February 23, 2013

HYDROGEOLOGICAL ASSESSMENT

Johnson's Crossing 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 Johnson's Crossing Solid Waste Disposal Facility (the "Facility" or "Site") is one of the sites included in the program. A multiphase approach was implemented at each Facility in order to carry out the hydrogeological assessment. The first phase completed for the program was a review of Site-specific requirements and considerations. The second phase was the preparation of a work plan and schedule. The third phase was the development of a Background Research and Facility Site Assessment Plan. The fourth phase consisted of the drill program tender specification and tender process management. The fifth phase consisted of the installation of a monitoring well network and collection of data on water levels, water quality, and aquifer parameters. The sixth and final phase resulted in a draft of this Hydrogeological Assessment Report, which includes the results of the Background Research and Facility Site Assessment Plan, documenting the results of the investigation.

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

- Site Description: The Facility is located in the southern part of the Yukon, within the Southern Lakes Ecological Region, and in the Teslin Tlingit Council traditional territory, at latitude 60˚ 29' north and longitude 133˚ 17' west. The Facility is located on a 9.9 hectare Federal Reserve Parcel to the Government of Yukon (Parcel ID # 105C06-00000-00045). The Site is accessed by a gravel road off the east side of the Canol Road, approximately 700 m north of the junction with the Alaska Highway at kilometre 1,295, approximately 128 km east of Whitehorse, and 500 m north of the bridge at Johnson's Crossing. The Facility presently serves the approximately 45 residents in the Johnson's Crossing area as a transfer facility for household waste. No evidence of spills or discharges was observed during the Site reconnaissance.
- Site Topography: The Facility is at an elevation of approximately 770 m (2,530 feet) above sea level and lies within the Judas Creek and Marsh Lake watersheds. A cleared area of approximately 12,000 square metres, sloped to the southwest, is present at the Facility. Local surficial geology is mapped as nearly flat terrace deposits of glaciofluvial origin, consisting of silt, sand, and gravel. The regional hydraulic gradient is expected to be to the southwest towards the Teslin River.
- Stratigraphy and Hydrogeology:
  - Surface expression at the Site is dominated by quaternary surficial deposits;
  - Subsurface conditions were investigated with the installation of three monitoring wells including: JC-MW12-01, JC-MW12-02, and JC-MW12-03, which were completed from May 27 to June 3, 2012, under the supervision of Golder Associates for the establishment of a monitoring well network at the Site;
  - The Site stratigraphy was investigated to a maximum depth of 89.9 m in JC-MW12-01 and was found to consist of approximately 35 m of silt overlying inter-bedded gravel, sand, and silt deposits;

- An unconfined groundwater aquifer was encountered during the drilling of all three monitoring wells at between 80.5 m and 84.4 m below grade (bg);
- Due to the depth to groundwater in all of the monitoring wells, no sampling or slug testing was conducted at the Site;
- Hydraulic conductivity of the surficial aquifer at the Site was calculated using a grain size analysis performed on cuttings taken during drilling to be between 2×10^{-4} and 1×10^{-3} (m/s);
- Hydraulic conductivity of the overlying silt layer was calculated to be approximately 6×10^{-9} m/s;
- A search of the Natural Resources Canada, Groundwater Information Network did not identify groundwater wells within 1,500 m of the Site;
- Due to the depth of groundwater underlying the Facility, the relatively low precipitation at the Site, and low permeability of the overlying soils, it was determined that there was negligible risk of contamination of the groundwater from buried waste at the Site; and
- Based on the estimated groundwater flow direction at the Site, it was determined that the minimum conditions of one upgradient and two downgradient wells have been met.

The following recommendations are made, based on the results of the 2012 hydrogeological assessment presented in this report:

- As the potential for the facility to impact groundwater quality is negligible we recommend that the Facility's Waste Management Permit be amended to eliminate the need for groundwater monitoring at this location.
- This Site should be considered to be of low concern with regards to potential for impact to sensitive downstream receptors.

Study Limitations

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

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

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

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

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

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

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

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1.0 INTRODUCTION

1.1 Background

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

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, accepted by Yukon Government Community Services on October 7, 2011, and additional works detailed in our letter dated April 26, 2012 and accepted April 30, 2012.

1.2 Purpose and Objectives

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

- Develop a conceptual hydrogeological model of the Site using existing data that identifies potential 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 of work was proposed to develop the conceptual hydrogeological model for the Site and installation of a monitoring well network. This work was performed in accordance with the relevant Environment Yukon Protocols, and in accordance with the Yukon Environmental and Socioeconomic Assessment Act.

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 and aquifer conditions; and
- Phase 6 resulted in the preparation of a draft of this Hydrogeological Assessment Report, documenting the results of this investigation.

1.4 Qualifications of Assessors

Project Manager

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

Project Director

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

Field Hydrogeologist-Engineer

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

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

1.5 Authorization

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

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Location

The Facility is located in the southern part of the Yukon, within the Southern Lakes Ecological Region, and in Teslin Tlingit Council traditional territory, at latitude 60˚ 29' north and longitude 133˚ 17' west. The Facility is located on a 9.9 hectare Federal Reserve Parcel to the Government of Yukon (Parcel ID # 105C06-00000-00045). The Site is accessed by a gravel road off the east side of the Canol Road, approximately 700m north of the junction with the Alaska Highway at kilometre 1,295, approximately 128 km east of Whitehorse, and 500 m north of the bridge at Johnson's Crossing.

2.2 Site History

A series of waste trenches have been utilized at the Facility throughout its operation. A series of domestic waste burial sites at the Facility were covered in 1992, 1995, and 2011. In addition, a bridge concrete burial Site is present at the Facility. According to the Solid Waste Operation Plan (2008) residential refuse is the primary material received at the Site. The Yukon Government Community Services, Infrastucture Branch converted the Johnson's Crossing Waste Disposal Facility into a transfer station in 2011.

3.0 METHODOLOGY

3.1 Preliminary Hydrogeological Assessment

The preliminary hydrogeological assessment involved a desktop review, interpretation of existing information, and an inspection of the Facility. The initial inspection of the Facility was conducted in October 2011. The purpose of the preliminary hydrogeological assessment was to identify the appropriate drilling methods, equipment, and potential well locations for the installation of a monitoring well network. This portion of the work included the following three tasks:

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

3.1.1 Data Sources

- Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.
- Environment Canada, Meteorological Service of Canada Last Modified 2012-05-29, 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.
- Government of Yukon. Environment Act Contaminated Sites Regulation. O.I.C. 2002/171, Schedule 3- Generic Numerical Water Standards.
- Government of Yukon, Yukon Environment, Protocol for the Contaminated Sites Regulation Under the Environment Act. 2011.
- Government of Yukon, Yukon Geological Survey, YGS MapMaker Online Website: http://maps.gov.yk.ca/imf.jsp?site=YGS
- Government of Yukon, Yukon Mining and Lands Viewer Website: http://maps.gov.yk.ca/imf.jsp?site=miningLands
- Government of Yukon, Yukon Water, Water Data Catalogue Website: http://yukonwater.ca/MonitoringYukonWater/WaterDataCatalogue/
- Government of Yukon, Department of Environment, Compiled from The Yukon Water Well Registry Summary of Yukon Water Wells, May 11, 2006- Website: http://www.env.gov.yk.ca/monitoringenvironment/hydrology.php
- Natural Resources Canada, Groundwater Information Network Website: http://ngwd-bdnes.cits.nrcan.gc.ca/service/api_ngwds:gin/en/wmc/aquifermap.html
- Morison, KcKenna, and Davies, 1978, 1980. Surficial Geology, Teslin, Yukon Territory, Geological Survey of Canada, unpublished.
- Site inspection of October 2012.
- Surveys and Mapping Branch, Department of Energy, Mines, and Resources. The Atlas of Canada Website: http://atlas.nrcan.gc.ca/site/english/maps/topo/map Map 105 C/6, scale 1:50,000.

3.1.2 Site Inspection

Prior to the Facility reconnaissance, Golder developed a Facility-specific health and safety plan (HASP) for implementation during the field work. The health and safety plan included a description of the potential hazards that could be encountered during the Facility reconnaissance and proposed mitigation. A Site inspection was conducted in October 2011. The initial Site visit was 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 also 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 Yukon Department of Energy Mines and Resources, 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), the Yukon Water Well Registry, and a search of the Yukon Water online Data Catalogue.

3.1.4 Contaminated Sites Registry

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

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

Waste Management Permit No. 80-009 was issued on February 29, 2012 for the Facility. It states that the Facility is to be operated in compliance with any applicable requirements in federal, territorial, and municipal legislation including the Environment Act and Solid Waste Regulations.

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

- Monitoring water levels and collecting water samples from groundwater monitoring wells at the Facility twice a year (spring and late summer);
- Sampling of downgradient surface water bodies concurrently with the groundwater sampling;
- Analyze surface water and groundwater samples for the parameters outlined in section 3.5;
- Analyze water samples at a laboratory that is accredited as conforming to ISO/IEC 17025 by an accrediting body that conforms to ISO/IEC 17011 standards; and
- Submitting monitoring results to Environment Yukon by January 31st each year.

