February 23, 2013

HYDROGEOLOGICAL ASSESSMENT REPORT

Swift River
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 Swift River Solid Waste Facility (the “Facility” or “Site”) is one of the sites included in the program. 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. This sixth and final phase resulted in a draft of this complete Hydrogeological Assessment Report detailing the impact of the Facility to groundwater quality, and risk to down gradient receptors.

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

- Site Description: The Facility is accessed by a 260 m gravel road, north off Kilometre 1,126.7 of the Alaska Highway in the southeast part of the Yukon Territory. It lies within the Pelly Mountains Ecological Region at latitude 60°02'23" North and longitude 131°01'54" West, approximately 150 km (Alaska Highway kilometres) west of the Town of Watson Lake and 10 km (Alaska Highway kilometres) northeast of Swift River, Yukon. The Facility is operated by the Yukon Government Highways and Public Works Transportation Maintenance Branch. The Facility was intended to serve only the Yukon Government highway camp and construction activities; however, three local hunting and fishing lodges and a drilling contractor also use the Facility. No evidence of chemical or fuel storage, above or below ground tanks, spills or discharges, or hazardous materials storage was observed during a Site reconnaissance.

- Topography: Site topography is characteristic of terraced glacio-fluvial landforms. The cleared area at the Facility is generally flat, with the surrounding area sloped to the southeast towards the Swift River. The Facility is located at a surface elevation of approximately 1,005 m above mean sea level (amsl).

- Hydrogeology:

  - A search of the Natural Resources Canada, Groundwater Information Network did not identify groundwater wells within 1,500 m of the Site.

  - Subsurface conditions were investigated with three monitoring wells SR-MW12-01, SR-MW12-02, and SR-MW12-03, which were installed between May 25 and May 27, 2012 under the supervision of Golder Associates to establish a monitoring well network at the Facility.

  - The Site stratigraphy consists of between 7 m and 14 m of till and minor glacio-fluvial outwash overlying bedrock of the Carboniferous to Permian Swift River formation, which is composed of phyllite and inter-layered quartzite and chert.

  - Groundwater was encountered as follows:
    - SR-MW12-01: at approximately 23.7 m below grade, 9.4 m below the surficial sediments/bedrock interface; at 7.4 m below grade;
    - SR-MW12-02: in an unconfined surficial flow system approximately 3.6 m thick on top of bedrock; and
    - SR-MW12-03: approximately 6.1 m below grade and approximately 1 m above the bedrock interface.
  - Due to the small size of the Site and inherent permeability of unconsolidated sediments and shallow, fractured bedrock it is anticipated that these units are hydraulically connected.
  - Based on the groundwater elevations observed in each of the wells it was determined that groundwater flow at the Site is southeast towards the Swift River with a gradient of approximately 0.045 m/m.
  - A round of hydraulic response testing (slug testing) was performed on July 4 and 5, 2012. Results indicated a hydraulic conductivity at the Site ranging from 3.2 x 10^{-5} to 3.5 x 10^{-7} m/s. This result produces an estimated average linear groundwater seepage velocity of up to 130 m per year.

- <u>Groundwater Chemistry</u>:
  - Monitoring wells SR-MW12-01, SR-MW12-02, and SR-MW12-03 were developed and sampled by Golder during one event on May 29, 2012, approximately one week after installation.
  - A water quality assessment was performed on the samples taken during this first monitoring event. Water samples from all three of the newly installed monitoring wells, as well as the Swift River, showed acceptable levels of all chemical parameters tested, when compared against the Yukon Contaminated Sites Regulation (CSR) criteria for freshwater aquatic life. Results of groundwater sampling performed on the monitoring well network at the Site showed low levels of all constituents, including those typically associated with leachate contamination. This suggests that leachate influence on the groundwater at the Site is negligible.
  - Detectable levels of petroleum hydrocarbons, naphthalene and heavy extractable petroleum hydrocarbons ($HEPH_w$) were found at SR-MW12-02. There is a possibility that the detected petroleum hydrocarbons are associated with the method used to drill the wells; therefore, the results may not have been representative of actual groundwater conditions.

The following recommendations are made based on the results of the 2012 hydrogeological and water quality investigations:

- As required by the Solid Waste Permit for the Facility, future groundwater monitoring should be conducted in the spring and late summer.
- Monitoring well locations and elevations should be surveyed by a professional land surveyor. Elevation and position of top of PVC pipe and ground elevation should be surveyed.
- The source and significance of detectable levels of petroleum hydrocarbons, naphthalene and HEPHw found at SR-MW12-02, should be revaluated following the two rounds of groundwater sampling (*i.e.,* one additional round of groundwater sampling). The presence of petroleum hydrocarbons may be associated with the method used to drill the well.
- As there are only five commercial-type users and only aquatic life standards apply to the site the source and significance of slightly elevated chemical parameters at SR-MW12-03 should be revaluated following the two rounds to groundwater sampling to ensure that groundwater at this well is not influenced by leachate and accurately depicts up-gradient groundwater conditions..

Study Limitations

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

The inferences concerning the Swift River, 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, monitoring wells installation, 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.

Table of Contents

TABLES

FIGURES

APPENDICES

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 Swift River Solid Waste Disposal Facility (the “Facility”, the “Site”) is one of the sites included in the program. This completed Hydrogeological Assessment represents the final stage of this project.

These works have been performed in accordance with the approved scope of work detailed in Golder’s proposal (P1-1436-0073) dated August 29, 2011, and accepted by Yukon Government Community Services on October 7, 2011. Additional works performed are detailed in our letter dated April 26, 2012 and were 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 confirm 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 was proposed to develop the hydrogeological conceptual model for the Site. This work was performed in accordance with the Waste Disposal Facility Permit (Permit No: 80-011 effective January 1, 2010 to December 31, 2011), relevant Environment Yukon Protocols and in accordance with the Yukon Environmental and Socioeconomic Assessment Act (YESAA) Decision Document issued for the Site (YESSA File 2011-0293) on March 15, 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 drill 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 the draft of this Hydrogeological Assessment Report detailing the impact of the Facility on groundwater quality, and risk to down gradient receptors.

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. in Hydrogeology from Saint Francis Xavier University (2012) and has completed numerous projects as a Hydrogeologist with Golder Associates including work on contaminated sites, and works with senior personnel on a regular basis.

Mr. Beebe was assisted by Ms. Andrea Badger. Ms. Badger joined Golder in May 2012 as a Junior Engineer-in-Training. 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. She has also been involved with surface water monitoring at a construction site in Northern British Columbia.

Technicians

Krista Meneghetti assisted with the drilling program. Ms. Meneghetti is a Senior Environmental Technologist based out of Golder's Vancouver, BC office. Joe Marquardson assisted with developing and sampling of wells. Mr. Marquardson is a Senior Fisheries Technician based out of Golder's Whitehorse office.

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 our letter dated April 26, 2012 on April 30, 2012. The Change Order for the work was attached to the e-mail message.

2.0 FACILITY DESCRIPTION AND HISTORY

2.1 Location of the Study Area

The Facility is located at Kilometre 1,126.7 of the Alaska Highway in the southeast part of the Yukon Territory. It lies within the Pelly Mountains Ecological Region at latitude 60°02'23" North and longitude 131°01'54" West. The Facility is accessed by a 260 m gravel road north off the Alaska Highway (Figure 1, "Key Plan"). The nearest inhabited area to the Site is the settlement of Swift River, which is located approximately 10 km to the southwest.

2.2 Site History

In 1994 the Yukon Government Highways and Public Works Transportation Maintenance Branch constructed the Swift River Waste Disposal Facility. A review of historical aerial photographs for the area indicates that the land was undeveloped prior to its use as a landfill. The approximate area land filled is included on Figure 2. Since 2006, some segregation of metals and other recyclable material from the waste was conducted.

Yukon Government Highways and Public Works Transportation Maintenance Branch (2008) prepared a Solid Waste Management Plan (SWMP) for the Facility.

3.0 METHODOLOGY

3.1 Preliminary Hydrogeological Assessment

The preliminary hydrogeological assessment involved a review and interpretation of existing information and an inspection for the Swift River solid waste disposal facility. The initial inspection of the Facility was conducted on October 23, 2011 and a follow-up inspection was completed on May 24, 2012. The purpose of preliminary hydrogeological assessment was to identify the appropriate drilling methods and equipment, and potential monitoring well locations. 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.

3.1.1 Data sources

Data used to complete the hydrogeological assessment was obtained from the following sources:

- Site inspection of October 23, 2011 and May 24, 2012.
- 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, Swift River, Yukon Territory*, 1978.
- Government of Yukon Territory, Highways and Public Works, Transportation Maintenance Branch, Solid Waste Management Plan: Swift River Solid Waste Disposal Facility. 2008.
- Government of Yukon Territory. 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 Territory, Yukon Environment, Protocol for the Contaminated Sites Regulation under the Environment Act. 2011.
- Government of Yukon Territory, Yukon Geological Survey, YGS MapMaker Online Website: http://maps.gov.yk.ca/imf.jsp?site=YGS.
- Government of Yukon Territory, Yukon Mining and Lands Viewer Website: http://maps.gov.yk.ca/imf.jsp?site=miningLands.
- Government of Yukon Territory, Yukon Water, Water Data Catalogue Website: http://yukonwater.ca/MonitoringYukonWater/WaterDataCatalogue/.
- Government of Yukon Territory, 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., Surficial Geology Map of Swift River, Yukon Territory. Open File #539. Geological Survey of Canada. 1978.
- Natural Resources Canada, Groundwater Information Network Website: http://ngwd-bdnes.cits.nrcan.gc.ca/service/api_ngwds:gin/en/wmc/aquifermap.html.

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. Site inspections were conducted on October 23, 2011 and May 24, 2012. These two Site visits were conducted to review the layout of the Facility and confirm geological and topographic information obtained from the review of background data. Proposed monitoring well locations were reviewed for access constraints. Selected photographs of the Facility were taken during the reconnaissance and are presented in Appendix A.

3.1.3 Background Geological information

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 Swift River Solid Waste Facility; however, it was noted by that the Facility does not have any analytical results in the file to compare against the Yukon CSR standards to determine if any contamination exists.

3.1.5 Review of Solid Waste Disposal Facility Permit and Waste Management Plan

Solid Waste Permit 80-011 was reviewed. The Solid Waste Permit was issued on March 17, 2012. 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 Permit 80-011 include:

- Monitoring water levels and collecting water samples from groundwater monitoring wells at the Facility twice a year (spring and late summer);
- Sampling of down gradient surface water bodies concurrently with the groundwater sampling;
- Analyze surface water and groundwater samples for the parameters outline in section 3.7;
- 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; and
- Submitting monitoring results to Environment Yukon by January 31st each year.

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
Swift River Solid Waste Disposal Facility	80-011	Solid Waste Disposal Facility	Yes (Highways and Public Works maintenance and transportation Branch 2011)	Twice Per Year

3.2 Field Investigations

3.2.1 Scope of Field Investigations

The scope of the field investigations included the following:

- Three on-site groundwater wells were drilled by Midnight Sun Drilling under the supervision of Golder Associates from May 25 to 27, 2012;
- Wells were developed and sampled by Golder Associates on May 29, 2012. The water levels at 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 ISO/IEC 17025 accredited laboratories for analysis;
- Wells were slug tested to assess hydraulic conductivity and linear groundwater velocity; and
- 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 Swift River Solid Waste Disposal Facility in general accordance with Yukon Contaminated Site Regulation Protocol (Yukon Environment, 2011).

Three (3) groundwater monitoring wells were proposed to be installed at the Site to assess potential groundwater contamination sourced from the waste disposal facility. SR-MW12-01 and SR-MW12-02 were intended to assess any impact to the groundwater quality sourced from the landfill while SR-MW12-03 was targeted to characterize up-gradient groundwater. Locations of the monitoring wells (Figure 2) were selected based on aerial photography, review of Site history, 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 May 25 to 27, 2012:

- SR-MW12-01 was installed on the southeast edge of the Site and advanced to a depth of 25.3 m below grade (m bg);
- SR-MW12-02 was installed at the southern corner of the Site and advanced to approximately 11.3 m bg; and
- SR-MW12-03 was installed on the northwest edge of the Site and advanced to approximately 10.1 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 by Trimble handheld GPS to an accuracy of 0.5 m or better. Elevations for top of casing (TOC) for all wells were obtained by level survey.

A Site plan showing the monitoring well locations and key Site features is provided in Figure 2. Note that newly installed wells were not surveyed.

Grab samples of drill cuttings were taken at regular intervals to log the lithology encountered in each borehole. Borehole logs indicating observed lithology along with well construction details are provided in Appendix B, with a summary of well construction details provided in Table 2. The following is a summary of the depth of saturated zones that were encountered at the Site:

- At well SR-MW12-01, which is located northwest and up gradient of the waste disposal cell, groundwater saturation was encountered at a depth of approximately 23.7 m bg, at 9.4 m below the surficial/bedrock interface;
- At well SR-MW12-02 groundwater saturation was encountered at approximately 7.4 m below the ground surface in an unconfined flow system approximately 3.6 m thick on top of bedrock; and
- At well SR-MW12-03 groundwater saturation was encountered at approximately 6.1 m bg, at approximately 1 m above the bedrock interface.

Each monitoring well was completed with the top of the screen installed as close as possible to the interval where the moisture content of the formation appeared to be transitioning from unsaturated to saturated.

Installation details are included on the borehole logs in Appendix B. Typical completion details are:

- Monitoring wells were completed with 50 mm PVC Schedule 40 PVC pipes;
- A 3 m long well screen (10-slot) was installed in all three monitoring wells;
- An un-slotted PVC pipe was installed above the well screen to about 0.80 m above grade;
- A silica sand 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 seal consisting of approximately 1.5 m of bentonite chips was placed directly above the sand pack. The remainder of the annulus was filled with bentonite well grout;
- Each well was capped with a PVC end-cap and the well PVC-standpipe protected with a lockable steel protective casing; and
- Each well was developed by removing a minimum of three well volumes using dedicated Waterra™ tubing and a Hydrolift™ pump. Development logs are provided in Appendix C.

Table 2: Well Construction Details

Well ID	Drilled Depth (m bg)	Aquifer Unit Monitored	Casing Diameter (mm)	Screened Interval (m bg)	Filter Pack Interval (m bg)
SR-MW12-01	25.3	Bedrock	50	22.3 – 25.3	20.7 – 25.3
SR-MW12-02	11.3	CLAYEY SILT/ GRAVEL/ BEDROCK	50	8.2 – 11.3	6.7 – 11.3
SR-MW12-03	10.1	Bedrock	50	7.0 – 10.1	5.8 – 10.1

3.2.3 Monitoring Well Surveying

Golder surveyed the vertical elevation to the top of the well PVC standpipe at SR-MW12-01, SR-MW12-02, and SR-MW12-03 on May 29, 2012. Elevations were relative to a benchmark, for which elevation was obtained via Trimble GPS with a vertical accuracy of approximately 0.1 m. Surveyed elevations were then determined relative to this single GPS elevation. 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 May 29, 2012

Well ID	GPS Location	Top of PVC Casing Elevation (masl)	Standing Water Level (mbtoc[1])	Groundwater Elevation (masl)
SR-MW12-01	6657509.8 m N 386864.0 m E	1009.6	9.33	1000.28
SR-MW12-02	6657461.2 m N 386809.5 m E	1008.9	7.94	999.59
SR-MW12-03	6657591.6 m N 386788.4 m E	1013.2	7.91	1005.29

3.2.4 Groundwater Monitoring Event

Monitoring wells SR-MW12-01, SR-MW12-02, and SR-MW12-03 were developed and sampled by Golder on May 29, 2012. This allowed approximately one week of rest after installation. Due to logistical constraints, the wells could not be developed immediately following installation.

The procedure used for sampling followed Contaminated Sites Regulation Protocol No. 7. Prior to and during development/purging of each well, the water level was first measured with an electronic measuring tape. Between three and ten well volumes were then purged from each well using 5/8 inch high density polyethylene (HDPE) Waterra™ tubing, a foot valve, and a Hydrolift™ pump. Following purging, a sample was collected immediately. During purging, physiochemical parameters (pH, temperature, electrical conductance (EC), dissolved oxygen (DO)) were collected at regular intervals using an YSI 650MDS and allowed to reach equilibrium prior to 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 same monitoring round. The nearest downgradient receptor was determined to be a small oxbow in the channel of the Swift River approximately 550 m southeast of the Site.

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 office, 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.

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[1] mbtoc = meters below top of casing

3.2.5 Hydraulic Response Tests

Hydraulic response (slug) tests were performed on July 4 and 5, 2012 to assess the hydraulic conductivity of aquifers at the Site. Both rising head and falling head tests were 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.

Multiple rising head tests were successfully completed for SR-MW12-02. SR-MW12-01 test results could not be interpreted, and only one single rising head test was successfully performed in SR-MW12-03 due to slow responses.

3.3 Laboratory Testing

Parameters included in the laboratory testing of groundwater samples are summarized in Table 4. The parameter list complies with the Facility's Solid Waste Disposal Permit (Permit No. 80-011).

Sampling and analysis were undertaken in general accordance with Yukon Contaminated Site Regulation Protocols 2 and 5 (YCSR, 2011).

Table 4: Parameters sampled for May 2012

Sample ID	General Parameters	Nutrients	Dissolved Metals	PAH, BTEX, DOC	Fecal Coliform
SR-MW12-01	√	√	√	√	√
SR-MW12-02	√	√	√	√	√
SR-MW12-03	√	√	√	√	√
Swift River	√	√	√	√	√

3.4 Quality Control Assurance

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 (Table 5) summarizes the QA/QC evaluation.

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	SR-MW12-03 was intended to be up gradient of the Facility to provide background levels of physiochemical parameters.
Field Procedures	Monitoring wells were developed and sampled using dedicated tubing. Equipment used in sampling more than one well 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.

QA/QC Aspect	Evidence and Evaluation
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 in each pair were below the laboratory method detection limit (MDL). Of the remaining pairs tested only three analytes (nitrate, nitrite, and Total Kjeldahl Nitrogen) exceeded the RPD[2] acceptance criteria of ±30%. These exceedances are considered to be generally minor and are related to the poor reproducibility of the analytical methods at low analyte concentrations.
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 acceptable results for the method blanks, laboratory duplicates and matrix spikes.
Holding Times	No samples exceeded the maximum holding.
Laboratory Detection Limit	Laboratory reports indicate that detection limits were below the standards applicable to this assessment.
Completeness of test program	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.

3.5 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, SO_4, N, NO_2, NO_3 and P)
- Dissolved Metals
- Mercury
- Hardness
- Alkalinity
- Carbonate
- Bicarbonate
- pH
- Total dissolved solids
- Ammonia
- Dissolved organic carbon
- VOCs
- Chemical oxygen demand
- Total Kjeldahl Nitrogen
- EPH_{w10-10} & VH_{w6-10}
- BTEX
- PAHs
- Faecal coliform

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[2] RPD calculations are presented in Appendix E of Golder's draft report entitled *Watson Lake Disposal Facility Hydrogeological Assessment* dated August 10, 2012

Groundwater and surface water analytical results were compared to the Yukon Contaminated Sites Regulation (YCSR) water standards or to the Canadian Environmental Quality Guidelines where no Yukon standard was available.

The four types of water uses outlined in the YCSR, 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	Not 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, as per YCSR, are applicable primarily due to the Facility's proximity to the Swift River and several small oxbow ponds in the Swift River channel, all of which fall within the 1 km radius of the Site. It was determined, therefore, that aquatic life standards were **applicable** for the Swift River 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 direction between the Site and the Swift River, nor in any other area within a 1.5 km radius of the Site. It was therefore concluded that YCSR drinking water standards were **not applicable** for the Swift River Facility.

Irrigation

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 on record for the Swift River 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 in the area that were not identified.

A review of Google Earth Images from 2004, 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 within 1.5 km of the Facility. It is therefore concluded that YCSR water quality standards for irrigation are **not applicable** to the Swift River Facility.

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 wells on record as being for livestock use in the Swift River area. It should be noted that this is not a complete record of all wells in the Yukon, and it is possible that there wells for livestock use in the area.

A review of Google Earth Images from 2004, conducted by Golder on July 26, 2012, as well as several visits to the Facility conducted in May and July 2012 showed no active livestock or livestock facilities within 1.5 km of the Facility. It is therefore concluded that YCSR standards for livestock are **not applicable** to the Swift River Facility.

4.0 CONCEPTUAL HYDROGEOLOGICAL MODEL

4.1 Setting

As illustrated on a Government of Canada topographic map, the Facility is at an elevation of approximately 1,005 m (3,300 feet) above sea level and lies within the Swift River Watershed. The regional hydraulic gradient near the Site is expected to follow the regional topography, which slopes southeast towards the Swift River. A cleared area is present at the Facility that is generally flat. A small pond is located up gradient, approximately 200 m west of the Facility.

4.2 Climate

Climate at the Site is likely similar to that at the Watson Lake A climate station (Climate ID 2101200), located approximately 150 km west of the Facility at an elevation of approximately 687.4 m above sea level. Average monthly precipitation reported at the Watson Lake station ranges from a low average of 13.9 mm in April to a high average of 59.9 mm in July. The average annual precipitation is approximately 404.4 mm, including 196.5 cm as snowfall. Temperature ranges from a low average of -24.2^{o} C in January to a high average of 15.5^{o}C in July. (Environment Canada, 2011)

Annual precipitation is relatively low (about 0.4m per year) and would suggest that infiltration of water through the waste and into the subsurface soils is relatively low. With a significant portion of the precipitation occurring in the form of snow, and the relatively cold climate, little infiltration would be expected during the winter months. During spring snow melt, there is the greatest potential for infiltration of water through the waste; however, a significant portion of the water would occur over land as surface runoff during this period.

4.3 Geology and Hydrogeology

4.3.1 Geological Framework

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

The Swift River area is mapped as being underlain primarily by unconsolidated till and glaciofluvial deposits of Quaternary origin, with modern alluvial deposits associated with low-lying areas adjacent to the Swift River. Ablation till, colluvial glacial debris, and bedrock exposures are found at higher elevations near the Site.

Surficial geology maps published by the Yukon Geological Survey (YGS) indicate natural surficial materials at the Facility are representative of ablation till and glaciofluvial material deposited directly by glacial ice or melt water, respectfully. In general, deposits consist of well compacted to non-compacted material that is non-stratified and contains a heterogeneous mixture of particle sizes, 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 30 m.

4.3.2 Principal Aquifers

As shown in Figure 4 (Conceptual Hydrogeological Model Section) it is inferred that groundwater occurs in a single phreatic aquifer composed of two hydraulically connected units; one unit being unconsolidated surficial sediments, and the other the underlying fractured bedrock. This aquifer probably also represents the “regional” flow conditions.

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

Aquifer Name	Location	Aquifer Type	Comment
Surficial Aquifer	SR-MW12-02 SR-MW12-03	Inter-granular, porous media	▪ CLAYEY SILT AND GRAVEL ▪ Shallow flow
Regional Bedrock Aquifer	SR-MW12-01 Possibly SR-MW12-03	Fractured rock	▪ Deep regional flow in this aquifer ▪ Recharged by infiltration in outcrop areas and through lateral and vertical flow from the overlying surficial aquifer

4.4 Groundwater Flow Systems

4.4.1 Regional and Intermediate Groundwater Flow

It can be inferred from the topography that regional groundwater likely flows from the mountains (elevation approximately 1900 m amsl) to the northwest of the Site southeast towards the Swift River (elevation approximately 900 m amsl). Groundwater recharges the bedrock aquifer through infiltration of rainfall in high elevation areas and exposed outcrops and by direct infiltration of surface water. Regional groundwater flow occurs mainly through fractures in bedrock and to a lesser extent through unconsolidated sediments where the bedrock head intersects the water table. Regional groundwater discharges to the Swift River. This regional flow system was encountered in SR-MW12-01, where no significant surficial aquifer was encountered.

4.4.2 Local Groundwater Flow

Local flow direction at the Site is inferred from groundwater elevations in the newly installed monitoring well network to be to the Southeast (Figure 6, Groundwater Elevation). This is in accordance with the inferred regional groundwater flow direction. Hydraulic gradient at the Site was found to be moderate (approximately 0.045 m/m) due to the change in elevation between the mountain range located north of the Site and the Swift River. It can be inferred from this strong hydraulic gradient that nearly all groundwater from the Site discharges to the Swift River.

