	14	29	
5	SS	100	11	32	
6	SS	100	8	34	
7	SS	100	10	37	
8	TW	75			...at 7.6m PP = 158 KPa TV (standard) = 49KPa
9	SS	14	11	20	
10	RC				...at 9.7m SPT spoon bouncing on possible boulders; switched to NQ coring
11	RC				
12	RC				
13	RC	75	58		



Continued on Next Page

RECORD OF BOREHOLE No. BH11-40

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Flotation Tailings
COMPILED BY NH
ELEVATION 370.100 m
COORD. N 5,411,994 E 425,356
BORING DATE Start: Feb 2, 12 End: Feb 3, 12
CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	PERMEABILITY (cm/s)	REMARKS
			14	RC	95	93		16	354		
			15	RC	93	57		17	353		
352.7 17.4	End of Borehole at 17.4m. Standpipe installed with 0.15m stick up and protected with steel casing. Water level(bgs): at 5.7m on Dec17/12										

RECORD OF BOREHOLE No. BH11-41

PAGE 1 OF 2

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY MM
CLIENT Rainy River Resources.
LOCATION Satelite Pit
COMPILED BY NH
ELEVATION 350.444 m
COORD. N 5,410,296 E 424,215
BORING DATE Start: Feb 4, 12 End: Feb 5, 12
CHECKED BY DGR

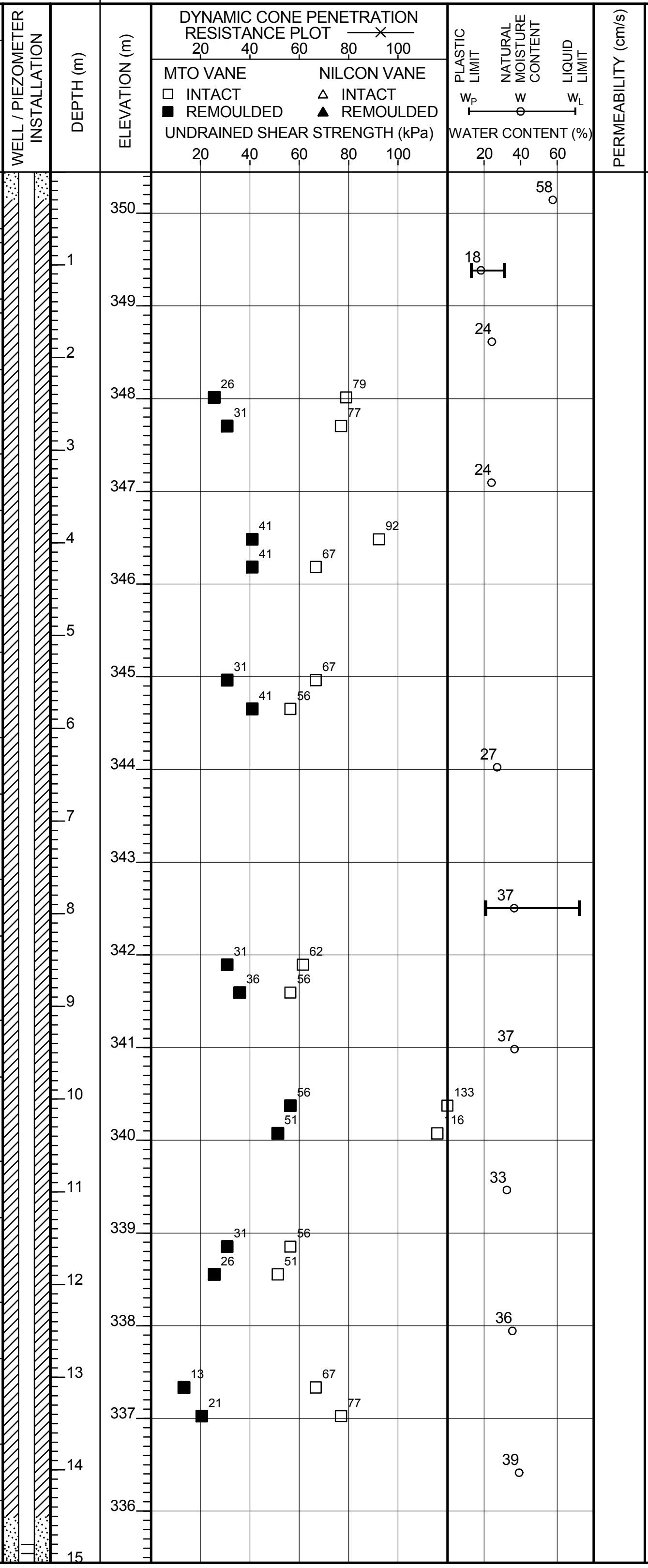
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
350.4	Ground surface					
0.0	**Silty SAND** Dark brown silty sand, trace gravel, organics, compact	1	SS	88	13	...frozen to 1.35m
349.7 0.8	**Silty CLAY** Light brown silty clay, trace gravel, trace organics, medium plasticity, varved [Upper Glaciolacustrine]	2	SS	92	10	
		3	SS	96	7	
		6	SS		4	
		9	TW	83		
344.3 6.1	**Silty CLAY** Dark grey silty clay, trace gravel, trace silt, moist, medium to high plasticity, firm [WML Till]	12	SS	100	7	
		13	SS	100	6	
		16	SS	100	9	
		19	SS	100	8	
		22	SS		2	
336.7 13.7	**Sandy Till** [Inferred WS Till]	25	SS	0.04	13	



Continued on Next Page

Format: AMEC GEO MWSK File: TC113921_BHLOGS_20120405.GPJ Date: 7/10/2012 1:30:29 PM

amec

RECORD OF BOREHOLE No. BH11-41

PAGE 2 OF 2

PROJECT: Rainy River - Geotechnical Investigation 2011/2012
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: MM
CLIENT: Rainy River Resources.
LOCATION: Satelite Pit
COMPILED BY: NH
ELEVATION: 350.444 m
COORD.: N 5,410,296 E 424,215
BORING DATE: Start: Feb 4, 12 End: Feb 5, 12
CHECKED BY: DGR

SAMPLE TYPES

AU	Auger
BU	Bulk
DC	Dynamic Cone
RC	Rock Core
SS	Split Spoon
TW	Thin Walled Open (Shelby)
WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer
U.W.	Wet Unit Weight
PT	Standard Proctor Test
P.L.	Point Load Strength Index (I_{50})
RQD	Rock Quality Designation
SCR	Solid Core Recovery
k	Permeability
C	Consolidation
DS	Direct Shear
GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
		26	RC	58		
334.1 16.3	**BEDROCK** Highly fractured	27	RC	28	0	
		28	RC	50	12	
		29	RC	80	0	
		30	RC	100	68	
328.0 22.4	**End of Borehole** at 22.41m. Standpipe installed with flush mounted casing Water Level (b.g.s): at surface upon completion					

DEPTH (m): 16, 17, 18, 19, 20, 21, 22
ELEVATION (m): 335, 334, 333, 332, 331, 330, 329

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
MTO VANE: □ INTACT ■ REMOULDED
NILCON VANE: △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa): 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%): 20 40 60
PERMEABILITY (cm/s)

RECORD OF BOREHOLE No. BH11-44

PAGE 1 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Pinewood River hydro			COMPILED BY	SM
ELEVATION	348.812 m	COORD.	N 5,408,622 E 426,560	BORING DATE	Start: Mar 13, 12 End: Mar 14, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

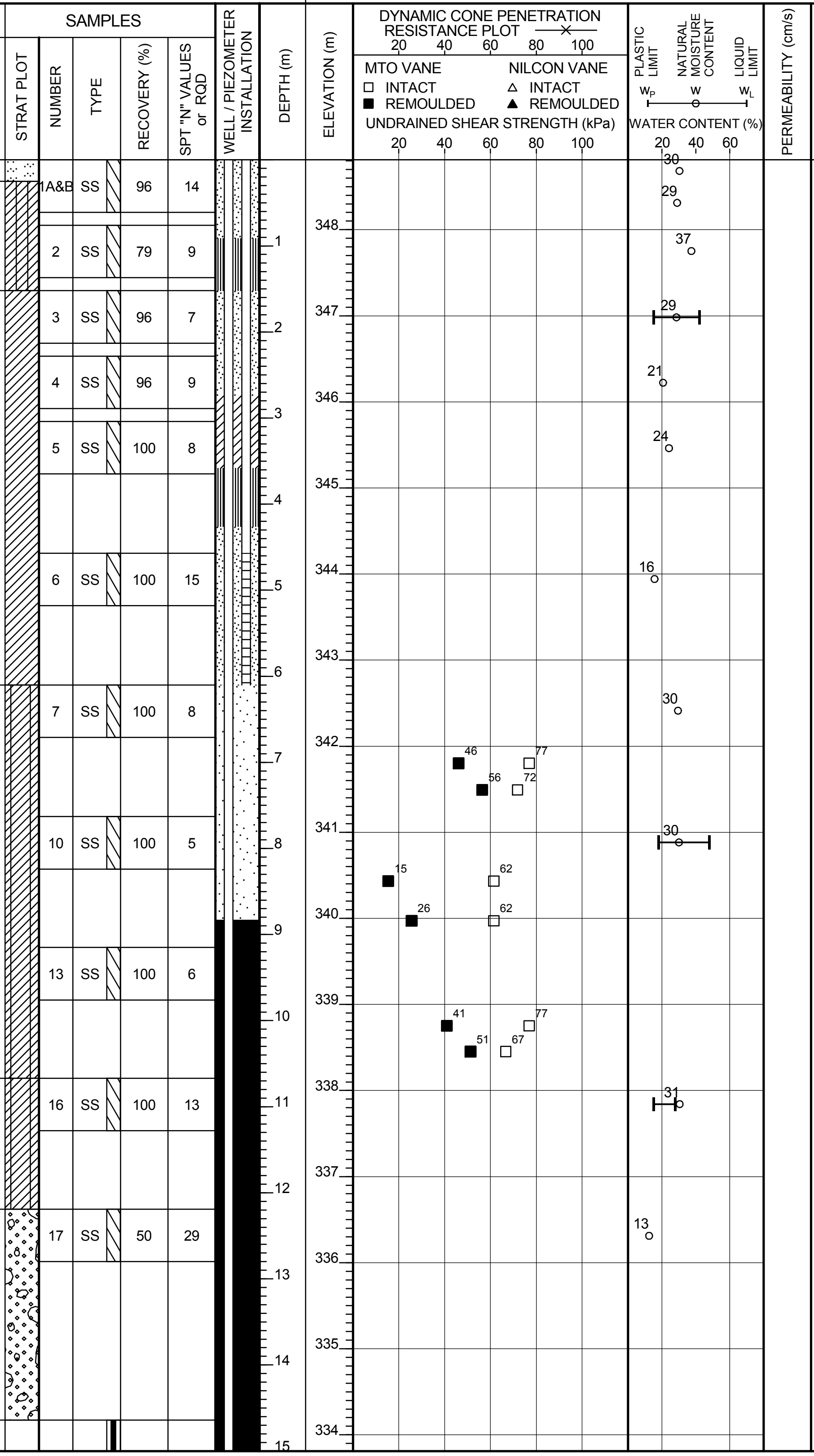
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
348.8	Ground surface
348.8 0.0	**TOPSOIL** Dark brown organics, fibrous, rootlets
0.3	**Silty CLAY to Clayey SILT** Brown silty clay, trace to some sand, trace to some organics, firm to stiff, medium plasticity, occasional rootlets
347.3 1.5	**Silty CLAY** Brown clayey silt, trace to some sand, grey clay lamination (varved), mottled brown lenses, firm, low to medium plasticity, damp [Upper Glaciolacustrine] ...at 2.43m, sandy, trace gravel, stiff ...at 4.6m, sandy, damp to moist
342.7 6.1	**CLAY** Dark grey clay, some silt, trace sand and gravel , stiff, high plasticity, moist [WML Till] ...at 7.6m, becoming firm, moist to wet
338.1 10.7	**Clayey SILT** Greyish green clayey silt, silt as green lamination (2-3mm) varved, firm, low plasticity, moist to wet [Lower Glaciolacustrine] ...below 10.9m, sandy
336.6 12.2	**SAND AND GRAVEL** Grey silty sand and gravel, angular to subangular, compact, well graded, wet [Inferred WS Till] ...below 13.1m, boulders
334.2 14.6	

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1A&B	SS	96	14
2	SS	79	9
3	SS	96	7
4	SS	96	9
5	SS	100	8
6	SS	100	15
7	SS	100	8
10	SS	100	5
13	SS	100	6
16	SS	100	13
17	SS	50	29



REMARKS

Frozen to 0.61m

...auger grinding at 11m

Switched to NQ coring at 14.64

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-44

PAGE 2 OF 2

PROJECT: Rainy River - Geotechnical Investigation 2011/2012
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: SM
CLIENT: Rainy River Resources.
LOCATION: Pinewood River hydro
COMPILED BY: SM
ELEVATION: 348.812 m
COORD.: N 5,408,622 E 426,560
BORING DATE: Start: Mar 13, 12 End: Mar 14, 12
CHECKED BY: DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE: ☐ INTACT ■ REMOULDED
NILCON VANE: △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	PERMEABILITY (cm/s)	REMARKS
	BEDROCK Grey bedrock		18	RC	100	67		16	333		
	...below 16.2m, highly fractured		19	RC	56	0			332		
			20	RC	100	0		17			
330.9			21	RC	95	20			331		
18.0	**End of Borehole** Standpipe installed with flushmounted steel casing. Water level(b.g.s): For Piezometer A (bottom sensing zone) at surface on March 14/12 For Piezometer B (top sensing zone) at surface on March 14/12										

RECORD OF BOREHOLE No. BH11-49

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	SM
ELEVATION	353.404 m	COORD.	N 5,411,233 E 419,800	BORING DATE	Start: Mar 19, 12 End: Mar 19, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

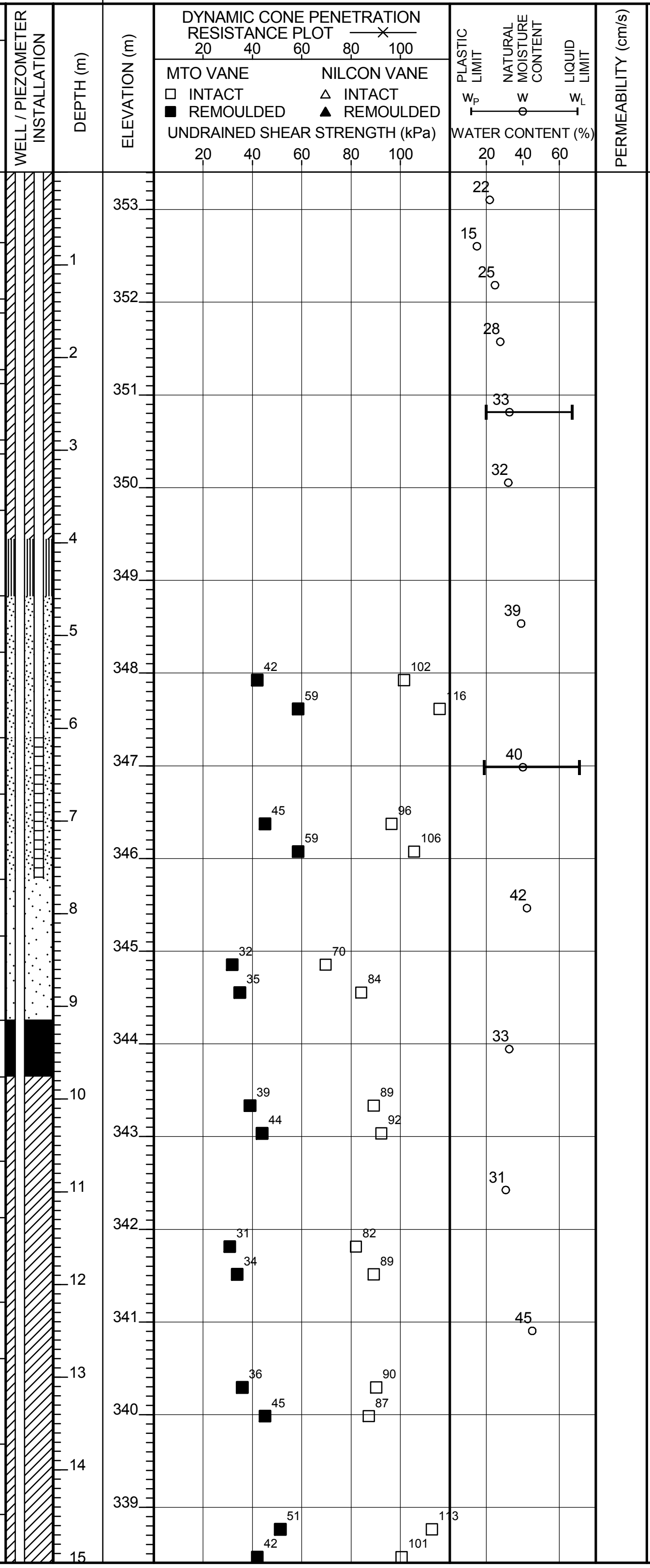
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
353.4	Ground surface
0.0	**SILTY CLAY** Brown silty clay, trace gravel, stiff, moist, trace rootlets
352.5 0.9	**SILTY CLAY** Dark brown silty clay, trace sand, trace fine gravel, trace silt pockets, stiff, medium to high plasticity, moist [WML Till] ...at 1.5m, some light brown silt lensing, trace fine gravel, oxidized ...becoming dark grey below 6.1m

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	AS		
2 A & B	SS	67	16
3	SS	67	13
4	SS	92	8
5	SS	96	7
6	SS	100	7
9	SS	100	6
12	SS	100	5
15	SS	100	5
18	SS	100	
21	SS	100	6
24	TW	100	



REMARKS

...at 14.1m
PP=24 KPa
Torvane=39 KPa

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-49

PAGE 2 OF 2

PROJECT Rainy River - Geotechnical Investigation 2011/2012
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Tailings Management Area
COMPILED BY SM
ELEVATION 353.404 m
COORD. N 5,411,233 E 419,800
BORING DATE Start: Mar 19, 12 End: Mar 19, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
U.W.	Wet Unit Weight	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT ——×—— 20 40 60 80 100
MTO VANE: □ INTACT ■ REMOULDED
NILCON VANE: △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60
PERMEABILITY (cm/s)

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
	...varved clay below 15.25m [Lower Glaciolacustrine]	27	TW	100		...at 15.6m Torvane=59 KPa
337.2 16.2	**BOULDERS** Boulders [Inferred WS Till]	28	RC			
334.5 18.9	**Bedrock** Greyish blue, highly fractured and weathered	29	RC	60	0	
	...some quartz between 20.4m and 21.95m	30	RC	33	0	
		31	RC	90	0	
329.9 23.5	**End of Borehole** at 23.47m Standpipes installed with flush mounted steel casing Water Level (b.g.s): For Piezometer A (bottom sensing zone) at 2 m on March 20/12 For Piezometer B (top sensing zone) at 1.4 m on March 20/12					

DEPTH (m): 16, 17, 18, 19, 20, 21, 22, 23

ELEVATION (m): 338, 337, 336, 335, 334, 333, 332, 331, 330

amec

RECORD OF BOREHOLE No. BH11-50

PAGE 1 OF 1

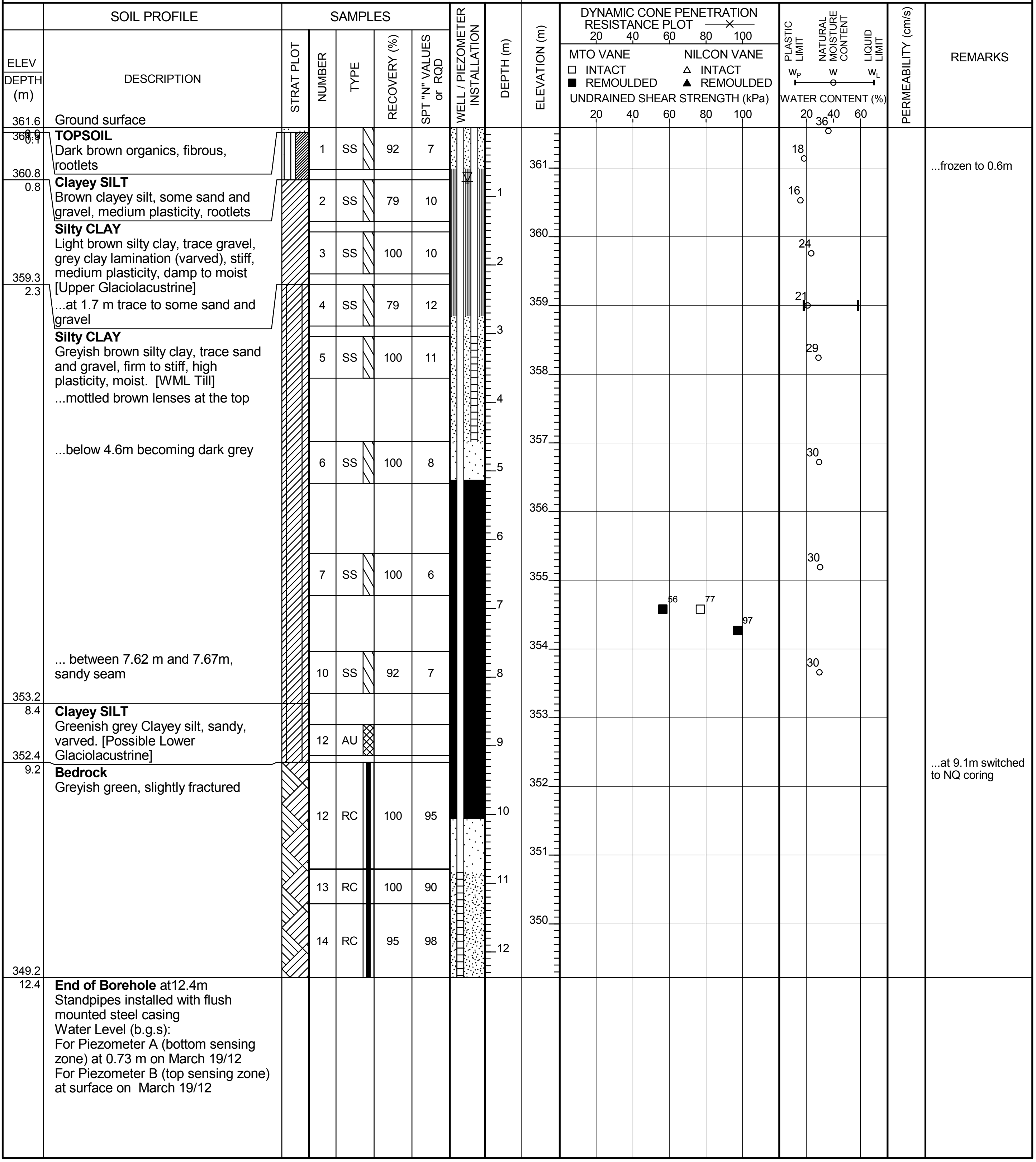
PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	SM
ELEVATION	361.591 m	COORD.	N 5,411,071 E 421,551	BORING DATE	Start: Mar 19, 12 End: Mar 19, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis



ELEV DEPTH (m)	DESCRIPTION
361.6	Ground surface
360.9 0.1	**TOPSOIL** Dark brown organics, fibrous, rootlets
360.8 0.8	**Clayey SILT** Brown clayey silt, some sand and gravel, medium plasticity, rootlets **Silty CLAY** Light brown silty clay, trace gravel, grey clay lamination (varved), stiff, medium plasticity, damp to moist [Upper Glaciolacustrine] ...at 1.7 m trace to some sand and gravel
359.3 2.3	**Silty CLAY** Greyish brown silty clay, trace sand and gravel, firm to stiff, high plasticity, moist. [WML Till] ...mottled brown lenses at the top ...below 4.6m becoming dark grey ... between 7.62 m and 7.67m, sandy seam
353.2 8.4	**Clayey SILT** Greenish grey Clayey silt, sandy, varved. [Possible Lower Glaciolacustrine]
352.4 9.2	**Bedrock** Greyish green, slightly fractured
349.2 12.4	**End of Borehole** at12.4m Standpipes installed with flush mounted steel casing Water Level (b.g.s): For Piezometer A (bottom sensing zone) at 0.73 m on March 19/12 For Piezometer B (top sensing zone) at surface on March 19/12

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	92	7
2	SS	79	10
3	SS	100	10
4	SS	79	12
5	SS	100	11
6	SS	100	8
7	SS	100	6
10	SS	92	7
12	AU		
12	RC	100	95
13	RC	100	90
14	RC	95	98

REMARKS

...frozen to 0.6m

...at 9.1m switched to NQ coring

Format: AMEC GEO MWSK File: TC113921_BHLOGS_20120405.GPJ Date: 7/10/2012 1:30:48 PM

RECORD OF BOREHOLE No. BH11-51

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	SM
ELEVATION	351.539 m	COORD.	N 5,410,423 E 421,543	BORING DATE	Start: Mar 17, 12 End: Mar 17, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

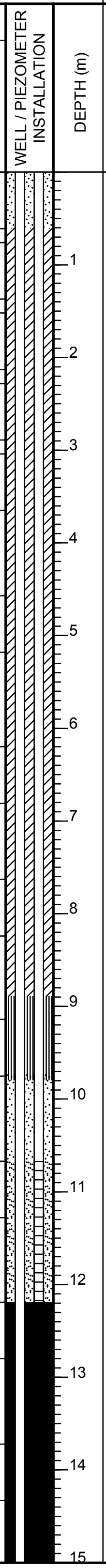
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
U.W.	Wet Unit Weight	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

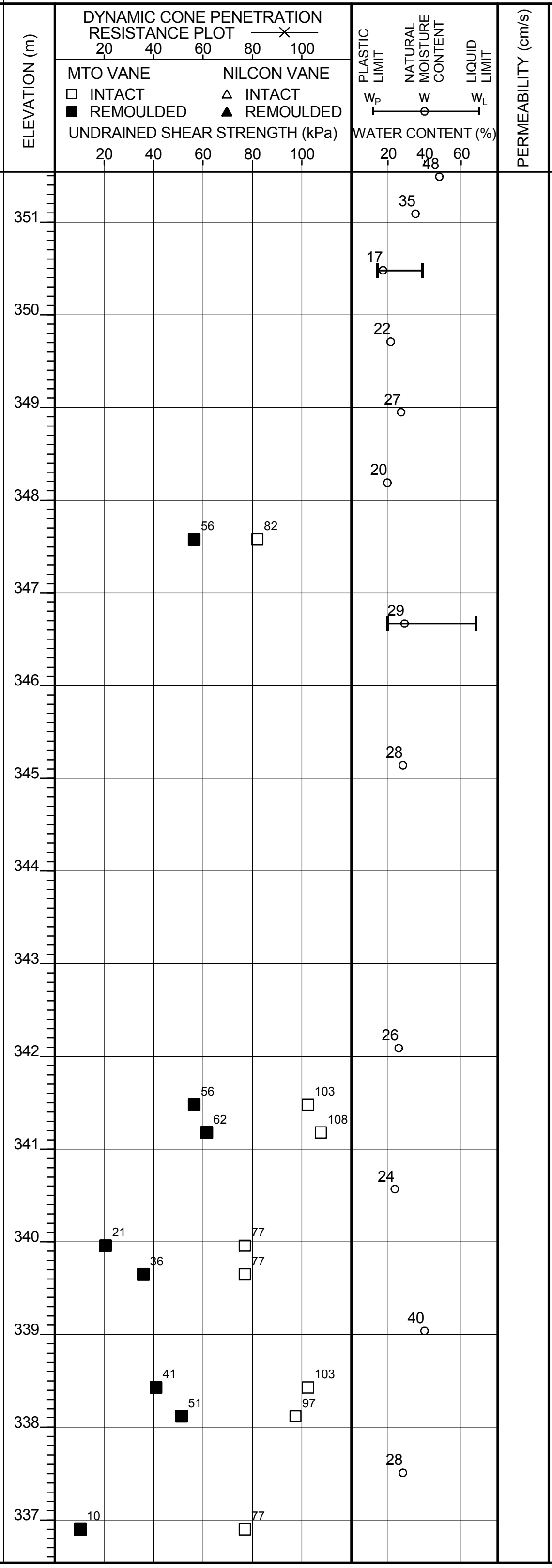
SOIL PROFILE

ELEV / DEPTH (m)	DESCRIPTION
351.5	Ground surface
351.5 0.0 0.1	**TOPSOIL** Black organics, fibrous, rootlets
	Silty CLAY Light brown silty clay, trace to some sand, trace gravel, trace mottled brown lenses, brown clay lamination (varved), firm, low to medium plasticity, moist [Upper Glacolacustrine]
	...at 2.5m no varving noted
	...at 3.4m very silty low plasticity
347.0 4.6	**Silty CLAY** Greyish brown silty clay, trace sand and gravel, stiff, high plasticity, moist [WML Till]
	... at 6.1m becoming grey
	...at 10.7m moist to wet, trace to some sand and gravel

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	75	4
2	SS	79	12
3	SS	100	7
4	SS	83	22
5	SS	88	7
8	SS	100	10
9	SS	100	10
10	TW	75	
11	SS	100	7
14	SS	100	8
17	SS	100	5
20	SS	100	6





REMARKS

...frozen to 0.6m

...at 7.62m,
PP=122 KPa
Torvane=69 KPa

...at 12.2m
switched to
washboring

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH11-51

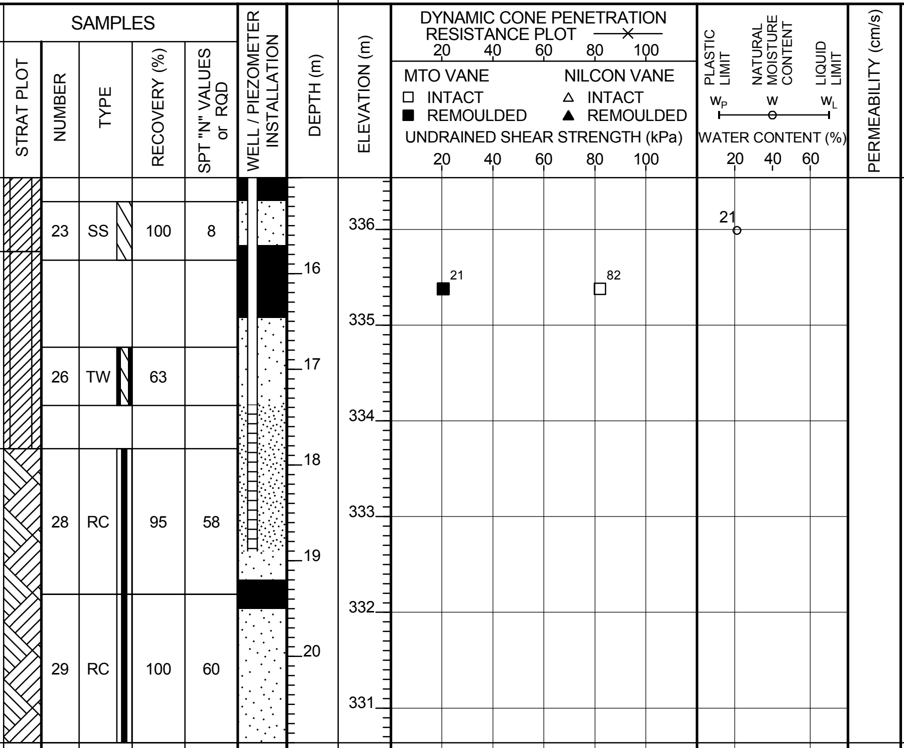
PAGE 2 OF 2

PROJECT	Rainy River - Geotechnical Investigation 2011/2012					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	SM
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	SM
ELEVATION	351.539 m	COORD.	N 5,410,423 E 421,543	BORING DATE	Start: Mar 17, 12 End: Mar 17, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
U.W. Wet Unit Weight
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
		23	SS	100	8	
335.8 15.8	**Silty CLAY** Grey silty clay,varved, firm, medium to high plasticity, moist [Lower Glaciolacustrine]	26	TW	63		...at 17.1m, PP=61 KPa Torvane=39 KPa
333.7 17.8	**Bedrock** Green, highly fractured and weathered, red veining	28	RC	95	58	...at 17.8m switched to NQ coring
		29	RC	100	60	
330.6 20.9	**End of Borehole** at 20.9m Standpipes installed with flush mounted steel casing Water Level (b.g.s): For Piezometer A (bottom sensing zone) at surface on March 18/12 For Piezometer B (top sensing zone) at surface on March 18/12					



RECORD OF BOREHOLE No. BH12-01

PAGE 1 OF 1

PROJECT: Rainy River Gold Project
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: TA
CLIENT: Rainy River Resources.
LOCATION: Tailings Management Area
COMPILED BY: DG
ELEVATION: 374.729 m
COORD.: N 5,413,954 E 421,733
BORING DATE: Start: Oct 3, 12 End: Oct 4, 12
CHECKED BY: DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
MTO VANE: ☐ INTACT ■ REMOULDED
NILCON VANE: △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
374.7	Ground surface							
374.6 0.1	**TOPSOIL** Topsoil, organics, rootlets	1	SS	22	12			
	Silty CLAY Brown silty clay, trace to some sand, dry, medium plasticity, stiff [Upper Glaciolacustrine]	2	SS	100	22			
		3	SS	100	19	20		
	...becoming moist at 2.29m	4	SS	100	21	23		
371.7 3.1	**Silty CLAY** Grey silty clay, trace sand, trace gravel, moist, high plasticity, firm to stiff [WML Till]	5	TW	100				
		6	SS	100	9			
		7	SS	100	9	36		
	...becoming moist to wet, some sand at 9.14m, possible transition zone	8	SS	83	24	32		
365.3 9.5	**SAND and GRAVEL** Grey sand and gravel, saturated [WS Till]							
362.8 11.9	**End of Borehole** at 11.9m [Inferred bedrock] Standpipe installed with 0.6m stick up Water level at surface upon completion							

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11
ELEVATION (m): 374 373 372 371 370 369 368 367 366 365 364 363

RECORD OF BOREHOLE No. BH12-03

PAGE 1 OF 2

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Tailings Management Area
COMPILED BY DG
ELEVATION 362.567 m
COORD. N 5,411,646 E 420,323
BORING DATE Start: Sep 14, 12 End: Sep 15, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

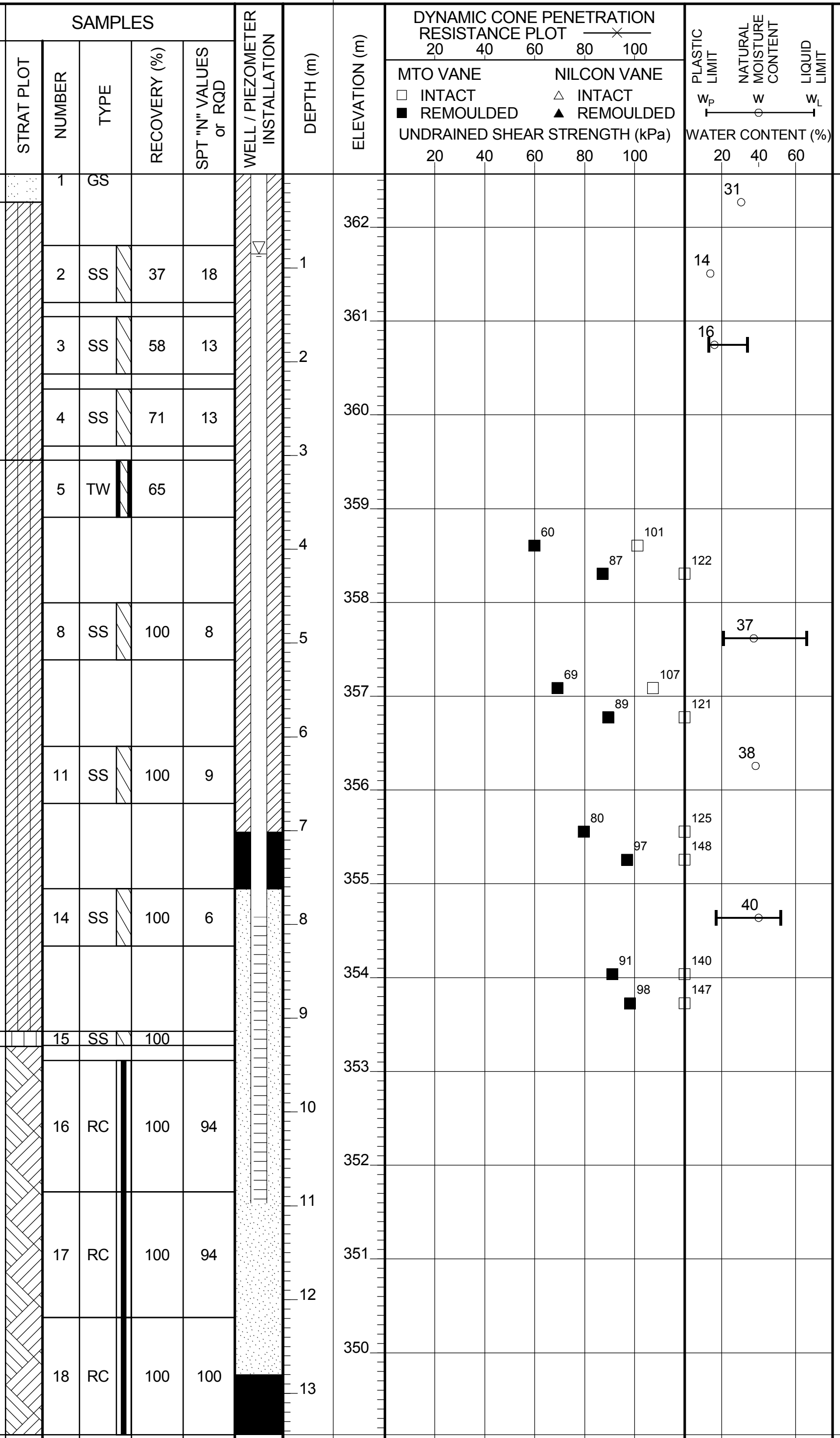
ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
TV	Torvane	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
362.6	Ground surface
0.0	**TOPSOIL** Dark brown, organics
362.3 0.3	**Silty CLAY** Brown silty clay, some sand, moist, varved, medium plasticity, very stiff [Upper Glaciolacustrine] ...occasional rootlets at top
359.5 3.1	**Silty CLAY** Grey silty clay, trace gravel, ocasional silt pockets, moist, firm [WML Till] ...occasionlal silt lensing
353.4 9.1	**SILT** Grey silt, some clay, wet [Possible Lower Glaciolacustrine]
353.3 9.3	**BEDROCK** Bluish grey bedrock, fractured
349.1 13.4	**End of Borehole** at 13.44m Standpipe installed with 0.9m stick up Water level at 5m below ground surface upon installation Water Level at 0.8m below ground

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	GS		
2	SS	37	18
3	SS	58	13
4	SS	71	13
5	TW	65	
8	SS	100	8
11	SS	100	9
14	SS	100	6
15	SS	100	
16	RC	100	94
17	RC	100	94
18	RC	100	100



PERMEABILITY (cm/s)

REMARKS

...at 3.66m
PP= 196.1 kPa
TV= 134.8 kPa

...at 9.3m SPT refusal

Continued on Next Page

RECORD OF BOREHOLE No. BH12-03

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	DG
ELEVATION	362.567 m	COORD.	N 5,411,646 E 420,323	BORING DATE	Start: Sep 14, 12 End: Sep 15, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE		SAMPLES					WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD							
	surface on Oct. 30, 2012												

RECORD OF BOREHOLE No. BH12-04

PAGE 1 OF 3

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	TA
CLIENT	Rainy River Resources.	LOCATION	Talings Management Area			COMPILED BY	DG
ELEVATION	357.346 m	COORD.	N 5,411,848 E 422,926	BORING DATE	Start: Sep 27, 12 End: Sep 29, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

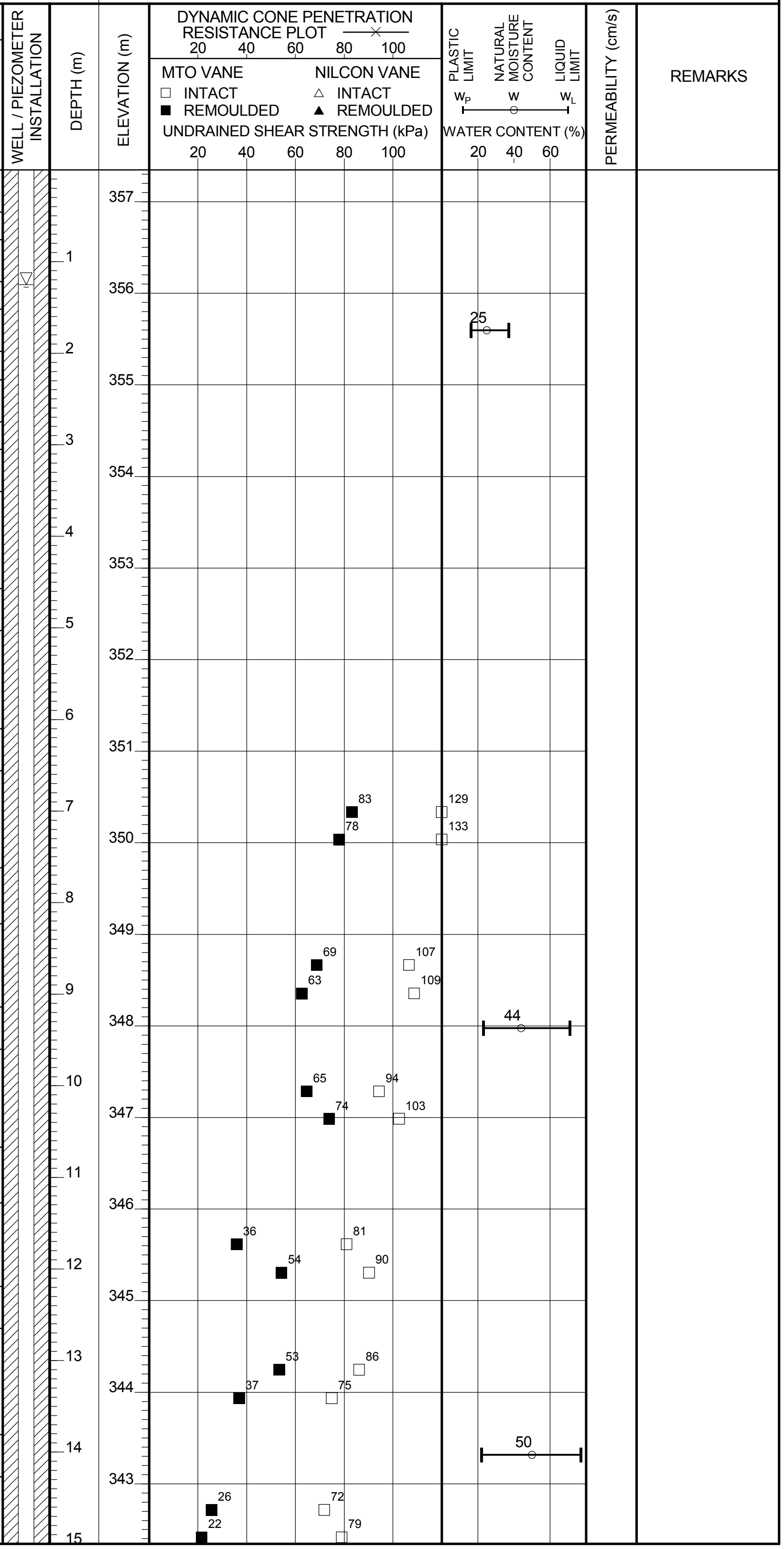
ABBREVIATIONS
P.P. Pocket Penetrometer
TV Torvane
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
357.3	Ground surface
0.0 357.2 0.2	**PEAT** Dark brown peat, fibrous
	Silty CLAY Brown silty clay, trace to some sand, trace gravel, moist, varved, low plasticity [Upper Glaciolacustrine]
354.3 3.1	**Silty CLAY** Brown silty clay, trace sand, teace gravel, moist, medium to high plasticity [WML Till] ...becoming grey below 6.1m

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	39	6
2	SS	33	9
3	SS	100	12
4	SS	100	12
5	SS	100	13
6	SS	100	10
7	SS	5	7
8	TW	100	
9	SS	100	7
10	TW	100	
11	SS	100	5
12	SS	100	7



Continued on Next Page

RECORD OF BOREHOLE No. BH12-04

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	TA
CLIENT	Rainy River Resources.	LOCATION	Talings Management Area			COMPILED BY	DG
ELEVATION	357.346 m	COORD.	N 5,411,848 E 422,926	BORING DATE	Start: Sep 27, 12 End: Sep 29, 12	CHECKED BY	DGR

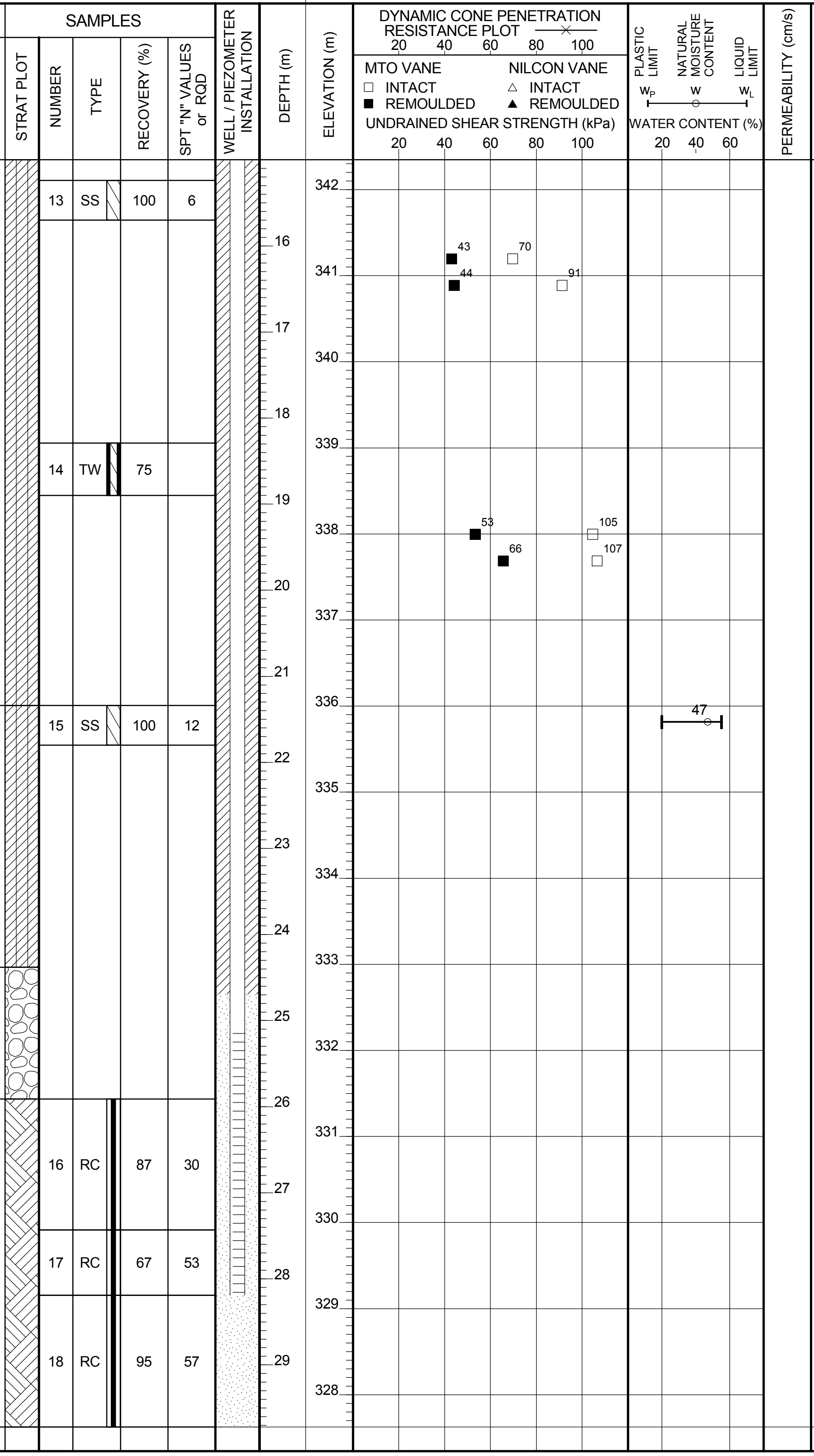
SAMPLE TYPES

AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS

P.P. Pocket Penetrometer
TV Torvane
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
	....some sand, trace gravel, medium to high plasticity at 15.24m	13	SS	100	6	
		14	TW	75		
336.0 21.3	**Silty CLAY** Greenish grey silty clay, varved, interbedded silt lenses, moist [Lower Glaciolacustrine]	15	SS	100	12	
333.0 24.4	**BOULDERS** [Inferred WS Till]					
331.4 25.9	**BEDROCK** Light grey volcanic rock ...weathered rock from 25.9m to 27.3m	16	RC	87	30	
		17	RC	67	53	
		18	RC	95	57	
327.6 29.7						



Continued on Next Page

amec

RECORD OF BOREHOLE No. BH12-04

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	TA
CLIENT	Rainy River Resources.	LOCATION	Talings Management Area			COMPILED BY	DG
ELEVATION	357.346 m	COORD.	N 5,411,848 E 422,926	BORING DATE	Start: Sep 27, 12 End: Sep 29, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

	SOIL PROFILE	SAMPLES											
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
	End of Borehole at 29.72m Standpipe installed with 0.76m sitck up Water Level 1.2m below ground surface on completion Water Level 1.2m below ground surface on Oct. 31, 2012												

RECORD OF BOREHOLE No. BH12-07

PAGE 1 OF 2

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	TA/AD
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	DG
ELEVATION	371.539 m	COORD.	N 5,412,438 E 424,542	BORING DATE	Start: Oct 4, 12 End: Oct 10, 12	CHECKED BY	DGR

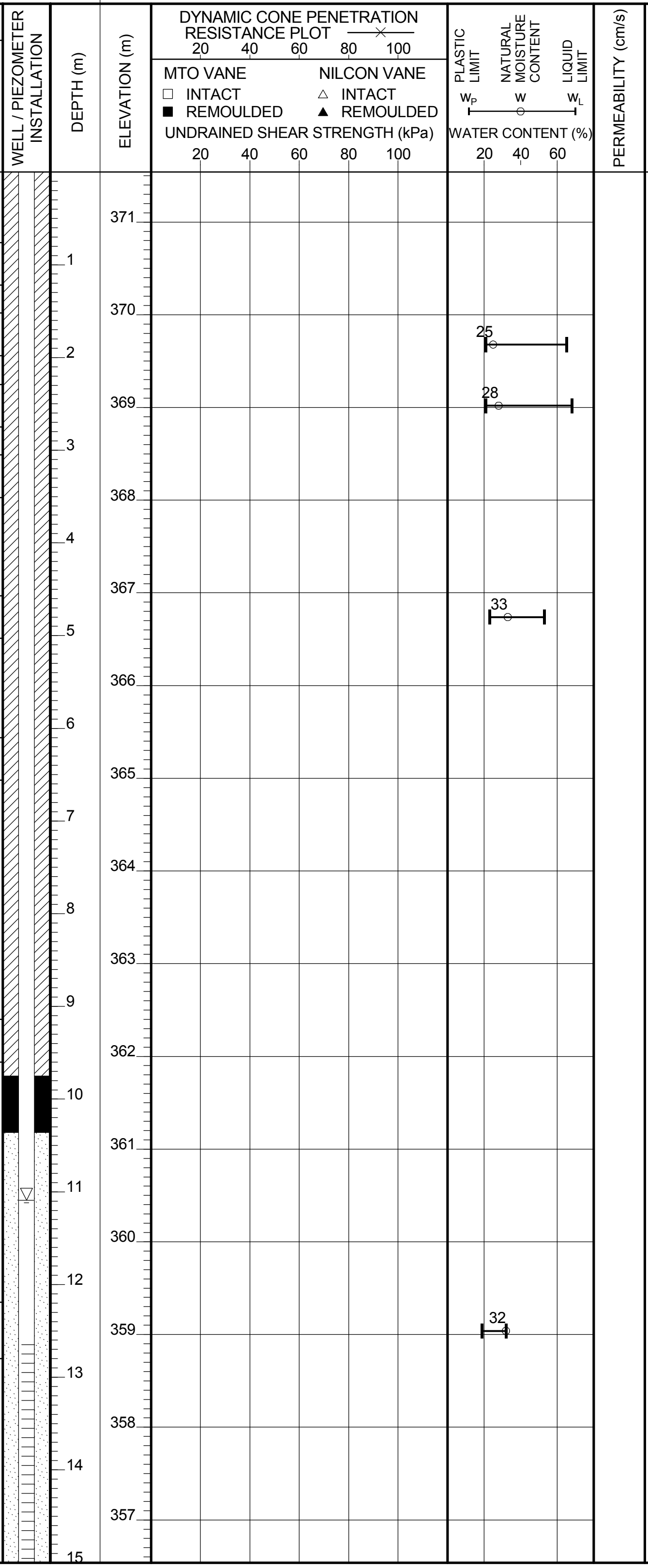
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
TV	Torvane	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

ELEV / DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
371.5	Ground surface				
[illegible] 0.0 0.1	**TOPSOIL**				
	Silty CLAY Brown silty clay, trace to some sand, dry, firm, medium to high plasticity [WML Till]				
		1	SS	94	20
		2	SS	94	16
		3	SS	100	15
	...brown to grey, trace sand, trace gravel at 3.0m	4	SS	100	17
		5	SS	100	11
		6	SS	100	13
		7	SS	100	12
359.3 12.2	**Silty CLAY** Dark grey silty clay, trace sand, trace gravel, varved with light grey silt laminations (approximately 3mm thick), damp to moist [Lower Glaciolacustrine]	8	SS	100	9



REMARKS

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH12-07

PAGE 2 OF 2

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY TA/AD
CLIENT Rainy River Resources.
LOCATION Tailings Management Area
COMPILED BY DG
ELEVATION 371.539 m
COORD. N 5,412,438 E 424,542
BORING DATE Start: Oct 4, 12 End: Oct 10, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
TV	Torvane	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

SOIL PROFILE		SAMPLES											
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
356.3													
355.8 15.2	**SAND** Medium to coarse grained sand, some silt, some clay, wet [WS Till]		9	SS	100				356				Sand heave in auger at 15.24m
15.7	**End of Borehole** at 15.7m Standpipe installed with 0.9m stick up Water level at 10.9m below ground surface upon completion Water level at 11m below ground surface on Oct. 31, 2012												

RECORD OF BOREHOLE No. BH12-08

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Tailings Management Area
COMPILED BY DG
ELEVATION 359.5 m
COORD. N 5,411,603 E 425,109
BORING DATE Start: Sep 13, 12 End: Sep 13, 12
CHECKED BY DGR

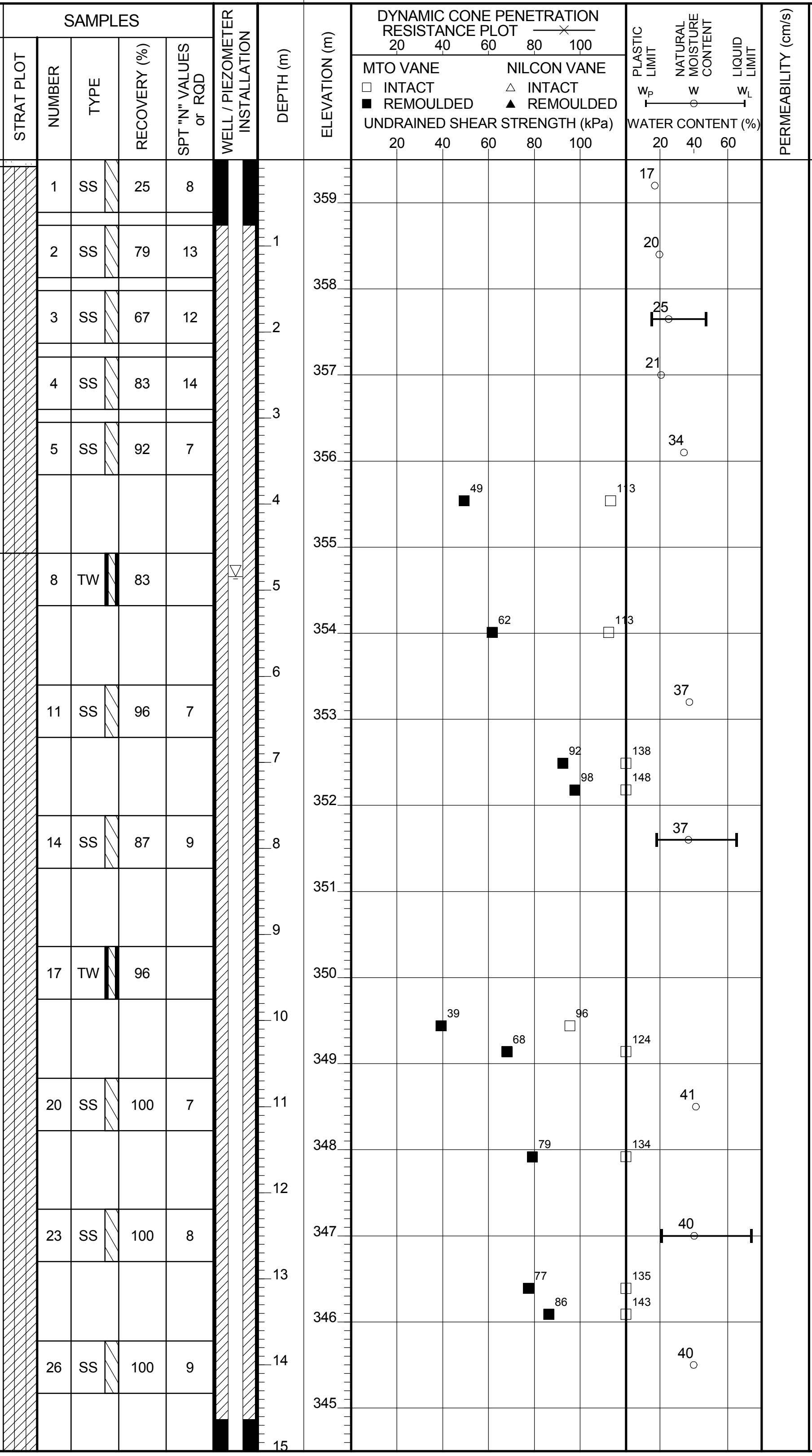
SAMPLE TYPES

AU	Auger
BU	Bulk
DC	Dynamic Cone
RC	Rock Core
SS	Split Spoon
TW	Thin Walled Open (Shelby)
WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer
TV	Torvane
PT	Standard Proctor Test
P.L.	Point Load Strength Index (I_{50})
RQD	Rock Quality Designation
SCR	Solid Core Recovery
k	Permeability
C	Consolidation
DS	Direct Shear
GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
359.5	Ground surface					
0.0 359.4 0.1	**TOPSOIL**					
	Silty CLAY Brown silty clay, trace gravel, trace sand, moist, varved, firm, low to medium plasticity [Upper Glaciolacustrine]	1	SS	25	8	
		2	SS	79	13	
	...stiff, some oxidized pockets at 0.8m	3	SS	67	12	
	...dark brown below 2.3m	4	SS	83	14	
		5	SS	92	7	
354.9 4.6	**Silty CLAY** Grey silty clay, trace sand, firm, medium to high plasticity, occasional silt pockets [WML Till]	8	TW	83		
						...at 5.2m PP= 171.6 kPa TV= 134.8 kPa
		11	SS	96	7	
	...becoming stiff at 7.6m	14	SS	87	9	
		17	TW	96		
						...at 9.8m PP= 147.1 kPa TV= 110.3 kPa
		20	SS	100	7	
		23	SS	100	8	
		26	SS	100	9	



Continued on Next Page

amec

RECORD OF BOREHOLE No. BH12-08

PAGE 2 OF 2

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	DG
ELEVATION	359.5 m	COORD.	N 5,411,603 E 425,109	BORING DATE	Start: Sep 13, 12 End: Sep 13, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
		27	SS	100	10	31		
342.9 16.6	**Silty CLAY** Varved silty clay [Lower Glaciolacustrine]	30	TW	100				
342.4 17.1	**BOULDERS** [Inferred WS Till]	31	RC					
342.1 17.4	**BEDROCK** Bluish grey bedrock, moderately fractured	32	RC	93	62			
	...becoming highly fractured at 19.5m	33	RC	100	83			
		34	RC	100	100			
338.6 20.9	**End of Borehole** at 20.9m Standpipe installed Water level at 10.9m below ground surface upon completion Water level at 4.8m below ground surface on Oct. 29, 2012							

DEPTH (m): 16, 17, 18, 19, 20

ELEVATION (m): 344, 343, 342, 341, 340, 339

RECORD OF BOREHOLE No. BH12-09

PAGE 1 OF 2

PROJECT	Rainy River Gold Project			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD 200 mm HSA, NQ Coring	LOGGED BY AD
CLIENT	Rainy River Resources.	LOCATION	Overburden Stockpile		COMPILED BY DG
ELEVATION	347.415 m	COORD.	N 5,409,548 E 422,612	BORING DATE Start: Sep 16, 12 End: Sep 17, 12	CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

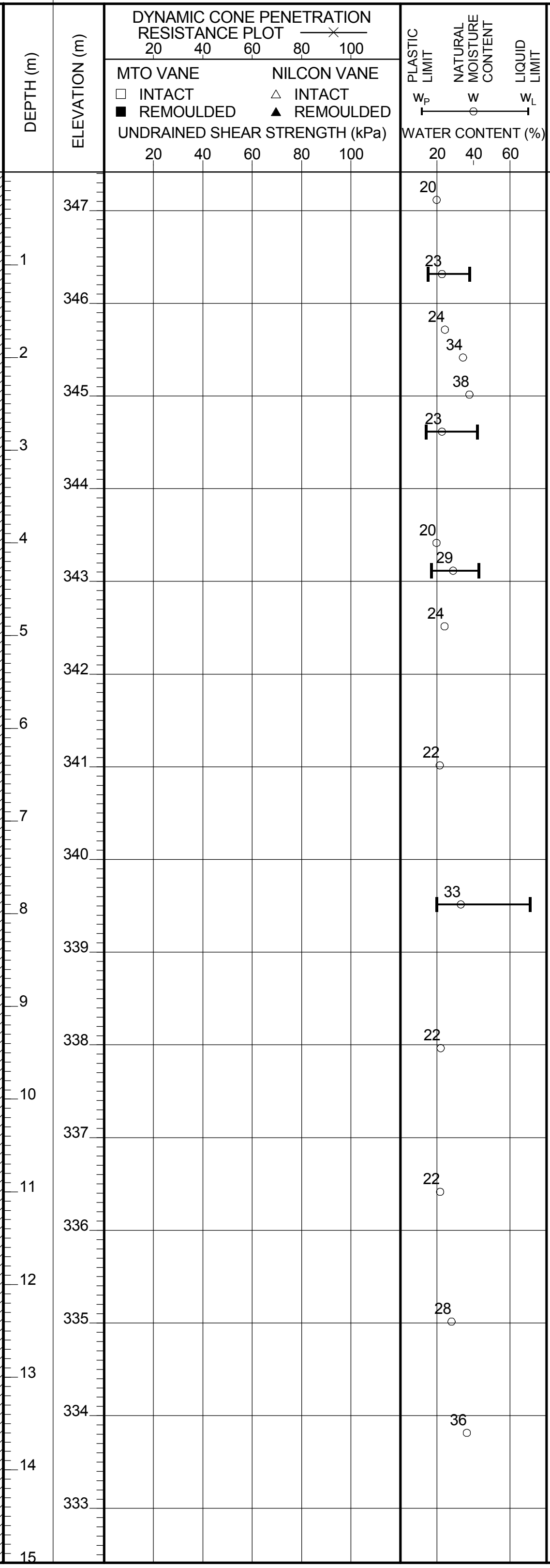
ABBREVIATIONS
P.P. Pocket Penetrometer
TV Torvane
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
347.4	Ground surface
347.4 0.0	**PEAT** Dark brown peat, some sand, some silt, some clay, fibrous
0.2	**Sandy SILT** Light brown sandy silt, damp to moist, soft, low plasticity, trace rootlets, trace oxidation, soft to firm
345.6 1.8	**Silty CLAY** Dark brown silty clay, trace sand, trace gravel, varved, damp to moist, occasional oxidized pockets, soft to firm, low to medium plasticity [Upper Glaciolacustrine] ...light grey laminations of silt with sand and gravel at 2.6m
341.3 6.2	**Silty SAND** Grey silty sand, fine grained, loose, wet [Glacio Fluvial]
340.7 6.7	**Silty CLAY** Dark grey silty clay, trace sand, trace fine gravel, damp to moist, stiff, medium to high plasticity [WML Till]
338.3 9.1	**Silty SAND** Grey silty sand, fine grained, loose, wet [Glacio Fluvial] ...becoming moist to wet at 10.7m
334.8 12.6	**Silty CLAY** Dark grey silty clay, trace sand, trace fine gravel, damp to moist, stiff, medium to high plasticity [WML Till]
332.5	

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	25	2
2	SS	92	4
3	SS	92	5
4	SS	92	7
5	TW	96	
6	SS	100	4
7	SS	100	4
8	SS	75	4
9	SS	100	8
10	SS	92	
11	SS	100	
12	SS	83	8
13	SS	100	4



PERMEABILITY (cm/s)

REMARKS

...at 3.4m PP= 76 kPa

...spoon dropped under weight of hammer at 9.1m; 0.15m of sand heave in auger

...spoon dropped under weight of hammer, likely heaved sand

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH12-09

PAGE 2 OF 2

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Overburden Stockpile			COMPILED BY	DG
ELEVATION	347.415 m	COORD.	N 5,409,548 E 422,612	BORING DATE	Start: Sep 16, 12 End: Sep 17, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
TV Torvane
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60; PERMEABILITY (cm/s)

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
14.9	**Silty SAND** Grey silty sand, fine grained, loose, wet [Glacio Fluvial]	14	SS	83	12	20	
331.0 16.5	**Silty CLAY** Dark grey silty clay, trace sand, trace fine gravel, damp to moist, stiff, medium to high plasticity [WML Till]	15	SS	75	5	23 34	
		16	SS	62	5	33	
		17	SS	100	8	33	
		18	SS	100	8	32	
324.6 22.9	**Silty CLAY** Light grey silty clay with dark grey clay varves [Lower Glaciolacustrine] ...sandier below 23.2m (possible transition zone)	19	SS	100	11	29	
323.3 24.1	**BOULDERS and COBBLES** Black to green boulders and cobbles [Inferred WS Till]	20	RC	35	0		...at 24.1m, 3.0m sand heave
322.2 25.2	**BEDROCK** Reddish green to black bands, silver metallic crystals throughout ...becoming red bedrock with blue to green bands, white intrusions	21	RC	100	100		
		22	RC	93	80		
		23	RC	100	81		...artisian flow observed at 27.1m
318.9 28.5	**End of Borehole** at 28.5m Standpipe installed with 1m stick up, artesian pressure condition upon completion Artesian flow noted on Oct. 30, 2012						

amec

RECORD OF BOREHOLE No. BH12-10

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Overburden Stockpile			COMPILED BY	DG
ELEVATION	345.232 m	COORD.	N 5,409,003 E 424,069	BORING DATE	Start: Aug 24, 12 End: Aug 27, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})		
TV	Torvane	RQD	Rock Quality Designation	C	Consolidation
PT	Standard Proctor Test	SCR	Solid Core Recovery	DS	Direct Shear
		k	Permeability	GS	Grain Size Analysis

SOIL PROFILE / SAMPLES

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
345.2	Ground surface							
34[illegible] 0.4	**PEAT** Dark brown, fibrous, dry, some rootlets	1	SS	62	5	36 17		
	Silty CLAY Some sand, grey to brown, damp, varved, oxidazed staining throughout, firm, occasional rootlets	2	SS	89	6	20		
		3	SS	100	6	22		
342.7 2.5	**Silty CLAY** Trace sand, trace fine gravel, grey, moist, medium to high plasticity, firm [WML Till]	4	SS	100	3	25 41 89		
		5	TW	62				
		6	SS	100		47		
	...coarse sand seam at 4.9m	7	SS	100	3	29		
		8	TW	87				
		9	SS	89	5	21		
		10	SS	100	4	24		
		11	SS	100	5	34		
		12	SS	100	6	32		
		13	SS	100	7	32		

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ELEVATION (m): 345 344 343 342 341 340 339 338 337 336 335 334 333 332 331

Continued on Next Page

RECORD OF BOREHOLE No. BH12-10

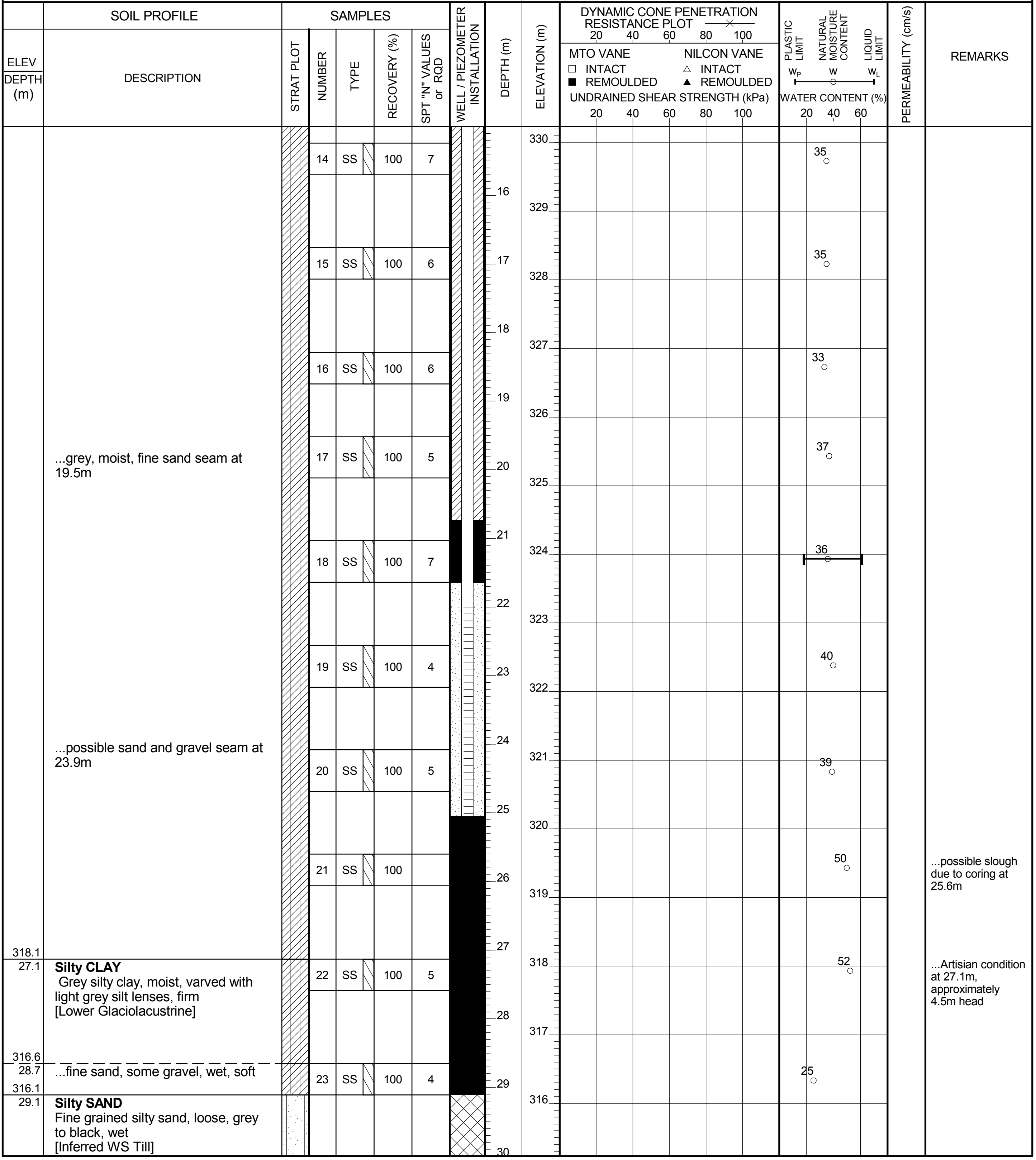
PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Overburden Stockpile			COMPILED BY	DG
ELEVATION	345.232 m	COORD.	N 5,409,003 E 424,069	BORING DATE	Start: Aug 24, 12 End: Aug 27, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis



ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
		14	SS	100	7	35	
		15	SS	100	6	35	
		16	SS	100	6	33	
	...grey, moist, fine sand seam at 19.5m	17	SS	100	5	37	
		18	SS	100	7	36	
		19	SS	100	4	40	
	...possible sand and gravel seam at 23.9m	20	SS	100	5	39	
		21	SS	100		50	...possible slough due to coring at 25.6m
318.1 27.1	**Silty CLAY** Grey silty clay, moist, varved with light grey silt lenses, firm [Lower Glaciolacustrine]	22	SS	100	5	52	...Artisian condition at 27.1m, approximately 4.5m head
316.6 28.7	...fine sand, some gravel, wet, soft	23	SS	100	4	25	
316.1 29.1	**Silty SAND** Fine grained silty sand, loose, grey to black, wet [Inferred WS Till]						

DEPTH (m): 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

ELEVATION (m): 330, 329, 328, 327, 326, 325, 324, 323, 322, 321, 320, 319, 318, 317, 316

Continued on Next Page

RECORD OF BOREHOLE No. BH12-10

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY AD
CLIENT Rainy River Resources.
LOCATION Overburden Stockpile
COMPILED BY DG
ELEVATION 345.232 m
COORD. N 5,409,003 E 424,069
BORING DATE Start: Aug 24, 12 End: Aug 27, 12
CHECKED BY DGR

SAMPLE TYPES				ABBREVIATIONS					
AU	Auger	RC	Rock Core	P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
BU	Bulk	SS	Split Spoon	TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)	PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		WS	Wash Sample			k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE □ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
314.1								31	315				
31.1	**End of Borehole**at 31.1m Standpipe installed with 0.9m stick up Artesian head of 0.7m above ground surface noted on Oct. 31, 2012												

RECORD OF BOREHOLE No. BH12-13

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area			COMPILED BY	DG
ELEVATION	352.625 m	COORD.	N 5,409,437 E 425,767	BORING DATE	Start: Sep 8, 12 End: Sep 9, 12	CHECKED BY	DGR

SAMPLE TYPES
- AU Auger
- BU Bulk
- DC Dynamic Cone
- RC Rock Core
- SS Split Spoon
- TW Thin Walled Open (Shelby)
- WS Wash Sample

ABBREVIATIONS
- P.P. Pocket Penetrometer
- TV Torvane
- PT Standard Proctor Test
- P.L. Point Load Strength Index (I_{50})
- RQD Rock Quality Designation
- SCR Solid Core Recovery
- k Permeability
- C Consolidation
- DS Direct Shear
- GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE □ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60; PERMEABILITY (cm/s)

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
352.6	Ground surface						
0.0	**Silty CLAY** Dark brown silty clay, some sand, damp to dry, stiff, trace rootlets	1	SS	46	7	18	
351.9 0.8	**Silty CLAY** Brown silty clay, trace sand, varved, light brown sand and gravel lenses, damp, very stiff [Upper Glaciolacustrine]	2	SS	54	7	34	
		3	SS	100			...102mm diameter split spoon sampler used for SS 3, 4, 5, and, 6
	...oxidized pockets from 2.6m to 3.1m						
349.6 3.1	**Silty CLAY** Grey silty clay, some sand, some gravel, trace cobbles, damp, firm to stiff, trace mottled brown oxidized pockets, medium to high plasticity [WML Till]	4	SS	100			
		5	SS	100			
		6	SS	100			
	...greyish black gravel at 7.8m	7	SS	83	18		
	...becoming more silty, coarse sand, wet (possible transition zone)	8	SS	79	4	33 29	
342.1 342.0 10.5 10.7	**SAND** Coarse grained, angular, some fine gravel, trace grey silty clay, wet [WS Till]	9	SS	100	50	16	
		10	RC	33	0		
	BEDROCK Greyish black bedrock, green bands along fractures	11	RC	100	63		
		12	RC	100	87		
338.7		13	RC	100	82		
13.9	**End of Borehole** at 13.9m Standpipe installed with 0.9m stick up Water level at 3.2m below ground						

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13

ELEVATION (m): 352 351 350 349 348 347 346 345 344 343 342 341 340 339

Continued on Next Page

RECORD OF BOREHOLE No. BH12-13

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY AD
CLIENT Rainy River Resources.
LOCATION Open Pit Area
COMPILED BY DG
ELEVATION 352.625 m
COORD. N 5,409,437 E 425,767
BORING DATE Start: Sep 8, 12 End: Sep 9, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE		SAMPLES					WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD							
	surface on installation Water level at 3.0m below ground surface on Oct. 30, 2012												

amec

RECORD OF BOREHOLE No. BH12-14

PAGE 1 OF 1

PROJECT	Rainy River Gold Project			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring
LOGGED BY	TA				
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area	COMPILED BY	DG
ELEVATION	354.133 m	COORD.	N 5,409,536 E 425,420	BORING DATE	Start: Oct 2, 12 End: Oct 2, 12
CHECKED BY	DGR				

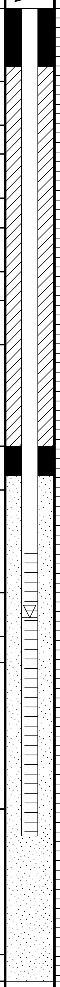
SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

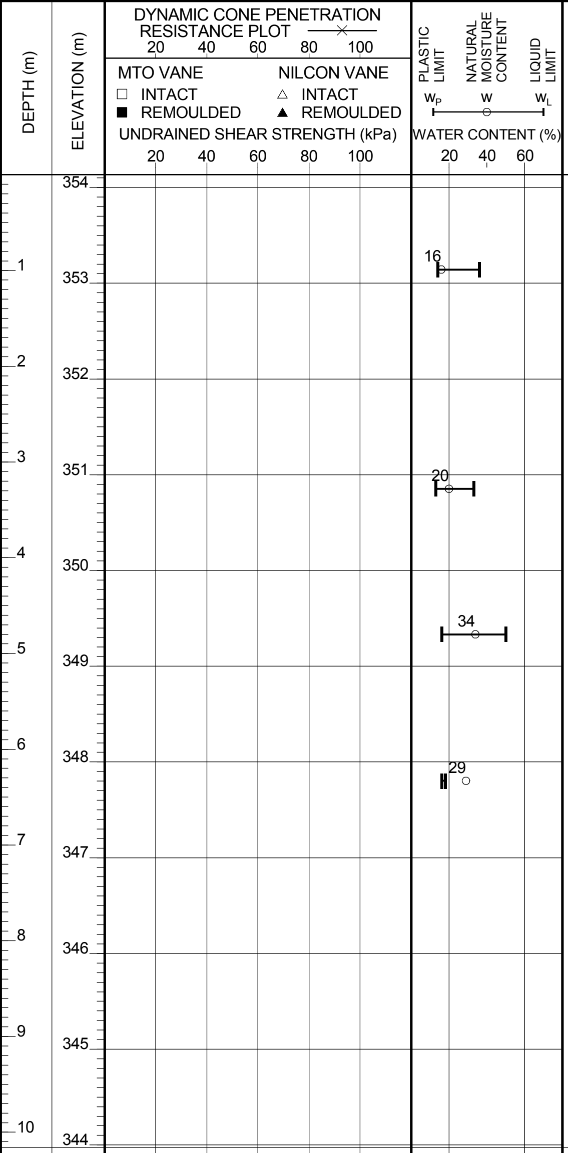
ABBREVIATIONS
P.P. Pocket Penetrometer
TV Torvane
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV / DEPTH (m)	SOIL PROFILE DESCRIPTION
354.1	Ground surface
0.0	**TOPSOIL**
354.0 0.2	**Silty CLAY** Brown silt clay, trace to some sand, moist, occasional silty lenses, low plasticity [Upper Glaciolacustrine] ...becoming varved at 2.3m
349.6 4.6	**Silty CLAY** Grey silty clay, trace sand, trace gravel, low to medium plasticity, stiff [WML Till]
347.7 6.5	**Sandy SILT** Grey sandy silt to silty sand
347.3 6.8	**BEDROCK** Light grey
344.0 10.2	End of Borehole at 10.2m Standpipe installed with 0.9m stick up Water level 5.4m below ground surface on completion Water level 5.4m below ground surface on Oct. 30, 2012

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	88	16
2	SS	100	19
3	TW	100	
4	SS	39	24
5	SS	83	23
6	SS	100	56
7	RC	95	57
8	RC	95	62
9	RC	100	91

WELL / PIEZOMETER INSTALLATION





PERMEABILITY (cm/s)

REMARKS

RECORD OF BOREHOLE No. BH12-15

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area			COMPILED BY	DG
ELEVATION	351.339 m	COORD.	N 5,409,732 E 426,116	BORING DATE	Start: Sep 10, 12 End: Sep 13, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

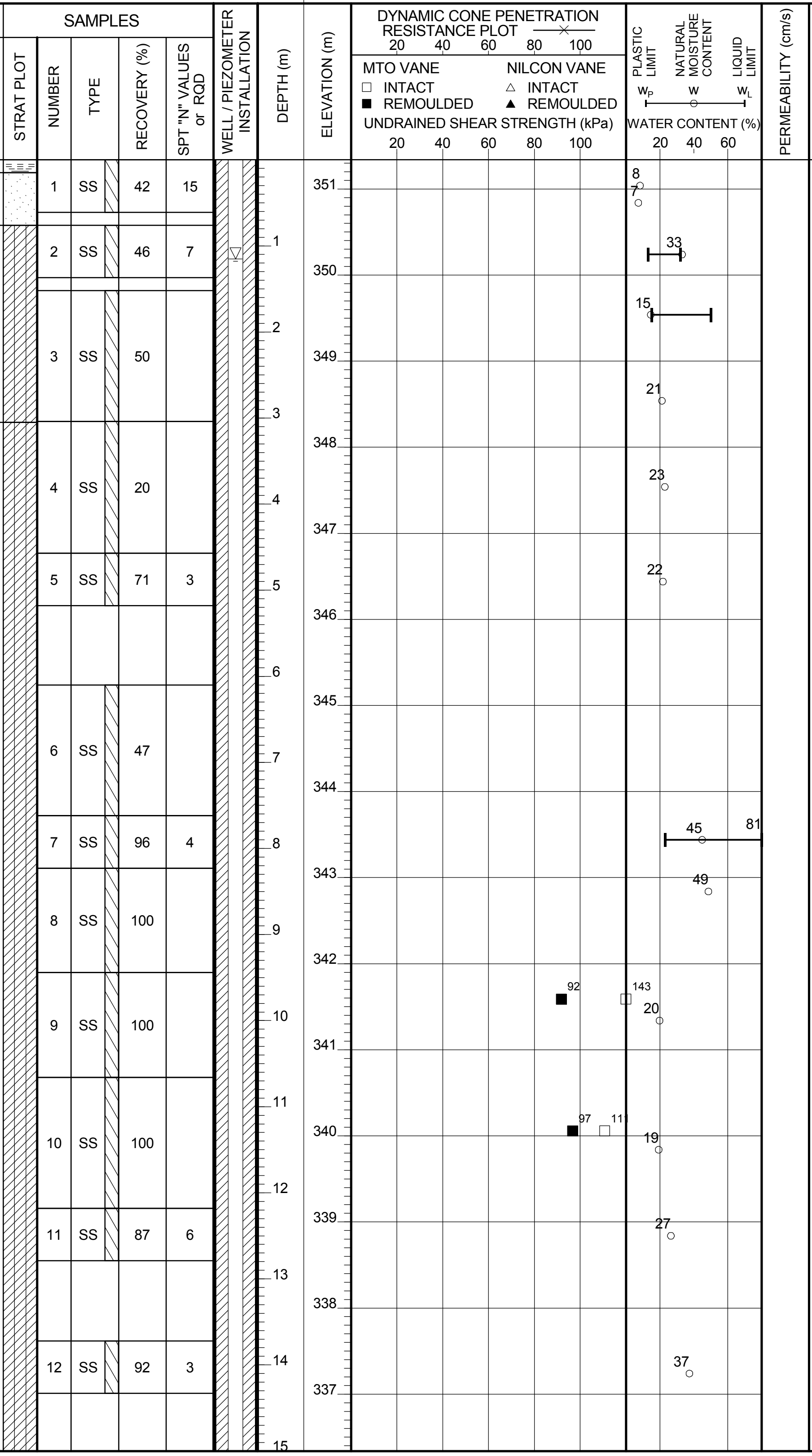
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
351.3	Ground surface
351.2 0.0 0.2	**PEAT** Dark brown peat, some gravel, fibrous, dry, occasional rootlets
350.6 0.8	**SAND** Light brown sand, fine to coarse, some gravel, dry, possibe road fill **Silty CLAY** Dark brown sitly clay, some sand, damp to dry, low plasticity, trace rootlets, soft to firm, varved [Upper Glaciolacustrine] ...occasional sand pockets below 1.5m
348.3 3.1	**Silty CLAY** Light brown to grey silty clay, trace sand, trace gravel, medium to high plasticity, damp to moist, trace oxidized pockets [WML Till] ...becoming grey at 4.6m ...occasional coarse sand pockets throughout, moist to wet ...at 8.9m light grey silt varves 20mm thick

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	42	15
2	SS	46	7
3	SS	50	
4	SS	20	
5	SS	71	3
6	SS	47	
7	SS	96	4
8	SS	100	
9	SS	100	
10	SS	100	
11	SS	87	6
12	SS	92	3



REMARKS

...102mm diameter split spoon sampler used for SS 3, 4, 6, 8, 9, and 10

Continued on Next Page

RECORD OF BOREHOLE No. BH12-15

PAGE 2 OF 4

PROJECT	Rainy River Gold Project			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring
				LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area	COMPILED BY	DG
ELEVATION	351.339 m	COORD.	N 5,409,732 E 426,116	BORING DATE	Start: Sep 10, 12 End: Sep 13, 12
				CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100

MTO VANE: □ INTACT ■ REMOULDED; NILCON VANE: △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
		13	SS		4	37		
		14	SS	75	6	41		
		15	SS	92	6	36		
		16	SS	79	7	46		
		17	SS	79	8	24		
		18	SS		12	27		
		19	SS	83	9	34		
		20	SS	83	9	26		
	...trace to some sand, fine gravel below 27.4m	21	SS	100	10	29		
	...sandy silt seam from 29.1m to 29.4m	22	SS	92	9	31		

DEPTH (m): 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

ELEVATION (m): 336 335 334 333 332 331 330 329 328 327 326 325 324 323 322

Continued on Next Page

RECORD OF BOREHOLE No. BH12-15

PAGE 3 OF 4

PROJECT	Rainy River Gold Project			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD 200 mm HSA, NQ Coring	LOGGED BY AD
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area	COMPILED BY	DG
ELEVATION	351.339 m	COORD.	N 5,409,732 E 426,116	BORING DATE Start: Sep 10, 12 End: Sep 13, 12	CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60; PERMEABILITY (cm/s)

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
		23	SS		11	28	
		24	SS		9	29	
	...increasing silt and sand content below 33.2m	25	SS	29	14	21	
		26	SS		10	25	
	...becoming light grey, wet, firm	27	SS	100	9	32	
313.5 37.9	**Silty SAND** Grey silty sand, fine to coarse grained, wet [WS Till]	28	SS		50	25	...heaving sand at 37.9m
		29	RC	100	0		
	...frequent boulders	30	RC	10	0		
311.4 39.9	**BEDROCK** Grey bedrock, black banding, highly weathered, soft, faintly cemented	31	RC	45	11		
		32	RC	58	13		
		33	RC	38	0		
		34	RC	100	21		

DEPTH (m): 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45

ELEVATION (m): 321 320 319 318 317 316 315 314 313 312 311 310 309 308 307

Continued on Next Page

Format: AMEC GEO MWSK File: TC113921_SUMMER2012BHLOGS_20120817.GPJ Date: 02/01/2013 3:13:41 PM

RECORD OF BOREHOLE No. BH12-15

PROJECT Rainy River Gold Project ENGINEER MS

PROJECT NO. TC113921 DRILLER Marathon Drilling BORING METHOD 200 mm HSA, NQ Coring LOGGED BY AD

CLIENT Rainy River Resources. LOCATION Open Pit Area COMPILED BY DG

ELEVATION 351.339 m COORD. N 5,409,732 E 426,116 BORING DATE Start: Sep 10, 12 End: Sep 13, 12 CHECKED BY DGR

SAMPLE TYPES		ABBREVIATIONS		
AU Auger	RC Rock Core	P.P. Pocket Penetrometer	P.L. Point Load Strength Index (I_{50})	C Consolidation
BU Bulk	SS Split Spoon	TV Torvane	RQD Rock Quality Designation	DS Direct Shear
DC Dynamic Cone	TW Thin Walled Open (Shelby)	PT Standard Proctor Test	SCR Solid Core Recovery	GS Grain Size Analysis
	WS Wash Sample		k Permeability	

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
304.5			35	RC	58	0		46	306 305				
46.8	**End of Borehole** at 46.8m Standpipe installed wiht 0.9m stick up Water level 1.2m below ground surface on completion Water level 1.1m below ground surface on Oct. 30, 2012												

amec

RECORD OF BOREHOLE No. BH12-17

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area			COMPILED BY	DG
ELEVATION	346.592 m	COORD.	N 5,409,329 E 424,634	BORING DATE	Start: Aug 28, 12 End: Sep 7, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED

UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
346.6	Ground surface							
0.0	**PEAT** Dark brown peat, trace rootlets, fibrous, damp	1	SS	8	0	315		
345.8 0.8	**Clayey SILT** Greyish brown clayey silt, trace sand, damp to moist, low plasticity, soft, trace organics, trace oxidized pockets	2	SS	78	3	34		
345.1 1.5	**Silty CLAY** Dark grey silty clay, varved (with light grey silt), soft to firm, moist [Upper Glaciolacustrine]	3	SS	100	3	27		
		4	SS	100	2	29		
		5	TW	100				
342.8 3.8	**Silty CLAY** Light grey silty clay, trace fine gravel, firm, damp to moist, medium to high plasticity [WML Till]	6	SS	100	6	36		...at 3.7m PP= 118kPa
		7	SS	100	6	36		
	...dark grey below 6.1m	8	SS	78	9	27		
	...becoming moist to wet at 7.6m	9	SS	100	4	10		
		10	SS	100	4	27		
		11	TW	100		19		...at 11.3m PP= 147kPa
		12	SS	100	9	16		
		13	SS	100	6	32		

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH12-17

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY AD
CLIENT Rainy River Resources.
LOCATION Open Pit Area
COMPILED BY DG
ELEVATION 346.592 m
COORD. N 5,409,329 E 424,634
BORING DATE Start: Aug 28, 12 End: Sep 7, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); MTO VANE: □ INTACT, ■ REMOULDED; NILCON VANE: △ INTACT, ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60; PERMEABILITY (cm/s)

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
		14	SS	100	7	27	
	...sandy layer between 16.8m to 17.2m	15	SS	100	6	28	
		16	SS	100	6	26	
		17	SS	100	7	38	
		18	SS	100	4	43	
		19	SS	100	6	39	
	...occasional pockets of light grey silty sand below 24.1m	20	SS	100	7	40	
320.7 25.9	**Silty CLAY** Grey silty clay, trace sand and gravel, light grey silt laminations, low plasticity, moist [Lower Glaciolacustrine]	21	SS	100	6	55	
319.5 27.1	**SAND and GRAVEL** Coarse grained, some silt, angular to semiangular, wet [Inferred WS Till] ....boulders suspected below 28m	22	SS	39	16	17	...approximately 6m of sand heave at 27.1m

Continued on Next Page

RECORD OF BOREHOLE No. BH12-17

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area			COMPILED BY	DG
ELEVATION	346.592 m	COORD.	N 5,409,329 E 424,634	BORING DATE	Start: Aug 28, 12 End: Sep 7, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 MTO VANE □ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
								31 32 33	316 315 314				
313.4 33.2	**BEDROCK** Greyish black to black bedrock		23	RC	71	42		34	313 312				
	...fractures (shards) from 34.7m to 35.1m		24	RC	87	0		35	311				
			25	RC	100	73		36	310				
309.9 36.7	**End of Borehole** at 36.7m Standpipe installed with 1.5m stick up; artesian condition upon completion Artesian head of 2.3m above ground surface noted on Oct. 30, 2012												

amec

RECORD OF BOREHOLE No. BH12-18

PAGE 1 OF 3

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY TA
CLIENT Rainy River Resources.
LOCATION Open Pit Area
COMPILED BY DG
ELEVATION 348.384 m
COORD. N 5,409,745 E 424,521
BORING DATE Start: Aug 11, 12 End: Aug 13, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60
PERMEABILITY (cm/s)
REMARKS

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)
348.4	Ground surface					
0.0	**TOPSOIL**	1	SS	0	6	41
347.8 0.6	**Silty CLAY** Brown silty clay, trace sand, trace gravel, varved, medium plasticity, firm [Upper Glaciolacustrine]					
		2	SS	100	5	25
		3	SS	100	6	33
345.9 2.4	**Silty CLAY** Grey silty clay, trace sand, trace greavel, medium to high plasticity, firm [WML Till]	4	TW	96		
		5	SS	100	7	36
		6	SS	100	7	39
	...sand seam at 4.8m, 30mm thick	7	SS	100	6	18
		8	SS	100	4	19
		9	TW	100		
		10	SS	100	5	40
		11	SS	100	5	37
		12	TW	100		
		13	SS	100	5	36

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ELEVATION (m): 348 347 346 345 344 343 342 341 340 339 338 337 336 335 334

Continued on Next Page

Format: AMEC GEO MWSK File: TC113921_SUMMER2012BHLOGS_20120817.GPJ Date: 02/01/2013 3:13:50 PM

RECORD OF BOREHOLE No. BH12-18

PAGE 2 OF 3

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY TA
CLIENT Rainy River Resources.
LOCATION Open Pit Area
COMPILED BY DG
ELEVATION 348.384 m
COORD. N 5,409,745 E 424,521
BORING DATE Start: Aug 11, 12 End: Aug 13, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60; PERMEABILITY (cm/s); REMARKS

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)
333.1 15.2	**Silty SAND** Grey silty sand to sandy silt, fine grained, trace clay lenses, saturated, loose [Glacio Fluvial]	14	SS	72	5	22
	...silty clay with fine sand at 17m	15	SS	100	5	24
	...clayey sand below 18.6m	16	SS	89	2	22 24
328.6 19.8	**Silty CLAY** Grey silty clay, some sand, occasional sand and silt seams, high plasticity, firm [WML Till]	17	SS	100	6	44 46
		18	SS	100	4	41
		19	SS	100	5	41
		20	SS	100	4	38
		21	SS	100		27 48
321.0 27.4	**Clayey SILT** Light grey to green clayey silt, trace to some sand, trace gravel, varved [Lower Glaciolacustrine]	22	SS	100	7	42
		23	RC	66	6	6
319.7 28.7	**SAND and GRAVEL** Coarse grained, trace silt, grey [Inferred WS Till]	24	SS	33	16	9

Continued on Next Page

RECORD OF BOREHOLE No. BH12-18

PAGE 3 OF 3

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	TA
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area			COMPILED BY	DG
ELEVATION	348.384 m	COORD.	N 5,409,745 E 424,521	BORING DATE	Start: Aug 11, 12 End: Aug 13, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)
							318
		25	SS	0	14	31	
							317
		26	SS	61	24	32	
							316
						33	
							315
		27	SS	33	13		
314.7 33.7	**End of Borehole** at 33.7m, no refusal Standpipe installed with 1.0m stick up Water level 2.7m below ground surface on installation. Artesian head 0.4m above ground surface noted on Oct. 20, 2012						

Column headings: SOIL PROFILE; SAMPLES; STRAT PLOT; WELL / PIEZOMETER INSTALLATION; DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE □ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100; PLASTIC LIMIT w_P; NATURAL MOISTURE CONTENT w; LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60; PERMEABILITY (cm/s); REMARKS

RECORD OF BOREHOLE No. BH12-19

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	TA
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area			COMPILED BY	DG
ELEVATION	351.189 m	COORD.	N 5,410,368 E 425,255	BORING DATE	Start: Aug 21, 12 End: Aug 23, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

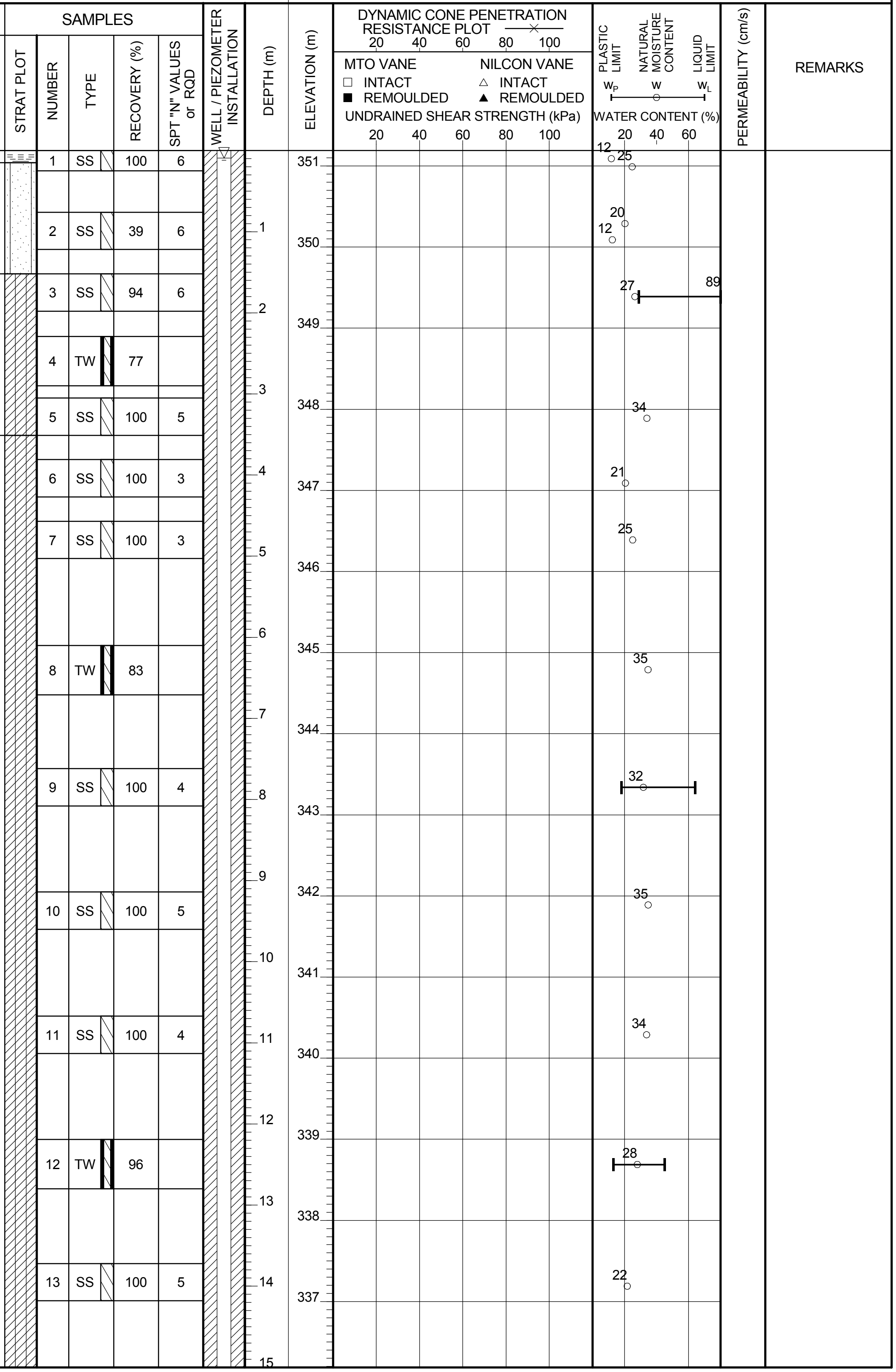
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
351.2	Ground surface
351.0 0.2	**PEAT** Dark brown peat, fibrous
	Silty SAND Brown fine grained silty sand, some organics, trace rootlets ...silty clay at 0.8m
349.7 1.5	**Silty CLAY** Brown to grey silty clay, varved, moist [Upper Glaciolacustrine]
347.7 3.5	**Silty CLAY** Grey silty clay, trace sand, trace gravel, medium to high plasticity, moist, occasional sand seams [WML Till] ...grey sandy silt, some clay, wet at 13.7m

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	100	6
2	SS	39	6
3	SS	94	6
4	TW	77	
5	SS	100	5
6	SS	100	3
7	SS	100	3
8	TW	83	
9	SS	100	4
10	SS	100	5
11	SS	100	4
12	TW	96	
13	SS	100	5



Continued on Next Page

RECORD OF BOREHOLE No. BH12-19

PAGE 2 OF 3

PROJECT	Rainy River Gold Project			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD 200 mm HSA, NQ Coring	LOGGED BY TA
CLIENT	Rainy River Resources.	LOCATION	Open Pit Area		COMPILED BY DG
ELEVATION	351.189 m	COORD.	N 5,410,368 E 425,255	BORING DATE Start: Aug 21, 12 End: Aug 23, 12	CHECKED BY DGR

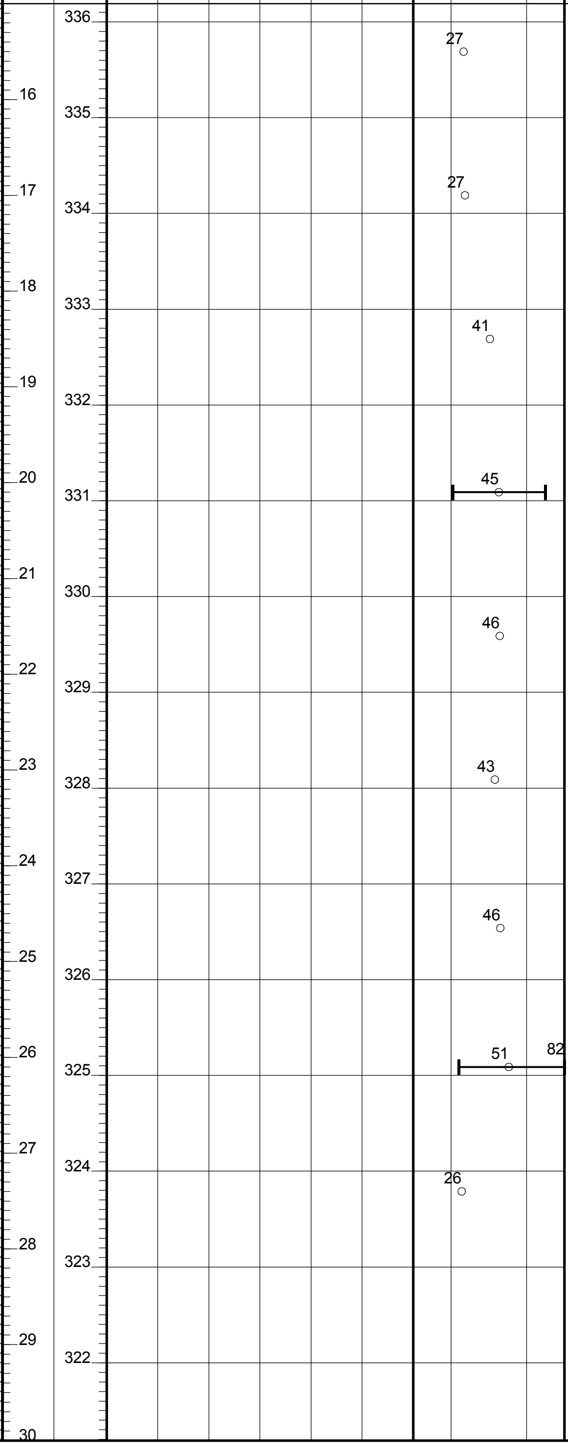
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	NATURAL MOISTURE CONTENT w (%)	REMARKS
		14	SS	100	3	27	
	...with trace silt lenses from 16.8m to 18.3m	15	SS	100	3	27	
		16	SS	100	3	41	
		17	SS	100	3	45	
		18	SS	100	3	46	
		19	SS	100	4	43	
		20	SS	100	4	46	
325.3 25.9	**Silty CLAY** grey silty clay,trace sand, medium plasticity, varved, moist [Lower Glaciolacustrine]	21	SS	100	7	51 (82)	
	...sandy below 27.4m, wet	22	SS	100	11	26	
322.7 28.5	**SAND TILL** [Inferred WS Till]	23	RC	53			
		24	RC	22			



Continued on Next Page

RECORD OF BOREHOLE No. BH12-19

PAGE 3 OF 3

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY TA
CLIENT Rainy River Resources.
LOCATION Open Pit Area
COMPILED BY DG
ELEVATION 351.189 m
COORD. N 5,410,368 E 425,255
BORING DATE Start: Aug 21, 12 End: Aug 23, 12
CHECKED BY DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE □ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
									321				
			25	RC	100								
320.2			26	RC	31								
31.0	**BEDROCK** ...0.10m seam at 31.3m		27	RC	87	12		31	320				
			28	RC	100	98		32 33	319 318				
316.9			29	RC	100	36		34	317				
34.3	**End of Borehole** at 34.3m Stand pipe installed with 0.6m stickup Water level at 0.3m below ground upon completion Water level at 0.04m below ground on Oct. 30, 2012												

RECORD OF BOREHOLE No. BH12-20

PAGE 1 OF 3

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY TA
CLIENT Rainy River Resources.
LOCATION Tailings Management Area
COMPILED BY DG
ELEVATION 362.401 m
COORD. N 5,411,780 E 421,225
BORING DATE Start: Sep 30, 12 End: Oct 1, 12
CHECKED BY DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
TV Torvane
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60
PERMEABILITY (cm/s)

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	REMARKS
362.4	Ground surface						
0.0	**PEAT** Dark brown peat, fibrous	1	SS	22	6		
361.5 0.9	**Silty CLAY** Brown silty clay, some sand, moist, occasional rootlets	2	SS	0	10		
360.9 1.5	**Silty CLAY** Brown silty clay, trace sand, low plasticity, varved, moist [Upper Glaciolacustrine]	3	SS	100	15		
		4	SS	100	14	20	...additional sample taken (thin wall) between 2.1m and 2.7m (TW 22, 0.46m recovery) ...at 3.0m, SPT sampler hit possible cobble
		5	SS	11	18		
357.8 4.6	**Silty CLAY** Grey silty clay, trace sand, trace gravel, moist, medium plasticity [WML Till]	6	SS	100	12	30	
		7	TW	100			
	...with interbedded silt lenses between 7.6m and 9.1m	8	SS	100	11	34	
353.3 9.1	**Sandy SILT** Greenish grey fine sandy silt, trace clay, moist to wet	9	SS	100	22	21	
		10	SS	100	31		
	...trace to some clay, moist at 12.2m	11	SS	100	25		
	...becoming wet, non-plastic, trace clay at 13.7m ...thin stone layer at 13.9m	12	SS	100	62		

Continued on Next Page

RECORD OF BOREHOLE No. BH12-20

PAGE 2 OF 3

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	TA
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	DG
ELEVATION	362.401 m	COORD.	N 5,411,780 E 421,225	BORING DATE	Start: Sep 30, 12 End: Oct 1, 12	CHECKED BY	DGR

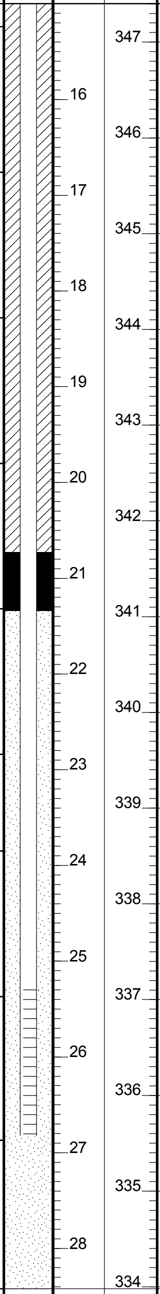
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
MTO VANE ☐ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60
PERMEABILITY (cm/s)
REMARKS



ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
347.2					
15.2	**BOULDERS and COBBLES** Boulders and cobbles with greenish grey sand and silt [WS Till]	13	RC	0	
		14	RC	12	
		15	RC	0	
		16	RC	0	0
		17	RC	3	
		18	RC	0	
338.6 23.9	**BEDROCK** Greenish grey bedrock, highly weathered, very soft	19	RC	87	0
		20	RC	93	0
		21	RC	100	12
334.0 28.4	**End of Borehole** at 28.42 m Standpipe installed with 0.9m stick up Artesian condition- Water level 0.4m above ground surface at completion Water level 0.8m above ground				

Continued on Next Page

RECORD OF BOREHOLE No. BH12-20

PAGE 3 OF 3

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	TA
CLIENT	Rainy River Resources.	LOCATION	Tailings Management Area			COMPILED BY	DG
ELEVATION	362.401 m	COORD.	N 5,411,780 E 421,225	BORING DATE	Start: Sep 30, 12 End: Oct 1, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
	surface on Oct. 30, 2012												

RECORD OF BOREHOLE No. BH12-21

PAGE 1 OF 1

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Mine Rock Area			COMPILED BY	DG
ELEVATION	372.765 m	COORD.	N 5,409,431 E 427,995	BORING DATE	Start: Sep 10, 12 End: Sep 10, 12	CHECKED BY	DGR

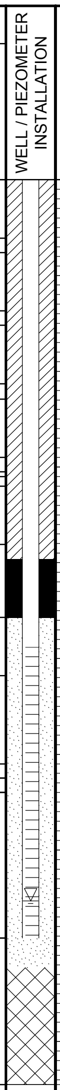
SAMPLE TYPES

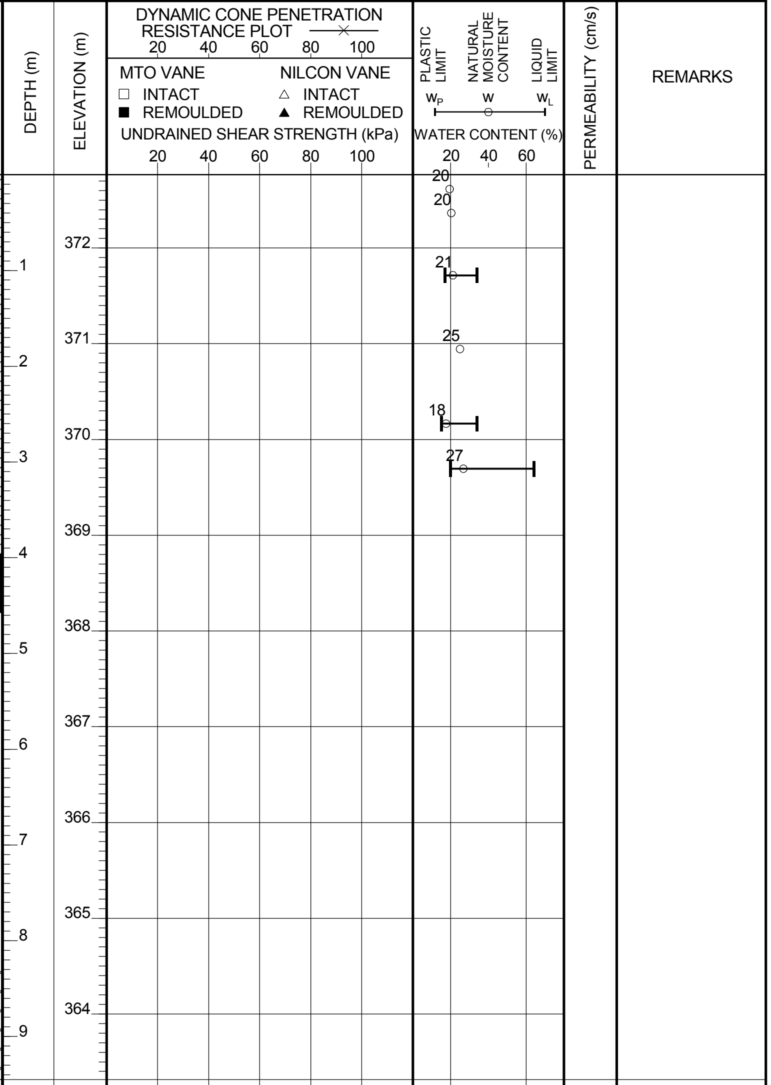
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS

P.P. Pocket Penetrometer
TV Torvane
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV / DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)
372.8	Ground surface					
372.7 0.0 0.1	**TOPSOIL**					20
	Silty CLAY Brown silty clay, trace sand, trace gravel, moist, varved, stiff, some rootlets [Upper Glaciolacustrine]	1	SS	42	9	20
		2	SS	92	17	21
		3	SS	92	13	25
	...very stiff, trace gravelly sand lensing below 2.3m	4	SS	100	19	18
		5	SS	0	50	27
	...boulder at 3.2m	6	RC	0		
		7	SS	100	12	
366.5	...sand and gravel below 6.1m, possible transition zone	8	SS	67	30	
366.4 6.3 6.4	**BOULDERS** [WS Till]	9	RC	67		
	BEDROCK Pink granite bedrock, slightly fractured	10	RC	100	83	
		11	RC	85	63	
363.3 9.5	**End of Borehole** at 9.5m Standpipe installed with flush mounted steel casing Water level at 5.6m below ground level upon completion Water level at 7.5m below ground surface on Oct. 3, 2012					





RECORD OF BOREHOLE No. BH12-22

PAGE 1 OF 2

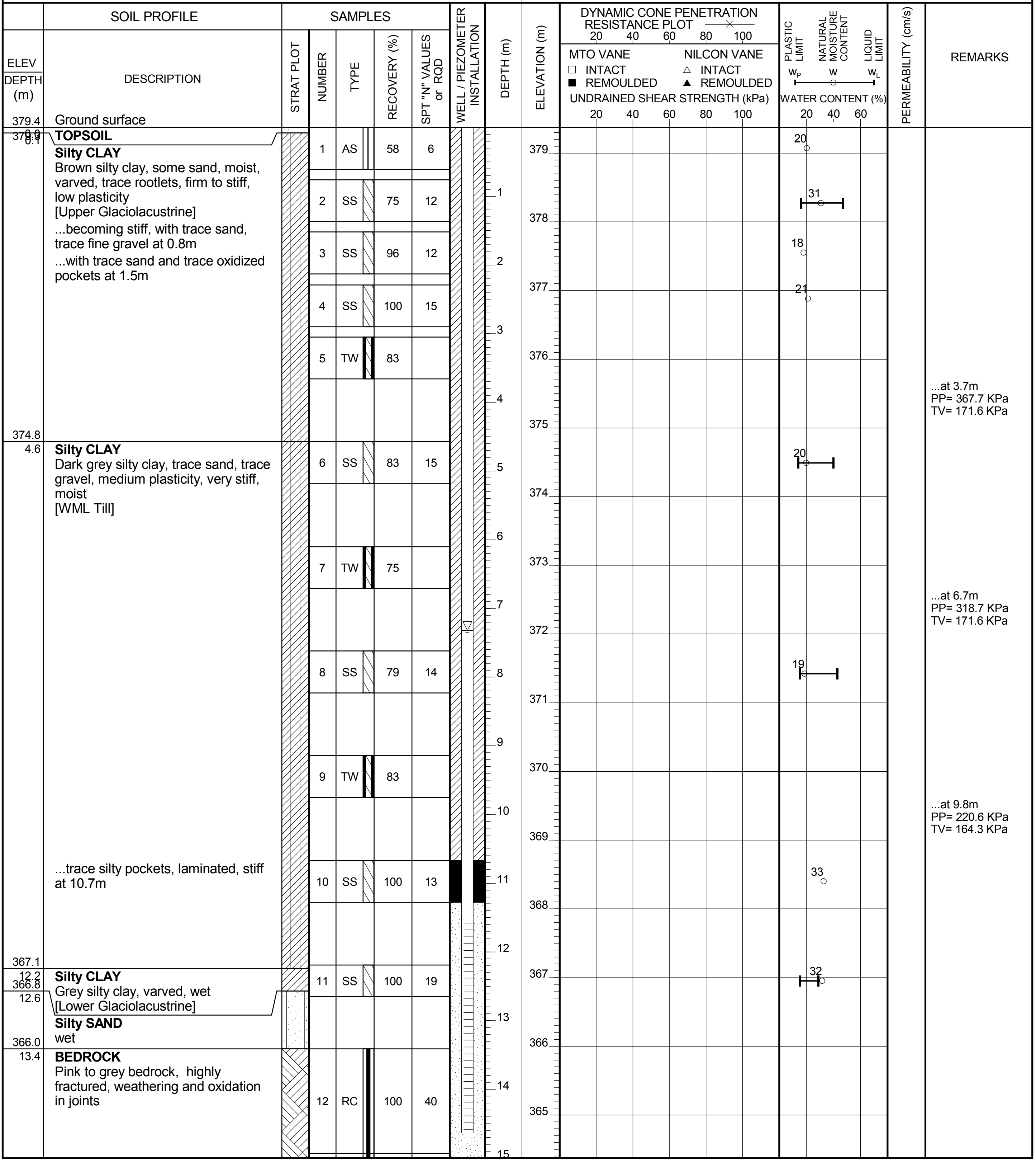
PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Mine Rock Area			COMPILED BY	DG
ELEVATION	379.373 m	COORD.	N 5,410,257 E 428,190	BORING DATE	Start: Sep 9, 12 End: Sep 9, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis



ELEV / DEPTH (m)	DESCRIPTION
379.4	Ground surface
0.0 379.3 0.1	**TOPSOIL**
	Silty CLAY Brown silty clay, some sand, moist, varved, trace rootlets, firm to stiff, low plasticity [Upper Glaciolacustrine] ...becoming stiff, with trace sand, trace fine gravel at 0.8m ...with trace sand and trace oxidized pockets at 1.5m
374.8 4.6	**Silty CLAY** Dark grey silty clay, trace sand, trace gravel, medium plasticity, very stiff, moist [WML Till] ...trace silty pockets, laminated, stiff at 10.7m
367.1 12.2	**Silty CLAY** Grey silty clay, varved, wet [Lower Glaciolacustrine]
366.8 12.6	**Silty SAND** wet
366.0 13.4	**BEDROCK** Pink to grey bedrock, highly fractured, weathering and oxidation in joints

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)
1	AS	58	6	20
2	SS	75	12	31
3	SS	96	12	18
4	SS	100	15	21
5	TW	83		
6	SS	83	15	20
7	TW	75		
8	SS	79	14	19
9	TW	83		
10	SS	100	13	33
11	SS	100	19	32
12	RC	100	40	

REMARKS

...at 3.7m
PP= 367.7 KPa
TV= 171.6 KPa

...at 6.7m
PP= 318.7 KPa
TV= 171.6 KPa

...at 9.8m
PP= 220.6 KPa
TV= 164.3 KPa

Continued on Next Page

amec

RECORD OF BOREHOLE No. BH12-22

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Mine Rock Area			COMPILED BY	DG
ELEVATION	379.373 m	COORD.	N 5,410,257 E 428,190	BORING DATE	Start: Sep 9, 12 End: Sep 9, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; MTO VANE □ INTACT ■ REMOULDED; NILCON VANE △ INTACT ▲ REMOULDED; UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
	...becoming moderately fractured, trace oxidized pockets	▨	13	RC				16	364 363				
362.9 16.5	**End of Borehole** at 16.5m Standppipe installed with flush mounted steel casing Water level at 9.6m below ground upon completion Water level at 7.4m below ground surface on Oct. 3, 2012												

amec

RECORD OF BOREHOLE No. BBAF-BH-2002

PAGE 1 OF 1

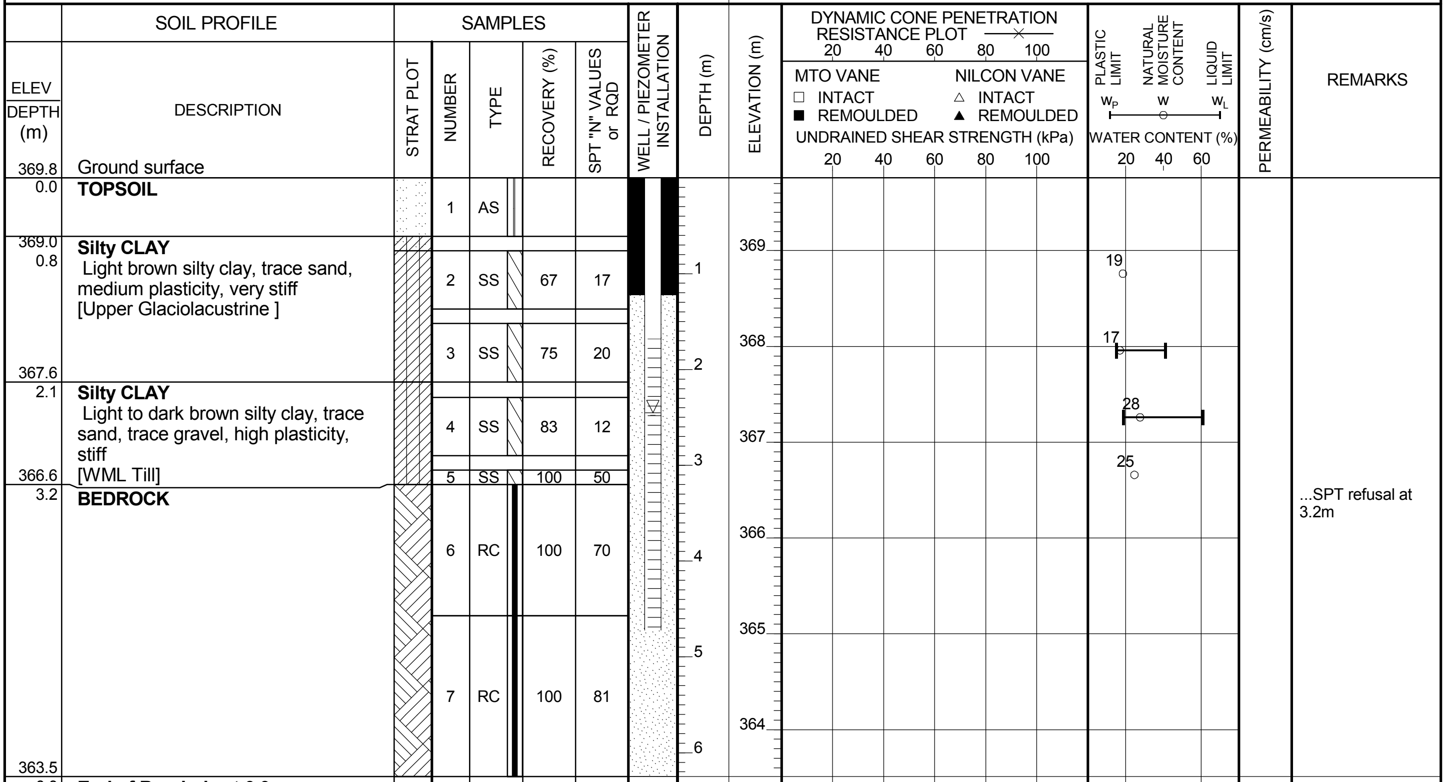
PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	ARM
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	DG
ELEVATION	369.759 m	COORD.	N 5,410,217 E 426,778	BORING DATE	Start: Aug 28, 12 End: Aug 28, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis



ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)	WATER CONTENT (%)	REMARKS
369.8	Ground surface								
0.0	**TOPSOIL**	1	AS						
369.0 0.8	**Silty CLAY** Light brown silty clay, trace sand, medium plasticity, very stiff [Upper Glaciolacustrine]	2	SS	67	17	1	369	19	
		3	SS	75	20	2	368	17	
367.6 2.1	**Silty CLAY** Light to dark brown silty clay, trace sand, trace gravel, high plasticity, stiff	4	SS	83	12		367	28	
366.6	[WML Till]	5	SS	100	50	3		25	
3.2	**BEDROCK**	6	RC	100	70	4	366		...SPT refusal at 3.2m
		7	RC	100	81	5 6	365 364		
363.5 6.3	**End of Borehole** at 6.3m Standpipe installed with 0.9 m stick up Water level 2.4 m below ground surface on Sept 15, 2012								

RECORD OF BOREHOLE No. BBAF-BH-2015

PAGE 1 OF 1

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	AD
ELEVATION	368.446 m	COORD.	N 5,410,507 E 426,591	BORING DATE	Start: Aug 11, 12 End: Aug 12, 12	CHECKED BY	DGR

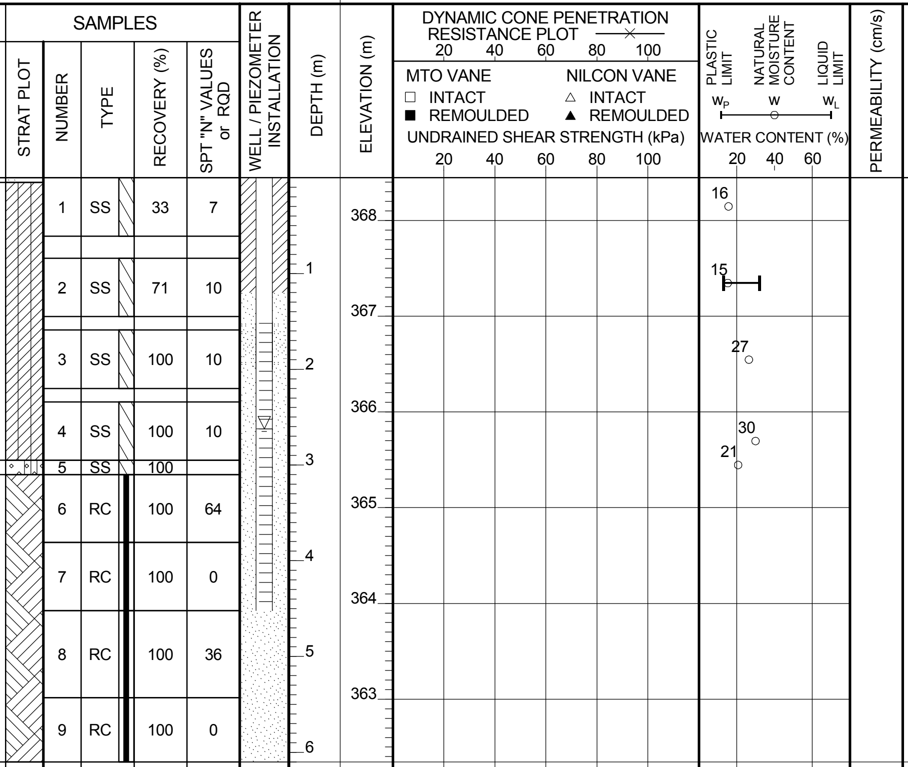
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)	NATURAL MOISTURE CONTENT	REMARKS
368.4	Ground surface								
368.4 0.0 368.4 0.1	**TOPSOIL**								
	Silty CLAY Brown silty clay, varved, firm, trace sand, medium plasticity, trace roots, moist [Upper Glaciolacustrine]	1	SS	33	7		368	16	
		2	SS	71	10	1	367	15	
		3	SS	100	10	2	366	27	
365.5	... moist to wet, occasional silt pockets at 2.6m	4	SS	100	10			30	
365.3 3.0		5	SS	100		3		21	
3.1	**Silty SAND** Brown silty sand, wet, trace clay. [WS Till]	6	RC	100	64		365		... at 3.0m SPT refusal
	BEDROCK Moderately to highly fractured	7	RC	100	0	4	364		
		8	RC	100	36	5	363		
362.3		9	RC	100	0	6			
6.1	**End of Borehole** at 6.1m Stand pipe installed with 0.9m stick up Water level at 2.6 m below ground on Sept. 15, 2012								



Format: AMEC GEO MWSK File: TC113921_SUMMER2012BHLOGS_20120817.GPJ Date: 02/01/2013 3:12:45 PM

amec

RECORD OF BOREHOLE No. BBAF-BH-2051

PAGE 1 OF 1

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	AD
ELEVATION	368.505 m	COORD.	N 5,410,538 E 426,591	BORING DATE	Start: Aug 11, 12 End: Aug 11, 12	CHECKED BY	DGR

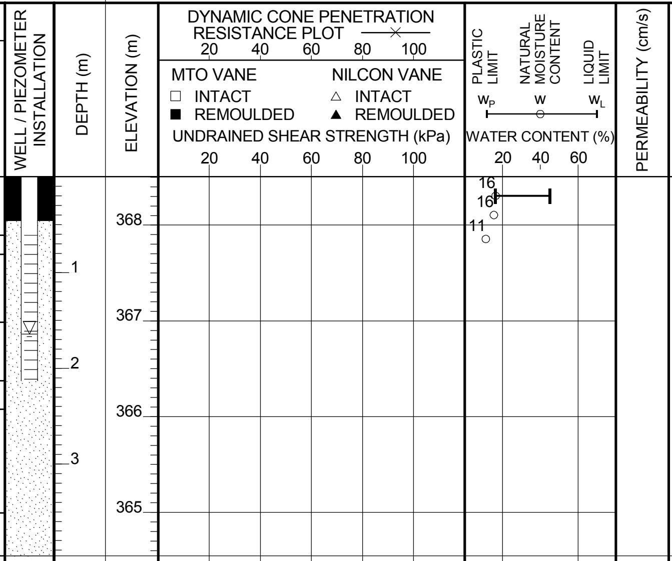
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
368.5	Ground surface					
368.4 0.1	**TOPSOIL**					
	Silty CLAY Brown silty clay, varved, stiff, medium plasticity, moist, trace roots [Upper Glaciolacustrine]	1	SS	58	13	
367.9 367.7		2	SS	67	50	
0.8	**Silty SAND** Reddish brown silty sand, trace fine gravel, very dense, moist [WS Till]	3	RC	100	21	
		4	RC	100	33	
	BEDROCK Greenish black bedrock, highly fractured	5	RC	100	17	
	...dark grey below 2.8m	6	RC	97	88	
364.5		7	RC	100	30	
4.0	**End of Borehole** at 3.96m Stand pipe installed with 0.9m stick up Water level at 1.6 m below ground surface on Sept. 15, 2012					



Format: AMEC GEO MWSK File: TC113921_SUMMER2012BHLOGS_20120817.GPJ Date: 02/01/2013 3:12:46 PM

amec

RECORD OF BOREHOLE No. BBAF-BH-2054

PAGE 1 OF 1

PROJECT: Rainy River Gold Project
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: PDR
CLIENT: Rainy River Resources.
LOCATION: Plant Site Area
COMPILED BY: AD
ELEVATION: 372.196 m
COORD.: N 5,410,874 E 426,572
BORING DATE: Start: Aug 10, 12 End: Aug 11, 12
CHECKED BY: DGR

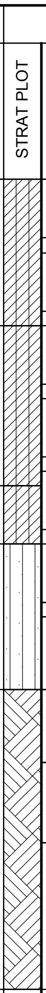
SAMPLE TYPES

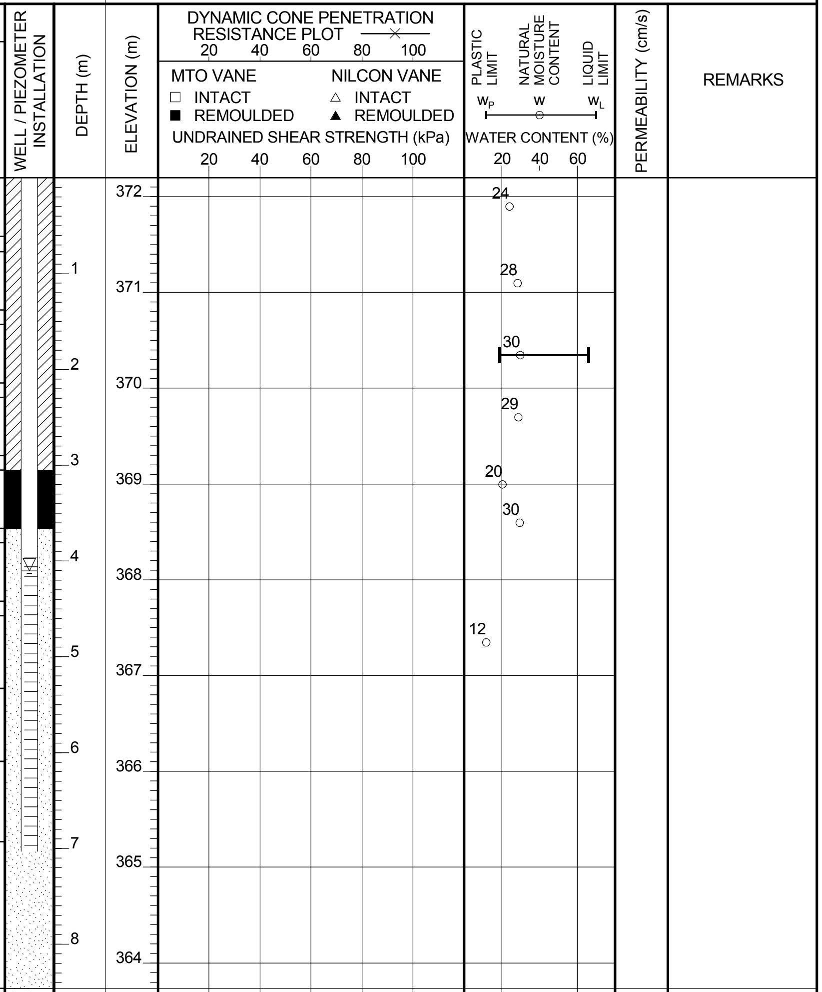
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
372.2	Ground surface				
0.0	**Silty CLAY** Brown silty clay, varved, firm, trace rootlets, moist [Upper Glaciolacustrine]	1	SS	63	5
	... becoming stiff, fine gravel pockets	2	SS	63	9
370.7 1.5	**Silty CLAY** Dark brown to grey silty clay, trace sand, trace fine gravel, occasional silt lenses, stiff, medium to high plasticity, occasional oxidized pockets [WML Till]	3	SS	79	11
		4	SS	83	11
369.0 3.2	**Silty CLAY** Dark brown silty clay, trace sand, trace gravel, varved, moist, occasional oxidized pockets [Lower Glaciolacustrine]	5	SS	100	15
368.4 3.8	**Silty SAND** Brown silty sand, with cobbles and boulders, some gravel, dense, wet [WS Till]	6	RC	67	
		7	RC	100	
		8	SS	63	34
366.9 5.3	**BEDROCK** Greenish grey bedrock	9	RC	100	80
	...highly fractured from 6.1m to 6.9m	10	RC	85	18
		11	RC	100	82
363.7 8.5	**End of Borehole** at 8.5m Stand pipe installed with 0.9m stick up Water level 4.1m below ground surface on Sept. 15, 2012				





Format: AMEC GEO MWSK File: TC113921_SUMMER2012BHLOGS_20120817.GPJ Date: 02/01/2013 3:12:48 PM

amec

RECORD OF BOREHOLE No. BBAF-BH-2061

PAGE 1 OF 1

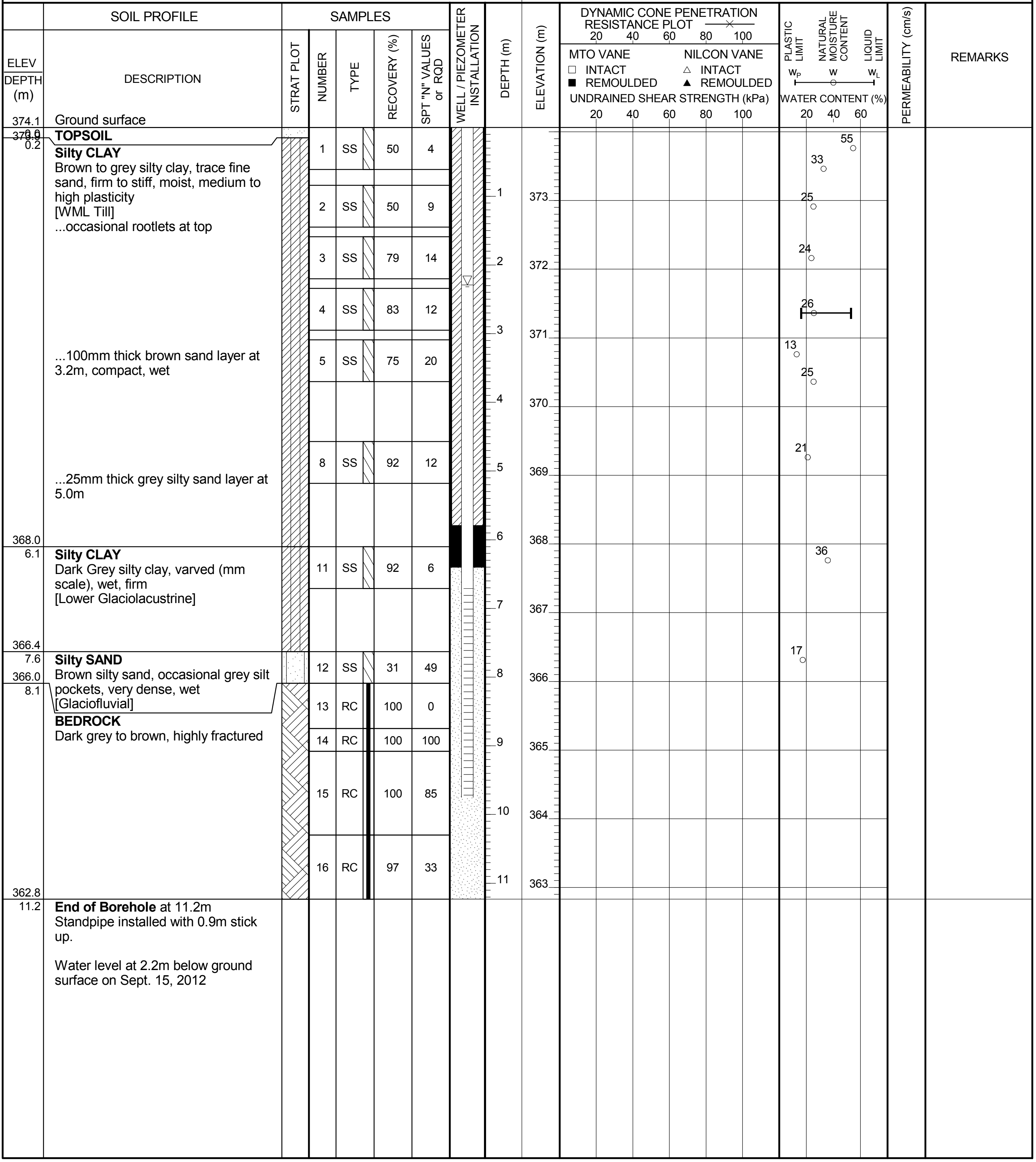
PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	DG
ELEVATION	374.062 m	COORD.	N 5,411,001 E 426,687	BORING DATE	Start: Aug 14, 12 End: Aug 14, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis



ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
374.1	Ground surface				
0.0	**TOPSOIL**				
373.9 0.2	**Silty CLAY** Brown to grey silty clay, trace fine sand, firm to stiff, moist, medium to high plasticity [WML Till] ...occasional rootlets at top	1	SS	50	4
		2	SS	50	9
		3	SS	79	14
		4	SS	83	12
	...100mm thick brown sand layer at 3.2m, compact, wet	5	SS	75	20
		8	SS	92	12
	...25mm thick grey silty sand layer at 5.0m				
368.0 6.1	**Silty CLAY** Dark Grey silty clay, varved (mm scale), wet, firm [Lower Glaciolacustrine]	11	SS	92	6
366.4 7.6	**Silty SAND** Brown silty sand, occasional grey silt pockets, very dense, wet [Glaciofluvial]	12	SS	31	49
366.0 8.1	**BEDROCK** Dark grey to brown, highly fractured	13	RC	100	0
		14	RC	100	100
		15	RC	100	85
		16	RC	97	33
362.8 11.2	**End of Borehole** at 11.2m Standpipe installed with 0.9m stick up. Water level at 2.2m below ground surface on Sept. 15, 2012				

amec

RECORD OF BOREHOLE No. BBAF-BH-2063

PAGE 1 OF 1

PROJECT: Rainy River Gold Project
ENGINEER: MS
PROJECT NO.: TC113921
DRILLER: Marathon Drilling
BORING METHOD: 200 mm HSA, NQ Coring
LOGGED BY: PDR
CLIENT: Rainy River Resources.
LOCATION: Plant Site Area
COMPILED BY: AD
ELEVATION: 372.395 m
COORD.: N 5,411,008 E 426,562
BORING DATE: Start: Aug 13, 12 End: Aug 13, 12
CHECKED BY: DGR

SAMPLE TYPES			
AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS					
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100
MTO VANE: □ INTACT ■ REMOULDED
NILCON VANE: △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
372.4	Ground surface							
372.3 0.1	**TOPSOIL**							
	Silty CLAY Brown silty clay, firm, trace sand and gravel, moist, occasional rootlets [Upper Glaciolacustrine]	1	SS	50	7	29 23		
	..becoming sandy, dry at 0.8 m	2	SS	81	50	7		
371.1 1.3	**BEDROCK** Bluish grey, moderately fractured	3	RC	100	87			
		4	RC	87	58			
368.1 4.3	**End of Borehole** at 4.3m Stand pipe installed with 0.9m stick up Water level at 2.46 m on Sept. 15 2012							

DEPTH (m): 1 2 3 4
ELEVATION (m): 372 371 370 369

amec

RECORD OF BOREHOLE No. BBAF-BH-2065

PAGE 1 OF 1

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY PDR
CLIENT Rainy River Resources.
LOCATION Plant Site Area
COMPILED BY DG
ELEVATION 375.942 m
COORD. N 5,411,099 E 426,758
BORING DATE Start: Aug 14, 12 End: Aug 14, 12
CHECKED BY DGR

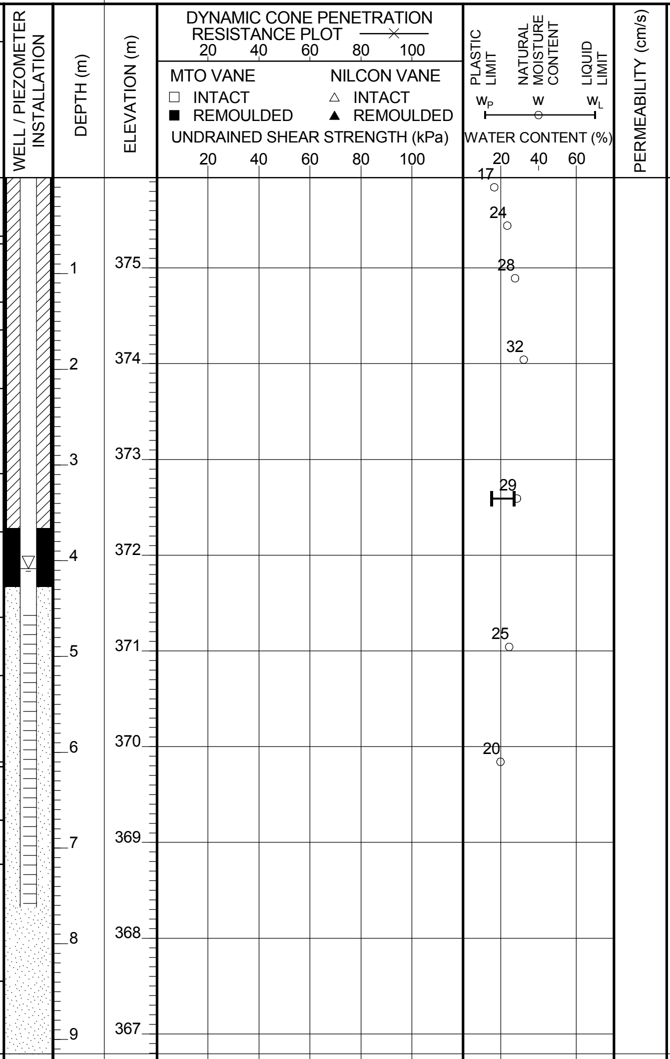
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})	C	Consolidation
TV	Torvane	RQD	Rock Quality Designation	DS	Direct Shear
PT	Standard Proctor Test	SCR	Solid Core Recovery	GS	Grain Size Analysis
		k	Permeability		

ELEV / DEPTH (m)	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)	PERMEABILITY (cm/s)	REMARKS
375.9	Ground surface							
376.0 0.0 0.1	**TOPSOIL**					17		
	Silty CLAY Brown silty clay, trace sand, moist, varved, stiff, occasional rootlets [Upper Glaciolacustrine]	1	SS	66	8	24		
		2	SS	58	13	28		
374.4 1.5	**Silty CLAY** Brown silty clay, trace fine gravel, trace sand, moist, occasional oxidized pockets, medium plasticity, stiff [WML Till]	3	SS	79	12	32		
		6	SS	96	14	29		
371.4 4.6	**Silty SAND** Brown silty sand, well graded, compact, very wet [Possible Glaciofluvial Sand]	9	SS	58	10	25		
		10	SS	100	12	20		
369.8 6.2	**BEDROCK** Dark grey, highly fractured	11	RC	95	0			
		12	RC	100	42			
		13	RC	100	44			
		14	RC	100	73			
366.8 9.2	**End of Borehole** at 9.2m Standpipe installed with 0.9m stick up Water Level at 4 m below ground on Sept. 15, 2012							



RECORD OF BOREHOLE No. BBAF-BH-2069

PAGE 1 OF 2

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	DG
ELEVATION	363.244 m	COORD.	N 5,411,089 E 426,442	BORING DATE		CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

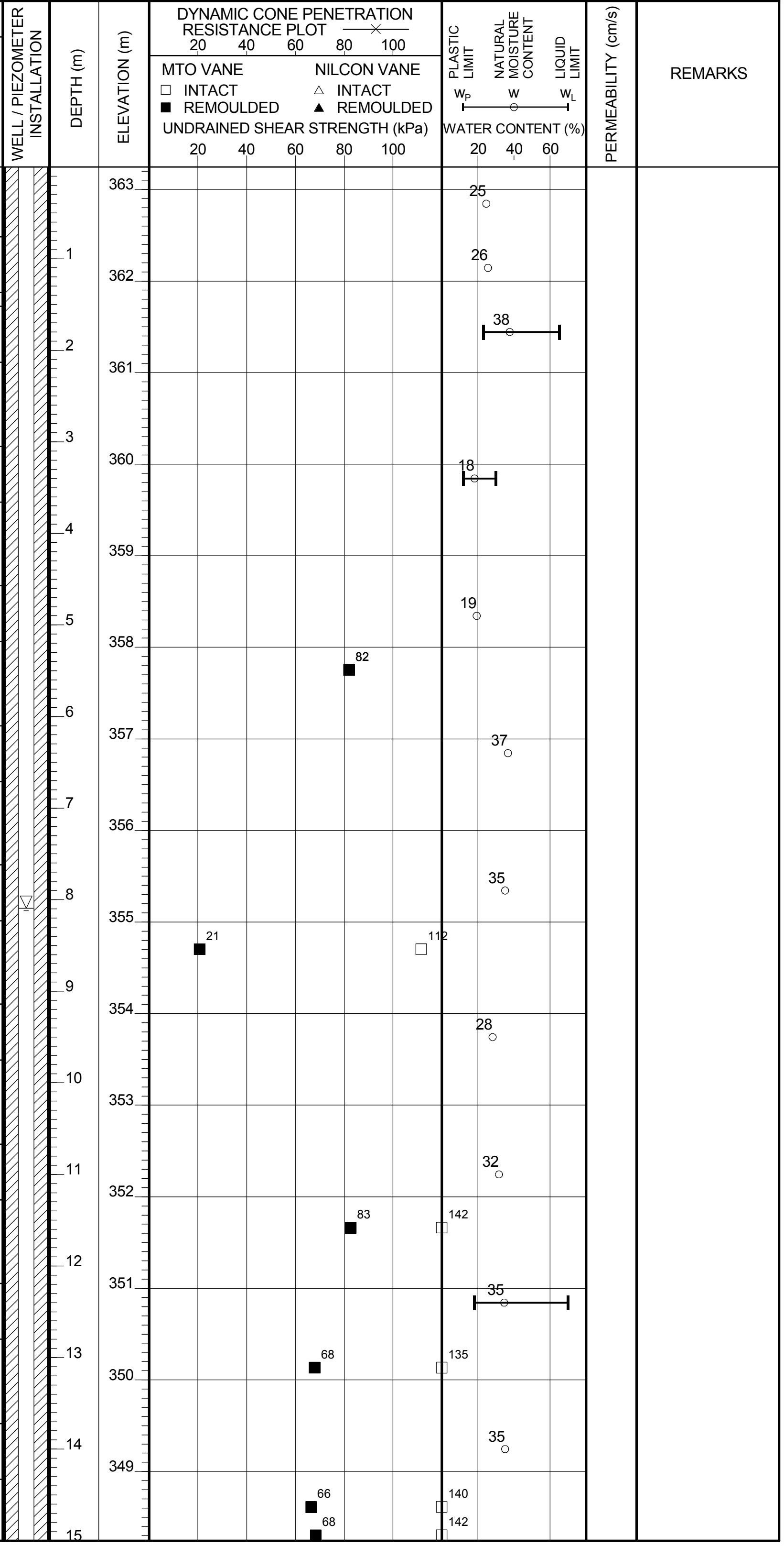
		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE

ELEV / DEPTH (m)	DESCRIPTION
363.2	Ground surface
363.1 0.0 0.2	**TOPSOIL** Dark brown topsoil
362.5 0.8	**Silty CLAY** Dark greyish brown silty clay, trace sand, trace roots
	Silty CLAY Grey silty clay, some sand, trace fine gravel, moist, firm, varved [Upper Glaciolacustrine]
	...occasional sand lenses
357.1 6.1	**Silty CLAY** Dark rey silty clay, trace fine gravel, moist, stiff, medium to high plasticity [WML Till]

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	BS		
2	SS	25	6
3	SS	79	12
6	SS	83	9
9	SS		6
12	SS	100	9
15	SS	100	9
18	SS	50	29
21	SS	100	17
24	SS	100	7
27	SS	100	8



Continued on Next Page

amec

RECORD OF BOREHOLE No. BBAF-BH-2069

PAGE 2 OF 2

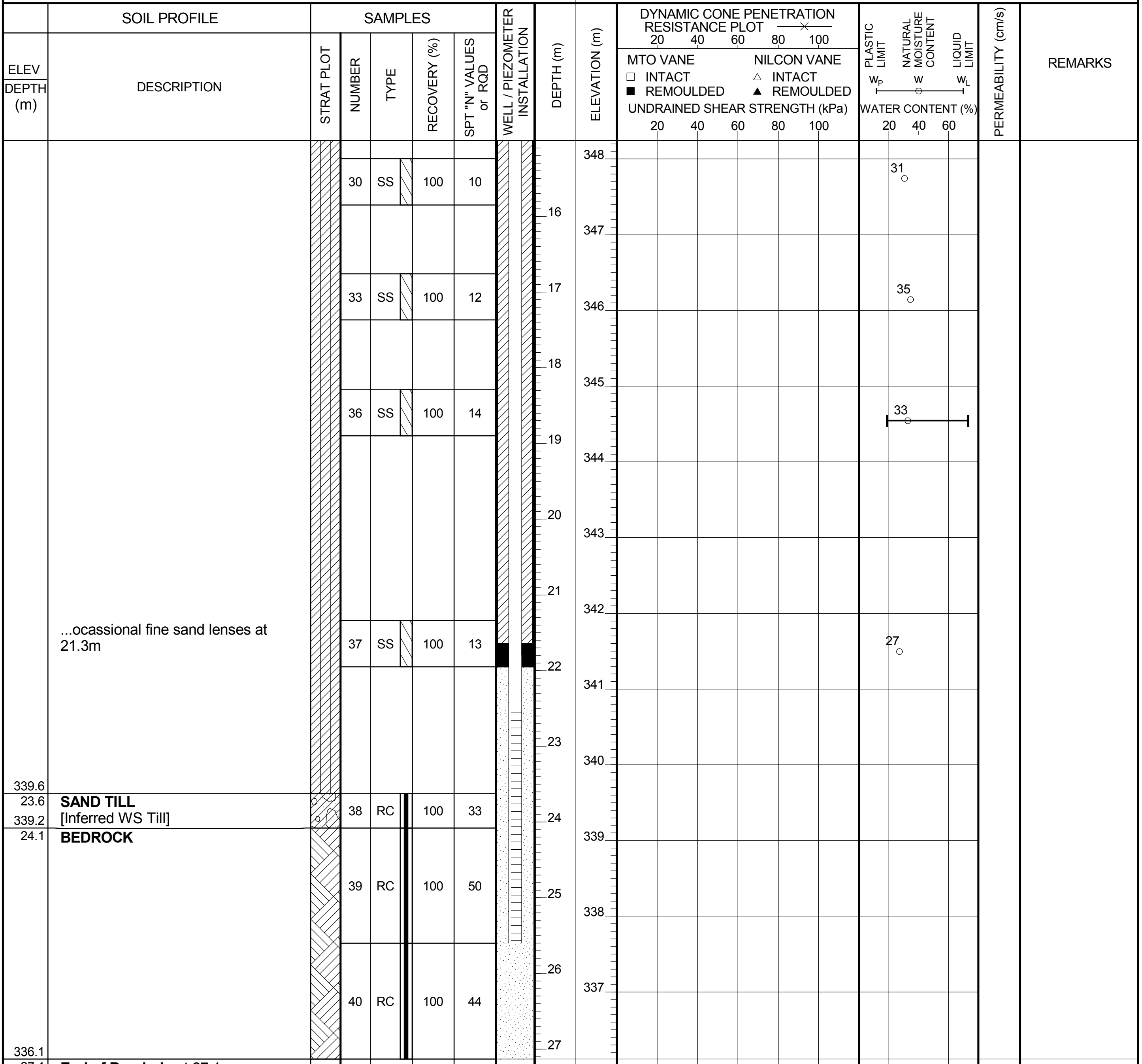
PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	DG
ELEVATION	363.244 m	COORD.	N 5,411,089 E 426,442	BORING DATE		CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis



ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WATER CONTENT (%)
		30	SS	100	10	31
		33	SS	100	12	35
		36	SS	100	14	33
	...ocassional fine sand lenses at 21.3m	37	SS	100	13	27
339.6 23.6	**SAND TILL** [Inferred WS Till]	38	RC	100	33	
339.2 24.1	**BEDROCK**	39	RC	100	50	
		40	RC	100	44	
336.1 27.1	**End of Borehole** at 27.1m Standpipe installed with 0.8m stick up Water level 8.0 m below ground surface on Sept. 15, 2012					

RECORD OF BOREHOLE No. BBAF-BH-2073

PAGE 1 OF 2

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	DG
ELEVATION	367.505 m	COORD.	N 5,411,158 E 426,547	BORING DATE	Start: Aug 15, 12 End: Aug 17, 12	CHECKED BY	DGR

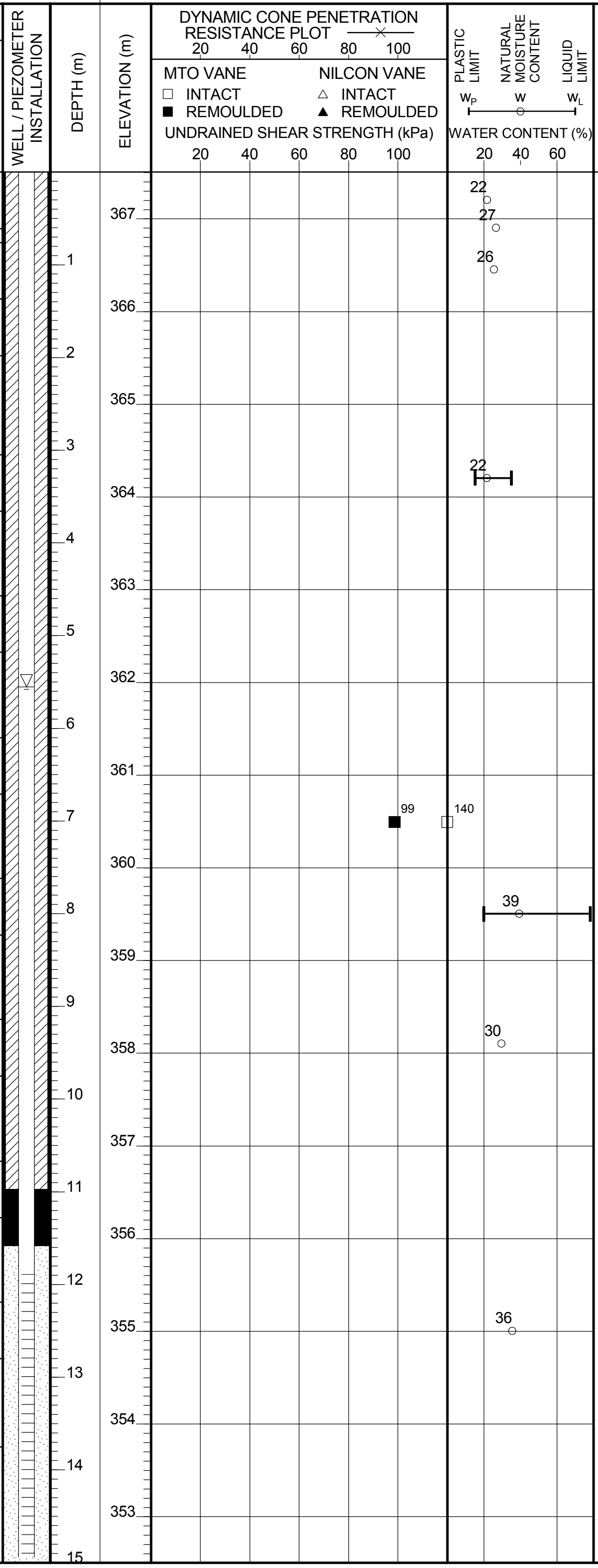
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV / DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
367.5	Ground surface					
0.0	**TOPSOIL**					
367.4 0.1	**Silty CLAY** Brown silty clay, trace gravel, occasional oxidized pockets, moist, varved, medium plasticity, stiff [Upper Glaciolacustrine]	1	SS	54	7	
		2	SS	66	15	
		3	TW	37		
		6	SS	100	11	
362.9 4.6	**Silty CLAY** Dark grey silty clay, moist, firm to stiff [WML Till]	9	TW	75		...at 4.6m PP=167.4 kPa TV=71.8 kPa
		12	TW	75		...at 6.1m PP=191.3 kPa TV=62.2 kPa
		15	SS	100	6	
		18	SS	100	8	
		21	TW	75		...at 10.7m PP=191.3 kPa TV=119.6 kPa
		24	SS	100	11	
353.8 13.7	**BEDROCK** Greenish grey, moderately fractured	28	RC	93	86	



Continued on Next Page

RECORD OF BOREHOLE No. BBAF-BH-2073

PAGE 2 OF 2

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	PDR
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	DG
ELEVATION	367.505 m	COORD.	N 5,411,158 E 426,547	BORING DATE	Start: Aug 15, 12 End: Aug 17, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE		SAMPLES								DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60		
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)			PERMEABILITY (cm/s)	REMARKS
			29	RC	93	84		16	352 351				
350.6 16.9	**End of Borehole** at 16.9m Stand pipe installed with 0.9m stick up Water level at 11 m below ground on Sept. 15, 2012												

RECORD OF BOREHOLE No. BBAF-BH-2076

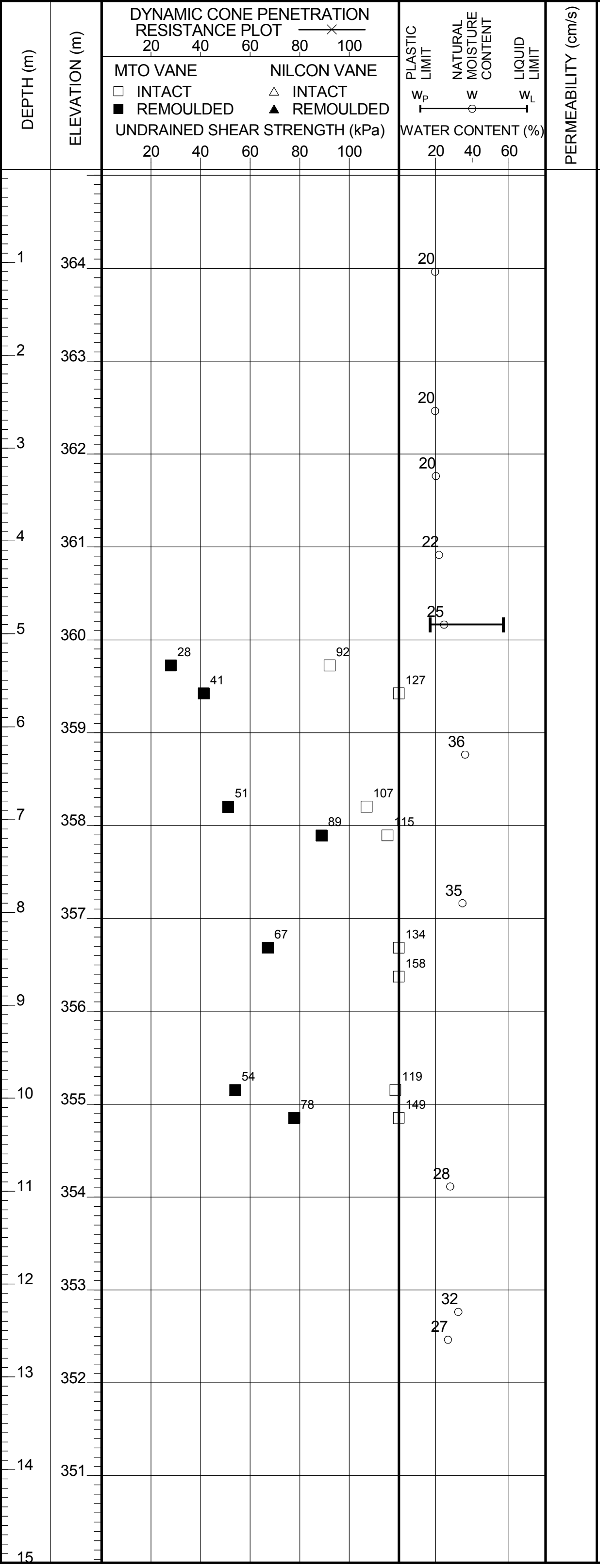
PAGE 1 OF 2

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	ARM
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	DG
ELEVATION	365.064 m	COORD.	N 5,410,335 E 426,698	BORING DATE	Start: Aug 26, 12 End: Aug 27, 12	CHECKED BY	DGR

SAMPLE TYPES
AU Auger
BU Bulk
DC Dynamic Cone
RC Rock Core
SS Split Spoon
TW Thin Walled Open (Shelby)
WS Wash Sample

ABBREVIATIONS
P.P. Pocket Penetrometer
TV Torvane
PT Standard Proctor Test
P.L. Point Load Strength Index (I_{50})
RQD Rock Quality Designation
SCR Solid Core Recovery
k Permeability
C Consolidation
DS Direct Shear
GS Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
365.1	Ground surface					
0.0	**Topsoil**	1	AS			...water flowing from installation
364.3 0.8	**Sandy SILT** Brown sandy silt, trace clay, varved, stiff [Upper Glaciolacustrine]	2	SS	54	15	
		3	TW	66		
362.8 2.3	**Silty CLAY** Dark brown silty clay, trace sand, trace gravel, stiff [WML Till]	4	SS	83	15	
		5	SS	100	16	
		6	SS	100	11	
		7	SS	100	6	
		10	SS	100	8	
		13	SS	100	10	
		14	TW	100		
		17	SS	100	10	
	...increased sand content, gravelly below 12.2m [Possible transition zone to WS Till]	18	SS	100	21	
						...SPt refusal at 13.7m
350.6 14.5	**COBBLES and BOULDERS** [Inferred WS Till]	19	RC	0		



Continued on Next Page

RECORD OF BOREHOLE No. BBAF-BH-2076

PAGE 2 OF 2

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY ARM
CLIENT Rainy River Resources.
LOCATION Plant Site Area
COMPILED BY DG
ELEVATION 365.064 m
COORD. N 5,410,335 E 426,698
BORING DATE Start: Aug 26, 12 End: Aug 27, 12
CHECKED BY DGR

SAMPLE TYPES				ABBREVIATIONS			
AU	Auger	RC	Rock Core	P.P.	Pocket Penetrometer	P.L.	Point Load Strength Index (I_{50})
BU	Bulk	SS	Split Spoon	TV	Torvane	RQD	Rock Quality Designation
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)	PT	Standard Proctor Test	SCR	Solid Core Recovery
		WS	Wash Sample			k	Permeability
				C	Consolidation	DS	Direct Shear
				GS	Grain Size Analysis		

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	DEPTH (m)	ELEVATION (m)	REMARKS
		20	RC	0		16	349	
348.6 16.5	**BEDROCK** ...subvertical fracture from 16.6m to 17.0m							
		21	RC	100	67	17	348	
						18	347	
		22	RC	100	90	19		
346.0 19.1	**End of Borehole** at 19.05m Standpipe installed with 0.9m stick up Artesian flow observed from the well on Sept. 15, 2012							

DYNAMIC CONE PENETRATION RESISTANCE PLOT —×— 20 40 60 80 100

MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

PERMEABILITY (cm/s)

RECORD OF BOREHOLE No. BH-4

PAGE 1 OF 2

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY AD
CLIENT Rainy River Resources.
LOCATION Plant Site Area
COMPILED BY DG
ELEVATION 369.078 m
COORD. N 5,410,181 E 426,759
BORING DATE Start: Oct 13, 12 End: Oct 14, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger
BU	Bulk
DC	Dynamic Cone
RC	Rock Core
SS	Split Spoon
TW	Thin Walled Open (Shelby)
WS	Wash Sample

ABBREVIATIONS

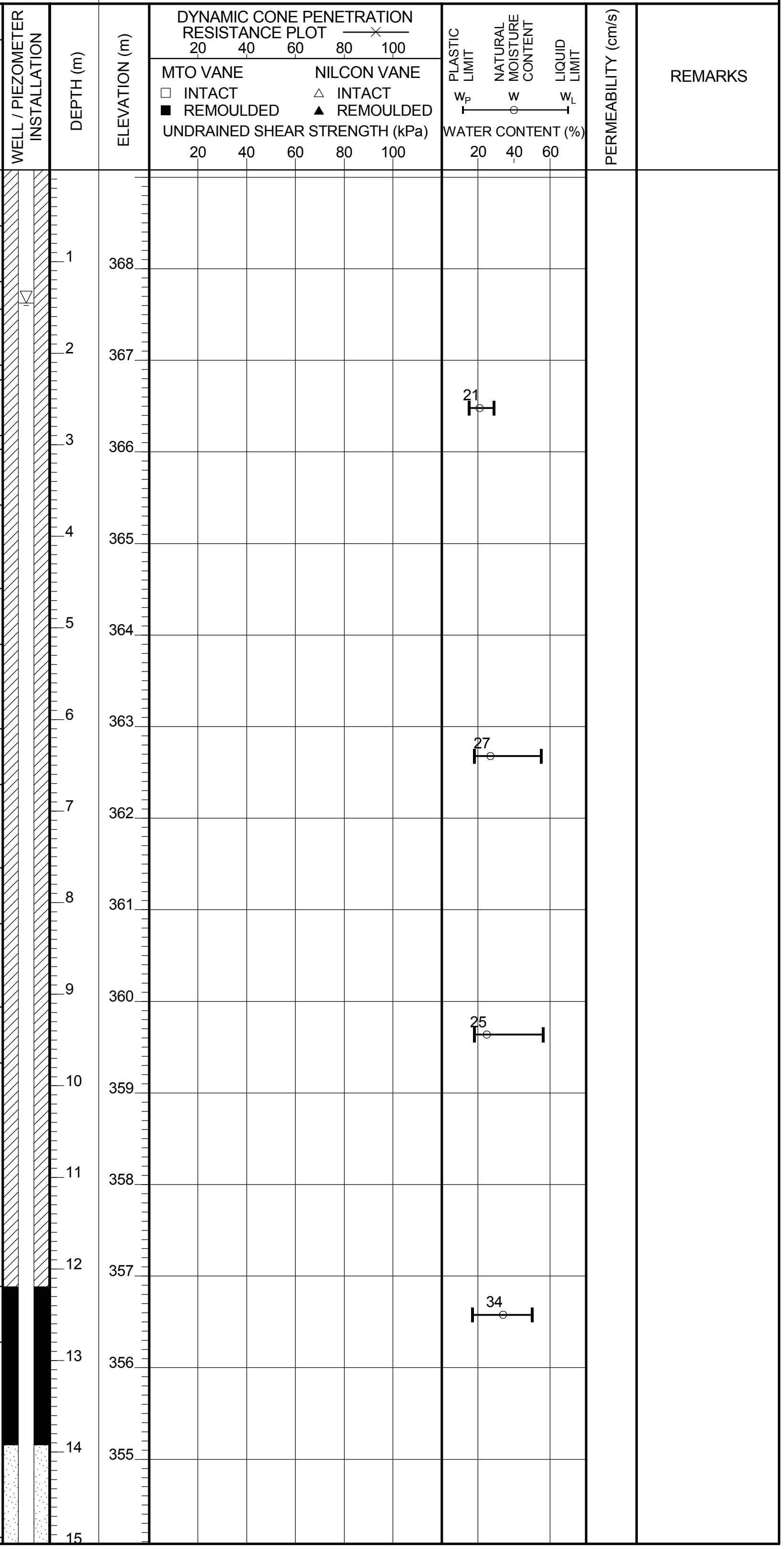
P.P.	Pocket Penetrometer
TV	Torvane
PT	Standard Proctor Test
P.L.	Point Load Strength Index (I_{50})
RQD	Rock Quality Designation
SCR	Solid Core Recovery
k	Permeability
C	Consolidation
DS	Direct Shear
GS	Grain Size Analysis

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
369.1	Ground surface
0.0	**PEAT** Black peat, fiberous, damp to moist, some rootlets
368.5 0.6	**Silty CLAY** Light brown silty clay, some sand, trace gravel, stiff, dry to damp, varved, occasional oxidized pockets [Upper Glaciolacustrine] ...trace sand, trace gravel, sand seams at 3.1m
364.5 4.6	**Silty CLAY** Dark grey silty clay, trace sand, trace gravel, firm, damp, medium plasticity [WML Till] ...becoming stiffer at 6.1m
356.9 12.2	**Silty CLAY** Dark grey silty clay, trace sand, trace gravel, varved, soft to firm, damp to moist [Lower Glaciolacustrine]
354.1	

SAMPLES

NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
1	SS	46	15
2	SS	100	13
3	SS	100	12
4	SS	100	11
5	SS	62	12
6	SS	100	9
7	SS	100	8
8	SS	100	10
9	SS	100	9



Continued on Next Page

RECORD OF BOREHOLE No. BH-4

PAGE 2 OF 2

PROJECT	Rainy River Gold Project			ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD 200 mm HSA, NQ Coring	LOGGED BY AD
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area		COMPILED BY DG
ELEVATION	369.078 m	COORD.	N 5,410,181 E 426,759	BORING DATE Start: Oct 13, 12 End: Oct 14, 12	CHECKED BY DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

SOIL PROFILE		SAMPLES											
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	DEPTH (m)	ELEVATION (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 MTO VANE ☐ INTACT ■ REMOULDED NILCON VANE △ INTACT ▲ REMOULDED UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT w LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	PERMEABILITY (cm/s)	REMARKS
14.9	**Silty SAND** Coarse grained silty sand, some silt, wet [WS Till] ...boulders and cobbles below 15.5m		10	SS	100								...heaving sand at 14.9m
			11	RC	52	0		16	353				
352.3			12	RC	71	0							
16.7	**BEDROCK** Grey bedrock		13	RC	100	68		17	352				
			14	RC	92	28		18	351				
			15	RC	100	75		19	350				
349.1			16	RC	100	80							
19.9	**End of Borehole** at 19.9m Standpipe installed with flush-mounted steel casing Water level at 1.4m below ground surface upon completion												

amec

RECORD OF BOREHOLE No. BH-5

PAGE 1 OF 1

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	DG
ELEVATION	370.995 m	COORD.	N 5,410,210 E 426,804	BORING DATE	Start: Oct 11, 12 End: Oct 12, 12	CHECKED BY	DGR

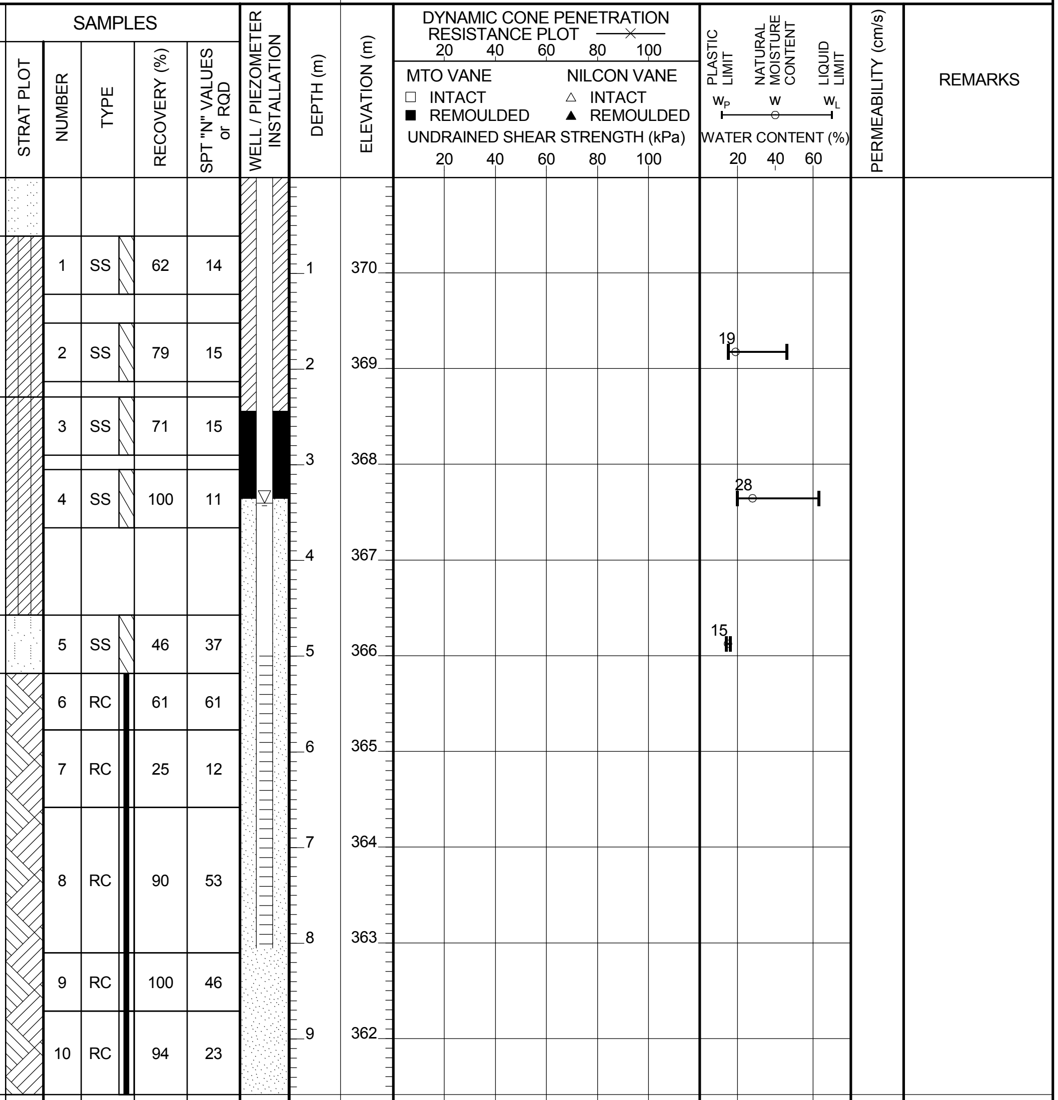
SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD
371.0	Ground surface				
0.0	**Topsoil**				
370.4 0.6	**Silty CLAY** Brown silty clay, some sand, some gravel, varved, stiff, damp [Upper Glaciolacustrine]	1	SS	62	14
		2	SS	79	15
368.7 2.3	**Silty CLAY** Dark brown silty clay, trace sand, trave gravel, stiff, damp [WML Till]	3	SS	71	15
		4	SS	100	11
366.4 4.6	**Silty SAND** Grey silt and sand, trace gravel, varved, firm, moist, wet [Lower Glaciolacustrine] ...cobbles at 5.1m	5	SS	46	37
365.8 5.2	**BEDROCK** Grey to black bedrock	6	RC	61	61
		7	RC	25	12
		8	RC	90	53
		9	RC	100	46
		10	RC	94	23
361.4 9.6	**End of Borehole** at 9.6m Standpipe installed with 0.9m stick up Water level at 3.4 m below ground surface upon completion				



RECORD OF BOREHOLE No. BH-7

PAGE 1 OF 2

PROJECT	Rainy River Gold Project					ENGINEER	MS
PROJECT NO.	TC113921	DRILLER	Marathon Drilling	BORING METHOD	200 mm HSA, NQ Coring	LOGGED BY	AD
CLIENT	Rainy River Resources.	LOCATION	Plant Site Area			COMPILED BY	DG
ELEVATION	369.494 m	COORD.	N 5,410,185 E 426,807	BORING DATE	Start: Oct 12, 12 End: Oct 13, 12	CHECKED BY	DGR

SAMPLE TYPES

AU	Auger	RC	Rock Core
BU	Bulk	SS	Split Spoon
DC	Dynamic Cone	TW	Thin Walled Open (Shelby)
		WS	Wash Sample

ABBREVIATIONS

		P.L.	Point Load Strength Index (I_{50})		
P.P.	Pocket Penetrometer	RQD	Rock Quality Designation	C	Consolidation
TV	Torvane	SCR	Solid Core Recovery	DS	Direct Shear
PT	Standard Proctor Test	k	Permeability	GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
MTO VANE: ☐ INTACT, ■ REMOULDED; NILCON VANE: △ INTACT, ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L — WATER CONTENT (%) 20 40 60
PERMEABILITY (cm/s)

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	WELL / PIEZOMETER INSTALLATION	WATER CONTENT (%)	REMARKS
369.5	Ground surface							
0.0	**TOPSOIL**							
368.9 0.6	**Silty CLAY** Brown silty clay, some sand, trace gravel, occasional light grey silt pockets, firm to stiff, dry to damp, trace organics [Upper Glaciolacustrine]	1	SS	67	13			
		2	SS	87	16		16	
	...occasional sand seams below 2.4m	3	SS	100	14			
		4	SS	100	9	▽		
364.9 4.6	**Silty CLAY** Dark grey silty clay, trace sand, trace gravel, stiff, high plasticity, becoming varved, more silty, soft to firm, damp, below 4.83m	5	SS	100	11		19	
363.4 6.1	**Silty CLAY** Dark grey silty clay, trave gravel, firm to stiff, damp, medium to high plasticity [WML Till]	6	SS	100	13			
		7	SS	100	13			
		8	SS	100	14		23	
357.3 12.2	**Silty CLAY** Dark brown silty clay, trace sand, trace gravel, varved, occasional brown silty sand pockets, soft to firm, damp [Lower Glaciolacustrine]	9	SS	100	11		27	

