February 23, 2013

HYDROGEOLOGICAL ASSESSMENT REPORT

Braeburn
Solid Waste Disposal Facility

Submitted to:
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REPORT

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Executive Summary

Golder Associates Ltd. ("Golder") was retained by the Government of Yukon Community Services Infrastructure Branch on September 28, 2011 to complete a groundwater monitoring well network installation and hydrogeological assessment program at up to 20 solid waste facilities located across the Territory. The Braeburn Solid Waste Disposal Facility (the "Facility" or "Site") is one of the sites included in the program. A multiphase approach was implemented at each Facility in order to carry out the hydrogeological assessment. The first phase completed for the program was a review of Site-specific requirements and considerations. The second phase was the preparation of a work plan and schedule. The third phase was the development and presentation of a Background Research and Facility Site Assessment Plan. The fourth phase consisted of the drill program tender specification and tender process management. The fifth phase consisted of the installation of a monitoring well network and collection of data on water levels, water quality, and aquifer parameters. The sixth and final phase resulted in a draft of this Hydrogeological Assessment Report, documenting the results of the investigation.

In summary, the information obtained during the Hydrogeological Site Assessment indicated the following:

- Site Description: The Facility is accessed by a gravel road located off the west side of the Klondike Highway at kilometre 276, approximately 95 km north of the City of Whitehorse and 80 km south of Carmacks, Yukon at latitude 61º16'07" North and longitude 136º45'35" West. No civic address or legal description is available for the Site. It is located on a 0.34 hectare Community Services Reserve (Disposition #105E05-015) in the Champagne and Aishihik First Nations, Ta'an Kwäch'än Council, Kwanlin Dün First Nation and Little Salmon-Carmacks First Nation traditional territory, and is located immediately adjacent to the Ta'an Kwäch'än Council settlement block R-8B. The Facility is currently being used as a transfer station serving between 10 and 15 users from the Braeburn and Fox Lake cottage areas, and is operated by the Government of Yukon, Department of Community Services. Prior to August 16, 2011 a burn vessel was used at the Facility to incinerate domestic, commercial, and demolition waste, which was then landfilled on-site. No evidence of chemical or fuel storage, above or below ground storage tanks, spills or discharges or hazardous materials storage were observed during the Site reconnaissance.
- Topography: The Facility is located at a surface elevation of approximately 760 m above mean sea level (amsl). The cleared area at the Site is generally flat, due to landfill activities, and slopes gently to the west. Surficial geology is characteristic of glacial outwash plain and terraced glaciofluvial sand and gravel deposits. Regional topography around the Site slopes to the northwest towards Braeburn Lake (elevation 695 m amsl).
- Stratigraphy and Hydrogeology:
  - Bedrock outcrops in the vicinity of the Facility are sparse; surface expression is dominated by quaternary, surficial deposits.
  - Subsurface conditions were investigated with the drilling and installation of three monitoring wells (BN-MW12-01, BN-MW12-02, and BN-MW12-03), which were installed between June 7 and 16, 2012 under the supervision of Golder Associates for the establishment of a monitoring well network at the Facility.

- Site stratigraphy was found to consist of approximately 17 m of glaciofluvial outwash deposits (sand and gravel) that overlie bedrock (dacite tuff) of the lower Jurassic Nordenskiold formation.
- A confined aquifer in fractured bedrock was identified at approximately 61.5 metres below grade (m bg), 29.1 m below the overburden/bedrock interface at BN-MW12-01.
- At BN-MW12-02, bedrock was encountered at 17.4 m bg and the borehole was drilled to a depth of 49.7 m bg; groundwater was not encountered at the time of drilling; however, groundwater was present after well installation, and when the well was developed it yielded a relatively small amount of water, indicating that it was completed in very low-permeability bedrock.
- At BN-MW12-03, bedrock was encountered at 17.4 m bg. The well screen was installed in the borehole so that it intersected the unconsolidated sediment/bedrock interface. Although no water was observed during installation, sufficient water was present during development to adequately develop and sample the well.
- A single hydraulic response test was performed on well BN-MW12-01 on July 31, 2012. BN-MW12-01 is screened in a confined water-bearing unit approximately 30 m below the bedrock surface The horizontal hydraulic conductivity of the fractured bedrock at this location was estimated to be approximately 6×10^{-6} m/s.
- The horizontal hydraulic gradient could not be determined from the monitoring well network because of varying potentiometric surfaces encountered in the wells and the very slow recovery to static conditions at BN-MW12-02. However, the regional horizontal hydraulic gradient can be estimated from the overlying topography, from the hills to the east of the Site down to Braeburn Lake. This provides an approximate horizontal hydraulic gradient of 0.05 m/m, sloping to the west.
- Based on the inferred direction of the hydraulic gradient, the minimum criteria for one upgradient and two downgradient monitoring wells at the facility were not entirely met. One upgradient well (BN-MW12-01) and one downgradient well (BN-MW12-02) were installed, with a third well (BN-MW12-03) installed side-gradient to the Facility.
- Due to the lack of a surficial aquifer at the Site at the time of drilling and due to the complex nature of groundwater flow in fractured bedrock, additional monitoring well installations may be necessary to more accurately assess groundwater flow direction and potential leachate migration to groundwater underlying the Facility.

- Groundwater Chemistry:
  - A desk-top study and several Site visits were used to evaluate the applicability of Yukon Contaminated Site Regulation (CSR) water quality standards at the Site. It was concluded that Yukon CSR water quality standards for freshwater aquatic life and for drinking water both apply to the Facility.
  - Monitoring wells BN-MW12-01 and BN-MW12-03 were developed and sampled by Golder on July 30 and 31, 2012, approximately six weeks after installation. BN-MW12-02 could not be properly developed and sampled due to a slow hydraulic response in the well. That well was bailed dry and left to recover and the total recovery time remains unknown. However, recovery is very slow and is greater than a single day.

- During this first monitoring event, a water quality assessment was performed on water samples collected from BN-MW12-01 and BN-MW12-03, as well as a small creek located hydraulically and topographically downgradient of the Site.
- All samples showed acceptable levels of all analytical parameters as defined by the Yukon CSR criteria for freshwater aquatic life. However, Yukon CSR standards for drinking water were exceeded in BN-MW12-01 for iron (0.965 mg/L), magnesium (112 mg/L), manganese (0.0527 mg/L), sodium (202 mg/L), and sulphate (966 mg/L). As well, manganese (1.84 mg/L) and sulphate (594 mg/L) exceeded the Yukon CSR for drinking water in BN-MW12-03. Standards for iron, magnesium, manganese, sodium, and sulphate in drinking water are secondary standards intended to prevent taste and odour concerns.
- Detectable levels of naphthalene and phenanthrene were found in BN-BH12-03; however, the concentrations were below CSR standards for aquatic life. These compounds may be associated with oily waste stored and/or disposed of at the site.
- Results of groundwater sampling performed on the monitoring well network and the creek that is down gradient of the Site, indicate low to non-detect levels of analytical parameters typically associated with landfill leachate contamination. This suggests that leachate influence on groundwater at the Site was insignificant at the time of sampling.

The following recommendations are made based on the results of the 2012 hydrogeological investigation:

- As required by the Facilities Solid Waste Disposal Permit, groundwater levels and water quality samples should be collected from the monitoring wells at the Facility twice a year (spring and late summer).
- Groundwater quality at the Facility should be revaluated following an additional round of groundwater monitoring to determine if there is any evidence of potential groundwater impacts.
- The efficacy of BN-MW12-02 for sampling groundwater should be revaluated, and the well should be replaced if low-yield conditions persist.

Study Limitations

This report was prepared for the Government of Yukon, Community Services Infrastructure Development Branch.

The inferences concerning the Braeburn Solid Waste Facility contained in this report are based on information obtained during the assessment conducted by Golder personnel, and are based solely on the condition of the property at the time of the Site reconnaissance, installation of monitoring wells, and groundwater monitoring events, supplemented by historical and interview information obtained by Golder, as described in this report.

This report was prepared, based in part, on information obtained from historic information sources. In evaluating the subject Site, Golder has relied in good faith on information provided. We accept no responsibility for deficiency or inaccuracy contained in this report as a result of our reliance on the aforementioned information.

The findings and conclusions documented in this report have been prepared for the specific application to this project, and have been developed in a manner consistent with that level of care normally exercised by environmental professionals currently practicing under similar conditions in the jurisdiction.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

With respect to regulatory compliance issues, regulatory statutes are subject to interpretation. These interpretations may change over time, and should be reviewed.

If new information is discovered during future work, Golder should be requested to re-evaluate the conclusions of this report and to provide amendments, as required, prior to any reliance upon the information presented herein.

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1.0 INTRODUCTION

1.1 Background

Golder Associates Ltd. ("Golder") was retained by the Government of Yukon Community Services Infrastructure Branch on September 28, 2011 to complete a groundwater monitoring well network installation and hydrogeological assessment program at up to 20 solid waste facilities located across the Territory. The Braeburn Solid Waste Facility (the "Facility", the "Site") is one of the sites included in the program. This Hydrogeological Assessment Report presents the findings of our investigation.

This work have been performed in accordance with the approved scope of work detailed in Golder's proposal (P1-1436-0073) dated August 29, 2011, accepted by Yukon Government Community Services on October 7, 2011, and additional works detailed in our letter dated April 26, 2012 and accepted April 30, 2012.

1.2 Purpose and Objectives

A phased approach is typically implemented in order to develop a site-specific groundwater monitoring program. The following objectives are included in the development of the program:

- Develop a conceptual hydrogeological model of the Site using existing data that identifies contaminant source(s), pathways and receptors;
- Visit the Site to corroborate the hydrogeological model, assess site conditions and identify monitoring well locations;
- Design a monitoring well network and drilling program;
- Install groundwater monitoring wells in accordance with the plan;
- Sample the groundwater and, if applicable, surface water;
- Analyze the data and identify potential impacts;
- With the new data, re-evaluate the conceptual hydrogeological model and groundwater monitoring program; and
- Provide recommendations, if needed, to further assess potential impacts to groundwater quality.

1.3 Scope and Sequence of Work

The following scope of work was proposed to develop the conceptual hydrogeological model for the Site and installation of a monitoring Well network. This work was performed in accordance with the Waste Management Permit (Permit No: 80-009 effective February 29, 2012 to December 31, 2014). No application pertaining to this Facility was available on the YESAB website as of October 5, 2012.

In summary, the work completed at the facility included the following six phases:

- Phase 1 assessed the needs for special considerations at the Site;
- Phase 2 outlined a work plan and schedule;
- Phase 3 consisted of background research and finalization of a draft of the Site Assessment Plan;
- Phase 4 consisted of the drilling program tender specification and tender process management;
- Phase 5 consisted of the installation of a monitoring well network and collection of data on water levels, water quality, and aquifer parameters; and
- Phase 6 comprised preparation of this draft Hydrogeological Assessment Report, documenting the results of the investigation.

1.4 Qualifications of Assessors

Project Manager

The role of Project Manager was filled by Gary Hamilton, P. Geo., of Golder's Burnaby, BC office. Mr. Hamilton is a senior contaminant hydrogeologist and Principal with Golder Associates. He has over 25 years of experience, has completed landfill monitoring projects locally, and is very familiar with Yukon environmental regulations. Mr. Hamilton conducted the initial Site inspections, coordinated the drilling work and reviewed this assessment report.

Project Director

The role of Project Director was filled by Guy Patrick, P. Eng., of Golder's Victoria, BC office. Mr. Patrick is a senior hydrogeologist and a Principal with Golder Associates. He is a Professional Engineer registered with the Association of Professional Engineers of the Yukon Territory. Mr. Patrick has over 30 years of experience in the field of environmental and hydrogeological assessments.

Field Hydrogeologist-Engineer

The role of Project Hydrogeologist was filled by Calvin Beebe of Golder's Nelson, BC office. Mr. Beebe has an M.Sc. degree in Hydrogeology from Saint Francis Xavier University (2012) and has completed numerous projects as a Hydrogeologist with Golder Associates including work on contaminated sites.

Mr. Beebe was assisted in carrying out the field work by Ms. Andrea Badger, who joined Golder in May 2012. She obtained a B.Sc. in Civil Engineering with an Environmental Option, from the University of Alberta, Edmonton (2012) and a Diploma of Northern Studies, Outdoor and Environmental Studies at Yukon College, Whitehorse (2007). She has been involved with monitoring well drilling, development, testing and sampling at landfills across the Yukon since beginning work at Golder. She has also been involved with surface water monitoring at a construction site in Northern British Columbia.

1.5 Authorization

Written authorization and a signed contract to proceed with the work outlined in our proposal dated August 29, 2011 was received by Ms. Laura Prentice, Program Manager, on October 7, 2011. Golder received e-mail authorization to proceed with additional work detailed in out letter dated April 26, 2012 on April 30, 2012. The Change Order for the work was attached to the e-mail message.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Location

The Facility is located at kilometre 276 on the Klondike Highway approximately 95 km north of the City of Whitehorse and 80 km south of Carmacks, Yukon. It lies within the Southern Lakes Ecological Region at latitude 61°26'06" North and longitude 135°45'33" West. The Site is located 400 m west of the Klondike Highway, and is accessed by a gravel road off the west side of the highway (Figure 1, Key Plan). No civic address or legal description is available for the Site. It is located on a 0.34 hectare Community Services Reserve (Disposition #105E05-015) in the Champagne and Aishihik First Nations, Ta'an Kwäch'än Council, Kwanlin Dün First Nation and Little Salmon-Carmacks First Nation traditional territory, and is located immediately adjacent to the Ta'an Kwäch'än Council settlement block R-8B.

2.2 Site History

The Facility is currently being used as a transfer station serving between 10 and 15 users from the Braeburn and Fox Lake cottage areas, and is operated by the Government of Yukon Department of Community Services. The Facility was converted to an unattended transfer station that is open to the public 24 hours a day seven days a week on August 16, 2011. Only domestic waste is accepted at this Site (*i.e.*, no batteries, appliances, special waste, *etc.*). Site management has been contracted to a private company that provides transportation of domestic waste and recyclables. The contractor uses a site checklist to ensure that basic maintenance occurs every two weeks.

According to the Solid Waste Operating Plan, the Facility was receiving residential, commercial, and demolition waste type wastes in 2008. A burn cell and waste trench were used for waste disposal at the Site. The domestic waste trench had a reported capacity of approximately 500 m^3 and it was estimated that 60 percent of the original capacity remained. Reclamation of the existing burn cell reportedly occurred in accordance with the Department of Environment's reclamation procedures, and the trench was covered sometime between 2008 and the initial Site visit by Golder in 2011. Another garbage burial site (open from 1995 to 1999) is adjacent to the covered domestic garbage trench (Figure 2).

3.0 METHODOLOGY

3.1 Preliminary Hydrogeological Assessment

The preliminary hydrogeological assessment involved a desk-top review and interpretation of existing information followed by an inspection of the Braeburn Solid Waste Disposal facility. The initial inspection of the facility was conducted on October 18, 2011 and a follow-up inspection was completed on June 7, 2012. The purpose of the preliminary hydrogeological assessment was to identify the appropriate drilling methods and equipment, and potential well locations for the installation of a monitoring well network. This portion of the work included the following three tasks:

- Compilation and review of available information;
- Assessment and interpretation of available hydrogeological data; and
- Development of a conceptual hydrogeological model.

Results of the preliminary hydrogeological assessment are documented in our report entitled “Braeburn Solid Waste Disposal Facility: Background Research and Facility Assessment Plan” dated June 7, 2012.

3.1.1 Data sources

The following references were used for compilation and review of information available for the Site:

- Access Consulting Group and G. J. Bull and Associates Inc., Solid Waste Management Plan – Braeburn. Prepared for Yukon Community Services, Community Development Branch. 2003.
- Bond, J.D. and Lipovsky, P.S., 2011. Surficial geology, soils and permafrost of the northern Dawson Range. In: Yukon Exploration and Geology 2010, K.E. MacFarlane, L.H. Weston and C. Relf (eds.), Yukon Geological Survey, p. 19-32.
- Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.
- Environment Canada, Meteorological Service of Canada Last Modified 2011-11-16, Website: http://www.climate.weatheroffice.ec.gc.ca/climate_normals/Canadian Climate Normals or Averages 1971 2000.
- Fetter, C. W., Applied Hydrogeology, Third Edition, PRENTICE HALL, New Jersey. 1994.
- Geological Survey of Canada. Geology, Braeburn, Yukon Territory, 1997.
- Government of Yukon, Department of Community Services, Solid Waste Operation Plan: Braeburn, Prepared for Yukon Government Community Services, Community Infrastructure Branch. 2008.

- Government of Yukon. Environment Act Contaminated Sites Regulation. O.I.C. 2002/171. Schedule 3-Generic Numerical Water Standards for Protection of Freshwater Aquatic Life and Drinking Water.
- Government of Yukon, Yukon Environment, Protocol for the Contaminated Sites Regulation Under the Environment Act. 2011.
- Government of Yukon, Yukon Geological Survey, YGS MapMaker Online Website: http://maps.gov.yk.ca/imf.jsp?site=YGS
- Government of Yukon, Yukon Mining and Lands Viewer Website: http://maps.gov.yk.ca/imf.jsp?site=miningLands
- Government of Yukon, Yukon Water, Water Data Catalogue Website: http://yukonwater.ca/MonitoringYukonWater/WaterDataCatalogue/
- Government of Yukon, Department of Environment, Compiled from The Yukon Water Well Registry Summary of Yukon Water Wells, May 11, 2006- Website: http://www.env.gov.yk.ca/monitoringenvironment/hydrology.php
- Klassen, R.W., and Morison, S.R., 1987. Surficial geology, Laberge, Yukon Territory, Geological Survey of Canada, Map 8-1985, scale 1:250,000.
- Natural Resources Canada, Groundwater Information Network Website: http://ngwd-bdnes.cits.nrcan.gc.ca/service/api_ngwds:gin/en/wmc/aquifermap.html
- Site inspection of October 18, 2011.

3.1.2 Site Inspection

Prior to the Facility reconnaissance, Golder developed a Facility-specific health and safety plan (HASP) for implementation during the work. The health and safety plan included a description of the potential hazards that could be encountered during the Facility reconnaissance and proposed mitigation.

No evidence of chemical or fuel storage, above or below ground tanks, spills or discharges or hazardous materials storage were observed during the reconnaissance. No Site utilities or existing water wells were observed at the Facility. Selected photographs of the Facility were taken during the reconnaissance and are presented in Appendix A.

3.1.3 Background Geological Information Sources

Geological information was obtained through a review of topographic and geological maps from the Department of Energy Mines and Resources Canada, and through the Canadian Geological Survey. Additional data on the subsurface of the surrounding area was obtained through the online Groundwater Information Network (GIN), provided by Natural Resources Canada (NRCAN), and the Yukon Water Well Registry. A search of the Yukon Water online Data Catalogue did not identify water testing results within the vicinity of the Facility.

3.1.4 Contaminated Sites Registry

A Site Registry search was conducted by Yukon Environment on December 1, 2011. The search identified no contaminated sites files or spill reports for the Watson Lake Solid Waste Disposal Facility; however, it was noted that the Facility does not have any analytical results in the file to compare against Yukon CSR standards to determine if any contamination exists. It was also noted that the Facility was largely unmonitored and that there was opportunity for improper disposal or spillage of contaminants during its operation.

3.1.5 Review of Waste Management Permit and Waste Management Plan

Waste Management Permit 80-009 was issued on February 29, 2012 for the Facility. It states that the Facility is to be operated in compliance with any applicable requirements in federal, territorial, and municipal legislation including the Environment Act and Solid Waste Regulations.

Monitoring requirements set out in Waste Management Permit 80-009 include:

- Monitor water levels and collect water samples from groundwater monitoring wells at the Facility twice a year (spring and late summer).
- Sample down gradient surface water bodies concurrently with the groundwater sampling.
- Analyze water samples at a laboratory that is accredited as conforming to ISO/IEC 17025 by an accrediting body that conforms to ISO/IEC 17011 standards.
- Submit monitoring results to Environment Yukon by January 31st each year.

A summary of the facility permits and groundwater monitoring requirements for the Site are summarized in Table 1 below.

Table 1: Summary of Waste Disposal Facility Permits and Groundwater Monitoring Requirements

Site	Site Disposal Facility Permit Number	Permit Type	Solid Waste Management Plan	Required Groundwater Monitoring
Braeburn Solid Waste Disposal Facility	80-009	Transfer Station	Community Services YG (2008)	Twice Per Year

3.1.6 Review of Environment Yukon Information

Golder reviewed documents pertaining to the Beaver Creek Facility on the Yukon Environment and Socioeconomic Board (YESAB) online registry on October 3, 2012. Documents reviewed included: the most current waste facility permit issued for the Facility, the most current Solid Waste Operation Plan, and the YG Environment Decision Document.

3.2 Field Investigations

3.2.1 Scope of Field Investigations

The scope of the field investigations included the following:

- Three on-site groundwater monitoring wells were drilled and installed by Midnight Sun Drilling under the supervision of Golder Associates between June 7 and 16, 2012.
- The wells were developed and sampled by Golder Associates on July 30, and 31, 2012. The water levels in each well were measured prior to purging and sampling, and physiochemical parameters were monitored at each well during development and sampling. Groundwater samples were sent to ALS Environmental Laboratory in Whitehorse, YT for analysis.
- BN-MW12-02 could not be developed or sampled. It was bailed dry and had not recovered by the following day.
- A single well response test (slug test) was carried out on one well (BN-MW12-01) to assess hydraulic conductivity within the bedrock aquifer.
- Results of field and laboratory data are summarized and are interpreted in this report.

3.2.2 Groundwater Monitoring Well Network

Groundwater monitoring well installation was undertaken at the Braeburn Solid Waste Disposal Facility in general accordance with Yukon Contaminated Site Regulation Protocol (Yukon Environment, 2011).

Three (3) groundwater monitoring wells were proposed for installation at the Site to characterize groundwater conditions underlying the waste disposal facility. BN-MW12-02 and BN-MW12-03 were installed with the intent to assess groundwater quality downgradient of the landfill, while BN-MW12-01 was targeted to characterize up-gradient groundwater conditions. Locations of the monitoring wells (Figure 2) were selected based on aerial photography, review of Site history, Site topography and suspected groundwater flow direction, and a Site inspection.

The drilling and monitoring well installation was completed by Midnight Sun Drilling of Whitehorse, Yukon under the direction of Golder Associates from June 7 to 16, 2012. Specifics for each well are listed below:

- BN-MW12-01 was installed on the northeast corner of the Site and advanced to a depth of 63.1 m below grade (m bg);
- BN-MW12-02 was installed on the southwest edge of the Site and advanced to approximately 49.4 m bg; and
- BN-MW12-03 was installed on the southeast edge of the Site and advanced to approximately 23.6 m bg.

All wells were installed using a Driltech Marlin 5 truck-mounted air rotary drill rig.

The locations of newly installed wells were obtained using a Trimble handheld GPS to an accuracy of 0.5 m or better for horizontal control. Elevations of the top of casing (TOC) for all wells were obtained by level survey relative to two legal survey posts at the Facility, with 1 cm accuracy. A site plan showing the monitoring well locations and key Site features is provided in Figure 2. Grab samples of drill cuttings were taken at regular intervals to log the lithology encountered in each borehole. Borehole logs documenting observed lithology along with well construction details are provided in Appendix B, with a summary of well construction details provided in Table 2. Saturated zones were encountered at varying depths throughout the Site, indicating varying hydrogeological conditions. The following is a summary of the depth of saturated zones that were encountered:

- At BN-MW12-01, bedrock was encountered at a depth of 16 m bg. A fractured bedrock confined water-bearing unit was encountered at approximately 61.6 m bg. No surficial water-bearing zone was identified in the overlying sediments, although the potentiometric surface in the bedrock aquifer rose in the well above the bedrock/sediment interface. Casing could not be withdrawn past a depth of 15.4 m and was left overlapping the well screen.
- At BN-MW12-02, bedrock was encountered at an approximate depth of 17.4 m and was drilled to a depth of 49.4 m without encountering groundwater. However, a monitoring well was installed in bedrock at this depth, and when developed, BN-MW12-02 contained approximately 2.9 m of water, indicating that it was likely installed in a low permeability water-bearing zone. It is not known whether this represented static conditions or whether the water level at the time of measurement was still recovering in the well.
- At BN-MW12-03, bedrock was encountered at an approximate depth of 17.4 m, and the borehole was drilled to a total depth of 49.4 m, with the subsequent installation of a monitoring well. Groundwater was not present at the time of installation; however, when the well was developed, it contained 2.1 m of water. The borehole was partially backfilled with bentonite so that the well could be screened at the interface between bedrock and unconsolidated sediments. The completion may allow the well to act as a sump within the top of the bedrock, catching perched groundwater that was ponding on the contact between the unconsolidated sediments and bedrock.

Installation details are included on the borehole logs in Appendix B. Typical monitoring well completion details for all three wells included:

- Monitoring wells were completed with flush-threaded, 50 mm Schedule 40 PVC casing;
- A 3 m long PVC, factory-slotted well screen (10-slot) was installed in all three monitoring wells;
- PVC casing was installed above the well screen to about 0.80 m above grade;
- A silica sand filter pack was used to fill the annulus between the PVC well screen and the borehole wall. The sand pack was extended approximately 1.5 m above the top of the screened interval;
- A bentonite chip seal, approximately 1.5 m thick, was placed directly above the sand pack. The remainder of the annulus was filled with bentonite well grout;

- Each well was covered with a PVC end-cap, and a lockable steel protective casing was installed to protect the wellhead; and
- BN-MW12-01 and BN-MW12-03 were developed by removing a minimum of three well volumes using dedicated Waterra™ tubing and a Hydrolift™ pump or hand bailer. BN-MW12-02 was bailed dry and left to recover. Development logs are provided in Appendix C.