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

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

Site	Site Disposal Facility Permit Number	Permit Type	Solid Waste Management Plan	Required Groundwater Monitoring
Johnson's Crossing Solid Waste Disposal Facility	80-009	Transfer Station	Community Services Operations and Programs (2011)	Twice Per Year

3.2 Field Investigations

3.2.1 Scope of Field Investigations

- Three onsite groundwater wells were drilled by Midnight Sun Drilling under the supervision of Golder Associates from May 27 to June 3, 2012;
- Grab samples taken at different depths throughout the Site, during monitoring well installation, were analyzed for grain size composition;
- Due to the depth to groundwater underlying the Site and low permeability soils encountered during drilling, it was decided by Golder to forgo developing and sampling the monitoring wells; and
- Results of field and laboratory data are summarized and interpreted in this report.

3.2.2 Groundwater Monitoring Well Network

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

Three (3) groundwater monitoring wells were proposed for installation at the Site to characterize groundwater conditions underlying the waste disposal Facility. A Site plan showing the monitoring well locations and key Site features is provided in Figure 2. JC-MW12-01 was intended to characterize upgradient groundwater conditions, while JC-MW12-02 and JC-MW12-03 were intended to assess groundwater conditions downgradient of the landfill. Locations of the monitoring wells were selected based on aerial photography, review of Site history, Site topography, suspected groundwater flow direction, and a Site inspection.

Specifics for each well are listed below:

- JC-MW12-01 was installed in the northern corner of the site and advanced to a depth of approximately 89.9 m below grade (m bg);
- JC-MW12-02 was installed in the west corner of the site and advanced to approximately 86.0 m bg; and
- JC-MW12-03 was installed along the southwest edge of the site and advanced to approximately 86.9 m bg.

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

Grab samples of drill cuttings were taken at regular intervals to log the stratigraphy encountered in each borehole. Borehole logs, documenting observed stratigraphy, along with well construction details, are provided in Appendix B. A summary of the stratigraphy and well construction details is provided in Table 2.

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

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 0.75 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 were 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
- Wells were not developed following drilling due to the depth to groundwater encountered at the Site.

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)
JC-MW12-01	90.2	Sand and Gravel, trace silt	50	86.9 – 89.9	83.8 – 89.9
JC-MW12-02	86.0	Sand and Gravel	50	82.3 – 85.3	80.5 – 85.3
JC-MW12-03	86.9	Sand and Gravel	50	83.5 – 86.6	82.3 – 86.6

3.2.3 Monitoring Well Surveying

Golder carried out a level survey to determine the vertical elevation of the top of the PVC wellhead (measuring point) for each well on June 3, 2012. Initial absolute elevation was surveyed relative to a survey control points located at the Site (Quest Engineering, 2002). Relative elevation between wells, as determined from the level survey, has a precision of ± 1 cm. Table 3 presents a summary of survey data (recorded on June 3, 2012). Horizontal position of all wells was obtained by GPS with an accuracy of ± 0.5 m or better.

Water level was measured using a 91 m (300 foot) tape measure, on which the water level was marked by a wet section. Estimated water level using this method is included in Table 2.

Table 3: Monitoring Well Locations and Groundwater Elevations from the Monitoring Events on June 3, 2012.

Well ID	GPS Location (UTM Zone 8 V)	Top of PVC Casing Elevation (masl)	Approximate Standing Water Level (mbtoc)	Water Table Elevation (masl)
JC-MW12-01	6707644.1 m N 594241.0 m E	771.61	87.6	684.01
JC-MW12-02	6707580.9 m N 594166.9 m E	767.14	82.0	685.14
JC-MW12-03	6707557.0 m N 594201.9 m E	766.73	84.4	682.33

3.2.4 Groundwater Monitoring Event

Monitoring wells were not developed or sampled following installation at the Site. Based on the depth to groundwater and the lithology encountered at the Site, it was determined that there was little chance of impact by buried waste at the Site to the underlying groundwater, and low concern for parameters exceeding the Yukon Contaminated Sites Regulation protocols.

4.0 CONCEPTUAL HYDROGEOLOGICAL MODEL

4.1 Setting

The Facility is at an elevation of approximately 770 m (2,530 feet) above sea level and lies within the Judas Creek and Marsh Lake watersheds. A cleared area of approximately 12,000 square metres, sloped to the south and southwest, is present at the Facility. The Facility presently serves the approximately 45 residents in the Johnson's Crossing area. No evidence of spills or discharges was observed during the Site reconnaissance. The primary receptor for contaminants that may migrate off site from the facility is likely to be the Teslin River.

4.2 Climate

Climate at the Site is assumed to be similar to climate at the Johnson's Crossing climate station (Climate ID 2100670), located approximately 1.4 km south west of the Facility at an elevation of approximately 690 m above sea level. Average monthly precipitation reported at the Johnson's Crossing station ranges from a low average of 8.0 mm in April to a high average of 53.2 mm in July. The average annual precipitation is approximately 376.2 mm, including 145.1 cm as snowfall. Temperature ranges from a low average of -18.6°C in January to a high average of 13.5°C in July (Environment Canada, 2011).

Annual precipitation is relatively low (about 0.4 m per year). This suggests that the amount of infiltration of water through buried waste at the Site 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. The greatest potential for infiltration of water through the waste is during the spring snow melt; however, a significant portion of the water from snow melt would typically occur as surface runoff during this period.

4.3 Geology and Hydrogeology

4.3.1 Geological Framework

The southern Yukon, including the Johnson's Crossing area, has undergone several episodes of glaciation, the most recent being the Quaternary McConnell glaciation. During that period, sediments such as glacial till, glaciofluvial sediments, and glaciolacustrine sediments were deposited, especially in low elevation areas such as the Teslin River Valley, located downgradient of the Site.

The Johnson's Crossing area is mapped as being underlain primarily by till, colluvium, and glaciofluvial outwash sediments of Quaternary origin, with modern lacustrine and fluvial sediments at lower elevations associated with the Teslin River and Teslin Lake. Ablation till, colluvial glacial debris, morainal deposits, and bedrock exposures are found at higher elevations in the mountains to the surrounding the Site.

Surficial geology maps published by the Yukon Geological Survey (YGS) indicate natural surficial materials at the Site are terrace deposits of glaciofluvial origin, consisting silt, sand, and gravel. Deposits range from 5 m to approximately 50 m in thickness. Topography associated with this setting is generally irregular or nearly flat, marked by shallow channel patterns or locally pitted surfaces (Figure 3).

4.3.2 Principal Aquifers

As shown in Figure 4, it is inferred that groundwater at the Site occurs in a deep, unconfined, surficial aquifer composed primarily of unconsolidated sand and gravel, with minor silt. For the purpose of this report, this aquifer has been named the Surficial Aquifer (Table 4).

Table 4 Aquifer Units Encountered at the Site

Aquifer Name	Location	Aquifer Type	Comments
Surficial Aquifer	JC-MW12-01 JC-MW12-02 JC-MW12-03	Unconfined; unconsolidated porus media	▪ Sand and Gravel ▪ High hydraulic conductivity ▪ Overlain by 35 - 45 m of SILT

4.4 Groundwater Flow Systems

4.4.1 Regional and Intermediate Groundwater Flow

Topography in the area surrounding the Facility slopes from the Big Salmon Range, located to the northeast of the Site (elevation approximately 1200 m amsl), southwest towards the Teslin River (elevation 685 m amsl). Regional hydraulic gradient is inferred to be a subdued replica of this topographic gradient, so that regional groundwater flow is primarily to the southwest, discharging to the Teslin River.

4.4.2 Local Groundwater Flow

Local groundwater flow direction at the Site is estimated from the Site topography to be to the southwest. Local hydraulic gradient at the Site is inferred, based on Site topography, to be approximately 0.1 m/m.

4.5 Grain Size Analysis

Grain size analysis was performed on several grab samples taken at various depths during monitoring well installation at the Site. Soil samples were analyzed at EBA's laboratory in Whitehorse. The table below provides a summary of the depth, soil description, and estimated hydraulic conductivity, of various strata throughout the Site, based on the grain size analysis.

Table 5: Grain Size Analysis

Monitoring Well ID	Depth (m bg)	Description	d_{10}, d_{60} (mm)	Calculated Hydraulic Conductivity (m/s)
JC-MW12-01	90.2	SAND (65% and GRAVEL (34%)	0.35, 4.00	1×10^{-3}
JC-MW12-02	3.1	SILT (88%), some Clay (10%)	0.002, 0.03	6×10^{-9}
JC-MW12-02	85.0	SAND (53%) and GRAVEL (39%), some Silt (7%)	0.17, 4.75	2×10^{-4}

4.6 Estimated Linear Groundwater Velocity

As determined from the gradation analysis summarized in Table 5, the hydraulic conductivity of the surficial aquifer underlying the Site is ranges between 2×10^{-4} m/s and 1×10^{-3} m/s. The horizontal hydraulic gradient across the Site was assessed, based on topography, to be 0.1 m/m to the southwest. A range of reasonable linear groundwater velocity 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); and

n: is the porosity which is estimated to be approximately 0.35 (Fetter, 1994) in sand and gravel.