Continued on Next Page

RECORD OF BOREHOLE No. BH-7

PAGE 2 OF 2

PROJECT Rainy River Gold Project
ENGINEER MS
PROJECT NO. TC113921
DRILLER Marathon Drilling
BORING METHOD 200 mm HSA, NQ Coring
LOGGED BY AD
CLIENT Rainy River Resources.
LOCATION Plant Site Area
COMPILED BY DG
ELEVATION 369.494 m
COORD. N 5,410,185 E 426,807
BORING DATE Start: Oct 12, 12 End: Oct 13, 12
CHECKED BY DGR

SAMPLE TYPES

AU	Auger
BU	Bulk
DC	Dynamic Cone
RC	Rock Core
SS	Split Spoon
TW	Thin Walled Open (Shelby)
WS	Wash Sample

ABBREVIATIONS

P.P.	Pocket Penetrometer
TV	Torvane
PT	Standard Proctor Test
P.L.	Point Load Strength Index (I_{50})
RQD	Rock Quality Designation
SCR	Solid Core Recovery
k	Permeability
C	Consolidation
DS	Direct Shear
GS	Grain Size Analysis

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

MTO VANE ☐ INTACT ■ REMOULDED
NILCON VANE △ INTACT ▲ REMOULDED
UNDRAINED SHEAR STRENGTH (kPa) 20 40 60 80 100

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

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	RECOVERY (%)	SPT "N" VALUES or RQD	REMARKS
354.3						
15.2	**BOULDERS** [Inferred WS Till]	10	RC	42	0	
		11	RC	47	0	
352.9 16.6	**BEDROCK** Grey to black bedrock, fractured	12	RC	100	83	
	...vertical fracture from 18.3m to the end of the core	13	RC	100	80	Vertical fracture running from 18.3m to the end of borehole at 20.0m
		14	RC	100	46	
349.5 20.0	**End of Borehole** at 20.02m Standpipe installed with 0.9m stickup Water level 3.4m below ground surface upon completion					

DEPTH (m): 16, 17, 18, 19, 20
ELEVATION (m): 354, 353, 352, 351, 350

APPENDIX B

SLUG TESTING RESULTS FOR OVERBURDEN AND SHALLOW BEDROCK

Table B-1 Summary Details of AMEC Slug Testing in Overburden and Shallow Bedrock

Borehole ID	Screen		Date of Test	Data Type	Screen and Sand Pack Lithology	Hydraulic Conductivity (m/s)	Method	Comments	Strat Unit*	Hydrostrat Unit**
	Top (mbgs)	Bottom (mbgs)								
BH11-04	13.4	16.5	June 8-9, 2012	Transducer	Highly Weathered/Fractured Bedrock. Sand pack extends into gravel till	4.0E-07	Bouwer-Rice Confined		BR	SBR
BH11-08A	24.0	25.5	June 16, 2012	Flow Measurement	Bedrock	2.6E-06	Constant Head	Flowing Artesian	BR	SBR
BH11-08B	19.8	21.3	June 16, 2012	Flow Measurement	Gravelly Till	1.6E-06	Constant Head	Flowing Artesian	WS	PLGD
BH11-08C	4.6	6.1	---	---	Silty Clay Till	---	---	Well Blocked; Silted in	WML	PA
BH11-09	4.6	6.1	June 11, 2012	Transducer	Silty Clay Till	5.0E-07	Bouwer-Rice Unconfined	Sand and Gravel layer between 4.64 and 4.8	WML	PA
BH11-11A	36.3	37.8	June 10, 2012	Transducer	Bedrock	2.8E-07	Bouwer-Rice Confined		BR	SBR
BH11-11B	32.8	34.3	June 10, 2012	Transducer	Silty Sand Till over bedrock	2.7E-06	Bouwer-Rice Confined	Test repeated twice	WS	PLGD
BH11-11C	6.1	7.6	June 10, 2012	Transducer	Silty Sand (Glacial Sand)	1.4E-06	Bouwer-Rice Unconfined	Test repeated twice	GS	NSS
BH11-12A	22.5	27.0	June 12, 2012	Transducer	Highly Weathered/Fractured Bedrock	1.7E-05	Bouwer-Rice Confined	Noisy data; possible underdamped response.	BR	SBR
BH11-12B	4.6	6.1	June 12-13, 2012	Transducer	Silty Clay Till	1.1E-08	Bouwer-Rice Unconfined		WML	PA
BH11-13A	19.8	22.8	---	---	Glaciolacustrine Sandy Silt / Bedrock	---	---	Not Assessed	BR/GL	SBR
BH11-13B	13.4	14.9	June 15, 2012	Flow Measurement	Silty Clay Till	3.7E-07	Constant Head	Flowing Artesian	WML	PA
BH11-17	10.7	12.2	June 9-10, 2012	Transducer	Silty Clay Till	1.3E-07	Bouwer-Rice Confined		WML	PA
BH11-18A	41.8	43.4	---	---	Bedrock	---	---	Well was inaccessible	BR	SBR
BH11-18B	24.4	25.9	---	---	Gravely Till	---	---	Well was inaccessible	WS	PLGD
BH11-18C	9.1	10.7	---	---	Silty Clay Till	---	---	Well was inaccessible	WML	PA
BH11-19A	28.5	30.1	June 13, 2012	Transducer	Bedrock	Highly Conductive	---	Fast response could not be analysed	BR	SBR
BH11-19C	4.6	6.1	June 13, 2012	Transducer	Silty Clay Till	1.9E-07	Bouwer-Rice Unconfined		WML	PA
BH11-20A	25.0	26.5	---	---	Glaciolacustrine Silty Clay / Gravely Till	---	---	Flowing artesian; head above surface not great enough conduct a constant head test	WS/GL	PLGD
BH11-21A	37.8	39.3	June 14, 2012	Flow Measurement	Highly Weathered / Fractured Bedrock	1.4E-07	Constant Head	Flowing Artesian	BR	SBR
BH11-21B	16.8	18.3	June 13, 2012	Transducer	Silty Clay Till	2.3E-08	Bouwer-Rice Unconfined		WML	PA
BH11-21C	7.6	9.1	June 13, 2012	Transducer	Silty Clay Till	8.6E-10	Bouwer-Rice Unconfined		WML	PA
BH11-22	20.0	21.5	June 14, 2012	Transducer	Bedrock	3.7E-06	Bouwer-Rice Unconfined	Test repeated twice	BR	SBR
BH11-23A	36.3	37.8	June 14, 2012	Manual and	Silty Sandy Gravel Till	3.2E-05	Bouwer-Rice Confined	Test repeated twice	WS	PLGD
BH11-24A	18.3	22.8	June 8, 2012	Manual	Bedrock (Top of screen in Silty Clay Till and Glaciolacustrine Clay)	1.3E-06	Bouwer-Rice Confined		BR/GL	SBR
BH11-24B	10.7	12.2	June 8-9, 2012	Transducer	Silty Clay Till	1.8E-05	Bouwer-Rice Confined	Test repeated twice; results suggest a seam of coarser material in the silty clay	WML	PA
BH11-25	23.6	25.1	June 15, 2012	Transducer	Gravely Till	1.0E-04	Bouwer-Rice Confined		WS	PLGD
BH11-27	25.9	28.9	June 8-9, 2012	Transducer	Sandy Gravel and Silt Till over Fractured Bedrock	3.6E-06	Bouwer-Rice Confined		BR/WS	PLGD
BH11-28	15.2	16.7	---	---	Silty Clay Till	---	---		WML	PA
BH11-29	24.4	25.9	June 15, 2012	Manual	Silty Clay Till	3.0E-08	Bouwer-Rice Unconfined		WML	PA
BH11-33A	42.4	43.9	June 14, 2012	Flow Measurement	Highly Weathered Bedrock	6.9E-07	Constant Head	Flowing Artesian	BR	SBR
BH11-33B	12.2	13.7	June 14, 2012	Manual	Silty Clay Till	2.7E-08	Bouwer-Rice Unconfined		WML	PA
BH11-34A	35.1	36.6	June 14, 2012	Flow Measurement	Highly Fractured Bedrock	8.2E-06	Constant Head	Flowing Artesian	BR	SBR
BH11-34B	9.2	10.6	---	---	Silty Clay Till	---	---	Well blocked	WML	PLGD
BH11-35	11.8	13.3	June 11-13, 2012	Transducer	Bedrock	3.2E-10	Bouwer-Rice Confined		BR	SBR
BH11-36	5.2	6.7	---	---	Sand Till over Highly Fractured Bedrock	---	---	Dry	BR/WS	PLGD
BH11-38	19.2	20.7	June 12, 2012	Transducer	Gravelly Till	Highly Conductive	---	Fast response could not be analysed	WS	PLGD
BH11-39	2.7	4.3	---	---	Fractured Bedrock	---	---	Inaccessible.	BR	SBR
BH11-40	10.0	11.6	June 10, 2012	Transducer	Boulders over Bedrock	5.9E-06	Bouwer-Rice Confined		BR	SBR
BH11-41	14.8	16.3	---	---	Sandy Till	---	---	Not Assessed	WS	PLGD
BH11-44A	16.2	17.7	---	---	Highly Fractured Bedrock	Highly Conductive	---	Fast response could not be analysed	BR	SBR

Borehole ID	Screen		Date of Test	Data Type	Screen and Sand Pack Lithology	Hydraulic Conductivity (m/s)	Method	Comments	Strat Unit*	Hydrostrat Unit**
	Top (mbgs)	Bottom (mbgs)								
BH11-50A	11.9	12.4	June 8, 2012	Manual	Bedrock	1.8E-11	Bouwer-Rice Confined		BR	SBR
BH11-51A	17.4	18.9	June 14, 2012	Flow Measurement	Glaciolacustrine Silty Clay over Highly Weathered/Fractured Bedrock	1.7E-05	Constant Head	Flowing Artesian	BR/GL	SBR
BH11-51B	10.7	12.2	---	---	Silty Clay Till	---	---	Under ponded water surface	WML	PA

*** Interpreted stratigraphic units for the piezometer interval**

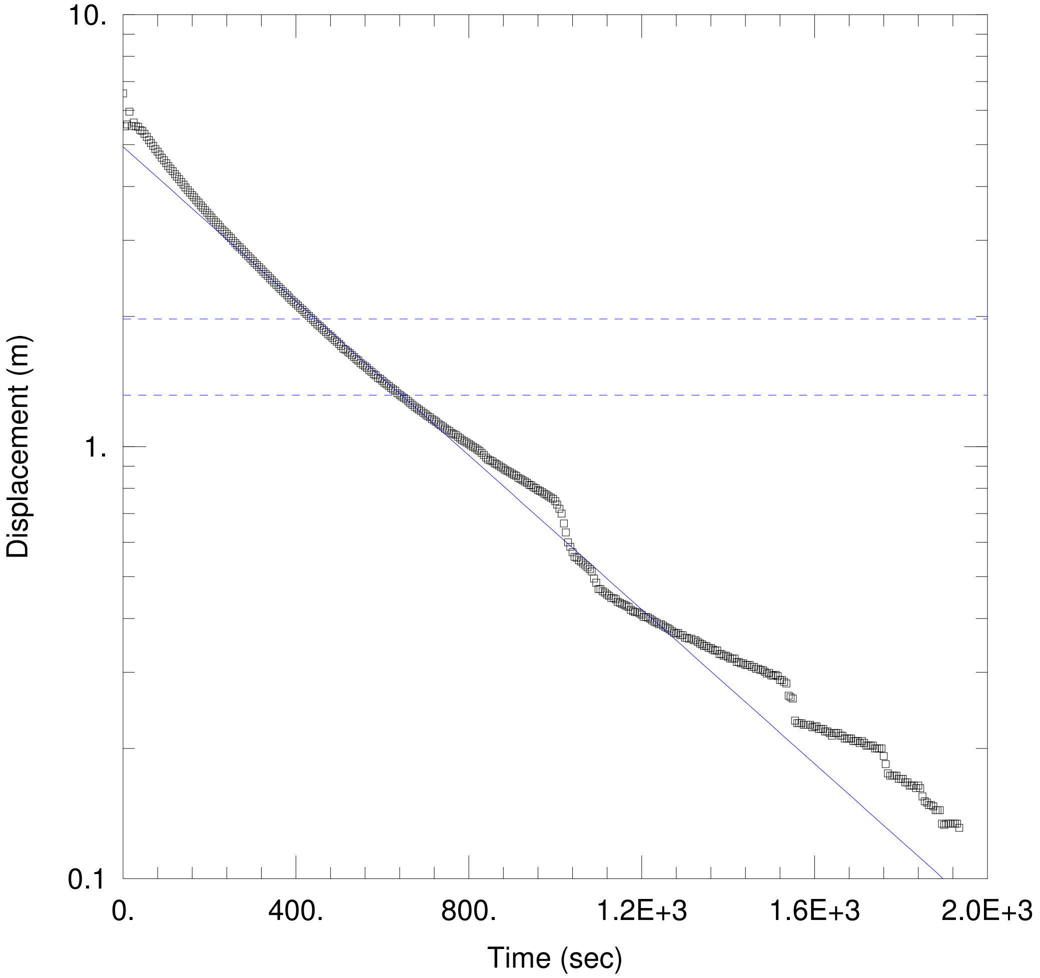
GL = Glaciolacustrine sediments, either from the Wylie or the Brenna Formations
GS = Glacial sand, most likely from the Brenna Formation
WML = Whitelake Mouth Till
WS = Whiteshell Till
BR = Bedrock

**** Hydrostratigraphic units for which the groundwater conditions at the piezometer interval are considered representative**

NSS = Near-surface system
PA = Pleistocene aquitard (in this case all Whitemouth Lake Till)
PLGD = Pleistocene lower granular deposits; in this case all Whiteshell Till, with the exception of BH11-21A which is interpreted as glacial sand; always assumed to be more dominant than shallow bedrock, when screen overlaps both
SBR = Shallow Bedrock

Table B-2 Summary Data from Flow and Head Measurements on Artesian Wells

Borehole	Field Measured Flowrate	Calculated Flowrate (L/min)	Static Water Level Above Ground surface (m)	Height of Discharge Point Above Ground Surface (m)
8A	5.7 L / 10.5 min	0.543	1.6	0.22
8B	0.46 L / 8 min	0.058	0.3	0.07
13 B	0.79 L / 8 min	0.099	1.38	0.09
21 A	0.2 L / 6 min	0.033	1.68	0.1
33 A	0.23 L / 3 min	0.077	0.87	0.2
33 A	0.99 L / 14.5 min	0.068	0.87	0.2
33 A	0.90 L / 13 min	0.069	0.87	0.2
51	1 L / 4.83 min	3.000	1.16	0
34	0.72 L / 2.38 min	0.303	0.54	0.3



BH11-04

Data Set: \...\BH11-04.aqt
Date: 10/18/12 Time: 13:27:02

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-04
Test Date: 09-Jun-12

AQUIFER DATA

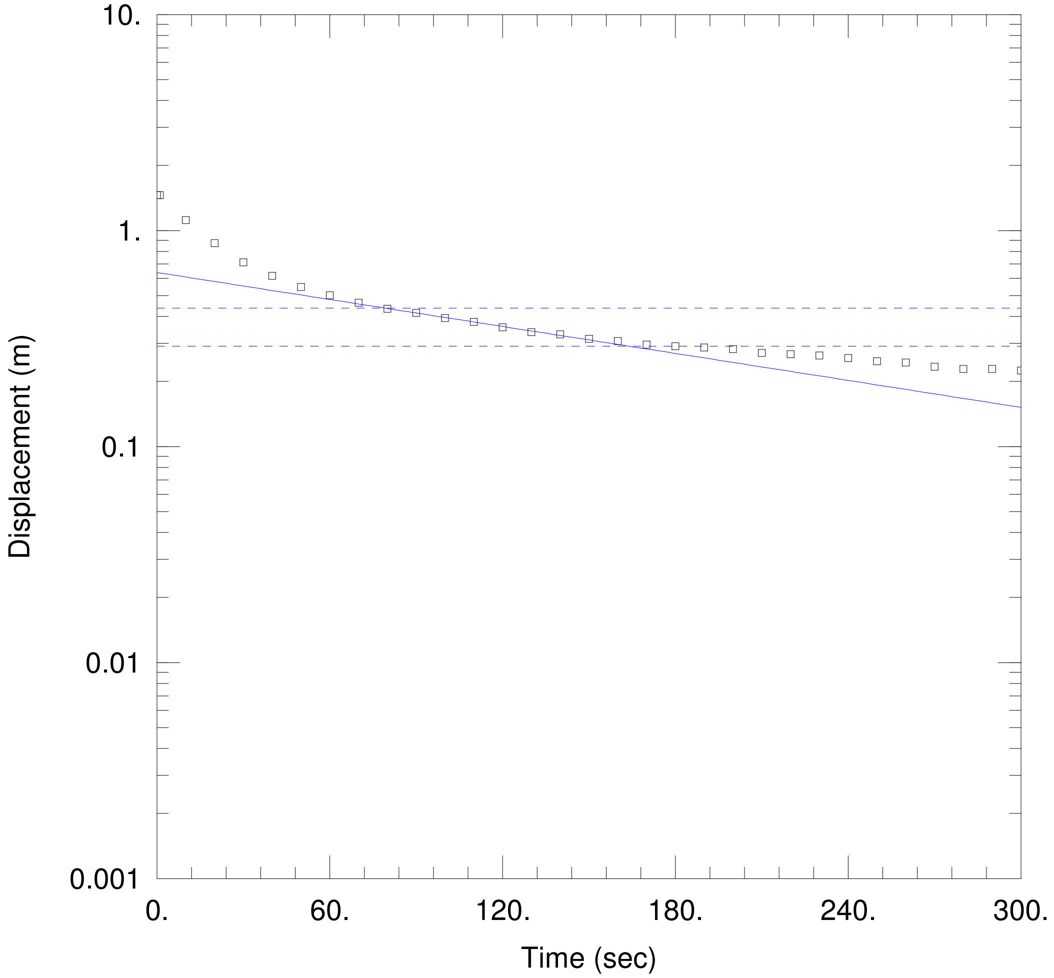
Saturated Thickness: 7.4 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-04)

Initial Displacement: 6.573 m
Static Water Column Height: 11.85 m
Total Well Penetration Depth: 7.4 m
Screen Length: 3.1 m
Casing Radius: 0.0176 m
Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 4.04E-7 m/sec
y0 = 4.941 m



BH11-09

Data Set: \...\BH11-09.aqt

Date: 10/18/12 Time: 13:28:27

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-09
Test Date: 11-Jun-12

AQUIFER DATA

Saturated Thickness: 28.2 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-09)

Initial Displacement: 1.458 m
Total Well Penetration Depth: 6. m
Casing Radius: 0.0127 m
Static Water Column Height: 28.2 m
Screen Length: 1.5 m
Well Radius: 0.1 m

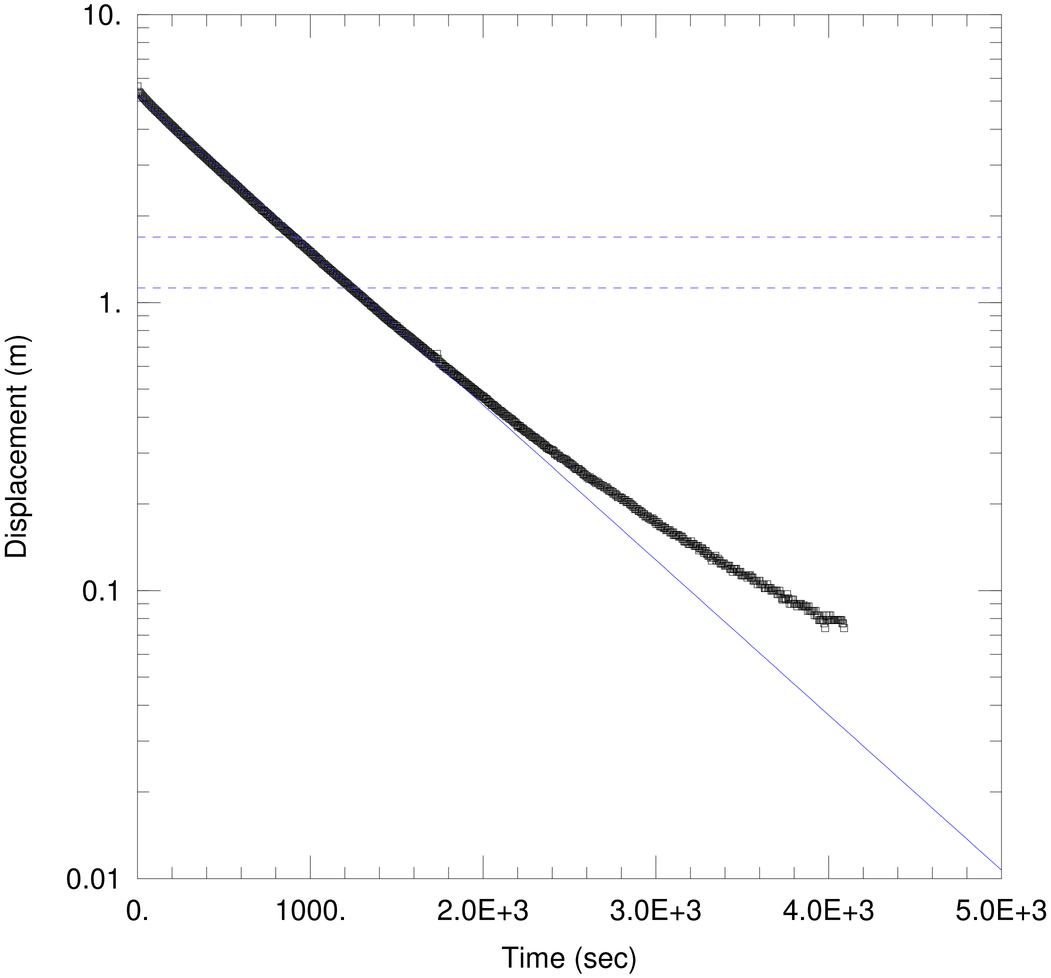
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 5.035E-7 m/sec

y0 = 0.6392 m



BH11-11A

Data Set: \...\BH11-11A.aqt
Date: 10/18/12 Time: 13:29:06

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-11A
Test Date: 10-Jun-12

AQUIFER DATA

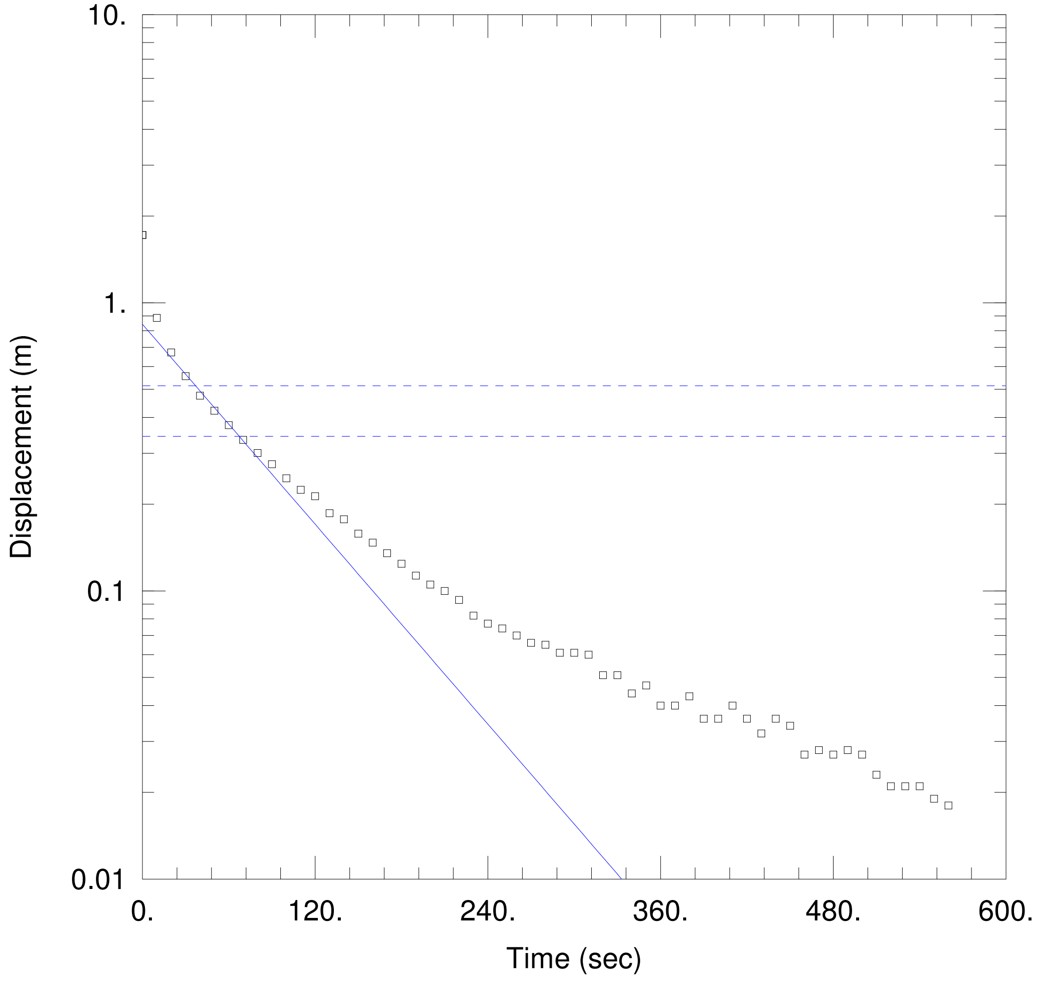
Saturated Thickness: 14.9 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-11A)

Initial Displacement: 5.624 m
Static Water Column Height: 32.39 m
Total Well Penetration Depth: 14.9 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 2.757E-7 m/sec
y0 = 5.262 m



BH11-11B

Data Set: \...\BH11-11B(1).aqt
Date: 10/18/12 Time: 13:29:55

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-11B
Test Date: 10-Jun-12

AQUIFER DATA

Saturated Thickness: 11.4 m Anisotropy Ratio (Kz/Kr): 1.

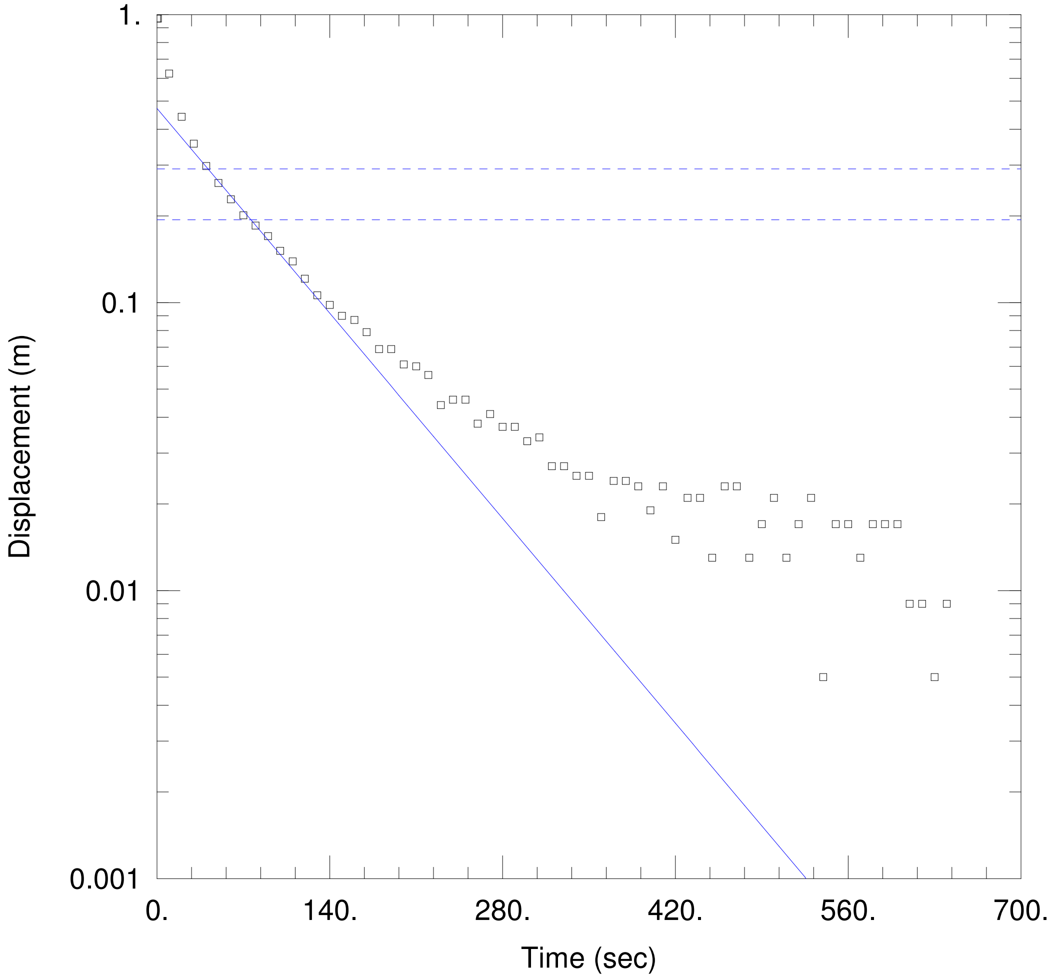
WELL DATA (BH11-11B)

Initial Displacement: 1.718 m Static Water Column Height: 28.89 m
Total Well Penetration Depth: 11.4 m Screen Length: 1.5 m
Casing Radius: 0.0127 m Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 2.859E-6 m/sec y0 = 0.8414 m



BH11-11B

Data Set: \...\BH11-11B(2).aqt
Date: 10/18/12 Time: 13:30:46

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-11B
Test Date: 10-Jun-12

AQUIFER DATA

Saturated Thickness: 11.4 m
Anisotropy Ratio (Kz/Kr): 1.

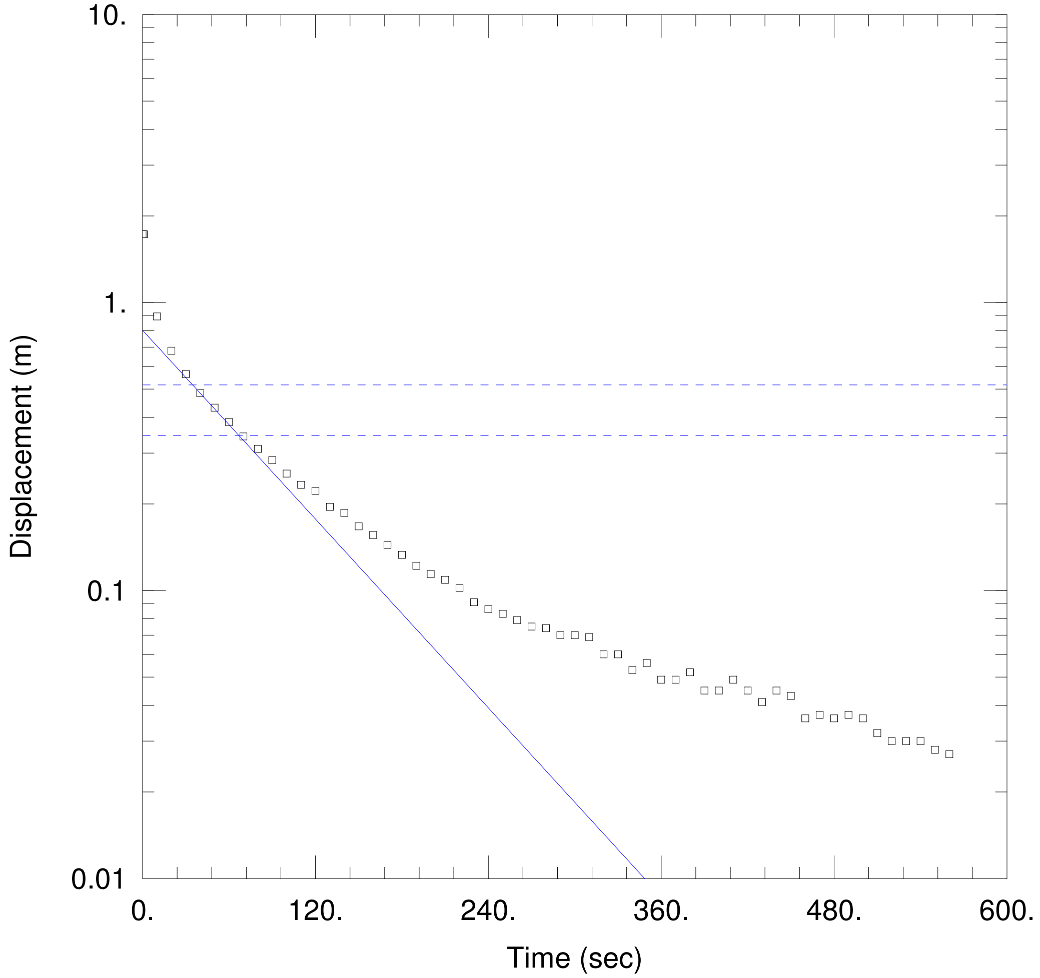
WELL DATA (BH11-11B)

Initial Displacement: 0.969 m
Total Well Penetration Depth: 11.4 m
Casing Radius: 0.0127 m
Static Water Column Height: 28.89 m
Screen Length: 1.5 m
Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.514E-6 m/sec
y0 = 0.4723 m



BH11-11C(1)

Data Set: \...\BH11-11C(1).aqt
Date: 10/18/12
Time: 14:10:45

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-11C
Test Date: 10-Jun-12

AQUIFER DATA

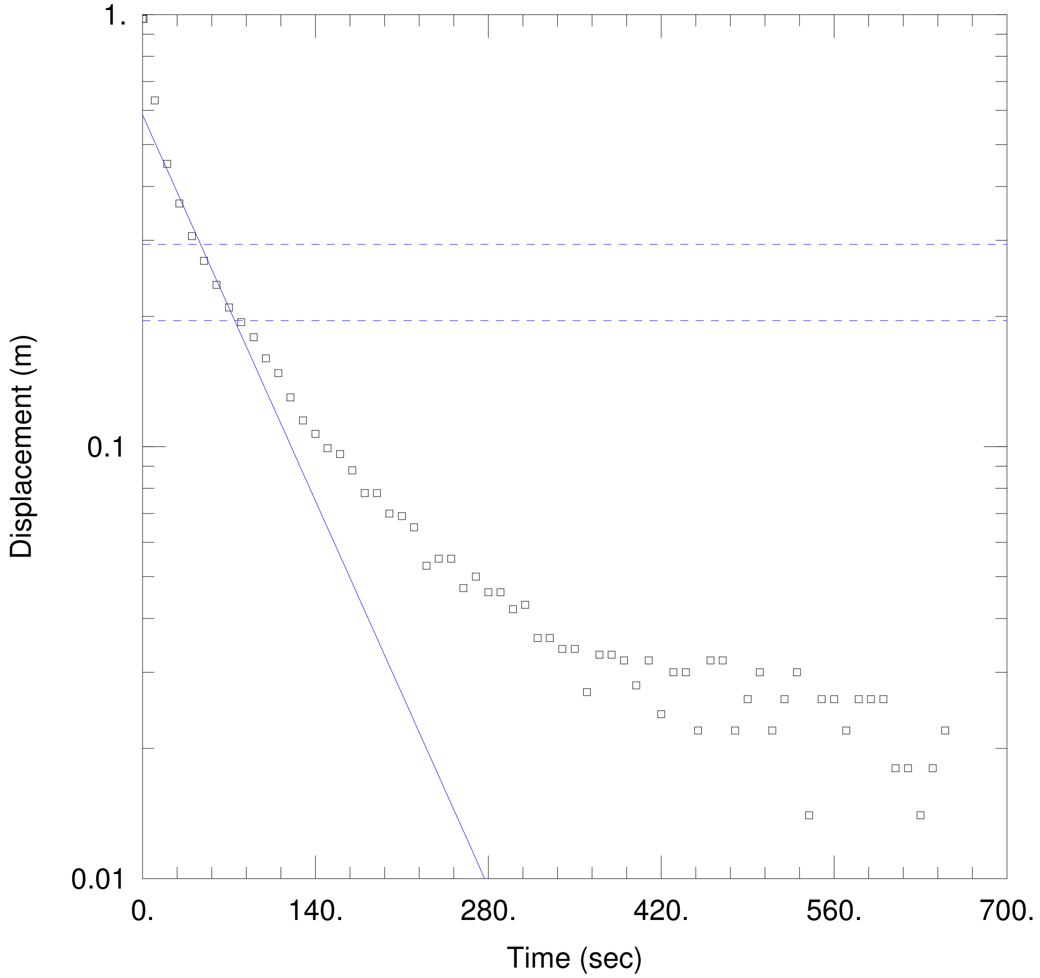
Saturated Thickness: 12.54 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-11C(1))

Initial Displacement: 1.727 m
Static Water Column Height: 12.54 m
Total Well Penetration Depth: 3.39 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.258E-6 m/sec
y0 = 0.8008 m



BH11-11C(2)

Data Set: \...\BH11-11C(2).aqt
Date: 10/18/12
Time: 14:11:09

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-11C
Test Date: 10-Jun-12

AQUIFER DATA

Saturated Thickness: 12.54 m
Anisotropy Ratio (Kz/Kr): 1.

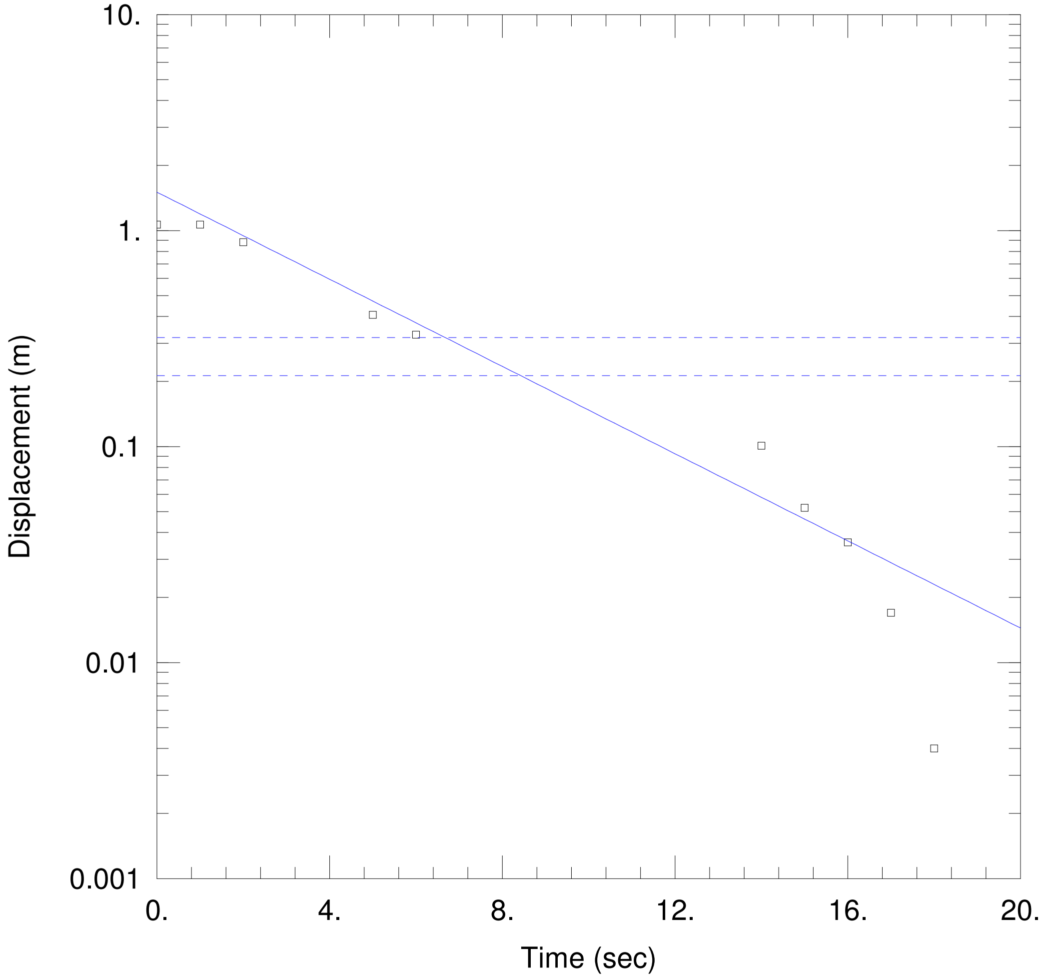
WELL DATA (BH11-11C(2))

Initial Displacement: 0.978 m
Total Well Penetration Depth: 3.39 m
Casing Radius: 0.0127 m
Static Water Column Height: 12.54 m
Screen Length: 1.5 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.469E-6 m/sec
y0 = 0.5854 m



BH11-12A

Data Set: \...\BH11-12A(Transducer).aqt
Date: 10/18/12 Time: 14:00:17

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-12A
Test Date: 12 Jun 2012

AQUIFER DATA

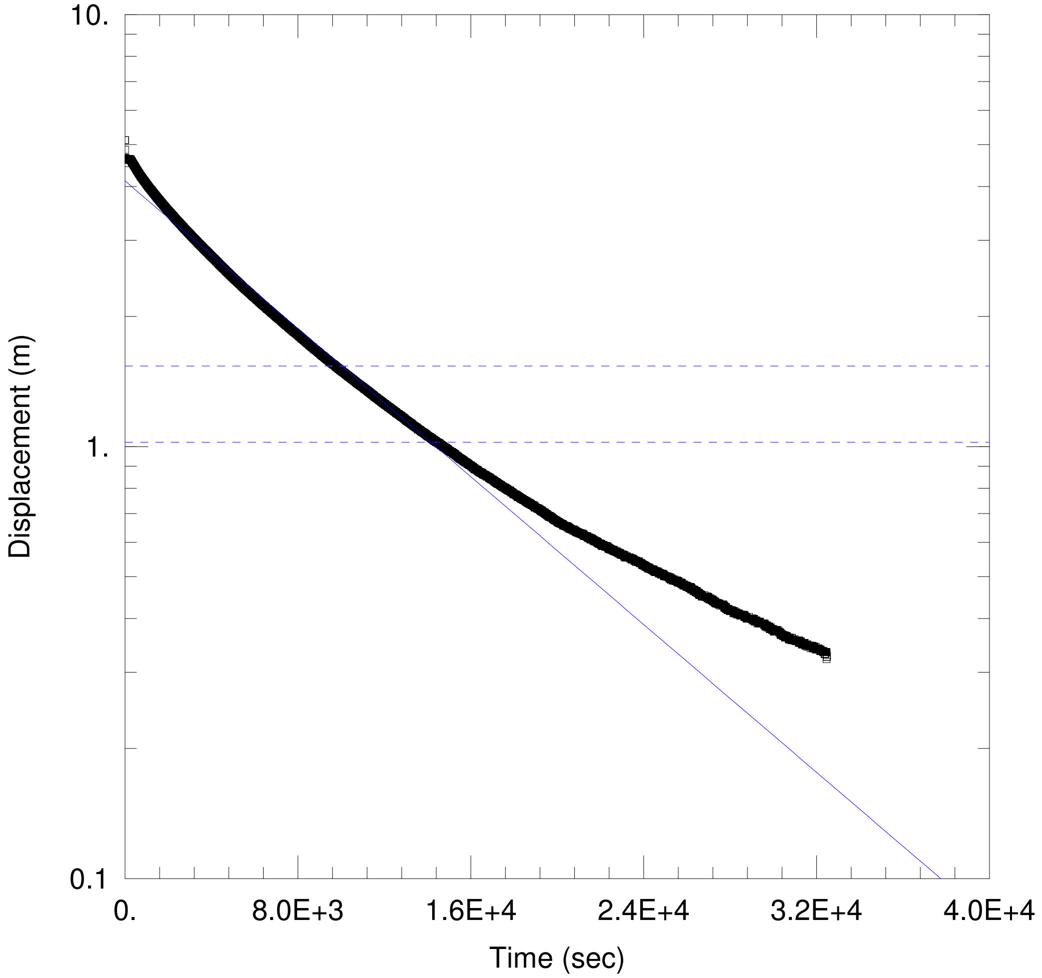
Saturated Thickness: 7.2 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-12A)

Initial Displacement: 1.066 m
Static Water Column Height: 25.74 m
Total Well Penetration Depth: 7.2 m
Screen Length: 4.5 m
Casing Radius: 0.0127 m
Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.659E-5 m/sec
y0 = 1.506 m



BH11-12B

Data Set: \...\BH11-12B.aqt
Date: 10/18/12 Time: 14:16:15

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-12B
Test Date: 12/13 Jun 2012

AQUIFER DATA

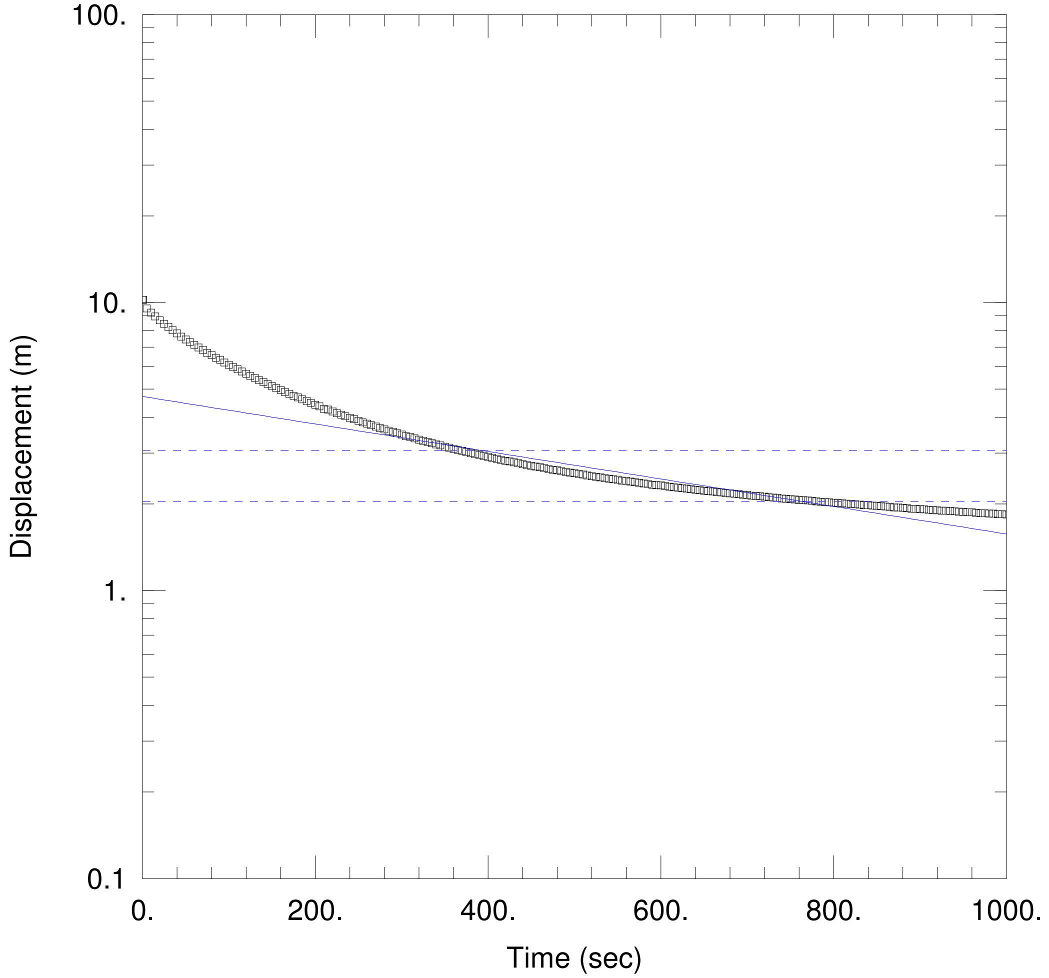
Saturated Thickness: 17.67 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-12B)

Initial Displacement: 5.119 m
Static Water Column Height: 17.67 m
Total Well Penetration Depth: 6.05 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.063E-8 m/sec
y0 = 4.119 m



BH11-17

Data Set: \...\BH11-17.aqt
Date: 10/18/12 Time: 13:42:07

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-17
Test Date: 9/10Jun-12

AQUIFER DATA

Saturated Thickness: 17. m Anisotropy Ratio (Kz/Kr): 1.

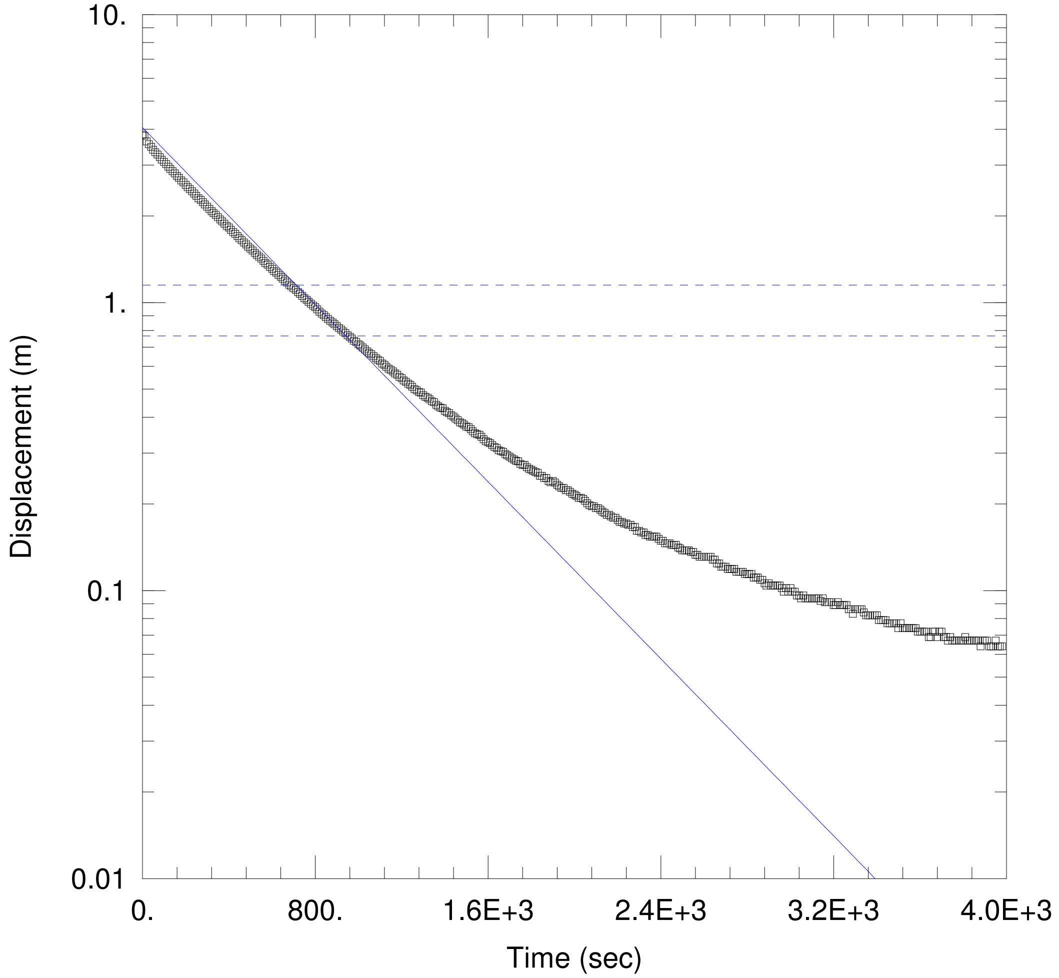
WELL DATA (BH11-17)

Initial Displacement: 10.21 m Static Water Column Height: 20.12 m
Total Well Penetration Depth: 9.15 m Screen Length: 1.5 m
Casing Radius: 0.0127 m Well Radius: 0.1 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 1.269E-7 m/sec y0 = 4.717 m



BH11-19C

Data Set: \...\BH11-19C.aqt
Date: 10/18/12
Time: 14:23:32

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-19C
Test Date: 13 Jun 2012

AQUIFER DATA

Saturated Thickness: 23.08 m
Anisotropy Ratio (Kz/Kr): 1.

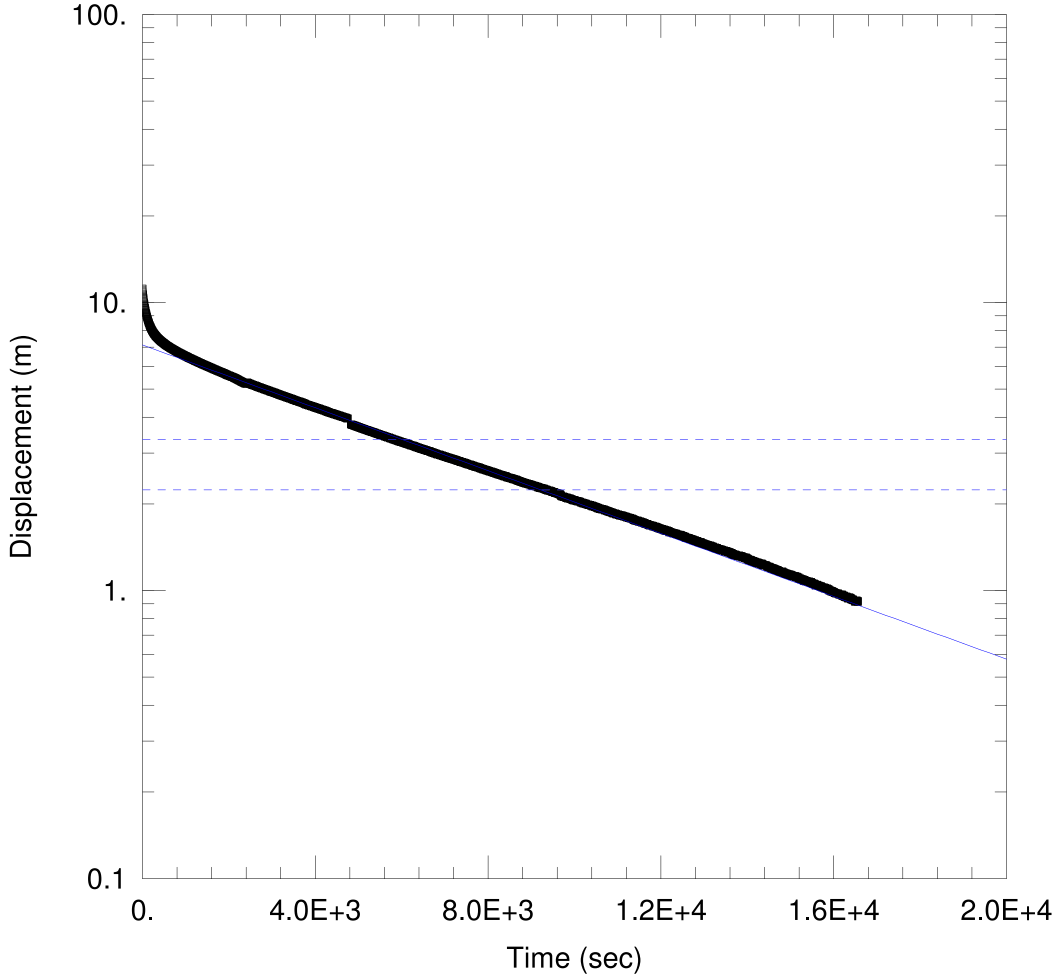
WELL DATA (BH11-19C)

Initial Displacement: 3.831 m
Static Water Column Height: 23.08 m
Total Well Penetration Depth: 6.05 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.881E-7 m/sec
y0 = 4.05 m



BH11-21B

Data Set: \...\BH11-21B.aqt
Date: 10/18/12
Time: 14:25:33

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-21B
Test Date: 13 - Jun - 2012

AQUIFER DATA

Saturated Thickness: 27.1 m
Anisotropy Ratio (Kz/Kr): 1.

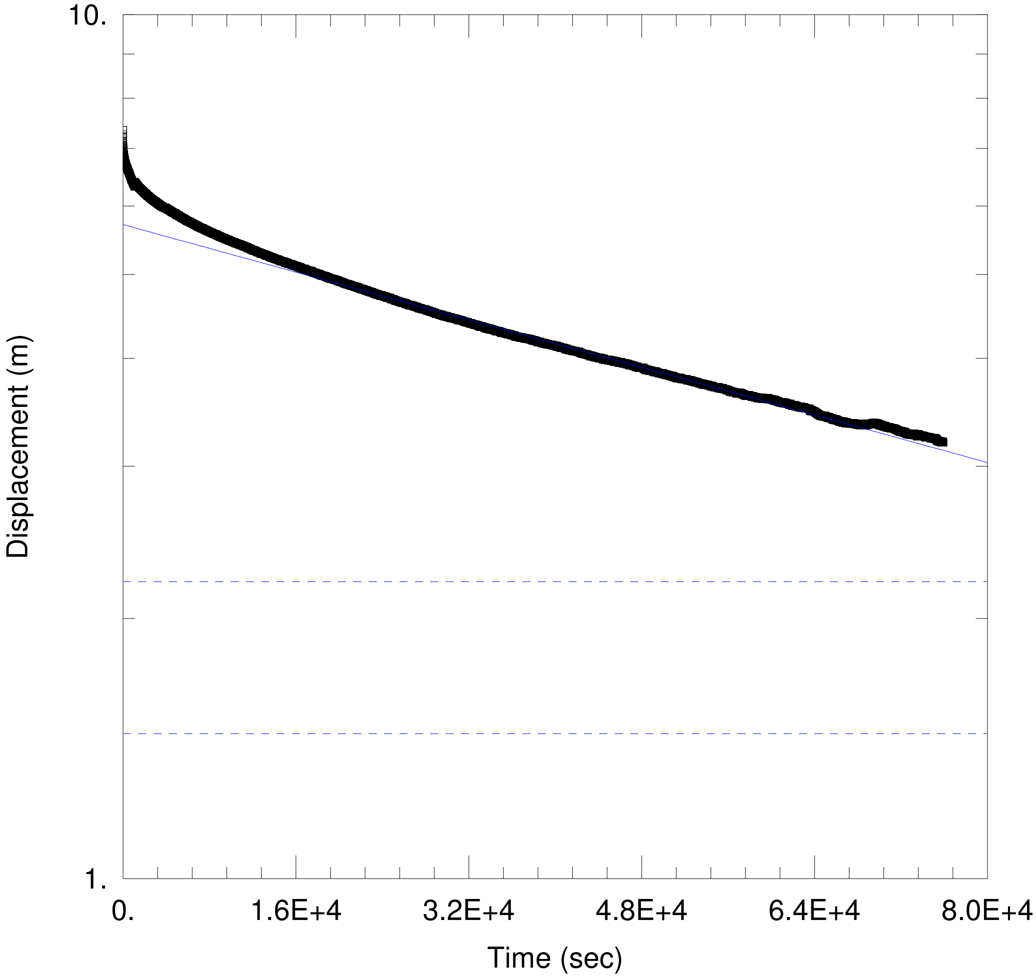
WELL DATA (BH11-21B)

Initial Displacement: 11.17 m
Static Water Column Height: 27.1 m
Total Well Penetration Depth: 27.1 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.28E-8 m/sec
y0 = 7.123 m



BH11-21C

Data Set: \...\BH11-21C.aqt
Date: 10/18/12 Time: 14:29:51

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-21C
Test Date: 13 - Jun - 2012

AQUIFER DATA

Saturated Thickness: 26.5 m
Anisotropy Ratio (Kz/Kr): 1.

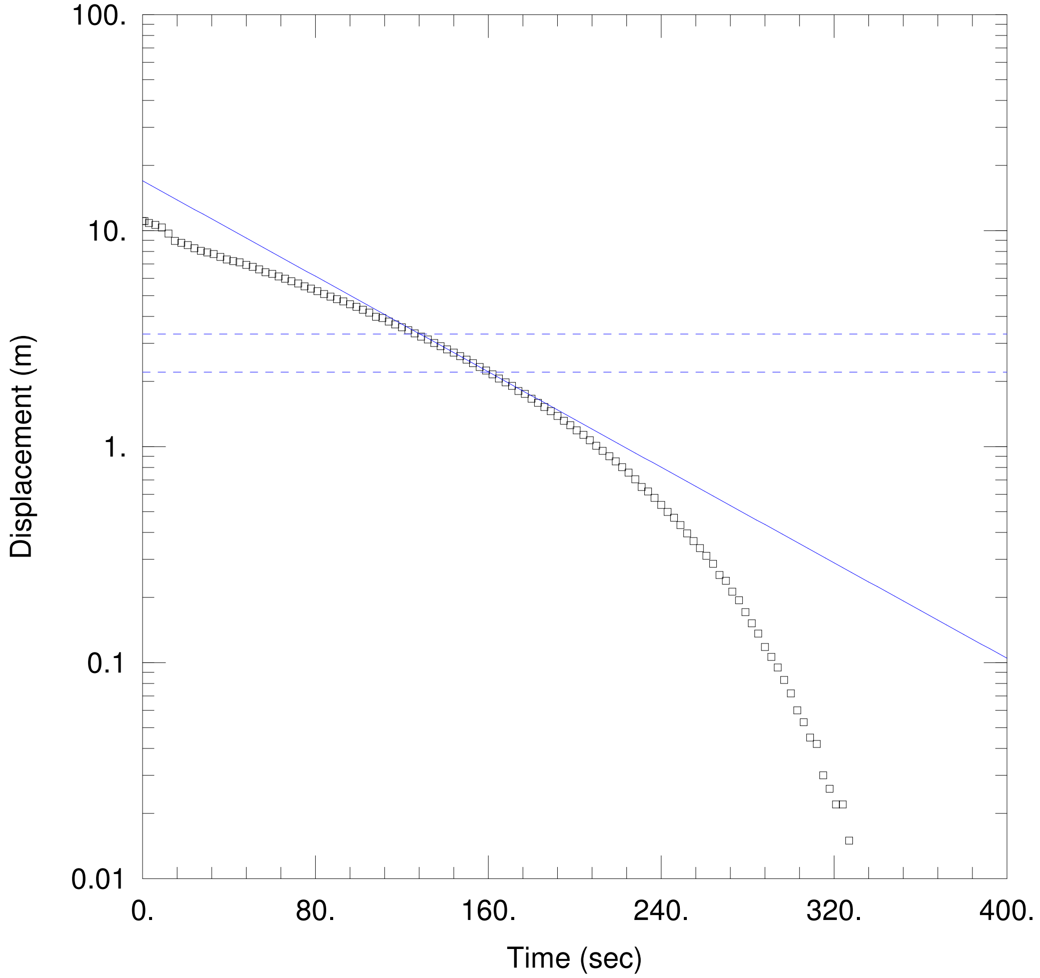
WELL DATA (BH11-21C)

Initial Displacement: 7.353 m
Static Water Column Height: 26.5 m
Total Well Penetration Depth: 7.6 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 8.631E-10 m/sec
y0 = 5.713 m



BH11-22(1)

Data Set: \...\BH11-22.aqt
Date: 10/18/12
Time: 14:35:07

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-22
Test Date: 14 - Jun - 2012

AQUIFER DATA

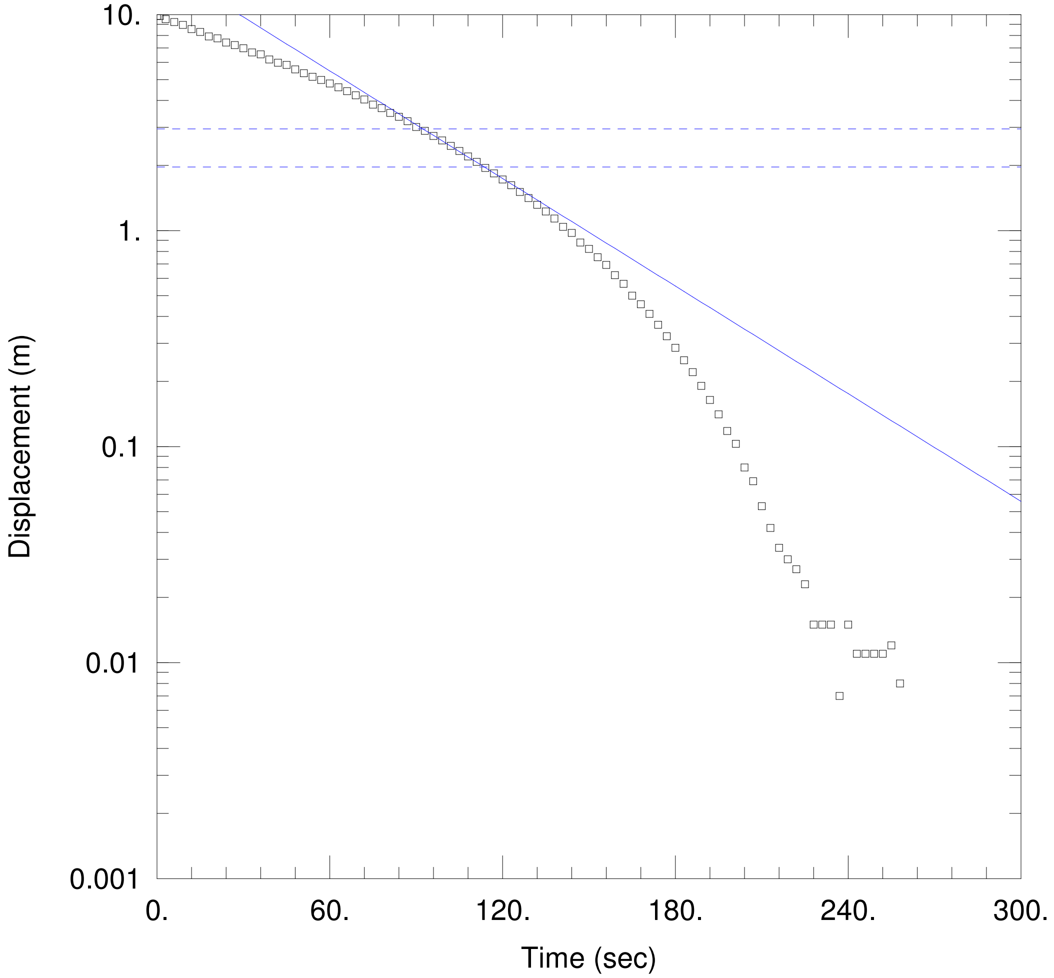
Saturated Thickness: 21.08 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-22)

Initial Displacement: 11.05 m
Static Water Column Height: 21.08 m
Total Well Penetration Depth: 21.08 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.954E-6 m/sec
y0 = 17. m



BH11-22(2)

Data Set: \...\BH11-22(2).aqt
Date: 10/18/12
Time: 14:34:26

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-22
Test Date: 14 - Jun - 2012

AQUIFER DATA

Saturated Thickness: 21.08 m
Anisotropy Ratio (Kz/Kr): 1.

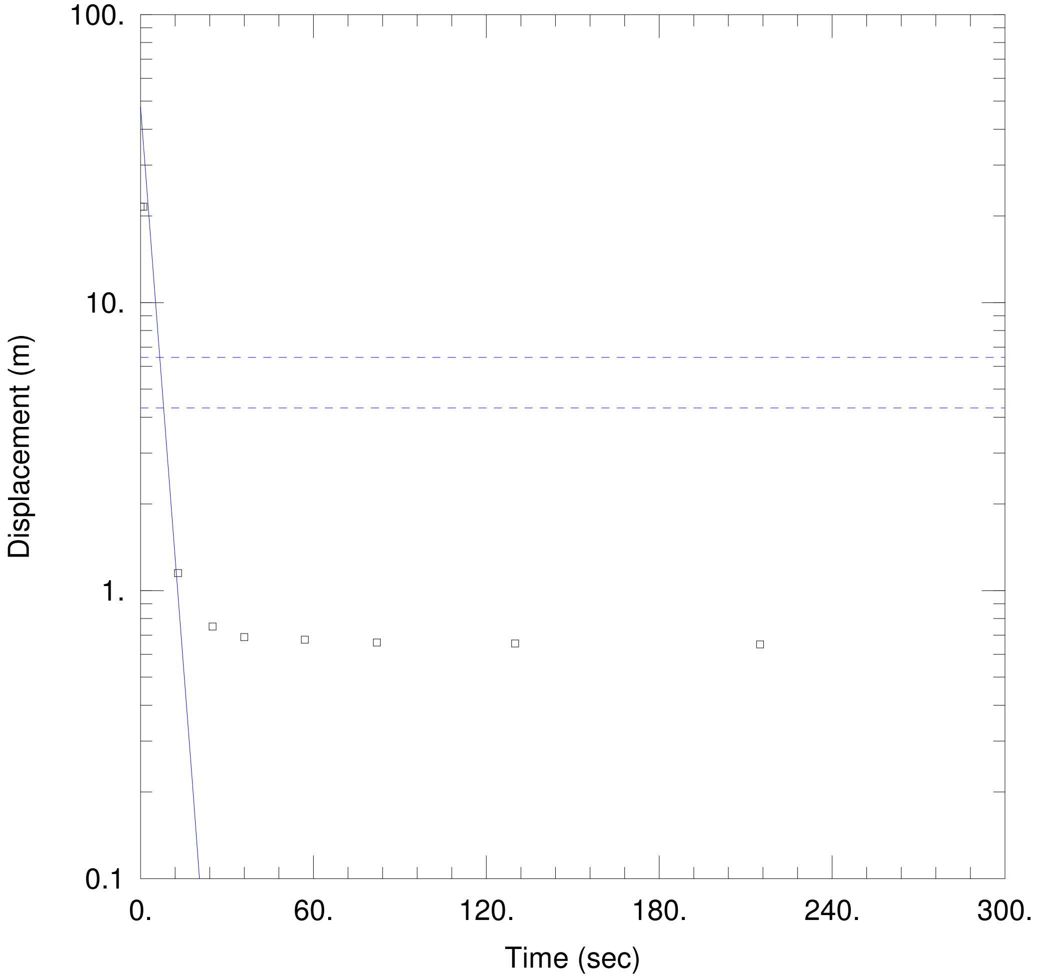
WELL DATA (BH11-22)

Initial Displacement: 9.857 m
Static Water Column Height: 21.08 m
Total Well Penetration Depth: 21.08 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.438E-6 m/sec
y0 = 17.27 m



BH11-23A(MANUAL)

Data Set: \...\BH11-23(Manual).aqt
Date: 10/18/12
Time: 14:40:42

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-23A
Test Date: 14-Jun-12

AQUIFER DATA

Saturated Thickness: 7.6 m
Anisotropy Ratio (Kz/Kr): 1.

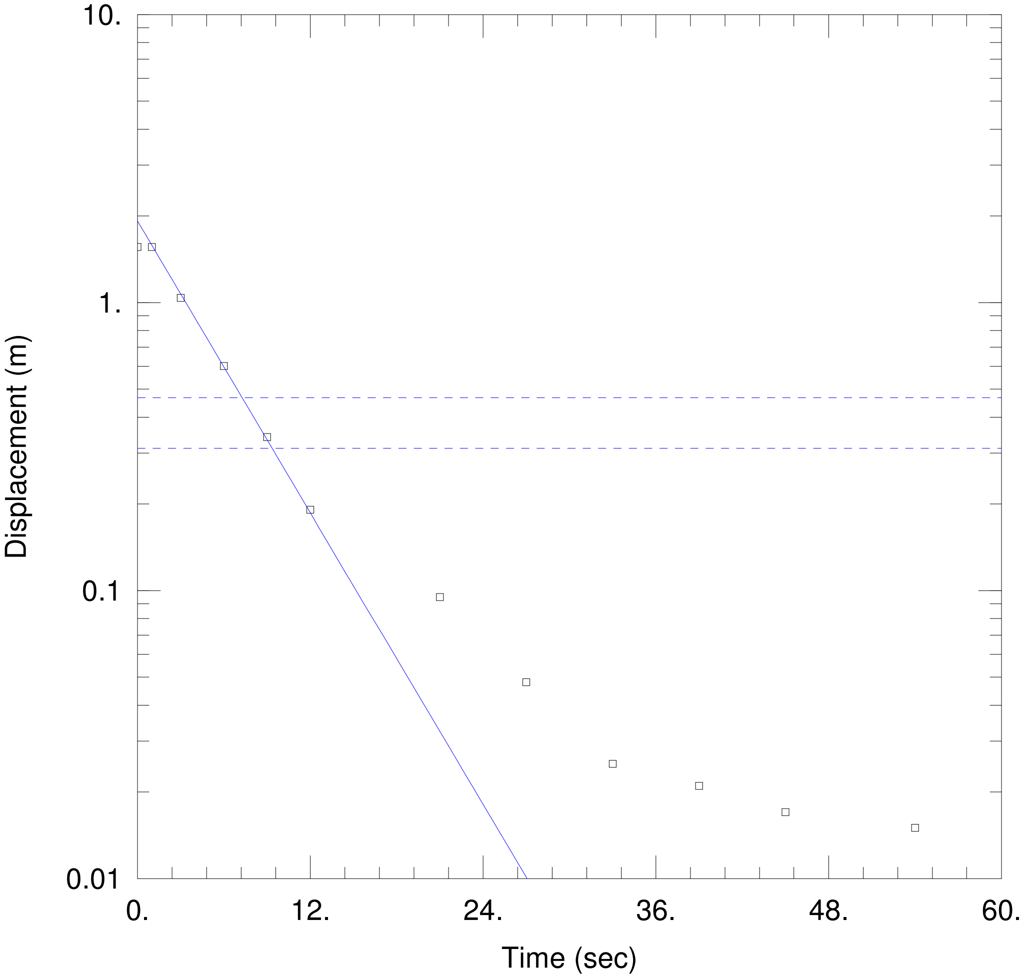
WELL DATA (BH11023A)

Initial Displacement: 21.5 m
Static Water Column Height: 38.53 m
Total Well Penetration Depth: 7.25 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.875E-5 m/sec
y0 = 47.69 m



BH11-23A(TRANSDUCER)

Data Set: \...\BH11-23(Transducer).aqt
Date: 10/18/12
Time: 14:39:53

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-23A
Test Date: 14-Jun-12

AQUIFER DATA

Saturated Thickness: 7.6 m
Anisotropy Ratio (Kz/Kr): 1.

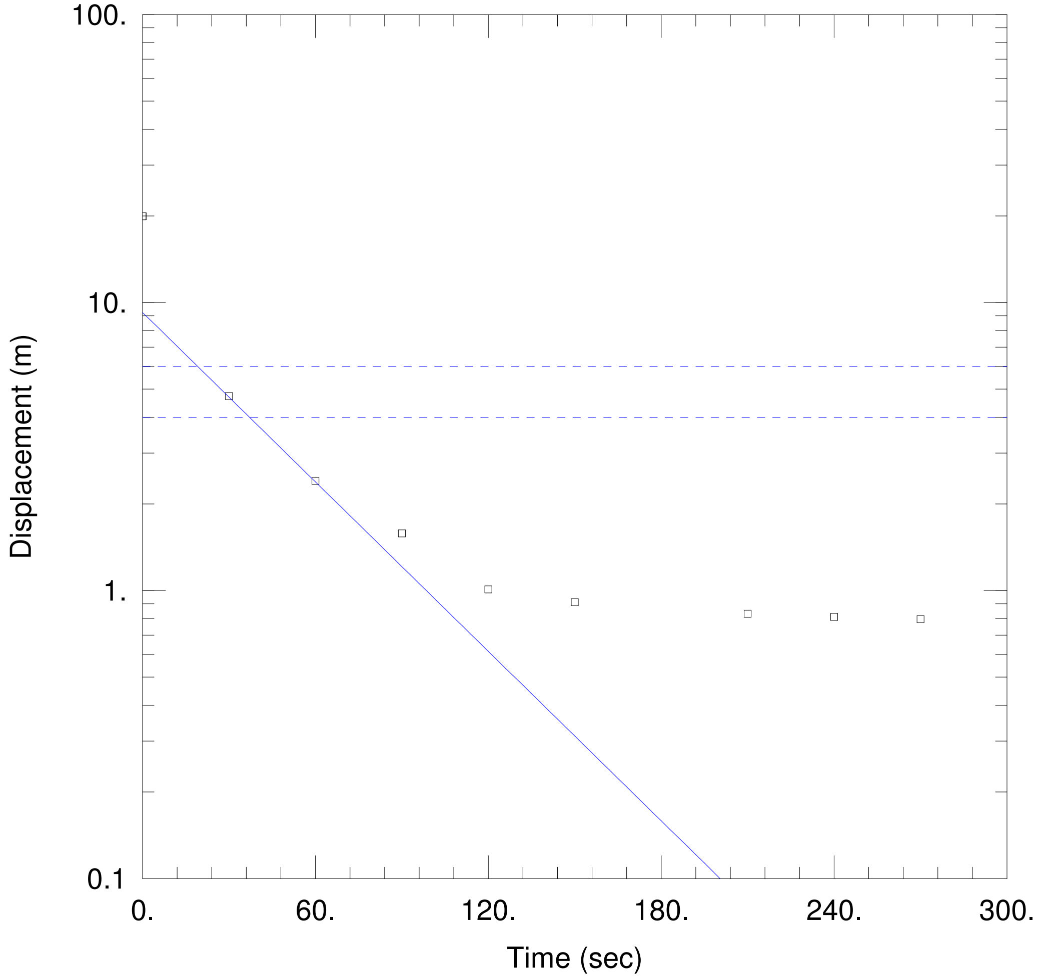
WELL DATA (BH11-23A)

Initial Displacement: 1.559 m
Static Water Column Height: 38.53 m
Total Well Penetration Depth: 7.25 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.507E-5 m/sec
y0 = 1.919 m



BH11-24A

Data Set: \...\BH11-24A.aqt
Date: 10/18/12 Time: 14:42:57

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-24A
Test Date: 08-Jun-12

AQUIFER DATA

Saturated Thickness: 15.5 m
Anisotropy Ratio (Kz/Kr): 1.

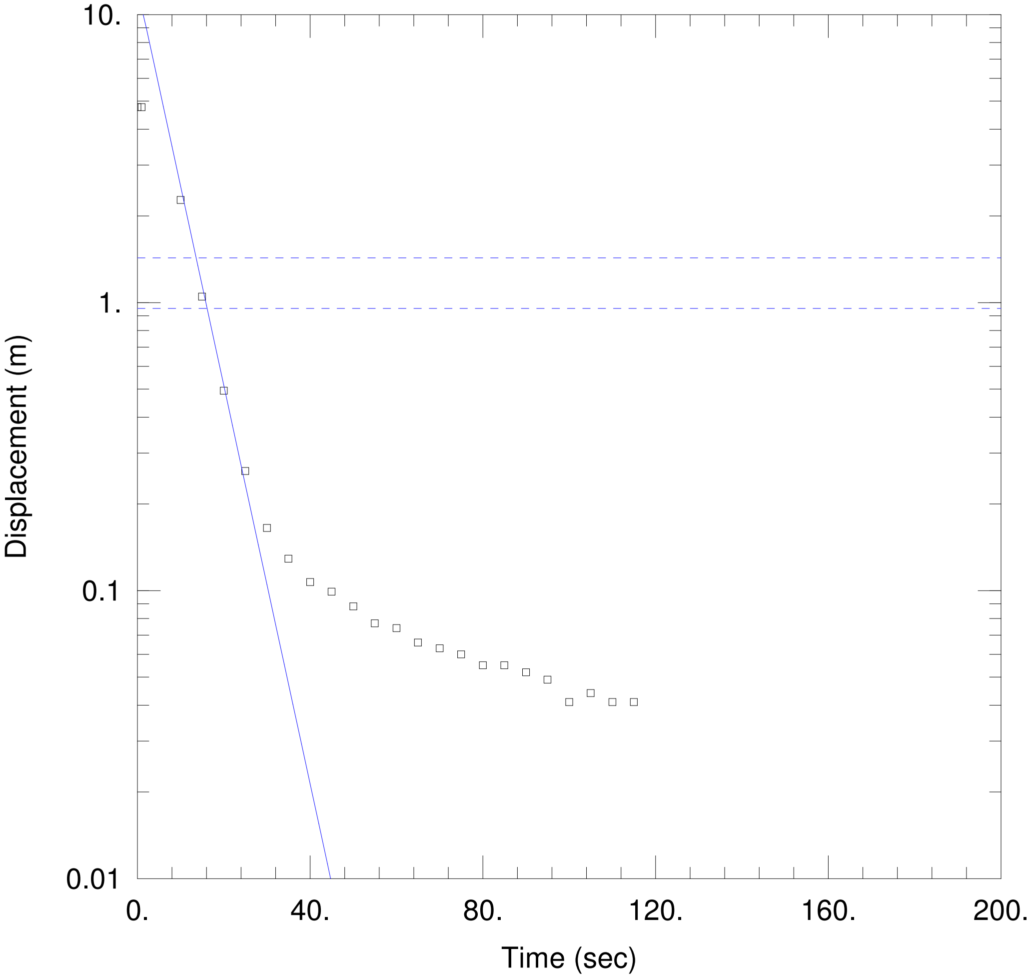
WELL DATA (BH11-24(A))

Initial Displacement: 19.95 m
Total Well Penetration Depth: 4.55 m
Casing Radius: 0.0127 m
Static Water Column Height: 3.9 m
Screen Length: 4.55 m
Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 1.298E-6 m/sec
y0 = 9.237 m



BH11-24B

Data Set: \...\BH11-24B.aqt
Date: 10/18/12 Time: 15:11:16

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-24B
Test Date: 08/09-Jun-12

AQUIFER DATA

Saturated Thickness: 13.7 m Anisotropy Ratio (Kz/Kr): 1.

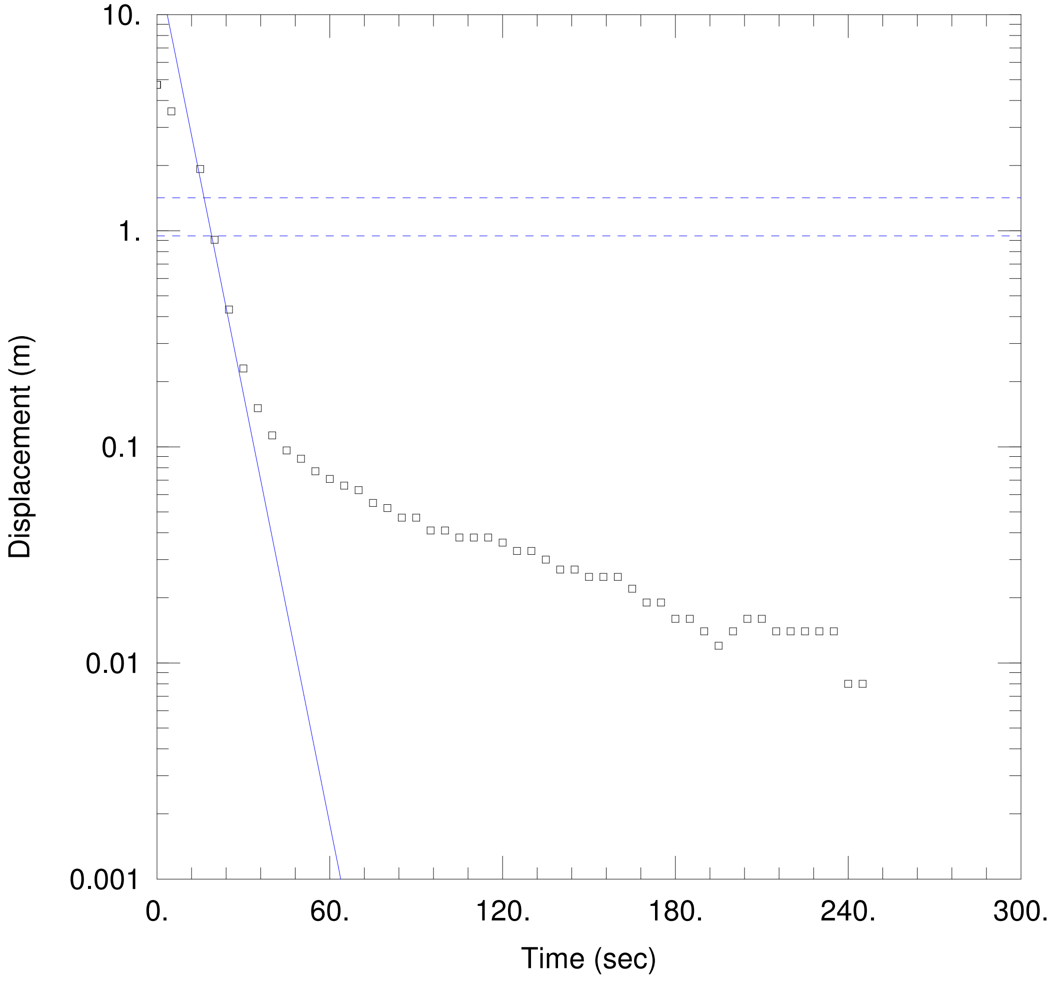
WELL DATA (BH11-24)

Initial Displacement: 4.765 m
Total Well Penetration Depth: 7.5 m
Casing Radius: 0.0127 m
Static Water Column Height: 17.85 m
Screen Length: 1.5 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 1.813E-5 m/sec y0 = 12.47 m



BH11-24B(2)

Data Set: \...\BH11-24B(2).aqt
Date: 10/18/12 Time: 15:11:48

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-24B
Test Date: 08/09-Jun-12

AQUIFER DATA

Saturated Thickness: 13.7 m Anisotropy Ratio (Kz/Kr): 1.

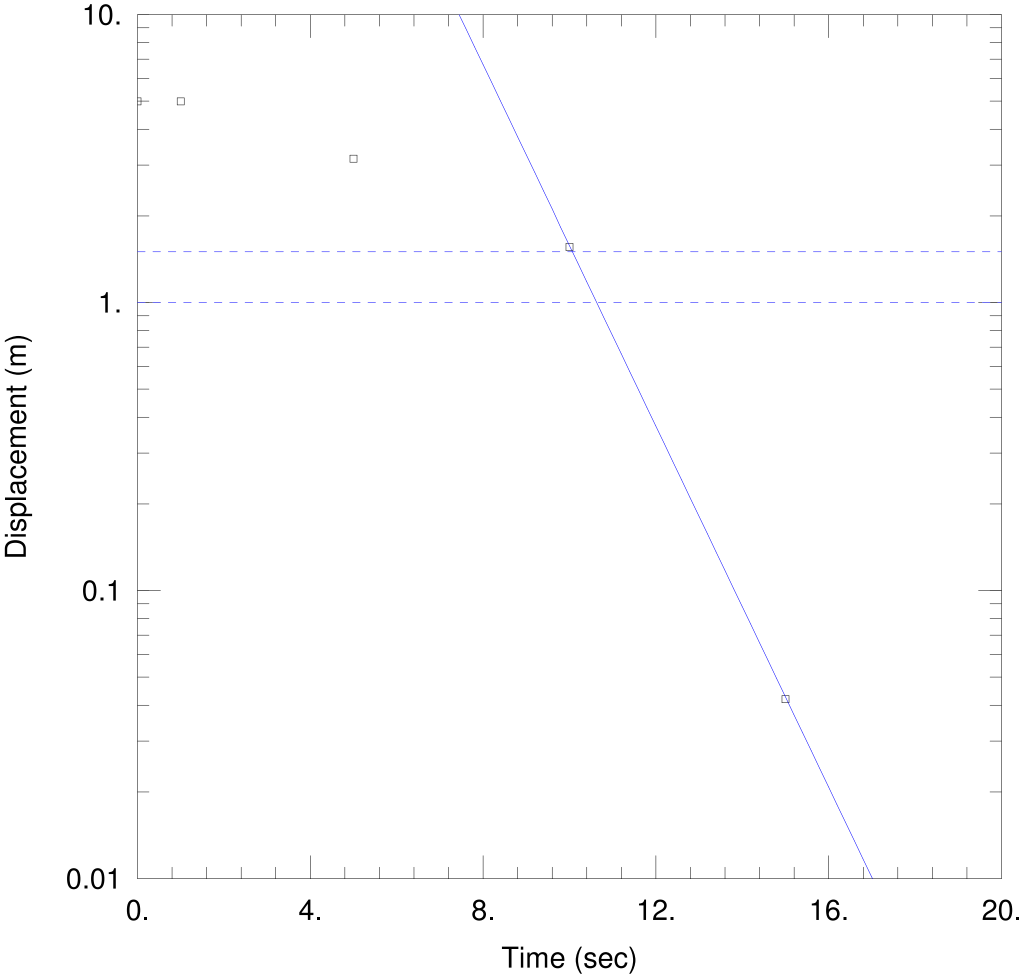
WELL DATA (BH11-24B(2))

Initial Displacement: 4.726 m Static Water Column Height: 17.85 m
Total Well Penetration Depth: 7.5 m Screen Length: 1.5 m
Casing Radius: 0.0127 m Well Radius: 0.1 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 1.741E-5 m/sec y0 = 17.27 m



BH11-25

Data Set: \...\BH11-25..aqt
Date: 10/18/12
Time: 15:13:04

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-25
Test Date: 15-Jun-12

AQUIFER DATA

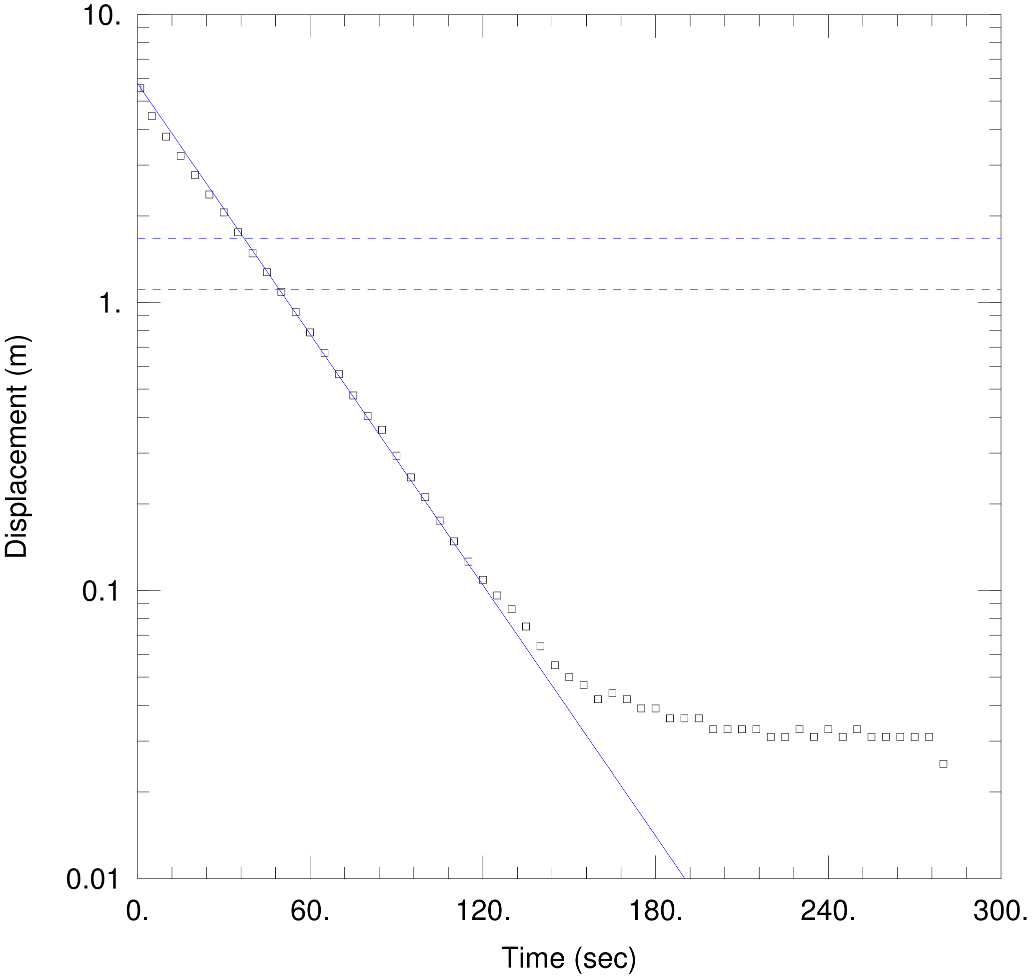
Saturated Thickness: 5.3 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-25)

Initial Displacement: 4.996 m
Total Well Penetration Depth: 5.3 m
Casing Radius: 0.0127 m
Static Water Column Height: 24.93 m
Screen Length: 1.5 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0001029 m/sec
y0 = 2152.8 m



BH11-27

Data Set: \...\BH11-27.aqt
Date: 10/18/12 Time: 15:13:44

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-27
Test Date: 08/09-Jun-12

AQUIFER DATA

Saturated Thickness: 9.1 m
Anisotropy Ratio (Kz/Kr): 1.