Table 2: Well Construction Details

Well ID	Drilled Depth (mbg)	Water-Bearing Unit	Well Casing Diameter (mm)	Screened Interval (m bg)	Filter Pack Interval (m bg)
BN-MW12-01	63.1	Bedrock	50	60.0 – 63.1	59.1 – 63.1
BN-MW12-02	49.4	Bedrock	50	46.6 – 49.4	43.3 – 49.4
BN-MW12-03	23.6	Bedrock/Overburden	50	17.4 – 18.9	17.4 – 18.9

3.2.3 Monitoring Well Surveying

Golder surveyed the vertical elevation of the top of the PVC wellhead (measuring point) for each well on June 16, 2012. Monitoring well elevations were obtained via level survey relative to two benchmarks (1L1063 and 4L1063), for which vertical elevation had been previously surveyed (Quest Engineering, 2006). Horizontal position of wells was obtained using a handheld Trimble GPS system with an accuracy of approximately 0.5 m. Table 3 presents a summary of survey data and water-level measurements.

Table 3: Monitoring Well Locations and Groundwater Elevations from the Monitoring Event on July 30 and 31, 2012

Well ID	GPS Location	Top of PVC Casing Elevation (masl)	Static Water Level (mbtoc[1])	Groundwater Elevation (masl)
BN-MW12-01	6811541.4 m N 459490.2 m E	756.09	10.52	745.57
BN-MW12-02	6811482.6 m N 459443.5 m E	755.09	47.77	707.32
BN-MW12-03	6811477.8 m N 459483.3 m E	755.90	17.76	738.14

3.2.4 Groundwater Monitoring Event

Monitoring wells BN-MW12-01 and BN-MW12-03 were developed and sampled by Golder on July 30 and 31, 2012, approximately six weeks after installation. Due to logistical constraints, the wells could not be developed immediately following installation. Although BN-MW12-02 contained water at the time of this event, it could not be properly developed or sampled due to a slow hydraulic response in the well (easily bailed dry).

[1] Mbtoc = meters below top of casing

The procedure used for sampling followed Contaminated Sites Regulation Protocol No. 7. Prior to and during development/purging of each well, a water level was measured in each well with an electronic measuring tape. Between 3 and 10 well volumes were purged from each well using 5/8" high density polyethylene (HDPE) Waterra™ tubing, a foot valve, and a Hydrolift™ pump or a HDPE hand bailer, prior to a sample being obtained. During purging, physiochemical parameters (pH, temperature, electrical conductance (EC)) were collected at regular intervals using a Hanna Instruments HI 991300 multi-meter, and purging continued until field parameters were stable before sampling. Groundwater Development and Sampling Datasheets are presented in Appendix C. In addition to the three groundwater monitoring wells sampled, a surface water sample from the nearest potential down gradient receptor was acquired during the sampling event. The nearest downgradient receptor was determined to be a small creek running into Braeburn Lake, located approximately 660 m to the west of the Site (Figure 1).

Sample containers and appropriate preservatives were obtained from ALS's Whitehorse laboratory. Samples for dissolved metals were field-filtered using 0.45-micron, in-line filters and preserved with nitric acid. All samples were kept in coolers with ice packs prior to their delivery to ALS's Whitehorse laboratory within appropriate holding times. ALS's laboratory is certified by the Canadian Association for Laboratory Accreditation and is accredited as conforming to ISO/IEC 17025 for analysis.

3.2.5 Rising Head Hydraulic Response Test

A single well hydraulic response (slug) test was performed on BN-MW12-01 on July 31, 2012 to assess the hydraulic conductivity of the bedrock aquifer underlying the Site. The slug test was performed using a solid 38 mm diameter PVC slug and a Solinst Levelogger electronic pressure transducer set to measure head fluctuations at one-second intervals. Manual water-level measurements were also recorded throughout the test.

Hydraulic response tests could not performed at BN-MW12-02 and BN-MW12-03, due to very slow response times; days and hours respectively.

3.3 Laboratory Analysis

Parameters included in the laboratory analysis of groundwater and surface water samples collected from the Braeburn Solid Waste Disposal Facility are summarized in Table 3. This list of parameters is in compliance with the Facility's Solid Waste Disposal Permit (Permit No. 80-009). Sampling and analysis of groundwater samples were undertaken in general accordance with Yukon Contaminated Site Regulation Protocols 2 and 5 (CSR, 2011).

Table 4: Parameters Sampled for – July 2012

Sample ID	General Parameters	Nutrients	Dissolved Metals	PAH & BTEX	DOC
BN-MW12-01	√	√	√	√	√
BN-MW12-03	√	√	√	√	√
Surface Water	√	√	√	√	√

3.3.1 Quality Assurance / Quality Control

The following section provides a detailed description of the Quality Assurance (QA) and Quality Control (QC) measures taken by Golder to ensure the accuracy and integrity of groundwater quality sample analysis.

The following table provides a summary of QA/QC measures and an evaluation of the ability to uphold standards.

Table 5: Review of QA/QC Procedures Taken

QA/QC Aspect	Evidence and Evaluation
Data Representativeness	
Sample Integrity	All samples were kept at the appropriate temperature and delivered to the laboratory within the appropriate holding times.
Background Samples	BN-MW12-01 was installed as an up gradient well of the Facility and is used to provide background levels of physiochemical parameters.
Field Procedures	Monitoring wells were developed and sampled using dedicated tubing. All equipment used in multiple wells was decontaminated using soap (Alconox™) and distilled water. Surface water samples were collected using one-time-use syringes.
Calibration of Field Equipment	Calibration of field equipment was undertaken daily, prior to sampling wells.
Data Precision and Accuracy	
Blind Duplicate	One blind duplicate was collected from WL-MW12-01 during the May 2012 groundwater monitoring event. Of the 112 analyte pairs tested, RPD values could not be calculated for 83 of the pairs as both values tested below the laboratory method detection limit (MDL). Of the remaining pairs tested only three analytes (nitrate, nitrite, and total Kjeldahl nitrogen) exceeded the RPD acceptance criteria of ±30%. These exceedances are considered to be generally minor and related to the poor reproducibility of the analytical methods at low analyte concentrations. RPD calculations are presented in Report # 1114360073-1400 Appendix E
Trip Blanks	A trip blank was not collected during the May 2012 groundwater monitoring event.
Laboratory Internal QA/QC	Laboratory QA/QC is detailed in the primary laboratory report (Appendix E). Overall, the primary lab showed acceptable testing frequency and results for the method blanks, laboratory duplicates and matrix spikes.
Holding Times	All maximum holding times were met as required by ASTM, laboratory, and Golder best practice standards.
Laboratory Detection Limit	Laboratory reports indicate that detection limits were below the standards required for this assessment.
Completeness of test program	All wells were sampled in accordance with the Site Assessment and Work Plan criteria.
Validity of Data Set	The data quality review indicates no significant systematic errors in the data collection or analysis process for groundwater. The results of laboratory internal QA/QC and analysis of blind duplicates were acceptable, and therefore, the data set is considered valid and complete for use as the basis for groundwater assessment.

3.4 Application of Applicable Water Quality Standards

In accordance with the Government of Yukon's solid waste facility monitoring requirements, groundwater wells and the nearest surface water receptor were sampled and tested for the following parameters:

- Major ions (Ca, Mg, Na, K, Cl, SO4, N, NO2, NO3 and P)
- Dissolved Metals
- Mercury
- Hardness
- Alkalinity
- Carbonate
- Bicarbonate
- pH
- Total dissolved solids
- Ammonia
- Dissolved organic carbon
- Chemical oxygen demand
- Total Kjeldahl Nitrogen
- EPHw10-10 & VHw6-10
- BTEX
- PAHs

Groundwater and surface water analytical results were compared to the Yukon CSR water quality standards, or to the Canadian Environmental Quality Guidelines for analytes in which no Yukon standard was available.

The four types of water uses outlined in the CSR, the relevant water quality standards, and their applicability to this assessment are presented in Table 6.

Table 6: Applicable Water Quality Standards

Water Use	Applicable Water Quality Standard	Applicable Plume Radius (km)	Applicability to Assessment
Aquatic Life	Schedule 3 – Contaminated Sites Regulation (O.I.C. 2002/171)	1	Applicable
Drinking Water	Schedule 3 – Contaminated Sites Regulation (O.I.C. 2002/171)	1.5	Applicable
Irrigation	Schedule 3 – Contaminated Sites Regulation (O.I.C. 2002/171)	1.5	Not Applicable
Livestock	Schedule 3 – Contaminated Sites Regulation (O.I.C. 2002/171)	1.5	Not Applicable

The following discusses the applicability of each water quality standard to the Facility.

Aquatic Life

Aquatic life standards are applied here primarily due to the Facilities proximity to a small creek and wetland approximately 650 m to the east of the Site within the 1 km radius required by the CSR. It was determined, therefore, that aquatic life standards were applicable for the Braeburn Facility.

Drinking Water

A search of drinking water wells on the Groundwater Information Network website (accessed July 10, 2012) showed no drinking water wells located along the predicted down gradient flow path between the Site and the Braeburn Facility, nor in any other area within a 1.5 km radius of the Site. In addition, multiple visits to the Site and review of Google Earth Images from 2012 showed no residences within a 1.5 km radius. However, a review of the solid waste operations plan for the Site indicated that the nearest dwelling used for human habitation was approximately 1 km to the south of the Site, which is within the 1.5 km limit specified by the Yukon CSR. It was therefore concluded that Yukon CSR drinking water standards were applicable for the Braeburn Facility.

Irrigation and Livestock

A review of the Summary of Yukon Water Wells, compiled from The Yukon Water Well Registry, reviewed by Golder on July 10, 2012, showed no irrigation wells or wells for livestock on record for the Braeburn area. It should be noted that this is not a complete record of all wells in the Yukon, and it is possible that there are irrigation wells or wells for livestock use in the area.

A review of Google Earth Images from 2012, conducted by Golder on July 26, 2012, as well as several visits to the Facility conducted in May and July 2012 showed no agricultural land or active livestock or livestock facilities within 1.5 km of the Site. It is therefore concluded that CSR water quality standards for irrigation and livestock are not applicable to the Braeburn Facility.

4.0 CONCEPTUAL HYDROGEOLOGICAL MODEL

4.1 Setting

The Facility is located at an elevation of approximately 760 m above mean sea level (amsl) and lies within the Braeburn Lake watershed. A cleared area is present at the Facility. Site topography slopes gradually to the West. Surficial deposits are characteristic of glacial outwash plain and terraced glaciofluvial sand and gravel deposits. Regional topography around the Site slopes to the northwest towards Braeburn Lake (elevation 695 m amsl).

4.2 Climate

Climate data at the Braeburn climate station (Climate ID 2130167), located approximately 5 km north of the Facility at an elevation of approximately 716.3 m amsl, were used to assess climatic conditions at the Site. Average monthly precipitation reported at the Braeburn station ranges from a low average of 5.5 mm in April to a high average of 58.5 mm in July. The average annual precipitation is approximately 280 mm, including 94.3 cm as snowfall. Temperature ranges from a low average of -21.2°C in January to a high average of 13.6°C in July (Environment Canada, 2011).

Annual precipitation is relatively low (less than 300 mm per year) and would therefore indicate that the degree of infiltration of precipitation through buried waste and into the subsurface soils is relatively low. With a significant portion of the precipitation occurring in the form of snow, and given the relatively cold climate, little infiltration would be expected during the winter months. The greatest potential for infiltration of water through the waste is during spring snow melt; however, a significant portion of the water from snow melt would typically occur as surface runoff during this period.

4.3 Geology and Hydrogeology

4.3.1 Geological Framework

The southern Yukon, including the Braeburn area, has undergone several episodes of glaciation, the most recent being the Quaternary McConnell glaciation (Figure 3, Regional Geology). During that period, sediments such as glacial till, glaciofluvial sediments, and glaciolacustrine sediments were deposited, especially in low elevation areas such as the Braeburn Lake area.

Surficial geology maps published by the Yukon Geological Survey (YGS) indicate natural surficial material at the Facility is representative of glacial outwash plain and terraced glaciofluvial material deposited directly by glacial ice and meltwater, respectively. In general, deposits consist of well compacted to non-compacted material that contains a mixture of sediment particle sizes, and is commonly in a matrix of gravel, sand and silt, supporting cobbles and boulders. The thickness of the unconsolidated sediments was estimated by Klassen (1978) to be between 5 m and 50 m.

Bedrock geology at the Site is mapped as being the Lower Jurrasic Nordenskiold dacite tuff with massive sandstone and interbedded conglomerate.

4.3.2 Principal Regional Aquifers

Regional groundwater occurs in water bearing zones composed of two geological units; a surficial aquifer consisting of permeable unconsolidated materials, and a fractured bedrock aquifer. The surficial aquifer unit is recharged directly from infiltration. Although a very thin groundwater zone was present in BN-MW12-03, perched on top of the bedrock, the unconsolidated sediments underlying the Site appear to be mostly unsaturated. Groundwater was present in fractured bedrock at a depth of 45.6 m in BN-MW12-01 and at a depth of approximately 48 m in BN-MW12-02. Although the groundwater present in these wells would be consistent with the depth of the regional bedrock aquifer, the permeability of the bedrock unit underlying the Site appears to be low at the locations drilled.

For the purpose of this report, aquifer units have been named the Surficial Aquifer and the Regional Bedrock Aquifer for ease of reference.

Table 7 Aquifer Units Encountered at the Site

Unit	Location	Material	Comment
Surficial Aquifer	BN-MW12-03	Unconsolidated glacial outwash	▪ Perched on bedrock surface at one location only; surficial aquifer not apparent.
Regional Bedrock Aquifer	BN-MW12-01 BN-MW12-02	Fractured rock	▪ Deep regional flow in this aquifer ▪ Fed by infiltration in outcrop areas and through lateral and vertical flow from the overlying surficial sediments.

4.4 Groundwater Flow Systems

4.4.1 Regional Groundwater Flow

It can be inferred from the Site topography that regional groundwater likely flows from the mountains (elevation approximately 1100 m amsl) that are located to the east of the Site, in a northwest direction towards Braeburn Lake (elevation approximately 700 m amsl). Groundwater recharges the bedrock aquifer through infiltration of rainfall through surficial sediments and exposed outcrops. Regional groundwater flow occurs mainly through fractures in bedrock and to a lesser extent through unconsolidated sediments where the bedrock aquifer is hydraulically connected to surficial units. Regional groundwater flows towards Braeburn Lake or to one of the numerous creeks draining into Braeburn Lake.

4.4.2 Local Groundwater Flow

There was no identifiable surficial aquifer underlying the Site at the time of well installation in June 2012 or during the monitoring event in July 2012. Only a thin water-bearing zone, between 0 m and 0.5 m in thickness and conforming closely to the top of bedrock, was observed during drilling at BN-MW12-03. The areal extent of this water-bearing zone is not known, although it was not observed at BN-MW12-01 and BN-MW12-02. However, it should be considered a primary initial pathway for leachate migration, in particular, at the location of well BN-MW12-03.

Golder used the groundwater depth data from July 2012 and well survey elevation information collected in June 2012 to calculate the groundwater elevation at each monitoring well. The water-level measurements and groundwater elevations from July 30-31, 2012 are presented in Table 3. Hydraulic gradient and groundwater flow direction underlying the Site could not be ascertained from the monitoring well network because of varying potentiometric surfaces and wells completed at different stratigraphic depths. Based on Site topography, the local groundwater flow direction appears to be to the west, with a maximum hydraulic gradient of approximately 0.05 m/m.

Shallow groundwater underlying the Site likely discharges to a small creek located 600 m to the west and directly downgradient; therefore the creek should be considered a primary receptor.

4.5 Hydraulic Response Tests

Golder Associates conducted a rising head slug test on BN-MW12-01 in July 2012. The slug test was analyzed using AQTESOLV version 4.5 software and the results are included in Appendix D. The following is a summary of the findings.

Table 8: Estimated Hydraulic Conductivity

Monitoring Well ID	Primary Hydrogeological Unit	Solution Used	Estimated Hydraulic Conductivity (m/s)
BN-MW12-01 (Rising Head)	Fractured Rock	Bouwer-Rice (1976)	6×10^{-6}

As shown in Table 8, hydraulic conductivity at well BN-MW12-01 was estimated, using the Bouwer-Rice (1976) analytical solution for confined aquifers, to be approximately 6×10^{-6} m/s, which is a reasonable estimate for a fractured bedrock aquifer (Fetter, 1994).

4.6 Estimated Linear Groundwater Velocity

Average linear groundwater velocities can be estimated in aquifers where the hydraulic gradient is known, and where hydraulic conductivity can be estimated. However, at this Site, an estimated hydraulic conductivity is only available for the bedrock aquifer, as the overburden was mostly unsaturated. In addition, the hydraulic gradient was estimated from surface topography only and could not be determined from the installed wells since they were screened in different hydrostratigraphic units. Therefore, there is insufficient information available to estimate the linear groundwater velocity underlying the Site.

4.7 Potential Contamination of Groundwater and Transport Mechanisms

Potential sources and transport mechanisms of groundwater contamination are evaluated based on the Site history, Site inspections, hydrogeological investigations and contaminant transport principals. Potential sources include:

- Leachate from present and former domestic waste, commercial waste, and any other waste disposed at the Facility. Potential contaminants leaching from these sources include: heavy metals, nutrients (NO_3, NH_3), organic hydrocarbons (Fuels, PAHs, chlorinated hydrocarbons), and salts.
- Leakage and spillage from on-site hydrocarbon storage areas.

No off-site sources of pollution have been identified in this report.

Transport mechanisms that may act on these sources of contamination and cause potential contamination of downgradient receptors include:

- Percolation of precipitation from the surface, through the unsaturated zone, and into the saturated zone. This includes interflow, or flow of water through the unsaturated zone.
- Transport of contaminants within the saturated zone (aquifer) to other downgradient locations.

5.0 GROUNDWATER IMPACT ASSESSMENT

5.1 Review of Groundwater Chemistry

As discussed in section 3.2.4, one round of groundwater monitoring was conducted on two of the three newly installed wells and one surface water location at the Braeburn Solid Waste Disposal Facility on July 30 and 31, 2012. Chain-of-custody forms for the groundwater samples collected, along with the complete groundwater chemistry results and QA/QC data can be found in Appendix E. Table 9 summarizes important parameters from the groundwater chemistry results that can be used to identify potential leachate contamination.

Table 9: Important Groundwater Chemistry Results

Sample Location	Total Dissolved Solids (mg/L)	Chloride (mg/L)	Ammonia (mg/L)	Sulphate (mg/L)	Dissolved Organic Carbon (mg/L)
BN-MW12-01	1900	<0.10	0.692	866	1.68
BN-MW12-03	1170	11.4	0.116	594	14.7
Surface Water	520	1.52	0.0152	164	6.96

Total Dissolved Solids

Total dissolved solids (TDS) is a measurement of the total amount of dissolved organic and inorganic material contained within a liquid. Elevated TDS can indicate the presence of groundwater contamination caused by, for example, landfill leachate. Typically, major ions that can comprise TDS include: NO_3, NH_3, Na, K, Mg, Ca, SO_4, Cl, and HCO_3.

Values of TDS in the monitoring well samples ranged from 1,170 mg/L to 1,900 mg/L across the Site. TDS content of the surface water sample was lower (520 mg/L) than concentrations in all of the monitoring well samples. Surface water typically has lower TDS concentrations compared to groundwater because of lower residence times and dilution from direct recharge of rainwater or runoff.

Dissolved Organic Carbon

Dissolved organic carbon (DOC) concentrations can be elevated by the presence of leachate originating from decomposed organic matter. Levels associated with landfill leachate can be in the hundreds or thousands of mg/L.

Dissolved organic carbon concentrations at all wells at the Braeburn Site were relatively low, and within values expected for natural background groundwater chemistry. DOC levels were highest in BN-MW12-03 (14.7 mg/L), and lowest in BN-MW12-01 (1.68 mg/L). The slight elevation of DOC in BN-MW12-03 may indicate the presence of minor leachate at this well, but it is also reasonable that this could be the result of natural variation in groundwater chemistry.

Chloride

Chloride is often used as a tracer for anthropogenic influence on groundwater. Elevated chloride levels are associated with a number of sources including sewage, leachate, and road salting. In the case of landfills, elevated chloride might be expected due to degradation of waste with high chloride concentrations. Chloride levels from the monitoring well network ranged from non-detect in BN-BH12-01 to 11.4 mg/L in BN-BH12-03, which is considered reasonable for natural variation in groundwater chemistry.

Ammonia

Ammonia is a typical landfill leachate indicator. Low levels of ammonia were detected in both of the monitoring wells sampled and the surface water sample. Values ranged from 0.0152 mg/L in the surface water sample to 0.692 in BN-MW12-01, which is considered reasonable for natural variation in groundwater chemistry. Levels were well below the limit for ammonia defined by the CSR standard for freshwater aquatic life.

Metals

Concentrations for iron (0.965 mg/L), magnesium (112 mg/L), manganese (0.0527 mg/L) and sodium (202 mg/L) all exceeded the Yukon CSR standards for drinking water in BN-MW12-01. The concentration of manganese (1.84 mg/L) exceeded the Yukon CSR standard for drinking water in BN-MW12-03. No metals concentrations exceeded CSR standards for freshwater aquatic life, and all were within what would be considered a reasonable range for naturally occurring groundwater. In general, metals concentrations were higher in BN-MW12-01.

Organics

Naphthalene and phenanthrene were present in low levels (0.000056 mg/L and 0.000103 mg/L, respectively, in BN-MW12-03). Both of these values are below the Yukon CSR standard for freshwater aquatic life. All other organics were non-detectable at all other sampling locations.

Sulphate

Sulphate concentrations in both BN-MW12-01 (996 mg/L) and BN-MW12-03 (594 mg/L) exceeded the Yukon CSR standard for drinking water of 500 mg/L. BN-MW12-01 is screened in a fractured bedrock aquifer at approximately 63 m bg, and is up-gradient of the facility. This suggests that elevated sulphate in both wells may be representative of background levels within the bedrock aquifer, and not due to landfill leachate.

5.2 Interpretation of Groundwater Chemistry

Four factors that may affect natural groundwater chemistry include:

- The source and chemical composition of recharge water;
- The lithological and hydrological properties of the geologic unit;
- The various chemical processes occurring within the geologic unit; and
- The amount of time the water has remained in contact with the geologic unit (residence time).

These factors may affect the type and quantities of dissolved constituents in groundwater. The ionic composition of water can be used to classify the water into ionic types based on the dominant cation and anion, expressed in milliequivalents per litre (meq/L). These can be compared for different water samples using various types of plots.

The ionic compositions of samples from the Site were compared to discern different water types by plotting the meq/L concentrations of the samples on three types of diagrams: a Schoeller plot (Figure 7), a Piper diagram (Figure 8), and a Stiff diagram (Figure 9).

- Schoeller: The Schoeller semi-logarithmic diagram (Figure 7) shows total concentrations of select cations and anions, and may be used to identify different water types. The Schoeller plot indicates that the groundwater chemistry from BN-MW12-03 and the surface water sample are similar, while the chemistry from BN-MW12-01 is slightly different, and most notably it is absent of chloride. The similarity in chemistry between BN-MW12-03 and the surface water sample provides evidence supporting the transport mechanisms (4.7) and shallow groundwater flow dynamics (4.4.2) described previously. The data also supports the concept of longer residence times in the regional fractured bedrock aquifer.
- Piper: The Piper diagram (Figure 8) illustrates that the groundwater and surface water samples have distinct water chemistry. Groundwater from BN-MW12-01 is classified as Mg-Na-Ca-SO4-HCO_3 type groundwater, groundwater from BN-MW12-03 is classified as Ca-Mg-SO_4-HCO_3 type water, and the surface water sample is classified as Ca-Mg-HCO_3-SO_4 type water.
- Stiff: A visual inspection of the Stiff diagram indicates differences between the groundwater and surface water samples. The primary differences are that the surface water sample is dominated by calcium, magnesium, and bicarbonate, while the groundwater samples are dominated by sulphate.

The presence of elevated DOC and organics at downgradient well BN-MW12-03, along with its position screened at the contact between the surficial aquifer unit and bedrock, suggests that this well may be slightly influenced by low levels of contamination from landfill leachate. Although no contamination was evident in the surface water sample, the lack of sodium and calcium over magnesium suggests that it is more influenced by a surficial flow system than the bedrock aquifer.