Golder used the groundwater depth data from June 2012 and well survey elevation information collected in May and June 2012 to calculate the groundwater elevation at each monitoring well. The water level measurements and groundwater elevations as of May 29, 2012 are presented in Table 3.

4.5 Hydraulic Response Tests

Golder Associates conducted slug tests on SR-MW12-01, SR-MW12-02 and SR-MW12-03 in July 2012. The slug tests were 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)
SR-MW12-01	Fractured Rock	-	-
SR-MW12-02	CLAYEY SILT/GRAVEL	Bouwer-Rice (1976)	3.2×10^{-5}
SR-MW12-03	Fractured Rock/CLAYEY SILT	Bouwer-Rice (1976)	3.5×10^{-7}

As shown in Table 8, two different wells were successfully tested for hydraulic conductivity. Hydraulic conductivity at well SR-MW12-02 was assessed using multiple rising head slug tests. The assessed mean hydraulic conductivity of the unconsolidated CLAYEY SILT and GRAVEL unit found at SR-MW12-02 was 3.2×10^{-5} m/s, which is just outside the upper range for hydraulic conductivity of tills with a silty matrix (Fetter, 1994). Hydraulic conductivity at well SR-MW-12-03 was assessed using a similar method, but only a single rising head test was completed successfully. The combination weathered bedrock and unconsolidated CLAYEY SILT aquifer at SR-MW12-03 was assessed as having a hydraulic conductivity of 3.5×10^{-7}, which is a reasonable result for the conditions.

4.6 Estimated Average Linear Groundwater Velocity

As determined by the slug tests above, the reasonable range of hydraulic conductivities at the Site is between 3.2×10^{-5} and 3.5×10^{-7}. The hydraulic gradient across the Site was assessed, using the monitoring well network, to be approximately 0.045 m/m to the southeast. A range of reasonable linear groundwater velocities is calculated using the following equation:

$$V = (Ki)/n$$

Where:

V: is the groundwater velocity in meters per second (m/s).

K: is the hydraulic conductivity in m/s as determined by slug testing

i: is the horizontal hydraulic gradient (m/m)

n: is the porosity which is estimated to be approximately 0.40 (Fetter, 1994) in the CLAYEY SILT, and probably somewhat lower in the weathered bedrock.

The resulting groundwater velocity is estimated to be between 4×10^{-6} (m/s) and 4×10^{-8} (m/s); meaning groundwater flow velocity can be estimated to be between 1.24 and 126 m per year. Groundwater at the Site may travel faster or slower than these estimates due local variations in hydraulic conductivity.

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, interviews with Facility personnel, hydrogeological investigation and contaminant transport principals. Potential sources include:

- Leachate from present and former domestic waste, commercial waste, industrial waste, metals, wood, rubber (tires), construction debris, derelict vehicles and any other waste disposed of 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; and
- No off-site sources of pollution have been identified in this report. The Facility is located in a remote area far from any other facilities, making off-site sources of contamination unlikely.

Transport mechanisms that may act on these sources of contamination and cause 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; and
- 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 three newly installed wells and one surface water location at the Swift River Solid Waste Disposal Facility on May 29, 2012. Table 9 summarizes important parameters from the groundwater chemistry results. Chain-of-custody forms for the groundwater samples collected, as well as the complete groundwater chemistry results, can be found in Appendix E.

Table 9: Important Groundwater Chemistry Results

Sample Location	Total Dissolved Solids (mg/L)	Chloride (mg/L)	Ammonia (mg/L)	Sulphate (mg/L)	DOC (mg/L)	HEPHw (mg/L)
SR-MW12-01	168	2.61	0.0619	22.40	1.62	<0.25
SR-MW12-02	282	9.55	0.181	39.80	3.99	0.53
SR-MW12-03	241	4.69	0.0814	26.50	2.37	<0.25
Swift River	56	<0.50	<0.0050	6.08	3.44	<0.25

Total Dissolved Solids

A total dissolved solid (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 the degradation of contaminants and dissolution of the degraded material into groundwater. Typical ions that may characterize degraded waste include: NO_3, NH_3, Na, K, Mg, Ca, SO_4, Cl, and HCO_3.

TDS Values in monitoring well samples ranged from 168 mg/L in SR-MW12-01 to 282 mg/L in SR-MW12-02. These concentrations are considered within the normal range and variation for naturally occurring groundwater. Slightly elevated levels in SR-MW12-02 above the other wells may suggest minor leachate influence. TDS in the surface water sample was much lower than that found in any of the groundwater samples. This is generally expected in surface water, especially rivers, because the waters are oxygenated and not in prolonged contact with soil or rock.

Chloride

Chloride is often used as a tracer to assess anthropogenic influence on groundwater chemistry. Elevated chloride levels are associated with a number of sources including sewage, leachate, and road salting. In the case of landfills, elevated chloride is common due to degradation of waste with elevated salts. Chloride levels from the monitoring well network were low, ranging from 2.61 mg/L to 9.55 mg/L (SR-MW12-02). These values are considered reasonable for groundwater chemistry and not indicative of landfill leachate.

Ammonia

Ammonia is a typical landfill leachate indicator. Low levels of ammonia were detected in all three of the monitoring wells sampled, with values ranging from 0.062 mg/L in SR-MW12-01 to 0.181 mg/L in SR-MW12-02. The ammonia may be the result of minor leachate contamination, or may be naturally occurring. Levels were well below the limit for ammonia defined by the YCSR standard for freshwater aquatic life.

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 Swift River Site were low, and within values expected for natural background groundwater chemistry. Highest DOC levels were found in SR-MW12-02 (3.99 mg/L) which is one of the downgradient wells, and lowest in the other downgradient well SR-MW12-01 (1.62 mg/L).

Metals

Metals concentrations followed an observable trend. Most were highest in SR-MW12-02, lower in SR-MW12-01, and lowest in the surface water sample, as expected. No metals concentrations exceeded YCSR standard for freshwater aquatic life, and all were within what would be considered a reasonable range for naturally occurring groundwater.

Organics

Detectable levels of HEPHw (0.53 mg/L) and naphthalene (0.000065 mg/L) were identified in SR-MW12-02. As these chemicals should not be found in detectable levels in naturally occurring groundwater, this suggests minor leachate contamination at this well. Although levels were elevated above background concentrations, naphthalene was well below the YCSR limit (0.01 mg/L). There is no limit currently set for HEPHw concentration. The presence of petroleum hydrocarbons may be associated with the method used to drill the well.

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 ground water. 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). The charge balance was calculated and the charge balance error was less than 5 percent, which is within the acceptable range for water that has a total ionic charge of 10 to 800 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 the cations and anions, and may be used to identify different water types. The water samples from wells are similar; however, SR-MW12-02 appears to have slightly higher concentrations for most anions than the other two groundwater samples. This suggests that this water may have had a longer residence time than the samples from SR-MW12-01 and SR-MW12-03, or that there is a difference in the lithology/or permeability, or that the sample is influenced by a surficial source (*i.e.*, landfill leachate).
- Piper: The Piper diagram (Figure 8) illustrates that although the groundwater and surface water samples have different concentrations of constituents, the overall groundwater chemistry is similar. All samples are classified as calcium-bicarbonate type water.
- Stiff: A visual inspection of the Stiff diagram indicates minor differences between the groundwater and surface water samples. The primary differences being that the surface water sample is depleted in sodium (Na) and chloride (Cl) and enriched in calcium (Ca) when compared to the groundwater samples. Water chemistry for well SR-MW12-02, located in the southeast corner of the Site has a higher portion of Na and Cl compared to the other two groundwater samples.

In addition to the above, a trend of notably elevated TDS, chloride, sulphate, DOC, and detectable naphthalene at SR-MW12-02 suggest that this well is influenced by leachate from the Site more than the other two wells; however, this influence appears to be relatively minor, with all constituents remaining below YCSR standard for freshwater aquatic life. Elevated levels of constituents at SR-MW12-03, although inconclusive, may potentially point to minor leachate influence, meaning that the well may not accurately characterize upgradient groundwater conditions despite being upgradient of most of the waste disposal Facility.

SR-MW12-01 has the lowest concentrations of most important constituents. Due to the location of this well in fractured bedrock, it is possible that the fracture network is not open to direct recharge from the Site. In such a case, then the parameters at this well may more closely reflect background conditions.

6.0 CONCLUSIONS

A monitoring well network consisting of three wells was successfully installed at the Swift River Solid Waste Disposal Facility from May 25 to 27, 2012. The wells were developed and sampled May 29, 2012, and slug tested on July 4 and 5, 2012.

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

- Site Description: The Facility is accessed by a 260 m gravel road north off Kilometre 1,126.7 of the Alaska Highway in the southeast part of the Yukon Territory. It lies within the Pelly Mountains Ecological Region at latitude 60°02'23" North and longitude 131°01'54" West, approximately 150 km (Alaska Highway kilometres) west of the Town of Watson Lake and 10 km (Alaska Highway kilometres) northeast of

Swift River, Yukon. The Facility is operated by the Yukon Government Highways and Public Works Transportation Maintenance Branch. The Facility was intended to serve only the Yukon Government highway camp and construction activities; however, three local lodges and a drilling contractor also use the Facility. No evidence of chemical or fuel storage, above or below ground tanks, spills or discharges or hazardous materials storage were observed during a Site reconnaissance.

- Topography: Site topography is characteristic of terraced glacio-fluvial landforms. The cleared area at the Facility is generally flat, with the surrounding area sloped to the southeast towards the Swift River. The Facility is located at a surface elevation of approximately 1,005 m above mean sea level (amsl).
- Hydrogeology:
  - A search of the Natural Resources Canada, Groundwater Information Network did not identify groundwater wells within 1,500 metres of the Site.
  - Subsurface conditions were investigated with three monitoring wells SR-MW12-01, SR-MW12-02, and SR-MW12-03, which were installed between May 25 and May 27, 2012 under the supervision of Golder Associates for the creation of a monitoring well network at the Facility.
  - The Site stratigraphy consists of between 7 m and 14 m of till and minor glaciofluvial outwash overlying bedrock of the Carboniferous to Permian Swift River formation, which is composed of phyllite and inter-layered quartzite and chert.
  - A confined groundwater aquifer was encountered as follows:
    - SR-MW12-01 at approximately 23.7 m below grade, 9.4 m below the surficial/bedrock, at 7.4 m below grade;
    - SR-MW12-02 in an unconfined surficial aquifer approximately 3.6 m thick on top of bedrock, and
    - SR-MW12-03 approximately 6.1 m below grade and approximately 1 m above the bedrock interface.
  - Due to the small size of the Site and inherent permeability of unconsolidated sediments and fractured bedrock it is anticipated that these units are hydraulically connected.
  - Wells SR-MW12-01 and SR-MW12-02 were shown to be downgradient of the Facility, while SR-MW12-03 is directly upgradient of the Facility.
  - Based on the groundwater elevations observed in each of the wells it was determined that groundwater flow at the Site is southeast towards the Swift River with a gradient of approximately 0.045 m/m.
  - A round of hydraulic response testing (slug testing) was performed on July 4 and 5, 2012. Results of indicated hydraulic conductivity at the Site ranging from 3.2 x 10^{-5} to 3.5 x 10^{-7} m/s. This result produces an estimated average linear groundwater seepage velocity of up to 130 m per year.
- Groundwater Chemistry:
  - Monitoring wells SR-MW12-01, SR-MW12-02, and SR-MW12-03 were developed and sampled by Golder during one event on May 29, 2012; approximately one week after installation.

- A water quality assessment was performed on the samples taken during this first monitoring event. Water samples from all three of the newly installed monitoring wells, as well as the Swift River, showed acceptable levels of all chemical parameters tested, when compared against the Yukon Contaminated Sites Regulation (YCSR) criteria for freshwater aquatic life.
- Results of groundwater sampling preformed on the monitoring well network at the Site showed low levels of all constituents, including those typically associated with leachate contamination. This suggests that leachate influence on the groundwater at the Site is minimal.
- A trend of elevated TDS, chloride, sulphate, DOC, and detectable naphthalene at SR-MW12-02 suggest that this well is influenced by leachate from the landfill.
- Groundwater samples taken from all wells met the Yukon Contaminated Site Regulation Standards for freshwater aquatic life, which was the only standard deemed applicable at the Swift River Facility.
- Detectable levels of petroleum hydrocarbons, naphthalene and heavy extractable petroleum hydrocarbons (HEPH$_w$) were found at SR-MW12-02. There is a possibility that the detected petroleum hydrocarbons are associated with the method used to drill the wells; therefore, the results may not have been representative of actual groundwater conditions.

7.0 RECOMMENDATIONS

The following recommendations are made based on the results of the hydrogeological assessment presented in this report:

- As required by the Solid Waste Permit for the Facility, future groundwater monitoring should be conducted in the spring and late summer.
- Monitoring well locations and elevations should be surveyed by a professional land surveyor. Elevation and position of top of PVC pipe and ground elevation should be surveyed.
- The source and significance of detectable levels of petroleum hydrocarbons, naphthalene and HEPHw found at SR-MW12-02, should be revaluated following the two rounds of groundwater sampling (*i.e.,* one additional round of groundwater sampling). The presence of petroleum hydrocarbons may be associated with the method used to drill the well.
- As there are only five commercial-type users and only aquatic life standards apply to the site the source and significance of slightly elevated chemical parameters at SR-MW12-03 should be revaluated following the two rounds to groundwater sampling to ensure that groundwater at this well is not influenced by leachate and accurately depicts up-gradient groundwater conditions.

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.

ORIGINAL SIGNED	ORIGINAL SIGNED
Calvin Beebe, M.Sc. Hydrogeologist	Gary Hamilton, P.Geo. Principal, Hydrogeologist

Reviewed By:

ORIGINAL SIGNED

Guy Patrick, P.Eng.
Principal, Hydrogeologist

CB/GJH/GCP/syd

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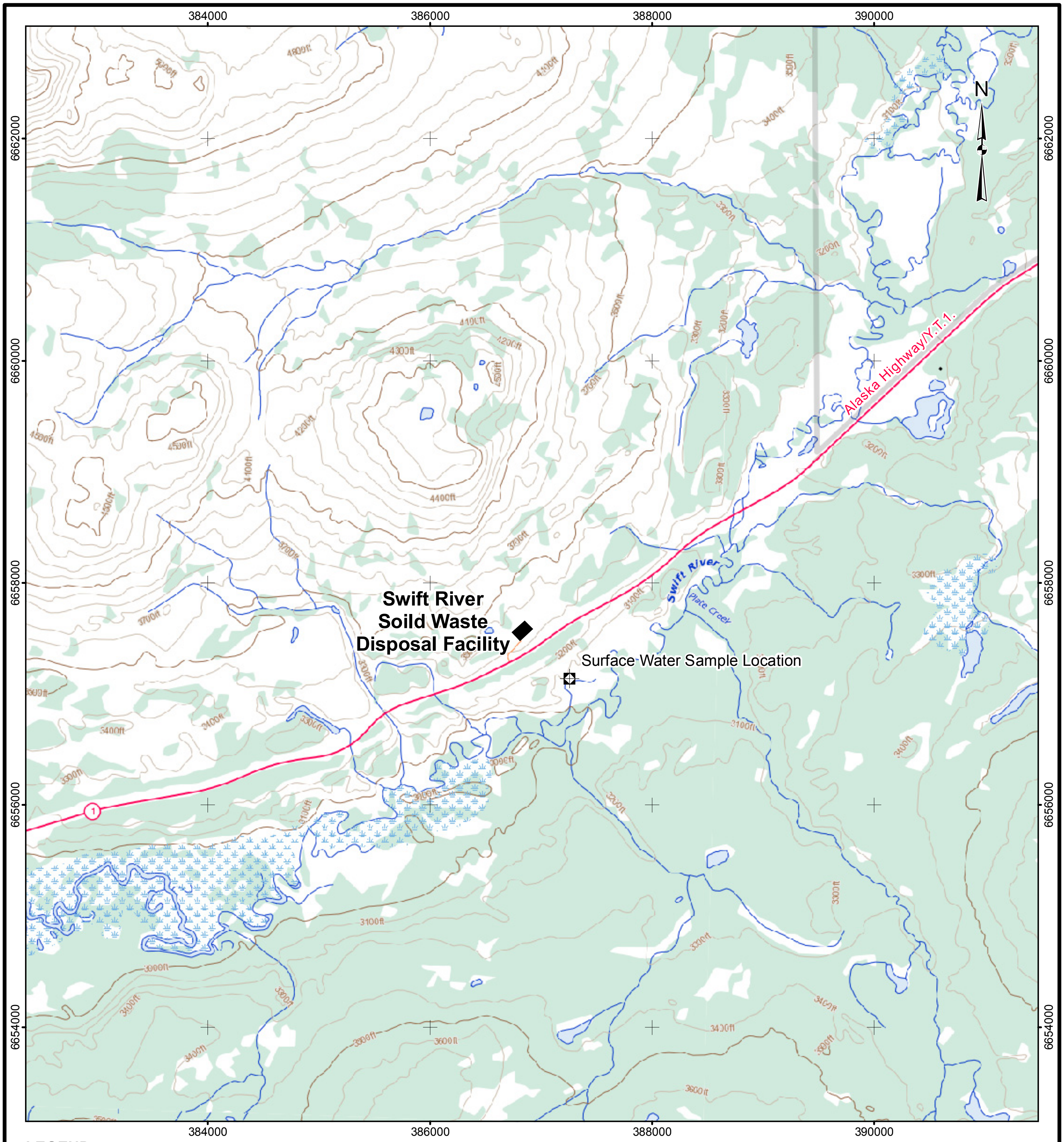

LEGEND

■	SWIFT RIVER SOLID WASTE DISPOSAL FACILITY
⌖	SURFACE WATER SAMPLE LOCATION

1 0 1

SCALE 1:50,000 KILOMETRES

REFERENCE

BASEDATA OBTAINED FROM GEOGRATIS (NATURAL RESOURCES CANADA).
DATUM: NAD83 PROJECTION: UTM ZONE 9

PROJECT YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
SWIFT RIVER, YUKON

TITLE

KEY PLAN

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.		11-1436-0073	PHASE No. 2930	
DESIGN	CB	27 Jul 2012	SCALE AS SHOWN	REV. 0
GIS	MH	27 Jul 2012	FIGURE: 1	
CHECK				
REVIEW				

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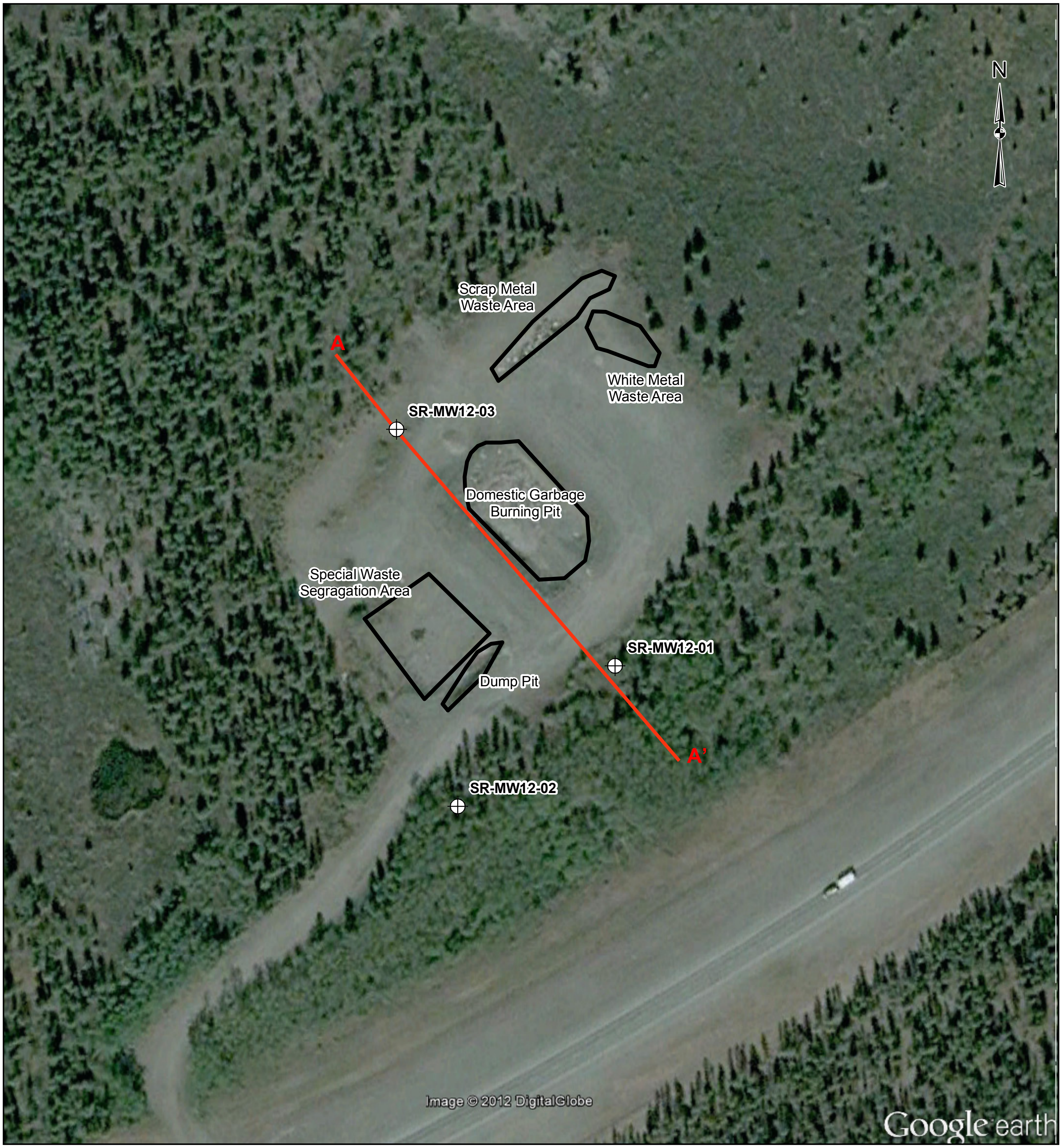

LEGEND

⌖ MONITORING WELL MONITORING WELL

━ CROSS SECTION

40 0 40

SCALE (APPROX.) METRES

REFERENCE

IMAGE OBTAINED FROM GOOGLE EARTH, USED UNDER LICENSE.
IMAGERY DATE: JUNE 1, 2005. GOOGLE EARTH IMAGE IS NOT TO SCALE.
DATUM: NAD83 PROJECTION: UTM ZONE 9

PROJECT
YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
SWIFT RIVER, YUKON

TITLE

SITE PLAN & CROSS SECTION LOCATION

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.		11-1436-0073	PHASE No. 2900	
DESIGN	CB	27 Jul 2012	SCALE AS SHOWN	REV. 0
GIS	JW	07 Aug 2012	**FIGURE: 2**	
CHECK				
REVIEW				