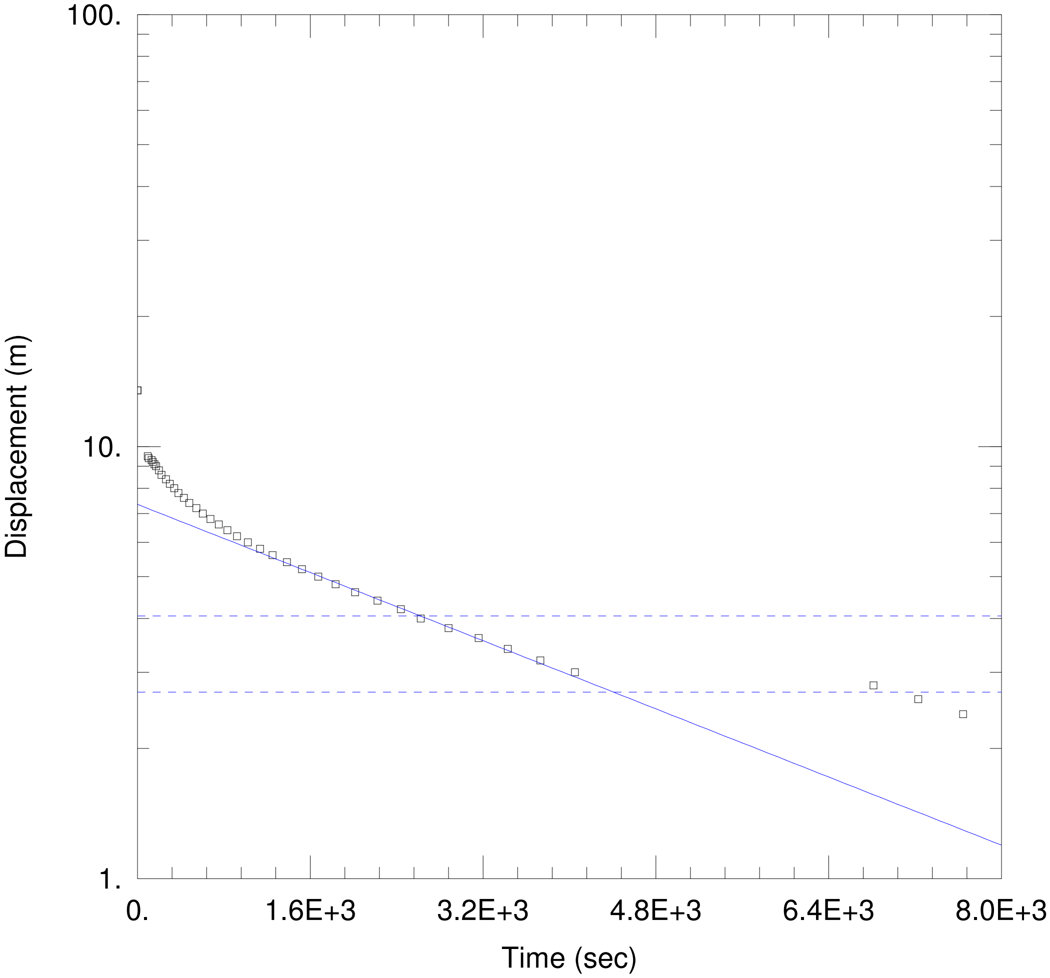
WELL DATA (BH11-27)

Initial Displacement: 5.547 m
Static Water Column Height: 28.33 m
Total Well Penetration Depth: 9.1 m
Screen Length: 3. m
Casing Radius: 0.0127 m
Well Radius: 0.0375 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.649E-6 m/sec
y0 = 5.772 m



BH11-29(MANUAL)

Data Set: \...\BH11-29(Manual).aqt
Date: 10/18/12 Time: 15:17:33

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-29(Manual)
Test Date: 15-June-12

AQUIFER DATA

Saturated Thickness: 35.34 m Anisotropy Ratio (Kz/Kr): 1.

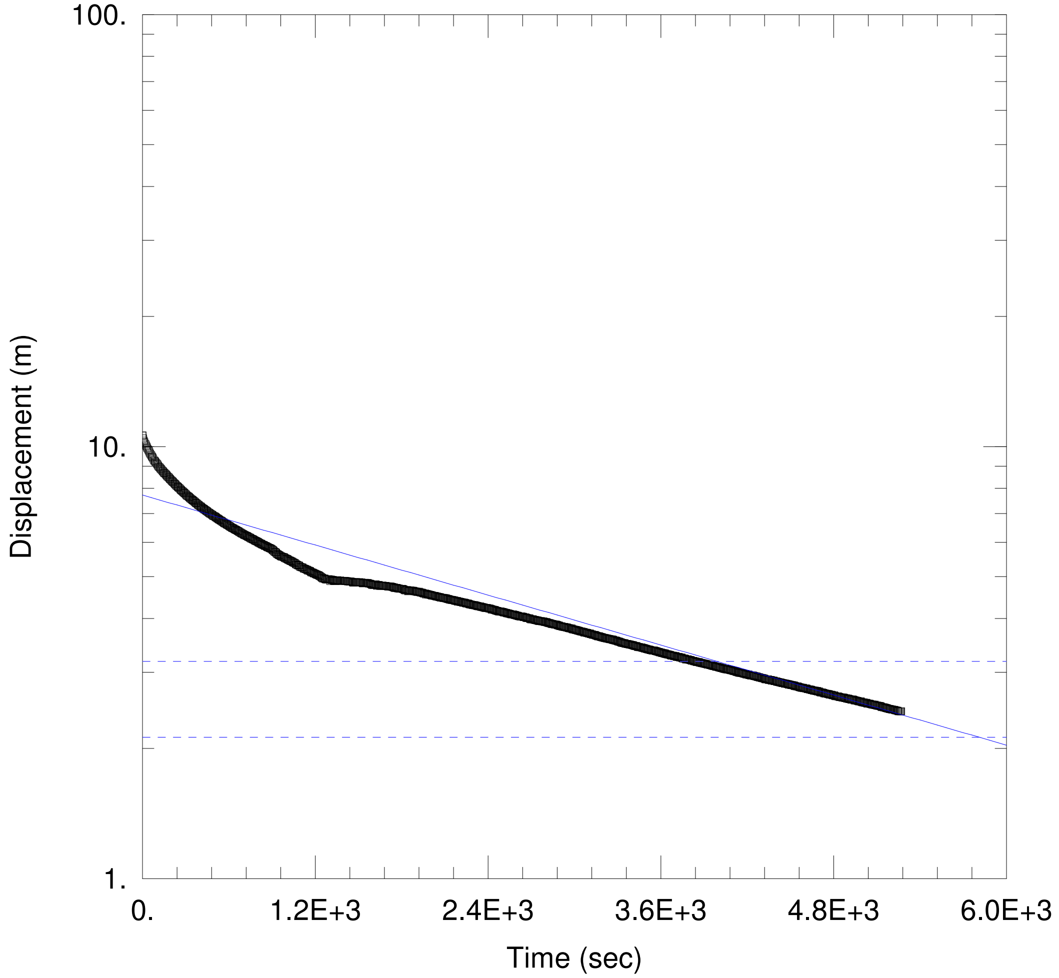
WELL DATA (BH11-29)

Initial Displacement: 13.5 m Static Water Column Height: 35.34 m
Total Well Penetration Depth: 25.24 m Screen Length: 1.5 m
Casing Radius: 0.0127 m Well Radius: 0.0762 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.2E-8 m/sec y0 = 7.346 m



BH11-29(TRANSDUCER)

Data Set: \...\BH11-29(Transducer).aqt
Date: 10/18/12
Time: 15:17:10

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-29
Test Date: 15-Jun-12

AQUIFER DATA

Saturated Thickness: 35.34 m
Anisotropy Ratio (Kz/Kr): 1.

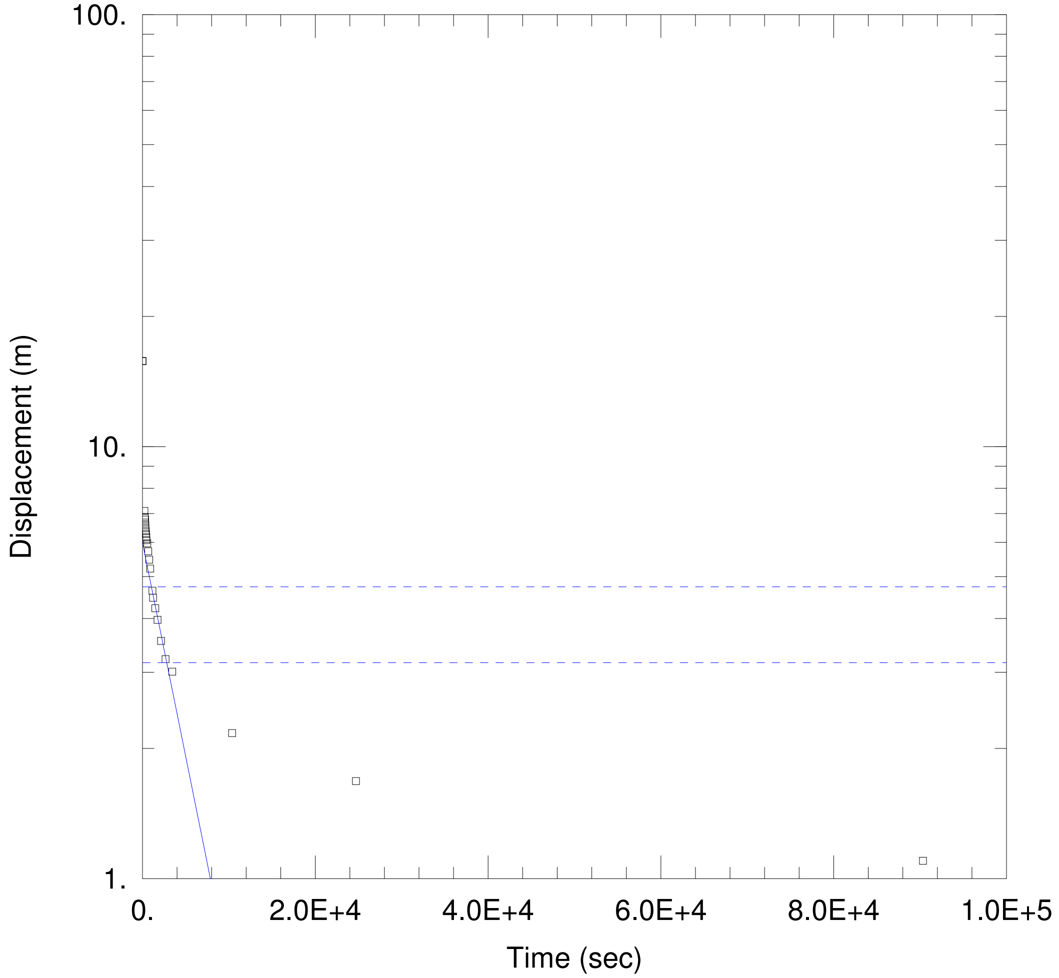
WELL DATA (BH11-29)

Initial Displacement: 10.61 m
Static Water Column Height: 35.34 m
Total Well Penetration Depth: 25.24 m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.802E-8 m/sec
y0 = 7.72 m



BH11-33B

Data Set: \...\BH11-33B.aqt
Date: 10/18/12
Time: 15:18:50

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-33B
Test Date: 14-Jun-12

AQUIFER DATA

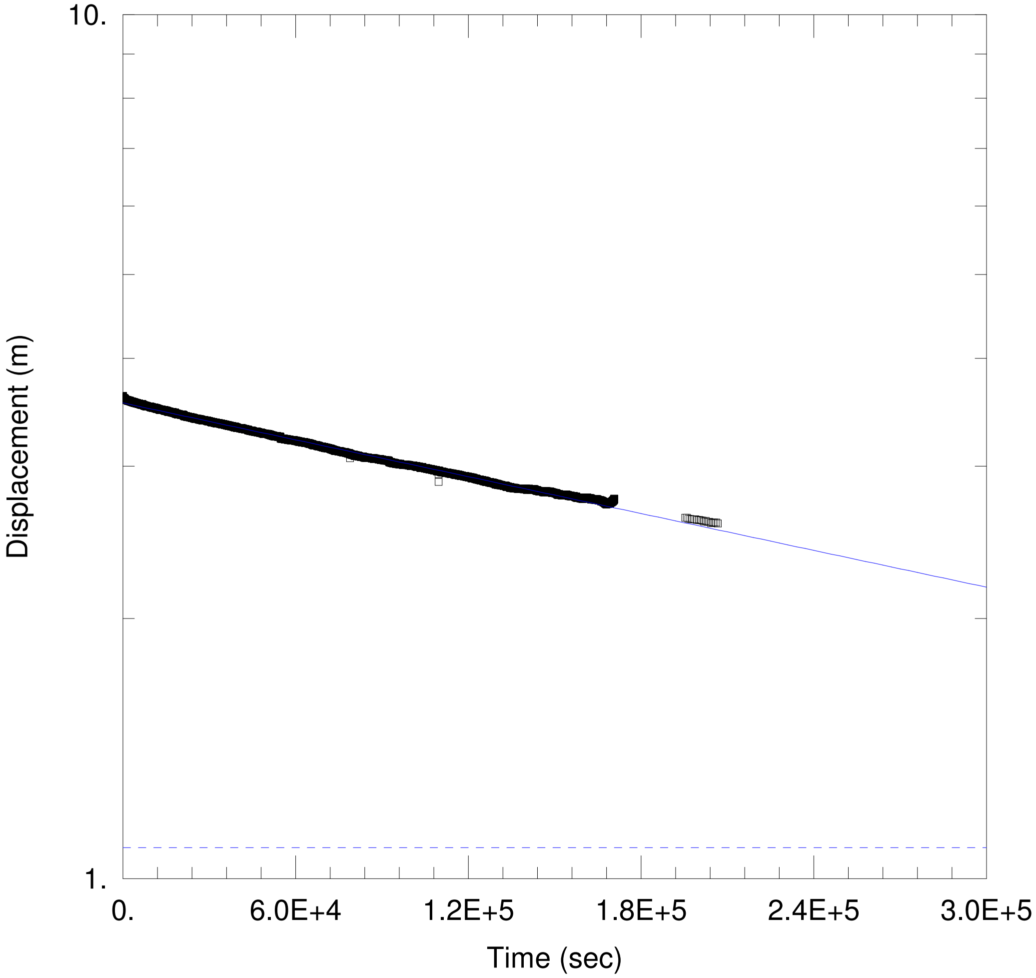
Saturated Thickness: 28.97 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-33B)

Initial Displacement: 15.79 m
Total Well Penetration Depth: 13.67 m
Casing Radius: 0.0127 m
Static Water Column Height: 28.97 m
Screen Length: 1.5 m
Well Radius: 0.1 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.667E-8 m/sec
y0 = 5.991 m



BH11-35

Data Set: \...\BH11-35.aqt

Date: 10/18/12 Time: 15:19:40

PROJECT INFORMATION

Company: AMEC E & I

Client: Rainy River Resources

Project: TC111504

Test Well: BH11-35

Test Date: June 11th to 13th, 2012

AQUIFER DATA

Saturated Thickness: 5.93 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-35)

Initial Displacement: 3.62 m

Total Well Penetration Depth: 5.93 m

Casing Radius: 0.0127 m

Static Water Column Height: 5.93 m

Screen Length: 1.5 m

Well Radius: 0.03785 m

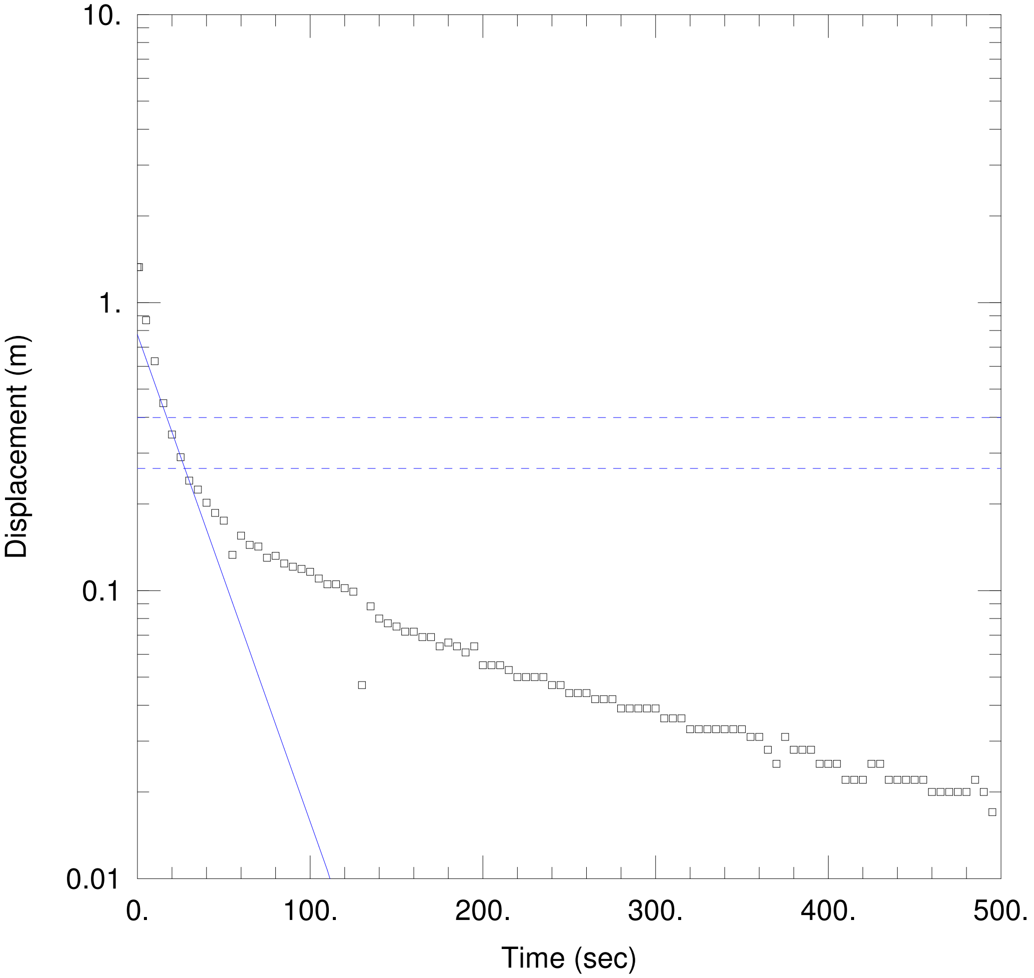
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 3.196E-10 m/sec

y0 = 3.551 m



BH11-40(1)

Data Set: \...\BH11-40(1).aqt
Date: 10/18/12 Time: 15:20:46

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-40(1)
Test Date: 10-Jun-12

AQUIFER DATA

Saturated Thickness: 6.33 m Anisotropy Ratio (Kz/Kr): 1.

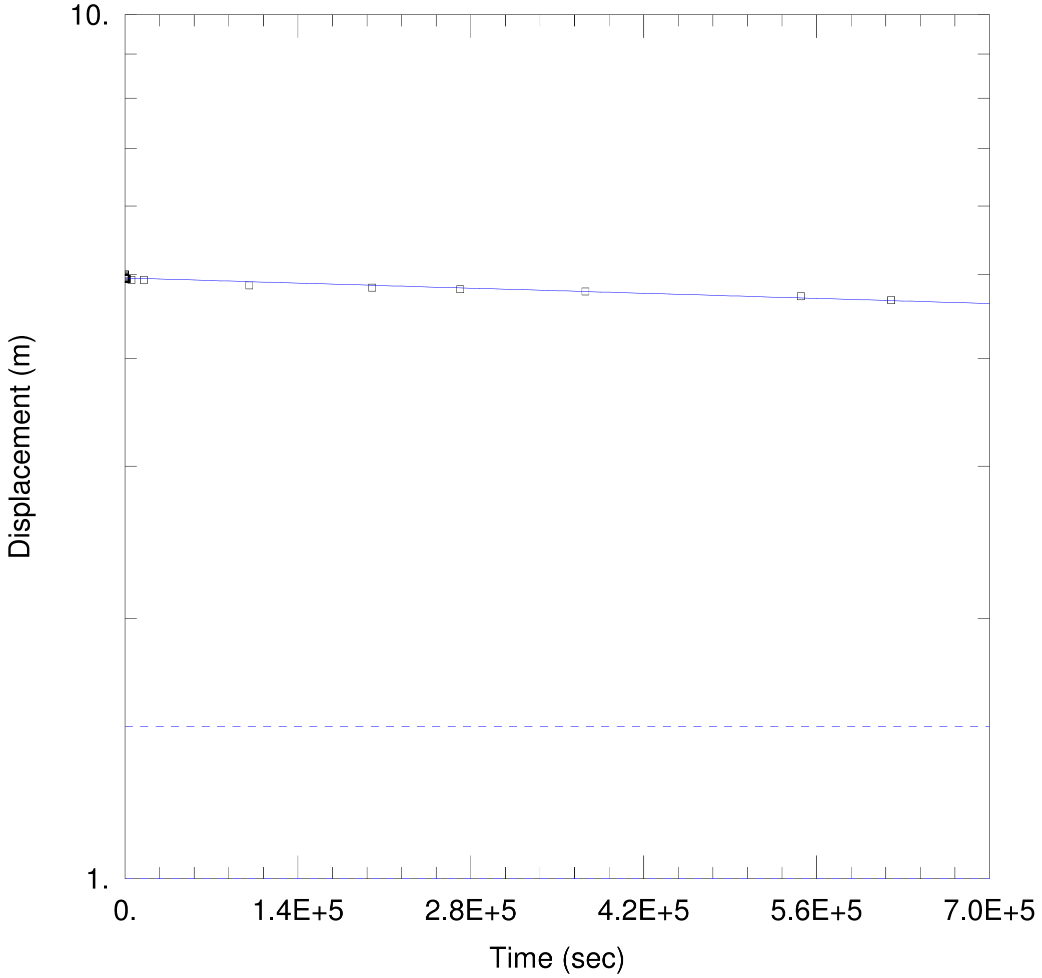
WELL DATA (BH11-40)

Initial Displacement: 1.328 m Static Water Column Height: 4.28 m
Total Well Penetration Depth: 3.93 m Screen Length: 1.5 m
Casing Radius: 0.0127 m Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 5.931E-6 m/sec y0 = 0.7731 m



BH11-50A

Data Set: \...\BH11-50A.aqt
Date: 10/18/12 Time: 15:21:29

PROJECT INFORMATION

Company: AMEC E & I
Client: Rainy River Resources
Project: TC111504
Test Well: BH11-50A
Test Date: 08-Jun-12

AQUIFER DATA

Saturated Thickness: 3.2 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH11-50A)

Initial Displacement: 5. m
Static Water Column Height: 6.56 m
Total Well Penetration Depth: 4. m
Screen Length: 1.5 m
Casing Radius: 0.0127 m
Well Radius: 0.03785 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.781E-11 m/sec
y0 = 4.956 m

APPENDIX C

PACKER TESTING RESULTS

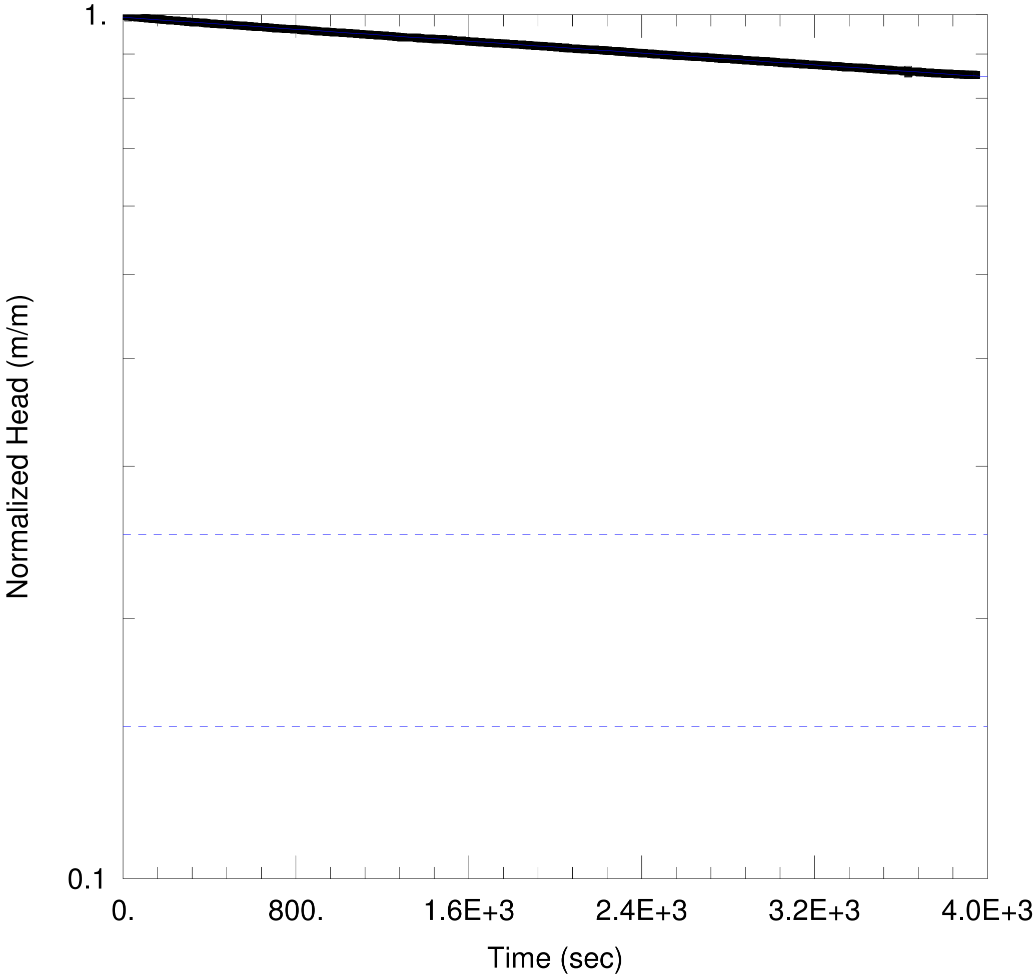
Table C-1 Summary of Hydraulic Conductivities from Packer Testing

Borehole	Test #	Date	Type	Top Depth (m along BH)	Bottom Depth (m along BH)	Centre (mbbs)*	Centre (mbgs)**	Average K (m/s)	Comments
BH12-UG-02	1	02/12/2012	Constant Head	62.1	80.8	15.9	69.0	1.1E-07	
BH12-UG-02	2	02/12/2012	Constant Head	84.8	103.7	37.9	91.0	3.1E-08	
BH12-UG-02	4	13/02/2012	Falling Head	124.9	143.1	76.3	129.4	3.0E-08	
BH12-UG-02	5	14/02/2012	Falling Head	144.5	162.7	95.2	148.3	4.4E-09	
BH12-UG-02	6	14/02/2012	Falling Head	164.1	182.2	114.1	167.3	1.4E-08	
BH12-UG-02	8	02/15/2012	Rising Head	202.8	221.2	151.7	204.8	5.4E-09	
BH12-UG-02	9	02/15/2012	Constant Head	222.4	240.6	170.5	223.6	5.4E-08	
BH12-UG-02	10	02/16/2012	Constant Head	240.6	259.9	188.6	241.7	1.1E-08	
BH12-UG-02	11b	02/16/2012	Constant Head	257.1	276.4	204.6	257.7	5.5E-07	
BH12-UG-02	12	02/17/2012	Constant Head	276.4	298.4	224.5	277.6	1.2E-08	
BH12-UG-02	13a	02/25/2012	Falling Head						failed test
BH12-UG-02	13b	02/25/2012	Constant Head						failed test
BH12-UG-03	1	31/03/2012	Falling Head	301.5	363.0	303.9	312.2	5.8E-09	
BH12-UG-03	2	01/04/2012	Falling Head	301.5	387.0	315.2	323.5	1.1E-09	
BH12-UG-03	3	02/04/2012	Falling Head	301.5	414.0	327.9	336.2	4.6E-09	
BH12-UG-03	4	03/04/2012	Falling Head	301.5	444.0	342.0	350.3	1.0E-07	
BH12-UG-03	5	04/04/2012	Falling Head	301.5	480.0	358.9	367.2	3.5E-09	
BH12-UG-03	6	04/04/2012	Falling Head	300.0	501.0	368.1	376.3	5.0E-09	
BH12-OP-01	1								failed test
BH12-OP-01	2	08/04/2012	Rising Head	82.5	102.0	31.0	83.6	4.9E-09	
BH12-OP-01	3	09/04/2012	Rising Head	103.5	123.0	50.1	102.6	8.5E-09	
BH12-OP-01	4	09/04/2012	Rising Head	123.0	144.0	68.4	121.0	2.3E-08	
BH12-OP-01	5	10/04/2012	Rising Head	144.0	165.0	87.5	140.0	7.9E-08	
BH12-OP-01	6	10/04/2012	Rising Head	165.0	186.0	106.5	159.1	3.9E-07	
BH12-OP-01	7	10/04/2012	Rising Head	186.0	207.0	125.5	178.1	3.3E-08	
BH12-OP-01	8	11/04/2012	Rising Head	208.5	228.0	145.2	197.8	3.3E-08	
BH12-OP-01	9	11/04/2012	Rising Head	229.5	249.0	164.3	216.8	3.0E-08	
BH12-OP-01	10	12/04/2012	Rising Head	250.5	270.0	183.3	235.9	2.7E-08	
BH12-OP-01	11	12/04/2012	Rising Head	271.5	291.0	202.3	254.9	2.6E-08	
BH12-OP-01	12	12/04/2012	Rising Head	292.5	312.0	221.4	273.9	5.8E-08	
BH12-OP-01	13	13/04/2012	Rising Head	301.5	345.0	240.4	293.0	2.8E-08	
BH12-OP-01	14	13/04/2012	Rising Head	301.5	372.0	252.6	305.2	8.4E-09	
BH12-OP-01	15	14/04/2012	Rising Head	301.5	402.0	266.2	318.8	3.2E-09	
BH12-OP-03	1	02/05/2012	Rising Head	40.0	61.0	18.6	36.1	1.6E-06	
BH12-OP-03	2	02/27/2012	Rising Head	61.0	82.0	37.6	54.2	1.2E-06	
BH12-OP-03	3	02/27/2012	Rising Head	82.0	103.0	56.6	72.3	3.8E-09	
BH12-OP-03	4	02/27/2012	Rising Head	103.0	124.0	75.7	90.5	9.9E-09	

Borehole	Test #	Date	Type	Top Depth (m along BH)	Bottom Depth (m along BH)	Centre (mbbs)*	Centre (mbgs)**	Average K (m/s)	Comments
BH12-OP-03	5	02/27/2012	Rising Head	124.0	145.0	94.7	108.6	1.6E-08	
BH12-OP-03	6	02/28/2012	Rising Head	145.0	166.0	113.7	126.8	7.3E-07	
BH12-OP-03	7	02/28/2012	Rising Head	166.0	187.0	132.8	144.9	1.4E-09	
BH12-OP-03	8	02/29/2012	Rising Head	187.0	208.0	151.8	163.0	1.5E-09	
BH12-OP-03	9	02/29/2012	Rising Head	208.0	229.0	170.8	181.2	1.3E-09	
BH12-OP-03	10	02/29/2012	Rising Head	229.0	250.0	189.9	199.3	1.8E-10	
BH12-OP-03	11	03/01/2012	Rising Head	250.0	271.0	208.9	217.5	4.9E-09	
BH12-OP-03	12	03/01/2012	Rising Head	271.0	292.0	227.9	235.6	1.6E-09	
BH12-OP-05	1	03/10/2012	Rising Head	37.0	58.0	10.4	43.0	4.3E-07	
BH12-OP-05	2a	03/11/2012	Rising Head	58.0	79.0	29.5	62.1	3.6E-07	
BH12-OP-05	3	03/11/2012	Rising Head	79.0	100.0	48.5	81.1	1.4E-06	
BH12-OP-05	4	03/12/2012	Rising Head	100.0	121.0	67.5	100.1	2.7E-08	
BH12-OP-05	5	03/12/2012	Rising Head	121.0	142.0	86.6	119.2	5.4E-08	
BH12-OP-05	6	13/03/2012	Rising Head	142.0	163.0	105.6	138.2	2.4E-08	
BH12-OP-05	7	13/03/2012	Rising Head	163.0	184.0	124.6	157.2	1.7E-08	
BH12-OP-05	8	14/03/2012	Rising Head	184.0	205.0	143.6	176.3	1.7E-08	
BH12-OP-05	9	14/03/2012	Rising Head	205.0	226.0	162.7	195.3	2.2E-08	
BH12-OP-05	10	15/03/2012	Rising Head	226.0	247.0	181.7	214.3	7.6E-07	
BH12-OP-05	11	15/03/2012	Rising Head	247.0	268.0	200.7	233.4	4.0E-07	
BH12-OP-05	11a	16/03/2012	Rising Head	268.0	300.0	224.8	257.4	1.2E-07	
BH12-OP-05	12	16/03/2012	Rising Head	60.0	300.0	130.5	163.1	1.1E-07	
BH12-OP-07	1	03/05/2012	Rising Head	87.0	108.0	20.9	68.9	7.9E-09	
BH12-OP-07	2	03/05/2012	Rising Head	108.0	129.0	35.7	83.8	3.1E-08	
BH12-OP-07	3	03/06/2012	Rising Head	129.0	150.0	50.6	98.6	2.0E-08	
BH12-OP-07	4	03/06/2012	Rising Head	150.0	171.0	65.4	113.5		failed test
BH12-OP-07	5	03/06/2012	Rising Head	171.0	192.0	80.3	128.3	1.3E-08	
BH12-OP-07	6	03/07/2012	Rising Head	192.0	213.0	95.1	143.2	8.4E-09	
BH12-OP-07	7	03/07/2012	Rising Head	213.0	234.0	110.0	158.0		failed test
BH12-OP-07	8	03/07/2012	Rising Head	234.0	255.0	124.8	172.9	8.7E-09	
BH12-OP-07	9	03/08/2012	Rising Head	258.0	279.0	141.8	189.9	2.2E-08	suspect
BH12-OP-07	10	03/08/2012	Rising Head	279.0	300.0	156.6	204.7	3.1E-09	
KCBL-101			Constant Head	56.0	76.0	53.2	65.0	3.3E-07	
KCBL-104			Constant Head	59.0	61.0	20.7	56.4	3.3E-06	

* mmbs = meters below bedrock surface

** mbgs = meters below ground surface



BH12-OP-01 TEST 2

Data Set: C:\...\BH12-OP-01- test 2_RH test.aqt
Date: 10/19/12 Time: 09:25:00

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 08/04/2012

AQUIFER DATA

Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

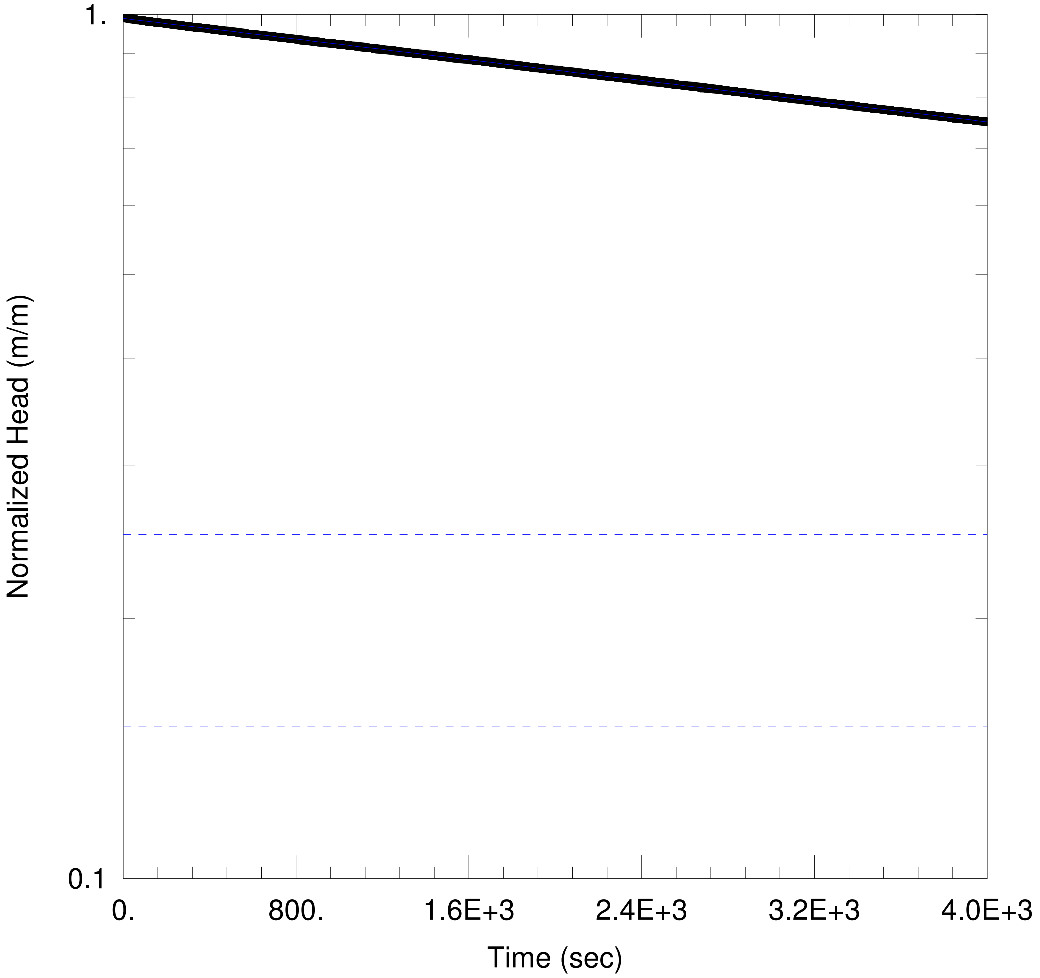
WELL DATA (BH12-OP-01 Test 2)

Initial Displacement: 5.439 m
Static Water Column Height: 102. m
Total Well Penetration Depth: 99.5 m
Screen Length: 19.5 m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 4.887E-9 m/sec
y0 = 5.397 m



BH12-OP-01 TEST 3

Data Set: C:\...\BH12-OP-01- test 3_RH test.aqt
Date: 10/19/12 Time: 09:20:16

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 09/04/2012

AQUIFER DATA

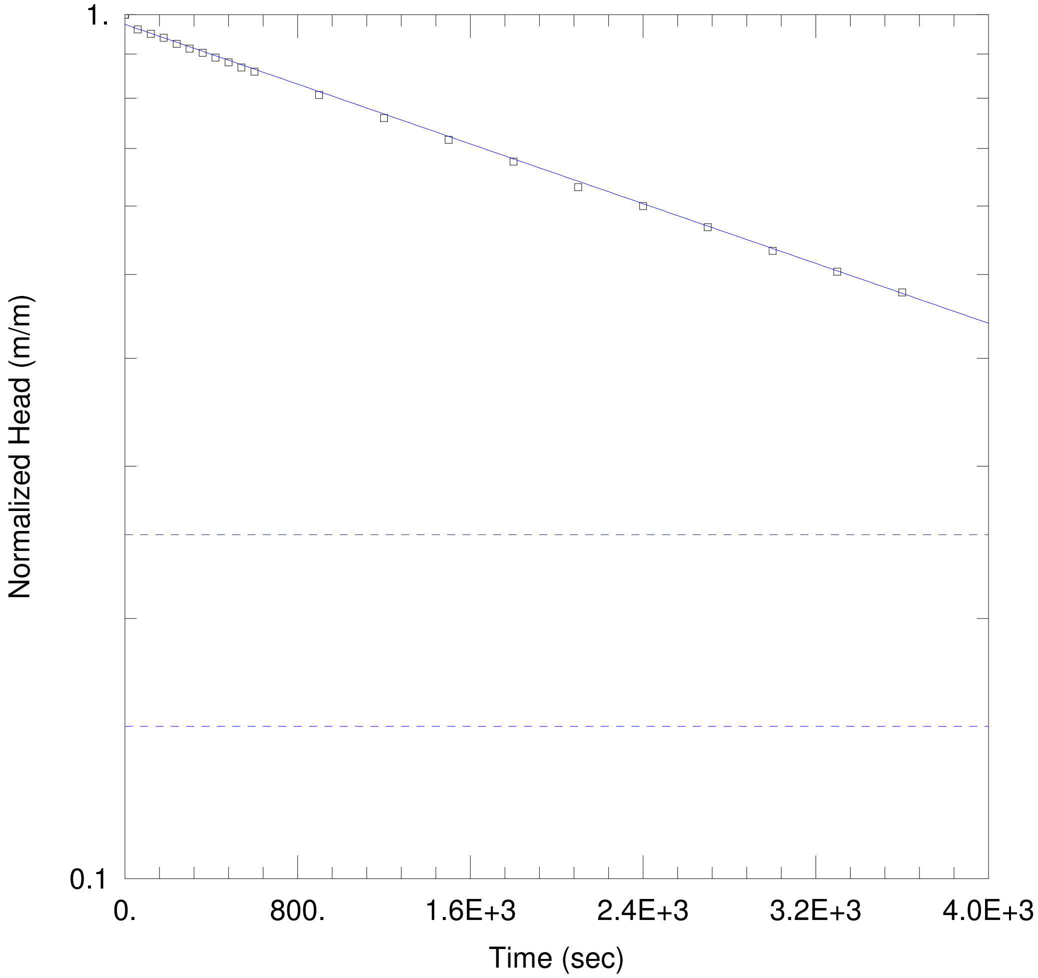
Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-01 Test 3)

Initial Displacement: 5.196 m
Static Water Column Height: 123. m
Total Well Penetration Depth: 122.5 m
Screen Length: 19.5 m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 8.517E-9 m/sec
y0 = 5.139 m



BH12-OP-01 TEST 4

Data Set: P:\...\BH12-OP-01- test 4_RH test - angle corrected (manual).aqt
Date: 10/23/12 Time: 11:26:24

PROJECT INFORMATION

Company: AMEC
Project: RRR TC113921
Test Well: BH12-OP-01
Test Date: 2012/03/16

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

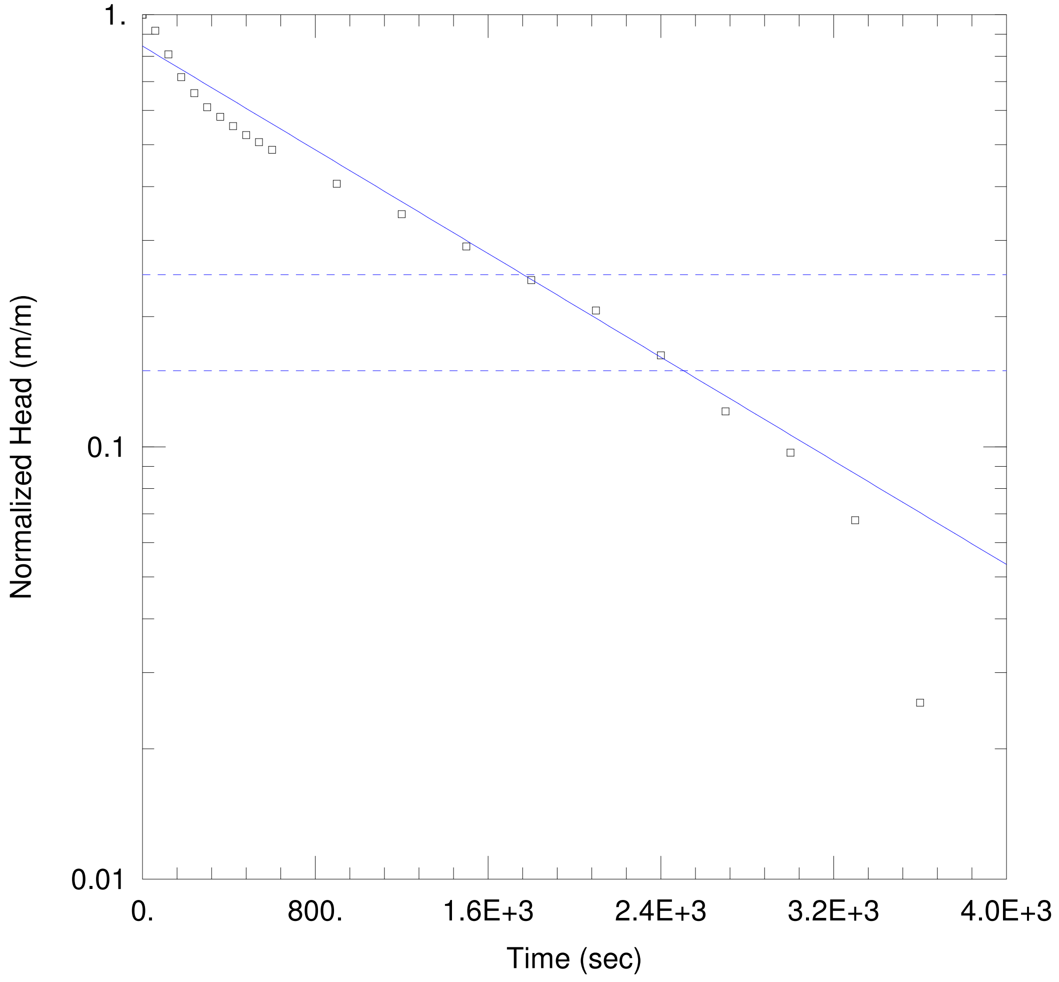
WELL DATA (BH12-OP-01Test 4)

Initial Displacement: 5.18 m
Total Well Penetration Depth: 144. m
Casing Radius: 0.03015 m
Static Water Column Height: 144. m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 2.283E-8 m/sec
y0 = 5.046 m



BH12-OP-05 TEST 5

Data Set: P:\...\BH12-OP-01- test 5_RH test - angle corrected (manual).aqt
Date: 10/23/12 Time: 11:35:12

PROJECT INFORMATION

Company: AMEC
Project: RRR TC113921
Test Well: BH12-OP-01
Test Date: 2012/03/16

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

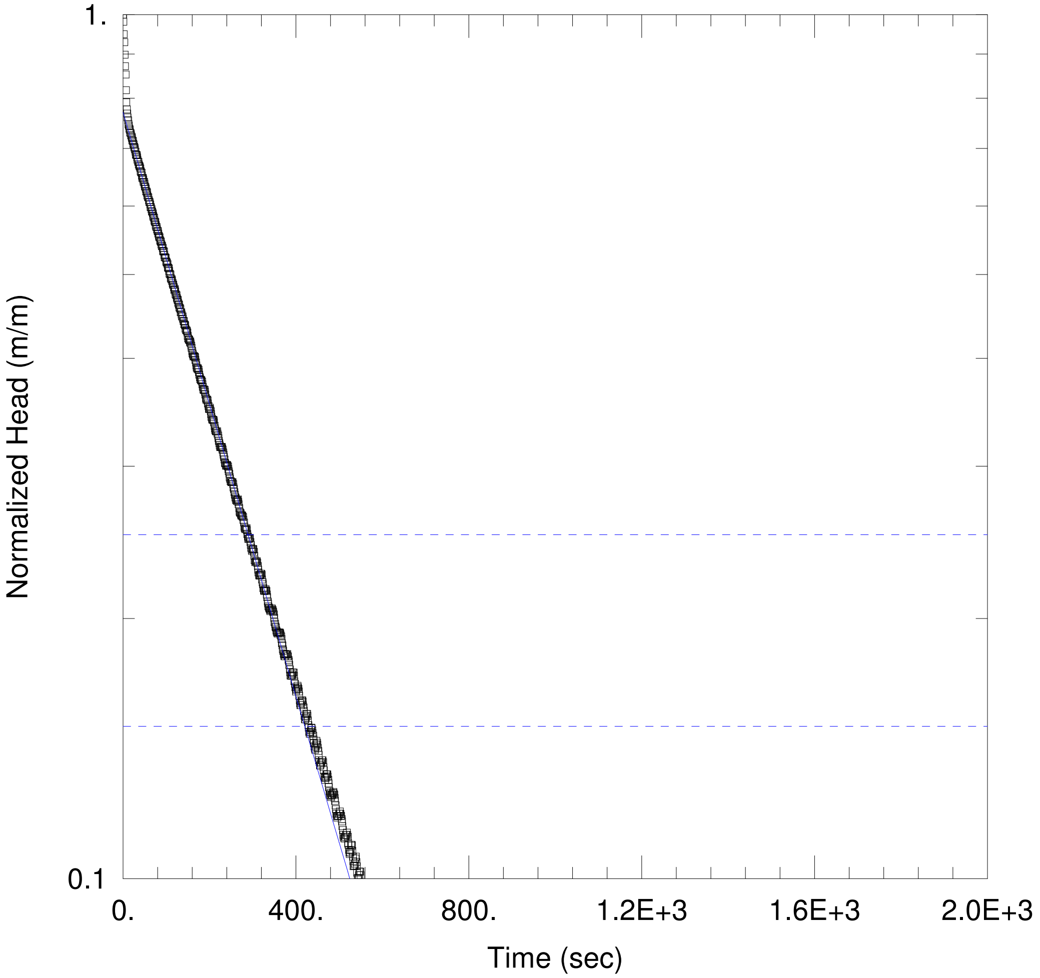
WELL DATA (BH12-OP-01 Test 5)

Initial Displacement: 5.47 m
Static Water Column Height: 165. m
Total Well Penetration Depth: 165. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 7.917E-8 m/sec
y0 = 4.622 m



BH12-OP-01 6A

Data Set: C:\...\BH12-OP-01- test 6a_RH test (transducer).aqt
Date: 10/19/12 Time: 10:24:41

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 10/04/2012

AQUIFER DATA

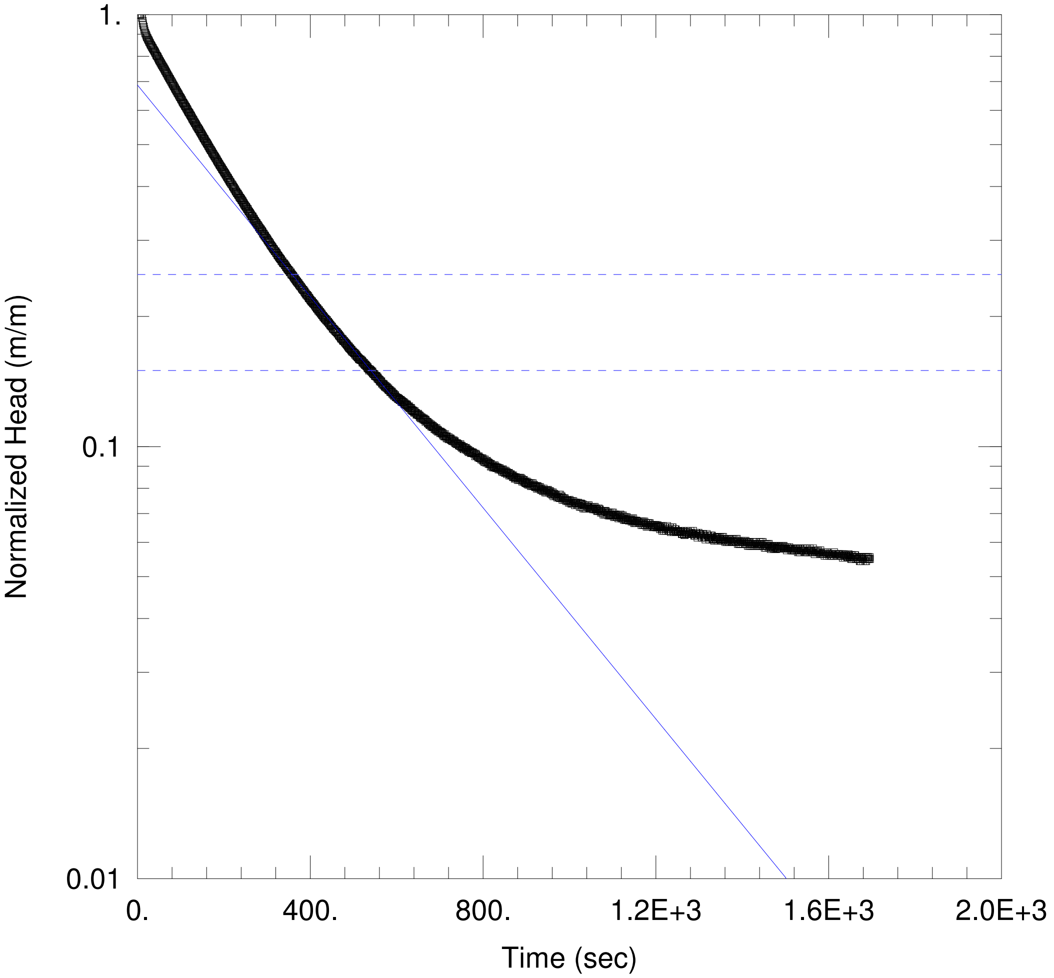
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-01 Test 6a)

Initial Displacement: 4.114 m
Static Water Column Height: 165. m
Total Well Penetration Depth: 165. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 4.463E-7 m/sec
y0 = 3.17 m



BH12-OP-01 TEST 6B

Data Set: C:\...\BH12-OP-01- test 6b_RH test (transducer).aqt
Date: 10/19/12 Time: 10:57:20

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 10/04/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

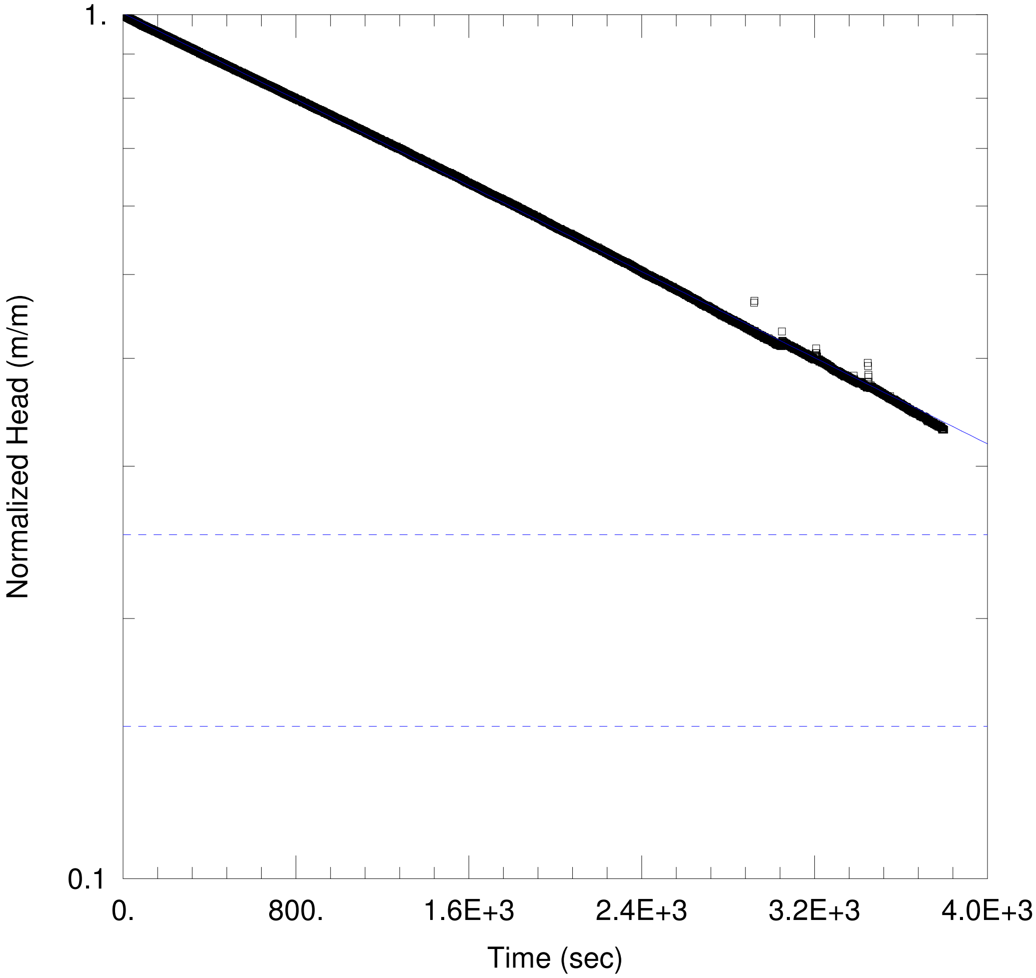
WELL DATA (BH12-OP-01 Test 6b)

Initial Displacement: 4.939 m
Total Well Penetration Depth: 165. m
Casing Radius: 0.03015 m
Static Water Column Height: 165. m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.228E-7 m/sec
y0 = 3.388 m



BH12-OP-01 TEST 7

Data Set: C:\...\BH12-OP-01- test 7_RH test.aqt
Date: 10/19/12 Time: 09:18:03

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 10/04/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

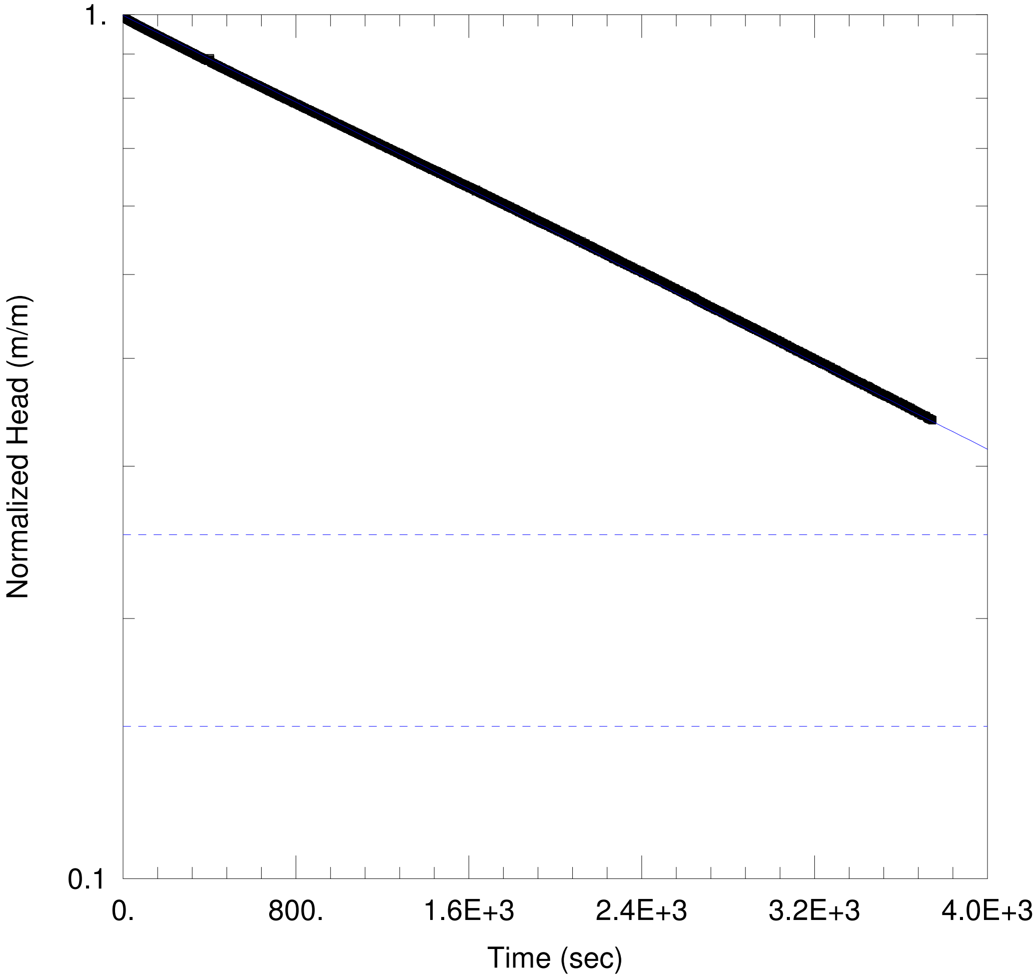
WELL DATA (BH12-OP-01 Test 7)

Initial Displacement: 4.879 m
Static Water Column Height: 207. m
Total Well Penetration Depth: 207. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.29E-8 m/sec
y0 = 4.896 m



BH12-OP-01 TEST 8

Data Set: C:\...\BH12-OP-01- test 8_RH test.aqt
Date: 10/19/12 Time: 09:15:07

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 11/04/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

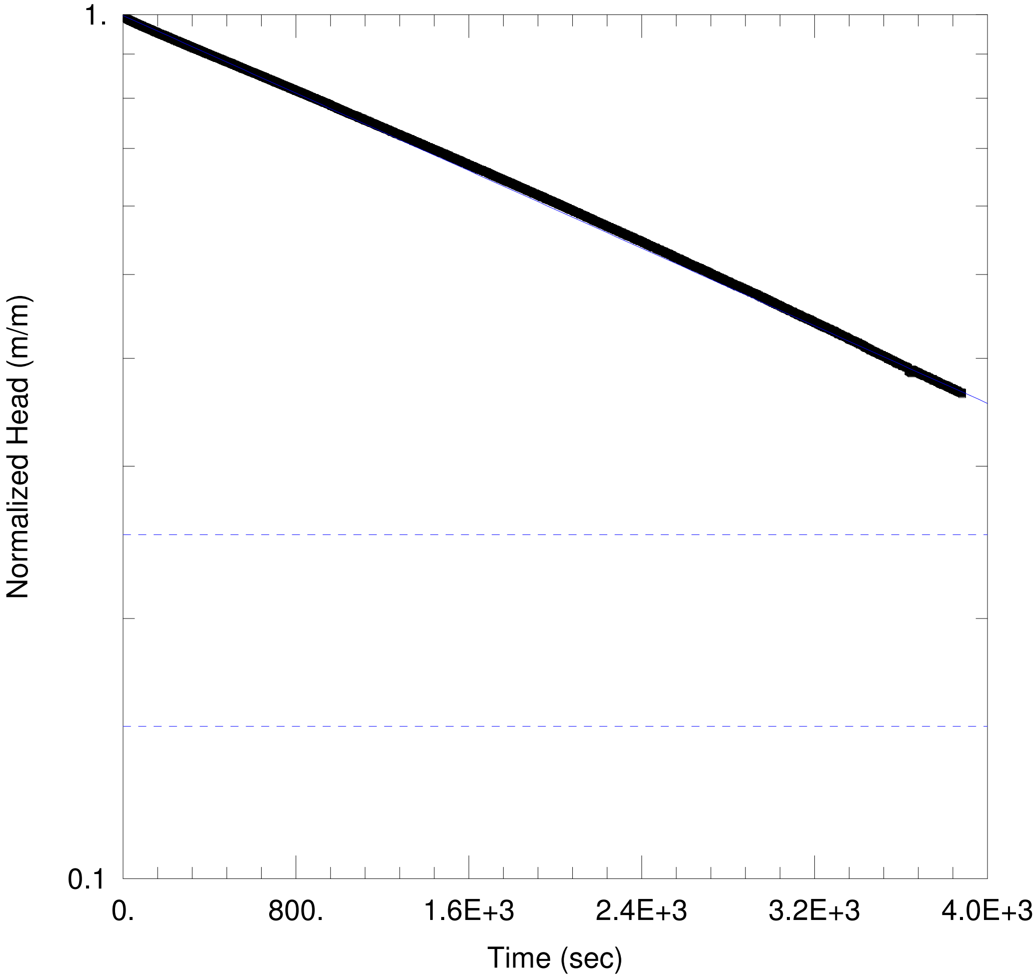
WELL DATA (BH12-OP-01 Test 8)

Initial Displacement: 4.889 m
Total Well Penetration Depth: 250.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 249. m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.314E-8 m/sec
y0 = 4.879 m



BH12-OP-01 TEST 9

Data Set: C:\...\BH12-OP-01- test 9_RH test.aqt
Date: 10/19/12 Time: 09:08:20

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 11/04/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

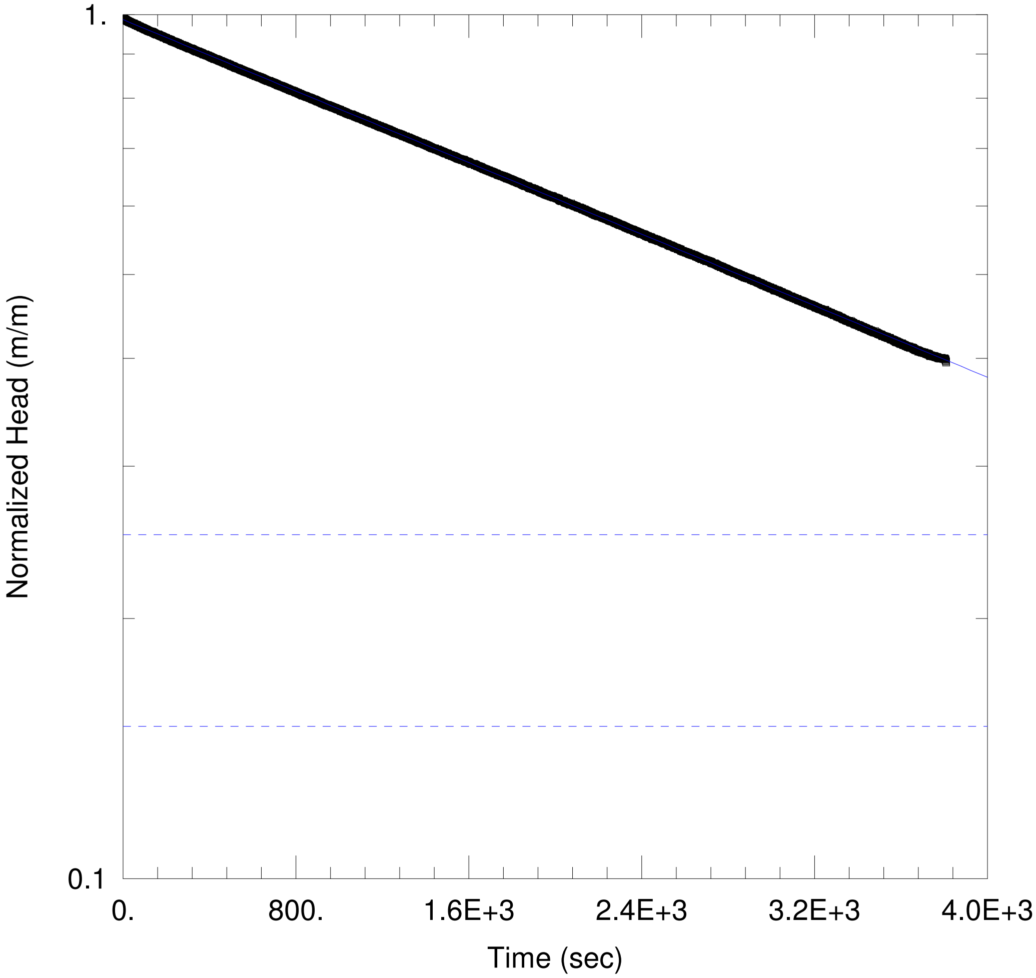
WELL DATA (BH12-OP-01 Test 9)

Initial Displacement: 4.867 m
Static Water Column Height: 228. m
Total Well Penetration Depth: 229. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 2.963E-8 m/sec
y0 = 4.853 m



BH12-OP-01 TEST 10

Data Set: C:\...\BH12-OP-01- test 10_RH test.aqt
Date: 10/19/12 Time: 09:07:53

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 12/04/2012

AQUIFER DATA

Saturated Thickness: 21. m Anisotropy Ratio (Kz/Kr): 1.

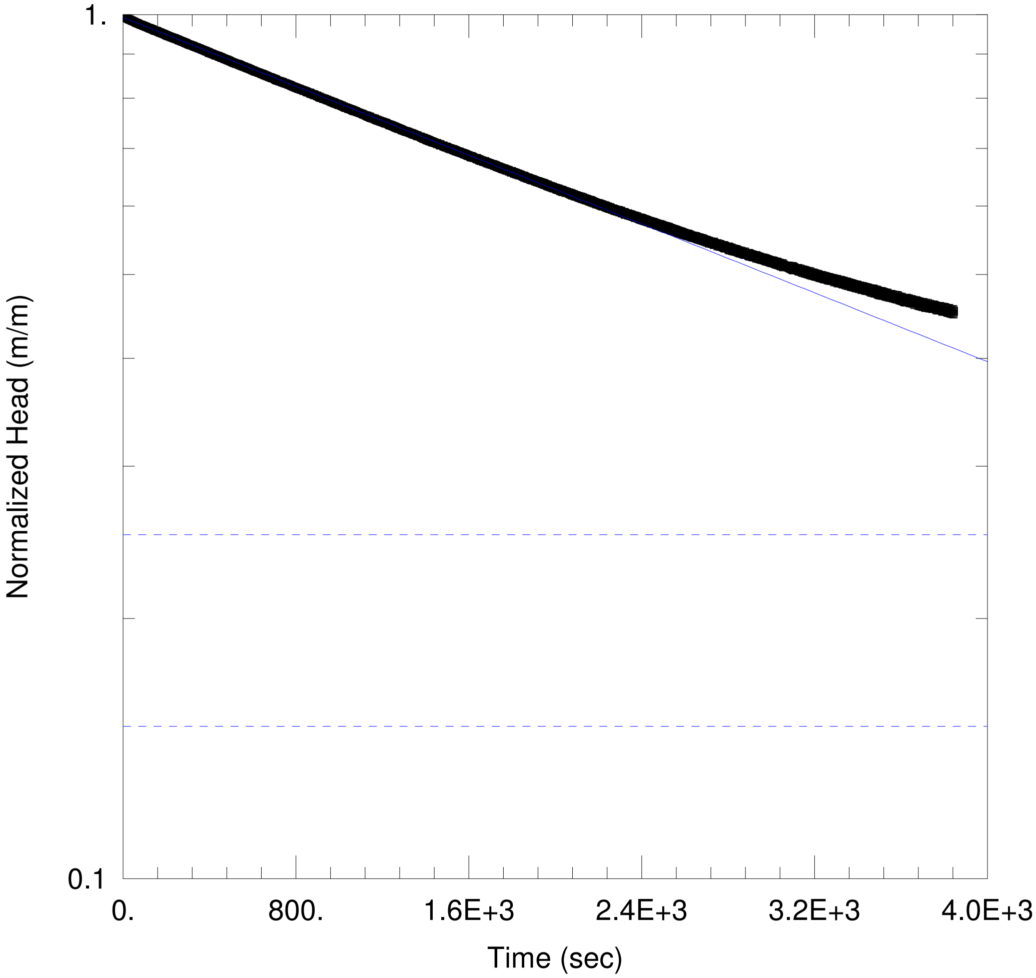
WELL DATA (BH12-OP-01 Test 10)

Initial Displacement: 4.982 m Static Water Column Height: 270. m
Total Well Penetration Depth: 271.5 m Screen Length: 21. m
Casing Radius: 0.03015 m Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 2.732E-8 m/sec y0 = 4.915 m



BH12-OP-01 TEST 11

Data Set: C:\...\BH12-OP-01- test 11_RH test.aqt
Date: 10/19/12 Time: 09:02:50

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 12/04/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

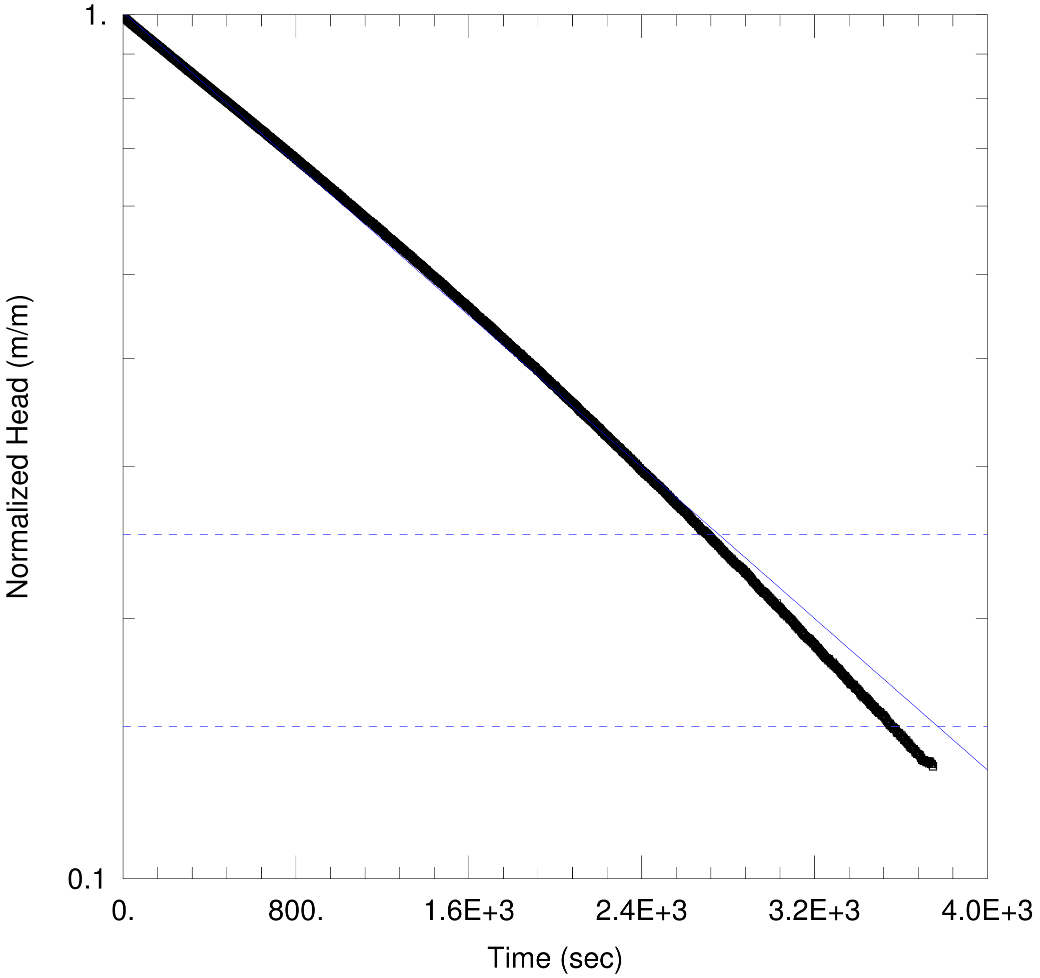
WELL DATA (BH12-OP-01 Test 11)

Initial Displacement: 6.294 m
Static Water Column Height: 291. m
Total Well Penetration Depth: 292.5 m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 2.63E-8 m/sec
y0 = 6.246 m



BH12-OP-01 TEST 12

Data Set: C:\...\BH12-OP-01- test 12_RH test.aqt
Date: 10/19/12 Time: 08:59:06

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 12/04/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

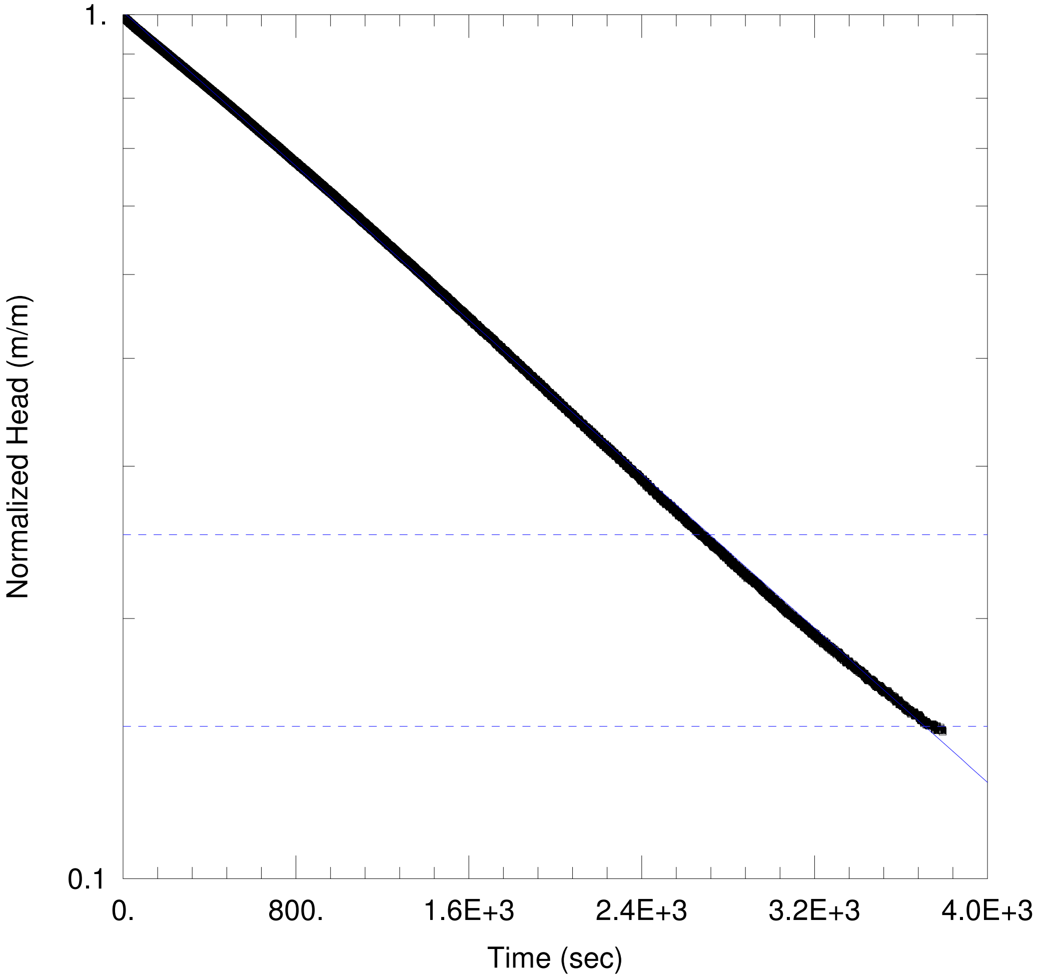
WELL DATA (BH12-OP-01 Test 12)

Initial Displacement: 5.036 m
Total Well Penetration Depth: 313.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 312. m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 5.789E-8 m/sec
y0 = 5.066 m



BH12-OP-01 TEST 13

Data Set: C:\...\BH12-OP-01- test 13_RH test.aqt
Date: 10/19/12
Time: 08:50:43

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC11392
Test Well: BH12-OP-01
Test Date: 13/04/2012

AQUIFER DATA

Saturated Thickness: 43.5 m
Anisotropy Ratio (Kz/Kr): 1.

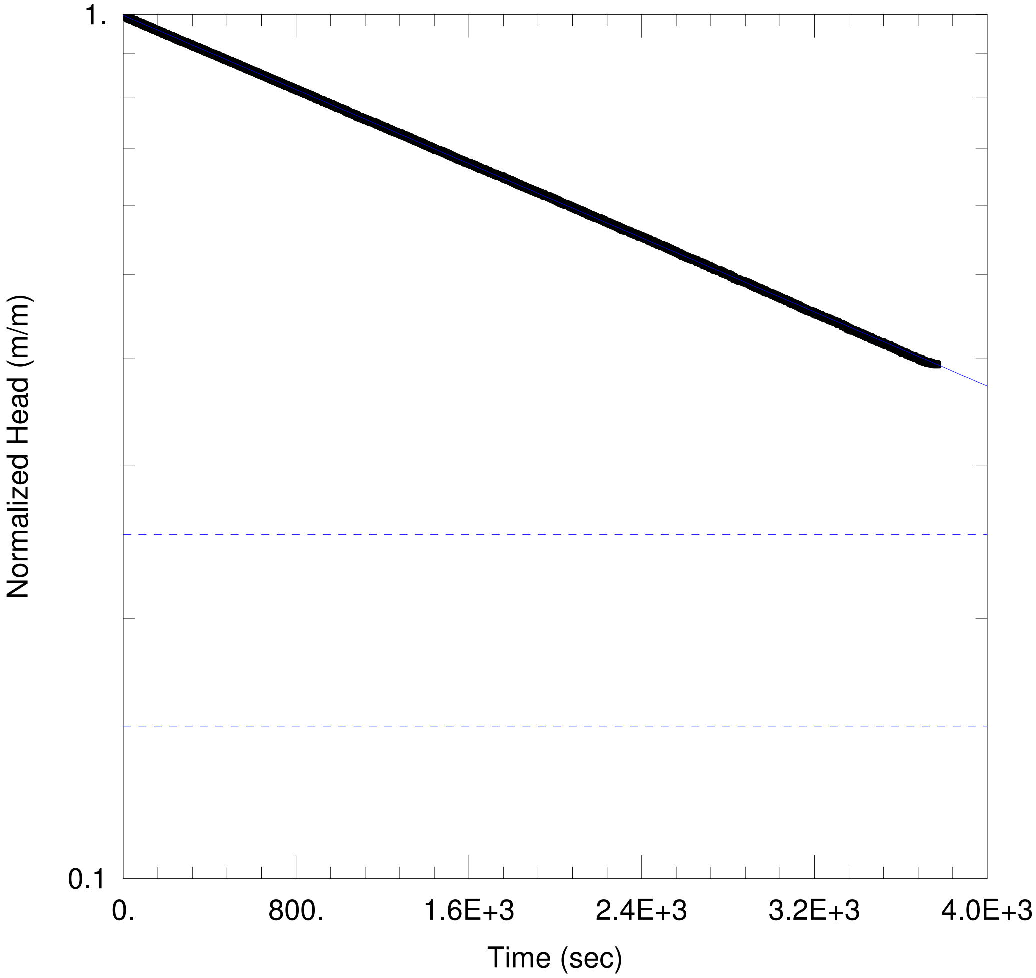
WELL DATA (BH12-OP-01 Test 13)

Initial Displacement: 5.42 m
Static Water Column Height: 345. m
Total Well Penetration Depth: 344.5 m
Screen Length: 43.5 m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 2.841E-8 m/sec
y0 = 5.458 m



BH12-OP-01 TEST 14

Data Set: C:\...\BH12-OP-01- test 14_RH test.aqt
Date: 10/19/12
Time: 08:47:51

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 13/04/2012

AQUIFER DATA

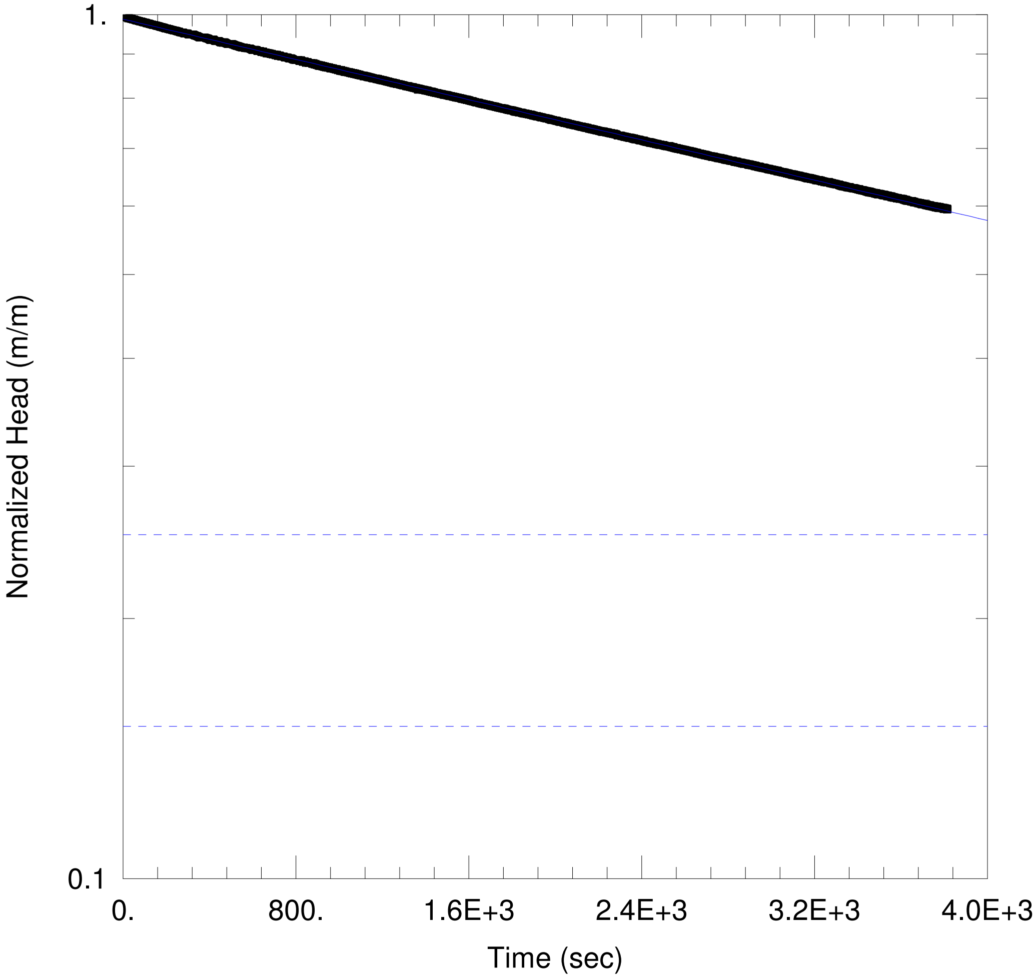
Saturated Thickness: 70.5 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-01 Test 14)

Initial Displacement: 5.04 m
Static Water Column Height: 372. m
Total Well Penetration Depth: 371.5 m
Screen Length: 70.5 m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 8.436E-9 m/sec
y0 = 5.025 m



BH12-OP-01 TEST 15

Data Set: C:\...\BH12-OP-01- test 15_RH test.aqt
Date: 10/19/12 Time: 08:52:00

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-01
Test Date: 14/04/2012

AQUIFER DATA

Saturated Thickness: 100.5 m
Anisotropy Ratio (Kz/Kr): 1.