6.0 CONCLUSIONS

The following conclusions are made based on the results of the 2012 hydrogeological assessment:

- Stratigraphy and Hydrogeology:
  - Site stratigraphy was found to consist of approximately 17 m of glaciofluvial outwash deposits overlying bedrock of the lower Jurassic Nordenskiold formation, which is composed of dacite tuff.
  - A monitoring well network consisting of three wells was installed at the Braeburn Solid Waste Disposal Facility from June 7 to 16, 2012. Two of the three wells (BN-MW12-01 and BN-MW12-03) were developed and sampled on July 30 and 31, 2012. The third well (BN-MW12-02) could not be developed or sampled due to a slow hydraulic response in the well (easily bailed dry).
  - A fractured bedrock flow system was encountered at approximately 61.5 meters below grade (m bg), 29.1 m below the surficial/bedrock interface at BN-MW12-01. At BN-MW12-02, bedrock was encountered at 17.4 m bg and was completed to a depth of 49.7 m bg; groundwater was not encountered at the time of drilling. However, groundwater was present after well installation, and when the well was developed, it yielded a small amount of water, indicating it was installed in very low permeability bedrock. At BN-MW12-03, bedrock was encountered at 17.4 m bg. Well screen was installed in the borehole so that the screen intersected the unconsolidated sediment/bedrock interface. Although no water was observed during installation, sufficient water was present during development to develop and sample the well.
  - A single hydraulic response test was performed on well BN-MW12-01 on July 31, 2012. BN-MW12-01 is screened in a confined water-bearing unit approximately 30 m below the bedrock surface. The horizontal hydraulic conductivity of the fractured bedrock at this location was estimated to be approximately 6×10^{-6} m/s. Hydraulic conductivity could not be determined for the surficial aquifer, as overburden material at the Site is mostly unsaturated. The hydraulic gradient and groundwater flow direction underlying the Site could not be ascertained from the monitoring well network because of varying potentiometric surfaces and wells completed at different stratigraphic depths. Based on site topography, the local groundwater flow direction appears to be to the west, with a maximum hydraulic gradient of approximately 0.05 m/m.
- Groundwater Chemistry:
  - A water quality assessment was performed on water samples collected from BN-MW12-01 and BN-MW12-03, and a small creek located down gradient of the Site, during this first monitoring event. All samples showed acceptable levels of all chemical parameters as defined by the Yukon Contaminated Sites Regulation (CSR) criteria for freshwater aquatic life.
  - Iron (0.965 mg/L**)**, magnesium (112 mg/L), manganese (0.0527 mg/L), sodium (202 mg/L), and sulphate (966 mg/L) exceeded the Yukon CSR for drinking water in BN-MW12-01. Manganese (1.84 mg/L) and sulphate (594 mg/L) exceeded the Yukon CSR for drinking water in BN-MW12-03.
  - Detectable levels of naphthalene and phenanthrene were found in BN-BH12-03, but the concentrations were below CSR standards and may to be associated with oily waste stored and/or disposed of at the site.
  - Results of groundwater sampling performed on the monitoring well network and the creek, down gradient of the Site, showed either low or non-detectable levels of chemical parameters that are typically associated with leachate contamination. This suggests that leachate influence on groundwater at the Site has not had a noticeable impact at the time of this monitoring event.

7.0 RECOMMENDATIONS

The following recommendations are made based on the results of the 2012 hydrogeological investigation:

- As required by the Facilities Solid Waste Disposal Permit, water levels and water samples should be collected from the groundwater monitoring wells at the Facility twice a year (spring and late summer).
- Groundwater quality at the Facility should be revaluated following an additional round of groundwater monitoring to see if there is any presence of potential impacts from landfill leachate.
- The efficacy of BN-MW12-02 for sampling groundwater should be reevaluated, and the well should be replaced if low flow conditions persist.

8.0 CLOSURE

We trust that this draft report is adequate for your current needs. Should you have any questions or require any additional information, please contact the undersigned at your convenience.

GOLDER ASSOCIATES LTD.

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CB\GJH\GCP\jcc

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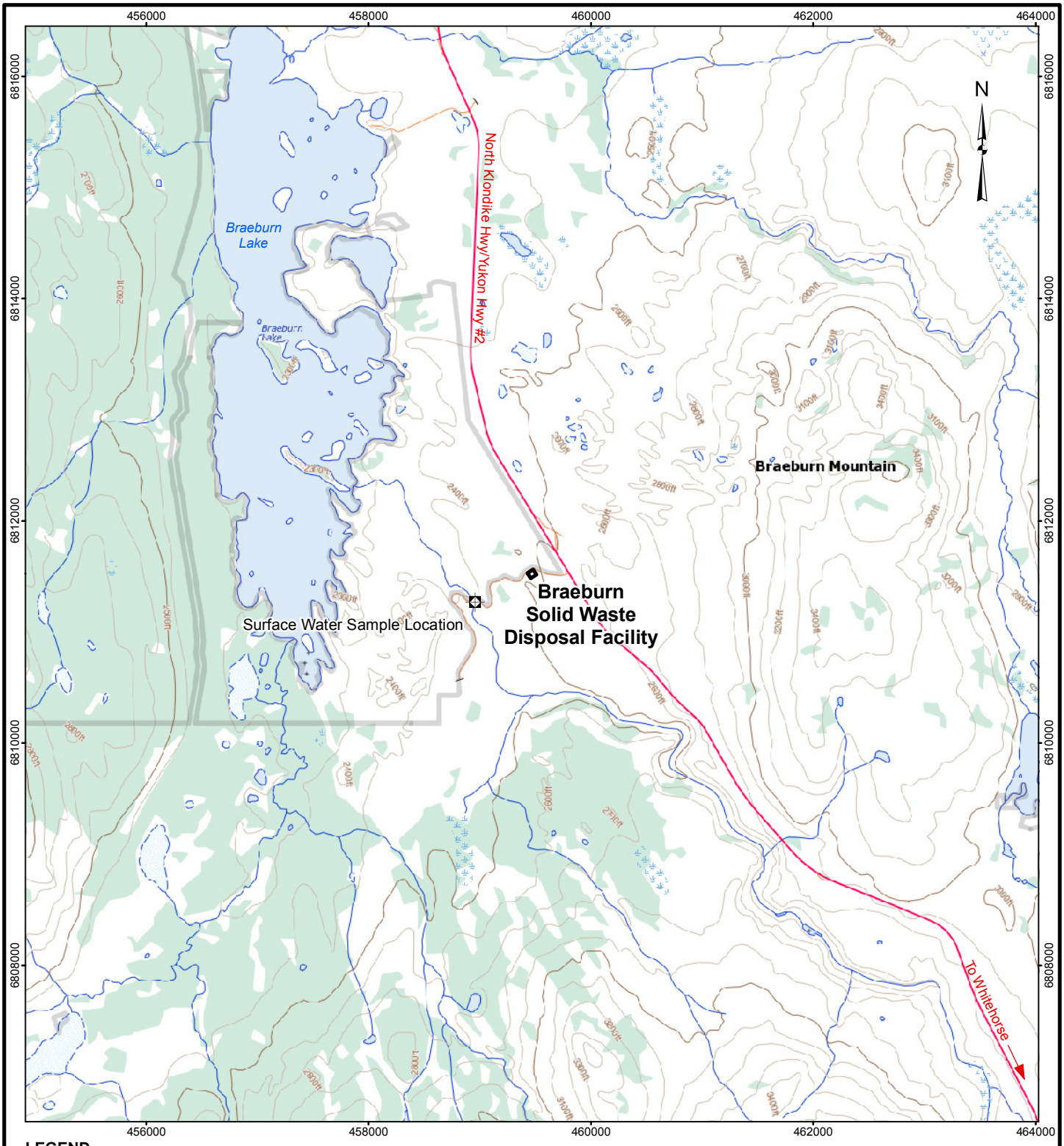

LEGEND

- FACILITY
- SURFACE WATER SAMPLE LOCATION

1 0 1

SCALE 1:50,000 KILOMETRES

PROJECT YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
BRAEBURN, YUKON

TITLE

KEY PLAN

REFERENCE

BASEDATA OBTAINED FROM GEOGRATIS (NATURAL RESOURCES CANADA).
DATUM: NAD83 PROJECTION: UTM ZONE 8

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.	11-1436-0073		PHASE No. 1600	
DESIGN	CB	27 Jul 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	16 Aug 2012		
CHECK				
REVIEW				

FIGURE: 1

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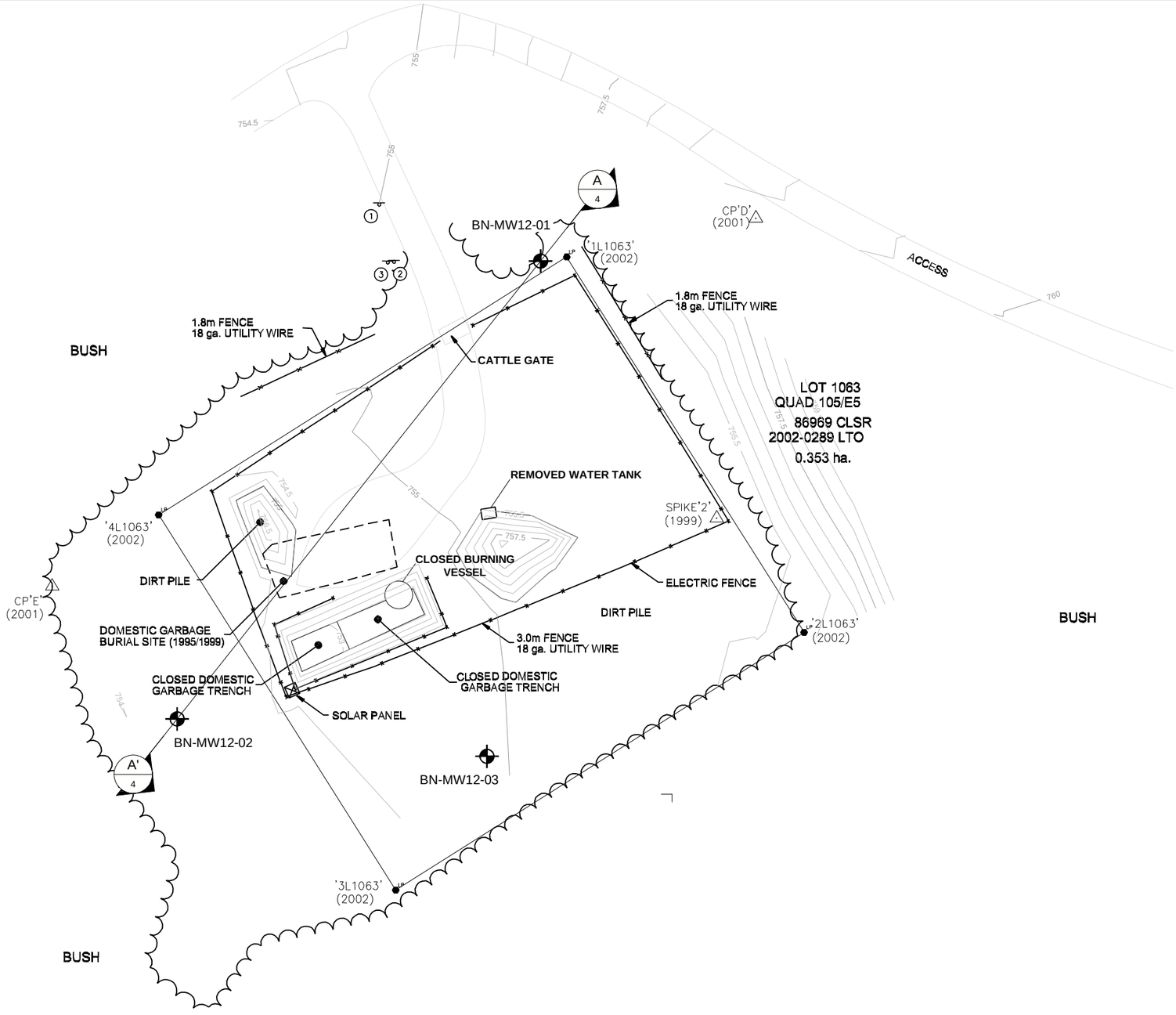

LEGEND

- FENCE
- EDGE OF CLEARING
- SHOULDER OF ROAD
- SURVEY CONTROL POINT/BENCHMARK
- LEGAL POST - IRON BAR
- LEGAL POST - '77
- LEGAL POST - '69
- SIGN
- MONITORING WELL LOCATION

REFERENCES

1. BASE PLAN PROVIDED BY QUEST ENGINEERING GROUP
   CAD FILE: BRAEBURN2006.DWG
   DATED:2006.11.07

NOTES

1. SITE PLAN IS NOT CONSISTENT WITH OBSERVED CONDITION DURING DRILLING, BUT IS INTENDED TO SHOW LOCATIONS OF NEWLY INSTALLED MONITORING WELLS IN RELATION TO BURIED STRUCTURES.

0 12 24 36m
1:600

PROJECT
YUKON GOVERNMENT-COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
BRAEBURN, YUKON

TITLE
SITE PLAN AND CROSS-SECTION LOCATION

Golder Associates

PROJECT No. 11-1436-0073			PHASE No.	1600-1660	
DESIGN	CB	20AUG12	SCALE AS SHOWN	REV.	–
CADD	TS	24AUG12			
CHECK					
REVIEW					

FIGURE 2

Drawing File: N:\Bur-Graphics\Projects\2011\1436\11-1436-0073\Drafting\Phase 1600\Task 1660\11-1436-0073-1600-1660-01-.dwg Wednesday, August 29, 2012 2:25:42 PM By: tsemino

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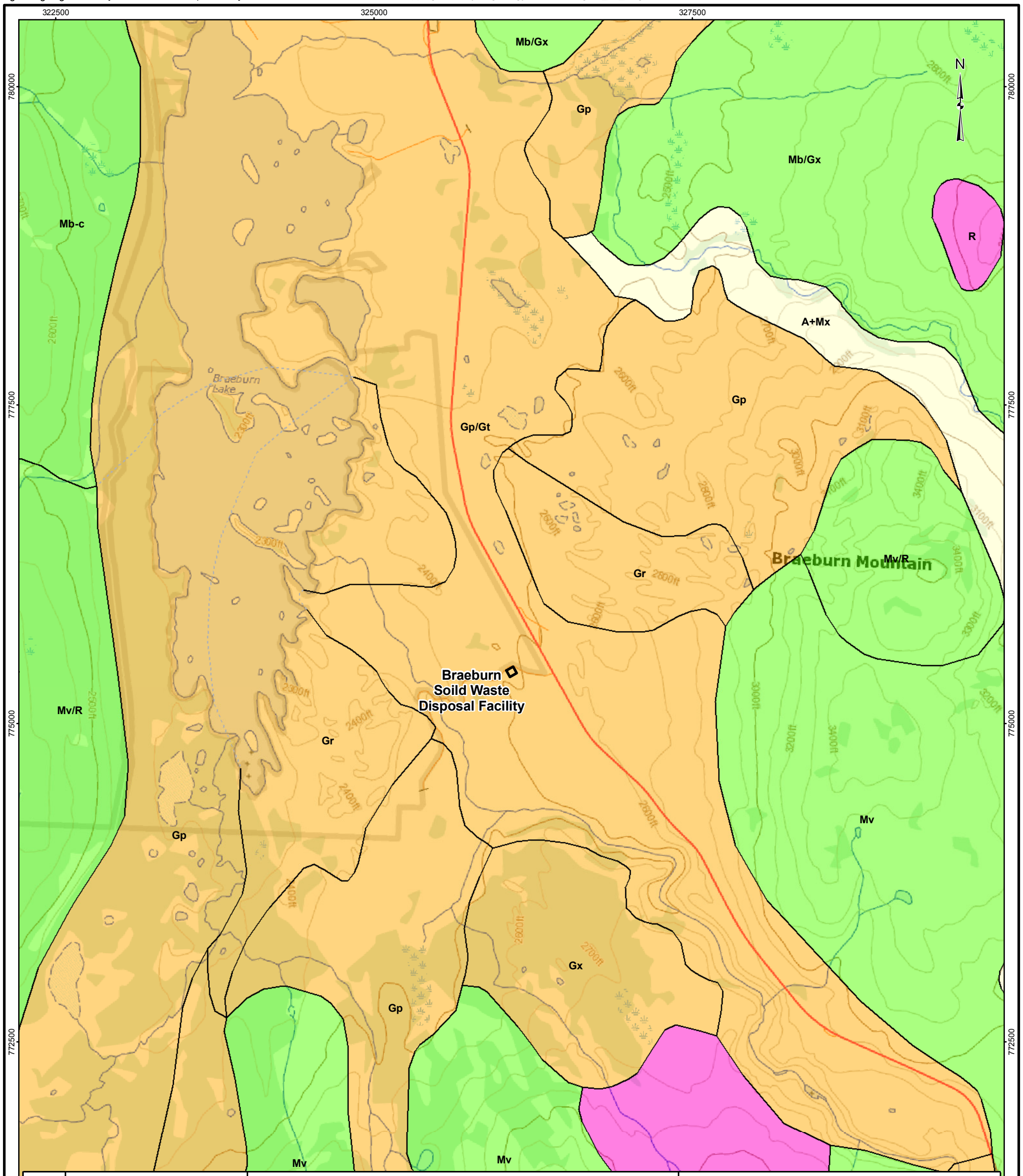


		LANDFORM OR LANDSCAPE		
	NATURE OF MATERIAL AND ESTIMATED THICKNESS	ORIGIN	TOPOGRAPHY	COMMENT
Gp	gravel, sand, and silt; 5 to 20 m thick	outwash plains	gently irregular or nearly flat terrain marked by shallow channel patterns or locally pitted surfaces	Extensive outwash occurs along the valleys of Yukon, Big Salmon, and Klusha rivers; some glaciolacustrine deposits may be included.
Gt	silt, sand, and gravel; 5 to 50 m thick	terraces underlain by glaciofuluvial, and/or glaciolacustrine deposits	nearly flat to irregular, pitted surfaces	Terraces occur within abandoned meltwater channels or at higher levels along former meltwater channels occupied by modern streams.
Gr	sand and gravel; 5 to 30 m thick	ice-contact glaciofuluvial deposits	strongly irregular, ridged, and kettled terrain with local relief of 30 m	Surfaces consist mainly of prominent esker-like anastomosing ridges.
Mv	till; silty sand matrix; bouldery; generally less than 1m thick	ablation and lodgement till	bedrock terrain with discontinuous cover of till	Morainic veneer forms a discontinuous cover where it is typically associated with colluvium and exposed bedrock.

322500
325000
327500

LEGEND

- FACILITY
- MAJOR ROAD
- WATERCOURSE

1 0 1

SCALE 1:30,000 KILOMETRES

REFERENCE

BASEDATA OBTAINED FROM GEOGRATIS (NATURAL RESOURCES CANADA).
SURFICIAL GEOLOGY DATA OBTAINED FROM THE YUKON OVERNMENT, ENERGY, MINES AND RESOUCES.
DATUM: NAD83 PROJECTION: ALBERS

PROJECT
YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
BRAEBURN, YUKON

TITLE
REGIONAL SURFICIAL GEOLOGY

Golder Associates
Greater Vancouver Office, B.C.

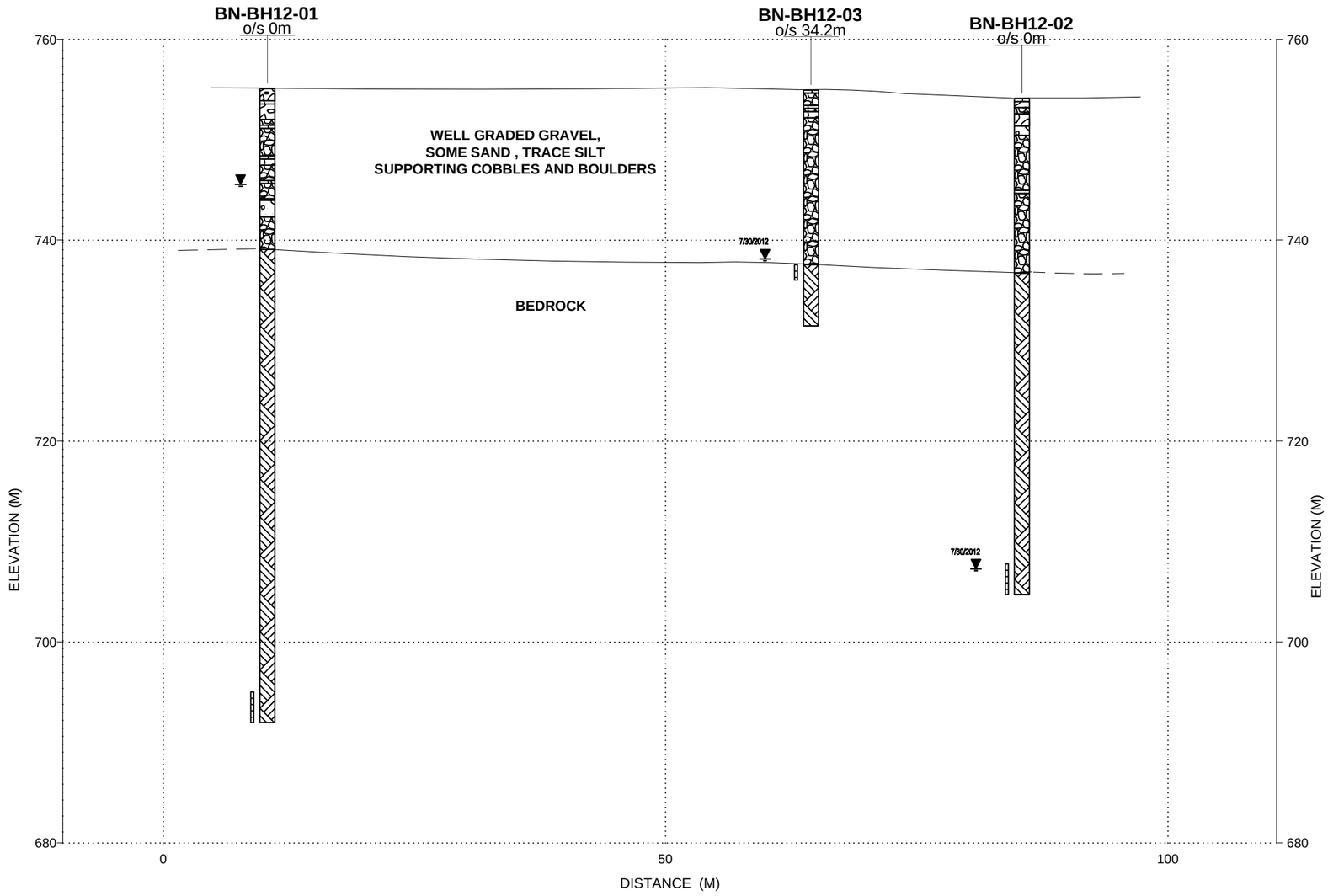
PROJECT No.	11-1436-0073		PHASE No. 1600		
DESIGN	CB	20 Aug. 2012	SCALE AS SHOWN	REV.	0
GIS	DSC	21 Aug. 2012			
CHECK					
REVIEW					

FIGURE: 3

Drawing File: N:\Bur-Graphics\Projects\2011\1436\11-1436-0073\Drafting\Phase 1600\Task 1660\11-1436-0073-1600-1660-01-.dwg Wednesday, August 29, 2012 8:25:09 AM By: tsemina

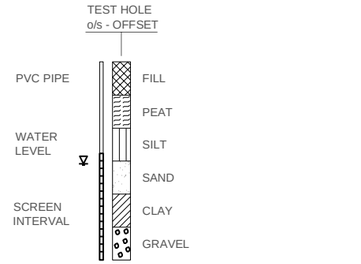
A **A'**

NORTHEAST **SOUTHWEST**



LEGEND

TEST HOLE LOCATION SHOWING INFERRED STRATIGRAPHIC DATA.
FOR DETAILED STRATIGRAPHY REFER TO RECORD OF TEST HOLE LOGS IN APPENDIX ?).



——— ? ——— INFERRED STRATIGRAPHIC BOUNDARY

——— ? ——— INFERRED GROUNDWATER (mASL)

NOTES

SPECIAL NOTE: DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND MAY VARY FROM THAT SHOWN.