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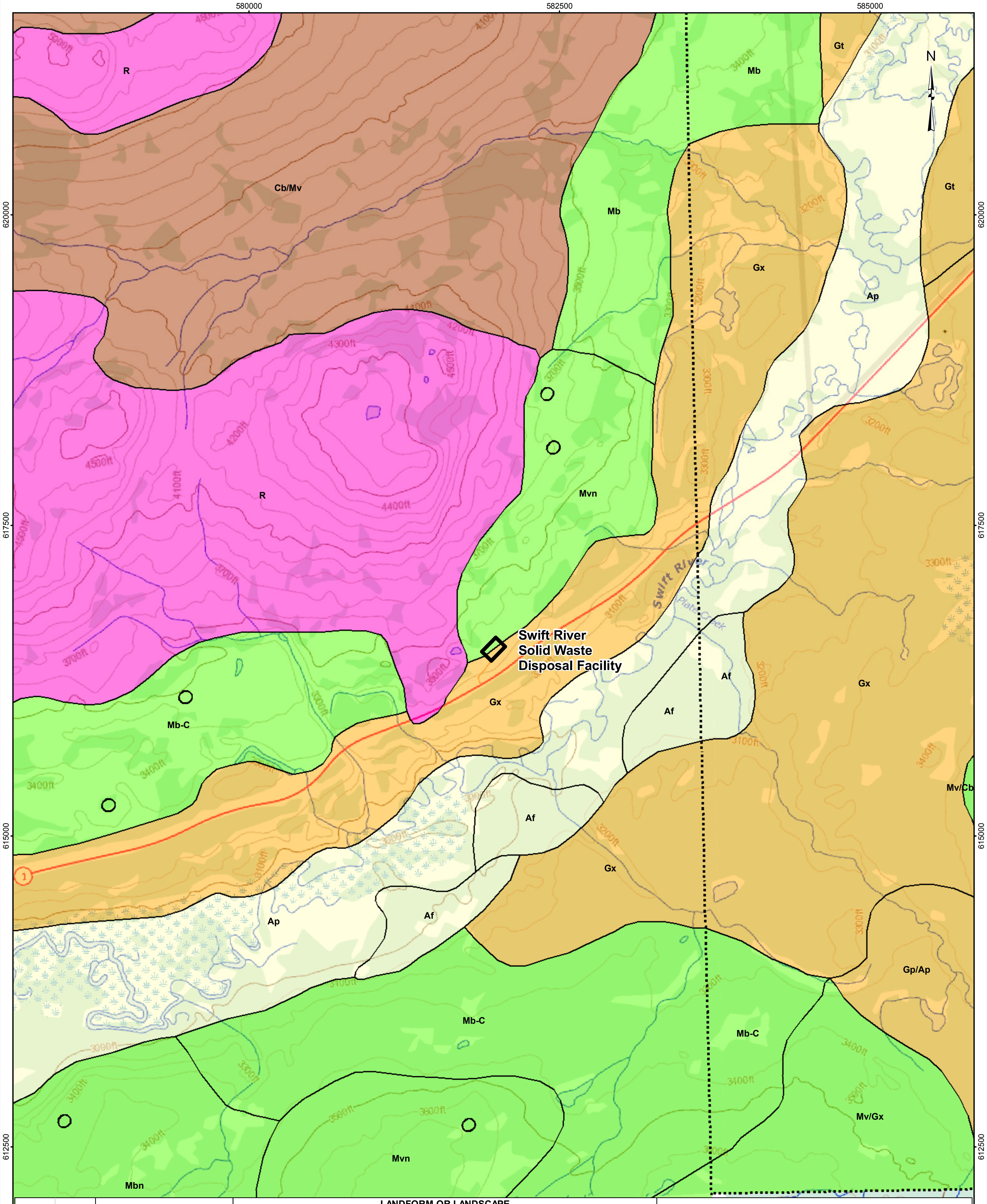

		LANDFORM OR LANDSCAPE			
		MATERIAL	ORIGIN	TOPOGRAPHY	COMMENT
🟩	Mvn	till; generally sandy and stony with numerous boulders	lodgement and oblation till veneer	bedrock topography of ridges and valleys mostly in alpine area	Moraine veneer is typically associated with colluvial debris on alpine slopes; rubble covered or bare bedrock out-crops are common in this type of alpine terrain
🟧	Gx	gravel, sand and silt	ice contact glaciofluvial (home and esker) complexes, small outwash plains and nuerous meltwater channels	irregular areas of braided ridges and hills along with gently irregular areas of outwash and numerous abandoned channels; local relief ranges from less than 5m to more than 30m	These complexes are mapped in valleys where meltwater erosion was significant in shaping local features; coarse aggregate in common

580000 582500 585000

LEGEND

▭	FACILITY
■	BUILDING
—	MAJOR ROAD
—	WATERCOURSE
▭	WATERBODY

1 0 1

SCALE 1:30,000 KILOMETRES

REFERENCE

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

PROJECT
SWIFT RIVER SOLID WASTE FACILITY HYDROGEOLOGICAL ASSESSMENT
GOVERNMENT OF YUKON, DEPARTMENT OF COMMUNITY SERVICES
SWIFT RIVER, YUKON

TITLE
REGIONAL SURFICIAL GEOLOGY

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.		11-1436-0073	PHASE No. 2900	
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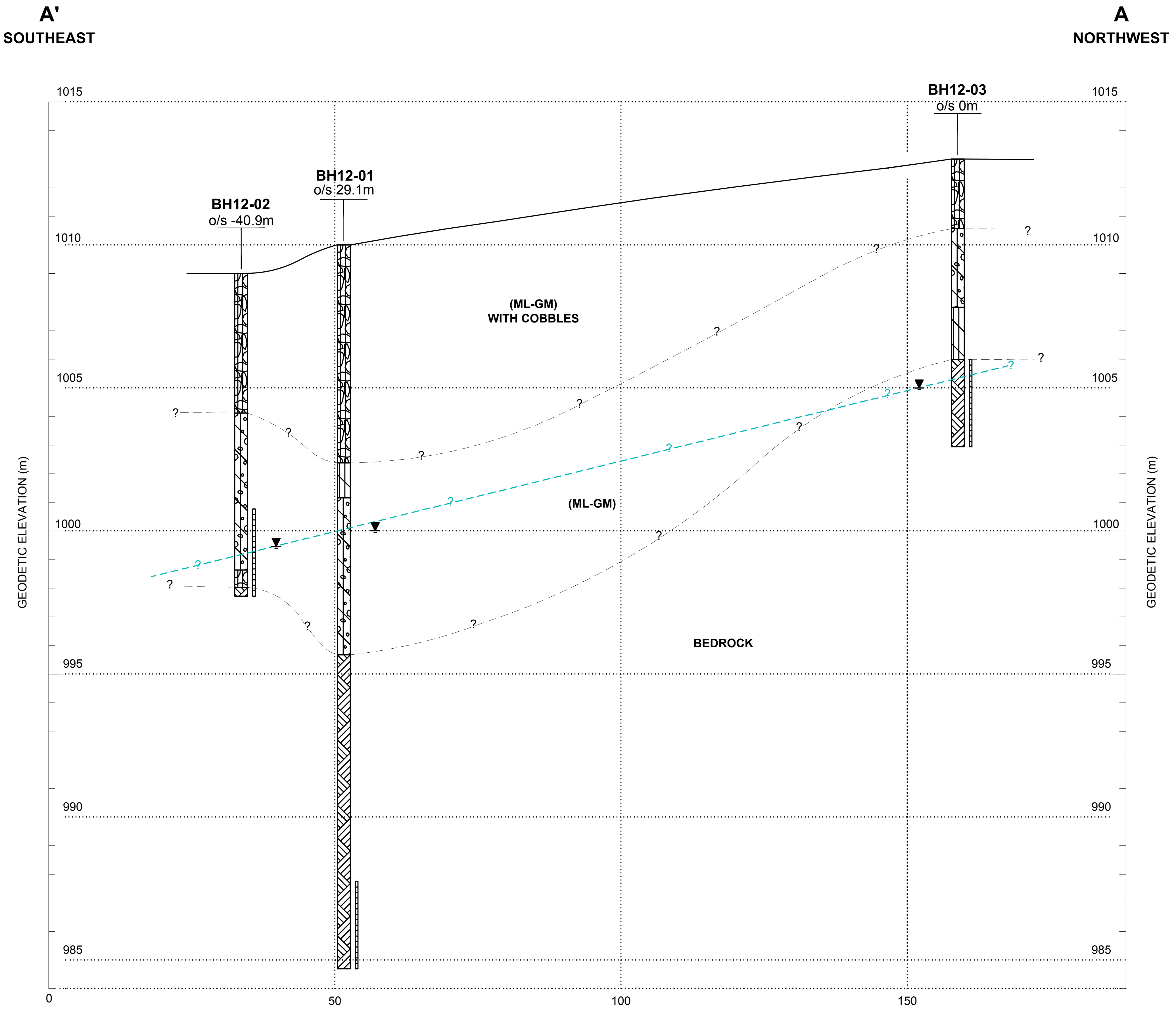
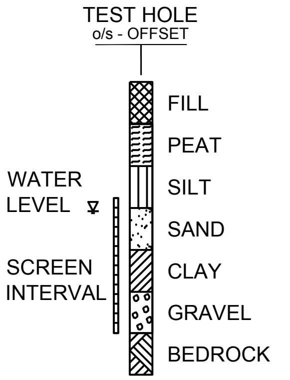
GIS	JW	07 Aug 2012	**FIGURE: 3**	
CHECK				
REVIEW				



LEGEND

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



APPROXIMATE GROUND SURFACE

?— INFERRED STRATIGRAPHIC BOUNDARY

?— INFERRED GROUNDWATER (mASL)

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 15 30 45m

1:750

VERTICAL SCALE EXAGGERATION 5X

PROJECT

GOVERNMENT OF YUKON, DEPARTMENT OF COMMUNITY SERVICES
SWIFT RIVER, Y.T.

TITLE

CONCEPTUAL HYDROGEOLOGICAL CROSS - SECTION

Golder Associates

PROJECT No.		11-1436-0073
DESIGN	CB	03AUG12
CADD	TS	03AUG12
CHECK		
REVIEW		

FILE No. 11-1436-0073-2900-2960-01

SCALE AS SHOWN

FIGURE 4

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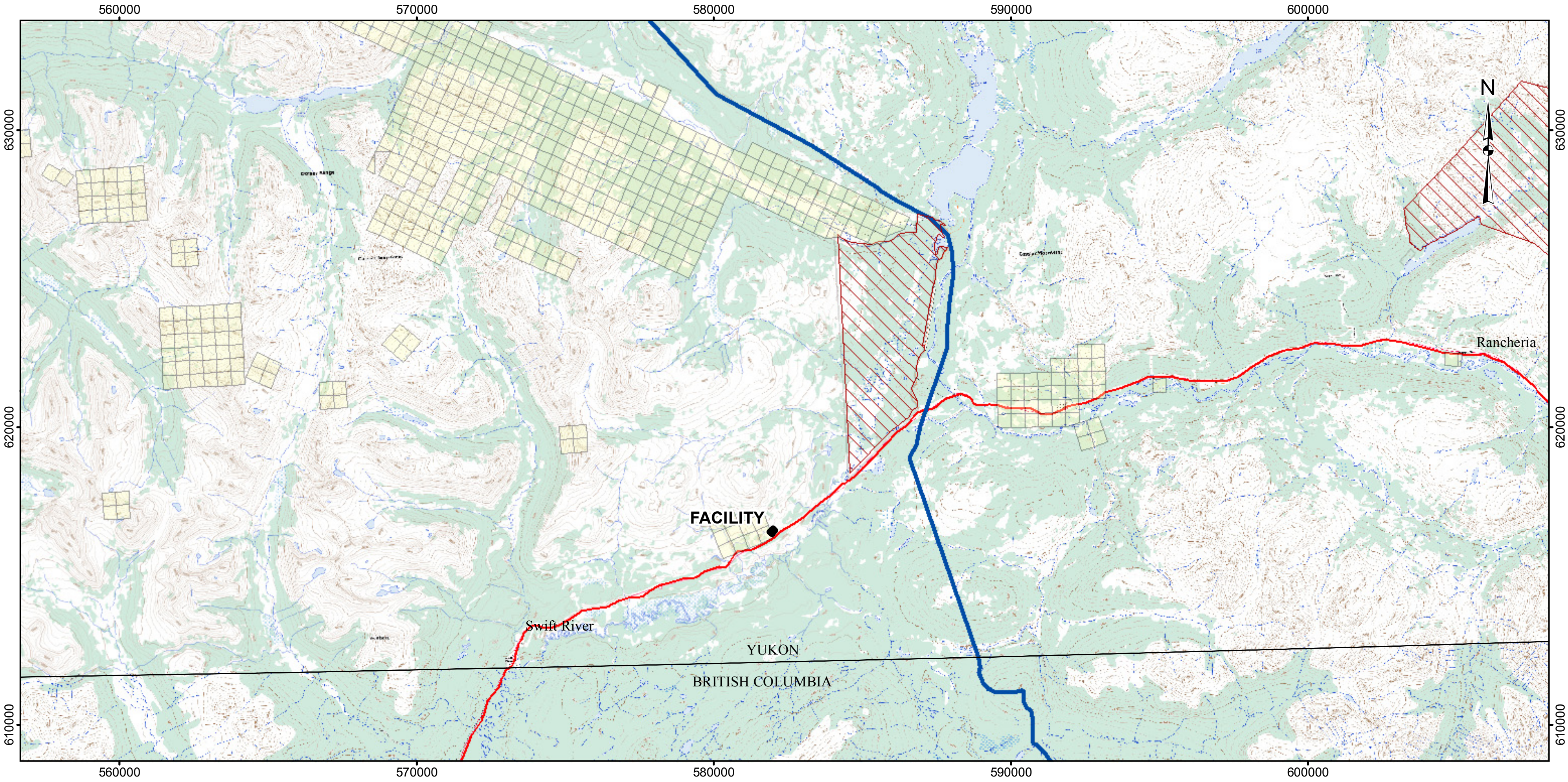


LEGEND

▭ FACILITY
━ MAJOR HIGHWAY
▨ FIRST NATIONS LANDS
▨ PARK/PROTECTED AREA
□ QUARTZ CLAIM
▭ WATERSHED BOUNDARY

5 0 5

SCALE 1:200,000 KILOMETRES

REFERENCE

FEATURE DATA OBTAINED FROM THE YUKON GOVERNMENT YGS MAPMAKER ONLINE. BASEDATA OBTAINED FROM GEOGRATIS (NATURAL RESOURCES CANADA).
DATUM: NAD83 PROJECTION: UTM ZONE 09

PROJECT
SWIFT RIVER SOLID WASTE FACILITY HYDROGEOLOGICAL ASSESSMENT
GOVERNMENT OF YUKON, DEPARTMENT OF COMMUNITY SERVICES
SWIFT RIVER, YUKON

TITLE

REGIONAL DRAINAGE & LAND ZONING

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.		11-1436-0073	PHASE No. 2900
DESIGN	CB	03 Aug 2012	SCALE AS SHOWN REV. 0
GIS	JW	14 Aug 2012	
CHECK			**FIGURE: 5**
REVIEW			

LEGEND

▼ GROUND WATER ELEVATION (MEASURED ON MAY 29, 2012)

⊕ MONITORING WELL MONITORING WELL

- - GROUNDWATER CONTOUR

40 0 40

SCALE (APPROX.) METRES

PROJECT YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
SWIFT RIVER, YUKON

TITLE

BOREHOLE LOCATION MAP
GROUNDWATER ELEVATION

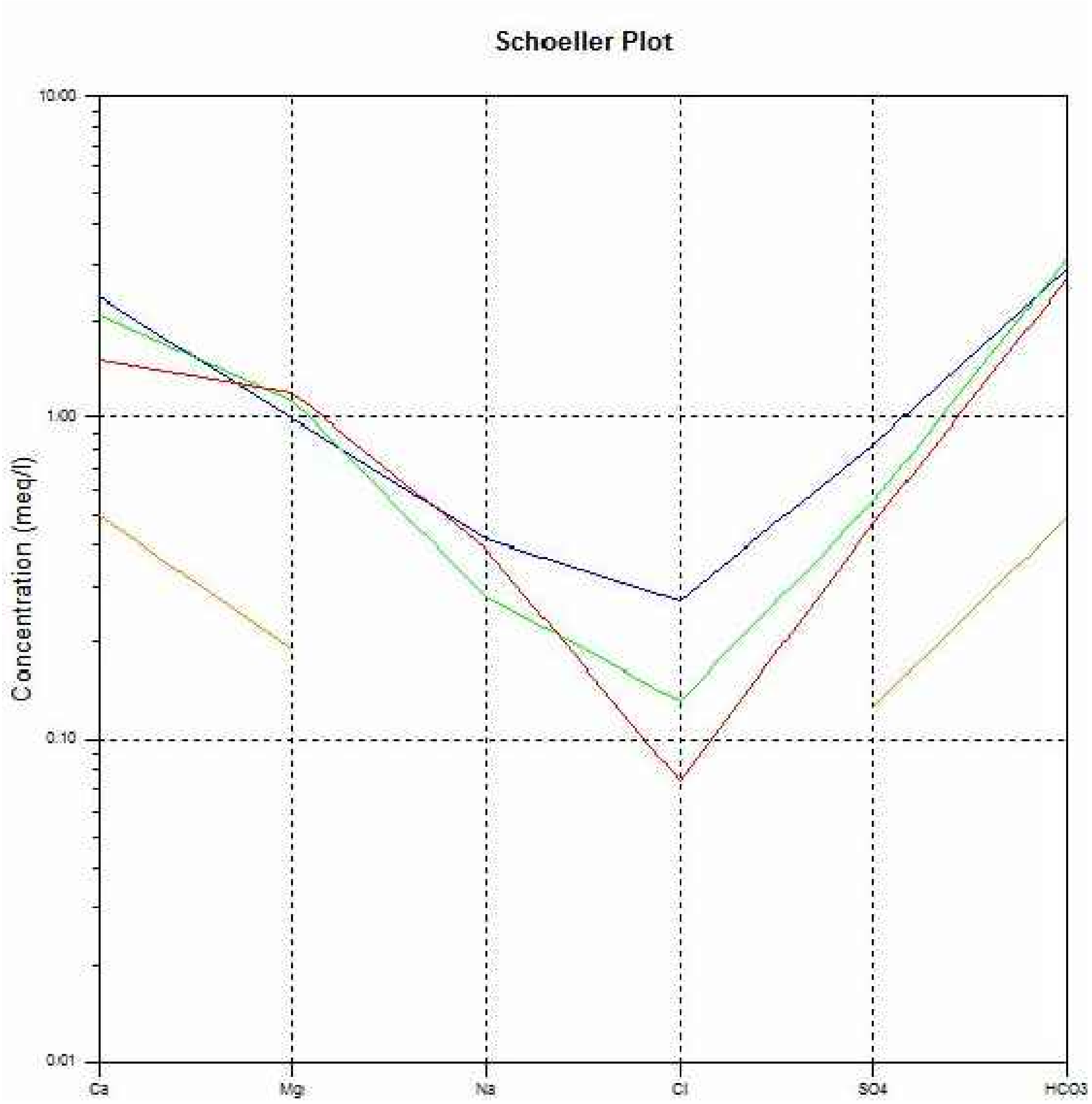
Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.		11-1436-0073	PHASE No. 2930	
DESIGN	CB	27 Jul 2012	SCALE AS SHOWN	REV. 0
GIS	JW	14 Aug 2012	**FIGURE: 6**	
CHECK				
REVIEW				

REFERENCE

IMAGE OBTAINED FROM GOOGLE EARTH, USED UNDER LICENSE.
IMAGERY DATE: JUNE 1, 2005. GOOGLE EARTH IMAGE IS NOT TO SCALE.
DATUM: NAD83 PROJECTION: UTM ZONE 9

N:\Bur-Graphics\Projects\2011\1436\11-1436-0073\GIS\Mapping\MXD\Hydrogeology\Swift_River\Figure_06_Borehole_location.mxd



LEGEND

Chemistry Data May 29, 2012 Sampling

🟥 SR-MW12-01
🟦 SR-MW12-02
🟩 SR-MW12-03
🟧 Swift River Surface Water

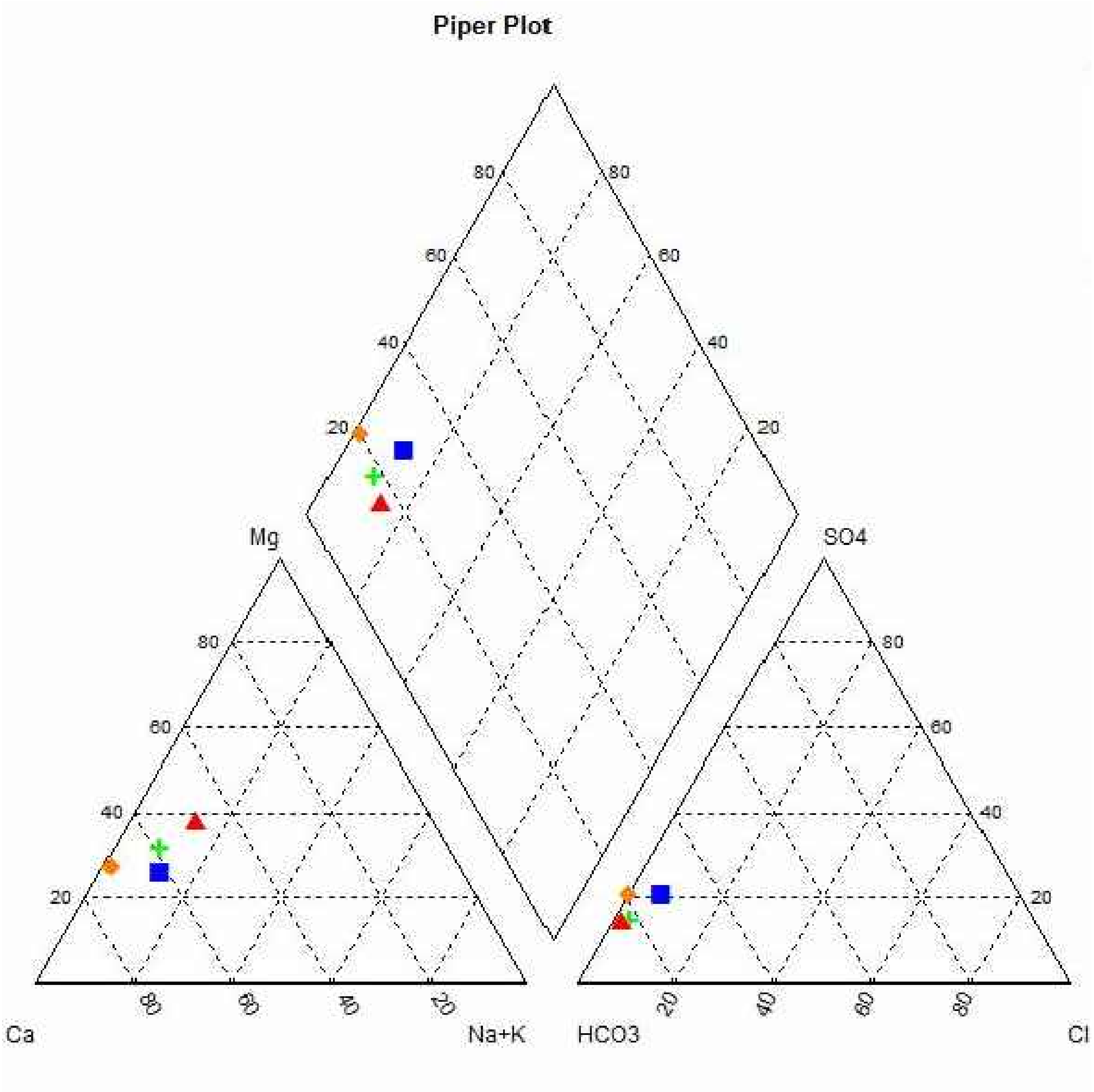
PROJECT
GOVERNMENT OF YUKON, DEPARTMENT OF COMMUNITY SERVICES
WIDE SOLID WASTER FACILITY
SWIFT RIVER, Y.T.

TITLE

SCHOELLER PLOT

Golder Associates	PROJECT No.		11-1436-0073	FILE No. 11-1436-0073-2900-2960-02
	DESIGN	CB	14AUG12	SCALE NOT TO SCALE
	CADD	TS	14AUG12	**FIGURE 7**
	CHECK			
	REVIEW			

N:\Bur-Graphics\Projects\2011\1436\11-1436-0073\Drafting\Phase 2900\Task 2960\11-1436-0073-2900-2960-02.dwg | Layout: 8.5X11 FIG7 (2) | Modified: tsemina 08/14/2012 3:17 PM | Plotted: tsemina 08/14/2012



LEGEND

▲ SR-MW12-01
■ SR-MW12-02
\+ SR-MW12-03
◆ Swift River Surface Water

PROJECT
GOVERNMENT OF YUKON, DEPARTMENT OF COMMUNITY SERVICES
WIDE SOLID WASTER FACILITY
SWIFT RIVER, Y.T.