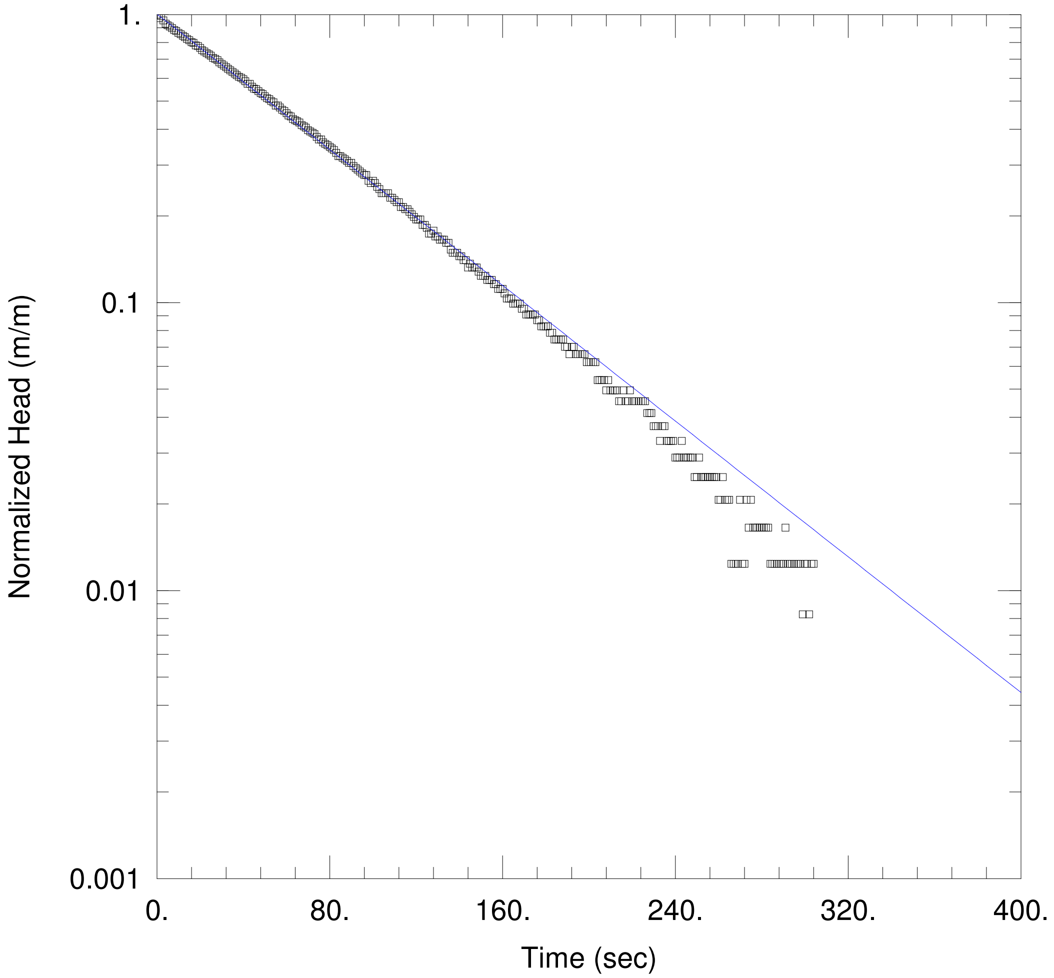
WELL DATA (BH12-OP-01 Test 15)

Initial Displacement: 6.19 m
Total Well Penetration Depth: 401.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 402. m
Screen Length: 100.5 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.212E-9 m/sec
y0 = 6.113 m



BH12-OP-03 TEST 1

Data Set: C:\...\BH12-OP-03_FH_Test_1.aqt
Date: 10/19/12
Time: 11:57:50

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/05/2012

AQUIFER DATA

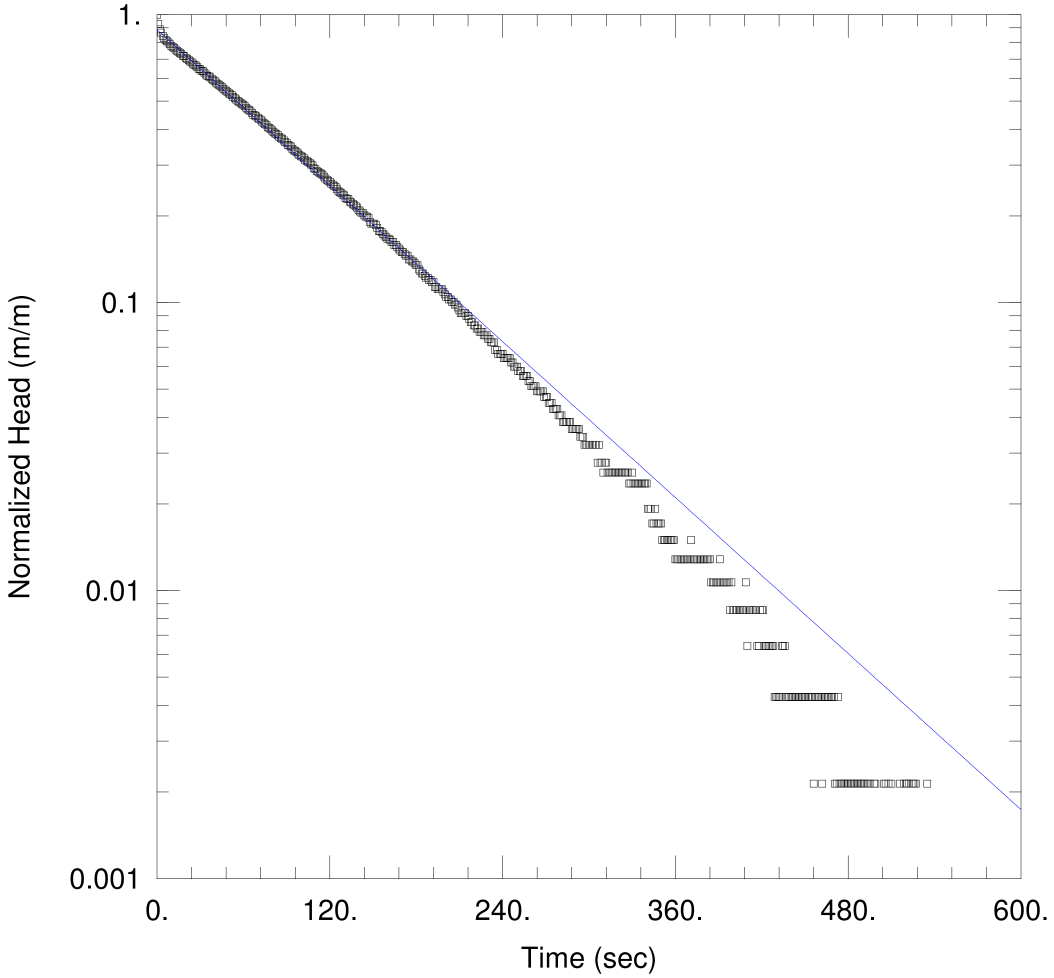
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 2.42 m
Static Water Column Height: 54.4 m
Total Well Penetration Depth: 57. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 1.556E-6 m/sec
y0 = 2.433 m



BH12-OP-03 TEST 2

Data Set: C:\...\BH12-OP-03_FH_Test_2.aqt
Date: 10/19/12 Time: 11:12:36

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/27/2012

AQUIFER DATA

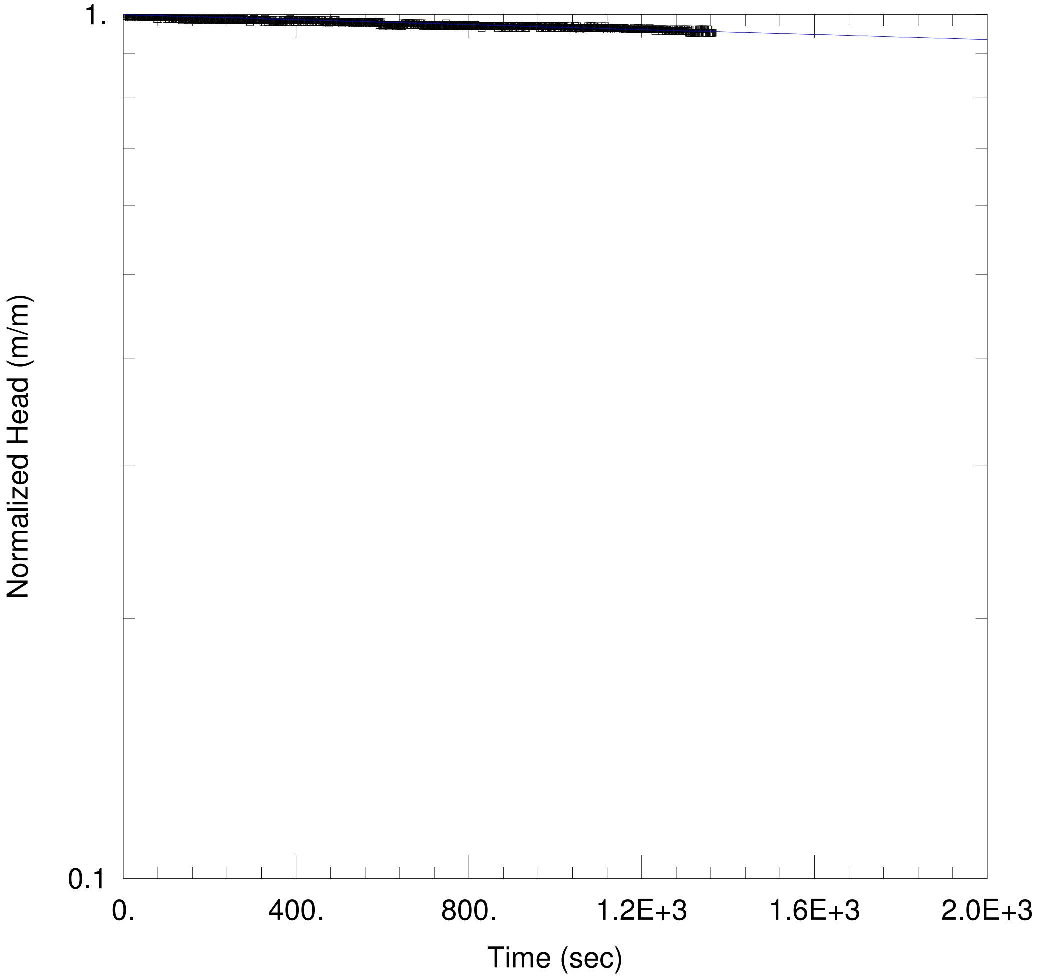
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 4.68 m
Total Well Penetration Depth: 76. m
Casing Radius: 0.03015 m
Static Water Column Height: 74.4 m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 1.192E-6 m/sec
y0 = 4.149 m



BH12-OP-03 TEST 3

Data Set: C:\...\BH12-OP-03_FH_Test_3.aqt
Date: 10/19/12 Time: 11:15:35

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/27/2012

AQUIFER DATA

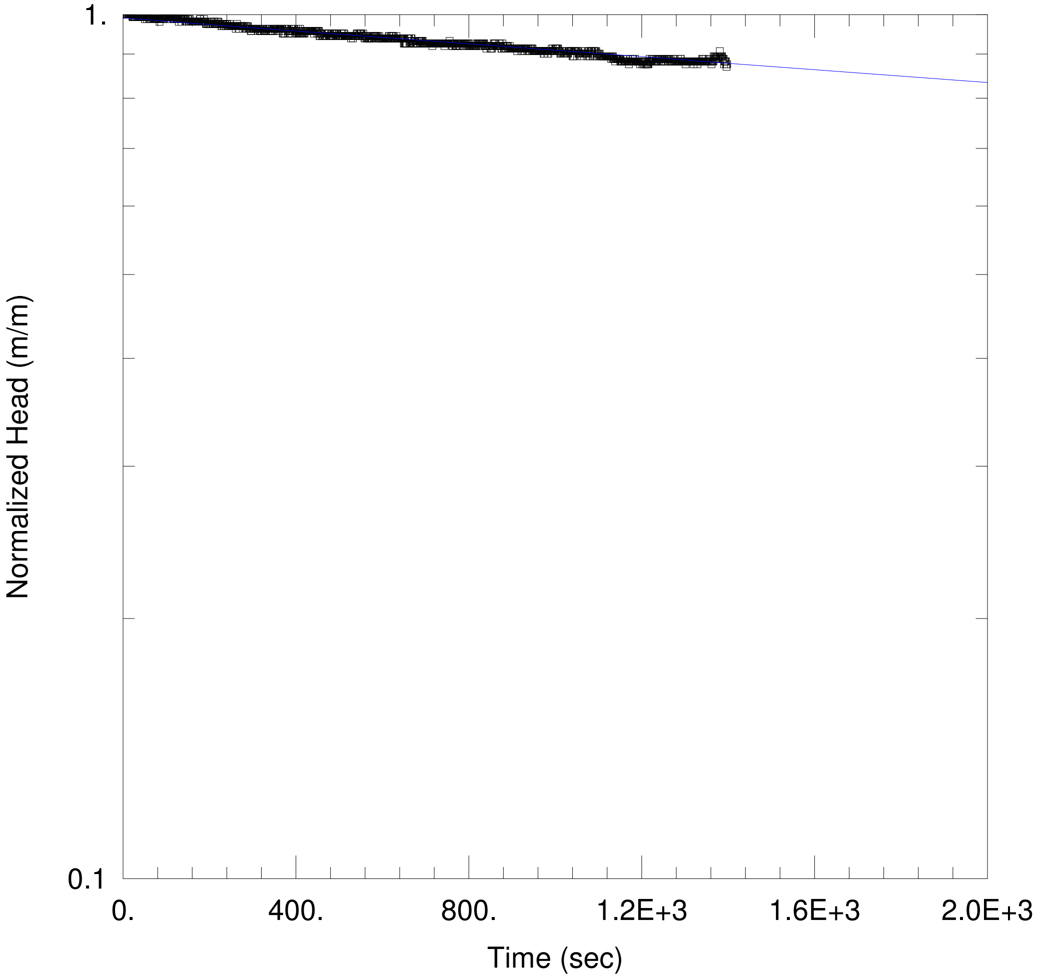
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 2.51 m
Static Water Column Height: 93.3 m
Total Well Penetration Depth: 95. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 3.816E-9 m/sec
y0 = 2.508 m



BH12-OP-03 TEST 4

Data Set: C:\...\BH12-OP-03_FH_Test_4.aqt
Date: 10/19/12
Time: 11:20:00

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/27/2012

AQUIFER DATA

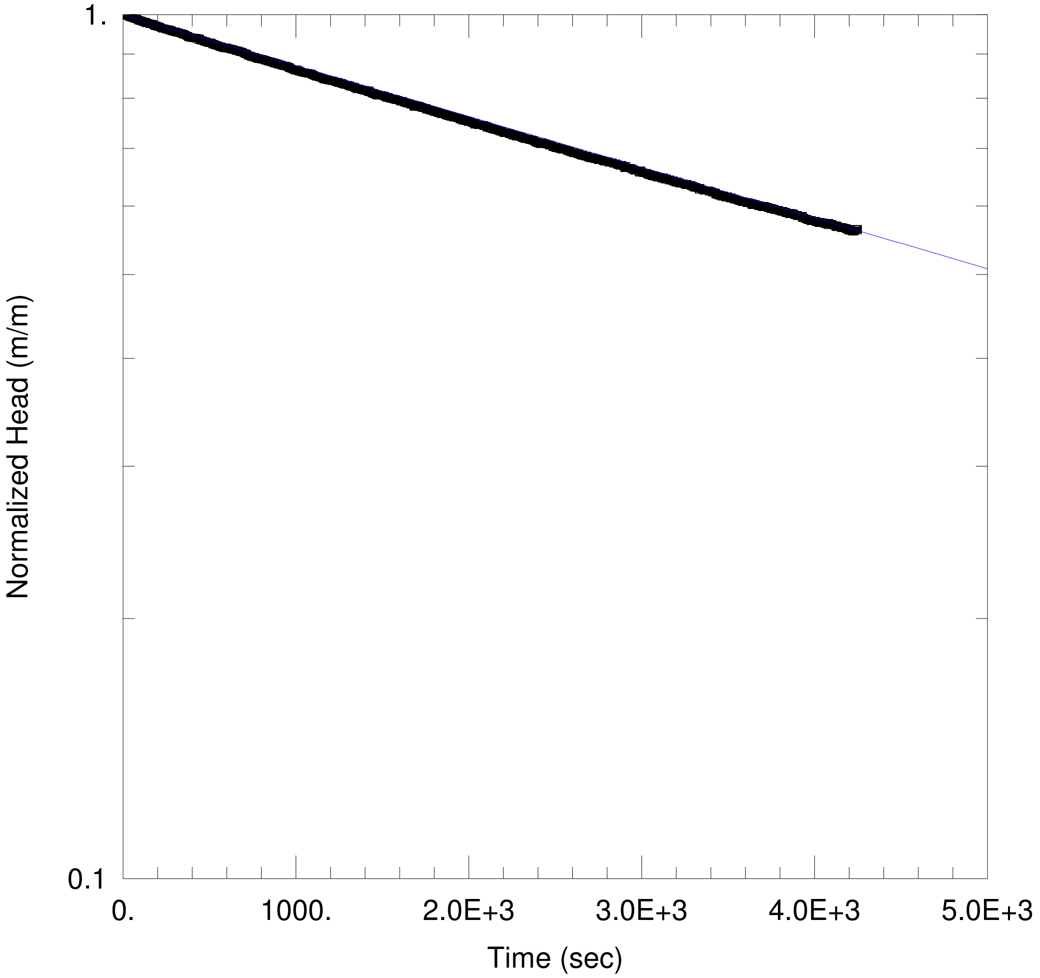
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 1.614 m
Static Water Column Height: 112.4 m
Total Well Penetration Depth: 115. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 9.859E-9 m/sec
y0 = 1.599 m



BH12-OP-03 TEST 5

Data Set: C:\...\BH12-OP-03_FH_Test_5.aqt
Date: 10/19/12
Time: 11:23:23

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/27/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

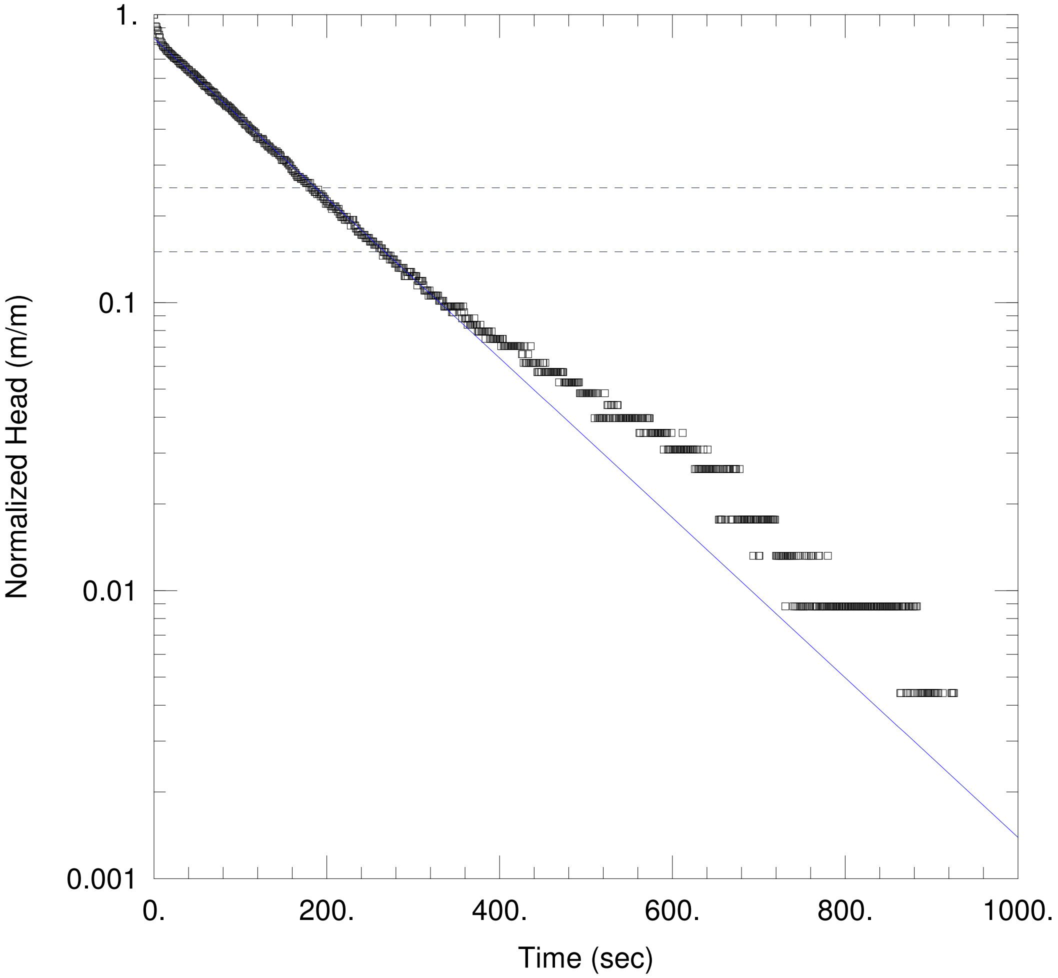
WELL DATA (New Well)

Initial Displacement: 6.38 m
Static Water Column Height: 131.4 m
Total Well Penetration Depth: 131.4 m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.551E-8 m/sec
y0 = 6.373 m



BH12-OP-03 TEST 6

Data Set: C:\...\BH12-OP-03_FH_Test_6.aqt
Date: 10/19/12
Time: 13:09:10

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/28/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

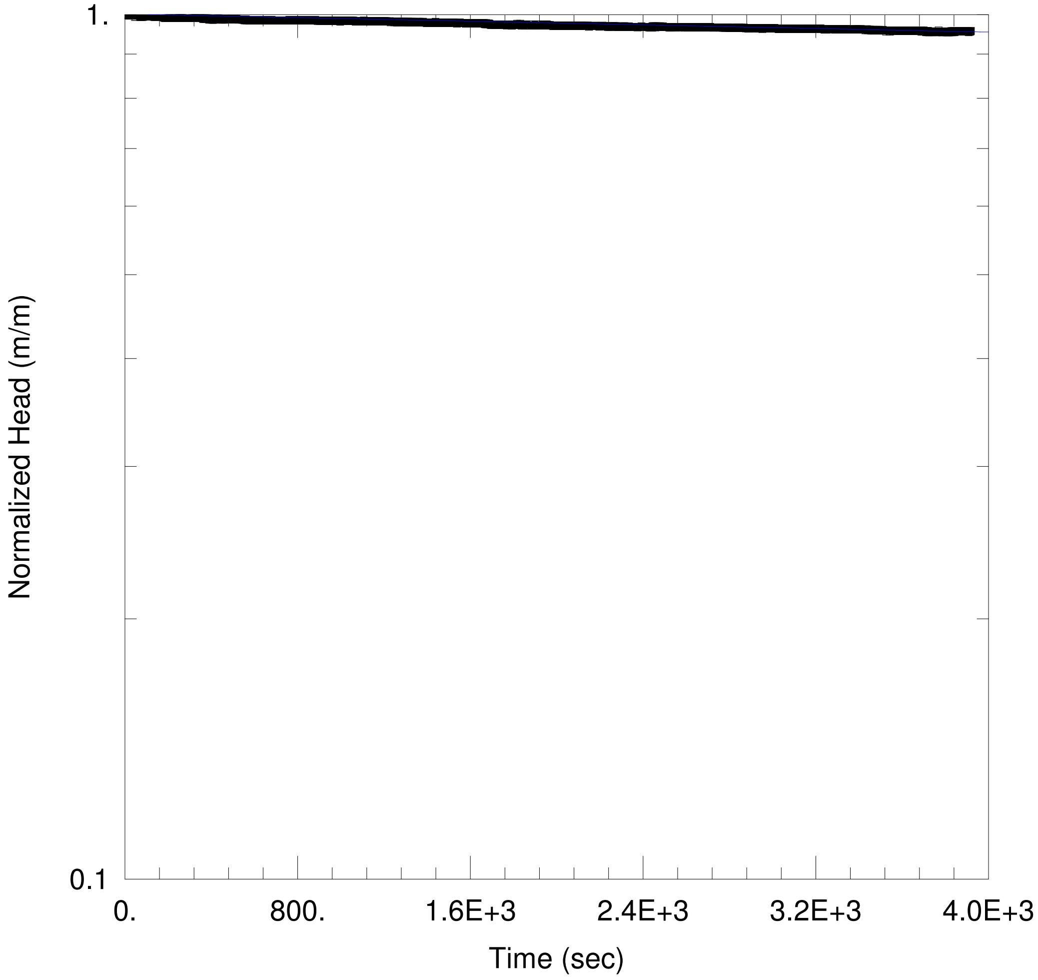
WELL DATA (BH12-OP-03)

Initial Displacement: 2.27 m
Static Water Column Height: 169.5 m
Total Well Penetration Depth: 166. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 7.327E-7 m/sec
y0 = 1.878 m



BH12-OP-03 TEST 7

Data Set: C:\...\BH12-OP-03_FH_Test_7.aqt
Date: 10/19/12
Time: 12:03:01

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/28/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

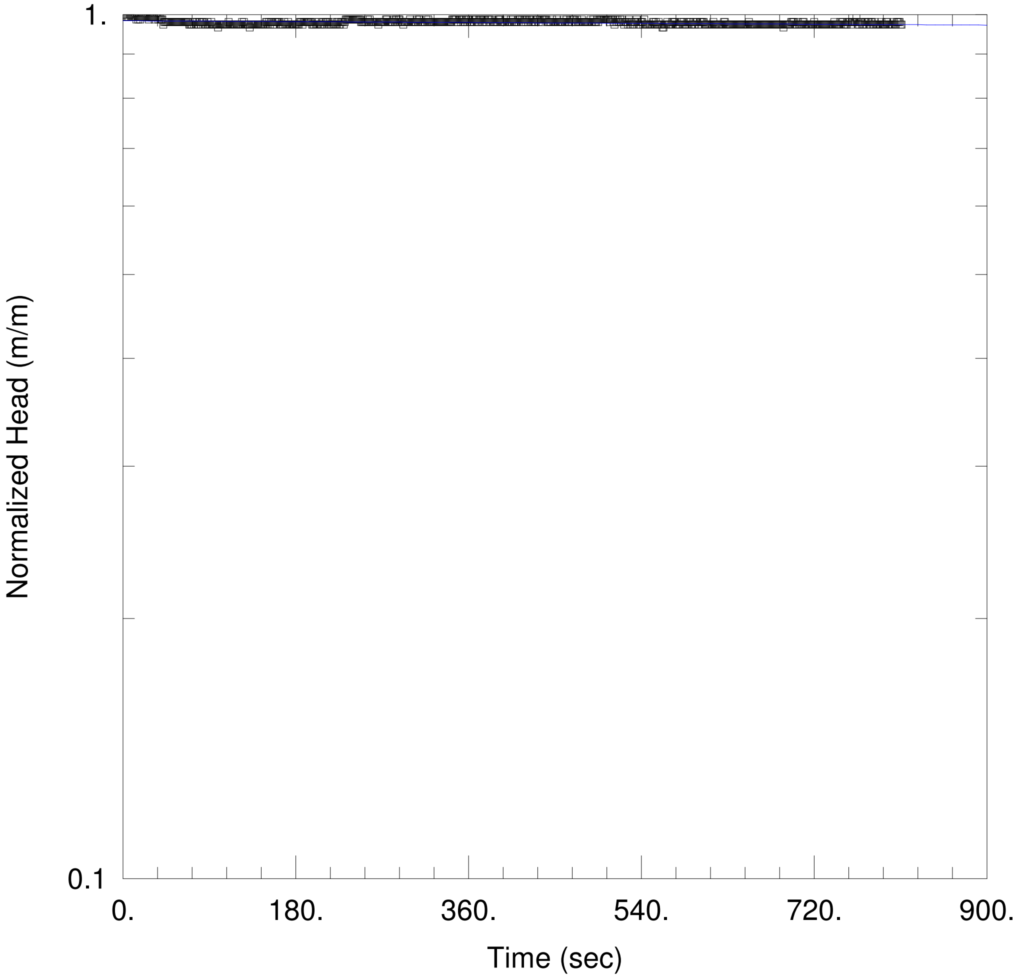
WELL DATA (New Well)

Initial Displacement: 6.26 m
Total Well Penetration Depth: 171. m
Casing Radius: 0.03015 m
Static Water Column Height: 169.5 m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.381E-9 m/sec
y0 = 6.268 m



BH12-OP-03 TEST 8

Data Set: C:\...\BH12-OP-03_FH_Test_8.aqt
Date: 10/19/12
Time: 12:14:46

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/29/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

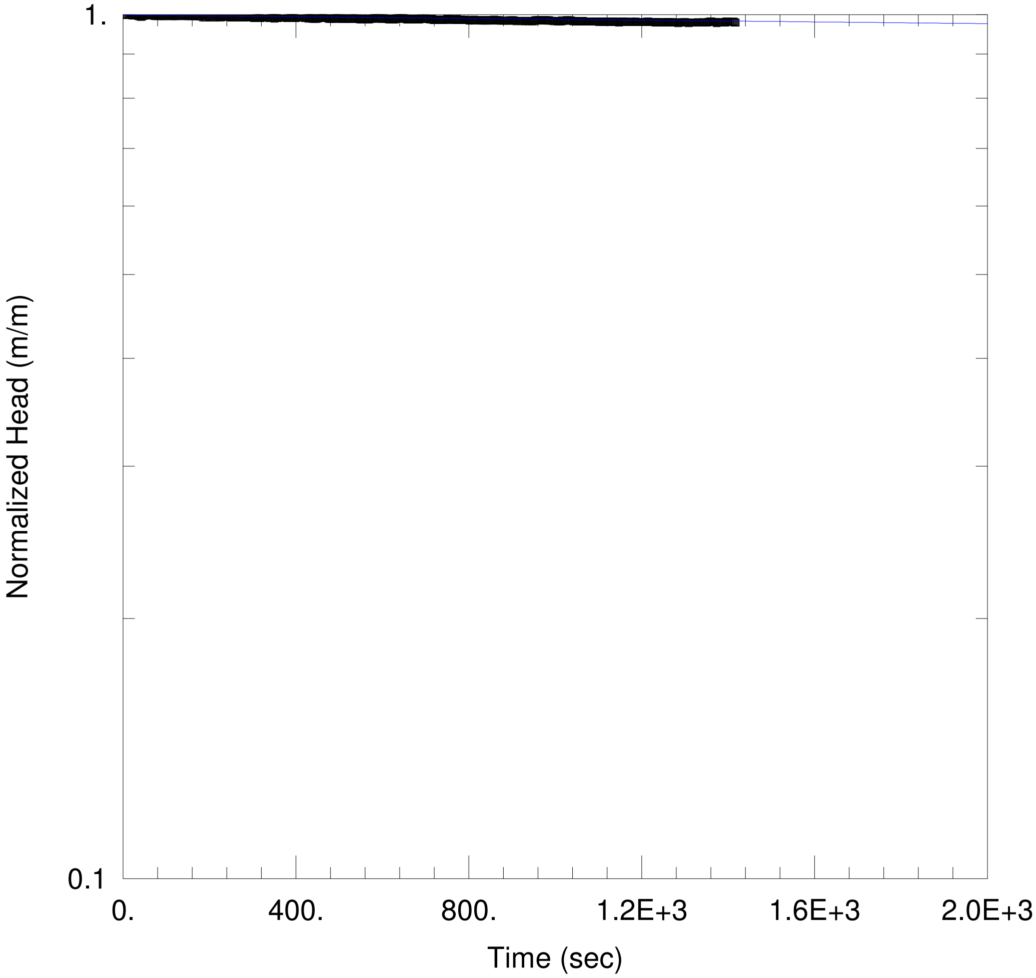
WELL DATA (New Well)

Initial Displacement: 1.49 m
Total Well Penetration Depth: 190.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 188.5 m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.46E-9 m/sec
y0 = 1.465 m



BH12-OP-03 TEST 9

Data Set: C:\...\BH12-OP-03_FH_Test_9.aqt
Date: 10/19/12 Time: 12:16:06

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/29/2012

AQUIFER DATA

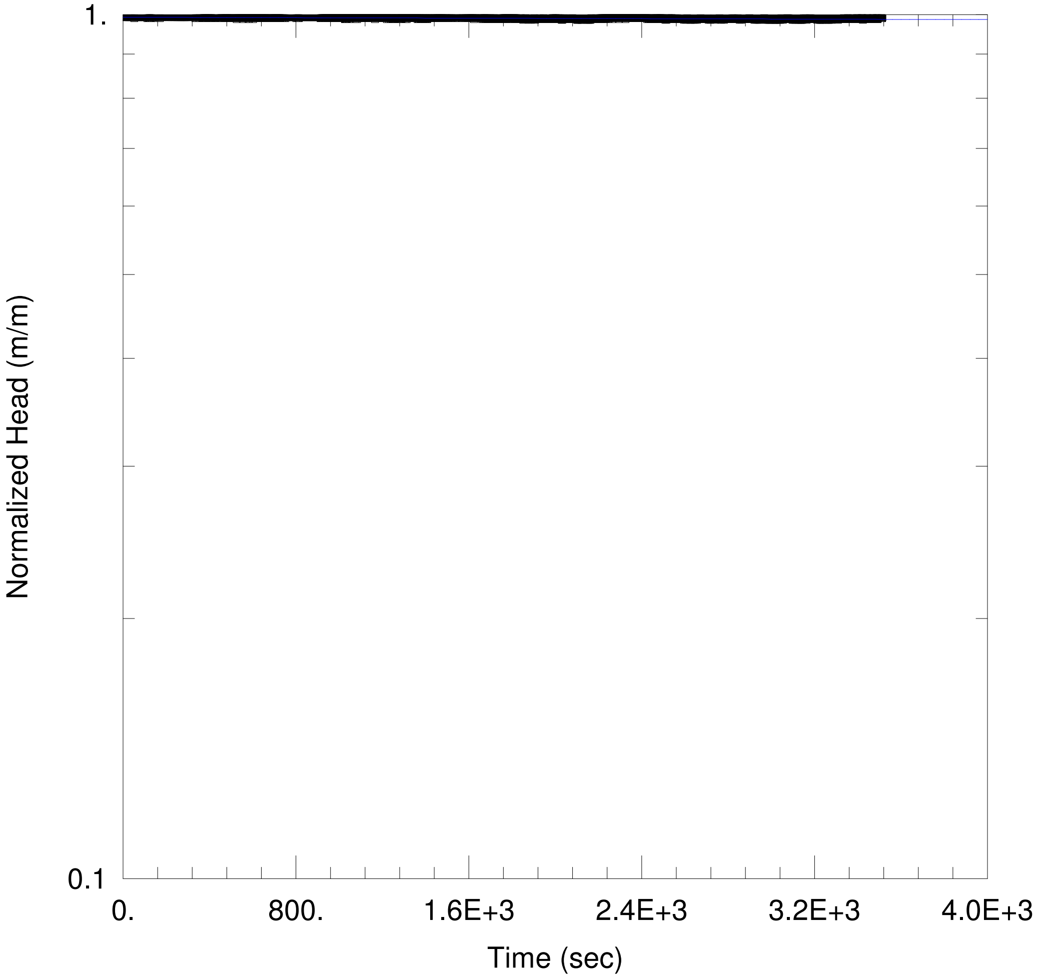
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 5.98 m
Total Well Penetration Depth: 209.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 207.5 m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 1.326E-9 m/sec
y0 = 5.973 m



BH12-OP-03 TEST 10

Data Set: C:\...\test10.aqt
Date: 10/19/12
Time: 12:17:55

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/29/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

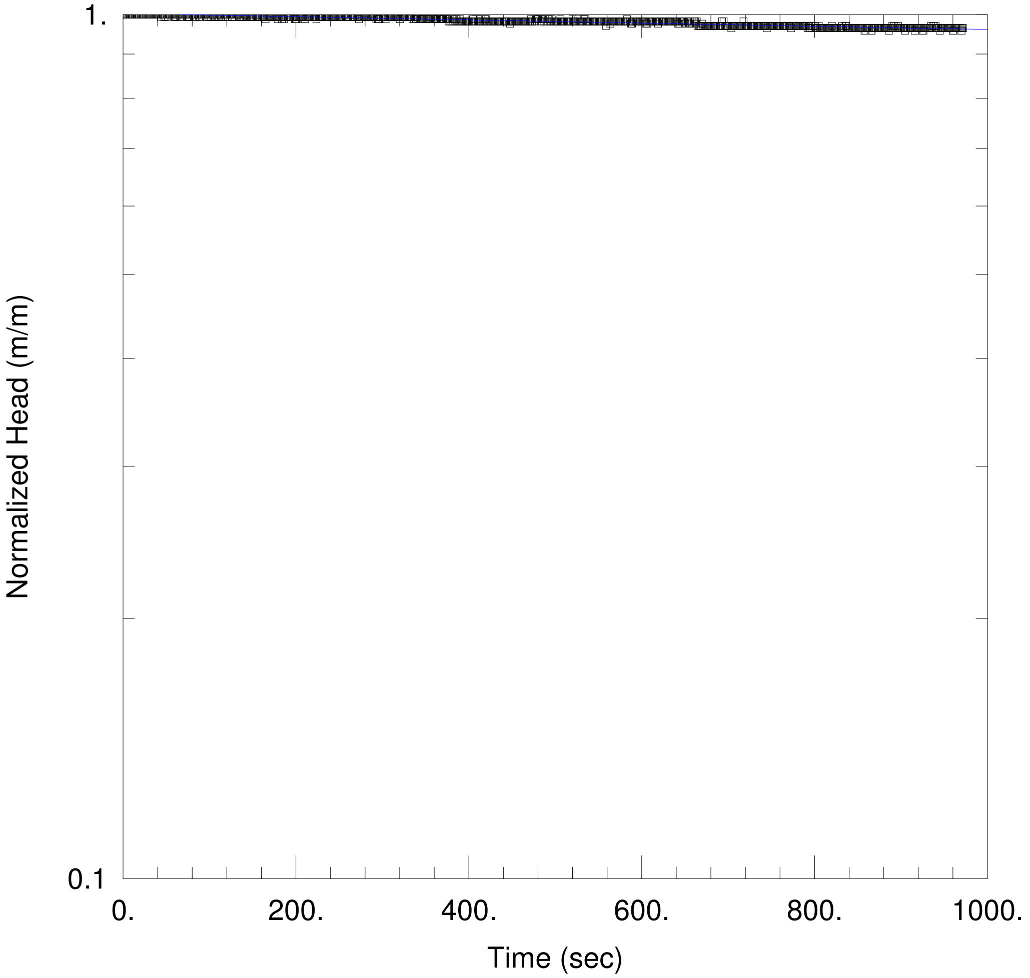
WELL DATA (BH12)

Initial Displacement: 4.19 m
Static Water Column Height: 226.3 m
Total Well Penetration Depth: 228.3 m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.842E-10 m/sec
y0 = 4.16 m



BH12-OP-03 TEST 11

Data Set: C:\...\test11.aqt
Date: 10/19/12
Time: 12:20:49

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 03/01/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

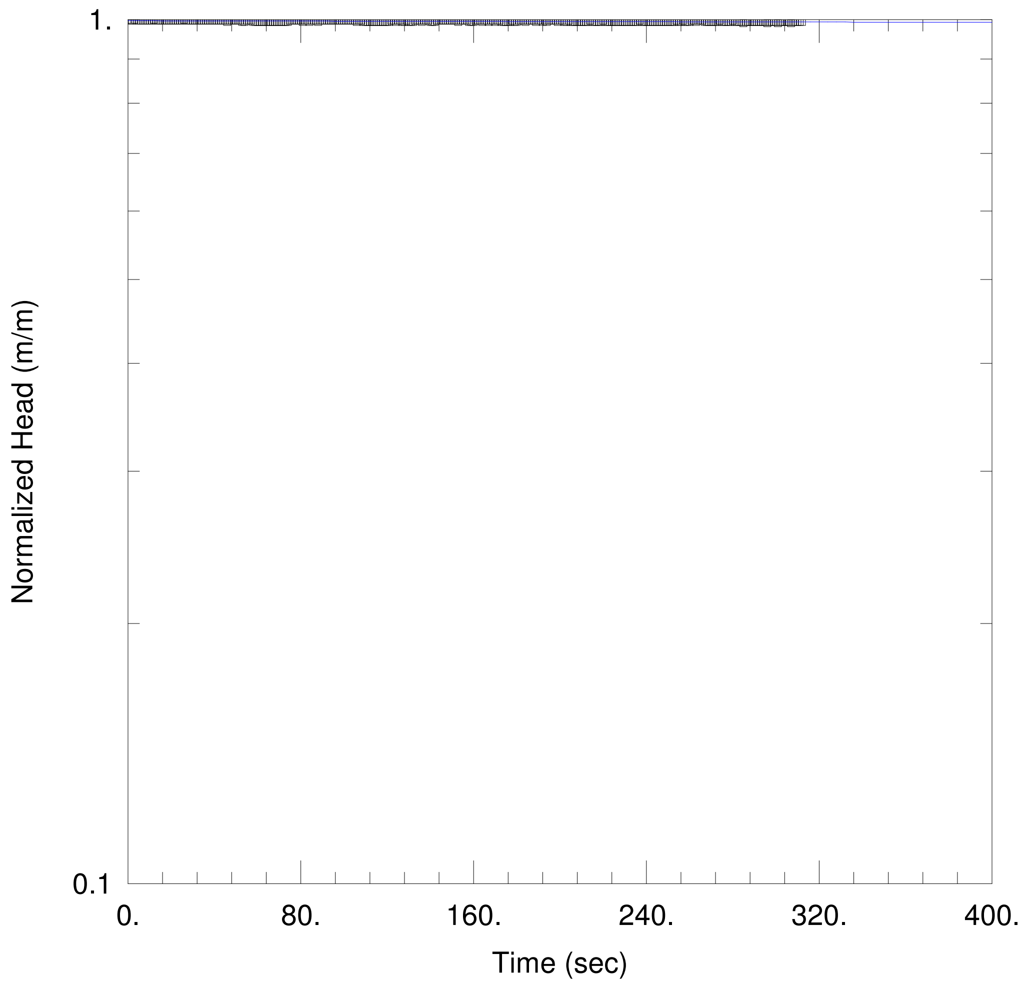
WELL DATA (BH12-OP-03)

Initial Displacement: 1.67 m
Static Water Column Height: 233.4 m
Total Well Penetration Depth: 218. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 4.919E-9 m/sec
y0 = 1.675 m



BH12-OP-03 TEST 12

Data Set: C:\...\test12.aqt
Date: 10/19/12 Time: 11:45:58

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-03
Test Date: 02/29/2012

AQUIFER DATA

Saturated Thickness: 21. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-03)

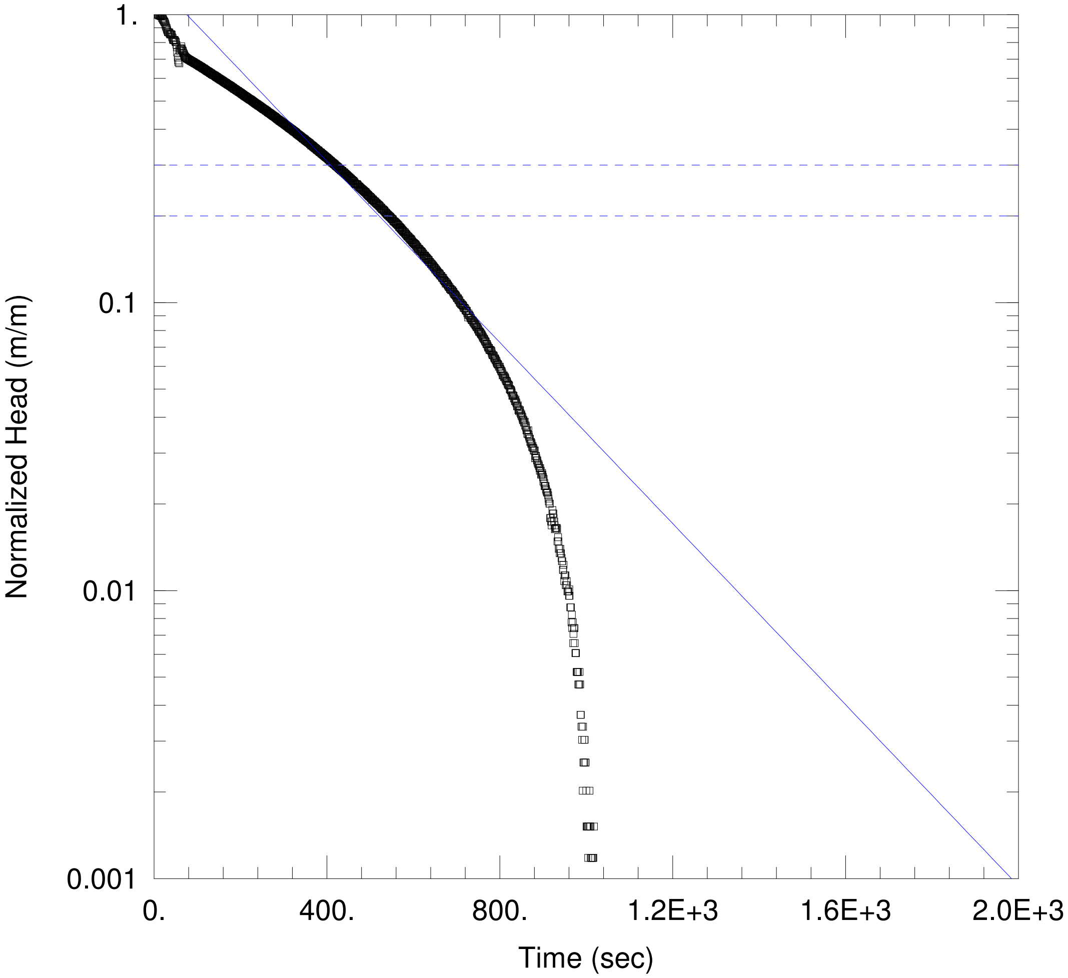
Initial Displacement: 3.12 m
Total Well Penetration Depth: 265. m
Casing Radius: 0.03015 m

Static Water Column Height: 263. m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.603E-9 m/sec y0 = 3.11 m



BH12-OP-05 TEST 1

Data Set: C:\...\BH12-OP-05- test 1_RH test.aqt

Date: 10/19/12 Time: 13:16:00

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 03/10/2012

AQUIFER DATA

Saturated Thickness: 19.5 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-05 Test 1)

Initial Displacement: 5.94 m
Total Well Penetration Depth: 19.5 m
Casing Radius: 0.03015 m

Static Water Column Height: 52.95 m
Screen Length: 19.5 m
Well Radius: 0.03775 m

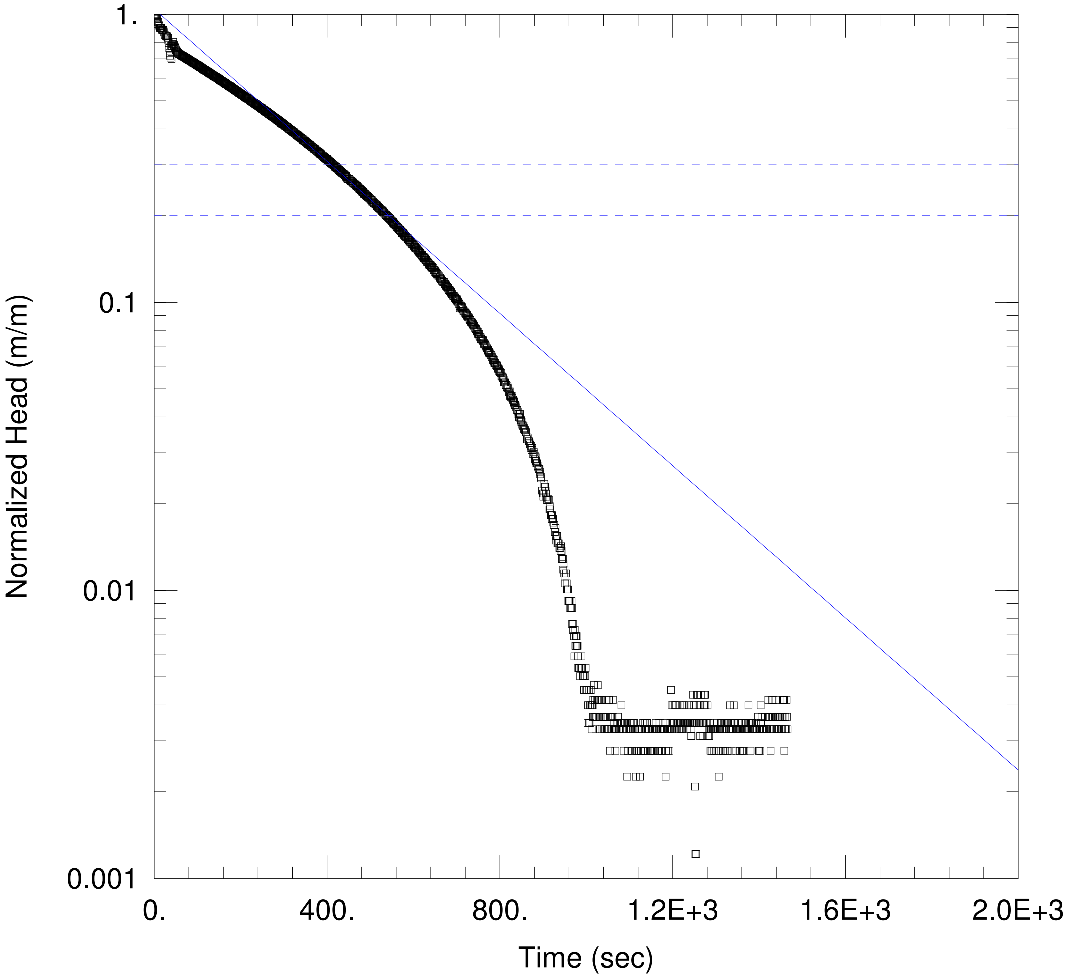
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 4.288E-7 m/sec

y0 = 7.814 m



BH12-OP-05 TEST 2A

Data Set: C:\...\BH12-OP-05- test 2a_RH test.aqt
Date: 10/19/12 Time: 13:19:15

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 03/11/2012

AQUIFER DATA

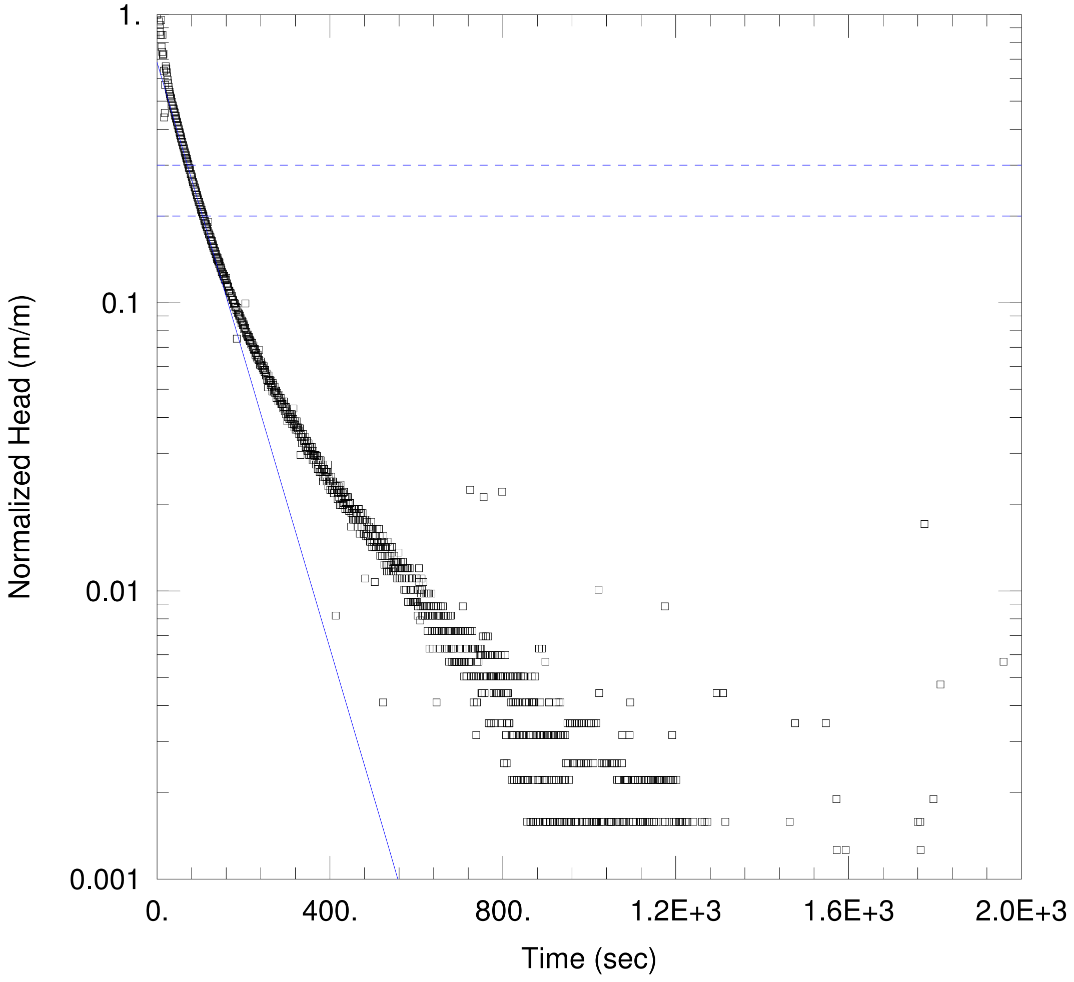
Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-05 Test 2a)

Initial Displacement: 5.77 m
Static Water Column Height: 71.9 m
Total Well Penetration Depth: 19.5 m
Screen Length: 19.5 m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.603E-7 m/sec
y0 = 6.015 m



BH12-OP-05 TEST 3

Data Set: C:\...\BH12-OP-05- test 3_RH test.aqt
Date: 10/19/12 Time: 13:20:54

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 03/11/2012

AQUIFER DATA

Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

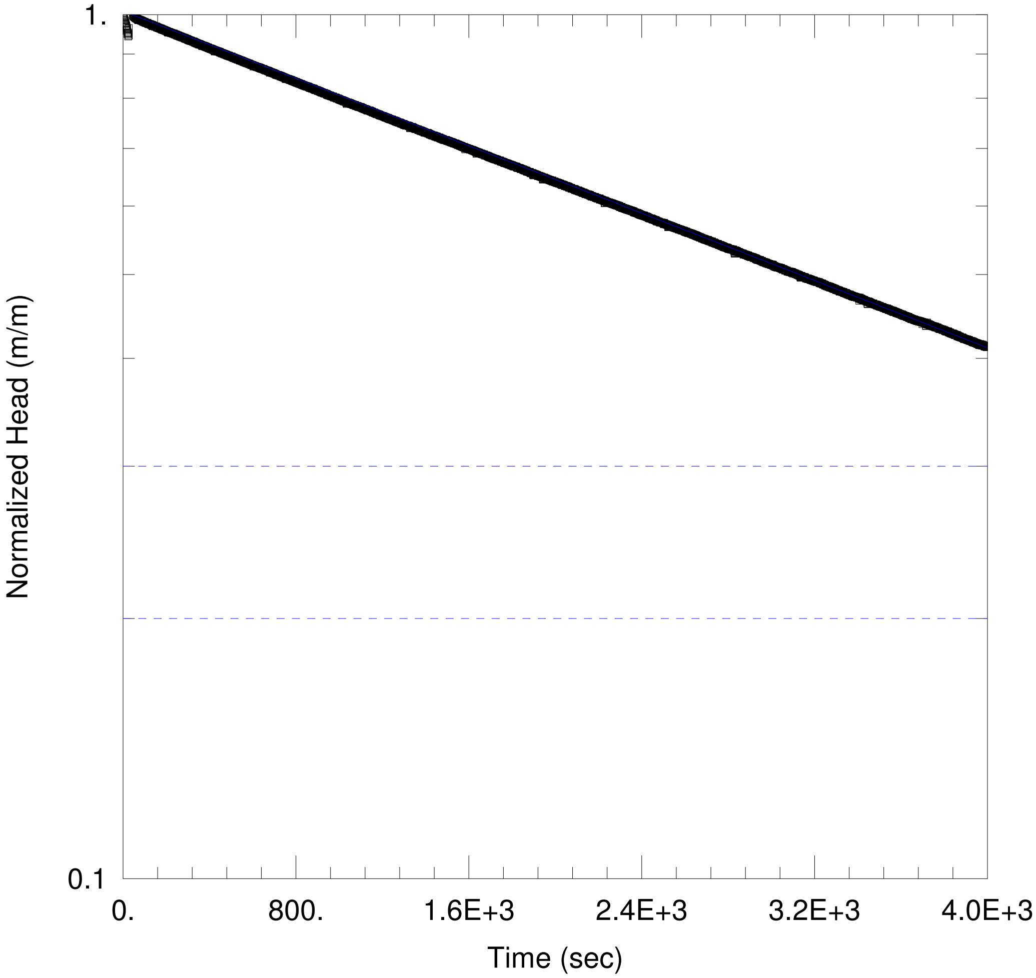
WELL DATA (BH12-OP-05 Test 3)

Initial Displacement: 3.17 m
Static Water Column Height: 91.12 m
Total Well Penetration Depth: 19.5 m
Screen Length: 19.5 m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.386E-6 m/sec
y0 = 2.164 m



BH12-OP-05 TEST 4

Data Set: C:\...\BH12-OP-05- test 4_RH test.aqt
Date: 10/19/12 Time: 13:21:53

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 03/12/2012

AQUIFER DATA

Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

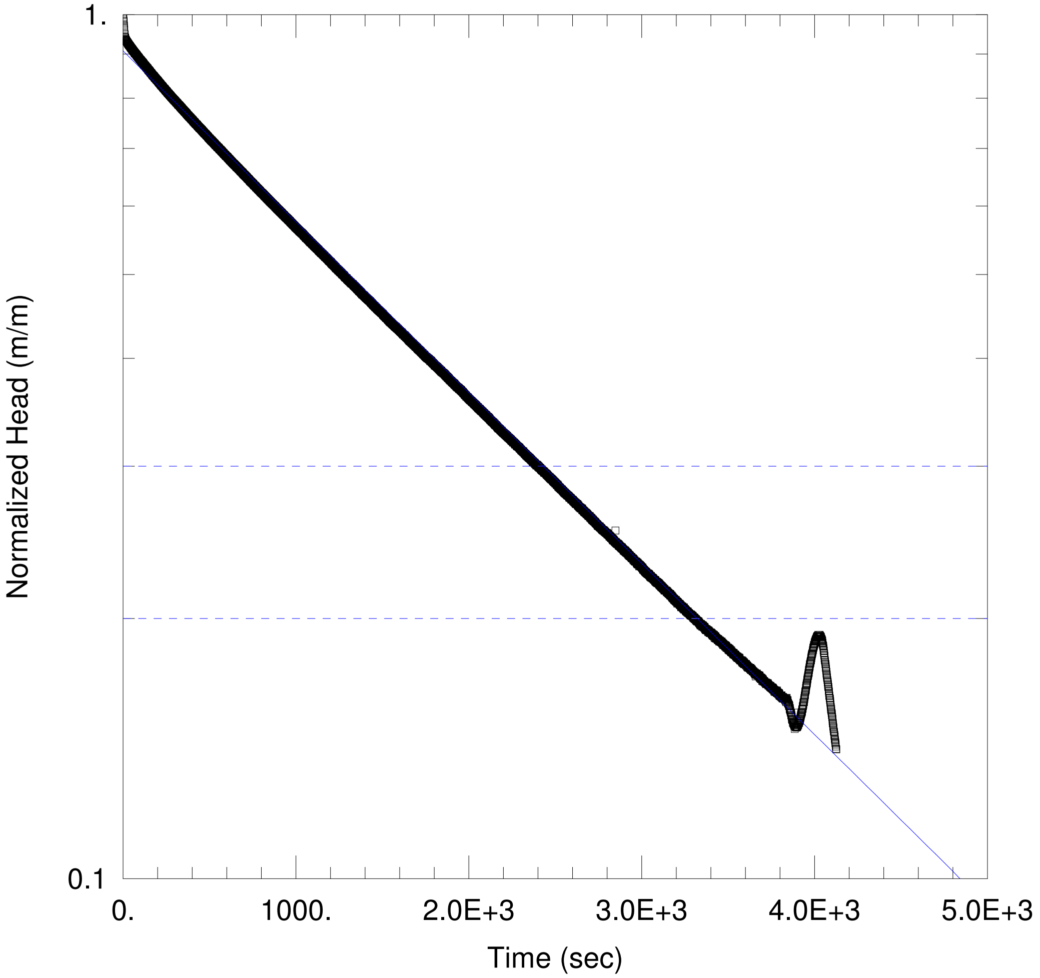
WELL DATA (BH12-OP-05 Test 4)

Initial Displacement: 4.88 m
Static Water Column Height: 110.2 m
Total Well Penetration Depth: 19.5 m
Screen Length: 19.5 m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.657E-8 m/sec
y0 = 4.925 m



BH12-OP-05 TEST 5

Data Set: C:\...\BH12-OP-05- test 5_RH test.aqt
Date: 10/19/12
Time: 13:24:19

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 03/12/2012

AQUIFER DATA

Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

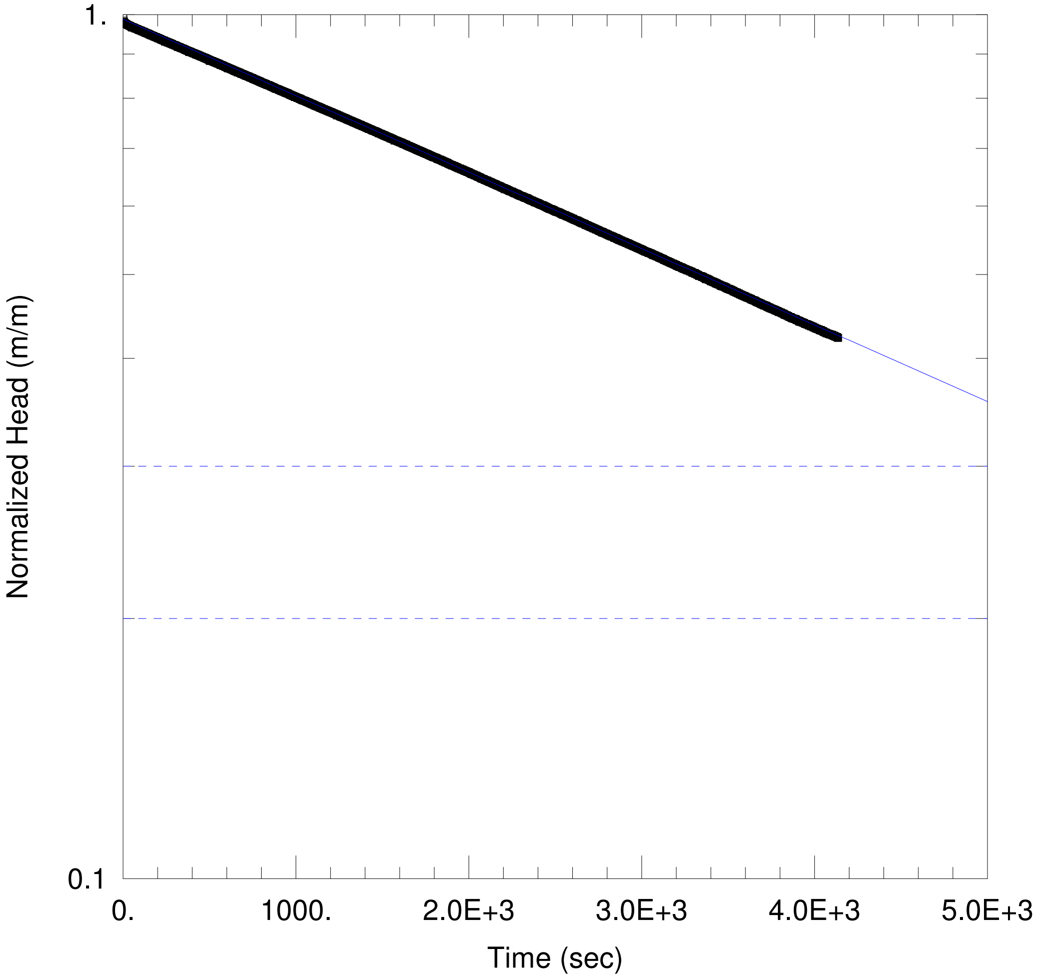
WELL DATA (BH12-OP-05 Test 5)

Initial Displacement: 7.11 m
Static Water Column Height: 129.5 m
Total Well Penetration Depth: 19.5 m
Screen Length: 19.5 m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.394E-8 m/sec
y0 = 6.453 m



BH12-OP-05 TEST 6

Data Set: P:\...\BH12-OP-05- test 6_RH test.aqt
Date: 10/23/12 Time: 10:28:20

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 13/03/2012

AQUIFER DATA

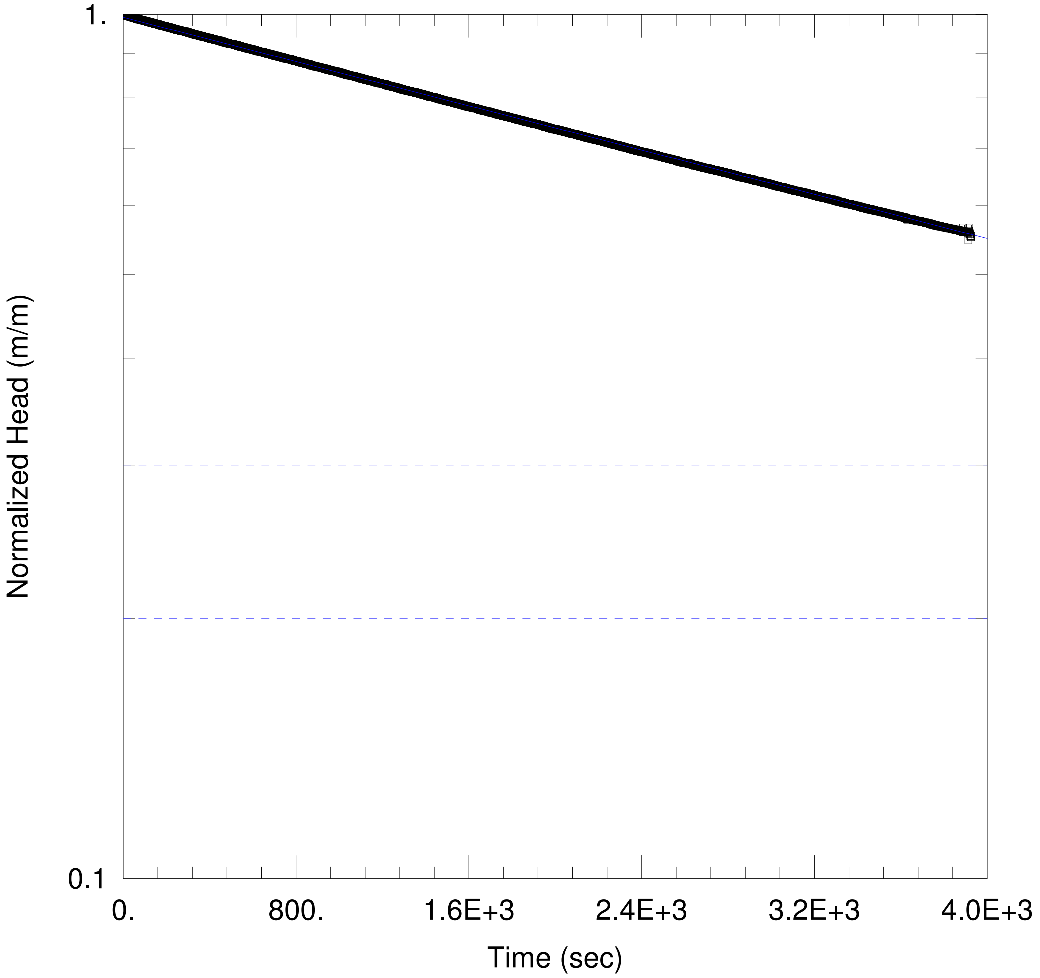
Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-05 Test 6)

Initial Displacement: 5.76 m
Total Well Penetration Depth: 19.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 148.2 m
Screen Length: 19.5 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.413E-8 m/sec
y0 = 5.69 m



BH12-OP-05 TEST 7

Data Set: P:\...\BH12-OP-05- test 7_RH test.aqt
Date: 10/23/12 Time: 10:29:09

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 13/03/2012

AQUIFER DATA

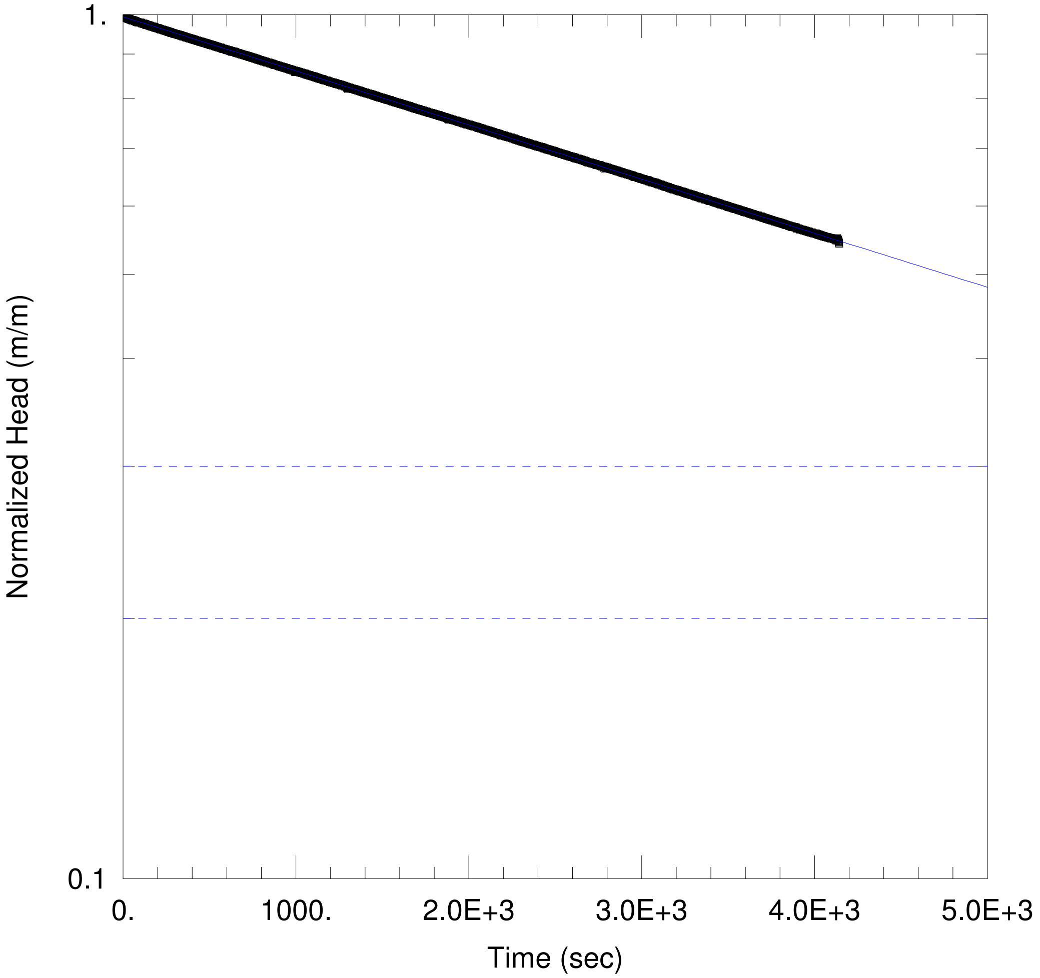
Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-05 Test 7)

Initial Displacement: 7.07 m
Static Water Column Height: 167.6 m
Total Well Penetration Depth: 19.5 m
Screen Length: 19.5 m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.746E-8 m/sec
y0 = 7.013 m



BH12-OP-05 TEST 8

Data Set: P:\...\BH12-OP-05- test 8_RH test.aqt
Date: 10/23/12 Time: 10:30:14

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 14/03/2012

AQUIFER DATA

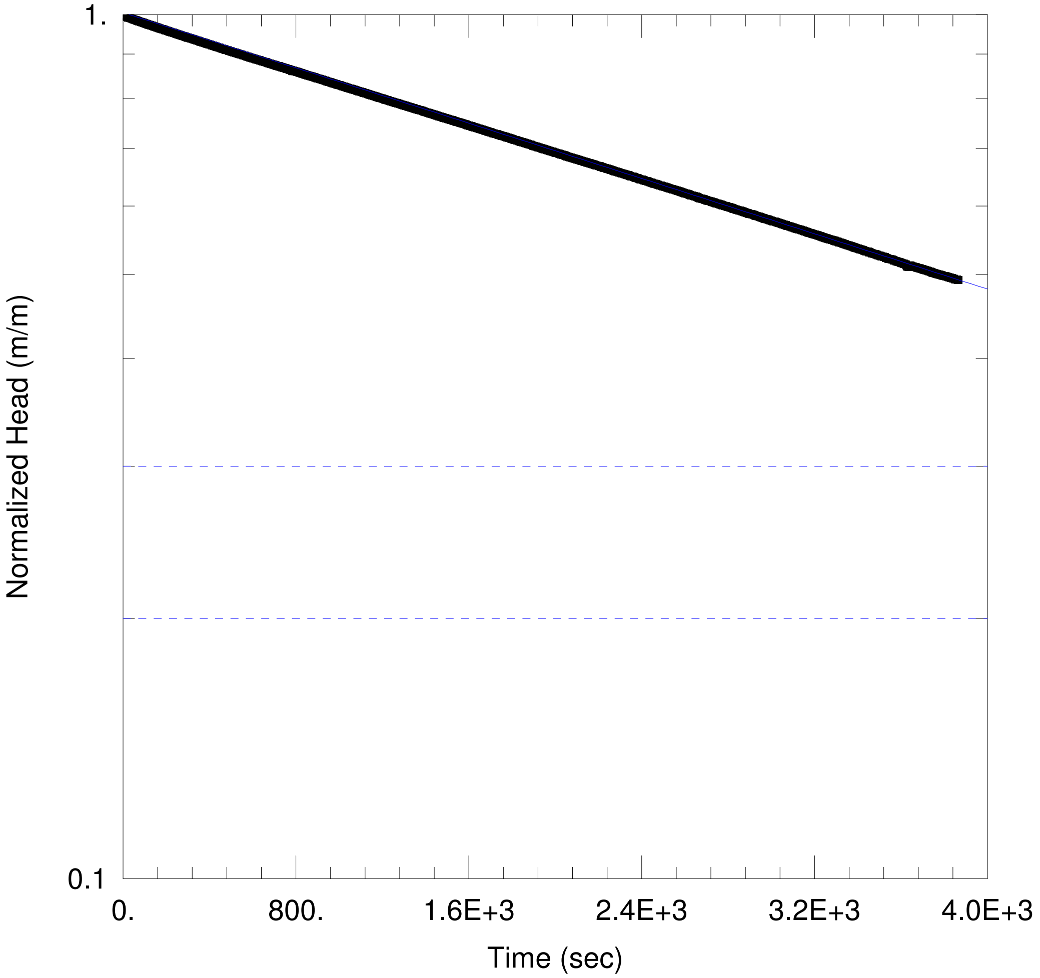
Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-05 Test 8)

Initial Displacement: 5.68 m
Total Well Penetration Depth: 19.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 186.1 m
Screen Length: 19.5 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.709E-8 m/sec
y0 = 5.648 m



BH12-OP-05 TEST 9

Data Set: P:\...\BH12-OP-05- test 9_RH test.aqt
Date: 10/23/12
Time: 10:30:59

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 14/03/2012

AQUIFER DATA

Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

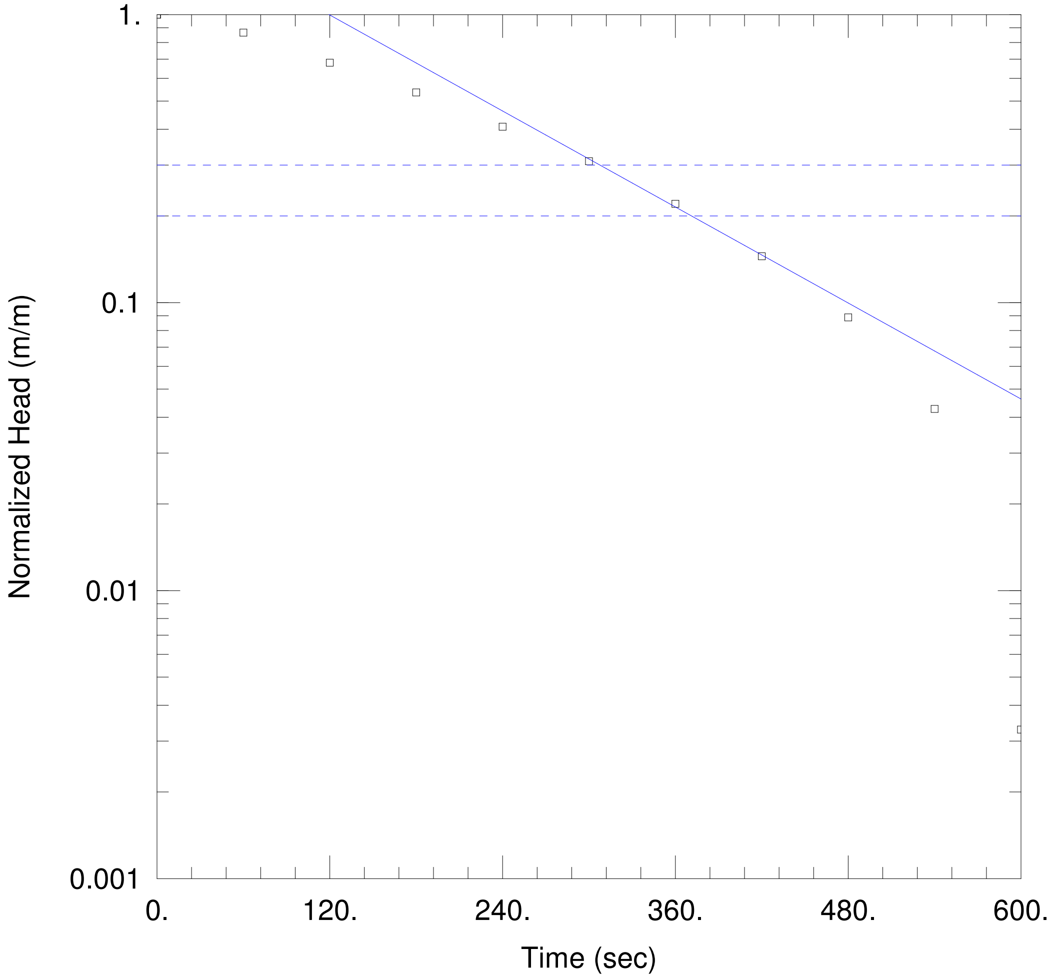
WELL DATA (BH12-OP-05 Test 9)

Initial Displacement: 5.91 m
Total Well Penetration Depth: 19.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 205.2 m
Screen Length: 19.5 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.182E-8 m/sec
y0 = 5.941 m



BH12-OP-05 TEST 10

Data Set: P:\...\BH12-OP-05- test 10_RH test (manual).aqt
Date: 10/23/12 Time: 11:56:28

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 15/03/2012

AQUIFER DATA

Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

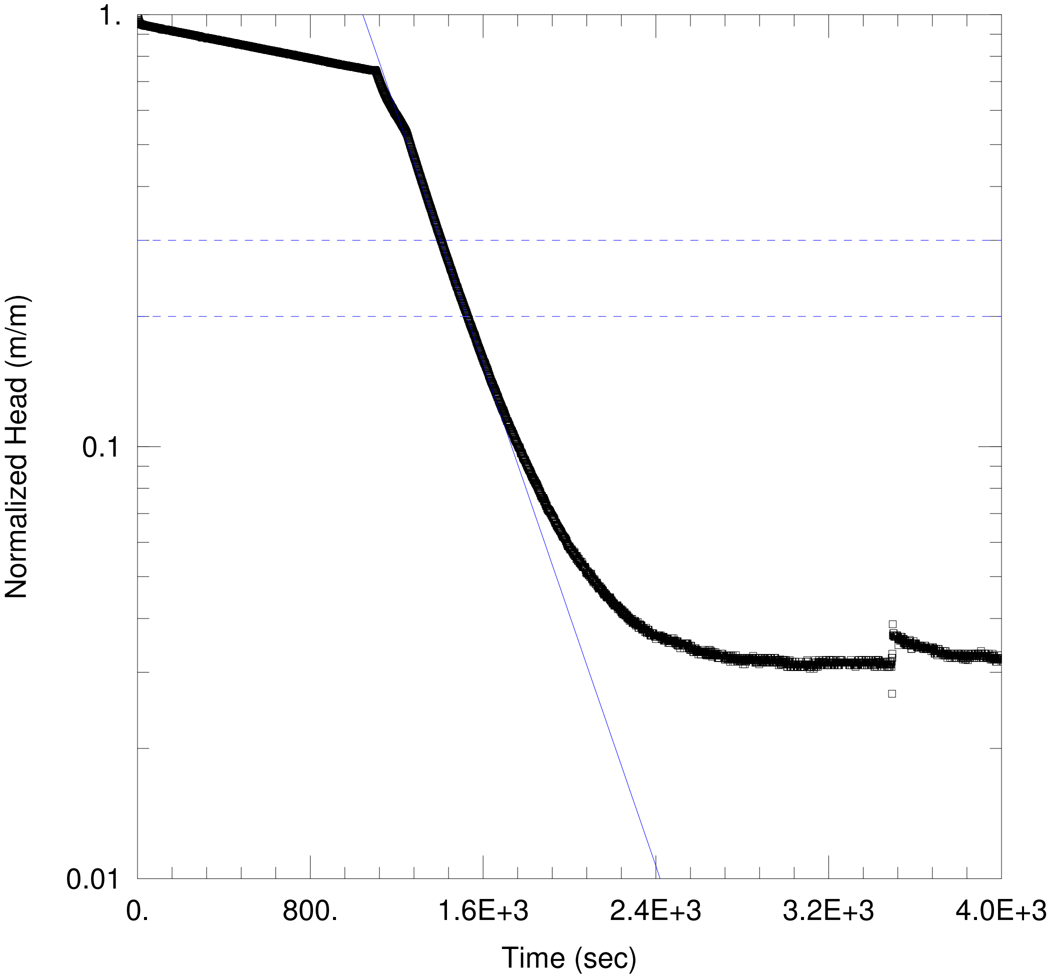
WELL DATA (BH12-OP-05 Test 10)

Initial Displacement: 3.04 m
Total Well Penetration Depth: 19.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 223.7 m
Screen Length: 19.5 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 7.573E-7 m/sec
y0 = 6.523 m



BH12-OP-05 TEST 11

Data Set: C:\...\BH12-OP-05- test 11_RH test.aqt
Date: 10/19/12 Time: 15:24:35

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 15/03/2012

AQUIFER DATA

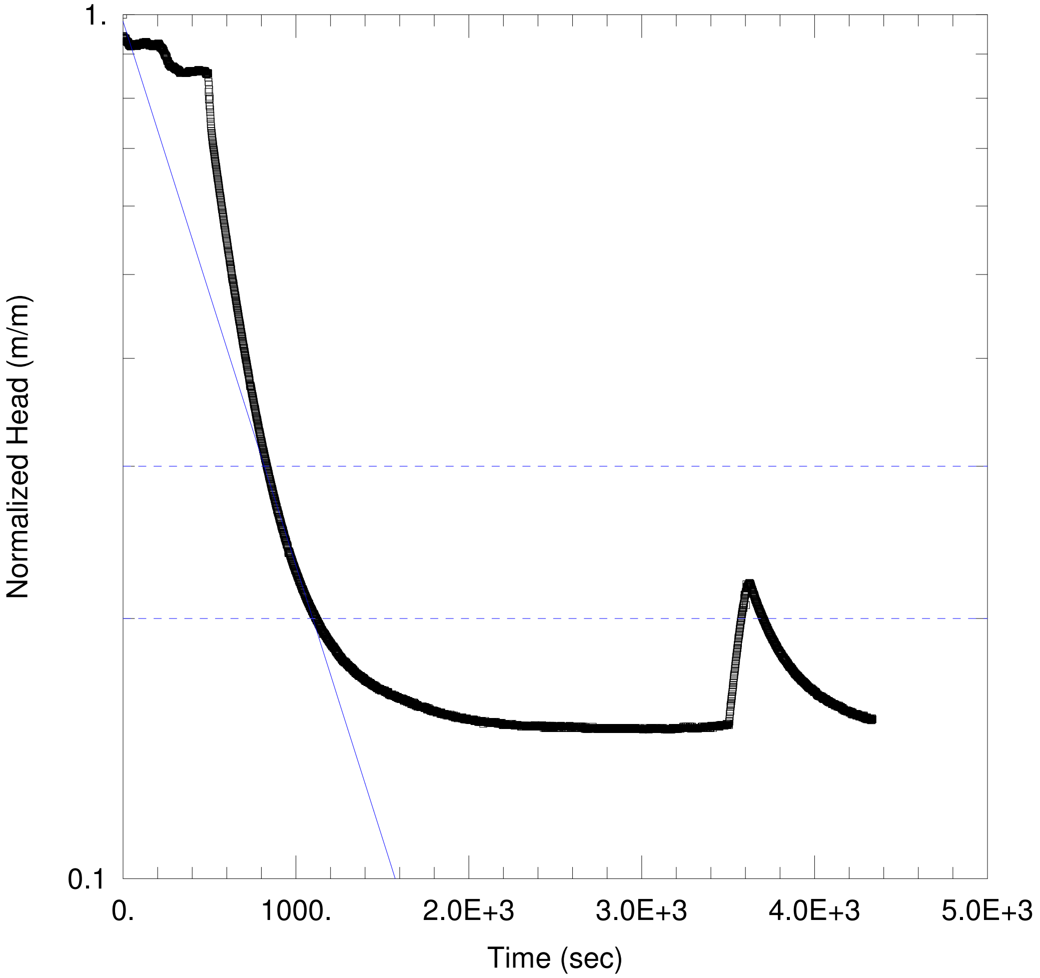
Saturated Thickness: 19.5 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-05 Test 11)

Initial Displacement: 7.09 m
Total Well Penetration Depth: 19.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 243.2 m
Screen Length: 19.5 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.963E-7 m/sec
y0 = 232.9 m



BH12-OP-05 TEST 11A

Data Set: C:\...\BH12-OP-05- test 11a_RH test b.aqt
Date: 10/19/12 Time: 15:21:31

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 16/03/2012

AQUIFER DATA

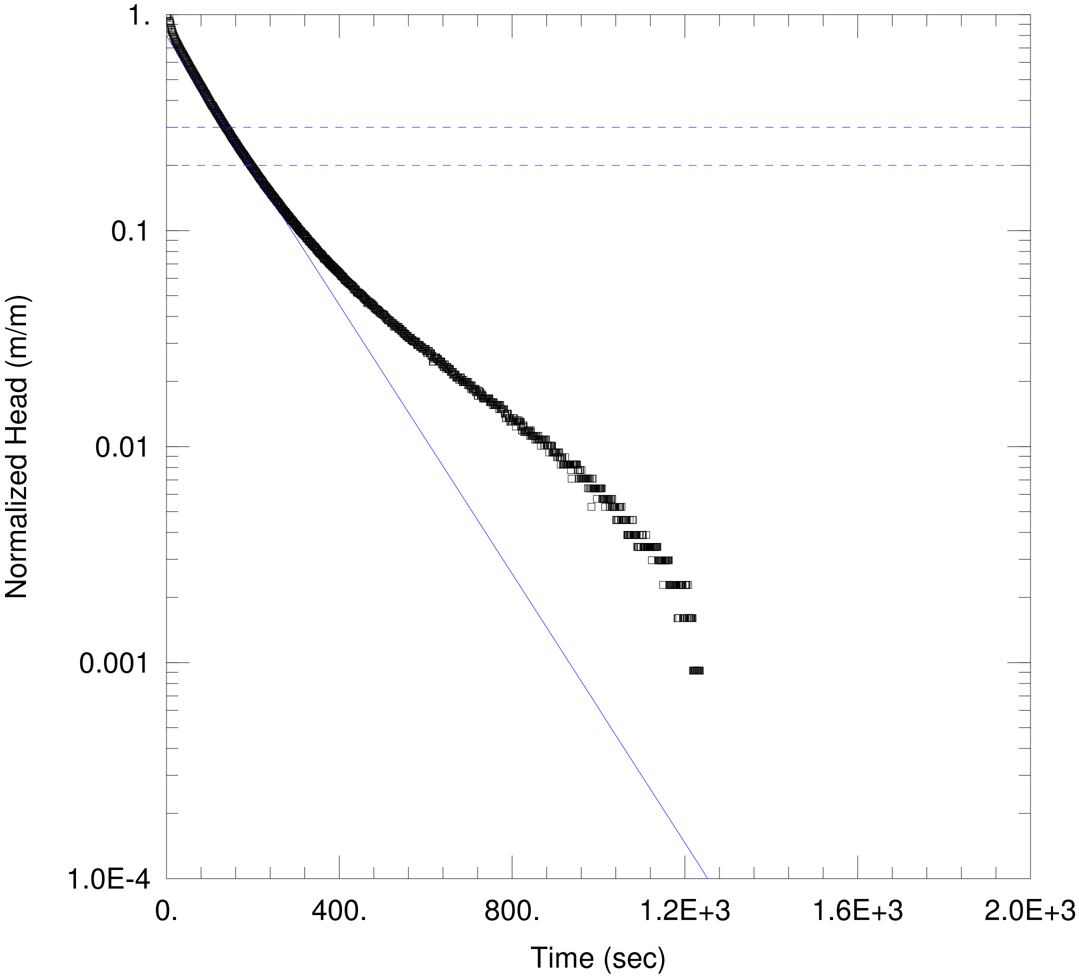
Saturated Thickness: 30.5 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-05 Test 11a)

Initial Displacement: 7. m
Total Well Penetration Depth: 30.5 m
Casing Radius: 0.03015 m
Static Water Column Height: 272.1 m
Screen Length: 30.5 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.207E-7 m/sec
y0 = 6.873 m



BH12-OP-05 TEST 12

Data Set: C:\...\BH12-OP-05- test 12_RH test.aqt
Date: 10/19/12 Time: 13:35:27

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-05
Test Date: 16/03/2012

AQUIFER DATA

Saturated Thickness: 240. m
Anisotropy Ratio (Kz/Kr): 1.