0 10 20 30m

1:500

PROJECT
YUKON GOVERNMENT-COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
BRAEBURN, YUKON

TITLE

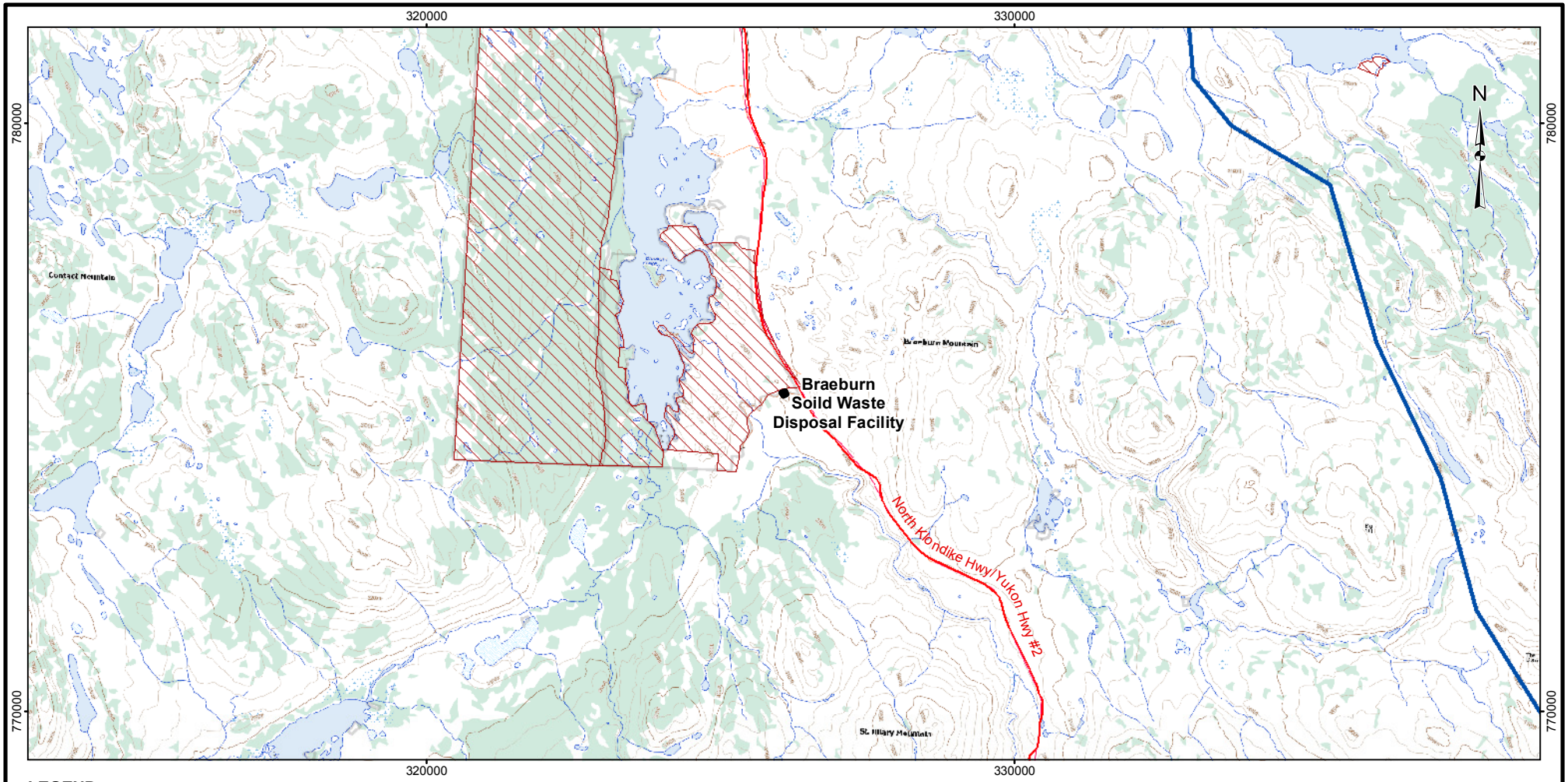
CROSS SECTION A-A'

Golder Associates

PROJECT No. 11-1436-0073			PHASE No.	1600-1660
DESIGN	CB	20AUG12	SCALE AS SHOWN	REV. –
CADD	TS	24AUG12		
CHECK				
REVIEW				

FIGURE 4

\\golder.gds\gal\Burnaby\CAD-GIS\Bur-Graphics\Projects\2011\1436\11-1436-0073\GIS\Mapping\MXD\Hydrogeology\Marsh_Lake\Figure_05_Regional_Drainage_Land_Zoning.mxd



LEGEND

- FACILITY
- MAJOR HIGHWAY
- FIRST NATIONS LANDS
- WATERSHED BOUNDARY

2 0 2

SCALE 1:100,000 KILOMETRES

PROJECT

YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
BRAEBURN, YUKON

TITLE

REGIONAL DRAINAGE & LAND ZONING

REFERENCE

FEATURE DATA OBTAINED FROM THE YUKON GOVERNMENT YGS MAPMAKER ONLINE. BASEDATA OBTAINED FROM GEOGRATIS (NATURAL RESOURCES CANADA).
DATUM: NAD83 PROJECTION: UTM ZONE 08

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.		11-1436-0073	PHASE No. 1600	
DESIGN	CB	16 Aug 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	17 Aug 2012		
CHECK				
REVIEW				

FIGURE: 5

LEGEND

GROUNDWATER ELEVATION (MEASURED ON JULY 30-31, 2012)

MONITORING WELL

20 0 20

SCALE 1:1,000 METRES

REFERENCE

IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, MAY 2009.
DATUM: NAD83 PROJECTION: UTM ZONE 8

PROJECT
YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
BRAEBURN, YUKON

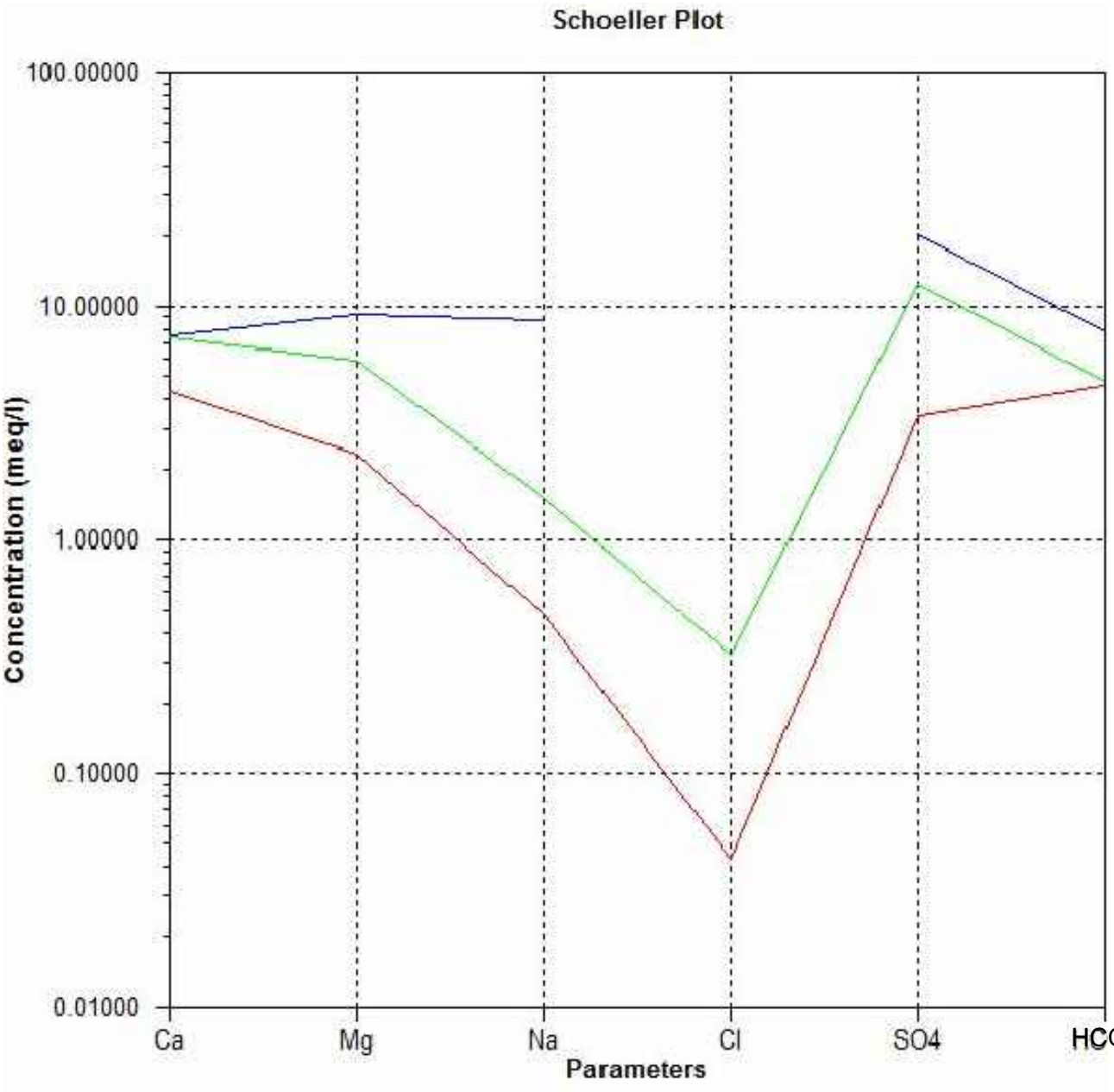
TITLE
MONITORING WELL LOCATION MAP GROUNDWATER ELEVATION

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.	11-1436-0073		PHASE No. 1600	
DESIGN	CB	20 Aug. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	21 Aug. 2012		
CHECK				
REVIEW				

FIGURE: 6

N:\Bur-Graphics\Projects\2011\1436\11-1436-0073\GIS\Mapping\MXD\Hydrogeology\Braeburn\Figure_06_Monitoring_Well_location.mxd



LEGEND

July 2012 Water Chemistry

- BN-MW12-01
- BN-MW12-03
- Braeburn Surface Water

PROJECT
YUKON GOVERNMENT-COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
BRAEBURN, YUKON

TITLE

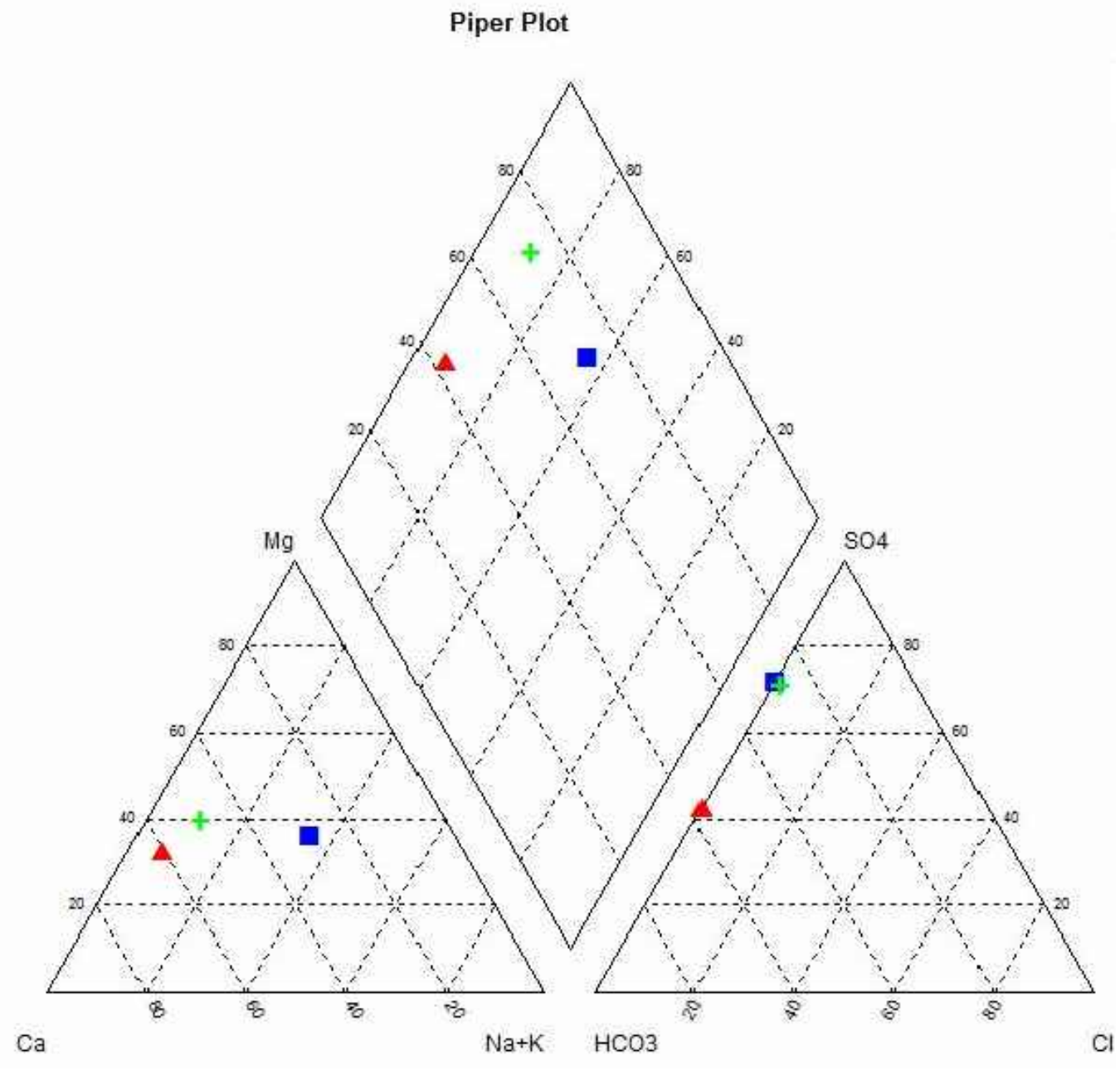
SCHOELLER PLOT

Golder Associates

PROJECT No.	11-1436-0073		FILE No.	1600-1660
DESIGN	CB	20AUG12	SCALE	N.T.S. –
CADD	TS	21AUG12		
CHECK				
REVIEW				

FIGURE 7

FILENAME|LAYOUT|MODIFIED|PLOTTED|OFFICE



LEGEND

July 2012 Water Chemistry Results

- BN-MW12-01
- BN-MW12-03
- Braeburn Surface Water

PROJECT
YUKON GOVERNMENT-COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
BRAEBURN, YUKON

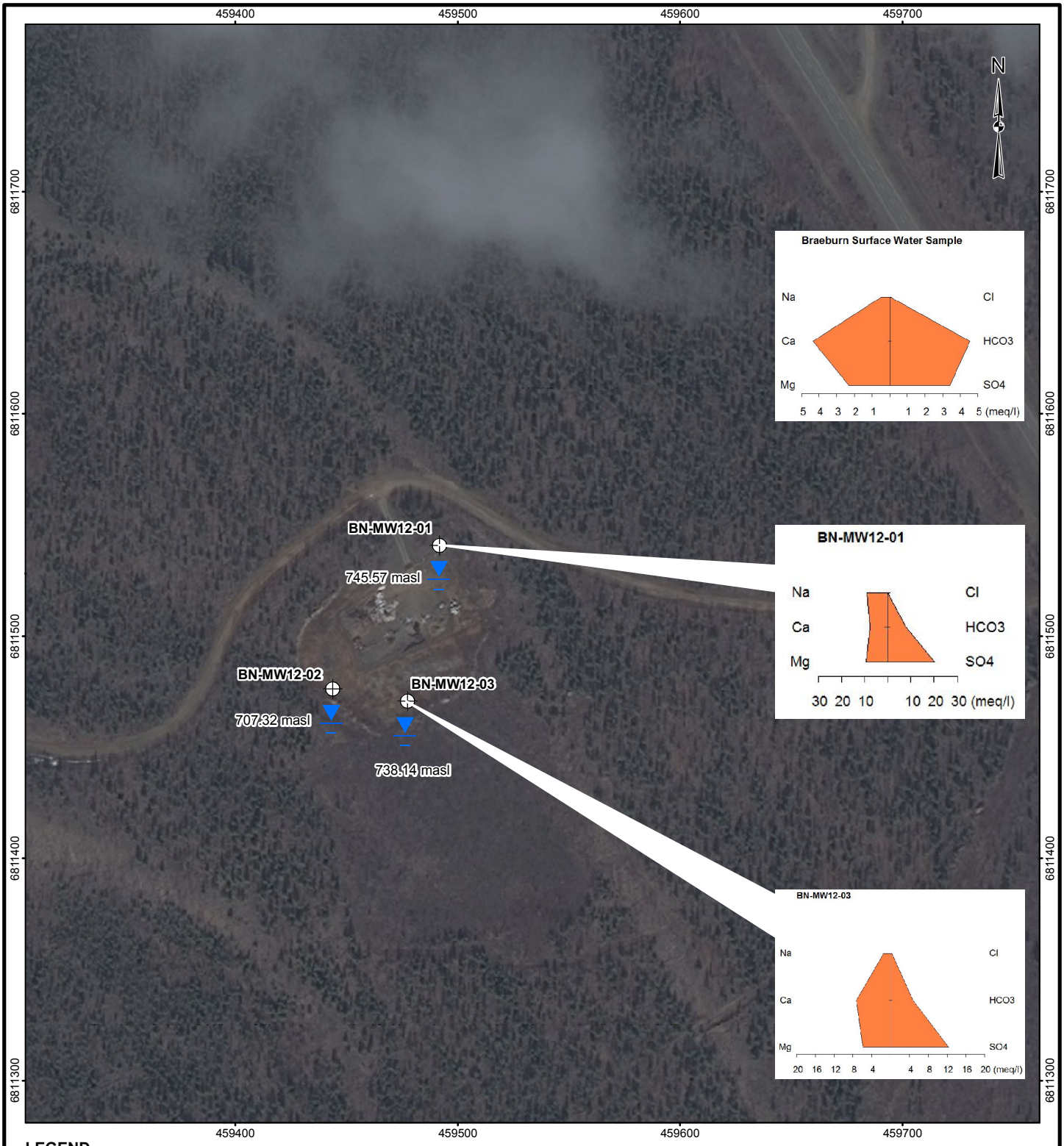
TITLE
PIPER PLOT

Golder Associates

PROJECT No.	11-1436-0073		FILE No.	1600-1660
DESIGN	CB	20AUG12	SCALE	N.T.S. –
CADD	TS	21AUG12		
CHECK				
REVIEW				

FIGURE 8

FILENAME|LAYOUT|MODIFIED|PLOTTED|OFFICE



LEGEND

- GROUNDWATER ELEVATION (MEASURED ON JUNE 7-16, 2012)
- MONITORING WELL

50 0 50

SCALE 1:2,500 METRES

REFERENCE

IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, MAY 2009.
DATUM: NAD83 PROJECTION: UTM ZONE 8

PROJECT
YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
BRAEBURN, YUKON

TITLE

STIFF DIAGRAM

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.	11-1436-0073		PHASE No. 1600		
DESIGN	CB	20 Aug. 2012	SCALE AS SHOWN	REV.	0
GIS	DSC	21 Aug. 2012			
CHECK					
REVIEW					

FIGURE: 9

\\golder.gds\gal\Burnaby\CAD-GIS\Bur-Graphics\Projects\2011\1436\11-1436-0073\GIS\Mapping\MXD\Hydrogeology\Braeburn\Figure_09_Stiff_Diagram.mxd

APPENDIX A

Site Photographs

Photograph 1: A view from the access road at the North side of the Site looking Southeast at waste transfer receptacles and hills to the South and East of the site.

Photograph 2: Photo taken from the West corner of the Site near BN-BH12-02 looking at the Southwest (foreground) and Southeast (background) edges of the Site.

Photograph 3: A view from the South corner of the Site looking North at the entrance, waste transfer receptacles, and wildlife fence.

Photograph 4: Sign at the entrance to the Facility specifying that the Facility is currently serving as a waste transfer facility for household waste only.

Photograph 5: A view of the Waste Transfer Facility taken during the June 2012 monitoring well installation program.

o:\final\2011\1436\11-1436-0073\1114360073-502-r-rev0-1600\appendices\app a - site photos\site photographs.docx

APPENDIX B

Well Construction Logs

FIELD BOREHOLE LOG

Borehole No. BN-BH12-01

Project Name: Yukon Landfills
Location: Braeburn SWTF
Field Screening Method: 10-slot 2" sched-40 PVC
Boring Method: Air Rotary
Casing/Borehole Diameter: 6 5/8" / 7 7/8"
GPS Coordinates:
Model: M5-Drilltech
Weather: 13° overcast
Project No.: 11-1436-0073 (1600)
Date: 7-6-12
Depth: 197'
Time: 0634S
to 207'
Contractor: Midnight Sun Drilling
Completed by: Calvin Beebe

DEPTH ELEV.	SOIL STRATIGRAPHY	WELL SKETCH	DEPTH SCALE	SAMPLES Cond.	Type	No.	Recov	PID (ppm)	SAMPLE DESCRIPTION & BORING NOTES
	GW GRAVEL some COBBLES & Boulders, some silt		0						0'-4' GW, GRAVEL and cobbles, some sand, trace silt dark brown, moist
	GW silt		10						4'-5' Boulder
	0'-52.5' GW, GRAVEL, some sand, some COBBLES & BOULDERS trace silt, moist, (Till)		20						
			30						
			40						5'-10' COBBLES and BOULDERS with some (GW), trace sand trace silt, brown, moist
			50						
	Bedrock		60						
	clay		70						10'-12' GW, GRAVEL, well graded, trace sand, brown, moist
			80						12'-13' SM, silty SAND, some gravel, brown, moist.
			90						
			100						13'-22' GW, GRAVEL, some sand, trace silt, brown, moist 17'
			110						22-23' SM, silty SAND, some gravel, brown moist
			120						25'-25' BOULDER
			130						25'-30' GW, trace sand, blue-grey, dry
			140						
			150						- seam ~6" SM, silty sand at 25'-26' 6".
			160						30'-31' SM-GM, silty SAND and GRAVEL, brown, moist.
			170						
			180						31'-36' GW, GRAVEL, trace sand, blue-grey, dry.
	Fracture		190						- with some silty sand at 34'-36'
			200						36'-36'6" SM, silty SAND, some gravel, brown, moist.
			210						36'6"-42' GM-SM, SAND and GRAVEL some silt, brown, moist.
									42'-52.5' GW, GRAVEL, trace sand, bluish grey, dry, very hard drilling.
									52.5' Bedrock.
									- some moisture at 67'
									- some moisture and darker rock 149'-76' Clayey texture.
									- water (7-8 gpm) 202'

SAMPLE CONDITION
DISTURBED / FAIR / GOOD / LOST

SAMPLE TYPES
A.S. - Auger sample
C.S. - Chunk sample (odex)
S.S. - Split spoon
C.C. - Sonic
D.P. - Direct Push

SPECIAL NOTES:
Est. Volume of drill H_2O used: _____ L(sonic)
Depth of H_2O:
Drum No.: _____ Date: _____ Time: _____

C:\Users\BrMacdonald\Desktop\New Forms\Field Borehole Log.docm

Note: this log is double-sided.

▽ inside casing 71' bg

FIELD BOREHOLE LOG

Borehole No. BN-BH12-02

Project Name: Yukon Landfills
Location: Braeburn SWDF
Field Screening Method: 10-slot 2" sched 40 PVC
Boring Method: Air Rotary
Casing/Borehole Diameter: 6 5/8" / 7 1/4" or 6"
GPS Coordinates:
Model: M5 - Drilltech
Weather: Partly cloudy 13°
Project No.: 11-1436-0073 (1000)
Date: 15/6/12
Time: 09:30
Depth: 162' to 152'
Contractor: Midnight Sun Drilling
Completed by: Calvin Beebe

DEPTH ELEV.	SOIL STRATIGRAPHY	WELL SKETCH	DEPTH SCALE	SAMPLES Cond.	Type	No.	Recov	PID (ppm)	SAMPLE DESCRIPTION & BORING NOTES
SM 1'-57'	GW (Till)		0' 10' 20' 30' 40' 50' 60' 70' 80' 90' 100' 110' 120' 130' 140' 150' 160' 170'						0'-1' SM, silty SAND, some gravel, orangish brown and white, dry to moist, (Topsoil). 1'-57' GW, GRAVEL, some cobbles, some sand, trace silt, brown, (Till) 1'-3' COBBLES & BOULDERS and GW 5'-9' BOULDER 9'-12' SW-GW, more sand 13' cobble 30'-31' SAND seam, wet, SM 57'-162' Bedrock
	Bedrock								

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
A.S. - Auger sample
C.S. - Chunk sample (odex)
S.S. - Split spoon
C.C. - Sonic
D.P. - Direct Push

SPECIAL NOTES:
Est. Volume of drill H_2O used: _____ L(sonic)
Depth of H_2O: _____
Drum No.: _____ Date: _____ Time: _____

Note: this log is double-sided.

FIELD BOREHOLE LOG

Borehole No. BN-BH12-02

Project Name: Yukon Landfills
Location: Braeburn SWDF
Field Screening Method: 10-slot 2" schedule 40 PVC
Boring Method: Air Rotary
Casing/Borehole Diameter: 6 5/8" / 7 1/4" or 6"
GPS Coordinates:
Model: MS-DriTech
Weather: Partly cloudy 8°
Project No.: 11-1436-0073 (1500)
Date: 15-6-12
Time: 09:30
Depth: 162' to 152'
Contractor: Midnight Sun Drilling
Completed by: Calvin Beebe

DEPTH ELEV.	SOIL STRATIGRAPHY	WELL SKETCH	DEPTH SCALE	SAMPLES Cond.	Type	No.	Recov	PID (ppm)	SAMPLE DESCRIPTION & BORING NOTES
	GW - GRAVEL, some sand, some boulders and cobbles, trace silt (Till)		+10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160						0'-1' SM, silty SAND, some gravel, orange brown, topsoil, white ash deposits. 1'-3' BOULDERS and COBBLES, trace gravel 3'-5' GW, GRAVEL, some cobbles, some sand, brown, moist. 5'-9' BOULDERS 9'-12' SW-GW, SAND and GRAVEL, trace silt, dark brown, moist to wet. 12'-30' GW, GRAVEL, some sand, trace silt, brown, moiste cobble or boulder @ 18' 30'-31' Sm fine SAND, some gravel, some silt, brown, moist wet 31'-41' GW, GRAVEL, some sand trace silt, brown, moist. 41'-57' similar dryer. 57'- Bedrock - weathered, greyish brown, dril. - black clay seam 65' hole ended at 162' and installed in dry borehole.
	Bedrock								

some cobbles 20'
37'
82 102 122 142 162'

SAMPLE CONDITION
DISTURBED / FAIR / GOOD / LOST

SAMPLE TYPES
A.S. - Auger sample
C.S. - Chunk sample (odex)
S.S. - Split spoon
C.C. - Sonic
D.P. - Direct Push

SPECIAL NOTES:
Est. Volume of drill H_2O used: _____ L(sonic)
Depth of H_2O:
Drum No.: _____ Date: _____ Time: _____

C:\Users\BrMacdonald\Desktop\New Forms\Field Borehole Log.docm

Note: this log is double-sided.