The resulting groundwater velocity is estimated to be between 6×10^{-5} m/s and 3×10^{-4} m/s (approximately 5 to 25 metres per day). Groundwater at the Site may travel faster or slower than these estimates due to inaccuracies or seasonal variations in these parameters. Infiltration of water through the overlying SILT is estimated to occur at a significantly lower rate of approximately 0.5 m per year.

4.7 Potential Contamination of Groundwater and Transport Mechanisms

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

- Leachate from waste disposed at the Facility; and
- Potential contaminates leaching from these sources include: heavy metals, nutrients (NO_3, NH_3), organic hydrocarbons (Fuels, PAH's, chlorinated hydrocarbons), and salts.

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

- Percolation of precipitation from the surface, through the unsaturated zone, and into the saturated zone; and
- Transport of contaminants within the saturated zone (aquifer) to other downgradient locations.

4.8 Analysis of Potential for Groundwater Contamination

The following factors help to mitigate the influence of landfill leachate on the quality of the groundwater underlying the Site:

- Moderate slope of the ground surface at the Site;
- Low hydraulic conductivity of the upper 35 plus metres of soil at the Site;
- High leachate renovation capacity of silts and clays;
- Low annual recharge; and
- Deep water table, with a highly conductive aquifer.

Based on the preponderance of these factors, it is unlikely that the groundwater quality underlying the Site is influenced by buried waste at the Site.

5.0 CONCLUSIONS

- Stratigraphy and Hydrogeology:
  - Surface expression at the Site is dominated by quaternary surficial deposits;
  - Subsurface conditions were investigated with the installation of three monitoring wells including: JC-MW12-01, JC-MW12-02, and JC-MW12-03, which were completed from May 27 to June 3, 2012, under the supervision of Golder Associates for the establishment of a monitoring well network at the Site;
  - The Site stratigraphy was investigated to a maximum depth of 89.9 m in JC-MW12-01 and was found to consist of approximately 35 m of silt overlying inter-bedded gravel, sand, and silt deposits;
  - An unconfined groundwater aquifer was encountered during the drilling of all three monitoring wells at between 80.5 m and 84.4 m below grade (bg);
  - Hydraulic conductivity of the surficial aquifer at the Site was calculated using a grain size analysis performed on cuttings taken during drilling to be between 2×10^{-4} and 1×10^{-3} (m/s);
  - Hydraulic conductivity of the overlying silt layer was calculated to be approximately 6×10^{-9} m/s;
  - A search of the Natural Resources Canada, Groundwater Information Network did not identify groundwater wells within 1,500 m of the Site;
  - Due to the depth of groundwater underlying the Facility, the relatively low precipitation at the Site, and low permeability of the overlying soils, it was determined that there was little risk of contamination of the groundwater from buried waste at the Site; and
  - Based on the estimated groundwater flow direction at the Site, it was determined that the minimum conditions of one upgradient and two downgradient wells have been met.

6.0 RECOMMENDATIONS

As the potential for the facility to impact groundwater quality is negligible we recommend that the Facility's Waste Management Permit be amended to eliminate the need for groundwater monitoring at this location. This Site should be considered to be of low concern with regards to potential for impact to sensitive downstream receptors.

7.0 CLOSURE

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

GOLDER ASSOCIATES LTD.

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LEGEND

FACILITY

2 0 2

SCALE 1:100,000 KILOMETRES

PROJECT

YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
JOHNSON'S CROSSING, YUKON

TITLE

KEY PLAN

REFERENCE

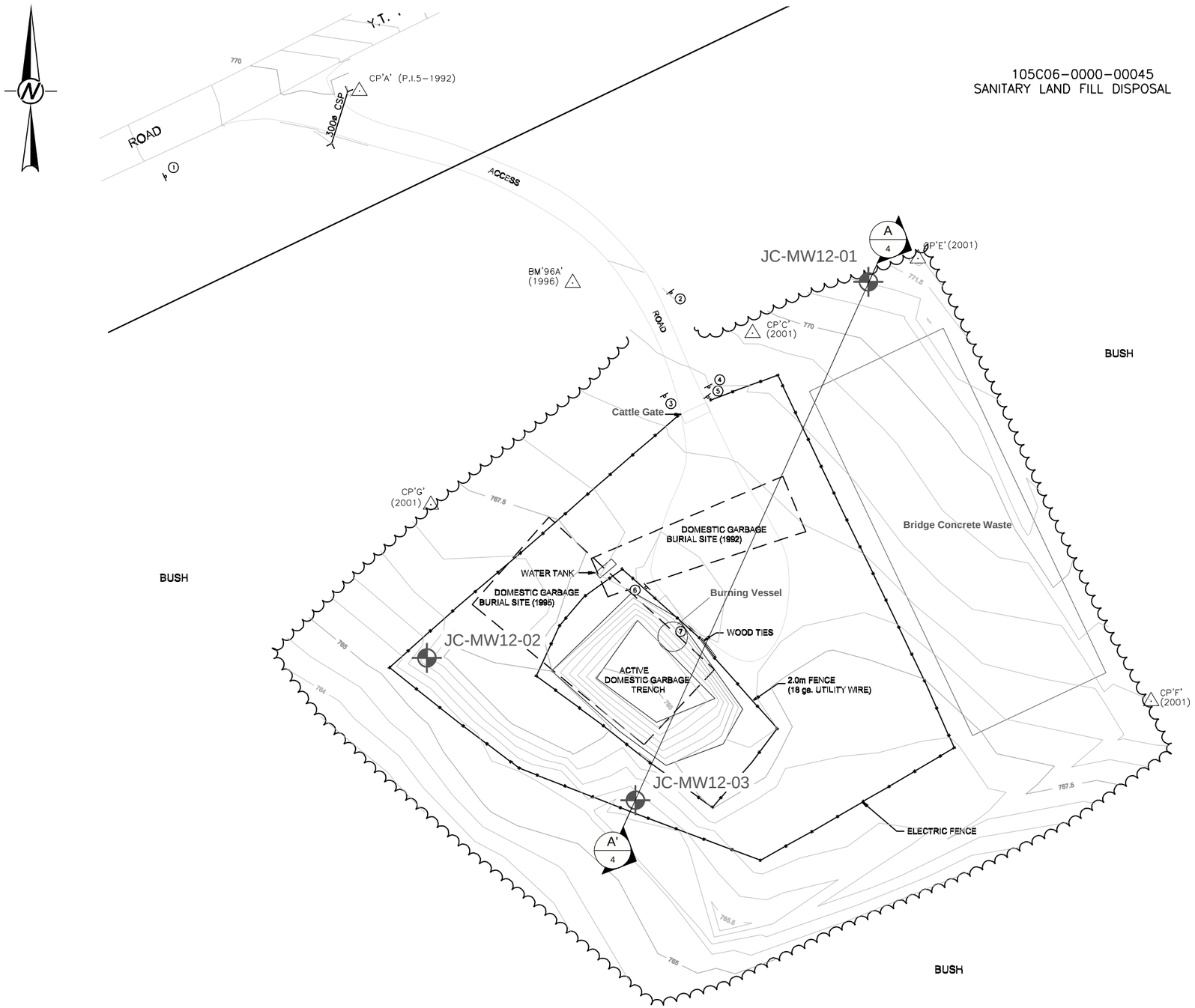
BASEDATA OBTAINED FROM GEOGRATIS (NATURAL RESOURCES CANADA).
DATUM: NAD83 PROJECTION: UTM ZONE 8

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.	11-1436-0073		PHASE No. 2100		
DESIGN	CB	17 Sep. 2012	SCALE AS SHOWN	REV.	0
GIS	DSC	18 Sep. 2012	FIGURE: 1		
CHECK					
REVIEW					

\\golder.gds\gal\Burnaby\CAD-GIS\Bur-Graphics\Projects\2011\1436\11-1436-0073\GIS\Mapping\MXD\Hydrogeology\Johnsons_Crossing\Figure_01_Key_Plan.mxd