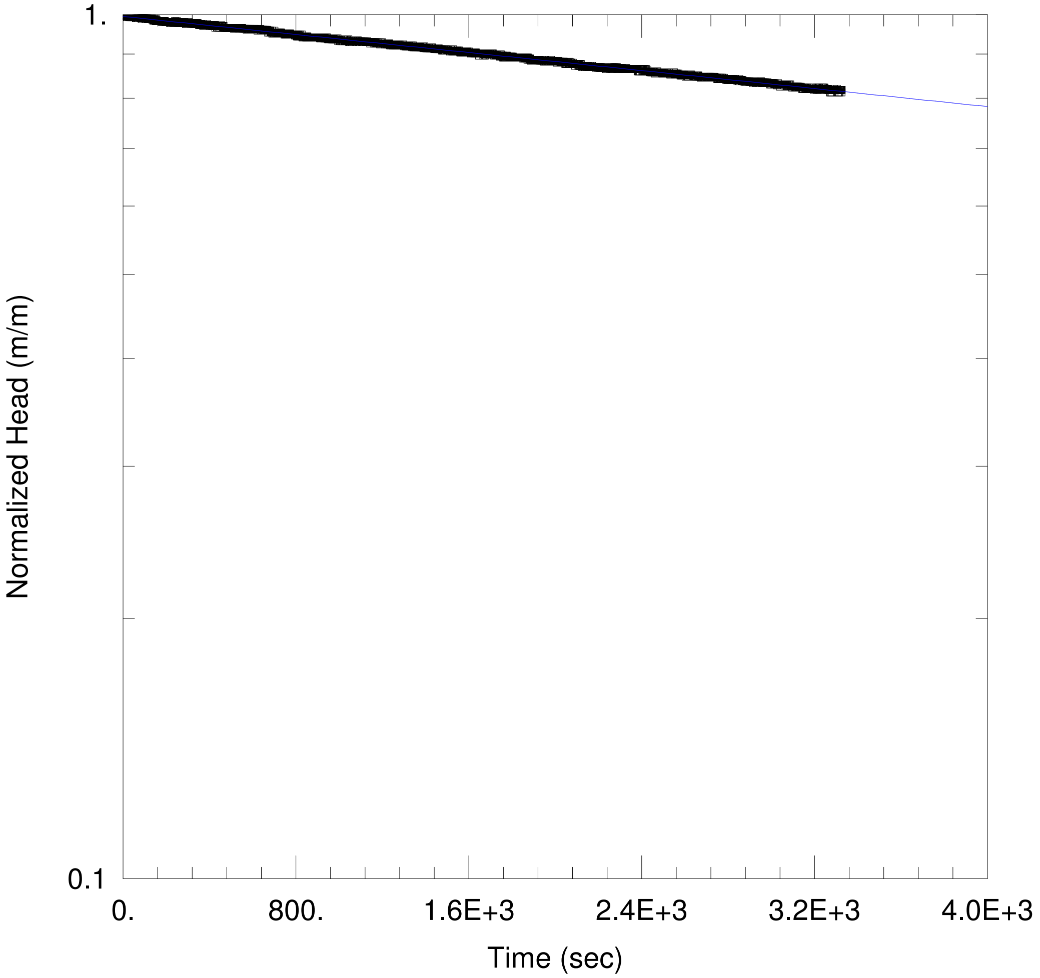
WELL DATA (BH12-OP-05 Test 12)

Initial Displacement: 4.37 m
Total Well Penetration Depth: 240. m
Casing Radius: 0.03015 m
Static Water Column Height: 272.4 m
Screen Length: 240. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.058E-7 m/sec
y0 = 3.47 m



BH12-OP-07 TEST 1

Data Set: C:\...\BH12-OP-07- test 1_RH.aqt
Date: 10/19/12 Time: 15:47:04

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-07
Test Date: 03/05/2012

AQUIFER DATA

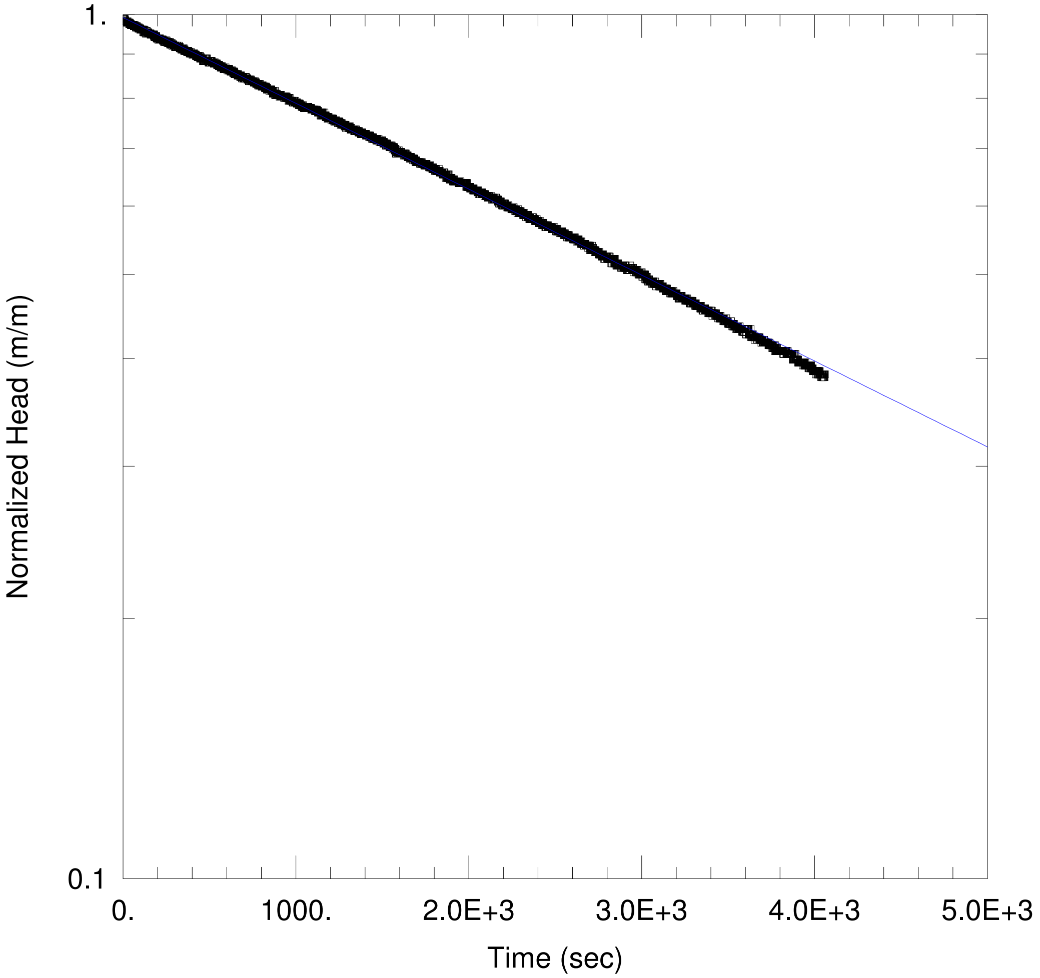
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 4.06 m
Static Water Column Height: 73.87 m
Total Well Penetration Depth: 78.17 m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 7.934E-9 m/sec
y0 = 4.039 m



BH12-OP-07 TEST 2

Data Set: C:\...\BH12-OP-07- test 2_RH.aqt
Date: 10/19/12 Time: 15:45:43

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-07
Test Date: 03/05/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

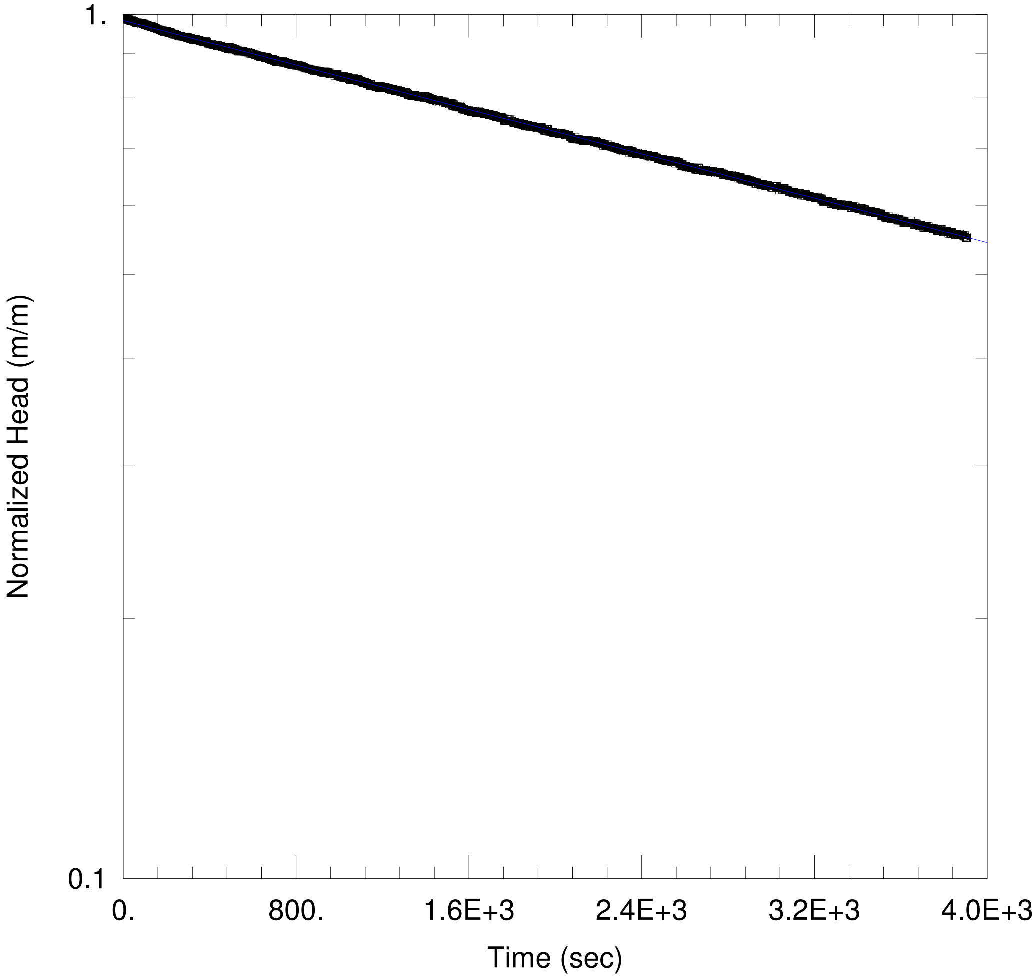
WELL DATA (New Well)

Initial Displacement: 3.26 m
Total Well Penetration Depth: 97.3 m
Casing Radius: 0.03015 m
Static Water Column Height: 90.37 m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.101E-8 m/sec
y0 = 3.235 m



BH12-OP-07 TEST 3

Data Set: C:\...\BH12-OP-07- test 3_RH.aqt
Date: 10/19/12 Time: 15:41:47

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-07
Test Date: 03/06/2012

AQUIFER DATA

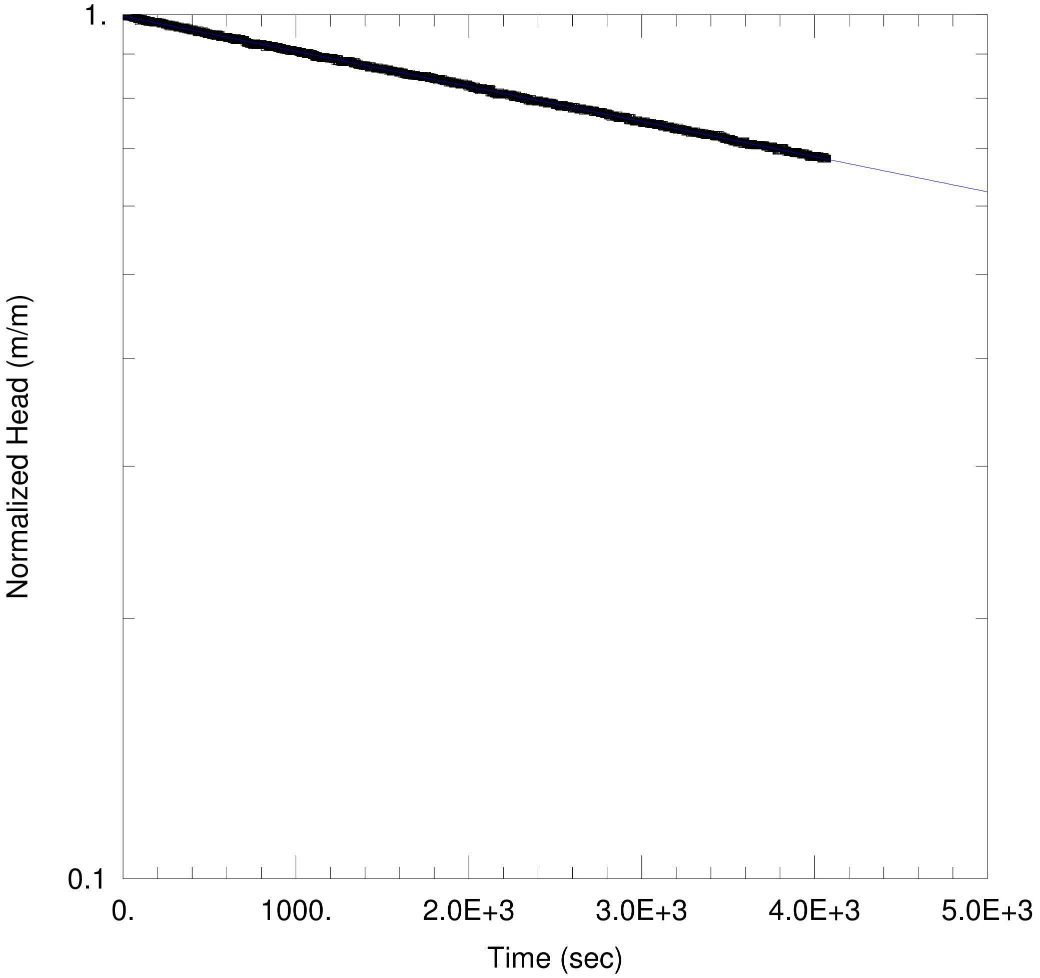
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 4.54 m
Static Water Column Height: 104. m
Total Well Penetration Depth: 110. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.033E-8 m/sec
y0 = 4.465 m



BH12-OP-07 TEST 5

Data Set: C:\...\BH12-OP-07- test 5_RH.aqt
Date: 10/19/12
Time: 15:40:26

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-07
Test Date: 03/06/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

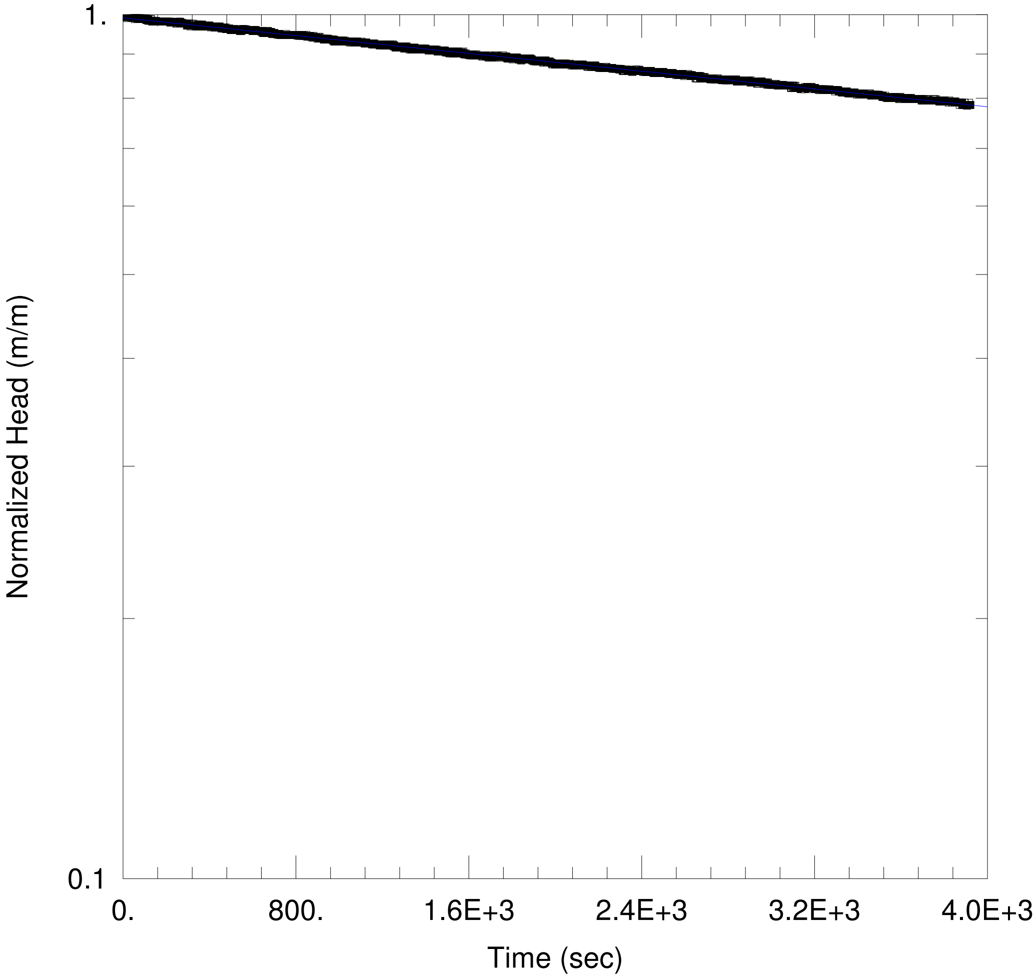
WELL DATA (New Well)

Initial Displacement: 4.11 m
Static Water Column Height: 133.7 m
Total Well Penetration Depth: 140. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.321E-8 m/sec
y0 = 4.093 m



BH12-OP-07 TEST 6

Data Set: C:\...\BH12-OP-07- test 6_RH.aqt
Date: 10/19/12
Time: 15:38:53

PROJECT INFORMATION

Company: AMEC
Client: Ministry of Transportation
Project: RRR TC113921
Test Well: BH12-OP-07
Test Date: 03/07/2012

AQUIFER DATA

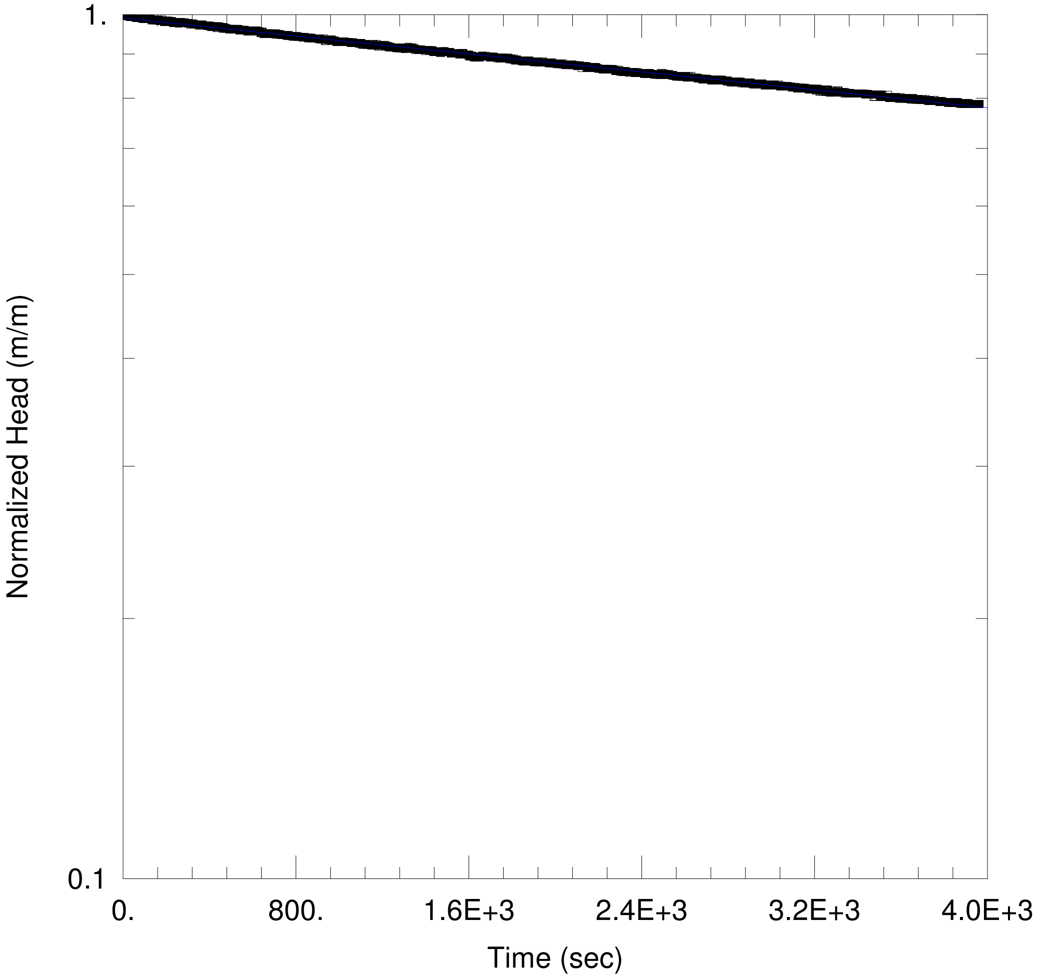
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 4.16 m
Static Water Column Height: 148.6 m
Total Well Penetration Depth: 154.7 m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 8.432E-9 m/sec
y0 = 4.123 m



BH12-OP-07 TEST 8

Data Set: C:\...\BH12-OP-07- test 8_RH.aqt
Date: 10/19/12
Time: 15:37:32

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-07
Test Date: 03/07/2012

AQUIFER DATA

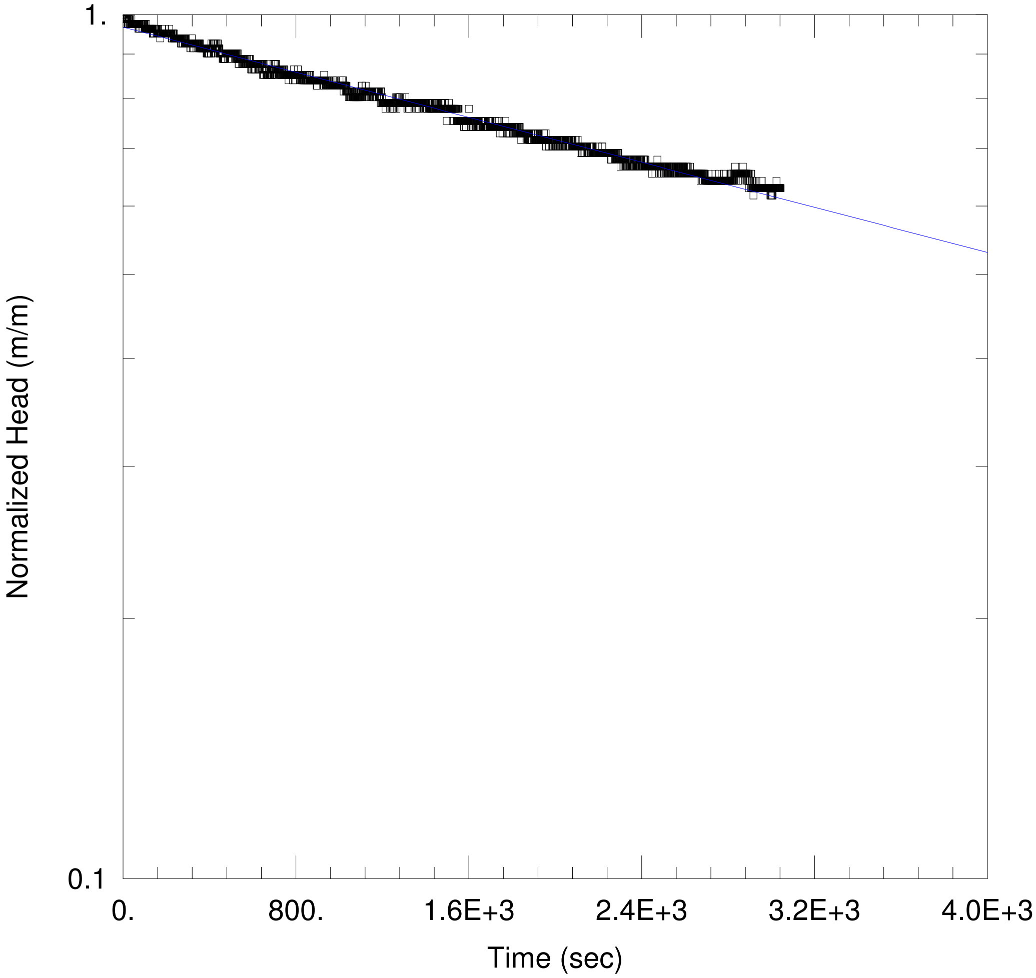
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 4.52 m
Static Water Column Height: 178.5 m
Total Well Penetration Depth: 184.9 m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 8.668E-9 m/sec
y0 = 4.477 m



BH12-OP-07 TEST 9

Data Set: C:\...\BH12-OP-07- test 9_RH.aqt
Date: 10/19/12
Time: 15:35:55

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-07
Test Date: 03/08/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

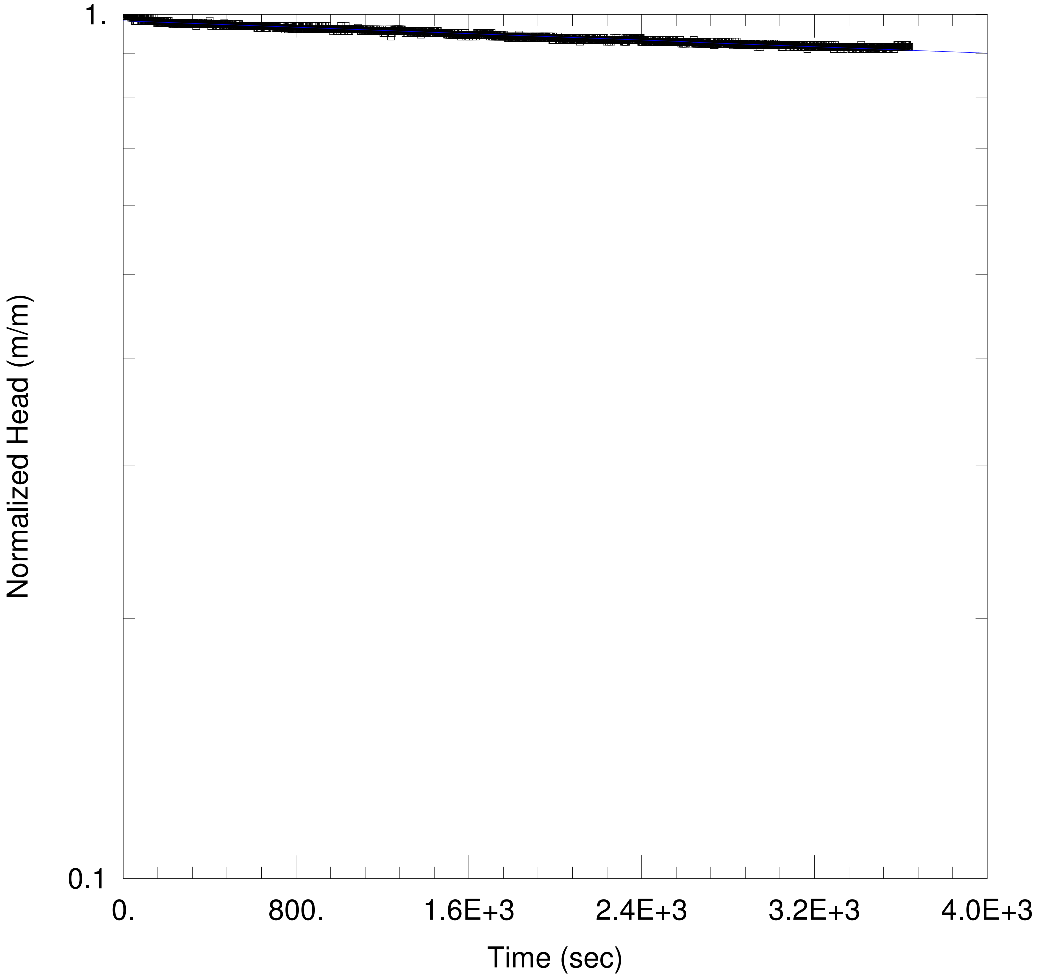
WELL DATA (New Well)

Initial Displacement: 0.81 m
Total Well Penetration Depth: 201.8 m
Casing Radius: 0.03015 m
Static Water Column Height: 195.8 m
Screen Length: 21. m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.197E-8 m/sec
y0 = 0.7831 m



BH12-OP-07 TEST 10

Data Set: C:\...\BH12-OP-07- test 10_RH.aqt
Date: 10/19/12
Time: 15:33:50

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-OP-07
Test Date: 03/08/2012

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH12-OP-07)

Initial Displacement: 2.27 m
Static Water Column Height: 212. m
Total Well Penetration Depth: 218. m
Screen Length: 21. m
Casing Radius: 0.03015 m
Well Radius: 0.03775 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.152E-9 m/sec
y0 = 2.23 m

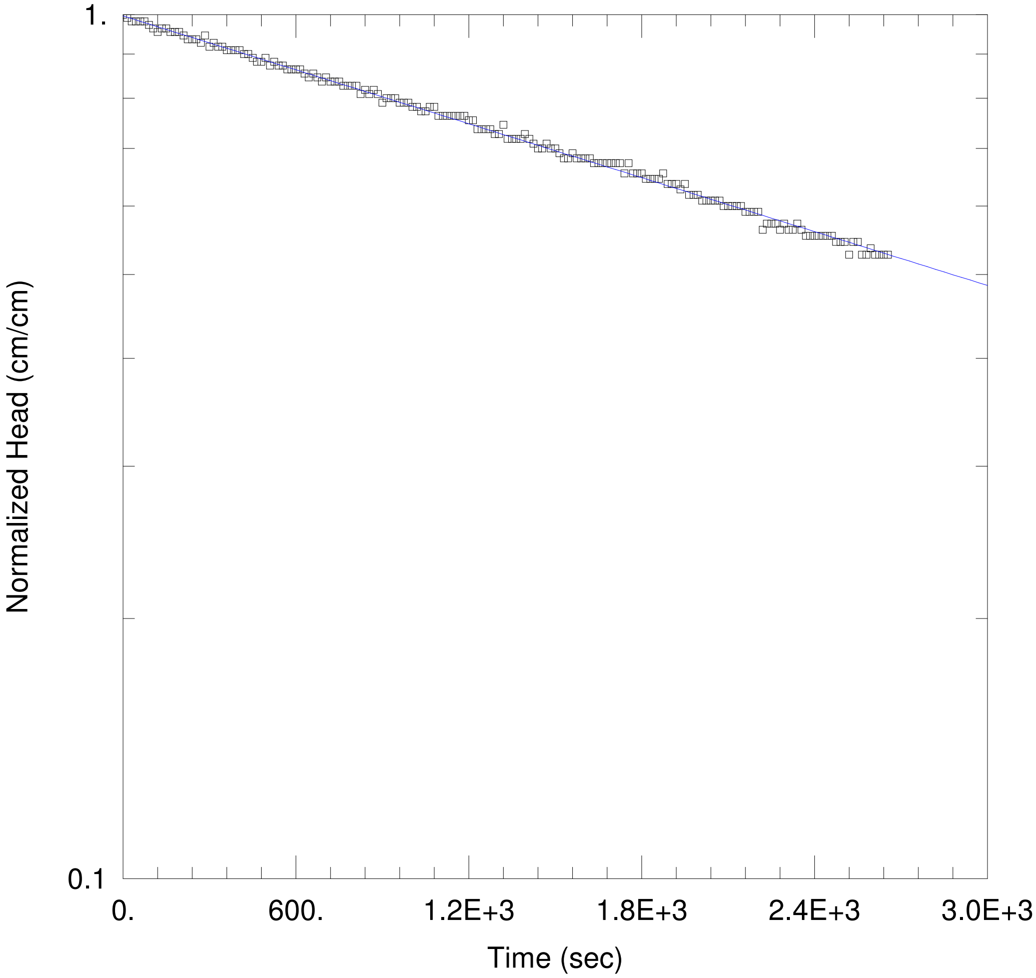
Summary of Packer testing

BH12-UG-02 **Date**

Depth to water table (mbgs) 0.03 **TC113921** 12-Feb-12

Borehole Angle (degrees) 75

Packer No.	Depth (mbgs)	Depth (mbgs)	Depth (mbgs)	Depth (mbgs)	L (m)	R (m)	h (m)	Pressure (psi)	H (m)	Q (m3/s)	K (m/s)	**Average K (m/s)**
1	64.34	83.84	62.15	80.79	18.6	0.038	1.86	20.0	15.92	0.00004	1.27E-07	
			62.15	80.79	18.6	0.038	1.86	40.0	29.97	0.00006	1.03E-07	
			62.15	80.79	18.6	0.038	1.86	60.0	44.03	0.00007	8.82E-08	1.07E-07
			62.15	80.79	18.6	0.038	1.86	40.0	29.97	0.00006	9.72E-08	
			62.15	80.79	18.6	0.038	1.86	20.0	15.92	0.00004	1.22E-07	
2	88	108	84.77	103.73	19.0	0.038	1.79	20.0	15.85	0.000012	3.84E-08	
			84.77	103.73	19.0	0.038	1.79	40.0	29.90	0.000017	2.91E-08	
			84.77	103.73	19.0	0.038	1.79	60.0	43.96	0.00003	3.31E-08	3.14E-08
			84.77	103.73	19.0	0.038	1.79	40.0	29.90	0.000017	2.91E-08	
			84.77	103.73	19.0	0.038	1.79	20.0	15.85	0.000008	2.75E-08	
9	235.25	255	222.37	240.59	18.2	0.038	1.685	20.0	15.74	0.00007	2.23E-07	
			222.37	240.59	18.2	0.038	1.685	40.0	29.80	0.00001	1.21E-08	
			222.37	240.59	18.2	0.038	1.685	60.0	43.86	0.00001	1.03E-08	5.38E-08
			222.37	240.59	18.2	0.038	1.685	40.0	29.80	0.00001	1.21E-08	
			222.37	240.59	18.2	0.038	1.685	20.0	15.74	0.00000	1.14E-08	
10	255	276	240.59	259.91	19.3	0.038	2.15	20.0	16.21	0.00001	1.59E-08	
			240.59	259.91	19.3	0.038	2.15	40.0	30.26	0.00001	1.13E-08	
			240.59	259.91	19.3	0.038	2.15	60.0	44.32	0.00001	9.67E-09	1.12E-08
			240.59	259.91	19.3	0.038	2.15	40.0	30.26	0.00001	8.49E-09	
			240.59	259.91	19.3	0.038	2.15	20.0	16.21	0.00000	1.06E-08	
11b	273	294	257.15	276.42	19.3	0.038	1	20.0	15.06	0.000185	6.33E-07	
			257.15	276.42	19.3	0.038	1	40.0	29.11	0.000282	4.98E-07	
			257.15	276.42	19.3	0.038	1	60.0	43.17	0.00036	4.29E-07	5.46E-07
			257.15	276.42	19.3	0.038	1	40.0	29.11	0.000272	4.81E-07	
			257.15	276.42	19.3	0.038	1	20.0	15.06	0.000202	6.90E-07	
12	294	318	276.42	298.38	22.0	0.038	1.15	20.0	15.21	0.000007	2.02E-08	
			276.42	298.38	22.0	0.038	1.15	40.0	29.26	0.000005	7.89E-09	
			276.42	298.38	22.0	0.038	1.15	60.0	43.32	0.000007	7.10E-09	1.17E-08
			276.42	298.38	22.0	0.038	1.15	40.0	29.26	0.000005	7.89E-09	
			276.42	298.38	22.0	0.038	1.15	20.0	15.21	0.000005	1.52E-08	



BH12-UG-02 TEST 4

Data Set: C:\...\BH12-UG-02_FH_Test_4.aqt
Date: 10/19/12
Time: 16:04:28

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-UG-02
Test Date: 13/02/2012

AQUIFER DATA

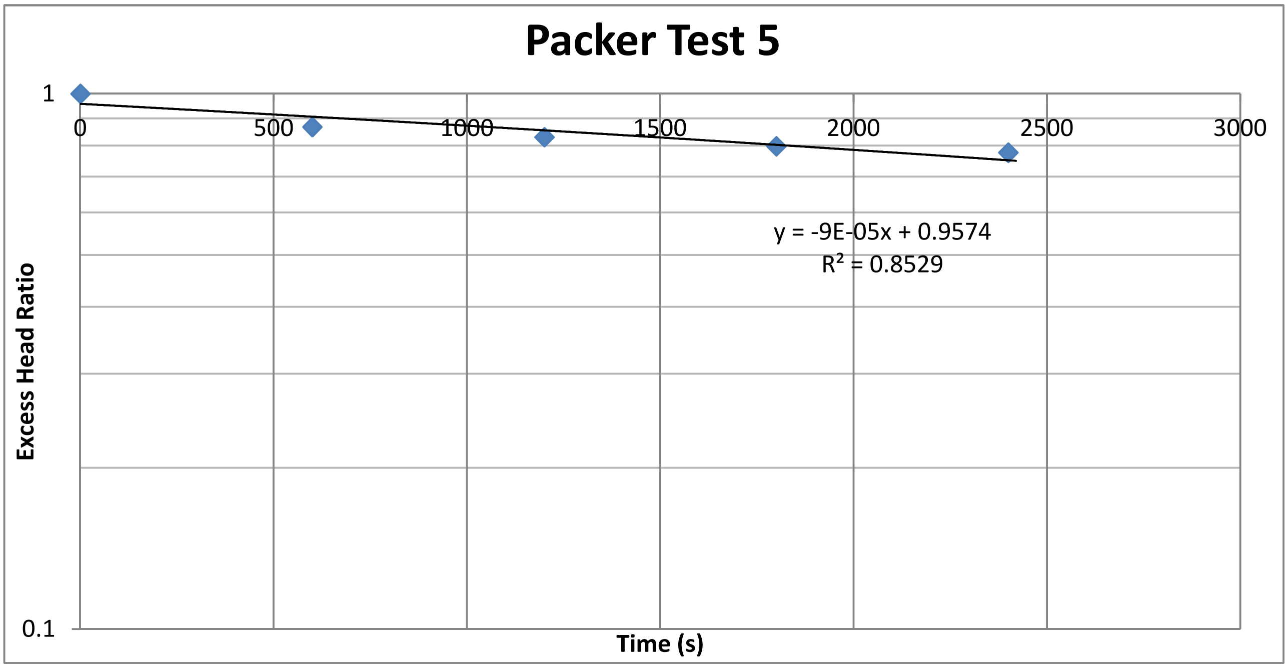
Saturated Thickness: 1950. cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 110. cm
Static Water Column Height: 1.489E+4 cm
Total Well Penetration Depth: 1.489E+4 cm
Screen Length: 1950. cm
Casing Radius: 3.015 cm
Well Radius: 3.775 cm

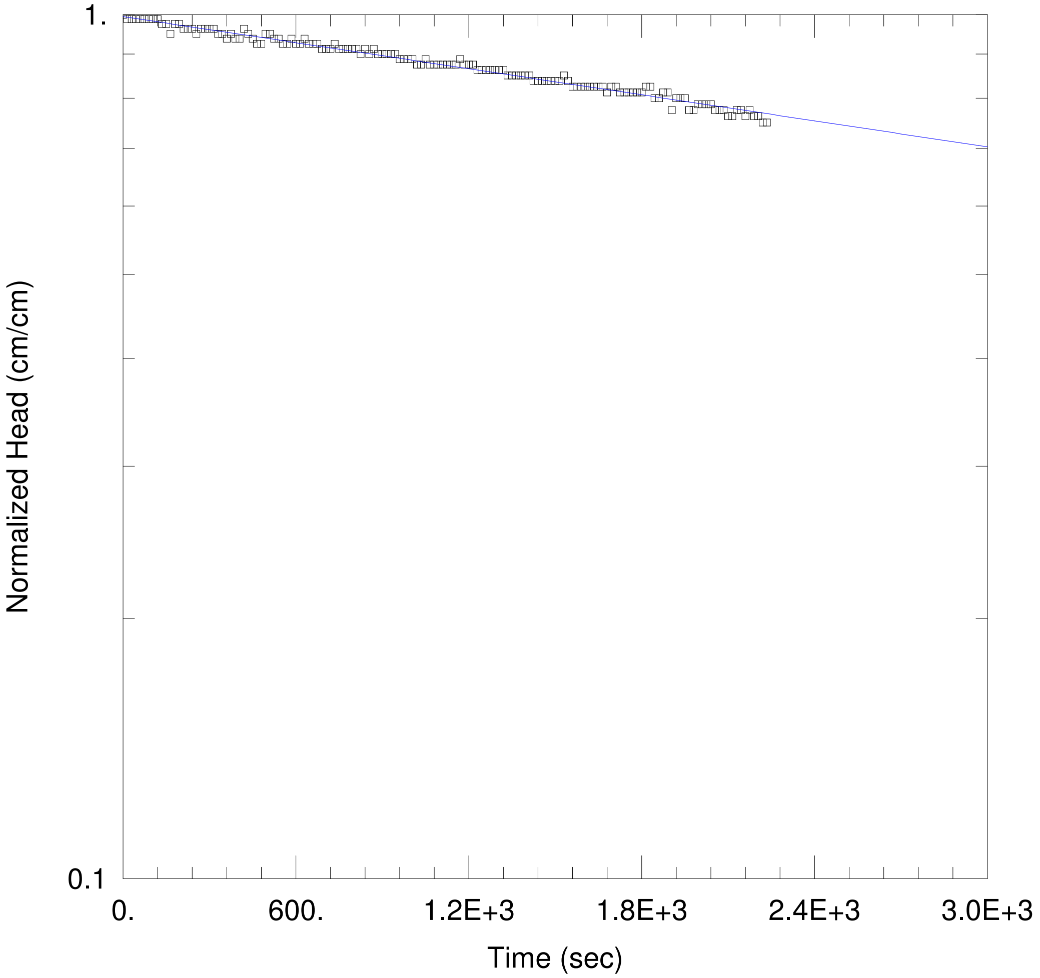
SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 2.957E-8 m/sec
y0 = 109.6 cm



Packer test #	Time Elapsed (s)	H(m)	H_o (m)	h (m)	Excess Head Ratio	$T_{o\ (s)}$
	0	0	1.88	0	1	34685.3826
	600	0	1.88	0.25	0.867021277	
	1200	0	1.88	0.32	0.829787234	
	1800	0	1.88	0.38	0.79787234	
	2400	0	1.88	0.42	0.776595745	

K
(m/s)
4.44939E-09



BH12-UG-02 TEST 6

Data Set: C:\...\BH12-UG-02_FH_Test_6.aqt
Date: 10/19/12
Time: 16:06:00

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-UG-02
Test Date: 14/02/2012

AQUIFER DATA

Saturated Thickness: 1950. cm
Anisotropy Ratio (Kz/Kr): 1.

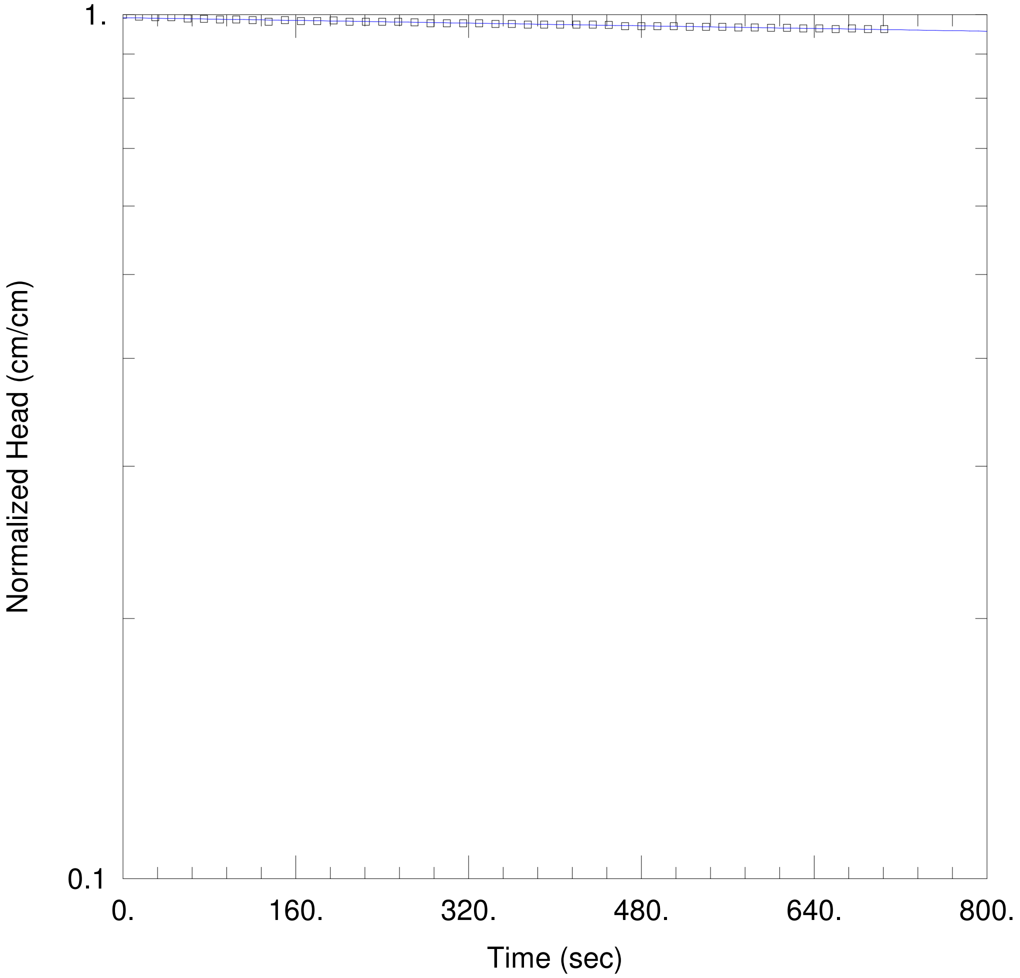
WELL DATA (New Well)

Initial Displacement: 80. cm
Static Water Column Height: 1.912E+4 cm
Total Well Penetration Depth: 1.912E+4 cm
Screen Length: 1950. cm
Casing Radius: 3.015 cm
Well Radius: 3.775 cm

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.43E-8 m/sec
y0 = 79.55 cm



BH12-UG-02 TEST 8

Data Set: C:\...\BH12-UG-02_RH_Test_8.aqt
Date: 10/19/12 Time: 16:07:05

PROJECT INFORMATION

Company: AMEC Earth & Environmental
Client: Rainy River
Project: TC113921
Test Well: BH12-UG-02
Test Date: 02/15/2012

AQUIFER DATA

Saturated Thickness: 1986. cm
Anisotropy Ratio (Kz/Kr): 1.

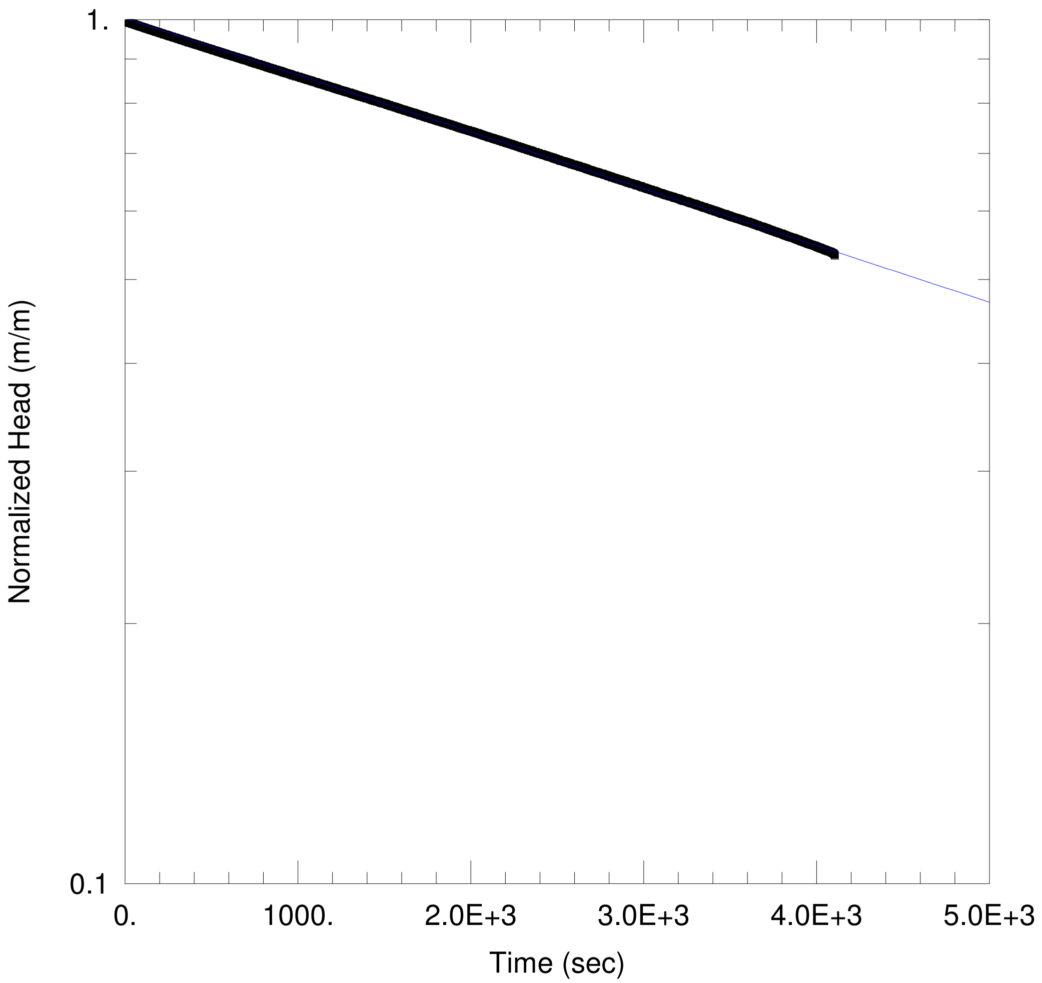
WELL DATA (New Well)

Initial Displacement: 685.2 cm
Total Well Penetration Depth: 2.324E+4 cm
Casing Radius: 3.015 cm
Static Water Column Height: 2.324E+4 cm
Screen Length: 1986. cm
Well Radius: 3.775 cm

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 5.446E-9 m/sec
y0 = 679.4 cm



BH12-UG-03 TEST 1

Data Set: \...\test1.aqt
Date: 10/18/12
Time: 15:50:10

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-UG-03

AQUIFER DATA

Saturated Thickness: 61.5 m
Anisotropy Ratio (Kz/Kr): 1.

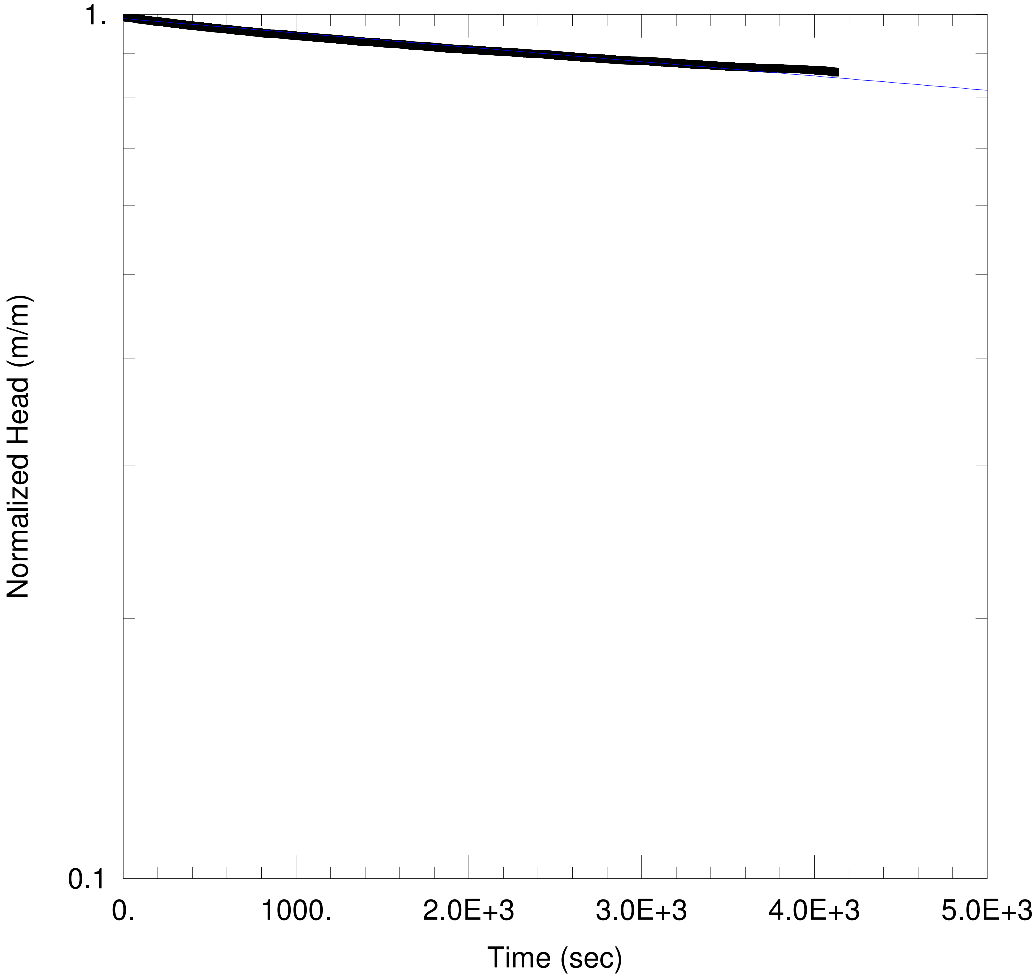
WELL DATA (New Well)

Initial Displacement: 5.75 m
Total Well Penetration Depth: 61.5 m
Casing Radius: 0.03 m
Static Water Column Height: 85.5 m
Screen Length: 61.5 m
Well Radius: 0.037 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 5.865E-9 m/sec
y0 = 5.767 m



BH12-UG-03 TEST2

Data Set: \...\test2.aqt
Date: 10/18/12
Time: 16:02:00

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-UG-03

AQUIFER DATA

Saturated Thickness: 85.5 m
Anisotropy Ratio (Kz/Kr): 1.

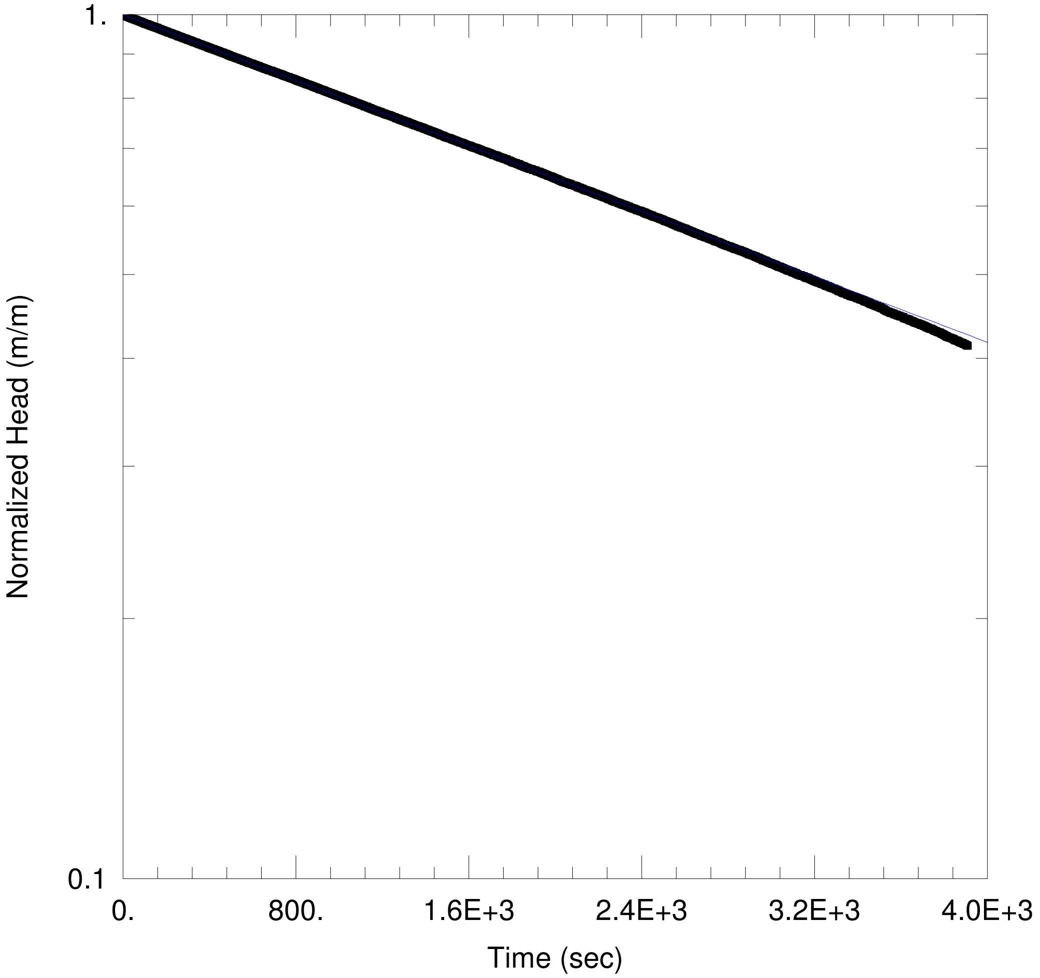
WELL DATA (New Well)

Initial Displacement: 5.01 m
Total Well Penetration Depth: 85.5 m
Casing Radius: 0.03 m
Static Water Column Height: 82.5 m
Screen Length: 85.5 m
Well Radius: 0.037 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.066E-9 m/sec
y0 = 4.952 m



BH12-UG-03 TEST 3

Data Set: \...\BH12-UG-03_Test_3.aqt

Date: 10/18/12	Time: 16:07:34

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-UG-03

AQUIFER DATA

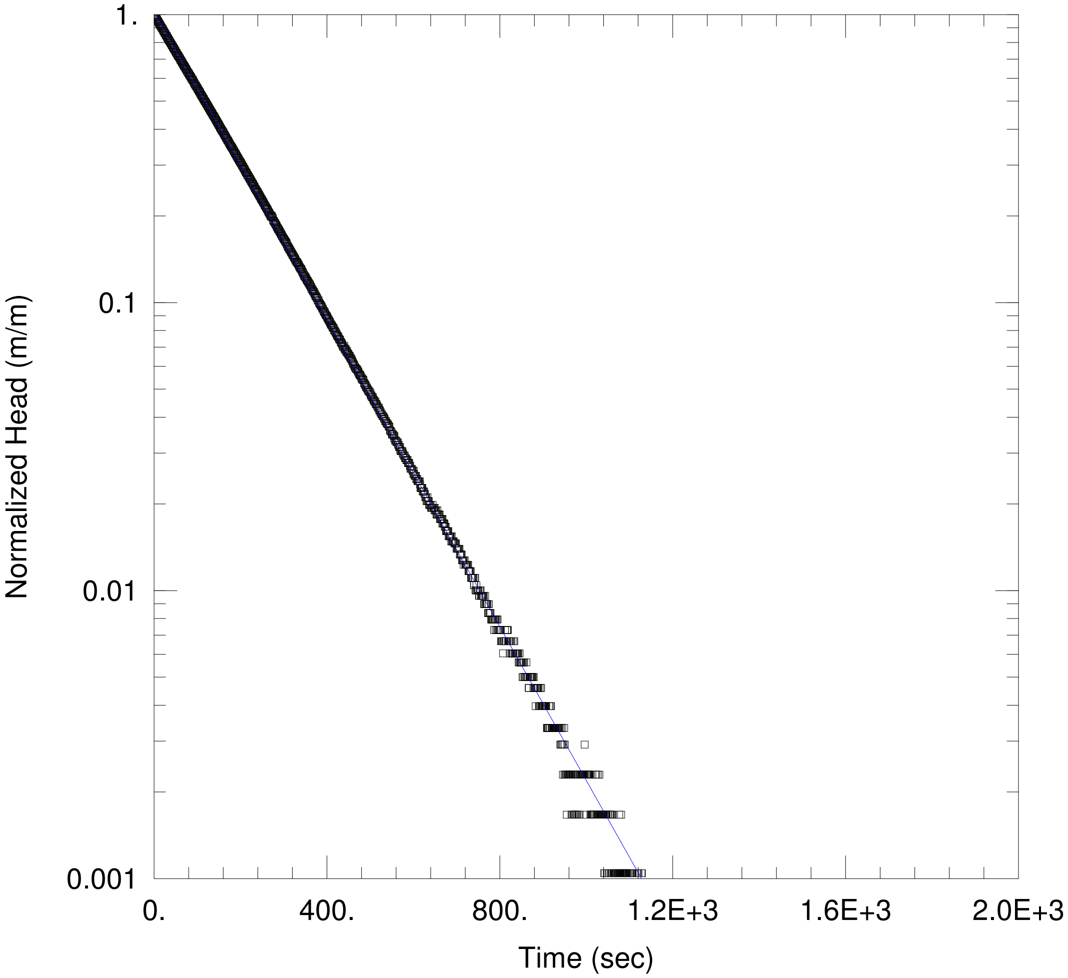
Saturated Thickness: 112.5 m	Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 4.891 m	Static Water Column Height: 393. m
Total Well Penetration Depth: 112.5 m	Screen Length: 112.5 m
Casing Radius: 0.03 m	Well Radius: 0.037 m

SOLUTION

Aquifer Model: Confined	Solution Method: Hvorslev
K = 4.626E-9 m/sec	y0 = 4.889 m



BH12-UG-03 TEST 4A

Data Set: \...\BH12-UG-03_Test_4a.aqt
Date: 10/18/12 Time: 16:12:20

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-UG-03

AQUIFER DATA

Saturated Thickness: 142.5 m
Anisotropy Ratio (Kz/Kr): 1.

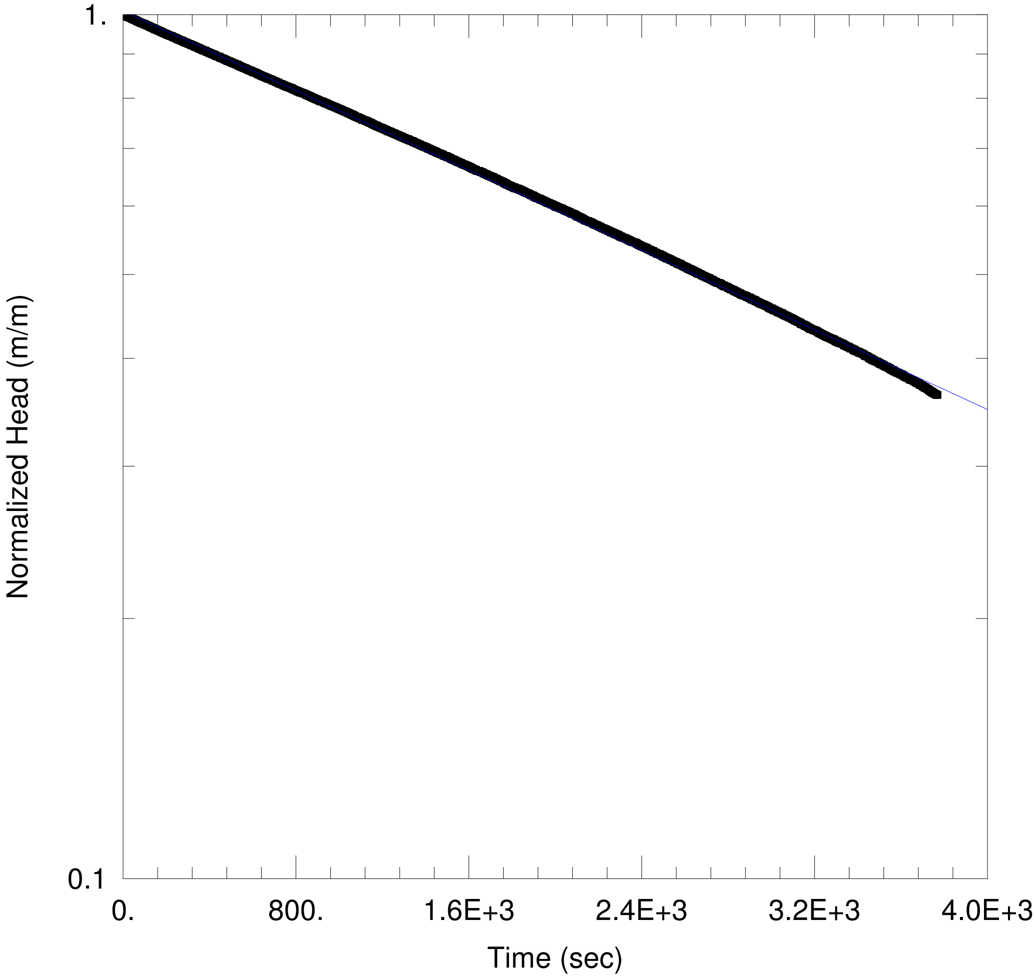
WELL DATA (New Well)

Initial Displacement: 4.796 m
Static Water Column Height: 423. m
Total Well Penetration Depth: 142.5 m
Screen Length: 142.5 m
Casing Radius: 0.03 m
Well Radius: 0.037 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 1.028E-7 m/sec
y0 = 4.909 m



BH-UG-03 TEST 5

Data Set: \...\BH12-UG-03_Test_5.aqt
Date: 10/18/12 Time: 16:15:43

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-UG-03

AQUIFER DATA

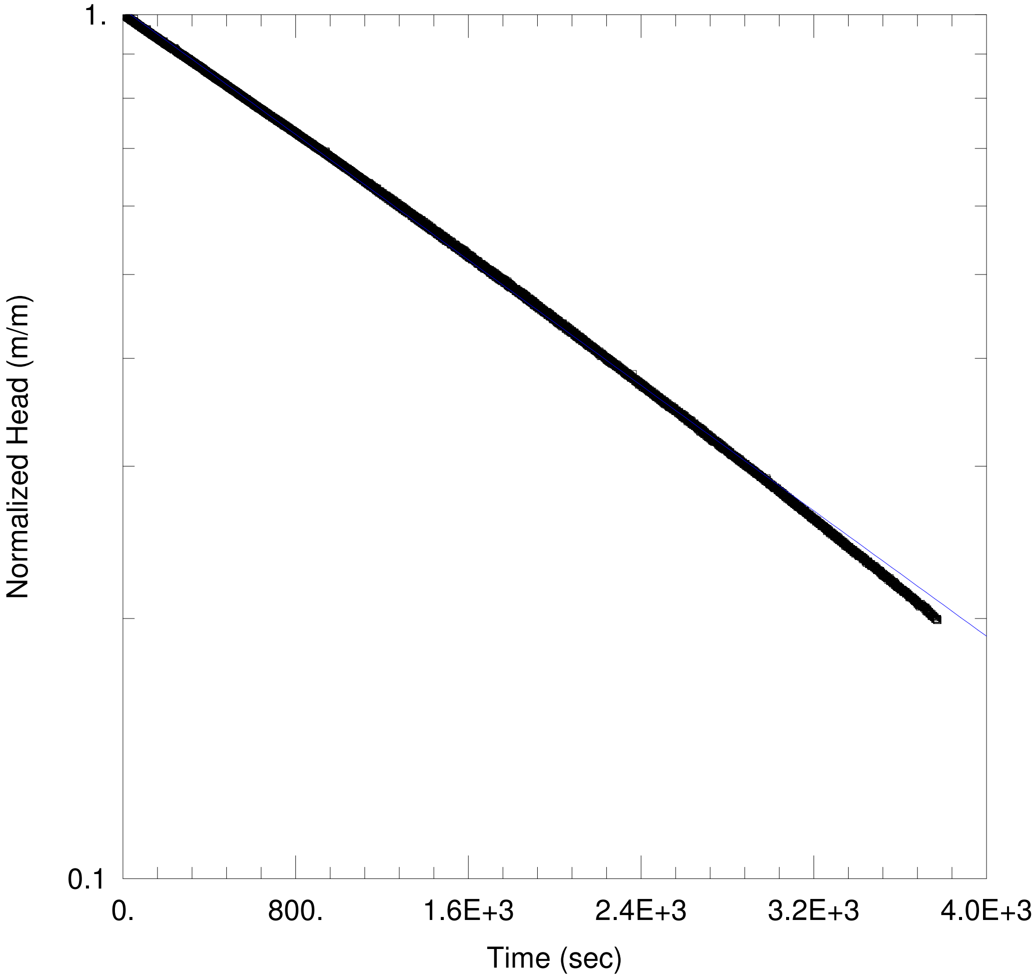
Saturated Thickness: 179. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 4.022 m
Static Water Column Height: 367. m
Total Well Penetration Depth: 179. m
Screen Length: 179. m
Casing Radius: 0.03 m
Well Radius: 0.037 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 3.537E-9 m/sec
y0 = 4.061 m



BH12-UG-03 TEST 6

Data Set: \...\BH12-UG-03_Test_6.aqt
Date: 10/18/12
Time: 16:14:40

PROJECT INFORMATION

Company: AMEC
Client: Rainy River
Project: TC113921
Test Well: BH12-UG-03

AQUIFER DATA

Saturated Thickness: 199. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 3.635 m
Static Water Column Height: 479.3 m
Total Well Penetration Depth: 199. m
Screen Length: 199. m
Casing Radius: 0.03 m
Well Radius: 0.037 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 5.006E-9 m/sec
y0 = 3.688 m

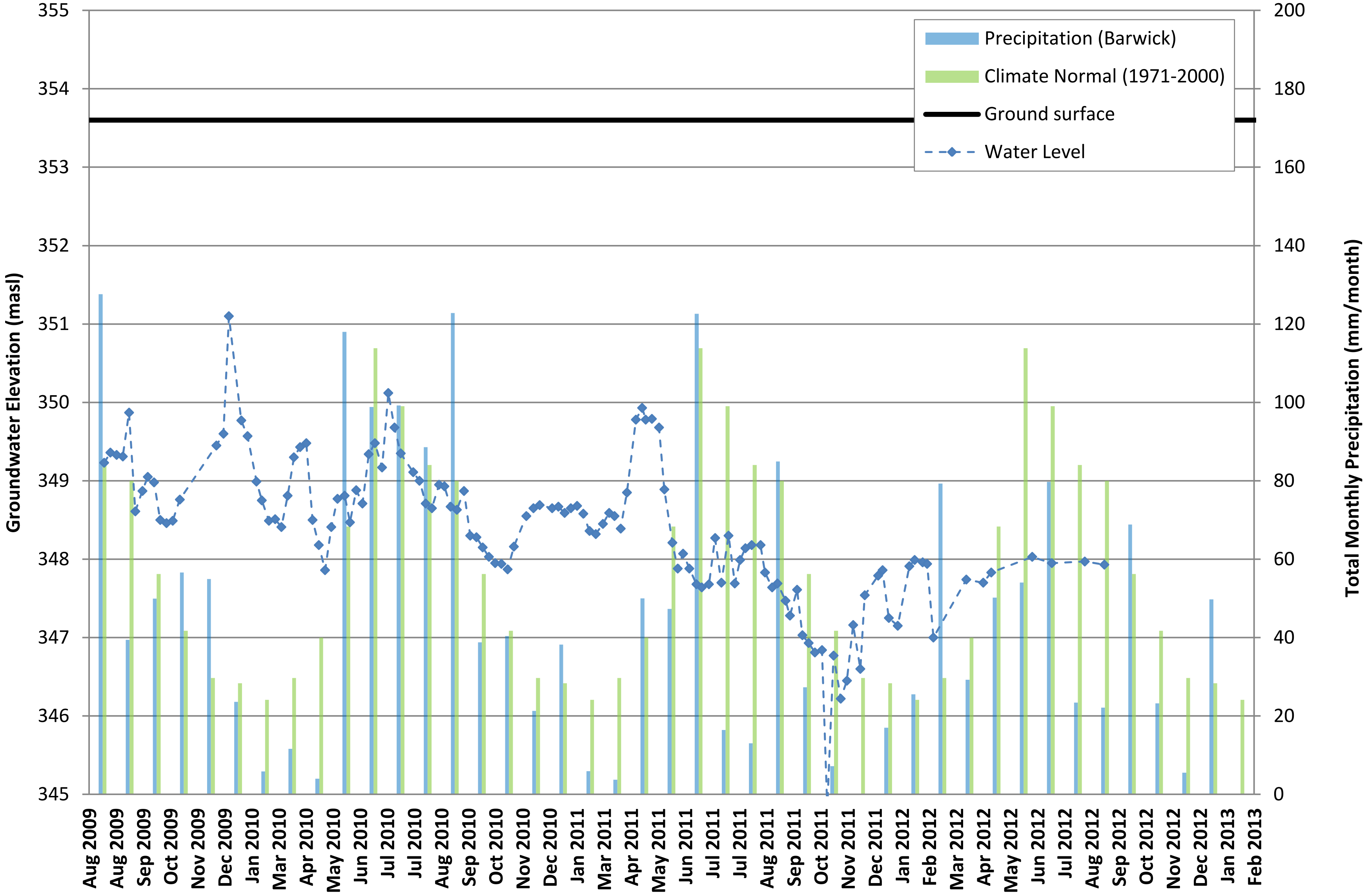
APPENDIX D

GROUNDWATER LEVEL HYDROGRAPHS

amec

Hydrograph of NR9628, 2009-2013
Completion in Bedrock

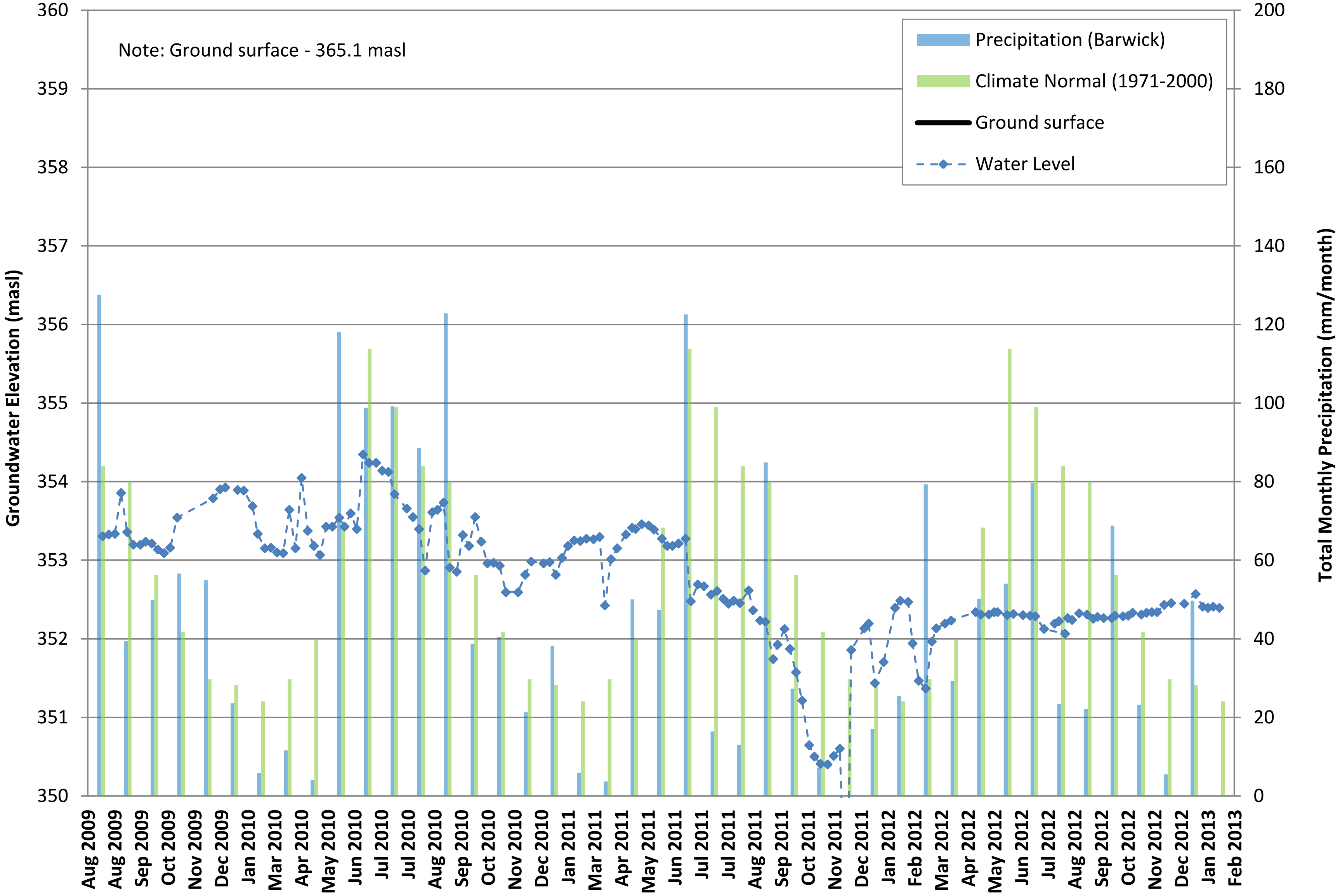
Depth of open hole well: 243 m at a dip angle of -60º



TC111504

Hydrograph of NR9664, 2009-2013
Completion in Bedrock

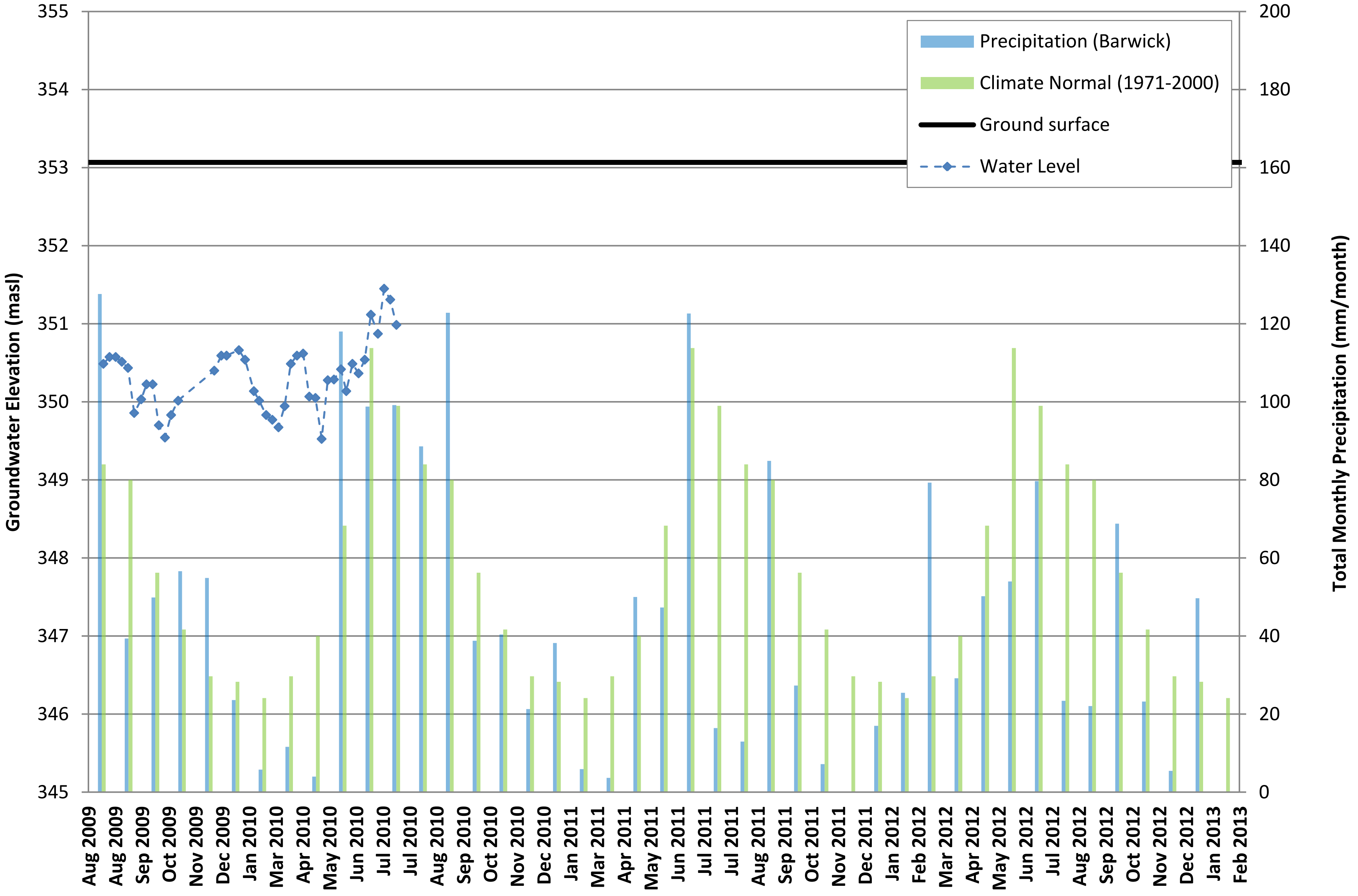
Depth of open hole well: 275 m at a dip angle of -50°



TC111504

Hydrograph of NR06104, 2009-2013
Completion in Bedrock

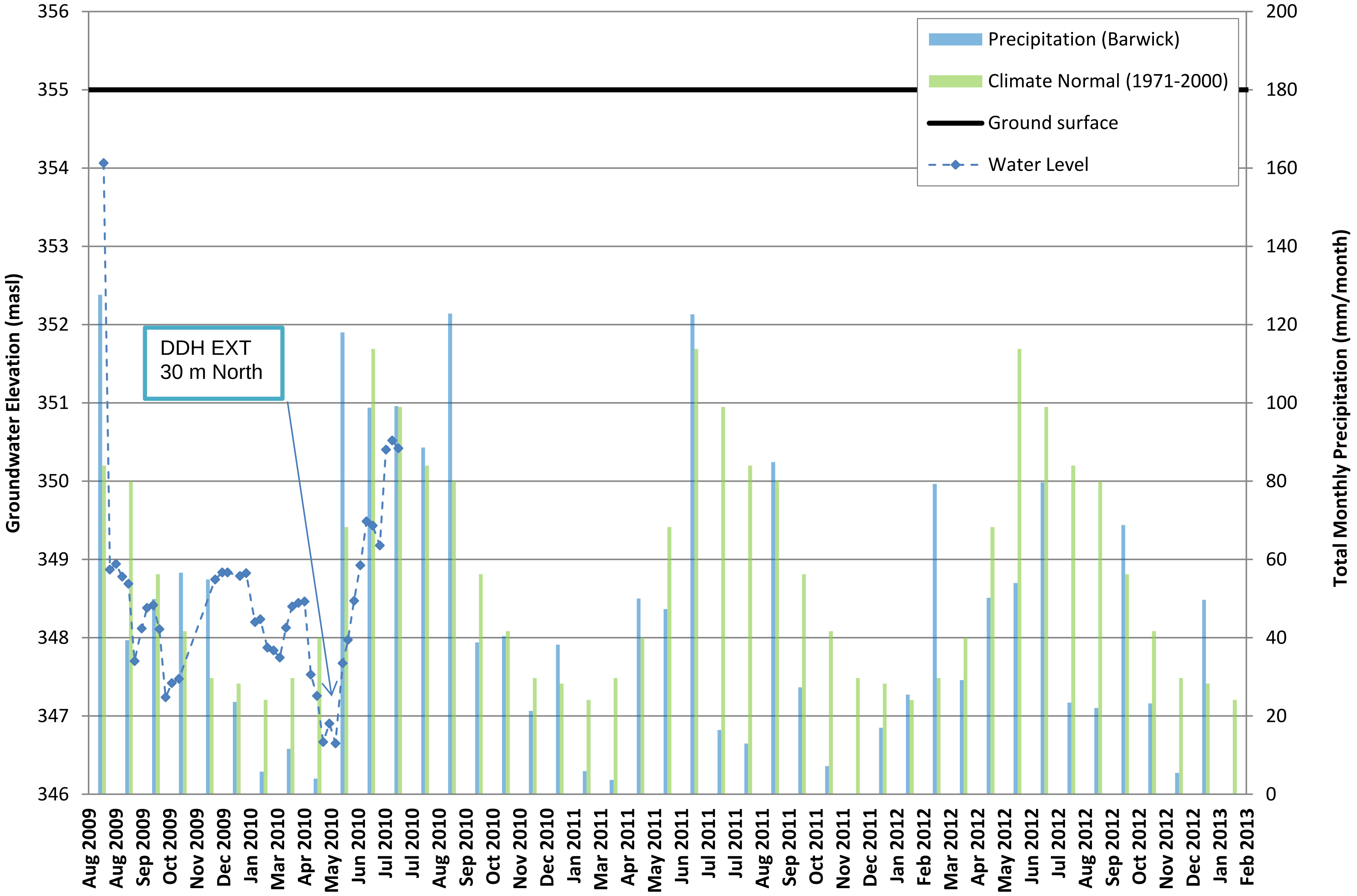
Depth of open hole well: 500 m at a dip angle of -61º



TC111504

Hydrograph of NR06115, 2009-2013
Completion in Bedrock

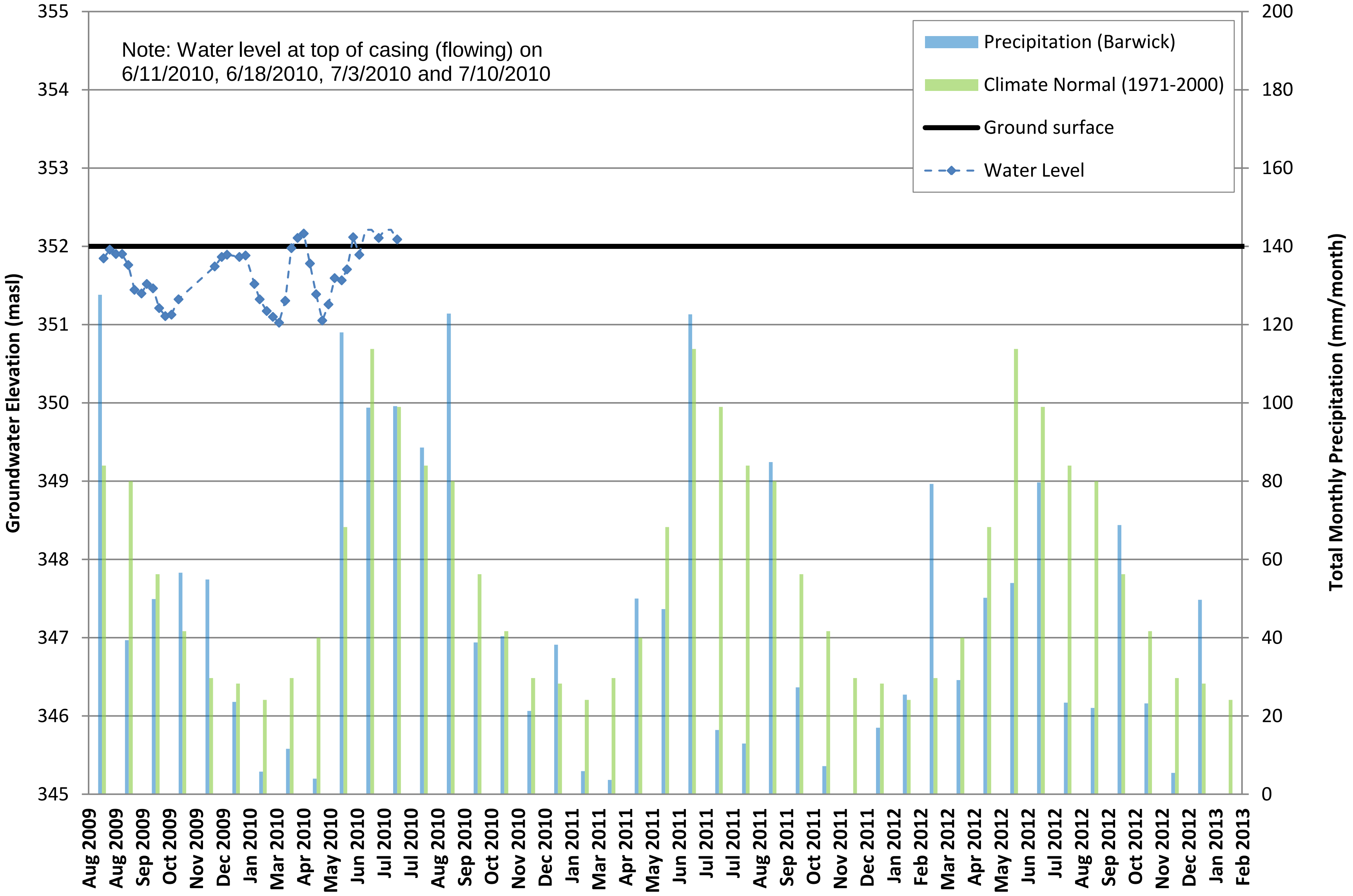
Depth of open hole well: 480 m at a dip angle of -65°