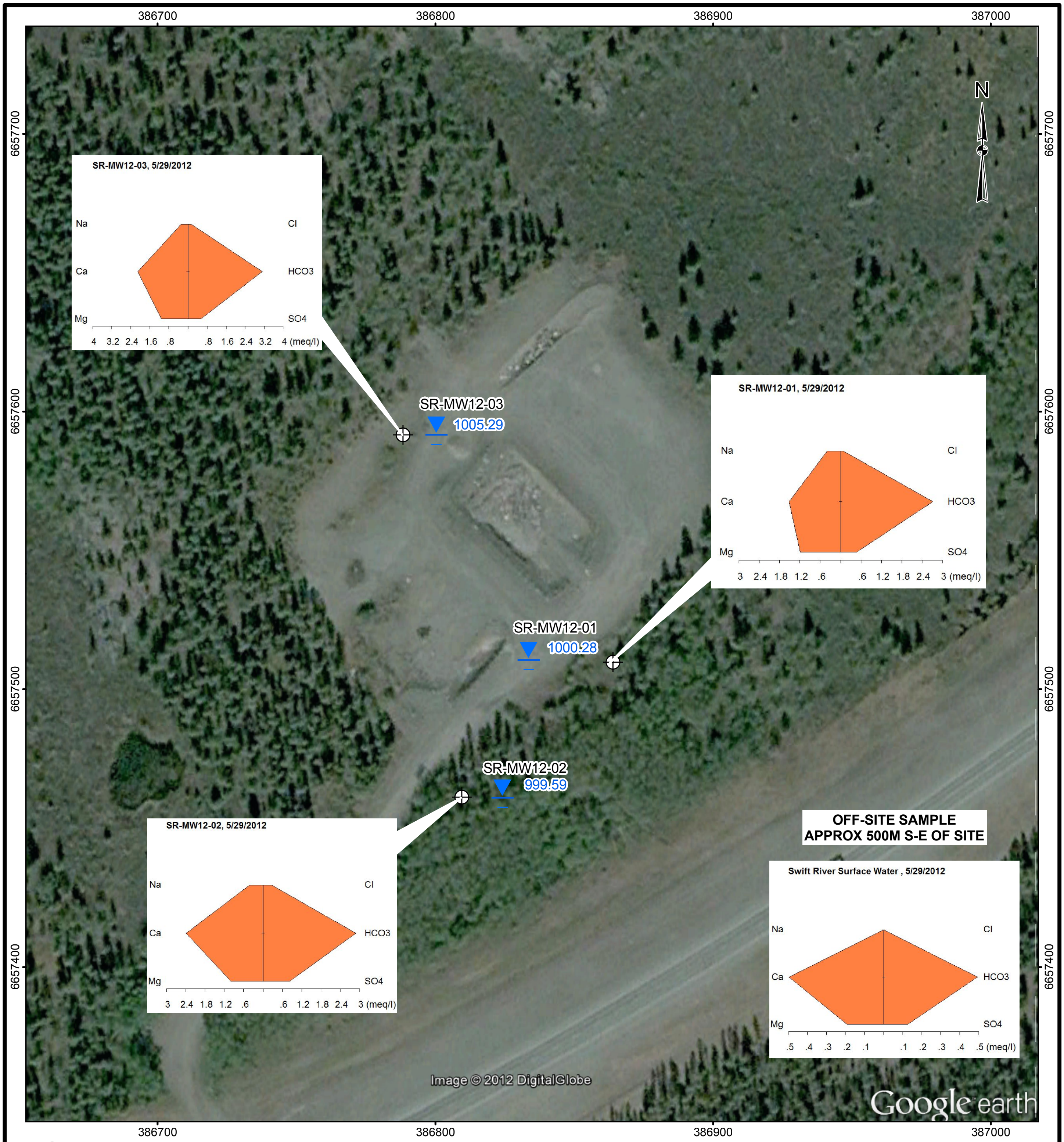
TITLE

PIPER PLOT

Golder Associates

PROJECT No.		11-1436-0073	FILE No. 11-1436-0073-2900-2960-02
DESIGN	CB	14AUG12	SCALE NOT TO SCALE
CADD	TS	15AUG12	**FIGURE 8**
CHECK			
REVIEW			

N:\Bur-Graphics\Projects\2011\1436\11-1436-0073\Drafting\Phase 2900\Task 2960\11-1436-0073-2900-2960-02.dwg | Layout: 8.5X11 FIG08 | Modified: tsemina 08/15/2012 12:25 PM | Plotted: tsemina 08/15/2012



LEGEND

⌖ MONITORING WELL MONITORING WELL

▼ GROUND WATER ELEVATION (MASL) - MEASURED ON MAY 29, 2012

40 0 40

SCALE (APPROX.) METRES

REFERENCE

IMAGE OBTAINED FROM GOOGLE EARTH, USED UNDER LICENSE.
IMAGERY DATE: JUNE 1, 2005. GOOGLE EARTH IMAGE IS NOT TO SCALE.
DATUM: NAD83 PROJECTION: UTM ZONE 9

PROJECT
YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
SWIFT RIVER, YUKON

TITLE

STIFF DIAGRAM

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.		11-1436-0073	PHASE No. 2930
DESIGN	CB	27 Jul 2012	SCALE AS SHOWN REV. 0
GIS	JW	14 Aug 2012	FIGURE: 9
CHECK			
REVIEW			

N:\Bur-Graphics\Projects\2011\1436\11-1436-0073\GIS\Mapping\MXD\Hydrogeology\Swift_River\Figure_09_Stiff_Diagram.mxd

APPENDIX A

Site Photographs

Photograph 1: Shows the installation of SR-MW12-01 May 2012.

Photograph 2: Looking west across the Facility at the domestic garbage burning pit and scrap metal area.

Photograph 3: View looking northwest across the Site at the domestic garbage burning pit from the initial Site visit.

Photograph 4: View looking south across the Site at the domestic garbage burning pit and special waste segregation area from the initial Site visit.

APPENDIX B

Well Construction Logs

PROJECT No.: 11-1436-0073 (2900)
CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Swift River, Yukon
N: 6657509.76 E: 386864 Zone: UTM 9 North

RECORD OF BOREHOLE: SR-MW12-01

DRILLING DATE: May 25, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

SHEET 1 OF 3
DATUM: Geodetic

PID ppm ⊕ 5 10 15 20
PID ppm □ 50 100 150 200
WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40
ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface	1008.72			Stickup = 0.88m
0	M5 Driltech Truck Mounted Auger Drill Rig Air Rotary	(ML-GM) SILT and GRAVEL, some fine to medium sand, brown, with cobbles, dry.	0.00			
5						Grout
6		- at 6.10m depth: moist.				
7		- at 7.62m depth: grades to grey, dense.				
		(ML) CLAYEY SILT, some gravel, some fine to medium sand, grey, moist, firm to hard.	1001.10 7.62			
8		- from 8.53m - 8.84m depth: boulder.				05/29/2012 ▼
		(ML) CLAYEY SILT and GRAVEL, grey, moist.	999.88 8.84			
9				1	GS	
10						

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

LOGGED: KM
CHECKED: DRAFT

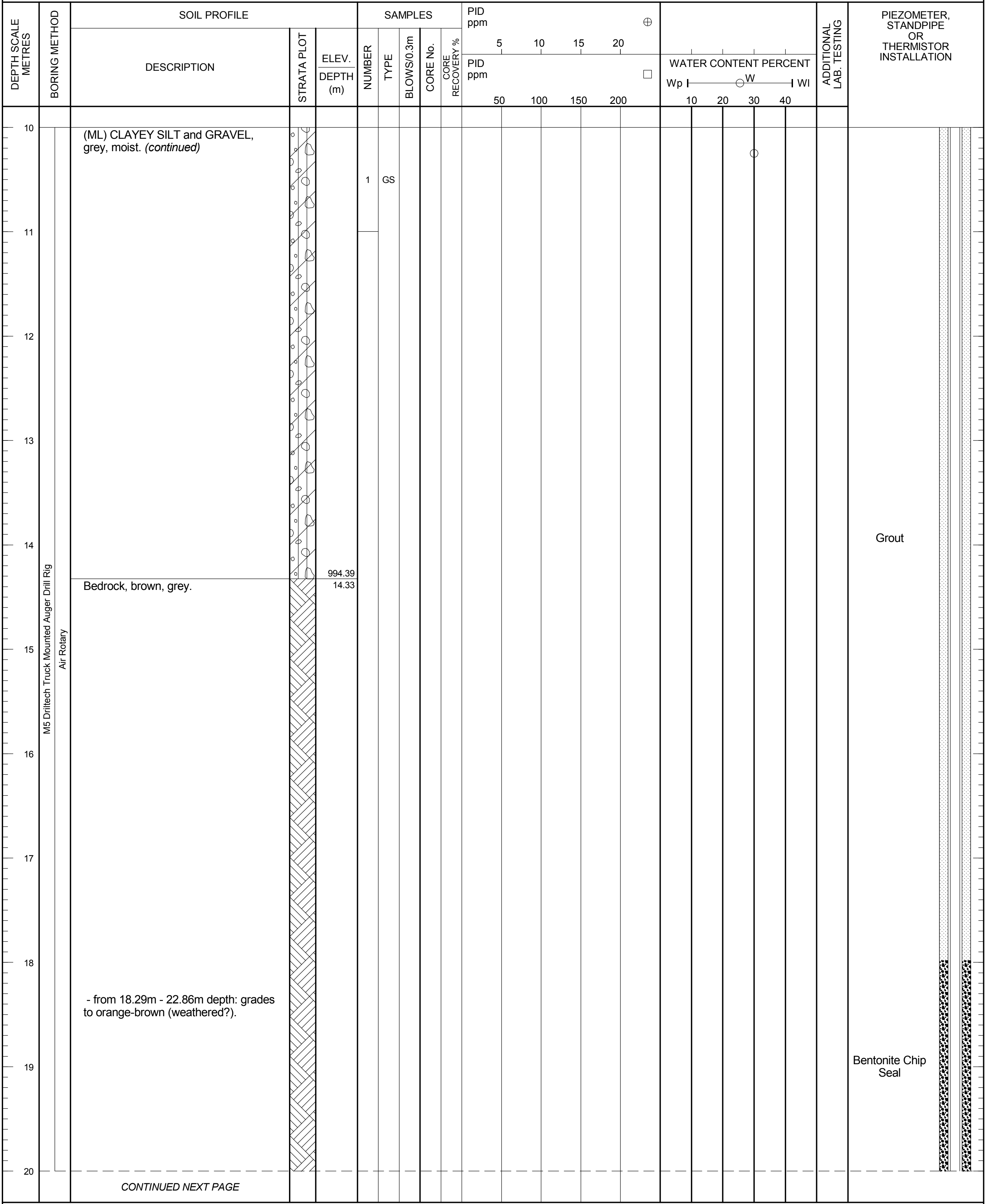
PROJECT No.: 11-1436-0073 (2900)

RECORD OF BOREHOLE: SR-MW12-01

SHEET 2 OF 3
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Swift River, Yukon
N: 6657509.76 E: 386864 Zone: UTM 9 North

DRILLING DATE: May 25, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling



DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	WATER CONTENT PERCENT	INSTALLATION
10	(ML) CLAYEY SILT and GRAVEL, grey, moist. *(continued)*		1	GS	○ 30	Grout
14.33	Bedrock, brown, grey.	994.39 14.33				
18	- from 18.29m - 22.86m depth: grades to orange-brown (weathered?).					Bentonite Chip Seal

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KM
CHECKED: **DRAFT**

File:N:\BUR-GRAPHICS\PROJECTS\2011\1436\11-1436-0073\DRAFTING\GINT\11-1436-0073 (2900 SR).GPJ Output Form:BC_BOREHOLE (ENVIRO) Template:BC REGION TEMPLATE BETA 1.GDT Library:BC REGION LIBRARY.GLB bdrozdiak 09/13/12

RECORD OF BOREHOLE: SR-MW12-01

PROJECT No.: 11-1436-0073 (2900)
CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Swift River, Yukon
N: 6657509.76 E: 386864 Zone: UTM 9 North

DRILLING DATE: May 25, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

SHEET 3 OF 3
DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	CORE No.	CORE RECOVERY %	PID ppm ⊕ 5 10 15 20 / PID ppm □ 50 100 150 200	WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
20	M5 Driltech Truck Mounted Auger Drill Rig Air Rotary	Bedrock, brown, grey. *(continued)*											Bentonite Chip Seal
21													10/20 Silica Sand
22													
23													
24													51mm Slotted PVC Pipe
25		- at 24.69m depth: increased moisture.		983.42 25.30									
		End of Borehole.											
26													
27													
28													
29													
30													

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DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KM
CHECKED: DRAFT

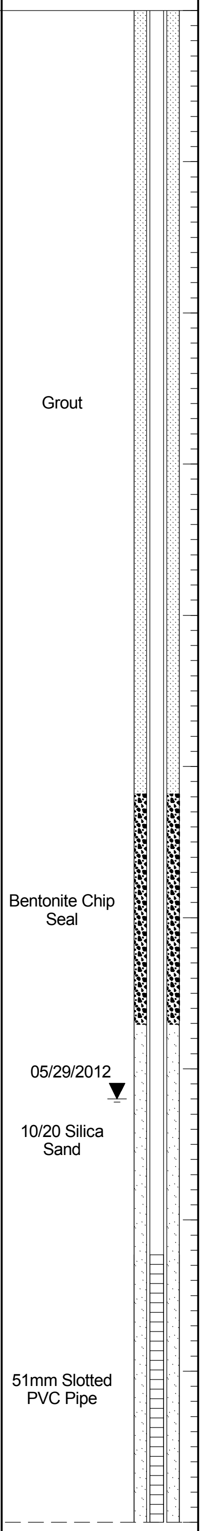
PROJECT No.: 11-1436-0073 (2900)
CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Swift River, Yukon
N: 6657461.22 E: 386809.5 Zone: UTM 9 North

RECORD OF BOREHOLE: SR-MW12-02

DRILLING DATE: May 25, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

SHEET 1 OF 2
DATUM: Geodetic

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	CORE No.	CORE RECOVERY %	PID ppm ⊕ 5 10 15 20 / PID ppm □ 50 100 150 200	WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface		1008.20									Stickup = 0.72m
0	M5 Driltech Truck Mounted Auger Drill Rig Air Rotary	(ML-GM) SILT and GRAVEL, some fine to medium sand, brown, with cobbles, dry.		0.00									
5		(ML-GM) CLAYEY SILT and GRAVEL, grey-brown, dry.		1003.32 4.88									
		- at 8.53m depth: grades to brown.											
		- at 9.14m depth: less gravel, some sand, dark brown, increased moisture, inferred groundwater table.											
10		*CONTINUED NEXT PAGE*											



DEPTH SCALE
1 : 50

LOGGED: KM
CHECKED: DRAFT

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PROJECT No.: 11-1436-0073 (2900)

RECORD OF BOREHOLE: SR-MW12-02

SHEET 2 OF 2
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Swift River, Yukon
N: 6657461.22 E: 386809.5 Zone: UTM 9 North

DRILLING DATE: May 25, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES					PID ppm ⊕ 5 10 15 20 PID ppm □ 50 100 150 200	WATER CONTENT PERCENT Wp ⊢ W ○ ⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	CORE No.	CORE RECOVERY %				
10	Air Rotary	(ML-GM) CLAYEY SILT and GRAVEL, grey-brown, dry. *(continued)*		997.84 10.36									
		(GM) SILTY GRAVEL, grey-brown, wet.		997.23 10.97									51mm Slotted PVC Pipe
11		Bedrock.		996.92 11.28									
		End of Borehole.											
12													
13													
14													
15													
16													
17													
18													
19													
20													

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KM
CHECKED: DRAFT

File:N:\BUR-GRAPHICS\PROJECTS\2011\1436\11-1436-0073\DRAFTING\GINT\11-1436-0073 (2900 SR).GPJ Output Form:BC_BOREHOLE (ENVIRO) Template:BC REGION TEMPLATE BETA 1.GDT Library:BC REGION LIBRARY.GLB bdrozdiak 09/13/12

PROJECT No.: 11-1436-0073 (2900)
CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Swift River, Yukon
N: 6657591.7 E: 386788.4 Zone: UTM 9 North

RECORD OF BOREHOLE: SR-MW12-03

DRILLING DATE: May 26, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

SHEET 1 OF 2
DATUM: Geodetic

BORING METHOD: M5 Driltech Truck Mounted Auger Drill Rig
Air Rotary

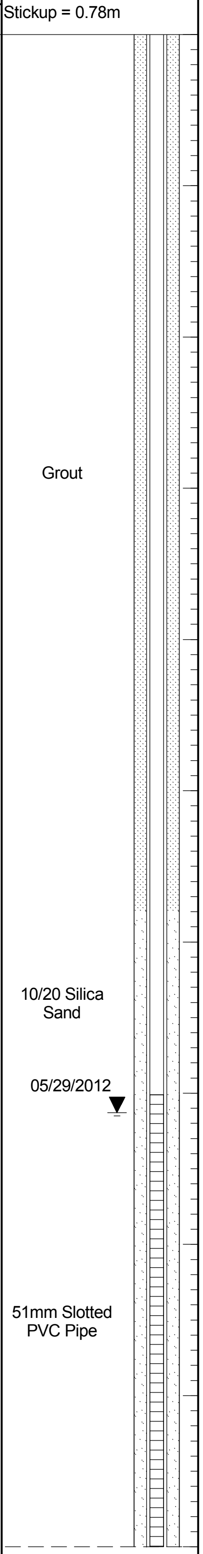
DESCRIPTION	ELEV. / DEPTH (m)
Ground Surface	1012.40
(ML-GM) SILT and GRAVEL, trace to some sand, brown, dry.	0.00
(ML-GM) CLAYEY SILT and GRAVEL, trace to some sand, brown, moist.	1009.96 2.44
(ML) CLAYEY SILT, some gravel, trace sand, grey, moist. - at 6.71m depth: grades to dark grey, increased moisture.	1007.22 5.18
Bedrock, dark grey, moist.	1005.39 7.01

DEPTH SCALE METRES: 0 – 10

SAMPLES: NUMBER | TYPE | BLOWS/0.3m | CORE No. | CORE RECOVERY %

PID ppm ⊕ 5 10 15 20
PID ppm ☐ 50 100 150 200
WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40
ADDITIONAL LAB. TESTING

PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION



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DEPTH SCALE
1 : 50

LOGGED: KM
CHECKED: DRAFT

PROJECT No.: 11-1436-0073 (2900)

RECORD OF BOREHOLE: SR-MW12-03

SHEET 2 OF 2
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Swift River, Yukon
N: 6657591.7 E: 386788.4 Zone: UTM 9 North

DRILLING DATE: May 26, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES					PID ppm ⊕ 5 10 15 20 PID ppm ☐ 50 100 150 200	WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	CORE No.	CORE RECOVERY %				
10				1002.34 10.06									
		End of Borehole.											
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KM
CHECKED: DRAFT

APPENDIX C

Well Development and Sampling Sheets

GROUNDWATER DEVELOPMENT AND PURGING/SAMPLING DATA SHEET

☐ Development
☐ Purging/Sampling

Well No.: MW12-04-SR
Location: SWIFT RIVER
Weather: YT SUN/WIND Temperature: 17
Project No.: JJ-1436-0073/2900
Date: 29 MAY 2012 Time: 1402
Completed by: J. MARQUARDSON, A. BADGER

MONITORING WELL INFORMATION

Time of Measurement: 1402
Depth to product: / Product thickness: /
Depth to water Below Top of Casing: A 7.20 metres
Depth to Bottom of Well Below Top of Casing: B 10.865 metres
Diameter Standpipe: C 50 mm
Tidally influenced: ☐ Yes ☒ No
One well volume:
(B-A)*2.0 = 19.2 litres - for a 51 mm (2.0 inch) diameter well
(B-A)*1.1 = litres - for a 38 mm (1.5 inch) diameter well
Sample intake depth: 10.2 metres

10.8
-1.2
9.6
× 2
19.2

EQUIPMENT LIST

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

WELL DEVELOPMENT/PURGING

Purge Volume: Well. Vol. X ______ = ______ litres
Avg. Flow Rate: ______ L/min. Start: 1405 Finish:

Time	Volume Removed (L)	Temp. (°C)	pH (Units)	Cond. (uS/cm)	Redox (mV)	Diss. O_2 (mg/L) or %		Water Level (m)	Remarks
1405									START PUMP
1412	6	5.37	7.29	244		1.68		6.110	VERY SILTY
1417	30	4.79	7.40	229		1.60		7.985	MOD SILT
1421	45	3.65	7.52	196		2.46		8.242	" "
1425	60	4.03	7.67	186		2.98		8.930	" "
1430	75	4.20	7.63	209				9.455	" "

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 I Very Silty

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	

SEE COC

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

GROUNDWATER DEVELOPMENT AND PURGING/SAMPLING DATA SHEET

☑ Development
☑ Purging/Sampling

Well No.: MW 12-05-SR
Location: SWIFT RIVER 386862/6657510
Weather: SUNNY WINDNW 25KM
Temperature: 10
Project No.: 11-1436-0073/2900
Date: 29 MAY 2012
Time: 1120
Completed by: J.MARQUARDSON, A.BADGER

MONITORING WELL INFORMATION

Time of Measurement: 1120
Depth to product: —
Product thickness: —
Depth to water Below Top of Casing: A 9.334 metres
Depth to Bottom of Well Below Top of Casing: B 26.266 metres
Diameter Standpipe: C 50 mm
Tidally Influenced: ☐ Yes ☑ No
One well volume:
(B-A)*2.0 = 34 litres - for a 51 mm (2.0 inch) diameter well
(B-A)*1.1 = litres - for a 38 mm (1.5 inch) diameter well
Sample intake depth: 25.3 metres

26.3
9.3
17.0
×2
34

EQUIPMENT LIST

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

WELL DEVELOPMENT/PURGING

Purge Volume: Well. Vol. X ______ = ______ litres
Avg. Flow Rate: ______ L/min.
Start: 1125
Finish: 1355

Time	Volume Removed (L)	Temp. (°C)	pH (Units)	Cond. (uS/cm)	Redox (mV)	Diss. O_2 (mg/L) or %		Water Level (m)	Remarks
11:25	0							9.334	START PUMP
1127	7	5.63	6.77	208		4.27		15.395	CLEAR
1137	30	4.11	7.31	174		4.63		23.300	CLEAR
1140	45	4.31	7.01	230		5.41		24.110	
1203	60	5.97	7.31	205		8.93		24.445	
1239	75							24.405	
1300	90							24.400	
13.45	105	7.02	7.21	197		7.30		23.20	

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

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

GROUNDWATER DEVELOPMENT AND PURGING/SAMPLING DATA SHEET

☑ Development
☑ Purging/Sampling

Well No.: MW12-06-~~SW~~ SR
Project No.: 11-1436-0073 / 2900
Location: SWIFT RIVER
Date: 29 MAY 2012 Time: 1025
Weather: CALM SUNNY Temperature: 8
Completed by:

MONITORING WELL INFORMATION

9V 386809 / 6657459

Time of Measurement: 1025
Depth to product: — Product thickness: —
Depth to water Below Top of Casing: A 7.942 metres
Depth to Bottom of Well Below Top of Casing: B 12.160 metres
Diameter Standpipe: C 50 mm
Tidally Influenced: ☐ Yes ☒ No
One well volume: 8.6
(B-A)*2.0 = ______ litres - for a 51 mm (2.0 inch) diameter well
(B-A)*1.1 = ______ litres - for a 38 mm (1.5 inch) diameter well
Sample intake depth: 1.0 metres (OFF BOTTOM)

12.2
-7.9
4.3

EQUIPMENT LIST

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

WELL DEVELOPMENT/PURGING

Purge Volume: Well. Vol. X ______ = ______ litres
Avg. Flow Rate: ______ L/min. Start: 1028 Finish:

Time	Volume Removed (L)	Temp. (°C)	pH (Units)	Cond. (uS/cm)	Redox (mV)	Diss. O₂ (mg/L) or %		Water Level (m)	Remarks
1028								7.942	START PUMP
1030	1	6.82	6.97	195		4.80			VERY SILTY
1036	15	4.09	7.18	266		4.89		8.830	"
1042'	20	3.84	7.21	303		5.98		9.550	"
1045	30	—	—	—		—		9.590	DRY (FOOT @ 1m OFF BOTTOM
1050								9.100	COLLECT SAMPLES