105C06-0000-00045
SANITARY LAND FILL DISPOSAL



LEGEND

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

REFERENCES

1. BASE PLAN PROVIDED BY QUEST ENGINEERING GROUP
   CAD FILE: JOHNSON2004.DWG
   DATED:2002.01.15

NOTES

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

0 15 30 45m
1:750

PROJECT
YUKON GOVERNMENT-COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
JOHNSON'S CROSSING, YUKON

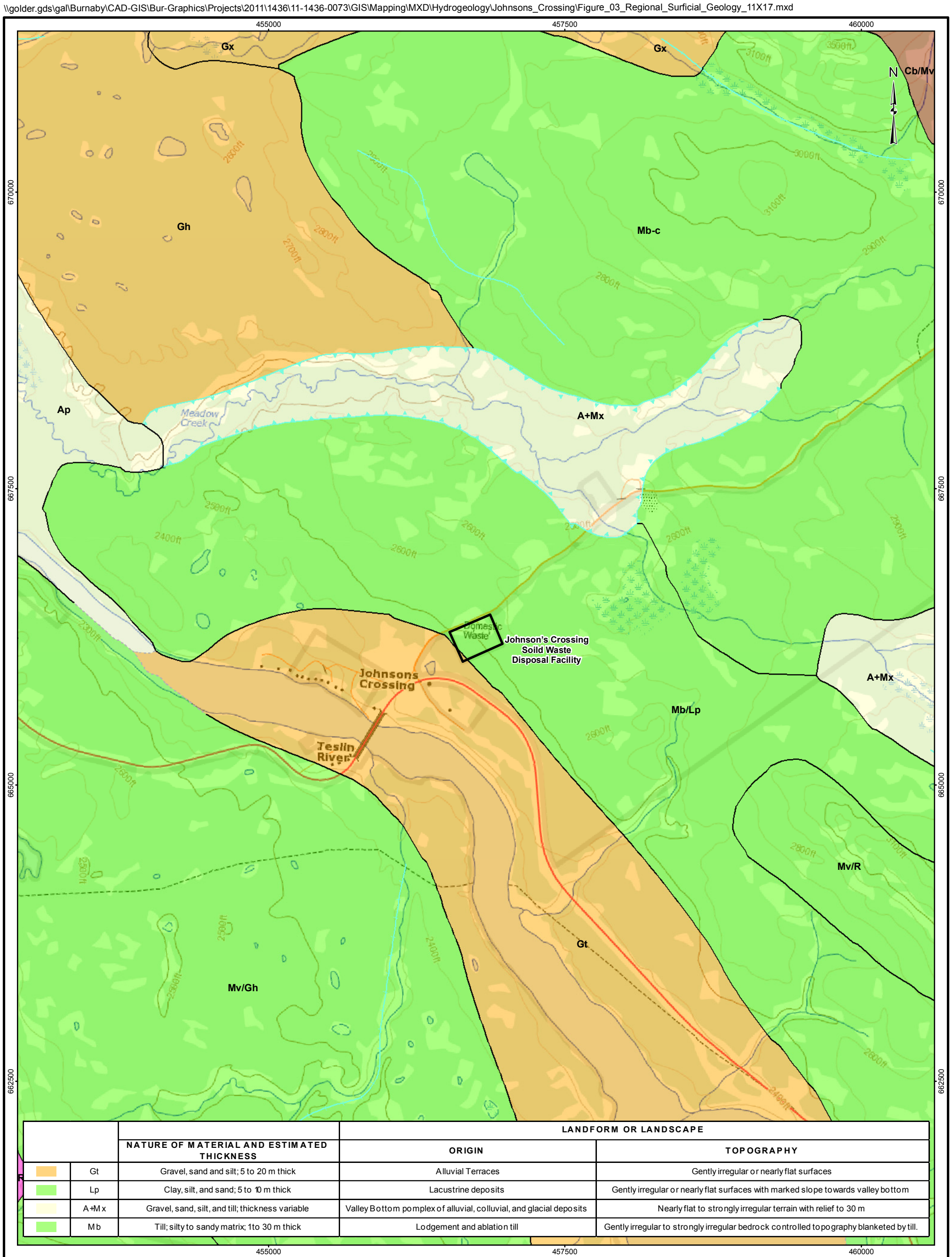
TITLE
SITE PLAN AND CROSS-SECTION LOCATION

Golder Associates
Greater Vancouver Office, BC

PROJECT No. 11-1436-0073			PHASE No.	2100-2160
DESIGN	CB	20SEP12	SCALE AS SHOWN	REV. -
CADD	TS	25SEP12		
CHECK	GCP			
REVIEW				

FIGURE 2

\\golder.gds\gal\Burnaby\CAD-GIS\Bur-Graphics\Projects\2011\1436\11-1436-0073\GIS\Mapping\MXD\Hydrogeology\Johnsons_Crossing\Figure_03_Regional_Surficial_Geology_11X17.mxd



		NATURE OF MATERIAL AND ESTIMATED THICKNESS	LANDFORM OR LANDSCAPE	
			ORIGIN	TOPOGRAPHY
	Gt	Gravel, sand and silt; 5 to 20 m thick	Alluvial Terraces	Gently irregular or nearly flat surfaces
	Lp	Clay, silt, and sand; 5 to 10 m thick	Lacustrine deposits	Gently irregular or nearly flat surfaces with marked slope towards valley bottom
	A+Mx	Gravel, sand, silt, and till; thickness variable	Valley Bottom pomplex of alluvial, colluvial, and glacial deposits	Nearly flat to strongly irregular terrain with relief to 30 m
	Mb	Till; silty to sandy matrix; 1to 30 m thick	Lodgement and ablation till	Gently irregular to strongly irregular bedrock controlled topography blanketed by till.

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 OVERNMENT, ENERGY, MINES AND RESOUCES.
DATUM: NAD83 PROJECTION: ALBERS

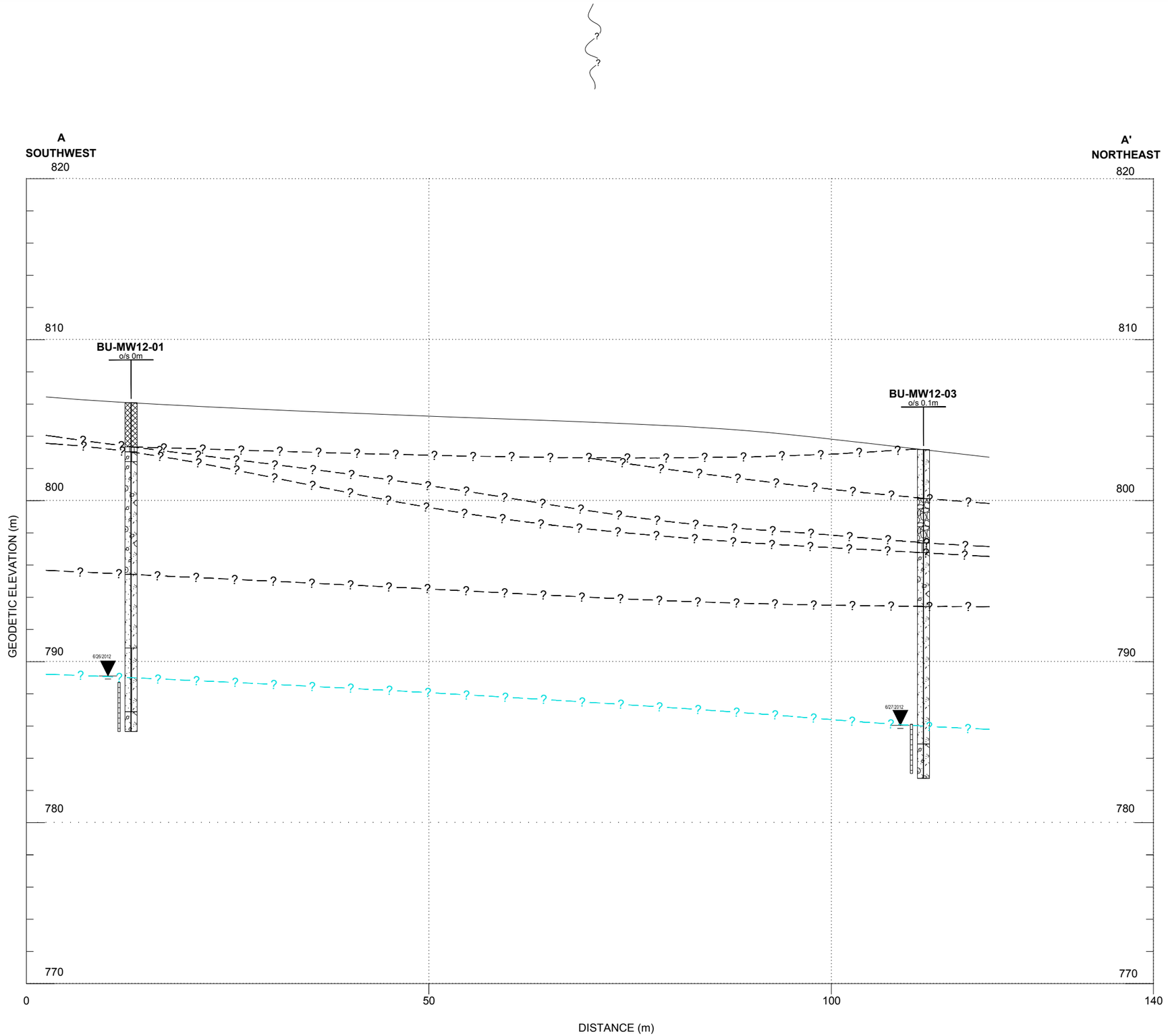
PROJECT
YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
JOHNSON'S CROSSING, YUKON

TITLE
REGIONAL SURFICIAL GEOLOGY

Golder Associates
Greater Vancouver Office, B.C.