TC111504

Hydrograph of NR07151, 2009-2013
Completion in Bedrock

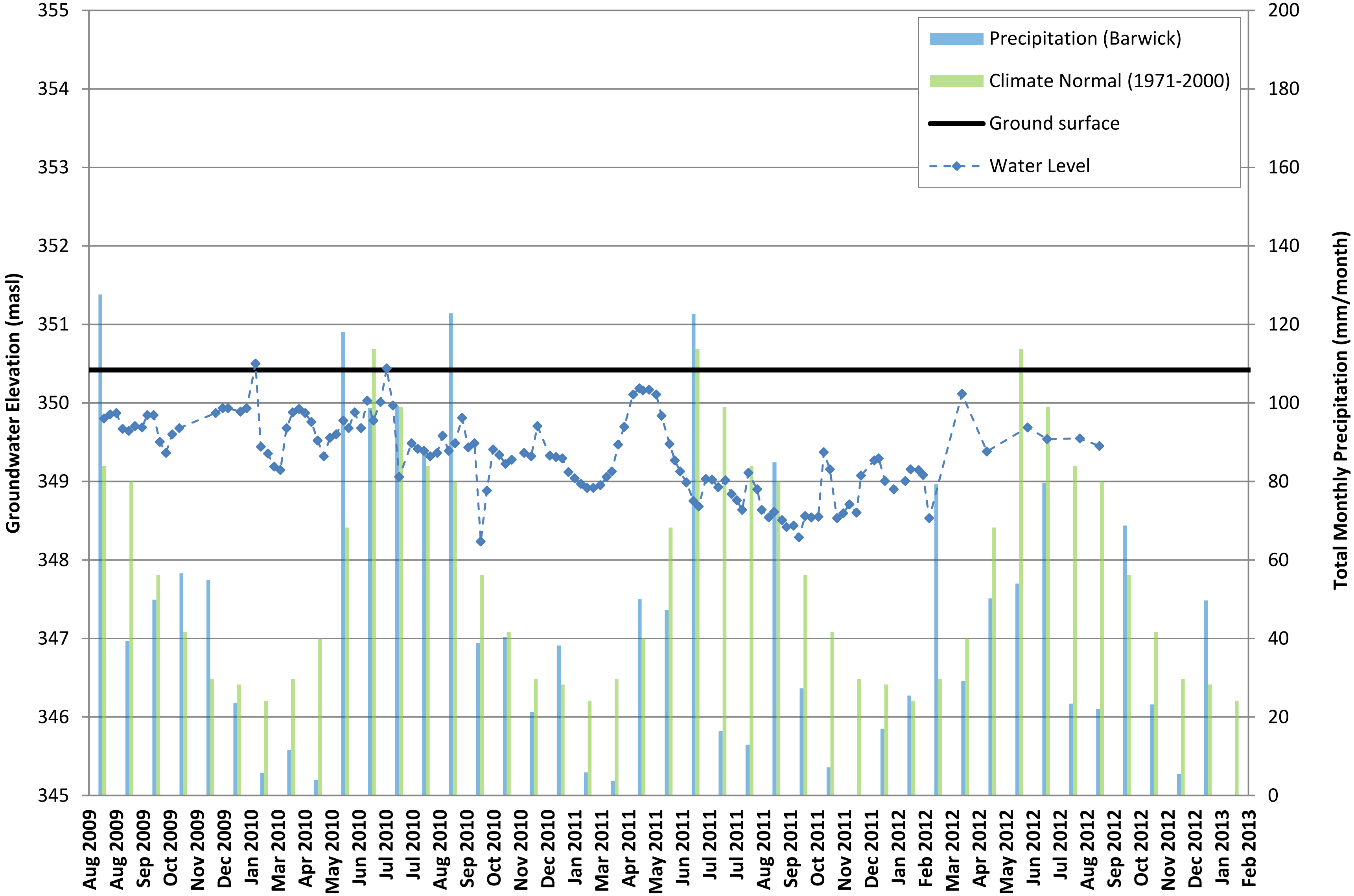
Depth of open hole well: 489 m at a dip angle of -69º


Note: Water level at top of casing (flowing) on 6/11/2010, 6/18/2010, 7/3/2010 and 7/10/2010

TC111504

Hydrograph of NR07190, 2009-2013
Completion in Bedrock

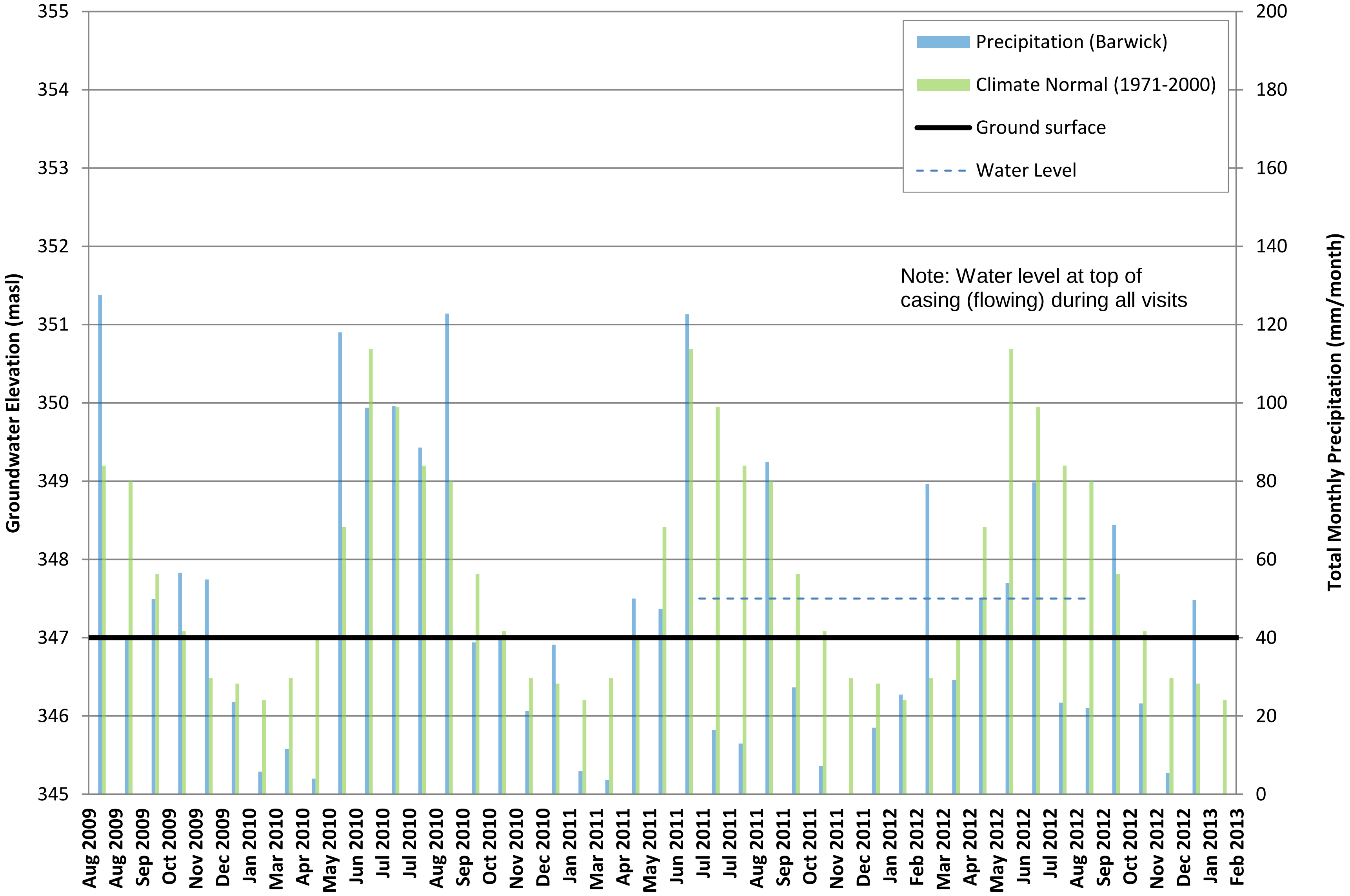
Depth of open hole well: 593 m at a dip angle of -61°



TC111504

Hydrograph of NR07214, 2009-2013
Completion in Bedrock

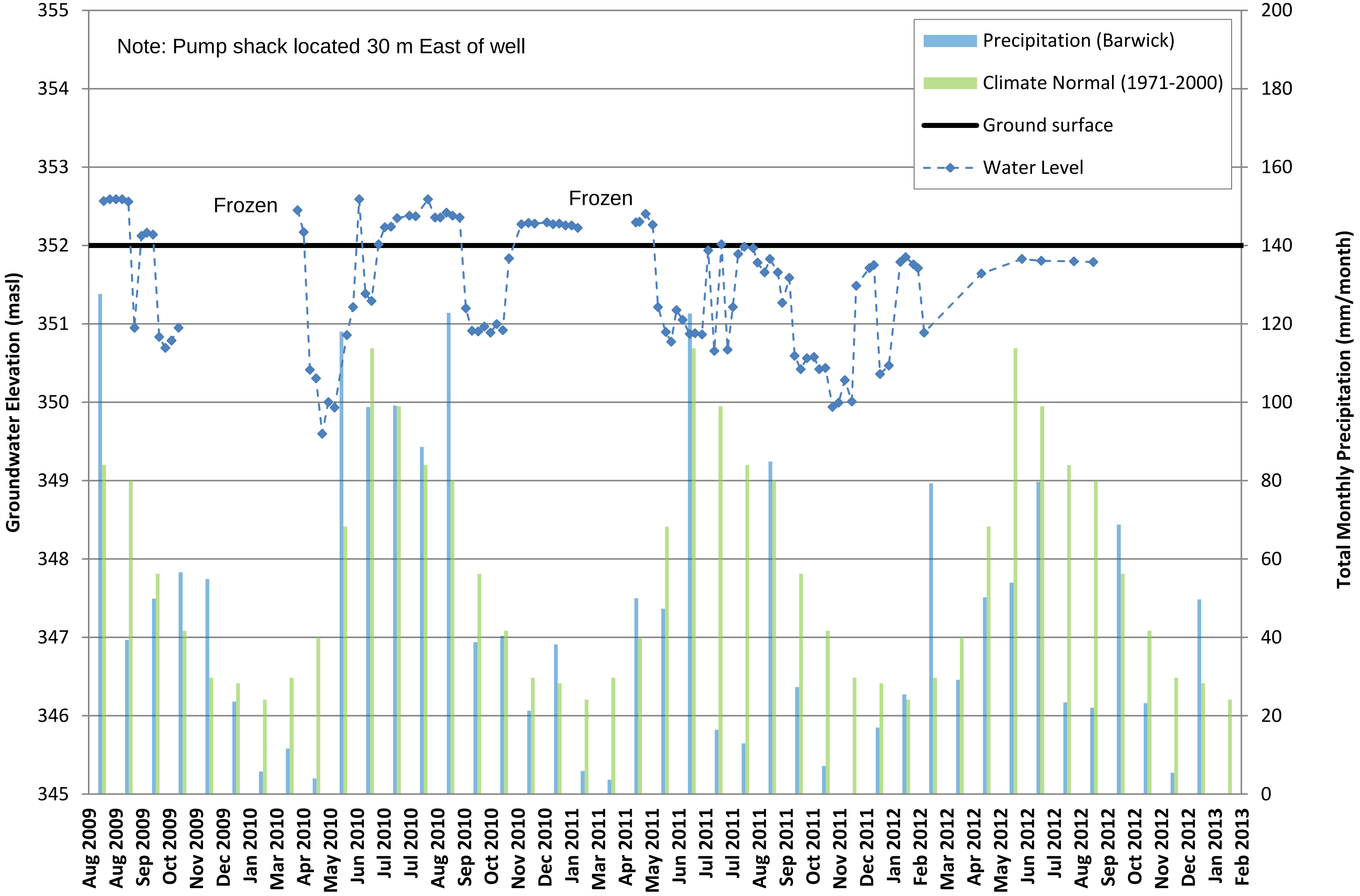
Depth of open hole well: 1090 m at a dip angle of -71°



Note: Water level at top of casing (flowing) during all visits

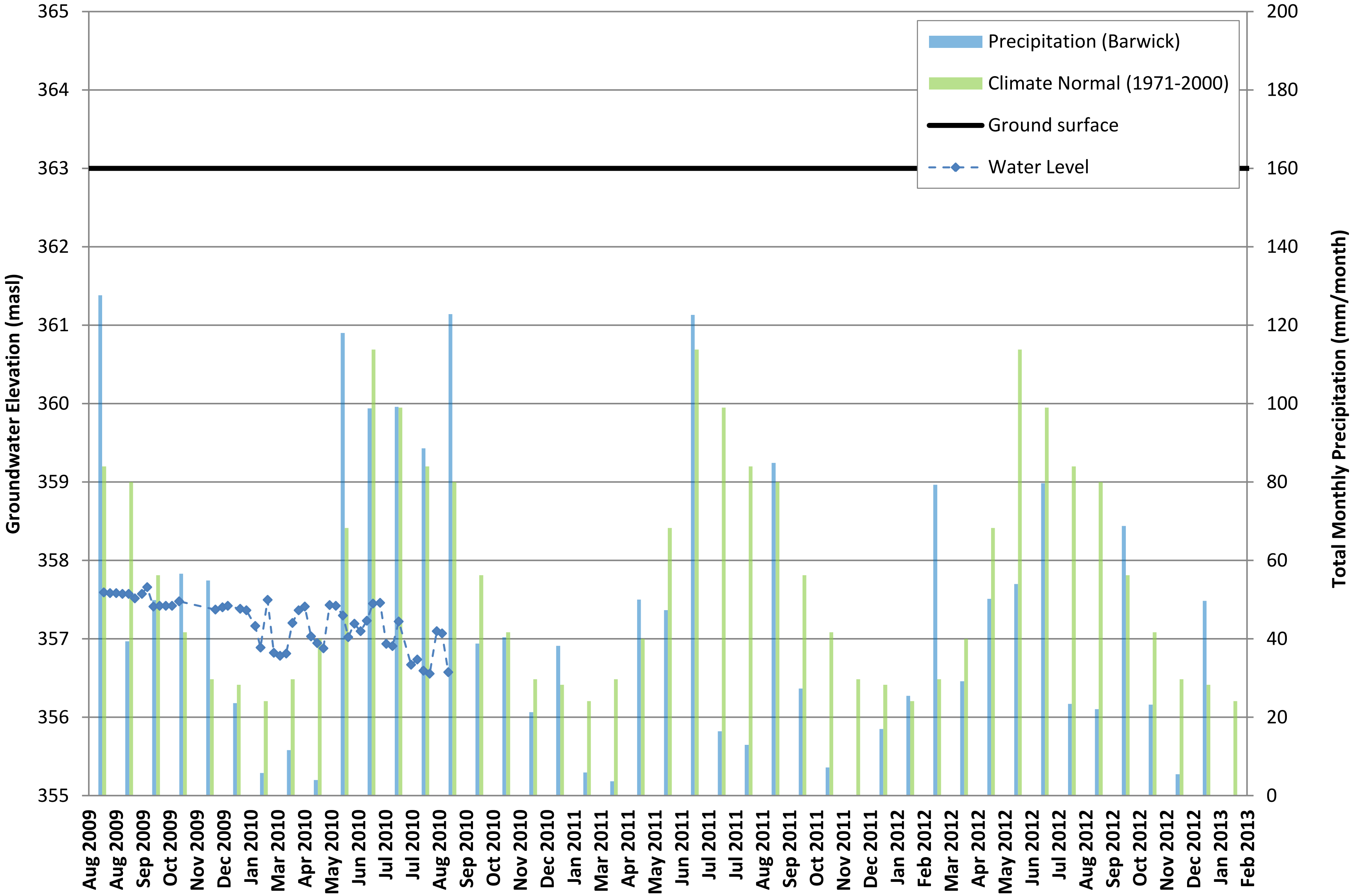
TC111504

Hydrograph of NR08246, 2009-2013
Completion in Bedrock
Depth of open hole well: 350 m at a dip angle of -51°



TC111504

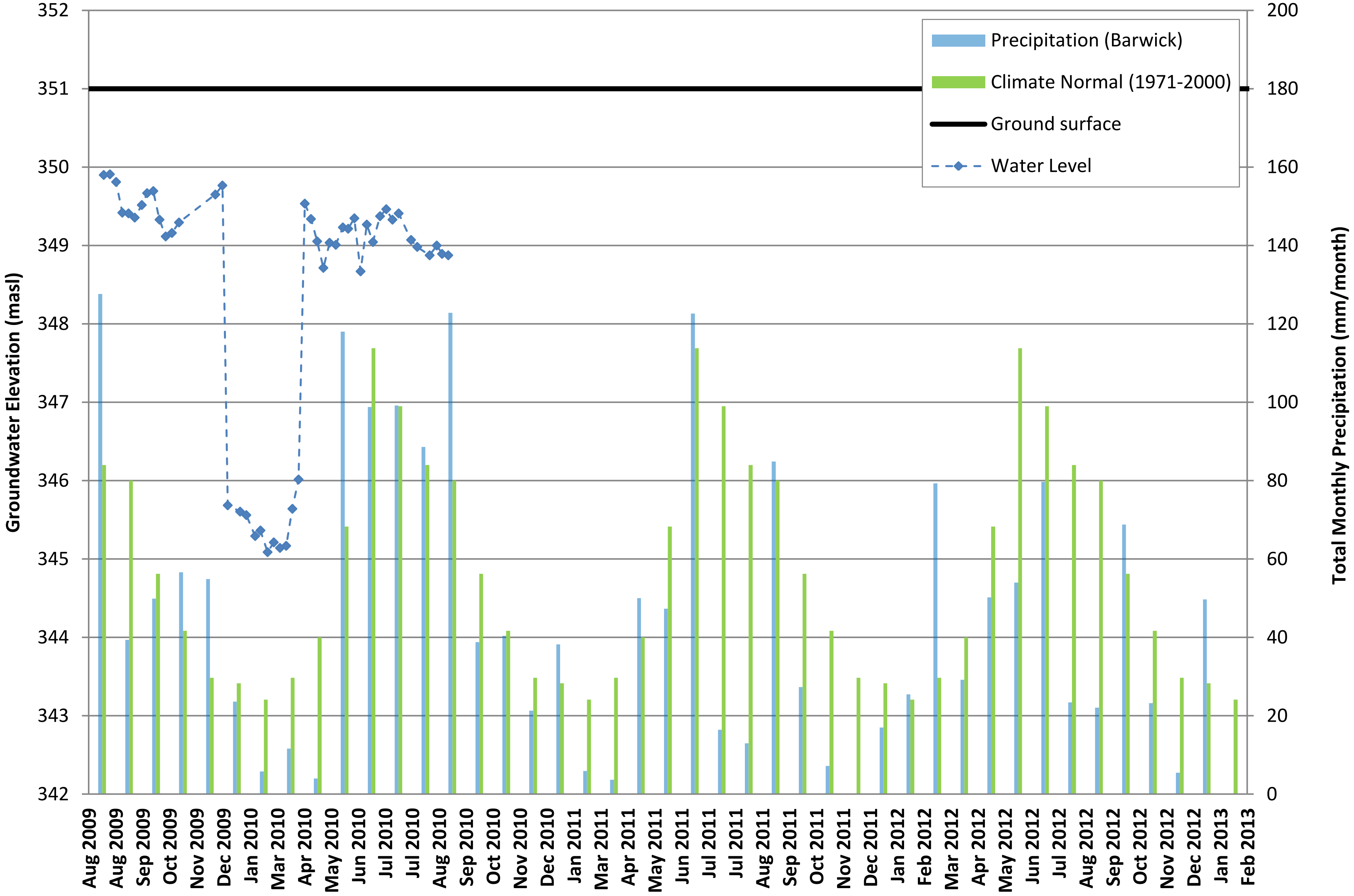
Hydrograph of NR08257, 2009-2013
Completion in Bedrock
Depth of open hole well: 792 m at a dip angle of -72°



TC111504

Hydrograph of NR08278, 2009-2013
Completion in Bedrock

Depth of open hole well: 626 m at a dip angle of -61°

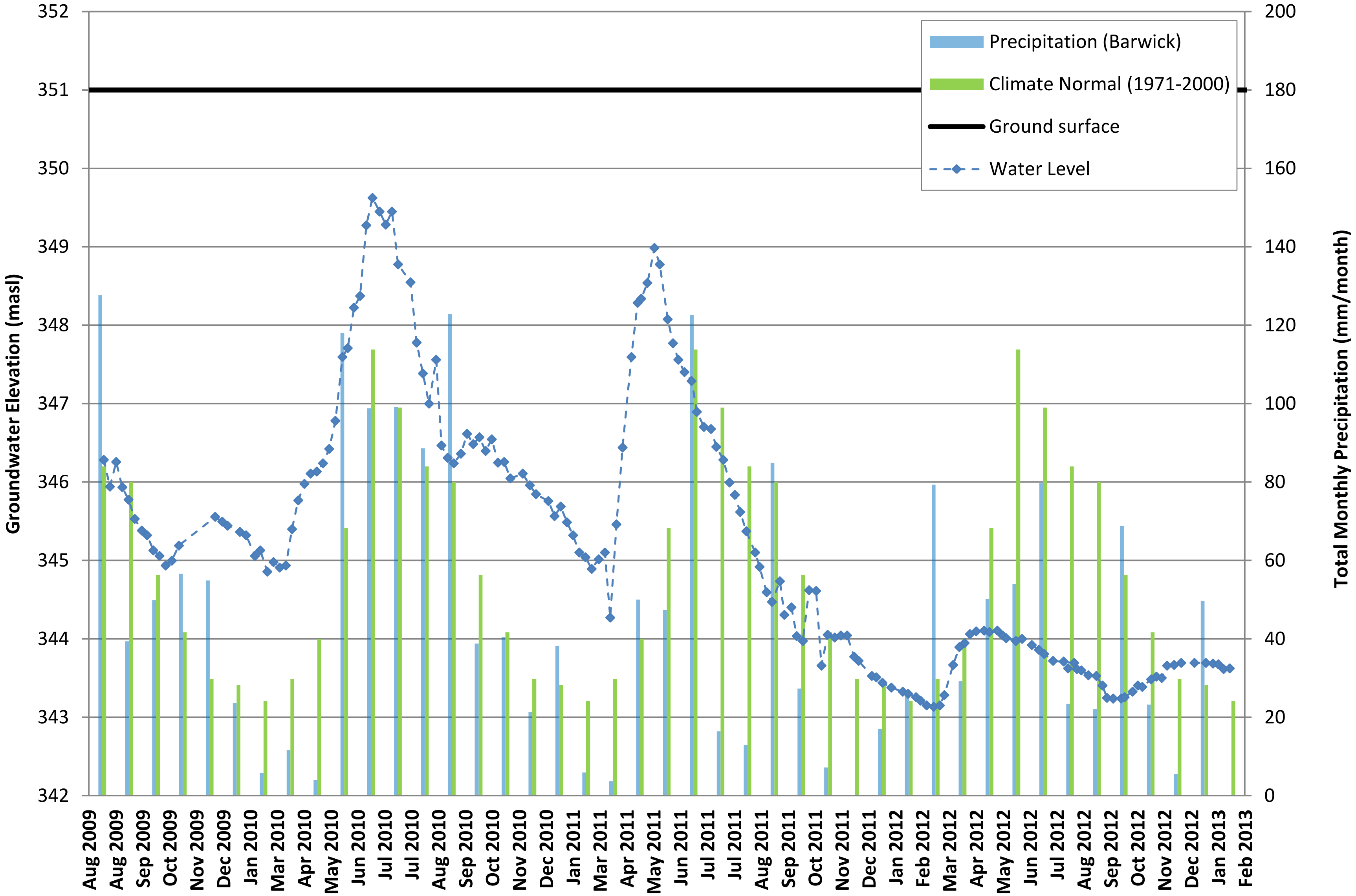


TC111504

Hydrograph of NR08287, 2009-2013

Completion in Bedrock

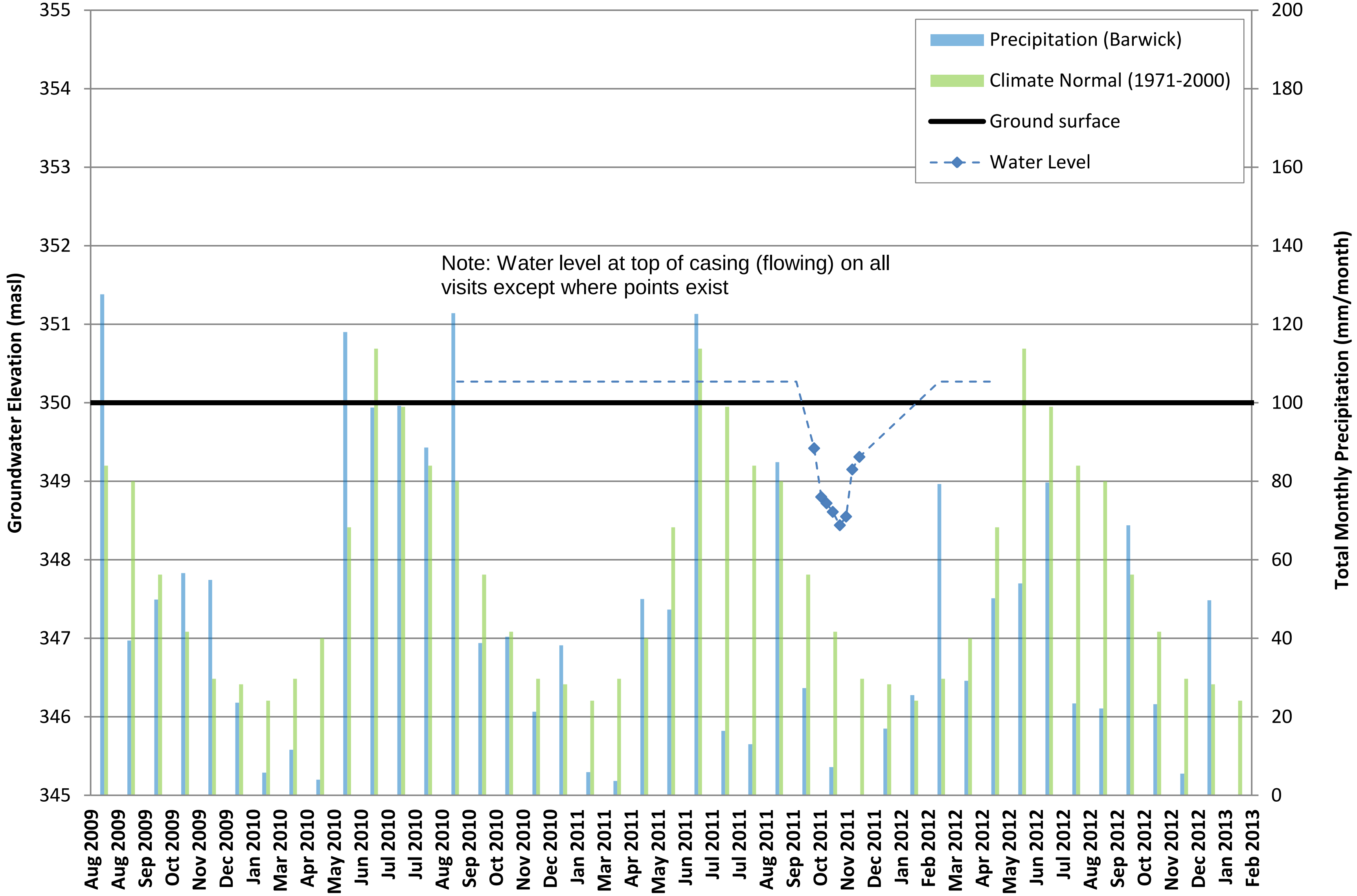
Depth of open hole well: 548 m at a dip angle of -61°



TC111504

Hydrograph of RR09213, 2009-2013
Completion in Bedrock

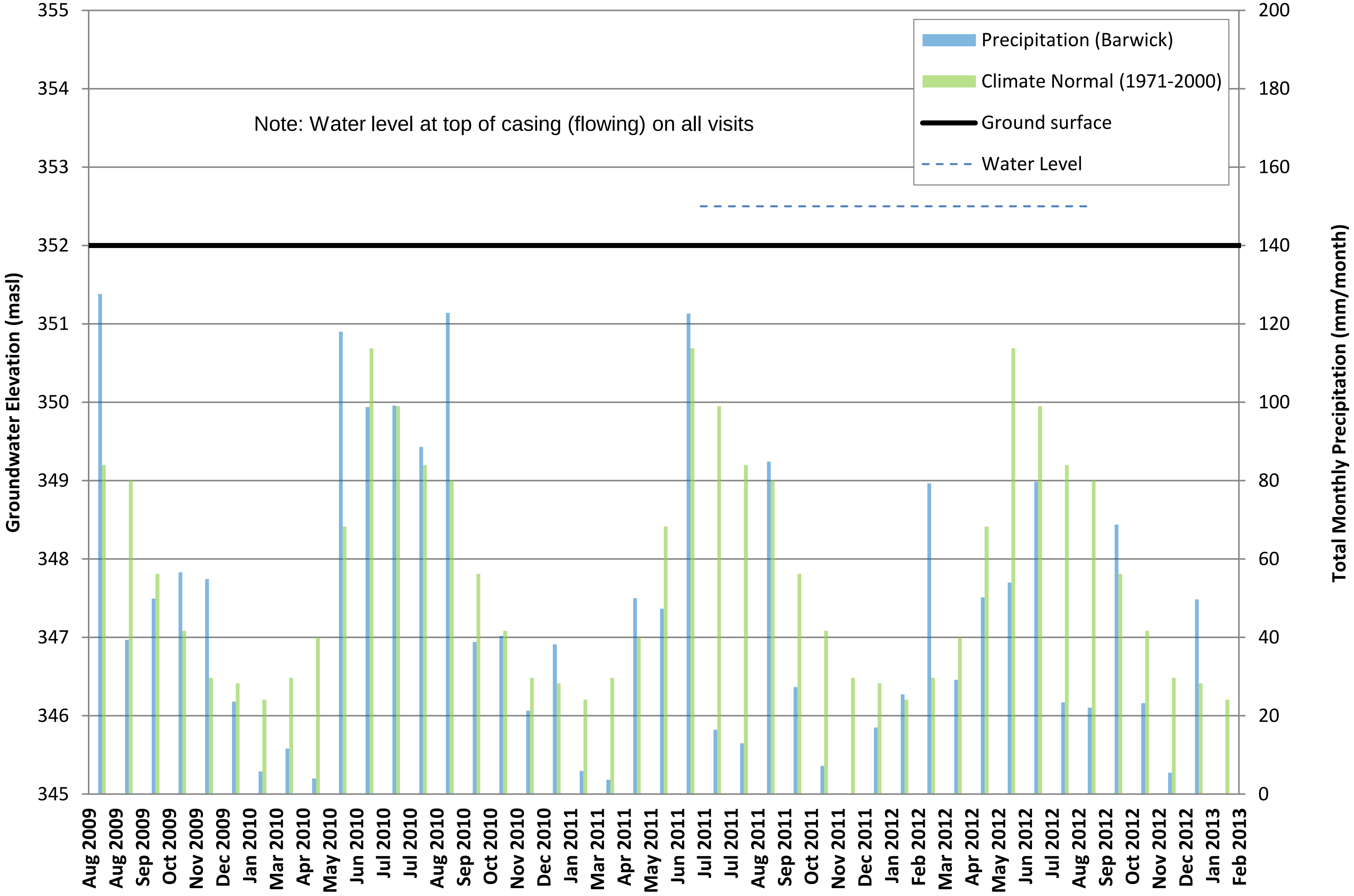
Depth of open hole well: 46.5 m at a dip angle of -90º



Note: Water level at top of casing (flowing) on all visits except where points exist

Hydrograph of NR09367, 2009-2013
Completion in Bedrock

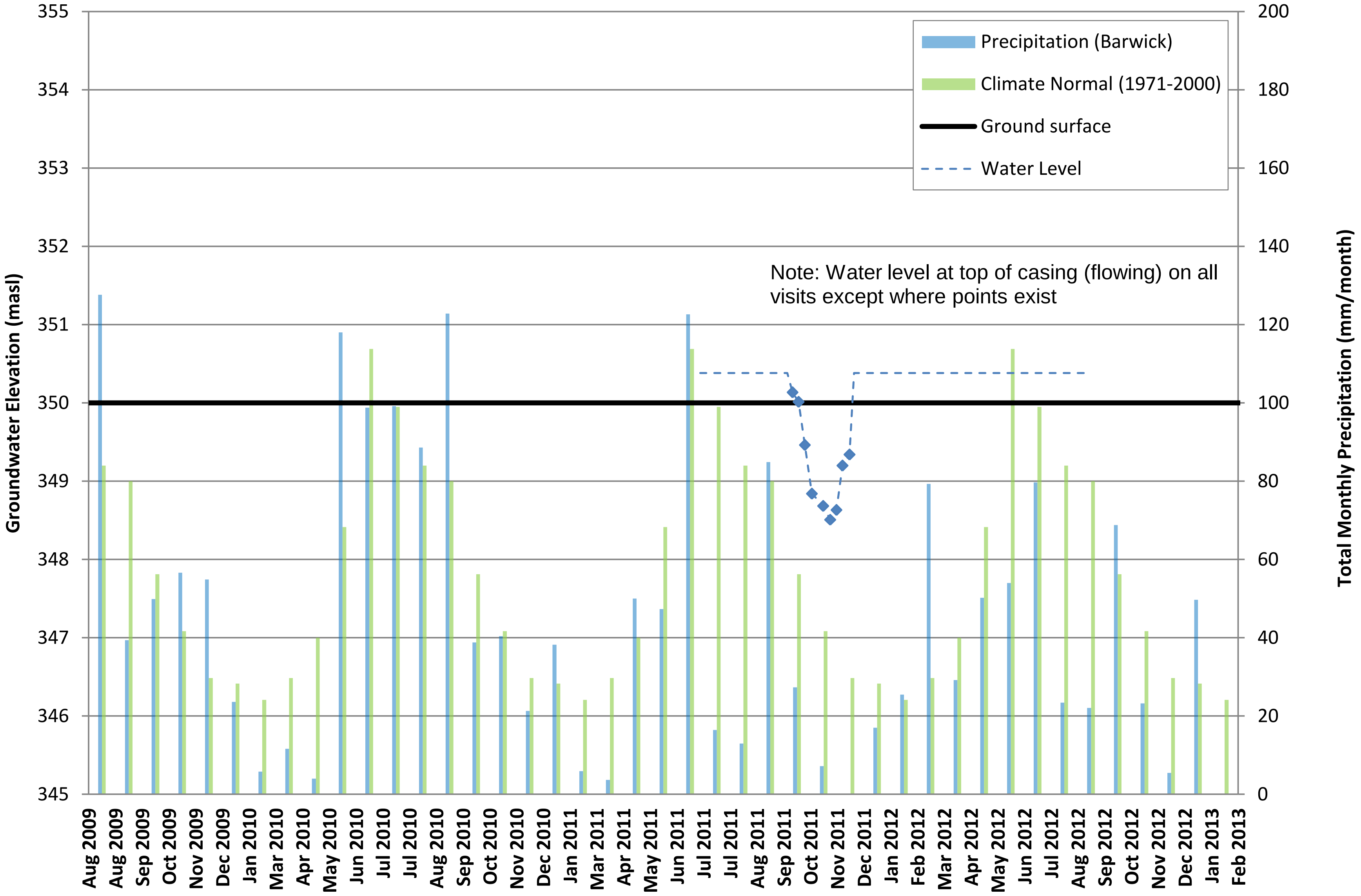
Depth of open hole well: 354 m at a dip angle of -62°



TC111504

Hydrograph of NR09428, 2009-2013
Completion in Bedrock

Depth of open hole well: 476 m at a dip angle of -61°

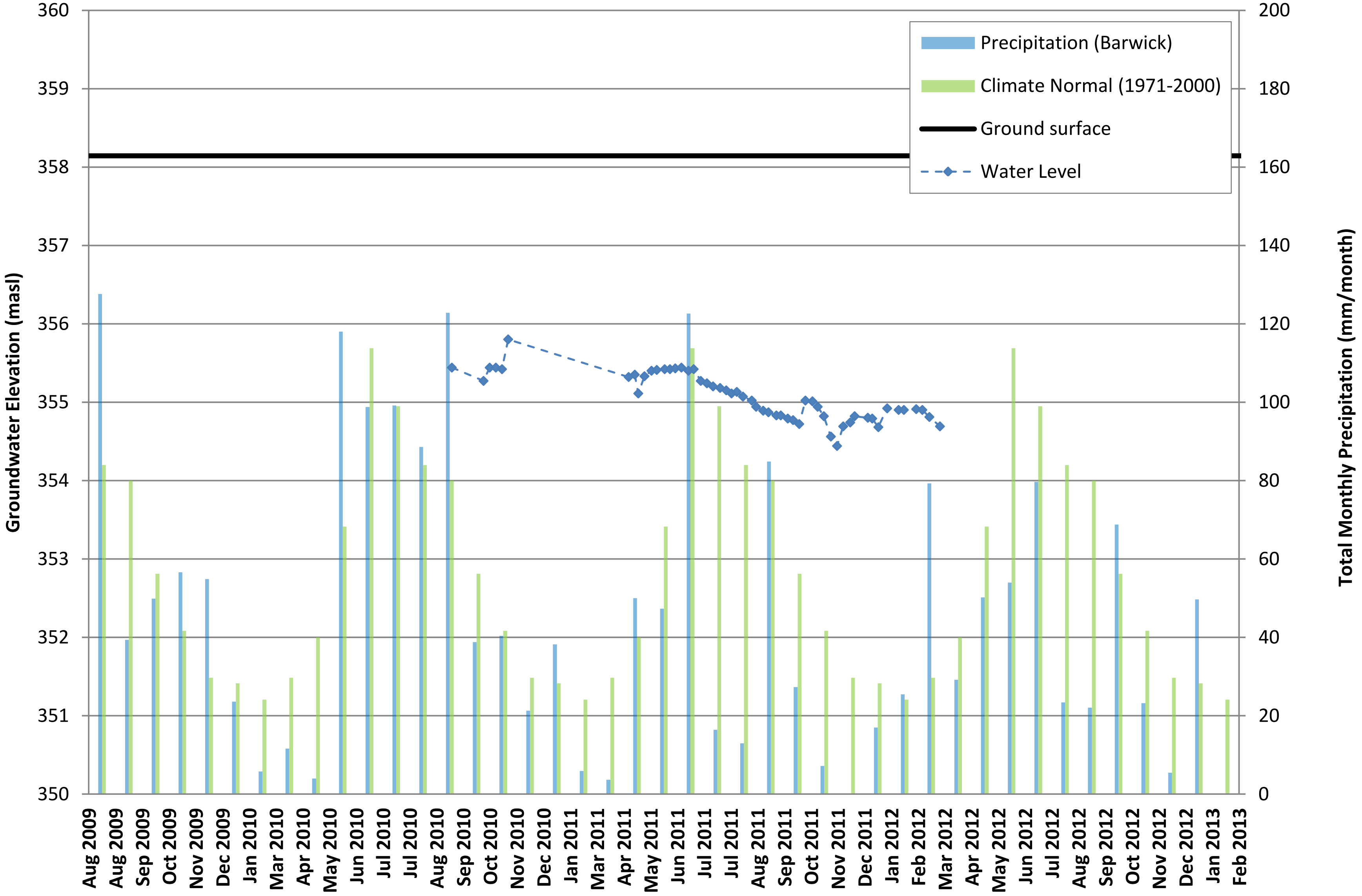


Note: Water level at top of casing (flowing) on all visits except where points exist

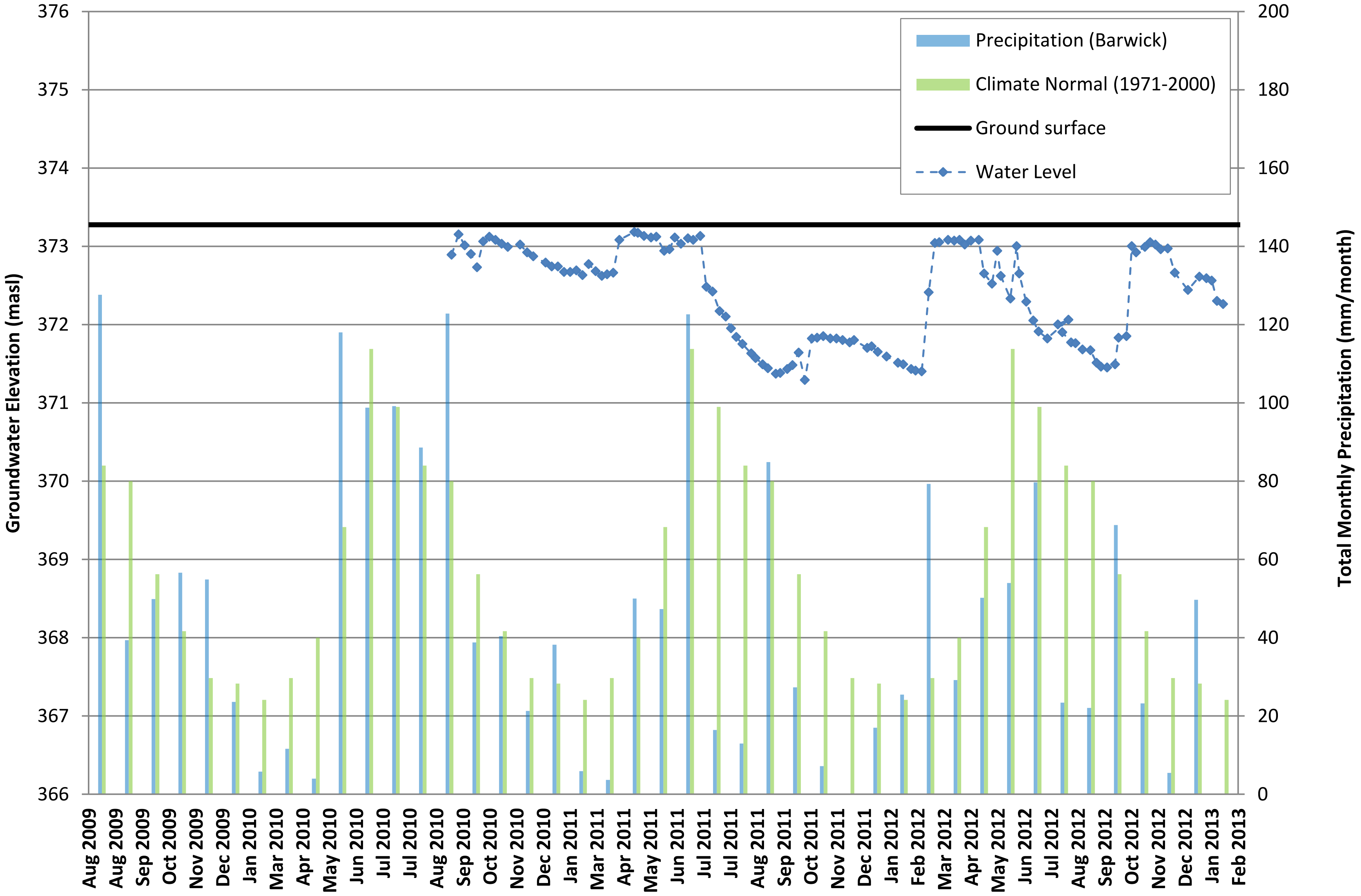
TC111504

Hydrograph of BH10-04 2009-2013
Whiteshell Till

Screen interval: 339.6-336.6 masl (Alternating Layers of Sand and Silty Clay)



Hydrograph of BH10-05 2009-2013
Whitemouth Lake Till
Screen interval: 370.3 - 367.3 masl (Silty Clay)

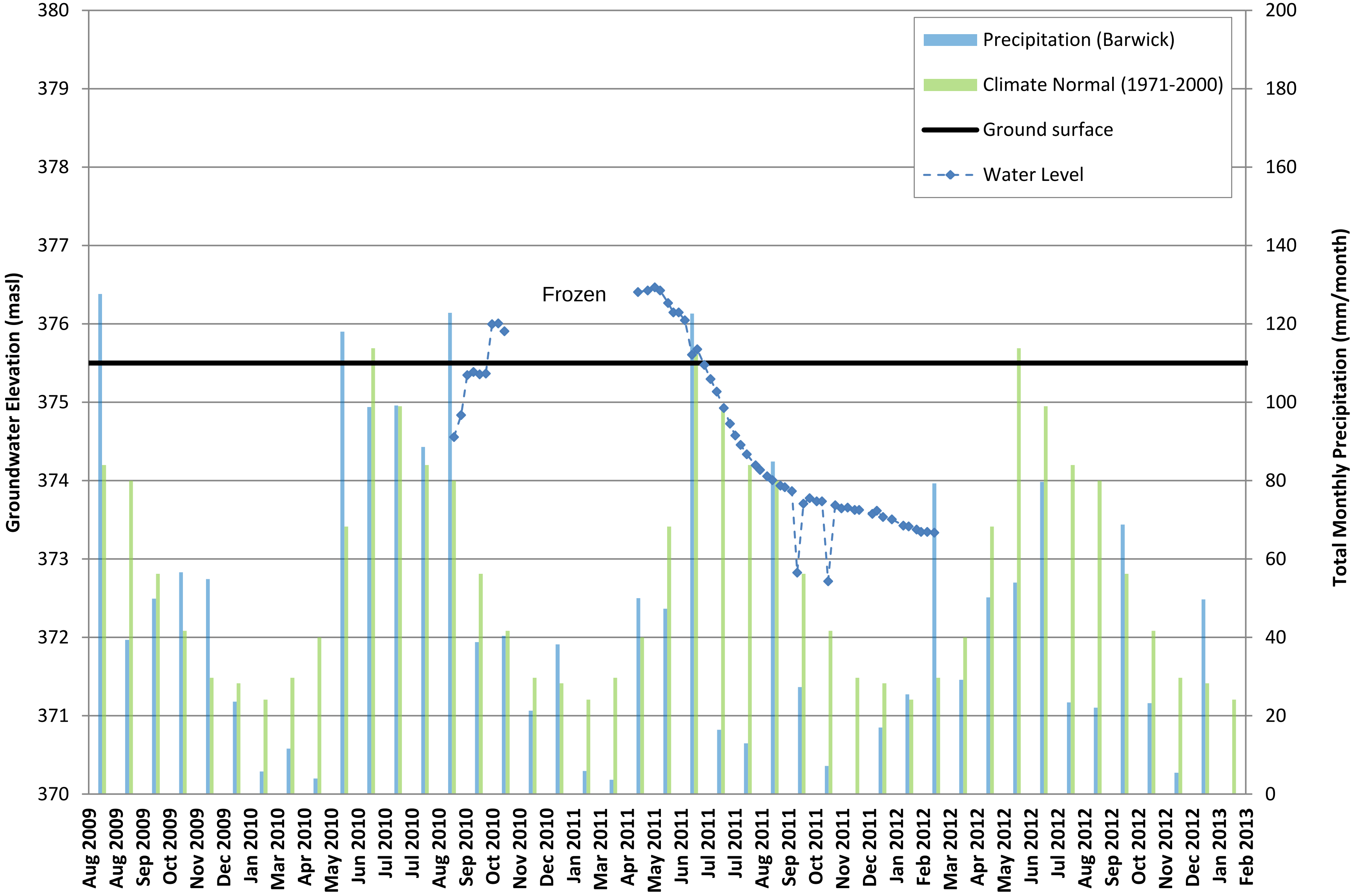


TC111504

amec

Hydrograph of BH10-06 2009-2013
Whitemouth Lake Till

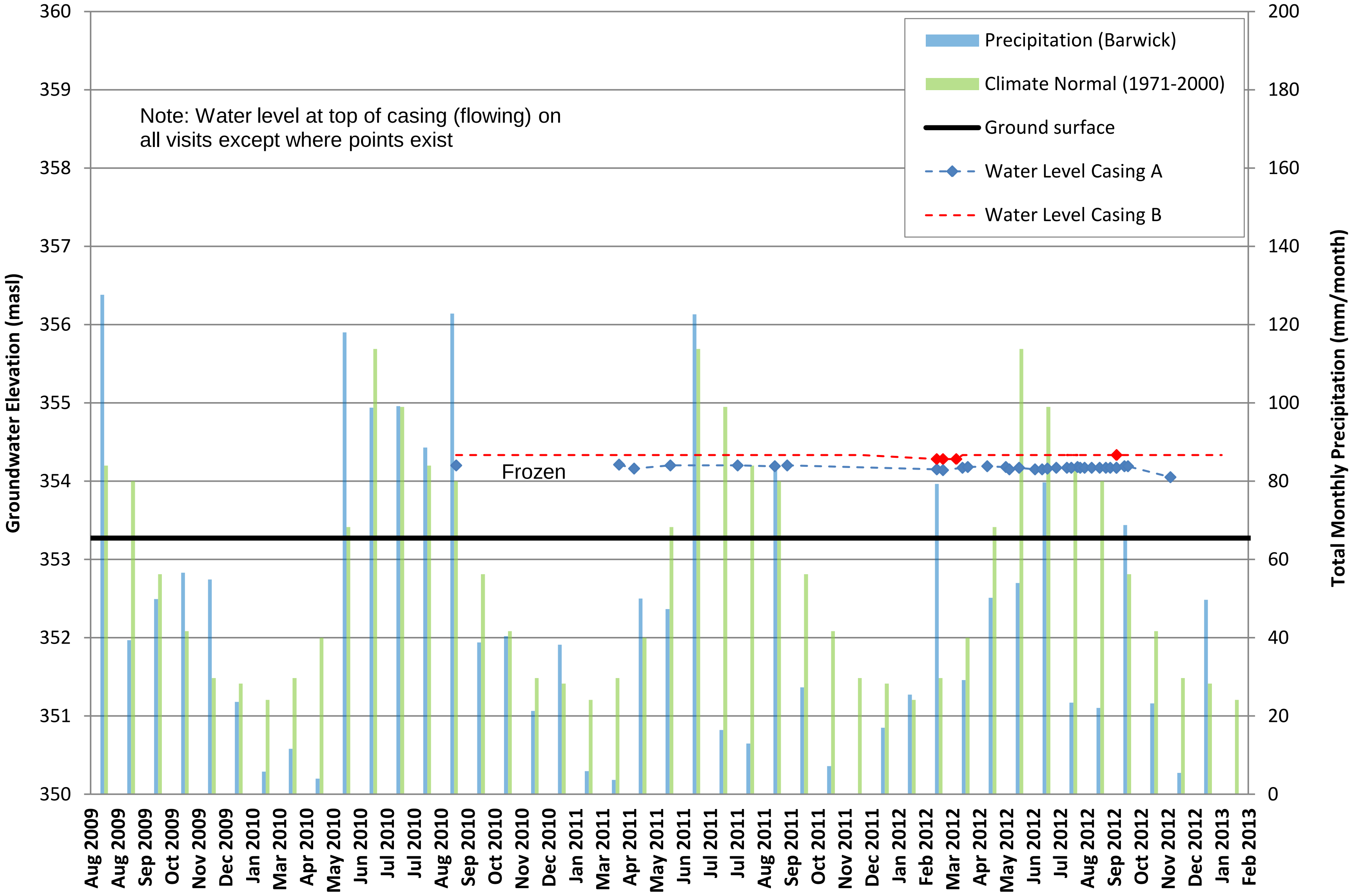
Screen interval: 371.9 - 368.9 masl (Silty Clay)



Hydrograph of BH10-07 2009-2013

Casing A - Whitemouth Lake Till; Casing B - Whitemouth Lake Till

Screen interval: Casing A - 331.3 - 328.3 masl (Silty Clay); Casing B - 351.9 - 348.9 masl (Silty Clay)

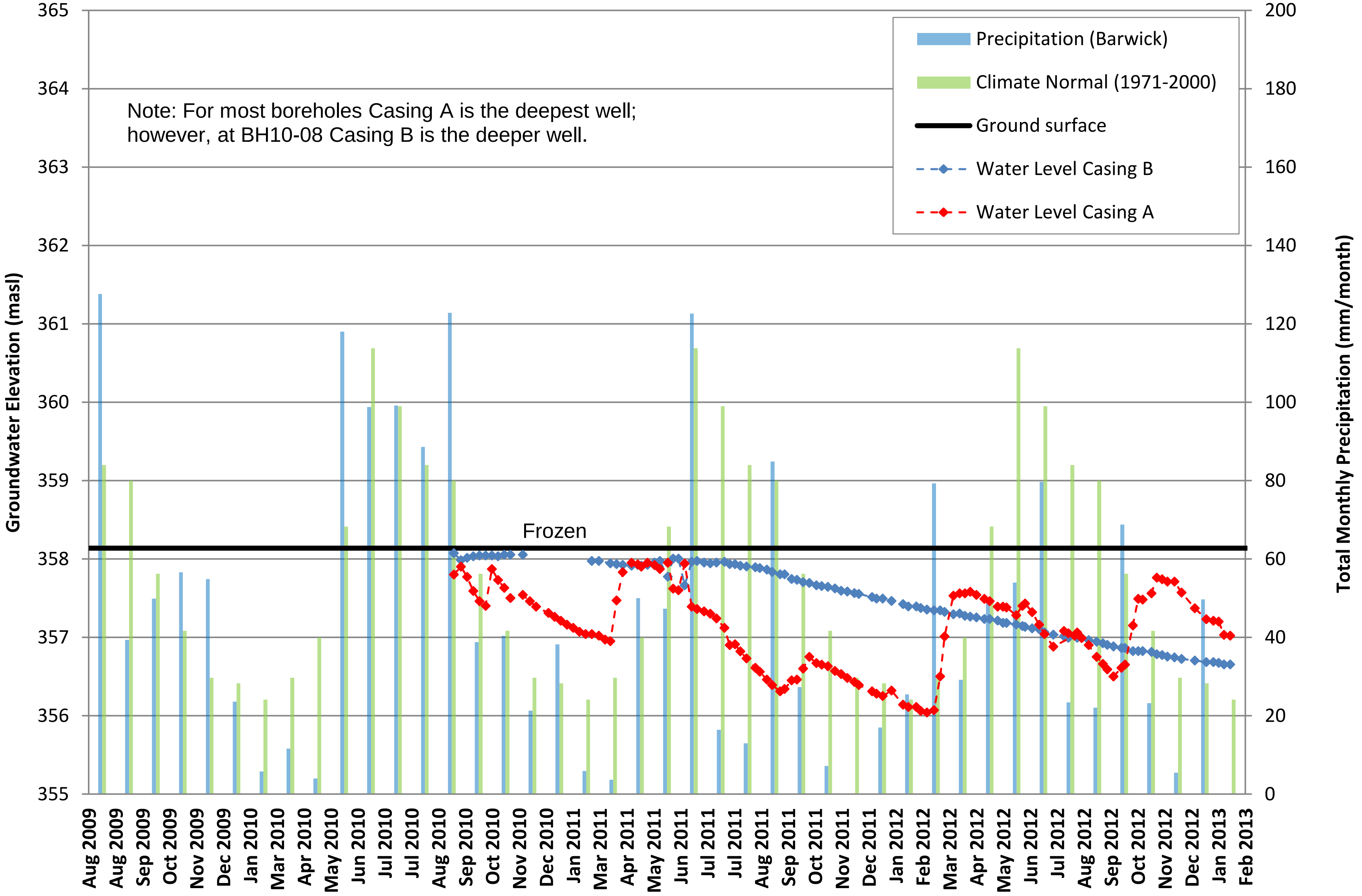


TC111504

Hydrograph of BH10-08 2009-2013

Casing A - Whitemouth Lake Till; Casing B - Whitemouth Lake Till

Screen interval: Casing A - 354.4 - 351.4 masl (Silty Clay); Casing B - 346.4 - 343.4 masl (Silty Clay and Varved Clay)

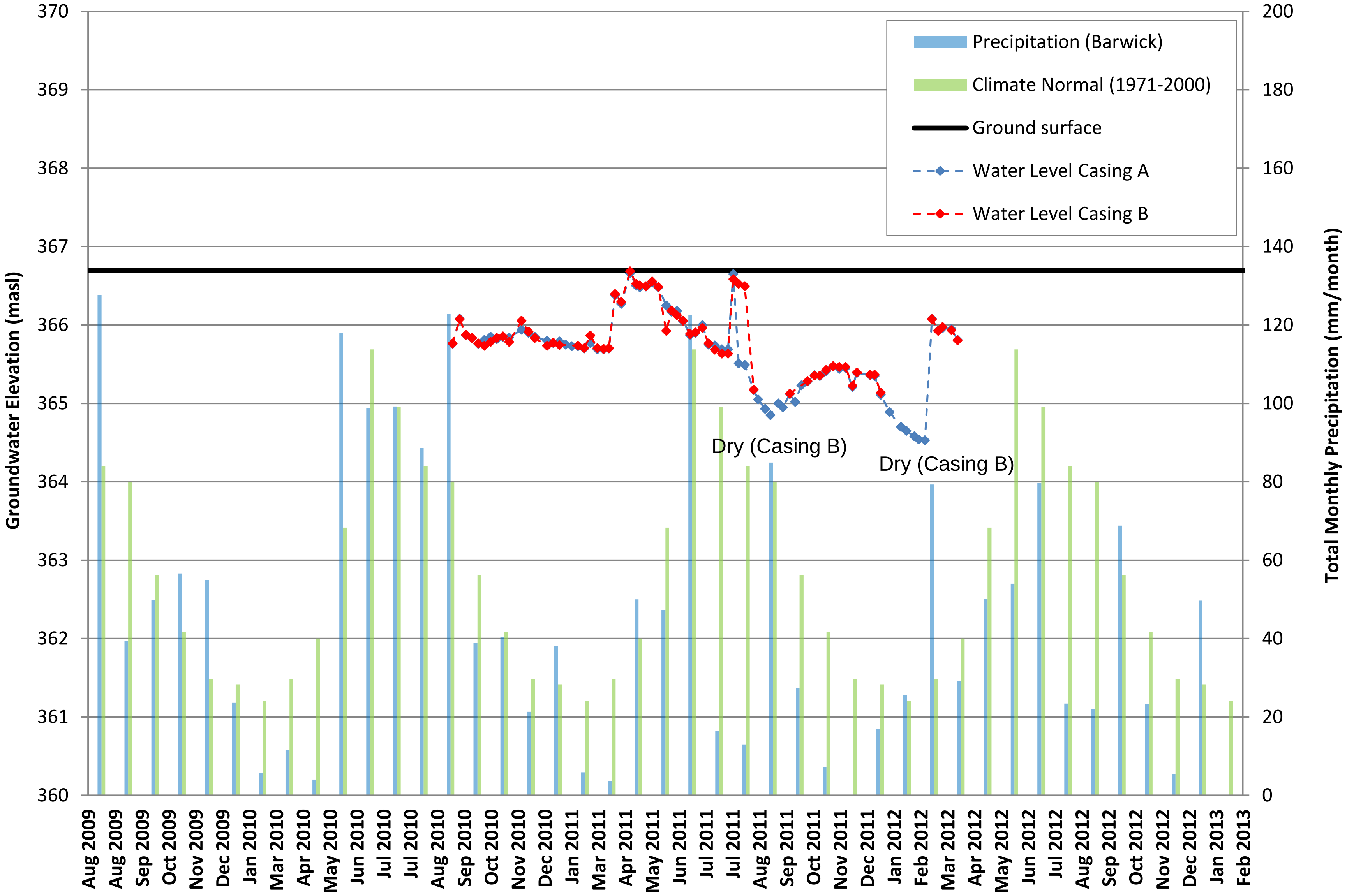


TC111504

Hydrograph of BH10-09 2009-2013

Casing A - Bedrock; Casing B - Whiteshell Till

Screen interval: Casing A - 364.5 - 363.0 masl (Bedrock); Casing B - 366.2 - 364.7 masl (Sandy Gravel)

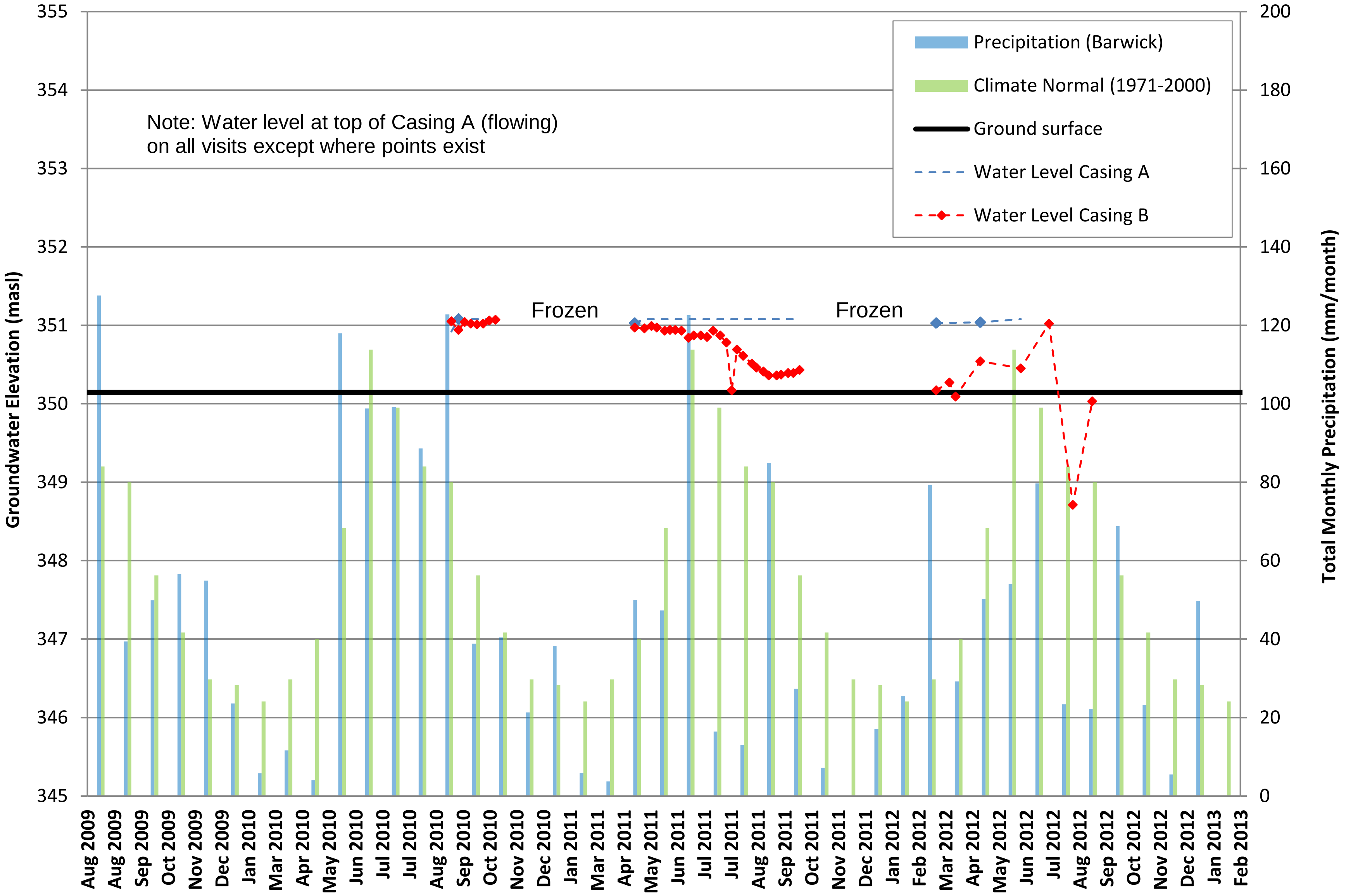


TC111504

Hydrograph of BH10-10 2009-2013

Casing A - Whitemouth Lake Till; Casing B - Whitemouth Lake Till

Screen interval: Casing A - 322.9 - 319.9 masl (Silty Clay and Silty Sand); Casing B - 340.3 - 337.3 masl (Silty Sand and Silty Clay)

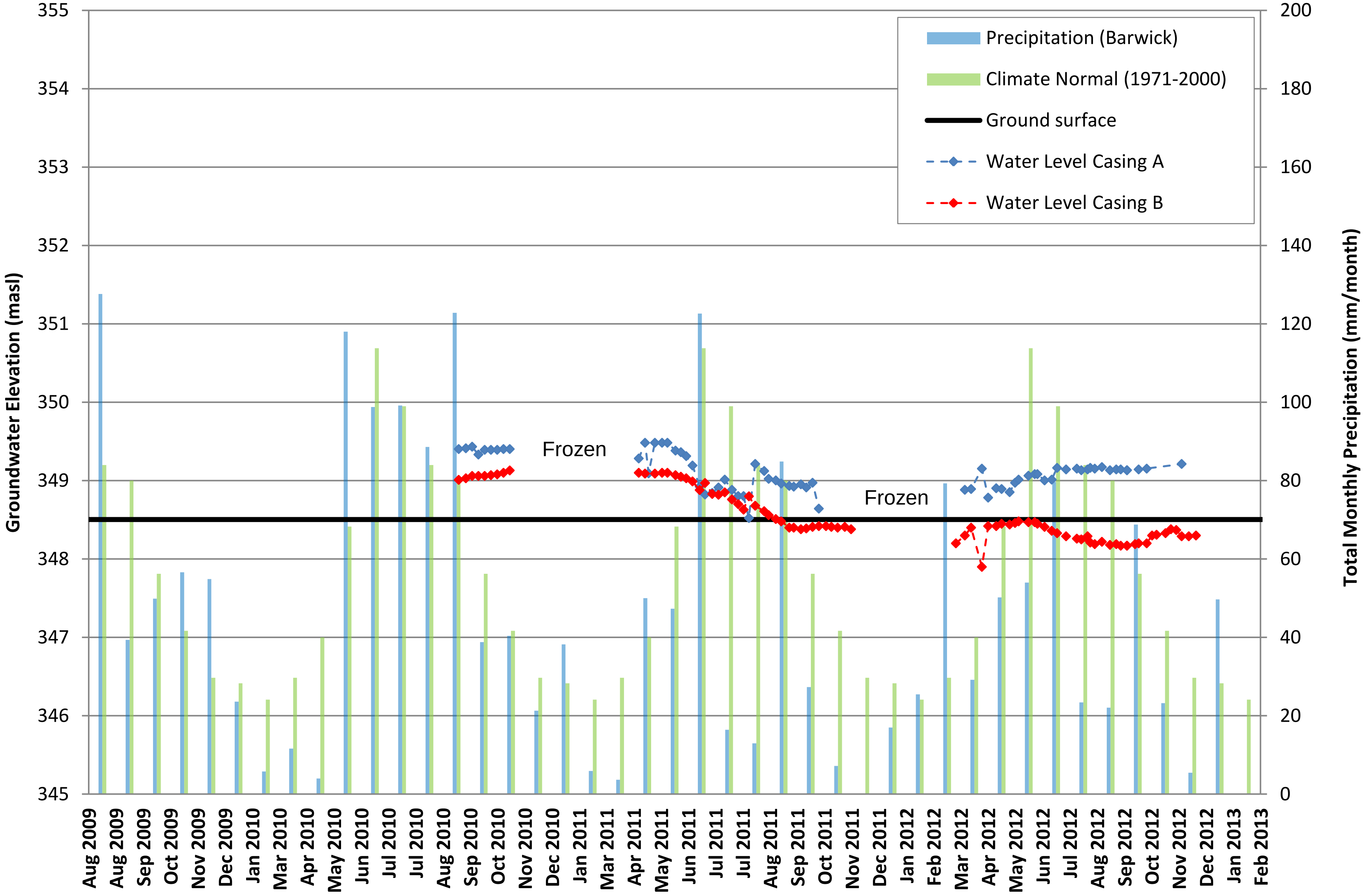


TC111504

Hydrograph of BH10-11 2009-2013

Casing A - Whiteshell Till; Casing B - Whitemouth Lake Till

Screen interval: Casing A - 321.8 - 318.8 masl (Silty Sand and Sand Gravel); Casing B - 339.1 - 336.1 masl (Silty Clay)



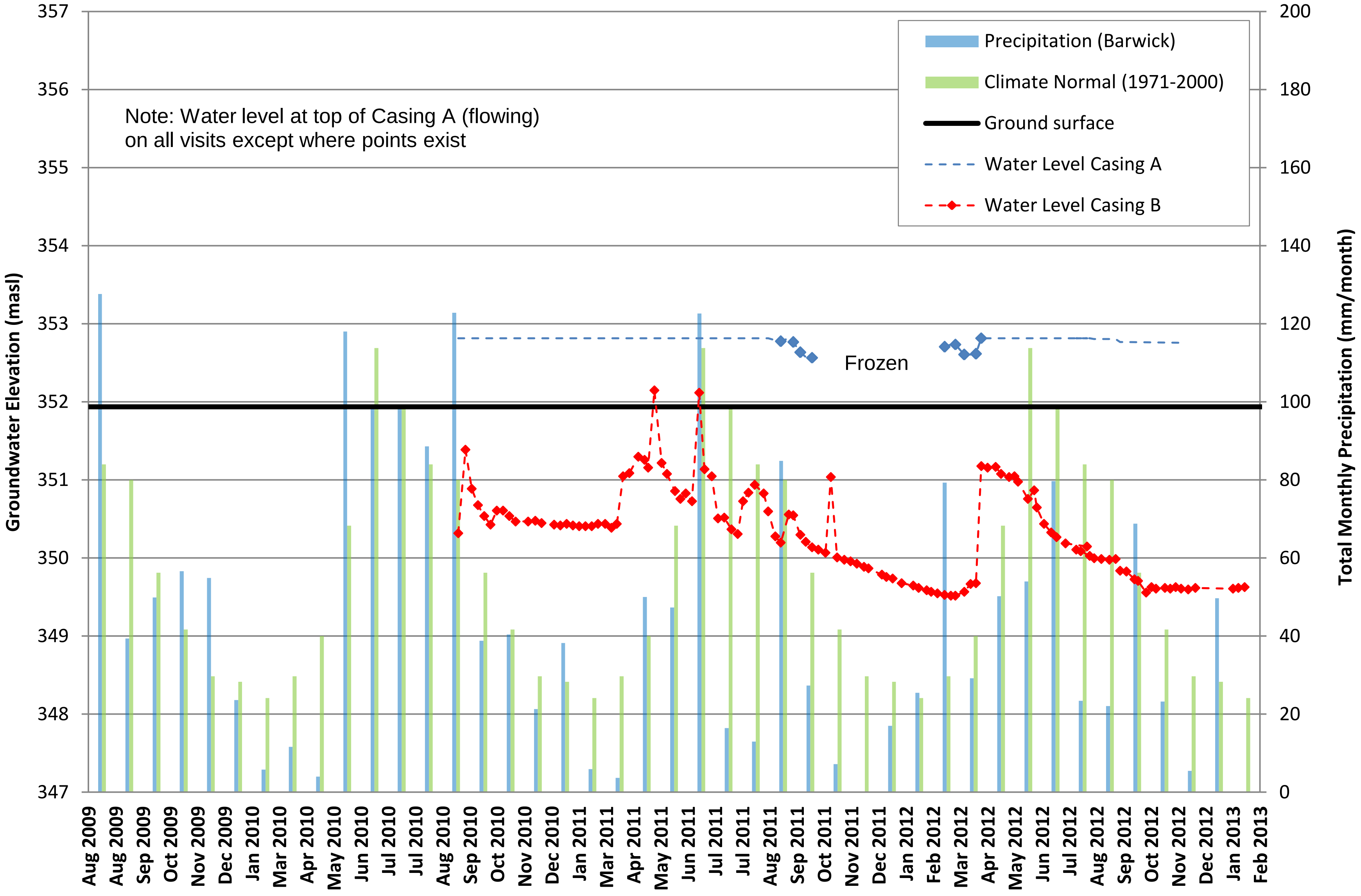
TC111504

amec

Hydrograph of BH10-12 2009-2013

Casing A - Whiteshell Till and Bedrock; Casing B - Whitemouth Lake Till

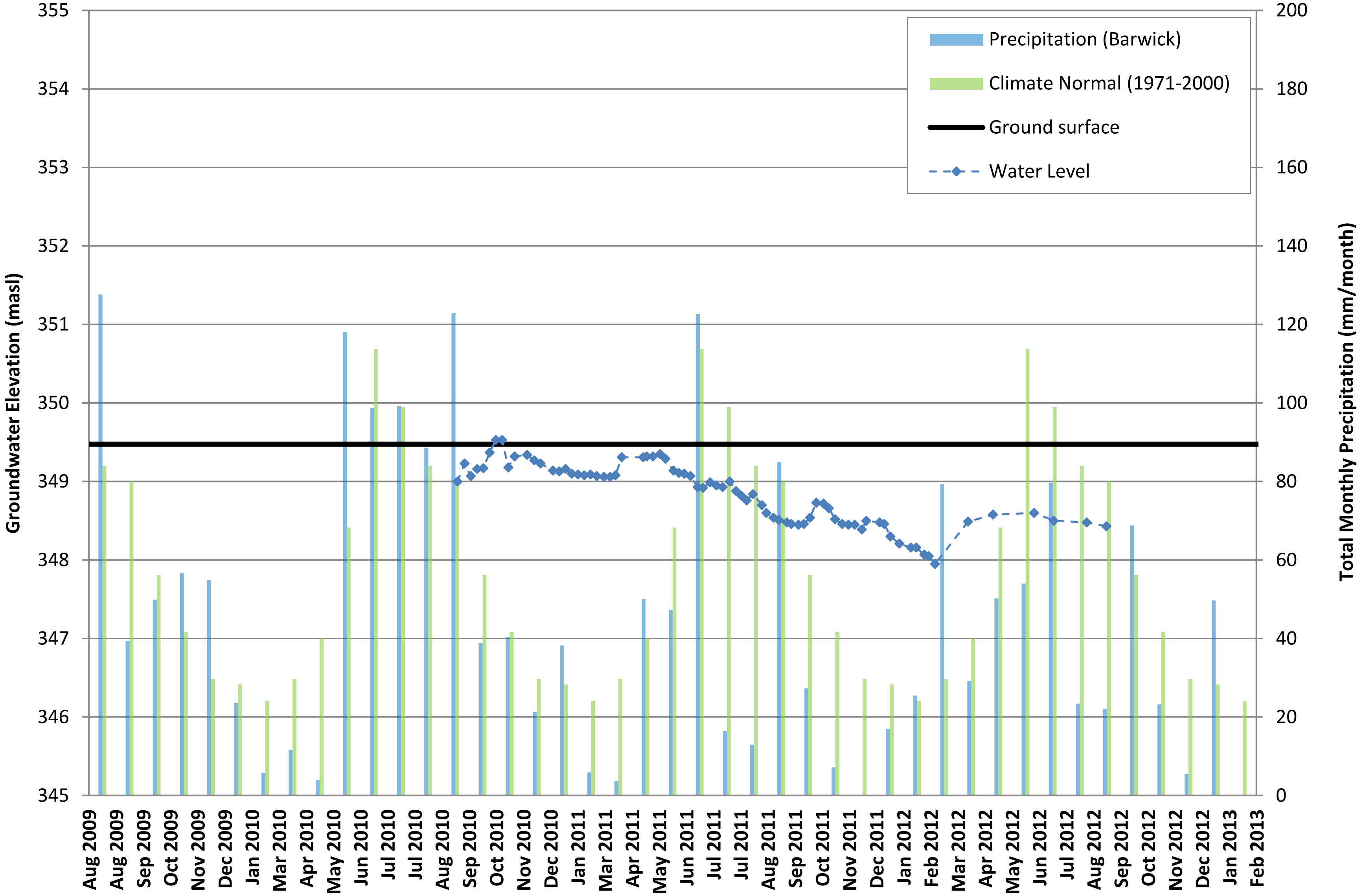
Screen interval: Casing A - 335.4 - 332.4 masl (Silty Sand and Bedrock); Casing - 345.9 - 342.9 masl (Silty Clay)



TC111504

Hydrograph of BH10-13 2009-2013
Whiteshell Till

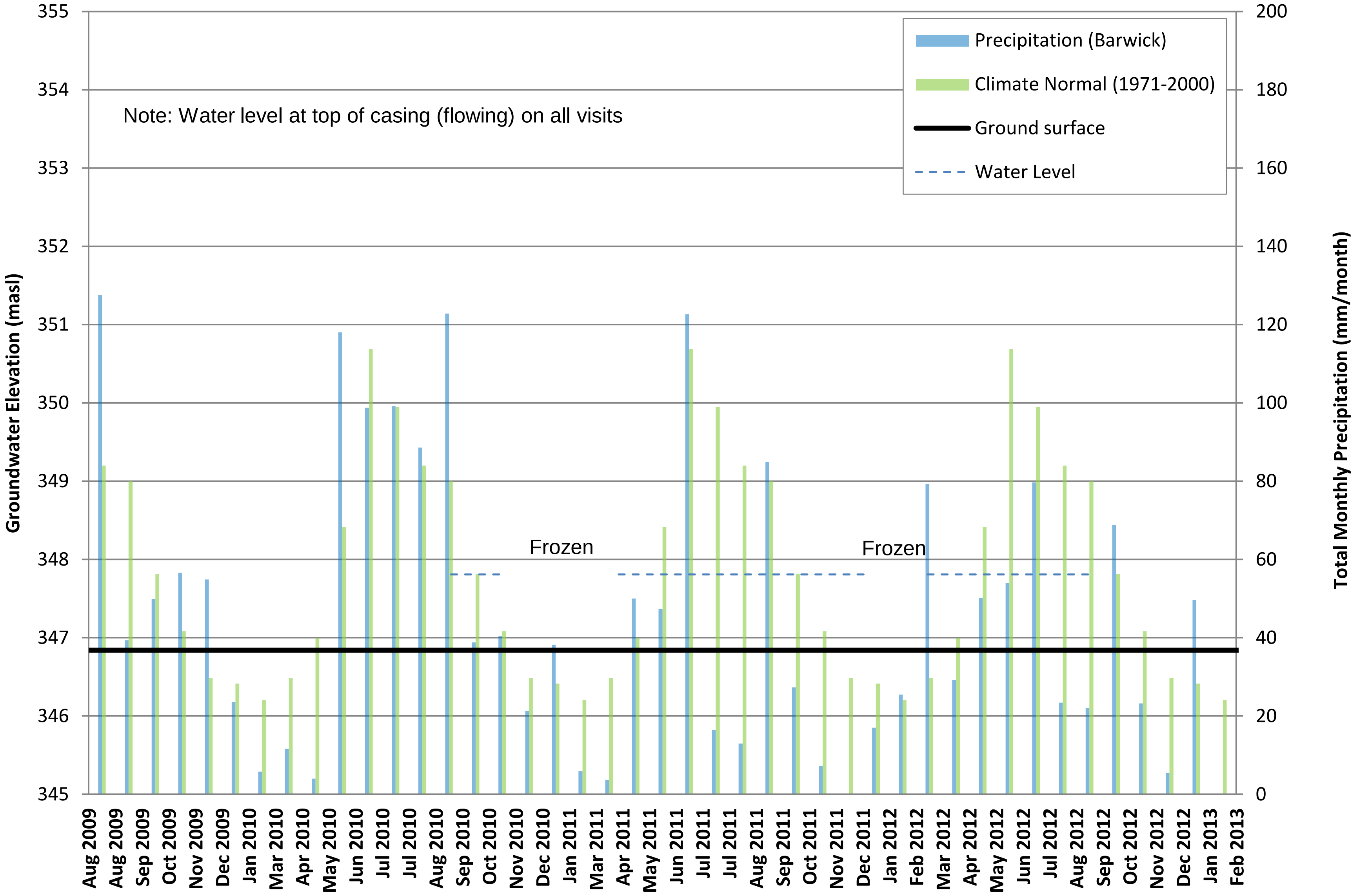
Screen interval: 333.2 - 330.2 masl (Sandy Gravel, Silty Clay, and Sand)



TC111504

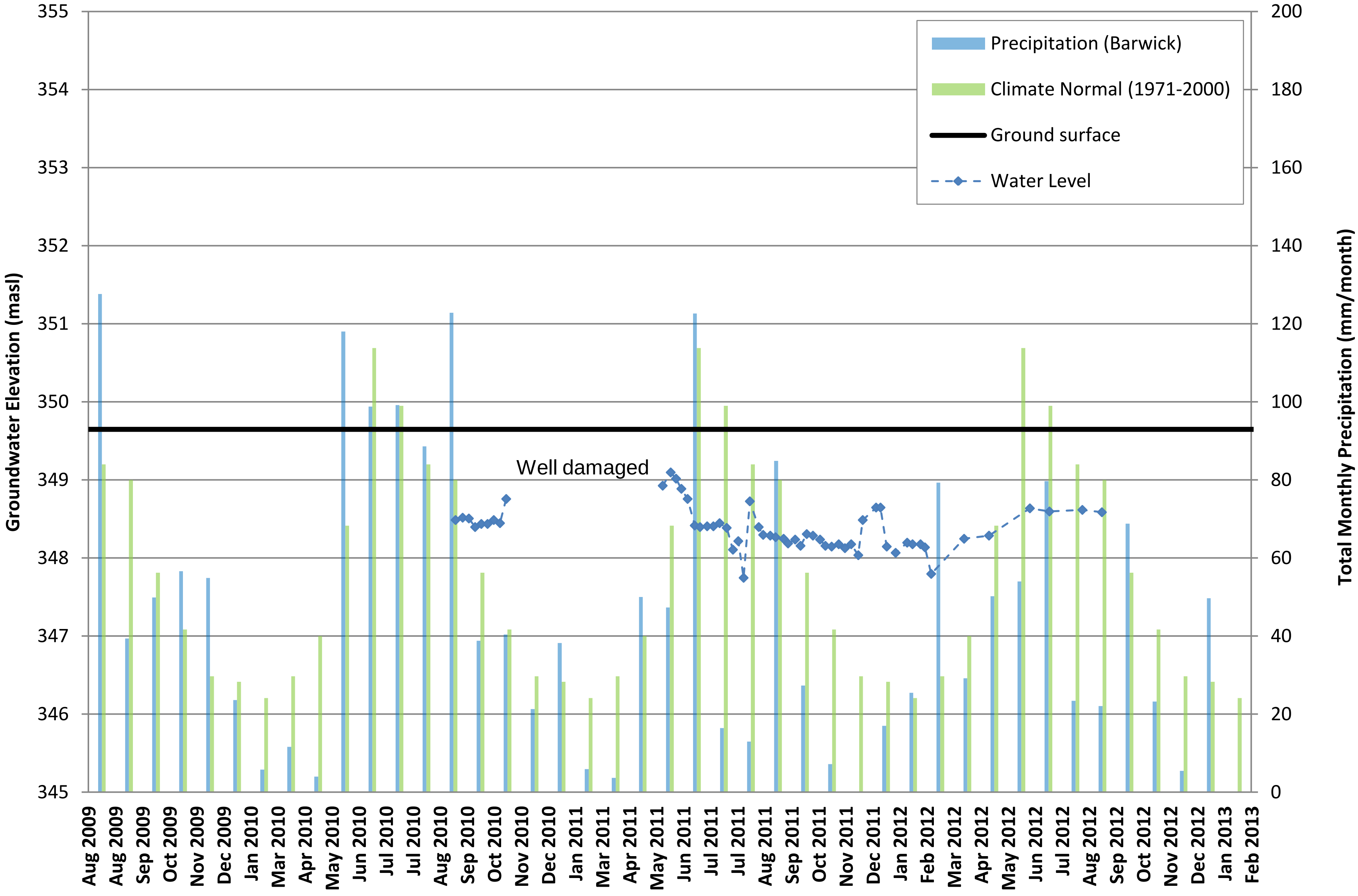
Hydrograph of BH10-14 2009-2013
Whitemouth Lake Till and Whiteshell Till

Screen interval: 330.2 - 327.3 masl (Silty Clay and Sandy Gravel)



TC111504

Hydrograph of BH10-15 2009-2013
Whitemouth Lake Till and Whiteshell Till
Screen interval: 334.1 - 331.1 masl (Silty Clay and Sandy Silt)



TC111504

APPENDIX E

FACTUAL REPORT ON AMEC 2011 LOW-FLOW SURVEY

RAINY RIVER RESOURCES
LOW FLOW FIELD INVESTIGATIONS

FIELD OBSERVATIONS REPORT

Submitted by:

AMEC Environment & Infrastructure,
a Division of AMEC Americas Limited
160 Traders Blvd., Suite 110
Mississauga, Ontario
L4Z 3K7

On behalf of:

Rainy River Resources Ltd.

September 2011

TC111504.2010

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PHOTOS

LIST OF APPENDICES

1.0 BACKGROUND

AMEC undertook a stream flow monitoring program in late August to early September 2011 with the objective of characterizing stream flows near the proposed Rainy River Project site under low flow conditions. The following report provides a summary of the field notes, results, photographs[1] and general observations, at each of the Rainy River Low flow stations in late August to early September 2011. The report also includes initial recommendations for each of the stations in regards to future flow monitoring.

The general conditions encountered at site were very dry. Only two stations yielded visible flow: Clark 1 and SW14, and were estimated visually to be less than 0.01 m^3/s. Flow measurements using the FlowTracker were not possible at these stations because the depth of body of water was less than 5 cm. All other stations were dry or had no visible flow due to impoundment of the creek by beaver activity.

Personal communication with Rainy River Resources staff (Bevin Burnell and Alyson Bisson) who reside in the immediate area of the site commented that from July 4, 2011 to present (August 29, 2011) there were no precipitation events. They also commented that the creeks / streams that normally exhibit flow were without flow. Mr. Burnell also stated that these conditions have not been experienced in years, and this is a phenomenon that is atypical. This staff member also recollects he has not seen these conditions since his early childhood (estimated by AMEC staff to be sometime between 1960 and 1970).

The order in which the stations appear in this report are the order in which they were investigated during the site visit.

2.0 METHODOLOGY

Twenty-five sites were selected for flow measurements, based on a desk top review of available information including historical stream flow measurements, surficial geology mapping and topography. Sites were selected on a number of local creeks, at locations to accommodate access to private lands, and where changes in physiography and surficial geology might indicate groundwater discharge conditions were likely to occur. The locations of the flow stations, as recorded in the field by hand held GPS are listed in Table 2.1.

Prior to taking flow measurements, field staff visually inspected the channels for water and to identify suitable channel locations. Where water was present and suitable access available, a few spot measurements were collected from the channel using the Sontek FlowTracker to determine that stream flows above the instrument threshold were present. Where sufficient flow was found, manual flow measurement were taken using the Sontek FlowTracker, using a 60/40 split along a cross section perpendicular to flow at 10 cm intervals where possible. Given the

---

[1] The order in which the stations are discussed in this report correspond to the order they were investigated during the site visit.

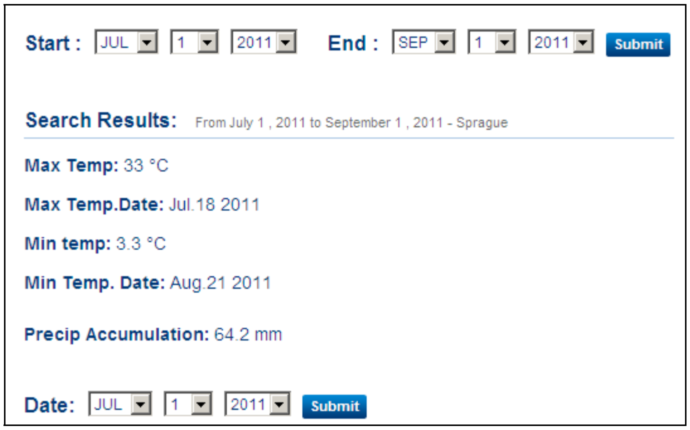
low flow found during this field campaign, this was not possible for the majority of the stations, and flow measurements without the depth rod were required to roughly estimate flow. If conditions were acceptable the measurements are undertaken using Water Survey Canada procedures for the use of the Sontek FlowTracker Acoustic Doppler Velocimeters (Document No. qSOP-NA022-02).

3.0 WEATHER RECORD

During the period staff were onsite, the following weather observations were recorded:

- August 30, 2011: 29ºC, intermittent clouds, no rain previous night, no wind.
- August 31, 2011: 20ºC, overcast skies, light drizzle in the morning, no wind. 3 mm of rain previous night.
- September 1, 2011: thunderstorms and lightning (with rain) in the morning, intermittent clouds in the afternoon.

The precipitation for the three months prior to the field visit were reviewed using publicly available data. The Weather Network website for Emo, Ontario recorded a total precipitation accumulation from July 1 to Sept 1, 2011 of 64.2 mm. The Environment Canada record for Fort Frances (30 minutes east of Emo) yielded similar results.