FIELD BOREHOLE LOG

Borehole No. BN-BH12-03

Project Name: Yukon Landfills | GPS Coordinates: | Project No.: 11-1436-0073 (1400)
Location: Braeburn SWDF | | Date: 16/6/12 | Time: 09:30
Field Screening Method: 10-Slot 2" Sched 40 PVC | | Depth: 52' | to 62'
Boring Method: Air Rotary | Model: M5-Drilltech | Contractor: Midnight Sun Drilling
Casing/Borehole Diameter: [redacted] | Weather: Overcast 12° | Completed by: Calvin Beebe

DEPTH ELEV.	SOIL STRATIGRAPHY	WELL SKETCH	DEPTH SCALE	SAMPLES Cond.	Type	No.	Recov	PID (ppm)	SAMPLE DESCRIPTION & BORING NOTES
	sm		0'						0'-1' SM, silt, SAND, some gravel, Orangish brown and white, dry to moist (topsoil)
	GW- GRAVEL, Some sand, some Cobbles, brown, moist		5'						1'-5' GW, Gravel, some sand, some cobbles, brown, moist.
	5'-6' boulder		10'						5'-6' Boulder
	7'-9' boulder		15'						6'-7' similar GW
			20'						7'-9' Boulder
			25'						9'-57' similar GW
			30'						
			35'						57'-77' Bedrock
			40'						
			45'						-Casing stuck at 57' could not remove.
			50'						
			55'						
	Bedrock		60'						
			65'						
			70'						
		Backfill	75'						
			80'						
			85'						
			90'						
			95'						

SAMPLE CONDITION
DISTURBED / FAIR / GOOD / LOST

SAMPLE TYPES
A.S. - Auger sample
C.S. - Chunk sample (odex)
S.S. - Split spoon
C.C. - Sonic
D.P. - Direct Push

SPECIAL NOTES:
Est. Volume of drill H_20 used: _____ L(sonic)
Depth of H_20: _____
Drum No.: _____ Date: _____ Time: _____

C:\Users\BrMacdonald\Desktop\New Forms\Field Borehole Log.docm

Note: this log is double-sided.

Casing 6 5/8", Shoe 7 1/4", Rod Hammer 6" OD.

FIELD BOREHOLE LOG

Borehole No. BN-BH12-03

Well ID: BN-MW12-03
Water Level (mbtoc): – Dry –
Well Depth (mbtoc):
Date: 16/6/12
Borehole Diameter: 6"

FLUSHMOUNT WELL INSTALLATION

DEPTH: 0
DEPTH:
DEPTH:
DEPTH:
DEPTH:
DEPTH:
DEPTH:

STICK-UP WELL INSTALLATION

HEIGHT: 3'
DEPTH: 0
DEPTH: 52'
DEPTH: 52'
Casing left at 57'
DEPTH: 62'
DEPTH: 77'4"
- Backfilled with native material.

ft	m	ft	m
1	0.3	41	12.5
2	0.6	42	12.8
3	0.9	43	13.1
4	1.2	44	13.4
5	1.5	45	13.7
6	1.8	46	14.0
7	2.1	47	14.3
8	2.4	48	14.6
9	2.7	49	14.9
10	3.0	50	15.2
11	3.4	51	15.5
12	3.7	52	15.8
13	4.0	53	16.2
14	4.3	54	16.5
15	4.6	55	16.8
16	4.9	56	17.1
17	5.2	57	17.4
18	5.5	58	17.7
19	5.8	59	18.0
20	6.1	60	18.3
21	6.4	61	18.6
22	6.7	62	18.9
23	7.0	63	19.2
24	7.3	64	19.5
25	7.6	65	19.8
26	7.9	66	20.1
27	8.2	67	20.4
28	8.5	68	20.7
29	8.8	69	21.0
30	9.1	70	21.3
31	9.4	71	21.6
32	9.8	72	21.9
33	10.1	73	22.3
34	10.4	74	22.6
35	10.7	75	22.9
36	11.0	76	23.2
37	11.3	77	23.5
38	11.6	78	23.8
39	11.9	79	24.1
40	12.2	80	24.4

Note:
0.15 meters = 6 inches

MONITORING WELL INSTALLATION GUIDELINES

BENTONITE SILICA SAND

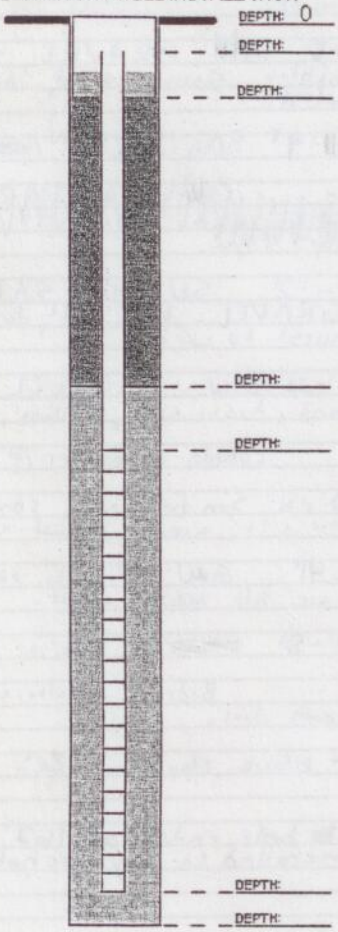
of 6" steel casin in

FIELD BOREHOLE LOG

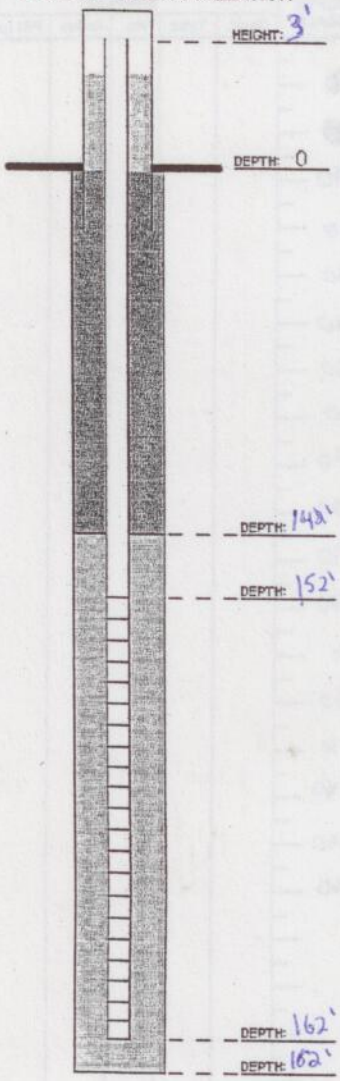
Borehole No. BN-BH12-02

Well ID: BN-MW12-02
Water Level (mbtoc): Dry
Well Depth (mbtoc): 50.29
Date: 16/6/12
Borehole Diameter: 6"

FLUSHMOUNT WELL INSTALLATION



STICK-UP WELL INSTALLATION



ft	m	ft	m
1	0.3	41	12.5
2	0.6	42	12.8
3	0.9	43	13.1
4	1.2	44	13.4
5	1.5	45	13.7
6	1.8	46	14.0
7	2.1	47	14.3
8	2.4	48	14.6
9	2.7	49	14.9
10	3.0	50	15.2
11	3.4	51	15.5
12	3.7	52	15.8
13	4.0	53	16.2
14	4.3	54	16.5
15	4.6	55	16.8
16	4.9	56	17.1
17	5.2	57	17.4
18	5.5	58	17.7
19	5.8	59	18.0
20	6.1	60	18.3
21	6.4	61	18.6
22	6.7	62	18.9
23	7.0	63	19.2
24	7.3	64	19.5
25	7.6	65	19.8
26	7.9	66	20.1
27	8.2	67	20.4
28	8.5	68	20.7
29	8.8	69	21.0
30	9.1	70	21.3
31	9.4	71	21.6
32	9.8	72	21.9
33	10.1	73	22.3
34	10.4	74	22.6
35	10.7	75	22.9
36	11.0	76	23.2
37	11.3	77	23.5
38	11.6	78	23.8
39	11.9	79	24.1
40	12.2	80	24.4

Note:
0.15 meters = 6 inches

MONITORING WELL INSTALLATION GUIDELINES

BENTONITE SILICA SAND

45' of casing in hole

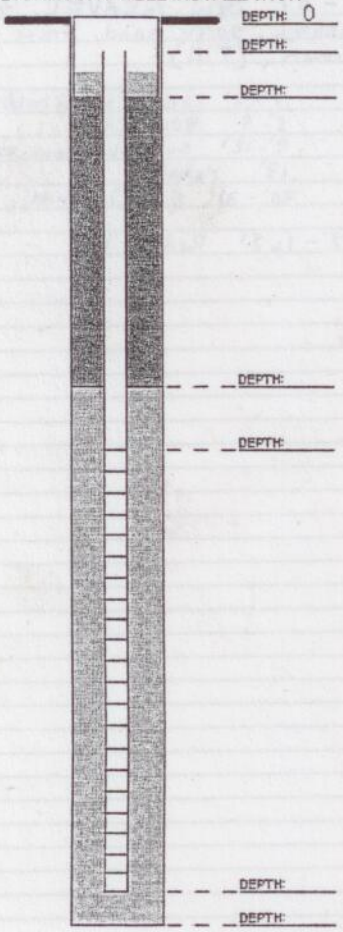
Golder

FIELD BOREHOLE LOG

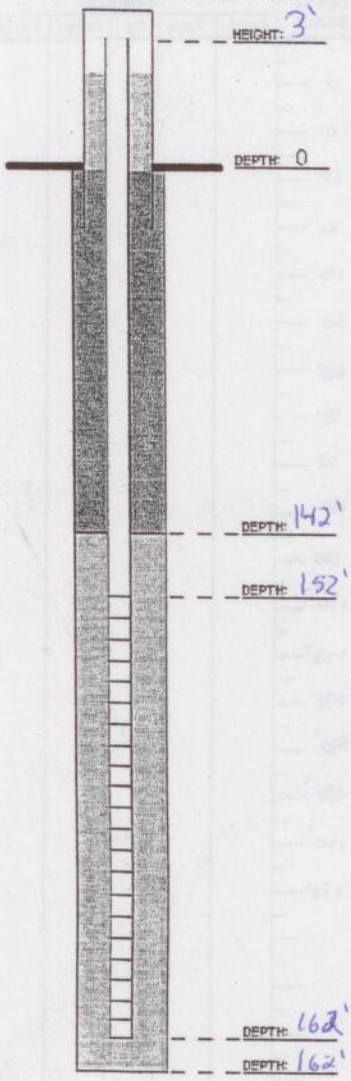
Borehole No. BN-BH12-02

Well ID: BN-MW12-02
Water Level (mbtoc): Dry
Well Depth (mbtoc): 50.29
Date: 16/6/12
Borehole Diameter: 6"

FLUSHMOUNT WELL INSTALLATION



STICK-UP WELL INSTALLATION



ft	m	ft	m
1	0.3	41	12.5
2	0.6	42	12.8
3	0.9	43	13.1
4	1.2	44	13.4
5	1.5	45	13.7
6	1.8	46	14.0
7	2.1	47	14.3
8	2.4	48	14.6
9	2.7	49	14.9
10	3.0	50	15.2
11	3.4	51	15.5
12	3.7	52	15.8
13	4.0	53	16.2
14	4.3	54	16.5
15	4.6	55	16.8
16	4.9	56	17.1
17	5.2	57	17.4
18	5.5	58	17.7
19	5.8	59	18.0
20	6.1	60	18.3
21	6.4	61	18.6
22	6.7	62	18.9
23	7.0	63	19.2
24	7.3	64	19.5
25	7.6	65	19.8
26	7.9	66	20.1
27	8.2	67	20.4
28	8.5	68	20.7
29	8.8	69	21.0
30	9.1	70	21.3
31	9.4	71	21.6
32	9.8	72	21.9
33	10.1	73	22.3
34	10.4	74	22.6
35	10.7	75	22.9
36	11.0	76	23.2
37	11.3	77	23.5
38	11.6	78	23.8
39	11.9	79	24.1
40	12.2	80	24.4

Note:
0.15 meters = 6 inches

MONITORING WELL INSTALLATION GUIDELINES

BENTONITE SILICA SAND

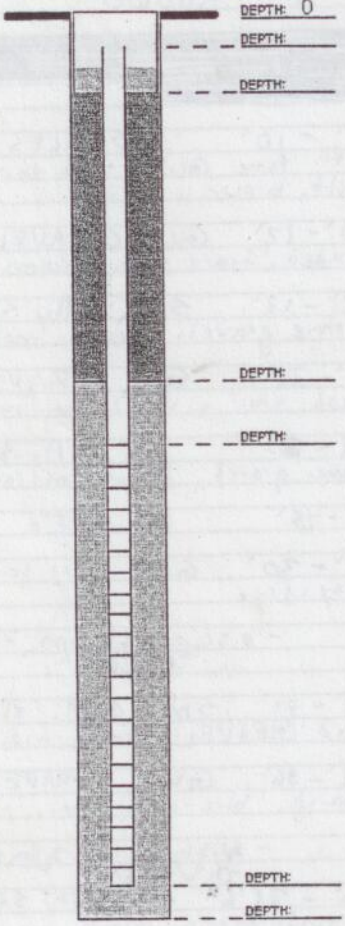
Golder

FIELD BOREHOLE LOG

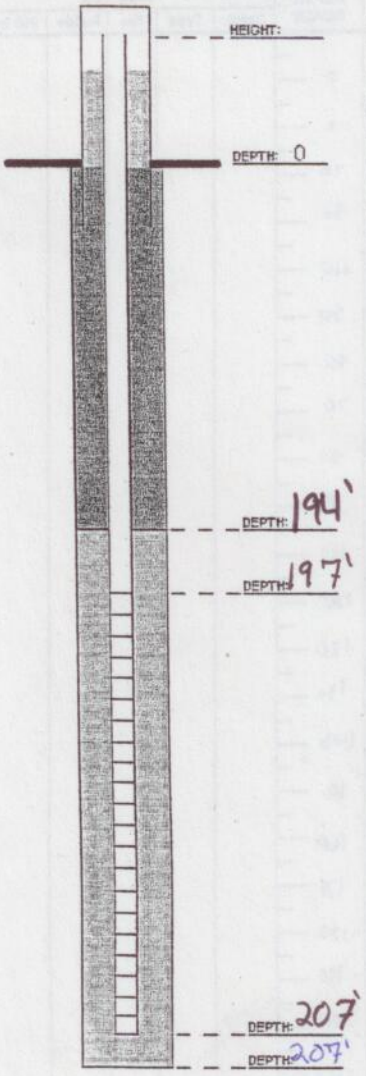
Borehole No: BN-BH12-01

Well ID: BN-MW17-01
Water Level (mbtoc): 10.45 m
Well Depth (mbtoc): 63.09 m
Date: 15-6-12
Borehole Diameter: 6"

FLUSHMOUNT WELL INSTALLATION



STICK-UP WELL INSTALLATION



ft	m	ft	m
1	0.3	41	12.5
2	0.6	42	12.8
3	0.9	43	13.1
4	1.2	44	13.4
5	1.5	45	13.7
6	1.8	46	14.0
7	2.1	47	14.3
8	2.4	48	14.6
9	2.7	49	14.9
10	3.0	50	15.2
11	3.4	51	15.5
12	3.7	52	15.8
13	4.0	53	16.2
14	4.3	54	16.5
15	4.6	55	16.8
16	4.9	56	17.1
17	5.2	57	17.4
18	5.5	58	17.7
19	5.8	59	18.0
20	6.1	60	18.3
21	6.4	61	18.6
22	6.7	62	18.9
23	7.0	63	19.2
24	7.3	64	19.5
25	7.6	65	19.8
26	7.9	66	20.1
27	8.2	67	20.4
28	8.5	68	20.7
29	8.8	69	21.0
30	9.1	70	21.3
31	9.4	71	21.6
32	9.8	72	21.9
33	10.1	73	22.3
34	10.4	74	22.6
35	10.7	75	22.9
36	11.0	76	23.2
37	11.3	77	23.5
38	11.6	78	23.8
39	11.9	79	24.1
40	12.2	80	24.4

Note:
0.15 meters = 6 inches

MONITORING WELL INSTALLATION GUIDELINES

BENTONITE SILICA SAND

Golder

APPENDIX C

Well Development and Sampling Sheets

1/2

GROUNDWATER DEVELOPMENT AND PURGING/SAMPLING DATA SHEET

☑ Development
☑ Purging/Sampling

Well No.: BN-MW12-01 **Project No.:** 11-1436-0073/1600
Location: BRAEBURN TRANSFER STATION **Date:** 30-JUL-12 **Time:** 1600
Weather: OVERCAST **Temperature:** 16°C **Completed by:** A BADGER

MONITORING WELL INFORMATION

Time of Measurement: 1600 Tidally Influenced: ☐ Yes ☑ No
Depth to product: ____ Product thickness: ____ One well volume: ____
Depth to water Below Top of Casing: A 10.52 metres (B-A)*2.0 = 100 litres - for a 51 mm (2.0 inch) diameter well
Depth to Bottom of Well Below Top of Casing: B 60.M metres (B-A)*1.1 = ____ litres - for a 38 mm (1.5 inch) diameter well
Diameter Standpipe: C 51 mm Sample intake depth: ____ metres

EQUIPMENT LIST HANNA HI 991300

pH and Temp. Meter: Model ____ Serial No. ____ Calibration Buffers: ☑ 4 ☑ 7 ☐ 10
Conductivity Meter: Model ____ Serial No. ____ Calibration Solution: 1413
Dissolved Oxygen Meter: Model ____ Serial No. ____ ☐ D.O. Chemet Ampoule
Pump: ☐ None ☑ Waterra ☐ Peristaltic ☐ Submersible ☐ Bailer Type: ____
Pump Details: ____

WELL DEVELOPMENT/PURGING

Purge Volume: Well. Vol. X 3 = 300 litres
Avg. Flow Rate: ____ L/min. Start: 1620 Finish: ____

Time	Volume Removed (L)	Temp. (°C)	pH (Units)	Cond. (uS/cm)	Redox (mV)	Diss. O_2 (mg/L) or %		Water Level (m)	Remarks
1625	15	6.0	7.08	5					VERY SILTY
1632	30	3.0	7.03	3					CLEAR
16:38	45	2.6	7.03	3					CLEAR
16:42	60	2.7	7.02	3					
16:49	75	2.7	7.02	3				12.09	
16:55	90	2.6	7.02	3					
1700	105	2.6	7.02	3					
1706	120	2.7	7.03	3					
1712	135	2.6	7.03	3					
1717	150	2.6	7.01	3				12.49	
1722	165	2.5	7.00	3					
1727	180	2.2	7.02	2					

Comments:

Odour: ☐ Yes ☐ No If yes ____
Sheen: ☐ Yes ☐ No If yes Hydrocarbon-like ☐ OR Metallic-like ☐
Turbidity: Clear I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I Very Silty

Analysis	Type		40 mL	100 mL	250 mL	500 mL	1 L	2 L	4 L	Filtered		Preservatives
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	

(Container Size spans 40 mL through 4 L columns.)

SCN No. ____ Consumables: ☐ Waterra Tubing ____ ☐ HDPE/Teflon Tubing ____ ☐ Groundwater Filter ____
Field Dup. ____ ☐ Silicon Tubing ____ ☐ D.O. Ampoules ____ ☐ ____

GROUNDWATER DEVELOPMENT AND PURGING/SAMPLING DATA SHEET

☐ Development
☐ Purging/Sampling

Well No.: BN-MW12-01 CONT'D
Project No.:
Location:
Date:
Time:
Weather:
Temperature:
Completed by:

MONITORING WELL INFORMATION

Time of Measurement:
Tidally influenced: ☐ Yes ☐ No
Depth to product: ______ Product thickness: ______
One well volume:
Depth to water Below Top of Casing: A ______ metres
(B-A)*2.0 = ______ litres - for a 51 mm (2.0 inch) diameter well
Depth to Bottom of Well Below Top of Casing: B ______ metres
(B-A)*1.1 = ______ litres - for a 38 mm (1.5 inch) diameter well
Diameter Standpipe: C ______ mm
Sample intake depth: ______ metres

EQUIPMENT LIST

pH and Temp. Meter: Model ______ Serial No. ______ Calibration Buffers: ☐ 4 ☐ 7 ☐ 10
Conductivity Meter: Model ______ Serial No. ______ Calibration Solution: ______
Dissolved Oxygen Meter: Model ______ Serial No. ______ ☐ D.O. Chemet Ampoule
Pump: ☐ None ☐ Waterra ☐ Peristaltic ☐ Submersible
☐ Bailer Type: ______
Pump Details:

WELL DEVELOPMENT/PURGING

Purge Volume: Well. Vol. X ______ = ______ litres
Avg. Flow Rate: ______ L/min.
Start: ______ Finish: ______

Time	Volume Removed (L)	Temp. (°C)	pH (Units)	Cond. (uS/cm)	Redox (mV)	Diss. O_2 (mg/L) or %		Water Level (m)	Remarks
17:32	195	2.2	7.01	3					
17:47	210	2.2	7.00	3					
17:50	225	2.3	7.03	1				12.76	
17:53	240	2.3	7.00	1					
17:58	255	2.2	7.00	1					
18:05	270	2.2	7.00	1					
18:11	285	2.3	699	1					
18:16	300	2.3	6.98	1				12.21	
19:20									SAMPLE COLLECTED.

Comments:

Odour: ☐ Yes ☐ No If yes ______
Sheen: ☐ Yes ☐ No If yes Hydrocarbon-like ☐ OR Metallic-like ☐
Turbidity: Clear I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I Very Silty

Analysis	Type	Container Size 40 mL	100 mL	250 mL	500 mL	1 L	2 L	4 L	Filtered	Preservatives
	☐ Plastic ☐ Glass								☐ Yes ☐ No	
	☐ Plastic ☐ Glass								☐ Yes ☐ No	
	☐ Plastic ☐ Glass								☐ Yes ☐ No	
	☐ Plastic ☐ Glass								☐ Yes ☐ No	
	☐ Plastic ☐ Glass								☐ Yes ☐ No	
	☐ Plastic ☐ Glass								☐ Yes ☐ No	
	☐ Plastic ☐ Glass								☐ Yes ☐ No	
	☐ Plastic ☐ Glass								☐ Yes ☐ No	

SCN No. ______ Consumables: ☐ Waterra Tubing ______ ☐ HDPE/Teflon Tubing ______ ☐ Groundwater Filter ______
Field Dup. ______ ☐ Silicon Tubing ______ ☐ D.O. Ampoules ______ ☐ ______

GROUNDWATER DEVELOPMENT AND PURGING/SAMPLING DATA SHEET

☑ Development
☑ Purging/Sampling

Well No.: BN-MW12-02 **Project No.:** 11-1436-0073/1600
Location: BRAEBURN **Date:** 31-JUL-12 **Time:** 11:00
Weather: OVERCAST **Temperature:** 15°C **Completed by:** A BRIDGER

MONITORING WELL INFORMATION

Time of Measurement: ~~18:45~~ 11:00 Tidally Influenced: ☐ Yes ☑ No
Depth to product: ______ Product thickness: ______ One well volume: = 5.80
Depth to water Below Top of Casing: A 47.77 metres (B-A)*2.0 = 2 × 2.89 litres - for a 51 mm (2.0 inch) diameter well
Depth to Bottom of Well Below Top of Casing: B 50.66 metres (B-A)*1.1 = ______ litres - for a 38 mm (1.5 inch) diameter well
Diameter Standpipe: C ______ mm Sample intake depth: ______ metres

EQUIPMENT LIST

pH and Temp. Meter: Model HANNA HI 99300 Serial No. ______ Calibration Buffers: ☒ 4 ☑ 7 ☐ 10
Conductivity Meter: Model ______ Serial No. ______ Calibration Solution: 1413
Dissolved Oxygen Meter: Model ______ Serial No. ______ ☐ D.O. Chemet Ampoule
Pump: ☒ None ☐ Waterra ☐ Peristaltic ☐ Submersible ☒ Bailer Type: HAND
Pump Details: BAILER

WELL DEVELOPMENT/PURGING

Purge Volume: Well. Vol. X 4 = 12 litres
Avg. Flow Rate: ______ L/min. Start: ______ Finish: ______

Time	Volume Removed (L)	Temp. (°C)	pH (Units)	Cond. (uS/cm)	Redox (mV)	Diss. O_2 (mg/L) or %	Water Level (m)	Remarks
11:20	6	12.5	7.06	4				
1200	12	15.1	7.06	4			49.30	
NO MORE WATER COULD BE REMOVED.								