* DIDN'T REALLY GO DRY → PROBLEM w FOOT VALVE

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 Very Silty

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	

SEE COC

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

PHOTOS 1722 –

Single-well Response Test Data Sheet

☑ Rising Head
☐ Falling Head

Well No.: MW 12-06-SR
Location: SWIFT RIVER 9V 386809/6657459
Project No.: 11-1436-0074/2900
Completed By: J. MARQUARDSON, A. BADGER
Date: 29 ~~MARCH~~ MAY 2012
Time: 1300

MONITORING WELL INFORMATION

Depth to water below top of casing: 8.404 meters
Depth to bottom of well below top of casing: 12.160 meters
Distance from top of pipe to ground surface: 0.73 meters
Well casing diameter: 0.050 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: 1 [✓ seconds] or minutes (circle one)

SINGLE-WELL RESPONSE TEST

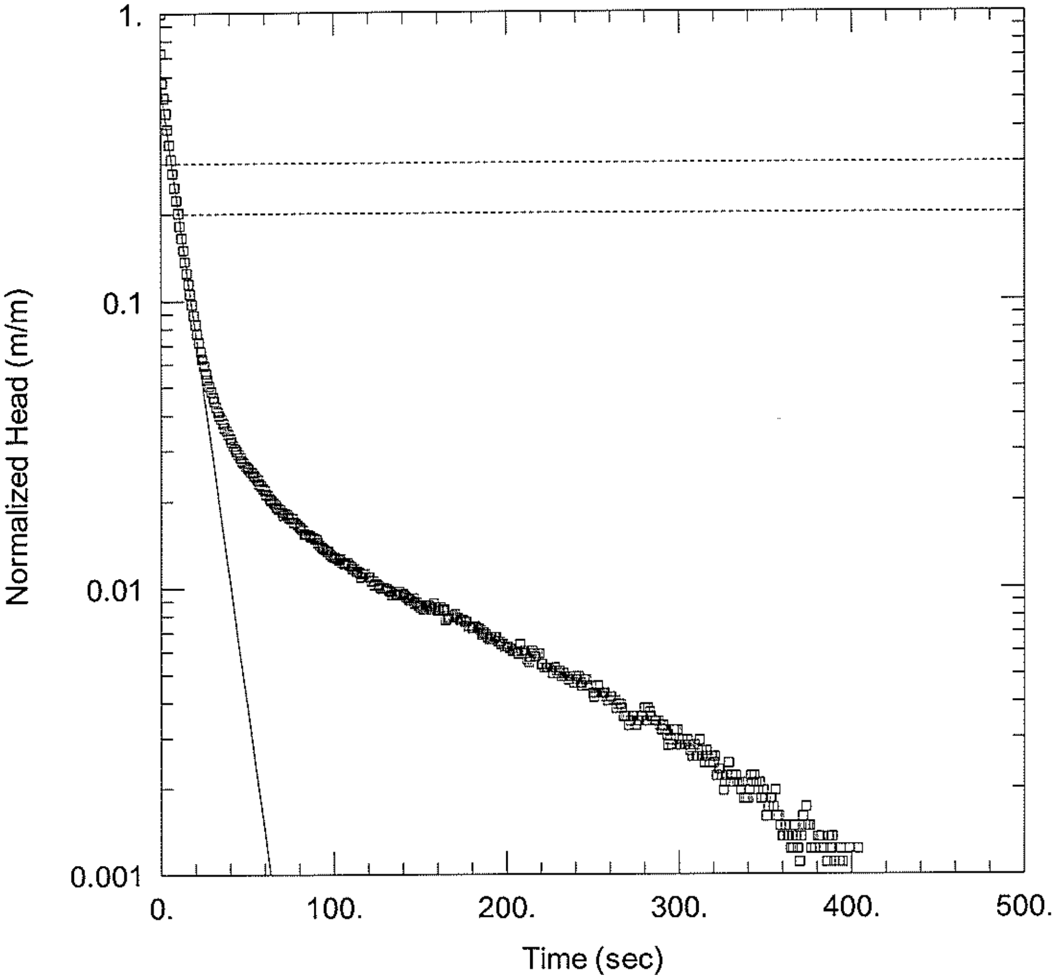
Start time: 1305 Finish time: ______

Time	Elapsed Time	Water Level (m)	Comments
1305		8.404	TX IN (0.2 OFF BOTTOM)
1312		8.272	SLUG IN
1323		8.250	SLUG OUT
1330			SLUG IN
1337			SLUG OUT
1343			SLUG IN
1350			SLUG OUT

POOR TEST RESULTS
– NEED TO REDO
– SLUG NOT OUT ALL THE WAY ?

APPENDIX D

Slug Test Logs and Data



SLUG TEST ANALYSIS FOR WELL SR-MW12-02 (TEST #1)

Data Set: \...\SR-MW12-02_TEST 1_CB.aqt
Date: 08/15/12 Time: 13:38:16

PROJECT INFORMATION

Test Well: SR-MW12-02
Test Date: 5-July-2012

AQUIFER DATA

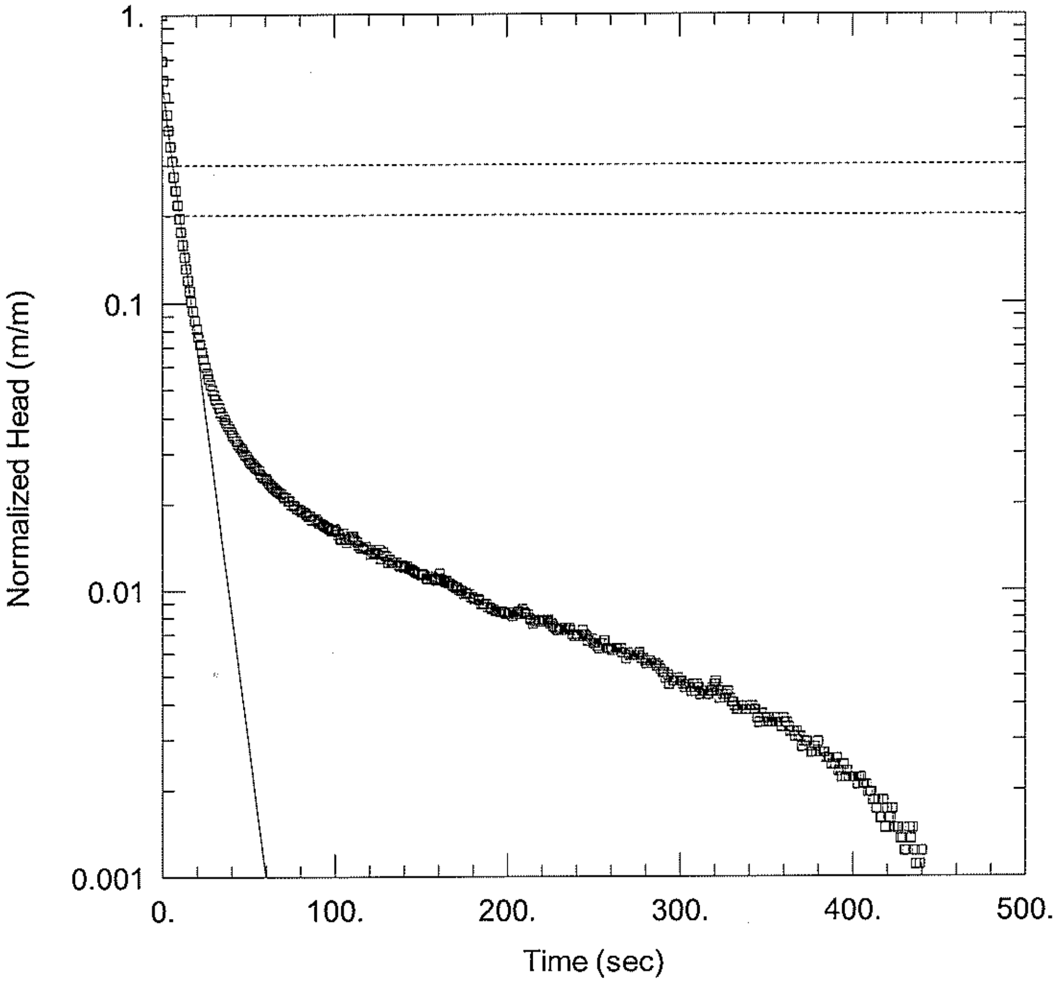
Saturated Thickness: 3.67 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (SR-MW12-02 Test #1)

Initial Displacement: 0.817 m
Static Water Column Height: 3.67 m
Total Well Penetration Depth: 3.67 m
Screen Length: 3.05 m
Casing Radius: 0.025 m
Well Radius: 0.092 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.838E-5 m/sec
y0 = 0.4536 m



SLUG TEST ANALYSIS FOR WELL SR-MW12-02 (TEST #2)

Data Set: \...\SR-MW12-02_TEST 2_CB.aqt
Date: 08/15/12 Time: 13:39:09

PROJECT INFORMATION

Test Well: SR-MW12-02
Test Date: 5-July-2012

AQUIFER DATA

Saturated Thickness: 3.67 m
Anisotropy Ratio (Kz/Kr): 1.

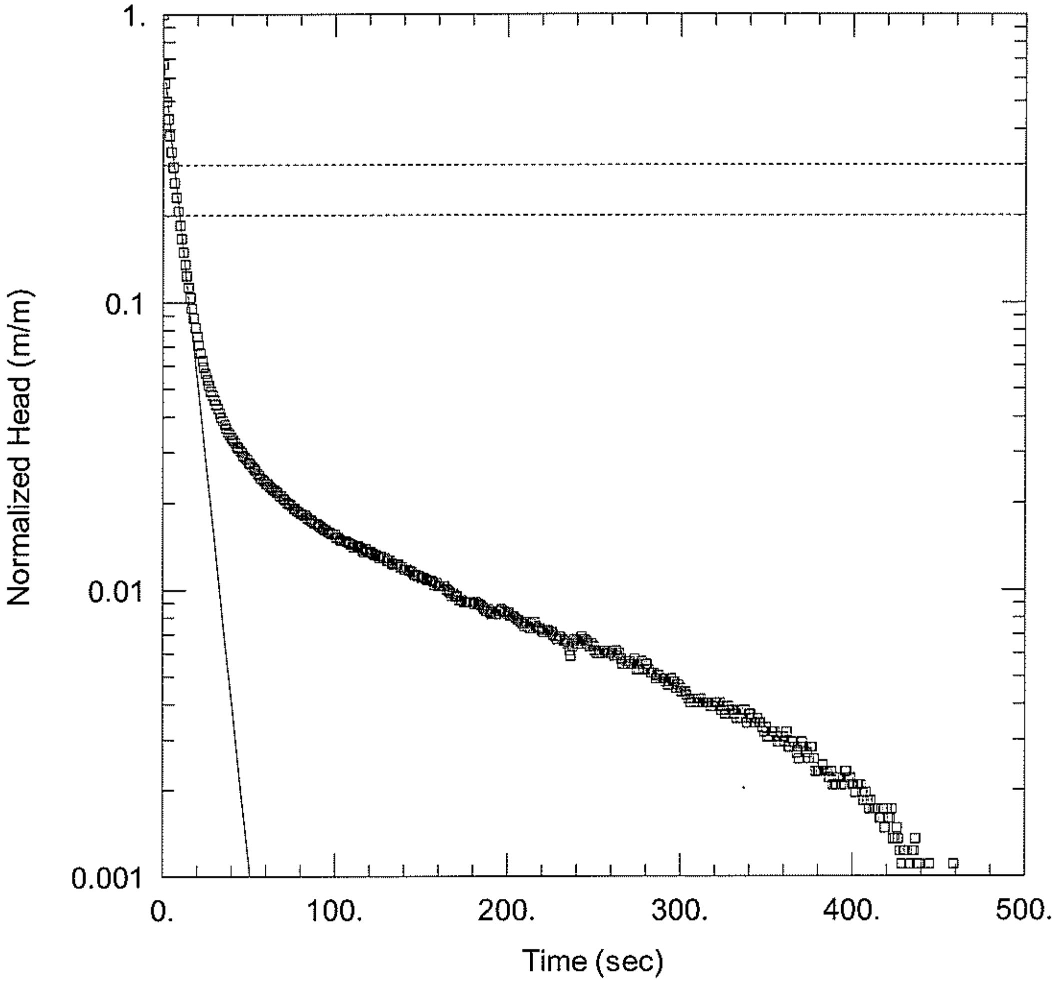
WELL DATA (Sr-MW12-02)

Initial Displacement: 0.817 m
Total Well Penetration Depth: 3.67 m
Casing Radius: 0.025 m
Static Water Column Height: 3.67 m
Screen Length: 3.05 m
Well Radius: 0.092 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.029E-5 m/sec
y0 = 0.4757 m



SLUG TEST ANALYSIS FOR WELL SR-MW12-02 (TEST #3)

Data Set: \...\SR-MW12-02_TEST 3_CB.aqt
Date: 08/15/12 Time: 13:39:42

PROJECT INFORMATION

Test Well: SR-MW12-02
Test Date: 5-July-2012

AQUIFER DATA

Saturated Thickness: 3.67 m
Anisotropy Ratio (Kz/Kr): 1.

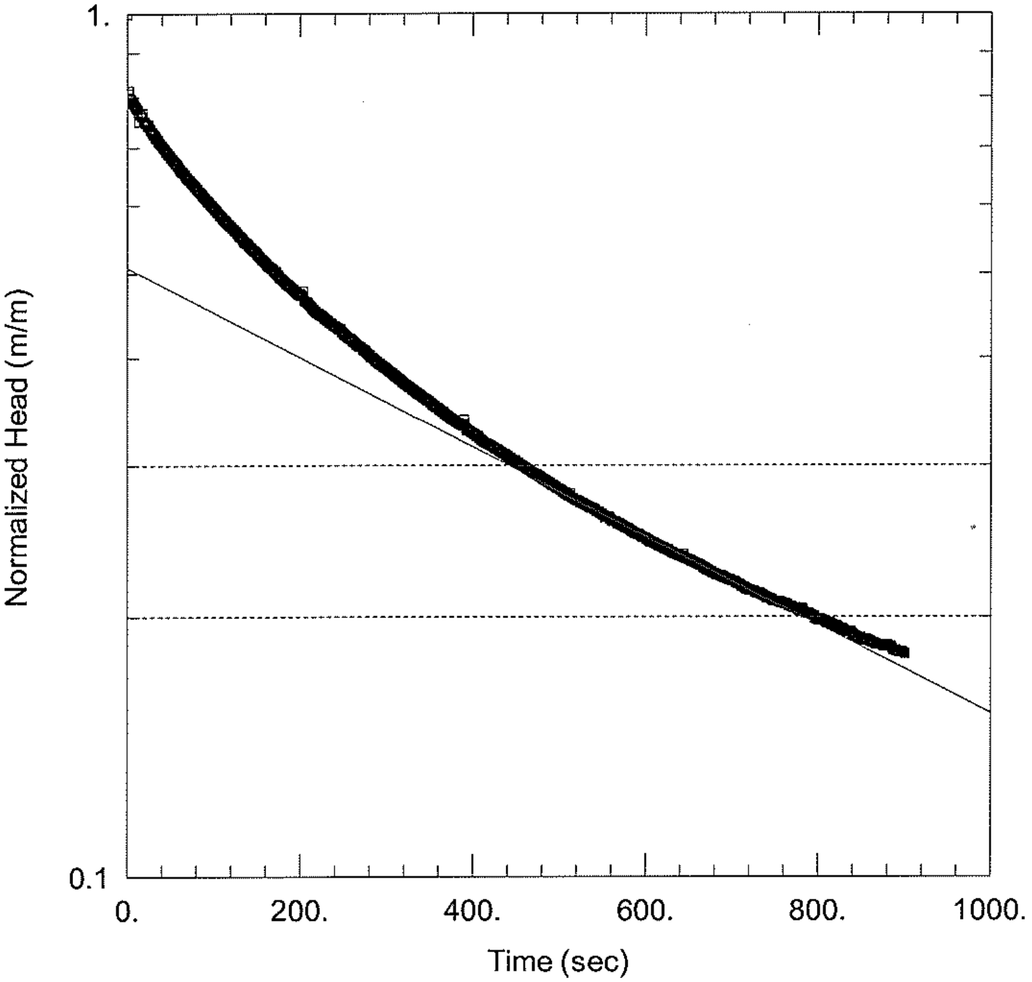
WELL DATA (Sr-MW12-02)

Initial Displacement: 0.817 m
Total Well Penetration Depth: 3.67 m
Casing Radius: 0.025 m
Static Water Column Height: 3.67 m
Screen Length: 3.05 m
Well Radius: 0.092 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.668E-5 m/sec
y0 = 0.5667 m



SLUG TEST ANALYSIS FOR WELL SR-MW12-03 (TEST #1)

Data Set: \...\SR-MW12-03_Slug test_5-July-12.aqt
Date: 08/15/12 Time: 13:40:15

PROJECT INFORMATION

Test Well: SR-MW12-03
Test Date: 5-July-2012

AQUIFER DATA

Saturated Thickness: 3.05 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (SR-MW12-03)

Initial Displacement: 0.487 m
Total Well Penetration Depth: 3.047 m
Casing Radius: 0.025 m
Static Water Column Height: 7.51 m
Screen Length: 3.047 m
Well Radius: 0.092 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 3.504E-7 m/sec
y0 = 0.2471 m

Single-well Response Test Data Sheet

☑ Rising Head

☐ Falling Head

Well No.: SR-MW12-04
Location: SWIFT RIVER
Project No.: 11-1436-0073 /2900
Completed By: A BADGER
Date: 05-JUL-12
Time: 1250

MONITORING WELL INFORMATION

Depth to water below top of casing: 3.44 meters
Depth to bottom of well below top of casing: 10.95 meters
Distance from top of pipe to ground surface: ______ meters
Well casing diameter: 0.05 meters (1 inch = 0.025 meters)
Borehold diameter: 0.181 meters
Screen length: 3.048 meters (1 foot = 0.3048 meters)
Screened unit: ______ (eg: sand, silt, clay)

EQUIPMENT LIST

☑ Slug
Mass: ______ kilograms
Length: 1.5 meters
Diameter: 0.037 meters

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

Pressure transducer serial #: 0011032686
Sampling Interval: 1 [✓ seconds] or minutes (circle one)

SINGLE-WELL RESPONSE TEST

Start time: 1252 Finish time: 1411

Time	Elapsed Time	Water Level (m)	Comments
1252			Tx in (0.2m FROM BOTTOM)
1254		2.56	SLUG IN
1256		2.69	
1300		2.74	
1302		2.77	
1304		2.78	
1306		2.78	
1309			SLUG OUT
1319			SLUG IN
1329			SLUG OUT
1339			SLUG IN
1349			SLUG OUT
1359			SLUG IN
1409			SLUG OUT

1411 Tx OUT

Single-well Response Test
Data Sheet

☑ Rising Head

☐ Falling Head

Well No.: SR-MW12-05
Location: SWIFT RIVER
Project No.: 11-1436-0073/2900
Completed By: A BADGER
Date: 04-JUL-12
Time: 1920

MONITORING WELL INFORMATION

Depth to water below top of casing: 11.745 meters
Depth to bottom of well below top of casing: 26.25 meters
Distance from top of pipe to ground surface: ______ meters
Well casing diameter: 0.05 meters (1 inch = 0.025 meters)
Borehold diameter: 0.181 meters
Screen length: 3.048 meters (1 foot = 0.3048 meters)
Screened unit: ______ (eg: sand, silt, clay)

EQUIPMENT LIST

☑ Slug
Mass: ______ kilograms
Length: 1.5 meters
Diameter: 0.05 meters

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

Pressure transducer serial #: 0011036280
Sampling Interval: 1 [✓ seconds] or minutes (circle one)

SINGLE-WELL RESPONSE TEST

Start time: 19.20 Finish time: 20.13

Time	Elapsed Time	Water Level (m)	Comments
19.20			TX IN (0.2 m OFF BOTTOM)
19.22		10.83	SLUG IN
19.26		10.81	
19.27		10.81	
19.29			SLUG OUT
19.36			SLUG IN
19.43			SLUG OUT
19.50			SLUG IN
19.57			SLUG OUT
20.04			SLUG IN
20.11			SLUG OUT
20.13			TX OUT

Single-well Response Test Data Sheet

☑ Rising Head

☐ Falling Head

Well No.: SR-MW12-05

Location: SWIFT RIVER

Project No.: 11-1436-0073/2900

Completed By: A BADGER

Date: 05-JUL-12

Time: 1015

MONITORING WELL INFORMATION

Depth to water below top of casing: 11.815 meters

Depth to bottom of well below top of casing: 26.25 meters

Distance from top of pipe to ground surface: meters

Well casing diameter: 0.05 meters (1 inch = 0.025 meters)

Borehold diameter: 0.181 meters

Screen length: 3.048 meters (1 foot = 0.3048 meters)

Screened unit: (eg: sand, silt, clay)

EQUIPMENT LIST

☑ Slug

Mass: kilograms

Length: 1.5 meters

Diameter: 0.0375 meters

☐ Bailer

Water column height: meters

Inside diameter: meters

and/or Volume of water removed: litres

Pressure transducer serial #: 0011032680

Sampling Interval: 1 [✓ seconds] or minutes (circle one)

SINGLE-WELL RESPONSE TEST

Start time: 10:15 Finish time: 12:40

Time	Elapsed Time	Water Level (m)	Comments
1015			Tx in (0.2m OFF BOTTOM)
1017		10.85	SLUG IN
1022		10.83	
1024		10.82	
1027		10.81	
1028		10.80	
1030		10.79	
1031		10.78	
1033		10.77	
1034		10.76	
1037		10.76	SLUG OUT
1057			SLUG IN
1111			SLUG OUT
1131			SLUG IN

1151 SLUG OUT

1211 SLUG IN

1231 SLUG OUT

1240 Tx OUT

Single-well Response Test
Data Sheet

☑ Rising Head
☐ Falling Head

Well No.: SR- MW12-06
Location: SWIFT RIVER
Project No.: 11-1436-0073 / 2900
Completed By: A BADGER
Date: 04- JUL-12
Time: 1800

MONITORING WELL INFORMATION

Depth to water below top of casing: 8.49 meters
Depth to bottom of well below top of casing: 12.16 meters
Distance from top of pipe to ground surface: ______ meters
Well casing diameter: 0.050 meters (1 inch = 0.025 meters)
Borehold diameter: 0.181 meters
Screen length: 3.048 meters (1 foot = 0.3048 meters)
Screened unit: ______ (eg: sand, silt, clay)

EQUIPMENT LIST

☑ Slug
Mass: ______ kilograms
Length: 1.5 meters
Diameter: 0.0375 meters

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

Pressure transducer serial #: 0011032680
Sampling Interval: 1 SECOND seconds or minutes (circle one)

SINGLE-WELL RESPONSE TEST

Start time: 18·02
Finish time: 19·08

Time	Elapsed Time	Water Level (m)	Comments
18:02			Tx in (0.2m off BOTTOM)
18:05		8.415	SLUG IN
18:09		8.44	
18:10		8.445	
18:11		8.445	
18·12			SLUG OUT
1820			SLUG IN
18:28			SLUG OUT
18:36			SLUG IN
18:44			SLUG OUT
18:52			SLUG IN
19:00			SLUG OUT
19:08			Tx OUT

APPENDIX E

Laboratory Analytical Results and COC

Table E1

Results of Water Analyses - Metals

[YTG Landfill Monitoring, Swift River, Yukon]