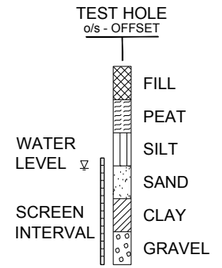
PROJECT No.	11-1436-0073		PHASE No. 2100		
DESIGN	CB	17 Sep. 2012	SCALE AS SHOWN	REV.	0
GIS	DSC	18 Sep. 2012			
CHECK					
REVIEW					

FIGURE: 3



LEGEND

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



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 10 20 30m

1:500

VERTICAL SCALE EXAGGERATION 2X

PROJECT

GOVERNMENT OF YUKON, DEPARTMENT OF COMMUNITY SERVICES
JOHNSON'S CROSSING, Y.T.

TITLE

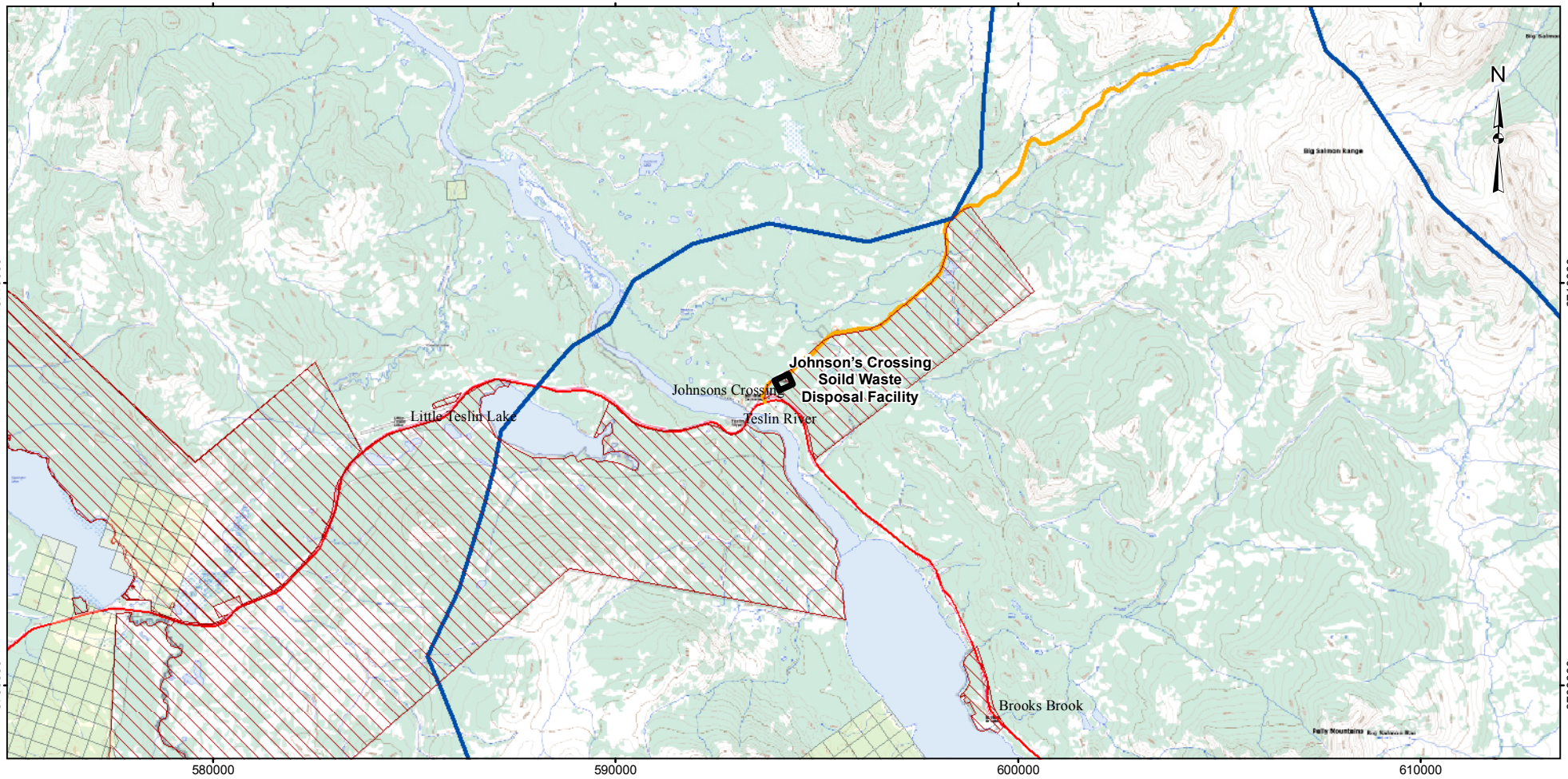
CONCEPTUAL HYDROGEOLOGICAL CROSS - SECTION A-A'

Golder Associates

PROJECT No.		11-1436-0073	FILE No.	1114360073-2100-2160-03
DESIGN	GJH	24OCT12	SCALE	AS SHOWN
CADD	JHL	02NOV12		
CHECK	GCP			
REVIEW				

FIGURE 4

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



LEGEND

- FACILITY
- MAJOR HIGHWAY
- FIRST NATIONS LANDS
- PARK/PROTECTED AREA
- QUARTZ CLAIM
- WATERSHED BOUNDARY

3 0 3

SCALE 1:150,000 KILOMETRES

PROJECT

YUKON GOVERNMENT - COMMUNITY SERVICES
SOLID WASTE DISPOSAL FACILITY
JOHNSON'S CROSSING, YUKON

TITLE

REGIONAL DRAINAGE & LAND ZONING

REFERENCE

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

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No.		11-1436-0073	PHASE No. 2100	
DESIGN	CB	17 Sep. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	18 Sep. 2012		
CHECK				
REVIEW				

FIGURE: 5

APPENDIX A

Site Photographs

Photograph 1: A view of the north corner of the Site during installation of JC-MW12-01; taken from the access road.

Photograph 2: A vew from the southwest edge of the Facility looking northeast, across the closed garbage trench and bridge concrete waste pit, at the present day waste transfer facility.

Photograph 3: A view of the west corner of the Site during the installation of JC-MW12-02; taken from the waste transfer facility in the center of the Site.

Photograph 4: Pond from which the downgradient water sample was taken.

APPENDIX B

Well Construction Logs

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

SHEET 1 OF 10
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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		770.95										Stickup = 0.66m
0	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT, trace fine sand, light brown, moist.		0.00										
1														
2														
3		- at 3.05m depth: seam with some clay. - from 3.05m - 7.32m depth: brown, trace clay.												
4														
5														Bentonite Seal
6														
7		- at 7.32m depth: wet.												
8														
9		- from 8.53m - 9.14m depth: some clay. - from 9.14m - 34.44m depth: no clay, moist.												
10		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
10	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT, trace fine sand, light brown, moist. *(continued)*												
11														
12														
13		- from 13.11m - 25.91m depth: light brown to olive grey.												
14														
15														Bentonite Seal
16														
17														
18														
19														
20		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

SHEET 3 OF 10
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT, trace fine sand, light brown, moist. *(continued)*												
21														
22														
23														
24														
25														Bentonite Seal
26		- from 25.91m - 34.44m depth: brown.												
27														
28														
29														
30		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

Golder Associates

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

SHEET 4 OF 10
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
30	M5 Drillech Truck Mounted Auger Drill Rig, Air Rotary	(ML) SILT, trace fine sand, light brown, moist. *(continued)*												
31														
32														
33														
34		- 33.83m - 34.44m depth: some gravel.												
				736.51										
35		(GM) SILTY GRAVEL, trace sand, dark brown, moist.		34.44										Bentonite Seal
36				734.37										
		(GM) sandy GRAVEL, some silt, dark brown, moist.		36.58										
37				733.76										
		(GP) sandy GRAVEL, trace silt, brown, moist.		37.19										
38														
39				731.63										
		(ML) sandy SILT, brown, moist.		39.32										
				731.02										
40		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

SHEET 5 OF 10
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
40	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GM) SILTY GRAVEL, trace sand, brown, moist. *(continued)*		39.93										
41														
42														
43				727.36										
		(ML) SILT, some sand, brown, cohesive, moist to wet.		43.59										
44														
45														Bentonite Seal
46				724.62										
		(GM) GRAVEL, some silt, trace sand.		46.33										
				724.32										
		(GW) sandy GRAVEL, light grey.		46.63										
47														
48				722.18										
		(ML) SILT, light brown, moist.		48.77										
49				721.57										
		(GM) SILTY GRAVEL, trace sand, brown, moist.		49.38										
50		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

SHEET 6 OF 10
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
50	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GM) SILTY GRAVEL, trace sand, brown, moist. *(continued)*												
51				719.13										
52		(GW) sandy GRAVEL, light grey, moist.		51.82 718.83										
		(ML) SILT, light brown, moist.		52.12										
53				717.91										
		(GM) GRAVEL, some silt, some sand, brown, wet.		53.04										
54				717.00										
		(ML) sandy SILT, brown, some cohesion, wet to moist.		53.95										
55				716.09										Bentonite Seal
		(GM) sandy GRAVEL, trace silt, dark grey, moist to wet.		54.86										
56														
57														
58		- from 57.91m - 68.58m depth: some clay and silt.												
59														
60		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

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PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