Comments:
Odour: ☐ Yes ☐ No If yes ______
Sheen: ☐ Yes ☐ No If yes Hydrocarbon-like ☐ OR Metallic-like ☐
Turbidity: Clear I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I Very Silty

Analysis	Type		Container Size 40 mL	100 mL	250 mL	500 mL	1 L	2 L	4 L	Filtered		Preservatives
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	

SCN No. ______ Consumables: ☐ Waterra Tubing ______ ☐ HDPE/Teflon Tubing ______ ☐ Groundwater Filter ______
Field Dup. ______ ☐ Silicon Tubing ______ ☐ D.O. Ampoules ______ ☐ ______

GROUNDWATER DEVELOPMENT AND PURGING/SAMPLING DATA SHEET

☑ Development
☑ Purging/Sampling

Well No.: BN-MW12-03 **Project No.:** 11-1436-0073/1600

Location: BRAEBURN **Date:** 31-JUL-12 **Time:** 16:35

Weather: OVERCAST **Temperature:** 15°C **Completed by:** A. BADGER

MONITORING WELL INFORMATION

Time of Measurement: 16:35 Tidally Influenced: ☐ Yes ☑ No

Depth to product: ______ Product thickness: ______ One well volume:

Depth to water Below Top of Casing: A 17.76 metres (B-A)*2.0 = 4.4 litres - for a 51 mm (2.0 inch) diameter well

Depth to Bottom of Well Below Top of Casing: B 19.96 metres (B-A)*1.1 = ______ litres - for a 38 mm (1.5 inch) diameter well

Diameter Standpipe: C ______ mm Sample intake depth: ______ metres

EQUIPMENT LIST

HANNA HI 991300

pH and Temp. Meter: Model ______ Serial No. ______ Calibration Buffers: ☐ 4 ☐ 7 ☐ 10

Conductivity Meter: Model ______ Serial No. ______ Calibration Solution:

Dissolved Oxygen Meter: Model ______ Serial No. ______ ☐ D.O. Chemet Ampoule

Pump: ☐ None ☑ Waterra ☐ Peristaltic ☐ Submersible ☐ Bailer Type: ______

Pump Details: ______

WELL DEVELOPMENT/PURGING

Purge Volume: Well. Vol. X 3 = 13.2 litres

Avg. Flow Rate: ______ L/min. Start: 16:50 Finish: ______

Time	Volume Removed (L)	Temp. (°C)	pH (Units)	Cond. (uS/cm)	Redox (mV)	Diss. O_2 (mg/L) or %		Water Level (m)	Remarks
16:50	1	7.2	7.06	6					
16:52	5	4.3	7.02	5				19.28	
17:41	10	8.6	7.03	4.6					
19:16	15	11.2	7.06	6				19.48	SAMPLE COLLECTED

Comments:

Odour: ☐ Yes ☐ No If yes ______

Sheen: ☐ Yes ☐ No If yes Hydrocarbon-like ☐ OR Metallic-like ☐

Turbidity: Clear I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I Very Silty

Analysis	Type		Container Size 40 mL	100 mL	250 mL	500 mL	1 L	2 L	4 L	Filtered		Preservatives
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	

SCN No. ______ Consumables: ☐ Waterra Tubing ______ ☐ HDPE/Teflon Tubing ______ ☐ Groundwater Filter ______

Field Dup. ______ ☐ Silicon Tubing ______ ☐ D.O. Ampoules ______ ☐ ______

Surface Water Sampling Data Sheet

☑ Field Characterization
☑ Sampling

Sample Number:	BN - SURFACE	**Project No.**	11-1436-0073 / 1600
Location:	BRAEBURN LANDFILL CREEK.	**Completed By:**	A BADGER
Weather:	OVERCAST	**Date:**	31 - JUL - 12
Temperature:	15 °C	**Time:**	18:00
		Reviewed By:	

EQUIPMENT LIST

HANNA HI 991300

pH and Temp. Meter: Model ______ Serial No. ______ Calibration Buffers: ☐ 4 ☐ 7 ☐ 10

Conductivity Meter: Model ______ Serial No. ______ Calibration Solution: ______

Dissolved Oxygen Meter: Model ______ Serial No. ______ ☐ D.O. Chemet Ampoule

Pump: ☑ None ☐ Waterra ☐ Peristaltic ☐ Submersible Bailer: ☐ None ☐ Stainless Steel ☐ Teflon ☐ PVC

Sample Depth: SURFACE

SURFACE WATER SAMPLING

Time	Volume Removed (L)	Temp. (°C)	pH (Units)	Cond. (uS/cm)	Redox (mV)	Diss. O_2 (mg/L) or %	Remarks
18:00		13.1	7.02	2			

Comments:

Odour: ☐ Yes ☐ No If yes ______

Sheen: ☐ Yes ☐ No If yes ______

Turbidity: Clear | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Very Silty

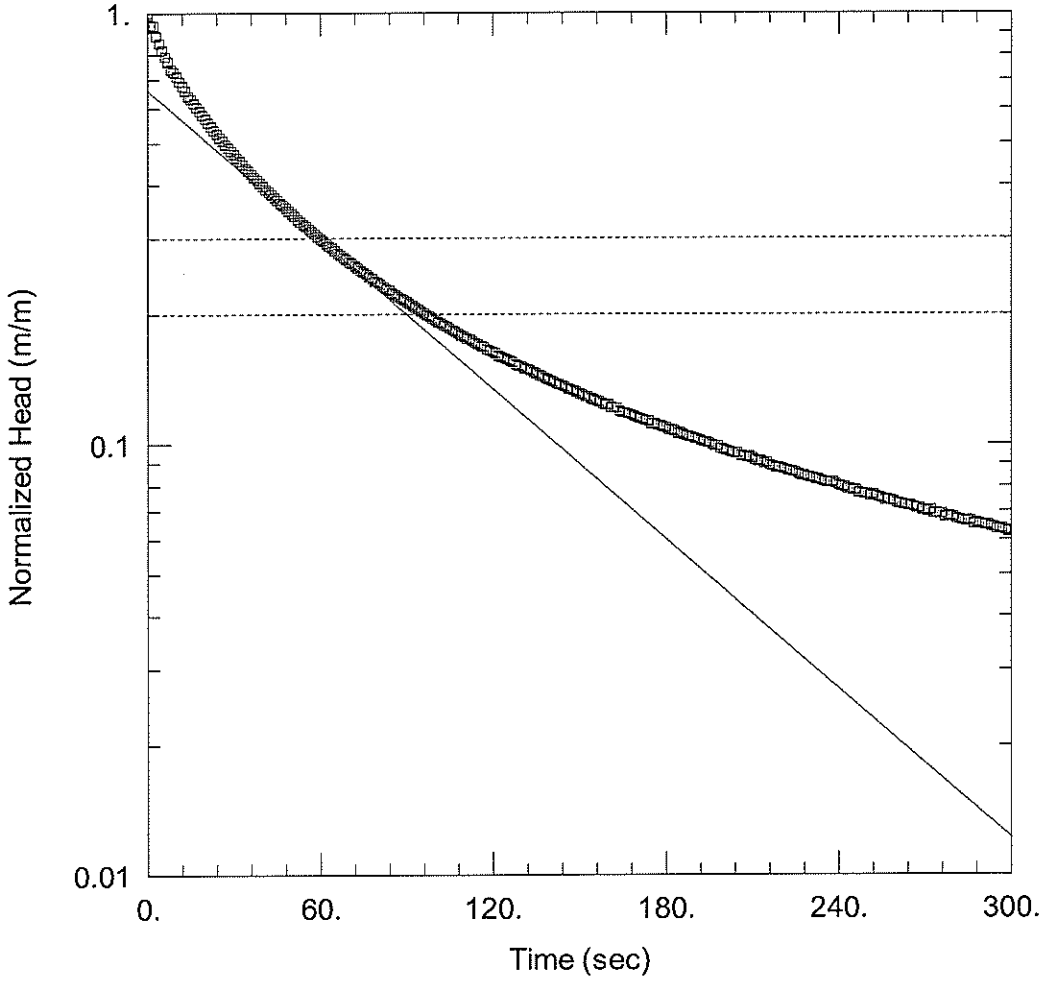
Other: ______

Analysis	Type		Container Size							Filtered		Preservatives
			40 mL	100 mL	250 mL	500 mL	1 L	2 L	4 L			
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	
	☐ Plastic	☐ Glass								☐ Yes	☐ No	

SCN No. Consumables: ☐ D.O. Ampoules ______ ☐ Alkalinity Test ______ ☐ Other ______

APPENDIX D

Slug Test Data



WELL TEST ANALYSIS

Data Set: \...\Breaburn Slug Test #2 31-Jul-12 RISING HEAD revGP.aqt
Date: 08/23/12 Time: 15:19:41

PROJECT INFORMATION

Test Well: BN-MW12-01
Test Date: 31-July-2012

AQUIFER DATA

Saturated Thickness: 20. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BN-MW12-01)

Initial Displacement: 0.817 m
Total Well Penetration Depth: 52.86 m
Casing Radius: 0.025 m
Static Water Column Height: 52.86 m
Screen Length: 3.05 m
Well Radius: 0.076 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 6.058E-6 m/sec
y0 = 0.542 m

Single-well Response Test Data Sheet

☐ Rising Head
☑ Falling Head

Well No.: BN-MW12-01
Location:
Project No.:
Completed By:
Date:
Time: 14:20

MONITORING WELL INFORMATION

Depth to water below top of casing: 10.47 meters
Depth to bottom of well below top of casing: ____ meters
Distance from top of pipe to ground surface: ____ meters
Well casing diameter: ____ meters (1 inch = 0.025 meters)
Borehold diameter: ____ meters
Screen length: ____ meters (1 foot = 0.3048 meters)
Screened unit: ____ (eg: sand, silt, clay)

EQUIPMENT LIST

☐ Slug
Mass: ____ kilograms
Length: 1.5 meters
Diameter: ____ meters

☐ Bailer
Water column height: ____ meters
Inside diameter: ____ meters
and/or Volume of water removed: ____ litres

Pressure transducer serial #: ____
Sampling Interval: ____ seconds or minutes (circle one)

SINGLE-WELL RESPONSE TEST

Start time: ____ Finish time: ____

Time	Elapsed Time	Water Level (m)	Comments
14:25			TX in 20m BTOC
14:30	0	10.23	SLUG IN
15:47	77	10.47	SLUG OUT

APPENDIX E

Analytical Reports and Chain of Custody Forms

Table E-1
Results of Water Analyses - Metals
YTG Landfill Monitoring, Braeburn, Yukon

SCN Location QA/QC Date	Drinking Water CSR-DW	Aquatic Life CSR-AW (freshwater)	Notes	L1187882-1 BN-SURFACE 31-JUL-12	L1187882-2 BN-MW12-01 30-JUL-12	L1187882-3 BN-MW12-03 31-JUL-12
Parameters						
pH (field)				7.02	6.98	7.06
Temperature °C				13.10	15.10	11.06
Conductivity (uS/cm)				-	-	-
Dissolved Oxygen (mg/L)				-	-	-
Laboratory Parameters						
pH (laboratory)				8.02	7.40	7.41
Hardness (as CaCO3)				333	838	660
total dissolved solids				520	1900	1170
Aggregate Organics						
COD				<20	<20	91
dissolved organic carbon				6.96	1.68	14.7
Bacteriological						
Coliform Bacteria - Fecal				<2	<2	8
Dissolved Metals						
aluminum	**0.2**			<0.010	<0.010	<0.010
antimony	**0.006**	0.2		<0.00050	0.00070	0.00329
arsenic	**0.025**	0.05		0.00066	0.00047	0.00066
barium	**1**	10		0.035	<0.020	0.048
beryllium		0.053		<0.0050	<0.0050	<0.0050
bismuth				<0.20	<0.20	<0.20
boron	**5**			<0.10	0.44	<0.10
cadmium	**0.005**	0.0001 - 0.0006	H	<0.00020	<0.00020	<0.00020
calcium				86.9	151	147
chromium	**0.05**	0.010^{VI}, 0.090^{III}	V	<0.0020	<0.0020	<0.0020
cobalt		0.009		*<0.010*	*<0.010*	*0.010*
copper	**1**	0.020 - 0.090	H	<0.0010	<0.0010	<0.0010
iron	**0.3**			0.061	**0.965**	<0.030
lead	**0.01**	0.040 - 0.160	H	<0.00050	<0.00050	<0.00050
lithium				<0.010	0.191	0.012
magnesium	**100**			28.2	**112**	71.5
manganese	**0.05**			0.0253	**0.0527**	**1.84**
mercury	**0.001**	0.001		<0.00020	<0.00020	<0.00020
molybdenum	**0.250**	10		<0.030	<0.030	<0.030
nickel		0.250 - 1.5	H	<0.050	<0.050	<0.050
phosphorus				<0.30	<0.30	<0.30
potassium				1.64	9.68	6.84
selenium	**0.01**	0.01		<0.0010	<0.0010	<0.0010
silicon				4.64	6.63	4.70
silver		0.0005 - 0.015	H	<0.010	<0.010	<0.010
sodium	**200**			11.1	**202**	34.6
strontium				1.03	10.7	3.18
thallium		0.003		*<0.20*	*<0.20*	*<0.20*
tin				<0.030	<0.030	<0.030
titanium		1		<0.010	<0.010	0.010
uranium	**0.1**	3		0.00068	0.00028	0.00319
vanadium				<0.030	<0.030	<0.030
zinc	**5**	0.075 - 2.4	H	<0.050	<0.050	<0.050
Other Inorganics						
bicarbonate (CaCO3)				228	392	237
carbonate (CaCO3)				<2.0	<2.0	<2.0
hydroxide (CaCO3)				<2.0	<2.0	<2.0
total alkalinity (CaCO3)				228	392	237
ammonia		1.31 - 18.5	pH	0.0152	0.692	0.116
bromide (free)						
chloride	**250**			1.52	<10	11.4
fluoride	**1.5**	2 - 3	H	0.042	0.60	<0.20
nitrate (as N)	**10**	400		<0.0050	<0.10	<0.050
nitrite (as N)	**3.2**	0.2 - 2	Cl	<0.0010	<0.020	<0.010
total Kjeldahl nitrogen				0.301	0.732	0.94
sulphate	**500**	1000		164	**966**	**594**

Notes:
All concentrations in milligrams per litre (mg/L), unless otherwise noted.
Standards from the Yukon Contaminated Sites Regulation (CSR), from the Environment Act (O.I.C. 2002/171) its associated Schedules.
Land Use abbreviations: AW (Aquatic Life) and DW (Drinking Water).
H = standard is Hardness dependent
CL = standard is chloride dependent
pH = standard is pH dependent
V= Standard is valence dependent VI refers to chromium VI and III refers to chromium III
T = standard varies with temperature
MCS = Most Conservative Standard
FDA = field duplicate available
FD = field duplicate
QA/QC = quality assurance/quality control
SCN = sample control number
Italics indicates standard is below detection limit.
Bold= Exceeds CSR Drinking water (DW) standard.
COC = Chain of Custody

Table E-2
Results of Water Analyses - Hydrocarbons
YTG Landfill Monitoring, Braeburn, Yukon

SCN Location QA/QC Date	Drinking Water CSR-DW	Aquatic Life CSR-AW (freshwater)	Notes	L1187882-1 BN-SURFACE 31-JUL-12	L1187882-2 BN-MW12-01 30-JUL-12	L1187882-3 BN-MW12-03 31-JUL-12
Monoaromatic Hydrocarbons						
benzene	**0.005**	4		<0.00050	<0.00050	<0.00050
ethylbenzene	**0.0024**	2		<0.00050	<0.00050	<0.00050
styrene		0.72		<0.00050	<0.00050	<0.00050
toluene	**0.024**	0.390		<0.00050	<0.00050	<0.00050
ortho-xylene				<0.00050	<0.00050	<0.00050
meta- & para-xylene				<0.00050	<0.00050	<0.00050
total xylene	**0.3**			<0.00075	<0.00075	<0.00075
VHw_{6-10}	**15**	15		<0.10	<0.10	<0.10
VPHw		1.5		<0.10	<0.10	<0.10
Polycyclic Aromatic Hydrocarbons						
acenaphthene				<0.000050	<0.000050	<0.000050
acenaphthylene				<0.000050	<0.000050	<0.000050
acridine		0.0005		<0.000050	<0.000050	<0.000050
anthracene		0.001		<0.000050	<0.000050	<0.000050
benzo(a)anthracene		0.001		<0.000050	<0.000050	<0.000050
benzo(a)pyrene	**0.00001**	0.0001		<0.000010	<0.000010	<0.000010
benzo(b)fluoranthene				<0.000050	<0.000050	<0.000050
benzo(g,h,i)perylene				<0.000050	<0.000050	<0.000050
benzo(k)fluoranthene				<0.000050	<0.000050	<0.000050
chrysene				<0.000050	<0.000050	<0.000050
dibenzo(a,h)anthracene				<0.000050	<0.000050	<0.000050
fluoranthene		0.002		<0.000050	<0.000050	<0.000050
fluorene		0.12		<0.000050	<0.000050	<0.000050
indeno(1,2,3-c,d)pyrene				<0.000050	<0.000050	<0.000050
naphthalene		0.01		<0.000050	<0.000050	0.000056
phenanthrene		0.003		<0.000050	<0.000050	0.000103
pyrene		0.0002		<0.000050	<0.000050	<0.000050
quinoline		0.034		<0.000050	<0.000050	<0.000050
Other Hydrocarbons						
$EPHw_{10-19}$		5		<0.25	<0.25	<0.25
$EPHw_{19-32}$				<0.25	<0.25	<0.25
LEPHw		0.5		<0.25	<0.25	<0.25
HEPHw				<0.25	<0.25	<0.25
Miscellaneous Organics						
methyl tertiary butyl ether (MTBE)				<0.00050	<0.00050	<0.00050

Notes:
All concentrations in milligrams per litre (mg/L), unless otherwise noted.
Standards from the Yukon Contaminated Sites Regulation (CSR), from the Environment Act (O.I.C. 2002/171) its associated Schedules.
Land Use abbreviations: DW (Drinking Water) and AW (Aquatic Life).
FDA = field duplicate available
FD = field duplicate
QA/QC = quality assurance/quality control
SCN = sample control number
COC = Chain of Custody
$EPHw_{10-19}$ = extractable petroleum hydrocarbons, carbon range 10-19
LEPHw = light extractable petroleum hydrocarbons
Where water use for the protection of aquatic life applies, the standards for $EPHw_{10-19}$ is equivalent to LEPHw, when no LEPHw analysis is undertaken.
VPHw = volatile petroleum hydrocarbons
VHw_{6-10} = volatile hydrocarbons, carbon range 6-10
Where water use for the protection of aquatic life applies, the standards for VHw6-10 equivalent to VPHw, when no VPHw analysis is undertaken.
PAH = polycyclic aromatic hydrocarbon
Italics indicates standard is below detection limit.

GOLDER ASSOCIATES LTD.
ATTN: Andrea Badger
201B 170 Titanium Way
Whitehorse YT Y1A 0G1

Date Received: 01-AUG-12
Report Date: 14-AUG-12 15:47 (MT)
Version: FINAL

Client Phone: 867-334-7423

Certificate of Analysis

Lab Work Order #: L1187882

Project P.O. #: NOT SUBMITTED
Job Reference: 11-1436-0073/1600
C of C Numbers: 1
Legal Site Desc:

Amber Springer
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1187882-1	L1187882-2	L1187882-3		
	Description	SURFACE WATE	GROUND WATE	GROUND WATE		
	Sampled Date	31-JUL-12	30-JUL-12	31-JUL-12		
	Sampled Time	18:00	18:30	19:20		
	Client ID	BN-SURFACE	BN-MW12-01	BN-MW12-03		
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	333	838	660		
	pH (pH)	8.02	7.40	7.41		
	Total Dissolved Solids (mg/L)	520	1900	1170		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	228	392	237		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<2.0	<2.0	<2.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<2.0	<2.0	<2.0		
	Alkalinity, Total (as CaCO3) (mg/L)	228	392	237		
	Ammonia, Total (as N) (mg/L)	0.0152	0.692	0.116		
	Chloride (Cl) (mg/L)	1.52	<10	11.4		
	Fluoride (F) (mg/L)	0.042	0.60	<0.20		
	Nitrate (as N) (mg/L)	<0.0050	<0.10	<0.050		
	Nitrite (as N) (mg/L)	<0.0010	<0.020	<0.010		
	Total Kjeldahl Nitrogen (mg/L)	0.301	0.732	0.94		
	Sulfate (SO4) (mg/L)	164	966	594		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	6.96	1.68	14.7		
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	<0.010	<0.010	<0.010		
	Antimony (Sb)-Dissolved (mg/L)	<0.00050	0.00070	0.00329		
	Arsenic (As)-Dissolved (mg/L)	0.00066	0.00047	0.00066		
	Barium (Ba)-Dissolved (mg/L)	0.035	<0.020	0.048		
	Beryllium (Be)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050		
	Bismuth (Bi)-Dissolved (mg/L)	<0.20	<0.20	<0.20		
	Boron (B)-Dissolved (mg/L)	<0.10	0.44	<0.10		
	Cadmium (Cd)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020		
	Calcium (Ca)-Dissolved (mg/L)	86.9	151	147		
	Chromium (Cr)-Dissolved (mg/L)	<0.0020	<0.0020	<0.0020		
	Cobalt (Co)-Dissolved (mg/L)	<0.010	<0.010	0.010		
	Copper (Cu)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010		
	Iron (Fe)-Dissolved (mg/L)	0.061	0.965	<0.030		
	Lead (Pb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Lithium (Li)-Dissolved (mg/L)	<0.010	0.191	0.012		
	Magnesium (Mg)-Dissolved (mg/L)	28.2	112	71.5		
	Manganese (Mn)-Dissolved (mg/L)	0.0253	0.0527	1.84		
	Mercury (Hg)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020		
	Molybdenum (Mo)-Dissolved (mg/L)	<0.030	<0.030	<0.030		
	Nickel (Ni)-Dissolved (mg/L)	<0.050	<0.050	<0.050		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1187882-1	L1187882-2	L1187882-3		
	Description	SURFACE WATE	GROUND WATE	GROUND WATE		
	Sampled Date	31-JUL-12	30-JUL-12	31-JUL-12		
	Sampled Time	18:00	18:30	19:20		
	Client ID	BN-SURFACE	BN-MW12-01	BN-MW12-03		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30	<0.30		
	Potassium (K)-Dissolved (mg/L)	1.64	9.68	6.84		
	Selenium (Se)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010		
	Silicon (Si)-Dissolved (mg/L)	4.64	6.63	4.70		
	Silver (Ag)-Dissolved (mg/L)	<0.010	<0.010	<0.010		
	Sodium (Na)-Dissolved (mg/L)	11.1	202	34.6		
	Strontium (Sr)-Dissolved (mg/L)	1.03	10.7	3.18		
	Thallium (Tl)-Dissolved (mg/L)	<0.20	<0.20	<0.20		
	Tin (Sn)-Dissolved (mg/L)	<0.030	<0.030	<0.030		
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	0.010		
	Uranium (U)-Dissolved (mg/L)	0.00068	0.00028	0.00319		
	Vanadium (V)-Dissolved (mg/L)	<0.030	<0.030	<0.030		
	Zinc (Zn)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
Aggregate Organics	COD (mg/L)	<20	<20	91		
Volatile Organic Compounds	Benzene (mg/L)	<0.00050	<0.00050	<0.00050		
	Ethylbenzene (mg/L)	<0.00050	<0.00050	<0.00050		
	Methyl t-butyl ether (MTBE) (mg/L)	<0.00050	<0.00050	<0.00050		
	Styrene (mg/L)	<0.00050	<0.00050	<0.00050		
	Toluene (mg/L)	<0.00050	<0.00050	<0.00050		
	ortho-Xylene (mg/L)	<0.00050	<0.00050	<0.00050		
	meta- & para-Xylene (mg/L)	<0.00050	<0.00050	<0.00050		
	Xylenes (mg/L)	<0.00075	<0.00075	<0.00075		
	Surrogate: 4-Bromofluorobenzene (SS) (%)	85.9	84.4	83.6		
	Surrogate: 1,4-Difluorobenzene (SS) (%)	85.4	85.2	85.1		
Hydrocarbons	EPH10-19 (mg/L)	<0.25	<0.25	<0.25		
	EPH19-32 (mg/L)	<0.25	<0.25	<0.25		
	LEPH (mg/L)	<0.25	<0.25	<0.25		
	HEPH (mg/L)	<0.25	<0.25	<0.25		
	Volatile Hydrocarbons (VH6-10) (mg/L)	<0.10	<0.10	<0.10		
	VPH (C6-C10) (mg/L)	<0.10	<0.10	<0.10		
	Surrogate: 3,4-Dichlorotoluene (SS) (%)	97.2	83.8	92.8		
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/L)	<0.000050	<0.000050	<0.000050		
	Acenaphthylene (mg/L)	<0.000050	<0.000050	<0.000050		
	Acridine (mg/L)	<0.000050	<0.000050	<0.000050		
	Anthracene (mg/L)	<0.000050	<0.000050	<0.000050		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1187882-1	L1187882-2	L1187882-3		
	Description	SURFACE WATE	GROUND WATE	GROUND WATE		
	Sampled Date	31-JUL-12	30-JUL-12	31-JUL-12		
	Sampled Time	18:00	18:30	19:20		
	Client ID	BN-SURFACE	BN-MW12-01	BN-MW12-03		
Grouping	**Analyte**					
WATER						
Polycyclic Aromatic Hydrocarbons	Benz(a)anthracene (mg/L)	<0.000050	<0.000050	<0.000050		
	Benzo(a)pyrene (mg/L)	<0.000010	<0.000010	<0.000010		
	Benzo(b)fluoranthene (mg/L)	<0.000050	<0.000050	<0.000050		
	Benzo(g,h,i)perylene (mg/L)	<0.000050	<0.000050	<0.000050		
	Benzo(k)fluoranthene (mg/L)	<0.000050	<0.000050	<0.000050		
	Chrysene (mg/L)	<0.000050	<0.000050	<0.000050		
	Dibenz(a,h)anthracene (mg/L)	<0.000050	<0.000050	<0.000050		
	Fluoranthene (mg/L)	<0.000050	<0.000050	<0.000050		
	Fluorene (mg/L)	<0.000050	<0.000050	<0.000050		
	Indeno(1,2,3-c,d)pyrene (mg/L)	<0.000050	<0.000050	<0.000050		
	Naphthalene (mg/L)	<0.000050	<0.000050	0.000056		
	Phenanthrene (mg/L)	<0.000050	<0.000050	0.000103		
	Pyrene (mg/L)	<0.000050	<0.000050	<0.000050		
	Quinoline (mg/L)	<0.000050	<0.000050	<0.000050		
	Surrogate: Acenaphthene d10 (%)	91.1	84.1	93.8		
	Surrogate: Acridine d9 (%)	93.9	86.3	98.8		
	Surrogate: Chrysene d12 (%)	79.4	73.4	81.8		
	Surrogate: Naphthalene d8 (%)	90.2	83.0	93.5		
	Surrogate: Phenanthrene d10 (%)	95.2	86.5	98.2		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Sulfate (SO4)	MS-B	L1187882-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Boron (B)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Dissolved Organic Carbon	MS-B	L1187882-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1187882-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1187882-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-SCR-VA	Water	Alkalinity by colour or titration	EPA 310.2 OR APHA 2320

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.
OR
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-CL-IC-WR	Water	Chloride by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

ANIONS-F-IC-WR	Water	Fluoride by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

ANIONS-NO2-IC-WR	Water	Nitrite Nitrogen by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ANIONS-NO3-IC-WR	Water	Nitrate Nitrogen by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ANIONS-SO4-IC-WR	Water	Sulphate by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

COD-COL-VA	Water	Chemical Oxygen Demand by Colorimetric	APHA 5220 D. CHEMICAL OXYGEN DEMAND

Reference Information

This analysis is carried out using procedures adapted from APHA Method 5220 "Chemical Oxygen Demand (COD)". Chemical oxygen demand is determined using the closed reflux colourimetric method.