SCN			10-174288-01	10-174288-02	10-174288-03	10-174288-04
Location	**Aquatic Life CSR-AW (freshwater)**		SR-MW12-02	SR-MW12-01	SR-MW12-03	SWIFT RIVER
QA/QC						
Date		Notes	29-MAY-12	29-MAY-12	29-MAY-12	29-MAY-12
Parameters						
pH (field)			7.21	7.21	7.63	-
Temperature °C			3.84	7.02	4.20	-
Conductivity (uS/cm)			303	197	209	-
Dissolved Oxygen (mg/L)			5.98	7.30	-	-
Laboratory Parameters						
pH (laboratory)			8.04	7.32	7.82	7.95
Hardness (as CaCO3)			169	136	161	34.6
total dissolved solids			282	168	241	56
Aggregate Organics						
COD			54	<20	<20	<20
dissolved organic carbon			3.99	1.62	2.37	3.44
Bacteriological						
Coliform Bacteria - Fecal			<2	<2	<2	8
Dissolved Metals						
aluminum			<0.010	<0.010	<0.010	0.029
antimony	**0.2**		<0.00050	<0.00050	<0.00050	<0.00050
arsenic	**0.05**		0.00074	0.00091	0.00171	0.00049
barium	**10**		0.074	0.061	0.059	<0.020
beryllium	**0.053**		<0.0050	<0.0050	<0.0050	<0.0050
bismuth			<0.20	<0.20	<0.20	<0.20
boron			<0.10	<0.10	<0.10	<0.10
cadmium	**0.0001 - 0.0006**	H	<0.00020	<0.00020	<0.00020	<0.00020
calcium			47.9	30.4	42.2	10.0
chromium	**0.010^{VI}, 0.090^{III}**	V	<0.0020	<0.0020	<0.0020	<0.0020
cobalt	**0.009**		*<0.010*	*<0.010*	*<0.010*	*<0.010*
copper	**0.020 - 0.090**	H	0.0011	<0.0010	<0.0010	<0.0010
iron			<0.030	<0.030	<0.030	0.041
lead	**0.040 - 0.160**	H	<0.00050	<0.00050	<0.00050	<0.00050
lithium			<0.010	<0.010	<0.010	<0.010
magnesium			12.1	14.5	13.6	2.33
manganese			0.613	0.544	0.425	0.0048
mercury	**0.001**		<0.00020	<0.00020	<0.00020	<0.00020
molybdenum	**10**		<0.030	<0.030	<0.030	<0.030
nickel	**0.250 - 1.5**	H	<0.050	<0.050	<0.050	<0.050
phosphorus			<0.30	<0.30	<0.30	<0.30
potassium			2.30	1.62	2.01	0.41
selenium	**0.01**		<0.0010	<0.0010	<0.0010	<0.0010
silicon			3.05	4.50	4.61	3.04
silver	**0.0005 - 0.015**	H	<0.010	<0.010	<0.010	<0.010
sodium			9.7	9.0	6.4	<2.0
strontium			0.164	0.170	0.168	0.0371
thallium	**0.003**		*<0.20*	*<0.20*	*<0.20*	*<0.20*
tin			<0.030	<0.030	<0.030	<0.030
titanium	**1**		<0.010	<0.010	<0.010	<0.010
uranium	**3**		0.00176	0.00179	0.00228	0.00023
vanadium			<0.030	<0.030	<0.030	<0.030
zinc	**0.075 - 2.4**	H	<0.050	<0.050	<0.050	<0.050
Other Inorganics						
bicarbonate (CaCO3)			145	136	156	30.1
carbonate (CaCO3)			<2.0	<2.0	<2.0	<2.0
hydroxide (CaCO3)			<2.0	<2.0	<2.0	<2.0
total alkalinity (CaCO3)			145	136	156	30.1
ammonia	**1.31 - 18.5**	pH	0.181	0.0619	0.0814	<0.0050
bromide (free)			<0.050	<0.050	<0.050	<0.050
chloride			9.55	2.61	4.69	<0.50
fluoride	**2 - 3**	H	0.280	0.278	0.209	0.125
nitrate (as N)	**400**		0.336	0.0177	0.0332	0.0171
nitrite (as N)	**0.2 - 2**	Cl	0.0013	<0.0010	<0.0010	<0.0010
total Kjeldahl nitrogen			8.77	0.152	0.897	0.163
sulphate	**1000**		39.8	22.4	26.5	6.08

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).
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.
COC = Chain of Custody

Table E2
Results of Water Analyses - Hydrocarbons
YTG Landfill Monitoring, Swift River, Yukon

SCN			10-174288-01	10-174288-02	10-174288-03	10-174288-04
Location	Aquatic Life CSR-AW (freshwater)		SR-MW12-02	SR-MW12-01	SR-MW12-03	SWIFT RIVER
QA/QC						
Date			29-MAY-12	29-MAY-12	29-MAY-12	29-MAY-12
		Notes				
Monoaromatic Hydrocarbons						
benzene	**4**		<0.00050	<0.00050	<0.00050	<0.00050
ethylbenzene	**2**		<0.00050	<0.00050	<0.00050	<0.00050
styrene	**0.72**		<0.00050	<0.00050	<0.00050	<0.00050
toluene	**0.390**		<0.00070	<0.00060	<0.00050	<0.00050
ortho-xylene			<0.00050	<0.00050	<0.00050	<0.00050
meta- & para-xylene			<0.00050	<0.00050	<0.00050	<0.00050
total xylene			<0.00075	<0.00075	<0.00075	<0.00075
VHw_{6-10}	**15**		<0.10	<0.10	<0.10	<0.10
VPHw	**1.5**		<0.10	<0.10	<0.10	<0.10
Polycyclic Aromatic Hydrocarbons						
acenaphthene			<0.000050	<0.000050	<0.000050	<0.000050
acenaphthylene			<0.000050	<0.000050	<0.000050	<0.000050
acridine	**0.0005**		<0.000050	<0.000050	<0.000050	<0.000050
anthracene	**0.001**		<0.000050	<0.000050	<0.000050	<0.000050
benzo(a)anthracene	**0.001**		<0.000050	<0.000050	<0.000050	<0.000050
benzo(a)pyrene	**0.0001**		<0.000010	<0.000010	<0.000010	<0.000010
benzo(b)fluoranthene			<0.000050	<0.000050	<0.000050	<0.000050
benzo(g,h,i)perylene			<0.000050	<0.000050	<0.000050	<0.000050
benzo(k)fluoranthene			<0.000050	<0.000050	<0.000050	<0.000050
chrysene			<0.000050	<0.000050	<0.000050	<0.000050
dibenzo(a,h)anthracene			<0.000050	<0.000050	<0.000050	<0.000050
fluoranthene	**0.002**		<0.000050	<0.000050	<0.000050	<0.000050
fluorene	**0.12**		<0.000050	<0.000050	<0.000050	<0.000050
indeno(1,2,3-c,d)pyrene			<0.000050	<0.000050	<0.000050	<0.000050
naphthalene	**0.01**		0.000065	<0.000050	<0.000050	<0.000050
phenanthrene	**0.003**		<0.000050	<0.000050	<0.000050	<0.000050
pyrene	**0.0002**		<0.000050	<0.000050	<0.000050	<0.000050
quinoline	**0.034**		<0.000050	<0.000050	<0.000050	<0.000050
Other Hydrocarbons						
$EPHw_{10-19}$	**5**		<0.25	<0.25	<0.25	<0.25
$EPHw_{19-32}$			0.53	<0.25	<0.25	<0.25
LEPHw	**0.5**		<0.25	<0.25	<0.25	<0.25
HEPHw			0.53	<0.25	<0.25	<0.25
Miscellaneous Organics						
methyl tertiary butyl ether (MTBE)			<0.00050	<0.00050	<0.00050	<0.00050
Chlorinated Hydrocarbons						
bromodichloromethane (BDCM)			<0.0010	<0.0010	<0.0010	<0.0010
tribromomethane (bromoform)			<0.0010	<0.0010	<0.0010	<0.0010
tetrachloromethane (carbon tetrachloride)	**0.13**		<0.00050	<0.00050	<0.00050	<0.00050
monochlorobenzene (chlorobenzene)	**0.013**		<0.0010	<0.0010	<0.0010	<0.0010
dibromochloromethane (DBCM)			<0.0010	<0.0010	<0.0010	<0.0010
chloroethane (ethyl chloride)			<0.0010	<0.0010	<0.0010	<0.0010
trichloromethane (chloroform)	**0.02**		<0.0010	<0.0010	<0.0010	<0.0010
chloromethane (methyl chloride)			<0.0050	<0.0050	<0.0050	<0.0050
1,2-dichlorobenzene			<0.00070	<0.00070	<0.00070	<0.00070
1,3-dichlorobenzene	**1.5**		<0.0010	<0.0010	<0.0010	<0.0010
1,4-dichlorobenzene	**0.26**		<0.0010	<0.0010	<0.0010	<0.0010
1,1-dichloroethane			<0.0010	<0.0010	<0.0010	<0.0010
1,2-dichloroethane	**1**		<0.0010	<0.0010	<0.0010	<0.0010
1,1-dichloroethylene (1,1-dichloroethene)			<0.0010	<0.0010	<0.0010	<0.0010
1,2-dichloroethylene (cis) (1,2-dichloroethene (cis))			<0.0010	<0.0010	<0.0010	<0.0010
1,2-dichloroethylene (trans) (1,2-dichloroethene (trans))			<0.0010	<0.0010	<0.0010	<0.0010
1,3-dichloropropene			<0.0014	<0.0014	<0.0014	<0.0014
dichloromethane (methylene chloride)	**0.98**		<0.0050	<0.0050	<0.0050	<0.0050
1,2-dichloropropane (propylene dichloride)			<0.0010	<0.0010	<0.0010	<0.0010
cis-1,3-Dichloropropylene			<0.0010	<0.0010	<0.0010	<0.0010
trans-1,3-Dichloropropylene			<0.0010	<0.0010	<0.0010	<0.0010
1,1,1,2-tetrachloroethane			<0.0010	<0.0010	<0.0010	<0.0010
1,1,2,2-tetrachloroethane			<0.0010	<0.0010	<0.0010	<0.0010
tetrachloroethylene (1,1,2,2-tetrachloroethene)	**1.1**		<0.0010	<0.0010	<0.0010	<0.0010
1,1,1-trichloroethane			<0.0010	<0.0010	<0.0010	<0.0010
1,1,2-trichloroethane			<0.0010	<0.0010	<0.0010	<0.0010
trichloroethylene (1,1,2-trichloroethene)	**0.2**		<0.0010	<0.0010	<0.0010	<0.0010
trichlorofluromethane (freon 11)			<0.0010	<0.0010	<0.0010	<0.0010
vinyl chloride (chloroethene)			<0.0010	<0.0010	<0.0010	<0.0010

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).

Italics indicates standard is below detection limit.

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

10- 174288

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

Page 1 of 1

Report To
Company: GOLDER
Contact: JOE MARQUARDSON
Address: 201 B 170 TITANIUM WAY
Y1A 0G1
Phone: 867-334-7423 Fax:

Invoice To Same as Report ? (circle) [✓ Yes] or No (if No, provide details)
Copy of Invoice with Report? (circle) Yes or No
Company:
Contact:
Address:
Phone: Fax:

Lab Work Order # (lab use only)

Report Format / Distribution
Standard: X Other (specify):
Select: PDF X Excel X Digital Fax
Email 1: jmarquardson@golder.com
Email 2: ghamilton@golder.com

Client / Project Information
Job #: 11-1436-0073/2900
PO / AFE:
LSD:
Quote #:
ALS Contact:
Sampler: J. MARQUARDSON / A. BADGER

Service Request:(Rush subject to availability - Contact ALS to confirm TAT)
☐ Regular (Standard Turnaround Times - Business Days)
☐ Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
☐ Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
☐ Same Day or Weekend Emergency - Contact ALS to confirm TAT

Analysis Request
(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	GENERAL	DOC	PAH	BTEX	NUTRIENTS	DISSOLVED METALS	FECAL COLIFORM						Number of Containers
	MW12-06-SR	29-MAY-12	10:50	GW	X	X	X	X	X	X	X						
	MW12-05-SR	29-MAY-12	13:45	GW	X	X	X	X	X	X	X						
	MW12-04-SR	29-MAY-12	14:30	GW	X	X	X	X	X	X	X						
	SWIFT RIVER	29-MAY-12	15:36	SW	X	X	X	X	X	X	X						

Special Instructions / Regulation 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 specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)
Released by: J. MARQUARDSON Date: 29-MAY-12 Time: 18:00

SHIPMENT RECEPTION (lab use only)
Received by: Date: Time: Temperature: °C

SHIPMENT VERIFICATION (lab use only)
Verified by: Date: Time: Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

GENF 18.01 Front

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

Date Received: 31-MAY-12
Report Date: 08-JUN-12 13:30 (MT)
Version: FINAL

Client Phone: 867-334-7423

Certificate of Analysis

Lab Work Order #: L1155242

Project P.O. #: NOT SUBMITTED
Job Reference: 11-1436-0073/2900
C of C Numbers: 10-174288
Legal Site Desc:

Amber Springer

Amber Springer
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1155242-1	L1155242-2	L1155242-3	L1155242-4
	Description	GW	GW	GW	GW
	Sampled Date	29-MAY-12	29-MAY-12	29-MAY-12	29-MAY-12
	Sampled Time	10:50	13:45	14:30	15:30
	Client ID	MW12-06-SR	MW12-05-SR	MW12-04-SR	SWIFT RIVER
Grouping	**Analyte**				
WATER					
Physical Tests	Hardness (as CaCO3) (mg/L)	169	136	161	34.6
	pH (pH)	8.04	7.32	7.82	7.95
	Total Dissolved Solids (mg/L)	282	168	241	56
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	145	136	156	30.1
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<2.0	<2.0	<2.0	<2.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<2.0	<2.0	<2.0	<2.0
	Alkalinity, Total (as CaCO3) (mg/L)	145	136	156	30.1
	Ammonia, Total (as N) (mg/L)	0.181	0.0619	0.0814	<0.0050
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.050	<0.050
	Chloride (Cl) (mg/L)	9.55	2.61	4.69	<0.50
	Fluoride (F) (mg/L)	0.280	0.278	0.209	0.125
	Nitrate (as N) (mg/L)	0.336	0.0177	0.0332	0.0171
	Nitrite (as N) (mg/L)	0.0013	<0.0010	<0.0010	<0.0010
	Total Kjeldahl Nitrogen (mg/L)	8.77	0.152	0.897	0.163
	Sulfate (SO4) (mg/L)	39.8	22.4	26.5	6.08
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	3.99	1.62	2.37	3.44
Bacteriological Tests	Coliform Bacteria - Fecal (MPN/100mL)	<2	<2	<2	8
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	<0.010	<0.010	<0.010	0.029
	Antimony (Sb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Dissolved (mg/L)	0.00074	0.00091	0.00171	0.00049
	Barium (Ba)-Dissolved (mg/L)	0.074	0.061	0.059	<0.020
	Beryllium (Be)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Dissolved (mg/L)	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020
	Calcium (Ca)-Dissolved (mg/L)	47.9	30.4	42.2	10.0
	Chromium (Cr)-Dissolved (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020
	Cobalt (Co)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Dissolved (mg/L)	0.0011	<0.0010	<0.0010	<0.0010
	Iron (Fe)-Dissolved (mg/L)	<0.030	<0.030	<0.030	0.041
	Lead (Pb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Dissolved (mg/L)	12.1	14.5	13.6	2.33
	Manganese (Mn)-Dissolved (mg/L)	0.613	0.544	0.425	0.0048
	Mercury (Hg)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020

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

	Sample ID	L1155242-1	L1155242-2	L1155242-3	L1155242-4
	Description	GW	GW	GW	GW
	Sampled Date	29-MAY-12	29-MAY-12	29-MAY-12	29-MAY-12
	Sampled Time	10:50	13:45	14:30	15:30
	Client ID	MW12-06-SR	MW12-05-SR	MW12-04-SR	SWIFT RIVER
Grouping	**Analyte**				
WATER					
Dissolved Metals	Molybdenum (Mo)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Dissolved (mg/L)	2.30	1.62	2.01	0.41
	Selenium (Se)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Silicon (Si)-Dissolved (mg/L)	3.05	4.50	4.61	3.04
	Silver (Ag)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Dissolved (mg/L)	9.7	9.0	6.4	<2.0
	Strontium (Sr)-Dissolved (mg/L)	0.164	0.170	0.168	0.0371
	Thallium (Tl)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)	0.00176	0.00179	0.00228	0.00023
	Vanadium (V)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050
Aggregate Organics	COD (mg/L)	54	<20	<20	<20
Volatile Organic Compounds	Benzene (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	Bromodichloromethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Bromoform (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Carbon Tetrachloride (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	Chlorobenzene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Dibromochloromethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Chloroethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Chloroform (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Chloromethane (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050
	1,2-Dichlorobenzene (mg/L)	<0.00070	<0.00070	<0.00070	<0.00070
	1,3-Dichlorobenzene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	1,4-Dichlorobenzene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	1,1-Dichloroethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	1,2-Dichloroethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	1,1-Dichloroethylene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	cis-1,2-Dichloroethylene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	trans-1,2-Dichloroethylene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	1,3-Dichloropropene (cis & trans) (mg/L)	<0.0014	<0.0014	<0.0014	<0.0014
	Dichloromethane (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050
	1,2-Dichloropropane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1155242-1	L1155242-2	L1155242-3	L1155242-4
	Description	GW	GW	GW	GW
	Sampled Date	29-MAY-12	29-MAY-12	29-MAY-12	29-MAY-12
	Sampled Time	10:50	13:45	14:30	15:30
	Client ID	MW12-06-SR	MW12-05-SR	MW12-04-SR	SWIFT RIVER
Grouping	**Analyte**				
WATER					
Volatile Organic Compounds	cis-1,3-Dichloropropylene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	trans-1,3-Dichloropropylene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Ethylbenzene (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	Methyl t-butyl ether (MTBE) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	Styrene (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	1,1,1,2-Tetrachloroethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	1,1,2,2-Tetrachloroethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Tetrachloroethylene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Toluene (mg/L)	DLM <0.00070	DLM <0.00060	<0.00050	<0.00050
	1,1,1-Trichloroethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	1,1,2-Trichloroethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Trichloroethylene (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Trichlorofluoromethane (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Vinyl Chloride (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	ortho-Xylene (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	meta- & para-Xylene (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	Xylenes (mg/L)	<0.00075	<0.00075	<0.00075	<0.00075
	Surrogate: 4-Bromofluorobenzene (SS) (%)	102.2	100.1	102.4	100.6
	Surrogate: 1,4-Difluorobenzene (SS) (%)	103.4	103.8	105.0	104.7
Hydrocarbons	EPH10-19 (mg/L)	<0.25	<0.25	<0.25	<0.25
	EPH19-32 (mg/L)	0.53	<0.25	<0.25	<0.25
	LEPH (mg/L)	<0.25	<0.25	<0.25	<0.25
	HEPH (mg/L)	0.53	<0.25	<0.25	<0.25
	Volatile Hydrocarbons (VH6-10) (mg/L)	<0.10	<0.10	<0.10	<0.10
	VPH (C6-C10) (mg/L)	<0.10	<0.10	<0.10	<0.10
	Surrogate: 3,4-Dichlorotoluene (SS) (%)	96.8	96.2	107.6	108.8
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Acenaphthylene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Acridine (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Anthracene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Benz(a)anthracene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Benzo(a)pyrene (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Benzo(b)fluoranthene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Benzo(g,h,i)perylene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Benzo(k)fluoranthene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Chrysene (mg/L)	<0.000050	<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 **Description** **Sampled Date** **Sampled Time** **Client ID**	L1155242-1 GW 29-MAY-12 10:50 MW12-06-SR	L1155242-2 GW 29-MAY-12 13:45 MW12-05-SR	L1155242-3 GW 29-MAY-12 14:30 MW12-04-SR	L1155242-4 GW 29-MAY-12 15:30 SWIFT RIVER	
Grouping	**Analyte**					
WATER						
Polycyclic Aromatic Hydrocarbons	Dibenz(a,h)anthracene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Fluoranthene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Fluorene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Indeno(1,2,3-c,d)pyrene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Naphthalene (mg/L)	0.000065	<0.000050	<0.000050	<0.000050	
	Phenanthrene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Pyrene (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Quinoline (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Surrogate: Acenaphthene d10 (%)	90.6	96.7	92.6	96.8	
	Surrogate: Acridine d9 (%)	98.4	106.3	110.9	120.1	
	Surrogate: Chrysene d12 (%)	79.8	97.0	86.4	97.1	
	Surrogate: Naphthalene d8 (%)	94.3	100.7	101.5	101.8	
	Surrogate: Phenanthrene d10 (%)	92.4	100.2	100.5	112.4	

* 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)
Duplicate	Aluminum (Al)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Chromium (Cr)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Lead (Pb)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Selenium (Se)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Zinc (Zn)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Beryllium (Be)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Bismuth (Bi)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Molybdenum (Mo)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Phosphorus (P)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Silver (Ag)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Thallium (Tl)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Tin (Sn)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Titanium (Ti)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Vanadium (V)-Dissolved	DLA	L1155242-1, -2, -3, -4
Duplicate	Bromide (Br)	DLM	L1155242-1, -2, -3, -4
Duplicate	Fluoride (F)	DLM	L1155242-1, -2, -3, -4
Duplicate	Nitrite (as N)	DLM	L1155242-1, -2, -3, -4
Duplicate	Cadmium (Cd)-Dissolved	DLM	L1155242-1, -2, -3, -4
Duplicate	Cadmium (Cd)-Dissolved	DLM	L1155242-1, -2, -3, -4
Laboratory Control Sample	1,1,1-Trichloroethane	LCS-ND	L1155242-1, -2, -3, -4
Laboratory Control Sample	Carbon Tetrachloride	LCS-ND	L1155242-1, -2, -3, -4
Laboratory Control Sample	Chloroform	LCS-ND	L1155242-1, -2, -3, -4
Laboratory Control Sample	Tetrachloroethylene	LCS-ND	L1155242-1, -2, -3, -4
Laboratory Control Sample	Trichloroethylene	LCS-ND	L1155242-1, -2, -3, -4
Laboratory Control Sample	Trichlorofluoromethane	LCS-ND	L1155242-1, -2, -3, -4
Laboratory Control Sample	cis-1,2-Dichloroethylene	LCS-ND	L1155242-1, -2, -3, -4
Matrix Spike	Nitrate (as N)	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Sulfate (SO4)	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1155242-1, -2, -3, -4
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1155242-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit Adjusted For required dilution
DLM	Detection Limit Adjusted For Sample Matrix Effects
LCS-ND	Lab Control Sample recovery was slightly outside ALS DQO. Reported non-detect results for associated samples were unaffected.
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

Reference Information

pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-BR-IC-VA Water Bromide by Ion Chromatography APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-CL-IC-VA Water Chloride by Ion Chromatography APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-F-IC-VA Water Fluoride by Ion Chromatography APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-NO2-IC-VA Water Nitrite in Water by Ion Chromatography EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA Water Nitrate in Water by Ion Chromatography EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

ANIONS-SO4-IC-VA Water Sulfate by Ion Chromatography APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

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

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).

FCOLI-MTF-ENV-VA Water Fecal coliform by MPN APHA METHOD 9221

This analysis is carried out using procedures adapted from APHA Method 9221 "Multiple-Tube Fermentation Technique for Members of the Coliform Group". Serial dilutions of the sample are incubated with the appropriate growth medium, and coliform bacteria is quantified by a statistical estimation of bacteria density (most probable number). The test involves an initial 48 hour incubation (presumptive test), postive results require further testing (up to an additional 72 hours) to confirm and quantify total and fecal coliform.

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).

Reference Information

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.

PH-PCT-VA Water pH by Meter (Automated) 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-PCT-VA Water pH by Meter (Automated) 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.

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)

VOC-HSMS-VA Water VOCs in water 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-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).