SHEET 7 OF 10
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
60	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GM) sandy GRAVEL, trace silt, dark grey, moist to wet. *(continued)*												
61														
62														
63														
64														
65														Bentonite Seal
66														
67														
68														
69		- from 68.58m - 68.88m depth: brown and moist. - at 68.88m depth: brown, moist.												
70				701.15 69.80										
		CONTINUED NEXT PAGE												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

Golder Associates

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PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

SHEET 8 OF 10
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
70	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GW) sandy GRAVEL, trace silt, dark grey, moist. *(continued)*											
71				699.32									
		(GW) sandy GRAVEL, trace silt, light grey, dry to moist.		71.63									
72				698.71									
		(GM) sandy GRAVEL, some silt and clay, dark grey.		72.24									
73													
74													
75													Bentonite Seal
76													
77													
78													
79													
80		*CONTINUED NEXT PAGE*											

DEPTH SCALE
1 : 50

Golder Associates

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PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

SHEET 9 OF 10
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
80	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GM) sandy GRAVEL, some silt and clay, dark grey. *(continued)*												
81														
82														Bentonite Seal
83														
84														
85				685.76										
		(SP) SAND, trace silt, brown, wet.		85.19										10/20 Silica Sand
86														
87														05/29/2012 BH12-01 ▼
88				682.56										
		(SW-GP) fine SAND to fine GRAVEL, trace silt, brown, wet.		88.39										51mm Slotted PVC Pipe
89				681.19										
		(SM) SILTY SAND, brown, very wet.		89.76										Slough
90		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

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PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-01

DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707644.09 E: 594240.96

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
90		(SM-GM) SILTY SAND and GRAVEL, brown, wet.		~~680.88~~ 680.73										Slough
				90.22										
		End of Borehole.												
91														
92														
93														
94														
95														
96														
97														
98														
99														
100														

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-02

SHEET 1 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707580.94 E: 594166.9

DRILLING DATE: May 30, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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		766.30										Stickup = 0.84m
0	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) sandy SILT, light brown, moist.		0.00										
				764.78										
		(ML) SILT, trace clay, light brown, some cohesion, moist.		1.52										
1														
2														
3														
4														
5														Bentonite Seal
6														
7														
8														
9				757.16										
		(ML) SILT, some clay, brown, cohesive, wet.		9.14										
10		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-02

SHEET 2 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707580.94 E: 594166.9

DRILLING DATE: May 30, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
10		(ML) SILT, some clay, brown, cohesive, wet. *(continued)*												
11														
12														
13														
14	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary													
				751.67										
		(ML) SILT, some very fine sand, trace fine gravel fragments, trace clay, brown to light brown.		14.63										
15														Bentonite Seal
16														
17														
18														
19														
20		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-02

DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707580.94 E: 594166.9

DRILLING DATE: May 30, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT, some very fine sand, trace fine gravel fragments, trace clay, brown to light brown. *(continued)*											
21													
22													
23													
24													
25													Bentonite Seal
26													
27													
28													
29													
30		*CONTINUED NEXT PAGE*											

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-02

SHEET 4 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707580.94 E: 594166.9

DRILLING DATE: May 30, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
30	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT, some very fine sand, trace fine gravel fragments, trace clay, brown to light brown. *(continued)*											
31													
32													
33													
34													
35													Bentonite Seal
36													
37													
38													
39													
40		*CONTINUED NEXT PAGE*											

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-02

SHEET 5 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707580.94 E: 594166.9

DRILLING DATE: May 30, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
40		(ML) SILT, some very fine sand, trace fine gravel fragments, trace clay, brown to light brown. *(continued)*											
41													
42													
43													
44				722.11									
		(ML) SILT, trace fine gravel, some sand, brown, moist.		44.20 721.80									
45	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(SM) SILTY SAND, some fine gravel, brown, moist.		44.50 720.58									Bentonite Seal
		(SM) silty gravelly SAND, dark brown, moist.		45.72 720.28									
46		(GM) sandy GRAVEL, some silt, brown, moist.		46.02									
47													
48				717.53									
		(ML) sandy SILT, some gravel, brown, moist.		48.77									
49													
50				716.31									
		CONTINUED NEXT PAGE											

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

Golder Associates

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-02

SHEET 6 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707580.94 E: 594166.9

DRILLING DATE: May 30, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
50	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GM) silty GRAVEL, some sand, brown, moist. *(continued)*		49.99 714.79										
51		(ML) SILT, some gravel, brown, moist, trace sand.		51.51 712.66										
52		(GM) sandy GRAVEL, trace silt, brown, moist.		53.64 710.83										
53		(GM) GRAVEL, trace to some silt, trace sand, brown, moist.		55.47										Bentonite Seal
54														
55														
56														
57														
58														
59														
60		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-02

SHEET 7 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707580.94 E: 594166.9

DRILLING DATE: May 30, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
60	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GM-SM) SAND and GRAVEL, some silt, brown, moist.		706.26 60.05										
61														
62														
63														
64														
65														Bentonite Seal
66				699.86 66.45										
67		(GM) GRAVEL, some sand, some silt, moist, brown.												
68														
69		- from 68.58m - 76.20m depth: slightly drier.												
70		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

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PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-02

SHEET 8 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707580.94 E: 594166.9

DRILLING DATE: May 30, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
70	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GM) GRAVEL, some sand, some silt, moist, brown. *(continued)*												
71														
72														
73														
74														
75														Bentonite Seal
76				690.10										
		(SM-GM) SILTY SAND and GRAVEL, brown, moist.		76.20										
77														
78				688.27										
		(SP) SAND, fine, trace gravel, olive-grey, moist.		78.03										
79														
80		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

Golder Associates

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-02

SHEET 9 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707580.94 E: 594166.9

DRILLING DATE: May 30, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
80	M5 Drilltech Truck Mounted Auger Drill Rig Air Rotary			686.14										
		(GM) sandy GRAVEL, some silt, brown, wet.		80.16										Bentonite Seal
				685.53										
81		(SM) SAND, some gravel, trace silt, dark olive grey, wet.		80.77										10/20 Silica Sand
82														
83				683.09										
		(SM-GM) SAND and GRAVEL, trace silt, dark olive-grey, wet.		83.21										51mm Slotted PVC Pipe
84														
85														
				680.35										
86		End of Borehole.		85.95										
87														
88														
89														
90														

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
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PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-03

SHEET 1 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707557.04 E: 594201.88

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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		765.92										Stickup = 0.81m
0	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT. trace to some clay, light brown, slight cohesion, moist.		0.00										
1														
2														
3														
4														
5														Bentonite Seal
6														
7														
8														
9		- from 9.14m - 10.36m depth: wet.												
10		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

Golder Associates

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-03

DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707557.04 E: 594201.88

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
10	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT. trace to some clay, light brown, slight cohesion, moist. *(continued)* - from 10.36m - 41.45m depth: moist.											
11													
12													
13													
14													
15													Bentonite Seal
16													
17													
18													
19													
20		*CONTINUED NEXT PAGE*											

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

Golder Associates

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-03

DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707557.04 E: 594201.88

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT. trace to some clay, light brown, slight cohesion, moist. *(continued)*												
21														
22														
23														
24														
25														Bentonite Seal
26														
27														
28														
29														
30		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-03

SHEET 4 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707557.04 E: 594201.88

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
30	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT. trace to some clay, light brown, slight cohesion, moist. *(continued)*												
31														
32														
33														
34														
35														Bentonite Seal
36														
37														
38														
39														
40		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-03

SHEET 5 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707557.04 E: 594201.88

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
40	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT. trace to some clay, light brown, slight cohesion, moist. *(continued)*												
41				724.46										
		(ML) SILT, trace gravel, trace sand, brown, moist.		41.45										
42														
43														
44				721.72										
		(GM) sandy GRAVEL, some silt, brown, moist.		44.20										
45														Bentonite Seal
46														
47														
48				717.15										
		(ML) SILT, trace sand, brown, moist.		48.77										
49				716.23										
		(GM) SILTY GRAVEL, some sand, brown, moist.		49.68										
50		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-03

SHEET 6 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707557.04 E: 594201.88

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
50	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GM) SILTY GRAVEL, some sand, brown, moist. *(continued)*		715.63										
		(GM) sandy GRAVEL, some silt, brown, moist.		50.29										
51														
52														
53														
				711.97										
54		(ML) SILT, trace sand, brown, moist.		53.95										
55														Bentonite Seal
				710.44										
		(ML) SILT, trace sand, trace clay, brown, slight cohesion, moist.		55.47										
56														
				708.92										
57		(GM) SILTY GRAVEL, some sand, brown, moist.		57.00										
58														
59														
60		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

Golder Associates

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-03

SHEET 7 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707557.04 E: 594201.88

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
60	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(GM) SILTY GRAVEL, some sand, brown, moist. *(continued)*												
61														
62														
63														
64				701.91										
		(ML) SILT, trace gravel, trace sand, brown, moist.		64.01										
65														Bentonite Seal
66														
67														
68														
69														
70		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

LOGGED: CB
CHECKED:

Golder Associates

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-03

SHEET 8 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707557.04 E: 594201.88