EPH-SF-FID-VA	Water	EPH in Water by GCFID	BCMOE EPH GCFID

This analysis is carried out in accordance with the British Columbia Ministry of Environment, Lands and Parks (BCMELP) Analytical Method for Contaminated Sites "Extractable Petroleum Hydrocarbons in Water by GC/FID" (Version 2.1, July 1999). The procedure involves extraction of the entire water sample with dichloromethane. The extract is then solvent exchanged to toluene and analysed by capillary column gas chromatography with flame ionization detection (GC/FID). EPH results include Polycyclic Aromatic Hydrocarbons (PAH) and are therefore not equivalent to Light and Heavy Extractable Petroleum Hydrocarbons (LEPH/HEPH).

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-DIS-CVAFS-VA	Water	Dissolved Mercury in Water by CVAFS	EPA SW-846 3005A & EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by filtration (EPA Method 3005A) and involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry (EPA Method 245.7).

LEPH/HEPH-CALC-VA	Water	LEPHs and HEPHs	BC MOE LABORATORY MANUAL (2005)

Light and Heavy Extractable Petroleum Hydrocarbons in water. These results are determined according to the British Columbia Ministry of Environment, Lands, and Parks Analytical Method for Contaminated Sites "Calculation of Light and Heavy Extractable Petroleum Hydrocarbons in Solids or Water". According to this method, LEPH and HEPH are calculated by subtracting selected Polycyclic Aromatic Hydrocarbon results from Extractable Petroleum Hydrocarbon results. To calculate LEPH, the individual results for Acenaphthene, Acridine, Anthracene, Fluorene, Naphthalene and Phenanthrene are subtracted from EPH(C10-19). To calculate HEPH, the individual results for Benz(a)anthracene, Benzo(a)pyrene, Fluoranthene, and Pyrene are subtracted from EPH(C19-32). Analysis of Extractable Petroleum Hydrocarbons adheres to all prescribed elements of the BCMELP method "Extractable Petroleum Hydrocarbons in Water by GC/FID" (Version 2.1, July 20, 1999).

MET-DIS-ICP-VA	Water	Dissolved Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-DIS-LOW-MS-VA	Water	Dissolved Metals in Water by ICPMS(Low)	EPA SW-846 3005A/6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures involves preliminary sample treatment by filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

PAH-SF-MS-VA	Water	PAH in Water by GCMS	EPA 3510, 8270

The entire water sample is extracted with dichloromethane, prior to analysis by gas chromatography with mass spectrometric detection (GC/MS). Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.

PAH-SURR-MS-VA	Water	PAH Surrogates for Waters	EPA 3510, 8270

Analysed as per the corresponding PAH test method. Known quantities of surrogate compounds are added prior to analysis to each sample to demonstrate analytical accuracy.

PH-MAN-VA	Water	pH by Manual Meter	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

It is recommended that this analysis be conducted in the field.

PH-MAN-VA	Water	pH by Manual Meter	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

It is recommended that this analysis be conducted in the field.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TKN-F-VA	Water	TKN in Water by Fluorescence	APHA 4500-NORG D.

Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

VH-HSFID-VA	Water	VH in Water by Headspace GCFID	B.C. MIN. OF ENV. LAB. MAN. (2009)

The water sample, with added reagents, is heated in a sealed vial to equilibrium. The headspace from the vial is transfered into a gas chromatograph. Compounds eluting between n-hexane and n-decane are measured and summed together using flame-ionization detection.

VH-SURR-FID-VA	Water	VH Surrogates for Waters	B.C. MIN. OF ENV. LAB. MAN. (2009)
VOC7-HSMS-VA	Water	BTEX/MTBE/Styrene by Headspace GCMS	EPA8260B, 5021

The water sample, with added reagents, is heated in a sealed vial to equilibrium. The headspace from the vial is transfered into a gas chromatograph. Target compound concentrations are measured using mass spectrometry detection.

VOC7/VOC-SURR-MS-VA	Water	VOC7 and/or VOC Surrogates for Waters	EPA8260B, 5021
VPH-CALC-VA	Water	VPH is VH minus select aromatics	BC MOE LABORATORY MANUAL (2005)

These results are determined according to the British Columbia Ministry of Environment Analytical Method for Contaminated Sites "Calculation of Volatile Petroleum Hydrocarbons in Solids or Water". The concentrations of specific Monocyclic Aromatic Hydrocarbons (Benzene, Toluene, Ethylbenzene, Xylenes and, in solids, Styrene) are subtracted from the collective concentration of Volatile Hydrocarbons (VH) that elute between n-hexane (nC6) and n-decane (nC10).

XYLENES-CALC-VA	Water	Sum of Xylene Isomer Concentrations	CALCULATION

Calculation of Total Xylenes

Total Xylenes is the sum of the concentrations of the ortho, meta, and para Xylene isomers. Results below detection limit (DL) are treated as zero. The DL for Total Xylenes is set to a value no less than the square root of the sum of the squares of the DLs of the individual Xylenes.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA

Chain of Custody Numbers:

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GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1187882 Report Date: 14-AUG-12

Client: GOLDER ASSOCIATES LTD.
201B 170 Titanium Way
Whitehorse YT Y1A 0G1
Contact: Andrea Badger

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-SCR-VA	**Water**							
Batch R2411858								
WG1520956-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			101.7		%		85-115	03-AUG-12
WG1520956-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			102.5		%		85-115	03-AUG-12
WG1520956-9 DUP		**L1187882-1**						
Alkalinity, Total (as CaCO3)		228	227		mg/L	0.6	20	03-AUG-12
WG1520956-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	03-AUG-12
WG1520956-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	03-AUG-12
WG1520956-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	03-AUG-12
ANIONS-CL-IC-WR	**Water**							
Batch R2411871								
WG1520928-3 DUP		**L1187882-1**						
Chloride (Cl)		1.52	1.52		mg/L	0.4	20	02-AUG-12
WG1520928-2 LCS								
Chloride (Cl)			99.0		%		85-115	02-AUG-12
WG1520928-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	02-AUG-12
WG1520928-4 MS		**L1187882-1**						
Chloride (Cl)			99.0		%		75-125	02-AUG-12
ANIONS-F-IC-WR	**Water**							
Batch R2411871								
WG1520928-3 DUP		**L1187882-1**						
Fluoride (F)		0.042	0.049		mg/L	16	20	02-AUG-12
WG1520928-2 LCS								
Fluoride (F)			93.6		%		85-115	02-AUG-12
WG1520928-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	02-AUG-12
WG1520928-4 MS		**L1187882-1**						
Fluoride (F)			89.1		%		75-125	02-AUG-12
ANIONS-NO2-IC-WR	**Water**							
Batch R2411871								
WG1520928-3 DUP		**L1187882-1**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	02-AUG-12
WG1520928-2 LCS								
Nitrite (as N)			106.1		%		85-115	02-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO2-IC-WR	**Water**							
Batch R2411871								
WG1520928-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	02-AUG-12
WG1520928-4 MS		**L1187882-1**						
Nitrite (as N)			97.9		%		75-125	02-AUG-12
ANIONS-NO3-IC-WR	**Water**							
Batch R2411871								
WG1520928-3 DUP		**L1187882-1**						
Nitrate (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	02-AUG-12
WG1520928-2 LCS								
Nitrate (as N)			100.6		%		85-115	02-AUG-12
WG1520928-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	02-AUG-12
WG1520928-4 MS		**L1187882-1**						
Nitrate (as N)			103.1		%		75-125	02-AUG-12
ANIONS-SO4-IC-WR	**Water**							
Batch R2411871								
WG1520928-3 DUP		**L1187882-1**						
Sulfate (SO4)		164	164		mg/L	0.1	20	02-AUG-12
WG1520928-2 LCS								
Sulfate (SO4)			103.1		%		85-115	02-AUG-12
WG1520928-1 MB								
Sulfate (SO4)			<0.50		mg/L		0.5	02-AUG-12
WG1520928-4 MS		**L1187882-1**						
Sulfate (SO4)			N/A	MS-B	%		-	02-AUG-12
CARBONS-DOC-VA	**Water**							
Batch R2413817								
WG1523471-2 CRM		**VA-DOC-C-CAFFEINE**						
Dissolved Organic Carbon			92.2		%		80-120	08-AUG-12
WG1523471-4 CRM		**VA-DOC-C-CAFFEINE**						
Dissolved Organic Carbon			93.5		%		80-120	08-AUG-12
WG1523471-6 CRM		**VA-DOC-C-CAFFEINE**						
Dissolved Organic Carbon			96.3		%		80-120	08-AUG-12
WG1523471-1 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	08-AUG-12
WG1523471-3 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	08-AUG-12
WG1523471-5 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	08-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CARBONS-DOC-VA	**Water**							
Batch R2413817								
WG1523471-8 MS		**L1187882-3**						
Dissolved Organic Carbon			N/A	MS-B	%		-	08-AUG-12
WG1523471-9 MS		**L1189257-5**						
Dissolved Organic Carbon			109.8		%		70-130	08-AUG-12
COD-COL-VA	**Water**							
Batch R2413825								
WG1523427-10 LCS								
COD			103.5		%		85-115	09-AUG-12
WG1523427-2 LCS								
COD			103.5		%		85-115	09-AUG-12
WG1523427-6 LCS								
COD			103.9		%		85-115	09-AUG-12
WG1523427-1 MB								
COD			<20		mg/L		20	09-AUG-12
WG1523427-5 MB								
COD			<20		mg/L		20	09-AUG-12
WG1523427-9 MB								
COD			<20		mg/L		20	09-AUG-12
WG1523427-4 MS		**L1190063-2**						
COD			103.9		%		75-125	09-AUG-12
WG1523427-8 MS		**L1190065-14**						
COD			104.8		%		75-125	09-AUG-12
EPH-SF-FID-VA	**Water**							
Batch R2410047								
WG1520830-1 MB								
EPH10-19			<0.25		mg/L		0.25	05-AUG-12
EPH19-32			<0.25		mg/L		0.25	05-AUG-12
HG-DIS-CVAFS-VA	**Water**							
Batch R2411028								
WG1520232-17 DUP		**L1187882-1**						
Mercury (Hg)-Dissolved		<0.00020	<0.000050	RPD-NA	mg/L	N/A	20	03-AUG-12
WG1520932-2 LCS								
Mercury (Hg)-Dissolved			100.2		%		80-120	03-AUG-12
WG1520232-1 MB								
Mercury (Hg)-Dissolved			<0.000050		mg/L		0.00005	03-AUG-12
WG1520932-1 MB								
Mercury (Hg)-Dissolved			<0.000050		mg/L		0.00005	03-AUG-12
WG1520232-10 MS		**L1188330-3**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-DIS-CVAFS-VA	**Water**							
Batch R2411028								
WG1520232-10 MS		**L1188330-3**						
Mercury (Hg)-Dissolved			80.0		%		70-130	03-AUG-12
WG1520232-18 MS		**L1187882-2**						
Mercury (Hg)-Dissolved			91.7		%		70-130	03-AUG-12
WG1520232-6 MS		**L1188408-3**						
Mercury (Hg)-Dissolved			91.9		%		70-130	03-AUG-12
MET-DIS-ICP-VA	**Water**							
Batch R2410969								
WG1520232-2 CRM		**VA-HIGH-WATRM**						
Beryllium (Be)-Dissolved			95.8		%		80-120	03-AUG-12
Bismuth (Bi)-Dissolved			100.0		%		80-120	03-AUG-12
Cobalt (Co)-Dissolved			95.4		%		80-120	03-AUG-12
Iron (Fe)-Dissolved			97.6		%		80-120	03-AUG-12
Lithium (Li)-Dissolved			101.6		%		80-120	03-AUG-12
Molybdenum (Mo)-Dissolved			97.1		%		80-120	03-AUG-12
Nickel (Ni)-Dissolved			97.4		%		80-120	03-AUG-12
Phosphorus (P)-Dissolved			100.3		%		80-120	03-AUG-12
Silicon (Si)-Dissolved			103.9		%		80-120	03-AUG-12
Silver (Ag)-Dissolved			98.0		%		80-120	03-AUG-12
Sodium (Na)-Dissolved			97.7		%		80-120	03-AUG-12
Strontium (Sr)-Dissolved			95.2		%		80-120	03-AUG-12
Thallium (Tl)-Dissolved			98.3		%		80-120	03-AUG-12
Tin (Sn)-Dissolved			98.2		%		80-120	03-AUG-12
Titanium (Ti)-Dissolved			101.8		%		80-120	03-AUG-12
Vanadium (V)-Dissolved			97.7		%		80-120	03-AUG-12
WG1520232-1 MB								
Beryllium (Be)-Dissolved			<0.0050		mg/L		0.005	03-AUG-12
Bismuth (Bi)-Dissolved			<0.20		mg/L		0.2	03-AUG-12
Cobalt (Co)-Dissolved			<0.010		mg/L		0.01	03-AUG-12
Iron (Fe)-Dissolved			<0.030		mg/L		0.03	03-AUG-12
Lithium (Li)-Dissolved			<0.010		mg/L		0.01	03-AUG-12
Molybdenum (Mo)-Dissolved			<0.030		mg/L		0.03	03-AUG-12
Nickel (Ni)-Dissolved			<0.050		mg/L		0.05	03-AUG-12
Phosphorus (P)-Dissolved			<0.30		mg/L		0.3	03-AUG-12
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	03-AUG-12
Silver (Ag)-Dissolved			<0.010		mg/L		0.01	03-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-VA	**Water**							
Batch R2410969								
WG1520232-1 MB								
Sodium (Na)-Dissolved			<2.0		mg/L		2	03-AUG-12
Strontium (Sr)-Dissolved			<0.0050		mg/L		0.005	03-AUG-12
Thallium (Tl)-Dissolved			<0.20		mg/L		0.2	03-AUG-12
Tin (Sn)-Dissolved			<0.030		mg/L		0.03	03-AUG-12
Titanium (Ti)-Dissolved			<0.010		mg/L		0.01	03-AUG-12
Vanadium (V)-Dissolved			<0.030		mg/L		0.03	03-AUG-12
Batch R2413721								
WG1520232-10 MS		**L1188330-3**						
Iron (Fe)-Dissolved			91.1		%		70-130	08-AUG-12
Sodium (Na)-Dissolved			104.1		%		70-130	08-AUG-12
Titanium (Ti)-Dissolved			104.2		%		70-130	08-AUG-12
WG1520232-6 MS		**L1188408-3**						
Iron (Fe)-Dissolved			97.2		%		70-130	08-AUG-12
Sodium (Na)-Dissolved			106.4		%		70-130	08-AUG-12
Titanium (Ti)-Dissolved			109.1		%		70-130	08-AUG-12
Batch R2413842								
WG1520232-17 DUP		**L1187882-1**						
Beryllium (Be)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	09-AUG-12
Bismuth (Bi)-Dissolved		<0.20	<0.20	RPD-NA	mg/L	N/A	20	09-AUG-12
Cobalt (Co)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	09-AUG-12
Iron (Fe)-Dissolved		0.061	0.060		mg/L	0.6	20	09-AUG-12
Lithium (Li)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	09-AUG-12
Molybdenum (Mo)-Dissolved		<0.030	<0.030	RPD-NA	mg/L	N/A	20	09-AUG-12
Nickel (Ni)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	09-AUG-12
Phosphorus (P)-Dissolved		<0.30	<0.30	RPD-NA	mg/L	N/A	20	09-AUG-12
Silicon (Si)-Dissolved		4.64	4.72		mg/L	1.8	20	09-AUG-12
Silver (Ag)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	09-AUG-12
Sodium (Na)-Dissolved		11.1	11.2		mg/L	1.1	20	09-AUG-12
Strontium (Sr)-Dissolved		1.03	1.04		mg/L	0.7	20	09-AUG-12
Thallium (Tl)-Dissolved		<0.20	<0.20	RPD-NA	mg/L	N/A	20	09-AUG-12
Tin (Sn)-Dissolved		<0.030	<0.030	RPD-NA	mg/L	N/A	20	09-AUG-12
Titanium (Ti)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	09-AUG-12
Vanadium (V)-Dissolved		<0.030	<0.030	RPD-NA	mg/L	N/A	20	09-AUG-12
WG1520232-18 MS		**L1187882-2**						
Iron (Fe)-Dissolved			91.5		%		70-130	09-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-VA	**Water**							
Batch R2413842								
WG1520232-18 MS		**L1187882-2**						
Sodium (Na)-Dissolved			N/A	MS-B	%		-	09-AUG-12
Titanium (Ti)-Dissolved			102.1		%		70-130	09-AUG-12
Batch R2414246								
WG1520232-20 MS		**L1188753-4**						
Iron (Fe)-Dissolved			92.9		%		70-130	09-AUG-12
Sodium (Na)-Dissolved			N/A	MS-B	%		-	09-AUG-12
Titanium (Ti)-Dissolved			101.7		%		70-130	09-AUG-12
Batch R2414709								
WG1520232-12 MS		**L1188723-3**						
Iron (Fe)-Dissolved			97.8		%		70-130	09-AUG-12
Sodium (Na)-Dissolved			105.1		%		70-130	09-AUG-12
Titanium (Ti)-Dissolved			104.6		%		70-130	09-AUG-12
Batch R2416611								
WG1520232-4 MS		**L1186483-4**						
Iron (Fe)-Dissolved			101.9		%		70-130	13-AUG-12
Sodium (Na)-Dissolved			105.3		%		70-130	13-AUG-12
Titanium (Ti)-Dissolved			110.2		%		70-130	13-AUG-12
MET-DIS-LOW-MS-VA	**Water**							
Batch R2411052								
WG1520232-1 MB								
Aluminum (Al)-Dissolved			<0.0030		mg/L		0.003	03-AUG-12
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	03-AUG-12
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	03-AUG-12
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	03-AUG-12
Boron (B)-Dissolved			<0.010		mg/L		0.01	03-AUG-12
Cadmium (Cd)-Dissolved			<0.000050		mg/L		0.00005	03-AUG-12
Calcium (Ca)-Dissolved			<0.020		mg/L		0.02	03-AUG-12
Chromium (Cr)-Dissolved			<0.00050		mg/L		0.0005	03-AUG-12
Copper (Cu)-Dissolved			<0.00050		mg/L		0.0005	03-AUG-12
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	03-AUG-12
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	03-AUG-12
Manganese (Mn)-Dissolved			<0.000050		mg/L		0.00005	03-AUG-12
Potassium (K)-Dissolved			<0.050		mg/L		0.05	03-AUG-12
Selenium (Se)-Dissolved			<0.0010		mg/L		0.001	03-AUG-12
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	03-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-LOW-MS-VA	**Water**							
Batch R2411052								
WG1520232-1 MB								
Zinc (Zn)-Dissolved			<0.0030		mg/L		0.003	03-AUG-12
Batch R2411906								
WG1520232-2 CRM		**VA-HIGH-WATRM**						
Aluminum (Al)-Dissolved			99.0		%		80-120	03-AUG-12
Antimony (Sb)-Dissolved			102.0		%		80-120	03-AUG-12
Arsenic (As)-Dissolved			99.8		%		80-120	03-AUG-12
Barium (Ba)-Dissolved			100.6		%		80-120	03-AUG-12
Boron (B)-Dissolved			90.3		%		80-120	03-AUG-12
Cadmium (Cd)-Dissolved			101.1		%		80-120	03-AUG-12
Calcium (Ca)-Dissolved			98.5		%		80-120	03-AUG-12
Chromium (Cr)-Dissolved			99.5		%		80-120	03-AUG-12
Copper (Cu)-Dissolved			94.8		%		80-120	03-AUG-12
Lead (Pb)-Dissolved			100.0		%		80-120	03-AUG-12
Magnesium (Mg)-Dissolved			97.5		%		80-120	03-AUG-12
Manganese (Mn)-Dissolved			100.7		%		80-120	03-AUG-12
Potassium (K)-Dissolved			98.7		%		80-120	03-AUG-12
Selenium (Se)-Dissolved			99.5		%		80-120	03-AUG-12
Uranium (U)-Dissolved			102.8		%		80-120	03-AUG-12
Zinc (Zn)-Dissolved			98.2		%		80-120	03-AUG-12
Batch R2412115								
WG1520232-17 DUP		**L1187882-1**						
Aluminum (Al)-Dissolved		<0.010	<0.0030	RPD-NA	mg/L	N/A	20	03-AUG-12
Antimony (Sb)-Dissolved		<0.00050	<0.00010	RPD-NA	mg/L	N/A	20	03-AUG-12
Arsenic (As)-Dissolved		0.00066	0.00069		mg/L	4.3	20	03-AUG-12
Barium (Ba)-Dissolved		0.035	0.0341		mg/L	1.8	20	03-AUG-12
Boron (B)-Dissolved		<0.10	0.016		mg/L	0.7	20	03-AUG-12
Cadmium (Cd)-Dissolved		<0.00020	<0.000050	RPD-NA	mg/L	N/A	20	03-AUG-12
Calcium (Ca)-Dissolved		86.9	88.6		mg/L	2.0	20	03-AUG-12
Chromium (Cr)-Dissolved		<0.0020	<0.00050	RPD-NA	mg/L	N/A	20	03-AUG-12
Copper (Cu)-Dissolved		<0.0010	<0.00050	RPD-NA	mg/L	N/A	20	03-AUG-12
Lead (Pb)-Dissolved		<0.00050	<0.000050	RPD-NA	mg/L	N/A	20	03-AUG-12
Magnesium (Mg)-Dissolved		28.2	27.9		mg/L	0.8	20	03-AUG-12
Manganese (Mn)-Dissolved		0.0253	0.0247		mg/L	2.5	20	03-AUG-12
Potassium (K)-Dissolved		1.64	1.62		mg/L	1.6	20	03-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-LOW-MS-VA	**Water**							
Batch R2412115								
WG1520232-17 DUP		**L1187882-1**						
Selenium (Se)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	03-AUG-12
Uranium (U)-Dissolved		0.00068	0.000671		mg/L	1.5	20	03-AUG-12
Zinc (Zn)-Dissolved		<0.050	<0.0030	RPD-NA	mg/L	N/A	20	03-AUG-12
WG1520232-18 MS		**L1187882-2**						
Aluminum (Al)-Dissolved			91.1		%		70-130	03-AUG-12
Antimony (Sb)-Dissolved			105.4		%		70-130	03-AUG-12
Arsenic (As)-Dissolved			111.5		%		70-130	03-AUG-12
Barium (Ba)-Dissolved			142.3	MS-B	%		70-130	03-AUG-12
Boron (B)-Dissolved			N/A	MS-B	%		-	03-AUG-12
Cadmium (Cd)-Dissolved			98.2		%		70-130	03-AUG-12
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	03-AUG-12
Chromium (Cr)-Dissolved			85.1		%		70-130	03-AUG-12
Copper (Cu)-Dissolved			86.7		%		70-130	03-AUG-12
Lead (Pb)-Dissolved			93.2		%		70-130	03-AUG-12
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	03-AUG-12
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	03-AUG-12
Potassium (K)-Dissolved			N/A	MS-B	%		-	03-AUG-12
Selenium (Se)-Dissolved			113.4		%		70-130	03-AUG-12
Uranium (U)-Dissolved			100.3		%		70-130	03-AUG-12
Zinc (Zn)-Dissolved			86.0		%		70-130	03-AUG-12
WG1520232-6 MS		**L1188408-3**						
Aluminum (Al)-Dissolved			95.7		%		70-130	03-AUG-12
Antimony (Sb)-Dissolved			110.2		%		70-130	03-AUG-12
Arsenic (As)-Dissolved			114.3		%		70-130	03-AUG-12
Barium (Ba)-Dissolved			N/A	MS-B	%		-	03-AUG-12
Boron (B)-Dissolved			91.4		%		70-130	03-AUG-12
Cadmium (Cd)-Dissolved			103.1		%		70-130	03-AUG-12
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	03-AUG-12
Chromium (Cr)-Dissolved			90.5		%		70-130	03-AUG-12
Copper (Cu)-Dissolved			90.2		%		70-130	03-AUG-12
Lead (Pb)-Dissolved			97.6		%		70-130	03-AUG-12
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	03-AUG-12
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	03-AUG-12
Potassium (K)-Dissolved			N/A	MS-B	%		-	03-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-LOW-MS-VA	**Water**							
Batch R2412115								
WG1520232-6 MS		**L1188408-3**						
Selenium (Se)-Dissolved			113.2		%		70-130	03-AUG-12
Uranium (U)-Dissolved			103.4		%		70-130	03-AUG-12
Zinc (Zn)-Dissolved			90.7		%		70-130	03-AUG-12
Batch R2413555								
WG1520232-10 MS		**L1188330-3**						
Aluminum (Al)-Dissolved			125.1		%		70-130	08-AUG-12
Antimony (Sb)-Dissolved			116.8		%		70-130	08-AUG-12
Barium (Ba)-Dissolved			N/A	MS-B	%		-	08-AUG-12
Boron (B)-Dissolved			117.6		%		70-130	08-AUG-12
Cadmium (Cd)-Dissolved			121.0		%		70-130	08-AUG-12
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	08-AUG-12
Chromium (Cr)-Dissolved			116.5		%		70-130	08-AUG-12
Copper (Cu)-Dissolved			107.9		%		70-130	08-AUG-12
Lead (Pb)-Dissolved			104.1		%		70-130	08-AUG-12
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	08-AUG-12
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	08-AUG-12
Potassium (K)-Dissolved			117.2		%		70-130	08-AUG-12
Uranium (U)-Dissolved			109.3		%		70-130	08-AUG-12
Zinc (Zn)-Dissolved			108.0		%		70-130	08-AUG-12
NH3-F-VA	**Water**							
Batch R2413866								
WG1523592-10 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			103.1		%		85-115	09-AUG-12
WG1523592-12 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.1		%		85-115	09-AUG-12
WG1523592-14 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			104.0		%		85-115	09-AUG-12
WG1523592-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			106.7		%		85-115	09-AUG-12
WG1523592-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			105.1		%		85-115	09-AUG-12
WG1523592-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.7		%		85-115	09-AUG-12
WG1523592-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			103.1		%		85-115	09-AUG-12
WG1523592-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2413866								
WG1523592-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523592-11 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523592-13 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523592-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523592-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523592-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523592-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523592-16 MS		**L1188686-1**						
Ammonia, Total (as N)			96.2		%		75-125	09-AUG-12
Batch R2413931								
WG1523185-10 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.1		%		85-115	09-AUG-12
WG1523185-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			107.5		%		85-115	09-AUG-12
WG1523185-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			101.4		%		85-115	09-AUG-12
WG1523185-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			104.2		%		85-115	09-AUG-12
WG1523185-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.7		%		85-115	09-AUG-12
WG1523185-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523185-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523185-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523185-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523185-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	09-AUG-12
WG1523185-12 MS		**L1187799-1**						
Ammonia, Total (as N)			100.4		%		75-125	09-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R2413931								
WG1523185-14 MS		**L1188620-6**						
Ammonia, Total (as N)			96.0		%		75-125	09-AUG-12
PAH-SF-MS-VA	**Water**							
Batch R2410939								
WG1520830-2 LCS								
Acenaphthene			82.6		%		60-130	08-AUG-12
Acenaphthylene			82.0		%		60-130	08-AUG-12
Acridine			95.7		%		60-130	08-AUG-12
Anthracene			91.5		%		60-130	08-AUG-12
Benz(a)anthracene			84.6		%		60-130	08-AUG-12
Benzo(a)pyrene			84.5		%		60-130	08-AUG-12
Benzo(b)fluoranthene			85.0		%		60-130	08-AUG-12
Benzo(g,h,i)perylene			81.4		%		60-130	08-AUG-12
Benzo(k)fluoranthene			94.1		%		60-130	08-AUG-12
Chrysene			93.8		%		60-130	08-AUG-12
Dibenz(a,h)anthracene			90.5		%		60-130	08-AUG-12
Fluoranthene			91.6		%		60-130	08-AUG-12
Fluorene			85.5		%		60-130	08-AUG-12
Indeno(1,2,3-c,d)pyrene			82.3		%		60-130	08-AUG-12
Naphthalene			81.5		%		50-130	08-AUG-12
Phenanthrene			90.5		%		60-130	08-AUG-12
Pyrene			91.1		%		60-130	08-AUG-12
Quinoline			84.1		%		60-130	08-AUG-12
WG1520830-1 MB								
Acenaphthene			<0.000050		mg/L		0.00005	08-AUG-12
Acenaphthylene			<0.000050		mg/L		0.00005	08-AUG-12
Acridine			<0.000050		mg/L		0.00005	08-AUG-12
Anthracene			<0.000050		mg/L		0.00005	08-AUG-12
Benz(a)anthracene			<0.000050		mg/L		0.00005	08-AUG-12
Benzo(a)pyrene			<0.000010		mg/L		0.00001	08-AUG-12
Benzo(b)fluoranthene			<0.000050		mg/L		0.00005	08-AUG-12
Benzo(g,h,i)perylene			<0.000050		mg/L		0.00005	08-AUG-12
Benzo(k)fluoranthene			<0.000050		mg/L		0.00005	08-AUG-12
Chrysene			<0.000050		mg/L		0.00005	08-AUG-12
Dibenz(a,h)anthracene			<0.000050		mg/L		0.00005	08-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-SF-MS-VA	**Water**							
Batch R2410939								
WG1520830-1 MB								
Fluoranthene			<0.000050		mg/L		0.00005	08-AUG-12
Fluorene			<0.000050		mg/L		0.00005	08-AUG-12
Indeno(1,2,3-c,d)pyrene			<0.000050		mg/L		0.00005	08-AUG-12
Naphthalene			<0.000050		mg/L		0.00005	08-AUG-12
Phenanthrene			<0.000050		mg/L		0.00005	08-AUG-12
Pyrene			<0.000050		mg/L		0.00005	08-AUG-12
Quinoline			<0.000050		mg/L		0.00005	08-AUG-12
PH-MAN-VA	**Water**							
Batch R2411155								
WG1521136-1 CRM		**VA-PH7-BUF**						
pH			7.08		pH		6.9-7.1	04-AUG-12
TDS-VA	**Water**							
Batch R2411495								
WG1520318-11 LCS								
Total Dissolved Solids			100.8		%		85-115	03-AUG-12
WG1520318-2 LCS								
Total Dissolved Solids			98.2		%		85-115	03-AUG-12
WG1520318-5 LCS								
Total Dissolved Solids			97.1		%		85-115	03-AUG-12
WG1520318-8 LCS								
Total Dissolved Solids			100.1		%		85-115	03-AUG-12
WG1520318-1 MB								
Total Dissolved Solids			<10		mg/L		10	03-AUG-12
WG1520318-10 MB								
Total Dissolved Solids			<10		mg/L		10	03-AUG-12
WG1520318-4 MB								
Total Dissolved Solids			<10		mg/L		10	03-AUG-12
WG1520318-7 MB								
Total Dissolved Solids			<10		mg/L		10	03-AUG-12
TKN-F-VA	**Water**							
Batch R2415898								
WG1523528-2 LCS								
Total Kjeldahl Nitrogen			100.6		%		75-125	13-AUG-12
WG1523528-5 LCS								
Total Kjeldahl Nitrogen			99.4		%		75-125	13-AUG-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TKN-F-VA	**Water**							
Batch R2415898								
WG1523528-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	13-AUG-12
WG1523528-4 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	13-AUG-12
VH-HSFID-VA	**Water**							
Batch R2412492								
WG1524009-2 LCS								
Volatile Hydrocarbons (VH6-10)			101.6		%		70-130	10-AUG-12
WG1524009-1 MB								
Volatile Hydrocarbons (VH6-10)			<0.10		mg/L		0.1	10-AUG-12
VOC7-HSMS-VA	**Water**							
Batch R2412417								
WG1524009-2 LCS								
Benzene			96.5		%		70-130	09-AUG-12
Ethylbenzene			98.0		%		70-130	09-AUG-12
Methyl t-butyl ether (MTBE)			98.2		%		70-130	09-AUG-12
Styrene			97.0		%		70-130	09-AUG-12
Toluene			94.8		%		70-130	09-AUG-12
meta- & para-Xylene			97.0		%		70-130	09-AUG-12
ortho-Xylene			98.6		%		70-130	09-AUG-12
WG1524009-1 MB								
Benzene			<0.00050		mg/L		0.0005	09-AUG-12
Ethylbenzene			<0.00050		mg/L		0.0005	09-AUG-12
Methyl t-butyl ether (MTBE)			<0.00050		mg/L		0.0005	09-AUG-12
Styrene			<0.00050		mg/L		0.0005	09-AUG-12
Toluene			<0.00050		mg/L		0.0005	09-AUG-12
meta- & para-Xylene			<0.00050		mg/L		0.0005	09-AUG-12
ortho-Xylene			<0.00050		mg/L		0.0005	09-AUG-12