Start : JUL 1 2011 **End :** SEP 1 2011

Search Results: From July 1 , 2011 to September 1 , 2011 - Sprague

Max Temp: 33 °C

Max Temp.Date: Jul.18 2011

Min temp: 3.3 °C

Min Temp. Date: Aug.21 2011

Precip Accumulation: 64.2 mm

Date: JUL 1 2011

Figure 1-1: Weather record for Emo, Ontario. Source:
http://www.theweathernetwork.com/index.php?product=historical&placecode=caon0573

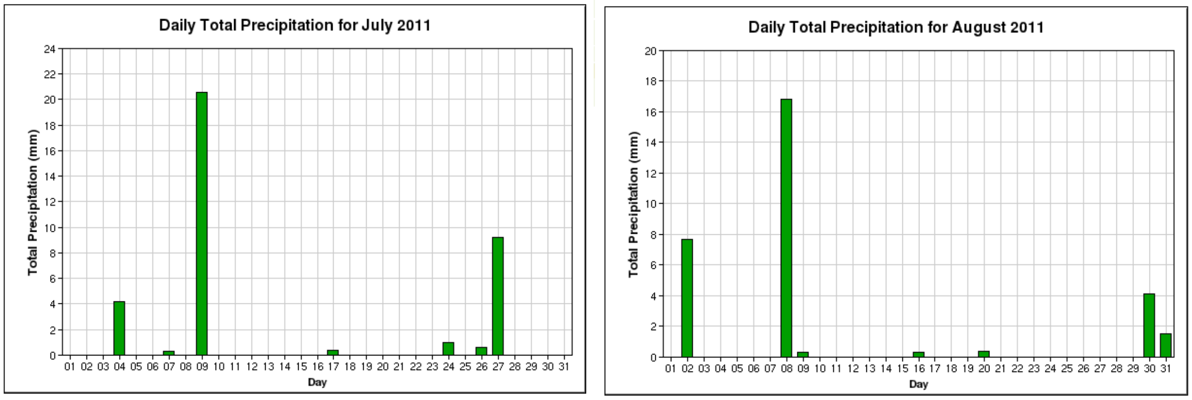


Figure 1-2: Environment Canada Weather Record for Fort Frances Ontario. Source:
http://www.climate.weatheroffice.gc.ca/climateData/generate_chart_e.html?StationID=46507&timeframe=2&Month=7&Year=2011&cmdB2=Go&Day=12&type=bar&MeasTypeID=totprecip

4.0 FLOW STATION GPS LOCATIONS

Table 4-1 below provides a GPS record of all the stations investigated.

Table 4-1: GPS Locations

Station ID	Easting	Northing
SW1	426311.63	5408489.8
SW1A	426149.82	5408767.96
SW2	425266.62	5410114.77
SW3	419493.55	5408095.73
SW4	432798.69	5413360.84
SW5	424634.14	5416585.94
SW10	427823.37	5407033.85
SW13	422183.98	5410152.15
SW14	426282.54	5411689.04
Clark 1	427956.89	5409190.52
Pine 1	429233.65	5406711.77
Pine 2	430089.53	5408419.07
Pine 3	425546.11	5408124.27
Pine 4	430950.67	5407633.79
West 1	426433.31	5411094.92
West 2	426431.62	5411616.04
West 3	426429.64	5410320.55
Marr 1	423675.03	5410238.04
Marr 2	423689.1	5411785.35
Loslo 1	422912.45	5412040.13
Tait 1	423668.81	5403689.19
Tait 2	418419.54	5405320.71
Jones 1	416577.56	5411820.76
Jones 2	418846.53	5413449.76
05PC023	413028.49	5405668.7

5.0 FIELD RECORD

The following section provides a description of conditions at each of the flow monitoring stations. They are listed in the order the work was undertaken in the field.

Pine 4 (E430950.67 N5407633.79)
August 30, 2011

This location was accessed from the west side of the road or from the field adjacent to Rainy River accommodations house location. Out of bank diffuse flow is evident and is likely the result of beaver activity. The stream channel is heavily vegetated and overgrown by dense alder thickets. Flow is minimal, with a 15 cm depth, and 2 m cross section (at largest) in some areas. The stream bed is a thick muck. There is a cattle pasture on the east side of the road, where cattle have direct access to the creek. Exploration drilling was ongoing nearby and there was an associated water taking directly from the watercourse. A flow measurement was not recorded due to the slow velocity of the creek at this location.

Picture 1: Culvert outlet on west side of the road, pool at basin of culvert.

Picture 2: Vegetated channel.

Pine 2 (E430089.53 N5408419.07)
August 30, 2011

This location was accessed from the west side of the road. Accessibility is good by means of a steep river rock embankment adjacent to the road. A poor flow measurement was obtained from this location by taking an instantaneous reading (with the flow tracker sensor detached from the depth rod) for 60 seconds and averaging the recorded values. This methodology was best suited due to the constraints provided by the shallow water, cobble stone bottom and physical limitations of the flow tracker. The water levels recorded at this station ranged from 3 to 8 cm in a channel that was approximately 1.5 to 3 m wide. Discharge was recorded at approximately 0.0062 m^3/s and may not be representative to the normal conditions of this channel under typical low flow conditions. Aquatic life was encountered (small minnows of unknown species).

Picture 3: Bottom of creek bed at Pine 2 GPS location.

Picture 4: AMEC Employee standing in creek channel.

Clark 1 (E427956.89 N5409190.52)
August 30 2011

This location was accessed from the west side of the road. Accessibility is decent and access into the GPS location is via a steep river rock embankment adjacent to the road. The GPS location and the immediate area surrounding were investigated. A poor flow measurement was obtained from this location by taking an instantaneous reading (with FlowTracker sensor detached from the depth rod) for 60 seconds and averaging the recorded values. This methodology (described above) was best suited due to the constraints provided by the shallow water, cobble stone bottom and physical limitations of the FlowTracker. The water levels recorded at this station ranged from 3 to 8 cm in a channel that was approximately 1.5 to 3 m wide. Discharge was recorded at approximately 0.0062 m^3/s and may not be representative to the normal conditions of this channel under typical low flow conditions. Aquatic life was encountered – small minnows of unknown species.

Picture 5: Culvert outlet on west side of road, private property with cattle.

Picture 6: Culvert inlet on east side of Clark road.

Picture 7: Evidence of flow seen in an upstream section of the channel at Clark 1.

West 3 (E426429.64 N5410320.55)
August 30, 2011

This location was accessed from the west side of Roen Road. A flow measurement was obtained from this location based on the methodology described above. Average discharge was recorded at 0.0013 m^3/s. The water levels recorded at were approximately 32 cm in a channel that was approximately 1.3 to 1.8 m wide. Aquatic life was encountered (small minnows of unknown species.

Picture 8: Flow Measurement taken across 1.3 m cross section.

Picture 9: AMEC employee taking flow measurement across channel section.

West 1 (E426433.31 N5411094.92)
August 30, 2011

This location was accessed from the west side of Roen Road. A flow measurement was not obtained from this location as the upstream portion of creek was dry. The culvert contained some wood debris at the outlet of the culvert (west side); however, not enough to contain flow. The channel on the west side of the road contained standing water. The channel on the east portion of the road was approximately 2 m wide and appeared to only have a depth of 10 to 20 cm.

Picture 10 : West side of road, culvert outlet into marshy area.

Picture 11: East side of Roen Road, culvert inlet dry.

West 2 (E426431.62 N5411616.04)
August 30, 2011

This location was accessed from the west side of Roen Road approximately 75 to 100 m adjacent to the road. Access is limited by a barbed wire fence. A flow measurement was not obtained from this location as the creek bed was dry. The channel was 0.5 to 1 m wide, and appeared to be 15 cm in depth under flow conditions.

Picture 12: AMEC employee standing in channel <15 cm deep, 0.5 to 1 m wide.

Marr 1 (E423675.03 N5410238.04)
August 30, 2011

This location was accessed from the north side of Highway 600 approximately 40 m adjacent to the road. Access was available by means of a drilling trail accessible by walking or ARGO only. During this investigation exploration drilling (including water taking) were underway immediately adjacent to the location. A flow measurement was not obtained from this location as the creek bed was found to be dry. The channel in most areas was 1 to 2 m wide, and appeared to be <15 cm in depth under flow conditions. The channel in areas exhibits out of bank flow under higher flows.

Picture 13: A potential cross section found north of the GPS location provided.

Picture 14: Facing north, culvert inlet basin.

Jones 2 (E418846.53 N5413449.76)
August 30, 2011

This location was accessed from the north side of Highway 600 immediately adjacent to the highway. Access is via private property, and was not permitted. The GPS location and the immediate area surrounding were visually investigated from the road. A flow measurement was not obtained from this location as culvert and channel were found to be dry. The channel is approximately 0.5 m wide; with a potential depth of approximately 5 to 10 cm. A portion of this channel is connected to the roadside ditch.

Picture 15: One of three culverts on the south side of Highway 600.

Picture 16: The Jones 2 flow station found to be without flow.

Jones 1 (E416577.56 N5411820.76)
August 30, 2011

This location was accessed from the south side of Jones Road immediately adjacent to the road. The GPS location and the immediate area surrounding were visually investigated from the road. A flow measurement was not obtained from this location as the channel was found to be dry. The creek is demarcated by a sign which reads McCallum Creek. The channel is approximately 2 m wide in the main channel and 3 to 4 m wide at meanders, with a potential depth of approximately 1m during higher flows. The area is surrounded by agricultural field primarily hay.

Picture 17: The culvert on the south side of Jones Road.

Picture 18: AMEC employee stands in McCallum Creek which is dry to the bottom.

Tait 1 (E423668.81 N5403689.19)
August 30, 2011

This location was accessed from the south side of an unmarked side road. The GPS location and the immediate area surrounding were visually investigated from the road. The creek flows immediately adjacent to the road in what appears to be the ditch. When flowing, the creek enters a culvert on the south side of the road flows north then west along the ditch for a 100 to 120 m on the north side of the road. A flow measurement was not obtained from this location as the channel was found to be dry. The channel appears to be 0.5 m wide and approximately 20 to 30 cm deep well incised channel.

Picture 19: Creek bed at the GPS location (ditch).

Picture 20: Culvert inlet on the south side of the road.

Pine 3 (E425546.11 N5408124.27)
August 31, 2011

This location was accessed from the north of a private road. The creek flows in between two agricultural fields and appears to be intermittent in nature. Access is provided via private property through a farm field trail. The GPS location and the immediate area surrounding were visually investigated from the road. A flow measurement was not obtained from this location as the channel was found to be dry. The channel appears to be 0.5 metres wide and approximately 5 to 15 cm deep well incised channel.

Picture 21: Channel bed dry to creek bottom.

Picture 22: Creek outlet at culvert on north side of creek crossing.

Marr 2 (E423689.10 N5411785.35)
August 31, 2011

This location was accessed through a community/municipal farm. The stream flows into private land owner parcels (owner is not a local citizen). The GPS location and the immediate area surrounding were visually investigated. A flow measurement was not obtained from this location as the channel was found to be dry. The stream is poorly defined and flows into a low lying area which appears to be inundated during wetter conditions, indicative of the type of swamp/sedge grass found in this area. A smaller channel through the midsection of area was found and is <0.5 m wide and approximately 5 cm.

Picture 23: Small <0.5 m wide channel through midsection of low-lying area.

Picture 24: Area of suspected intermittent stream channel.

Loslo 1 (E422912.45 N5412040.13)
August 31, 2011

This location was accessed by means of an approximately one kilometre through dense bush at the end of Eluik Road. The GPS location and the immediate area surrounding were inaccessible due to a large, well-established beaver dam. The crest of the dam measured approximately 3 m above the smaller channel 1 to 2 m channel below the crest. No flow was observed.

Picture 25: Rainy River employee stands upon the crest of the beaver dam.

Picture 26: The yellow dot above indicates the location with which the Rainy River employee is standing in Picture 25 above.

Tait 2 (E418419.54 N5405320.71)
August 31, 2011

This location was inaccessible due to unsafe conditions (flooding caused by potential of beaver activity on the watercourse). A boat would be required to access this location in the future. The condition of the watercourse and the level of impact imposed by the beaver activity is unknown; however, a lodge was observed near to the GPS location. The channel presently appears to be 30 to 40 m in width with unknown depth. Substrate is likely that of muck, based on conditions near to the shore.

Picture 27: West shoreline of flooded channel at Tait 2.

Picture 28: Photo location represented by yellow dot. Beaver dam location shown as red line.

05PC023 (E413028.49 N5405668.70)
August 31, 2011

This location was easily accessible and was adjacent to the road. The watercourse appears to provide sufficient flow to establish a flow station; however, because the watercourse was dry along portions of channel a flow measurement was not obtainable. The channel is 8 to 10 m wide in areas, and depth appears to be 1 to 1.5 m deep, under normal conditions. Substrate is likely that of muck and sand, based on conditions near to the shore.

Picture 29: Facing upstream while standing on bridge.

Picture 30: Damaged WSC benchmark.

Picture 31: Facing downstream, tributary channel that feeds main channel.

Picture 32: Upstream log jam at the bridge.

SW3 (E419493.55 N5408095.73)
August 31, 2011

This location was easily accessible although on private property. The previous cross section is adequate; however, there are other more suitable locations available. The watercourse appears to provide sufficient flow to maintain a flow monitoring station but there was insufficient flow to obtain a measurement. The channel is 6 to 9 m wide in areas, and depth appears to be 1 to 1.5 m deep under normal conditions. In personal communications with Rainy River staff it was mentioned that a boat is required for safe flow measurements during higher flow conditions. Substrate is a mixture of muck and sand. A Levelogger Silver Series is currently installed; however a more permanent fixture (static level) is required as the logger needs to be removed for downloading each time, which could compromise data if the logger is not replaced properly (too deep into muck). See Appendix B for additional photo of the site taken in June 2010 in wetter conditions.

Picture 33 (Left): Standing at the other shore, facing along cross section.

Picture 34 (Right): Levelogger Silver series transducer out of water.

Pine 1 (E429233.65 N5406711.77)
August 31, 2011

This location was easily accessible by means of a municipal travelled road. A flow measurement at Pine 1 was taken; however, it was of poor quality (likely a beaver dam downstream). Average discharge was recorded at 0.0020 m^3/s approximately 2 m downstream from the outlet of a wood box culvert. The team was unable to investigate the potential for beaver activity because of private property constraints. The channel is 3 m wide with a straight section of channel (GPS location) which would provide a representative cross section.

Picture 35: Facing upstream standing on wood box culvert.

Picture 36: Facing downstream with AMEC employee doing flow measurement.

SW10 (E427823.37 N5407033.85)
August 31, 2011

This location was easily accessible via a municipal road. Portions of the stream were saturated but did not show water. This location was similar to Jones 1 in characteristics, in that it appeared to promote flow under saturated conditions, but pockets of the channel were dry. The channel is 2 to 3.5 m wide and 20 to 40 cm deep in some areas. Substrate is a mixture of muck with some boulders present. A flow measurement was not recorded.

Picture 37: Culvert outlet on west side of the road.

Picture 38: Facing downstream.

SW1 (E426311.63 N5408489.80)
August 31, 2011

This location was easily accessible by a municipal road. A flow measurement at this location is not currently possible due to safety (too deep without boat) and the impact of beaver activity on the area. A flow measurement was not recorded.

Picture 39: Flooded channel at SW1 facing downstream.

Picture 40: Network of man-made and natural watercourse features.

SW1A (E426149.82 N5408767.96)
August 31, 2011

This location was easily accessible by a municipal road. A flow measurement at this location is not currently possible due to safety (nearby drilling / pumping) and pumping activity from drilling immediately adjacent to (10 m away) from the GPS location. In addition, beaver activity in the area is evident. The conditions of the creek appear to have been impacted by drilling activity as hydrocarbons and sediment entrainment (murky discoloured water) was evident along this portion of the channel. This area maintains a good straight portion for a potential flow measurement however, not with present conditions. A flow measurement was not recorded. See Appendix B for additional photo record.

Picture 41: GPS location of SW1A, appears to be man-made channel.

Picture 42: Outlet of culvert on west side of the road.

SW2 (E425266.62 N5410114.77)
August 31, 2011

This location was easily accessible by a municipal road. A flow measurement at this location was not possible as the creek bed was dry. This area maintains a good straight portion for a potential flow measurement however, not with present conditions.

Picture 43: AMEC employee stands in the dry basin at the outlet of the culvert basin on the south side of the road.

Picture 44: Culverts outlets on the south side of the road.

SW13 (E422183.98 N5410152.15)
August 31, 2011

This location was easily accessible by a municipal road. While the creek bed was saturated, the flow present did not exceed the instrument threshold. This area maintains a good straight portion for a potential flow measurement however, not with present conditions. A flow measurement was not recorded. See Appendix B for additional photo record.

Picture 45: Facing downstream, potential straight portion of channel to conduct flow measurement.

Picture 46: Culvert outlet on the south side of the road.

SW14 (E426282.54 N5411689.04)
August 31, 2011

This location was easily accessible from the municipal road. Flow was present at this location; however, a flow measurement was not obtained as the water was too shallow (<10 cm) to obtain accurate measurements. The creek bed was bedrock controlled and well defined in areas. The flow was estimated (based on instantaneous flow) of 0.0100 m^3/s. See Appendix B for additional photo record.

Picture 47: Culvert on south side of road, facing north.

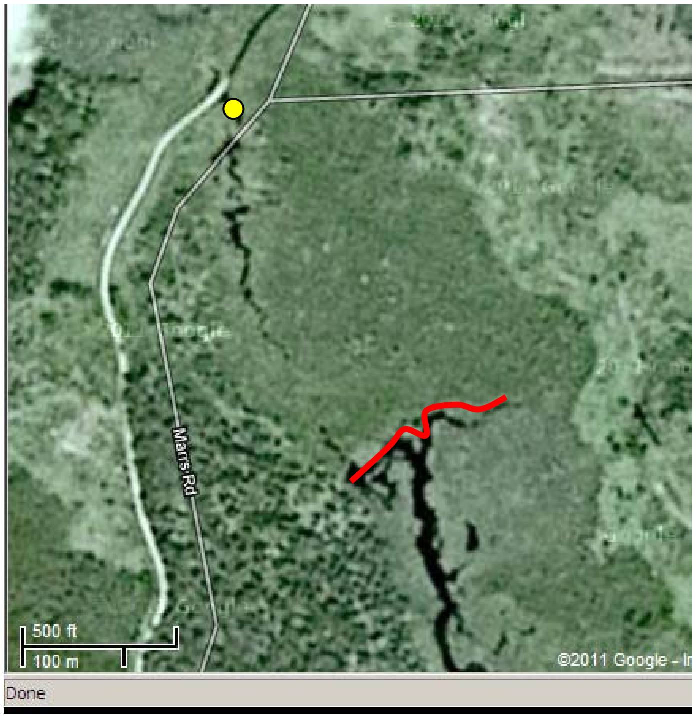
Picture 48: Facing downstream, some flow evident.

.

SW5 (E424634.14 N5416585.94)
September 1, 2011

This location was easily accessible by a municipal road. This location is in what appears to be a low-lying marshy area, with an abundance of grasses. A straight section of channel is available to collect a flow measurement; however, given the out of bank flow conditions, a representative measurement was not available. A flow measurement was taken regardless, and it was recorded at -0.0019 m^3/s, likely a result of the diffuse flow. Beaver activity is hypothesized.

Picture 49: Facing upstream.



Picture 50: Location of GPS and potential beaver dam.

SW4 (E432798.69 N5413360.84)
September 1, 2011

This location was easily accessible from the road. A flow measurement at this location is not currently possible due to safety (boat required) the impact of beaver activity on the area.

Picture 51: Beaver lodge on west side of Highway 71.

Picture 52: Ponding water on east side of Highway 71.

6.0 STATION RECOMMENDATIONS

Table 6-1 provides recommendation for removal, continued or future investigations and/or flow monitoring at the locations investigated. These recommendations are based on the physical attributes (channel width and depth) of the watercourse and the evidence of that watercourses ability to maintain flow under normal conditions. As such the following recommendations are based on optimizing the collection of data on additional flow monitoring campaigns in the future should normal conditions be present.

Table 6-1: Flow Station Summary and Recommendations

Station	Average Discharge (m^3/s)	Flow Conditions	Removal/Continue Monitoring/Move	Reason for Removal/Continue/Move	Beaver Activity
05PC023	0	Disconnected pools in creek	Continue	Well defined channel	Not evident
*Clark 1	0.0062	Visible flow	Continue	Good cross section/flow	Not evident
Jones 1	0	Disconnected pools in creek	Continue	Well defined channel	Not evident
Jones 2	0	Creek bed dry	Removal/Move	Move to better location	Not evident
Loslo 1	0	No Flow	Removal	Heavy beaver influence	Yes
Marr 1	0	Disconnected pools in creek	Move	Needs defined cross section	Possible
Marr 2	0	Creek bed dry	Removal	No real defined channel	No
*Pine 1	0.0020	Water in creek, no visible flow	Continue	Address Beaver Issue	Likely
Pine 2	0	Creek bed dry	Removal	Channel not well defined	No
Pine 3	0	Creek bed dry	Continue	Good cross section avail.	No
Pine 4	0	No visible flow	Move	Channel not well defined	Likely
SW1	0	No visible flow	Removal	Beaver	Yes
SW1A	0	No visible flow	Move	Unnatural channel in use	Yes
SW2	0	Disconnected pools in creek	Continue	Well defined channel	No
SW3	0	Disconnected pools in creek	Continue	Well defined channel	No
SW4	0	No visible flow	Remove	Beaver	Yes
*SW5	0.0019	Water in creek, no visible flow	Remove or Move	Beaver	Yes
SW10	0	Water in creek, too shallow	Continue	Well defined channel	No
SW13	0	Water in creek, too shallow	Continue	Well defined channel	No
**SW14	0.0100	Visible flow	Continue	Well defined channel	No
Tait 1	0	Creek bed dry	Move	Better location upstream	No
Tait 2	0	No visible flow	Remove	Beaver	Yes
West 1	0	Creek bed dry	Move	Beaver	Likely
West 2	0	Creek bed dry	Continue	Well defined channel	No
*West 3	0.0013	Water in creek, no visible flow	Continue	Well defined channel	No

*Although a flow measurement was taken the methodology due to poor conditions impacted measurement, and this is not a representative record.
** Estimate of flow based on visual observations comparable to other watercourses in the area.

Table 6-2 below is an excerpt from the Klohn 2010 report which highlights measurements collected during the June 2010 field program.

Table 6-2: Previous Klohn 2010 Streamflow Measurements

Streamflow Section	Coordinates	Date	Calculated Flow (m3/s)
SW-1A	426152E, 5408779N	June 1	0.10
SW-3	419490E, 540813N	June 1	1.36
SW-13	422205E, 5410218N	May 31	0.20
SW-14	426279E, 5411745N	June 1	0.07

Source: Klohn 2010.

7.0 SUMMARY

The 2011 field program conditions are atypical. In communication with local residents (Rainy River Staff) it was confirmed that the levels in the surrounding watercourses do not reflect water conditions that are normally sustained during the months of August and September. This phenomenon has also been confirmed through review of past reports (Klohn 2010) where the flow measurements recorded and a photographic record comparison yield considerable differences in the conditions observed. The lack of flow data collected is a reflection of these conditions. Table 6-1 provides a summary of the conditions encountered while visiting the flow monitoring stations the lack flow, and poor data collecting conditions (beaver activity) is evident.

8.0 REFERENCES

Environment Canada Website 2011 Accessed September 13, 2011. <http://www.climate.weatheroffice.gc.ca/climateData/generate_chart_e.html?StationID=46507&timeframe=2&Month=7&Year=2011&cmdB2=Go&Day=12&type=bar&MeasTypeID=totprecip>.

Google Maps Airphoto Screen Capture, 2011. Accessed September 11, 2011.

Klohn Crippen Berger, 2010. Rainy River Resources Ltd - Rainy River Project. June 2010 Hydrogeology/Hydrology Field Investigation.

Personal Communication Rainy River Staff – Bevin Burnell. August 30, 2011.

Personal Communication Rainy River Staff – Alyson Bisson. August 30, 2011.

The Weather Network Website 2011, Accessed September 13, 2011. <http://www.theweathernetwork.com/index.php?product=historical&placecode=caon0573>.

If you have any questions regarding this report, or require further information, please feel free to contact the undersigned or Sheila Daniel (905-568-2929).

Author:

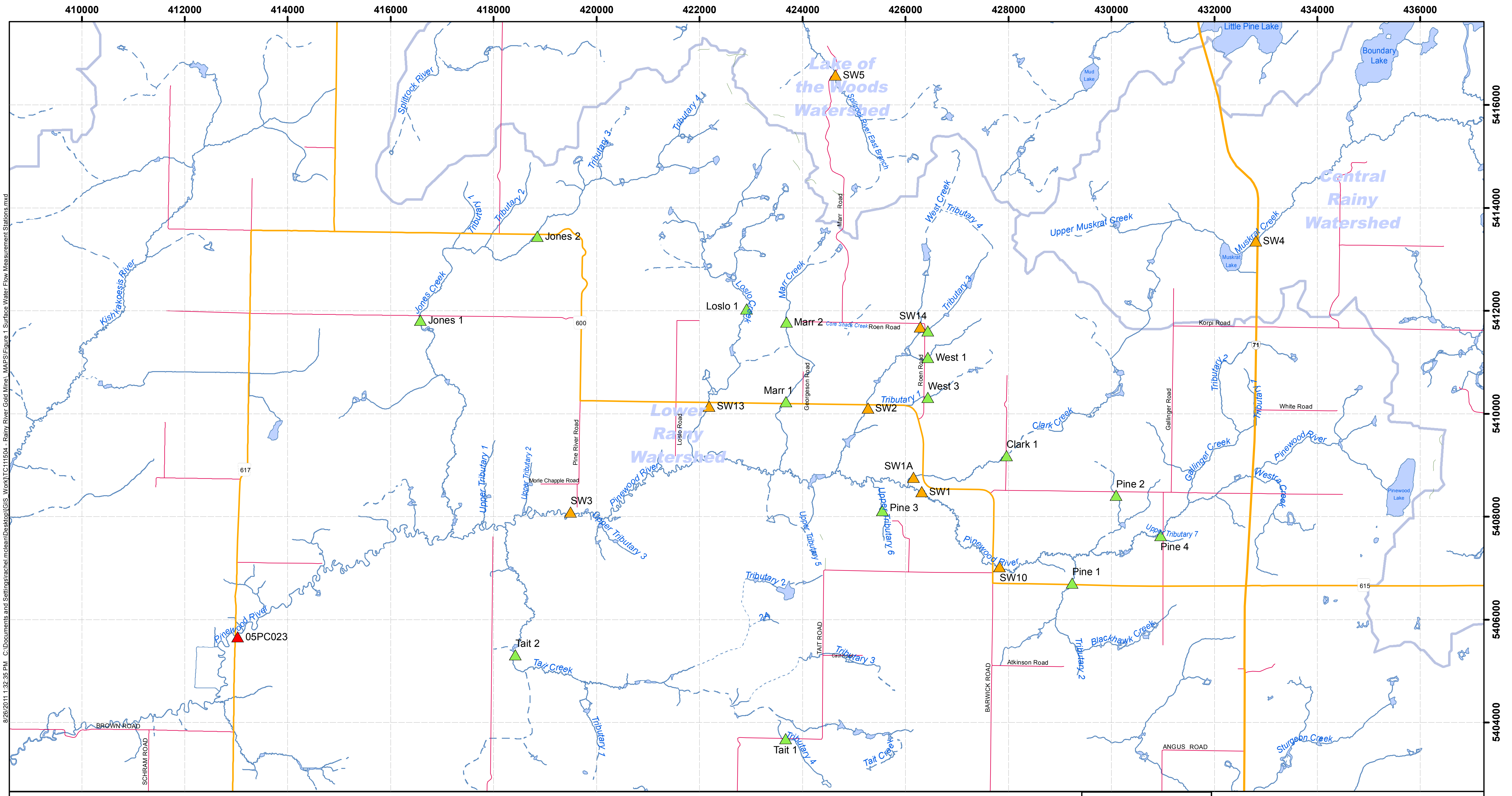
Antonio DiFebo, M.Sc.
Environmental Scientist

Reviewer:

Simon Gautrey, M.Sc., P.Geo.
Senior Hydrogeologist

APPENDIX A

FIELD MAPS



8/26/2011 1:32:35 PM   C:\Documents and Settings\rachel.mclean\Desktop\GIS_Work\TC111504 - Rainy River Gold Mine_MAPS\Figure 1 Surface Water Flow Measurement Stations.mxd

LEGEND

Surfacewater Flow Stations
- ▲ AMEC 2011 Low Flow Monitoring Program
- ▲ Environment Canada
- ▲ Klohn Crippen Berger 2008-2010 Baseline

Ontario Road Network
- Expressway / Highway
- Toll Highway
- Freeway
- Arterial
- Collector
- Local / Street, No
- Resource / Recreation, No

Watercourse Type, Permanency, Class
- Stream, Intermittent, Flow Gap
- Stream, Intermittent, Primary
- Stream, Intermittent, Secondary
- Stream, Permanent, Flow Gap
- Stream, Permanent, Primary
- Stream, Permanent, Secondary
- Virtual Connector, Permanent, Flow Gap
- Virtual Connector, Permanent, Primary

Waterbody Type, Permanency
- ▨ Lake, Intermittent
- ▨ Lake, Permanent
- ▨ River, Permanent
- ☐ Watersheds_Tertiary

NOTES:

Datum: NAD83
Projection: UTM Zone 15N

N W E S

0 3 6 12 18 Kilometres

RainyRiver RESOURCES LTD.
amec

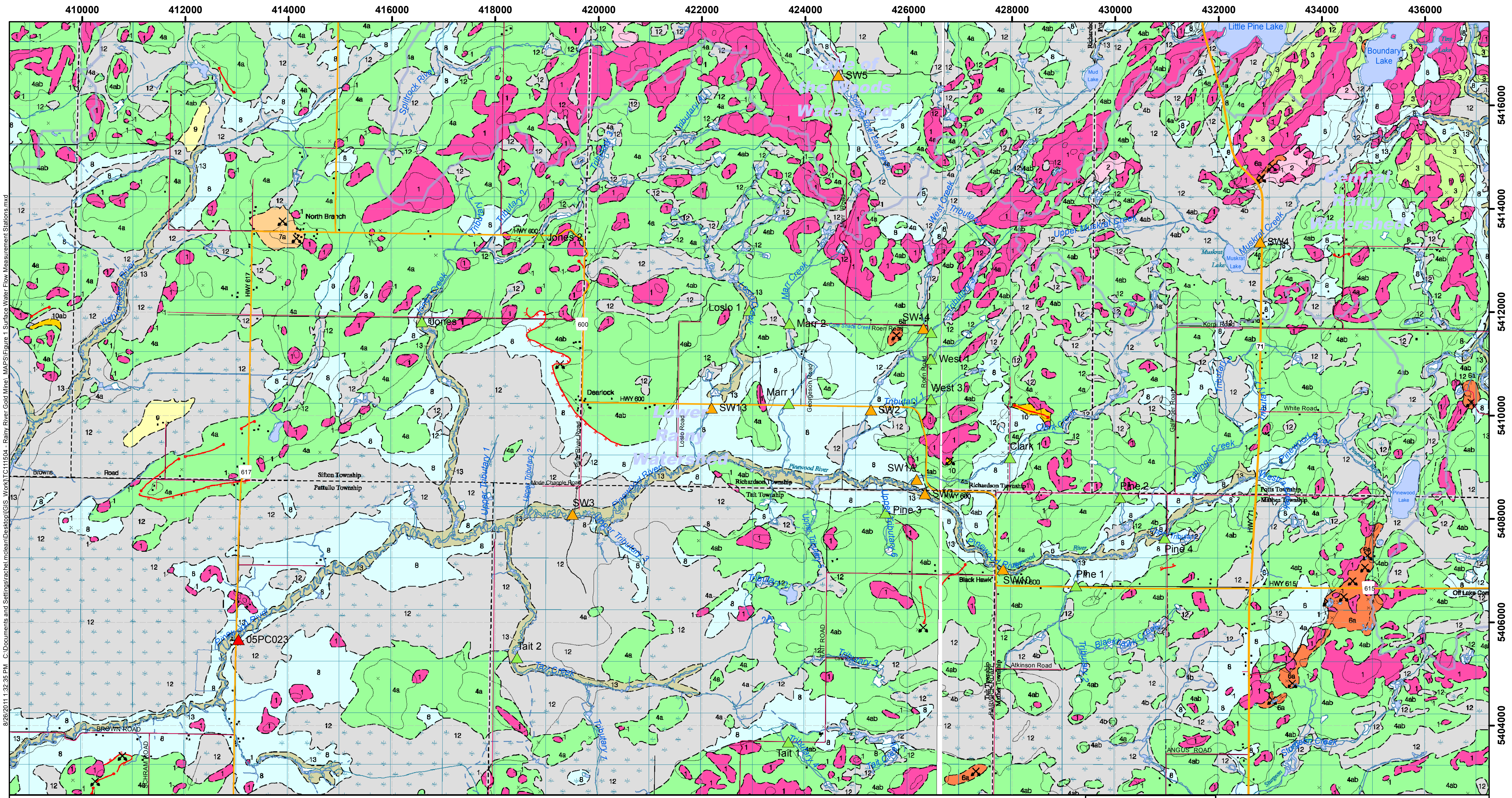
RAINY RIVER GOLD PROJECT

Surface Water Flow Measurement Stations

DRAFT

PROJECT N°: TC111504	FIGURE: 1
SCALE: 1:70,000	DATE: August 2011

8/26/2011 1:32:35 PM C:\Documents and Settings\rachel.mclean\Desktop\GIS_Work\TC111504 - Rainy River Gold Mine\ MAPS\Figure 1 Surface Water Flow Measurement Stations.mxd



NOTES:

Datum: NAD83
Projection: UTM Zone 15N

RAINY RIVER GOLD PROJECT

Surface Water Flow Measurement Stations

DRAFT

PROJECT N°: TC111504

FIGURE: 1

SCALE: 1:70,000

DATE: August 2011

8/26/2011 2:03:42 PM C:\Documents and Settings\rachel.mclean\Desktop\GIS_Work\TC111504 - Rainy River Gold Mine_MAPS\Figure 1 Surface Water Flow Measurement Stations.mxd

LEGEND

Surfacewater Flow Stations
- ▲ AMEC 2011 Low Flow Monitoring Program
- ▲ Environment Canada
- ▲ Klohn Crippen Berger 2008-2010 Baseline

Ontario Road Network
- Expressway / Highway
- Toll Highway
- Freeway
- Arterial
- Collector
- Local / Street, No
- Resource / Recreation, No

Watercourse Type, Permanency, Class
- Stream, Intermittent, Flow Gap
- Stream, Intermittent, Primary
- Stream, Intermittent, Secondary
- Stream, Permanent, Flow Gap
- Stream, Permanent, Primary
- Stream, Permanent, Secondary
- Virtual Connector, Permanent, Flow Gap
- Virtual Connector, Permanent, Primary

Waterbody Type, Permanency
- ▨ Lake, Intermittent
- ▨ Lake, Permanent
- ▨ River, Permanent
- ▭ Watersheds_Tertiary

0 0.5 1 2 3
Kilometres

NOTES:

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

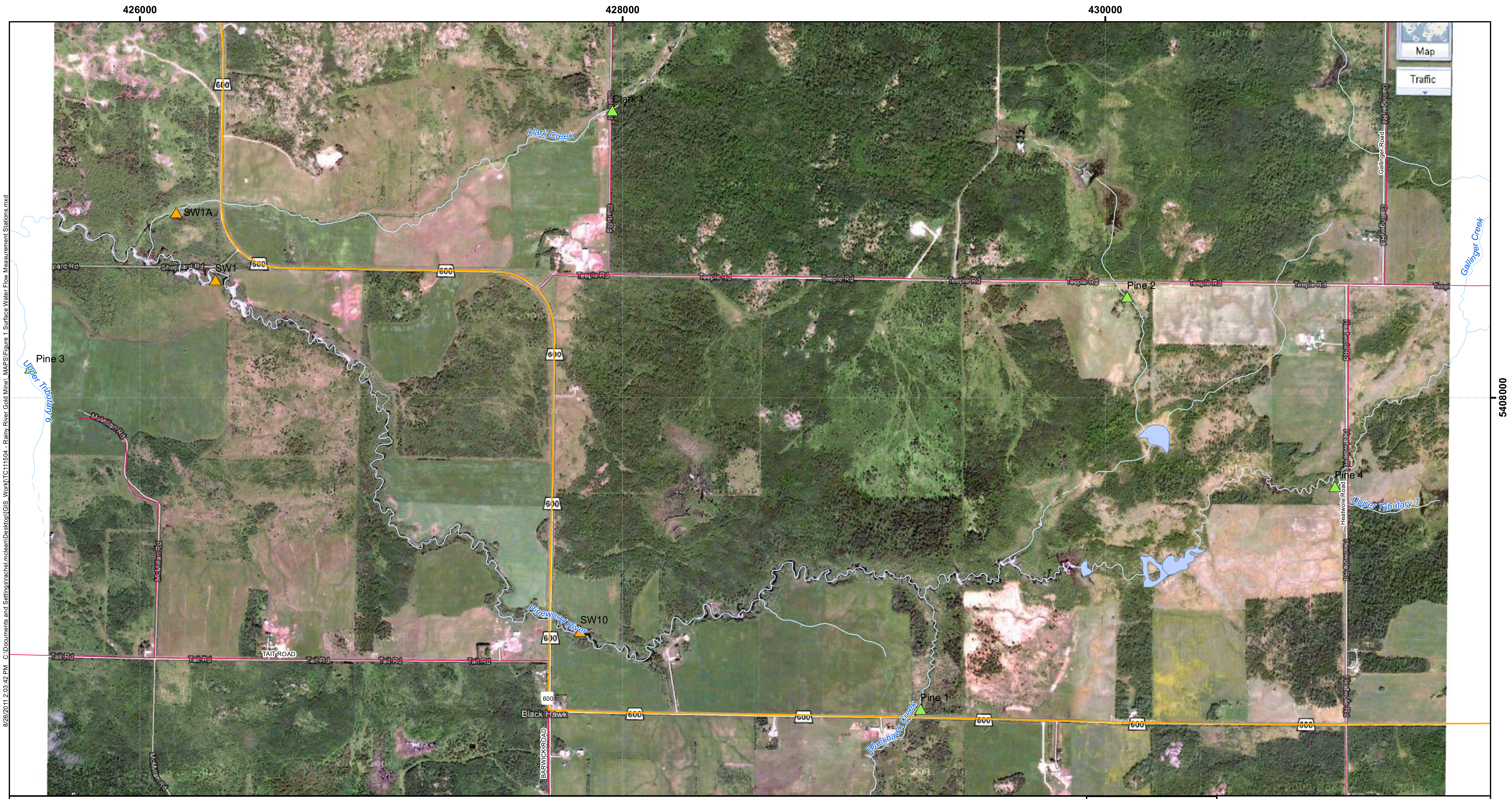
Rainy River Resources Ltd.

amec

RAINY RIVER GOLD PROJECT

Surface Water Flow Measurement Stations

PROJECT N°: TC111504	FIGURE: 1
SCALE: 1:15,000	DATE: August 2011



8/26/2011 2:03:42 PM C:\Documents and Settings\rachel.mclean\Desktop\GIS_Work\TC111504 - Rainy River Gold Mine_MAPS\Figure 1 Surface Water Flow Measurement Stations.mxd

LEGEND

Surfacewater Flow Stations
- ▲ AMEC 2011 Low Flow Monitoring Program
- ▲ Environment Canada
- ▲ Klohn Crippen Berger 2008-2010 Baseline

Ontario Road Network
- Expressway / Highway
- Toll Highway
- Freeway
- Arterial
- Collector
- Local / Street, No
- Resource / Recreation, No

Watercourse Type, Permanency, Class
- Stream, Intermittent, Flow Gap
- Stream, Intermittent, Primary
- Stream, Intermittent, Secondary
- Stream, Permanent, Flow Gap
- Stream, Permanent, Primary
- Stream, Permanent, Secondary
- Virtual Connector, Permanent, Flow Gap
- Virtual Connector, Permanent, Primary

Waterbody Type, Permanency
- ▨ Lake, Intermittent
- ▨ Lake, Permanent
- ▨ River, Permanent
- ☐ Watersheds_Tertiary

NOTES:

Datum: NAD83
Projection: UTM Zone 15N

N W E S

0 0.5 1 2 3 Kilometres

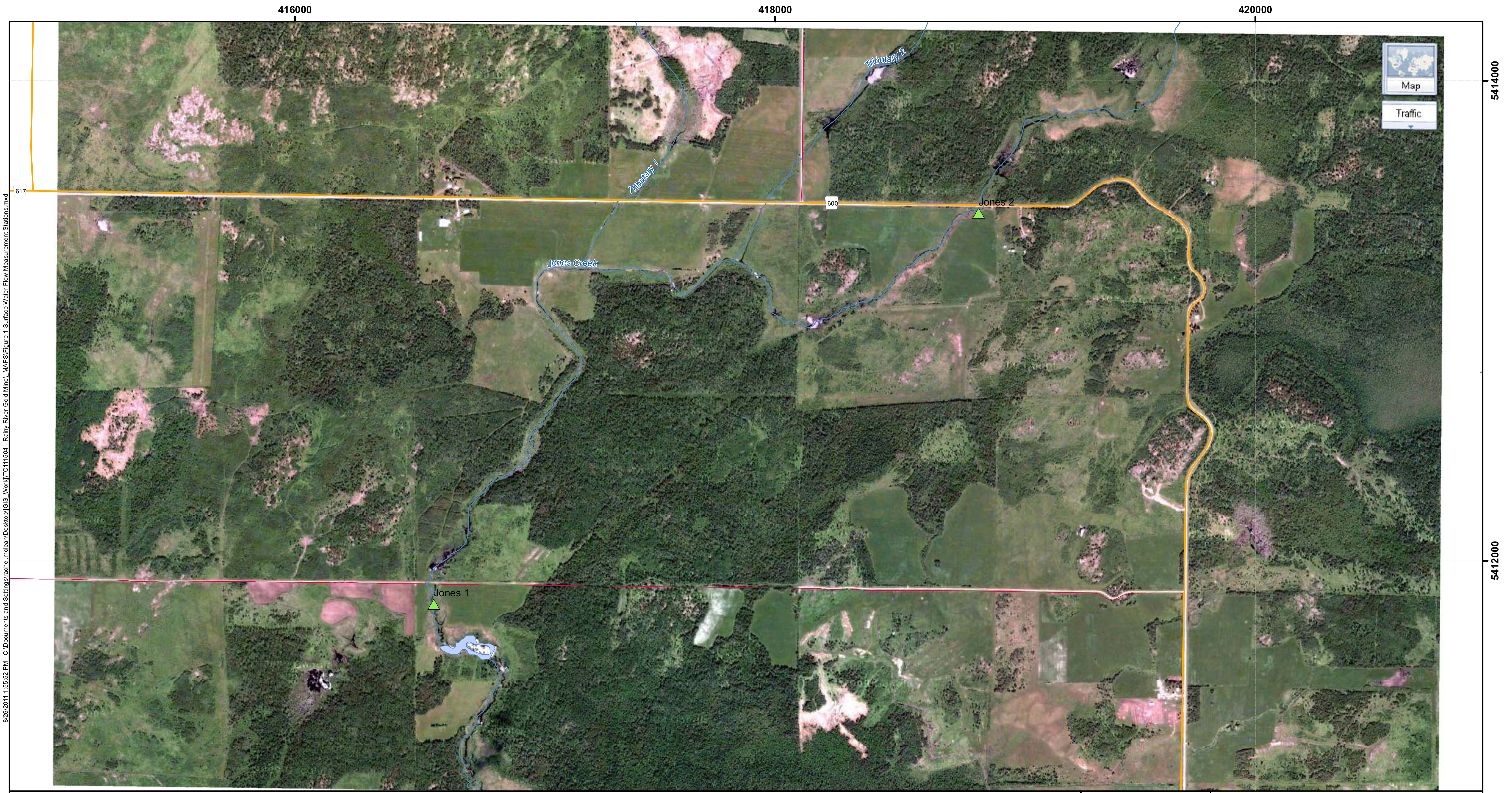
Rainy River RESOURCES LTD. amec

RAINY RIVER GOLD PROJECT

DRAFT

Surface Water Flow Measurement Stations

PROJECT N°: TC111504	FIGURE: 1
SCALE: 1:15,000	DATE: August 2011



8/26/2011 1:55:52 PM C:\Documents and Settings\rachel.mclean\Desktop\GIS_Work\TC111504 - Rainy River Gold Mine_MAPS\Figure 1 Surface Water Flow Measurement Stations.mxd

LEGEND

Surfacewater Flow Stations
- 🟩 AMEC 2011 Low Flow Monitoring Program
- 🟥 Environment Canada
- 🟧 Klohn Crippen Berger 2008-2010 Baseline

Ontario Road Network
- Expressway / Highway
- Toll Highway
- Freeway
- Arterial
- Collector
- Local / Street, No
- Resource / Recreation, No

Watercourse Type, Permanency, Class
- Stream, Intermittent, Flow Gap
- Stream, Intermittent, Primary
- Stream, Intermittent, Secondary
- Stream, Permanent, Flow Gap
- Stream, Permanent, Primary
- Stream, Permanent, Secondary
- Virtual Connector, Permanent, Flow Gap
- Virtual Connector, Permanent, Primary

Waterbody Type, Permanency
- ▨ Lake, Intermittent
- Lake, Permanent
- River, Permanent
- Watersheds_Tertiary

0 0.5 1 2 3 Kilometres

NOTES:

Datum: NAD83
Projection: UTM Zone 15N

N E S W

RainyRiver RESOURCES LTD.

amec

RAINY RIVER GOLD PROJECT

DRAFT

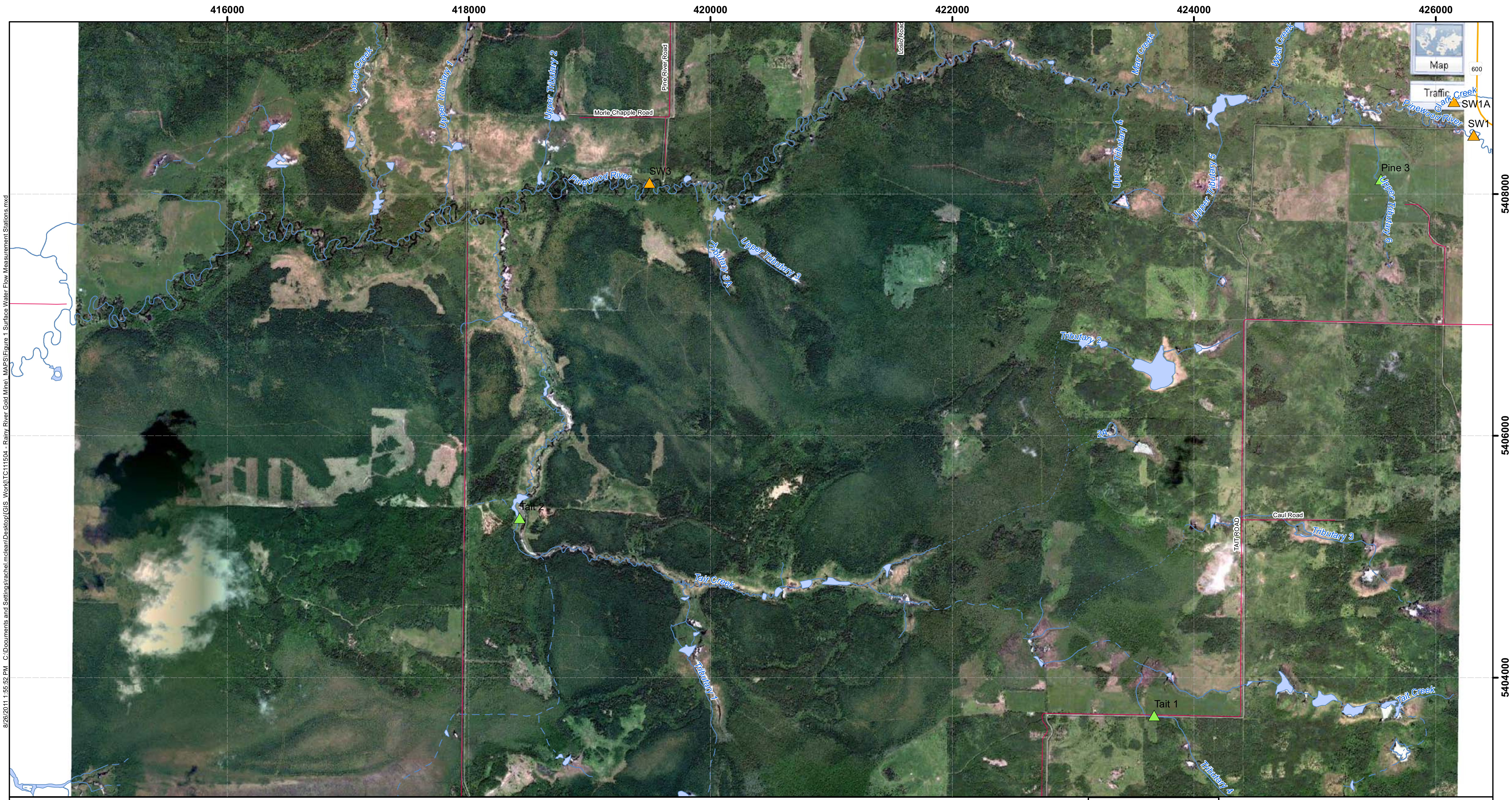
Surface Water Flow Measurement Stations

PROJECT Nº: TC111504

FIGURE: 1

SCALE: 1:15,000

DATE: August 2011



8/26/2011 1:55:52 PM C:\Documents and Settings\rachel.mclean\Desktop\[GIS_Work]\TC111504 - Rainy River Gold Mine_MAPS\Figure 1 Surface Water Flow Measurement Stations.mxd

LEGEND

Surfacewater Flow Stations
- ▲ AMEC 2011 Low Flow Monitoring Program
- ▲ Environment Canada
- ▲ Klohn Crippen Berger 2008-2010 Baseline

Ontario Road Network
- Expressway / Highway
- Toll Highway
- Freeway
- Arterial
- Collector
- Local / Street, No
- Resource / Recreation, No

Watercourse Type, Permanency, Class
- Stream, Intermittent, Flow Gap
- Stream, Intermittent, Primary
- Stream, Intermittent, Secondary
- Stream, Permanent, Flow Gap
- Stream, Permanent, Primary
- Stream, Permanent, Secondary
- Virtual Connector, Permanent, Flow Gap
- Virtual Connector, Permanent, Primary

Waterbody Type, Permanency
- ▨ Lake, Intermittent
- ▭ Lake, Permanent
- ▭ River, Permanent
- ▭ Watersheds_Tertiary

NOTES:

Datum: NAD83
Projection: UTM Zone 15N

N
W E
S

Rainy River Resources Ltd.
amec

RAINY RIVER GOLD PROJECT

Surface Water Flow Measurement Stations

DRAFT

PROJECT Nº: TC111504	FIGURE: 1
SCALE: 1:30,000	DATE: August 2011

0 1.25 2.5 5 7.5 Kilometres

APPENDIX B

KLOHN 2010 FIELD PHOTO RECORD

Photo I-20 **May 31, 2010 SW-13 Flow Measurement**

Photo I-21 **June 1, 2010 SW-14 Flow Measurement**

Photo I-22 June 1, 2010 SW-1A Flow Measurement

Photo I-23 June 1, 2010 SW-3 Flow Measurement

APPENDIX F

SUMMARY OF RRR WATER QUALITY SAMPLING 2011 TO 2012

Table F-1 Summary of Dissolved Major Ions and Anions in Groundwater

				Parameters	pH	Conductivity	Total Dissolved Solids	Colour	Total Ammonia	Dissolved Chloride	Fluoride	Orthophosphate	Nitrate	Nitrite	Nitrate + Nitrite	Alkalinity	Acidity	Total Cyanide	TOC	Hardness
				Units		µS/cm	mg/L	TCU	as N mg/L	mg/L	mg/L	mg/L	as N mg/L	as N mg/L	as Nmg/L	mg/L as $CaCO_3$	mg/L as $CaCO_3$	mg/L	mg/L	mg/L as $CaCO_3$
				ODWS	6.5-8.5		500	5		250			10^d	1^d	1^d	30-500		0.2		
				PWQO	6.5-8.5													0.005		
UTM 15				CEQG	6.5-9															
Station Name	Easting	Northing	Lithology	Date																
NR-08-240	424771	5410129	BR	24-Oct-2011	8.10	845	456	<1.0	0.159	44.1	0.160	<0.0050	<0.030	<0.020	<0.030	386	8.2	<0.0020	3.1	
NR-08-240				16-Jan-2012	7.56	834	424	2.3	0.400	56.6	0.128	<0.0050	<0.030	<0.020	<0.030	392	6.4	<0.0020	3.3	395
NR-08-240				25-Apr-2012	7.83	766	407	<1.0	0.247	59.4	0.059	<0.0050	<0.030	<0.020	<0.030	312	9.6	<0.0020	6.1	
NR-08-0240				10-Jul-2012	8.00	673	376	<1.0	0.196	60.1	<0.030	<0.0050	<0.030	<0.020	<0.030	268	7.2	<0.0020	16.8	
NR-09-367	452814	5410139	BR	24-Oct-2011	8.12	788	436	<1.0	0.137	20.6	0.163	<0.0050	<0.030	<0.020	<0.030	396	7.2	<0.0020	3.0	
NR-09-367				16-Jan-2012	7.62	707	358	3.0	0.137	20.9	0.202	<0.0050	<0.030	<0.020	<0.030	377	7.0	<0.0020	3.7	398
NR-09-367				25-Apr-2012	7.52	741	422	<1.0	0.137	10.1	0.209	<0.0050	<0.030	<0.020	<0.030	370	15.4	<0.0020	2.2	
NR-09-367				10-Jul-2012	7.67	703	410	<1.0	0.147	0.17	<0.030	<0.0050	<0.030	<0.020	<0.030	380	13.6	<0.0020	2.9	
NR-09-428	425835	5409700	BR	24-Oct-2011	8.20	713	385	<1.0	0.348	14.7	0.707	<0.0050	<0.030	<0.020	<0.030	386	7.0	<0.0020	5.8	
NR-09-428				25-Apr-2012	7.66	773	440	1.6	0.224	10.5	0.146	<0.0050	<0.030	<0.020	<0.030	387	15.6	<0.0020	3.2	
NR-09-428				10-Jul-2012	8.06	594	304	<1.0	0.227	14.9	<0.030	<0.0050	<0.030	<0.020	<0.030	305	6.2	<0.0020	7.7	
NR-10-12			BR	25-Apr-2012	7.57	758	451	<1.0	0.241	2.19	0.162	<0.0050	<0.030	<0.020	<0.030	389	15.2	<0.0020	2.4	
RR-09-213A	425850	5409786	BR	24-Oct-2011	8.03	765	452	<1.0	0.210	7.86	0.081	<0.0050	<0.030	<0.020	<0.030	404	7.8	<0.0020	3.3	
RR-09-213A				25-Apr-2012	7.61	784	457	1.2	0.234	8.14	0.178	<0.0050	<0.030	<0.020	<0.030	398	15.6	<0.0020	2.8	
RR-09-213A				10-Jul-2012	7.72	761	442	2.5	0.230	7.03	0.117	0.0061	<0.030	<0.020	<0.030	399	16.0	<0.0020	2.9	
RR-09-214	425286	5409856	BR	24-Oct-2011	8.04	753	443	<1.0	0.190	5.16	0.085	<0.0050	<0.030	<0.020	<0.030	400	6.8	<0.0020	3.4	0.0236
RR-09-214				25-Apr-2012	7.65	763	429	<1.0	0.196	5.54	0.136	<0.0050	<0.030	<0.020	<0.030	394	16.4	<0.0020	2.7	
BH-10-04	425813	5410648	PLGD	24-Oct-2011	8.21	771	446	<1.0	0.165	1.34	0.251	<0.0050	<0.030	<0.020	<0.030	417	4.4	<0.0020	2.8	
BH-10-04				16-Jan-2012	7.50	729	436	<1.0	0.147	0.58	0.279	<0.0050	<0.030	<0.020	<0.030	406	6.6	<0.0020	3.2	383
BH-10-04				25-Apr-2012	7.87	797	458	<1.0	0.189	0.56	0.254	0.0074	<0.030	<0.020	<0.030	414	15.4	<0.0020	1.9	
BH-10-04				10-Jul-2012	7.83	777	463	1.0	0.193	0.57	0.201	<0.0050	<0.030	<0.020	<0.030	416	16.0	<0.0020	2.3	
BH-10-05	426397	5411994	PA	24-Oct-2011	8.03	1020	*630*	2.0	0.075	1.11	0.288	<0.0050	0.073	<0.020	0.073	465	6.4	<0.0020	3.5	
BH-10-05				16-Jan-2012	7.62	981	*692*	2.5	<0.020	0.46	0.258	<0.0050	0.080	<0.020	0.080	489	15.2	<0.0020	4.7	690
BH-10-05				25-Apr-2012	7.49	1050	*701*	1.0	<0.020	0.25	0.226	<0.0050	<0.030	<0.020	<0.030	483	21.2	<0.0020	2.4	
BH-10-05				10-Jul-2012	7.70	1030	*718*	3.9	0.044	0.35	0.125	<0.0050	0.043	<0.020	0.043	486	23.0	<0.0020	3.1	
BH-10-7A	424608	5411634	PA	24-Oct-2011	8.01	581	320	<1.0	0.099	1.00	0.058	0.0124	<0.030	<0.020	<0.030	293	4.4	<0.0020	2.2	
BH-10-7A				25-Apr-2012	7.63	570	337	1.1	0.118	0.53	0.121	<0.0050	<0.030	<0.020	<0.030	275	7.4	<0.0020	1.7	
BH-10-7A				10-Jul-2012	7.79	606	366	1.5	0.193	0.58	0.113	<0.0050	<0.030	<0.020	<0.030	300	12.0	<0.0020	2.9	
BH-10-11A	424736	5409865	PLGD	24-Oct-2011	7.86	686	402	<1.0	0.423	2.15	0.093	<0.0050	<0.030	<0.020	<0.030	447	5.0	<0.0020	3.4	
BH-10-11A				25-Apr-2012	7.86	732	488	2.6	0.202	1.78	0.170	<0.0050	<0.030	<0.020	<0.030	444	10.0	<0.0020	3.5	
BH-10-11A				10-Jul-2012	7.74	707	484	1.8	0.697	1.72	0.125	<0.0050	0.030	<0.020	0.030	392	8.8	<0.0020	<5.0	
BH-10-12	423964	5410512	PLGD	24-Oct-2011	8.08	767	424	<1.0	0.325	2.53	0.169	<0.0050	<0.030	<0.020	<0.030	412	6.2	<0.0020	2.7	
BH-10-12A				10-Jul-2012	7.67	753	452	2.8	0.316	<0.10	<0.030	<0.0050	<0.030	<0.020	<0.030	393	14.4	<0.0020	2.8	
BH-10-14	425173	5408923	PLGD	24-Oct-2011	8.13	795	457	<1.0	0.305	4.51	0.100	<0.0050	<0.030	<0.020	<0.030	434	9.8	<0.0020	2.8	
BH-10-14				25-Apr-2012	7.77	836	471	<1.0	0.314	4.48	0.152	<0.0050	<0.030	<0.020	<0.030	414	16.2	<0.0020	2.2	
BH-10-14				10-Jul-2012	7.86	782	470	2.0	0.309	3.83	0.136	<0.0050	<0.030	<0.020	<0.030	425	16.0	<0.0020	2.8	
BH-10-20				24-Oct-2011	8.07	765	434	<1.0	0.224	7.68	0.182	<0.0050	<0.030	<0.020	<0.030	405	9.0	<0.0020	2.7	
BH-10-20				16-Jan-2012	7.58	826	*516*	<1.0	0.303	56.4	0.126	<0.0050	<0.030	<0.020	<0.030	388	9.0	<0.0020	4.4	396
BH-10-20				10-Jul-2012	7.82	703	406	4.2	0.153	3.70	0.086	<0.0050	<0.030	<0.020	<0.030	379	16.0	<0.0020	2.4	

Table F-1 Summary of Dissolved Major Ions and Anions in Groundwater

Notes: PWQO: Provincial Water Quality Objective (provided for information purposes only)
CEQG: Canadian Environmental Quality Guidelines
ODWS: Ontario Drinking Water Standard as per O. Reg 169/03

bold	Concentration is above the PWQO
☐	Concentration is above the CEQG
italic	Concentration is above the ODWS

a Aesthetic Objective
b Aesthetic Objective for sodium in drinking water is 200 mg/L
c When sulphate levels exceed 500 mg/L, water may have a laxative effect on some people
d Where both nitrate and nitrite are present, the total of the two should not exceed 10 mg/L (as nitrogen)
e Applies to water at point of consumption. Since lead is a component in some plumbing systems,first flush water may contain higher concentrations of lead than water that has been flushed for five minutes
f 0.005 mg/L if pH<6.5 or 0.1 mg/L if pH>6.5
o Operational Guideline

PA = Pleistocene aquitard (in this case all Whitemouth Lake Till)
PLGD = Pleistocene lower granular deposits (in this case all Whiteshell Till)

Table F-2 Summary of Dissolved Metals in Groundwater

	Parameters	Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Mercury	Nickel
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	ODWS	0.1	0.006	0.025	1			5	0.005		0.05		0.100	0.3[a]	0.01			0.05	0.001	
	PWQO	0.075	0.02	0.1		1.1		0.2	0.0005		0.0089	0.0009	0.005	0.3	0.025				0.0002	0.025
	CEQG	0.005-0.1[f]		0.005				1.5	0.00002		0.001		0.004	0.3	0.007				0.000026	0.15
Station Name	Date																			
NR-08-240	24-Oct-2011	<0.0010	<0.00020	0.000634	0.0464	<0.000060	<0.00010	0.115	<0.000030	100	<0.00020	<0.000030	<0.00040	0.0275	<0.00010	0.0223	33.5	*0.158*	<0.000020	0.00115
NR-08-240	16-Jan-2012	<0.030	<0.0010	<0.0010	0.0495	<0.00060	<0.0020	0.145	<0.00010	94.9	<0.0050	<0.00050	<0.0070	***0.55***	<0.0010	0.023	38.0	*0.214*	<0.000010	<0.010
NR-08-240	25-Apr-2012	<0.0030	<0.00010	0.00018	0.0434	<0.000060	<0.00020	0.115	0.000014	70.5	<0.00050	<0.000050	<0.00070	<0.010	<0.00010	0.0228	39.5	*0.250*	<0.000010	<0.0010
NR-08-0240	10-Jul-2012	<0.0050	<0.00060	<0.0010	0.180	<0.0010	<0.0010	0.123	<0.000017	51.8	<0.0010	<0.00050	<0.0010	<0.020	<0.0010	<0.050	39.7	*0.152*	<0.000010	<0.0020
NR-09-367	24-Oct-2011	<0.0010	<0.00020	0.00158	0.0495	<0.000060	<0.00010	0.0757	<0.000030	96.0	<0.00020	<0.000030	<0.00040	0.0329	<0.00010	0.0340	39.7	*0.122*	<0.000020	0.00165
NR-09-367	16-Jan-2012	<0.030	<0.0010	<0.0010	0.0208	<0.00060	<0.0020	0.059	0.00019	76.9	<0.0050	**0.00158**	<0.0070	***0.91***	<0.0010	0.026	35.6	*0.191*	<0.000010	<0.010
NR-09-367	25-Apr-2012	<0.0030	<0.00010	0.00166	0.0511	<0.000060	<0.00020	0.0642	0.000012	92.9	0.00052	<0.000050	<0.00070	<0.010	<0.00010	0.0349	45.1	*0.147*	0.000028	<0.0010
NR09-0367	10-Jul-2012	<0.0050	<0.00060	<0.0010	0.038	<0.0010	<0.0010	0.059	<0.000017	90.1	<0.0010	<0.00050	<0.0010	<0.020	<0.0010	<0.050	43.9	*0.195*	<0.000010	<0.0020
NH-09-428	24-Oct-2011	<0.0010	<0.00020	0.000819	0.0129	<0.000060	<0.00010	0.130	<0.000030	67.4	<0.00020	<0.000030	<0.00040	0.0306	<0.00010	0.0267	32.7	*0.171*	<0.000020	0.00117
NR-09-428	25-Apr-2012	<0.0030	<0.00010	0.00232	0.0252	<0.000060	<0.00020	0.103	0.000010	100	0.00050	<0.000050	<0.00070	0.054	<0.00010	0.0291	40.1	*0.301*	<0.000010	<0.0010
NR-09-428	10-Jul-2012	<0.0050	<0.00060	<0.0010	<0.010	<0.0010	<0.0010	0.126	0.000021	49.3	<0.0010	<0.00050	<0.0010	<0.020	<0.0010	<0.050	37.6	*0.128*	<0.000010	<0.0020
NR-10-12	25-Apr-2012	<0.0030	<0.00010	0.00593	0.0678	<0.000060	<0.00020	0.0657	<0.000010	98.4	0.00062	<0.000050	<0.00070	***0.533***	<0.00010	0.0358	44.4	*0.180*	<0.000010	<0.0010
RR-09-213A	24-Oct-2011	<0.0010	0.00187	0.00287	0.0502	<0.000060	<0.00010	0.0785	<0.000030	91.6	<0.00020	0.000727	<0.00040	0.0309	0.00060	0.0299	37.2	*0.175*	<0.000020	0.00193
RR-09-213A	25-Apr-2012	<0.0030	0.00117	0.00248	0.0603	<0.000060	<0.00020	0.0768	0.000024	99.1	<0.00050	0.000575	<0.00070	<0.010	0.00016	0.0370	44.9	*0.251*	<0.000010	0.0013
RR-09-213A	10-Jul-2012	<0.0050	0.00123	0.0045	0.056	<0.0010	<0.0010	0.079	<0.000017	99.9	<0.0010	0.00055	<0.0010	<0.020	<0.0010	<0.050	46.2	*0.202*	<0.000010	<0.0020
RR-09-214	24-Oct-2011	<0.0010	<0.00020	0.00267	0.0735	<0.000060	<0.00010	0.0701	<0.000030	91.5	<0.00020	**0.00800**	<0.00040	0.0298	<0.00010	0.0330	36.5	*0.143*	<0.000020	0.00169
RR-09-214	25-Apr-2012	<0.0030	<0.00010	0.00265	0.0886	<0.000060	<0.00020	0.0678	0.000018	95.6	<0.00050	**0.00689**	<0.00070	<0.010	<0.00010	0.0365	40.7	*0.188*	<0.000010	0.0021
BH-10-04	24-Oct-2011	0.0015	<0.00020	0.0195	0.0685	<0.000060	<0.00010	0.175	<0.000030	64.3	<0.00020	0.000670	0.00050	0.0278	<0.00010	0.0727	46.5	*0.103*	<0.000020	0.00181
BH-10-04	16-Jan-2012	<0.030	<0.0010	0.0188	0.0713	<0.00060	<0.0020	0.186	<0.00010	72.5	<0.0050	0.00075	<0.0070	<0.10	<0.0010	0.076	52.1	*0.0967*	<0.000010	<0.010
BH-10-04	25-Apr-2012	<0.0030	<0.00010	0.0222	0.0740	<0.000060	<0.00020	0.176	0.000018	81.9	<0.00050	0.000723	<0.00070	<0.010	<0.00010	0.0803	53.0	*0.114*	<0.000010	0.0012
BH-10-04	10-Jul-2012	<0.0050	<0.00060	0.0200	0.068	<0.0010	<0.0010	0.193	0.000020	78.4	<0.0010	0.00072	<0.0010	<0.020	<0.0010	0.079	52.8	*0.103*	<0.000010	<0.0020
BH-10-05	24-Oct-2011	0.0032	0.00026	0.00141	0.0492	<0.000060	<0.00010	0.187	0.000036	119	<0.00020	0.000946	0.00072	0.0377	<0.00010	0.107	68.2	*0.152*	<0.000020	0.00378
BH-10-05	16-Jan-2012	<0.030	<0.0010	<0.0010	0.0394	<0.00060	<0.0020	0.164	<0.00010	113	<0.0050	<0.00050	<0.0070	<0.10	<0.0010	0.095	73.3	0.0267	<0.000010	<0.010
BH-10-05	25-Apr-2012	<0.0030	0.00010	0.00090	0.0422	<0.000060	<0.00020	0.106	0.000026	121	0.00051	<0.000050	0.00193	<0.010	<0.00010	0.0872	79.8	*0.0578*	<0.000010	0.0028
BH-10-05	10-Jul-2012	<0.0050	<0.00060	<0.0010	0.045	<0.0010	<0.0010	0.131	0.000033	118	<0.0010	<0.00050	<0.0010	<0.020	<0.0010	0.090	78.0	0.0439	<0.000010	<0.0020
BH-10-7A	24-Oct-2011	<0.0010	<0.00020	0.00619	0.0569	<0.000060	<0.00010	0.0493	<0.000030	64.9	<0.00020	0.000052	<0.00040	0.0255	<0.00010	0.0310	24.2	*0.209*	<0.000020	0.00086
BH-10-7A	25-Apr-2012	<0.0030	<0.00010	0.00666	0.0647	<0.000060	<0.00020	0.0495	<0.000010	80.1	<0.00050	<0.000050	<0.00070	<0.010	<0.00010	0.0327	27.1	*0.263*	<0.000010	<0.0010
BH-10-7A	10-Jul-2012	<0.0050	<0.00060	0.0103	0.076	<0.0010	<0.0010	0.103	<0.000017	82.8	<0.0010	<0.00050	<0.0010	<0.020	<0.0010	<0.050	27.7	*0.315*	<0.000010	<0.0020
BH-10-11A	24-Oct-2011	0.0011	0.00028	0.00349	0.116	<0.000060	<0.00010	0.0652	<0.000030	96.5	<0.00020	0.000135	<0.00040	0.0403	<0.00010	0.0325	34.2	*0.135*	<0.000020	0.00154
BH-10-11A	25-Apr-2012	<0.0030	0.00016	0.00478	0.118	<0.000060	<0.00020	0.0603	0.000017	97.4	0.00050	0.000113	<0.00070	<0.010	<0.00010	0.0339	40.4	*0.206*	<0.000010	0.0012
BH-10-11A	10-Jul-2012	0.0052	<0.00060	0.0031	0.126	<0.0010	<0.0010	0.058	<0.000017	96.8	<0.0010	<0.00050	<0.0010	<0.020	<0.0010	<0.050	40.5	*0.156*	<0.000010	<0.0020
BH-10-12	24-Oct-2011	<0.0010	<0.00020	0.00320	0.0587	<0.000060	<0.00010	0.0784	<0.000030	85.4	<0.00020	<0.000030	<0.00040	<0.0050	<0.00010	0.0412	35.6	*0.154*	<0.000020	0.00101
BH-10-12A	10-Jul-2012	<0.0050	<0.00060	0.0046	0.069	<0.0010	<0.0010	0.086	<0.000017	92.9	<0.0010	<0.00050	<0.0010	<0.020	<0.0010	<0.050	41.2	*0.206*	<0.000010	<0.0020
BH-10-14	24-Oct-2011	0.0011	<0.00020	0.00911	0.0687	<0.000060	<0.00010	0.103	<0.000030	96.4	<0.00020	<0.000030	0.00066	0.0230	<0.00010	0.0331	37.3	*0.158*	<0.000020	0.00109
BH-10-14	25-Apr-2012	<0.0030	<0.00010	0.0114	0.0770	<0.000060	<0.00020	0.0982	0.000013	108	<0.00050	<0.000050	<0.00070	<0.010	<0.00010	0.0348	39.4	*0.202*	<0.000010	<0.0010
BH-10-14	10-Jul-2012	<0.0050	<0.00060	0.0104	0.073	<0.0010	<0.0010	0.110	<0.000017	94.9	<0.0010	<0.00050	<0.0010	<0.020	<0.0010	<0.050	40.5	*0.179*	<0.000010	<0.0020
BH-10-20	24-Oct-2011	<0.0010	0.00290	0.00253	0.0531	<0.000060	<0.00010	0.0809	<0.000030	94.0	<0.00020	0.000829	0.00052	0.0274	0.00031	0.0327	39.2	*0.182*	<0.000020	0.00167
BH-10-20	16-Jan-2012	<0.030	<0.0010	<0.0010	0.0860	<0.00060	<0.0020	0.137	<0.00010	94.9	<0.0050	<0.00050	<0.0070	***2.21***	<0.0010	0.019	37.6	*0.228*	<0.000010	<0.010
BH-10-20	10-Jul-2012	<0.0050	<0.00060	<0.0010	0.040	<0.0010	<0.0010	0.063	<0.000017	92.7	<0.0010	<0.00050	<0.0010	0.257	<0.0010	<0.050	43.2	*0.190*	<0.000010	<0.0020

Table F-2 Summary of Dissolved Metals in Groundwater

	Parameters	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Tellurium	Thallium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	ODWS			0.01[a]		200[b]							0.02		5[a]	
	PWQO	0.02-0.03		0.1					0.0003			0.03	0.005		0.02	0.004
	CEQG			0.001					0.001				0.015		0.03	
Station Name	Date															
NR-08-240	24-Oct-2011	<0.0050	4.52	<0.0010	<0.000010	26.3	0.579	<0.000070	<0.000010	<0.00010	<0.00050	0.000494	0.000362	0.00010	<0.0020	0.000043
NR-08-240	16-Jan-2012	<0.0100	4.48	<0.0050	<0.00050	30.2	0.761	<0.00070	<0.00030	<0.0010	<0.0050	<0.0010	0.00042	<0.0020	<0.020	<0.0010
NR-08-240	25-Apr-2012	0.0064	5.03	<0.00050	<0.000050	34.2	0.503	<0.000070	<0.000030	<0.00010	<0.00050	0.00073	0.000027	<0.00020	<0.0020	<0.00010
NR-08-0240	10-Jul-2012	0.0113	4.78	<0.0010	<0.00010	32.9	0.352	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	<0.0050	<0.0010	<0.0030	<0.0010
NR-09-367	24-Oct-2011	<0.0050	3.57	<0.0010	<0.000010	15.0	0.420	<0.000070	<0.000010	<0.00010	0.00071	0.000415	0.000556	<0.00010	<0.0020	0.000065
NR-09-367	16-Jan-2012	<0.0100	3.18	<0.0050	<0.00050	12.3	0.379	<0.00070	<0.00030	<0.0010	<0.0050	<0.0010	0.00055	<0.0020	<0.020	<0.0010
NR-09-367	25-Apr-2012	<0.0050	3.79	<0.00050	<0.000050	12.8	0.417	<0.000070	<0.000030	<0.00010	0.00067	0.00032	0.000496	<0.00020	<0.0020	<0.00010
NR09-0367	10-Jul-2012	<0.0050	3.76	<0.0010	<0.00010	10.6	0.389	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	<0.0050	<0.0010	<0.0030	<0.0010
NH-09-428	24-Oct-2011	<0.0050	3.55	<0.0010	<0.000010	19.3	0.424	<0.000070	<0.000010	<0.00010	<0.00050	0.00271	0.0000393	<0.00010	<0.0020	<0.000020
NR-09-428	25-Apr-2012	<0.0050	3.84	<0.00050	<0.000050	17.7	0.558	<0.000070	<0.000030	<0.00010	0.00052	0.00193	0.000144	<0.00020	0.0038	<0.00010
NR-09-428	10-Jul-2012	0.0050	3.67	<0.0010	<0.00010	20.7	0.257	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	<0.0050	<0.0010	<0.0030	<0.0010
NR-10-12	25-Apr-2012	<0.0050	5.07	<0.00050	<0.000050	12.3	0.380	<0.000070	<0.000030	<0.00010	0.00075	0.00053	0.000160	<0.00020	<0.0020	<0.00010
RR-09-213A	24-Oct-2011	<0.0050	3.33	<0.0010	<0.000010	13.4	0.393	<0.000070	<0.000010	<0.00010	<0.00050	0.000533	0.000570	<0.00010	0.0035	0.000063
RR-09-213A	25-Apr-2012	<0.0050	3.71	<0.00050	<0.000050	14.0	0.448	<0.000070	<0.000030	<0.00010	0.00059	0.00020	0.000497	<0.00020	0.0097	<0.00010
RR-09-213A	10-Jul-2012	<0.0050	3.66	<0.0010	<0.00010	13.5	0.465	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	<0.0050	<0.0010	0.0067	<0.0010
RR-09-214	24-Oct-2011	<0.0050	4.68	<0.0010	<0.000010	15.2	0.340	<0.000070	<0.000010	<0.00010	<0.00050	**0.0449**	0.00142	<0.00010	<0.0020	0.000099
RR-09-214	25-Apr-2012	<0.0050	5.13	<0.00050	<0.000050	16.3	0.384	<0.000070	<0.000030	<0.00010	<0.00050	**0.0491**	0.00136	<0.00020	<0.0020	0.00010
BH-10-04	24-Oct-2011	<0.0050	3.62	<0.0010	<0.000010	22.3	0.435	<0.000070	<0.000010	<0.00010	0.00061	0.000111	**0.00960**	<0.00010	0.0039	0.000135
BH-10-04	16-Jan-2012	<0.0100	3.66	<0.0050	<0.00050	19.6	0.495	<0.00070	<0.00030	<0.0010	<0.0050	<0.0010	**0.00888**	<0.0020	<0.020	<0.0010
BH-10-04	25-Apr-2012	0.0075	3.89	<0.00050	<0.000050	19.9	0.506	<0.000070	<0.000030	<0.00010	0.00072	<0.00010	**0.0103**	<0.00020	<0.0020	<0.00010
BH-10-04	10-Jul-2012	0.0076	3.64	<0.0010	<0.00010	18.4	0.500	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	**0.0102**	<0.0010	<0.0030	<0.0010
BH-10-05	24-Oct-2011	<0.0050	3.54	<0.0010	<0.000010	19.4	0.620	<0.000070	<0.000010	<0.00010	0.00273	0.00145	**0.0186**	0.00075	<0.0020	0.000195
BH-10-05	16-Jan-2012	<0.0100	2.87	<0.0050	<0.00050	16.1	0.664	<0.00070	<0.00030	<0.0010	<0.0050	<0.0010	**0.0145**	<0.0020	<0.020	<0.0010
BH-10-05	25-Apr-2012	0.0052	2.73	<0.00050	<0.000050	16.0	0.623	<0.000070	<0.000030	<0.00010	0.00275	0.00049	**0.0152**	0.00054	<0.0020	0.00017
BH-10-05	10-Jul-2012	<0.0050	2.87	<0.0010	<0.00010	15.5	0.633	<0.0010	<0.00030	<0.0010	0.0031	<0.010	**0.0162**	<0.0010	<0.0030	<0.0010
BH-10-7A	24-Oct-2011	<0.0050	3.90	<0.0010	<0.000010	9.32	0.217	<0.000070	<0.000010	<0.00010	0.00060	0.000142	0.00139	<0.00010	<0.0020	<0.000020
BH-10-7A	25-Apr-2012	<0.0050	4.02	0.00054	<0.000050	9.18	0.267	<0.000070	<0.000030	<0.00010	0.00075	0.00033	0.00155	<0.00020	<0.0020	<0.00010
BH-10-7A	10-Jul-2012	<0.0050	4.06	<0.0010	<0.00010	13.6	0.367	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	<0.0050	<0.0010	<0.0030	<0.0010
BH-10-11A	24-Oct-2011	<0.0050	5.79	<0.0010	<0.000010	10.5	0.350	<0.000070	<0.000010	<0.00010	<0.00050	0.000068	0.00237	0.00069	<0.0020	0.000052
BH-10-11A	25-Apr-2012	<0.0050	5.59	<0.00050	<0.000050	10.5	0.393	<0.000070	<0.000030	<0.00010	0.00067	<0.00010	0.00107	0.00046	<0.0020	<0.00010
BH-10-11A	10-Jul-2012	<0.0050	6.12	<0.0010	<0.00010	10.2	0.385	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	<0.0050	0.0010	<0.0030	<0.0010
BH-10-12	24-Oct-2011	<0.0050	4.63	<0.0010	<0.000010	19.2	0.343	<0.000070	<0.000010	<0.00010	0.00052	0.000431	0.000526	<0.00010	<0.0020	0.000054
BH-10-12A	10-Jul-2012	<0.0050	4.81	<0.0010	<0.00010	15.7	0.404	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	<0.0050	<0.0010	<0.0030	<0.0010
BH-10-14	24-Oct-2011	<0.0050	4.59	<0.0010	<0.000010	17.1	0.426	<0.000070	<0.000010	<0.00010	<0.00050	0.000152	0.000740	<0.00010	<0.0020	0.000174
BH-10-14	25-Apr-2012	<0.0050	4.73	0.00056	<0.000050	16.8	0.536	<0.000070	<0.000030	<0.00010	0.00052	<0.00010	0.000719	<0.00020	<0.0020	<0.00010
BH-10-14	10-Jul-2012	<0.0050	4.45	<0.0010	<0.00010	16.2	0.476	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	<0.0050	<0.0010	<0.0030	<0.0010
BH-10-20	24-Oct-2011	<0.0050	3.52	<0.0010	<0.000010	14.0	0.393	<0.000070	0.000019	<0.00010	<0.00050	0.000659	0.000605	<0.00010	0.0051	0.000050
BH-10-20	16-Jan-2012	<0.0100	4.61	<0.0050	<0.00050	29.9	0.784	<0.00070	<0.00030	<0.0010	<0.0050	<0.0010	0.00031	<0.0020	<0.020	<0.0010
BH-10-20	10-Jul-2012	<0.0050	3.74	<0.0010	<0.00010	10.2	0.385	<0.0010	<0.00030	<0.0010	<0.0020	<0.010	<0.0050	<0.0010	<0.0030	<0.0010

Table F-2 Summary of Dissolved Metals in Groundwater

Notes: PWQO: Provincial Water Quality Objective (provided for information purposes only)
CEQG: Canadian Environmental Quality Guidelines
ODWS: Ontario Drinking Water Standard as per O. Reg 169/03

bold	Concentration is above the PWQO
▭	Concentration is above the CEQG
italic	Concentration is above the ODWS

^^ PWQO and/or CEQG is an interim value
a Aesthetic Objective
b Aesthetic Objective for sodium in drinking water is 200 mg/L
c When sulphate levels exceed 500 mg/L, water may have a laxative effect on some people
d Where both nitrate and nitrite are present, the total of the two should not exceed 10 mg/L (as nitrogen)
e Applies to water at point of consumption. Since lead is a component in some plumbing systems,first flush water may contain higher concentrations of lead than water that has been flushed for five minutes
f 0.005 mg/L if pH<6.5 or 0.1 mg/L if pH>6.5
o Operational Guideline

APPENDIX G

ESTIMATING MAXIMUM POTENTIAL PERCOLATION RATE FOR THE RAINY RIVER PROJECT AREA

APPENDIX G

ESTIMATING MAXIMUM POTENTIAL PERCOLATION RATE FOR THE RAINY RIVER PROJECT AREA

1.0 HELP MODEL

The Hydrologic Evaluation of Landfill Performance model (HELP), developed by the United States EPA (EPA 1995a,b) was used to estimate maximum potential percolation/recharge rate that may be encountered during the open pit operation (i.e. under reversed vertical gradient and depressed water table conditions). Although the HELP model was designed primarily to evaluate cover options for landfill applications, it is considered to be a useful tool for estimating water balance of soil profiles at other types of sites.

For estimating the water balance of soil profiles the HELP model utilizes weather, soil and stratigraphy data to account for the effects of:

- surface storage;
- snowmelt;
- runoff;
- vegetative growth;
- evapotranspiration;
- soil moisture storage; and
- unsaturated vertical drainage and leakage through soil.

Detailed description of the HELP model is provided in its documentation (EPA 1995a,b).

2.0 HELP MODEL INPUT PARAMETERS

HELP model input parameters are subdivided into two major groups:

- weather data; and
- soil and design data.

2.1 Weather Data

According to the HELP's manual input weather data consists of the following components:

- precipitation;
- temperature;
- solar radiation; and
- evapotranspiration parameters.

The precipitation and temperature daily data for the Rainy River Project area for 10 years was generated by the HELP (synthetic data) based on:

- normal mean monthly temperature and precipitation values for Barwick, ON over the period from 1971 – 2000 (Table F-1); and
- statistics of historical data for Duluth (MN) – the closest US city to Rainy River with climatological data included in the HELP database.

TABLE F-1
NORMAL MEAN DAILY TEMPERATURE AND PRECIPITATION FOR BARWICK[(1)]

Month	Temperature (°C)	Precipitation (mm)
January	-15.9	28.3
February	-11.6	24.1
March	-4.4	29.7
April	4.2	40
May	11.7	68.3
June	16.2	113.8
July	18.8	99.0
August	17.8	84.0
September	12.1	80.0
October	5.5	56.2
November	-3.8	41.7
December	-12.7	29.7

(1) Canadian Climate Normals 1971-2000 for Barwick, ON (Station I.D. 6020559)

The solar radiation data for the Rainy River Project area was generated by the HELP model based on the available data for Duluth (MN), corrected for the actual latitude of the Project area location (48^o 83' North).

The evapotranspiration input data for the HELP model is summarized in Table F-2.

TABLE F-2
EVAPOTRANSPIRATION INPUT DATA

Parameter	Value	Units	Comments
Evaporative zone depth	50	cm	Default HELP value for Duluth, MN with a fair stand of grass
Maximum leaf area index	2-3		HELP recommended value for fair to good stand of grass
Growing season start day	144	Julian day	Default HELP value for Detroit, MI
Growing season end day	261	Julian day	Default HELP value for Detroit, MI
Average wind speed	17	km/hr	Average wind speed at the Sarnia airport according to Canadian Climate Normals for 1971-2000
First quarter relative	70.0%		Reported average relative humidity

humidity			data for Duluth, MN
Second quarter relative humidity	66.0%		Reported average relative humidity data for Duluth, MN
Third quarter relative humidity	74.0%		Reported average relative humidity data for Duluth, MN
Fourth quarter relative humidity	74.0%		Reported average relative humidity data for Duluth, MN

2.2 Soil and Design Data

The soil and design parameters affecting the estimated percolation rates include the following:

- percent of the area where runoff is possible;
- soil layer thicknesses;
- moisture retention parameters (total porosity, field capacity and wilting point);
- saturated hydraulic conductivities of soil layers;
- slope;
- slope length;
- soil texture number; and
- vegetation index of the uppermost layer.

For the purpose of this study the HELP model was used to estimate the percolation rate through a typical overburden profile encountered for the Project area in the low-lying areas, where glaciolacustrine clay deposits (Brenna Formation) are present at surface.

Soil and design parameters utilized in the HELP model runs are summarized in Table F-3.

TABLE F-3
SOIL AND DESIGN INPUT PARAMETERS

Parameter	Value/Range	Units	Comments
Slope	1%		
Slope length	5,500	m	Characteristic distance from higher ground north of the mine site to the Pinewood River
Desiccated Upper Clay – HELP Percolation Layer			
Thickness	1	m	
Saturated hydraulic conductivity	$1.2x10^{-6}$(1)	cm/s	Default HELP value for soil texture #28, silty clay.
Total porosity	0.452	vol/vol	
Field capacity	0.411	vol/vol	
Wilting point	0.311	vol/vol	
Run-off curve number	83		Run-off curve number for soil texture #28
Upper Lacustrine Clay (Brenna) – HELP Barrier Soil Layer			
Thickness	1	m	
Saturated hydraulic conductivity	$1.2x10^{-6}$	cm/s	Default HELP value for soil texture #28, silty clay.
Total porosity	0.452	vol/vol	
Field capacity	0.411	vol/vol	
Wilting point	0.311	vol/vol	
Whitemouth Lake Till – HELP Percolation Layer			
Thickness	20	m	Average thickness of till
Saturated hydraulic conductivity	$3.3x10^{-5}$	cm/s	Default HELP values for soil texture #13
Total porosity	0.430	vol/vol	
Field capacity	0.321	vol/vol	
Wilting point	0.221	vol/vol	
Lower Lacustrine (Wylie) – HELP Barrier Soil Layer			
Thickness	5	m	
Saturated hydraulic conductivity	$1.2x10^{-6}$	cm/s	Default HELP values for soil texture #28
Total porosity	0.452	vol/vol	
Field capacity	0.411	vol/vol	
Wilting point	0.311	vol/vol	
PLGD – HELP Percolation Layer			
Thickness	4.5	m	Average thickness of PLGD
Saturated hydraulic conductivity	$5.8x10^{-3}$	cm/s	Default HELP values for soil texture #2
Total porosity	0.437	vol/vol	
Field capacity	0.062	vol/vol	
Wilting point	0.024	vol/vol	

Note: (1)To account for root channels in the top half of evaporative zone (0.5m) saturated hydraulic conductivity of this layer was multiplied by 3 by the HELP model.

.

3.0 HELP MODEL RESULTS

Table F-4 shows average water balance components estimated by running the HELP model over a period of 100 years.

TABLE F-4
AVERAGE ANNUAL TOTALS ESTIMATED OVER A PERIOD OF 100 YEARS

Component	Value (mm)	Percent
Precipitation	682	100
Runoff	153	22
Evapotranspiration	481	71
Percolation/leakage through layer 2	48	7
Average head on top of layer 2	8	NA
Percolation/leakage through layer 4	46	7
Average head on top of layer 4	<1	NA
Percolation/leakage through layer 5	44	6
Change in water storage	5	<1

The HELP model runs conducted for the proposed dewatered mine conditions (water table depressed to below the PLGD unit) showed that maximum potential percolation rate in the low-lying areas of the mine site with clay layer at/near surface are expected to be close to 50 mm/yr. This rate was utilized simulating the Base Case scenario. The impact of lower (25 mm/yr) and higher (75 mm/yr) maximum potential percolation/leakage rates on the groundwater model predictions was examined by the conducted sensitivity analysis (Section 4-6 of main report)

REFRENCES

EPA. 1995a. The Hydrologic Evaluation of Landfill Performance Model, User's Guide for Version 3. Cincinnati, Ohio.

EPA. 1995b. The Hydrologic Evaluation of Landfill Performance Model. Engineering Documentation for Version 3. Cincinnati, Ohio.