Reference Information

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

Chain of Custody Numbers:

10-174288

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: L1155242 Report Date: 08-JUN-12

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-SCR-VA	**Water**							
Batch R2376596								
WG1483140-2 CRM		**VA-ALKL-CONTROL**						
Alkalinity, Total (as CaCO3)			100.9		%		85-115	04-JUN-12
WG1483140-5 CRM		**VA-ALKM-CONTROL**						
Alkalinity, Total (as CaCO3)			94.4		%		85-115	04-JUN-12
WG1483140-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	04-JUN-12
WG1483140-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	04-JUN-12
WG1483140-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	04-JUN-12
ANIONS-BR-IC-VA	**Water**							
Batch R2375973								
WG1481952-6 DUP		**L1155242-1**						
Bromide (Br)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	01-JUN-12
WG1481952-18 LCS								
Bromide (Br)			88.5		%		85-115	01-JUN-12
WG1481952-2 LCS								
Bromide (Br)			92.5		%		85-115	01-JUN-12
WG1481952-1 MB								
Bromide (Br)			<0.050		mg/L		0.05	01-JUN-12
WG1481952-10 MB								
Bromide (Br)			<0.050		mg/L		0.05	01-JUN-12
WG1481952-13 MB								
Bromide (Br)			<0.050		mg/L		0.05	01-JUN-12
WG1481952-16 MB								
Bromide (Br)			<0.050		mg/L		0.05	01-JUN-12
WG1481952-4 MB								
Bromide (Br)			<0.050		mg/L		0.05	01-JUN-12
WG1481952-7 MB								
Bromide (Br)			<0.050		mg/L		0.05	01-JUN-12
WG1481952-11 MS		**L1155242-4**						
Bromide (Br)			88.8		%		75-125	01-JUN-12
WG1481952-14 MS		**L1155660-8**						
Bromide (Br)			89.8		%		75-125	01-JUN-12
WG1481952-5 MS		**L1155041-1**						
Bromide (Br)			85.6		%		75-125	01-JUN-12
WG1481952-8 MS		**L1155161-4**						
Bromide (Br)			85.6		%		75-125	01-JUN-12

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-CL-IC-VA	**Water**							
Batch R2375973								
WG1481952-6 DUP		**L1155242-1**						
Chloride (Cl)		9.55	9.56		mg/L	0.1	20	01-JUN-12
WG1481952-18 LCS								
Chloride (Cl)			100.2		%		85-115	01-JUN-12
WG1481952-2 LCS								
Chloride (Cl)			100.2		%		85-115	01-JUN-12
WG1481952-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-10 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-13 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-16 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-4 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-7 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-11 MS		**L1155242-4**						
Chloride (Cl)			101.0		%		75-125	01-JUN-12
WG1481952-14 MS		**L1155660-8**						
Chloride (Cl)			102.0		%		75-125	01-JUN-12
WG1481952-5 MS		**L1155041-1**						
Chloride (Cl)			101.3		%		75-125	01-JUN-12
WG1481952-8 MS		**L1155161-4**						
Chloride (Cl)			101.3		%		75-125	01-JUN-12
ANIONS-F-IC-VA	**Water**							
Batch R2375973								
WG1481952-6 DUP		**L1155242-1**						
Fluoride (F)		0.280	0.284		mg/L	1.4	20	01-JUN-12
WG1481952-18 LCS								
Fluoride (F)			105.5		%		85-115	01-JUN-12
WG1481952-2 LCS								
Fluoride (F)			105.4		%		85-115	01-JUN-12
WG1481952-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	01-JUN-12
WG1481952-10 MB								
Fluoride (F)			<0.020		mg/L		0.02	01-JUN-12
WG1481952-13 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-F-IC-VA	**Water**							
Batch R2375973								
WG1481952-13 MB								
Fluoride (F)			<0.020		mg/L		0.02	01-JUN-12
WG1481952-16 MB								
Fluoride (F)			<0.020		mg/L		0.02	01-JUN-12
WG1481952-4 MB								
Fluoride (F)			<0.020		mg/L		0.02	01-JUN-12
WG1481952-7 MB								
Fluoride (F)			<0.020		mg/L		0.02	01-JUN-12
WG1481952-11 MS		**L1155242-4**						
Fluoride (F)			104.8		%		75-125	01-JUN-12
WG1481952-14 MS		**L1155660-8**						
Fluoride (F)			107.1		%		75-125	01-JUN-12
WG1481952-17 MS		**L1155779-16**						
Fluoride (F)			104.2		%		75-125	01-JUN-12
WG1481952-5 MS		**L1155041-1**						
Fluoride (F)			106.4		%		75-125	01-JUN-12
WG1481952-8 MS		**L1155161-4**						
Fluoride (F)			106.5		%		75-125	01-JUN-12
ANIONS-NO2-IC-VA	**Water**							
Batch R2375973								
WG1481952-6 DUP		**L1155242-1**						
Nitrite (as N)		0.0013	0.0014		mg/L	8.7	20	01-JUN-12
WG1481952-18 LCS								
Nitrite (as N)			98.8		%		85-115	01-JUN-12
WG1481952-2 LCS								
Nitrite (as N)			98.4		%		85-115	01-JUN-12
WG1481952-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	01-JUN-12
WG1481952-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	01-JUN-12
WG1481952-16 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	01-JUN-12
WG1481952-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	01-JUN-12
WG1481952-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	01-JUN-12
WG1481952-11 MS		**L1155242-4**						
Nitrite (as N)			96.3		%		75-125	01-JUN-12
WG1481952-14 MS		**L1155660-8**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-NO2-IC-VA	**Water**							
Batch R2375973								
WG1481952-14 MS		**L1155660-8**						
Nitrite (as N)			97.3		%		75-125	01-JUN-12
WG1481952-17 MS		**L1155779-16**						
Nitrite (as N)			92.9		%		75-125	01-JUN-12
WG1481952-5 MS		**L1155041-1**						
Nitrite (as N)			95.8		%		75-125	01-JUN-12
WG1481952-8 MS		**L1155161-4**						
Nitrite (as N)			95.3		%		75-125	01-JUN-12
ANIONS-NO3-IC-VA	**Water**							
Batch R2375973								
WG1481952-6 DUP		**L1155242-1**						
Nitrate (as N)		0.336	0.336		mg/L	0.0	20	01-JUN-12
WG1481952-18 LCS								
Nitrate (as N)			101.6		%		85-115	01-JUN-12
WG1481952-2 LCS								
Nitrate (as N)			101.5		%		85-115	01-JUN-12
WG1481952-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	01-JUN-12
WG1481952-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	01-JUN-12
WG1481952-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	01-JUN-12
WG1481952-16 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	01-JUN-12
WG1481952-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	01-JUN-12
WG1481952-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	01-JUN-12
WG1481952-11 MS		**L1155242-4**						
Nitrate (as N)			101.4		%		75-125	01-JUN-12
WG1481952-14 MS		**L1155660-8**						
Nitrate (as N)			102.6		%		75-125	01-JUN-12
WG1481952-17 MS		**L1155779-16**						
Nitrate (as N)			N/A	MS-B	%		-	01-JUN-12
WG1481952-5 MS		**L1155041-1**						
Nitrate (as N)			101.9		%		75-125	01-JUN-12
WG1481952-8 MS		**L1155161-4**						
Nitrate (as N)			102.0		%		75-125	01-JUN-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ANIONS-SO4-IC-VA	**Water**							
Batch R2375973								
WG1481952-6 DUP		**L1155242-1**						
Sulfate (SO4)		39.8	39.8		mg/L	0.0	20	01-JUN-12
WG1481952-18 LCS								
Sulfate (SO4)			102.9		%		85-115	01-JUN-12
WG1481952-2 LCS								
Sulfate (SO4)			102.6		%		85-115	01-JUN-12
WG1481952-1 MB								
Sulfate (SO4)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-10 MB								
Sulfate (SO4)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-13 MB								
Sulfate (SO4)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-16 MB								
Sulfate (SO4)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-4 MB								
Sulfate (SO4)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-7 MB								
Sulfate (SO4)			<0.50		mg/L		0.5	01-JUN-12
WG1481952-11 MS		**L1155242-4**						
Sulfate (SO4)			102.4		%		75-125	01-JUN-12
WG1481952-14 MS		**L1155660-8**						
Sulfate (SO4)			102.9		%		75-125	01-JUN-12
WG1481952-17 MS		**L1155779-16**						
Sulfate (SO4)			N/A	MS-B	%		-	01-JUN-12
WG1481952-5 MS		**L1155041-1**						
Sulfate (SO4)			102.6		%		75-125	01-JUN-12
WG1481952-8 MS		**L1155161-4**						
Sulfate (SO4)			102.8		%		75-125	01-JUN-12
CARBONS-DOC-VA	**Water**							
Batch R2376983								
WG1483515-1 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	04-JUN-12
WG1483515-2 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	04-JUN-12
COD-COL-VA	**Water**							

Quality Control Report

Workorder: L1155242 Report Date: 08-JUN-12

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
COD-COL-VA	**Water**							
Batch R2376580								
WG1482075-2 LCS								
COD			101.4		%		85-115	04-JUN-12
WG1482075-5 LCS								
COD			101.0		%		85-115	04-JUN-12
WG1482075-1 MB								
COD			<20		mg/L		20	04-JUN-12
WG1482075-4 MB								
COD			<20		mg/L		20	04-JUN-12
Batch R2377663								
WG1484599-2 LCS								
COD			100.5		%		85-115	06-JUN-12
WG1484599-5 LCS								
COD			99.8		%		85-115	06-JUN-12
WG1484599-8 LCS								
COD			101.7		%		85-115	06-JUN-12
WG1484599-1 MB								
COD			<20		mg/L		20	06-JUN-12
WG1484599-4 MB								
COD			<20		mg/L		20	06-JUN-12
WG1484599-7 MB								
COD			<20		mg/L		20	06-JUN-12
EPH-SF-FID-VA	**Water**							
Batch R2378052								
WG1484780-1 MB								
EPH10-19			<0.25		mg/L		0.25	07-JUN-12
EPH19-32			<0.25		mg/L		0.25	07-JUN-12
Batch R2378250								
WG1484780-3 MB								
EPH10-19			<0.25		mg/L		0.25	07-JUN-12
EPH19-32			<0.25		mg/L		0.25	07-JUN-12
HG-DIS-CVAFS-VA	**Water**							
Batch R2375154								
WG1481705-1 MB								
Mercury (Hg)-Dissolved			<0.000050		mg/L		0.00005	01-JUN-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-DIS-CVAFS-VA	**Water**							
Batch R2376273								
WG1481705-3 MS		**L1155048-15**						
Mercury (Hg)-Dissolved			80.6		%		70-130	04-JUN-12
Batch R2376930								
WG1481705-8 MS		**L1155418-1**						
Mercury (Hg)-Dissolved			91.9		%		70-130	05-JUN-12
MET-DIS-ICP-VA	**Water**							
Batch R2375338								
WG1481705-3 MS		**L1155048-15**						
Iron (Fe)-Dissolved			94.7		%		70-130	01-JUN-12
Sodium (Na)-Dissolved			97.0		%		70-130	01-JUN-12
Titanium (Ti)-Dissolved			103.9		%		70-130	01-JUN-12
Batch R2375353								
WG1481705-2 CRM		**VA-HIGH-WATRM**						
Beryllium (Be)-Dissolved			98.4		%		80-120	01-JUN-12
Bismuth (Bi)-Dissolved			99.2		%		80-120	01-JUN-12
Cobalt (Co)-Dissolved			96.0		%		80-120	01-JUN-12
Iron (Fe)-Dissolved			98.2		%		80-120	01-JUN-12
Lithium (Li)-Dissolved			98.8		%		80-120	01-JUN-12
Molybdenum (Mo)-Dissolved			99.0		%		80-120	01-JUN-12
Nickel (Ni)-Dissolved			100.1		%		80-120	01-JUN-12
Phosphorus (P)-Dissolved			100.5		%		80-120	01-JUN-12
Silicon (Si)-Dissolved			104.2		%		80-120	01-JUN-12
Silver (Ag)-Dissolved			91.7		%		80-120	01-JUN-12
Sodium (Na)-Dissolved			101.7		%		80-120	01-JUN-12
Strontium (Sr)-Dissolved			101.5		%		80-120	01-JUN-12
Thallium (Tl)-Dissolved			97.8		%		80-120	01-JUN-12
Tin (Sn)-Dissolved			99.6		%		80-120	01-JUN-12
Titanium (Ti)-Dissolved			101.8		%		80-120	01-JUN-12
Vanadium (V)-Dissolved			98.4		%		80-120	01-JUN-12
WG1481705-1 MB								
Beryllium (Be)-Dissolved			<0.0050		mg/L		0.005	01-JUN-12
Bismuth (Bi)-Dissolved			<0.20		mg/L		0.2	01-JUN-12
Cobalt (Co)-Dissolved			<0.010		mg/L		0.01	01-JUN-12
Iron (Fe)-Dissolved			<0.030		mg/L		0.03	01-JUN-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-VA	**Water**							
Batch R2375353								
WG1481705-1 MB								
Lithium (Li)-Dissolved			<0.010		mg/L		0.01	01-JUN-12
Molybdenum (Mo)-Dissolved			<0.030		mg/L		0.03	01-JUN-12
Nickel (Ni)-Dissolved			<0.050		mg/L		0.05	01-JUN-12
Phosphorus (P)-Dissolved			<0.30		mg/L		0.3	01-JUN-12
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	01-JUN-12
Silver (Ag)-Dissolved			<0.010		mg/L		0.01	01-JUN-12
Sodium (Na)-Dissolved			<2.0		mg/L		2	01-JUN-12
Strontium (Sr)-Dissolved			<0.0050		mg/L		0.005	01-JUN-12
Thallium (Tl)-Dissolved			<0.20		mg/L		0.2	01-JUN-12
Tin (Sn)-Dissolved			<0.030		mg/L		0.03	01-JUN-12
Titanium (Ti)-Dissolved			<0.010		mg/L		0.01	01-JUN-12
Vanadium (V)-Dissolved			<0.030		mg/L		0.03	01-JUN-12
Batch R2376807								
WG1481705-9 MS		**L1155041-2**						
Iron (Fe)-Dissolved			94.9		%		70-130	04-JUN-12
Sodium (Na)-Dissolved			100.8		%		70-130	04-JUN-12
Titanium (Ti)-Dissolved			103.1		%		70-130	04-JUN-12
Batch R2376833								
WG1481705-8 MS		**L1155418-1**						
Iron (Fe)-Dissolved			92.3		%		70-130	04-JUN-12
Sodium (Na)-Dissolved			96.6		%		70-130	04-JUN-12
Titanium (Ti)-Dissolved			107.1		%		70-130	04-JUN-12
MET-DIS-LOW-MS-VA	**Water**							
Batch R2376155								
WG1481705-1 MB								
Aluminum (Al)-Dissolved			<0.0030		mg/L		0.003	02-JUN-12
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	02-JUN-12
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	02-JUN-12
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	02-JUN-12
Boron (B)-Dissolved			<0.010		mg/L		0.01	02-JUN-12
Cadmium (Cd)-Dissolved			<0.000050		mg/L		0.00005	02-JUN-12
Calcium (Ca)-Dissolved			<0.020		mg/L		0.02	02-JUN-12
Chromium (Cr)-Dissolved			<0.00050		mg/L		0.0005	02-JUN-12
Copper (Cu)-Dissolved			<0.00050		mg/L		0.0005	02-JUN-12
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	02-JUN-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-LOW-MS-VA	**Water**							
Batch R2376155								
WG1481705-1 MB								
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	02-JUN-12
Manganese (Mn)-Dissolved			<0.000050		mg/L		0.00005	02-JUN-12
Potassium (K)-Dissolved			<0.050		mg/L		0.05	02-JUN-12
Selenium (Se)-Dissolved			<0.0010		mg/L		0.001	02-JUN-12
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	02-JUN-12
Zinc (Zn)-Dissolved			<0.0030		mg/L		0.003	02-JUN-12
Batch R2376765								
WG1481705-3 MS		**L1155048-15**						
Aluminum (Al)-Dissolved			112.6		%		70-130	04-JUN-12
Antimony (Sb)-Dissolved			118.1		%		70-130	04-JUN-12
Arsenic (As)-Dissolved			129.5		%		70-130	04-JUN-12
Barium (Ba)-Dissolved			N/A	MS-B	%		-	04-JUN-12
Boron (B)-Dissolved			122.5		%		70-130	04-JUN-12
Cadmium (Cd)-Dissolved			113.1		%		70-130	04-JUN-12
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	04-JUN-12
Chromium (Cr)-Dissolved			109.2		%		70-130	04-JUN-12
Copper (Cu)-Dissolved			104.8		%		70-130	04-JUN-12
Lead (Pb)-Dissolved			104.4		%		70-130	04-JUN-12
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	04-JUN-12
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	04-JUN-12
Potassium (K)-Dissolved			N/A	MS-B	%		-	04-JUN-12
Selenium (Se)-Dissolved			116.1		%		70-130	04-JUN-12
Uranium (U)-Dissolved			111.2		%		70-130	04-JUN-12
Zinc (Zn)-Dissolved			103.5		%		70-130	04-JUN-12
Batch R2377264								
WG1481705-8 MS		**L1155418-1**						
Antimony (Sb)-Dissolved			117.3		%		70-130	05-JUN-12
Barium (Ba)-Dissolved			N/A	MS-B	%		-	05-JUN-12
Boron (B)-Dissolved			119.6		%		70-130	05-JUN-12
Cadmium (Cd)-Dissolved			127.9		%		70-130	05-JUN-12
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	05-JUN-12
Chromium (Cr)-Dissolved			125.9		%		70-130	05-JUN-12
Copper (Cu)-Dissolved			119.9		%		70-130	05-JUN-12
Lead (Pb)-Dissolved			108.2		%		70-130	05-JUN-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-LOW-MS-VA	**Water**							
Batch R2377264								
WG1481705-8 MS		**L1155418-1**						
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	05-JUN-12
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	05-JUN-12
Potassium (K)-Dissolved			N/A	MS-B	%		-	05-JUN-12
Uranium (U)-Dissolved			104.4		%		70-130	05-JUN-12
Zinc (Zn)-Dissolved			123.0		%		70-130	05-JUN-12
Batch R2378075								
WG1481705-8 MS		**L1155418-1**						
Aluminum (Al)-Dissolved			111.7		%		70-130	06-JUN-12
Arsenic (As)-Dissolved			122.8		%		70-130	06-JUN-12
Selenium (Se)-Dissolved			118.3		%		70-130	06-JUN-12
NH3-F-VA	**Water**							
Batch R2376836								
WG1483429-2 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			104.4		%		85-115	05-JUN-12
WG1483429-4 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			102.6		%		85-115	05-JUN-12
WG1483429-6 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			103.2		%		85-115	05-JUN-12
WG1483429-8 CRM		**VA-NH3-F**						
Ammonia, Total (as N)			97.6		%		85-115	05-JUN-12
WG1483429-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	05-JUN-12
WG1483429-3 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	05-JUN-12
WG1483429-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	05-JUN-12
WG1483429-7 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	05-JUN-12
WG1483429-10 MS		**L1150266-1**						
Ammonia, Total (as N)			94.1		%		75-125	05-JUN-12
PAH-SF-MS-VA	**Water**							
Batch R2378045								
WG1484780-2 LCS								
Acenaphthene			102.9		%		60-130	07-JUN-12
Acenaphthylene			102.2		%		60-130	07-JUN-12
Acridine			99.9		%		60-130	07-JUN-12

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-SF-MS-VA	**Water**							
Batch R2378045								
WG1484780-2 LCS								
Anthracene			98.6		%		60-130	07-JUN-12
Benz(a)anthracene			100.8		%		60-130	07-JUN-12
Benzo(a)pyrene			103.3		%		60-130	07-JUN-12
Benzo(b)fluoranthene			97.8		%		60-130	07-JUN-12
Benzo(g,h,i)perylene			100.0		%		60-130	07-JUN-12
Benzo(k)fluoranthene			104.5		%		60-130	07-JUN-12
Chrysene			105.2		%		60-130	07-JUN-12
Dibenz(a,h)anthracene			92.1		%		60-130	07-JUN-12
Fluoranthene			102.9		%		60-130	07-JUN-12
Fluorene			103.5		%		60-130	07-JUN-12
Indeno(1,2,3-c,d)pyrene			96.3		%		60-130	07-JUN-12
Naphthalene			103.2		%		50-130	07-JUN-12
Phenanthrene			104.1		%		60-130	07-JUN-12
Pyrene			104.8		%		60-130	07-JUN-12
Quinoline			101.1		%		60-130	07-JUN-12
WG1484780-1 MB								
Acenaphthene			<0.000050		mg/L		0.00005	07-JUN-12
Acenaphthylene			<0.000050		mg/L		0.00005	07-JUN-12
Acridine			<0.000050		mg/L		0.00005	07-JUN-12
Anthracene			<0.000050		mg/L		0.00005	07-JUN-12
Benz(a)anthracene			<0.000050		mg/L		0.00005	07-JUN-12
Benzo(a)pyrene			<0.000010		mg/L		0.00001	07-JUN-12
Benzo(b)fluoranthene			<0.000050		mg/L		0.00005	07-JUN-12
Benzo(g,h,i)perylene			<0.000050		mg/L		0.00005	07-JUN-12
Benzo(k)fluoranthene			<0.000050		mg/L		0.00005	07-JUN-12
Chrysene			<0.000050		mg/L		0.00005	07-JUN-12
Dibenz(a,h)anthracene			<0.000050		mg/L		0.00005	07-JUN-12
Fluoranthene			<0.000050		mg/L		0.00005	07-JUN-12
Fluorene			<0.000050		mg/L		0.00005	07-JUN-12
Indeno(1,2,3-c,d)pyrene			<0.000050		mg/L		0.00005	07-JUN-12
Naphthalene			<0.000050		mg/L		0.00005	07-JUN-12
Phenanthrene			<0.000050		mg/L		0.00005	07-JUN-12
Pyrene			<0.000050		mg/L		0.00005	07-JUN-12
Quinoline			<0.000050		mg/L		0.00005	07-JUN-12

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-SF-MS-VA	**Water**							
Batch R2378363								
WG1484780-3 MB								
Acenaphthene			<0.000050		mg/L		0.00005	07-JUN-12
Acenaphthylene			<0.000050		mg/L		0.00005	07-JUN-12
Acridine			<0.000050		mg/L		0.00005	07-JUN-12
Anthracene			<0.000050		mg/L		0.00005	07-JUN-12
Benz(a)anthracene			<0.000050		mg/L		0.00005	07-JUN-12
Benzo(a)pyrene			<0.000010		mg/L		0.00001	07-JUN-12
Benzo(b)fluoranthene			<0.000050		mg/L		0.00005	07-JUN-12
Benzo(g,h,i)perylene			<0.000050		mg/L		0.00005	07-JUN-12
Benzo(k)fluoranthene			<0.000050		mg/L		0.00005	07-JUN-12
Chrysene			<0.000050		mg/L		0.00005	07-JUN-12
Dibenz(a,h)anthracene			<0.000050		mg/L		0.00005	07-JUN-12
Fluoranthene			<0.000050		mg/L		0.00005	07-JUN-12
Fluorene			<0.000050		mg/L		0.00005	07-JUN-12
Indeno(1,2,3-c,d)pyrene			<0.000050		mg/L		0.00005	07-JUN-12
Naphthalene			<0.000050		mg/L		0.00005	07-JUN-12
Phenanthrene			<0.000050		mg/L		0.00005	07-JUN-12
Pyrene			<0.000050		mg/L		0.00005	07-JUN-12
Quinoline			<0.000050		mg/L		0.00005	07-JUN-12
PH-MAN-VA	**Water**							
Batch R2376409								
WG1483635-1 CRM		**VA-PH7-BUF**						
pH			7.09		pH		6.9-7.1	05-JUN-12
WG1483635-2 DUP		**L1155242-3**						
pH		7.82	7.78	J	pH	0.04	0.2	05-JUN-12
PH-PCT-VA	**Water**							
Batch R2375592								
WG1482317-22 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	01-JUN-12
WG1482317-23 CRM		**VA-PH7-BUF**						
pH			6.98		pH		6.9-7.1	01-JUN-12
WG1482317-25 CRM		**VA-PH7-BUF**						
pH			6.98		pH		6.9-7.1	01-JUN-12
WG1482317-26 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	01-JUN-12
WG1482317-27 CRM		**VA-PH7-BUF**						