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
70	M5 Drillech Truck Mounted Auger Drill Rig Air Rotary	(ML) SILT, trace gravel, trace sand, brown, moist. *(continued)*												
71														
72														
73														
				692.16										
		(SM) SILTY SAND, trace gravel, brown, slight cohesion, moist.		73.76										
74				691.55										
		(ML) SILT, some sand, trace gravel, brown, moist.		74.37										
75														Bentonite Seal
76														
				689.72										
		(ML) SILT, some sand, some gravel, brown, moist.		76.20										
77														
78														
79														
80		*CONTINUED NEXT PAGE*												

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

PROJECT No.: 11-1436-0073 (2100)

RECORD OF BOREHOLE: JC-MW12-03

SHEET 9 OF 9
DATUM: Geodetic

CLIENT: Yukon Government Community Services
PROJECT: Yukon Landfill Assessment
LOCATION: Johnson's Crossing Solid Waste Disposal Facility
N: 6707557.04 E: 594201.88

DRILLING DATE: May 27, 2012
DRILLING CONTRACTOR: Midnight Sun Drilling

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
80	M5 Driltech Truck Mounted Auger Drill Rig, Air Rotary	(ML) SILT, some sand, some gravel, brown, moist. *(continued)*												
81				684.54										Bentonite Seal
		(SM) SAND, some silt, brown, wet.		81.38										
82				683.01										
83		(ML) sandy SILT, trace clay, brown, moist to wet.		82.91										10/20 Silica Sand
84				681.49										
		(GM) sandy GRAVEL, some silt, trace clay, brown, very wet.		84.43										
85														51mm Slotted PVC Pipe
86				679.05										
87		End of Borehole.		86.87										
88														
89														
90														

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CB
CHECKED:

File:N:\BUR-GRAPHICS\PROJECTS\2011\1436\11-1436-0073\DRAFTING\GINT\11-1436-0073 (2100 JC).GPJ Output Form:BC_BOREHOLE (ENVIRO) Template:BC REGION TEMPLATE BETA 1.GDT Library:BC REGION LIBRARY.GLB bdrozdiak 09/13/12

APPENDIX C

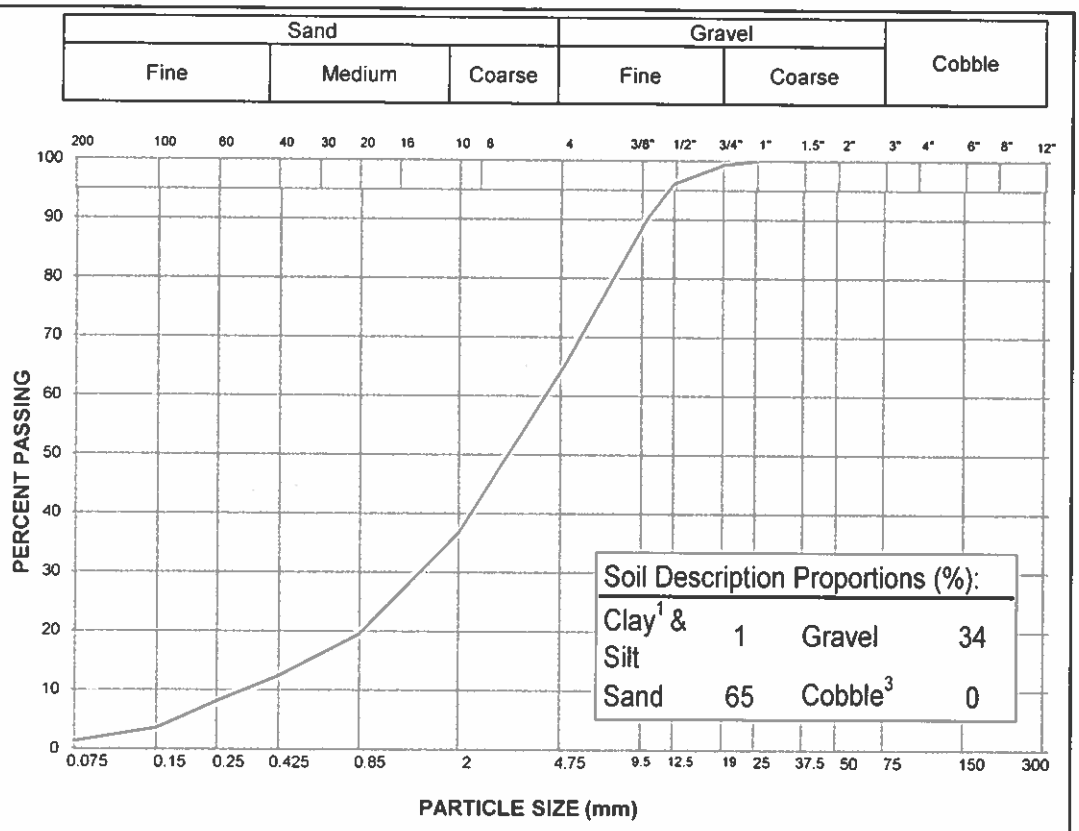
Well Development and Sampling Sheets

PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Miscellaneous Lab Testing	Sample No.:	BH12-01
Project No.:	W14103034-01	Material Type:	
Site:	Johnson's Crossing, YT	Sample Loc.:	
Client:	Golder Associates Ltd.	Sample Depth:	296'
Client Rep.:	Calvin Beebe	Sampling Method:	
Date Tested:	July 20, 2012 By: SMS	Date sampled:	
Soil Description[2]:	SAND - gravelly, trace silt	Sampled By:	
		USC Classification:	Cu: 13.6
Moisture Content:	11.6%		Cc: 1.7

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	100
19	99
12.5	96
10	90
5	66
2	37
0.85	20
0.425	12
0.25	8
0.15	4
0.075	1



Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to EBA description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks:

Reviewed By: _____

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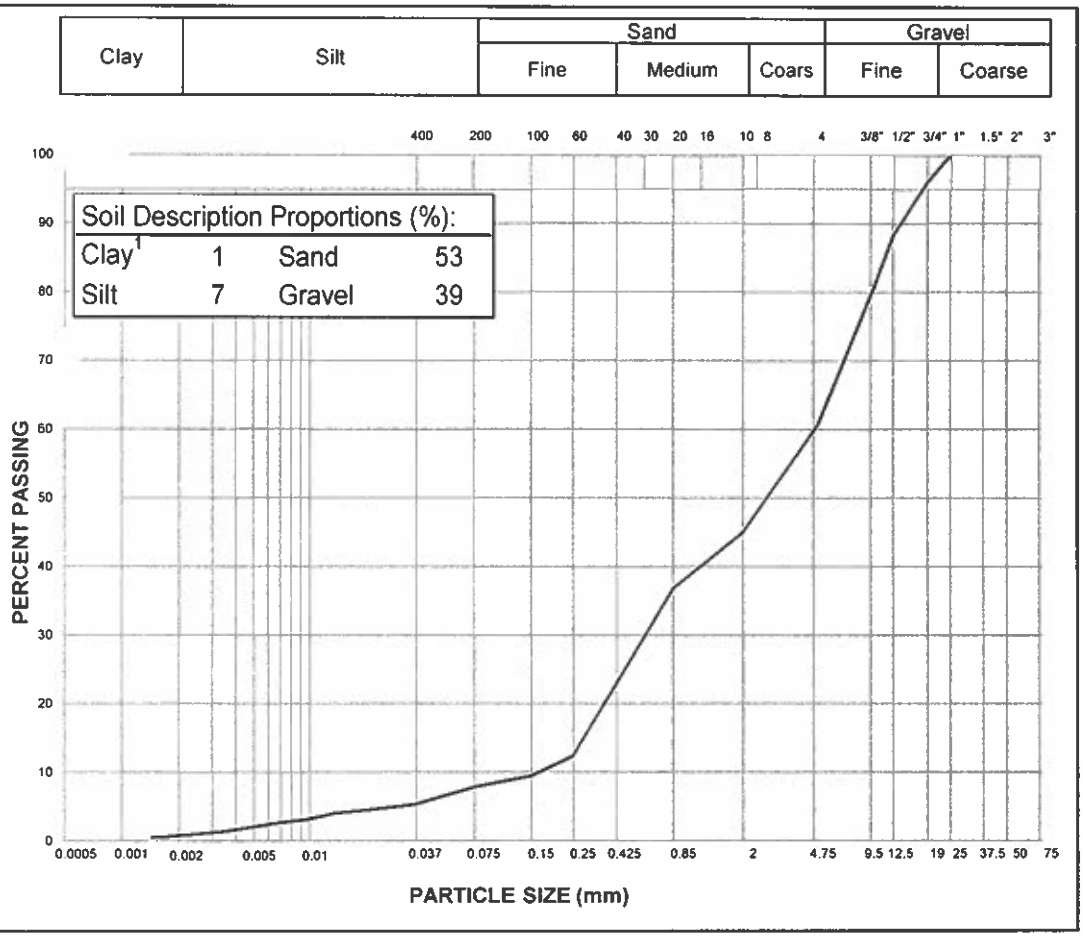
PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Miscellaneous Lab Testing	Sample No.:	BH12-02 SA3
Project No.:	W14103034-01	Material Type:	
Site:	Johnson's Crossing, YT	Sample Loc.:	
Client:	Golder Associates Ltd.	Sample Depth:	282'
Client Rep.:	Calvin Beebe	Sampling Method:	
Date Tested:	July 23, 2012 By: SMS	Date sampled:	
Soil Description[2]:	SAND and GRAVEL - trace silt, trace clay	Sampled By:	
		USC Classification:	Cu: 29.2
Moisture Content:	11.5%		Cc: 0.5