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Manual Meter							
	1	31-JUL-12 18:00	04-AUG-12 00:19	0.25	78	hours	EHTR-FM
	2	30-JUL-12 18:30	04-AUG-12 00:19	0.25	102	hours	EHTR-FM
	3	31-JUL-12 19:20	04-AUG-12 00:19	0.25	77	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1187882 were received on 01-AUG-12 13:25.

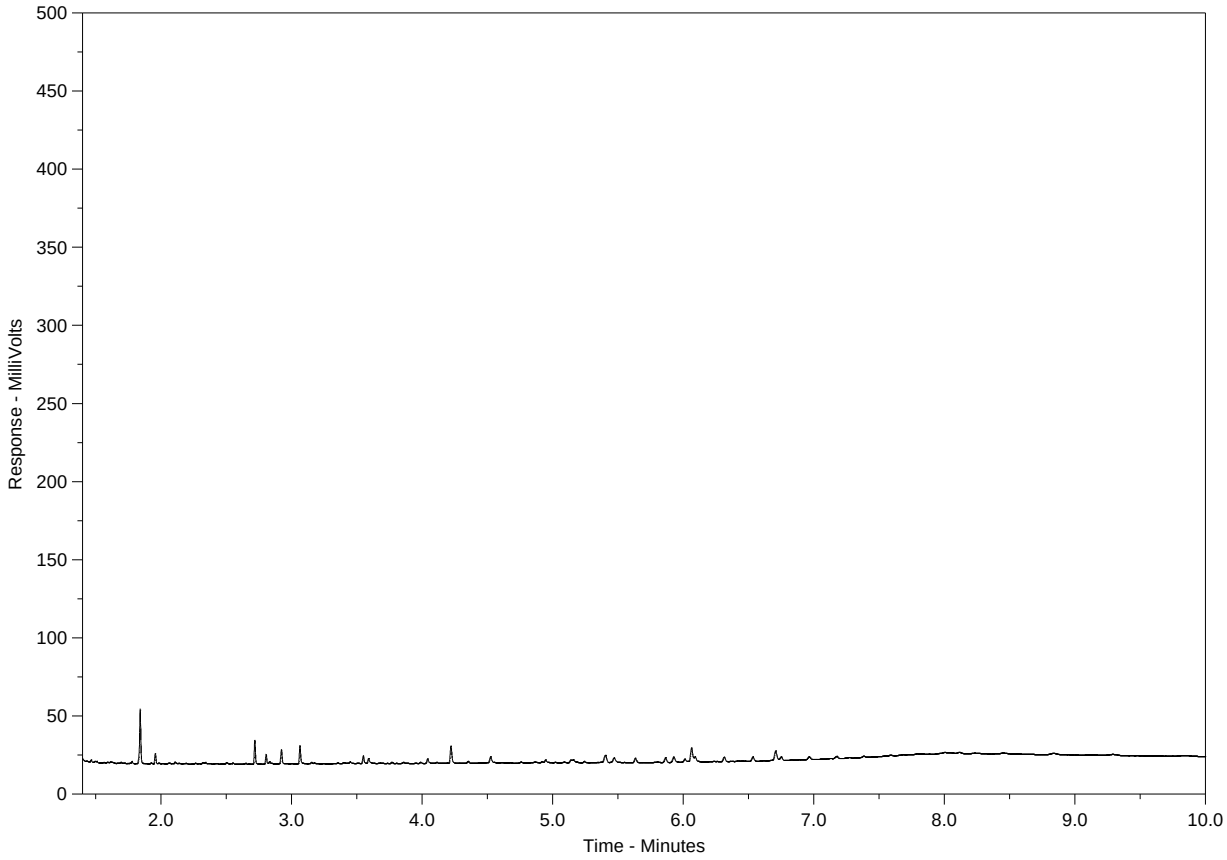
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Hydrocarbon Distribution Report

ALS Sample ID: L1187882-1
Client Sample ID: BN-SURFACE



nC10	nC19	nC32
174°C	330°C	467°C
346°F	626°F	873°F
← Gasoline →	← Motor Oils / Lube Oils / Grease →	
← Diesel / Jet Fuels →		

The EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample. For further interpretation, a current library of reference products is available on www.alsglobal.com or upon request.

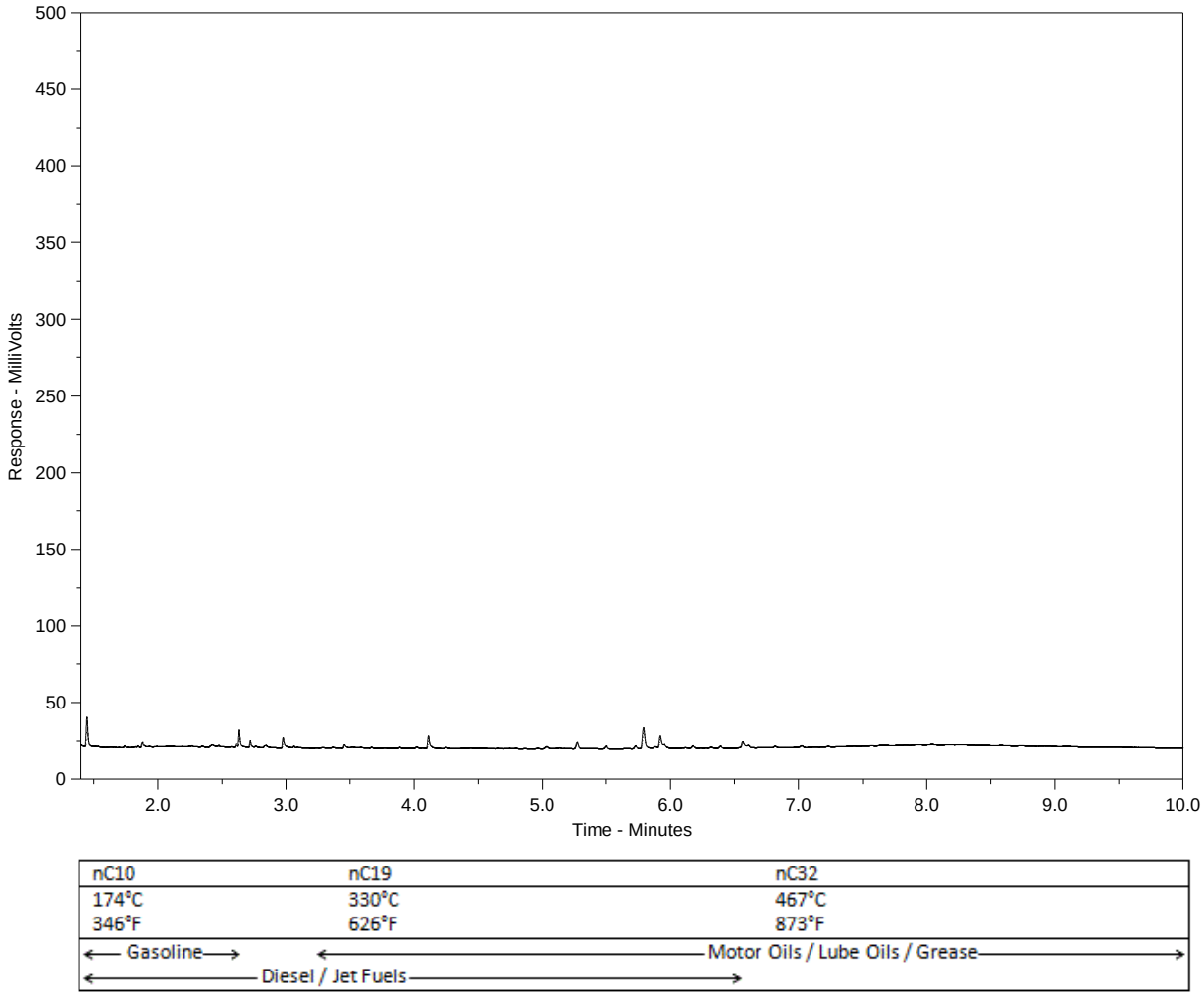
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples by as much as 0.5 minutes.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the response scale at the left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

Hydrocarbon Distribution Report

ALS Sample ID: L1187882-2
Client Sample ID: BN-MW12-01



nC10	nC19	nC32
174°C	330°C	467°C
346°F	626°F	873°F
← Gasoline →	← Motor Oils / Lube Oils / Grease →	
← Diesel / Jet Fuels →		

The EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample. For further interpretation, a current library of reference products is available on www.alsglobal.com or upon request.

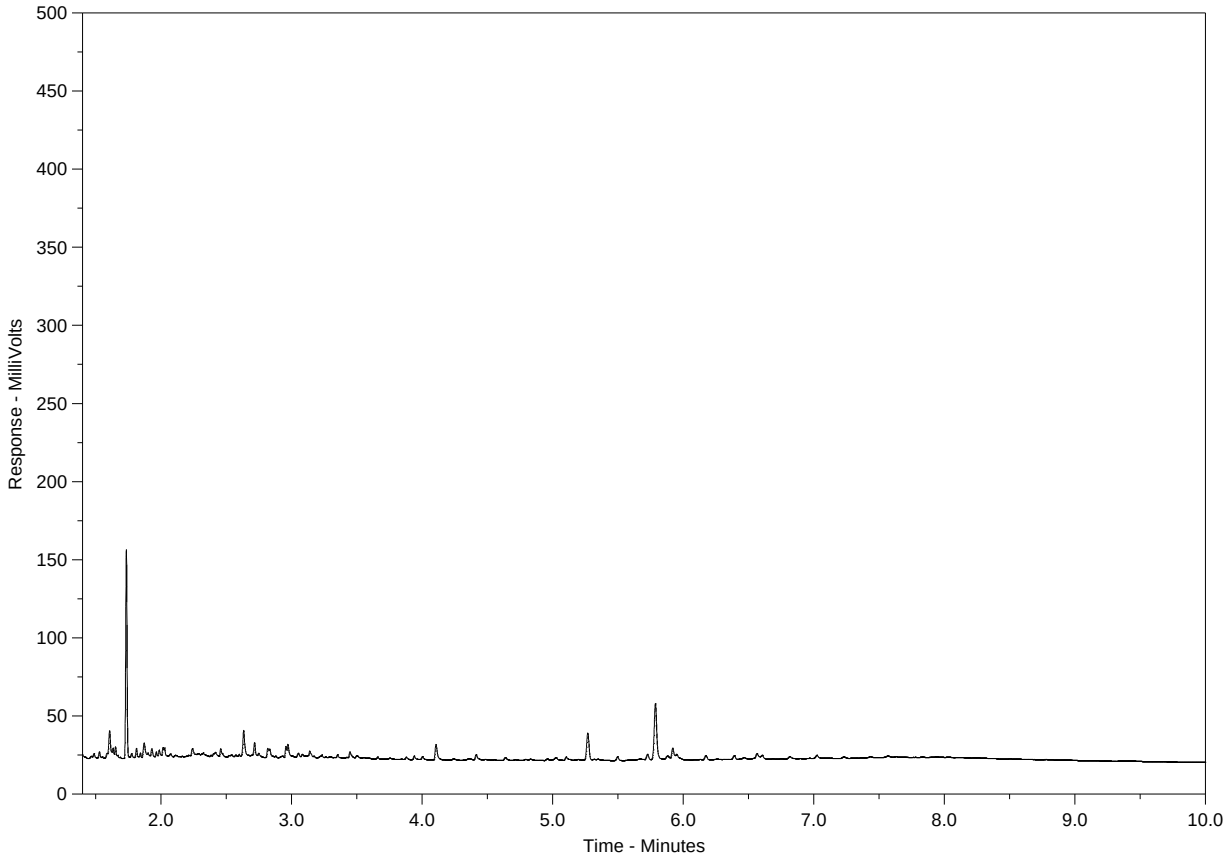
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples by as much as 0.5 minutes.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the response scale at the left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

Hydrocarbon Distribution Report

ALS Sample ID: L1187882-3
Client Sample ID: BN-MW12-03



nC10	nC19	nC32
174°C	330°C	467°C
346°F	626°F	873°F
← Gasoline →	← Motor Oils / Lube Oils / Grease →	
← Diesel / Jet Fuels →		

The EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample. For further interpretation, a current library of reference products is available on www.alsglobal.com or upon request.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples by as much as 0.5 minutes.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the response scale at the left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

ALS Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

COC # _____

Report To		Report Format / Distribution	Service Requested (Rush for routine analysis subject to availability)
Company:	Golder Associates	☑ Standard ☐ Other	◉ Regular (Standard Turnaround Times - Business Days)
Contact:	Andrea Badger	☑ PDF ☑ Excel ☐ Digital ☐ Fax	○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	201B 170 Titanium Way	Email 1: andrea_badger@golder.com	○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Whitehorse, YT Y1A 0G1	Email 2: gary_hamilton@golder.com	○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	867-633-6076 Fax:	Email 3: calvin_beebe@golder.com	
Invoice To	Same as Report ? ☑ Yes ☐ No	**Client / Project Information**	**Analysis Request**
Hardcopy of Invoice with Report?	☐ Yes ☐ No	Job #: 11-1436-0073/1600	Please indicate below Filtered, Preserved or both (F, P, F/P)
Company:		PO / AFE:	
Contact:		LSD:	
Address:			
Phone:	Fax:	Quote #:	
Lab Work Order # (lab use only)	L1187882	**ALS Contact:**	**Sampler:**

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Nutrients	General	DOC	BTEX	Dissolved Metals	PAH	Number of Containers
	BN-Surface	31-Jul-12	18:00	Surface Water	X	X	X	X	X	X	
	BN-MW12-01	30-Jul-12	18:30	Groundwater	X	X	X	X	X	X	
	BN-MW12-03	31-Jul-12	19:20	Groundwater	X	X	X	X	X	X	

L1187882-COFC

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Andrea Badger	1-Aug-12	13:15		01-Aug-12	13:25	4.3 °C				

Sample Receipt Confirmation

Report Distribution:

Company Name: GOLDER ASSOCIATES LTD.
Contact: Andrea Badger
Address: 201B 170 Titanium Way, Whitehorse, YT, Y1A 0G1
Phone: 867-334-7423
Fax: 867-633-6077
Email: andrea_badger@golder.com ghamilton@golder.com calvin_beebe@golder.com
Report Name: CROSSTAB_ALSQC
Digital Type: --
Digital Email: --
Distribution: Hard Copy: Email: Y Fax: N

Invoice Distribution:

Acct Name: GOLDER ASSOCIATES LTD.
Contact: Accounts Payable
Address: # 500 - 4260 Still Creek Drive, Burnaby, BC, V5C 6C6
Phone: 604-298-6623
Fax: --
Invoice Email: --
Project #: GOL050-GOL200-VA
Account #: GOL200

Client Information:

Job Reference #: 11-1436-0073/1600
Project PO #:
Legal Site Description: N/A
Quote #: N/A
Date Sampled: 30-JUL-12
Date Received: 01-AUG-12
Sampled By:
Chain Of Custody: 1

Workorder Summary:

Lab Work Order #: **L1187882**
Estimated completion date: 13-AUG-12
3 Samples received at ALS in **VANCOUVER**
Client Job #: 11-1436-0073/1600
Account Manager: Amber Springer
Estimated sample disposal date: 12-SEP-12

Lab Sample ID	Client Sample ID	Date Sampled	Date Received	Sample Due Date	Priority Flag	Sample Type
L1187882-1	BN-SURFACE	31-JUL-12 18:00	01-AUG-12 13:25	13-AUG-12		SURFACE WATER
L1187882-2	BN-MW12-01	30-JUL-12 18:30	01-AUG-12 13:25	13-AUG-12		GROUND WATER
L1187882-3	BN-MW12-03	31-JUL-12 19:20	01-AUG-12 13:25	13-AUG-12		GROUND WATER

Analysis Requested:

	Alkalinity by colour or titration	Anions by Ion Chromatography	BTEX+VPH+MTBE+Styrene in Water GCMS/FID	Dissolved organic carbon by combustion	Chemical Oxygen Demand by Colorimetric	LEPH & HEPH CSR by SF	Dissolved Metals in Water [DW] + ICP	Ammonia in Water by Fluorescence	pH by Manual Meter	Total Dissolved Solids by Gravimetric	TKN in Water by Fluorescence	Sample Handling and Disposal Fee
BN-SURFACE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BN-MW12-01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BN-MW12-03	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Hold Time Exceedences: The following samples have exceeded recommended holding times prior to sample receipt.

Analysis Requested	Lab Sample ID	Recommended Hold Time	Date Sampled	Date Received
	L1187882-1, 2, 3			

Hold Time Exceedences:

Analysis Requested	Lab Sample ID	Recommended Hold Time	Date Sampled	Date Received
pH by Manual Meter		0.25 hours	31-JUL-12	01-AUG-12
pH by Manual Meter	L1187882-1, 2, 3	0.25 hours	30-JUL-12	01-AUG-12

Sample Integrity Observations:

No observations were identified for this work order submission.

Notice of Sub-contract Laboratory Service

Please be advised that the following tests will be subcontracted to the corresponding laboratory:

Sulphate by Ion Chromatography subcontracted to: ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
Nitrite Nitrogen by Ion Chromatography subcontracted to: ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
Chloride by Ion Chromatography subcontracted to: ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
Fluoride by Ion Chromatography subcontracted to: ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
Nitrate Nitrogen by Ion Chromatography subcontracted to: ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA

Please contact your Account Manager immediately should you have questions or concerns regarding this arrangement. Approval of this arrangement shall be implied unless otherwise notified by you.

ALS Group strives to deliver on-time results to our clients at all times. However, there are times when due to capacity issues or other unforeseen circumstances we are unable to meet our expected turnaround times. The information above is related to a recent workorder you have submitted to our laboratory. In the event that you have an inquiry, please refer to the Lab Work Order # when calling your Account Manager.

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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