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-PCT-VA	**Water**							
Batch R2375592								
WG1482317-27 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	01-JUN-12
WG1482317-28 CRM		**VA-PH7-BUF**						
pH			7.08		pH		6.9-7.1	01-JUN-12
Batch R2377345								
WG1483124-22 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	04-JUN-12
WG1483124-23 CRM		**VA-PH7-BUF**						
pH			7.03		pH		6.9-7.1	04-JUN-12
WG1483124-24 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	04-JUN-12
WG1483124-25 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	04-JUN-12
WG1483124-26 CRM		**VA-PH7-BUF**						
pH			7.02		pH		6.9-7.1	04-JUN-12
WG1483124-27 CRM		**VA-PH7-BUF**						
pH			6.99		pH		6.9-7.1	04-JUN-12
WG1483124-28 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	04-JUN-12
TDS-VA	**Water**							
Batch R2377443								
WG1483560-11 LCS								
Total Dissolved Solids			100.8		%		85-115	04-JUN-12
WG1483560-2 LCS								
Total Dissolved Solids			101.2		%		85-115	04-JUN-12
WG1483560-5 LCS								
Total Dissolved Solids			98.6		%		85-115	04-JUN-12
WG1483560-8 LCS								
Total Dissolved Solids			100.8		%		85-115	04-JUN-12
WG1483560-1 MB								
Total Dissolved Solids			<10		mg/L		10	04-JUN-12
WG1483560-10 MB								
Total Dissolved Solids			<10		mg/L		10	04-JUN-12
WG1483560-4 MB								
Total Dissolved Solids			<10		mg/L		10	04-JUN-12
WG1483560-7 MB								
Total Dissolved Solids			<10		mg/L		10	04-JUN-12
TKN-F-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TKN-F-VA	**Water**							
Batch R2377312								
WG1483574-2 LCS								
Total Kjeldahl Nitrogen			97.6		%		75-125	05-JUN-12
WG1483574-5 LCS								
Total Kjeldahl Nitrogen			96.2		%		75-125	05-JUN-12
WG1483574-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	05-JUN-12
WG1483574-4 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	05-JUN-12
VH-HSFID-VA	**Water**							
Batch R2374599								
WG1483283-2 LCS								
Volatile Hydrocarbons (VH6-10)			114.3		%		70-130	05-JUN-12
WG1483283-1 MB								
Volatile Hydrocarbons (VH6-10)			<0.10		mg/L		0.1	05-JUN-12
VOC-HSMS-VA	**Water**							
Batch R2373952								
WG1483283-2 LCS								
Bromodichloromethane			110.1		%		70-130	04-JUN-12
Bromoform			107.8		%		70-130	04-JUN-12
Carbon Tetrachloride			132.9	LCS-ND	%		70-130	04-JUN-12
Chlorobenzene			121.7		%		70-130	04-JUN-12
Dibromochloromethane			106.0		%		70-130	04-JUN-12
Chloroethane			122.3		%		60-140	04-JUN-12
Chloroform			134.7	LCS-ND	%		70-130	04-JUN-12
Chloromethane			100.0		%		60-140	04-JUN-12
1,2-Dichlorobenzene			110.9		%		70-130	04-JUN-12
1,3-Dichlorobenzene			112.7		%		70-130	04-JUN-12
1,4-Dichlorobenzene			109.5		%		70-130	04-JUN-12
1,1-Dichloroethane			120.8		%		70-130	04-JUN-12
1,2-Dichloroethane			102.2		%		70-130	04-JUN-12
1,1-Dichloroethylene			120.0		%		70-130	04-JUN-12
cis-1,2-Dichloroethylene			131.2	LCS-ND	%		70-130	04-JUN-12
trans-1,2-Dichloroethylene			122.6		%		70-130	04-JUN-12
Dichloromethane			121.6		%		60-140	04-JUN-12
1,2-Dichloropropane			111.0		%		70-130	04-JUN-12
cis-1,3-Dichloropropylene			106.6		%		70-130	04-JUN-12

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-HSMS-VA	**Water**							
Batch	**R2373952**							
WG1483283-2 LCS								
trans-1,3-Dichloropropylene			96.3		%		70-130	04-JUN-12
1,1,1,2-Tetrachloroethane			119.3		%		70-130	04-JUN-12
1,1,2,2-Tetrachloroethane			98.9		%		70-130	04-JUN-12
Tetrachloroethylene			130.3	LCS-ND	%		70-130	04-JUN-12
1,1,1-Trichloroethane			134.8	LCS-ND	%		70-130	04-JUN-12
1,1,2-Trichloroethane			112.0		%		70-130	04-JUN-12
Trichloroethylene			134.3	LCS-ND	%		70-130	04-JUN-12
Trichlorofluoromethane			156.7	LCS-ND	%		60-140	04-JUN-12
Vinyl Chloride			120.9		%		60-140	04-JUN-12
WG1483283-1 MB								
Bromodichloromethane			<0.0010		mg/L		0.001	04-JUN-12
Bromoform			<0.0010		mg/L		0.001	04-JUN-12
Carbon Tetrachloride			<0.00050		mg/L		0.0005	04-JUN-12
Chlorobenzene			<0.0010		mg/L		0.001	04-JUN-12
Dibromochloromethane			<0.0010		mg/L		0.001	04-JUN-12
Chloroethane			<0.0010		mg/L		0.001	04-JUN-12
Chloroform			<0.0010		mg/L		0.001	04-JUN-12
Chloromethane			<0.0050		mg/L		0.005	04-JUN-12
1,2-Dichlorobenzene			<0.00070		mg/L		0.0007	04-JUN-12
1,3-Dichlorobenzene			<0.0010		mg/L		0.001	04-JUN-12
1,4-Dichlorobenzene			<0.0010		mg/L		0.001	04-JUN-12
1,1-Dichloroethane			<0.0010		mg/L		0.001	04-JUN-12
1,2-Dichloroethane			<0.0010		mg/L		0.001	04-JUN-12
1,1-Dichloroethylene			<0.0010		mg/L		0.001	04-JUN-12
cis-1,2-Dichloroethylene			<0.0010		mg/L		0.001	04-JUN-12
trans-1,2-Dichloroethylene			<0.0010		mg/L		0.001	04-JUN-12
Dichloromethane			<0.0050		mg/L		0.005	04-JUN-12
1,2-Dichloropropane			<0.0010		mg/L		0.001	04-JUN-12
cis-1,3-Dichloropropylene			<0.0010		mg/L		0.001	04-JUN-12
trans-1,3-Dichloropropylene			<0.0010		mg/L		0.001	04-JUN-12
1,1,1,2-Tetrachloroethane			<0.0010		mg/L		0.001	04-JUN-12
1,1,2,2-Tetrachloroethane			<0.0010		mg/L		0.001	04-JUN-12
Tetrachloroethylene			<0.0010		mg/L		0.001	04-JUN-12
1,1,1-Trichloroethane			<0.0010		mg/L		0.001	04-JUN-12

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-HSMS-VA	**Water**							
Batch R2373952								
WG1483283-1 MB								
1,1,2-Trichloroethane			<0.0010		mg/L		0.001	04-JUN-12
Trichloroethylene			<0.0010		mg/L		0.001	04-JUN-12
Trichlorofluoromethane			<0.0010		mg/L		0.001	04-JUN-12
Vinyl Chloride			<0.0010		mg/L		0.001	04-JUN-12
VOC7-HSMS-VA	**Water**							
Batch R2373952								
WG1483283-2 LCS								
Benzene			126.2		%		70-130	04-JUN-12
Ethylbenzene			123.5		%		70-130	04-JUN-12
Methyl t-butyl ether (MTBE)			110.6		%		70-130	04-JUN-12
Styrene			116.7		%		70-130	04-JUN-12
Toluene			115.4		%		70-130	04-JUN-12
meta- & para-Xylene			123.6		%		70-130	04-JUN-12
ortho-Xylene			122.4		%		70-130	04-JUN-12
WG1483283-1 MB								
Benzene			<0.00050		mg/L		0.0005	04-JUN-12
Ethylbenzene			<0.00050		mg/L		0.0005	04-JUN-12
Methyl t-butyl ether (MTBE)			<0.00050		mg/L		0.0005	04-JUN-12
Styrene			<0.00050		mg/L		0.0005	04-JUN-12
Toluene			<0.00050		mg/L		0.0005	04-JUN-12
meta- & para-Xylene			<0.00050		mg/L		0.0005	04-JUN-12
ortho-Xylene			<0.00050		mg/L		0.0005	04-JUN-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.
LCS-ND	Lab Control Sample recovery was slightly outside ALS DQO. Reported non-detect results for associated samples were unaffected.
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.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Manual Meter							
	2	29-MAY-12 13:45	05-JUN-12 00:00	0.25	154	hours	EHTR-FM
	3	29-MAY-12 14:30	05-JUN-12 00:00	0.25	154	hours	EHTR-FM
pH by Meter (Automated)							
	1	29-MAY-12 10:50	01-JUN-12 16:56	0.25	78	hours	EHTR-FM
	4	29-MAY-12 15:30	04-JUN-12 18:52	0.25	147	hours	EHTR-FM
Bacteriological Tests							
Fecal coliform by MPN							
	1	29-MAY-12 10:50	31-MAY-12 14:30	30	52	hours	EHTR
	2	29-MAY-12 13:45	31-MAY-12 14:30	30	49	hours	EHTR
	3	29-MAY-12 14:30	31-MAY-12 14:30	30	48	hours	EHTR
	4	29-MAY-12 15:30	31-MAY-12 14:30	30	47	hours	EHTR

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 L1155242 were received on 31-MAY-12 09:45.

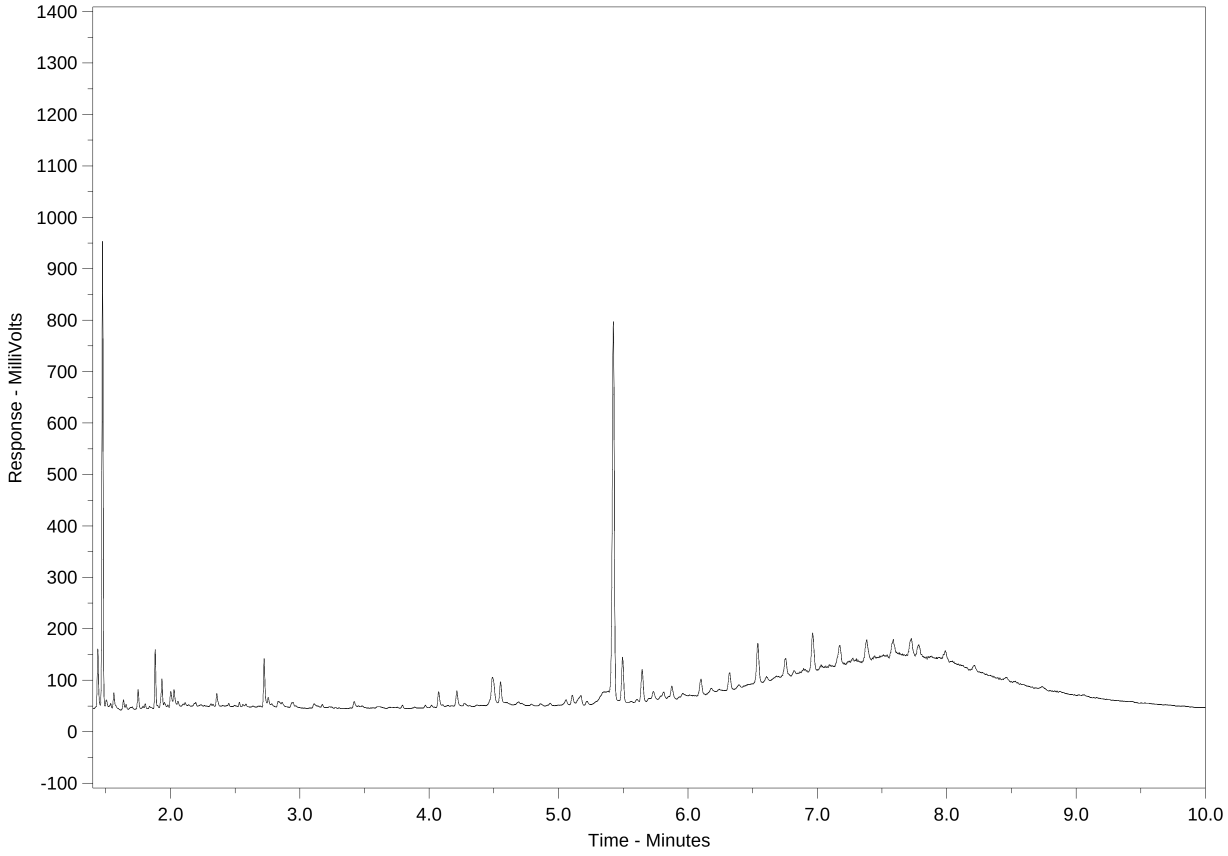
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where 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: L1155242-1
Client Sample ID: MW12-06-SR



nC10	nC19	nC32
174°C 346°F	330°C 626°F	467°C 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.

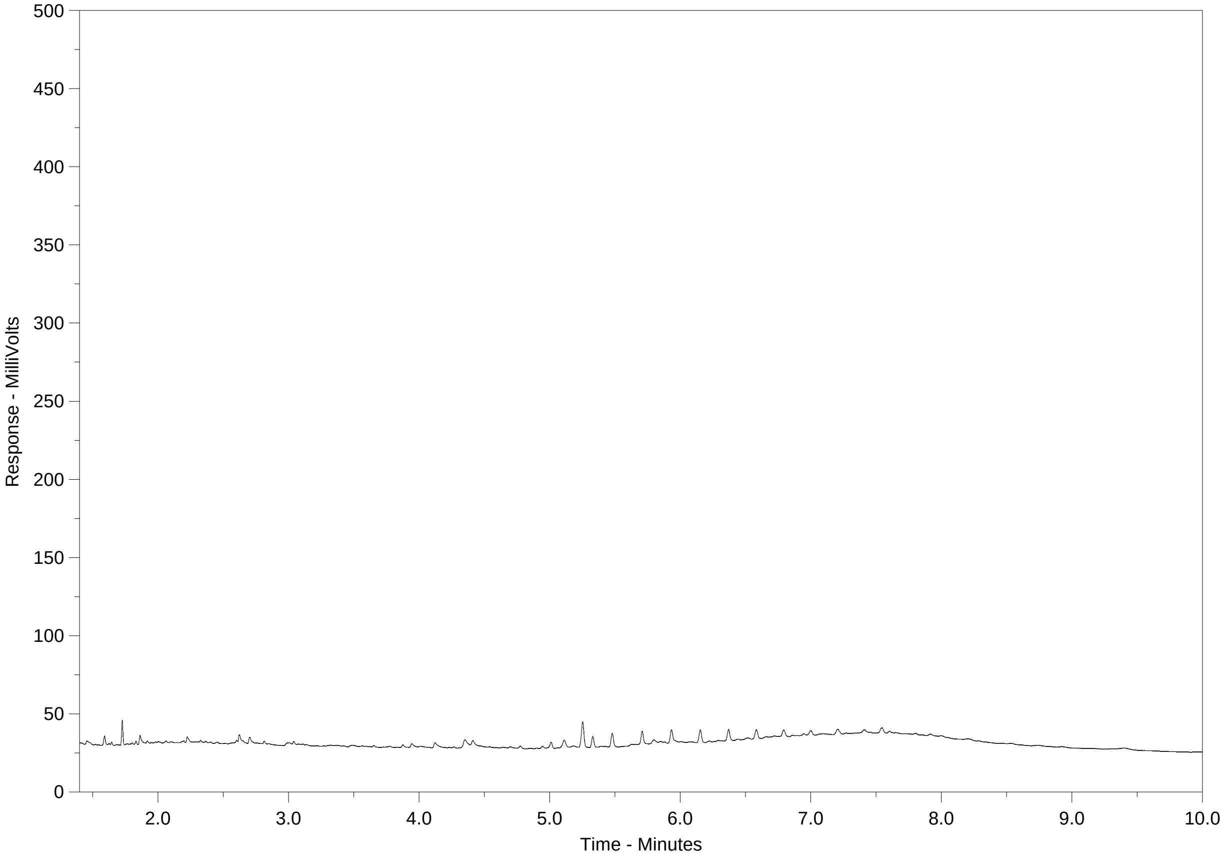
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples by as much as 0.5 minutes.

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: L1155242-2
Client Sample ID: MW12-05-SR



nC10	nC19	nC32
174°C 346°F	330°C 626°F	467°C 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.

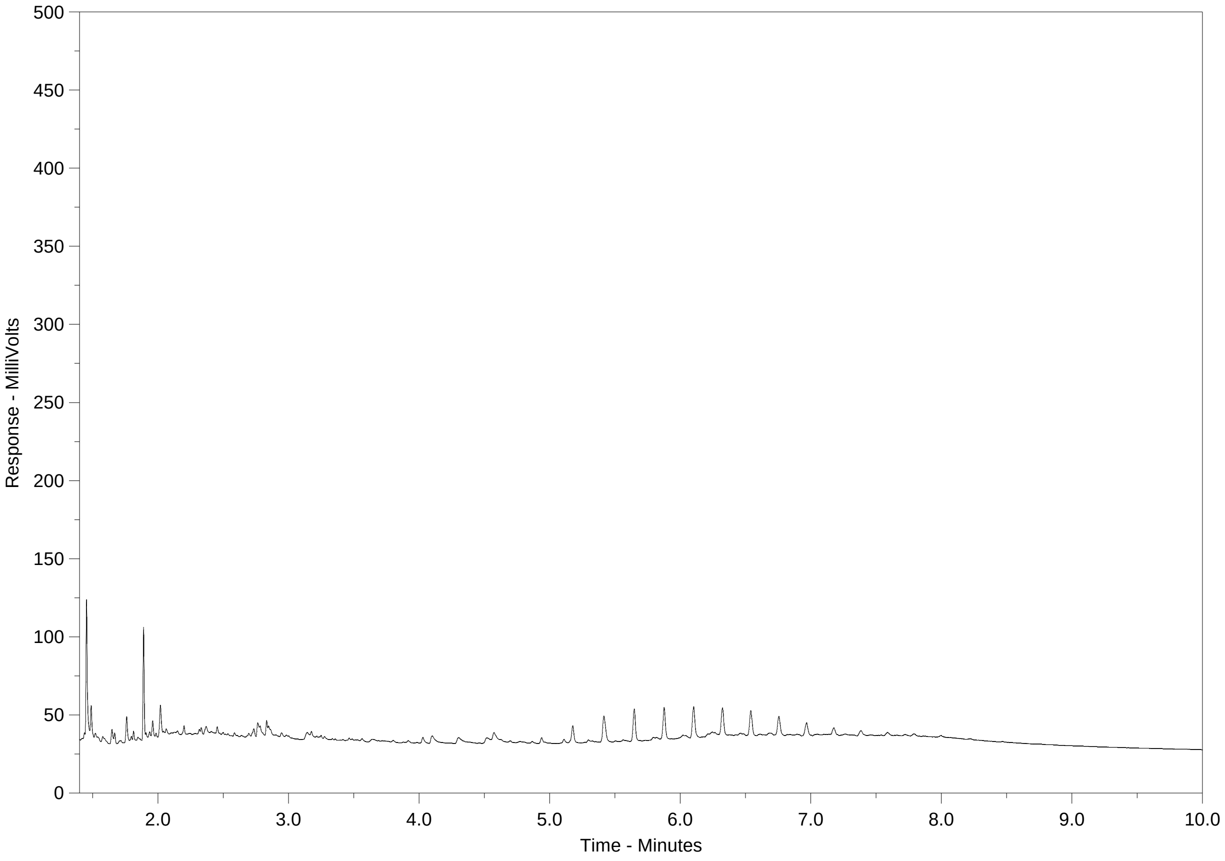
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples by as much as 0.5 minutes.

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: L1155242-3
Client Sample ID: MW12-04-SR



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.

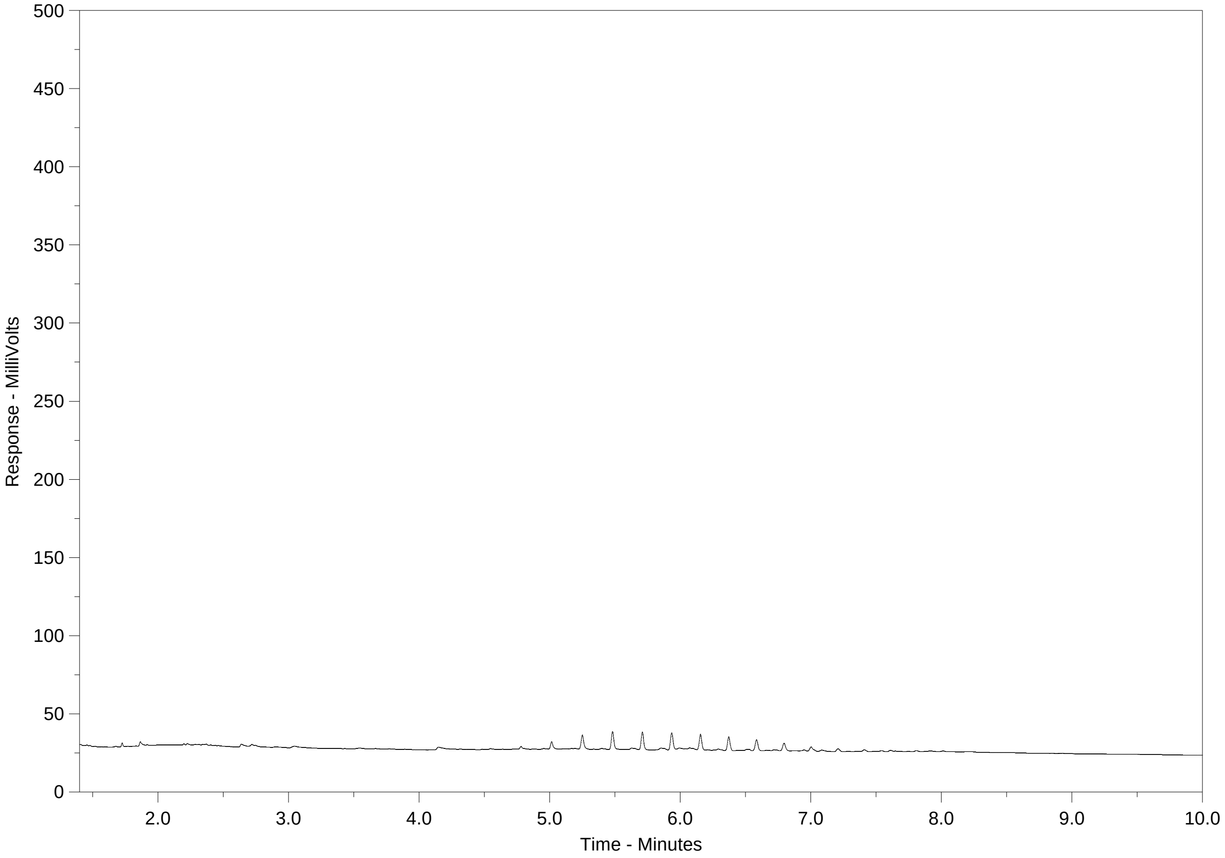
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples by as much as 0.5 minutes.

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: L1155242-4
Client Sample ID: SWIFT RIVER



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.

10-174288

ALS Environmental

L1155242-COFC

Page 1 of 1

Report To

Company: GOLDER

Contact: JOE MARQUARDSON

Address: 201 B 170 TITANIUM WAY

Y1A 0G1

Phone: 867.334.7423 Fax:

Report Format / Distribution

Standard: X Other (specify):

Select: PDF X Excel X Digital Fax

Email 1: jmarquardson@golder.com

Email 2: ghamilton@golder.com

Service Request: (Rush subject to availability - Contact ALS to confirm TAT)

☐ Regular (Standard Turnaround Times - Business Days)

☐ Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT

☐ Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT

☐ Same Day or Weekend Emergency - Contact ALS to confirm TAT

Invoice To Same as Report ? (circle) [✓ Yes] or No (if No, provide details)

Copy of Invoice with Report? (circle) Yes or No

Company:

Contact:

Address:

Phone: Fax:

Client / Project Information

Job #: 11-1436-0073/2900

PO / AFE:

LSD:

Quote #:

Lab Work Order # (lab use only) L1155242.

ALS Contact:

Sampler: J. MARQUARDSON / A. BADGER

Analysis Request

(Indicate Filtered or Preserved, F/P)

Sample #	**Sample Identification** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	GENERAL	DOC	PAH	BTEX	NUTRIENTS	DISSOLVED METALS	FECAL COLIFORM						Number of Containers
	MW12-06-SR	29-MAY-12	10.50	GW	X	X	X	X	X	X	X						
	MW12-05-SR	29-MAY-12	13.45	GW	X	X	X	X	X	X	X						
	MW12-04-SR	29-MAY-12	14.30	GW	X	X	X	X	X	X	X						
	SWIFT RIVER	29-MAY-12	15.30	SW	X	X	X	X	X	X	X						

Short Holding Time

Rush Processing

Special Instructions / Regulation 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 specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: J. MARQUARDSON	Date: 29-MAY-12	Time: 18:00	Received by: BP	Date: May 31	Time: 9:45	Temperature: 8.8 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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.

Africa	+ 27 11 254 4800
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North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

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