Particle Size (mm)	Percent Passing
75	
50	
38	
25	100
19	96
12.5	88
10	81
5	61
2	45
0.85	37
0.425	23
0.25	12
0.15	9
0.075	8
0.0364	5.3
0.0233	4.7
0.0135	4.0
0.0097	3.1
0.0069	2.7
0.0034	1.3
0.0014	0.4



Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to EBA description protocols

Specification:

Remarks:

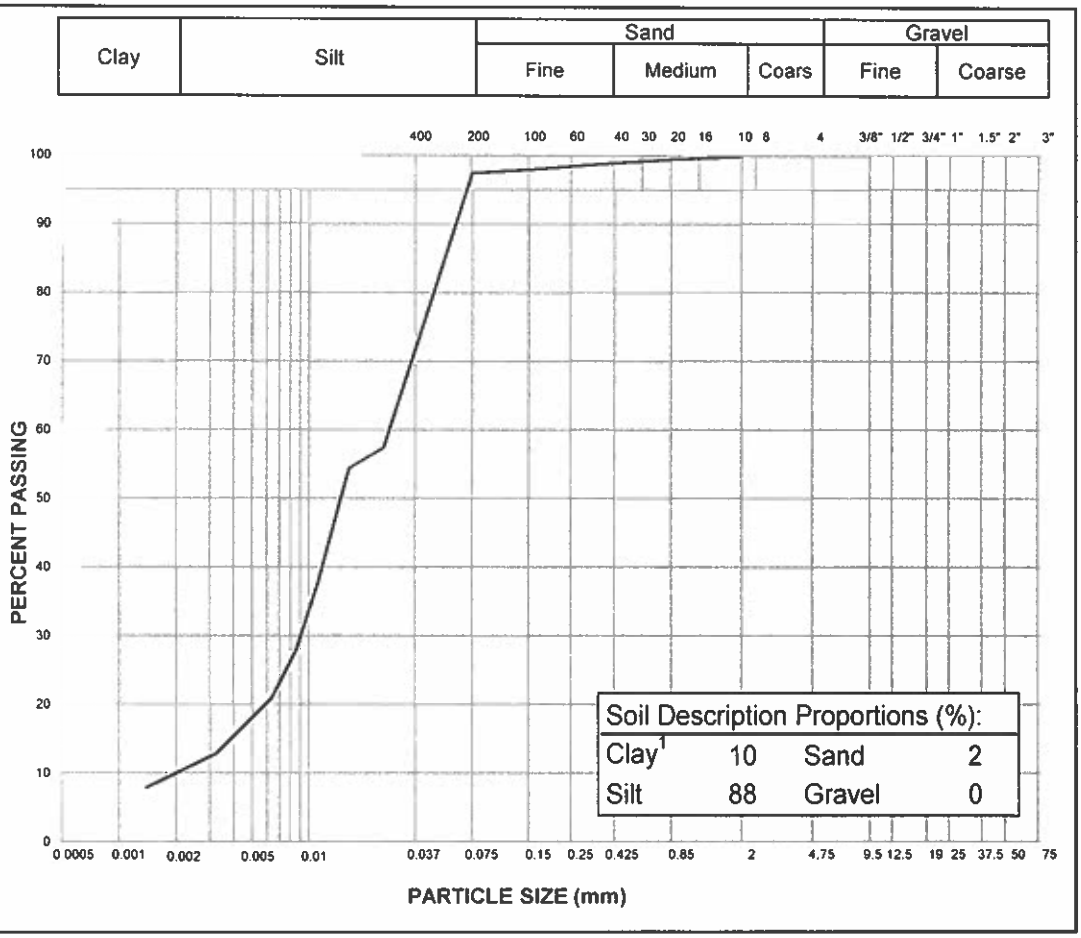
Reviewed By: _____

PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Miscellaneous Lab Testing	Sample No.:	BH12-02 SA1
Project No.:	W14103034-01	Material Type:	
Site:	Johnson's Crossing	Sample Loc.:	
Client:	Golder Associates Ltd.	Sample Depth:	10'
Client Rep.:	Calvin Beebe	Sampling Method:	
Date Tested:	July 23, 2012 By: SMS	Date sampled:	
Soil Description[2]:	SILT - trace clay, trace sand	Sampled By:	
		USC Classification:	Cu: 13.1
Moisture Content:	18.3%		Cc: 1.4

Particle Size (mm)	Percent Passing
75	
50	
38	
25	
19	
12.5	
10	
5	
2	100
0.85	100
0.425	99
0.25	99
0.15	98
0.075	98
0.0251	57.4
0.0164	54.5
0.0112	37.6
0.0085	27.7
0.0063	20.8
0.0032	12.9
0.0014	7.9



Notes. [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to EBA description protocols

Specification:

Remarks:

Reviewed By: _____

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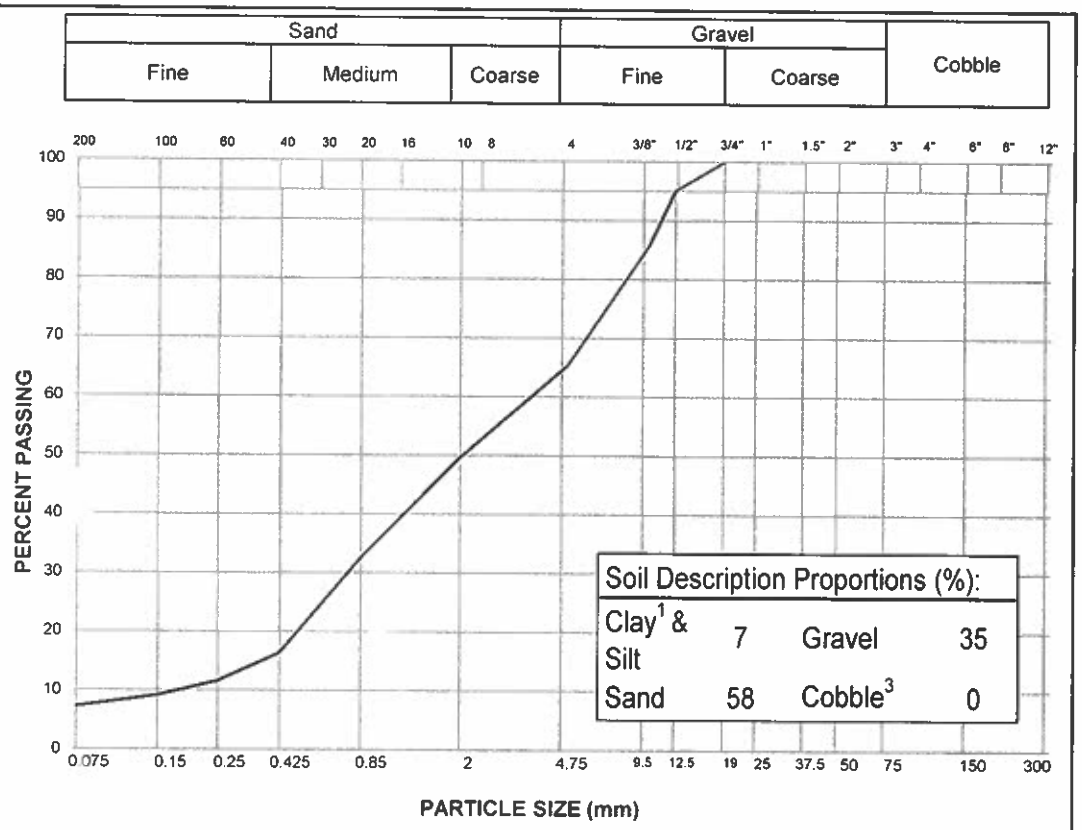
PARTICLE SIZE ANALYSIS REPORT

ASTM D422, C136 & C117

Project:	Miscellaneous Lab Testing	Sample No.:	BH12-02 SA2
Project No.:	W14103034-01	Material Type:	
Site:	Johnson's Crossing, YT	Sample Loc.:	
Client:	Golder Associates Ltd.	Sample Depth:	275'
Client Rep.:	Calvin Beebe	Sampling Method:	
Date Tested:	July 20, 2012 By: SMS	Date sampled:	
Soil Description[2]:	SAND - gravelly, trace silt	Sampled By:	
		USC Classification:	Cu: 21.8
Moisture Content:	4.2%		Cc: 0.8

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	
19	100
12.5	95
10	86
5	65
2	50
0.85	33
0.425	16
0.25	12
0.15	9
0.075	7



Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to EBA description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks:

Reviewed By: _____

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

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